HANDBOOK OF
NITINOL ACTUATORS

Miniature linear and rotational actuators

Force, movement and fatigue life for every shape we make.

Kellogg's Research Labs

326 Chestnut Hill Road, New Boston, NH 03070

1-855-583-5353 · nitinol@KelloggsResearchLabs.com

www.KelloggsResearchLabs.com

How to use this handbook

Nitinol is a metal that remembers a shape. Bend it while it is cool and it stays bent. Warm it and it pulls itself back to the shape it was set to, hard enough to do work.

A piece of nitinol that does work is an actuator, and it needs nothing around it. No motor, no gearbox, no solenoid, no hydraulics. The metal is the whole mechanism. This handbook exists so that you can choose one the same way you would choose a bearing or a screw: look up the job, read off the part.

Three choices, and they do not interfere with each other

Every actuator in this handbook is chosen the same way, whatever shape it is.

THE CROSS-SECTION SETS THE FORCE. How much metal is working decides how hard it pulls, pushes or twists. Length has nothing to do with it.

THE LENGTH AND THE FORM SET THE MOTION. How much it moves depends on how long it is and on what shape it has been put into. Cross-section has nothing to do with it.

THE TRANSITION TEMPERATURE SETS WHEN IT HAPPENS. Nothing else. A 35 C part and an 80 C part of the same size and shape give exactly the same force and exactly the same movement. They differ only in how warm they have to get.

So work through it in that order. Find the force you need, which gives you a cross-section. Find the movement you need, which gives you a length and a shape. Then choose the temperature for your trigger, independently of both.

The shape is the "gear ratio"

The same gram of nitinol will give you a large force over a small distance, or a small force over a large distance, depending only on what shape it is in. A straight wire gives high force and little travel. The same wire wound into a spring actuator gives little force and a great deal of travel. Nothing has been added and nothing taken away.

Every mechanical system has to solve this problem. A motor turns fast and weakly, and the machine needs slow and strong, so a gearbox goes in between. The gearbox is parts, weight, space, backlash, lubrication and a list of things that can fail. Here the "gear ratio" is decided when the part is made, and there is no gearbox in the way.

This is why the handbook is arranged by shape rather than by size. Choosing the chapter is choosing where you sit on that trade. If you are not sure which chapter you want, the table opposite will point you at one.

A wound spring actuator is a flat strip wrapped round a mandrel. Before winding it, someone has to decide which way up the strip goes. Lay it flat against the mandrel and you have a face wound spring actuator. Stand it on its edge and you have an edge wound spring actuator. Nothing else changes. Same strip, same mandrel, same material, same heat treatment, same fatigue life.

Take our 0.152 by 0.411 millimeter strip on the smallest mandrel and pull it along its axis. Wound on its face it gives 2.3 newtons and eight millimeters of movement for every hundred millimeters of

strip. Wound on its edge it gives 0.6 newtons and thirty millimeters. Nearly four times the force one way, nearly four times the travel the other, from one decision made at the winding machine.

> *Multiply the force by the movement in each case and you get the same number. Nothing is gained and nothing is lost. Only the "gear ratio" changes.*

For a straight pull, if you need more force we wind it on its face, and if you need more travel we wind it on its edge; a Slinky is an edge wound coil, and it shows you what that looks like. For a twist about the axis it is the other way round. You get the "gear ratio" and you do not get the gears.

Face wound spring actuators have a chapter of their own, Chapter 5, and edge wound spring actuators have Chapter 6. They are listed separately because a designer who wants the travel of one is rarely shopping for the force of the other.

Flat strip reaches further than round wire

The chapters that follow are built from two raw materials, round wire and flat strip. Round wire wound into a helical spring actuator sits in the middle of the force-versus-travel scale. Flat strip lets you go further out in either direction without changing the space the part occupies.

Take the smallest mandrel we wind on. A 0.0059 in [0.15 mm] round wire makes a spring actuator 0.031 in [0.8 mm] across that pulls with 0.046 lbf [0.2 N] and travels 59 percent of its length. A 0.006 by 0.016 in [0.152 by 0.411 mm] strip laid flat on that same mandrel makes a spring actuator the same 0.031 in [0.8 mm] across that pulls with 0.3 lbf [1.3 N], six and a half times as hard, over 7.8 percent. Stand the same strip on its edge and the coil grows to 0.052 in [1.3 mm], where it travels 110 percent against the 16 percent you would get from a round wire spring actuator of that diameter.

None of it is free. The strip versions hold about a third more metal in the same envelope and give up roughly fifteen percent of the total work, since bending a strip strains its outer faces hard while the middle does little, where twisting a round wire loads the whole section more evenly. What the strip buys is a ratio you cannot reach any other way in that diameter.

Nitinol scales like nothing else

Size is the one thing this technology is indifferent to. An actuator can be a speck of dust or the size of a dining table, and nothing in this handbook changes between them.

The smallest parts we make measure five microns across. They are produced by photolithography, the same process that makes integrated circuits, and at that size the actuator is built rather than wound or cut. The largest we have on the books is a Belleville actuator four feet [1.2 m] in diameter, specified from simulation to deliver millions of pounds of force. It has not been built yet, and we would like nothing better than an excuse to build it. Between those two parts lies a range of five orders of magnitude, filled by one material.

The reason the range is so wide is that the numbers governing it are ratios. Stress is force per unit of cross-section and strain is motion per unit of length, so neither one knows how big the part is. The four design stresses in this handbook, and the strain levels that set the fatigue life of each design level, hold at five microns and at four feet alike. Scale the cross-section and the force follows. Scale the length and the motion follows. An actuator that works on the bench can be rebuilt ten times larger, and the arithmetic that sized the first one sizes the second.

That is not how other actuators behave. A motor small enough for a catheter and a motor large enough to drive a ship share a principle and nothing else: different bearings, different windings, different manufacturing, different suppliers, and no design that carries from one to the other. Hydraulics has a floor where seals and pumps stop making sense. Piezoelectric stacks scale in size but never in travel. A nitinol actuator is the same metal doing the same thing at any size, which means a proven design travels with you as the product grows.

What the limits actually are

At the small end there is a genuine floor, and it belongs to the physics rather than to our tooling. Shape memory works by moving the crystal structure from one phase to another, and that transformation needs room to happen. Confine the grain structure below a few tens of nanometers and the material stops transforming and starts behaving like an ordinary alloy. That floor sits about three orders of magnitude below where we work today, which leaves a great deal of room for the parts nobody has asked for yet.

At the large end there is no such limit. Nothing in the material argues against a part measured in feet, and nothing argues against one measured in yards. The constraints are furnaces, fixtures and imagination, in roughly that order. There is no physical reason a ship's hull could not fold itself into a more efficient shape for the empty run home, and the fact that it sounds absurd is a statement about our habits rather than about the metal. At the top end, the limit on a nitinol actuator is what we think to ask of it.

Designing for Fatigue Life

Every table in this handbook gives four answers instead of one, labeled A, B, C and D.

They are a fatigue choice. How hard you work a piece of nitinol decides how many times it will do the job before it wears out, and that is a trade you should be making deliberately rather than discovering later. Working it gently gives a small movement and a very long life. Working it hard gives a large movement and a short one.

Choose the column that matches the life your design needs, then read the force and the movement from it. Level C is the one most designs land on.

The levels in this handbook stop at one million cycles because that is where most designs stop. It is not where nitinol stops. For extreme fatigue-life applications we build actuators rated out to ten billion cycles. Those are engineered to the job rather than read from a table, so if your design needs to run that long, talk to us.

There is also a way to get more out of a given part. Training an actuator before it ships stabilizes its stroke and extends its total fatigue life, which is worth asking about if your design is pushing both at once. It is an extra step in manufacturing, so it is not assumed anywhere in this handbook; every figure here is for an untrained part. If you want it, ask.

Units

We are bilingual. Every table leads with inch-pound units and gives the metric figure in square brackets, so 0.125 [3.18] means 0.125 inches, 3.18 millimeters. Force is in pounds-force [newtons]; torque in inch-pounds [newton-millimeters], or foot-pounds [newton-meters] where the numbers are

large. Columns that count per length lead per inch [per 100 mm], so the two figures in those cells differ by a factor of about four; that is the base, not the data. Angles are in degrees. The four design levels are explained above under Designing for Fatigue Life and are the same on every table.

What is not in here

Not every possible part is listed. Several of these shapes are made to order, and for those the tables give a representative grid and the method to work out anything in between. If what you need is not on the page, it very probably exists.

Single-use actuators are not in here either, and they deserve a mention. Everything in this handbook is rated to recover its shape again and again, within the strain limits of its design level. A single-use actuator is asked to do it once, and since it will never be asked again it can be pushed far beyond those limits: strain recoveries of up to 250 percent. A part deformed that far does something no reusable actuator can do. It falls away. Whatever mechanism it was holding is left completely free, with nothing in the way and nothing to reset. That is exactly what fire suppression needs, a hold that releases fully, on temperature, with no power and no moving parts, and it is where most of these go. They are a special case rather than the norm, so there is no data for them here. Ask us.

The same goes for the complicated things. Actuators with more than one degree of freedom, two-way and multi-way parts that move to one shape when warm and another when cool, and assemblies that combine several of the forms in this handbook into one motion are all things we build. None of them is a handbook part. Each is engineered to the job, and the place to start is a conversation.

The four design levels

Level	Strain	Cycles before wear-out	Movement you get	Typical use
A	1%	1,000,000	Smallest	Something that works continuously for the life of the machine.
B	2.5%	100,000	Moderate	Regular duty. A mechanism used many times a day for years.
C	5%	10,000	Large	The usual choice. Frequent use over a normal service life.
D	7%	100	Largest	Occasional or one-shot. Deployment, release, set-and-forget.

Which chapter do you want?

If you need	Read	What it gives you
A strong straight pull, small movement	Round Wire	Highest force per gram. The default choice.
A very strong straight pull	Rod and Bar, or Separation Actuators	Kilonewtons to tens of kilonewtons in a small diameter. A separation actuator is the same pull as a ready-made, resettable part.
A straight pull that stays aligned	Flat Wire	Sits in a slot and cannot roll or twist.
A long movement, modest force	Helical Spring Actuators	Many times its own length in travel.
A strong pull from a wound strip, short travel	Face Wound Spring Actuators	The strip laid flat. Stiff in a pull; linear or rotary output.
Long, soft travel from a wound strip	Edge Wound Spring Actuators	The same strip on its edge - a Slinky. Tight pitch, pulls only.
Rotation about an axis	Torsion Spring Actuators	Degrees per wrap. Order the wraps you need.
A spring actuator that fits in a slot	Flat Spring Actuators	A wave that flattens. Stroke counted per wave.
Very high force, very small movement	Belleville Actuators	Tens of kilonewtons in the size of a coin. Stack for travel.
To release something on command	Separation Actuators	Shears a bolt. Replaces an explosive bolt, leaves no debris, and the actuator can be reset and reused.
High torque in a small twist	Torque Tube Actuators	Diameter sets the angle, wall sets the torque.

If you need	Read	What it gives you
A pull that resets quickly	Tube Actuators in Tension	Cools from inside and out, so it cycles faster.
Something a motor cannot do at all	Curl Actuators	Wraps, shortens and sweeps at the same time, in one piece.
To cut your own shape	Plates and Sheets	Raw material for flexures, clips and multi-axis parts.

Contents

Chapter 1	Round Wire	9
Chapter 2	Rod and Bar	21
Chapter 3	Flat Wire	28
Chapter 4	Helical Spring Actuators	35
Chapter 5	Face Wound Spring Actuators	118
Chapter 6	Edge Wound Spring Actuators	235
Chapter 7	Torsion Spring Actuators	282
Chapter 8	Flat Spring Actuators	338
Chapter 9	Belleville Actuators	400
Chapter 10	Separation Actuators	450
Chapter 11	Torque Tube Actuators	457
Chapter 12	Tube Actuators in Tension	474
Chapter 13	Curl Actuators	491
Chapter 14	Plates and Sheets	513

CHAPTER 1

Round Wire

Straight-line pull

A nitinol wire pulls like a muscle. Stretch it while it is cool and it stays stretched. Warm it and it pulls itself back to the length it was set to, hard enough to move whatever is attached to it. There is nothing around it. No motor, no gearbox, no piston. The wire is the whole mechanism.

That is what makes it the first thing to reach for. A straight wire is the smallest, lightest and cheapest way to get a strong straight pull, and it will fit into a space that no conventional actuator can enter. It can also run around a corner, through a guide, or over a pulley, because it does not care what path it takes between its two ends.

What sets the force, and what sets the stroke

Two separate choices, and they do not interfere with each other.

FORCE COMES FROM THE CROSS-SECTION. A thicker wire pulls harder, in direct proportion to its area. Double the diameter and you get four times the force. Length makes no difference at all to how hard a wire pulls.

STROKE COMES FROM THE LENGTH. A wire shortens by a set percentage of whatever length it is, so a longer wire moves further. Diameter makes no difference at all to how far a wire travels.

So pick the diameter from the force table for the load you have to move, then pick the length from the stroke table for the travel you need. Neither choice spoils the other.

How to read the tables

The force table lists every diameter we supply against four design levels. The levels are the same everywhere in this handbook and they are a fatigue choice: how hard you work the wire decides how many times it will do the job before it wears out. Level A is the gentlest and lasts a million cycles. Level D is the hardest and lasts a hundred. Read across to the column that matches the life your design needs. They are also deliberately conservative, for the reasons set out under Overdriving an actuator later in this chapter.

The stroke table has only four lines, because stroke does not depend on diameter. Every wire in this chapter moves the same percentage of its own length. The most useful column is the one that reverses the question: how much wire do you need for one millimeter of movement. If you need five millimeters of travel at level C, you need a hundred millimeters of wire, whatever its thickness.

What to watch

A wire pulls. It does not push. Whatever it moves has to be brought back some other way, which is the subject of the next section.

Speed is set by cooling, not by heating. Heating can be as fast as you can put current in. Cooling is what makes you wait, and a thin wire cools much faster than a thick one. If you need a high cycle rate, that pushes you towards a thinner wire and a longer one.

Cycle life and cycle rate are different things. The four design levels cover life, as Designing for Fatigue Life explains. Rate is about how quickly heat leaves the wire, and it is a separate conversation.

Think about the ends. However you attach the wire, the attachment changes the section, and a change in section concentrates strain. The figures in these tables are strain figures, so a wire at level C is at five percent along its length but can be at much more where it is gripped, and that is where it will fail first. Tell us the load and how you intend to hold it and we will recommend a termination.

Getting it back

Like every shape in this handbook, a nitinol actuator moves one way when it is heated. Getting it back to where it started is the designer's problem, and there are three ways to solve it.

AN ANTAGONISTIC PAIR uses a second actuator working against the first. Heat one and it moves the mechanism and resets the other; heat the other and it goes back. You get powered motion in both directions with full output each way, at the cost of two actuators and a control scheme that never heats both at once.

A BIAS is a passive element, usually a conventional spring or a weight, that the actuator works against as it moves and that pushes it back as it cools. It is the simplest arrangement and the most common. The price is that the bias resists the actuator through the whole stroke, so part of the force in the table is spent returning the mechanism rather than doing the job. Size it to return the actuator and no more.

SYSTEM FORCES are the return you already have. If the mechanism pushes back on its own, if gravity closes the door, if the thing being clamped is springy, if line pressure acts on the valve, that force resets the actuator for nothing. It is the best answer when it is available, and worth looking for before adding parts.

Whichever you choose, the return has to be strong enough to reset the actuator while it is cool and weak enough not to stall it while it is hot. That window is what sizes a bias, and it is the most common thing to get wrong on a first build.

There is a fourth possibility. Any nitinol actuator can be given a two way set, so that it takes one shape hot and another cold and needs no return at all. Two way parts are made to order and are outside the scope of this handbook, so nothing here is rated for it, but it exists. Ask.

Overdriving an actuator

The figures in this handbook are conservative. Every force in every table is rated at a stress we are confident the part will deliver, cycle after cycle, at the fatigue life of its design level. A part will usually do more than the table says. We would rather you found that out in testing than the other way round.

The second reason a part will beat its table is that you can overdrive it, and this one is a feature you can design with. There are two ways to do it, and they add.

The first is to heat it further. Nitinol makes its force by changing phase, and the temperature at which it does that is the transition temperature we set for you. The force does not stop climbing when the part gets there. Keep heating it past the transition and the force keeps rising with temperature, well beyond the rated figure. The table gives you the force at a working temperature comfortably above transition. Drive the part hotter and there is more.

The second is to heat it faster. Heat the part slowly and it makes the force in the table. Heat it quickly, with a sharp pulse of current rather than a gentle ramp, and it makes more, and the harder the pulse, the bigger the difference. A part that is driven both fast and hot gets the gain from each, one on top of the other. The tables assume neither. They are the floor.

Emergency mode

That gives a nitinol actuator something most actuators do not have: a reserve. A motor or a solenoid has a rated output and a thermal limit close behind it. A nitinol actuator can be driven, briefly, to a force well above its rating simply by putting more heat into it, faster. Think of it as an emergency mode. A latch that normally needs a modest pull can, on the day something jams, be hit with a short hard pulse and told to pull much harder. A release that must not fail gets a margin that costs nothing in size or weight.

Use it as a reserve, not as the rating, and know where the limits are. There is a temperature, called Md, above which the metal can no longer be pushed into martensite by stress; up to Md the material is still behaving as nitinol should. Overdriving up to Md costs some fatigue life, but it also does the part a favor: the extra heat drives out residual martensite that builds up over many cycles, a kind of rehabilitation in place, so a part that is occasionally run hard can come back sharper than one that never is. Above Md the accounting changes. Degradation is faster, and each hot cycle takes a larger bite out of the life. Above 350 °C (660 °F) the part is past saving: treat an actuator that has been driven that hot as spent and replace it. Used within those limits, for the rare event, emergency mode is one of the best arguments for the material.

Actuator safety

Most actuators fail badly when they are overdriven, and engineers know exactly how. Put too much current into a motor or a solenoid and it explodes. Overpressure a hydraulic cylinder and it bursts, or springs a pinhole leak, and a jet of oil at that pressure will cut through a glove and a hand, take a limb, and put oil into the ground and the water where it can be years being cleaned up. Every one of them has the same problem: the energy is stored in the actuator, and when something goes wrong it has nowhere to go but out. A nitinol actuator, very simply, does not carry these risks. It is a piece of metal with a current in it, and there is nothing in it to burst, nothing to leak, and nothing to poison.

A nitinol actuator fails the other way. Put too much power into it and it simply gets hotter. Past the working range the force keeps rising; past that, the part reaches the temperatures at which it was shape set, and at that point the metal lets go of its memory. The actuator loses its force, goes slack, and parts, which opens the circuit that was heating it. It shuts itself off. There is nothing stored in it to release: no pressure, no winding, no field. The failure mode is a dead part and an open circuit, not an event.

That is worth stating plainly for anyone writing a safety case. The worst thing an overdriven nitinol actuator does is stop.

What we supply

Diameters	0.15, 0.25, 0.4, 0.5, 0.75, 1, 1.25, 1.5, 2, 3 and 5 mm. Also 0.010 to 0.100 inches in thousandth-of-an-inch steps.
Transition temperatures	20 C, 35 C, 45 C and 80 C. Also available super elastic, which springs back mechanically but does not actuate.
Alloys	Standard NiTi. Low hysteresis NiTiCu, which resets at a warmer temperature and so cycles faster. High strength NiTiFe.
Sold as	Five foot lengths, or full spools.

Finish	Black oxide or polished.

The transition temperature decides WHEN the wire pulls, and nothing else. It has no effect on how hard it pulls or how far it moves. Choose the geometry for the job, then choose the temperature for the trigger.

ROUND WIRE — Pull force by wire diameter

Part reference	Diameter, in [mm]	Section area, in² [mm²]	Force A, lbf [N]	Force B, lbf [N]	Force C, lbf [N]	Force D, lbf [N]
0.15	0.0059 [0.15]	0.000027 [0.018]	0.4 [1.8]	0.55 [2.4]	0.68 [3]	0.99 [4.4]
0.25	0.0098 [0.25]	0.000076 [0.049]	1.1 [4.9]	1.5 [6.8]	1.9 [8.4]	2.8 [12]
0.4	0.016 [0.4]	0.00019 [0.13]	2.8 [13]	3.9 [17]	4.9 [22]	7.1 [31]
0.5	0.02 [0.5]	0.0003 [0.2]	4.4 [20]	6.1 [27]	7.6 [34]	11 [49]
0.75	0.03 [0.75]	0.00068 [0.44]	9.9 [44]	14 [61]	17 [76]	25 [110]
1	0.039 [1]	0.0012 [0.79]	18 [79]	24 [110]	30 [140]	44 [200]
1.25	0.049 [1.25]	0.0019 [1.2]	28 [120]	38 [170]	47 [210]	69 [310]
1.5	0.059 [1.5]	0.0027 [1.8]	40 [180]	55 [240]	68 [300]	99 [440]
2	0.079 [2]	0.0049 [3.1]	71 [310]	97 [430]	120 [540]	180 [780]
3	0.12 [3]	0.011 [7.1]	160 [710]	220 [980]	270 [1200]	400 [1800]
5	0.2 [5]	0.03 [20]	440 [2000]	610 [2700]	760 [3400]	1100 [4900]

ROUND WIRE — Stroke - the same for every diameter, because stroke is set by length

Design level	Stroke, in per ft [mm per 100 mm]	Wire length per unit of stroke (same in any unit)	Stroke from one 5 ft pack, in [mm]
A - 1% strain, 1,000,000 cycles	0.12 [1]	100	0.6 [15]
B - 2.5% strain, 100,000 cycles	0.3 [2.5]	40	1.5 [38]
C - 5% strain, 10,000 cycles	0.6 [5]	20	3 [76]
D - 7% strain, 100 cycles	0.84 [7]	14	4.2 [110]

ROUND WIRE — Imperial range - available to order in 0.001 in steps from 0.010 to 0.100 in

Part reference	Diameter, in [mm]	Section area, in² [mm²]	Force A, lbf [N]	Force B, lbf [N]	Force C, lbf [N]	Force D, lbf [N]
0.010in	0.01 [0.254]	0.000079 [0.051]	1.1 [5.1]	1.6 [7]	2 [8.7]	2.8 [13]
0.011in	0.011 [0.2794]	0.000095 [0.061]	1.4 [6.1]	1.9 [8.5]	2.4 [11]	3.4 [15]
0.012in	0.012 [0.3048]	0.00011 [0.073]	1.6 [7.3]	2.3 [10]	2.8 [13]	4.1 [18]
0.013in	0.013 [0.3302]	0.00013 [0.086]	1.9 [8.6]	2.7 [12]	3.3 [15]	4.8 [21]
0.014in	0.014 [0.3556]	0.00015 [0.099]	2.2 [9.9]	3.1 [14]	3.8 [17]	5.6 [25]
0.015in	0.015 [0.381]	0.00018 [0.11]	2.6 [11]	3.5 [16]	4.4 [20]	6.4 [28]
0.016in	0.016 [0.4064]	0.0002 [0.13]	2.9 [13]	4 [18]	5 [22]	7.3 [32]
0.017in	0.017 [0.4318]	0.00023 [0.15]	3.3 [15]	4.5 [20]	5.7 [25]	8.2 [37]
0.018in	0.018 [0.4572]	0.00025 [0.16]	3.7 [16]	5.1 [23]	6.3 [28]	9.2 [41]
0.019in	0.019 [0.4826]	0.00028 [0.18]	4.1 [18]	5.7 [25]	7.1 [31]	10 [46]
0.020in	0.02 [0.508]	0.00031 [0.2]	4.6 [20]	6.3 [28]	7.8 [35]	11 [51]
0.021in	0.021 [0.5334]	0.00035 [0.22]	5 [22]	6.9 [31]	8.6 [38]	13 [56]
0.022in	0.022 [0.5588]	0.00038 [0.25]	5.5 [25]	7.6 [34]	9.5 [42]	14 [61]
0.023in	0.023 [0.5842]	0.00042 [0.27]	6 [27]	8.3 [37]	10 [46]	15 [67]
0.024in	0.024 [0.6096]	0.00045 [0.29]	6.6 [29]	9.1 [40]	11 [50]	16 [73]
0.025in	0.025 [0.635]	0.00049 [0.32]	7.1 [32]	9.8 [44]	12 [54]	18 [79]
0.026in	0.026 [0.6604]	0.00053 [0.34]	7.7 [34]	11 [47]	13 [59]	19 [86]
0.027in	0.027 [0.6858]	0.00057 [0.37]	8.3 [37]	11 [51]	14 [64]	21 [92]
0.028in	0.028 [0.7112]	0.00062 [0.4]	8.9 [40]	12 [55]	15 [68]	22 [99]
0.029in	0.029 [0.7366]	0.00066 [0.43]	9.6 [43]	13 [59]	16 [73]	24 [110]
0.030in	0.03 [0.762]	0.00071 [0.46]	10 [46]	14 [63]	18 [78]	26 [110]
0.031in	0.031 [0.7874]	0.00075 [0.49]	11 [49]	15 [67]	19 [84]	27 [120]
0.032in	0.032 [0.8128]	0.0008 [0.52]	12 [52]	16 [72]	20 [89]	29 [130]
0.033in	0.033 [0.8382]	0.00086 [0.55]	12 [55]	17 [76]	21 [95]	31 [140]
0.034in	0.034 [0.8636]	0.00091 [0.59]	13 [59]	18 [81]	23 [100]	33 [150]

ROUND WIRE — Imperial range - available to order in 0.001 in steps from 0.010 to 0.100 in

Part reference	Diameter, in [mm]	Section area, in² [mm²]	Force A, lbf [N]	Force B, lbf [N]	Force C, lbf [N]	Force D, lbf [N]
0.035in	0.035 [0.889]	0.00096 [0.62]	14 [62]	19 [86]	24 [110]	35 [160]
0.036in	0.036 [0.9144]	0.001 [0.66]	15 [66]	20 [91]	25 [110]	37 [160]
0.037in	0.037 [0.9398]	0.0011 [0.69]	16 [69]	22 [96]	27 [120]	39 [170]
0.038in	0.038 [0.9652]	0.0011 [0.73]	16 [73]	23 [100]	28 [130]	41 [180]
0.039in	0.039 [0.9906]	0.0012 [0.77]	17 [77]	24 [110]	30 [130]	43 [190]
0.040in	0.04 [1.016]	0.0013 [0.81]	18 [81]	25 [110]	31 [140]	46 [200]
0.041in	0.041 [1.0414]	0.0013 [0.85]	19 [85]	26 [120]	33 [150]	48 [210]
0.042in	0.042 [1.0668]	0.0014 [0.89]	20 [89]	28 [120]	35 [150]	50 [220]
0.043in	0.043 [1.0922]	0.0015 [0.94]	21 [94]	29 [130]	36 [160]	53 [230]
0.044in	0.044 [1.1176]	0.0015 [0.98]	22 [98]	30 [140]	38 [170]	55 [240]
0.045in	0.045 [1.143]	0.0016 [1]	23 [100]	32 [140]	40 [180]	58 [260]
0.046in	0.046 [1.1684]	0.0017 [1.1]	24 [110]	33 [150]	41 [180]	60 [270]
0.047in	0.047 [1.1938]	0.0017 [1.1]	25 [110]	35 [150]	43 [190]	63 [280]
0.048in	0.048 [1.2192]	0.0018 [1.2]	26 [120]	36 [160]	45 [200]	66 [290]
0.049in	0.049 [1.2446]	0.0019 [1.2]	27 [120]	38 [170]	47 [210]	68 [300]
0.050in	0.05 [1.27]	0.002 [1.3]	28 [130]	39 [180]	49 [220]	71 [320]
0.051in	0.051 [1.2954]	0.002 [1.3]	30 [130]	41 [180]	51 [230]	74 [330]
0.052in	0.052 [1.3208]	0.0021 [1.4]	31 [140]	43 [190]	53 [240]	77 [340]
0.053in	0.053 [1.3462]	0.0022 [1.4]	32 [140]	44 [200]	55 [240]	80 [360]
0.054in	0.054 [1.3716]	0.0023 [1.5]	33 [150]	46 [200]	57 [250]	83 [370]
0.055in	0.055 [1.397]	0.0024 [1.5]	34 [150]	48 [210]	59 [260]	86 [380]
0.056in	0.056 [1.4224]	0.0025 [1.6]	36 [160]	49 [220]	61 [270]	89 [400]
0.057in	0.057 [1.4478]	0.0026 [1.6]	37 [160]	51 [230]	64 [280]	93 [410]
0.058in	0.058 [1.4732]	0.0026 [1.7]	38 [170]	53 [240]	66 [290]	96 [430]
0.059in	0.059 [1.4986]	0.0027 [1.8]	40 [180]	55 [240]	68 [300]	99 [440]

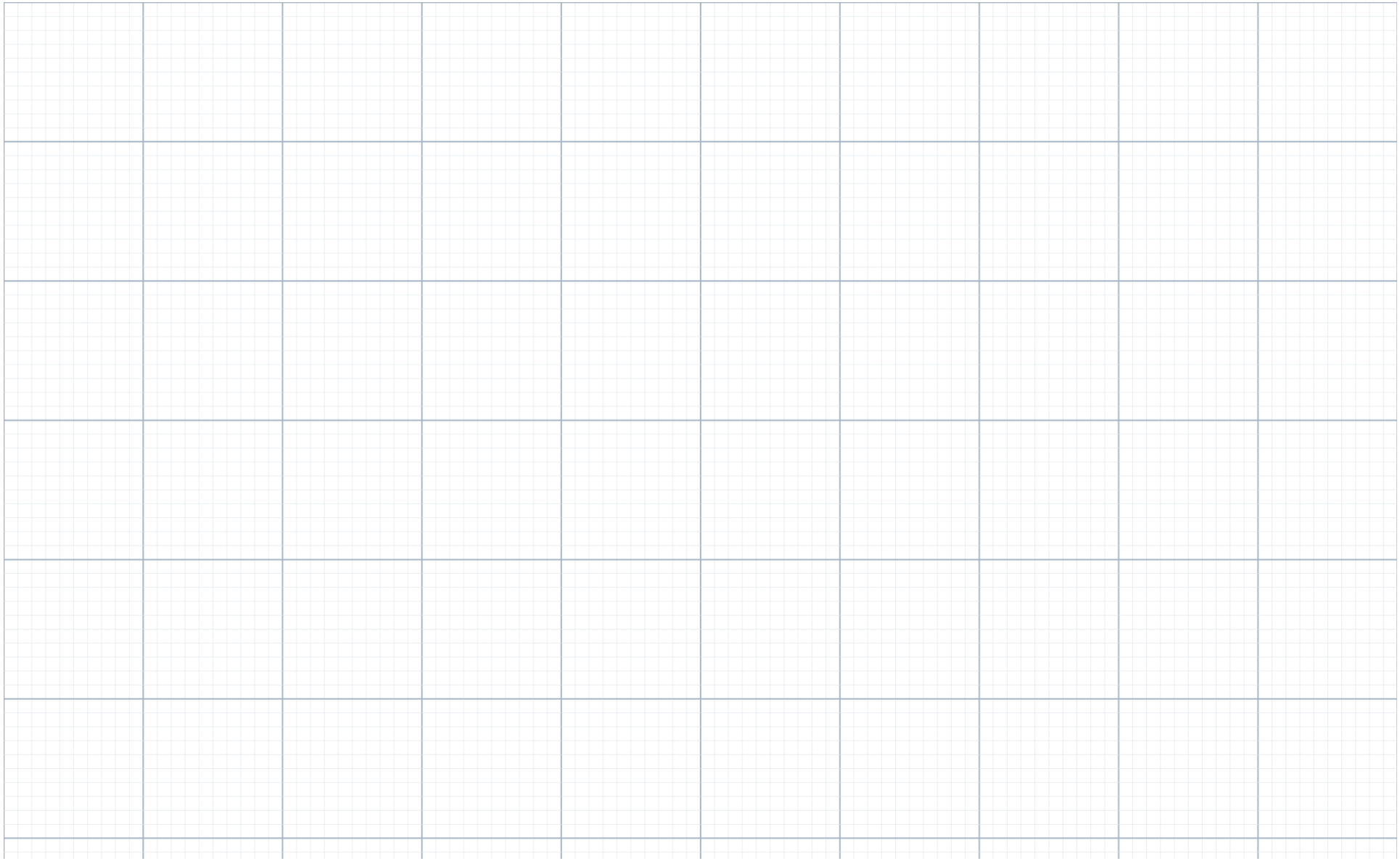
ROUND WIRE — Imperial range - available to order in 0.001 in steps from 0.010 to 0.100 in

Part reference	Diameter, in [mm]	Section area, in² [mm²]	Force A, lbf [N]	Force B, lbf [N]	Force C, lbf [N]	Force D, lbf [N]
0.060in	0.06 [1.524]	0.0028 [1.8]	41 [180]	57 [250]	71 [310]	100 [460]
0.061in	0.061 [1.5494]	0.0029 [1.9]	42 [190]	58 [260]	73 [320]	110 [470]
0.062in	0.062 [1.5748]	0.003 [1.9]	44 [200]	60 [270]	75 [340]	110 [490]
0.063in	0.063 [1.6002]	0.0031 [2]	45 [200]	62 [280]	78 [350]	110 [500]
0.064in	0.064 [1.6256]	0.0032 [2.1]	47 [210]	64 [290]	80 [360]	120 [520]
0.065in	0.065 [1.651]	0.0033 [2.1]	48 [210]	66 [300]	83 [370]	120 [540]
0.066in	0.066 [1.6764]	0.0034 [2.2]	50 [220]	68 [300]	85 [380]	120 [550]
0.067in	0.067 [1.7018]	0.0035 [2.3]	51 [230]	71 [310]	88 [390]	130 [570]
0.068in	0.068 [1.7272]	0.0036 [2.3]	53 [230]	73 [320]	91 [400]	130 [590]
0.069in	0.069 [1.7526]	0.0037 [2.4]	54 [240]	75 [330]	93 [420]	140 [600]
0.070in	0.07 [1.778]	0.0038 [2.5]	56 [250]	77 [340]	96 [430]	140 [620]
0.071in	0.071 [1.8034]	0.004 [2.6]	57 [260]	79 [350]	99 [440]	140 [640]
0.072in	0.072 [1.8288]	0.0041 [2.6]	59 [260]	81 [360]	100 [450]	150 [660]
0.073in	0.073 [1.8542]	0.0042 [2.7]	61 [270]	84 [370]	100 [460]	150 [680]
0.074in	0.074 [1.8796]	0.0043 [2.8]	62 [280]	86 [380]	110 [480]	160 [690]
0.075in	0.075 [1.905]	0.0044 [2.9]	64 [280]	88 [390]	110 [490]	160 [710]
0.076in	0.076 [1.9304]	0.0045 [2.9]	66 [290]	91 [400]	110 [500]	160 [730]
0.077in	0.077 [1.9558]	0.0047 [3]	68 [300]	93 [420]	120 [520]	170 [750]
0.078in	0.078 [1.9812]	0.0048 [3.1]	69 [310]	96 [420]	120 [530]	170 [770]
0.079in	0.079 [2.0066]	0.0049 [3.2]	71 [320]	98 [440]	120 [540]	180 [790]
0.080in	0.08 [2.032]	0.005 [3.2]	73 [320]	100 [450]	120 [560]	180 [810]
0.081in	0.081 [2.0574]	0.0052 [3.3]	75 [330]	100 [460]	130 [570]	190 [830]
0.082in	0.082 [2.0828]	0.0053 [3.4]	77 [340]	110 [470]	130 [590]	190 [850]
0.083in	0.083 [2.1082]	0.0054 [3.5]	78 [350]	110 [480]	140 [600]	200 [870]
0.084in	0.084 [2.1336]	0.0055 [3.6]	80 [360]	110 [490]	140 [620]	200 [890]

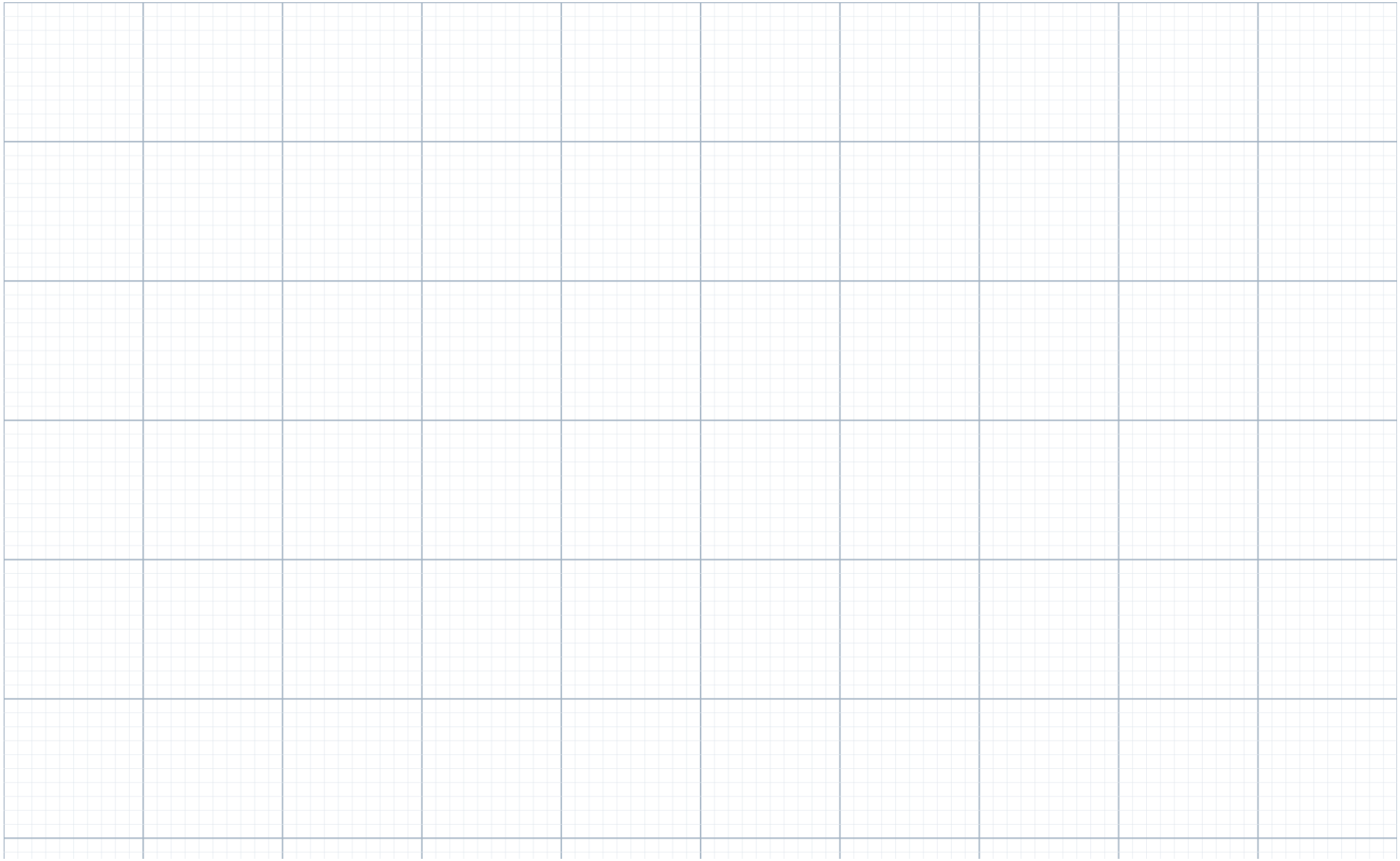
ROUND WIRE — Imperial range - available to order in 0.001 in steps from 0.010 to 0.100 in

Part reference	Diameter, in [mm]	Section area, in² [mm²]	Force A, lbf [N]	Force B, lbf [N]	Force C, lbf [N]	Force D, lbf [N]
0.085in	0.085 [2.159]	0.0057 [3.7]	82 [370]	110 [500]	140 [630]	210 [920]
0.086in	0.086 [2.1844]	0.0058 [3.7]	84 [380]	120 [520]	140 [640]	210 [940]
0.087in	0.087 [2.2098]	0.0059 [3.8]	86 [380]	120 [530]	150 [660]	220 [960]
0.088in	0.088 [2.2352]	0.0061 [3.9]	88 [390]	120 [540]	150 [680]	220 [980]
0.089in	0.089 [2.2606]	0.0062 [4]	90 [400]	120 [550]	160 [690]	230 [1000]
0.090in	0.09 [2.286]	0.0064 [4.1]	92 [410]	130 [570]	160 [710]	230 [1000]
0.091in	0.091 [2.3114]	0.0065 [4.2]	94 [420]	130 [580]	160 [720]	240 [1000]
0.092in	0.092 [2.3368]	0.0066 [4.3]	96 [430]	130 [590]	170 [740]	240 [1100]
0.093in	0.093 [2.3622]	0.0068 [4.4]	99 [440]	140 [600]	170 [750]	250 [1100]
0.094in	0.094 [2.3876]	0.0069 [4.5]	100 [450]	140 [620]	170 [770]	250 [1100]
0.095in	0.095 [2.413]	0.0071 [4.6]	100 [460]	140 [630]	180 [790]	260 [1100]
0.096in	0.096 [2.4384]	0.0072 [4.7]	100 [470]	140 [640]	180 [800]	260 [1200]
0.097in	0.097 [2.4638]	0.0074 [4.8]	110 [480]	150 [660]	180 [820]	270 [1200]
0.098in	0.098 [2.4892]	0.0075 [4.9]	110 [490]	150 [670]	190 [840]	270 [1200]
0.099in	0.099 [2.5146]	0.0077 [5]	110 [500]	150 [680]	190 [850]	280 [1200]
0.100in	0.1 [2.54]	0.0079 [5.1]	110 [510]	160 [700]	200 [870]	280 [1300]

NOTES



NOTES



CHAPTER 2

Rod and Bar

Straight-line pull at high force

A rod is a wire that has stopped being flexible. Everything in the previous chapter still applies, but at a scale where the forces stop being interesting and start being serious. A five millimeter rod pulls with about three and a half kilonewtons at the middle design level. A twenty five millimeter bar pulls with eighty five.

That is the whole reason to choose one. When the load is measured in tonnes and the space is measured in centimeters, there is very little else that fits.

What sets the force, and what sets the stroke

The same two independent choices as a wire. Section area sets the force. Length sets the stroke. A rod shortens by the same percentage of its length that a wire does, so a hundred millimeter rod at the middle level gives five millimeters of travel, exactly as a hundred millimeter wire would.

This is worth saying plainly because it surprises people. Going from a half millimeter wire to a twenty five millimeter bar multiplies the force by two and a half thousand and changes the stroke not at all.

Our rod is made differently

These rods are cold rolled so that the grain runs along the length of the bar. That lines the material up with the direction it has to pull, and it lifts the shape memory effect by about a fifth over rod that has not been treated that way.

What to watch

Cooling is the limit, and it is a harder limit here than anywhere else in this handbook. A thick bar holds a lot of heat and sheds it slowly, so a rod actuator is for jobs where the move matters more than the speed. Clamping, locking, releasing, setting a position once. If you need a fast cycle, use several thin wires in parallel instead of one thick rod; they will give you the same force and cool many times faster.

Ends matter, and they matter more than most people expect. A rod that has to pull needs something to pull against. We weld titanium ring terminals to the ends for that, and on bars we also forge a loop directly into the end, which gives you a wrought termination: no joint, no second material, the metal continuous from the bar into the loop. Crimps, swaged sleeves, threaded ends and clamps all have their place too, depending on the load, the space and what the rod is pulling against. What every termination has in common is that it is a place where the geometry changes abruptly, and an abrupt change in geometry concentrates strain. That matters more here than it would in steel, since the numbers in these tables are strain numbers. A rod working at level C is at five percent everywhere the section is uniform; at a poorly chosen end it may be at considerably more, and the part will fail there, early, while the middle is still well inside its rated life. The termination is part of the actuator,

not a detail to settle afterwards. Tell us the load and how you intend to hold it, and we will size the termination with the rod.

Getting it back

Like every shape in this handbook, a nitinol actuator moves one way when it is heated. Getting it back to where it started is the designer's problem, and there are three ways to solve it.

AN ANTAGONISTIC PAIR uses a second actuator working against the first. Heat one and it moves the mechanism and resets the other; heat the other and it goes back. You get powered motion in both directions with full output each way, at the cost of two actuators and a control scheme that never heats both at once.

A BIAS is a passive element, usually a conventional spring or a weight, that the actuator works against as it moves and that pushes it back as it cools. It is the simplest arrangement and the most common. The price is that the bias resists the actuator through the whole stroke, so part of the force in the table is spent returning the mechanism rather than doing the job. Size it to return the actuator and no more.

SYSTEM FORCES are the return you already have. If the mechanism pushes back on its own, if gravity closes the door, if the thing being clamped is springy, if line pressure acts on the valve, that force resets the actuator for nothing. It is the best answer when it is available, and worth looking for before adding parts.

Whichever you choose, the return has to be strong enough to reset the actuator while it is cool and weak enough not to stall it while it is hot. That window is what sizes a bias, and it is the most common thing to get wrong on a first build.

There is a fourth possibility. Any nitinol actuator can be given a two way set, so that it takes one shape hot and another cold and needs no return at all. Two way parts are made to order and are outside the scope of this handbook, so nothing here is rated for it, but it exists. Ask.

Overdriving an actuator

The figures in this handbook are conservative. Every force in every table is rated at a stress we are confident the part will deliver, cycle after cycle, at the fatigue life of its design level. A part will usually do more than the table says. We would rather you found that out in testing than the other way round.

The second reason a part will beat its table is that you can overdrive it, and this one is a feature you can design with. There are two ways to do it, and they add.

The first is to heat it further. Nitinol makes its force by changing phase, and the temperature at which it does that is the transition temperature we set for you. The force does not stop climbing when the part gets there. Keep heating it past the transition and the force keeps rising with temperature, well beyond the rated figure. The table gives you the force at a working temperature comfortably above transition. Drive the part hotter and there is more.

The second is to heat it faster. Heat the part slowly and it makes the force in the table. Heat it quickly, with a sharp pulse of current rather than a gentle ramp, and it makes more, and the harder the pulse, the bigger the difference. A part that is driven both fast and hot gets the gain from each, one on top of the other. The tables assume neither. They are the floor.

Emergency mode

That gives a nitinol actuator something most actuators do not have: a reserve. A motor or a solenoid has a rated output and a thermal limit close behind it. A nitinol actuator can be driven, briefly, to a force well above its rating simply by putting more heat into it, faster. Think of it as an emergency mode. A latch that normally needs a modest pull can, on the day something jams, be hit with a short hard pulse and told to pull much harder. A release that must not fail gets a margin that costs nothing in size or weight.

Use it as a reserve, not as the rating, and know where the limits are. There is a temperature, called Md, above which the metal can no longer be pushed into martensite by stress; up to Md the material is still behaving as nitinol should. Overdriving up to Md costs some fatigue life, but it also does the part a favor: the extra heat drives out residual martensite that builds up over many cycles, a kind of rehabilitation in place, so a part that is occasionally run hard can come back sharper than one that never is. Above Md the accounting changes. Degradation is faster, and each hot cycle takes a larger bite out of the life. Above 350 °C (660 °F) the part is past saving: treat an actuator that has been driven that hot as spent and replace it. Used within those limits, for the rare event, emergency mode is one of the best arguments for the material.

Actuator safety

Most actuators fail badly when they are overdriven, and engineers know exactly how. Put too much current into a motor or a solenoid and it explodes. Overpressure a hydraulic cylinder and it bursts, or springs a pinhole leak, and a jet of oil at that pressure will cut through a glove and a hand, take a limb, and put oil into the ground and the water where it can be years being cleaned up. Every one of them has the same problem: the energy is stored in the actuator, and when something goes wrong it has nowhere to go but out. A nitinol actuator, very simply, does not carry these risks. It is a piece of metal with a current in it, and there is nothing in it to burst, nothing to leak, and nothing to poison.

A nitinol actuator fails the other way. Put too much power into it and it simply gets hotter. Past the working range the force keeps rising; past that, the part reaches the temperatures at which it was shape set, and at that point the metal lets go of its memory. The actuator loses its force, goes slack, and parts, which opens the circuit that was heating it. It shuts itself off. There is nothing stored in it to release: no pressure, no winding, no field. The failure mode is a dead part and an open circuit, not an event.

That is worth stating plainly for anyone writing a safety case. The worst thing an overdriven nitinol actuator does is stop.

What we supply

Diameters	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 16, 19 and 25 mm. The 8 mm size is also supplied as 0.3125 inches.
Transition temperature	Made to the temperature you specify. Heat treatment to fine-tune it afterwards is available as a separate service.
Sold as	Cut to length, up to two meters continuous.
Shape setting	Heat at 500 C for ten to fifteen minutes, then quench in cold water.

ROD AND BAR — Pull force by rod diameter

Part reference	Diameter, in [mm]	Section area, in² [mm²]	Force A, lbf [kN]	Force B, lbf [kN]	Force C, lbf [kN]	Force D, lbf [kN]	
2	0.079 [2]	0.0049 [3.1]	71 [0.31]	98 [0.43]	120 [0.54]	180 [0.79]	
3	0.12 [3]	0.011 [7.1]	160 [0.71]	220 [0.97]	270 [1.2]	400 [1.8]	
4	0.16 [4]	0.019 [13]	280 [1.3]	390 [1.7]	490 [2.2]	710 [3.1]	
5	0.2 [5]	0.03 [20]	440 [2]	610 [2.7]	760 [3.4]	1100 [4.9]	
6	0.24 [6]	0.044 [28]	640 [2.8]	880 [3.9]	1100 [4.9]	1600 [7.1]	
7	0.28 [7]	0.06 [38]	860 [3.8]	1200 [5.3]	1500 [6.6]	2200 [9.6]	
8	0.012 [0.3125 in (8)]	0.078 [50]	1100 [5]	1600 [6.9]	1900 [8.6]	2800 [13]	
9	0.35 [9]	0.099 [64]	1400 [6.4]	2000 [8.8]	2500 [11]	3600 [16]	
10	0.39 [10]	0.12 [79]	1800 [7.9]	2400 [11]	3000 [14]	4400 [20]	
11	0.43 [11]	0.15 [95]	2100 [9.5]	2900 [13]	3700 [16]	5300 [24]	
12	0.47 [12]	0.18 [110]	2500 [11]	3500 [16]	4400 [19]	6400 [28]	
16	0.63 [16]	0.31 [200]	4500 [20]	6200 [28]	7800 [35]	11000 [50]	
19	0.75 [19]	0.44 [280]	6400 [28]	8800 [39]	11000 [49]	16000 [71]	
25	0.98 [25]	0.76 [490]	11000 [49]	15000 [68]	19000 [84]	28000 [120]	

ROD AND BAR — Stroke - the same for every diameter

Design level	Stroke, in per ft [mm per 100 mm]	Rod length per unit of stroke (same in any unit)	Stroke from one 3.94 in [100 mm] unit, in [mm]
A - 1% strain, 1,000,000 cycles	0.12 [1]	100	0.039 [1]
B - 2.5% strain, 100,000 cycles	0.3 [2.5]	40	0.098 [2.5]
C - 5% strain, 10,000 cycles	0.6 [5]	20	0.2 [5]
D - 7% strain, 100 cycles	0.84 [7]	14	0.28 [7]

NOTES

NOTES

CHAPTER 3

Flat Wire

Straight-line pull in a rectangular section

Flat wire pulls exactly as round wire does, and for the same reasons. What it adds is that it knows which way up it is.

A round wire is free to roll and twist in its housing. A flat one is not. It sits in a slot, it stays in the plane you put it in, and it presents a broad face to whatever it is clamped or welded to. When an actuator has to be located as well as strong, that is worth more than the force it saves.

What sets the force, and what sets the stroke

Force comes from the cross-section, which here is simply width times thickness. Stroke comes from the length, and it is the same percentage as every other straight pulling element in this handbook. The stroke table in this chapter is identical to the one in the round wire chapter, and that is not an oversight; it is the point. Straight is straight.

Why you might choose it

Three reasons come up again and again.

IT FITS A SLOT. A thin wide section can be threaded through a gap that no round wire of the same area would pass.

IT JOINS BETTER. A flat face welds, clamps and bonds far more reliably than a line of contact on a curved surface.

IT DOES NOT ROTATE. In a mechanism where the actuator must stay aligned, the section does the aligning for you.

Flat wire is also the raw material for two other forms in this handbook. Wound on a mandrel it becomes a wound spring actuator, which is the chapter after next. Formed into a wave it becomes a flat spring actuator. In both of those the choice of which way round to lay the strip changes everything, and the flat wire chapter is where that choice starts.

Think about the ends. However you attach the wire, the attachment changes the section, and a change in section concentrates strain. The figures in these tables are strain figures, so a wire at level C is at five percent along its length but can be at much more where it is gripped, and that is where it will fail first. Tell us the load and how you intend to hold it and we will recommend a termination.

Getting it back

Like every shape in this handbook, a nitinol actuator moves one way when it is heated. Getting it back to where it started is the designer's problem, and there are three ways to solve it.

AN ANTAGONISTIC PAIR uses a second actuator working against the first. Heat one and it moves the mechanism and resets the other; heat the other and it goes back. You get powered motion in both directions with full output each way, at the cost of two actuators and a control scheme that never heats both at once.

A BIAS is a passive element, usually a conventional spring or a weight, that the actuator works against as it moves and that pushes it back as it cools. It is the simplest arrangement and the most common. The price is that the bias resists the actuator through the whole stroke, so part of the force in the table is spent returning the mechanism rather than doing the job. Size it to return the actuator and no more.

SYSTEM FORCES are the return you already have. If the mechanism pushes back on its own, if gravity closes the door, if the thing being clamped is springy, if line pressure acts on the valve, that force resets the actuator for nothing. It is the best answer when it is available, and worth looking for before adding parts.

Whichever you choose, the return has to be strong enough to reset the actuator while it is cool and weak enough not to stall it while it is hot. That window is what sizes a bias, and it is the most common thing to get wrong on a first build.

There is a fourth possibility. Any nitinol actuator can be given a two way set, so that it takes one shape hot and another cold and needs no return at all. Two way parts are made to order and are outside the scope of this handbook, so nothing here is rated for it, but it exists. Ask.

Overdriving an actuator

The figures in this handbook are conservative. Every force in every table is rated at a stress we are confident the part will deliver, cycle after cycle, at the fatigue life of its design level. A part will usually do more than the table says. We would rather you found that out in testing than the other way round.

The second reason a part will beat its table is that you can overdrive it, and this one is a feature you can design with. There are two ways to do it, and they add.

The first is to heat it further. Nitinol makes its force by changing phase, and the temperature at which it does that is the transition temperature we set for you. The force does not stop climbing when the part gets there. Keep heating it past the transition and the force keeps rising with temperature, well beyond the rated figure. The table gives you the force at a working temperature comfortably above transition. Drive the part hotter and there is more.

The second is to heat it faster. Heat the part slowly and it makes the force in the table. Heat it quickly, with a sharp pulse of current rather than a gentle ramp, and it makes more, and the harder the pulse, the bigger the difference. A part that is driven both fast and hot gets the gain from each, one on top of the other. The tables assume neither. They are the floor.

Emergency mode

That gives a nitinol actuator something most actuators do not have: a reserve. A motor or a solenoid has a rated output and a thermal limit close behind it. A nitinol actuator can be driven, briefly, to a force well above its rating simply by putting more heat into it, faster. Think of it as an emergency mode. A latch that normally needs a modest pull can, on the day something jams, be hit with a short hard pulse and told to pull much harder. A release that must not fail gets a margin that costs nothing in size or weight.

Use it as a reserve, not as the rating, and know where the limits are. There is a temperature, called Md, above which the metal can no longer be pushed into martensite by stress; up to Md the material is still behaving as nitinol should. Overdriving up to Md costs some fatigue life, but it also does the part a favor: the extra heat drives out residual martensite that builds up over many cycles, a kind of rehabilitation in place, so a part that is occasionally run hard can come back sharper than one that never is. Above Md the accounting changes. Degradation is faster, and each hot cycle takes a larger bite out of the life. Above 350 °C (660 °F) the part is past saving: treat an actuator that has been driven that hot as spent and replace it. Used within those limits, for the rare event, emergency mode is one of the best arguments for the material.

Actuator safety

Most actuators fail badly when they are overdriven, and engineers know exactly how. Put too much current into a motor or a solenoid and it explodes. Overpressure a hydraulic cylinder and it bursts, or springs a pinhole leak, and a jet of oil at that pressure will cut through a glove and a hand, take a limb, and put oil into the ground and the water where it can be years being cleaned up. Every one of them has the same problem: the energy is stored in the actuator, and when something goes wrong it has nowhere to go but out. A nitinol actuator, very simply, does not carry these risks. It is a piece of metal with a current in it, and there is nothing in it to burst, nothing to leak, and nothing to poison.

A nitinol actuator fails the other way. Put too much power into it and it simply gets hotter. Past the working range the force keeps rising; past that, the part reaches the temperatures at which it was shape set, and at that point the metal lets go of its memory. The actuator loses its force, goes slack, and parts, which opens the circuit that was heating it. It shuts itself off. There is nothing stored in it to release: no pressure, no winding, no field. The failure mode is a dead part and an open circuit, not an event.

That is worth stating plainly for anyone writing a safety case. The worst thing an overdriven nitinol actuator does is stop.

What we supply

Cross-sections	Fourteen, from 0.152 x 0.411 mm up to 1.5 x 4 mm. The full list is in the table.
Transition temperatures	20 C, 35 C, 45 C and 80 C, plus super elastic.
Sold as	Five foot lengths.
Custom	Other sections are rolled to order for larger quantities.

FLAT WIRE — Pull force by cross-section

Part reference	Cross-section, in [mm]	Section area, in² [mm²]	Force A, lbf [N]	Force B, lbf [N]	Force C, lbf [N]	Force D, lbf [N]
0.152x0.411	0.006 x 0.016 [0.152 x 0.411]	0.000097 [0.062]	1.4 [6.2]	1.9 [8.6]	2.4 [11]	3.5 [16]
0.152x0.813	0.006 x 0.032 [0.152 x 0.813]	0.00019 [0.12]	2.8 [12]	3.8 [17]	4.8 [21]	6.9 [31]
0.25x0.5	0.0098 x 0.02 [0.25 x 0.5]	0.00019 [0.12]	2.8 [12]	3.9 [17]	4.8 [22]	7 [31]
0.3x2	0.012 x 0.079 [0.3 x 2]	0.00093 [0.6]	13 [60]	19 [83]	23 [100]	34 [150]
0.406x0.559	0.016 x 0.022 [0.406 x 0.559]	0.00035 [0.23]	5.1 [23]	7 [31]	8.8 [39]	13 [57]
0.4x0.8	0.016 x 0.031 [0.4 x 0.8]	0.0005 [0.32]	7.2 [32]	9.9 [44]	12 [55]	18 [80]
0.4x1	0.016 x 0.039 [0.4 x 1]	0.00062 [0.4]	9 [40]	12 [55]	15 [69]	22 [100]
0.5x0.25	0.02 x 0.0098 [0.5 x 0.25]	0.00019 [0.12]	2.8 [12]	3.9 [17]	4.8 [22]	7 [31]
0.55x1.4	0.022 x 0.055 [0.55 x 1.4]	0.0012 [0.77]	17 [77]	24 [110]	30 [130]	43 [190]
0.5x0.8	0.02 x 0.031 [0.5 x 0.8]	0.00062 [0.4]	9 [40]	12 [55]	15 [69]	22 [100]
0.6x2.3	0.024 x 0.091 [0.6 x 2.3]	0.0021 [1.4]	31 [140]	43 [190]	53 [240]	78 [340]
0.8x1.5	0.031 x 0.059 [0.8 x 1.5]	0.0019 [1.2]	27 [120]	37 [170]	46 [210]	67 [300]
1x2.6	0.039 x 0.1 [1 x 2.6]	0.004 [2.6]	58 [260]	81 [360]	100 [450]	150 [650]
1.5x4	0.059 x 0.16 [1.5 x 4]	0.0093 [6]	140 [600]	190 [830]	230 [1000]	340 [1500]

FLAT WIRE — Stroke - the same for every cross-section

Design level	Stroke, in per ft [mm per 100 mm]	Wire length per unit of stroke (same in any unit)	Stroke from one 5 ft pack, in [mm]
A - 1% strain, 1,000,000 cycles	0.12 [1]	100	0.6 [15]
B - 2.5% strain, 100,000 cycles	0.3 [2.5]	40	1.5 [38]
C - 5% strain, 10,000 cycles	0.6 [5]	20	3 [76]
D - 7% strain, 100 cycles	0.84 [7]	14	4.2 [110]

NOTES

NOTES

CHAPTER 4

Helical Spring Actuators

Large stroke, low force - micro, standard and heavy duty

A spring actuator is the same wire doing the same thing, wound up. And winding it changes the answer completely.

Take a half millimeter wire. Straight, it pulls with thirty four newtons and moves five millimeters for every hundred millimeters of its length. Wind that same wire into a spring actuator on a four and three quarter millimeter mandrel and it now pulls with one and a half newtons and moves seventeen hundred millimeters for every hundred millimeters of spring actuator. Same wire. Same material. Same fatigue life. Twenty times less force and three hundred times more movement.

> *Nothing was added and nothing was taken away. The wire was simply put into a different shape, and the shape decided the trade.*

That is the reason to use a spring actuator. When you need a lot of travel and not much force, a spring actuator gives it to you in a package that is shorter than the travel it produces.

What sets the force, and what sets the stroke

In a spring actuator the two choices are no longer independent, and it is worth understanding why.

When you pull a spring actuator along its axis, the wire itself is not being stretched. It is being twisted. Every coil winds up slightly, and all those small twists add together into a large movement at the ends. So the force depends on the wire thickness and the coil diameter together, and the movement depends on how many coils there are and how big they are.

In practice that gives three levers.

WIRE DIAMETER raises the force sharply and cuts the stroke. It is the main force control.

MANDREL SIZE does the opposite. A bigger coil on the same wire gives more stroke and less force.

PITCH is how tightly the coils are packed, and it sets the spring actuator's neutral position. A tight pitch puts more coils into the same length, so it gives more stroke per unit of spring actuator, but it leaves the actuator hard against one end of its travel, where contraction is all it can do. Opening the pitch to twice or three times the wire size divides the stroke by that number and leaves the force alone, and it moves neutral away from that wall so there is room to move on both sides of it.

How to read the table

Each level column carries the force on the top line and the stroke under it, pull first and push in parentheses, per inch [per hundred millimeters] of spring actuator. Find the force you need at the fatigue life you want, then read the stroke beneath it. Spring actuators multiply movement so strongly that most designs are limited by force rather than by travel, so it is usually quicker to search the force figures first.

Pitch decides which way it works

Wind the coils tight against each other and the spring actuator can only pull. There is nowhere for it to go but open, so you stretch it while it is cool and it draws itself back when it warms.

Leave a gap between the coils and you have made room to compress into. The same spring actuator can now be squashed while it is cool and push itself back out when it warms, as well as pull. One part, both directions.

If you want an actuator that pushes as well as pulls, ask for a looser wind.

How far it pushes depends on the wind

Pulling is limited by the metal. Pushing is limited by whichever runs out first, the metal or the coils meeting each other. The length at which the coils close against one another and the spring actuator can compress no further is its solid height.

Which one you hit depends on how thick the wire is relative to the coil. A stiff spring actuator, thick wire on a small mandrel, runs out of metal before the coils touch, and it pushes exactly as far as it pulls. Our two millimeter wire on the smallest mandrel behaves this way: wound at three times the wire diameter it gives sixty millimeters of travel for every hundred millimeters of free length, and wound at four times it gives forty five. Both figures are the same in both directions.

A soft spring actuator, thin wire on a large mandrel, is the opposite. It has so much travel in it that the coils close up long before the metal is spent, so it pulls a long way and pushes only as far as the gaps allow. Wound at twice the wire diameter that ceiling is fifty millimeters per hundred, at three times it is sixty seven, and at four times it is seventy five, whatever the wire.

Every row lists the push figure in parentheses after the pull, so you do not have to work out which case you are in. An asterisk marks a push that is limited by the coils meeting rather than by the metal. If your mechanism has to do both, take the smaller of the two figures.

What to watch

The stroke figures are what the material allows. They are not always what the assembly allows. A spring actuator that computes to seventeen times its own length will, long before it gets there, be limited by whatever it is attached to, by the coils reaching solid height, or by the actuator buckling sideways at that aspect ratio. Treat a stroke of more than about ten times the free length as a number to discuss with us rather than a number to design to.

A spring actuator pulls or pushes along its axis, but like a wire it only works in one direction on its own.

Getting it back

Like every shape in this handbook, a nitinol actuator moves one way when it is heated. Getting it back to where it started is the designer's problem, and there are three ways to solve it.

AN ANTAGONISTIC PAIR uses a second actuator working against the first. Heat one and it moves the mechanism and resets the other; heat the other and it goes back. You get powered motion in both directions with full output each way, at the cost of two actuators and a control scheme that never heats both at once.

A BIAS is a passive element, usually a conventional spring or a weight, that the actuator works against as it moves and that pushes it back as it cools. It is the simplest arrangement and the most common. The price is that the bias resists the actuator through the whole stroke, so part of the force in the table is spent returning the mechanism rather than doing the job. Size it to return the actuator and no more.

SYSTEM FORCES are the return you already have. If the mechanism pushes back on its own, if gravity closes the door, if the thing being clamped is springy, if line pressure acts on the valve, that force resets the actuator for nothing. It is the best answer when it is available, and worth looking for before adding parts.

Whichever you choose, the return has to be strong enough to reset the actuator while it is cool and weak enough not to stall it while it is hot. That window is what sizes a bias, and it is the most common thing to get wrong on a first build.

There is a fourth possibility. Any nitinol actuator can be given a two way set, so that it takes one shape hot and another cold and needs no return at all. Two way parts are made to order and are outside the scope of this handbook, so nothing here is rated for it, but it exists. Ask.

Overdriving an actuator

The figures in this handbook are conservative. Every force in every table is rated at a stress we are confident the part will deliver, cycle after cycle, at the fatigue life of its design level. A part will usually do more than the table says. We would rather you found that out in testing than the other way round.

The second reason a part will beat its table is that you can overdrive it, and this one is a feature you can design with. There are two ways to do it, and they add.

The first is to heat it further. Nitinol makes its force by changing phase, and the temperature at which it does that is the transition temperature we set for you. The force does not stop climbing when the part gets there. Keep heating it past the transition and the force keeps rising with temperature, well beyond the rated figure. The table gives you the force at a working temperature comfortably above transition. Drive the part hotter and there is more.

The second is to heat it faster. Heat the part slowly and it makes the force in the table. Heat it quickly, with a sharp pulse of current rather than a gentle ramp, and it makes more, and the harder the pulse, the bigger the difference. A part that is driven both fast and hot gets the gain from each, one on top of the other. The tables assume neither. They are the floor.

Emergency mode

That gives a nitinol actuator something most actuators do not have: a reserve. A motor or a solenoid has a rated output and a thermal limit close behind it. A nitinol actuator can be driven, briefly, to a force well above its rating simply by putting more heat into it, faster. Think of it as an emergency mode. A latch that normally needs a modest pull can, on the day something jams, be hit with a short hard pulse and told to pull much harder. A release that must not fail gets a margin that costs nothing in size or weight.

Use it as a reserve, not as the rating, and know where the limits are. There is a temperature, called Md, above which the metal can no longer be pushed into martensite by stress; up to Md the material is still behaving as nitinol should. Overdriving up to Md costs some fatigue life, but it also does the part a favor: the extra heat drives out residual martensite that builds up over many cycles, a kind of rehabilitation in place, so a part that is occasionally run hard can come back sharper than one that never is. Above Md the accounting changes. Degradation is faster, and each hot cycle takes a larger bite out of the life. Above 350 °C (660 °F) the part is past saving: treat an actuator that has been driven that hot as spent and replace it. Used within those limits, for the rare event, emergency mode is one of the best arguments for the material.

Actuator safety

Most actuators fail badly when they are overdriven, and engineers know exactly how. Put too much current into a motor or a solenoid and it explodes. Overpressure a hydraulic cylinder and it bursts, or springs a pinhole leak, and a jet of oil at that pressure will cut through a glove and a hand, take a limb, and put oil into the ground and the water where it can be years being cleaned up. Every one of them has the same problem: the energy is stored in the actuator, and when something goes wrong it has nowhere to go but out. A nitinol actuator, very simply, does not carry these risks. It is a piece of metal with a current in it, and there is nothing in it to burst, nothing to leak, and nothing to poison.

A nitinol actuator fails the other way. Put too much power into it and it simply gets hotter. Past the working range the force keeps rising; past that, the part reaches the temperatures at which it was shape set, and at that point the metal lets go of its memory. The actuator loses its force, goes slack, and parts, which opens the circuit that was heating it. It shuts itself off. There is nothing stored in it to release: no pressure, no winding, no field. The failure mode is a dead part and an open circuit, not an event.

That is worth stating plainly for anyone writing a safety case. The worst thing an overdriven nitinol actuator does is stop.

What we supply

Micro spring actuators	Mandrels from 0.5 to 3.2 mm. The smallest and lightest actuators made anywhere.
Standard spring actuators	Mandrels from 4.75 to 25.4 mm, wire from 0.15 to 2 mm.
Heavy duty spring actuators	3 mm and 5 mm wire on mandrels from 4.75 to 25.4 mm. These carry real part numbers, in the form H-NiTi-wire-mandrel.
Pitch	Tight, or two, three or four times the wire size.

Transition temperatures	Minus 15 C, 20 C, 35 C, 45 C and 80 C.
Sold as	Continuous length, by the inch. Micro spring actuators by the 5 mm.
Two way	Spring Actuators that move in both directions on their own are made to order.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.15-4.75-P1	0.0059 [0.15]	0.2 [5.05]	0.0059 [0.15]	170 [670]	0.0061 [0.027] 34 (0) [3400 (0)]	0.0084 [0.037] 84 (0) [8400 (0)]	0.01 [0.046] 170 (0) [17000 (0)]	0.015 [0.068] 230 (0) [23000 (0)]
0.15-4.75-P2	0.0059 [0.15]	0.2 [5.05]	0.012 [0.3]	85 [330]	0.0061 [0.027] 17 (0.5*) [1700 (50*)]	0.0084 [0.037] 42 (0.5*) [4200 (50*)]	0.01 [0.046] 84 (0.5*) [8400 (50*)]	0.015 [0.068] 120 (0.5*) [12000 (50*)]
0.15-4.75-P3	0.0059 [0.15]	0.2 [5.05]	0.018 [0.45]	56 [220]	0.0061 [0.027] 11 (0.67*) [1100 (67*)]	0.0084 [0.037] 28 (0.67*) [2800 (67*)]	0.01 [0.046] 56 (0.67*) [5600 (67*)]	0.015 [0.068] 78 (0.67*) [7800 (67*)]
0.15-4.75-P4	0.0059 [0.15]	0.2 [5.05]	0.024 [0.6]	42 [170]	0.0061 [0.027] 8.4 (0.75*) [840 (75*)]	0.0084 [0.037] 21 (0.75*) [2100 (75*)]	0.01 [0.046] 42 (0.75*) [4200 (75*)]	0.015 [0.068] 59 (0.75*) [5900 (75*)]
0.15-6-P1	0.0059 [0.15]	0.25 [6.3]	0.0059 [0.15]	170 [670]	0.0049 [0.022] 53 (0) [5300 (0)]	0.0067 [0.03] 130 (0) [13000 (0)]	0.0083 [0.037] 260 (0) [26000 (0)]	0.012 [0.054] 370 (0) [37000 (0)]
0.15-6-P2	0.0059 [0.15]	0.25 [6.3]	0.012 [0.3]	85 [330]	0.0049 [0.022] 26 (0.5*) [2600 (50*)]	0.0067 [0.03] 66 (0.5*) [6600 (50*)]	0.0083 [0.037] 130 (0.5*) [13000 (50*)]	0.012 [0.054] 180 (0.5*) [18000 (50*)]
0.15-6-P3	0.0059 [0.15]	0.25 [6.3]	0.018 [0.45]	56 [220]	0.0049 [0.022] 18 (0.67*) [1800 (67*)]	0.0067 [0.03] 44 (0.67*) [4400 (67*)]	0.0083 [0.037] 88 (0.67*) [8800 (67*)]	0.012 [0.054] 120 (0.67*) [12000 (67*)]
0.15-6-P4	0.0059 [0.15]	0.25 [6.3]	0.024 [0.6]	42 [170]	0.0049 [0.022] 13 (0.75*) [1300 (75*)]	0.0067 [0.03] 33 (0.75*) [3300 (75*)]	0.0083 [0.037] 66 (0.75*) [6600 (75*)]	0.012 [0.054] 92 (0.75*) [9200 (75*)]
0.15-8-P1	0.0059 [0.15]	0.33 [8.3]	0.0059 [0.15]	170 [670]	0.0037 [0.016] 93 (0) [9300 (0)]	0.005 [0.022] 230 (0) [23000 (0)]	0.0063 [0.028] 460 (0) [46000 (0)]	0.0091 [0.041] 650 (0) [65000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.15-8-P2	0.0059 [0.15]	0.33 [8.3]	0.012 [0.3]	85 [330]	0.0037 [0.016] 46 (0.5*) [4600 (50*)]	0.005 [0.022] 120 (0.5*) [12000 (50*)]	0.0063 [0.028] 230 (0.5*) [23000 (50*)]	0.0091 [0.041] 320 (0.5*) [32000 (50*)]
0.15-8-P3	0.0059 [0.15]	0.33 [8.3]	0.018 [0.45]	56 [220]	0.0037 [0.016] 31 (0.67*) [3100 (67*)]	0.005 [0.022] 77 (0.67*) [7700 (67*)]	0.0063 [0.028] 150 (0.67*) [15000 (67*)]	0.0091 [0.041] 220 (0.67*) [22000 (67*)]
0.15-8-P4	0.0059 [0.15]	0.33 [8.3]	0.024 [0.6]	42 [170]	0.0037 [0.016] 23 (0.75*) [2300 (75*)]	0.005 [0.022] 58 (0.75*) [5800 (75*)]	0.0063 [0.028] 120 (0.75*) [12000 (75*)]	0.0091 [0.041] 160 (0.75*) [16000 (75*)]
0.15-9.5-P1	0.0059 [0.15]	0.39 [9.8]	0.0059 [0.15]	170 [670]	0.0031 [0.014] 130 (0) [13000 (0)]	0.0043 [0.019] 330 (0) [33000 (0)]	0.0053 [0.024] 650 (0) [65000 (0)]	0.0077 [0.034] 910 (0) [91000 (0)]
0.15-9.5-P2	0.0059 [0.15]	0.39 [9.8]	0.012 [0.3]	85 [330]	0.0031 [0.014] 65 (0.5*) [6500 (50*)]	0.0043 [0.019] 160 (0.5*) [16000 (50*)]	0.0053 [0.024] 330 (0.5*) [33000 (50*)]	0.0077 [0.034] 460 (0.5*) [46000 (50*)]
0.15-9.5-P3	0.0059 [0.15]	0.39 [9.8]	0.018 [0.45]	56 [220]	0.0031 [0.014] 43 (0.67*) [4300 (67*)]	0.0043 [0.019] 110 (0.67*) [11000 (67*)]	0.0053 [0.024] 220 (0.67*) [22000 (67*)]	0.0077 [0.034] 300 (0.67*) [30000 (67*)]
0.15-9.5-P4	0.0059 [0.15]	0.39 [9.8]	0.024 [0.6]	42 [170]	0.0031 [0.014] 33 (0.75*) [3300 (75*)]	0.0043 [0.019] 81 (0.75*) [8100 (75*)]	0.0053 [0.024] 160 (0.75*) [16000 (75*)]	0.0077 [0.034] 230 (0.75*) [23000 (75*)]
0.15-12.7-P1	0.0059 [0.15]	0.51 [13]	0.0059 [0.15]	170 [670]	0.0023 [0.01] 230 (0) [23000 (0)]	0.0032 [0.014] 580 (0) [58000 (0)]	0.004 [0.018] 1200 (0) [120000 (0)]	0.0058 [0.026] 1600 (0) [160000 (0)]
0.15-12.7-P2	0.0059 [0.15]	0.51 [13]	0.012 [0.3]	85 [330]	0.0023 [0.01] 120 (0.5*) [12000 (50*)]	0.0032 [0.014] 290 (0.5*) [29000 (50*)]	0.004 [0.018] 580 (0.5*) [58000 (50*)]	0.0058 [0.026] 810 (0.5*) [81000 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.15-12.7-P3	0.0059 [0.15]	0.51 [13]	0.018 [0.45]	56 [220]	0.0023 [0.01] 77 (0.67*) [7700 (67*)]	0.0032 [0.014] 190 (0.67*) [19000 (67*)]	0.004 [0.018] 380 (0.67*) [38000 (67*)]	0.0058 [0.026] 540 (0.67*) [54000 (67*)]
0.15-12.7-P4	0.0059 [0.15]	0.51 [13]	0.024 [0.6]	42 [170]	0.0023 [0.01] 58 (0.75*) [5800 (75*)]	0.0032 [0.014] 140 (0.75*) [14000 (75*)]	0.004 [0.018] 290 (0.75*) [29000 (75*)]	0.0058 [0.026] 400 (0.75*) [40000 (75*)]
0.15-14.2-P1	0.0059 [0.15]	0.57 [14.5]	0.0059 [0.15]	170 [670]	0.0021 [0.0092] 290 (0) [29000 (0)]	0.0029 [0.013] 720 (0) [72000 (0)]	0.0036 [0.016] 1400 (0) [140000 (0)]	0.0052 [0.023] 2000 (0) [200000 (0)]
0.15-14.2-P2	0.0059 [0.15]	0.57 [14.5]	0.012 [0.3]	85 [330]	0.0021 [0.0092] 140 (0.5*) [14000 (50*)]	0.0029 [0.013] 360 (0.5*) [36000 (50*)]	0.0036 [0.016] 720 (0.5*) [72000 (50*)]	0.0052 [0.023] 1000 (0.5*) [100000 (50*)]
0.15-14.2-P3	0.0059 [0.15]	0.57 [14.5]	0.018 [0.45]	56 [220]	0.0021 [0.0092] 96 (0.67*) [9600 (67*)]	0.0029 [0.013] 240 (0.67*) [24000 (67*)]	0.0036 [0.016] 480 (0.67*) [48000 (67*)]	0.0052 [0.023] 670 (0.67*) [67000 (67*)]
0.15-14.2-P4	0.0059 [0.15]	0.57 [14.5]	0.024 [0.6]	42 [170]	0.0021 [0.0092] 72 (0.75*) [7200 (75*)]	0.0029 [0.013] 180 (0.75*) [18000 (75*)]	0.0036 [0.016] 360 (0.75*) [36000 (75*)]	0.0052 [0.023] 500 (0.75*) [50000 (75*)]
0.15-16-P1	0.0059 [0.15]	0.64 [16.3]	0.0059 [0.15]	170 [670]	0.0018 [0.0082] 360 (0) [36000 (0)]	0.0025 [0.011] 910 (0) [91000 (0)]	0.0032 [0.014] 1800 (0) [180000 (0)]	0.0046 [0.021] 2500 (0) [250000 (0)]
0.15-16-P2	0.0059 [0.15]	0.64 [16.3]	0.012 [0.3]	85 [330]	0.0018 [0.0082] 180 (0.5*) [18000 (50*)]	0.0025 [0.011] 460 (0.5*) [46000 (50*)]	0.0032 [0.014] 910 (0.5*) [91000 (50*)]	0.0046 [0.021] 1300 (0.5*) [130000 (50*)]
0.15-16-P3	0.0059 [0.15]	0.64 [16.3]	0.018 [0.45]	56 [220]	0.0018 [0.0082] 120 (0.67*) [12000 (67*)]	0.0025 [0.011] 300 (0.67*) [30000 (67*)]	0.0032 [0.014] 610 (0.67*) [61000 (67*)]	0.0046 [0.021] 850 (0.67*) [85000 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.15-16-P4	0.0059 [0.15]	0.64 [16.3]	0.024 [0.6]	42 [170]	0.0018 [0.0082] 91 (0.75*) [9100 (75*)]	0.0025 [0.011] 230 (0.75*) [23000 (75*)]	0.0032 [0.014] 460 (0.75*) [46000 (75*)]	0.0046 [0.021] 640 (0.75*) [64000 (75*)]
0.15-19-P1	0.0059 [0.15]	0.76 [19.3]	0.0059 [0.15]	170 [670]	0.0016 [0.0069] 510 (0) [51000 (0)]	0.0022 [0.0096] 1300 (0) [130000 (0)]	0.0027 [0.012] 2600 (0) [260000 (0)]	0.0039 [0.017] 3600 (0) [360000 (0)]
0.15-19-P2	0.0059 [0.15]	0.76 [19.3]	0.012 [0.3]	85 [330]	0.0016 [0.0069] 260 (0.5*) [26000 (50*)]	0.0022 [0.0096] 640 (0.5*) [64000 (50*)]	0.0027 [0.012] 1300 (0.5*) [130000 (50*)]	0.0039 [0.017] 1800 (0.5*) [180000 (50*)]
0.15-19-P3	0.0059 [0.15]	0.76 [19.3]	0.018 [0.45]	56 [220]	0.0016 [0.0069] 170 (0.67*) [17000 (67*)]	0.0022 [0.0096] 430 (0.67*) [43000 (67*)]	0.0027 [0.012] 850 (0.67*) [85000 (67*)]	0.0039 [0.017] 1200 (0.67*) [120000 (67*)]
0.15-19-P4	0.0059 [0.15]	0.76 [19.3]	0.024 [0.6]	42 [170]	0.0016 [0.0069] 130 (0.75*) [13000 (75*)]	0.0022 [0.0096] 320 (0.75*) [32000 (75*)]	0.0027 [0.012] 640 (0.75*) [64000 (75*)]	0.0039 [0.017] 900 (0.75*) [90000 (75*)]
0.15-22.2-P1	0.0059 [0.15]	0.89 [22.5]	0.0059 [0.15]	170 [670]	0.0013 [0.0059] 700 (0) [70000 (0)]	0.0018 [0.0082] 1700 (0) [170000 (0)]	0.0023 [0.01] 3500 (0) [350000 (0)]	0.0033 [0.015] 4900 (0) [490000 (0)]
0.15-22.2-P2	0.0059 [0.15]	0.89 [22.5]	0.012 [0.3]	85 [330]	0.0013 [0.0059] 350 (0.5*) [35000 (50*)]	0.0018 [0.0082] 870 (0.5*) [87000 (50*)]	0.0023 [0.01] 1700 (0.5*) [170000 (50*)]	0.0033 [0.015] 2400 (0.5*) [240000 (50*)]
0.15-22.2-P3	0.0059 [0.15]	0.89 [22.5]	0.018 [0.45]	56 [220]	0.0013 [0.0059] 230 (0.67*) [23000 (67*)]	0.0018 [0.0082] 580 (0.67*) [58000 (67*)]	0.0023 [0.01] 1200 (0.67*) [120000 (67*)]	0.0033 [0.015] 1600 (0.67*) [160000 (67*)]
0.15-22.2-P4	0.0059 [0.15]	0.89 [22.5]	0.024 [0.6]	42 [170]	0.0013 [0.0059] 170 (0.75*) [17000 (75*)]	0.0018 [0.0082] 440 (0.75*) [44000 (75*)]	0.0023 [0.01] 870 (0.75*) [87000 (75*)]	0.0033 [0.015] 1200 (0.75*) [120000 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.15-25.4-P1	0.0059 [0.15]	1 [25.7]	0.0059 [0.15]	170 [670]	0.0012 [0.0052] 910 (0) [91000 (0)]	0.0016 [0.0072] 2300 (0) [230000 (0)]	0.002 [0.0089] 4600 (0) [460000 (0)]	0.0029 [0.013] 6400 (0) [640000 (0)]
0.15-25.4-P2	0.0059 [0.15]	1 [25.7]	0.012 [0.3]	85 [330]	0.0012 [0.0052] 460 (0.5*) [46000 (50*)]	0.0016 [0.0072] 1100 (0.5*) [110000 (50*)]	0.002 [0.0089] 2300 (0.5*) [230000 (50*)]	0.0029 [0.013] 3200 (0.5*) [320000 (50*)]
0.15-25.4-P3	0.0059 [0.15]	1 [25.7]	0.018 [0.45]	56 [220]	0.0012 [0.0052] 300 (0.67*) [30000 (67*)]	0.0016 [0.0072] 760 (0.67*) [76000 (67*)]	0.002 [0.0089] 1500 (0.67*) [150000 (67*)]	0.0029 [0.013] 2100 (0.67*) [210000 (67*)]
0.15-25.4-P4	0.0059 [0.15]	1 [25.7]	0.024 [0.6]	42 [170]	0.0012 [0.0052] 230 (0.75*) [23000 (75*)]	0.0016 [0.0072] 570 (0.75*) [57000 (75*)]	0.002 [0.0089] 1100 (0.75*) [110000 (75*)]	0.0029 [0.013] 1600 (0.75*) [160000 (75*)]
0.25-4.75-P1	0.0098 [0.25]	0.21 [5.25]	0.0098 [0.25]	100 [400]	0.028 [0.12] 13 (0) [1300 (0)]	0.038 [0.17] 31 (0) [3100 (0)]	0.047 [0.21] 63 (0) [6300 (0)]	0.069 [0.31] 88 (0) [8800 (0)]
0.25-4.75-P2	0.0098 [0.25]	0.21 [5.25]	0.02 [0.5]	51 [200]	0.028 [0.12] 6.3 (0.5*) [630 (50*)]	0.038 [0.17] 16 (0.5*) [1600 (50*)]	0.047 [0.21] 31 (0.5*) [3100 (50*)]	0.069 [0.31] 44 (0.5*) [4400 (50*)]
0.25-4.75-P3	0.0098 [0.25]	0.21 [5.25]	0.03 [0.75]	34 [130]	0.028 [0.12] 4.2 (0.67*) [420 (67*)]	0.038 [0.17] 10 (0.67*) [1000 (67*)]	0.047 [0.21] 21 (0.67*) [2100 (67*)]	0.069 [0.31] 29 (0.67*) [2900 (67*)]
0.25-4.75-P4	0.0098 [0.25]	0.21 [5.25]	0.039 [1]	25 [100]	0.028 [0.12] 3.1 (0.75*) [310 (75*)]	0.038 [0.17] 7.8 (0.75*) [780 (75*)]	0.047 [0.21] 16 (0.75*) [1600 (75*)]	0.069 [0.31] 22 (0.75*) [2200 (75*)]
0.25-6-P1	0.0098 [0.25]	0.26 [6.5]	0.0098 [0.25]	100 [400]	0.022 [0.098] 20 (0) [2000 (0)]	0.03 [0.14] 49 (0) [4900 (0)]	0.038 [0.17] 98 (0) [9800 (0)]	0.055 [0.25] 140 (0) [14000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25-6-P2	0.0098 [0.25]	0.26 [6.5]	0.02 [0.5]	51 [200]	0.022 [0.098] 9.8 (0.5*) [980 (50*)]	0.03 [0.14] 25 (0.5*) [2500 (50*)]	0.038 [0.17] 49 (0.5*) [4900 (50*)]	0.055 [0.25] 69 (0.5*) [6900 (50*)]
0.25-6-P3	0.0098 [0.25]	0.26 [6.5]	0.03 [0.75]	34 [130]	0.022 [0.098] 6.5 (0.67*) [650 (67*)]	0.03 [0.14] 16 (0.67*) [1600 (67*)]	0.038 [0.17] 33 (0.67*) [3300 (67*)]	0.055 [0.25] 46 (0.67*) [4600 (67*)]
0.25-6-P4	0.0098 [0.25]	0.26 [6.5]	0.039 [1]	25 [100]	0.022 [0.098] 4.9 (0.75*) [490 (75*)]	0.03 [0.14] 12 (0.75*) [1200 (75*)]	0.038 [0.17] 25 (0.75*) [2500 (75*)]	0.055 [0.25] 34 (0.75*) [3400 (75*)]
0.25-8-P1	0.0098 [0.25]	0.33 [8.5]	0.0098 [0.25]	100 [400]	0.017 [0.074] 34 (0) [3400 (0)]	0.023 [0.1] 86 (0) [8600 (0)]	0.029 [0.13] 170 (0) [17000 (0)]	0.042 [0.19] 240 (0) [24000 (0)]
0.25-8-P2	0.0098 [0.25]	0.33 [8.5]	0.02 [0.5]	51 [200]	0.017 [0.074] 17 (0.5*) [1700 (50*)]	0.023 [0.1] 43 (0.5*) [4300 (50*)]	0.029 [0.13] 86 (0.5*) [8600 (50*)]	0.042 [0.19] 120 (0.5*) [12000 (50*)]
0.25-8-P3	0.0098 [0.25]	0.33 [8.5]	0.03 [0.75]	34 [130]	0.017 [0.074] 11 (0.67*) [1100 (67*)]	0.023 [0.1] 29 (0.67*) [2900 (67*)]	0.029 [0.13] 57 (0.67*) [5700 (67*)]	0.042 [0.19] 80 (0.67*) [8000 (67*)]
0.25-8-P4	0.0098 [0.25]	0.33 [8.5]	0.039 [1]	25 [100]	0.017 [0.074] 8.6 (0.75*) [860 (75*)]	0.023 [0.1] 21 (0.75*) [2100 (75*)]	0.029 [0.13] 43 (0.75*) [4300 (75*)]	0.042 [0.19] 60 (0.75*) [6000 (75*)]
0.25-9.5-P1	0.0098 [0.25]	0.39 [10]	0.0098 [0.25]	100 [400]	0.014 [0.063] 48 (0) [4800 (0)]	0.02 [0.087] 120 (0) [12000 (0)]	0.024 [0.11] 240 (0) [24000 (0)]	0.035 [0.16] 330 (0) [33000 (0)]
0.25-9.5-P2	0.0098 [0.25]	0.39 [10]	0.02 [0.5]	51 [200]	0.014 [0.063] 24 (0.5*) [2400 (50*)]	0.02 [0.087] 60 (0.5*) [6000 (50*)]	0.024 [0.11] 120 (0.5*) [12000 (50*)]	0.035 [0.16] 170 (0.5*) [17000 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25-9.5-P3	0.0098 [0.25]	0.39 [10]	0.03 [0.75]	34 [130]	0.014 [0.063] 16 (0.67*) [1600 (67*)]	0.02 [0.087] 40 (0.67*) [4000 (67*)]	0.024 [0.11] 80 (0.67*) [8000 (67*)]	0.035 [0.16] 110 (0.67*) [11000 (67*)]
0.25-9.5-P4	0.0098 [0.25]	0.39 [10]	0.039 [1]	25 [100]	0.014 [0.063] 12 (0.75*) [1200 (75*)]	0.02 [0.087] 30 (0.75*) [3000 (75*)]	0.024 [0.11] 60 (0.75*) [6000 (75*)]	0.035 [0.16] 84 (0.75*) [8400 (75*)]
0.25-12.7-P1	0.0098 [0.25]	0.52 [13.2]	0.0098 [0.25]	100 [400]	0.011 [0.047] 84 (0) [8400 (0)]	0.015 [0.065] 210 (0) [21000 (0)]	0.018 [0.082] 420 (0) [42000 (0)]	0.027 [0.12] 590 (0) [59000 (0)]
0.25-12.7-P2	0.0098 [0.25]	0.52 [13.2]	0.02 [0.5]	51 [200]	0.011 [0.047] 42 (0.5*) [4200 (50*)]	0.015 [0.065] 110 (0.5*) [11000 (50*)]	0.018 [0.082] 210 (0.5*) [21000 (50*)]	0.027 [0.12] 300 (0.5*) [30000 (50*)]
0.25-12.7-P3	0.0098 [0.25]	0.52 [13.2]	0.03 [0.75]	34 [130]	0.011 [0.047] 28 (0.67*) [2800 (67*)]	0.015 [0.065] 70 (0.67*) [7000 (67*)]	0.018 [0.082] 140 (0.67*) [14000 (67*)]	0.027 [0.12] 200 (0.67*) [20000 (67*)]
0.25-12.7-P4	0.0098 [0.25]	0.52 [13.2]	0.039 [1]	25 [100]	0.011 [0.047] 21 (0.75*) [2100 (75*)]	0.015 [0.065] 53 (0.75*) [5300 (75*)]	0.018 [0.082] 110 (0.75*) [11000 (75*)]	0.027 [0.12] 150 (0.75*) [15000 (75*)]
0.25-14.2-P1	0.0098 [0.25]	0.58 [14.7]	0.0098 [0.25]	100 [400]	0.0096 [0.043] 100 (0) [10000 (0)]	0.013 [0.059] 260 (0) [26000 (0)]	0.016 [0.073] 520 (0) [52000 (0)]	0.024 [0.11] 730 (0) [73000 (0)]
0.25-14.2-P2	0.0098 [0.25]	0.58 [14.7]	0.02 [0.5]	51 [200]	0.0096 [0.043] 52 (0.5*) [5200 (50*)]	0.013 [0.059] 130 (0.5*) [13000 (50*)]	0.016 [0.073] 260 (0.5*) [26000 (50*)]	0.024 [0.11] 370 (0.5*) [37000 (50*)]
0.25-14.2-P3	0.0098 [0.25]	0.58 [14.7]	0.03 [0.75]	34 [130]	0.0096 [0.043] 35 (0.67*) [3500 (67*)]	0.013 [0.059] 87 (0.67*) [8700 (67*)]	0.016 [0.073] 170 (0.67*) [17000 (67*)]	0.024 [0.11] 240 (0.67*) [24000 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25-14.2-P4	0.0098 [0.25]	0.58 [14.7]	0.039 [1]	25 [100]	0.0096 [0.043] 26 (0.75*) [2600 (75*)]	0.013 [0.059] 66 (0.75*) [6600 (75*)]	0.016 [0.073] 130 (0.75*) [13000 (75*)]	0.024 [0.11] 180 (0.75*) [18000 (75*)]
0.25-16-P1	0.0098 [0.25]	0.65 [16.5]	0.0098 [0.25]	100 [400]	0.0085 [0.038] 130 (0) [13000 (0)]	0.012 [0.052] 330 (0) [33000 (0)]	0.015 [0.065] 660 (0) [66000 (0)]	0.021 [0.094] 930 (0) [93000 (0)]
0.25-16-P2	0.0098 [0.25]	0.65 [16.5]	0.02 [0.5]	51 [200]	0.0085 [0.038] 66 (0.5*) [6600 (50*)]	0.012 [0.052] 170 (0.5*) [17000 (50*)]	0.015 [0.065] 330 (0.5*) [33000 (50*)]	0.021 [0.094] 460 (0.5*) [46000 (50*)]
0.25-16-P3	0.0098 [0.25]	0.65 [16.5]	0.03 [0.75]	34 [130]	0.0085 [0.038] 44 (0.67*) [4400 (67*)]	0.012 [0.052] 110 (0.67*) [11000 (67*)]	0.015 [0.065] 220 (0.67*) [22000 (67*)]	0.021 [0.094] 310 (0.67*) [31000 (67*)]
0.25-16-P4	0.0098 [0.25]	0.65 [16.5]	0.039 [1]	25 [100]	0.0085 [0.038] 33 (0.75*) [3300 (75*)]	0.012 [0.052] 83 (0.75*) [8300 (75*)]	0.015 [0.065] 170 (0.75*) [17000 (75*)]	0.021 [0.094] 230 (0.75*) [23000 (75*)]
0.25-19-P1	0.0098 [0.25]	0.77 [19.5]	0.0098 [0.25]	100 [400]	0.0072 [0.032] 190 (0) [19000 (0)]	0.0099 [0.044] 470 (0) [47000 (0)]	0.012 [0.055] 930 (0) [93000 (0)]	0.018 [0.08] 1300 (0) [130000 (0)]
0.25-19-P2	0.0098 [0.25]	0.77 [19.5]	0.02 [0.5]	51 [200]	0.0072 [0.032] 93 (0.5*) [9300 (50*)]	0.0099 [0.044] 230 (0.5*) [23000 (50*)]	0.012 [0.055] 470 (0.5*) [47000 (50*)]	0.018 [0.08] 650 (0.5*) [65000 (50*)]
0.25-19-P3	0.0098 [0.25]	0.77 [19.5]	0.03 [0.75]	34 [130]	0.0072 [0.032] 62 (0.67*) [6200 (67*)]	0.0099 [0.044] 160 (0.67*) [16000 (67*)]	0.012 [0.055] 310 (0.67*) [31000 (67*)]	0.018 [0.08] 430 (0.67*) [43000 (67*)]
0.25-19-P4	0.0098 [0.25]	0.77 [19.5]	0.039 [1]	25 [100]	0.0072 [0.032] 47 (0.75*) [4700 (75*)]	0.0099 [0.044] 120 (0.75*) [12000 (75*)]	0.012 [0.055] 230 (0.75*) [23000 (75*)]	0.018 [0.08] 330 (0.75*) [33000 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25-22.2-P1	0.0098 [0.25]	0.89 [22.7]	0.0098 [0.25]	100 [400]	0.0061 [0.027] 250 (0) [25000 (0)]	0.0085 [0.038] 630 (0) [63000 (0)]	0.011 [0.047] 1300 (0) [130000 (0)]	0.015 [0.068] 1800 (0) [180000 (0)]
0.25-22.2-P2	0.0098 [0.25]	0.89 [22.7]	0.02 [0.5]	51 [200]	0.0061 [0.027] 130 (0.5*) [13000 (50*)]	0.0085 [0.038] 320 (0.5*) [32000 (50*)]	0.011 [0.047] 630 (0.5*) [63000 (50*)]	0.015 [0.068] 890 (0.5*) [89000 (50*)]
0.25-22.2-P3	0.0098 [0.25]	0.89 [22.7]	0.03 [0.75]	34 [130]	0.0061 [0.027] 84 (0.67*) [8400 (67*)]	0.0085 [0.038] 210 (0.67*) [21000 (67*)]	0.011 [0.047] 420 (0.67*) [42000 (67*)]	0.015 [0.068] 590 (0.67*) [59000 (67*)]
0.25-22.2-P4	0.0098 [0.25]	0.89 [22.7]	0.039 [1]	25 [100]	0.0061 [0.027] 63 (0.75*) [6300 (75*)]	0.0085 [0.038] 160 (0.75*) [16000 (75*)]	0.011 [0.047] 320 (0.75*) [32000 (75*)]	0.015 [0.068] 440 (0.75*) [44000 (75*)]
0.25-25.4-P1	0.0098 [0.25]	1 [25.9]	0.0098 [0.25]	100 [400]	0.0054 [0.024] 330 (0) [33000 (0)]	0.0074 [0.033] 830 (0) [83000 (0)]	0.0092 [0.041] 1700 (0) [170000 (0)]	0.013 [0.06] 2300 (0) [230000 (0)]
0.25-25.4-P2	0.0098 [0.25]	1 [25.9]	0.02 [0.5]	51 [200]	0.0054 [0.024] 170 (0.5*) [17000 (50*)]	0.0074 [0.033] 410 (0.5*) [41000 (50*)]	0.0092 [0.041] 830 (0.5*) [83000 (50*)]	0.013 [0.06] 1200 (0.5*) [120000 (50*)]
0.25-25.4-P3	0.0098 [0.25]	1 [25.9]	0.03 [0.75]	34 [130]	0.0054 [0.024] 110 (0.67*) [11000 (67*)]	0.0074 [0.033] 280 (0.67*) [28000 (67*)]	0.0092 [0.041] 550 (0.67*) [55000 (67*)]	0.013 [0.06] 770 (0.67*) [77000 (67*)]
0.25-25.4-P4	0.0098 [0.25]	1 [25.9]	0.039 [1]	25 [100]	0.0054 [0.024] 83 (0.75*) [8300 (75*)]	0.0074 [0.033] 210 (0.75*) [21000 (75*)]	0.0092 [0.041] 410 (0.75*) [41000 (75*)]	0.013 [0.06] 580 (0.75*) [58000 (75*)]
0.4-4.75-P1	0.016 [0.4]	0.22 [5.55]	0.016 [0.4]	64 [250]	0.11 [0.49] 5.2 (0) [520 (0)]	0.15 [0.67] 13 (0) [1300 (0)]	0.19 [0.84] 26 (0) [2600 (0)]	0.27 [1.2] 36 (0) [3600 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4-4.75-P2	0.016 [0.4]	0.22 [5.55]	0.031 [0.8]	32 [120]	0.11 [0.49] 2.6 (0.5*) [260 (50*)]	0.15 [0.67] 6.5 (0.5*) [650 (50*)]	0.19 [0.84] 13 (0.5*) [1300 (50*)]	0.27 [1.2] 18 (0.5*) [1800 (50*)]
0.4-4.75-P3	0.016 [0.4]	0.22 [5.55]	0.047 [1.2]	21 [83]	0.11 [0.49] 1.7 (0.67*) [170 (67*)]	0.15 [0.67] 4.3 (0.67*) [430 (67*)]	0.19 [0.84] 8.7 (0.67*) [870 (67*)]	0.27 [1.2] 12 (0.67*) [1200 (67*)]
0.4-4.75-P4	0.016 [0.4]	0.22 [5.55]	0.063 [1.6]	16 [62]	0.11 [0.49] 1.3 (0.75*) [130 (75*)]	0.15 [0.67] 3.3 (0.75*) [330 (75*)]	0.19 [0.84] 6.5 (0.75*) [650 (75*)]	0.27 [1.2] 9.1 (0.75*) [910 (75*)]
0.4-6-P1	0.016 [0.4]	0.27 [6.8]	0.016 [0.4]	64 [250]	0.088 [0.39] 8 (0) [800 (0)]	0.12 [0.54] 20 (0) [2000 (0)]	0.15 [0.68] 40 (0) [4000 (0)]	0.22 [0.98] 56 (0) [5600 (0)]
0.4-6-P2	0.016 [0.4]	0.27 [6.8]	0.031 [0.8]	32 [120]	0.088 [0.39] 4 (0.5*) [400 (50*)]	0.12 [0.54] 10 (0.5*) [1000 (50*)]	0.15 [0.68] 20 (0.5*) [2000 (50*)]	0.22 [0.98] 28 (0.5*) [2800 (50*)]
0.4-6-P3	0.016 [0.4]	0.27 [6.8]	0.047 [1.2]	21 [83]	0.088 [0.39] 2.7 (0.67*) [270 (67*)]	0.12 [0.54] 6.7 (0.67*) [670 (67*)]	0.15 [0.68] 13 (0.67*) [1300 (67*)]	0.22 [0.98] 19 (0.67*) [1900 (67*)]
0.4-6-P4	0.016 [0.4]	0.27 [6.8]	0.063 [1.6]	16 [62]	0.088 [0.39] 2 (0.75*) [200 (75*)]	0.12 [0.54] 5 (0.75*) [500 (75*)]	0.15 [0.68] 10 (0.75*) [1000 (75*)]	0.22 [0.98] 14 (0.75*) [1400 (75*)]
0.4-8-P1	0.016 [0.4]	0.35 [8.8]	0.016 [0.4]	64 [250]	0.067 [0.3] 14 (0) [1400 (0)]	0.093 [0.41] 35 (0) [3500 (0)]	0.12 [0.51] 69 (0) [6900 (0)]	0.17 [0.75] 97 (0) [9700 (0)]
0.4-8-P2	0.016 [0.4]	0.35 [8.8]	0.031 [0.8]	32 [120]	0.067 [0.3] 6.9 (0.5*) [690 (50*)]	0.093 [0.41] 17 (0.5*) [1700 (50*)]	0.12 [0.51] 35 (0.5*) [3500 (50*)]	0.17 [0.75] 48 (0.5*) [4800 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4-8-P3	0.016 [0.4]	0.35 [8.8]	0.047 [1.2]	21 [83]	0.067 [0.3] 4.6 (0.67*) [460 (67*)]	0.093 [0.41] 12 (0.67*) [1200 (67*)]	0.12 [0.51] 23 (0.67*) [2300 (67*)]	0.17 [0.75] 32 (0.67*) [3200 (67*)]
0.4-8-P4	0.016 [0.4]	0.35 [8.8]	0.063 [1.6]	16 [62]	0.067 [0.3] 3.5 (0.75*) [350 (75*)]	0.093 [0.41] 8.7 (0.75*) [870 (75*)]	0.12 [0.51] 17 (0.75*) [1700 (75*)]	0.17 [0.75] 24 (0.75*) [2400 (75*)]
0.4-9.5-P1	0.016 [0.4]	0.41 [10.3]	0.016 [0.4]	64 [250]	0.057 [0.25] 19 (0) [1900 (0)]	0.079 [0.35] 48 (0) [4800 (0)]	0.098 [0.44] 96 (0) [9600 (0)]	0.14 [0.63] 130 (0) [13000 (0)]
0.4-9.5-P2	0.016 [0.4]	0.41 [10.3]	0.031 [0.8]	32 [120]	0.057 [0.25] 9.6 (0.5*) [960 (50*)]	0.079 [0.35] 24 (0.5*) [2400 (50*)]	0.098 [0.44] 48 (0.5*) [4800 (50*)]	0.14 [0.63] 67 (0.5*) [6700 (50*)]
0.4-9.5-P3	0.016 [0.4]	0.41 [10.3]	0.047 [1.2]	21 [83]	0.057 [0.25] 6.4 (0.67*) [640 (67*)]	0.079 [0.35] 16 (0.67*) [1600 (67*)]	0.098 [0.44] 32 (0.67*) [3200 (67*)]	0.14 [0.63] 45 (0.67*) [4500 (67*)]
0.4-9.5-P4	0.016 [0.4]	0.41 [10.3]	0.063 [1.6]	16 [62]	0.057 [0.25] 4.8 (0.75*) [480 (75*)]	0.079 [0.35] 12 (0.75*) [1200 (75*)]	0.098 [0.44] 24 (0.75*) [2400 (75*)]	0.14 [0.63] 34 (0.75*) [3400 (75*)]
0.4-12.7-P1	0.016 [0.4]	0.53 [13.5]	0.016 [0.4]	64 [250]	0.043 [0.19] 34 (0) [3400 (0)]	0.06 [0.26] 84 (0) [8400 (0)]	0.074 [0.33] 170 (0) [17000 (0)]	0.11 [0.48] 240 (0) [24000 (0)]
0.4-12.7-P2	0.016 [0.4]	0.53 [13.5]	0.031 [0.8]	32 [120]	0.043 [0.19] 17 (0.5*) [1700 (50*)]	0.06 [0.26] 42 (0.5*) [4200 (50*)]	0.074 [0.33] 84 (0.5*) [8400 (50*)]	0.11 [0.48] 120 (0.5*) [12000 (50*)]
0.4-12.7-P3	0.016 [0.4]	0.53 [13.5]	0.047 [1.2]	21 [83]	0.043 [0.19] 11 (0.67*) [1100 (67*)]	0.06 [0.26] 28 (0.67*) [2800 (67*)]	0.074 [0.33] 56 (0.67*) [5600 (67*)]	0.11 [0.48] 79 (0.67*) [7900 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4-12.7-P4	0.016 [0.4]	0.53 [13.5]	0.063 [1.6]	16 [62]	0.043 [0.19] 8.4 (0.75*) [840 (75*)]	0.06 [0.26] 21 (0.75*) [2100 (75*)]	0.074 [0.33] 42 (0.75*) [4200 (75*)]	0.11 [0.48] 59 (0.75*) [5900 (75*)]
0.4-14.2-P1	0.016 [0.4]	0.59 [15]	0.016 [0.4]	64 [250]	0.039 [0.17] 42 (0) [4200 (0)]	0.053 [0.24] 100 (0) [10000 (0)]	0.067 [0.3] 210 (0) [21000 (0)]	0.097 [0.43] 290 (0) [29000 (0)]
0.4-14.2-P2	0.016 [0.4]	0.59 [15]	0.031 [0.8]	32 [120]	0.039 [0.17] 21 (0.5*) [2100 (50*)]	0.053 [0.24] 52 (0.5*) [5200 (50*)]	0.067 [0.3] 100 (0.5*) [10000 (50*)]	0.097 [0.43] 150 (0.5*) [15000 (50*)]
0.4-14.2-P3	0.016 [0.4]	0.59 [15]	0.047 [1.2]	21 [83]	0.039 [0.17] 14 (0.67*) [1400 (67*)]	0.053 [0.24] 35 (0.67*) [3500 (67*)]	0.067 [0.3] 70 (0.67*) [7000 (67*)]	0.097 [0.43] 98 (0.67*) [9800 (67*)]
0.4-14.2-P4	0.016 [0.4]	0.59 [15]	0.063 [1.6]	16 [62]	0.039 [0.17] 10 (0.75*) [1000 (75*)]	0.053 [0.24] 26 (0.75*) [2600 (75*)]	0.067 [0.3] 52 (0.75*) [5200 (75*)]	0.097 [0.43] 73 (0.75*) [7300 (75*)]
0.4-16-P1	0.016 [0.4]	0.66 [16.8]	0.016 [0.4]	64 [250]	0.034 [0.15] 53 (0) [5300 (0)]	0.048 [0.21] 130 (0) [13000 (0)]	0.059 [0.26] 260 (0) [26000 (0)]	0.086 [0.38] 370 (0) [37000 (0)]
0.4-16-P2	0.016 [0.4]	0.66 [16.8]	0.031 [0.8]	32 [120]	0.034 [0.15] 26 (0.5*) [2600 (50*)]	0.048 [0.21] 66 (0.5*) [6600 (50*)]	0.059 [0.26] 130 (0.5*) [13000 (50*)]	0.086 [0.38] 180 (0.5*) [18000 (50*)]
0.4-16-P3	0.016 [0.4]	0.66 [16.8]	0.047 [1.2]	21 [83]	0.034 [0.15] 18 (0.67*) [1800 (67*)]	0.048 [0.21] 44 (0.67*) [4400 (67*)]	0.059 [0.26] 88 (0.67*) [8800 (67*)]	0.086 [0.38] 120 (0.67*) [12000 (67*)]
0.4-16-P4	0.016 [0.4]	0.66 [16.8]	0.063 [1.6]	16 [62]	0.034 [0.15] 13 (0.75*) [1300 (75*)]	0.048 [0.21] 33 (0.75*) [3300 (75*)]	0.059 [0.26] 66 (0.75*) [6600 (75*)]	0.086 [0.38] 92 (0.75*) [9200 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4-19-P1	0.016 [0.4]	0.78 [19.8]	0.016 [0.4]	64 [250]	0.029 [0.13] 74 (0) [7400 (0)]	0.04 [0.18] 180 (0) [18000 (0)]	0.05 [0.22] 370 (0) [37000 (0)]	0.073 [0.32] 520 (0) [52000 (0)]
0.4-19-P2	0.016 [0.4]	0.78 [19.8]	0.031 [0.8]	32 [120]	0.029 [0.13] 37 (0.5*) [3700 (50*)]	0.04 [0.18] 92 (0.5*) [9200 (50*)]	0.05 [0.22] 180 (0.5*) [18000 (50*)]	0.073 [0.32] 260 (0.5*) [26000 (50*)]
0.4-19-P3	0.016 [0.4]	0.78 [19.8]	0.047 [1.2]	21 [83]	0.029 [0.13] 25 (0.67*) [2500 (67*)]	0.04 [0.18] 62 (0.67*) [6200 (67*)]	0.05 [0.22] 120 (0.67*) [12000 (67*)]	0.073 [0.32] 170 (0.67*) [17000 (67*)]
0.4-19-P4	0.016 [0.4]	0.78 [19.8]	0.063 [1.6]	16 [62]	0.029 [0.13] 18 (0.75*) [1800 (75*)]	0.04 [0.18] 46 (0.75*) [4600 (75*)]	0.05 [0.22] 92 (0.75*) [9200 (75*)]	0.073 [0.32] 130 (0.75*) [13000 (75*)]
0.4-22.2-P1	0.016 [0.4]	0.91 [23]	0.016 [0.4]	64 [250]	0.025 [0.11] 100 (0) [10000 (0)]	0.035 [0.15] 250 (0) [25000 (0)]	0.043 [0.19] 500 (0) [50000 (0)]	0.062 [0.28] 700 (0) [70000 (0)]
0.4-22.2-P2	0.016 [0.4]	0.91 [23]	0.031 [0.8]	32 [120]	0.025 [0.11] 50 (0.5*) [5000 (50*)]	0.035 [0.15] 130 (0.5*) [13000 (50*)]	0.043 [0.19] 250 (0.5*) [25000 (50*)]	0.062 [0.28] 350 (0.5*) [35000 (50*)]
0.4-22.2-P3	0.016 [0.4]	0.91 [23]	0.047 [1.2]	21 [83]	0.025 [0.11] 33 (0.67*) [3300 (67*)]	0.035 [0.15] 84 (0.67*) [8400 (67*)]	0.043 [0.19] 170 (0.67*) [17000 (67*)]	0.062 [0.28] 230 (0.67*) [23000 (67*)]
0.4-22.2-P4	0.016 [0.4]	0.91 [23]	0.063 [1.6]	16 [62]	0.025 [0.11] 25 (0.75*) [2500 (75*)]	0.035 [0.15] 63 (0.75*) [6300 (75*)]	0.043 [0.19] 130 (0.75*) [13000 (75*)]	0.062 [0.28] 180 (0.75*) [18000 (75*)]
0.4-25.4-P1	0.016 [0.4]	1 [26.2]	0.016 [0.4]	64 [250]	0.022 [0.097] 130 (0) [13000 (0)]	0.03 [0.13] 330 (0) [33000 (0)]	0.038 [0.17] 650 (0) [65000 (0)]	0.055 [0.24] 910 (0) [91000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4-25.4-P2	0.016 [0.4]	1 [26.2]	0.031 [0.8]	32 [120]	0.022 [0.097] 65 (0.5*) [6500 (50*)]	0.03 [0.13] 160 (0.5*) [16000 (50*)]	0.038 [0.17] 330 (0.5*) [33000 (50*)]	0.055 [0.24] 460 (0.5*) [46000 (50*)]
0.4-25.4-P3	0.016 [0.4]	1 [26.2]	0.047 [1.2]	21 [83]	0.022 [0.097] 44 (0.67*) [4400 (67*)]	0.03 [0.13] 110 (0.67*) [11000 (67*)]	0.038 [0.17] 220 (0.67*) [22000 (67*)]	0.055 [0.24] 300 (0.67*) [30000 (67*)]
0.4-25.4-P4	0.016 [0.4]	1 [26.2]	0.063 [1.6]	16 [62]	0.022 [0.097] 33 (0.75*) [3300 (75*)]	0.03 [0.13] 82 (0.75*) [8200 (75*)]	0.038 [0.17] 160 (0.75*) [16000 (75*)]	0.055 [0.24] 230 (0.75*) [23000 (75*)]
0.5-4.75-P1	0.02 [0.5]	0.23 [5.75]	0.02 [0.5]	51 [200]	0.21 [0.94] 3.5 (0) [350 (0)]	0.29 [1.3] 8.7 (0) [870 (0)]	0.36 [1.6] 17 (0) [1700 (0)]	0.53 [2.3] 24 (0) [2400 (0)]
0.5-4.75-P2	0.02 [0.5]	0.23 [5.75]	0.039 [1]	25 [100]	0.21 [0.94] 1.7 (0.5*) [170 (50*)]	0.29 [1.3] 4.3 (0.5*) [430 (50*)]	0.36 [1.6] 8.7 (0.5*) [870 (50*)]	0.53 [2.3] 12 (0.5*) [1200 (50*)]
0.5-4.75-P3	0.02 [0.5]	0.23 [5.75]	0.059 [1.5]	17 [67]	0.21 [0.94] 1.2 (0.67*) [120 (67*)]	0.29 [1.3] 2.9 (0.67*) [290 (67*)]	0.36 [1.6] 5.8 (0.67*) [580 (67*)]	0.53 [2.3] 8.1 (0.67*) [810 (67*)]
0.5-4.75-P4	0.02 [0.5]	0.23 [5.75]	0.079 [2]	13 [50]	0.21 [0.94] 0.87 (0.75*) [87 (75*)]	0.29 [1.3] 2.2 (0.75*) [220 (75*)]	0.36 [1.6] 4.3 (0.75*) [430 (75*)]	0.53 [2.3] 6.1 (0.75*) [610 (75*)]
0.5-6-P1	0.02 [0.5]	0.28 [7]	0.02 [0.5]	51 [200]	0.17 [0.76] 5.3 (0) [530 (0)]	0.23 [1] 13 (0) [1300 (0)]	0.29 [1.3] 27 (0) [2700 (0)]	0.42 [1.9] 37 (0) [3700 (0)]
0.5-6-P2	0.02 [0.5]	0.28 [7]	0.039 [1]	25 [100]	0.17 [0.76] 2.7 (0.5*) [270 (50*)]	0.23 [1] 6.6 (0.5*) [660 (50*)]	0.29 [1.3] 13 (0.5*) [1300 (50*)]	0.42 [1.9] 19 (0.5*) [1900 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5-6-P3	0.02 [0.5]	0.28 [7]	0.059 [1.5]	17 [67]	0.17 [0.76] 1.8 (0.67*) [180 (67*)]	0.23 [1] 4.4 (0.67*) [440 (67*)]	0.29 [1.3] 8.8 (0.67*) [880 (67*)]	0.42 [1.9] 12 (0.67*) [1200 (67*)]
0.5-6-P4	0.02 [0.5]	0.28 [7]	0.079 [2]	13 [50]	0.17 [0.76] 1.3 (0.75*) [130 (75*)]	0.23 [1] 3.3 (0.75*) [330 (75*)]	0.29 [1.3] 6.6 (0.75*) [660 (75*)]	0.42 [1.9] 9.3 (0.75*) [930 (75*)]
0.5-8-P1	0.02 [0.5]	0.35 [9]	0.02 [0.5]	51 [200]	0.13 [0.58] 9.1 (0) [910 (0)]	0.18 [0.8] 23 (0) [2300 (0)]	0.22 [0.99] 45 (0) [4500 (0)]	0.32 [1.4] 64 (0) [6400 (0)]
0.5-8-P2	0.02 [0.5]	0.35 [9]	0.039 [1]	25 [100]	0.13 [0.58] 4.5 (0.5*) [450 (50*)]	0.18 [0.8] 11 (0.5*) [1100 (50*)]	0.22 [0.99] 23 (0.5*) [2300 (50*)]	0.32 [1.4] 32 (0.5*) [3200 (50*)]
0.5-8-P3	0.02 [0.5]	0.35 [9]	0.059 [1.5]	17 [67]	0.13 [0.58] 3 (0.67*) [300 (67*)]	0.18 [0.8] 7.6 (0.67*) [760 (67*)]	0.22 [0.99] 15 (0.67*) [1500 (67*)]	0.32 [1.4] 21 (0.67*) [2100 (67*)]
0.5-8-P4	0.02 [0.5]	0.35 [9]	0.079 [2]	13 [50]	0.13 [0.58] 2.3 (0.75*) [230 (75*)]	0.18 [0.8] 5.7 (0.75*) [570 (75*)]	0.22 [0.99] 11 (0.75*) [1100 (75*)]	0.32 [1.4] 16 (0.75*) [1600 (75*)]
0.5-9.5-P1	0.02 [0.5]	0.41 [10.5]	0.02 [0.5]	51 [200]	0.11 [0.49] 13 (0) [1300 (0)]	0.15 [0.68] 31 (0) [3100 (0)]	0.19 [0.84] 63 (0) [6300 (0)]	0.28 [1.2] 88 (0) [8800 (0)]
0.5-9.5-P2	0.02 [0.5]	0.41 [10.5]	0.039 [1]	25 [100]	0.11 [0.49] 6.3 (0.5*) [630 (50*)]	0.15 [0.68] 16 (0.5*) [1600 (50*)]	0.19 [0.84] 31 (0.5*) [3100 (50*)]	0.28 [1.2] 44 (0.5*) [4400 (50*)]
0.5-9.5-P3	0.02 [0.5]	0.41 [10.5]	0.059 [1.5]	17 [67]	0.11 [0.49] 4.2 (0.67*) [420 (67*)]	0.15 [0.68] 10 (0.67*) [1000 (67*)]	0.19 [0.84] 21 (0.67*) [2100 (67*)]	0.28 [1.2] 29 (0.67*) [2900 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5-9.5-P4	0.02 [0.5]	0.41 [10.5]	0.079 [2]	13 [50]	0.11 [0.49] 3.1 (0.75*) [310 (75*)]	0.15 [0.68] 7.8 (0.75*) [780 (75*)]	0.19 [0.84] 16 (0.75*) [1600 (75*)]	0.28 [1.2] 22 (0.75*) [2200 (75*)]
0.5-12.7-P1	0.02 [0.5]	0.54 [13.7]	0.02 [0.5]	51 [200]	0.084 [0.37] 22 (0) [2200 (0)]	0.12 [0.51] 55 (0) [5500 (0)]	0.14 [0.64] 110 (0) [11000 (0)]	0.21 [0.93] 150 (0) [15000 (0)]
0.5-12.7-P2	0.02 [0.5]	0.54 [13.7]	0.039 [1]	25 [100]	0.084 [0.37] 11 (0.5*) [1100 (50*)]	0.12 [0.51] 27 (0.5*) [2700 (50*)]	0.14 [0.64] 55 (0.5*) [5500 (50*)]	0.21 [0.93] 77 (0.5*) [7700 (50*)]
0.5-12.7-P3	0.02 [0.5]	0.54 [13.7]	0.059 [1.5]	17 [67]	0.084 [0.37] 7.3 (0.67*) [730 (67*)]	0.12 [0.51] 18 (0.67*) [1800 (67*)]	0.14 [0.64] 36 (0.67*) [3600 (67*)]	0.21 [0.93] 51 (0.67*) [5100 (67*)]
0.5-12.7-P4	0.02 [0.5]	0.54 [13.7]	0.079 [2]	13 [50]	0.084 [0.37] 5.5 (0.75*) [550 (75*)]	0.12 [0.51] 14 (0.75*) [1400 (75*)]	0.14 [0.64] 27 (0.75*) [2700 (75*)]	0.21 [0.93] 38 (0.75*) [3800 (75*)]
0.5-14.2-P1	0.02 [0.5]	0.6 [15.2]	0.02 [0.5]	51 [200]	0.075 [0.33] 27 (0) [2700 (0)]	0.1 [0.46] 68 (0) [6800 (0)]	0.13 [0.57] 140 (0) [14000 (0)]	0.19 [0.83] 190 (0) [19000 (0)]
0.5-14.2-P2	0.02 [0.5]	0.6 [15.2]	0.039 [1]	25 [100]	0.075 [0.33] 14 (0.5*) [1400 (50*)]	0.1 [0.46] 34 (0.5*) [3400 (50*)]	0.13 [0.57] 68 (0.5*) [6800 (50*)]	0.19 [0.83] 95 (0.5*) [9500 (50*)]
0.5-14.2-P3	0.02 [0.5]	0.6 [15.2]	0.059 [1.5]	17 [67]	0.075 [0.33] 9.1 (0.67*) [900 (67*)]	0.1 [0.46] 23 (0.67*) [2300 (67*)]	0.13 [0.57] 45 (0.67*) [4500 (67*)]	0.19 [0.83] 63 (0.67*) [6300 (67*)]
0.5-14.2-P4	0.02 [0.5]	0.6 [15.2]	0.079 [2]	13 [50]	0.075 [0.33] 6.8 (0.75*) [680 (75*)]	0.1 [0.46] 17 (0.75*) [1700 (75*)]	0.13 [0.57] 34 (0.75*) [3400 (75*)]	0.19 [0.83] 48 (0.75*) [4800 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5-16-P1	0.02 [0.5]	0.67 [17]	0.02 [0.5]	51 [200]	0.067 [0.3] 34 (0) [3400 (0)]	0.092 [0.41] 86 (0) [8600 (0)]	0.12 [0.51] 170 (0) [17000 (0)]	0.17 [0.74] 240 (0) [24000 (0)]
0.5-16-P2	0.02 [0.5]	0.67 [17]	0.039 [1]	25 [100]	0.067 [0.3] 17 (0.5*) [1700 (50*)]	0.092 [0.41] 43 (0.5*) [4300 (50*)]	0.12 [0.51] 86 (0.5*) [8600 (50*)]	0.17 [0.74] 120 (0.5*) [12000 (50*)]
0.5-16-P3	0.02 [0.5]	0.67 [17]	0.059 [1.5]	17 [67]	0.067 [0.3] 11 (0.67*) [1100 (67*)]	0.092 [0.41] 29 (0.67*) [2900 (67*)]	0.12 [0.51] 57 (0.67*) [5700 (67*)]	0.17 [0.74] 80 (0.67*) [8000 (67*)]
0.5-16-P4	0.02 [0.5]	0.67 [17]	0.079 [2]	13 [50]	0.067 [0.3] 8.6 (0.75*) [860 (75*)]	0.092 [0.41] 21 (0.75*) [2100 (75*)]	0.12 [0.51] 43 (0.75*) [4300 (75*)]	0.17 [0.74] 60 (0.75*) [6000 (75*)]
0.5-19-P1	0.02 [0.5]	0.79 [20]	0.02 [0.5]	51 [200]	0.057 [0.25] 48 (0) [4800 (0)]	0.078 [0.35] 120 (0) [12000 (0)]	0.097 [0.43] 240 (0) [24000 (0)]	0.14 [0.63] 330 (0) [33000 (0)]
0.5-19-P2	0.02 [0.5]	0.79 [20]	0.039 [1]	25 [100]	0.057 [0.25] 24 (0.5*) [2400 (50*)]	0.078 [0.35] 60 (0.5*) [6000 (50*)]	0.097 [0.43] 120 (0.5*) [12000 (50*)]	0.14 [0.63] 170 (0.5*) [17000 (50*)]
0.5-19-P3	0.02 [0.5]	0.79 [20]	0.059 [1.5]	17 [67]	0.057 [0.25] 16 (0.67*) [1600 (67*)]	0.078 [0.35] 40 (0.67*) [4000 (67*)]	0.097 [0.43] 80 (0.67*) [8000 (67*)]	0.14 [0.63] 110 (0.67*) [11000 (67*)]
0.5-19-P4	0.02 [0.5]	0.79 [20]	0.079 [2]	13 [50]	0.057 [0.25] 12 (0.75*) [1200 (75*)]	0.078 [0.35] 30 (0.75*) [3000 (75*)]	0.097 [0.43] 60 (0.75*) [6000 (75*)]	0.14 [0.63] 84 (0.75*) [8400 (75*)]
0.5-22.2-P1	0.02 [0.5]	0.91 [23.2]	0.02 [0.5]	51 [200]	0.049 [0.22] 65 (0) [6500 (0)]	0.067 [0.3] 160 (0) [16000 (0)]	0.084 [0.37] 320 (0) [32000 (0)]	0.12 [0.54] 450 (0) [45000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5-22.2-P2	0.02 [0.5]	0.91 [23.2]	0.039 [1]	25 [100]	0.049 [0.22] 32 (0.5*) [3200 (50*)]	0.067 [0.3] 81 (0.5*) [8100 (50*)]	0.084 [0.37] 160 (0.5*) [16000 (50*)]	0.12 [0.54] 230 (0.5*) [23000 (50*)]
0.5-22.2-P3	0.02 [0.5]	0.91 [23.2]	0.059 [1.5]	17 [67]	0.049 [0.22] 22 (0.67*) [2200 (67*)]	0.067 [0.3] 54 (0.67*) [5400 (67*)]	0.084 [0.37] 110 (0.67*) [11000 (67*)]	0.12 [0.54] 150 (0.67*) [15000 (67*)]
0.5-22.2-P4	0.02 [0.5]	0.91 [23.2]	0.079 [2]	13 [50]	0.049 [0.22] 16 (0.75*) [1600 (75*)]	0.067 [0.3] 40 (0.75*) [4000 (75*)]	0.084 [0.37] 81 (0.75*) [8100 (75*)]	0.12 [0.54] 110 (0.75*) [11000 (75*)]
0.5-25.4-P1	0.02 [0.5]	1 [26.4]	0.02 [0.5]	51 [200]	0.043 [0.19] 84 (0) [8400 (0)]	0.059 [0.26] 210 (0) [21000 (0)]	0.073 [0.33] 420 (0) [42000 (0)]	0.11 [0.47] 590 (0) [59000 (0)]
0.5-25.4-P2	0.02 [0.5]	1 [26.4]	0.039 [1]	25 [100]	0.043 [0.19] 42 (0.5*) [4200 (50*)]	0.059 [0.26] 110 (0.5*) [11000 (50*)]	0.073 [0.33] 210 (0.5*) [21000 (50*)]	0.11 [0.47] 300 (0.5*) [30000 (50*)]
0.5-25.4-P3	0.02 [0.5]	1 [26.4]	0.059 [1.5]	17 [67]	0.043 [0.19] 28 (0.67*) [2800 (67*)]	0.059 [0.26] 70 (0.67*) [7000 (67*)]	0.073 [0.33] 140 (0.67*) [14000 (67*)]	0.11 [0.47] 200 (0.67*) [20000 (67*)]
0.5-25.4-P4	0.02 [0.5]	1 [26.4]	0.079 [2]	13 [50]	0.043 [0.19] 21 (0.75*) [2100 (75*)]	0.059 [0.26] 53 (0.75*) [5300 (75*)]	0.073 [0.33] 110 (0.75*) [11000 (75*)]	0.11 [0.47] 150 (0.75*) [15000 (75*)]
0.75-4.75-P1	0.03 [0.75]	0.25 [6.25]	0.03 [0.75]	34 [130]	0.68 [3] 1.7 (0) [170 (0)]	0.93 [4.2] 4.2 (0) [420 (0)]	1.2 [5.2] 8.4 (0) [840 (0)]	1.7 [7.5] 12 (0) [1200 (0)]
0.75-4.75-P2	0.03 [0.75]	0.25 [6.25]	0.059 [1.5]	17 [67]	0.68 [3] 0.84 (0.5*) [84 (50*)]	0.93 [4.2] 2.1 (0.5*) [210 (50*)]	1.2 [5.2] 4.2 (0.5*) [420 (50*)]	1.7 [7.5] 5.9 (0.5*) [590 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.75-4.75-P3	0.03 [0.75]	0.25 [6.25]	0.089 [2.25]	11 [44]	0.68 [3] 0.56 (0.56) [56 (56)]	0.93 [4.2] 1.4 (0.67*) [140 (67*)]	1.2 [5.2] 2.8 (0.67*) [280 (67*)]	1.7 [7.5] 3.9 (0.67*) [390 (67*)]
0.75-4.75-P4	0.03 [0.75]	0.25 [6.25]	0.12 [3]	8.5 [33]	0.68 [3] 0.42 (0.42) [42 (42)]	0.93 [4.2] 1.1 (0.75*) [110 (75*)]	1.2 [5.2] 2.1 (0.75*) [210 (75*)]	1.7 [7.5] 3 (0.75*) [300 (75*)]
0.75-6-P1	0.03 [0.75]	0.3 [7.5]	0.03 [0.75]	34 [130]	0.55 [2.5] 2.5 (0) [250 (0)]	0.76 [3.4] 6.4 (0) [640 (0)]	0.95 [4.2] 13 (0) [1300 (0)]	1.4 [6.1] 18 (0) [1800 (0)]
0.75-6-P2	0.03 [0.75]	0.3 [7.5]	0.059 [1.5]	17 [67]	0.55 [2.5] 1.3 (0.5*) [130 (50*)]	0.76 [3.4] 3.2 (0.5*) [320 (50*)]	0.95 [4.2] 6.4 (0.5*) [640 (50*)]	1.4 [6.1] 8.9 (0.5*) [890 (50*)]
0.75-6-P3	0.03 [0.75]	0.3 [7.5]	0.089 [2.25]	11 [44]	0.55 [2.5] 0.85 (0.67*) [85 (67*)]	0.76 [3.4] 2.1 (0.67*) [210 (67*)]	0.95 [4.2] 4.2 (0.67*) [420 (67*)]	1.4 [6.1] 5.9 (0.67*) [590 (67*)]
0.75-6-P4	0.03 [0.75]	0.3 [7.5]	0.12 [3]	8.5 [33]	0.55 [2.5] 0.64 (0.64) [64 (64)]	0.76 [3.4] 1.6 (0.75*) [160 (75*)]	0.95 [4.2] 3.2 (0.75*) [320 (75*)]	1.4 [6.1] 4.5 (0.75*) [440 (75*)]
0.75-8-P1	0.03 [0.75]	0.37 [9.5]	0.03 [0.75]	34 [130]	0.43 [1.9] 4.3 (0) [430 (0)]	0.59 [2.6] 11 (0) [1100 (0)]	0.73 [3.3] 21 (0) [2100 (0)]	1.1 [4.7] 30 (0) [3000 (0)]
0.75-8-P2	0.03 [0.75]	0.37 [9.5]	0.059 [1.5]	17 [67]	0.43 [1.9] 2.1 (0.5*) [210 (50*)]	0.59 [2.6] 5.3 (0.5*) [530 (50*)]	0.73 [3.3] 11 (0.5*) [1100 (50*)]	1.1 [4.7] 15 (0.5*) [1500 (50*)]
0.75-8-P3	0.03 [0.75]	0.37 [9.5]	0.089 [2.25]	11 [44]	0.43 [1.9] 1.4 (0.67*) [140 (67*)]	0.59 [2.6] 3.6 (0.67*) [360 (67*)]	0.73 [3.3] 7.1 (0.67*) [710 (67*)]	1.1 [4.7] 10 (0.67*) [1000 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.75-8-P4	0.03 [0.75]	0.37 [9.5]	0.12 [3]	8.5 [33]	0.43 [1.9] 1.1 (0.75*) [110 (75*)]	0.59 [2.6] 2.7 (0.75*) [270 (75*)]	0.73 [3.3] 5.3 (0.75*) [530 (75*)]	1.1 [4.7] 7.5 (0.75*) [750 (75*)]
0.75-9.5-P1	0.03 [0.75]	0.43 [11]	0.03 [0.75]	34 [130]	0.36 [1.6] 5.9 (0) [590 (0)]	0.5 [2.2] 15 (0) [1500 (0)]	0.62 [2.8] 29 (0) [2900 (0)]	0.91 [4] 41 (0) [4100 (0)]
0.75-9.5-P2	0.03 [0.75]	0.43 [11]	0.059 [1.5]	17 [67]	0.36 [1.6] 2.9 (0.5*) [290 (50*)]	0.5 [2.2] 7.3 (0.5*) [730 (50*)]	0.62 [2.8] 15 (0.5*) [1500 (50*)]	0.91 [4] 21 (0.5*) [2100 (50*)]
0.75-9.5-P3	0.03 [0.75]	0.43 [11]	0.089 [2.25]	11 [44]	0.36 [1.6] 2 (0.67*) [200 (67*)]	0.5 [2.2] 4.9 (0.67*) [490 (67*)]	0.62 [2.8] 9.8 (0.67*) [980 (67*)]	0.91 [4] 14 (0.67*) [1400 (67*)]
0.75-9.5-P4	0.03 [0.75]	0.43 [11]	0.12 [3]	8.5 [33]	0.36 [1.6] 1.5 (0.75*) [150 (75*)]	0.5 [2.2] 3.7 (0.75*) [370 (75*)]	0.62 [2.8] 7.3 (0.75*) [730 (75*)]	0.91 [4] 10 (0.75*) [1000 (75*)]
0.75-12.7-P1	0.03 [0.75]	0.56 [14.2]	0.03 [0.75]	34 [130]	0.28 [1.2] 10 (0) [1000 (0)]	0.38 [1.7] 25 (0) [2500 (0)]	0.48 [2.1] 51 (0) [5100 (0)]	0.69 [3.1] 71 (0) [7100 (0)]
0.75-12.7-P2	0.03 [0.75]	0.56 [14.2]	0.059 [1.5]	17 [67]	0.28 [1.2] 5 (0.5*) [500 (50*)]	0.38 [1.7] 13 (0.5*) [1300 (50*)]	0.48 [2.1] 25 (0.5*) [2500 (50*)]	0.69 [3.1] 35 (0.5*) [3500 (50*)]
0.75-12.7-P3	0.03 [0.75]	0.56 [14.2]	0.089 [2.25]	11 [44]	0.28 [1.2] 3.4 (0.67*) [340 (67*)]	0.38 [1.7] 8.4 (0.67*) [840 (67*)]	0.48 [2.1] 17 (0.67*) [1700 (67*)]	0.69 [3.1] 24 (0.67*) [2400 (67*)]
0.75-12.7-P4	0.03 [0.75]	0.56 [14.2]	0.12 [3]	8.5 [33]	0.28 [1.2] 2.5 (0.75*) [250 (75*)]	0.38 [1.7] 6.3 (0.75*) [630 (75*)]	0.48 [2.1] 13 (0.75*) [1300 (75*)]	0.69 [3.1] 18 (0.75*) [1800 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.75-14.2-P1	0.03 [0.75]	0.62 [15.7]	0.03 [0.75]	34 [130]	0.25 [1.1] 12 (0) [1200 (0)]	0.34 [1.5] 31 (0) [3100 (0)]	0.43 [1.9] 62 (0) [6200 (0)]	0.62 [2.8] 87 (0) [8700 (0)]
0.75-14.2-P2	0.03 [0.75]	0.62 [15.7]	0.059 [1.5]	17 [67]	0.25 [1.1] 6.2 (0.5*) [620 (50*)]	0.34 [1.5] 16 (0.5*) [1600 (50*)]	0.43 [1.9] 31 (0.5*) [3100 (50*)]	0.62 [2.8] 44 (0.5*) [4400 (50*)]
0.75-14.2-P3	0.03 [0.75]	0.62 [15.7]	0.089 [2.25]	11 [44]	0.25 [1.1] 4.2 (0.67*) [420 (67*)]	0.34 [1.5] 10 (0.67*) [1000 (67*)]	0.43 [1.9] 21 (0.67*) [2100 (67*)]	0.62 [2.8] 29 (0.67*) [2900 (67*)]
0.75-14.2-P4	0.03 [0.75]	0.62 [15.7]	0.12 [3]	8.5 [33]	0.25 [1.1] 3.1 (0.75*) [310 (75*)]	0.34 [1.5] 7.8 (0.75*) [780 (75*)]	0.43 [1.9] 16 (0.75*) [1600 (75*)]	0.62 [2.8] 22 (0.75*) [2200 (75*)]
0.75-16-P1	0.03 [0.75]	0.69 [17.5]	0.03 [0.75]	34 [130]	0.22 [0.99] 16 (0) [1600 (0)]	0.31 [1.4] 39 (0) [3900 (0)]	0.38 [1.7] 78 (0) [7800 (0)]	0.56 [2.5] 110 (0) [11000 (0)]
0.75-16-P2	0.03 [0.75]	0.69 [17.5]	0.059 [1.5]	17 [67]	0.22 [0.99] 7.8 (0.5*) [780 (50*)]	0.31 [1.4] 20 (0.5*) [2000 (50*)]	0.38 [1.7] 39 (0.5*) [3900 (50*)]	0.56 [2.5] 55 (0.5*) [5500 (50*)]
0.75-16-P3	0.03 [0.75]	0.69 [17.5]	0.089 [2.25]	11 [44]	0.22 [0.99] 5.2 (0.67*) [520 (67*)]	0.31 [1.4] 13 (0.67*) [1300 (67*)]	0.38 [1.7] 26 (0.67*) [2600 (67*)]	0.56 [2.5] 37 (0.67*) [3700 (67*)]
0.75-16-P4	0.03 [0.75]	0.69 [17.5]	0.12 [3]	8.5 [33]	0.22 [0.99] 3.9 (0.75*) [390 (75*)]	0.31 [1.4] 9.8 (0.75*) [980 (75*)]	0.38 [1.7] 20 (0.75*) [2000 (75*)]	0.56 [2.5] 27 (0.75*) [2700 (75*)]
0.75-19-P1	0.03 [0.75]	0.81 [20.5]	0.03 [0.75]	34 [130]	0.19 [0.84] 22 (0) [2200 (0)]	0.26 [1.2] 54 (0) [5400 (0)]	0.32 [1.4] 110 (0) [11000 (0)]	0.47 [2.1] 150 (0) [15000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.75-19-P2	0.03 [0.75]	0.81 [20.5]	0.059 [1.5]	17 [67]	0.19 [0.84] 11 (0.5*) [1100 (50*)]	0.26 [1.2] 27 (0.5*) [2700 (50*)]	0.32 [1.4] 54 (0.5*) [5400 (50*)]	0.47 [2.1] 76 (0.5*) [7600 (50*)]
0.75-19-P3	0.03 [0.75]	0.81 [20.5]	0.089 [2.25]	11 [44]	0.19 [0.84] 7.3 (0.67*) [730 (67*)]	0.26 [1.2] 18 (0.67*) [1800 (67*)]	0.32 [1.4] 36 (0.67*) [3600 (67*)]	0.47 [2.1] 51 (0.67*) [5100 (67*)]
0.75-19-P4	0.03 [0.75]	0.81 [20.5]	0.12 [3]	8.5 [33]	0.19 [0.84] 5.5 (0.75*) [540 (75*)]	0.26 [1.2] 14 (0.75*) [1400 (75*)]	0.32 [1.4] 27 (0.75*) [2700 (75*)]	0.47 [2.1] 38 (0.75*) [3800 (75*)]
0.75-22.2-P1	0.03 [0.75]	0.93 [23.7]	0.03 [0.75]	34 [130]	0.16 [0.72] 29 (0) [2900 (0)]	0.22 [1] 74 (0) [7400 (0)]	0.28 [1.2] 150 (0) [15000 (0)]	0.41 [1.8] 210 (0) [21000 (0)]
0.75-22.2-P2	0.03 [0.75]	0.93 [23.7]	0.059 [1.5]	17 [67]	0.16 [0.72] 15 (0.5*) [1500 (50*)]	0.22 [1] 37 (0.5*) [3700 (50*)]	0.28 [1.2] 74 (0.5*) [7400 (50*)]	0.41 [1.8] 100 (0.5*) [10000 (50*)]
0.75-22.2-P3	0.03 [0.75]	0.93 [23.7]	0.089 [2.25]	11 [44]	0.16 [0.72] 9.8 (0.67*) [980 (67*)]	0.22 [1] 25 (0.67*) [2500 (67*)]	0.28 [1.2] 49 (0.67*) [4900 (67*)]	0.41 [1.8] 69 (0.67*) [6900 (67*)]
0.75-22.2-P4	0.03 [0.75]	0.93 [23.7]	0.12 [3]	8.5 [33]	0.16 [0.72] 7.3 (0.75*) [740 (75*)]	0.22 [1] 18 (0.75*) [1800 (75*)]	0.28 [1.2] 37 (0.75*) [3700 (75*)]	0.41 [1.8] 51 (0.75*) [5100 (75*)]
0.75-25.4-P1	0.03 [0.75]	1.1 [26.9]	0.03 [0.75]	34 [130]	0.14 [0.63] 38 (0) [3800 (0)]	0.2 [0.87] 95 (0) [9500 (0)]	0.25 [1.1] 190 (0) [19000 (0)]	0.36 [1.6] 270 (0) [27000 (0)]
0.75-25.4-P2	0.03 [0.75]	1.1 [26.9]	0.059 [1.5]	17 [67]	0.14 [0.63] 19 (0.5*) [1900 (50*)]	0.2 [0.87] 48 (0.5*) [4800 (50*)]	0.25 [1.1] 95 (0.5*) [9500 (50*)]	0.36 [1.6] 130 (0.5*) [13000 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.75-25.4-P3	0.03 [0.75]	1.1 [26.9]	0.089 [2.25]	11 [44]	0.14 [0.63] 13 (0.67*) [1300 (67*)]	0.2 [0.87] 32 (0.67*) [3200 (67*)]	0.25 [1.1] 64 (0.67*) [6400 (67*)]	0.36 [1.6] 89 (0.67*) [8900 (67*)]
0.75-25.4-P4	0.03 [0.75]	1.1 [26.9]	0.12 [3]	8.5 [33]	0.14 [0.63] 9.6 (0.75*) [960 (75*)]	0.2 [0.87] 24 (0.75*) [2400 (75*)]	0.25 [1.1] 48 (0.75*) [4800 (75*)]	0.36 [1.6] 67 (0.75*) [6700 (75*)]
1-4.75-P1	0.039 [1]	0.27 [6.75]	0.039 [1]	25 [100]	1.5 [6.8] 1 (0) [100 (0)]	2.1 [9.4] 2.6 (0) [260 (0)]	2.6 [12] 5.2 (0) [520 (0)]	3.8 [17] 7.3 (0) [730 (0)]
1-4.75-P2	0.039 [1]	0.27 [6.75]	0.079 [2]	13 [50]	1.5 [6.8] 0.52 (0.5*) [52 (50*)]	2.1 [9.4] 1.3 (0.5*) [130 (50*)]	2.6 [12] 2.6 (0.5*) [260 (50*)]	3.8 [17] 3.6 (0.5*) [360 (50*)]
1-4.75-P3	0.039 [1]	0.27 [6.75]	0.12 [3]	8.5 [33]	1.5 [6.8] 0.35 (0.35) [35 (35)]	2.1 [9.4] 0.87 (0.67*) [87 (67*)]	2.6 [12] 1.7 (0.67*) [170 (67*)]	3.8 [17] 2.4 (0.67*) [240 (67*)]
1-4.75-P4	0.039 [1]	0.27 [6.75]	0.16 [4]	6.3 [25]	1.5 [6.8] 0.26 (0.26) [26 (26)]	2.1 [9.4] 0.65 (0.65) [65 (65)]	2.6 [12] 1.3 (0.75*) [130 (75*)]	3.8 [17] 1.8 (0.75*) [180 (75*)]
1-6-P1	0.039 [1]	0.31 [8]	0.039 [1]	25 [100]	1.3 [5.6] 1.5 (0) [150 (0)]	1.7 [7.7] 3.9 (0) [380 (0)]	2.2 [9.6] 7.7 (0) [770 (0)]	3.2 [14] 11 (0) [1100 (0)]
1-6-P2	0.039 [1]	0.31 [8]	0.079 [2]	13 [50]	1.3 [5.6] 0.77 (0.5*) [77 (50*)]	1.7 [7.7] 1.9 (0.5*) [190 (50*)]	2.2 [9.6] 3.9 (0.5*) [380 (50*)]	3.2 [14] 5.4 (0.5*) [540 (50*)]
1-6-P3	0.039 [1]	0.31 [8]	0.12 [3]	8.5 [33]	1.3 [5.6] 0.51 (0.51) [51 (51)]	1.7 [7.7] 1.3 (0.67*) [130 (67*)]	2.2 [9.6] 2.6 (0.67*) [260 (67*)]	3.2 [14] 3.6 (0.67*) [360 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1-6-P4	0.039 [1]	0.31 [8]	0.16 [4]	6.3 [25]	1.3 [5.6] 0.38 (0.38) [38 (38)]	1.7 [7.7] 0.96 (0.75*) [96 (75*)]	2.2 [9.6] 1.9 (0.75*) [190 (75*)]	3.2 [14] 2.7 (0.75*) [270 (75*)]
1-8-P1	0.039 [1]	0.39 [10]	0.039 [1]	25 [100]	0.98 [4.4] 2.5 (0) [250 (0)]	1.4 [6] 6.4 (0) [640 (0)]	1.7 [7.5] 13 (0) [1300 (0)]	2.5 [11] 18 (0) [1800 (0)]
1-8-P2	0.039 [1]	0.39 [10]	0.079 [2]	13 [50]	0.98 [4.4] 1.3 (0.5*) [130 (50*)]	1.4 [6] 3.2 (0.5*) [320 (50*)]	1.7 [7.5] 6.4 (0.5*) [640 (50*)]	2.5 [11] 8.9 (0.5*) [890 (50*)]
1-8-P3	0.039 [1]	0.39 [10]	0.12 [3]	8.5 [33]	0.98 [4.4] 0.85 (0.67*) [85 (67*)]	1.4 [6] 2.1 (0.67*) [210 (67*)]	1.7 [7.5] 4.2 (0.67*) [420 (67*)]	2.5 [11] 5.9 (0.67*) [590 (67*)]
1-8-P4	0.039 [1]	0.39 [10]	0.16 [4]	6.3 [25]	0.98 [4.4] 0.64 (0.64) [64 (64)]	1.4 [6] 1.6 (0.75*) [160 (75*)]	1.7 [7.5] 3.2 (0.75*) [320 (75*)]	2.5 [11] 4.5 (0.75*) [440 (75*)]
1-9.5-P1	0.039 [1]	0.45 [11.5]	0.039 [1]	25 [100]	0.84 [3.7] 3.5 (0) [350 (0)]	1.2 [5.2] 8.7 (0) [870 (0)]	1.4 [6.4] 17 (0) [1700 (0)]	2.1 [9.3] 24 (0) [2400 (0)]
1-9.5-P2	0.039 [1]	0.45 [11.5]	0.079 [2]	13 [50]	0.84 [3.7] 1.7 (0.5*) [170 (50*)]	1.2 [5.2] 4.3 (0.5*) [430 (50*)]	1.4 [6.4] 8.7 (0.5*) [870 (50*)]	2.1 [9.3] 12 (0.5*) [1200 (50*)]
1-9.5-P3	0.039 [1]	0.45 [11.5]	0.12 [3]	8.5 [33]	0.84 [3.7] 1.2 (0.67*) [120 (67*)]	1.2 [5.2] 2.9 (0.67*) [290 (67*)]	1.4 [6.4] 5.8 (0.67*) [580 (67*)]	2.1 [9.3] 8.1 (0.67*) [810 (67*)]
1-9.5-P4	0.039 [1]	0.45 [11.5]	0.16 [4]	6.3 [25]	0.84 [3.7] 0.87 (0.75*) [87 (75*)]	1.2 [5.2] 2.2 (0.75*) [220 (75*)]	1.4 [6.4] 4.3 (0.75*) [430 (75*)]	2.1 [9.3] 6.1 (0.75*) [610 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1-12.7-P1	0.039 [1]	0.58 [14.7]	0.039 [1]	25 [100]	0.64 [2.9] 5.9 (0) [590 (0)]	0.89 [4] 15 (0) [1500 (0)]	1.1 [4.9] 29 (0) [2900 (0)]	1.6 [7.2] 41 (0) [4100 (0)]
1-12.7-P2	0.039 [1]	0.58 [14.7]	0.079 [2]	13 [50]	0.64 [2.9] 3 (0.5*) [300 (50*)]	0.89 [4] 7.4 (0.5*) [740 (50*)]	1.1 [4.9] 15 (0.5*) [1500 (50*)]	1.6 [7.2] 21 (0.5*) [2100 (50*)]
1-12.7-P3	0.039 [1]	0.58 [14.7]	0.12 [3]	8.5 [33]	0.64 [2.9] 2 (0.67*) [200 (67*)]	0.89 [4] 4.9 (0.67*) [490 (67*)]	1.1 [4.9] 9.8 (0.67*) [980 (67*)]	1.6 [7.2] 14 (0.67*) [1400 (67*)]
1-12.7-P4	0.039 [1]	0.58 [14.7]	0.16 [4]	6.3 [25]	0.64 [2.9] 1.5 (0.75*) [150 (75*)]	0.89 [4] 3.7 (0.75*) [370 (75*)]	1.1 [4.9] 7.4 (0.75*) [740 (75*)]	1.6 [7.2] 10 (0.75*) [1000 (75*)]
1-14.2-P1	0.039 [1]	0.64 [16.2]	0.039 [1]	25 [100]	0.58 [2.6] 7.3 (0) [730 (0)]	0.8 [3.6] 18 (0) [1800 (0)]	1 [4.4] 36 (0) [3600 (0)]	1.5 [6.5] 51 (0) [5100 (0)]
1-14.2-P2	0.039 [1]	0.64 [16.2]	0.079 [2]	13 [50]	0.58 [2.6] 3.6 (0.5*) [360 (50*)]	0.8 [3.6] 9.1 (0.5*) [910 (50*)]	1 [4.4] 18 (0.5*) [1800 (50*)]	1.5 [6.5] 25 (0.5*) [2500 (50*)]
1-14.2-P3	0.039 [1]	0.64 [16.2]	0.12 [3]	8.5 [33]	0.58 [2.6] 2.4 (0.67*) [240 (67*)]	0.8 [3.6] 6 (0.67*) [600 (67*)]	1 [4.4] 12 (0.67*) [1200 (67*)]	1.5 [6.5] 17 (0.67*) [1700 (67*)]
1-14.2-P4	0.039 [1]	0.64 [16.2]	0.16 [4]	6.3 [25]	0.58 [2.6] 1.8 (0.75*) [180 (75*)]	0.8 [3.6] 4.5 (0.75*) [450 (75*)]	1 [4.4] 9.1 (0.75*) [910 (75*)]	1.5 [6.5] 13 (0.75*) [1300 (75*)]
1-16-P1	0.039 [1]	0.71 [18]	0.039 [1]	25 [100]	0.52 [2.3] 9.1 (0) [910 (0)]	0.72 [3.2] 23 (0) [2300 (0)]	0.89 [4] 45 (0) [4500 (0)]	1.3 [5.8] 64 (0) [6400 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1-16-P2	0.039 [1]	0.71 [18]	0.079 [2]	13 [50]	0.52 [2.3] 4.5 (0.5*) [450 (50*)]	0.72 [3.2] 11 (0.5*) [1100 (50*)]	0.89 [4] 23 (0.5*) [2300 (50*)]	1.3 [5.8] 32 (0.5*) [3200 (50*)]
1-16-P3	0.039 [1]	0.71 [18]	0.12 [3]	8.5 [33]	0.52 [2.3] 3 (0.67*) [300 (67*)]	0.72 [3.2] 7.6 (0.67*) [760 (67*)]	0.89 [4] 15 (0.67*) [1500 (67*)]	1.3 [5.8] 21 (0.67*) [2100 (67*)]
1-16-P4	0.039 [1]	0.71 [18]	0.16 [4]	6.3 [25]	0.52 [2.3] 2.3 (0.75*) [230 (75*)]	0.72 [3.2] 5.7 (0.75*) [570 (75*)]	0.89 [4] 11 (0.75*) [1100 (75*)]	1.3 [5.8] 16 (0.75*) [1600 (75*)]
1-19-P1	0.039 [1]	0.83 [21]	0.039 [1]	25 [100]	0.44 [2] 13 (0) [1300 (0)]	0.61 [2.7] 31 (0) [3100 (0)]	0.76 [3.4] 63 (0) [6300 (0)]	1.1 [4.9] 88 (0) [8800 (0)]
1-19-P2	0.039 [1]	0.83 [21]	0.079 [2]	13 [50]	0.44 [2] 6.3 (0.5*) [630 (50*)]	0.61 [2.7] 16 (0.5*) [1600 (50*)]	0.76 [3.4] 31 (0.5*) [3100 (50*)]	1.1 [4.9] 44 (0.5*) [4400 (50*)]
1-19-P3	0.039 [1]	0.83 [21]	0.12 [3]	8.5 [33]	0.44 [2] 4.2 (0.67*) [420 (67*)]	0.61 [2.7] 10 (0.67*) [1000 (67*)]	0.76 [3.4] 21 (0.67*) [2100 (67*)]	1.1 [4.9] 29 (0.67*) [2900 (67*)]
1-19-P4	0.039 [1]	0.83 [21]	0.16 [4]	6.3 [25]	0.44 [2] 3.1 (0.75*) [310 (75*)]	0.61 [2.7] 7.8 (0.75*) [780 (75*)]	0.76 [3.4] 16 (0.75*) [1600 (75*)]	1.1 [4.9] 22 (0.75*) [2200 (75*)]
1-22.2-P1	0.039 [1]	0.95 [24.2]	0.039 [1]	25 [100]	0.38 [1.7] 17 (0) [1700 (0)]	0.53 [2.3] 42 (0) [4200 (0)]	0.65 [2.9] 85 (0) [8500 (0)]	0.95 [4.2] 120 (0) [12000 (0)]
1-22.2-P2	0.039 [1]	0.95 [24.2]	0.079 [2]	13 [50]	0.38 [1.7] 8.5 (0.5*) [850 (50*)]	0.53 [2.3] 21 (0.5*) [2100 (50*)]	0.65 [2.9] 42 (0.5*) [4200 (50*)]	0.95 [4.2] 59 (0.5*) [5900 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1-22.2-P3	0.039 [1]	0.95 [24.2]	0.12 [3]	8.5 [33]	0.38 [1.7] 5.6 (0.67*) [560 (67*)]	0.53 [2.3] 14 (0.67*) [1400 (67*)]	0.65 [2.9] 28 (0.67*) [2800 (67*)]	0.95 [4.2] 39 (0.67*) [3900 (67*)]
1-22.2-P4	0.039 [1]	0.95 [24.2]	0.16 [4]	6.3 [25]	0.38 [1.7] 4.2 (0.75*) [420 (75*)]	0.53 [2.3] 11 (0.75*) [1100 (75*)]	0.65 [2.9] 21 (0.75*) [2100 (75*)]	0.95 [4.2] 30 (0.75*) [3000 (75*)]
1-25.4-P1	0.039 [1]	1.1 [27.4]	0.039 [1]	25 [100]	0.33 [1.5] 22 (0) [2200 (0)]	0.46 [2.1] 55 (0) [5500 (0)]	0.58 [2.6] 110 (0) [11000 (0)]	0.84 [3.7] 150 (0) [15000 (0)]
1-25.4-P2	0.039 [1]	1.1 [27.4]	0.079 [2]	13 [50]	0.33 [1.5] 11 (0.5*) [1100 (50*)]	0.46 [2.1] 27 (0.5*) [2700 (50*)]	0.58 [2.6] 55 (0.5*) [5500 (50*)]	0.84 [3.7] 77 (0.5*) [7700 (50*)]
1-25.4-P3	0.039 [1]	1.1 [27.4]	0.12 [3]	8.5 [33]	0.33 [1.5] 7.3 (0.67*) [730 (67*)]	0.46 [2.1] 18 (0.67*) [1800 (67*)]	0.58 [2.6] 36 (0.67*) [3600 (67*)]	0.84 [3.7] 51 (0.67*) [5100 (67*)]
1-25.4-P4	0.039 [1]	1.1 [27.4]	0.16 [4]	6.3 [25]	0.33 [1.5] 5.5 (0.75*) [550 (75*)]	0.46 [2.1] 14 (0.75*) [1400 (75*)]	0.58 [2.6] 27 (0.75*) [2700 (75*)]	0.84 [3.7] 38 (0.75*) [3800 (75*)]
1.25-4.75-P1	0.049 [1.25]	0.29 [7.25]	0.049 [1.25]	20 [80]	2.9 [13] 0.72 (0) [72 (0)]	4 [18] 1.8 (0) [180 (0)]	4.9 [22] 3.6 (0) [360 (0)]	7.2 [32] 5.1 (0) [510 (0)]
1.25-4.75-P2	0.049 [1.25]	0.29 [7.25]	0.098 [2.5]	10 [40]	2.9 [13] 0.36 (0.36) [36 (36)]	4 [18] 0.9 (0.5*) [90 (50*)]	4.9 [22] 1.8 (0.5*) [180 (50*)]	7.2 [32] 2.5 (0.5*) [250 (50*)]
1.25-4.75-P3	0.049 [1.25]	0.29 [7.25]	0.15 [3.75]	6.8 [27]	2.9 [13] 0.24 (0.24) [24 (24)]	4 [18] 0.6 (0.6) [60 (60)]	4.9 [22] 1.2 (0.67*) [120 (67*)]	7.2 [32] 1.7 (0.67*) [170 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.25-4.75-P4	0.049 [1.25]	0.29 [7.25]	0.2 [5]	5.1 [20]	2.9 [13] 0.18 (0.18) [18 (18)]	4 [18] 0.45 (0.45) [45 (45)]	4.9 [22] 0.9 (0.75*) [90 (75*)]	7.2 [32] 1.3 (0.75*) [130 (75*)]
1.25-6-P1	0.049 [1.25]	0.33 [8.5]	0.049 [1.25]	20 [80]	2.4 [11] 1.1 (0) [110 (0)]	3.3 [15] 2.6 (0) [260 (0)]	4.1 [18] 5.3 (0) [530 (0)]	5.9 [26] 7.4 (0) [740 (0)]
1.25-6-P2	0.049 [1.25]	0.33 [8.5]	0.098 [2.5]	10 [40]	2.4 [11] 0.53 (0.5*) [53 (50*)]	3.3 [15] 1.3 (0.5*) [130 (50*)]	4.1 [18] 2.6 (0.5*) [260 (50*)]	5.9 [26] 3.7 (0.5*) [370 (50*)]
1.25-6-P3	0.049 [1.25]	0.33 [8.5]	0.15 [3.75]	6.8 [27]	2.4 [11] 0.35 (0.35) [35 (35)]	3.3 [15] 0.88 (0.67*) [88 (67*)]	4.1 [18] 1.8 (0.67*) [180 (67*)]	5.9 [26] 2.5 (0.67*) [250 (67*)]
1.25-6-P4	0.049 [1.25]	0.33 [8.5]	0.2 [5]	5.1 [20]	2.4 [11] 0.26 (0.26) [26 (26)]	3.3 [15] 0.66 (0.66) [66 (66)]	4.1 [18] 1.3 (0.75*) [130 (75*)]	5.9 [26] 1.9 (0.75*) [180 (75*)]
1.25-8-P1	0.049 [1.25]	0.41 [10.5]	0.049 [1.25]	20 [80]	1.9 [8.3] 1.7 (0) [170 (0)]	2.6 [11] 4.3 (0) [430 (0)]	3.2 [14] 8.6 (0) [860 (0)]	4.7 [21] 12 (0) [1200 (0)]
1.25-8-P2	0.049 [1.25]	0.41 [10.5]	0.098 [2.5]	10 [40]	1.9 [8.3] 0.86 (0.5*) [86 (50*)]	2.6 [11] 2.1 (0.5*) [220 (50*)]	3.2 [14] 4.3 (0.5*) [430 (50*)]	4.7 [21] 6 (0.5*) [600 (50*)]
1.25-8-P3	0.049 [1.25]	0.41 [10.5]	0.15 [3.75]	6.8 [27]	1.9 [8.3] 0.57 (0.57) [57 (57)]	2.6 [11] 1.4 (0.67*) [140 (67*)]	3.2 [14] 2.9 (0.67*) [290 (67*)]	4.7 [21] 4 (0.67*) [400 (67*)]
1.25-8-P4	0.049 [1.25]	0.41 [10.5]	0.2 [5]	5.1 [20]	1.9 [8.3] 0.43 (0.43) [43 (43)]	2.6 [11] 1.1 (0.75*) [110 (75*)]	3.2 [14] 2.1 (0.75*) [220 (75*)]	4.7 [21] 3 (0.75*) [300 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.25-9.5-P1	0.049 [1.25]	0.47 [12]	0.049 [1.25]	20 [80]	1.6 [7.1] 2.3 (0) [230 (0)]	2.2 [9.8] 5.8 (0) [580 (0)]	2.8 [12] 12 (0) [1200 (0)]	4 [18] 16 (0) [1600 (0)]
1.25-9.5-P2	0.049 [1.25]	0.47 [12]	0.098 [2.5]	10 [40]	1.6 [7.1] 1.2 (0.5*) [120 (50*)]	2.2 [9.8] 2.9 (0.5*) [290 (50*)]	2.8 [12] 5.8 (0.5*) [580 (50*)]	4 [18] 8.1 (0.5*) [810 (50*)]
1.25-9.5-P3	0.049 [1.25]	0.47 [12]	0.15 [3.75]	6.8 [27]	1.6 [7.1] 0.78 (0.67*) [78 (67*)]	2.2 [9.8] 1.9 (0.67*) [190 (67*)]	2.8 [12] 3.9 (0.67*) [390 (67*)]	4 [18] 5.4 (0.67*) [540 (67*)]
1.25-9.5-P4	0.049 [1.25]	0.47 [12]	0.2 [5]	5.1 [20]	1.6 [7.1] 0.58 (0.58) [58 (58)]	2.2 [9.8] 1.4 (0.75*) [140 (75*)]	2.8 [12] 2.9 (0.75*) [290 (75*)]	4 [18] 4.1 (0.75*) [410 (75*)]
1.25-12.7-P1	0.049 [1.25]	0.6 [15.2]	0.049 [1.25]	20 [80]	1.2 [5.5] 3.9 (0) [390 (0)]	1.7 [7.6] 9.8 (0) [980 (0)]	2.1 [9.5] 20 (0) [2000 (0)]	3.1 [14] 27 (0) [2700 (0)]
1.25-12.7-P2	0.049 [1.25]	0.6 [15.2]	0.098 [2.5]	10 [40]	1.2 [5.5] 2 (0.5*) [200 (50*)]	1.7 [7.6] 4.9 (0.5*) [490 (50*)]	2.1 [9.5] 9.8 (0.5*) [980 (50*)]	3.1 [14] 14 (0.5*) [1400 (50*)]
1.25-12.7-P3	0.049 [1.25]	0.6 [15.2]	0.15 [3.75]	6.8 [27]	1.2 [5.5] 1.3 (0.67*) [130 (67*)]	1.7 [7.6] 3.3 (0.67*) [330 (67*)]	2.1 [9.5] 6.5 (0.67*) [650 (67*)]	3.1 [14] 9.1 (0.67*) [910 (67*)]
1.25-12.7-P4	0.049 [1.25]	0.6 [15.2]	0.2 [5]	5.1 [20]	1.2 [5.5] 0.98 (0.75*) [98 (75*)]	1.7 [7.6] 2.4 (0.75*) [240 (75*)]	2.1 [9.5] 4.9 (0.75*) [490 (75*)]	3.1 [14] 6.8 (0.75*) [680 (75*)]
1.25-14.2-P1	0.049 [1.25]	0.66 [16.7]	0.049 [1.25]	20 [80]	1.1 [5] 4.8 (0) [480 (0)]	1.5 [6.9] 12 (0) [1200 (0)]	1.9 [8.5] 24 (0) [2400 (0)]	2.8 [12] 34 (0) [3400 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.25-14.2-P2	0.049 [1.25]	0.66 [16.7]	0.098 [2.5]	10 [40]	1.1 [5] 2.4 (0.5*) [240 (50*)]	1.5 [6.9] 6 (0.5*) [600 (50*)]	1.9 [8.5] 12 (0.5*) [1200 (50*)]	2.8 [12] 17 (0.5*) [1700 (50*)]
1.25-14.2-P3	0.049 [1.25]	0.66 [16.7]	0.15 [3.75]	6.8 [27]	1.1 [5] 1.6 (0.67*) [160 (67*)]	1.5 [6.9] 4 (0.67*) [400 (67*)]	1.9 [8.5] 8 (0.67*) [800 (67*)]	2.8 [12] 11 (0.67*) [1100 (67*)]
1.25-14.2-P4	0.049 [1.25]	0.66 [16.7]	0.2 [5]	5.1 [20]	1.1 [5] 1.2 (0.75*) [120 (75*)]	1.5 [6.9] 3 (0.75*) [300 (75*)]	1.9 [8.5] 6 (0.75*) [600 (75*)]	2.8 [12] 8.4 (0.75*) [840 (75*)]
1.25-16-P1	0.049 [1.25]	0.73 [18.5]	0.049 [1.25]	20 [80]	1 [4.4] 6 (0) [600 (0)]	1.4 [6.1] 15 (0) [1500 (0)]	1.7 [7.6] 30 (0) [3000 (0)]	2.5 [11] 42 (0) [4200 (0)]
1.25-16-P2	0.049 [1.25]	0.73 [18.5]	0.098 [2.5]	10 [40]	1 [4.4] 3 (0.5*) [300 (50*)]	1.4 [6.1] 7.5 (0.5*) [750 (50*)]	1.7 [7.6] 15 (0.5*) [1500 (50*)]	2.5 [11] 21 (0.5*) [2100 (50*)]
1.25-16-P3	0.049 [1.25]	0.73 [18.5]	0.15 [3.75]	6.8 [27]	1 [4.4] 2 (0.67*) [200 (67*)]	1.4 [6.1] 5 (0.67*) [500 (67*)]	1.7 [7.6] 10 (0.67*) [1000 (67*)]	2.5 [11] 14 (0.67*) [1400 (67*)]
1.25-16-P4	0.049 [1.25]	0.73 [18.5]	0.2 [5]	5.1 [20]	1 [4.4] 1.5 (0.75*) [150 (75*)]	1.4 [6.1] 3.7 (0.75*) [370 (75*)]	1.7 [7.6] 7.5 (0.75*) [750 (75*)]	2.5 [11] 10 (0.75*) [1000 (75*)]
1.25-19-P1	0.049 [1.25]	0.85 [21.5]	0.049 [1.25]	20 [80]	0.85 [3.8] 8.2 (0) [820 (0)]	1.2 [5.2] 21 (0) [2100 (0)]	1.5 [6.5] 41 (0) [4100 (0)]	2.1 [9.5] 58 (0) [5800 (0)]
1.25-19-P2	0.049 [1.25]	0.85 [21.5]	0.098 [2.5]	10 [40]	0.85 [3.8] 4.1 (0.5*) [410 (50*)]	1.2 [5.2] 10 (0.5*) [1000 (50*)]	1.5 [6.5] 21 (0.5*) [2100 (50*)]	2.1 [9.5] 29 (0.5*) [2900 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.25-19-P3	0.049 [1.25]	0.85 [21.5]	0.15 [3.75]	6.8 [27]	0.85 [3.8] 2.8 (0.67*) [280 (67*)]	1.2 [5.2] 6.9 (0.67*) [690 (67*)]	1.5 [6.5] 14 (0.67*) [1400 (67*)]	2.1 [9.5] 19 (0.67*) [1900 (67*)]
1.25-19-P4	0.049 [1.25]	0.85 [21.5]	0.2 [5]	5.1 [20]	0.85 [3.8] 2.1 (0.75*) [210 (75*)]	1.2 [5.2] 5.2 (0.75*) [520 (75*)]	1.5 [6.5] 10 (0.75*) [1000 (75*)]	2.1 [9.5] 14 (0.75*) [1400 (75*)]
1.25-22.2-P1	0.049 [1.25]	0.97 [24.7]	0.049 [1.25]	20 [80]	0.74 [3.3] 11 (0) [1100 (0)]	1 [4.5] 28 (0) [2800 (0)]	1.3 [5.6] 55 (0) [5500 (0)]	1.8 [8.2] 77 (0) [7700 (0)]
1.25-22.2-P2	0.049 [1.25]	0.97 [24.7]	0.098 [2.5]	10 [40]	0.74 [3.3] 5.5 (0.5*) [550 (50*)]	1 [4.5] 14 (0.5*) [1400 (50*)]	1.3 [5.6] 28 (0.5*) [2800 (50*)]	1.8 [8.2] 39 (0.5*) [3900 (50*)]
1.25-22.2-P3	0.049 [1.25]	0.97 [24.7]	0.15 [3.75]	6.8 [27]	0.74 [3.3] 3.7 (0.67*) [370 (67*)]	1 [4.5] 9.2 (0.67*) [920 (67*)]	1.3 [5.6] 18 (0.67*) [1800 (67*)]	1.8 [8.2] 26 (0.67*) [2600 (67*)]
1.25-22.2-P4	0.049 [1.25]	0.97 [24.7]	0.2 [5]	5.1 [20]	0.74 [3.3] 2.8 (0.75*) [280 (75*)]	1 [4.5] 6.9 (0.75*) [690 (75*)]	1.3 [5.6] 14 (0.75*) [1400 (75*)]	1.8 [8.2] 19 (0.75*) [1900 (75*)]
1.25-25.4-P1	0.049 [1.25]	1.1 [27.9]	0.049 [1.25]	20 [80]	0.65 [2.9] 14 (0) [1400 (0)]	0.89 [4] 36 (0) [3600 (0)]	1.1 [5] 71 (0) [7100 (0)]	1.6 [7.2] 100 (0) [10000 (0)]
1.25-25.4-P2	0.049 [1.25]	1.1 [27.9]	0.098 [2.5]	10 [40]	0.65 [2.9] 7.1 (0.5*) [710 (50*)]	0.89 [4] 18 (0.5*) [1800 (50*)]	1.1 [5] 36 (0.5*) [3600 (50*)]	1.6 [7.2] 50 (0.5*) [5000 (50*)]
1.25-25.4-P3	0.049 [1.25]	1.1 [27.9]	0.15 [3.75]	6.8 [27]	0.65 [2.9] 4.8 (0.67*) [480 (67*)]	0.89 [4] 12 (0.67*) [1200 (67*)]	1.1 [5] 24 (0.67*) [2400 (67*)]	1.6 [7.2] 33 (0.67*) [3300 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.25-25.4-P4	0.049 [1.25]	1.1 [27.9]	0.2 [5]	5.1 [20]	0.65 [2.9] 3.6 (0.75*) [360 (75*)]	0.89 [4] 8.9 (0.75*) [890 (75*)]	1.1 [5] 18 (0.75*) [1800 (75*)]	1.6 [7.2] 25 (0.75*) [2500 (75*)]
1.5-4.75-P1	0.059 [1.5]	0.31 [7.75]	0.059 [1.5]	17 [67]	4.8 [21] 0.54 (0) [54 (0)]	6.6 [29] 1.4 (0) [140 (0)]	8.2 [36] 2.7 (0) [270 (0)]	12 [53] 3.8 (0) [380 (0)]
1.5-4.75-P2	0.059 [1.5]	0.31 [7.75]	0.12 [3]	8.5 [33]	4.8 [21] 0.27 (0.27) [27 (27)]	6.6 [29] 0.68 (0.5*) [68 (50*)]	8.2 [36] 1.4 (0.5*) [140 (50*)]	12 [53] 1.9 (0.5*) [190 (50*)]
1.5-4.75-P3	0.059 [1.5]	0.31 [7.75]	0.18 [4.5]	5.6 [22]	4.8 [21] 0.18 (0.18) [18 (18)]	6.6 [29] 0.46 (0.46) [46 (46)]	8.2 [36] 0.91 (0.67*) [91 (67*)]	12 [53] 1.3 (0.67*) [130 (67*)]
1.5-4.75-P4	0.059 [1.5]	0.31 [7.75]	0.24 [6]	4.2 [17]	4.8 [21] 0.14 (0.14) [14 (14)]	6.6 [29] 0.34 (0.34) [34 (34)]	8.2 [36] 0.68 (0.68) [68 (68)]	12 [53] 0.96 (0.75*) [96 (75*)]
1.5-6-P1	0.059 [1.5]	0.35 [9]	0.059 [1.5]	17 [67]	4 [18] 0.78 (0) [78 (0)]	5.5 [24] 2 (0) [200 (0)]	6.8 [30] 3.9 (0) [390 (0)]	9.9 [44] 5.5 (0) [550 (0)]
1.5-6-P2	0.059 [1.5]	0.35 [9]	0.12 [3]	8.5 [33]	4 [18] 0.39 (0.39) [39 (39)]	5.5 [24] 0.98 (0.5*) [98 (50*)]	6.8 [30] 2 (0.5*) [200 (50*)]	9.9 [44] 2.8 (0.5*) [280 (50*)]
1.5-6-P3	0.059 [1.5]	0.35 [9]	0.18 [4.5]	5.6 [22]	4 [18] 0.26 (0.26) [26 (26)]	5.5 [24] 0.66 (0.66) [66 (66)]	6.8 [30] 1.3 (0.67*) [130 (67*)]	9.9 [44] 1.8 (0.67*) [180 (67*)]
1.5-6-P4	0.059 [1.5]	0.35 [9]	0.24 [6]	4.2 [17]	4 [18] 0.2 (0.2) [20 (20)]	5.5 [24] 0.49 (0.49) [49 (49)]	6.8 [30] 0.98 (0.75*) [98 (75*)]	9.9 [44] 1.4 (0.75*) [140 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5-8-P1	0.059 [1.5]	0.43 [11]	0.059 [1.5]	17 [67]	3.1 [14] 1.3 (0) [130 (0)]	4.3 [19] 3.1 (0) [320 (0)]	5.4 [24] 6.3 (0) [630 (0)]	7.8 [35] 8.8 (0) [880 (0)]
1.5-8-P2	0.059 [1.5]	0.43 [11]	0.12 [3]	8.5 [33]	3.1 [14] 0.63 (0.5*) [63 (50*)]	4.3 [19] 1.6 (0.5*) [160 (50*)]	5.4 [24] 3.1 (0.5*) [320 (50*)]	7.8 [35] 4.4 (0.5*) [440 (50*)]
1.5-8-P3	0.059 [1.5]	0.43 [11]	0.18 [4.5]	5.6 [22]	3.1 [14] 0.42 (0.42) [42 (42)]	4.3 [19] 1.1 (0.67*) [100 (67*)]	5.4 [24] 2.1 (0.67*) [210 (67*)]	7.8 [35] 2.9 (0.67*) [290 (67*)]
1.5-8-P4	0.059 [1.5]	0.43 [11]	0.24 [6]	4.2 [17]	3.1 [14] 0.32 (0.32) [32 (32)]	4.3 [19] 0.79 (0.75*) [79 (75*)]	5.4 [24] 1.6 (0.75*) [160 (75*)]	7.8 [35] 2.2 (0.75*) [220 (75*)]
1.5-9.5-P1	0.059 [1.5]	0.49 [12.5]	0.059 [1.5]	17 [67]	2.7 [12] 1.7 (0) [170 (0)]	3.7 [17] 4.2 (0) [420 (0)]	4.7 [21] 8.4 (0) [840 (0)]	6.8 [30] 12 (0) [1200 (0)]
1.5-9.5-P2	0.059 [1.5]	0.49 [12.5]	0.12 [3]	8.5 [33]	2.7 [12] 0.84 (0.5*) [84 (50*)]	3.7 [17] 2.1 (0.5*) [210 (50*)]	4.7 [21] 4.2 (0.5*) [420 (50*)]	6.8 [30] 5.9 (0.5*) [590 (50*)]
1.5-9.5-P3	0.059 [1.5]	0.49 [12.5]	0.18 [4.5]	5.6 [22]	2.7 [12] 0.56 (0.56) [56 (56)]	3.7 [17] 1.4 (0.67*) [140 (67*)]	4.7 [21] 2.8 (0.67*) [280 (67*)]	6.8 [30] 3.9 (0.67*) [390 (67*)]
1.5-9.5-P4	0.059 [1.5]	0.49 [12.5]	0.24 [6]	4.2 [17]	2.7 [12] 0.42 (0.42) [42 (42)]	3.7 [17] 1.1 (0.75*) [110 (75*)]	4.7 [21] 2.1 (0.75*) [210 (75*)]	6.8 [30] 3 (0.75*) [300 (75*)]
1.5-12.7-P1	0.059 [1.5]	0.62 [15.7]	0.059 [1.5]	17 [67]	2.1 [9.3] 2.8 (0) [280 (0)]	2.9 [13] 7 (0) [700 (0)]	3.6 [16] 14 (0) [1400 (0)]	5.2 [23] 20 (0) [2000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5-12.7-P2	0.059 [1.5]	0.62 [15.7]	0.12 [3]	8.5 [33]	2.1 [9.3] 1.4 (0.5*) [140 (50*)]	2.9 [13] 3.5 (0.5*) [350 (50*)]	3.6 [16] 7 (0.5*) [700 (50*)]	5.2 [23] 9.8 (0.5*) [980 (50*)]
1.5-12.7-P3	0.059 [1.5]	0.62 [15.7]	0.18 [4.5]	5.6 [22]	2.1 [9.3] 0.94 (0.67*) [94 (67*)]	2.9 [13] 2.4 (0.67*) [240 (67*)]	3.6 [16] 4.7 (0.67*) [470 (67*)]	5.2 [23] 6.6 (0.67*) [660 (67*)]
1.5-12.7-P4	0.059 [1.5]	0.62 [15.7]	0.24 [6]	4.2 [17]	2.1 [9.3] 0.7 (0.7) [70 (70)]	2.9 [13] 1.8 (0.75*) [180 (75*)]	3.6 [16] 3.5 (0.75*) [350 (75*)]	5.2 [23] 4.9 (0.75*) [490 (75*)]
1.5-14.2-P1	0.059 [1.5]	0.68 [17.2]	0.059 [1.5]	17 [67]	1.9 [8.4] 3.4 (0) [340 (0)]	2.6 [12] 8.6 (0) [860 (0)]	3.3 [15] 17 (0) [1700 (0)]	4.7 [21] 24 (0) [2400 (0)]
1.5-14.2-P2	0.059 [1.5]	0.68 [17.2]	0.12 [3]	8.5 [33]	1.9 [8.4] 1.7 (0.5*) [170 (50*)]	2.6 [12] 4.3 (0.5*) [430 (50*)]	3.3 [15] 8.6 (0.5*) [860 (50*)]	4.7 [21] 12 (0.5*) [1200 (50*)]
1.5-14.2-P3	0.059 [1.5]	0.68 [17.2]	0.18 [4.5]	5.6 [22]	1.9 [8.4] 1.1 (0.67*) [120 (67*)]	2.6 [12] 2.9 (0.67*) [290 (67*)]	3.3 [15] 5.7 (0.67*) [570 (67*)]	4.7 [21] 8 (0.67*) [800 (67*)]
1.5-14.2-P4	0.059 [1.5]	0.68 [17.2]	0.24 [6]	4.2 [17]	1.9 [8.4] 0.86 (0.75*) [86 (75*)]	2.6 [12] 2.1 (0.75*) [220 (75*)]	3.3 [15] 4.3 (0.75*) [430 (75*)]	4.7 [21] 6 (0.75*) [600 (75*)]
1.5-16-P1	0.059 [1.5]	0.75 [19]	0.059 [1.5]	17 [67]	1.7 [7.6] 4.3 (0) [430 (0)]	2.3 [10] 11 (0) [1100 (0)]	2.9 [13] 21 (0) [2100 (0)]	4.3 [19] 30 (0) [3000 (0)]
1.5-16-P2	0.059 [1.5]	0.75 [19]	0.12 [3]	8.5 [33]	1.7 [7.6] 2.1 (0.5*) [210 (50*)]	2.3 [10] 5.3 (0.5*) [530 (50*)]	2.9 [13] 11 (0.5*) [1100 (50*)]	4.3 [19] 15 (0.5*) [1500 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5-16-P3	0.059 [1.5]	0.75 [19]	0.18 [4.5]	5.6 [22]	1.7 [7.6] 1.4 (0.67*) [140 (67*)]	2.3 [10] 3.6 (0.67*) [360 (67*)]	2.9 [13] 7.1 (0.67*) [710 (67*)]	4.3 [19] 10 (0.67*) [1000 (67*)]
1.5-16-P4	0.059 [1.5]	0.75 [19]	0.24 [6]	4.2 [17]	1.7 [7.6] 1.1 (0.75*) [110 (75*)]	2.3 [10] 2.7 (0.75*) [270 (75*)]	2.9 [13] 5.3 (0.75*) [530 (75*)]	4.3 [19] 7.5 (0.75*) [750 (75*)]
1.5-19-P1	0.059 [1.5]	0.87 [22]	0.059 [1.5]	17 [67]	1.5 [6.5] 5.9 (0) [590 (0)]	2 [8.9] 15 (0) [1500 (0)]	2.5 [11] 29 (0) [2900 (0)]	3.6 [16] 41 (0) [4100 (0)]
1.5-19-P2	0.059 [1.5]	0.87 [22]	0.12 [3]	8.5 [33]	1.5 [6.5] 2.9 (0.5*) [290 (50*)]	2 [8.9] 7.3 (0.5*) [730 (50*)]	2.5 [11] 15 (0.5*) [1500 (50*)]	3.6 [16] 21 (0.5*) [2100 (50*)]
1.5-19-P3	0.059 [1.5]	0.87 [22]	0.18 [4.5]	5.6 [22]	1.5 [6.5] 2 (0.67*) [200 (67*)]	2 [8.9] 4.9 (0.67*) [490 (67*)]	2.5 [11] 9.8 (0.67*) [980 (67*)]	3.6 [16] 14 (0.67*) [1400 (67*)]
1.5-19-P4	0.059 [1.5]	0.87 [22]	0.24 [6]	4.2 [17]	1.5 [6.5] 1.5 (0.75*) [150 (75*)]	2 [8.9] 3.7 (0.75*) [370 (75*)]	2.5 [11] 7.3 (0.75*) [730 (75*)]	3.6 [16] 10 (0.75*) [1000 (75*)]
1.5-22.2-P1	0.059 [1.5]	0.99 [25.2]	0.059 [1.5]	17 [67]	1.3 [5.6] 7.8 (0) [780 (0)]	1.7 [7.7] 20 (0) [2000 (0)]	2.2 [9.6] 39 (0) [3900 (0)]	3.1 [14] 55 (0) [5500 (0)]
1.5-22.2-P2	0.059 [1.5]	0.99 [25.2]	0.12 [3]	8.5 [33]	1.3 [5.6] 3.9 (0.5*) [390 (50*)]	1.7 [7.7] 9.8 (0.5*) [980 (50*)]	2.2 [9.6] 20 (0.5*) [2000 (50*)]	3.1 [14] 27 (0.5*) [2700 (50*)]
1.5-22.2-P3	0.059 [1.5]	0.99 [25.2]	0.18 [4.5]	5.6 [22]	1.3 [5.6] 2.6 (0.67*) [260 (67*)]	1.7 [7.7] 6.5 (0.67*) [650 (67*)]	2.2 [9.6] 13 (0.67*) [1300 (67*)]	3.1 [14] 18 (0.67*) [1800 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5-22.2-P4	0.059 [1.5]	0.99 [25.2]	0.24 [6]	4.2 [17]	1.3 [5.6] 2 (0.75*) [200 (75*)]	1.7 [7.7] 4.9 (0.75*) [490 (75*)]	2.2 [9.6] 9.8 (0.75*) [980 (75*)]	3.1 [14] 14 (0.75*) [1400 (75*)]
1.5-25.4-P1	0.059 [1.5]	1.1 [28.4]	0.059 [1.5]	17 [67]	1.1 [4.9] 10 (0) [1000 (0)]	1.5 [6.8] 25 (0) [2500 (0)]	1.9 [8.5] 51 (0) [5100 (0)]	2.8 [12] 71 (0) [7100 (0)]
1.5-25.4-P2	0.059 [1.5]	1.1 [28.4]	0.12 [3]	8.5 [33]	1.1 [4.9] 5 (0.5*) [500 (50*)]	1.5 [6.8] 13 (0.5*) [1300 (50*)]	1.9 [8.5] 25 (0.5*) [2500 (50*)]	2.8 [12] 35 (0.5*) [3500 (50*)]
1.5-25.4-P3	0.059 [1.5]	1.1 [28.4]	0.18 [4.5]	5.6 [22]	1.1 [4.9] 3.4 (0.67*) [340 (67*)]	1.5 [6.8] 8.4 (0.67*) [840 (67*)]	1.9 [8.5] 17 (0.67*) [1700 (67*)]	2.8 [12] 24 (0.67*) [2400 (67*)]
1.5-25.4-P4	0.059 [1.5]	1.1 [28.4]	0.24 [6]	4.2 [17]	1.1 [4.9] 2.5 (0.75*) [250 (75*)]	1.5 [6.8] 6.3 (0.75*) [630 (75*)]	1.9 [8.5] 13 (0.75*) [1300 (75*)]	2.8 [12] 18 (0.75*) [1800 (75*)]
2-4.75-P1	0.079 [2]	0.34 [8.75]	0.079 [2]	13 [50]	10 [47] 0.36 (0) [36 (0)]	14 [64] 0.9 (0) [90 (0)]	18 [80] 1.8 (0) [180 (0)]	26 [120] 2.5 (0) [250 (0)]
2-4.75-P2	0.079 [2]	0.34 [8.75]	0.16 [4]	6.3 [25]	10 [47] 0.18 (0.18) [18 (18)]	14 [64] 0.45 (0.45) [45 (45)]	18 [80] 0.9 (0.5*) [90 (50*)]	26 [120] 1.2 (0.5*) [120 (50*)]
2-4.75-P3	0.079 [2]	0.34 [8.75]	0.24 [6]	4.2 [17]	10 [47] 0.12 (0.12) [12 (12)]	14 [64] 0.3 (0.3) [30 (30)]	18 [80] 0.6 (0.6) [60 (60)]	26 [120] 0.84 (0.67*) [84 (67*)]
2-4.75-P4	0.079 [2]	0.34 [8.75]	0.31 [8]	3.2 [12]	10 [47] 0.089 (0.089) [8.9 (8.9)]	14 [64] 0.22 (0.22) [22 (22)]	18 [80] 0.45 (0.45) [45 (45)]	26 [120] 0.63 (0.63) [63 (63)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
2-6-P1	0.079 [2]	0.39 [10]	0.079 [2]	13 [50]	8.8 [39] 0.5 (0) [50 (0)]	12 [54] 1.3 (0) [130 (0)]	15 [68] 2.5 (0) [250 (0)]	22 [98] 3.5 (0) [350 (0)]
2-6-P2	0.079 [2]	0.39 [10]	0.16 [4]	6.3 [25]	8.8 [39] 0.25 (0.25) [25 (25)]	12 [54] 0.63 (0.5*) [63 (50*)]	15 [68] 1.3 (0.5*) [130 (50*)]	22 [98] 1.8 (0.5*) [180 (50*)]
2-6-P3	0.079 [2]	0.39 [10]	0.24 [6]	4.2 [17]	8.8 [39] 0.17 (0.17) [17 (17)]	12 [54] 0.42 (0.42) [42 (42)]	15 [68] 0.84 (0.67*) [84 (67*)]	22 [98] 1.2 (0.67*) [120 (67*)]
2-6-P4	0.079 [2]	0.39 [10]	0.31 [8]	3.2 [12]	8.8 [39] 0.13 (0.13) [13 (13)]	12 [54] 0.31 (0.31) [31 (31)]	15 [68] 0.63 (0.63) [63 (63)]	22 [98] 0.88 (0.75*) [88 (75*)]
2-8-P1	0.079 [2]	0.47 [12]	0.079 [2]	13 [50]	7.1 [31] 0.78 (0) [78 (0)]	9.7 [43] 2 (0) [200 (0)]	12 [54] 3.9 (0) [390 (0)]	18 [79] 5.5 (0) [550 (0)]
2-8-P2	0.079 [2]	0.47 [12]	0.16 [4]	6.3 [25]	7.1 [31] 0.39 (0.39) [39 (39)]	9.7 [43] 0.98 (0.5*) [98 (50*)]	12 [54] 2 (0.5*) [200 (50*)]	18 [79] 2.8 (0.5*) [280 (50*)]
2-8-P3	0.079 [2]	0.47 [12]	0.24 [6]	4.2 [17]	7.1 [31] 0.26 (0.26) [26 (26)]	9.7 [43] 0.66 (0.66) [66 (66)]	12 [54] 1.3 (0.67*) [130 (67*)]	18 [79] 1.8 (0.67*) [180 (67*)]
2-8-P4	0.079 [2]	0.47 [12]	0.31 [8]	3.2 [12]	7.1 [31] 0.2 (0.2) [20 (20)]	9.7 [43] 0.49 (0.49) [49 (49)]	12 [54] 0.98 (0.75*) [98 (75*)]	18 [79] 1.4 (0.75*) [140 (75*)]
2-9.5-P1	0.079 [2]	0.53 [13.5]	0.079 [2]	13 [50]	6.1 [27] 1 (0) [100 (0)]	8.5 [38] 2.6 (0) [260 (0)]	11 [47] 5.2 (0) [520 (0)]	15 [68] 7.3 (0) [730 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
2-9.5-P2	0.079 [2]	0.53 [13.5]	0.16 [4]	6.3 [25]	6.1 [27] 0.52 (0.5*) [52 (50*)]	8.5 [38] 1.3 (0.5*) [130 (50*)]	11 [47] 2.6 (0.5*) [260 (50*)]	15 [68] 3.6 (0.5*) [360 (50*)]
2-9.5-P3	0.079 [2]	0.53 [13.5]	0.24 [6]	4.2 [17]	6.1 [27] 0.35 (0.35) [35 (35)]	8.5 [38] 0.87 (0.67*) [87 (67*)]	11 [47] 1.7 (0.67*) [170 (67*)]	15 [68] 2.4 (0.67*) [240 (67*)]
2-9.5-P4	0.079 [2]	0.53 [13.5]	0.31 [8]	3.2 [12]	6.1 [27] 0.26 (0.26) [26 (26)]	8.5 [38] 0.65 (0.65) [65 (65)]	11 [47] 1.3 (0.75*) [130 (75*)]	15 [68] 1.8 (0.75*) [180 (75*)]
2-12.7-P1	0.079 [2]	0.66 [16.7]	0.079 [2]	13 [50]	4.8 [21] 1.7 (0) [170 (0)]	6.6 [29] 4.2 (0) [420 (0)]	8.3 [37] 8.5 (0) [850 (0)]	12 [53] 12 (0) [1200 (0)]
2-12.7-P2	0.079 [2]	0.66 [16.7]	0.16 [4]	6.3 [25]	4.8 [21] 0.85 (0.5*) [85 (50*)]	6.6 [29] 2.1 (0.5*) [210 (50*)]	8.3 [37] 4.2 (0.5*) [420 (50*)]	12 [53] 5.9 (0.5*) [590 (50*)]
2-12.7-P3	0.079 [2]	0.66 [16.7]	0.24 [6]	4.2 [17]	4.8 [21] 0.57 (0.57) [57 (57)]	6.6 [29] 1.4 (0.67*) [140 (67*)]	8.3 [37] 2.8 (0.67*) [280 (67*)]	12 [53] 4 (0.67*) [400 (67*)]
2-12.7-P4	0.079 [2]	0.66 [16.7]	0.31 [8]	3.2 [12]	4.8 [21] 0.42 (0.42) [42 (42)]	6.6 [29] 1.1 (0.75*) [110 (75*)]	8.3 [37] 2.1 (0.75*) [210 (75*)]	12 [53] 3 (0.75*) [300 (75*)]
2-14.2-P1	0.079 [2]	0.72 [18.2]	0.079 [2]	13 [50]	4.4 [19] 2.1 (0) [210 (0)]	6 [27] 5.2 (0) [520 (0)]	7.5 [33] 10 (0) [1000 (0)]	11 [48] 14 (0) [1400 (0)]
2-14.2-P2	0.079 [2]	0.72 [18.2]	0.16 [4]	6.3 [25]	4.4 [19] 1 (0.5*) [100 (50*)]	6 [27] 2.6 (0.5*) [260 (50*)]	7.5 [33] 5.2 (0.5*) [520 (50*)]	11 [48] 7.2 (0.5*) [720 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
2-14.2-P3	0.079 [2]	0.72 [18.2]	0.24 [6]	4.2 [17]	4.4 [19] 0.69 (0.67*) [69 (67*)]	6 [27] 1.7 (0.67*) [170 (67*)]	7.5 [33] 3.4 (0.67*) [340 (67*)]	11 [48] 4.8 (0.67*) [480 (67*)]
2-14.2-P4	0.079 [2]	0.72 [18.2]	0.31 [8]	3.2 [12]	4.4 [19] 0.52 (0.52) [52 (52)]	6 [27] 1.3 (0.75*) [130 (75*)]	7.5 [33] 2.6 (0.75*) [260 (75*)]	11 [48] 3.6 (0.75*) [360 (75*)]
2-16-P1	0.079 [2]	0.79 [20]	0.079 [2]	13 [50]	3.9 [17] 2.5 (0) [250 (0)]	5.4 [24] 6.4 (0) [640 (0)]	6.7 [30] 13 (0) [1300 (0)]	9.8 [44] 18 (0) [1800 (0)]
2-16-P2	0.079 [2]	0.79 [20]	0.16 [4]	6.3 [25]	3.9 [17] 1.3 (0.5*) [130 (50*)]	5.4 [24] 3.2 (0.5*) [320 (50*)]	6.7 [30] 6.4 (0.5*) [640 (50*)]	9.8 [44] 8.9 (0.5*) [890 (50*)]
2-16-P3	0.079 [2]	0.79 [20]	0.24 [6]	4.2 [17]	3.9 [17] 0.85 (0.67*) [85 (67*)]	5.4 [24] 2.1 (0.67*) [210 (67*)]	6.7 [30] 4.2 (0.67*) [420 (67*)]	9.8 [44] 5.9 (0.67*) [590 (67*)]
2-16-P4	0.079 [2]	0.79 [20]	0.31 [8]	3.2 [12]	3.9 [17] 0.64 (0.64) [64 (64)]	5.4 [24] 1.6 (0.75*) [160 (75*)]	6.7 [30] 3.2 (0.75*) [320 (75*)]	9.8 [44] 4.5 (0.75*) [440 (75*)]
2-19-P1	0.079 [2]	0.91 [23]	0.079 [2]	13 [50]	3.4 [15] 3.5 (0) [350 (0)]	4.6 [21] 8.7 (0) [870 (0)]	5.8 [26] 17 (0) [1700 (0)]	8.4 [37] 24 (0) [2400 (0)]
2-19-P2	0.079 [2]	0.91 [23]	0.16 [4]	6.3 [25]	3.4 [15] 1.7 (0.5*) [170 (50*)]	4.6 [21] 4.3 (0.5*) [430 (50*)]	5.8 [26] 8.7 (0.5*) [870 (50*)]	8.4 [37] 12 (0.5*) [1200 (50*)]
2-19-P3	0.079 [2]	0.91 [23]	0.24 [6]	4.2 [17]	3.4 [15] 1.2 (0.67*) [120 (67*)]	4.6 [21] 2.9 (0.67*) [290 (67*)]	5.8 [26] 5.8 (0.67*) [580 (67*)]	8.4 [37] 8.1 (0.67*) [810 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
2-19-P4	0.079 [2]	0.91 [23]	0.31 [8]	3.2 [12]	3.4 [15] 0.87 (0.75*) [87 (75*)]	4.6 [21] 2.2 (0.75*) [220 (75*)]	5.8 [26] 4.3 (0.75*) [430 (75*)]	8.4 [37] 6.1 (0.75*) [610 (75*)]
2-22.2-P1	0.079 [2]	1 [26.2]	0.079 [2]	13 [50]	2.9 [13] 4.6 (0) [460 (0)]	4 [18] 12 (0) [1200 (0)]	5 [22] 23 (0) [2300 (0)]	7.3 [32] 32 (0) [3200 (0)]
2-22.2-P2	0.079 [2]	1 [26.2]	0.16 [4]	6.3 [25]	2.9 [13] 2.3 (0.5*) [230 (50*)]	4 [18] 5.8 (0.5*) [580 (50*)]	5 [22] 12 (0.5*) [1200 (50*)]	7.3 [32] 16 (0.5*) [1600 (50*)]
2-22.2-P3	0.079 [2]	1 [26.2]	0.24 [6]	4.2 [17]	2.9 [13] 1.5 (0.67*) [150 (67*)]	4 [18] 3.8 (0.67*) [380 (67*)]	5 [22] 7.7 (0.67*) [770 (67*)]	7.3 [32] 11 (0.67*) [1100 (67*)]
2-22.2-P4	0.079 [2]	1 [26.2]	0.31 [8]	3.2 [12]	2.9 [13] 1.1 (0.75*) [120 (75*)]	4 [18] 2.9 (0.75*) [290 (75*)]	5 [22] 5.8 (0.75*) [580 (75*)]	7.3 [32] 8.1 (0.75*) [800 (75*)]
2-25.4-P1	0.079 [2]	1.2 [29.4]	0.079 [2]	13 [50]	2.6 [11] 5.9 (0) [590 (0)]	3.6 [16] 15 (0) [1500 (0)]	4.4 [20] 29 (0) [2900 (0)]	6.4 [29] 41 (0) [4100 (0)]
2-25.4-P2	0.079 [2]	1.2 [29.4]	0.16 [4]	6.3 [25]	2.6 [11] 3 (0.5*) [300 (50*)]	3.6 [16] 7.4 (0.5*) [740 (50*)]	4.4 [20] 15 (0.5*) [1500 (50*)]	6.4 [29] 21 (0.5*) [2100 (50*)]
2-25.4-P3	0.079 [2]	1.2 [29.4]	0.24 [6]	4.2 [17]	2.6 [11] 2 (0.67*) [200 (67*)]	3.6 [16] 4.9 (0.67*) [490 (67*)]	4.4 [20] 9.8 (0.67*) [980 (67*)]	6.4 [29] 14 (0.67*) [1400 (67*)]
2-25.4-P4	0.079 [2]	1.2 [29.4]	0.31 [8]	3.2 [12]	2.6 [11] 1.5 (0.75*) [150 (75*)]	3.6 [16] 3.7 (0.75*) [370 (75*)]	4.4 [20] 7.4 (0.75*) [740 (75*)]	6.4 [29] 10 (0.75*) [1000 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.15-0.5-P1	0.0059 [0.15]	0.031 [0.8]	0.0059 [0.15]	170 [670]	0.046 [0.2] 0.59 (0) [59 (0)]	0.063 [0.28] 1.5 (0) [150 (0)]	0.079 [0.35] 3 (0) [300 (0)]	0.11 [0.51] 4.1 (0) [410 (0)]
0.15-0.5-P2	0.0059 [0.15]	0.031 [0.8]	0.012 [0.3]	85 [330]	0.046 [0.2] 0.3 (0.3) [30 (30)]	0.063 [0.28] 0.74 (0.5*) [74 (50*)]	0.079 [0.35] 1.5 (0.5*) [150 (50*)]	0.11 [0.51] 2.1 (0.5*) [210 (50*)]
0.15-0.5-P3	0.0059 [0.15]	0.031 [0.8]	0.018 [0.45]	56 [220]	0.046 [0.2] 0.2 (0.2) [20 (20)]	0.063 [0.28] 0.49 (0.49) [49 (49)]	0.079 [0.35] 0.98 (0.67*) [98 (67*)]	0.11 [0.51] 1.4 (0.67*) [140 (67*)]
0.15-0.5-P4	0.0059 [0.15]	0.031 [0.8]	0.024 [0.6]	42 [170]	0.046 [0.2] 0.15 (0.15) [15 (15)]	0.063 [0.28] 0.37 (0.37) [37 (37)]	0.079 [0.35] 0.74 (0.74) [74 (74)]	0.11 [0.51] 1 (0.75*) [100 (75*)]
0.15-0.9-P1	0.0059 [0.15]	0.047 [1.2]	0.0059 [0.15]	170 [670]	0.028 [0.13] 1.5 (0) [150 (0)]	0.039 [0.17] 3.9 (0) [380 (0)]	0.049 [0.22] 7.7 (0) [770 (0)]	0.071 [0.32] 11 (0) [1100 (0)]
0.15-0.9-P2	0.0059 [0.15]	0.047 [1.2]	0.012 [0.3]	85 [330]	0.028 [0.13] 0.77 (0.5*) [77 (50*)]	0.039 [0.17] 1.9 (0.5*) [190 (50*)]	0.049 [0.22] 3.9 (0.5*) [380 (50*)]	0.071 [0.32] 5.4 (0.5*) [540 (50*)]
0.15-0.9-P3	0.0059 [0.15]	0.047 [1.2]	0.018 [0.45]	56 [220]	0.028 [0.13] 0.51 (0.51) [51 (51)]	0.039 [0.17] 1.3 (0.67*) [130 (67*)]	0.049 [0.22] 2.6 (0.67*) [260 (67*)]	0.071 [0.32] 3.6 (0.67*) [360 (67*)]
0.15-0.9-P4	0.0059 [0.15]	0.047 [1.2]	0.024 [0.6]	42 [170]	0.028 [0.13] 0.38 (0.38) [38 (38)]	0.039 [0.17] 0.96 (0.75*) [96 (75*)]	0.049 [0.22] 1.9 (0.75*) [190 (75*)]	0.071 [0.32] 2.7 (0.75*) [270 (75*)]
0.15-1.15-P1	0.0059 [0.15]	0.057 [1.45]	0.0059 [0.15]	170 [670]	0.023 [0.1] 2.4 (0) [240 (0)]	0.032 [0.14] 5.9 (0) [590 (0)]	0.039 [0.18] 12 (0) [1200 (0)]	0.057 [0.25] 17 (0) [1700 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.15-1.15-P2	0.0059 [0.15]	0.057 [1.45]	0.012 [0.3]	85 [330]	0.023 [0.1] 1.2 (0.5*) [120 (50*)]	0.032 [0.14] 3 (0.5*) [300 (50*)]	0.039 [0.18] 5.9 (0.5*) [590 (50*)]	0.057 [0.25] 8.3 (0.5*) [830 (50*)]
0.15-1.15-P3	0.0059 [0.15]	0.057 [1.45]	0.018 [0.45]	56 [220]	0.023 [0.1] 0.79 (0.67*) [79 (67*)]	0.032 [0.14] 2 (0.67*) [200 (67*)]	0.039 [0.18] 3.9 (0.67*) [390 (67*)]	0.057 [0.25] 5.5 (0.67*) [550 (67*)]
0.15-1.15-P4	0.0059 [0.15]	0.057 [1.45]	0.024 [0.6]	42 [170]	0.023 [0.1] 0.59 (0.59) [59 (59)]	0.032 [0.14] 1.5 (0.75*) [150 (75*)]	0.039 [0.18] 3 (0.75*) [300 (75*)]	0.057 [0.25] 4.1 (0.75*) [410 (75*)]
0.15-1.6-P1	0.0059 [0.15]	0.075 [1.9]	0.0059 [0.15]	170 [670]	0.017 [0.076] 4.3 (0) [430 (0)]	0.023 [0.1] 11 (0) [1100 (0)]	0.029 [0.13] 21 (0) [2100 (0)]	0.043 [0.19] 30 (0) [3000 (0)]
0.15-1.6-P2	0.0059 [0.15]	0.075 [1.9]	0.012 [0.3]	85 [330]	0.017 [0.076] 2.1 (0.5*) [210 (50*)]	0.023 [0.1] 5.3 (0.5*) [530 (50*)]	0.029 [0.13] 11 (0.5*) [1100 (50*)]	0.043 [0.19] 15 (0.5*) [1500 (50*)]
0.15-1.6-P3	0.0059 [0.15]	0.075 [1.9]	0.018 [0.45]	56 [220]	0.017 [0.076] 1.4 (0.67*) [140 (67*)]	0.023 [0.1] 3.6 (0.67*) [360 (67*)]	0.029 [0.13] 7.1 (0.67*) [710 (67*)]	0.043 [0.19] 10 (0.67*) [1000 (67*)]
0.15-1.6-P4	0.0059 [0.15]	0.075 [1.9]	0.024 [0.6]	42 [170]	0.017 [0.076] 1.1 (0.75*) [110 (75*)]	0.023 [0.1] 2.7 (0.75*) [270 (75*)]	0.029 [0.13] 5.3 (0.75*) [530 (75*)]	0.043 [0.19] 7.5 (0.75*) [750 (75*)]
0.15-2.4-P1	0.0059 [0.15]	0.11 [2.7]	0.0059 [0.15]	170 [670]	0.012 [0.052] 9.1 (0) [910 (0)]	0.016 [0.072] 23 (0) [2300 (0)]	0.02 [0.089] 45 (0) [4500 (0)]	0.029 [0.13] 64 (0) [6400 (0)]
0.15-2.4-P2	0.0059 [0.15]	0.11 [2.7]	0.012 [0.3]	85 [330]	0.012 [0.052] 4.5 (0.5*) [450 (50*)]	0.016 [0.072] 11 (0.5*) [1100 (50*)]	0.02 [0.089] 23 (0.5*) [2300 (50*)]	0.029 [0.13] 32 (0.5*) [3200 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.15-2.4-P3	0.0059 [0.15]	0.11 [2.7]	0.018 [0.45]	56 [220]	0.012 [0.052] 3 (0.67*) [300 (67*)]	0.016 [0.072] 7.6 (0.67*) [760 (67*)]	0.02 [0.089] 15 (0.67*) [1500 (67*)]	0.029 [0.13] 21 (0.67*) [2100 (67*)]
0.15-2.4-P4	0.0059 [0.15]	0.11 [2.7]	0.024 [0.6]	42 [170]	0.012 [0.052] 2.3 (0.75*) [230 (75*)]	0.016 [0.072] 5.7 (0.75*) [570 (75*)]	0.02 [0.089] 11 (0.75*) [1100 (75*)]	0.029 [0.13] 16 (0.75*) [1600 (75*)]
0.15-3.2-P1	0.0059 [0.15]	0.14 [3.5]	0.0059 [0.15]	170 [670]	0.0089 [0.04] 16 (0) [1600 (0)]	0.012 [0.055] 39 (0) [3900 (0)]	0.015 [0.068] 78 (0) [7800 (0)]	0.022 [0.099] 110 (0) [11000 (0)]
0.15-3.2-P2	0.0059 [0.15]	0.14 [3.5]	0.012 [0.3]	85 [330]	0.0089 [0.04] 7.8 (0.5*) [780 (50*)]	0.012 [0.055] 20 (0.5*) [2000 (50*)]	0.015 [0.068] 39 (0.5*) [3900 (50*)]	0.022 [0.099] 55 (0.5*) [5500 (50*)]
0.15-3.2-P3	0.0059 [0.15]	0.14 [3.5]	0.018 [0.45]	56 [220]	0.0089 [0.04] 5.2 (0.67*) [520 (67*)]	0.012 [0.055] 13 (0.67*) [1300 (67*)]	0.015 [0.068] 26 (0.67*) [2600 (67*)]	0.022 [0.099] 37 (0.67*) [3700 (67*)]
0.15-3.2-P4	0.0059 [0.15]	0.14 [3.5]	0.024 [0.6]	42 [170]	0.0089 [0.04] 3.9 (0.75*) [390 (75*)]	0.012 [0.055] 9.8 (0.75*) [980 (75*)]	0.015 [0.068] 20 (0.75*) [2000 (75*)]	0.022 [0.099] 27 (0.75*) [2700 (75*)]
0.25-0.5-P1	0.0098 [0.25]	0.039 [1]	0.0098 [0.25]	100 [400]	0.18 [0.82] 0.28 (0) [28 (0)]	0.25 [1.1] 0.71 (0) [71 (0)]	0.32 [1.4] 1.4 (0) [140 (0)]	0.46 [2] 2 (0) [200 (0)]
0.25-0.5-P2	0.0098 [0.25]	0.039 [1]	0.02 [0.5]	51 [200]	0.18 [0.82] 0.14 (0.14) [14 (14)]	0.25 [1.1] 0.35 (0.35) [35 (35)]	0.32 [1.4] 0.71 (0.5*) [71 (50*)]	0.46 [2] 0.99 (0.5*) [99 (50*)]
0.25-0.5-P3	0.0098 [0.25]	0.039 [1]	0.03 [0.75]	34 [130]	0.18 [0.82] 0.094 (0.094) [9.4 (9.4)]	0.25 [1.1] 0.24 (0.24) [24 (24)]	0.32 [1.4] 0.47 (0.47) [47 (47)]	0.46 [2] 0.66 (0.66) [66 (66)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25-0.5-P4	0.0098 [0.25]	0.039 [1]	0.039 [1]	25 [100]	0.18 [0.82] 0.071 (0.071) [7.1 (7.1)]	0.25 [1.1] 0.18 (0.18) [18 (18)]	0.32 [1.4] 0.35 (0.35) [35 (35)]	0.46 [2] 0.5 (0.5) [50 (50)]
0.25-0.9-P1	0.0098 [0.25]	0.055 [1.4]	0.0098 [0.25]	100 [400]	0.12 [0.53] 0.66 (0) [66 (0)]	0.17 [0.74] 1.7 (0) [170 (0)]	0.21 [0.92] 3.3 (0) [330 (0)]	0.3 [1.3] 4.7 (0) [460 (0)]
0.25-0.9-P2	0.0098 [0.25]	0.055 [1.4]	0.02 [0.5]	51 [200]	0.12 [0.53] 0.33 (0.33) [33 (33)]	0.17 [0.74] 0.83 (0.5*) [83 (50*)]	0.21 [0.92] 1.7 (0.5*) [170 (50*)]	0.3 [1.3] 2.3 (0.5*) [230 (50*)]
0.25-0.9-P3	0.0098 [0.25]	0.055 [1.4]	0.03 [0.75]	34 [130]	0.12 [0.53] 0.22 (0.22) [22 (22)]	0.17 [0.74] 0.55 (0.55) [55 (55)]	0.21 [0.92] 1.1 (0.67*) [110 (67*)]	0.3 [1.3] 1.6 (0.67*) [160 (67*)]
0.25-0.9-P4	0.0098 [0.25]	0.055 [1.4]	0.039 [1]	25 [100]	0.12 [0.53] 0.17 (0.17) [17 (17)]	0.17 [0.74] 0.42 (0.42) [42 (42)]	0.21 [0.92] 0.83 (0.75*) [83 (75*)]	0.3 [1.3] 1.2 (0.75*) [120 (75*)]
0.25-1.15-P1	0.0098 [0.25]	0.065 [1.65]	0.0098 [0.25]	100 [400]	0.099 [0.44] 0.98 (0) [98 (0)]	0.14 [0.6] 2.5 (0) [250 (0)]	0.17 [0.75] 4.9 (0) [490 (0)]	0.25 [1.1] 6.9 (0) [690 (0)]
0.25-1.15-P2	0.0098 [0.25]	0.065 [1.65]	0.02 [0.5]	51 [200]	0.099 [0.44] 0.49 (0.49) [49 (49)]	0.14 [0.6] 1.2 (0.5*) [120 (50*)]	0.17 [0.75] 2.5 (0.5*) [250 (50*)]	0.25 [1.1] 3.5 (0.5*) [340 (50*)]
0.25-1.15-P3	0.0098 [0.25]	0.065 [1.65]	0.03 [0.75]	34 [130]	0.099 [0.44] 0.33 (0.33) [33 (33)]	0.14 [0.6] 0.82 (0.67*) [82 (67*)]	0.17 [0.75] 1.6 (0.67*) [160 (67*)]	0.25 [1.1] 2.3 (0.67*) [230 (67*)]
0.25-1.15-P4	0.0098 [0.25]	0.065 [1.65]	0.039 [1]	25 [100]	0.099 [0.44] 0.25 (0.25) [25 (25)]	0.14 [0.6] 0.62 (0.62) [62 (62)]	0.17 [0.75] 1.2 (0.75*) [120 (75*)]	0.25 [1.1] 1.7 (0.75*) [170 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25-1.6-P1	0.0098 [0.25]	0.083 [2.1]	0.0098 [0.25]	100 [400]	0.075 [0.33] 1.7 (0) [170 (0)]	0.1 [0.46] 4.3 (0) [430 (0)]	0.13 [0.57] 8.6 (0) [860 (0)]	0.19 [0.83] 12 (0) [1200 (0)]
0.25-1.6-P2	0.0098 [0.25]	0.083 [2.1]	0.02 [0.5]	51 [200]	0.075 [0.33] 0.86 (0.5*) [86 (50*)]	0.1 [0.46] 2.1 (0.5*) [220 (50*)]	0.13 [0.57] 4.3 (0.5*) [430 (50*)]	0.19 [0.83] 6 (0.5*) [600 (50*)]
0.25-1.6-P3	0.0098 [0.25]	0.083 [2.1]	0.03 [0.75]	34 [130]	0.075 [0.33] 0.57 (0.57) [57 (57)]	0.1 [0.46] 1.4 (0.67*) [140 (67*)]	0.13 [0.57] 2.9 (0.67*) [290 (67*)]	0.19 [0.83] 4 (0.67*) [400 (67*)]
0.25-1.6-P4	0.0098 [0.25]	0.083 [2.1]	0.039 [1]	25 [100]	0.075 [0.33] 0.43 (0.43) [43 (43)]	0.1 [0.46] 1.1 (0.75*) [110 (75*)]	0.13 [0.57] 2.1 (0.75*) [220 (75*)]	0.19 [0.83] 3 (0.75*) [300 (75*)]
0.25-2.4-P1	0.0098 [0.25]	0.11 [2.9]	0.0098 [0.25]	100 [400]	0.052 [0.23] 3.5 (0) [350 (0)]	0.072 [0.32] 8.8 (0) [880 (0)]	0.09 [0.4] 18 (0) [1800 (0)]	0.13 [0.58] 25 (0) [2500 (0)]
0.25-2.4-P2	0.0098 [0.25]	0.11 [2.9]	0.02 [0.5]	51 [200]	0.052 [0.23] 1.8 (0.5*) [180 (50*)]	0.072 [0.32] 4.4 (0.5*) [440 (50*)]	0.09 [0.4] 8.8 (0.5*) [880 (50*)]	0.13 [0.58] 12 (0.5*) [1200 (50*)]
0.25-2.4-P3	0.0098 [0.25]	0.11 [2.9]	0.03 [0.75]	34 [130]	0.052 [0.23] 1.2 (0.67*) [120 (67*)]	0.072 [0.32] 2.9 (0.67*) [290 (67*)]	0.09 [0.4] 5.9 (0.67*) [590 (67*)]	0.13 [0.58] 8.2 (0.67*) [820 (67*)]
0.25-2.4-P4	0.0098 [0.25]	0.11 [2.9]	0.039 [1]	25 [100]	0.052 [0.23] 0.88 (0.75*) [88 (75*)]	0.072 [0.32] 2.2 (0.75*) [220 (75*)]	0.09 [0.4] 4.4 (0.75*) [440 (75*)]	0.13 [0.58] 6.2 (0.75*) [620 (75*)]
0.25-3.2-P1	0.0098 [0.25]	0.15 [3.7]	0.0098 [0.25]	100 [400]	0.04 [0.18] 6 (0) [600 (0)]	0.055 [0.25] 15 (0) [1500 (0)]	0.069 [0.31] 30 (0) [3000 (0)]	0.1 [0.44] 42 (0) [4200 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25-3.2-P2	0.0098 [0.25]	0.15 [3.7]	0.02 [0.5]	51 [200]	0.04 [0.18] 3 (0.5*) [300 (50*)]	0.055 [0.25] 7.5 (0.5*) [750 (50*)]	0.069 [0.31] 15 (0.5*) [1500 (50*)]	0.1 [0.44] 21 (0.5*) [2100 (50*)]
0.25-3.2-P3	0.0098 [0.25]	0.15 [3.7]	0.03 [0.75]	34 [130]	0.04 [0.18] 2 (0.67*) [200 (67*)]	0.055 [0.25] 5 (0.67*) [500 (67*)]	0.069 [0.31] 10 (0.67*) [1000 (67*)]	0.1 [0.44] 14 (0.67*) [1400 (67*)]
0.25-3.2-P4	0.0098 [0.25]	0.15 [3.7]	0.039 [1]	25 [100]	0.04 [0.18] 1.5 (0.75*) [150 (75*)]	0.055 [0.25] 3.7 (0.75*) [370 (75*)]	0.069 [0.31] 7.5 (0.75*) [750 (75*)]	0.1 [0.44] 10 (0.75*) [1000 (75*)]
0.4-0.5-P1	0.016 [0.4]	0.051 [1.3]	0.016 [0.4]	64 [250]	0.63 [2.8] 0.16 (0) [16 (0)]	0.87 [3.9] 0.4 (0) [40 (0)]	1.1 [4.8] 0.8 (0) [80 (0)]	1.6 [7] 1.1 (0) [110 (0)]
0.4-0.5-P2	0.016 [0.4]	0.051 [1.3]	0.031 [0.8]	32 [120]	0.63 [2.8] 0.08 (0.08) [8 (8)]	0.87 [3.9] 0.2 (0.2) [20 (20)]	1.1 [4.8] 0.4 (0.4) [40 (40)]	1.6 [7] 0.56 (0.5*) [56 (50*)]
0.4-0.5-P3	0.016 [0.4]	0.051 [1.3]	0.047 [1.2]	21 [83]	0.63 [2.8] 0.053 (0.053) [5.3 (5.3)]	0.87 [3.9] 0.13 (0.13) [13 (13)]	1.1 [4.8] 0.26 (0.26) [26 (26)]	1.6 [7] 0.37 (0.37) [37 (37)]
0.4-0.5-P4	0.016 [0.4]	0.051 [1.3]	0.063 [1.6]	16 [62]	0.63 [2.8] 0.04 (0.04) [4 (4)]	0.87 [3.9] 0.099 (0.099) [9.9 (9.9)]	1.1 [4.8] 0.2 (0.2) [20 (20)]	1.6 [7] 0.28 (0.28) [28 (28)]
0.4-0.9-P1	0.016 [0.4]	0.067 [1.7]	0.016 [0.4]	64 [250]	0.43 [1.9] 0.33 (0) [33 (0)]	0.6 [2.7] 0.83 (0) [83 (0)]	0.75 [3.3] 1.7 (0) [170 (0)]	1.1 [4.8] 2.3 (0) [230 (0)]
0.4-0.9-P2	0.016 [0.4]	0.067 [1.7]	0.031 [0.8]	32 [120]	0.43 [1.9] 0.17 (0.17) [17 (17)]	0.6 [2.7] 0.42 (0.42) [42 (42)]	0.75 [3.3] 0.83 (0.5*) [83 (50*)]	1.1 [4.8] 1.2 (0.5*) [120 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4-0.9-P3	0.016 [0.4]	0.067 [1.7]	0.047 [1.2]	21 [83]	0.43 [1.9] 0.11 (0.11) [11 (11)]	0.6 [2.7] 0.28 (0.28) [28 (28)]	0.75 [3.3] 0.55 (0.55) [55 (55)]	1.1 [4.8] 0.77 (0.67*) [77 (67*)]
0.4-0.9-P4	0.016 [0.4]	0.067 [1.7]	0.063 [1.6]	16 [62]	0.43 [1.9] 0.083 (0.083) [8.3 (8.3)]	0.6 [2.7] 0.21 (0.21) [21 (21)]	0.75 [3.3] 0.42 (0.42) [42 (42)]	1.1 [4.8] 0.58 (0.58) [58 (58)]
0.4-1.15-P1	0.016 [0.4]	0.077 [1.95]	0.016 [0.4]	64 [250]	0.36 [1.6] 0.47 (0) [47 (0)]	0.5 [2.2] 1.2 (0) [120 (0)]	0.63 [2.8] 2.4 (0) [240 (0)]	0.91 [4.1] 3.3 (0) [330 (0)]
0.4-1.15-P2	0.016 [0.4]	0.077 [1.95]	0.031 [0.8]	32 [120]	0.36 [1.6] 0.24 (0.24) [24 (24)]	0.5 [2.2] 0.59 (0.5*) [59 (50*)]	0.63 [2.8] 1.2 (0.5*) [120 (50*)]	0.91 [4.1] 1.6 (0.5*) [160 (50*)]
0.4-1.15-P3	0.016 [0.4]	0.077 [1.95]	0.047 [1.2]	21 [83]	0.36 [1.6] 0.16 (0.16) [16 (16)]	0.5 [2.2] 0.39 (0.39) [39 (39)]	0.63 [2.8] 0.79 (0.67*) [79 (67*)]	0.91 [4.1] 1.1 (0.67*) [110 (67*)]
0.4-1.15-P4	0.016 [0.4]	0.077 [1.95]	0.063 [1.6]	16 [62]	0.36 [1.6] 0.12 (0.12) [12 (12)]	0.5 [2.2] 0.3 (0.3) [30 (30)]	0.63 [2.8] 0.59 (0.59) [59 (59)]	0.91 [4.1] 0.82 (0.75*) [82 (75*)]
0.4-1.6-P1	0.016 [0.4]	0.094 [2.4]	0.016 [0.4]	64 [250]	0.28 [1.3] 0.78 (0) [78 (0)]	0.39 [1.7] 2 (0) [200 (0)]	0.49 [2.2] 3.9 (0) [390 (0)]	0.71 [3.1] 5.5 (0) [550 (0)]
0.4-1.6-P2	0.016 [0.4]	0.094 [2.4]	0.031 [0.8]	32 [120]	0.28 [1.3] 0.39 (0.39) [39 (39)]	0.39 [1.7] 0.98 (0.5*) [98 (50*)]	0.49 [2.2] 2 (0.5*) [200 (50*)]	0.71 [3.1] 2.8 (0.5*) [280 (50*)]
0.4-1.6-P3	0.016 [0.4]	0.094 [2.4]	0.047 [1.2]	21 [83]	0.28 [1.3] 0.26 (0.26) [26 (26)]	0.39 [1.7] 0.66 (0.66) [66 (66)]	0.49 [2.2] 1.3 (0.67*) [130 (67*)]	0.71 [3.1] 1.8 (0.67*) [180 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4-1.6-P4	0.016 [0.4]	0.094 [2.4]	0.063 [1.6]	16 [62]	0.28 [1.3] 0.2 (0.2) [20 (20)]	0.39 [1.7] 0.49 (0.49) [49 (49)]	0.49 [2.2] 0.98 (0.75*) [98 (75*)]	0.71 [3.1] 1.4 (0.75*) [140 (75*)]
0.4-2.4-P1	0.016 [0.4]	0.13 [3.2]	0.016 [0.4]	64 [250]	0.2 [0.9] 1.5 (0) [150 (0)]	0.28 [1.2] 3.9 (0) [380 (0)]	0.35 [1.5] 7.7 (0) [770 (0)]	0.5 [2.2] 11 (0) [1100 (0)]
0.4-2.4-P2	0.016 [0.4]	0.13 [3.2]	0.031 [0.8]	32 [120]	0.2 [0.9] 0.77 (0.5*) [77 (50*)]	0.28 [1.2] 1.9 (0.5*) [190 (50*)]	0.35 [1.5] 3.9 (0.5*) [380 (50*)]	0.5 [2.2] 5.4 (0.5*) [540 (50*)]
0.4-2.4-P3	0.016 [0.4]	0.13 [3.2]	0.047 [1.2]	21 [83]	0.2 [0.9] 0.51 (0.51) [51 (51)]	0.28 [1.2] 1.3 (0.67*) [130 (67*)]	0.35 [1.5] 2.6 (0.67*) [260 (67*)]	0.5 [2.2] 3.6 (0.67*) [360 (67*)]
0.4-2.4-P4	0.016 [0.4]	0.13 [3.2]	0.063 [1.6]	16 [62]	0.2 [0.9] 0.38 (0.38) [38 (38)]	0.28 [1.2] 0.96 (0.75*) [96 (75*)]	0.35 [1.5] 1.9 (0.75*) [190 (75*)]	0.5 [2.2] 2.7 (0.75*) [270 (75*)]
0.4-3.2-P1	0.016 [0.4]	0.16 [4]	0.016 [0.4]	64 [250]	0.16 [0.7] 2.5 (0) [250 (0)]	0.22 [0.96] 6.4 (0) [640 (0)]	0.27 [1.2] 13 (0) [1300 (0)]	0.39 [1.7] 18 (0) [1800 (0)]
0.4-3.2-P2	0.016 [0.4]	0.16 [4]	0.031 [0.8]	32 [120]	0.16 [0.7] 1.3 (0.5*) [130 (50*)]	0.22 [0.96] 3.2 (0.5*) [320 (50*)]	0.27 [1.2] 6.4 (0.5*) [640 (50*)]	0.39 [1.7] 8.9 (0.5*) [890 (50*)]
0.4-3.2-P3	0.016 [0.4]	0.16 [4]	0.047 [1.2]	21 [83]	0.16 [0.7] 0.85 (0.67*) [85 (67*)]	0.22 [0.96] 2.1 (0.67*) [210 (67*)]	0.27 [1.2] 4.2 (0.67*) [420 (67*)]	0.39 [1.7] 5.9 (0.67*) [590 (67*)]
0.4-3.2-P4	0.016 [0.4]	0.16 [4]	0.063 [1.6]	16 [62]	0.16 [0.7] 0.64 (0.64) [64 (64)]	0.22 [0.96] 1.6 (0.75*) [160 (75*)]	0.27 [1.2] 3.2 (0.75*) [320 (75*)]	0.39 [1.7] 4.5 (0.75*) [440 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5-0.5-P1	0.02 [0.5]	0.059 [1.5]	0.02 [0.5]	51 [200]	1.1 [4.9] 0.13 (0) [13 (0)]	1.5 [6.8] 0.31 (0) [31 (0)]	1.9 [8.4] 0.63 (0) [63 (0)]	2.8 [12] 0.88 (0) [88 (0)]
0.5-0.5-P2	0.02 [0.5]	0.059 [1.5]	0.039 [1]	25 [100]	1.1 [4.9] 0.063 (0.063) [6.3 (6.3)]	1.5 [6.8] 0.16 (0.16) [16 (16)]	1.9 [8.4] 0.31 (0.31) [31 (31)]	2.8 [12] 0.44 (0.44) [44 (44)]
0.5-0.5-P3	0.02 [0.5]	0.059 [1.5]	0.059 [1.5]	17 [67]	1.1 [4.9] 0.042 (0.042) [4.2 (4.2)]	1.5 [6.8] 0.1 (0.1) [10 (10)]	1.9 [8.4] 0.21 (0.21) [21 (21)]	2.8 [12] 0.29 (0.29) [29 (29)]
0.5-0.5-P4	0.02 [0.5]	0.059 [1.5]	0.079 [2]	13 [50]	1.1 [4.9] 0.031 (0.031) [3.1 (3.1)]	1.5 [6.8] 0.078 (0.078) [7.8 (7.8)]	1.9 [8.4] 0.16 (0.16) [16 (16)]	2.8 [12] 0.22 (0.22) [22 (22)]
0.5-0.9-P1	0.02 [0.5]	0.075 [1.9]	0.02 [0.5]	51 [200]	0.79 [3.5] 0.25 (0) [25 (0)]	1.1 [4.8] 0.62 (0) [62 (0)]	1.4 [6] 1.2 (0) [120 (0)]	2 [8.8] 1.7 (0) [170 (0)]
0.5-0.9-P2	0.02 [0.5]	0.075 [1.9]	0.039 [1]	25 [100]	0.79 [3.5] 0.12 (0.12) [12 (12)]	1.1 [4.8] 0.31 (0.31) [31 (31)]	1.4 [6] 0.62 (0.5*) [62 (50*)]	2 [8.8] 0.86 (0.5*) [86 (50*)]
0.5-0.9-P3	0.02 [0.5]	0.075 [1.9]	0.059 [1.5]	17 [67]	0.79 [3.5] 0.082 (0.082) [8.2 (8.2)]	1.1 [4.8] 0.2 (0.2) [20 (20)]	1.4 [6] 0.41 (0.41) [41 (41)]	2 [8.8] 0.58 (0.58) [58 (58)]
0.5-0.9-P4	0.02 [0.5]	0.075 [1.9]	0.079 [2]	13 [50]	0.79 [3.5] 0.062 (0.062) [6.2 (6.2)]	1.1 [4.8] 0.15 (0.15) [15 (15)]	1.4 [6] 0.31 (0.31) [31 (31)]	2 [8.8] 0.43 (0.43) [43 (43)]
0.5-1.15-P1	0.02 [0.5]	0.085 [2.15]	0.02 [0.5]	51 [200]	0.67 [3] 0.34 (0) [34 (0)]	0.92 [4.1] 0.86 (0) [86 (0)]	1.2 [5.1] 1.7 (0) [170 (0)]	1.7 [7.4] 2.4 (0) [240 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5-1.15-P2	0.02 [0.5]	0.085 [2.15]	0.039 [1]	25 [100]	0.67 [3] 0.17 (0.17) [17 (17)]	0.92 [4.1] 0.43 (0.43) [43 (43)]	1.2 [5.1] 0.86 (0.5*) [86 (50*)]	1.7 [7.4] 1.2 (0.5*) [120 (50*)]
0.5-1.15-P3	0.02 [0.5]	0.085 [2.15]	0.059 [1.5]	17 [67]	0.67 [3] 0.11 (0.11) [11 (11)]	0.92 [4.1] 0.28 (0.28) [28 (28)]	1.2 [5.1] 0.57 (0.57) [57 (57)]	1.7 [7.4] 0.8 (0.67*) [80 (67*)]
0.5-1.15-P4	0.02 [0.5]	0.085 [2.15]	0.079 [2]	13 [50]	0.67 [3] 0.086 (0.086) [8.6 (8.6)]	0.92 [4.1] 0.21 (0.21) [21 (21)]	1.2 [5.1] 0.43 (0.43) [43 (43)]	1.7 [7.4] 0.6 (0.6) [60 (60)]
0.5-1.6-P1	0.02 [0.5]	0.1 [2.6]	0.02 [0.5]	51 [200]	0.53 [2.3] 0.55 (0) [55 (0)]	0.73 [3.2] 1.4 (0) [140 (0)]	0.9 [4] 2.8 (0) [280 (0)]	1.3 [5.8] 3.9 (0) [390 (0)]
0.5-1.6-P2	0.02 [0.5]	0.1 [2.6]	0.039 [1]	25 [100]	0.53 [2.3] 0.28 (0.28) [28 (28)]	0.73 [3.2] 0.69 (0.5*) [69 (50*)]	0.9 [4] 1.4 (0.5*) [140 (50*)]	1.3 [5.8] 1.9 (0.5*) [190 (50*)]
0.5-1.6-P3	0.02 [0.5]	0.1 [2.6]	0.059 [1.5]	17 [67]	0.53 [2.3] 0.18 (0.18) [18 (18)]	0.73 [3.2] 0.46 (0.46) [46 (46)]	0.9 [4] 0.92 (0.67*) [92 (67*)]	1.3 [5.8] 1.3 (0.67*) [130 (67*)]
0.5-1.6-P4	0.02 [0.5]	0.1 [2.6]	0.079 [2]	13 [50]	0.53 [2.3] 0.14 (0.14) [14 (14)]	0.73 [3.2] 0.35 (0.35) [35 (35)]	0.9 [4] 0.69 (0.69) [69 (69)]	1.3 [5.8] 0.97 (0.75*) [97 (75*)]
0.5-2.4-P1	0.02 [0.5]	0.13 [3.4]	0.02 [0.5]	51 [200]	0.38 [1.7] 1.1 (0) [110 (0)]	0.53 [2.3] 2.6 (0) [260 (0)]	0.65 [2.9] 5.3 (0) [530 (0)]	0.95 [4.2] 7.4 (0) [740 (0)]
0.5-2.4-P2	0.02 [0.5]	0.13 [3.4]	0.039 [1]	25 [100]	0.38 [1.7] 0.53 (0.5*) [53 (50*)]	0.53 [2.3] 1.3 (0.5*) [130 (50*)]	0.65 [2.9] 2.6 (0.5*) [260 (50*)]	0.95 [4.2] 3.7 (0.5*) [370 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5-2.4-P3	0.02 [0.5]	0.13 [3.4]	0.059 [1.5]	17 [67]	0.38 [1.7] 0.35 (0.35) [35 (35)]	0.53 [2.3] 0.88 (0.67*) [88 (67*)]	0.65 [2.9] 1.8 (0.67*) [180 (67*)]	0.95 [4.2] 2.5 (0.67*) [250 (67*)]
0.5-2.4-P4	0.02 [0.5]	0.13 [3.4]	0.079 [2]	13 [50]	0.38 [1.7] 0.26 (0.26) [26 (26)]	0.53 [2.3] 0.66 (0.66) [66 (66)]	0.65 [2.9] 1.3 (0.75*) [130 (75*)]	0.95 [4.2] 1.9 (0.75*) [180 (75*)]
0.5-3.2-P1	0.02 [0.5]	0.17 [4.2]	0.02 [0.5]	51 [200]	0.3 [1.3] 1.7 (0) [170 (0)]	0.41 [1.8] 4.3 (0) [430 (0)]	0.51 [2.3] 8.6 (0) [860 (0)]	0.75 [3.3] 12 (0) [1200 (0)]
0.5-3.2-P2	0.02 [0.5]	0.17 [4.2]	0.039 [1]	25 [100]	0.3 [1.3] 0.86 (0.5*) [86 (50*)]	0.41 [1.8] 2.1 (0.5*) [220 (50*)]	0.51 [2.3] 4.3 (0.5*) [430 (50*)]	0.75 [3.3] 6 (0.5*) [600 (50*)]
0.5-3.2-P3	0.02 [0.5]	0.17 [4.2]	0.059 [1.5]	17 [67]	0.3 [1.3] 0.57 (0.57) [57 (57)]	0.41 [1.8] 1.4 (0.67*) [140 (67*)]	0.51 [2.3] 2.9 (0.67*) [290 (67*)]	0.75 [3.3] 4 (0.67*) [400 (67*)]
0.5-3.2-P4	0.02 [0.5]	0.17 [4.2]	0.079 [2]	13 [50]	0.3 [1.3] 0.43 (0.43) [43 (43)]	0.41 [1.8] 1.1 (0.75*) [110 (75*)]	0.51 [2.3] 2.1 (0.75*) [220 (75*)]	0.75 [3.3] 3 (0.75*) [300 (75*)]
0.75-0.5-P1	0.03 [0.75]	0.079 [2]	0.03 [0.75]	34 [130]	3 [13] 0.087 (0) [8.7 (0)]	4.1 [18] 0.22 (0) [22 (0)]	5.1 [23] 0.44 (0) [44 (0)]	7.4 [33] 0.61 (0) [61 (0)]
0.75-0.5-P2	0.03 [0.75]	0.079 [2]	0.059 [1.5]	17 [67]	3 [13] 0.044 (0.044) [4.4 (4.4)]	4.1 [18] 0.11 (0.11) [11 (11)]	5.1 [23] 0.22 (0.22) [22 (22)]	7.4 [33] 0.3 (0.3) [30 (30)]
0.75-0.5-P3	0.03 [0.75]	0.079 [2]	0.089 [2.25]	11 [44]	3 [13] 0.029 (0.029) [2.9 (2.9)]	4.1 [18] 0.073 (0.073) [7.3 (7.3)]	5.1 [23] 0.14 (0.14) [14 (14)]	7.4 [33] 0.2 (0.2) [20 (20)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.75-0.5-P4	0.03 [0.75]	0.079 [2]	0.12 [3]	8.5 [33]	3 [13] 0.022 (0.022) [2.2 (2.2)]	4.1 [18] 0.055 (0.055) [5.5 (5.5)]	5.1 [23] 0.11 (0.11) [11 (11)]	7.4 [33] 0.15 (0.15) [15 (15)]
0.75-0.9-P1	0.03 [0.75]	0.094 [2.4]	0.03 [0.75]	34 [130]	2.3 [10] 0.15 (0) [15 (0)]	3.1 [14] 0.38 (0) [38 (0)]	3.9 [17] 0.76 (0) [76 (0)]	5.6 [25] 1.1 (0) [110 (0)]
0.75-0.9-P2	0.03 [0.75]	0.094 [2.4]	0.059 [1.5]	17 [67]	2.3 [10] 0.076 (0.076) [7.6 (7.6)]	3.1 [14] 0.19 (0.19) [19 (19)]	3.9 [17] 0.38 (0.38) [38 (38)]	5.6 [25] 0.53 (0.5*) [53 (50*)]
0.75-0.9-P3	0.03 [0.75]	0.094 [2.4]	0.089 [2.25]	11 [44]	2.3 [10] 0.051 (0.051) [5.1 (5.1)]	3.1 [14] 0.13 (0.13) [13 (13)]	3.9 [17] 0.25 (0.25) [25 (25)]	5.6 [25] 0.36 (0.36) [36 (36)]
0.75-0.9-P4	0.03 [0.75]	0.094 [2.4]	0.12 [3]	8.5 [33]	2.3 [10] 0.038 (0.038) [3.8 (3.8)]	3.1 [14] 0.095 (0.095) [9.5 (9.5)]	3.9 [17] 0.19 (0.19) [19 (19)]	5.6 [25] 0.27 (0.27) [27 (27)]
0.75-1.15-P1	0.03 [0.75]	0.1 [2.65]	0.03 [0.75]	34 [130]	2 [8.7] 0.2 (0) [20 (0)]	2.7 [12] 0.5 (0) [50 (0)]	3.4 [15] 1 (0) [100 (0)]	4.9 [22] 1.4 (0) [140 (0)]
0.75-1.15-P2	0.03 [0.75]	0.1 [2.65]	0.059 [1.5]	17 [67]	2 [8.7] 0.1 (0.1) [10 (10)]	2.7 [12] 0.25 (0.25) [25 (25)]	3.4 [15] 0.5 (0.5) [50 (50)]	4.9 [22] 0.71 (0.5*) [71 (50*)]
0.75-1.15-P3	0.03 [0.75]	0.1 [2.65]	0.089 [2.25]	11 [44]	2 [8.7] 0.067 (0.067) [6.7 (6.7)]	2.7 [12] 0.17 (0.17) [17 (17)]	3.4 [15] 0.34 (0.34) [34 (34)]	4.9 [22] 0.47 (0.47) [47 (47)]
0.75-1.15-P4	0.03 [0.75]	0.1 [2.65]	0.12 [3]	8.5 [33]	2 [8.7] 0.05 (0.05) [5 (5)]	2.7 [12] 0.13 (0.13) [13 (13)]	3.4 [15] 0.25 (0.25) [25 (25)]	4.9 [22] 0.35 (0.35) [35 (35)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.75-1.6-P1	0.03 [0.75]	0.12 [3.1]	0.03 [0.75]	34 [130]	1.6 [7] 0.31 (0) [31 (0)]	2.2 [9.7] 0.77 (0) [77 (0)]	2.7 [12] 1.5 (0) [150 (0)]	4 [18] 2.2 (0) [220 (0)]
0.75-1.6-P2	0.03 [0.75]	0.12 [3.1]	0.059 [1.5]	17 [67]	1.6 [7] 0.15 (0.15) [15 (15)]	2.2 [9.7] 0.38 (0.38) [38 (38)]	2.7 [12] 0.77 (0.5*) [77 (50*)]	4 [18] 1.1 (0.5*) [110 (50*)]
0.75-1.6-P3	0.03 [0.75]	0.12 [3.1]	0.089 [2.25]	11 [44]	1.6 [7] 0.1 (0.1) [10 (10)]	2.2 [9.7] 0.26 (0.26) [26 (26)]	2.7 [12] 0.51 (0.51) [51 (51)]	4 [18] 0.72 (0.67*) [72 (67*)]
0.75-1.6-P4	0.03 [0.75]	0.12 [3.1]	0.12 [3]	8.5 [33]	1.6 [7] 0.077 (0.077) [7.7 (7.7)]	2.2 [9.7] 0.19 (0.19) [19 (19)]	2.7 [12] 0.38 (0.38) [38 (38)]	4 [18] 0.54 (0.54) [54 (54)]
0.75-2.4-P1	0.03 [0.75]	0.15 [3.9]	0.03 [0.75]	34 [130]	1.2 [5.3] 0.55 (0) [55 (0)]	1.6 [7.3] 1.4 (0) [140 (0)]	2 [9] 2.8 (0) [280 (0)]	3 [13] 3.9 (0) [390 (0)]
0.75-2.4-P2	0.03 [0.75]	0.15 [3.9]	0.059 [1.5]	17 [67]	1.2 [5.3] 0.28 (0.28) [28 (28)]	1.6 [7.3] 0.69 (0.5*) [69 (50*)]	2 [9] 1.4 (0.5*) [140 (50*)]	3 [13] 1.9 (0.5*) [190 (50*)]
0.75-2.4-P3	0.03 [0.75]	0.15 [3.9]	0.089 [2.25]	11 [44]	1.2 [5.3] 0.18 (0.18) [18 (18)]	1.6 [7.3] 0.46 (0.46) [46 (46)]	2 [9] 0.92 (0.67*) [92 (67*)]	3 [13] 1.3 (0.67*) [130 (67*)]
0.75-2.4-P4	0.03 [0.75]	0.15 [3.9]	0.12 [3]	8.5 [33]	1.2 [5.3] 0.14 (0.14) [14 (14)]	1.6 [7.3] 0.35 (0.35) [35 (35)]	2 [9] 0.69 (0.69) [69 (69)]	3 [13] 0.97 (0.75*) [97 (75*)]
0.75-3.2-P1	0.03 [0.75]	0.19 [4.7]	0.03 [0.75]	34 [130]	0.94 [4.2] 0.87 (0) [87 (0)]	1.3 [5.8] 2.2 (0) [220 (0)]	1.6 [7.2] 4.4 (0) [440 (0)]	2.4 [10] 6.1 (0) [610 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.75-3.2-P2	0.03 [0.75]	0.19 [4.7]	0.059 [1.5]	17 [67]	0.94 [4.2] 0.44 (0.44) [44 (44)]	1.3 [5.8] 1.1 (0.5*) [110 (50*)]	1.6 [7.2] 2.2 (0.5*) [220 (50*)]	2.4 [10] 3 (0.5*) [300 (50*)]
0.75-3.2-P3	0.03 [0.75]	0.19 [4.7]	0.089 [2.25]	11 [44]	0.94 [4.2] 0.29 (0.29) [29 (29)]	1.3 [5.8] 0.73 (0.67*) [73 (67*)]	1.6 [7.2] 1.4 (0.67*) [140 (67*)]	2.4 [10] 2 (0.67*) [200 (67*)]
0.75-3.2-P4	0.03 [0.75]	0.19 [4.7]	0.12 [3]	8.5 [33]	0.94 [4.2] 0.22 (0.22) [22 (22)]	1.3 [5.8] 0.54 (0.54) [54 (54)]	1.6 [7.2] 1.1 (0.75*) [110 (75*)]	2.4 [10] 1.5 (0.75*) [150 (75*)]
1-0.5-P1	0.039 [1]	0.098 [2.5]	0.039 [1]	25 [100]	5.9 [26] 0.071 (0) [7.1 (0)]	8.1 [36] 0.18 (0) [18 (0)]	10 [45] 0.35 (0) [35 (0)]	15 [65] 0.5 (0) [50 (0)]
1-0.5-P2	0.039 [1]	0.098 [2.5]	0.079 [2]	13 [50]	5.9 [26] 0.035 (0.035) [3.5 (3.5)]	8.1 [36] 0.088 (0.088) [8.8 (8.8)]	10 [45] 0.18 (0.18) [18 (18)]	15 [65] 0.25 (0.25) [25 (25)]
1-0.5-P3	0.039 [1]	0.098 [2.5]	0.12 [3]	8.5 [33]	5.9 [26] 0.024 (0.024) [2.4 (2.4)]	8.1 [36] 0.059 (0.059) [5.9 (5.9)]	10 [45] 0.12 (0.12) [12 (12)]	15 [65] 0.16 (0.16) [16 (16)]
1-0.5-P4	0.039 [1]	0.098 [2.5]	0.16 [4]	6.3 [25]	5.9 [26] 0.018 (0.018) [1.8 (1.8)]	8.1 [36] 0.044 (0.044) [4.4 (4.4)]	10 [45] 0.088 (0.088) [8.8 (8.8)]	15 [65] 0.12 (0.12) [12 (12)]
1-0.9-P1	0.039 [1]	0.11 [2.9]	0.039 [1]	25 [100]	4.6 [21] 0.11 (0) [11 (0)]	6.4 [29] 0.28 (0) [28 (0)]	8 [36] 0.57 (0) [57 (0)]	12 [52] 0.79 (0) [79 (0)]
1-0.9-P2	0.039 [1]	0.11 [2.9]	0.079 [2]	13 [50]	4.6 [21] 0.057 (0.057) [5.7 (5.7)]	6.4 [29] 0.14 (0.14) [14 (14)]	8 [36] 0.28 (0.28) [28 (28)]	12 [52] 0.4 (0.4) [40 (40)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1-0.9-P3	0.039 [1]	0.11 [2.9]	0.12 [3]	8.5 [33]	4.6 [21] 0.038 (0.038) [3.8 (3.8)]	6.4 [29] 0.094 (0.094) [9.4 (9.4)]	8 [36] 0.19 (0.19) [19 (19)]	12 [52] 0.26 (0.26) [26 (26)]
1-0.9-P4	0.039 [1]	0.11 [2.9]	0.16 [4]	6.3 [25]	4.6 [21] 0.028 (0.028) [2.8 (2.8)]	6.4 [29] 0.071 (0.071) [7.1 (7.1)]	8 [36] 0.14 (0.14) [14 (14)]	12 [52] 0.2 (0.2) [20 (20)]
1-1.15-P1	0.039 [1]	0.12 [3.15]	0.039 [1]	25 [100]	4.1 [18] 0.14 (0) [14 (0)]	5.7 [25] 0.36 (0) [36 (0)]	7.1 [31] 0.73 (0) [73 (0)]	10 [46] 1 (0) [100 (0)]
1-1.15-P2	0.039 [1]	0.12 [3.15]	0.079 [2]	13 [50]	4.1 [18] 0.073 (0.073) [7.3 (7.3)]	5.7 [25] 0.18 (0.18) [18 (18)]	7.1 [31] 0.36 (0.36) [36 (36)]	10 [46] 0.51 (0.5*) [51 (50*)]
1-1.15-P3	0.039 [1]	0.12 [3.15]	0.12 [3]	8.5 [33]	4.1 [18] 0.048 (0.048) [4.8 (4.8)]	5.7 [25] 0.12 (0.12) [12 (12)]	7.1 [31] 0.24 (0.24) [24 (24)]	10 [46] 0.34 (0.34) [34 (34)]
1-1.15-P4	0.039 [1]	0.12 [3.15]	0.16 [4]	6.3 [25]	4.1 [18] 0.036 (0.036) [3.6 (3.6)]	5.7 [25] 0.091 (0.091) [9.1 (9.1)]	7.1 [31] 0.18 (0.18) [18 (18)]	10 [46] 0.25 (0.25) [25 (25)]
1-1.6-P1	0.039 [1]	0.14 [3.6]	0.039 [1]	25 [100]	3.4 [15] 0.21 (0) [21 (0)]	4.7 [21] 0.53 (0) [53 (0)]	5.8 [26] 1.1 (0) [110 (0)]	8.5 [38] 1.5 (0) [150 (0)]
1-1.6-P2	0.039 [1]	0.14 [3.6]	0.079 [2]	13 [50]	3.4 [15] 0.11 (0.11) [11 (11)]	4.7 [21] 0.27 (0.27) [27 (27)]	5.8 [26] 0.53 (0.5*) [53 (50*)]	8.5 [38] 0.74 (0.5*) [74 (50*)]
1-1.6-P3	0.039 [1]	0.14 [3.6]	0.12 [3]	8.5 [33]	3.4 [15] 0.071 (0.071) [7.1 (7.1)]	4.7 [21] 0.18 (0.18) [18 (18)]	5.8 [26] 0.35 (0.35) [35 (35)]	8.5 [38] 0.5 (0.5) [50 (50)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1-1.6-P4	0.039 [1]	0.14 [3.6]	0.16 [4]	6.3 [25]	3.4 [15] 0.053 (0.053) [5.3 (5.3)]	4.7 [21] 0.13 (0.13) [13 (13)]	5.8 [26] 0.27 (0.27) [27 (27)]	8.5 [38] 0.37 (0.37) [37 (37)]
1-2.4-P1	0.039 [1]	0.17 [4.4]	0.039 [1]	25 [100]	2.6 [12] 0.36 (0) [36 (0)]	3.6 [16] 0.91 (0) [91 (0)]	4.5 [20] 1.8 (0) [180 (0)]	6.5 [29] 2.5 (0) [250 (0)]
1-2.4-P2	0.039 [1]	0.17 [4.4]	0.079 [2]	13 [50]	2.6 [12] 0.18 (0.18) [18 (18)]	3.6 [16] 0.45 (0.45) [45 (45)]	4.5 [20] 0.91 (0.5*) [91 (50*)]	6.5 [29] 1.3 (0.5*) [130 (50*)]
1-2.4-P3	0.039 [1]	0.17 [4.4]	0.12 [3]	8.5 [33]	2.6 [12] 0.12 (0.12) [12 (12)]	3.6 [16] 0.3 (0.3) [30 (30)]	4.5 [20] 0.6 (0.6) [60 (60)]	6.5 [29] 0.85 (0.67*) [85 (67*)]
1-2.4-P4	0.039 [1]	0.17 [4.4]	0.16 [4]	6.3 [25]	2.6 [12] 0.091 (0.091) [9.1 (9.1)]	3.6 [16] 0.23 (0.23) [23 (23)]	4.5 [20] 0.45 (0.45) [45 (45)]	6.5 [29] 0.64 (0.64) [64 (64)]
1-3.2-P1	0.039 [1]	0.2 [5.2]	0.039 [1]	25 [100]	2.1 [9.3] 0.55 (0) [55 (0)]	2.9 [13] 1.4 (0) [140 (0)]	3.6 [16] 2.8 (0) [280 (0)]	5.3 [23] 3.9 (0) [390 (0)]
1-3.2-P2	0.039 [1]	0.2 [5.2]	0.079 [2]	13 [50]	2.1 [9.3] 0.28 (0.28) [28 (28)]	2.9 [13] 0.69 (0.5*) [69 (50*)]	3.6 [16] 1.4 (0.5*) [140 (50*)]	5.3 [23] 1.9 (0.5*) [190 (50*)]
1-3.2-P3	0.039 [1]	0.2 [5.2]	0.12 [3]	8.5 [33]	2.1 [9.3] 0.18 (0.18) [18 (18)]	2.9 [13] 0.46 (0.46) [46 (46)]	3.6 [16] 0.92 (0.67*) [92 (67*)]	5.3 [23] 1.3 (0.67*) [130 (67*)]
1-3.2-P4	0.039 [1]	0.2 [5.2]	0.16 [4]	6.3 [25]	2.1 [9.3] 0.14 (0.14) [14 (14)]	2.9 [13] 0.35 (0.35) [35 (35)]	3.6 [16] 0.69 (0.69) [69 (69)]	5.3 [23] 0.97 (0.75*) [97 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.25-0.5-P1	0.049 [1.25]	0.12 [3]	0.049 [1.25]	20 [80]	9.9 [44] 0.062 (0) [6.2 (0)]	14 [60] 0.15 (0) [15 (0)]	17 [75] 0.31 (0) [31 (0)]	25 [110] 0.43 (0) [43 (0)]
1.25-0.5-P2	0.049 [1.25]	0.12 [3]	0.098 [2.5]	10 [40]	9.9 [44] 0.031 (0.031) [3.1 (3.1)]	14 [60] 0.077 (0.077) [7.7 (7.7)]	17 [75] 0.15 (0.15) [15 (15)]	25 [110] 0.22 (0.22) [22 (22)]
1.25-0.5-P3	0.049 [1.25]	0.12 [3]	0.15 [3.75]	6.8 [27]	9.9 [44] 0.02 (0.02) [2 (2)]	14 [60] 0.051 (0.051) [5.1 (5.1)]	17 [75] 0.1 (0.1) [10 (10)]	25 [110] 0.14 (0.14) [14 (14)]
1.25-0.5-P4	0.049 [1.25]	0.12 [3]	0.2 [5]	5.1 [20]	9.9 [44] 0.015 (0.015) [1.5 (1.5)]	14 [60] 0.039 (0.039) [3.9 (3.9)]	17 [75] 0.077 (0.077) [7.7 (7.7)]	25 [110] 0.11 (0.11) [11 (11)]
1.25-0.9-P1	0.049 [1.25]	0.13 [3.4]	0.049 [1.25]	20 [80]	8 [36] 0.093 (0) [9.3 (0)]	11 [49] 0.23 (0) [23 (0)]	14 [61] 0.46 (0) [46 (0)]	20 [89] 0.65 (0) [65 (0)]
1.25-0.9-P2	0.049 [1.25]	0.13 [3.4]	0.098 [2.5]	10 [40]	8 [36] 0.047 (0.047) [4.7 (4.7)]	11 [49] 0.12 (0.12) [12 (12)]	14 [61] 0.23 (0.23) [23 (23)]	20 [89] 0.32 (0.32) [32 (32)]
1.25-0.9-P3	0.049 [1.25]	0.13 [3.4]	0.15 [3.75]	6.8 [27]	8 [36] 0.031 (0.031) [3.1 (3.1)]	11 [49] 0.078 (0.078) [7.8 (7.8)]	14 [61] 0.16 (0.16) [16 (16)]	20 [89] 0.22 (0.22) [22 (22)]
1.25-0.9-P4	0.049 [1.25]	0.13 [3.4]	0.2 [5]	5.1 [20]	8 [36] 0.023 (0.023) [2.3 (2.3)]	11 [49] 0.058 (0.058) [5.8 (5.8)]	14 [61] 0.12 (0.12) [12 (12)]	20 [89] 0.16 (0.16) [16 (16)]
1.25-1.15-P1	0.049 [1.25]	0.14 [3.65]	0.049 [1.25]	20 [80]	7.2 [32] 0.12 (0) [12 (0)]	9.9 [44] 0.29 (0) [29 (0)]	12 [55] 0.58 (0) [58 (0)]	18 [80] 0.81 (0) [81 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.25-1.15-P2	0.049 [1.25]	0.14 [3.65]	0.098 [2.5]	10 [40]	7.2 [32] 0.058 (0.058) [5.8 (5.8)]	9.9 [44] 0.14 (0.14) [14 (14)]	12 [55] 0.29 (0.29) [29 (29)]	18 [80] 0.4 (0.4) [40 (40)]
1.25-1.15-P3	0.049 [1.25]	0.14 [3.65]	0.15 [3.75]	6.8 [27]	7.2 [32] 0.039 (0.039) [3.9 (3.9)]	9.9 [44] 0.097 (0.097) [9.7 (9.7)]	12 [55] 0.19 (0.19) [19 (19)]	18 [80] 0.27 (0.27) [27 (27)]
1.25-1.15-P4	0.049 [1.25]	0.14 [3.65]	0.2 [5]	5.1 [20]	7.2 [32] 0.029 (0.029) [2.9 (2.9)]	9.9 [44] 0.072 (0.072) [7.2 (7.2)]	12 [55] 0.14 (0.14) [14 (14)]	18 [80] 0.2 (0.2) [20 (20)]
1.25-1.6-P1	0.049 [1.25]	0.16 [4.1]	0.049 [1.25]	20 [80]	6 [27] 0.16 (0) [16 (0)]	8.3 [37] 0.41 (0) [41 (0)]	10 [46] 0.82 (0) [82 (0)]	15 [67] 1.1 (0) [110 (0)]
1.25-1.6-P2	0.049 [1.25]	0.16 [4.1]	0.098 [2.5]	10 [40]	6 [27] 0.082 (0.082) [8.2 (8.2)]	8.3 [37] 0.2 (0.2) [20 (20)]	10 [46] 0.41 (0.41) [41 (41)]	15 [67] 0.57 (0.5*) [57 (50*)]
1.25-1.6-P3	0.049 [1.25]	0.16 [4.1]	0.15 [3.75]	6.8 [27]	6 [27] 0.054 (0.054) [5.4 (5.4)]	8.3 [37] 0.14 (0.14) [14 (14)]	10 [46] 0.27 (0.27) [27 (27)]	15 [67] 0.38 (0.38) [38 (38)]
1.25-1.6-P4	0.049 [1.25]	0.16 [4.1]	0.2 [5]	5.1 [20]	6 [27] 0.041 (0.041) [4.1 (4.1)]	8.3 [37] 0.1 (0.1) [10 (10)]	10 [46] 0.2 (0.2) [20 (20)]	15 [67] 0.29 (0.29) [29 (29)]
1.25-2.4-P1	0.049 [1.25]	0.19 [4.9]	0.049 [1.25]	20 [80]	4.7 [21] 0.27 (0) [27 (0)]	6.5 [29] 0.67 (0) [67 (0)]	8.1 [36] 1.3 (0) [130 (0)]	12 [53] 1.9 (0) [190 (0)]
1.25-2.4-P2	0.049 [1.25]	0.19 [4.9]	0.098 [2.5]	10 [40]	4.7 [21] 0.13 (0.13) [13 (13)]	6.5 [29] 0.34 (0.34) [34 (34)]	8.1 [36] 0.67 (0.5*) [67 (50*)]	12 [53] 0.94 (0.5*) [94 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.25-2.4-P3	0.049 [1.25]	0.19 [4.9]	0.15 [3.75]	6.8 [27]	4.7 [21] 0.089 (0.089) [8.9 (8.9)]	6.5 [29] 0.22 (0.22) [22 (22)]	8.1 [36] 0.45 (0.45) [45 (45)]	12 [53] 0.62 (0.62) [62 (62)]
1.25-2.4-P4	0.049 [1.25]	0.19 [4.9]	0.2 [5]	5.1 [20]	4.7 [21] 0.067 (0.067) [6.7 (6.7)]	6.5 [29] 0.17 (0.17) [17 (17)]	8.1 [36] 0.34 (0.34) [34 (34)]	12 [53] 0.47 (0.47) [47 (47)]
1.25-3.2-P1	0.049 [1.25]	0.22 [5.7]	0.049 [1.25]	20 [80]	3.9 [17] 0.4 (0) [40 (0)]	5.3 [24] 1 (0) [100 (0)]	6.7 [30] 2 (0) [200 (0)]	9.7 [43] 2.8 (0) [280 (0)]
1.25-3.2-P2	0.049 [1.25]	0.22 [5.7]	0.098 [2.5]	10 [40]	3.9 [17] 0.2 (0.2) [20 (20)]	5.3 [24] 0.5 (0.5) [50 (50)]	6.7 [30] 1 (0.5*) [100 (50*)]	9.7 [43] 1.4 (0.5*) [140 (50*)]
1.25-3.2-P3	0.049 [1.25]	0.22 [5.7]	0.15 [3.75]	6.8 [27]	3.9 [17] 0.13 (0.13) [13 (13)]	5.3 [24] 0.33 (0.33) [33 (33)]	6.7 [30] 0.66 (0.66) [66 (66)]	9.7 [43] 0.93 (0.67*) [93 (67*)]
1.25-3.2-P4	0.049 [1.25]	0.22 [5.7]	0.2 [5]	5.1 [20]	3.9 [17] 0.099 (0.099) [9.9 (9.9)]	5.3 [24] 0.25 (0.25) [25 (25)]	6.7 [30] 0.5 (0.5) [50 (50)]	9.7 [43] 0.7 (0.7) [70 (70)]
1.5-0.5-P1	0.059 [1.5]	0.14 [3.5]	0.059 [1.5]	17 [67]	15 [66] 0.056 (0) [5.6 (0)]	21 [91] 0.14 (0) [14 (0)]	26 [110] 0.28 (0) [28 (0)]	37 [170] 0.39 (0) [39 (0)]
1.5-0.5-P2	0.059 [1.5]	0.14 [3.5]	0.12 [3]	8.5 [33]	15 [66] 0.028 (0.028) [2.8 (2.8)]	21 [91] 0.07 (0.07) [7 (7)]	26 [110] 0.14 (0.14) [14 (14)]	37 [170] 0.2 (0.2) [20 (20)]
1.5-0.5-P3	0.059 [1.5]	0.14 [3.5]	0.18 [4.5]	5.6 [22]	15 [66] 0.019 (0.019) [1.9 (1.9)]	21 [91] 0.047 (0.047) [4.7 (4.7)]	26 [110] 0.093 (0.093) [9.3 (9.3)]	37 [170] 0.13 (0.13) [13 (13)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5-0.5-P4	0.059 [1.5]	0.14 [3.5]	0.24 [6]	4.2 [17]	15 [66] 0.014 (0.014) [1.4 (1.4)]	21 [91] 0.035 (0.035) [3.5 (3.5)]	26 [110] 0.07 (0.07) [7 (7)]	37 [170] 0.098 (0.098) [9.8 (9.8)]
1.5-0.9-P1	0.059 [1.5]	0.15 [3.9]	0.059 [1.5]	17 [67]	12 [55] 0.08 (0) [8 (0)]	17 [76] 0.2 (0) [20 (0)]	21 [95] 0.4 (0) [40 (0)]	31 [140] 0.56 (0) [56 (0)]
1.5-0.9-P2	0.059 [1.5]	0.15 [3.9]	0.12 [3]	8.5 [33]	12 [55] 0.04 (0.04) [4 (4)]	17 [76] 0.1 (0.1) [10 (10)]	21 [95] 0.2 (0.2) [20 (20)]	31 [140] 0.28 (0.28) [28 (28)]
1.5-0.9-P3	0.059 [1.5]	0.15 [3.9]	0.18 [4.5]	5.6 [22]	12 [55] 0.027 (0.027) [2.7 (2.7)]	17 [76] 0.067 (0.067) [6.7 (6.7)]	21 [95] 0.13 (0.13) [13 (13)]	31 [140] 0.19 (0.19) [19 (19)]
1.5-0.9-P4	0.059 [1.5]	0.15 [3.9]	0.24 [6]	4.2 [17]	12 [55] 0.02 (0.02) [2 (2)]	17 [76] 0.05 (0.05) [5 (5)]	21 [95] 0.1 (0.1) [10 (10)]	31 [140] 0.14 (0.14) [14 (14)]
1.5-1.15-P1	0.059 [1.5]	0.16 [4.15]	0.059 [1.5]	17 [67]	11 [50] 0.098 (0) [9.8 (0)]	16 [69] 0.24 (0) [24 (0)]	19 [86] 0.49 (0) [49 (0)]	28 [120] 0.69 (0) [69 (0)]
1.5-1.15-P2	0.059 [1.5]	0.16 [4.15]	0.12 [3]	8.5 [33]	11 [50] 0.049 (0.049) [4.9 (4.9)]	16 [69] 0.12 (0.12) [12 (12)]	19 [86] 0.24 (0.24) [24 (24)]	28 [120] 0.34 (0.34) [34 (34)]
1.5-1.15-P3	0.059 [1.5]	0.16 [4.15]	0.18 [4.5]	5.6 [22]	11 [50] 0.033 (0.033) [3.3 (3.3)]	16 [69] 0.082 (0.082) [8.2 (8.2)]	19 [86] 0.16 (0.16) [16 (16)]	28 [120] 0.23 (0.23) [23 (23)]
1.5-1.15-P4	0.059 [1.5]	0.16 [4.15]	0.24 [6]	4.2 [17]	11 [50] 0.025 (0.025) [2.5 (2.5)]	16 [69] 0.061 (0.061) [6.1 (6.1)]	19 [86] 0.12 (0.12) [12 (12)]	28 [120] 0.17 (0.17) [17 (17)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5-1.6-P1	0.059 [1.5]	0.18 [4.6]	0.059 [1.5]	17 [67]	9.6 [43] 0.13 (0) [13 (0)]	13 [59] 0.34 (0) [34 (0)]	17 [74] 0.67 (0) [67 (0)]	24 [110] 0.94 (0) [94 (0)]
1.5-1.6-P2	0.059 [1.5]	0.18 [4.6]	0.12 [3]	8.5 [33]	9.6 [43] 0.067 (0.067) [6.7 (6.7)]	13 [59] 0.17 (0.17) [17 (17)]	17 [74] 0.34 (0.34) [34 (34)]	24 [110] 0.47 (0.47) [47 (47)]
1.5-1.6-P3	0.059 [1.5]	0.18 [4.6]	0.18 [4.5]	5.6 [22]	9.6 [43] 0.045 (0.045) [4.5 (4.5)]	13 [59] 0.11 (0.11) [11 (11)]	17 [74] 0.22 (0.22) [22 (22)]	24 [110] 0.31 (0.31) [31 (31)]
1.5-1.6-P4	0.059 [1.5]	0.18 [4.6]	0.24 [6]	4.2 [17]	9.6 [43] 0.034 (0.034) [3.4 (3.4)]	13 [59] 0.084 (0.084) [8.4 (8.4)]	17 [74] 0.17 (0.17) [17 (17)]	24 [110] 0.24 (0.24) [24 (24)]
1.5-2.4-P1	0.059 [1.5]	0.21 [5.4]	0.059 [1.5]	17 [67]	7.6 [34] 0.21 (0) [21 (0)]	11 [47] 0.53 (0) [53 (0)]	13 [58] 1.1 (0) [110 (0)]	19 [85] 1.5 (0) [150 (0)]
1.5-2.4-P2	0.059 [1.5]	0.21 [5.4]	0.12 [3]	8.5 [33]	7.6 [34] 0.11 (0.11) [11 (11)]	11 [47] 0.27 (0.27) [27 (27)]	13 [58] 0.53 (0.5*) [53 (50*)]	19 [85] 0.74 (0.5*) [74 (50*)]
1.5-2.4-P3	0.059 [1.5]	0.21 [5.4]	0.18 [4.5]	5.6 [22]	7.6 [34] 0.071 (0.071) [7.1 (7.1)]	11 [47] 0.18 (0.18) [18 (18)]	13 [58] 0.35 (0.35) [35 (35)]	19 [85] 0.5 (0.5) [50 (50)]
1.5-2.4-P4	0.059 [1.5]	0.21 [5.4]	0.24 [6]	4.2 [17]	7.6 [34] 0.053 (0.053) [5.3 (5.3)]	11 [47] 0.13 (0.13) [13 (13)]	13 [58] 0.27 (0.27) [27 (27)]	19 [85] 0.37 (0.37) [37 (37)]
1.5-3.2-P1	0.059 [1.5]	0.24 [6.2]	0.059 [1.5]	17 [67]	6.3 [28] 0.31 (0) [31 (0)]	8.7 [39] 0.77 (0) [77 (0)]	11 [48] 1.5 (0) [150 (0)]	16 [70] 2.2 (0) [220 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5-3.2-P2	0.059 [1.5]	0.24 [6.2]	0.12 [3]	8.5 [33]	6.3 [28] 0.15 (0.15) [15 (15)]	8.7 [39] 0.38 (0.38) [38 (38)]	11 [48] 0.77 (0.5*) [77 (50*)]	16 [70] 1.1 (0.5*) [110 (50*)]
1.5-3.2-P3	0.059 [1.5]	0.24 [6.2]	0.18 [4.5]	5.6 [22]	6.3 [28] 0.1 (0.1) [10 (10)]	8.7 [39] 0.26 (0.26) [26 (26)]	11 [48] 0.51 (0.51) [51 (51)]	16 [70] 0.72 (0.67*) [72 (67*)]
1.5-3.2-P4	0.059 [1.5]	0.24 [6.2]	0.24 [6]	4.2 [17]	6.3 [28] 0.077 (0.077) [7.7 (7.7)]	8.7 [39] 0.19 (0.19) [19 (19)]	11 [48] 0.38 (0.38) [38 (38)]	16 [70] 0.54 (0.54) [54 (54)]
2-0.5-P1	0.079 [2]	0.18 [4.5]	0.079 [2]	13 [50]	28 [130] 0.049 (0) [4.9 (0)]	39 [170] 0.12 (0) [12 (0)]	49 [220] 0.24 (0) [24 (0)]	71 [310] 0.34 (0) [34 (0)]
2-0.5-P2	0.079 [2]	0.18 [4.5]	0.16 [4]	6.3 [25]	28 [130] 0.025 (0.025) [2.5 (2.5)]	39 [170] 0.061 (0.061) [6.1 (6.1)]	49 [220] 0.12 (0.12) [12 (12)]	71 [310] 0.17 (0.17) [17 (17)]
2-0.5-P3	0.079 [2]	0.18 [4.5]	0.24 [6]	4.2 [17]	28 [130] 0.016 (0.016) [1.6 (1.6)]	39 [170] 0.041 (0.041) [4.1 (4.1)]	49 [220] 0.082 (0.082) [8.2 (8.2)]	71 [310] 0.11 (0.11) [11 (11)]
2-0.5-P4	0.079 [2]	0.18 [4.5]	0.31 [8]	3.2 [12]	28 [130] 0.012 (0.012) [1.2 (1.2)]	39 [170] 0.031 (0.031) [3.1 (3.1)]	49 [220] 0.061 (0.061) [6.1 (6.1)]	71 [310] 0.086 (0.086) [8.6 (8.6)]
2-0.9-P1	0.079 [2]	0.19 [4.9]	0.079 [2]	13 [50]	24 [110] 0.066 (0) [6.6 (0)]	34 [150] 0.16 (0) [16 (0)]	42 [190] 0.33 (0) [33 (0)]	61 [270] 0.46 (0) [46 (0)]
2-0.9-P2	0.079 [2]	0.19 [4.9]	0.16 [4]	6.3 [25]	24 [110] 0.033 (0.033) [3.3 (3.3)]	34 [150] 0.083 (0.083) [8.3 (8.3)]	42 [190] 0.16 (0.16) [16 (16)]	61 [270] 0.23 (0.23) [23 (23)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
2-0.9-P3	0.079 [2]	0.19 [4.9]	0.24 [6]	4.2 [17]	24 [110] 0.022 (0.022) [2.2 (2.2)]	34 [150] 0.055 (0.055) [5.5 (5.5)]	42 [190] 0.11 (0.11) [11 (11)]	61 [270] 0.15 (0.15) [15 (15)]
2-0.9-P4	0.079 [2]	0.19 [4.9]	0.31 [8]	3.2 [12]	24 [110] 0.016 (0.016) [1.6 (1.6)]	34 [150] 0.041 (0.041) [4.1 (4.1)]	42 [190] 0.083 (0.083) [8.3 (8.3)]	61 [270] 0.12 (0.12) [12 (12)]
2-1.15-P1	0.079 [2]	0.2 [5.15]	0.079 [2]	13 [50]	22 [100] 0.078 (0) [7.8 (0)]	31 [140] 0.2 (0) [20 (0)]	39 [170] 0.39 (0) [39 (0)]	56 [250] 0.54 (0) [54 (0)]
2-1.15-P2	0.079 [2]	0.2 [5.15]	0.16 [4]	6.3 [25]	22 [100] 0.039 (0.039) [3.9 (3.9)]	31 [140] 0.097 (0.097) [9.7 (9.7)]	39 [170] 0.2 (0.2) [20 (20)]	56 [250] 0.27 (0.27) [27 (27)]
2-1.15-P3	0.079 [2]	0.2 [5.15]	0.24 [6]	4.2 [17]	22 [100] 0.026 (0.026) [2.6 (2.6)]	31 [140] 0.065 (0.065) [6.5 (6.5)]	39 [170] 0.13 (0.13) [13 (13)]	56 [250] 0.18 (0.18) [18 (18)]
2-1.15-P4	0.079 [2]	0.2 [5.15]	0.31 [8]	3.2 [12]	22 [100] 0.019 (0.019) [1.9 (1.9)]	31 [140] 0.049 (0.049) [4.9 (4.9)]	39 [170] 0.097 (0.097) [9.7 (9.7)]	56 [250] 0.14 (0.14) [14 (14)]
2-1.6-P1	0.079 [2]	0.22 [5.6]	0.079 [2]	13 [50]	20 [87] 0.1 (0) [10 (0)]	27 [120] 0.25 (0) [25 (0)]	34 [150] 0.51 (0) [51 (0)]	49 [220] 0.71 (0) [71 (0)]
2-1.6-P2	0.079 [2]	0.22 [5.6]	0.16 [4]	6.3 [25]	20 [87] 0.051 (0.051) [5.1 (5.1)]	27 [120] 0.13 (0.13) [13 (13)]	34 [150] 0.25 (0.25) [25 (25)]	49 [220] 0.36 (0.36) [36 (36)]
2-1.6-P3	0.079 [2]	0.22 [5.6]	0.24 [6]	4.2 [17]	20 [87] 0.034 (0.034) [3.4 (3.4)]	27 [120] 0.085 (0.085) [8.5 (8.5)]	34 [150] 0.17 (0.17) [17 (17)]	49 [220] 0.24 (0.24) [24 (24)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
2-1.6-P4	0.079 [2]	0.22 [5.6]	0.31 [8]	3.2 [12]	20 [87] 0.025 (0.025) [2.5 (2.5)]	27 [120] 0.064 (0.064) [6.4 (6.4)]	34 [150] 0.13 (0.13) [13 (13)]	49 [220] 0.18 (0.18) [18 (18)]
2-2.4-P1	0.079 [2]	0.25 [6.4]	0.079 [2]	13 [50]	16 [71] 0.15 (0) [15 (0)]	22 [99] 0.38 (0) [38 (0)]	28 [120] 0.76 (0) [76 (0)]	40 [180] 1.1 (0) [110 (0)]
2-2.4-P2	0.079 [2]	0.25 [6.4]	0.16 [4]	6.3 [25]	16 [71] 0.076 (0.076) [7.6 (7.6)]	22 [99] 0.19 (0.19) [19 (19)]	28 [120] 0.38 (0.38) [38 (38)]	40 [180] 0.53 (0.5*) [53 (50*)]
2-2.4-P3	0.079 [2]	0.25 [6.4]	0.24 [6]	4.2 [17]	16 [71] 0.051 (0.051) [5.1 (5.1)]	22 [99] 0.13 (0.13) [13 (13)]	28 [120] 0.25 (0.25) [25 (25)]	40 [180] 0.36 (0.36) [36 (36)]
2-2.4-P4	0.079 [2]	0.25 [6.4]	0.31 [8]	3.2 [12]	16 [71] 0.038 (0.038) [3.8 (3.8)]	22 [99] 0.095 (0.095) [9.5 (9.5)]	28 [120] 0.19 (0.19) [19 (19)]	40 [180] 0.27 (0.27) [27 (27)]
2-3.2-P1	0.079 [2]	0.28 [7.2]	0.079 [2]	13 [50]	14 [60] 0.21 (0) [21 (0)]	19 [83] 0.53 (0) [53 (0)]	23 [100] 1.1 (0) [110 (0)]	34 [150] 1.5 (0) [150 (0)]
2-3.2-P2	0.079 [2]	0.28 [7.2]	0.16 [4]	6.3 [25]	14 [60] 0.11 (0.11) [11 (11)]	19 [83] 0.27 (0.27) [27 (27)]	23 [100] 0.53 (0.5*) [53 (50*)]	34 [150] 0.74 (0.5*) [74 (50*)]
2-3.2-P3	0.079 [2]	0.28 [7.2]	0.24 [6]	4.2 [17]	14 [60] 0.071 (0.071) [7.1 (7.1)]	19 [83] 0.18 (0.18) [18 (18)]	23 [100] 0.35 (0.35) [35 (35)]	34 [150] 0.5 (0.5) [50 (50)]
2-3.2-P4	0.079 [2]	0.28 [7.2]	0.31 [8]	3.2 [12]	14 [60] 0.053 (0.053) [5.3 (5.3)]	19 [83] 0.13 (0.13) [13 (13)]	23 [100] 0.27 (0.27) [27 (27)]	34 [150] 0.37 (0.37) [37 (37)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
3-0.5-P1	0.12 [3]	0.26 [6.5]	0.12 [3]	8.5 [33]	68 [300] 0.043 (0) [4.3 (0)]	94 [420] 0.11 (0) [11 (0)]	120 [520] 0.21 (0) [21 (0)]	170 [760] 0.3 (0) [30 (0)]
3-0.5-P2	0.12 [3]	0.26 [6.5]	0.24 [6]	4.2 [17]	68 [300] 0.021 (0.021) [2.1 (2.1)]	94 [420] 0.053 (0.053) [5.3 (5.3)]	120 [520] 0.11 (0.11) [11 (11)]	170 [760] 0.15 (0.15) [15 (15)]
3-0.5-P3	0.12 [3]	0.26 [6.5]	0.35 [9]	2.8 [11]	68 [300] 0.014 (0.014) [1.4 (1.4)]	94 [420] 0.036 (0.036) [3.6 (3.6)]	120 [520] 0.071 (0.071) [7.1 (7.1)]	170 [760] 0.1 (0.1) [10 (10)]
3-0.5-P4	0.12 [3]	0.26 [6.5]	0.47 [12]	2.1 [8.3]	68 [300] 0.011 (0.011) [1.1 (1.1)]	94 [420] 0.027 (0.027) [2.7 (2.7)]	120 [520] 0.053 (0.053) [5.3 (5.3)]	170 [760] 0.075 (0.075) [7.5 (7.5)]
3-0.9-P1	0.12 [3]	0.27 [6.9]	0.12 [3]	8.5 [33]	61 [270] 0.053 (0) [5.3 (0)]	84 [380] 0.13 (0) [13 (0)]	100 [470] 0.27 (0) [27 (0)]	150 [680] 0.37 (0) [37 (0)]
3-0.9-P2	0.12 [3]	0.27 [6.9]	0.24 [6]	4.2 [17]	61 [270] 0.026 (0.026) [2.6 (2.6)]	84 [380] 0.066 (0.066) [6.6 (6.6)]	100 [470] 0.13 (0.13) [13 (13)]	150 [680] 0.19 (0.19) [19 (19)]
3-0.9-P3	0.12 [3]	0.27 [6.9]	0.35 [9]	2.8 [11]	61 [270] 0.018 (0.018) [1.8 (1.8)]	84 [380] 0.044 (0.044) [4.4 (4.4)]	100 [470] 0.088 (0.088) [8.8 (8.8)]	150 [680] 0.12 (0.12) [12 (12)]
3-0.9-P4	0.12 [3]	0.27 [6.9]	0.47 [12]	2.1 [8.3]	61 [270] 0.013 (0.013) [1.3 (1.3)]	84 [380] 0.033 (0.033) [3.3 (3.3)]	100 [470] 0.066 (0.066) [6.6 (6.6)]	150 [680] 0.093 (0.093) [9.3 (9.3)]
3-1.15-P1	0.12 [3]	0.28 [7.15]	0.12 [3]	8.5 [33]	57 [260] 0.06 (0) [6 (0)]	79 [350] 0.15 (0) [15 (0)]	99 [440] 0.3 (0) [30 (0)]	140 [640] 0.42 (0) [42 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
3-1.15-P2	0.12 [3]	0.28 [7.15]	0.24 [6]	4.2 [17]	57 [260] 0.03 (0.03) [3 (3)]	79 [350] 0.075 (0.075) [7.5 (7.5)]	99 [440] 0.15 (0.15) [15 (15)]	140 [640] 0.21 (0.21) [21 (21)]
3-1.15-P3	0.12 [3]	0.28 [7.15]	0.35 [9]	2.8 [11]	57 [260] 0.02 (0.02) [2 (2)]	79 [350] 0.05 (0.05) [5 (5)]	99 [440] 0.1 (0.1) [10 (10)]	140 [640] 0.14 (0.14) [14 (14)]
3-1.15-P4	0.12 [3]	0.28 [7.15]	0.47 [12]	2.1 [8.3]	57 [260] 0.015 (0.015) [1.5 (1.5)]	79 [350] 0.038 (0.038) [3.8 (3.8)]	99 [440] 0.075 (0.075) [7.5 (7.5)]	140 [640] 0.1 (0.1) [10 (10)]
3-1.6-P1	0.12 [3]	0.3 [7.6]	0.12 [3]	8.5 [33]	52 [230] 0.074 (0) [7.4 (0)]	72 [320] 0.18 (0) [18 (0)]	89 [400] 0.37 (0) [37 (0)]	130 [580] 0.52 (0) [52 (0)]
3-1.6-P2	0.12 [3]	0.3 [7.6]	0.24 [6]	4.2 [17]	52 [230] 0.037 (0.037) [3.7 (3.7)]	72 [320] 0.092 (0.092) [9.2 (9.2)]	89 [400] 0.18 (0.18) [18 (18)]	130 [580] 0.26 (0.26) [26 (26)]
3-1.6-P3	0.12 [3]	0.3 [7.6]	0.35 [9]	2.8 [11]	52 [230] 0.025 (0.025) [2.5 (2.5)]	72 [320] 0.062 (0.062) [6.2 (6.2)]	89 [400] 0.12 (0.12) [12 (12)]	130 [580] 0.17 (0.17) [17 (17)]
3-1.6-P4	0.12 [3]	0.3 [7.6]	0.47 [12]	2.1 [8.3]	52 [230] 0.019 (0.019) [1.9 (1.9)]	72 [320] 0.046 (0.046) [4.6 (4.6)]	89 [400] 0.092 (0.092) [9.2 (9.2)]	130 [580] 0.13 (0.13) [13 (13)]
3-2.4-P1	0.12 [3]	0.33 [8.4]	0.12 [3]	8.5 [33]	44 [200] 0.1 (0) [10 (0)]	61 [270] 0.25 (0) [25 (0)]	76 [340] 0.51 (0) [51 (0)]	110 [490] 0.71 (0) [71 (0)]
3-2.4-P2	0.12 [3]	0.33 [8.4]	0.24 [6]	4.2 [17]	44 [200] 0.051 (0.051) [5.1 (5.1)]	61 [270] 0.13 (0.13) [13 (13)]	76 [340] 0.25 (0.25) [25 (25)]	110 [490] 0.36 (0.36) [36 (36)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
3-2.4-P3	0.12 [3]	0.33 [8.4]	0.35 [9]	2.8 [11]	44 [200] 0.034 (0.034) [3.4 (3.4)]	61 [270] 0.085 (0.085) [8.5 (8.5)]	76 [340] 0.17 (0.17) [17 (17)]	110 [490] 0.24 (0.24) [24 (24)]
3-2.4-P4	0.12 [3]	0.33 [8.4]	0.47 [12]	2.1 [8.3]	44 [200] 0.025 (0.025) [2.5 (2.5)]	61 [270] 0.064 (0.064) [6.4 (6.4)]	76 [340] 0.13 (0.13) [13 (13)]	110 [490] 0.18 (0.18) [18 (18)]
3-3.2-P1	0.12 [3]	0.36 [9.2]	0.12 [3]	8.5 [33]	38 [170] 0.13 (0) [13 (0)]	53 [240] 0.34 (0) [34 (0)]	66 [290] 0.67 (0) [67 (0)]	96 [430] 0.94 (0) [94 (0)]
3-3.2-P2	0.12 [3]	0.36 [9.2]	0.24 [6]	4.2 [17]	38 [170] 0.067 (0.067) [6.7 (6.7)]	53 [240] 0.17 (0.17) [17 (17)]	66 [290] 0.34 (0.34) [34 (34)]	96 [430] 0.47 (0.47) [47 (47)]
3-3.2-P3	0.12 [3]	0.36 [9.2]	0.35 [9]	2.8 [11]	38 [170] 0.045 (0.045) [4.5 (4.5)]	53 [240] 0.11 (0.11) [11 (11)]	66 [290] 0.22 (0.22) [22 (22)]	96 [430] 0.31 (0.31) [31 (31)]
3-3.2-P4	0.12 [3]	0.36 [9.2]	0.47 [12]	2.1 [8.3]	38 [170] 0.034 (0.034) [3.4 (3.4)]	53 [240] 0.084 (0.084) [8.4 (8.4)]	66 [290] 0.17 (0.17) [17 (17)]	96 [430] 0.24 (0.24) [24 (24)]
NiTi-3-4.75-P1	0.12 [3]	0.42 [10.75]	0.12 [3]	8.5 [33]	31 [140] 0.21 (0) [21 (0)]	42 [190] 0.52 (0) [52 (0)]	53 [240] 1.1 (0) [100 (0)]	77 [340] 1.5 (0) [150 (0)]
NiTi-3-4.75-P2	0.12 [3]	0.42 [10.75]	0.24 [6]	4.2 [17]	31 [140] 0.1 (0.1) [10 (10)]	42 [190] 0.26 (0.26) [26 (26)]	53 [240] 0.52 (0.5*) [52 (50*)]	77 [340] 0.73 (0.5*) [73 (50*)]
NiTi-3-4.75-P3	0.12 [3]	0.42 [10.75]	0.35 [9]	2.8 [11]	31 [140] 0.07 (0.07) [7 (7)]	42 [190] 0.18 (0.18) [18 (18)]	53 [240] 0.35 (0.35) [35 (35)]	77 [340] 0.49 (0.49) [49 (49)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
NiTi-3-4.75-P4	0.12 [3]	0.42 [10.75]	0.47 [12]	2.1 [8.3]	31 [140] 0.052 (0.052) [5.2 (5.2)]	42 [190] 0.13 (0.13) [13 (13)]	53 [240] 0.26 (0.26) [26 (26)]	77 [340] 0.37 (0.37) [37 (37)]
NiTi-3-6-P1	0.12 [3]	0.47 [12]	0.12 [3]	8.5 [33]	26 [120] 0.28 (0) [28 (0)]	37 [160] 0.71 (0) [71 (0)]	46 [200] 1.4 (0) [140 (0)]	66 [290] 2 (0) [200 (0)]
NiTi-3-6-P2	0.12 [3]	0.47 [12]	0.24 [6]	4.2 [17]	26 [120] 0.14 (0.14) [14 (14)]	37 [160] 0.35 (0.35) [35 (35)]	46 [200] 0.71 (0.5*) [71 (50*)]	66 [290] 0.99 (0.5*) [99 (50*)]
NiTi-3-6-P3	0.12 [3]	0.47 [12]	0.35 [9]	2.8 [11]	26 [120] 0.094 (0.094) [9.4 (9.4)]	37 [160] 0.24 (0.24) [24 (24)]	46 [200] 0.47 (0.47) [47 (47)]	66 [290] 0.66 (0.66) [66 (66)]
NiTi-3-6-P4	0.12 [3]	0.47 [12]	0.47 [12]	2.1 [8.3]	26 [120] 0.071 (0.071) [7.1 (7.1)]	37 [160] 0.18 (0.18) [18 (18)]	46 [200] 0.35 (0.35) [35 (35)]	66 [290] 0.5 (0.5) [50 (50)]
NiTi-3-8-P1	0.12 [3]	0.55 [14]	0.12 [3]	8.5 [33]	22 [96] 0.42 (0) [42 (0)]	30 [130] 1.1 (0) [110 (0)]	37 [170] 2.1 (0) [210 (0)]	54 [240] 3 (0) [300 (0)]
NiTi-3-8-P2	0.12 [3]	0.55 [14]	0.24 [6]	4.2 [17]	22 [96] 0.21 (0.21) [21 (21)]	30 [130] 0.53 (0.5*) [53 (50*)]	37 [170] 1.1 (0.5*) [110 (50*)]	54 [240] 1.5 (0.5*) [150 (50*)]
NiTi-3-8-P3	0.12 [3]	0.55 [14]	0.35 [9]	2.8 [11]	22 [96] 0.14 (0.14) [14 (14)]	30 [130] 0.35 (0.35) [35 (35)]	37 [170] 0.7 (0.67*) [70 (67*)]	54 [240] 0.98 (0.67*) [98 (67*)]
NiTi-3-8-P4	0.12 [3]	0.55 [14]	0.47 [12]	2.1 [8.3]	22 [96] 0.11 (0.11) [11 (11)]	30 [130] 0.26 (0.26) [26 (26)]	37 [170] 0.53 (0.53) [53 (53)]	54 [240] 0.74 (0.74) [74 (74)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
NiTi-3-9.5-P1	0.12 [3]	0.61 [15.5]	0.12 [3]	8.5 [33]	19 [85] 0.54 (0) [54 (0)]	26 [120] 1.4 (0) [140 (0)]	33 [150] 2.7 (0) [270 (0)]	48 [210] 3.8 (0) [380 (0)]
NiTi-3-9.5-P2	0.12 [3]	0.61 [15.5]	0.24 [6]	4.2 [17]	19 [85] 0.27 (0.27) [27 (27)]	26 [120] 0.68 (0.5*) [68 (50*)]	33 [150] 1.4 (0.5*) [140 (50*)]	48 [210] 1.9 (0.5*) [190 (50*)]
NiTi-3-9.5-P3	0.12 [3]	0.61 [15.5]	0.35 [9]	2.8 [11]	19 [85] 0.18 (0.18) [18 (18)]	26 [120] 0.46 (0.46) [46 (46)]	33 [150] 0.91 (0.67*) [91 (67*)]	48 [210] 1.3 (0.67*) [130 (67*)]
NiTi-3-9.5-P4	0.12 [3]	0.61 [15.5]	0.47 [12]	2.1 [8.3]	19 [85] 0.14 (0.14) [14 (14)]	26 [120] 0.34 (0.34) [34 (34)]	33 [150] 0.68 (0.68) [68 (68)]	48 [210] 0.96 (0.75*) [96 (75*)]
NiTi-3-12.7-P1	0.12 [3]	0.74 [18.7]	0.12 [3]	8.5 [33]	15 [68] 0.86 (0) [86 (0)]	21 [93] 2.1 (0) [220 (0)]	26 [120] 4.3 (0) [430 (0)]	38 [170] 6 (0) [600 (0)]
NiTi-3-12.7-P2	0.12 [3]	0.74 [18.7]	0.24 [6]	4.2 [17]	15 [68] 0.43 (0.43) [43 (43)]	21 [93] 1.1 (0.5*) [110 (50*)]	26 [120] 2.1 (0.5*) [220 (50*)]	38 [170] 3 (0.5*) [300 (50*)]
NiTi-3-12.7-P3	0.12 [3]	0.74 [18.7]	0.35 [9]	2.8 [11]	15 [68] 0.29 (0.29) [29 (29)]	21 [93] 0.72 (0.67*) [72 (67*)]	26 [120] 1.4 (0.67*) [140 (67*)]	38 [170] 2 (0.67*) [200 (67*)]
NiTi-3-12.7-P4	0.12 [3]	0.74 [18.7]	0.47 [12]	2.1 [8.3]	15 [68] 0.22 (0.22) [22 (22)]	21 [93] 0.54 (0.54) [54 (54)]	26 [120] 1.1 (0.75*) [110 (75*)]	38 [170] 1.5 (0.75*) [150 (75*)]
NiTi-3-14.2-P1	0.12 [3]	0.8 [20.2]	0.12 [3]	8.5 [33]	14 [62] 1 (0) [100 (0)]	19 [85] 2.6 (0) [260 (0)]	24 [110] 5.2 (0) [520 (0)]	35 [150] 7.2 (0) [720 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
NiTi-3-14.2-P2	0.12 [3]	0.8 [20.2]	0.24 [6]	4.2 [17]	14 [62] 0.52 (0.5*) [52 (50*)]	19 [85] 1.3 (0.5*) [130 (50*)]	24 [110] 2.6 (0.5*) [260 (50*)]	35 [150] 3.6 (0.5*) [360 (50*)]
NiTi-3-14.2-P3	0.12 [3]	0.8 [20.2]	0.35 [9]	2.8 [11]	14 [62] 0.34 (0.34) [34 (34)]	19 [85] 0.86 (0.67*) [86 (67*)]	24 [110] 1.7 (0.67*) [170 (67*)]	35 [150] 2.4 (0.67*) [240 (67*)]
NiTi-3-14.2-P4	0.12 [3]	0.8 [20.2]	0.47 [12]	2.1 [8.3]	14 [62] 0.26 (0.26) [26 (26)]	19 [85] 0.64 (0.64) [64 (64)]	24 [110] 1.3 (0.75*) [130 (75*)]	35 [150] 1.8 (0.75*) [180 (75*)]
NiTi-3-16-P1	0.12 [3]	0.87 [22]	0.12 [3]	8.5 [33]	13 [56] 1.3 (0) [130 (0)]	17 [77] 3.1 (0) [320 (0)]	22 [96] 6.3 (0) [630 (0)]	31 [140] 8.8 (0) [880 (0)]
NiTi-3-16-P2	0.12 [3]	0.87 [22]	0.24 [6]	4.2 [17]	13 [56] 0.63 (0.5*) [63 (50*)]	17 [77] 1.6 (0.5*) [160 (50*)]	22 [96] 3.1 (0.5*) [320 (50*)]	31 [140] 4.4 (0.5*) [440 (50*)]
NiTi-3-16-P3	0.12 [3]	0.87 [22]	0.35 [9]	2.8 [11]	13 [56] 0.42 (0.42) [42 (42)]	17 [77] 1.1 (0.67*) [100 (67*)]	22 [96] 2.1 (0.67*) [210 (67*)]	31 [140] 2.9 (0.67*) [290 (67*)]
NiTi-3-16-P4	0.12 [3]	0.87 [22]	0.47 [12]	2.1 [8.3]	13 [56] 0.32 (0.32) [32 (32)]	17 [77] 0.79 (0.75*) [79 (75*)]	22 [96] 1.6 (0.75*) [160 (75*)]	31 [140] 2.2 (0.75*) [220 (75*)]
NiTi-3-19-P1	0.12 [3]	0.98 [25]	0.12 [3]	8.5 [33]	11 [48] 1.7 (0) [170 (0)]	15 [67] 4.2 (0) [420 (0)]	19 [83] 8.4 (0) [840 (0)]	27 [120] 12 (0) [1200 (0)]
NiTi-3-19-P2	0.12 [3]	0.98 [25]	0.24 [6]	4.2 [17]	11 [48] 0.84 (0.5*) [84 (50*)]	15 [67] 2.1 (0.5*) [210 (50*)]	19 [83] 4.2 (0.5*) [420 (50*)]	27 [120] 5.9 (0.5*) [590 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
NiTi-3-19-P3	0.12 [3]	0.98 [25]	0.35 [9]	2.8 [11]	11 [48] 0.56 (0.56) [56 (56)]	15 [67] 1.4 (0.67*) [140 (67*)]	19 [83] 2.8 (0.67*) [280 (67*)]	27 [120] 3.9 (0.67*) [390 (67*)]
NiTi-3-19-P4	0.12 [3]	0.98 [25]	0.47 [12]	2.1 [8.3]	11 [48] 0.42 (0.42) [42 (42)]	15 [67] 1.1 (0.75*) [110 (75*)]	19 [83] 2.1 (0.75*) [210 (75*)]	27 [120] 3 (0.75*) [300 (75*)]
NiTi-3-22.2-P1	0.12 [3]	1.1 [28.2]	0.12 [3]	8.5 [33]	9.5 [42] 2.2 (0) [220 (0)]	13 [58] 5.5 (0) [550 (0)]	16 [72] 11 (0) [1100 (0)]	24 [100] 16 (0) [1600 (0)]
NiTi-3-22.2-P2	0.12 [3]	1.1 [28.2]	0.24 [6]	4.2 [17]	9.5 [42] 1.1 (0.5*) [110 (50*)]	13 [58] 2.8 (0.5*) [280 (50*)]	16 [72] 5.5 (0.5*) [550 (50*)]	24 [100] 7.8 (0.5*) [780 (50*)]
NiTi-3-22.2-P3	0.12 [3]	1.1 [28.2]	0.35 [9]	2.8 [11]	9.5 [42] 0.74 (0.67*) [74 (67*)]	13 [58] 1.9 (0.67*) [180 (67*)]	16 [72] 3.7 (0.67*) [370 (67*)]	24 [100] 5.2 (0.67*) [520 (67*)]
NiTi-3-22.2-P4	0.12 [3]	1.1 [28.2]	0.47 [12]	2.1 [8.3]	9.5 [42] 0.55 (0.55) [55 (55)]	13 [58] 1.4 (0.75*) [140 (75*)]	16 [72] 2.8 (0.75*) [280 (75*)]	24 [100] 3.9 (0.75*) [390 (75*)]
NiTi-3-25.4-P1	0.12 [3]	1.2 [31.4]	0.12 [3]	8.5 [33]	8.4 [37] 2.8 (0) [280 (0)]	12 [52] 7 (0) [700 (0)]	14 [64] 14 (0) [1400 (0)]	21 [93] 20 (0) [2000 (0)]
NiTi-3-25.4-P2	0.12 [3]	1.2 [31.4]	0.24 [6]	4.2 [17]	8.4 [37] 1.4 (0.5*) [140 (50*)]	12 [52] 3.5 (0.5*) [350 (50*)]	14 [64] 7 (0.5*) [700 (50*)]	21 [93] 9.8 (0.5*) [980 (50*)]
NiTi-3-25.4-P3	0.12 [3]	1.2 [31.4]	0.35 [9]	2.8 [11]	8.4 [37] 0.94 (0.67*) [94 (67*)]	12 [52] 2.4 (0.67*) [240 (67*)]	14 [64] 4.7 (0.67*) [470 (67*)]	21 [93] 6.6 (0.67*) [660 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
NiTi-3-25.4-P4	0.12 [3]	1.2 [31.4]	0.47 [12]	2.1 [8.3]	8.4 [37] 0.7 (0.7) [70 (70)]	12 [52] 1.8 (0.75*) [180 (75*)]	14 [64] 3.5 (0.75*) [350 (75*)]	21 [93] 4.9 (0.75*) [490 (75*)]
NiTi-5-4.75-P1	0.2 [5]	0.58 [14.75]	0.2 [5]	5.1 [20]	110 [500] 0.12 (0) [12 (0)]	160 [700] 0.3 (0) [30 (0)]	200 [870] 0.6 (0) [60 (0)]	280 [1300] 0.84 (0) [84 (0)]
NiTi-5-4.75-P2	0.2 [5]	0.58 [14.75]	0.39 [10]	2.5 [10]	110 [500] 0.06 (0.06) [6 (6)]	160 [700] 0.15 (0.15) [15 (15)]	200 [870] 0.3 (0.3) [30 (30)]	280 [1300] 0.42 (0.42) [42 (42)]
NiTi-5-4.75-P3	0.2 [5]	0.58 [14.75]	0.59 [15]	1.7 [6.7]	110 [500] 0.04 (0.04) [4 (4)]	160 [700] 0.099 (0.099) [9.9 (9.9)]	200 [870] 0.2 (0.2) [20 (20)]	280 [1300] 0.28 (0.28) [28 (28)]
NiTi-5-4.75-P4	0.2 [5]	0.58 [14.75]	0.79 [20]	1.3 [5]	110 [500] 0.03 (0.03) [3 (3)]	160 [700] 0.075 (0.075) [7.5 (7.5)]	200 [870] 0.15 (0.15) [15 (15)]	280 [1300] 0.21 (0.21) [21 (21)]
NiTi-5-6-P1	0.2 [5]	0.63 [16]	0.2 [5]	5.1 [20]	100 [450] 0.15 (0) [15 (0)]	140 [620] 0.38 (0) [38 (0)]	170 [770] 0.76 (0) [76 (0)]	250 [1100] 1.1 (0) [110 (0)]
NiTi-5-6-P2	0.2 [5]	0.63 [16]	0.39 [10]	2.5 [10]	100 [450] 0.076 (0.076) [7.6 (7.6)]	140 [620] 0.19 (0.19) [19 (19)]	170 [770] 0.38 (0.38) [38 (38)]	250 [1100] 0.53 (0.5*) [53 (50*)]
NiTi-5-6-P3	0.2 [5]	0.63 [16]	0.59 [15]	1.7 [6.7]	100 [450] 0.051 (0.051) [5.1 (5.1)]	140 [620] 0.13 (0.13) [13 (13)]	170 [770] 0.25 (0.25) [25 (25)]	250 [1100] 0.36 (0.36) [36 (36)]
NiTi-5-6-P4	0.2 [5]	0.63 [16]	0.79 [20]	1.3 [5]	100 [450] 0.038 (0.038) [3.8 (3.8)]	140 [620] 0.095 (0.095) [9.5 (9.5)]	170 [770] 0.19 (0.19) [19 (19)]	250 [1100] 0.27 (0.27) [27 (27)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
NiTi-5-8-P1	0.2 [5]	0.71 [18]	0.2 [5]	5.1 [20]	85 [380] 0.21 (0) [21 (0)]	120 [520] 0.53 (0) [53 (0)]	150 [650] 1.1 (0) [110 (0)]	210 [940] 1.5 (0) [150 (0)]
NiTi-5-8-P2	0.2 [5]	0.71 [18]	0.39 [10]	2.5 [10]	85 [380] 0.11 (0.11) [11 (11)]	120 [520] 0.27 (0.27) [27 (27)]	150 [650] 0.53 (0.5*) [53 (50*)]	210 [940] 0.74 (0.5*) [74 (50*)]
NiTi-5-8-P3	0.2 [5]	0.71 [18]	0.59 [15]	1.7 [6.7]	85 [380] 0.071 (0.071) [7.1 (7.1)]	120 [520] 0.18 (0.18) [18 (18)]	150 [650] 0.35 (0.35) [35 (35)]	210 [940] 0.5 (0.5) [50 (50)]
NiTi-5-8-P4	0.2 [5]	0.71 [18]	0.79 [20]	1.3 [5]	85 [380] 0.053 (0.053) [5.3 (5.3)]	120 [520] 0.13 (0.13) [13 (13)]	150 [650] 0.27 (0.27) [27 (27)]	210 [940] 0.37 (0.37) [37 (37)]
NiTi-5-9.5-P1	0.2 [5]	0.77 [19.5]	0.2 [5]	5.1 [20]	76 [340] 0.26 (0) [26 (0)]	100 [470] 0.66 (0) [66 (0)]	130 [580] 1.3 (0) [130 (0)]	190 [850] 1.9 (0) [180 (0)]
NiTi-5-9.5-P2	0.2 [5]	0.77 [19.5]	0.39 [10]	2.5 [10]	76 [340] 0.13 (0.13) [13 (13)]	100 [470] 0.33 (0.33) [33 (33)]	130 [580] 0.66 (0.5*) [66 (50*)]	190 [850] 0.92 (0.5*) [92 (50*)]
NiTi-5-9.5-P3	0.2 [5]	0.77 [19.5]	0.59 [15]	1.7 [6.7]	76 [340] 0.088 (0.088) [8.8 (8.8)]	100 [470] 0.22 (0.22) [22 (22)]	130 [580] 0.44 (0.44) [44 (44)]	190 [850] 0.62 (0.62) [62 (62)]
NiTi-5-9.5-P4	0.2 [5]	0.77 [19.5]	0.79 [20]	1.3 [5]	76 [340] 0.066 (0.066) [6.6 (6.6)]	100 [470] 0.16 (0.16) [16 (16)]	130 [580] 0.33 (0.33) [33 (33)]	190 [850] 0.46 (0.46) [46 (46)]
NiTi-5-12.7-P1	0.2 [5]	0.89 [22.7]	0.2 [5]	5.1 [20]	62 [280] 0.39 (0) [39 (0)]	86 [380] 0.98 (0) [98 (0)]	110 [480] 2 (0) [200 (0)]	160 [690] 2.8 (0) [280 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
NiTi-5-12.7-P2	0.2 [5]	0.89 [22.7]	0.39 [10]	2.5 [10]	62 [280] 0.2 (0.2) [20 (20)]	86 [380] 0.49 (0.49) [49 (49)]	110 [480] 0.98 (0.5*) [98 (50*)]	160 [690] 1.4 (0.5*) [140 (50*)]
NiTi-5-12.7-P3	0.2 [5]	0.89 [22.7]	0.59 [15]	1.7 [6.7]	62 [280] 0.13 (0.13) [13 (13)]	86 [380] 0.33 (0.33) [33 (33)]	110 [480] 0.66 (0.66) [66 (66)]	160 [690] 0.92 (0.67*) [92 (67*)]
NiTi-5-12.7-P4	0.2 [5]	0.89 [22.7]	0.79 [20]	1.3 [5]	62 [280] 0.098 (0.098) [9.8 (9.8)]	86 [380] 0.25 (0.25) [25 (25)]	110 [480] 0.49 (0.49) [49 (49)]	160 [690] 0.69 (0.69) [69 (69)]
NiTi-5-14.2-P1	0.2 [5]	0.95 [24.2]	0.2 [5]	5.1 [20]	57 [260] 0.46 (0) [46 (0)]	79 [350] 1.2 (0) [120 (0)]	99 [440] 2.3 (0) [230 (0)]	140 [640] 3.2 (0) [320 (0)]
NiTi-5-14.2-P2	0.2 [5]	0.95 [24.2]	0.39 [10]	2.5 [10]	57 [260] 0.23 (0.23) [23 (23)]	79 [350] 0.58 (0.5*) [58 (50*)]	99 [440] 1.2 (0.5*) [120 (50*)]	140 [640] 1.6 (0.5*) [160 (50*)]
NiTi-5-14.2-P3	0.2 [5]	0.95 [24.2]	0.59 [15]	1.7 [6.7]	57 [260] 0.15 (0.15) [15 (15)]	79 [350] 0.39 (0.39) [39 (39)]	99 [440] 0.77 (0.67*) [77 (67*)]	140 [640] 1.1 (0.67*) [110 (67*)]
NiTi-5-14.2-P4	0.2 [5]	0.95 [24.2]	0.79 [20]	1.3 [5]	57 [260] 0.12 (0.12) [12 (12)]	79 [350] 0.29 (0.29) [29 (29)]	99 [440] 0.58 (0.58) [58 (58)]	140 [640] 0.81 (0.75*) [81 (75*)]
NiTi-5-16-P1	0.2 [5]	1 [26]	0.2 [5]	5.1 [20]	53 [230] 0.55 (0) [55 (0)]	73 [320] 1.4 (0) [140 (0)]	90 [400] 2.8 (0) [280 (0)]	130 [580] 3.9 (0) [390 (0)]
NiTi-5-16-P2	0.2 [5]	1 [26]	0.39 [10]	2.5 [10]	53 [230] 0.28 (0.28) [28 (28)]	73 [320] 0.69 (0.5*) [69 (50*)]	90 [400] 1.4 (0.5*) [140 (50*)]	130 [580] 1.9 (0.5*) [190 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
NiTi-5-16-P3	0.2 [5]	1 [26]	0.59 [15]	1.7 [6.7]	53 [230] 0.18 (0.18) [18 (18)]	73 [320] 0.46 (0.46) [46 (46)]	90 [400] 0.92 (0.67*) [92 (67*)]	130 [580] 1.3 (0.67*) [130 (67*)]
NiTi-5-16-P4	0.2 [5]	1 [26]	0.79 [20]	1.3 [5]	53 [230] 0.14 (0.14) [14 (14)]	73 [320] 0.35 (0.35) [35 (35)]	90 [400] 0.69 (0.69) [69 (69)]	130 [580] 0.97 (0.75*) [97 (75*)]
NiTi-5-19-P1	0.2 [5]	1.1 [29]	0.2 [5]	5.1 [20]	46 [200] 0.72 (0) [72 (0)]	63 [280] 1.8 (0) [180 (0)]	79 [350] 3.6 (0) [360 (0)]	120 [510] 5.1 (0) [510 (0)]
NiTi-5-19-P2	0.2 [5]	1.1 [29]	0.39 [10]	2.5 [10]	46 [200] 0.36 (0.36) [36 (36)]	63 [280] 0.9 (0.5*) [90 (50*)]	79 [350] 1.8 (0.5*) [180 (50*)]	120 [510] 2.5 (0.5*) [250 (50*)]
NiTi-5-19-P3	0.2 [5]	1.1 [29]	0.59 [15]	1.7 [6.7]	46 [200] 0.24 (0.24) [24 (24)]	63 [280] 0.6 (0.6) [60 (60)]	79 [350] 1.2 (0.67*) [120 (67*)]	120 [510] 1.7 (0.67*) [170 (67*)]
NiTi-5-19-P4	0.2 [5]	1.1 [29]	0.79 [20]	1.3 [5]	46 [200] 0.18 (0.18) [18 (18)]	63 [280] 0.45 (0.45) [45 (45)]	79 [350] 0.9 (0.75*) [90 (75*)]	120 [510] 1.3 (0.75*) [130 (75*)]
NiTi-5-22.2-P1	0.2 [5]	1.3 [32.2]	0.2 [5]	5.1 [20]	41 [180] 0.93 (0) [93 (0)]	56 [250] 2.3 (0) [230 (0)]	70 [310] 4.7 (0) [460 (0)]	100 [450] 6.5 (0) [650 (0)]
NiTi-5-22.2-P2	0.2 [5]	1.3 [32.2]	0.39 [10]	2.5 [10]	41 [180] 0.46 (0.46) [46 (46)]	56 [250] 1.2 (0.5*) [120 (50*)]	70 [310] 2.3 (0.5*) [230 (50*)]	100 [450] 3.2 (0.5*) [320 (50*)]
NiTi-5-22.2-P3	0.2 [5]	1.3 [32.2]	0.59 [15]	1.7 [6.7]	41 [180] 0.31 (0.31) [31 (31)]	56 [250] 0.78 (0.67*) [78 (67*)]	70 [310] 1.6 (0.67*) [160 (67*)]	100 [450] 2.2 (0.67*) [220 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

HELICAL SPRING ACTUATORS — Force and stroke by wire size, coil OD and pitch

Part reference	Wire, in [mm]	Coil OD, in [mm]	Pitch, in [mm]	Coils per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
NiTi-5-22.2-P4	0.2 [5]	1.3 [32.2]	0.79 [20]	1.3 [5]	41 [180] 0.23 (0.23) [23 (23)]	56 [250] 0.58 (0.58) [58 (58)]	70 [310] 1.2 (0.75*) [120 (75*)]	100 [450] 1.6 (0.75*) [160 (75*)]
NiTi-5-25.4-P1	0.2 [5]	1.4 [35.4]	0.2 [5]	5.1 [20]	36 [160] 1.2 (0) [120 (0)]	50 [220] 2.9 (0) [290 (0)]	62 [280] 5.8 (0) [580 (0)]	91 [400] 8.1 (0) [810 (0)]
NiTi-5-25.4-P2	0.2 [5]	1.4 [35.4]	0.39 [10]	2.5 [10]	36 [160] 0.58 (0.5*) [58 (50*)]	50 [220] 1.4 (0.5*) [140 (50*)]	62 [280] 2.9 (0.5*) [290 (50*)]	91 [400] 4.1 (0.5*) [410 (50*)]
NiTi-5-25.4-P3	0.2 [5]	1.4 [35.4]	0.59 [15]	1.7 [6.7]	36 [160] 0.39 (0.39) [39 (39)]	50 [220] 0.97 (0.67*) [97 (67*)]	62 [280] 1.9 (0.67*) [190 (67*)]	91 [400] 2.7 (0.67*) [270 (67*)]
NiTi-5-25.4-P4	0.2 [5]	1.4 [35.4]	0.79 [20]	1.3 [5]	36 [160] 0.29 (0.29) [29 (29)]	50 [220] 0.73 (0.73) [73 (73)]	62 [280] 1.4 (0.75*) [140 (75*)]	91 [400] 2 (0.75*) [200 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

NOTES

NOTES

CHAPTER 5

Face Wound Spring Actuators

The strip laid flat against the mandrel - high force actuators

A face wound spring actuator is a flat strip wrapped round a mandrel with its wide face against the mandrel. Pull it along its axis and the strip has to bend across its width, which is the hard way to bend a strip. That is what gives this spring actuator its character as a linear actuator: a strong pull over a short travel, from a coil that packs a lot of metal into a small length.

The same strip can be wound the other way, standing on its edge. Pulled along its axis that gives a much softer, much longer travel - a Slinky is an edge wound coil - and it has its own chapter, the next one. If you have come here for travel rather than force, that is the chapter you want.

Two outputs from one part

A wound spring actuator does two different jobs depending on how you load it, and both are listed.

LINEAR. Pull it along its axis and the coil opens out. You get a straight-line stroke, listed per inch [per 100 mm] of spring actuator.

ROTARY. Hold one end and turn the other and it winds or unwinds. You get rotation, listed in degrees per inch [per 100 mm].

It is the same part. Which one you get depends on how you mount it, so decide that before you choose a size. The ranking reverses between the two: as a linear actuator the face wound spring actuator is the strong, short-travel one, but turned about its axis it bends the strip the easy way, so in rotary use it is the large-angle, low-torque one.

One part does two jobs for a reason worth understanding. Nitinol recovers a shape rather than producing a motion, and it recovers the whole shape at once. The coil is moving toward a particular length, a particular diameter and a particular number of turns at the same time. What you mount it in decides which of those you take. Hold the ends and take the length change and it is a linear actuator. Hold one end and let the other turn and it is a rotary one. Leave both free and you get both together: one heating event delivers a pull and a twist at the same time, and a mechanism built to use them can take work off each.

This handbook cannot size that part for you. The two modes are coupled. Twisting the coil changes its diameter, and the diameter is what sets how it behaves in linear mode, so neither set of figures holds while the other motion is happening. Every number in this chapter is for one mode at a time. If you want a part that does both at once, that is a conversation.

The same parts appear again in Chapter 7, listed as torsion spring actuators with their torque and angular sweep per wrap.

Getting it back

Like every shape in this handbook, a nitinol actuator moves one way when it is heated. Getting it back to where it started is the designer's problem, and there are three ways to solve it.

AN ANTAGONISTIC PAIR uses a second actuator working against the first. Heat one and it moves the mechanism and resets the other; heat the other and it goes back. You get powered motion in both directions with full output each way, at the cost of two actuators and a control scheme that never heats both at once.

A BIAS is a passive element, usually a conventional spring or a weight, that the actuator works against as it moves and that pushes it back as it cools. It is the simplest arrangement and the most common. The price is that the bias resists the actuator through the whole stroke, so part of the force in the table is spent returning the mechanism rather than doing the job. Size it to return the actuator and no more.

SYSTEM FORCES are the return you already have. If the mechanism pushes back on its own, if gravity closes the door, if the thing being clamped is springy, if line pressure acts on the valve, that force resets the actuator for nothing. It is the best answer when it is available, and worth looking for before adding parts.

Whichever you choose, the return has to be strong enough to reset the actuator while it is cool and weak enough not to stall it while it is hot. That window is what sizes a bias, and it is the most common thing to get wrong on a first build.

There is a fourth possibility. Any nitinol actuator can be given a two way set, so that it takes one shape hot and another cold and needs no return at all. Two way parts are made to order and are outside the scope of this handbook, so nothing here is rated for it, but it exists. Ask.

Overdriving an actuator

The figures in this handbook are conservative. Every force in every table is rated at a stress we are confident the part will deliver, cycle after cycle, at the fatigue life of its design level. A part will usually do more than the table says. We would rather you found that out in testing than the other way round.

The second reason a part will beat its table is that you can overdrive it, and this one is a feature you can design with. There are two ways to do it, and they add.

The first is to heat it further. Nitinol makes its force by changing phase, and the temperature at which it does that is the transition temperature we set for you. The force does not stop climbing when the part gets there. Keep heating it past the transition and the force keeps rising with temperature, well beyond the rated figure. The table gives you the force at a working temperature comfortably above transition. Drive the part hotter and there is more.

The second is to heat it faster. Heat the part slowly and it makes the force in the table. Heat it quickly, with a sharp pulse of current rather than a gentle ramp, and it makes more, and the harder the pulse, the bigger the difference. A part that is driven both fast and hot gets the gain from each, one on top of the other. The tables assume neither. They are the floor.

Emergency mode

That gives a nitinol actuator something most actuators do not have: a reserve. A motor or a solenoid has a rated output and a thermal limit close behind it. A nitinol actuator can be driven, briefly, to a force well above its rating simply by putting more heat into it, faster. Think of it as an emergency mode. A latch that normally needs a modest pull can, on the day something jams, be hit with a short hard pulse and told to pull much harder. A release that must not fail gets a margin that costs nothing in size or weight.

Use it as a reserve, not as the rating, and know where the limits are. There is a temperature, called Md, above which the metal can no longer be pushed into martensite by stress; up to Md the material is still behaving as nitinol should. Overdriving up to Md costs some fatigue life, but it also does the part a favor: the extra heat drives out residual martensite that builds up over many cycles, a kind of rehabilitation in place, so a part that is occasionally run hard can come back sharper than one that never is. Above Md the accounting changes. Degradation is faster, and each hot cycle takes a larger bite out of the life. Above 350 °C (660 °F) the part is past saving: treat an actuator that has been driven that hot as spent and replace it. Used within those limits, for the rare event, emergency mode is one of the best arguments for the material.

Actuator safety

Most actuators fail badly when they are overdriven, and engineers know exactly how. Put too much current into a motor or a solenoid and it explodes. Overpressure a hydraulic cylinder and it bursts, or springs a pinhole leak, and a jet of oil at that pressure will cut through a glove and a hand, take a limb, and put oil into the ground and the water where it can be years being cleaned up. Every one of them has the same problem: the energy is stored in the actuator, and when something goes wrong it has nowhere to go but out. A nitinol actuator, very simply, does not carry these risks. It is a piece of metal with a current in it, and there is nothing in it to burst, nothing to leak, and nothing to poison.

A nitinol actuator fails the other way. Put too much power into it and it simply gets hotter. Past the working range the force keeps rising; past that, the part reaches the temperatures at which it was shape set, and at that point the metal lets go of its memory. The actuator loses its force, goes slack, and parts, which opens the circuit that was heating it. It shuts itself off. There is nothing stored in it to release: no pressure, no winding, no field. The failure mode is a dead part and an open circuit, not an event.

That is worth stating plainly for anyone writing a safety case. The worst thing an overdriven nitinol actuator does is stop.

What we supply

Strip sections	Thirteen, from 0.152 x 0.411 mm to 1.5 x 4 mm.
Mandrels	Sixteen, from 0.5 to 25.4 mm.
Pitch	Face wound is supplied tight or at two, three or four times the strip size. Edge wound is tight pitch only.
Transition temperatures	20 C, 35 C, 45 C and 80 C.
Sold as	Continuous length, by the inch.

The tables list every pitch we wind: tight, and at two, three and four times the strip width. Opening the pitch divides the pull stroke by that multiplier and leaves the force alone. A looser pitch also lets a face wound spring actuator push. The push figure is in parentheses after the pull; it is the smaller of the pull stroke at that pitch and the coil gap, which is fifty millimeters per hundred at twice the strip width, sixty seven at three times and seventy five at four times, and an asterisk marks the rows where the gap is the limit.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.411-0.5-P1 0.006 x 0.016	0.032 [0.804]	0.016 [0.411]	62 [240]	0.3 [1.3] 0.078 (0) [7.8 (0)]	0.41 [1.8] 0.2 (0) [20 (0)]	0.51 [2.3] 0.39 (0) [39 (0)]	0.74 [3.3] 0.55 (0) [55 (0)]
0.152x0.411-0.5-P2 0.006 x 0.016	0.032 [0.804]	0.032 [0.822]	31 [120]	0.3 [1.3] 0.039 (0.039) [3.9 (3.9)]	0.41 [1.8] 0.098 (0.098) [9.8 (9.8)]	0.51 [2.3] 0.2 (0.2) [20 (20)]	0.74 [3.3] 0.27 (0.27) [27 (27)]
0.152x0.411-0.5-P3 0.006 x 0.016	0.032 [0.804]	0.049 [1.23]	21 [81]	0.3 [1.3] 0.026 (0.026) [2.6 (2.6)]	0.41 [1.8] 0.065 (0.065) [6.5 (6.5)]	0.51 [2.3] 0.13 (0.13) [13 (13)]	0.74 [3.3] 0.18 (0.18) [18 (18)]
0.152x0.411-0.5-P4 0.006 x 0.016	0.032 [0.804]	0.065 [1.64]	16 [61]	0.3 [1.3] 0.019 (0.019) [1.9 (1.9)]	0.41 [1.8] 0.049 (0.049) [4.9 (4.9)]	0.51 [2.3] 0.098 (0.098) [9.8 (9.8)]	0.74 [3.3] 0.14 (0.14) [14 (14)]
0.152x0.411-0.9-P1 0.006 x 0.016	0.047 [1.2]	0.016 [0.411]	62 [240]	0.18 [0.82] 0.2 (0) [20 (0)]	0.25 [1.1] 0.51 (0) [51 (0)]	0.32 [1.4] 1 (0) [100 (0)]	0.46 [2] 1.4 (0) [140 (0)]
0.152x0.411-0.9-P2 0.006 x 0.016	0.047 [1.2]	0.032 [0.822]	31 [120]	0.18 [0.82] 0.1 (0.1) [10 (10)]	0.25 [1.1] 0.26 (0.26) [26 (26)]	0.32 [1.4] 0.51 (0.5*) [51 (50*)]	0.46 [2] 0.71 (0.5*) [71 (50*)]
0.152x0.411-0.9-P3 0.006 x 0.016	0.047 [1.2]	0.049 [1.23]	21 [81]	0.18 [0.82] 0.068 (0.068) [6.8 (6.8)]	0.25 [1.1] 0.17 (0.17) [17 (17)]	0.32 [1.4] 0.34 (0.34) [34 (34)]	0.46 [2] 0.48 (0.48) [48 (48)]
0.152x0.411-0.9-P4 0.006 x 0.016	0.047 [1.2]	0.065 [1.64]	16 [61]	0.18 [0.82] 0.051 (0.051) [5.1 (5.1)]	0.25 [1.1] 0.13 (0.13) [13 (13)]	0.32 [1.4] 0.26 (0.26) [26 (26)]	0.46 [2] 0.36 (0.36) [36 (36)]
0.152x0.411-1.15-P1 0.006 x 0.016	0.057 [1.45]	0.016 [0.411]	62 [240]	0.15 [0.66] 0.31 (0) [31 (0)]	0.2 [0.91] 0.79 (0) [78 (0)]	0.25 [1.1] 1.6 (0) [160 (0)]	0.37 [1.6] 2.2 (0) [220 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.411-1.15-P2 0.006 x 0.016	0.057 [1.45]	0.032 [0.822]	31 [120]	0.15 [0.66] 0.16 (0.16) [16 (16)]	0.2 [0.91] 0.39 (0.39) [39 (39)]	0.25 [1.1] 0.79 (0.5*) [78 (50*)]	0.37 [1.6] 1.1 (0.5*) [110 (50*)]
0.152x0.411-1.15-P3 0.006 x 0.016	0.057 [1.45]	0.049 [1.23]	21 [81]	0.15 [0.66] 0.1 (0.1) [10 (10)]	0.2 [0.91] 0.26 (0.26) [26 (26)]	0.25 [1.1] 0.52 (0.52) [52 (52)]	0.37 [1.6] 0.73 (0.67*) [73 (67*)]
0.152x0.411-1.15-P4 0.006 x 0.016	0.057 [1.45]	0.065 [1.64]	16 [61]	0.15 [0.66] 0.079 (0.079) [7.8 (7.8)]	0.2 [0.91] 0.2 (0.2) [20 (20)]	0.25 [1.1] 0.39 (0.39) [39 (39)]	0.37 [1.6] 0.55 (0.55) [55 (55)]
0.152x0.411-1.6-P1 0.006 x 0.016	0.075 [1.9]	0.016 [0.411]	62 [240]	0.11 [0.49] 0.57 (0) [57 (0)]	0.15 [0.67] 1.4 (0) [140 (0)]	0.19 [0.84] 2.9 (0) [280 (0)]	0.27 [1.2] 4 (0) [400 (0)]
0.152x0.411-1.6-P2 0.006 x 0.016	0.075 [1.9]	0.032 [0.822]	31 [120]	0.11 [0.49] 0.28 (0.28) [28 (28)]	0.15 [0.67] 0.71 (0.5*) [71 (50*)]	0.19 [0.84] 1.4 (0.5*) [140 (50*)]	0.27 [1.2] 2 (0.5*) [200 (50*)]
0.152x0.411-1.6-P3 0.006 x 0.016	0.075 [1.9]	0.049 [1.23]	21 [81]	0.11 [0.49] 0.19 (0.19) [19 (19)]	0.15 [0.67] 0.47 (0.47) [48 (48)]	0.19 [0.84] 0.95 (0.67*) [95 (67*)]	0.27 [1.2] 1.3 (0.67*) [130 (67*)]
0.152x0.411-1.6-P4 0.006 x 0.016	0.075 [1.9]	0.065 [1.64]	16 [61]	0.11 [0.49] 0.14 (0.14) [14 (14)]	0.15 [0.67] 0.36 (0.36) [36 (36)]	0.19 [0.84] 0.71 (0.71) [71 (71)]	0.27 [1.2] 1 (0.75*) [100 (75*)]
0.152x0.411-2.4-P1 0.006 x 0.016	0.11 [2.7]	0.016 [0.411]	62 [240]	0.075 [0.34] 1.2 (0) [120 (0)]	0.1 [0.46] 3 (0) [300 (0)]	0.13 [0.58] 6 (0) [600 (0)]	0.19 [0.84] 8.5 (0) [850 (0)]
0.152x0.411-2.4-P2 0.006 x 0.016	0.11 [2.7]	0.032 [0.822]	31 [120]	0.075 [0.34] 0.6 (0.5*) [60 (50*)]	0.1 [0.46] 1.5 (0.5*) [150 (50*)]	0.13 [0.58] 3 (0.5*) [300 (50*)]	0.19 [0.84] 4.2 (0.5*) [420 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.411-2.4-P3 0.006 x 0.016	0.11 [2.7]	0.049 [1.23]	21 [81]	0.075 [0.34] 0.4 (0.4) [40 (40)]	0.1 [0.46] 1 (0.67*) [100 (67*)]	0.13 [0.58] 2 (0.67*) [200 (67*)]	0.19 [0.84] 2.8 (0.67*) [280 (67*)]
0.152x0.411-2.4-P4 0.006 x 0.016	0.11 [2.7]	0.065 [1.64]	16 [61]	0.075 [0.34] 0.3 (0.3) [30 (30)]	0.1 [0.46] 0.76 (0.75*) [76 (75*)]	0.13 [0.58] 1.5 (0.75*) [150 (75*)]	0.19 [0.84] 2.1 (0.75*) [210 (75*)]
0.152x0.411-3.2-P1 0.006 x 0.016	0.14 [3.5]	0.016 [0.411]	62 [240]	0.057 [0.26] 2.1 (0) [210 (0)]	0.079 [0.35] 5.2 (0) [520 (0)]	0.099 [0.44] 10 (0) [1000 (0)]	0.14 [0.64] 15 (0) [1500 (0)]
0.152x0.411-3.2-P2 0.006 x 0.016	0.14 [3.5]	0.032 [0.822]	31 [120]	0.057 [0.26] 1 (0.5*) [100 (50*)]	0.079 [0.35] 2.6 (0.5*) [260 (50*)]	0.099 [0.44] 5.2 (0.5*) [520 (50*)]	0.14 [0.64] 7.3 (0.5*) [730 (50*)]
0.152x0.411-3.2-P3 0.006 x 0.016	0.14 [3.5]	0.049 [1.23]	21 [81]	0.057 [0.26] 0.7 (0.67*) [70 (67*)]	0.079 [0.35] 1.7 (0.67*) [170 (67*)]	0.099 [0.44] 3.5 (0.67*) [350 (67*)]	0.14 [0.64] 4.9 (0.67*) [490 (67*)]
0.152x0.411-3.2-P4 0.006 x 0.016	0.14 [3.5]	0.065 [1.64]	16 [61]	0.057 [0.26] 0.52 (0.52) [52 (52)]	0.079 [0.35] 1.3 (0.75*) [130 (75*)]	0.099 [0.44] 2.6 (0.75*) [260 (75*)]	0.14 [0.64] 3.7 (0.75*) [370 (75*)]
0.152x0.411-4.75-P1 0.006 x 0.016	0.2 [5.05]	0.016 [0.411]	62 [240]	0.039 [0.17] 4.5 (0) [450 (0)]	0.054 [0.24] 11 (0) [1100 (0)]	0.068 [0.3] 22 (0) [2200 (0)]	0.098 [0.44] 31 (0) [3100 (0)]
0.152x0.411-4.75-P2 0.006 x 0.016	0.2 [5.05]	0.032 [0.822]	31 [120]	0.039 [0.17] 2.2 (0.5*) [220 (50*)]	0.054 [0.24] 5.6 (0.5*) [560 (50*)]	0.068 [0.3] 11 (0.5*) [1100 (50*)]	0.098 [0.44] 16 (0.5*) [1600 (50*)]
0.152x0.411-4.75-P3 0.006 x 0.016	0.2 [5.05]	0.049 [1.23]	21 [81]	0.039 [0.17] 1.5 (0.67*) [150 (67*)]	0.054 [0.24] 3.7 (0.67*) [370 (67*)]	0.068 [0.3] 7.4 (0.67*) [740 (67*)]	0.098 [0.44] 10 (0.67*) [1000 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.411-4.75-P4 0.006 x 0.016	0.2 [5.05]	0.065 [1.64]	16 [61]	0.039 [0.17] 1.1 (0.75*) [110 (75*)]	0.054 [0.24] 2.8 (0.75*) [280 (75*)]	0.068 [0.3] 5.6 (0.75*) [560 (75*)]	0.098 [0.44] 7.8 (0.75*) [780 (75*)]
0.152x0.411-6-P1 0.006 x 0.016	0.25 [6.3]	0.016 [0.411]	62 [240]	0.031 [0.14] 7 (0) [700 (0)]	0.043 [0.19] 18 (0) [1800 (0)]	0.054 [0.24] 35 (0) [3500 (0)]	0.078 [0.35] 49 (0) [4900 (0)]
0.152x0.411-6-P2 0.006 x 0.016	0.25 [6.3]	0.032 [0.822]	31 [120]	0.031 [0.14] 3.5 (0.5*) [350 (50*)]	0.043 [0.19] 8.8 (0.5*) [880 (50*)]	0.054 [0.24] 18 (0.5*) [1800 (50*)]	0.078 [0.35] 25 (0.5*) [2500 (50*)]
0.152x0.411-6-P3 0.006 x 0.016	0.25 [6.3]	0.049 [1.23]	21 [81]	0.031 [0.14] 2.3 (0.67*) [230 (67*)]	0.043 [0.19] 5.9 (0.67*) [590 (67*)]	0.054 [0.24] 12 (0.67*) [1200 (67*)]	0.078 [0.35] 16 (0.67*) [1600 (67*)]
0.152x0.411-6-P4 0.006 x 0.016	0.25 [6.3]	0.065 [1.64]	16 [61]	0.031 [0.14] 1.8 (0.75*) [180 (75*)]	0.043 [0.19] 4.4 (0.75*) [440 (75*)]	0.054 [0.24] 8.8 (0.75*) [880 (75*)]	0.078 [0.35] 12 (0.75*) [1200 (75*)]
0.152x0.411-8-P1 0.006 x 0.016	0.33 [8.3]	0.016 [0.411]	62 [240]	0.024 [0.1] 12 (0) [1200 (0)]	0.033 [0.14] 31 (0) [3100 (0)]	0.041 [0.18] 62 (0) [6200 (0)]	0.059 [0.26] 86 (0) [8600 (0)]
0.152x0.411-8-P2 0.006 x 0.016	0.33 [8.3]	0.032 [0.822]	31 [120]	0.024 [0.1] 6.2 (0.5*) [620 (50*)]	0.033 [0.14] 15 (0.5*) [1500 (50*)]	0.041 [0.18] 31 (0.5*) [3100 (50*)]	0.059 [0.26] 43 (0.5*) [4300 (50*)]
0.152x0.411-8-P3 0.006 x 0.016	0.33 [8.3]	0.049 [1.23]	21 [81]	0.024 [0.1] 4.1 (0.67*) [410 (67*)]	0.033 [0.14] 10 (0.67*) [1000 (67*)]	0.041 [0.18] 21 (0.67*) [2100 (67*)]	0.059 [0.26] 29 (0.67*) [2900 (67*)]
0.152x0.411-8-P4 0.006 x 0.016	0.33 [8.3]	0.065 [1.64]	16 [61]	0.024 [0.1] 3.1 (0.75*) [310 (75*)]	0.033 [0.14] 7.7 (0.75*) [770 (75*)]	0.041 [0.18] 15 (0.75*) [1500 (75*)]	0.059 [0.26] 22 (0.75*) [2200 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.411-9.5-P1 0.006 x 0.016	0.39 [9.8]	0.016 [0.411]	62 [240]	0.02 [0.089] 17 (0) [1700 (0)]	0.028 [0.12] 43 (0) [4300 (0)]	0.034 [0.15] 87 (0) [8700 (0)]	0.05 [0.22] 120 (0) [12000 (0)]
0.152x0.411-9.5-P2 0.006 x 0.016	0.39 [9.8]	0.032 [0.822]	31 [120]	0.02 [0.089] 8.7 (0.5*) [870 (50*)]	0.028 [0.12] 22 (0.5*) [2200 (50*)]	0.034 [0.15] 43 (0.5*) [4300 (50*)]	0.05 [0.22] 61 (0.5*) [6100 (50*)]
0.152x0.411-9.5-P3 0.006 x 0.016	0.39 [9.8]	0.049 [1.23]	21 [81]	0.02 [0.089] 5.8 (0.67*) [580 (67*)]	0.028 [0.12] 14 (0.67*) [1400 (67*)]	0.034 [0.15] 29 (0.67*) [2900 (67*)]	0.05 [0.22] 40 (0.67*) [4000 (67*)]
0.152x0.411-9.5-P4 0.006 x 0.016	0.39 [9.8]	0.065 [1.64]	16 [61]	0.02 [0.089] 4.3 (0.75*) [430 (75*)]	0.028 [0.12] 11 (0.75*) [1100 (75*)]	0.034 [0.15] 22 (0.75*) [2200 (75*)]	0.05 [0.22] 30 (0.75*) [3000 (75*)]
0.152x0.411-12.7-P1 0.006 x 0.016	0.51 [13]	0.016 [0.411]	62 [240]	0.015 [0.067] 31 (0) [3100 (0)]	0.021 [0.092] 77 (0) [7700 (0)]	0.026 [0.11] 150 (0) [15000 (0)]	0.037 [0.17] 210 (0) [21000 (0)]
0.152x0.411-12.7-P2 0.006 x 0.016	0.51 [13]	0.032 [0.822]	31 [120]	0.015 [0.067] 15 (0.5*) [1500 (50*)]	0.021 [0.092] 38 (0.5*) [3800 (50*)]	0.026 [0.11] 77 (0.5*) [7700 (50*)]	0.037 [0.17] 110 (0.5*) [11000 (50*)]
0.152x0.411-12.7-P3 0.006 x 0.016	0.51 [13]	0.049 [1.23]	21 [81]	0.015 [0.067] 10 (0.67*) [1000 (67*)]	0.021 [0.092] 26 (0.67*) [2600 (67*)]	0.026 [0.11] 51 (0.67*) [5100 (67*)]	0.037 [0.17] 72 (0.67*) [7200 (67*)]
0.152x0.411-12.7-P4 0.006 x 0.016	0.51 [13]	0.065 [1.64]	16 [61]	0.015 [0.067] 7.7 (0.75*) [770 (75*)]	0.021 [0.092] 19 (0.75*) [1900 (75*)]	0.026 [0.11] 38 (0.75*) [3800 (75*)]	0.037 [0.17] 54 (0.75*) [5400 (75*)]
0.152x0.411-14.2-P1 0.006 x 0.016	0.57 [14.5]	0.016 [0.411]	62 [240]	0.013 [0.06] 38 (0) [3800 (0)]	0.019 [0.082] 96 (0) [9600 (0)]	0.023 [0.1] 190 (0) [19000 (0)]	0.034 [0.15] 270 (0) [27000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.411-14.2-P2 0.006 x 0.016	0.57 [14.5]	0.032 [0.822]	31 [120]	0.013 [0.06] 19 (0.5*) [1900 (50*)]	0.019 [0.082] 48 (0.5*) [4800 (50*)]	0.023 [0.1] 96 (0.5*) [9600 (50*)]	0.034 [0.15] 130 (0.5*) [13000 (50*)]
0.152x0.411-14.2-P3 0.006 x 0.016	0.57 [14.5]	0.049 [1.23]	21 [81]	0.013 [0.06] 13 (0.67*) [1300 (67*)]	0.019 [0.082] 32 (0.67*) [3200 (67*)]	0.023 [0.1] 64 (0.67*) [6400 (67*)]	0.034 [0.15] 89 (0.67*) [8900 (67*)]
0.152x0.411-14.2-P4 0.006 x 0.016	0.57 [14.5]	0.065 [1.64]	16 [61]	0.013 [0.06] 9.6 (0.75*) [960 (75*)]	0.019 [0.082] 24 (0.75*) [2400 (75*)]	0.023 [0.1] 48 (0.75*) [4800 (75*)]	0.034 [0.15] 67 (0.75*) [6700 (75*)]
0.152x0.411-16-P1 0.006 x 0.016	0.64 [16.3]	0.016 [0.411]	62 [240]	0.012 [0.053] 49 (0) [4900 (0)]	0.016 [0.073] 120 (0) [12000 (0)]	0.021 [0.091] 240 (0) [24000 (0)]	0.03 [0.13] 340 (0) [34000 (0)]
0.152x0.411-16-P2 0.006 x 0.016	0.64 [16.3]	0.032 [0.822]	31 [120]	0.012 [0.053] 24 (0.5*) [2400 (50*)]	0.016 [0.073] 61 (0.5*) [6100 (50*)]	0.021 [0.091] 120 (0.5*) [12000 (50*)]	0.03 [0.13] 170 (0.5*) [17000 (50*)]
0.152x0.411-16-P3 0.006 x 0.016	0.64 [16.3]	0.049 [1.23]	21 [81]	0.012 [0.053] 16 (0.67*) [1600 (67*)]	0.016 [0.073] 40 (0.67*) [4000 (67*)]	0.021 [0.091] 81 (0.67*) [8100 (67*)]	0.03 [0.13] 110 (0.67*) [11000 (67*)]
0.152x0.411-16-P4 0.006 x 0.016	0.64 [16.3]	0.065 [1.64]	16 [61]	0.012 [0.053] 12 (0.75*) [1200 (75*)]	0.016 [0.073] 30 (0.75*) [3000 (75*)]	0.021 [0.091] 61 (0.75*) [6100 (75*)]	0.03 [0.13] 85 (0.75*) [8500 (75*)]
0.152x0.411-19-P1 0.006 x 0.016	0.76 [19.3]	0.016 [0.411]	62 [240]	0.01 [0.045] 68 (0) [6800 (0)]	0.014 [0.062] 170 (0) [17000 (0)]	0.017 [0.077] 340 (0) [34000 (0)]	0.025 [0.11] 480 (0) [48000 (0)]
0.152x0.411-19-P2 0.006 x 0.016	0.76 [19.3]	0.032 [0.822]	31 [120]	0.01 [0.045] 34 (0.5*) [3400 (50*)]	0.014 [0.062] 85 (0.5*) [8500 (50*)]	0.017 [0.077] 170 (0.5*) [17000 (50*)]	0.025 [0.11] 240 (0.5*) [24000 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.411-19-P3 0.006 x 0.016	0.76 [19.3]	0.049 [1.23]	21 [81]	0.01 [0.045] 23 (0.67*) [2300 (67*)]	0.014 [0.062] 57 (0.67*) [5700 (67*)]	0.017 [0.077] 110 (0.67*) [11000 (67*)]	0.025 [0.11] 160 (0.67*) [16000 (67*)]
0.152x0.411-19-P4 0.006 x 0.016	0.76 [19.3]	0.065 [1.64]	16 [61]	0.01 [0.045] 17 (0.75*) [1700 (75*)]	0.014 [0.062] 43 (0.75*) [4300 (75*)]	0.017 [0.077] 85 (0.75*) [8500 (75*)]	0.025 [0.11] 120 (0.75*) [12000 (75*)]
0.152x0.411-22.2-P1 0.006 x 0.016	0.89 [22.5]	0.016 [0.411]	62 [240]	0.0086 [0.038] 93 (0) [9300 (0)]	0.012 [0.053] 230 (0) [23000 (0)]	0.015 [0.066] 460 (0) [46000 (0)]	0.022 [0.096] 650 (0) [65000 (0)]
0.152x0.411-22.2-P2 0.006 x 0.016	0.89 [22.5]	0.032 [0.822]	31 [120]	0.0086 [0.038] 46 (0.5*) [4600 (50*)]	0.012 [0.053] 120 (0.5*) [12000 (50*)]	0.015 [0.066] 230 (0.5*) [23000 (50*)]	0.022 [0.096] 330 (0.5*) [33000 (50*)]
0.152x0.411-22.2-P3 0.006 x 0.016	0.89 [22.5]	0.049 [1.23]	21 [81]	0.0086 [0.038] 31 (0.67*) [3100 (67*)]	0.012 [0.053] 77 (0.67*) [7700 (67*)]	0.015 [0.066] 150 (0.67*) [15000 (67*)]	0.022 [0.096] 220 (0.67*) [22000 (67*)]
0.152x0.411-22.2-P4 0.006 x 0.016	0.89 [22.5]	0.065 [1.64]	16 [61]	0.0086 [0.038] 23 (0.75*) [2300 (75*)]	0.012 [0.053] 58 (0.75*) [5800 (75*)]	0.015 [0.066] 120 (0.75*) [12000 (75*)]	0.022 [0.096] 160 (0.75*) [16000 (75*)]
0.152x0.411-25.4-P1 0.006 x 0.016	1 [25.7]	0.016 [0.411]	62 [240]	0.0075 [0.034] 120 (0) [12000 (0)]	0.01 [0.046] 300 (0) [30000 (0)]	0.013 [0.058] 610 (0) [61000 (0)]	0.019 [0.084] 850 (0) [85000 (0)]
0.152x0.411-25.4-P2 0.006 x 0.016	1 [25.7]	0.032 [0.822]	31 [120]	0.0075 [0.034] 61 (0.5*) [6100 (50*)]	0.01 [0.046] 150 (0.5*) [15000 (50*)]	0.013 [0.058] 300 (0.5*) [30000 (50*)]	0.019 [0.084] 420 (0.5*) [42000 (50*)]
0.152x0.411-25.4-P3 0.006 x 0.016	1 [25.7]	0.049 [1.23]	21 [81]	0.0075 [0.034] 40 (0.67*) [4000 (67*)]	0.01 [0.046] 100 (0.67*) [10000 (67*)]	0.013 [0.058] 200 (0.67*) [20000 (67*)]	0.019 [0.084] 280 (0.67*) [28000 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.411-25.4-P4 0.006 x 0.016	1 [25.7]	0.065 [1.64]	16 [61]	0.0075 [0.034] 30 (0.75*) [3000 (75*)]	0.01 [0.046] 76 (0.75*) [7600 (75*)]	0.013 [0.058] 150 (0.75*) [15000 (75*)]	0.019 [0.084] 210 (0.75*) [21000 (75*)]
0.152x0.813-0.5-P1 0.006 x 0.032	0.032 [0.804]	0.032 [0.813]	31 [120]	1.2 [5.2] 0.02 (0) [2 (0)]	1.6 [7.1] 0.05 (0) [5 (0)]	2 [8.9] 0.1 (0) [10 (0)]	2.9 [13] 0.14 (0) [14 (0)]
0.152x0.813-0.5-P2 0.006 x 0.032	0.032 [0.804]	0.064 [1.63]	16 [62]	1.2 [5.2] 0.01 (0.01) [1 (1)]	1.6 [7.1] 0.025 (0.025) [2.5 (2.5)]	2 [8.9] 0.05 (0.05) [5 (5)]	2.9 [13] 0.07 (0.07) [7 (7)]
0.152x0.813-0.5-P3 0.006 x 0.032	0.032 [0.804]	0.096 [2.44]	10 [41]	1.2 [5.2] 0.0067 (0.0067) [0.67 (0.67)]	1.6 [7.1] 0.017 (0.017) [1.7 (1.7)]	2 [8.9] 0.033 (0.033) [3.3 (3.3)]	2.9 [13] 0.047 (0.047) [4.7 (4.7)]
0.152x0.813-0.5-P4 0.006 x 0.032	0.032 [0.804]	0.13 [3.25]	7.8 [31]	1.2 [5.2] 0.005 (0.005) [0.5 (0.5)]	1.6 [7.1] 0.013 (0.013) [1.2 (1.2)]	2 [8.9] 0.025 (0.025) [2.5 (2.5)]	2.9 [13] 0.035 (0.035) [3.5 (3.5)]
0.152x0.813-0.9-P1 0.006 x 0.032	0.047 [1.2]	0.032 [0.813]	31 [120]	0.72 [3.2] 0.052 (0) [5.2 (0)]	0.99 [4.4] 0.13 (0) [13 (0)]	1.2 [5.5] 0.26 (0) [26 (0)]	1.8 [8] 0.36 (0) [36 (0)]
0.152x0.813-0.9-P2 0.006 x 0.032	0.047 [1.2]	0.064 [1.63]	16 [62]	0.72 [3.2] 0.026 (0.026) [2.6 (2.6)]	0.99 [4.4] 0.065 (0.065) [6.5 (6.5)]	1.2 [5.5] 0.13 (0.13) [13 (13)]	1.8 [8] 0.18 (0.18) [18 (18)]
0.152x0.813-0.9-P3 0.006 x 0.032	0.047 [1.2]	0.096 [2.44]	10 [41]	0.72 [3.2] 0.017 (0.017) [1.7 (1.7)]	0.99 [4.4] 0.043 (0.043) [4.3 (4.3)]	1.2 [5.5] 0.087 (0.087) [8.7 (8.7)]	1.8 [8] 0.12 (0.12) [12 (12)]
0.152x0.813-0.9-P4 0.006 x 0.032	0.047 [1.2]	0.13 [3.25]	7.8 [31]	0.72 [3.2] 0.013 (0.013) [1.3 (1.3)]	0.99 [4.4] 0.033 (0.033) [3.2 (3.2)]	1.2 [5.5] 0.065 (0.065) [6.5 (6.5)]	1.8 [8] 0.091 (0.091) [9.1 (9.1)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.813-1.15-P1 0.006 x 0.032	0.057 [1.45]	0.032 [0.813]	31 [120]	0.58 [2.6] 0.08 (0) [8 (0)]	0.8 [3.6] 0.2 (0) [20 (0)]	1 [4.4] 0.4 (0) [40 (0)]	1.4 [6.4] 0.56 (0) [56 (0)]
0.152x0.813-1.15-P2 0.006 x 0.032	0.057 [1.45]	0.064 [1.63]	16 [62]	0.58 [2.6] 0.04 (0.04) [4 (4)]	0.8 [3.6] 0.1 (0.1) [10 (10)]	1 [4.4] 0.2 (0.2) [20 (20)]	1.4 [6.4] 0.28 (0.28) [28 (28)]
0.152x0.813-1.15-P3 0.006 x 0.032	0.057 [1.45]	0.096 [2.44]	10 [41]	0.58 [2.6] 0.027 (0.027) [2.7 (2.7)]	0.8 [3.6] 0.067 (0.067) [6.7 (6.7)]	1 [4.4] 0.13 (0.13) [13 (13)]	1.4 [6.4] 0.19 (0.19) [19 (19)]
0.152x0.813-1.15-P4 0.006 x 0.032	0.057 [1.45]	0.13 [3.25]	7.8 [31]	0.58 [2.6] 0.02 (0.02) [2 (2)]	0.8 [3.6] 0.05 (0.05) [5 (5)]	1 [4.4] 0.1 (0.1) [10 (10)]	1.4 [6.4] 0.14 (0.14) [14 (14)]
0.152x0.813-1.6-P1 0.006 x 0.032	0.075 [1.9]	0.032 [0.813]	31 [120]	0.43 [1.9] 0.15 (0) [15 (0)]	0.59 [2.6] 0.36 (0) [36 (0)]	0.74 [3.3] 0.73 (0) [73 (0)]	1.1 [4.8] 1 (0) [100 (0)]
0.152x0.813-1.6-P2 0.006 x 0.032	0.075 [1.9]	0.064 [1.63]	16 [62]	0.43 [1.9] 0.073 (0.073) [7.3 (7.3)]	0.59 [2.6] 0.18 (0.18) [18 (18)]	0.74 [3.3] 0.36 (0.36) [36 (36)]	1.1 [4.8] 0.51 (0.5*) [51 (50*)]
0.152x0.813-1.6-P3 0.006 x 0.032	0.075 [1.9]	0.096 [2.44]	10 [41]	0.43 [1.9] 0.049 (0.049) [4.9 (4.9)]	0.59 [2.6] 0.12 (0.12) [12 (12)]	0.74 [3.3] 0.24 (0.24) [24 (24)]	1.1 [4.8] 0.34 (0.34) [34 (34)]
0.152x0.813-1.6-P4 0.006 x 0.032	0.075 [1.9]	0.13 [3.25]	7.8 [31]	0.43 [1.9] 0.036 (0.036) [3.6 (3.6)]	0.59 [2.6] 0.091 (0.091) [9.1 (9.1)]	0.74 [3.3] 0.18 (0.18) [18 (18)]	1.1 [4.8] 0.26 (0.26) [26 (26)]
0.152x0.813-2.4-P1 0.006 x 0.032	0.11 [2.7]	0.032 [0.813]	31 [120]	0.3 [1.3] 0.31 (0) [31 (0)]	0.41 [1.8] 0.77 (0) [77 (0)]	0.51 [2.3] 1.5 (0) [150 (0)]	0.74 [3.3] 2.2 (0) [220 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.813-2.4-P2 0.006 x 0.032	0.11 [2.7]	0.064 [1.63]	16 [62]	0.3 [1.3] 0.15 (0.15) [15 (15)]	0.41 [1.8] 0.39 (0.39) [38 (38)]	0.51 [2.3] 0.77 (0.5*) [77 (50*)]	0.74 [3.3] 1.1 (0.5*) [110 (50*)]
0.152x0.813-2.4-P3 0.006 x 0.032	0.11 [2.7]	0.096 [2.44]	10 [41]	0.3 [1.3] 0.1 (0.1) [10 (10)]	0.41 [1.8] 0.26 (0.26) [26 (26)]	0.51 [2.3] 0.51 (0.51) [51 (51)]	0.74 [3.3] 0.72 (0.67*) [72 (67*)]
0.152x0.813-2.4-P4 0.006 x 0.032	0.11 [2.7]	0.13 [3.25]	7.8 [31]	0.3 [1.3] 0.077 (0.077) [7.7 (7.7)]	0.41 [1.8] 0.19 (0.19) [19 (19)]	0.51 [2.3] 0.39 (0.39) [38 (38)]	0.74 [3.3] 0.54 (0.54) [54 (54)]
0.152x0.813-3.2-P1 0.006 x 0.032	0.14 [3.5]	0.032 [0.813]	31 [120]	0.22 [1] 0.53 (0) [53 (0)]	0.31 [1.4] 1.3 (0) [130 (0)]	0.39 [1.7] 2.7 (0) [270 (0)]	0.56 [2.5] 3.7 (0) [370 (0)]
0.152x0.813-3.2-P2 0.006 x 0.032	0.14 [3.5]	0.064 [1.63]	16 [62]	0.22 [1] 0.27 (0.27) [27 (27)]	0.31 [1.4] 0.67 (0.5*) [67 (50*)]	0.39 [1.7] 1.3 (0.5*) [130 (50*)]	0.56 [2.5] 1.9 (0.5*) [190 (50*)]
0.152x0.813-3.2-P3 0.006 x 0.032	0.14 [3.5]	0.096 [2.44]	10 [41]	0.22 [1] 0.18 (0.18) [18 (18)]	0.31 [1.4] 0.45 (0.45) [44 (44)]	0.39 [1.7] 0.89 (0.67*) [89 (67*)]	0.56 [2.5] 1.2 (0.67*) [120 (67*)]
0.152x0.813-3.2-P4 0.006 x 0.032	0.14 [3.5]	0.13 [3.25]	7.8 [31]	0.22 [1] 0.13 (0.13) [13 (13)]	0.31 [1.4] 0.33 (0.33) [33 (33)]	0.39 [1.7] 0.67 (0.67) [67 (67)]	0.56 [2.5] 0.93 (0.75*) [93 (75*)]
0.152x0.813-4.75-P1 0.006 x 0.032	0.2 [5.05]	0.032 [0.813]	31 [120]	0.15 [0.68] 1.1 (0) [110 (0)]	0.21 [0.94] 2.9 (0) [290 (0)]	0.26 [1.2] 5.7 (0) [570 (0)]	0.38 [1.7] 8 (0) [800 (0)]
0.152x0.813-4.75-P2 0.006 x 0.032	0.2 [5.05]	0.064 [1.63]	16 [62]	0.15 [0.68] 0.57 (0.5*) [57 (50*)]	0.21 [0.94] 1.4 (0.5*) [140 (50*)]	0.26 [1.2] 2.9 (0.5*) [290 (50*)]	0.38 [1.7] 4 (0.5*) [400 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.813-4.75-P3 0.006 x 0.032	0.2 [5.05]	0.096 [2.44]	10 [41]	0.15 [0.68] 0.38 (0.38) [38 (38)]	0.21 [0.94] 0.95 (0.67*) [95 (67*)]	0.26 [1.2] 1.9 (0.67*) [190 (67*)]	0.38 [1.7] 2.7 (0.67*) [270 (67*)]
0.152x0.813-4.75-P4 0.006 x 0.032	0.2 [5.05]	0.13 [3.25]	7.8 [31]	0.15 [0.68] 0.29 (0.29) [29 (29)]	0.21 [0.94] 0.71 (0.71) [71 (71)]	0.26 [1.2] 1.4 (0.75*) [140 (75*)]	0.38 [1.7] 2 (0.75*) [200 (75*)]
0.152x0.813-6-P1 0.006 x 0.032	0.25 [6.3]	0.032 [0.813]	31 [120]	0.12 [0.54] 1.8 (0) [180 (0)]	0.17 [0.75] 4.5 (0) [450 (0)]	0.21 [0.94] 9 (0) [900 (0)]	0.31 [1.4] 13 (0) [1300 (0)]
0.152x0.813-6-P2 0.006 x 0.032	0.25 [6.3]	0.064 [1.63]	16 [62]	0.12 [0.54] 0.9 (0.5*) [90 (50*)]	0.17 [0.75] 2.2 (0.5*) [220 (50*)]	0.21 [0.94] 4.5 (0.5*) [450 (50*)]	0.31 [1.4] 6.3 (0.5*) [630 (50*)]
0.152x0.813-6-P3 0.006 x 0.032	0.25 [6.3]	0.096 [2.44]	10 [41]	0.12 [0.54] 0.6 (0.6) [60 (60)]	0.17 [0.75] 1.5 (0.67*) [150 (67*)]	0.21 [0.94] 3 (0.67*) [300 (67*)]	0.31 [1.4] 4.2 (0.67*) [420 (67*)]
0.152x0.813-6-P4 0.006 x 0.032	0.25 [6.3]	0.13 [3.25]	7.8 [31]	0.12 [0.54] 0.45 (0.45) [45 (45)]	0.17 [0.75] 1.1 (0.75*) [110 (75*)]	0.21 [0.94] 2.2 (0.75*) [220 (75*)]	0.31 [1.4] 3.1 (0.75*) [310 (75*)]
0.152x0.813-8-P1 0.006 x 0.032	0.33 [8.3]	0.032 [0.813]	31 [120]	0.092 [0.41] 3.2 (0) [320 (0)]	0.13 [0.57] 7.9 (0) [790 (0)]	0.16 [0.71] 16 (0) [1600 (0)]	0.23 [1] 22 (0) [2200 (0)]
0.152x0.813-8-P2 0.006 x 0.032	0.33 [8.3]	0.064 [1.63]	16 [62]	0.092 [0.41] 1.6 (0.5*) [160 (50*)]	0.13 [0.57] 3.9 (0.5*) [390 (50*)]	0.16 [0.71] 7.9 (0.5*) [790 (50*)]	0.23 [1] 11 (0.5*) [1100 (50*)]
0.152x0.813-8-P3 0.006 x 0.032	0.33 [8.3]	0.096 [2.44]	10 [41]	0.092 [0.41] 1.1 (0.67*) [110 (67*)]	0.13 [0.57] 2.6 (0.67*) [260 (67*)]	0.16 [0.71] 5.3 (0.67*) [530 (67*)]	0.23 [1] 7.4 (0.67*) [740 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.813-8-P4 0.006 x 0.032	0.33 [8.3]	0.13 [3.25]	7.8 [31]	0.092 [0.41] 0.79 (0.75*) [79 (75*)]	0.13 [0.57] 2 (0.75*) [200 (75*)]	0.16 [0.71] 3.9 (0.75*) [390 (75*)]	0.23 [1] 5.5 (0.75*) [550 (75*)]
0.152x0.813-9.5-P1 0.006 x 0.032	0.39 [9.8]	0.032 [0.813]	31 [120]	0.078 [0.35] 4.4 (0) [440 (0)]	0.11 [0.48] 11 (0) [1100 (0)]	0.13 [0.6] 22 (0) [2200 (0)]	0.2 [0.87] 31 (0) [3100 (0)]
0.152x0.813-9.5-P2 0.006 x 0.032	0.39 [9.8]	0.064 [1.63]	16 [62]	0.078 [0.35] 2.2 (0.5*) [220 (50*)]	0.11 [0.48] 5.5 (0.5*) [550 (50*)]	0.13 [0.6] 11 (0.5*) [1100 (50*)]	0.2 [0.87] 15 (0.5*) [1500 (50*)]
0.152x0.813-9.5-P3 0.006 x 0.032	0.39 [9.8]	0.096 [2.44]	10 [41]	0.078 [0.35] 1.5 (0.67*) [150 (67*)]	0.11 [0.48] 3.7 (0.67*) [370 (67*)]	0.13 [0.6] 7.4 (0.67*) [740 (67*)]	0.2 [0.87] 10 (0.67*) [1000 (67*)]
0.152x0.813-9.5-P4 0.006 x 0.032	0.39 [9.8]	0.13 [3.25]	7.8 [31]	0.078 [0.35] 1.1 (0.75*) [110 (75*)]	0.11 [0.48] 2.8 (0.75*) [280 (75*)]	0.13 [0.6] 5.5 (0.75*) [550 (75*)]	0.2 [0.87] 7.7 (0.75*) [770 (75*)]
0.152x0.813-12.7-P1 0.006 x 0.032	0.51 [13]	0.032 [0.813]	31 [120]	0.059 [0.26] 7.8 (0) [780 (0)]	0.081 [0.36] 20 (0) [2000 (0)]	0.1 [0.45] 39 (0) [3900 (0)]	0.15 [0.65] 55 (0) [5500 (0)]
0.152x0.813-12.7-P2 0.006 x 0.032	0.51 [13]	0.064 [1.63]	16 [62]	0.059 [0.26] 3.9 (0.5*) [390 (50*)]	0.081 [0.36] 9.8 (0.5*) [980 (50*)]	0.1 [0.45] 20 (0.5*) [2000 (50*)]	0.15 [0.65] 27 (0.5*) [2700 (50*)]
0.152x0.813-12.7-P3 0.006 x 0.032	0.51 [13]	0.096 [2.44]	10 [41]	0.059 [0.26] 2.6 (0.67*) [260 (67*)]	0.081 [0.36] 6.5 (0.67*) [650 (67*)]	0.1 [0.45] 13 (0.67*) [1300 (67*)]	0.15 [0.65] 18 (0.67*) [1800 (67*)]
0.152x0.813-12.7-P4 0.006 x 0.032	0.51 [13]	0.13 [3.25]	7.8 [31]	0.059 [0.26] 2 (0.75*) [200 (75*)]	0.081 [0.36] 4.9 (0.75*) [490 (75*)]	0.1 [0.45] 9.8 (0.75*) [980 (75*)]	0.15 [0.65] 14 (0.75*) [1400 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.813-14.2-P1 0.006 x 0.032	0.57 [14.5]	0.032 [0.813]	31 [120]	0.052 [0.23] 9.8 (0) [980 (0)]	0.072 [0.32] 24 (0) [2400 (0)]	0.09 [0.4] 49 (0) [4900 (0)]	0.13 [0.58] 69 (0) [6900 (0)]
0.152x0.813-14.2-P2 0.006 x 0.032	0.57 [14.5]	0.064 [1.63]	16 [62]	0.052 [0.23] 4.9 (0.5*) [490 (50*)]	0.072 [0.32] 12 (0.5*) [1200 (50*)]	0.09 [0.4] 24 (0.5*) [2400 (50*)]	0.13 [0.58] 34 (0.5*) [3400 (50*)]
0.152x0.813-14.2-P3 0.006 x 0.032	0.57 [14.5]	0.096 [2.44]	10 [41]	0.052 [0.23] 3.3 (0.67*) [330 (67*)]	0.072 [0.32] 8.2 (0.67*) [820 (67*)]	0.09 [0.4] 16 (0.67*) [1600 (67*)]	0.13 [0.58] 23 (0.67*) [2300 (67*)]
0.152x0.813-14.2-P4 0.006 x 0.032	0.57 [14.5]	0.13 [3.25]	7.8 [31]	0.052 [0.23] 2.4 (0.75*) [240 (75*)]	0.072 [0.32] 6.1 (0.75*) [610 (75*)]	0.09 [0.4] 12 (0.75*) [1200 (75*)]	0.13 [0.58] 17 (0.75*) [1700 (75*)]
0.152x0.813-16-P1 0.006 x 0.032	0.64 [16.3]	0.032 [0.813]	31 [120]	0.047 [0.21] 12 (0) [1200 (0)]	0.064 [0.29] 31 (0) [3100 (0)]	0.08 [0.36] 62 (0) [6200 (0)]	0.12 [0.52] 87 (0) [8700 (0)]
0.152x0.813-16-P2 0.006 x 0.032	0.64 [16.3]	0.064 [1.63]	16 [62]	0.047 [0.21] 6.2 (0.5*) [620 (50*)]	0.064 [0.29] 15 (0.5*) [1500 (50*)]	0.08 [0.36] 31 (0.5*) [3100 (50*)]	0.12 [0.52] 43 (0.5*) [4300 (50*)]
0.152x0.813-16-P3 0.006 x 0.032	0.64 [16.3]	0.096 [2.44]	10 [41]	0.047 [0.21] 4.1 (0.67*) [410 (67*)]	0.064 [0.29] 10 (0.67*) [1000 (67*)]	0.08 [0.36] 21 (0.67*) [2100 (67*)]	0.12 [0.52] 29 (0.67*) [2900 (67*)]
0.152x0.813-16-P4 0.006 x 0.032	0.64 [16.3]	0.13 [3.25]	7.8 [31]	0.047 [0.21] 3.1 (0.75*) [310 (75*)]	0.064 [0.29] 7.7 (0.75*) [770 (75*)]	0.08 [0.36] 15 (0.75*) [1500 (75*)]	0.12 [0.52] 22 (0.75*) [2200 (75*)]
0.152x0.813-19-P1 0.006 x 0.032	0.76 [19.3]	0.032 [0.813]	31 [120]	0.039 [0.17] 17 (0) [1700 (0)]	0.054 [0.24] 44 (0) [4400 (0)]	0.068 [0.3] 87 (0) [8700 (0)]	0.098 [0.44] 120 (0) [12000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.813-19-P2 0.006 x 0.032	0.76 [19.3]	0.064 [1.63]	16 [62]	0.039 [0.17] 8.7 (0.5*) [870 (50*)]	0.054 [0.24] 22 (0.5*) [2200 (50*)]	0.068 [0.3] 44 (0.5*) [4400 (50*)]	0.098 [0.44] 61 (0.5*) [6100 (50*)]
0.152x0.813-19-P3 0.006 x 0.032	0.76 [19.3]	0.096 [2.44]	10 [41]	0.039 [0.17] 5.8 (0.67*) [580 (67*)]	0.054 [0.24] 15 (0.67*) [1500 (67*)]	0.068 [0.3] 29 (0.67*) [2900 (67*)]	0.098 [0.44] 41 (0.67*) [4100 (67*)]
0.152x0.813-19-P4 0.006 x 0.032	0.76 [19.3]	0.13 [3.25]	7.8 [31]	0.039 [0.17] 4.4 (0.75*) [440 (75*)]	0.054 [0.24] 11 (0.75*) [1100 (75*)]	0.068 [0.3] 22 (0.75*) [2200 (75*)]	0.098 [0.44] 31 (0.75*) [3100 (75*)]
0.152x0.813-22.2-P1 0.006 x 0.032	0.89 [22.5]	0.032 [0.813]	31 [120]	0.034 [0.15] 24 (0) [2400 (0)]	0.046 [0.21] 59 (0) [5900 (0)]	0.058 [0.26] 120 (0) [12000 (0)]	0.084 [0.37] 170 (0) [17000 (0)]
0.152x0.813-22.2-P2 0.006 x 0.032	0.89 [22.5]	0.064 [1.63]	16 [62]	0.034 [0.15] 12 (0.5*) [1200 (50*)]	0.046 [0.21] 30 (0.5*) [3000 (50*)]	0.058 [0.26] 59 (0.5*) [5900 (50*)]	0.084 [0.37] 83 (0.5*) [8300 (50*)]
0.152x0.813-22.2-P3 0.006 x 0.032	0.89 [22.5]	0.096 [2.44]	10 [41]	0.034 [0.15] 7.9 (0.67*) [790 (67*)]	0.046 [0.21] 20 (0.67*) [2000 (67*)]	0.058 [0.26] 40 (0.67*) [4000 (67*)]	0.084 [0.37] 55 (0.67*) [5500 (67*)]
0.152x0.813-22.2-P4 0.006 x 0.032	0.89 [22.5]	0.13 [3.25]	7.8 [31]	0.034 [0.15] 5.9 (0.75*) [590 (75*)]	0.046 [0.21] 15 (0.75*) [1500 (75*)]	0.058 [0.26] 30 (0.75*) [3000 (75*)]	0.084 [0.37] 42 (0.75*) [4200 (75*)]
0.152x0.813-25.4-P1 0.006 x 0.032	1 [25.7]	0.032 [0.813]	31 [120]	0.029 [0.13] 31 (0) [3100 (0)]	0.041 [0.18] 78 (0) [7800 (0)]	0.051 [0.23] 160 (0) [16000 (0)]	0.074 [0.33] 220 (0) [22000 (0)]
0.152x0.813-25.4-P2 0.006 x 0.032	1 [25.7]	0.064 [1.63]	16 [62]	0.029 [0.13] 16 (0.5*) [1600 (50*)]	0.041 [0.18] 39 (0.5*) [3900 (50*)]	0.051 [0.23] 78 (0.5*) [7800 (50*)]	0.074 [0.33] 110 (0.5*) [11000 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.813-25.4-P3 0.006 x 0.032	1 [25.7]	0.096 [2.44]	10 [41]	0.029 [0.13] 10 (0.67*) [1000 (67*)]	0.041 [0.18] 26 (0.67*) [2600 (67*)]	0.051 [0.23] 52 (0.67*) [5200 (67*)]	0.074 [0.33] 72 (0.67*) [7200 (67*)]
0.152x0.813-25.4-P4 0.006 x 0.032	1 [25.7]	0.13 [3.25]	7.8 [31]	0.029 [0.13] 7.8 (0.75*) [780 (75*)]	0.041 [0.18] 19 (0.75*) [1900 (75*)]	0.051 [0.23] 39 (0.75*) [3900 (75*)]	0.074 [0.33] 54 (0.75*) [5400 (75*)]
0.25x0.5-0.5-P1 0.0098 x 0.02	0.039 [1]	0.02 [0.5]	51 [200]	0.62 [2.8] 0.07 (0) [7 (0)]	0.86 [3.8] 0.17 (0) [18 (0)]	1.1 [4.8] 0.35 (0) [35 (0)]	1.6 [6.9] 0.49 (0) [49 (0)]
0.25x0.5-0.5-P2 0.0098 x 0.02	0.039 [1]	0.039 [1]	26 [100]	0.62 [2.8] 0.035 (0.035) [3.5 (3.5)]	0.86 [3.8] 0.087 (0.087) [8.8 (8.8)]	1.1 [4.8] 0.17 (0.17) [18 (18)]	1.6 [6.9] 0.25 (0.25) [25 (25)]
0.25x0.5-0.5-P3 0.0098 x 0.02	0.039 [1]	0.059 [1.5]	17 [67]	0.62 [2.8] 0.023 (0.023) [2.3 (2.3)]	0.86 [3.8] 0.058 (0.058) [5.8 (5.8)]	1.1 [4.8] 0.12 (0.12) [12 (12)]	1.6 [6.9] 0.16 (0.16) [16 (16)]
0.25x0.5-0.5-P4 0.0098 x 0.02	0.039 [1]	0.079 [2]	13 [50]	0.62 [2.8] 0.017 (0.017) [1.7 (1.7)]	0.86 [3.8] 0.044 (0.044) [4.4 (4.4)]	1.1 [4.8] 0.087 (0.087) [8.8 (8.8)]	1.6 [6.9] 0.12 (0.12) [12 (12)]
0.25x0.5-0.9-P1 0.0098 x 0.02	0.055 [1.4]	0.02 [0.5]	51 [200]	0.41 [1.8] 0.17 (0) [17 (0)]	0.56 [2.5] 0.41 (0) [42 (0)]	0.7 [3.1] 0.83 (0) [83 (0)]	1 [4.5] 1.2 (0) [120 (0)]
0.25x0.5-0.9-P2 0.0098 x 0.02	0.055 [1.4]	0.039 [1]	26 [100]	0.41 [1.8] 0.083 (0.083) [8.3 (8.3)]	0.56 [2.5] 0.21 (0.21) [21 (21)]	0.7 [3.1] 0.41 (0.41) [42 (42)]	1 [4.5] 0.58 (0.5*) [58 (50*)]
0.25x0.5-0.9-P3 0.0098 x 0.02	0.055 [1.4]	0.059 [1.5]	17 [67]	0.41 [1.8] 0.055 (0.055) [5.5 (5.5)]	0.56 [2.5] 0.14 (0.14) [14 (14)]	0.7 [3.1] 0.28 (0.28) [28 (28)]	1 [4.5] 0.39 (0.39) [39 (39)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25x0.5-0.9-P4 0.0098 x 0.02	0.055 [1.4]	0.079 [2]	13 [50]	0.41 [1.8] 0.041 (0.041) [4.1 (4.1)]	0.56 [2.5] 0.1 (0.1) [10 (10)]	0.7 [3.1] 0.21 (0.21) [21 (21)]	1 [4.5] 0.29 (0.29) [29 (29)]
0.25x0.5-1.15-P1 0.0098 x 0.02	0.065 [1.65]	0.02 [0.5]	51 [200]	0.33 [1.5] 0.25 (0) [25 (0)]	0.46 [2.1] 0.61 (0) [62 (0)]	0.58 [2.6] 1.2 (0) [120 (0)]	0.84 [3.7] 1.7 (0) [170 (0)]
0.25x0.5-1.15-P2 0.0098 x 0.02	0.065 [1.65]	0.039 [1]	26 [100]	0.33 [1.5] 0.12 (0.12) [12 (12)]	0.46 [2.1] 0.31 (0.31) [31 (31)]	0.58 [2.6] 0.61 (0.5*) [62 (50*)]	0.84 [3.7] 0.86 (0.5*) [86 (50*)]
0.25x0.5-1.15-P3 0.0098 x 0.02	0.065 [1.65]	0.059 [1.5]	17 [67]	0.33 [1.5] 0.082 (0.082) [8.2 (8.2)]	0.46 [2.1] 0.2 (0.2) [20 (20)]	0.58 [2.6] 0.41 (0.41) [41 (41)]	0.84 [3.7] 0.57 (0.57) [57 (57)]
0.25x0.5-1.15-P4 0.0098 x 0.02	0.065 [1.65]	0.079 [2]	13 [50]	0.33 [1.5] 0.061 (0.061) [6.1 (6.1)]	0.46 [2.1] 0.15 (0.15) [15 (15)]	0.58 [2.6] 0.31 (0.31) [31 (31)]	0.84 [3.7] 0.43 (0.43) [43 (43)]
0.25x0.5-1.6-P1 0.0098 x 0.02	0.083 [2.1]	0.02 [0.5]	51 [200]	0.25 [1.1] 0.43 (0) [43 (0)]	0.35 [1.6] 1.1 (0) [110 (0)]	0.44 [1.9] 2.1 (0) [220 (0)]	0.63 [2.8] 3 (0) [300 (0)]
0.25x0.5-1.6-P2 0.0098 x 0.02	0.083 [2.1]	0.039 [1]	26 [100]	0.25 [1.1] 0.21 (0.21) [21 (21)]	0.35 [1.6] 0.54 (0.5*) [54 (50*)]	0.44 [1.9] 1.1 (0.5*) [110 (50*)]	0.63 [2.8] 1.5 (0.5*) [150 (50*)]
0.25x0.5-1.6-P3 0.0098 x 0.02	0.083 [2.1]	0.059 [1.5]	17 [67]	0.25 [1.1] 0.14 (0.14) [14 (14)]	0.35 [1.6] 0.36 (0.36) [36 (36)]	0.44 [1.9] 0.72 (0.67*) [72 (67*)]	0.63 [2.8] 1 (0.67*) [100 (67*)]
0.25x0.5-1.6-P4 0.0098 x 0.02	0.083 [2.1]	0.079 [2]	13 [50]	0.25 [1.1] 0.11 (0.11) [11 (11)]	0.35 [1.6] 0.27 (0.27) [27 (27)]	0.44 [1.9] 0.54 (0.54) [54 (54)]	0.63 [2.8] 0.75 (0.75*) [75 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25x0.5-2.4-P1 0.0098 x 0.02	0.11 [2.9]	0.02 [0.5]	51 [200]	0.18 [0.79] 0.88 (0) [88 (0)]	0.24 [1.1] 2.2 (0) [220 (0)]	0.3 [1.4] 4.4 (0) [440 (0)]	0.44 [2] 6.2 (0) [620 (0)]
0.25x0.5-2.4-P2 0.0098 x 0.02	0.11 [2.9]	0.039 [1]	26 [100]	0.18 [0.79] 0.44 (0.44) [44 (44)]	0.24 [1.1] 1.1 (0.5*) [110 (50*)]	0.3 [1.4] 2.2 (0.5*) [220 (50*)]	0.44 [2] 3.1 (0.5*) [310 (50*)]
0.25x0.5-2.4-P3 0.0098 x 0.02	0.11 [2.9]	0.059 [1.5]	17 [67]	0.18 [0.79] 0.29 (0.29) [29 (29)]	0.24 [1.1] 0.73 (0.67*) [74 (67*)]	0.3 [1.4] 1.5 (0.67*) [150 (67*)]	0.44 [2] 2.1 (0.67*) [210 (67*)]
0.25x0.5-2.4-P4 0.0098 x 0.02	0.11 [2.9]	0.079 [2]	13 [50]	0.18 [0.79] 0.22 (0.22) [22 (22)]	0.24 [1.1] 0.55 (0.55) [55 (55)]	0.3 [1.4] 1.1 (0.75*) [110 (75*)]	0.44 [2] 1.5 (0.75*) [150 (75*)]
0.25x0.5-3.2-P1 0.0098 x 0.02	0.15 [3.7]	0.02 [0.5]	51 [200]	0.14 [0.6] 1.5 (0) [150 (0)]	0.19 [0.83] 3.7 (0) [370 (0)]	0.23 [1] 7.5 (0) [750 (0)]	0.34 [1.5] 10 (0) [1000 (0)]
0.25x0.5-3.2-P2 0.0098 x 0.02	0.15 [3.7]	0.039 [1]	26 [100]	0.14 [0.6] 0.75 (0.5*) [75 (50*)]	0.19 [0.83] 1.9 (0.5*) [190 (50*)]	0.23 [1] 3.7 (0.5*) [370 (50*)]	0.34 [1.5] 5.2 (0.5*) [520 (50*)]
0.25x0.5-3.2-P3 0.0098 x 0.02	0.15 [3.7]	0.059 [1.5]	17 [67]	0.14 [0.6] 0.5 (0.5) [50 (50)]	0.19 [0.83] 1.2 (0.67*) [120 (67*)]	0.23 [1] 2.5 (0.67*) [250 (67*)]	0.34 [1.5] 3.5 (0.67*) [350 (67*)]
0.25x0.5-3.2-P4 0.0098 x 0.02	0.15 [3.7]	0.079 [2]	13 [50]	0.14 [0.6] 0.37 (0.37) [37 (37)]	0.19 [0.83] 0.94 (0.75*) [94 (75*)]	0.23 [1] 1.9 (0.75*) [190 (75*)]	0.34 [1.5] 2.6 (0.75*) [260 (75*)]
0.25x0.5-4.75-P1 0.0098 x 0.02	0.21 [5.25]	0.02 [0.5]	51 [200]	0.094 [0.42] 3.1 (0) [310 (0)]	0.13 [0.57] 7.9 (0) [790 (0)]	0.16 [0.72] 16 (0) [1600 (0)]	0.23 [1] 22 (0) [2200 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25x0.5-4.75-P2 0.0098 x 0.02	0.21 [5.25]	0.039 [1]	26 [100]	0.094 [0.42] 1.6 (0.5*) [160 (50*)]	0.13 [0.57] 3.9 (0.5*) [390 (50*)]	0.16 [0.72] 7.9 (0.5*) [790 (50*)]	0.23 [1] 11 (0.5*) [1100 (50*)]
0.25x0.5-4.75-P3 0.0098 x 0.02	0.21 [5.25]	0.059 [1.5]	17 [67]	0.094 [0.42] 1 (0.67*) [100 (67*)]	0.13 [0.57] 2.6 (0.67*) [260 (67*)]	0.16 [0.72] 5.2 (0.67*) [520 (67*)]	0.23 [1] 7.3 (0.67*) [730 (67*)]
0.25x0.5-4.75-P4 0.0098 x 0.02	0.21 [5.25]	0.079 [2]	13 [50]	0.094 [0.42] 0.79 (0.75*) [79 (75*)]	0.13 [0.57] 2 (0.75*) [200 (75*)]	0.16 [0.72] 3.9 (0.75*) [390 (75*)]	0.23 [1] 5.5 (0.75*) [550 (75*)]
0.25x0.5-6-P1 0.0098 x 0.02	0.26 [6.5]	0.02 [0.5]	51 [200]	0.075 [0.33] 4.9 (0) [490 (0)]	0.1 [0.46] 12 (0) [1200 (0)]	0.13 [0.57] 25 (0) [2500 (0)]	0.19 [0.83] 34 (0) [3400 (0)]
0.25x0.5-6-P2 0.0098 x 0.02	0.26 [6.5]	0.039 [1]	26 [100]	0.075 [0.33] 2.5 (0.5*) [250 (50*)]	0.1 [0.46] 6.1 (0.5*) [610 (50*)]	0.13 [0.57] 12 (0.5*) [1200 (50*)]	0.19 [0.83] 17 (0.5*) [1700 (50*)]
0.25x0.5-6-P3 0.0098 x 0.02	0.26 [6.5]	0.059 [1.5]	17 [67]	0.075 [0.33] 1.6 (0.67*) [160 (67*)]	0.1 [0.46] 4.1 (0.67*) [410 (67*)]	0.13 [0.57] 8.2 (0.67*) [820 (67*)]	0.19 [0.83] 11 (0.67*) [1100 (67*)]
0.25x0.5-6-P4 0.0098 x 0.02	0.26 [6.5]	0.079 [2]	13 [50]	0.075 [0.33] 1.2 (0.75*) [120 (75*)]	0.1 [0.46] 3.1 (0.75*) [310 (75*)]	0.13 [0.57] 6.1 (0.75*) [610 (75*)]	0.19 [0.83] 8.6 (0.75*) [860 (75*)]
0.25x0.5-8-P1 0.0098 x 0.02	0.33 [8.5]	0.02 [0.5]	51 [200]	0.057 [0.25] 8.6 (0) [860 (0)]	0.078 [0.35] 21 (0) [2100 (0)]	0.098 [0.43] 43 (0) [4300 (0)]	0.14 [0.63] 60 (0) [6000 (0)]
0.25x0.5-8-P2 0.0098 x 0.02	0.33 [8.5]	0.039 [1]	26 [100]	0.057 [0.25] 4.3 (0.5*) [430 (50*)]	0.078 [0.35] 11 (0.5*) [1100 (50*)]	0.098 [0.43] 21 (0.5*) [2100 (50*)]	0.14 [0.63] 30 (0.5*) [3000 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25x0.5-8-P3 0.0098 x 0.02	0.33 [8.5]	0.059 [1.5]	17 [67]	0.057 [0.25] 2.9 (0.67*) [290 (67*)]	0.078 [0.35] 7.1 (0.67*) [710 (67*)]	0.098 [0.43] 14 (0.67*) [1400 (67*)]	0.14 [0.63] 20 (0.67*) [2000 (67*)]
0.25x0.5-8-P4 0.0098 x 0.02	0.33 [8.5]	0.079 [2]	13 [50]	0.057 [0.25] 2.1 (0.75*) [210 (75*)]	0.078 [0.35] 5.3 (0.75*) [530 (75*)]	0.098 [0.43] 11 (0.75*) [1100 (75*)]	0.14 [0.63] 15 (0.75*) [1500 (75*)]
0.25x0.5-9.5-P1 0.0098 x 0.02	0.39 [10]	0.02 [0.5]	51 [200]	0.048 [0.21] 12 (0) [1200 (0)]	0.066 [0.29] 30 (0) [3000 (0)]	0.083 [0.37] 60 (0) [6000 (0)]	0.12 [0.53] 84 (0) [8400 (0)]
0.25x0.5-9.5-P2 0.0098 x 0.02	0.39 [10]	0.039 [1]	26 [100]	0.048 [0.21] 6 (0.5*) [600 (50*)]	0.066 [0.29] 15 (0.5*) [1500 (50*)]	0.083 [0.37] 30 (0.5*) [3000 (50*)]	0.12 [0.53] 42 (0.5*) [4200 (50*)]
0.25x0.5-9.5-P3 0.0098 x 0.02	0.39 [10]	0.059 [1.5]	17 [67]	0.048 [0.21] 4 (0.67*) [400 (67*)]	0.066 [0.29] 10 (0.67*) [1000 (67*)]	0.083 [0.37] 20 (0.67*) [2000 (67*)]	0.12 [0.53] 28 (0.67*) [2800 (67*)]
0.25x0.5-9.5-P4 0.0098 x 0.02	0.39 [10]	0.079 [2]	13 [50]	0.048 [0.21] 3 (0.75*) [300 (75*)]	0.066 [0.29] 7.5 (0.75*) [750 (75*)]	0.083 [0.37] 15 (0.75*) [1500 (75*)]	0.12 [0.53] 21 (0.75*) [2100 (75*)]
0.25x0.5-12.7-P1 0.0098 x 0.02	0.52 [13.2]	0.02 [0.5]	51 [200]	0.036 [0.16] 21 (0) [2100 (0)]	0.05 [0.22] 53 (0) [5300 (0)]	0.062 [0.28] 110 (0) [11000 (0)]	0.09 [0.4] 150 (0) [15000 (0)]
0.25x0.5-12.7-P2 0.0098 x 0.02	0.52 [13.2]	0.039 [1]	26 [100]	0.036 [0.16] 11 (0.5*) [1100 (50*)]	0.05 [0.22] 26 (0.5*) [2600 (50*)]	0.062 [0.28] 53 (0.5*) [5300 (50*)]	0.09 [0.4] 74 (0.5*) [7400 (50*)]
0.25x0.5-12.7-P3 0.0098 x 0.02	0.52 [13.2]	0.059 [1.5]	17 [67]	0.036 [0.16] 7 (0.67*) [700 (67*)]	0.05 [0.22] 18 (0.67*) [1800 (67*)]	0.062 [0.28] 35 (0.67*) [3500 (67*)]	0.09 [0.4] 49 (0.67*) [4900 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25x0.5-12.7-P4 0.0098 x 0.02	0.52 [13.2]	0.079 [2]	13 [50]	0.036 [0.16] 5.3 (0.75*) [530 (75*)]	0.05 [0.22] 13 (0.75*) [1300 (75*)]	0.062 [0.28] 26 (0.75*) [2600 (75*)]	0.09 [0.4] 37 (0.75*) [3700 (75*)]
0.25x0.5-14.2-P1 0.0098 x 0.02	0.58 [14.7]	0.02 [0.5]	51 [200]	0.032 [0.14] 26 (0) [2600 (0)]	0.045 [0.2] 66 (0) [6600 (0)]	0.056 [0.25] 130 (0) [13000 (0)]	0.081 [0.36] 180 (0) [18000 (0)]
0.25x0.5-14.2-P2 0.0098 x 0.02	0.58 [14.7]	0.039 [1]	26 [100]	0.032 [0.14] 13 (0.5*) [1300 (50*)]	0.045 [0.2] 33 (0.5*) [3300 (50*)]	0.056 [0.25] 66 (0.5*) [6600 (50*)]	0.081 [0.36] 92 (0.5*) [9200 (50*)]
0.25x0.5-14.2-P3 0.0098 x 0.02	0.58 [14.7]	0.059 [1.5]	17 [67]	0.032 [0.14] 8.7 (0.67*) [870 (67*)]	0.045 [0.2] 22 (0.67*) [2200 (67*)]	0.056 [0.25] 44 (0.67*) [4400 (67*)]	0.081 [0.36] 61 (0.67*) [6100 (67*)]
0.25x0.5-14.2-P4 0.0098 x 0.02	0.58 [14.7]	0.079 [2]	13 [50]	0.032 [0.14] 6.6 (0.75*) [660 (75*)]	0.045 [0.2] 16 (0.75*) [1600 (75*)]	0.056 [0.25] 33 (0.75*) [3300 (75*)]	0.081 [0.36] 46 (0.75*) [4600 (75*)]
0.25x0.5-16-P1 0.0098 x 0.02	0.65 [16.5]	0.02 [0.5]	51 [200]	0.029 [0.13] 33 (0) [3300 (0)]	0.04 [0.18] 83 (0) [8300 (0)]	0.05 [0.22] 170 (0) [17000 (0)]	0.072 [0.32] 230 (0) [23000 (0)]
0.25x0.5-16-P2 0.0098 x 0.02	0.65 [16.5]	0.039 [1]	26 [100]	0.029 [0.13] 17 (0.5*) [1700 (50*)]	0.04 [0.18] 41 (0.5*) [4100 (50*)]	0.05 [0.22] 83 (0.5*) [8300 (50*)]	0.072 [0.32] 120 (0.5*) [12000 (50*)]
0.25x0.5-16-P3 0.0098 x 0.02	0.65 [16.5]	0.059 [1.5]	17 [67]	0.029 [0.13] 11 (0.67*) [1100 (67*)]	0.04 [0.18] 28 (0.67*) [2800 (67*)]	0.05 [0.22] 55 (0.67*) [5500 (67*)]	0.072 [0.32] 77 (0.67*) [7700 (67*)]
0.25x0.5-16-P4 0.0098 x 0.02	0.65 [16.5]	0.079 [2]	13 [50]	0.029 [0.13] 8.3 (0.75*) [830 (75*)]	0.04 [0.18] 21 (0.75*) [2100 (75*)]	0.05 [0.22] 41 (0.75*) [4100 (75*)]	0.072 [0.32] 58 (0.75*) [5800 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25x0.5-19-P1 0.0098 x 0.02	0.77 [19.5]	0.02 [0.5]	51 [200]	0.024 [0.11] 47 (0) [4700 (0)]	0.034 [0.15] 120 (0) [12000 (0)]	0.042 [0.19] 230 (0) [23000 (0)]	0.061 [0.27] 330 (0) [33000 (0)]
0.25x0.5-19-P2 0.0098 x 0.02	0.77 [19.5]	0.039 [1]	26 [100]	0.024 [0.11] 23 (0.5*) [2300 (50*)]	0.034 [0.15] 58 (0.5*) [5800 (50*)]	0.042 [0.19] 120 (0.5*) [12000 (50*)]	0.061 [0.27] 160 (0.5*) [16000 (50*)]
0.25x0.5-19-P3 0.0098 x 0.02	0.77 [19.5]	0.059 [1.5]	17 [67]	0.024 [0.11] 16 (0.67*) [1600 (67*)]	0.034 [0.15] 39 (0.67*) [3900 (67*)]	0.042 [0.19] 78 (0.67*) [7800 (67*)]	0.061 [0.27] 110 (0.67*) [11000 (67*)]
0.25x0.5-19-P4 0.0098 x 0.02	0.77 [19.5]	0.079 [2]	13 [50]	0.024 [0.11] 12 (0.75*) [1200 (75*)]	0.034 [0.15] 29 (0.75*) [2900 (75*)]	0.042 [0.19] 58 (0.75*) [5800 (75*)]	0.061 [0.27] 81 (0.75*) [8100 (75*)]
0.25x0.5-22.2-P1 0.0098 x 0.02	0.89 [22.7]	0.02 [0.5]	51 [200]	0.021 [0.093] 63 (0) [6300 (0)]	0.029 [0.13] 160 (0) [16000 (0)]	0.036 [0.16] 320 (0) [32000 (0)]	0.052 [0.23] 440 (0) [44000 (0)]
0.25x0.5-22.2-P2 0.0098 x 0.02	0.89 [22.7]	0.039 [1]	26 [100]	0.021 [0.093] 32 (0.5*) [3200 (50*)]	0.029 [0.13] 79 (0.5*) [7900 (50*)]	0.036 [0.16] 160 (0.5*) [16000 (50*)]	0.052 [0.23] 220 (0.5*) [22000 (50*)]
0.25x0.5-22.2-P3 0.0098 x 0.02	0.89 [22.7]	0.059 [1.5]	17 [67]	0.021 [0.093] 21 (0.67*) [2100 (67*)]	0.029 [0.13] 53 (0.67*) [5300 (67*)]	0.036 [0.16] 110 (0.67*) [11000 (67*)]	0.052 [0.23] 150 (0.67*) [15000 (67*)]
0.25x0.5-22.2-P4 0.0098 x 0.02	0.89 [22.7]	0.079 [2]	13 [50]	0.021 [0.093] 16 (0.75*) [1600 (75*)]	0.029 [0.13] 40 (0.75*) [4000 (75*)]	0.036 [0.16] 79 (0.75*) [7900 (75*)]	0.052 [0.23] 110 (0.75*) [11000 (75*)]
0.25x0.5-25.4-P1 0.0098 x 0.02	1 [25.9]	0.02 [0.5]	51 [200]	0.018 [0.081] 83 (0) [8300 (0)]	0.025 [0.11] 210 (0) [21000 (0)]	0.031 [0.14] 410 (0) [41000 (0)]	0.046 [0.2] 580 (0) [58000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25x0.5-25.4-P2 0.0098 x 0.02	1 [25.9]	0.039 [1]	26 [100]	0.018 [0.081] 41 (0.5*) [4100 (50*)]	0.025 [0.11] 100 (0.5*) [10000 (50*)]	0.031 [0.14] 210 (0.5*) [21000 (50*)]	0.046 [0.2] 290 (0.5*) [29000 (50*)]
0.25x0.5-25.4-P3 0.0098 x 0.02	1 [25.9]	0.059 [1.5]	17 [67]	0.018 [0.081] 28 (0.67*) [2800 (67*)]	0.025 [0.11] 69 (0.67*) [6900 (67*)]	0.031 [0.14] 140 (0.67*) [14000 (67*)]	0.046 [0.2] 190 (0.67*) [19000 (67*)]
0.25x0.5-25.4-P4 0.0098 x 0.02	1 [25.9]	0.079 [2]	13 [50]	0.018 [0.081] 21 (0.75*) [2100 (75*)]	0.025 [0.11] 52 (0.75*) [5200 (75*)]	0.031 [0.14] 100 (0.75*) [10000 (75*)]	0.046 [0.2] 140 (0.75*) [14000 (75*)]
0.3x2-0.5-P1 0.012 x 0.079	0.043 [1.1]	0.079 [2]	13 [50]	11 [50] 0.005 (0) [0.5 (0)]	16 [69] 0.013 (0) [1.2 (0)]	19 [86] 0.025 (0) [2.5 (0)]	28 [120] 0.035 (0) [3.5 (0)]
0.3x2-0.5-P2 0.012 x 0.079	0.043 [1.1]	0.16 [4]	6.5 [25]	11 [50] 0.0025 (0.0025) [0.25 (0.25)]	16 [69] 0.0063 (0.0063) [0.62 (0.62)]	19 [86] 0.013 (0.013) [1.2 (1.2)]	28 [120] 0.018 (0.018) [1.8 (1.8)]
0.3x2-0.5-P3 0.012 x 0.079	0.043 [1.1]	0.24 [6]	4.3 [17]	11 [50] 0.0017 (0.0017) [0.17 (0.17)]	16 [69] 0.0042 (0.0042) [0.42 (0.42)]	19 [86] 0.0083 (0.0083) [0.83 (0.83)]	28 [120] 0.012 (0.012) [1.2 (1.2)]
0.3x2-0.5-P4 0.012 x 0.079	0.043 [1.1]	0.31 [8]	3.2 [12]	11 [50] 0.0012 (0.0012) [0.12 (0.12)]	16 [69] 0.0031 (0.0031) [0.31 (0.31)]	19 [86] 0.0063 (0.0063) [0.62 (0.62)]	28 [120] 0.0088 (0.0088) [0.88 (0.88)]
0.3x2-0.9-P1 0.012 x 0.079	0.059 [1.5]	0.079 [2]	13 [50]	7.5 [33] 0.011 (0) [1.1 (0)]	10 [46] 0.029 (0) [2.9 (0)]	13 [57] 0.057 (0) [5.7 (0)]	19 [83] 0.08 (0) [8 (0)]
0.3x2-0.9-P2 0.012 x 0.079	0.059 [1.5]	0.16 [4]	6.5 [25]	7.5 [33] 0.0057 (0.0057) [0.57 (0.57)]	10 [46] 0.014 (0.014) [1.4 (1.4)]	13 [57] 0.029 (0.029) [2.9 (2.9)]	19 [83] 0.04 (0.04) [4 (4)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.3x2-0.9-P3 0.012 x 0.079	0.059 [1.5]	0.24 [6]	4.3 [17]	7.5 [33] 0.0038 (0.0038) [0.38 (0.38)]	10 [46] 0.0095 (0.0095) [0.95 (0.95)]	13 [57] 0.019 (0.019) [1.9 (1.9)]	19 [83] 0.027 (0.027) [2.7 (2.7)]
0.3x2-0.9-P4 0.012 x 0.079	0.059 [1.5]	0.31 [8]	3.2 [12]	7.5 [33] 0.0028 (0.0028) [0.28 (0.28)]	10 [46] 0.0071 (0.0071) [0.71 (0.71)]	13 [57] 0.014 (0.014) [1.4 (1.4)]	19 [83] 0.02 (0.02) [2 (2)]
0.3x2-1.15-P1 0.012 x 0.079	0.069 [1.75]	0.079 [2]	13 [50]	6.2 [28] 0.017 (0) [1.7 (0)]	8.6 [38] 0.042 (0) [4.2 (0)]	11 [47] 0.083 (0) [8.3 (0)]	16 [69] 0.12 (0) [12 (0)]
0.3x2-1.15-P2 0.012 x 0.079	0.069 [1.75]	0.16 [4]	6.5 [25]	6.2 [28] 0.0083 (0.0083) [0.83 (0.83)]	8.6 [38] 0.021 (0.021) [2.1 (2.1)]	11 [47] 0.042 (0.042) [4.2 (4.2)]	16 [69] 0.058 (0.058) [5.8 (5.8)]
0.3x2-1.15-P3 0.012 x 0.079	0.069 [1.75]	0.24 [6]	4.3 [17]	6.2 [28] 0.0055 (0.0055) [0.55 (0.55)]	8.6 [38] 0.014 (0.014) [1.4 (1.4)]	11 [47] 0.028 (0.028) [2.8 (2.8)]	16 [69] 0.039 (0.039) [3.9 (3.9)]
0.3x2-1.15-P4 0.012 x 0.079	0.069 [1.75]	0.31 [8]	3.2 [12]	6.2 [28] 0.0042 (0.0042) [0.41 (0.41)]	8.6 [38] 0.01 (0.01) [1 (1)]	11 [47] 0.021 (0.021) [2.1 (2.1)]	16 [69] 0.029 (0.029) [2.9 (2.9)]
0.3x2-1.6-P1 0.012 x 0.079	0.087 [2.2]	0.079 [2]	13 [50]	4.7 [21] 0.028 (0) [2.8 (0)]	6.5 [29] 0.07 (0) [7 (0)]	8.1 [36] 0.14 (0) [14 (0)]	12 [53] 0.2 (0) [20 (0)]
0.3x2-1.6-P2 0.012 x 0.079	0.087 [2.2]	0.16 [4]	6.5 [25]	4.7 [21] 0.014 (0.014) [1.4 (1.4)]	6.5 [29] 0.035 (0.035) [3.5 (3.5)]	8.1 [36] 0.07 (0.07) [7 (7)]	12 [53] 0.098 (0.098) [9.8 (9.8)]
0.3x2-1.6-P3 0.012 x 0.079	0.087 [2.2]	0.24 [6]	4.3 [17]	4.7 [21] 0.0093 (0.0093) [0.93 (0.93)]	6.5 [29] 0.023 (0.023) [2.3 (2.3)]	8.1 [36] 0.047 (0.047) [4.7 (4.7)]	12 [53] 0.065 (0.065) [6.5 (6.5)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.3x2-1.6-P4 0.012 x 0.079	0.087 [2.2]	0.31 [8]	3.2 [12]	4.7 [21] 0.007 (0.007) [0.7 (0.7)]	6.5 [29] 0.018 (0.018) [1.8 (1.8)]	8.1 [36] 0.035 (0.035) [3.5 (3.5)]	12 [53] 0.049 (0.049) [4.9 (4.9)]
0.3x2-2.4-P1 0.012 x 0.079	0.12 [3]	0.079 [2]	13 [50]	3.3 [15] 0.058 (0) [5.8 (0)]	4.6 [20] 0.14 (0) [14 (0)]	5.7 [25] 0.29 (0) [29 (0)]	8.3 [37] 0.41 (0) [41 (0)]
0.3x2-2.4-P2 0.012 x 0.079	0.12 [3]	0.16 [4]	6.5 [25]	3.3 [15] 0.029 (0.029) [2.9 (2.9)]	4.6 [20] 0.072 (0.072) [7.2 (7.2)]	5.7 [25] 0.14 (0.14) [14 (14)]	8.3 [37] 0.2 (0.2) [20 (20)]
0.3x2-2.4-P3 0.012 x 0.079	0.12 [3]	0.24 [6]	4.3 [17]	3.3 [15] 0.019 (0.019) [1.9 (1.9)]	4.6 [20] 0.048 (0.048) [4.8 (4.8)]	5.7 [25] 0.097 (0.097) [9.7 (9.7)]	8.3 [37] 0.14 (0.14) [14 (14)]
0.3x2-2.4-P4 0.012 x 0.079	0.12 [3]	0.31 [8]	3.2 [12]	3.3 [15] 0.014 (0.014) [1.4 (1.4)]	4.6 [20] 0.036 (0.036) [3.6 (3.6)]	5.7 [25] 0.072 (0.072) [7.2 (7.2)]	8.3 [37] 0.1 (0.1) [10 (10)]
0.3x2-3.2-P1 0.012 x 0.079	0.15 [3.8]	0.079 [2]	13 [50]	2.6 [11] 0.096 (0) [9.6 (0)]	3.5 [16] 0.24 (0) [24 (0)]	4.4 [20] 0.48 (0) [48 (0)]	6.4 [29] 0.67 (0) [67 (0)]
0.3x2-3.2-P2 0.012 x 0.079	0.15 [3.8]	0.16 [4]	6.5 [25]	2.6 [11] 0.048 (0.048) [4.8 (4.8)]	3.5 [16] 0.12 (0.12) [12 (12)]	4.4 [20] 0.24 (0.24) [24 (24)]	6.4 [29] 0.34 (0.34) [34 (34)]
0.3x2-3.2-P3 0.012 x 0.079	0.15 [3.8]	0.24 [6]	4.3 [17]	2.6 [11] 0.032 (0.032) [3.2 (3.2)]	3.5 [16] 0.08 (0.08) [8 (8)]	4.4 [20] 0.16 (0.16) [16 (16)]	6.4 [29] 0.22 (0.22) [22 (22)]
0.3x2-3.2-P4 0.012 x 0.079	0.15 [3.8]	0.31 [8]	3.2 [12]	2.6 [11] 0.024 (0.024) [2.4 (2.4)]	3.5 [16] 0.06 (0.06) [6 (6)]	4.4 [20] 0.12 (0.12) [12 (12)]	6.4 [29] 0.17 (0.17) [17 (17)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.3x2-4.75-P1 0.012 x 0.079	0.21 [5.35]	0.079 [2]	13 [50]	1.8 [7.9] 0.2 (0) [20 (0)]	2.5 [11] 0.5 (0) [50 (0)]	3.1 [14] 1 (0) [100 (0)]	4.5 [20] 1.4 (0) [140 (0)]
0.3x2-4.75-P2 0.012 x 0.079	0.21 [5.35]	0.16 [4]	6.5 [25]	1.8 [7.9] 0.1 (0.1) [10 (10)]	2.5 [11] 0.25 (0.25) [25 (25)]	3.1 [14] 0.5 (0.5) [50 (50)]	4.5 [20] 0.7 (0.5*) [70 (50*)]
0.3x2-4.75-P3 0.012 x 0.079	0.21 [5.35]	0.24 [6]	4.3 [17]	1.8 [7.9] 0.067 (0.067) [6.7 (6.7)]	2.5 [11] 0.17 (0.17) [17 (17)]	3.1 [14] 0.33 (0.33) [33 (33)]	4.5 [20] 0.47 (0.47) [47 (47)]
0.3x2-4.75-P4 0.012 x 0.079	0.21 [5.35]	0.31 [8]	3.2 [12]	1.8 [7.9] 0.05 (0.05) [5 (5)]	2.5 [11] 0.12 (0.12) [12 (12)]	3.1 [14] 0.25 (0.25) [25 (25)]	4.5 [20] 0.35 (0.35) [35 (35)]
0.3x2-6-P1 0.012 x 0.079	0.26 [6.6]	0.079 [2]	13 [50]	1.4 [6.3] 0.31 (0) [31 (0)]	2 [8.8] 0.78 (0) [78 (0)]	2.5 [11] 1.6 (0) [160 (0)]	3.6 [16] 2.2 (0) [220 (0)]
0.3x2-6-P2 0.012 x 0.079	0.26 [6.6]	0.16 [4]	6.5 [25]	1.4 [6.3] 0.16 (0.16) [16 (16)]	2 [8.8] 0.39 (0.39) [39 (39)]	2.5 [11] 0.78 (0.5*) [78 (50*)]	3.6 [16] 1.1 (0.5*) [110 (50*)]
0.3x2-6-P3 0.012 x 0.079	0.26 [6.6]	0.24 [6]	4.3 [17]	1.4 [6.3] 0.1 (0.1) [10 (10)]	2 [8.8] 0.26 (0.26) [26 (26)]	2.5 [11] 0.52 (0.52) [52 (52)]	3.6 [16] 0.73 (0.67*) [73 (67*)]
0.3x2-6-P4 0.012 x 0.079	0.26 [6.6]	0.31 [8]	3.2 [12]	1.4 [6.3] 0.078 (0.078) [7.8 (7.8)]	2 [8.8] 0.2 (0.2) [20 (20)]	2.5 [11] 0.39 (0.39) [39 (39)]	3.6 [16] 0.55 (0.55) [55 (55)]
0.3x2-8-P1 0.012 x 0.079	0.34 [8.6]	0.079 [2]	13 [50]	1.1 [4.8] 0.54 (0) [54 (0)]	1.5 [6.7] 1.4 (0) [140 (0)]	1.9 [8.3] 2.7 (0) [270 (0)]	2.7 [12] 3.8 (0) [380 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.3x2-8-P2 0.012 x 0.079	0.34 [8.6]	0.16 [4]	6.5 [25]	1.1 [4.8] 0.27 (0.27) [27 (27)]	1.5 [6.7] 0.68 (0.5*) [68 (50*)]	1.9 [8.3] 1.4 (0.5*) [140 (50*)]	2.7 [12] 1.9 (0.5*) [190 (50*)]
0.3x2-8-P3 0.012 x 0.079	0.34 [8.6]	0.24 [6]	4.3 [17]	1.1 [4.8] 0.18 (0.18) [18 (18)]	1.5 [6.7] 0.45 (0.45) [45 (45)]	1.9 [8.3] 0.9 (0.67*) [90 (67*)]	2.7 [12] 1.3 (0.67*) [130 (67*)]
0.3x2-8-P4 0.012 x 0.079	0.34 [8.6]	0.31 [8]	3.2 [12]	1.1 [4.8] 0.13 (0.13) [13 (13)]	1.5 [6.7] 0.34 (0.34) [34 (34)]	1.9 [8.3] 0.68 (0.68) [68 (68)]	2.7 [12] 0.95 (0.75*) [95 (75*)]
0.3x2-9.5-P1 0.012 x 0.079	0.4 [10.1]	0.079 [2]	13 [50]	0.92 [4.1] 0.75 (0) [75 (0)]	1.3 [5.6] 1.9 (0) [190 (0)]	1.6 [7] 3.8 (0) [380 (0)]	2.3 [10] 5.3 (0) [530 (0)]
0.3x2-9.5-P2 0.012 x 0.079	0.4 [10.1]	0.16 [4]	6.5 [25]	0.92 [4.1] 0.38 (0.38) [38 (38)]	1.3 [5.6] 0.94 (0.5*) [94 (50*)]	1.6 [7] 1.9 (0.5*) [190 (50*)]	2.3 [10] 2.6 (0.5*) [260 (50*)]
0.3x2-9.5-P3 0.012 x 0.079	0.4 [10.1]	0.24 [6]	4.3 [17]	0.92 [4.1] 0.25 (0.25) [25 (25)]	1.3 [5.6] 0.63 (0.63) [63 (63)]	1.6 [7] 1.3 (0.67*) [130 (67*)]	2.3 [10] 1.8 (0.67*) [180 (67*)]
0.3x2-9.5-P4 0.012 x 0.079	0.4 [10.1]	0.31 [8]	3.2 [12]	0.92 [4.1] 0.19 (0.19) [19 (19)]	1.3 [5.6] 0.47 (0.47) [47 (47)]	1.6 [7] 0.94 (0.75*) [94 (75*)]	2.3 [10] 1.3 (0.75*) [130 (75*)]
0.3x2-12.7-P1 0.012 x 0.079	0.52 [13.3]	0.079 [2]	13 [50]	0.69 [3.1] 1.3 (0) [130 (0)]	0.95 [4.2] 3.3 (0) [330 (0)]	1.2 [5.3] 6.6 (0) [660 (0)]	1.7 [7.7] 9.3 (0) [930 (0)]
0.3x2-12.7-P2 0.012 x 0.079	0.52 [13.3]	0.16 [4]	6.5 [25]	0.69 [3.1] 0.66 (0.5*) [66 (50*)]	0.95 [4.2] 1.7 (0.5*) [170 (50*)]	1.2 [5.3] 3.3 (0.5*) [330 (50*)]	1.7 [7.7] 4.6 (0.5*) [460 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.3x2-12.7-P3 0.012 x 0.079	0.52 [13.3]	0.24 [6]	4.3 [17]	0.69 [3.1] 0.44 (0.44) [44 (44)]	0.95 [4.2] 1.1 (0.67*) [110 (67*)]	1.2 [5.3] 2.2 (0.67*) [220 (67*)]	1.7 [7.7] 3.1 (0.67*) [310 (67*)]
0.3x2-12.7-P4 0.012 x 0.079	0.52 [13.3]	0.31 [8]	3.2 [12]	0.69 [3.1] 0.33 (0.33) [33 (33)]	0.95 [4.2] 0.83 (0.75*) [83 (75*)]	1.2 [5.3] 1.7 (0.75*) [170 (75*)]	1.7 [7.7] 2.3 (0.75*) [230 (75*)]
0.3x2-14.2-P1 0.012 x 0.079	0.58 [14.8]	0.079 [2]	13 [50]	0.62 [2.8] 1.7 (0) [170 (0)]	0.86 [3.8] 4.1 (0) [410 (0)]	1.1 [4.7] 8.3 (0) [830 (0)]	1.6 [6.9] 12 (0) [1200 (0)]
0.3x2-14.2-P2 0.012 x 0.079	0.58 [14.8]	0.16 [4]	6.5 [25]	0.62 [2.8] 0.83 (0.5*) [83 (50*)]	0.86 [3.8] 2.1 (0.5*) [210 (50*)]	1.1 [4.7] 4.1 (0.5*) [410 (50*)]	1.6 [6.9] 5.8 (0.5*) [580 (50*)]
0.3x2-14.2-P3 0.012 x 0.079	0.58 [14.8]	0.24 [6]	4.3 [17]	0.62 [2.8] 0.55 (0.55) [55 (55)]	0.86 [3.8] 1.4 (0.67*) [140 (67*)]	1.1 [4.7] 2.8 (0.67*) [280 (67*)]	1.6 [6.9] 3.9 (0.67*) [390 (67*)]
0.3x2-14.2-P4 0.012 x 0.079	0.58 [14.8]	0.31 [8]	3.2 [12]	0.62 [2.8] 0.41 (0.41) [41 (41)]	0.86 [3.8] 1 (0.75*) [100 (75*)]	1.1 [4.7] 2.1 (0.75*) [210 (75*)]	1.6 [6.9] 2.9 (0.75*) [290 (75*)]
0.3x2-16-P1 0.012 x 0.079	0.65 [16.6]	0.079 [2]	13 [50]	0.55 [2.5] 2.1 (0) [210 (0)]	0.76 [3.4] 5.2 (0) [520 (0)]	0.95 [4.2] 10 (0) [1000 (0)]	1.4 [6.1] 15 (0) [1500 (0)]
0.3x2-16-P2 0.012 x 0.079	0.65 [16.6]	0.16 [4]	6.5 [25]	0.55 [2.5] 1 (0.5*) [100 (50*)]	0.76 [3.4] 2.6 (0.5*) [260 (50*)]	0.95 [4.2] 5.2 (0.5*) [520 (50*)]	1.4 [6.1] 7.3 (0.5*) [730 (50*)]
0.3x2-16-P3 0.012 x 0.079	0.65 [16.6]	0.24 [6]	4.3 [17]	0.55 [2.5] 0.7 (0.67*) [70 (67*)]	0.76 [3.4] 1.7 (0.67*) [170 (67*)]	0.95 [4.2] 3.5 (0.67*) [350 (67*)]	1.4 [6.1] 4.9 (0.67*) [490 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.3x2-16-P4 0.012 x 0.079	0.65 [16.6]	0.31 [8]	3.2 [12]	0.55 [2.5] 0.52 (0.52) [52 (52)]	0.76 [3.4] 1.3 (0.75*) [130 (75*)]	0.95 [4.2] 2.6 (0.75*) [260 (75*)]	1.4 [6.1] 3.7 (0.75*) [370 (75*)]
0.3x2-19-P1 0.012 x 0.079	0.77 [19.6]	0.079 [2]	13 [50]	0.47 [2.1] 2.9 (0) [290 (0)]	0.64 [2.9] 7.3 (0) [730 (0)]	0.8 [3.6] 15 (0) [1500 (0)]	1.2 [5.2] 20 (0) [2000 (0)]
0.3x2-19-P2 0.012 x 0.079	0.77 [19.6]	0.16 [4]	6.5 [25]	0.47 [2.1] 1.5 (0.5*) [150 (50*)]	0.64 [2.9] 3.7 (0.5*) [370 (50*)]	0.8 [3.6] 7.3 (0.5*) [730 (50*)]	1.2 [5.2] 10 (0.5*) [1000 (50*)]
0.3x2-19-P3 0.012 x 0.079	0.77 [19.6]	0.24 [6]	4.3 [17]	0.47 [2.1] 0.98 (0.67*) [98 (67*)]	0.64 [2.9] 2.4 (0.67*) [240 (67*)]	0.8 [3.6] 4.9 (0.67*) [490 (67*)]	1.2 [5.2] 6.8 (0.67*) [680 (67*)]
0.3x2-19-P4 0.012 x 0.079	0.77 [19.6]	0.31 [8]	3.2 [12]	0.47 [2.1] 0.73 (0.73) [73 (73)]	0.64 [2.9] 1.8 (0.75*) [180 (75*)]	0.8 [3.6] 3.7 (0.75*) [370 (75*)]	1.2 [5.2] 5.1 (0.75*) [510 (75*)]
0.3x2-22.2-P1 0.012 x 0.079	0.9 [22.8]	0.079 [2]	13 [50]	0.4 [1.8] 4 (0) [400 (0)]	0.55 [2.5] 9.9 (0) [990 (0)]	0.69 [3.1] 20 (0) [2000 (0)]	1 [4.4] 28 (0) [2800 (0)]
0.3x2-22.2-P2 0.012 x 0.079	0.9 [22.8]	0.16 [4]	6.5 [25]	0.4 [1.8] 2 (0.5*) [200 (50*)]	0.55 [2.5] 5 (0.5*) [500 (50*)]	0.69 [3.1] 9.9 (0.5*) [990 (50*)]	1 [4.4] 14 (0.5*) [1400 (50*)]
0.3x2-22.2-P3 0.012 x 0.079	0.9 [22.8]	0.24 [6]	4.3 [17]	0.4 [1.8] 1.3 (0.67*) [130 (67*)]	0.55 [2.5] 3.3 (0.67*) [330 (67*)]	0.69 [3.1] 6.6 (0.67*) [660 (67*)]	1 [4.4] 9.3 (0.67*) [930 (67*)]
0.3x2-22.2-P4 0.012 x 0.079	0.9 [22.8]	0.31 [8]	3.2 [12]	0.4 [1.8] 0.99 (0.75*) [99 (75*)]	0.55 [2.5] 2.5 (0.75*) [250 (75*)]	0.69 [3.1] 5 (0.75*) [500 (75*)]	1 [4.4] 7 (0.75*) [700 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.3x2-25.4-P1 0.012 x 0.079	1 [26]	0.079 [2]	13 [50]	0.35 [1.6] 5.2 (0) [520 (0)]	0.48 [2.1] 13 (0) [1300 (0)]	0.6 [2.7] 26 (0) [2600 (0)]	0.87 [3.9] 36 (0) [3600 (0)]
0.3x2-25.4-P2 0.012 x 0.079	1 [26]	0.16 [4]	6.5 [25]	0.35 [1.6] 2.6 (0.5*) [260 (50*)]	0.48 [2.1] 6.5 (0.5*) [650 (50*)]	0.6 [2.7] 13 (0.5*) [1300 (50*)]	0.87 [3.9] 18 (0.5*) [1800 (50*)]
0.3x2-25.4-P3 0.012 x 0.079	1 [26]	0.24 [6]	4.3 [17]	0.35 [1.6] 1.7 (0.67*) [170 (67*)]	0.48 [2.1] 4.3 (0.67*) [430 (67*)]	0.6 [2.7] 8.6 (0.67*) [860 (67*)]	0.87 [3.9] 12 (0.67*) [1200 (67*)]
0.3x2-25.4-P4 0.012 x 0.079	1 [26]	0.31 [8]	3.2 [12]	0.35 [1.6] 1.3 (0.75*) [130 (75*)]	0.48 [2.1] 3.2 (0.75*) [320 (75*)]	0.6 [2.7] 6.5 (0.75*) [650 (75*)]	0.87 [3.9] 9.1 (0.75*) [910 (75*)]
0.4x0.8-0.5-P1 0.016 x 0.031	0.051 [1.3]	0.031 [0.8]	32 [120]	2.1 [9.5] 0.04 (0) [4 (0)]	2.9 [13] 0.1 (0) [10 (0)]	3.7 [16] 0.2 (0) [20 (0)]	5.3 [24] 0.28 (0) [28 (0)]
0.4x0.8-0.5-P2 0.016 x 0.031	0.051 [1.3]	0.063 [1.6]	16 [62]	2.1 [9.5] 0.02 (0.02) [2 (2)]	2.9 [13] 0.05 (0.05) [5 (5)]	3.7 [16] 0.1 (0.1) [10 (10)]	5.3 [24] 0.14 (0.14) [14 (14)]
0.4x0.8-0.5-P3 0.016 x 0.031	0.051 [1.3]	0.094 [2.4]	11 [42]	2.1 [9.5] 0.013 (0.013) [1.3 (1.3)]	2.9 [13] 0.033 (0.033) [3.3 (3.3)]	3.7 [16] 0.067 (0.067) [6.7 (6.7)]	5.3 [24] 0.093 (0.093) [9.3 (9.3)]
0.4x0.8-0.5-P4 0.016 x 0.031	0.051 [1.3]	0.13 [3.2]	8 [31]	2.1 [9.5] 0.01 (0.01) [1 (1)]	2.9 [13] 0.025 (0.025) [2.5 (2.5)]	3.7 [16] 0.05 (0.05) [5 (5)]	5.3 [24] 0.07 (0.07) [7 (7)]
0.4x0.8-0.9-P1 0.016 x 0.031	0.067 [1.7]	0.031 [0.8]	32 [120]	1.5 [6.6] 0.084 (0) [8.4 (0)]	2 [9.1] 0.21 (0) [21 (0)]	2.5 [11] 0.42 (0) [42 (0)]	3.7 [16] 0.59 (0) [59 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x0.8-0.9-P2 0.016 x 0.031	0.067 [1.7]	0.063 [1.6]	16 [62]	1.5 [6.6] 0.042 (0.042) [4.2 (4.2)]	2 [9.1] 0.1 (0.1) [10 (10)]	2.5 [11] 0.21 (0.21) [21 (21)]	3.7 [16] 0.29 (0.29) [29 (29)]
0.4x0.8-0.9-P3 0.016 x 0.031	0.067 [1.7]	0.094 [2.4]	11 [42]	1.5 [6.6] 0.028 (0.028) [2.8 (2.8)]	2 [9.1] 0.07 (0.07) [7 (7)]	2.5 [11] 0.14 (0.14) [14 (14)]	3.7 [16] 0.2 (0.2) [20 (20)]
0.4x0.8-0.9-P4 0.016 x 0.031	0.067 [1.7]	0.13 [3.2]	8 [31]	1.5 [6.6] 0.021 (0.021) [2.1 (2.1)]	2 [9.1] 0.052 (0.052) [5.2 (5.2)]	2.5 [11] 0.1 (0.1) [10 (10)]	3.7 [16] 0.15 (0.15) [15 (15)]
0.4x0.8-1.15-P1 0.016 x 0.031	0.077 [1.95]	0.031 [0.8]	32 [120]	1.2 [5.5] 0.12 (0) [12 (0)]	1.7 [7.6] 0.29 (0) [30 (0)]	2.1 [9.5] 0.59 (0) [59 (0)]	3.1 [14] 0.83 (0) [83 (0)]
0.4x0.8-1.15-P2 0.016 x 0.031	0.077 [1.95]	0.063 [1.6]	16 [62]	1.2 [5.5] 0.059 (0.059) [5.9 (5.9)]	1.7 [7.6] 0.15 (0.15) [15 (15)]	2.1 [9.5] 0.29 (0.29) [30 (30)]	3.1 [14] 0.41 (0.41) [41 (41)]
0.4x0.8-1.15-P3 0.016 x 0.031	0.077 [1.95]	0.094 [2.4]	11 [42]	1.2 [5.5] 0.039 (0.039) [3.9 (3.9)]	1.7 [7.6] 0.098 (0.098) [9.8 (9.8)]	2.1 [9.5] 0.2 (0.2) [20 (20)]	3.1 [14] 0.28 (0.28) [28 (28)]
0.4x0.8-1.15-P4 0.016 x 0.031	0.077 [1.95]	0.13 [3.2]	8 [31]	1.2 [5.5] 0.029 (0.029) [2.9 (2.9)]	1.7 [7.6] 0.074 (0.074) [7.4 (7.4)]	2.1 [9.5] 0.15 (0.15) [15 (15)]	3.1 [14] 0.21 (0.21) [21 (21)]
0.4x0.8-1.6-P1 0.016 x 0.031	0.094 [2.4]	0.031 [0.8]	32 [120]	0.96 [4.3] 0.2 (0) [20 (0)]	1.3 [5.9] 0.49 (0) [49 (0)]	1.6 [7.3] 0.98 (0) [98 (0)]	2.4 [11] 1.4 (0) [140 (0)]
0.4x0.8-1.6-P2 0.016 x 0.031	0.094 [2.4]	0.063 [1.6]	16 [62]	0.96 [4.3] 0.098 (0.098) [9.8 (9.8)]	1.3 [5.9] 0.24 (0.24) [24 (24)]	1.6 [7.3] 0.49 (0.49) [49 (49)]	2.4 [11] 0.69 (0.5*) [69 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x0.8-1.6-P3 0.016 x 0.031	0.094 [2.4]	0.094 [2.4]	11 [42]	0.96 [4.3] 0.065 (0.065) [6.5 (6.5)]	1.3 [5.9] 0.16 (0.16) [16 (16)]	1.6 [7.3] 0.33 (0.33) [33 (33)]	2.4 [11] 0.46 (0.46) [46 (46)]
0.4x0.8-1.6-P4 0.016 x 0.031	0.094 [2.4]	0.13 [3.2]	8 [31]	0.96 [4.3] 0.049 (0.049) [4.9 (4.9)]	1.3 [5.9] 0.12 (0.12) [12 (12)]	1.6 [7.3] 0.24 (0.24) [24 (24)]	2.4 [11] 0.34 (0.34) [34 (34)]
0.4x0.8-2.4-P1 0.016 x 0.031	0.13 [3.2]	0.031 [0.8]	32 [120]	0.69 [3] 0.38 (0) [38 (0)]	0.95 [4.2] 0.96 (0) [96 (0)]	1.2 [5.2] 1.9 (0) [190 (0)]	1.7 [7.6] 2.7 (0) [270 (0)]
0.4x0.8-2.4-P2 0.016 x 0.031	0.13 [3.2]	0.063 [1.6]	16 [62]	0.69 [3] 0.19 (0.19) [19 (19)]	0.95 [4.2] 0.48 (0.48) [48 (48)]	1.2 [5.2] 0.96 (0.5*) [96 (50*)]	1.7 [7.6] 1.3 (0.5*) [130 (50*)]
0.4x0.8-2.4-P3 0.016 x 0.031	0.13 [3.2]	0.094 [2.4]	11 [42]	0.69 [3] 0.13 (0.13) [13 (13)]	0.95 [4.2] 0.32 (0.32) [32 (32)]	1.2 [5.2] 0.64 (0.64) [64 (64)]	1.7 [7.6] 0.9 (0.67*) [90 (67*)]
0.4x0.8-2.4-P4 0.016 x 0.031	0.13 [3.2]	0.13 [3.2]	8 [31]	0.69 [3] 0.096 (0.096) [9.6 (9.6)]	0.95 [4.2] 0.24 (0.24) [24 (24)]	1.2 [5.2] 0.48 (0.48) [48 (48)]	1.7 [7.6] 0.67 (0.67) [67 (67)]
0.4x0.8-3.2-P1 0.016 x 0.031	0.16 [4]	0.031 [0.8]	32 [120]	0.53 [2.4] 0.64 (0) [64 (0)]	0.74 [3.3] 1.6 (0) [160 (0)]	0.92 [4.1] 3.2 (0) [320 (0)]	1.3 [5.9] 4.5 (0) [450 (0)]
0.4x0.8-3.2-P2 0.016 x 0.031	0.16 [4]	0.063 [1.6]	16 [62]	0.53 [2.4] 0.32 (0.32) [32 (32)]	0.74 [3.3] 0.8 (0.5*) [80 (50*)]	0.92 [4.1] 1.6 (0.5*) [160 (50*)]	1.3 [5.9] 2.2 (0.5*) [220 (50*)]
0.4x0.8-3.2-P3 0.016 x 0.031	0.16 [4]	0.094 [2.4]	11 [42]	0.53 [2.4] 0.21 (0.21) [21 (21)]	0.74 [3.3] 0.53 (0.53) [53 (53)]	0.92 [4.1] 1.1 (0.67*) [110 (67*)]	1.3 [5.9] 1.5 (0.67*) [150 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x0.8-3.2-P4 0.016 x 0.031	0.16 [4]	0.13 [3.2]	8 [31]	0.53 [2.4] 0.16 (0.16) [16 (16)]	0.74 [3.3] 0.4 (0.4) [40 (40)]	0.92 [4.1] 0.8 (0.75*) [80 (75*)]	1.3 [5.9] 1.1 (0.75*) [110 (75*)]
0.4x0.8-4.75-P1 0.016 x 0.031	0.22 [5.55]	0.031 [0.8]	32 [120]	0.37 [1.7] 1.3 (0) [130 (0)]	0.51 [2.3] 3.3 (0) [330 (0)]	0.64 [2.9] 6.5 (0) [650 (0)]	0.93 [4.1] 9.1 (0) [910 (0)]
0.4x0.8-4.75-P2 0.016 x 0.031	0.22 [5.55]	0.063 [1.6]	16 [62]	0.37 [1.7] 0.65 (0.5*) [65 (50*)]	0.51 [2.3] 1.6 (0.5*) [160 (50*)]	0.64 [2.9] 3.3 (0.5*) [330 (50*)]	0.93 [4.1] 4.6 (0.5*) [460 (50*)]
0.4x0.8-4.75-P3 0.016 x 0.031	0.22 [5.55]	0.094 [2.4]	11 [42]	0.37 [1.7] 0.43 (0.43) [43 (43)]	0.51 [2.3] 1.1 (0.67*) [110 (67*)]	0.64 [2.9] 2.2 (0.67*) [220 (67*)]	0.93 [4.1] 3 (0.67*) [300 (67*)]
0.4x0.8-4.75-P4 0.016 x 0.031	0.22 [5.55]	0.13 [3.2]	8 [31]	0.37 [1.7] 0.33 (0.33) [33 (33)]	0.51 [2.3] 0.81 (0.75*) [81 (75*)]	0.64 [2.9] 1.6 (0.75*) [160 (75*)]	0.93 [4.1] 2.3 (0.75*) [230 (75*)]
0.4x0.8-6-P1 0.016 x 0.031	0.27 [6.8]	0.031 [0.8]	32 [120]	0.3 [1.3] 2 (0) [200 (0)]	0.41 [1.8] 5 (0) [500 (0)]	0.52 [2.3] 10 (0) [1000 (0)]	0.75 [3.3] 14 (0) [1400 (0)]
0.4x0.8-6-P2 0.016 x 0.031	0.27 [6.8]	0.063 [1.6]	16 [62]	0.3 [1.3] 1 (0.5*) [100 (50*)]	0.41 [1.8] 2.5 (0.5*) [250 (50*)]	0.52 [2.3] 5 (0.5*) [500 (50*)]	0.75 [3.3] 7 (0.5*) [700 (50*)]
0.4x0.8-6-P3 0.016 x 0.031	0.27 [6.8]	0.094 [2.4]	11 [42]	0.3 [1.3] 0.67 (0.67*) [67 (67*)]	0.41 [1.8] 1.7 (0.67*) [170 (67*)]	0.52 [2.3] 3.4 (0.67*) [340 (67*)]	0.75 [3.3] 4.7 (0.67*) [470 (67*)]
0.4x0.8-6-P4 0.016 x 0.031	0.27 [6.8]	0.13 [3.2]	8 [31]	0.3 [1.3] 0.5 (0.5) [50 (50)]	0.41 [1.8] 1.3 (0.75*) [130 (75*)]	0.52 [2.3] 2.5 (0.75*) [250 (75*)]	0.75 [3.3] 3.5 (0.75*) [350 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x0.8-8-P1 0.016 x 0.031	0.35 [8.8]	0.031 [0.8]	32 [120]	0.23 [1] 3.5 (0) [350 (0)]	0.32 [1.4] 8.7 (0) [870 (0)]	0.39 [1.7] 17 (0) [1700 (0)]	0.57 [2.5] 24 (0) [2400 (0)]
0.4x0.8-8-P2 0.016 x 0.031	0.35 [8.8]	0.063 [1.6]	16 [62]	0.23 [1] 1.7 (0.5*) [170 (50*)]	0.32 [1.4] 4.3 (0.5*) [430 (50*)]	0.39 [1.7] 8.7 (0.5*) [870 (50*)]	0.57 [2.5] 12 (0.5*) [1200 (50*)]
0.4x0.8-8-P3 0.016 x 0.031	0.35 [8.8]	0.094 [2.4]	11 [42]	0.23 [1] 1.2 (0.67*) [120 (67*)]	0.32 [1.4] 2.9 (0.67*) [290 (67*)]	0.39 [1.7] 5.8 (0.67*) [580 (67*)]	0.57 [2.5] 8.1 (0.67*) [810 (67*)]
0.4x0.8-8-P4 0.016 x 0.031	0.35 [8.8]	0.13 [3.2]	8 [31]	0.23 [1] 0.87 (0.75*) [87 (75*)]	0.32 [1.4] 2.2 (0.75*) [220 (75*)]	0.39 [1.7] 4.3 (0.75*) [430 (75*)]	0.57 [2.5] 6.1 (0.75*) [610 (75*)]
0.4x0.8-9.5-P1 0.016 x 0.031	0.41 [10.3]	0.031 [0.8]	32 [120]	0.19 [0.86] 4.8 (0) [480 (0)]	0.27 [1.2] 12 (0) [1200 (0)]	0.33 [1.5] 24 (0) [2400 (0)]	0.48 [2.2] 34 (0) [3400 (0)]
0.4x0.8-9.5-P2 0.016 x 0.031	0.41 [10.3]	0.063 [1.6]	16 [62]	0.19 [0.86] 2.4 (0.5*) [240 (50*)]	0.27 [1.2] 6 (0.5*) [600 (50*)]	0.33 [1.5] 12 (0.5*) [1200 (50*)]	0.48 [2.2] 17 (0.5*) [1700 (50*)]
0.4x0.8-9.5-P3 0.016 x 0.031	0.41 [10.3]	0.094 [2.4]	11 [42]	0.19 [0.86] 1.6 (0.67*) [160 (67*)]	0.27 [1.2] 4 (0.67*) [400 (67*)]	0.33 [1.5] 8 (0.67*) [800 (67*)]	0.48 [2.2] 11 (0.67*) [1100 (67*)]
0.4x0.8-9.5-P4 0.016 x 0.031	0.41 [10.3]	0.13 [3.2]	8 [31]	0.19 [0.86] 1.2 (0.75*) [120 (75*)]	0.27 [1.2] 3 (0.75*) [300 (75*)]	0.33 [1.5] 6 (0.75*) [600 (75*)]	0.48 [2.2] 8.4 (0.75*) [840 (75*)]
0.4x0.8-12.7-P1 0.016 x 0.031	0.53 [13.5]	0.031 [0.8]	32 [120]	0.15 [0.65] 8.4 (0) [840 (0)]	0.2 [0.9] 21 (0) [2100 (0)]	0.25 [1.1] 42 (0) [4200 (0)]	0.37 [1.6] 59 (0) [5900 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x0.8-12.7-P2 0.016 x 0.031	0.53 [13.5]	0.063 [1.6]	16 [62]	0.15 [0.65] 4.2 (0.5*) [420 (50*)]	0.2 [0.9] 11 (0.5*) [1100 (50*)]	0.25 [1.1] 21 (0.5*) [2100 (50*)]	0.37 [1.6] 29 (0.5*) [2900 (50*)]
0.4x0.8-12.7-P3 0.016 x 0.031	0.53 [13.5]	0.094 [2.4]	11 [42]	0.15 [0.65] 2.8 (0.67*) [280 (67*)]	0.2 [0.9] 7 (0.67*) [700 (67*)]	0.25 [1.1] 14 (0.67*) [1400 (67*)]	0.37 [1.6] 20 (0.67*) [2000 (67*)]
0.4x0.8-12.7-P4 0.016 x 0.031	0.53 [13.5]	0.13 [3.2]	8 [31]	0.15 [0.65] 2.1 (0.75*) [210 (75*)]	0.2 [0.9] 5.3 (0.75*) [530 (75*)]	0.25 [1.1] 11 (0.75*) [1100 (75*)]	0.37 [1.6] 15 (0.75*) [1500 (75*)]
0.4x0.8-14.2-P1 0.016 x 0.031	0.59 [15]	0.031 [0.8]	32 [120]	0.13 [0.58] 10 (0) [1000 (0)]	0.18 [0.81] 26 (0) [2600 (0)]	0.23 [1] 52 (0) [5200 (0)]	0.33 [1.5] 73 (0) [7300 (0)]
0.4x0.8-14.2-P2 0.016 x 0.031	0.59 [15]	0.063 [1.6]	16 [62]	0.13 [0.58] 5.2 (0.5*) [520 (50*)]	0.18 [0.81] 13 (0.5*) [1300 (50*)]	0.23 [1] 26 (0.5*) [2600 (50*)]	0.33 [1.5] 37 (0.5*) [3700 (50*)]
0.4x0.8-14.2-P3 0.016 x 0.031	0.59 [15]	0.094 [2.4]	11 [42]	0.13 [0.58] 3.5 (0.67*) [350 (67*)]	0.18 [0.81] 8.7 (0.67*) [870 (67*)]	0.23 [1] 17 (0.67*) [1700 (67*)]	0.33 [1.5] 24 (0.67*) [2400 (67*)]
0.4x0.8-14.2-P4 0.016 x 0.031	0.59 [15]	0.13 [3.2]	8 [31]	0.13 [0.58] 2.6 (0.75*) [260 (75*)]	0.18 [0.81] 6.5 (0.75*) [650 (75*)]	0.23 [1] 13 (0.75*) [1300 (75*)]	0.33 [1.5] 18 (0.75*) [1800 (75*)]
0.4x0.8-16-P1 0.016 x 0.031	0.66 [16.8]	0.031 [0.8]	32 [120]	0.12 [0.52] 13 (0) [1300 (0)]	0.16 [0.72] 33 (0) [3300 (0)]	0.2 [0.9] 66 (0) [6600 (0)]	0.29 [1.3] 92 (0) [9200 (0)]
0.4x0.8-16-P2 0.016 x 0.031	0.66 [16.8]	0.063 [1.6]	16 [62]	0.12 [0.52] 6.6 (0.5*) [660 (50*)]	0.16 [0.72] 17 (0.5*) [1700 (50*)]	0.2 [0.9] 33 (0.5*) [3300 (50*)]	0.29 [1.3] 46 (0.5*) [4600 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x0.8-16-P3 0.016 x 0.031	0.66 [16.8]	0.094 [2.4]	11 [42]	0.12 [0.52] 4.4 (0.67*) [440 (67*)]	0.16 [0.72] 11 (0.67*) [1100 (67*)]	0.2 [0.9] 22 (0.67*) [2200 (67*)]	0.29 [1.3] 31 (0.67*) [3100 (67*)]
0.4x0.8-16-P4 0.016 x 0.031	0.66 [16.8]	0.13 [3.2]	8 [31]	0.12 [0.52] 3.3 (0.75*) [330 (75*)]	0.16 [0.72] 8.3 (0.75*) [830 (75*)]	0.2 [0.9] 17 (0.75*) [1700 (75*)]	0.29 [1.3] 23 (0.75*) [2300 (75*)]
0.4x0.8-19-P1 0.016 x 0.031	0.78 [19.8]	0.031 [0.8]	32 [120]	0.099 [0.44] 18 (0) [1800 (0)]	0.14 [0.61] 46 (0) [4600 (0)]	0.17 [0.76] 92 (0) [9200 (0)]	0.25 [1.1] 130 (0) [13000 (0)]
0.4x0.8-19-P2 0.016 x 0.031	0.78 [19.8]	0.063 [1.6]	16 [62]	0.099 [0.44] 9.2 (0.5*) [920 (50*)]	0.14 [0.61] 23 (0.5*) [2300 (50*)]	0.17 [0.76] 46 (0.5*) [4600 (50*)]	0.25 [1.1] 65 (0.5*) [6500 (50*)]
0.4x0.8-19-P3 0.016 x 0.031	0.78 [19.8]	0.094 [2.4]	11 [42]	0.099 [0.44] 6.2 (0.67*) [620 (67*)]	0.14 [0.61] 15 (0.67*) [1500 (67*)]	0.17 [0.76] 31 (0.67*) [3100 (67*)]	0.25 [1.1] 43 (0.67*) [4300 (67*)]
0.4x0.8-19-P4 0.016 x 0.031	0.78 [19.8]	0.13 [3.2]	8 [31]	0.099 [0.44] 4.6 (0.75*) [460 (75*)]	0.14 [0.61] 12 (0.75*) [1200 (75*)]	0.17 [0.76] 23 (0.75*) [2300 (75*)]	0.25 [1.1] 32 (0.75*) [3200 (75*)]
0.4x0.8-22.2-P1 0.016 x 0.031	0.91 [23]	0.031 [0.8]	32 [120]	0.085 [0.38] 25 (0) [2500 (0)]	0.12 [0.52] 63 (0) [6300 (0)]	0.15 [0.65] 130 (0) [13000 (0)]	0.21 [0.94] 180 (0) [18000 (0)]
0.4x0.8-22.2-P2 0.016 x 0.031	0.91 [23]	0.063 [1.6]	16 [62]	0.085 [0.38] 13 (0.5*) [1300 (50*)]	0.12 [0.52] 31 (0.5*) [3100 (50*)]	0.15 [0.65] 63 (0.5*) [6300 (50*)]	0.21 [0.94] 88 (0.5*) [8800 (50*)]
0.4x0.8-22.2-P3 0.016 x 0.031	0.91 [23]	0.094 [2.4]	11 [42]	0.085 [0.38] 8.4 (0.67*) [840 (67*)]	0.12 [0.52] 21 (0.67*) [2100 (67*)]	0.15 [0.65] 42 (0.67*) [4200 (67*)]	0.21 [0.94] 59 (0.67*) [5900 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x0.8-22.2-P4 0.016 x 0.031	0.91 [23]	0.13 [3.2]	8 [31]	0.085 [0.38] 6.3 (0.75*) [630 (75*)]	0.12 [0.52] 16 (0.75*) [1600 (75*)]	0.15 [0.65] 31 (0.75*) [3100 (75*)]	0.21 [0.94] 44 (0.75*) [4400 (75*)]
0.4x0.8-25.4-P1 0.016 x 0.031	1 [26.2]	0.031 [0.8]	32 [120]	0.074 [0.33] 33 (0) [3300 (0)]	0.1 [0.46] 82 (0) [8200 (0)]	0.13 [0.57] 160 (0) [16000 (0)]	0.19 [0.83] 230 (0) [23000 (0)]
0.4x0.8-25.4-P2 0.016 x 0.031	1 [26.2]	0.063 [1.6]	16 [62]	0.074 [0.33] 16 (0.5*) [1600 (50*)]	0.1 [0.46] 41 (0.5*) [4100 (50*)]	0.13 [0.57] 82 (0.5*) [8200 (50*)]	0.19 [0.83] 110 (0.5*) [11000 (50*)]
0.4x0.8-25.4-P3 0.016 x 0.031	1 [26.2]	0.094 [2.4]	11 [42]	0.074 [0.33] 11 (0.67*) [1100 (67*)]	0.1 [0.46] 27 (0.67*) [2700 (67*)]	0.13 [0.57] 54 (0.67*) [5400 (67*)]	0.19 [0.83] 76 (0.67*) [7600 (67*)]
0.4x0.8-25.4-P4 0.016 x 0.031	1 [26.2]	0.13 [3.2]	8 [31]	0.074 [0.33] 8.2 (0.75*) [820 (75*)]	0.1 [0.46] 20 (0.75*) [2000 (75*)]	0.13 [0.57] 41 (0.75*) [4100 (75*)]	0.19 [0.83] 57 (0.75*) [5700 (75*)]
0.4x1-0.5-P1 0.016 x 0.039	0.051 [1.3]	0.039 [1]	25 [100]	3.3 [15] 0.026 (0) [2.6 (0)]	4.6 [20] 0.065 (0) [6.5 (0)]	5.7 [25] 0.13 (0) [13 (0)]	8.3 [37] 0.18 (0) [18 (0)]
0.4x1-0.5-P2 0.016 x 0.039	0.051 [1.3]	0.079 [2]	12 [50]	3.3 [15] 0.013 (0.013) [1.3 (1.3)]	4.6 [20] 0.033 (0.033) [3.2 (3.2)]	5.7 [25] 0.065 (0.065) [6.5 (6.5)]	8.3 [37] 0.091 (0.091) [9.1 (9.1)]
0.4x1-0.5-P3 0.016 x 0.039	0.051 [1.3]	0.12 [3]	8.3 [33]	3.3 [15] 0.0087 (0.0087) [0.87 (0.87)]	4.6 [20] 0.022 (0.022) [2.2 (2.2)]	5.7 [25] 0.043 (0.043) [4.3 (4.3)]	8.3 [37] 0.061 (0.061) [6.1 (6.1)]
0.4x1-0.5-P4 0.016 x 0.039	0.051 [1.3]	0.16 [4]	6.2 [25]	3.3 [15] 0.0065 (0.0065) [0.65 (0.65)]	4.6 [20] 0.016 (0.016) [1.6 (1.6)]	5.7 [25] 0.033 (0.033) [3.2 (3.2)]	8.3 [37] 0.046 (0.046) [4.6 (4.6)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x1-0.9-P1 0.016 x 0.039	0.067 [1.7]	0.039 [1]	25 [100]	2.3 [10] 0.052 (0) [5.2 (0)]	3.2 [14] 0.13 (0) [13 (0)]	4 [18] 0.26 (0) [26 (0)]	5.8 [26] 0.36 (0) [36 (0)]
0.4x1-0.9-P2 0.016 x 0.039	0.067 [1.7]	0.079 [2]	12 [50]	2.3 [10] 0.026 (0.026) [2.6 (2.6)]	3.2 [14] 0.065 (0.065) [6.5 (6.5)]	4 [18] 0.13 (0.13) [13 (13)]	5.8 [26] 0.18 (0.18) [18 (18)]
0.4x1-0.9-P3 0.016 x 0.039	0.067 [1.7]	0.12 [3]	8.3 [33]	2.3 [10] 0.017 (0.017) [1.7 (1.7)]	3.2 [14] 0.043 (0.043) [4.3 (4.3)]	4 [18] 0.087 (0.087) [8.7 (8.7)]	5.8 [26] 0.12 (0.12) [12 (12)]
0.4x1-0.9-P4 0.016 x 0.039	0.067 [1.7]	0.16 [4]	6.2 [25]	2.3 [10] 0.013 (0.013) [1.3 (1.3)]	3.2 [14] 0.033 (0.033) [3.2 (3.2)]	4 [18] 0.065 (0.065) [6.5 (6.5)]	5.8 [26] 0.091 (0.091) [9.1 (9.1)]
0.4x1-1.15-P1 0.016 x 0.039	0.077 [1.95]	0.039 [1]	25 [100]	1.9 [8.6] 0.076 (0) [7.6 (0)]	2.7 [12] 0.19 (0) [19 (0)]	3.3 [15] 0.38 (0) [38 (0)]	4.8 [22] 0.53 (0) [53 (0)]
0.4x1-1.15-P2 0.016 x 0.039	0.077 [1.95]	0.079 [2]	12 [50]	1.9 [8.6] 0.038 (0.038) [3.8 (3.8)]	2.7 [12] 0.095 (0.095) [9.5 (9.5)]	3.3 [15] 0.19 (0.19) [19 (19)]	4.8 [22] 0.27 (0.27) [27 (27)]
0.4x1-1.15-P3 0.016 x 0.039	0.077 [1.95]	0.12 [3]	8.3 [33]	1.9 [8.6] 0.025 (0.025) [2.5 (2.5)]	2.7 [12] 0.063 (0.063) [6.3 (6.3)]	3.3 [15] 0.13 (0.13) [13 (13)]	4.8 [22] 0.18 (0.18) [18 (18)]
0.4x1-1.15-P4 0.016 x 0.039	0.077 [1.95]	0.16 [4]	6.2 [25]	1.9 [8.6] 0.019 (0.019) [1.9 (1.9)]	2.7 [12] 0.048 (0.048) [4.8 (4.8)]	3.3 [15] 0.095 (0.095) [9.5 (9.5)]	4.8 [22] 0.13 (0.13) [13 (13)]
0.4x1-1.6-P1 0.016 x 0.039	0.094 [2.4]	0.039 [1]	25 [100]	1.5 [6.7] 0.13 (0) [13 (0)]	2.1 [9.2] 0.32 (0) [32 (0)]	2.6 [11] 0.63 (0) [63 (0)]	3.7 [17] 0.88 (0) [88 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x1-1.6-P2 0.016 x 0.039	0.094 [2.4]	0.079 [2]	12 [50]	1.5 [6.7] 0.063 (0.063) [6.3 (6.3)]	2.1 [9.2] 0.16 (0.16) [16 (16)]	2.6 [11] 0.32 (0.32) [32 (32)]	3.7 [17] 0.44 (0.44) [44 (44)]
0.4x1-1.6-P3 0.016 x 0.039	0.094 [2.4]	0.12 [3]	8.3 [33]	1.5 [6.7] 0.042 (0.042) [4.2 (4.2)]	2.1 [9.2] 0.1 (0.1) [10 (10)]	2.6 [11] 0.21 (0.21) [21 (21)]	3.7 [17] 0.29 (0.29) [29 (29)]
0.4x1-1.6-P4 0.016 x 0.039	0.094 [2.4]	0.16 [4]	6.2 [25]	1.5 [6.7] 0.032 (0.032) [3.1 (3.1)]	2.1 [9.2] 0.079 (0.079) [7.9 (7.9)]	2.6 [11] 0.16 (0.16) [16 (16)]	3.7 [17] 0.22 (0.22) [22 (22)]
0.4x1-2.4-P1 0.016 x 0.039	0.13 [3.2]	0.039 [1]	25 [100]	1.1 [4.8] 0.25 (0) [25 (0)]	1.5 [6.6] 0.61 (0) [62 (0)]	1.8 [8.2] 1.2 (0) [120 (0)]	2.7 [12] 1.7 (0) [170 (0)]
0.4x1-2.4-P2 0.016 x 0.039	0.13 [3.2]	0.079 [2]	12 [50]	1.1 [4.8] 0.12 (0.12) [12 (12)]	1.5 [6.6] 0.31 (0.31) [31 (31)]	1.8 [8.2] 0.61 (0.5*) [62 (50*)]	2.7 [12] 0.86 (0.5*) [86 (50*)]
0.4x1-2.4-P3 0.016 x 0.039	0.13 [3.2]	0.12 [3]	8.3 [33]	1.1 [4.8] 0.082 (0.082) [8.2 (8.2)]	1.5 [6.6] 0.2 (0.2) [20 (20)]	1.8 [8.2] 0.41 (0.41) [41 (41)]	2.7 [12] 0.57 (0.57) [57 (57)]
0.4x1-2.4-P4 0.016 x 0.039	0.13 [3.2]	0.16 [4]	6.2 [25]	1.1 [4.8] 0.061 (0.061) [6.1 (6.1)]	1.5 [6.6] 0.15 (0.15) [15 (15)]	1.8 [8.2] 0.31 (0.31) [31 (31)]	2.7 [12] 0.43 (0.43) [43 (43)]
0.4x1-3.2-P1 0.016 x 0.039	0.16 [4]	0.039 [1]	25 [100]	0.83 [3.7] 0.41 (0) [41 (0)]	1.1 [5.1] 1 (0) [100 (0)]	1.4 [6.4] 2 (0) [200 (0)]	2.1 [9.3] 2.9 (0) [290 (0)]
0.4x1-3.2-P2 0.016 x 0.039	0.16 [4]	0.079 [2]	12 [50]	0.83 [3.7] 0.2 (0.2) [20 (20)]	1.1 [5.1] 0.51 (0.5*) [51 (50*)]	1.4 [6.4] 1 (0.5*) [100 (50*)]	2.1 [9.3] 1.4 (0.5*) [140 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x1-3.2-P3 0.016 x 0.039	0.16 [4]	0.12 [3]	8.3 [33]	0.83 [3.7] 0.14 (0.14) [14 (14)]	1.1 [5.1] 0.34 (0.34) [34 (34)]	1.4 [6.4] 0.68 (0.67*) [68 (67*)]	2.1 [9.3] 0.95 (0.67*) [95 (67*)]
0.4x1-3.2-P4 0.016 x 0.039	0.16 [4]	0.16 [4]	6.2 [25]	0.83 [3.7] 0.1 (0.1) [10 (10)]	1.1 [5.1] 0.26 (0.26) [26 (26)]	1.4 [6.4] 0.51 (0.51) [51 (51)]	2.1 [9.3] 0.71 (0.71) [71 (71)]
0.4x1-4.75-P1 0.016 x 0.039	0.22 [5.55]	0.039 [1]	25 [100]	0.58 [2.6] 0.83 (0) [83 (0)]	0.8 [3.6] 2.1 (0) [210 (0)]	1 [4.5] 4.2 (0) [420 (0)]	1.5 [6.5] 5.8 (0) [580 (0)]
0.4x1-4.75-P2 0.016 x 0.039	0.22 [5.55]	0.079 [2]	12 [50]	0.58 [2.6] 0.42 (0.42) [42 (42)]	0.8 [3.6] 1 (0.5*) [100 (50*)]	1 [4.5] 2.1 (0.5*) [210 (50*)]	1.5 [6.5] 2.9 (0.5*) [290 (50*)]
0.4x1-4.75-P3 0.016 x 0.039	0.22 [5.55]	0.12 [3]	8.3 [33]	0.58 [2.6] 0.28 (0.28) [28 (28)]	0.8 [3.6] 0.69 (0.67*) [70 (67*)]	1 [4.5] 1.4 (0.67*) [140 (67*)]	1.5 [6.5] 1.9 (0.67*) [190 (67*)]
0.4x1-4.75-P4 0.016 x 0.039	0.22 [5.55]	0.16 [4]	6.2 [25]	0.58 [2.6] 0.21 (0.21) [21 (21)]	0.8 [3.6] 0.52 (0.52) [52 (52)]	1 [4.5] 1 (0.75*) [100 (75*)]	1.5 [6.5] 1.5 (0.75*) [150 (75*)]
0.4x1-6-P1 0.016 x 0.039	0.27 [6.8]	0.039 [1]	25 [100]	0.47 [2.1] 1.3 (0) [130 (0)]	0.65 [2.9] 3.2 (0) [320 (0)]	0.81 [3.6] 6.4 (0) [640 (0)]	1.2 [5.2] 9 (0) [900 (0)]
0.4x1-6-P2 0.016 x 0.039	0.27 [6.8]	0.079 [2]	12 [50]	0.47 [2.1] 0.64 (0.5*) [64 (50*)]	0.65 [2.9] 1.6 (0.5*) [160 (50*)]	0.81 [3.6] 3.2 (0.5*) [320 (50*)]	1.2 [5.2] 4.5 (0.5*) [450 (50*)]
0.4x1-6-P3 0.016 x 0.039	0.27 [6.8]	0.12 [3]	8.3 [33]	0.47 [2.1] 0.43 (0.43) [43 (43)]	0.65 [2.9] 1.1 (0.67*) [110 (67*)]	0.81 [3.6] 2.1 (0.67*) [210 (67*)]	1.2 [5.2] 3 (0.67*) [300 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x1-6-P4 0.016 x 0.039	0.27 [6.8]	0.16 [4]	6.2 [25]	0.47 [2.1] 0.32 (0.32) [32 (32)]	0.65 [2.9] 0.8 (0.75*) [80 (75*)]	0.81 [3.6] 1.6 (0.75*) [160 (75*)]	1.2 [5.2] 2.3 (0.75*) [230 (75*)]
0.4x1-8-P1 0.016 x 0.039	0.35 [8.8]	0.039 [1]	25 [100]	0.36 [1.6] 2.2 (0) [220 (0)]	0.49 [2.2] 5.5 (0) [550 (0)]	0.61 [2.7] 11 (0) [1100 (0)]	0.89 [4] 16 (0) [1600 (0)]
0.4x1-8-P2 0.016 x 0.039	0.35 [8.8]	0.079 [2]	12 [50]	0.36 [1.6] 1.1 (0.5*) [110 (50*)]	0.49 [2.2] 2.8 (0.5*) [280 (50*)]	0.61 [2.7] 5.5 (0.5*) [550 (50*)]	0.89 [4] 7.8 (0.5*) [780 (50*)]
0.4x1-8-P3 0.016 x 0.039	0.35 [8.8]	0.12 [3]	8.3 [33]	0.36 [1.6] 0.74 (0.67*) [74 (67*)]	0.49 [2.2] 1.8 (0.67*) [180 (67*)]	0.61 [2.7] 3.7 (0.67*) [370 (67*)]	0.89 [4] 5.2 (0.67*) [520 (67*)]
0.4x1-8-P4 0.016 x 0.039	0.35 [8.8]	0.16 [4]	6.2 [25]	0.36 [1.6] 0.55 (0.55) [55 (55)]	0.49 [2.2] 1.4 (0.75*) [140 (75*)]	0.61 [2.7] 2.8 (0.75*) [280 (75*)]	0.89 [4] 3.9 (0.75*) [390 (75*)]
0.4x1-9.5-P1 0.016 x 0.039	0.41 [10.3]	0.039 [1]	25 [100]	0.3 [1.3] 3.1 (0) [310 (0)]	0.42 [1.9] 7.7 (0) [770 (0)]	0.52 [2.3] 15 (0) [1500 (0)]	0.76 [3.4] 22 (0) [2200 (0)]
0.4x1-9.5-P2 0.016 x 0.039	0.41 [10.3]	0.079 [2]	12 [50]	0.3 [1.3] 1.5 (0.5*) [150 (50*)]	0.42 [1.9] 3.9 (0.5*) [380 (50*)]	0.52 [2.3] 7.7 (0.5*) [770 (50*)]	0.76 [3.4] 11 (0.5*) [1100 (50*)]
0.4x1-9.5-P3 0.016 x 0.039	0.41 [10.3]	0.12 [3]	8.3 [33]	0.3 [1.3] 1 (0.67*) [100 (67*)]	0.42 [1.9] 2.6 (0.67*) [260 (67*)]	0.52 [2.3] 5.1 (0.67*) [510 (67*)]	0.76 [3.4] 7.2 (0.67*) [720 (67*)]
0.4x1-9.5-P4 0.016 x 0.039	0.41 [10.3]	0.16 [4]	6.2 [25]	0.3 [1.3] 0.77 (0.75*) [77 (75*)]	0.42 [1.9] 1.9 (0.75*) [190 (75*)]	0.52 [2.3] 3.9 (0.75*) [380 (75*)]	0.76 [3.4] 5.4 (0.75*) [540 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x1-12.7-P1 0.016 x 0.039	0.53 [13.5]	0.039 [1]	25 [100]	0.23 [1] 5.4 (0) [540 (0)]	0.32 [1.4] 13 (0) [1300 (0)]	0.39 [1.8] 27 (0) [2700 (0)]	0.57 [2.5] 38 (0) [3800 (0)]
0.4x1-12.7-P2 0.016 x 0.039	0.53 [13.5]	0.079 [2]	12 [50]	0.23 [1] 2.7 (0.5*) [270 (50*)]	0.32 [1.4] 6.7 (0.5*) [670 (50*)]	0.39 [1.8] 13 (0.5*) [1300 (50*)]	0.57 [2.5] 19 (0.5*) [1900 (50*)]
0.4x1-12.7-P3 0.016 x 0.039	0.53 [13.5]	0.12 [3]	8.3 [33]	0.23 [1] 1.8 (0.67*) [180 (67*)]	0.32 [1.4] 4.5 (0.67*) [450 (67*)]	0.39 [1.8] 9 (0.67*) [900 (67*)]	0.57 [2.5] 13 (0.67*) [1300 (67*)]
0.4x1-12.7-P4 0.016 x 0.039	0.53 [13.5]	0.16 [4]	6.2 [25]	0.23 [1] 1.3 (0.75*) [130 (75*)]	0.32 [1.4] 3.4 (0.75*) [340 (75*)]	0.39 [1.8] 6.7 (0.75*) [670 (75*)]	0.57 [2.5] 9.4 (0.75*) [940 (75*)]
0.4x1-14.2-P1 0.016 x 0.039	0.59 [15]	0.039 [1]	25 [100]	0.21 [0.91] 6.7 (0) [670 (0)]	0.28 [1.3] 17 (0) [1700 (0)]	0.35 [1.6] 33 (0) [3300 (0)]	0.51 [2.3] 47 (0) [4700 (0)]
0.4x1-14.2-P2 0.016 x 0.039	0.59 [15]	0.079 [2]	12 [50]	0.21 [0.91] 3.3 (0.5*) [330 (50*)]	0.28 [1.3] 8.4 (0.5*) [840 (50*)]	0.35 [1.6] 17 (0.5*) [1700 (50*)]	0.51 [2.3] 23 (0.5*) [2300 (50*)]
0.4x1-14.2-P3 0.016 x 0.039	0.59 [15]	0.12 [3]	8.3 [33]	0.21 [0.91] 2.2 (0.67*) [220 (67*)]	0.28 [1.3] 5.6 (0.67*) [560 (67*)]	0.35 [1.6] 11 (0.67*) [1100 (67*)]	0.51 [2.3] 16 (0.67*) [1600 (67*)]
0.4x1-14.2-P4 0.016 x 0.039	0.59 [15]	0.16 [4]	6.2 [25]	0.21 [0.91] 1.7 (0.75*) [170 (75*)]	0.28 [1.3] 4.2 (0.75*) [420 (75*)]	0.35 [1.6] 8.4 (0.75*) [840 (75*)]	0.51 [2.3] 12 (0.75*) [1200 (75*)]
0.4x1-16-P1 0.016 x 0.039	0.66 [16.8]	0.039 [1]	25 [100]	0.18 [0.81] 8.4 (0) [840 (0)]	0.25 [1.1] 21 (0) [2100 (0)]	0.31 [1.4] 42 (0) [4200 (0)]	0.46 [2] 59 (0) [5900 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x1-16-P2 0.016 x 0.039	0.66 [16.8]	0.079 [2]	12 [50]	0.18 [0.81] 4.2 (0.5*) [420 (50*)]	0.25 [1.1] 11 (0.5*) [1100 (50*)]	0.31 [1.4] 21 (0.5*) [2100 (50*)]	0.46 [2] 30 (0.5*) [3000 (50*)]
0.4x1-16-P3 0.016 x 0.039	0.66 [16.8]	0.12 [3]	8.3 [33]	0.18 [0.81] 2.8 (0.67*) [280 (67*)]	0.25 [1.1] 7 (0.67*) [700 (67*)]	0.31 [1.4] 14 (0.67*) [1400 (67*)]	0.46 [2] 20 (0.67*) [2000 (67*)]
0.4x1-16-P4 0.016 x 0.039	0.66 [16.8]	0.16 [4]	6.2 [25]	0.18 [0.81] 2.1 (0.75*) [210 (75*)]	0.25 [1.1] 5.3 (0.75*) [530 (75*)]	0.31 [1.4] 11 (0.75*) [1100 (75*)]	0.46 [2] 15 (0.75*) [1500 (75*)]
0.4x1-19-P1 0.016 x 0.039	0.78 [19.8]	0.039 [1]	25 [100]	0.15 [0.69] 12 (0) [1200 (0)]	0.21 [0.95] 30 (0) [3000 (0)]	0.27 [1.2] 59 (0) [5900 (0)]	0.39 [1.7] 83 (0) [8300 (0)]
0.4x1-19-P2 0.016 x 0.039	0.78 [19.8]	0.079 [2]	12 [50]	0.15 [0.69] 5.9 (0.5*) [590 (50*)]	0.21 [0.95] 15 (0.5*) [1500 (50*)]	0.27 [1.2] 30 (0.5*) [3000 (50*)]	0.39 [1.7] 41 (0.5*) [4100 (50*)]
0.4x1-19-P3 0.016 x 0.039	0.78 [19.8]	0.12 [3]	8.3 [33]	0.15 [0.69] 3.9 (0.67*) [390 (67*)]	0.21 [0.95] 9.9 (0.67*) [990 (67*)]	0.27 [1.2] 20 (0.67*) [2000 (67*)]	0.39 [1.7] 28 (0.67*) [2800 (67*)]
0.4x1-19-P4 0.016 x 0.039	0.78 [19.8]	0.16 [4]	6.2 [25]	0.15 [0.69] 3 (0.75*) [300 (75*)]	0.21 [0.95] 7.4 (0.75*) [740 (75*)]	0.27 [1.2] 15 (0.75*) [1500 (75*)]	0.39 [1.7] 21 (0.75*) [2100 (75*)]
0.4x1-22.2-P1 0.016 x 0.039	0.91 [23]	0.039 [1]	25 [100]	0.13 [0.59] 16 (0) [1600 (0)]	0.18 [0.81] 40 (0) [4000 (0)]	0.23 [1] 80 (0) [8000 (0)]	0.33 [1.5] 110 (0) [11000 (0)]
0.4x1-22.2-P2 0.016 x 0.039	0.91 [23]	0.079 [2]	12 [50]	0.13 [0.59] 8 (0.5*) [800 (50*)]	0.18 [0.81] 20 (0.5*) [2000 (50*)]	0.23 [1] 40 (0.5*) [4000 (50*)]	0.33 [1.5] 56 (0.5*) [5600 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x1-22.2-P3 0.016 x 0.039	0.91 [23]	0.12 [3]	8.3 [33]	0.13 [0.59] 5.3 (0.67*) [530 (67*)]	0.18 [0.81] 13 (0.67*) [1300 (67*)]	0.23 [1] 27 (0.67*) [2700 (67*)]	0.33 [1.5] 37 (0.67*) [3700 (67*)]
0.4x1-22.2-P4 0.016 x 0.039	0.91 [23]	0.16 [4]	6.2 [25]	0.13 [0.59] 4 (0.75*) [400 (75*)]	0.18 [0.81] 10 (0.75*) [1000 (75*)]	0.23 [1] 20 (0.75*) [2000 (75*)]	0.33 [1.5] 28 (0.75*) [2800 (75*)]
0.4x1-25.4-P1 0.016 x 0.039	1 [26.2]	0.039 [1]	25 [100]	0.12 [0.52] 21 (0) [2100 (0)]	0.16 [0.71] 52 (0) [5200 (0)]	0.2 [0.89] 100 (0) [10000 (0)]	0.29 [1.3] 150 (0) [15000 (0)]
0.4x1-25.4-P2 0.016 x 0.039	1 [26.2]	0.079 [2]	12 [50]	0.12 [0.52] 10 (0.5*) [1000 (50*)]	0.16 [0.71] 26 (0.5*) [2600 (50*)]	0.2 [0.89] 52 (0.5*) [5200 (50*)]	0.29 [1.3] 73 (0.5*) [7300 (50*)]
0.4x1-25.4-P3 0.016 x 0.039	1 [26.2]	0.12 [3]	8.3 [33]	0.12 [0.52] 7 (0.67*) [700 (67*)]	0.16 [0.71] 17 (0.67*) [1700 (67*)]	0.2 [0.89] 35 (0.67*) [3500 (67*)]	0.29 [1.3] 49 (0.67*) [4900 (67*)]
0.4x1-25.4-P4 0.016 x 0.039	1 [26.2]	0.16 [4]	6.2 [25]	0.12 [0.52] 5.2 (0.75*) [520 (75*)]	0.16 [0.71] 13 (0.75*) [1300 (75*)]	0.2 [0.89] 26 (0.75*) [2600 (75*)]	0.29 [1.3] 37 (0.75*) [3700 (75*)]
0.5x0.25-0.5-P1 0.02 x 0.0098	0.059 [1.5]	0.0098 [0.25]	100 [400]	0.23 [1] 0.5 (0) [50 (0)]	0.32 [1.4] 1.3 (0) [130 (0)]	0.4 [1.8] 2.5 (0) [250 (0)]	0.59 [2.6] 3.5 (0) [350 (0)]
0.5x0.25-0.5-P2 0.02 x 0.0098	0.059 [1.5]	0.02 [0.5]	51 [200]	0.23 [1] 0.25 (0.25) [25 (25)]	0.32 [1.4] 0.63 (0.5*) [63 (50*)]	0.4 [1.8] 1.3 (0.5*) [130 (50*)]	0.59 [2.6] 1.8 (0.5*) [180 (50*)]
0.5x0.25-0.5-P3 0.02 x 0.0098	0.059 [1.5]	0.03 [0.75]	34 [130]	0.23 [1] 0.17 (0.17) [17 (17)]	0.32 [1.4] 0.42 (0.42) [42 (42)]	0.4 [1.8] 0.84 (0.67*) [84 (67*)]	0.59 [2.6] 1.2 (0.67*) [120 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.25-0.5-P4 0.02 x 0.0098	0.059 [1.5]	0.039 [1]	26 [100]	0.23 [1] 0.13 (0.13) [13 (13)]	0.32 [1.4] 0.31 (0.31) [31 (31)]	0.4 [1.8] 0.63 (0.63) [63 (63)]	0.59 [2.6] 0.88 (0.75*) [88 (75*)]
0.5x0.25-0.9-P1 0.02 x 0.0098	0.075 [1.9]	0.0098 [0.25]	100 [400]	0.17 [0.74] 0.99 (0) [99 (0)]	0.23 [1] 2.5 (0) [250 (0)]	0.29 [1.3] 4.9 (0) [490 (0)]	0.42 [1.9] 6.9 (0) [690 (0)]
0.5x0.25-0.9-P2 0.02 x 0.0098	0.075 [1.9]	0.02 [0.5]	51 [200]	0.17 [0.74] 0.49 (0.49) [49 (49)]	0.23 [1] 1.2 (0.5*) [120 (50*)]	0.29 [1.3] 2.5 (0.5*) [250 (50*)]	0.42 [1.9] 3.5 (0.5*) [350 (50*)]
0.5x0.25-0.9-P3 0.02 x 0.0098	0.075 [1.9]	0.03 [0.75]	34 [130]	0.17 [0.74] 0.33 (0.33) [33 (33)]	0.23 [1] 0.82 (0.67*) [82 (67*)]	0.29 [1.3] 1.6 (0.67*) [160 (67*)]	0.42 [1.9] 2.3 (0.67*) [230 (67*)]
0.5x0.25-0.9-P4 0.02 x 0.0098	0.075 [1.9]	0.039 [1]	26 [100]	0.17 [0.74] 0.25 (0.25) [25 (25)]	0.23 [1] 0.62 (0.62) [62 (62)]	0.29 [1.3] 1.2 (0.75*) [120 (75*)]	0.42 [1.9] 1.7 (0.75*) [170 (75*)]
0.5x0.25-1.15-P1 0.02 x 0.0098	0.085 [2.15]	0.0098 [0.25]	100 [400]	0.14 [0.63] 1.4 (0) [140 (0)]	0.2 [0.87] 3.4 (0) [340 (0)]	0.24 [1.1] 6.8 (0) [680 (0)]	0.35 [1.6] 9.6 (0) [960 (0)]
0.5x0.25-1.15-P2 0.02 x 0.0098	0.085 [2.15]	0.02 [0.5]	51 [200]	0.14 [0.63] 0.68 (0.5*) [68 (50*)]	0.2 [0.87] 1.7 (0.5*) [170 (50*)]	0.24 [1.1] 3.4 (0.5*) [340 (50*)]	0.35 [1.6] 4.8 (0.5*) [480 (50*)]
0.5x0.25-1.15-P3 0.02 x 0.0098	0.085 [2.15]	0.03 [0.75]	34 [130]	0.14 [0.63] 0.46 (0.46) [46 (46)]	0.2 [0.87] 1.1 (0.67*) [110 (67*)]	0.24 [1.1] 2.3 (0.67*) [230 (67*)]	0.35 [1.6] 3.2 (0.67*) [320 (67*)]
0.5x0.25-1.15-P4 0.02 x 0.0098	0.085 [2.15]	0.039 [1]	26 [100]	0.14 [0.63] 0.34 (0.34) [34 (34)]	0.2 [0.87] 0.85 (0.75*) [86 (75*)]	0.24 [1.1] 1.7 (0.75*) [170 (75*)]	0.35 [1.6] 2.4 (0.75*) [240 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.25-1.6-P1 0.02 x 0.0098	0.1 [2.6]	0.0098 [0.25]	100 [400]	0.11 [0.5] 2.2 (0) [220 (0)]	0.15 [0.68] 5.5 (0) [550 (0)]	0.19 [0.85] 11 (0) [1100 (0)]	0.28 [1.2] 16 (0) [1600 (0)]
0.5x0.25-1.6-P2 0.02 x 0.0098	0.1 [2.6]	0.02 [0.5]	51 [200]	0.11 [0.5] 1.1 (0.5*) [110 (50*)]	0.15 [0.68] 2.8 (0.5*) [280 (50*)]	0.19 [0.85] 5.5 (0.5*) [550 (50*)]	0.28 [1.2] 7.8 (0.5*) [780 (50*)]
0.5x0.25-1.6-P3 0.02 x 0.0098	0.1 [2.6]	0.03 [0.75]	34 [130]	0.11 [0.5] 0.74 (0.67*) [74 (67*)]	0.15 [0.68] 1.8 (0.67*) [180 (67*)]	0.19 [0.85] 3.7 (0.67*) [370 (67*)]	0.28 [1.2] 5.2 (0.67*) [520 (67*)]
0.5x0.25-1.6-P4 0.02 x 0.0098	0.1 [2.6]	0.039 [1]	26 [100]	0.11 [0.5] 0.55 (0.55) [55 (55)]	0.15 [0.68] 1.4 (0.75*) [140 (75*)]	0.19 [0.85] 2.8 (0.75*) [280 (75*)]	0.28 [1.2] 3.9 (0.75*) [390 (75*)]
0.5x0.25-2.4-P1 0.02 x 0.0098	0.13 [3.4]	0.0098 [0.25]	100 [400]	0.081 [0.36] 4.2 (0) [420 (0)]	0.11 [0.5] 11 (0) [1100 (0)]	0.14 [0.62] 21 (0) [2100 (0)]	0.2 [0.9] 30 (0) [3000 (0)]
0.5x0.25-2.4-P2 0.02 x 0.0098	0.13 [3.4]	0.02 [0.5]	51 [200]	0.081 [0.36] 2.1 (0.5*) [210 (50*)]	0.11 [0.5] 5.3 (0.5*) [530 (50*)]	0.14 [0.62] 11 (0.5*) [1100 (50*)]	0.2 [0.9] 15 (0.5*) [1500 (50*)]
0.5x0.25-2.4-P3 0.02 x 0.0098	0.13 [3.4]	0.03 [0.75]	34 [130]	0.081 [0.36] 1.4 (0.67*) [140 (67*)]	0.11 [0.5] 3.5 (0.67*) [350 (67*)]	0.14 [0.62] 7 (0.67*) [700 (67*)]	0.2 [0.9] 9.9 (0.67*) [990 (67*)]
0.5x0.25-2.4-P4 0.02 x 0.0098	0.13 [3.4]	0.039 [1]	26 [100]	0.081 [0.36] 1.1 (0.75*) [110 (75*)]	0.11 [0.5] 2.6 (0.75*) [260 (75*)]	0.14 [0.62] 5.3 (0.75*) [530 (75*)]	0.2 [0.9] 7.4 (0.75*) [740 (75*)]
0.5x0.25-3.2-P1 0.02 x 0.0098	0.17 [4.2]	0.0098 [0.25]	100 [400]	0.063 [0.28] 6.9 (0) [690 (0)]	0.087 [0.39] 17 (0) [1700 (0)]	0.11 [0.48] 34 (0) [3400 (0)]	0.16 [0.7] 48 (0) [4800 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.25-3.2-P2 0.02 x 0.0098	0.17 [4.2]	0.02 [0.5]	51 [200]	0.063 [0.28] 3.4 (0.5*) [340 (50*)]	0.087 [0.39] 8.6 (0.5*) [860 (50*)]	0.11 [0.48] 17 (0.5*) [1700 (50*)]	0.16 [0.7] 24 (0.5*) [2400 (50*)]
0.5x0.25-3.2-P3 0.02 x 0.0098	0.17 [4.2]	0.03 [0.75]	34 [130]	0.063 [0.28] 2.3 (0.67*) [230 (67*)]	0.087 [0.39] 5.7 (0.67*) [570 (67*)]	0.11 [0.48] 11 (0.67*) [1100 (67*)]	0.16 [0.7] 16 (0.67*) [1600 (67*)]
0.5x0.25-3.2-P4 0.02 x 0.0098	0.17 [4.2]	0.039 [1]	26 [100]	0.063 [0.28] 1.7 (0.75*) [170 (75*)]	0.087 [0.39] 4.3 (0.75*) [430 (75*)]	0.11 [0.48] 8.6 (0.75*) [860 (75*)]	0.16 [0.7] 12 (0.75*) [1200 (75*)]
0.5x0.25-4.75-P1 0.02 x 0.0098	0.23 [5.75]	0.0098 [0.25]	100 [400]	0.045 [0.2] 14 (0) [1400 (0)]	0.062 [0.27] 35 (0) [3500 (0)]	0.077 [0.34] 69 (0) [6900 (0)]	0.11 [0.5] 97 (0) [9700 (0)]
0.5x0.25-4.75-P2 0.02 x 0.0098	0.23 [5.75]	0.02 [0.5]	51 [200]	0.045 [0.2] 6.9 (0.5*) [690 (50*)]	0.062 [0.27] 17 (0.5*) [1700 (50*)]	0.077 [0.34] 35 (0.5*) [3500 (50*)]	0.11 [0.5] 48 (0.5*) [4800 (50*)]
0.5x0.25-4.75-P3 0.02 x 0.0098	0.23 [5.75]	0.03 [0.75]	34 [130]	0.045 [0.2] 4.6 (0.67*) [460 (67*)]	0.062 [0.27] 12 (0.67*) [1200 (67*)]	0.077 [0.34] 23 (0.67*) [2300 (67*)]	0.11 [0.5] 32 (0.67*) [3200 (67*)]
0.5x0.25-4.75-P4 0.02 x 0.0098	0.23 [5.75]	0.039 [1]	26 [100]	0.045 [0.2] 3.5 (0.75*) [350 (75*)]	0.062 [0.27] 8.7 (0.75*) [870 (75*)]	0.077 [0.34] 17 (0.75*) [1700 (75*)]	0.11 [0.5] 24 (0.75*) [2400 (75*)]
0.5x0.25-6-P1 0.02 x 0.0098	0.28 [7]	0.0098 [0.25]	100 [400]	0.036 [0.16] 21 (0) [2100 (0)]	0.05 [0.22] 53 (0) [5300 (0)]	0.062 [0.28] 110 (0) [11000 (0)]	0.09 [0.4] 150 (0) [15000 (0)]
0.5x0.25-6-P2 0.02 x 0.0098	0.28 [7]	0.02 [0.5]	51 [200]	0.036 [0.16] 11 (0.5*) [1100 (50*)]	0.05 [0.22] 27 (0.5*) [2700 (50*)]	0.062 [0.28] 53 (0.5*) [5300 (50*)]	0.09 [0.4] 74 (0.5*) [7400 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.25-6-P3 0.02 x 0.0098	0.28 [7]	0.03 [0.75]	34 [130]	0.036 [0.16] 7.1 (0.67*) [710 (67*)]	0.05 [0.22] 18 (0.67*) [1800 (67*)]	0.062 [0.28] 35 (0.67*) [3500 (67*)]	0.09 [0.4] 50 (0.67*) [5000 (67*)]
0.5x0.25-6-P4 0.02 x 0.0098	0.28 [7]	0.039 [1]	26 [100]	0.036 [0.16] 5.3 (0.75*) [530 (75*)]	0.05 [0.22] 13 (0.75*) [1300 (75*)]	0.062 [0.28] 27 (0.75*) [2700 (75*)]	0.09 [0.4] 37 (0.75*) [3700 (75*)]
0.5x0.25-8-P1 0.02 x 0.0098	0.35 [9]	0.0098 [0.25]	100 [400]	0.028 [0.12] 36 (0) [3600 (0)]	0.038 [0.17] 91 (0) [9100 (0)]	0.047 [0.21] 180 (0) [18000 (0)]	0.069 [0.31] 250 (0) [25000 (0)]
0.5x0.25-8-P2 0.02 x 0.0098	0.35 [9]	0.02 [0.5]	51 [200]	0.028 [0.12] 18 (0.5*) [1800 (50*)]	0.038 [0.17] 45 (0.5*) [4500 (50*)]	0.047 [0.21] 91 (0.5*) [9100 (50*)]	0.069 [0.31] 130 (0.5*) [13000 (50*)]
0.5x0.25-8-P3 0.02 x 0.0098	0.35 [9]	0.03 [0.75]	34 [130]	0.028 [0.12] 12 (0.67*) [1200 (67*)]	0.038 [0.17] 30 (0.67*) [3000 (67*)]	0.047 [0.21] 61 (0.67*) [6100 (67*)]	0.069 [0.31] 85 (0.67*) [8500 (67*)]
0.5x0.25-8-P4 0.02 x 0.0098	0.35 [9]	0.039 [1]	26 [100]	0.028 [0.12] 9.1 (0.75*) [910 (75*)]	0.038 [0.17] 23 (0.75*) [2300 (75*)]	0.047 [0.21] 45 (0.75*) [4500 (75*)]	0.069 [0.31] 64 (0.75*) [6400 (75*)]
0.5x0.25-9.5-P1 0.02 x 0.0098	0.41 [10.5]	0.0098 [0.25]	100 [400]	0.023 [0.1] 50 (0) [5000 (0)]	0.032 [0.14] 130 (0) [13000 (0)]	0.04 [0.18] 250 (0) [25000 (0)]	0.059 [0.26] 350 (0) [35000 (0)]
0.5x0.25-9.5-P2 0.02 x 0.0098	0.41 [10.5]	0.02 [0.5]	51 [200]	0.023 [0.1] 25 (0.5*) [2500 (50*)]	0.032 [0.14] 63 (0.5*) [6300 (50*)]	0.04 [0.18] 130 (0.5*) [13000 (50*)]	0.059 [0.26] 180 (0.5*) [18000 (50*)]
0.5x0.25-9.5-P3 0.02 x 0.0098	0.41 [10.5]	0.03 [0.75]	34 [130]	0.023 [0.1] 17 (0.67*) [1700 (67*)]	0.032 [0.14] 42 (0.67*) [4200 (67*)]	0.04 [0.18] 84 (0.67*) [8400 (67*)]	0.059 [0.26] 120 (0.67*) [12000 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.25-9.5-P4 0.02 x 0.0098	0.41 [10.5]	0.039 [1]	26 [100]	0.023 [0.1] 13 (0.75*) [1300 (75*)]	0.032 [0.14] 31 (0.75*) [3100 (75*)]	0.04 [0.18] 63 (0.75*) [6300 (75*)]	0.059 [0.26] 88 (0.75*) [8800 (75*)]
0.5x0.25-12.7-P1 0.02 x 0.0098	0.54 [13.7]	0.0098 [0.25]	100 [400]	0.018 [0.079] 88 (0) [8800 (0)]	0.024 [0.11] 220 (0) [22000 (0)]	0.031 [0.14] 440 (0) [44000 (0)]	0.044 [0.2] 610 (0) [61000 (0)]
0.5x0.25-12.7-P2 0.02 x 0.0098	0.54 [13.7]	0.02 [0.5]	51 [200]	0.018 [0.079] 44 (0.5*) [4400 (50*)]	0.024 [0.11] 110 (0.5*) [11000 (50*)]	0.031 [0.14] 220 (0.5*) [22000 (50*)]	0.044 [0.2] 310 (0.5*) [31000 (50*)]
0.5x0.25-12.7-P3 0.02 x 0.0098	0.54 [13.7]	0.03 [0.75]	34 [130]	0.018 [0.079] 29 (0.67*) [2900 (67*)]	0.024 [0.11] 73 (0.67*) [7300 (67*)]	0.031 [0.14] 150 (0.67*) [15000 (67*)]	0.044 [0.2] 200 (0.67*) [20000 (67*)]
0.5x0.25-12.7-P4 0.02 x 0.0098	0.54 [13.7]	0.039 [1]	26 [100]	0.018 [0.079] 22 (0.75*) [2200 (75*)]	0.024 [0.11] 55 (0.75*) [5500 (75*)]	0.031 [0.14] 110 (0.75*) [11000 (75*)]	0.044 [0.2] 150 (0.75*) [15000 (75*)]
0.5x0.25-14.2-P1 0.02 x 0.0098	0.6 [15.2]	0.0098 [0.25]	100 [400]	0.016 [0.071] 110 (0) [11000 (0)]	0.022 [0.098] 270 (0) [27000 (0)]	0.027 [0.12] 540 (0) [54000 (0)]	0.04 [0.18] 760 (0) [76000 (0)]
0.5x0.25-14.2-P2 0.02 x 0.0098	0.6 [15.2]	0.02 [0.5]	51 [200]	0.016 [0.071] 54 (0.5*) [5400 (50*)]	0.022 [0.098] 140 (0.5*) [14000 (50*)]	0.027 [0.12] 270 (0.5*) [27000 (50*)]	0.04 [0.18] 380 (0.5*) [38000 (50*)]
0.5x0.25-14.2-P3 0.02 x 0.0098	0.6 [15.2]	0.03 [0.75]	34 [130]	0.016 [0.071] 36 (0.67*) [3600 (67*)]	0.022 [0.098] 91 (0.67*) [9100 (67*)]	0.027 [0.12] 180 (0.67*) [18000 (67*)]	0.04 [0.18] 250 (0.67*) [25000 (67*)]
0.5x0.25-14.2-P4 0.02 x 0.0098	0.6 [15.2]	0.039 [1]	26 [100]	0.016 [0.071] 27 (0.75*) [2700 (75*)]	0.022 [0.098] 68 (0.75*) [6800 (75*)]	0.027 [0.12] 140 (0.75*) [14000 (75*)]	0.04 [0.18] 190 (0.75*) [19000 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.25-16-P1 0.02 x 0.0098	0.67 [17]	0.0098 [0.25]	100 [400]	0.014 [0.063] 140 (0) [14000 (0)]	0.02 [0.087] 340 (0) [34000 (0)]	0.024 [0.11] 680 (0) [68000 (0)]	0.035 [0.16] 960 (0) [96000 (0)]
0.5x0.25-16-P2 0.02 x 0.0098	0.67 [17]	0.02 [0.5]	51 [200]	0.014 [0.063] 68 (0.5*) [6800 (50*)]	0.02 [0.087] 170 (0.5*) [17000 (50*)]	0.024 [0.11] 340 (0.5*) [34000 (50*)]	0.035 [0.16] 480 (0.5*) [48000 (50*)]
0.5x0.25-16-P3 0.02 x 0.0098	0.67 [17]	0.03 [0.75]	34 [130]	0.014 [0.063] 46 (0.67*) [4600 (67*)]	0.02 [0.087] 110 (0.67*) [11000 (67*)]	0.024 [0.11] 230 (0.67*) [23000 (67*)]	0.035 [0.16] 320 (0.67*) [32000 (67*)]
0.5x0.25-16-P4 0.02 x 0.0098	0.67 [17]	0.039 [1]	26 [100]	0.014 [0.063] 34 (0.75*) [3400 (75*)]	0.02 [0.087] 86 (0.75*) [8600 (75*)]	0.024 [0.11] 170 (0.75*) [17000 (75*)]	0.035 [0.16] 240 (0.75*) [24000 (75*)]
0.5x0.25-19-P1 0.02 x 0.0098	0.79 [20]	0.0098 [0.25]	100 [400]	0.012 [0.053] 190 (0) [19000 (0)]	0.017 [0.074] 480 (0) [48000 (0)]	0.021 [0.092] 960 (0) [96000 (0)]	0.03 [0.13] 1300 (0) [130000 (0)]
0.5x0.25-19-P2 0.02 x 0.0098	0.79 [20]	0.02 [0.5]	51 [200]	0.012 [0.053] 96 (0.5*) [9600 (50*)]	0.017 [0.074] 240 (0.5*) [24000 (50*)]	0.021 [0.092] 480 (0.5*) [48000 (50*)]	0.03 [0.13] 670 (0.5*) [67000 (50*)]
0.5x0.25-19-P3 0.02 x 0.0098	0.79 [20]	0.03 [0.75]	34 [130]	0.012 [0.053] 64 (0.67*) [6400 (67*)]	0.017 [0.074] 160 (0.67*) [16000 (67*)]	0.021 [0.092] 320 (0.67*) [32000 (67*)]	0.03 [0.13] 450 (0.67*) [45000 (67*)]
0.5x0.25-19-P4 0.02 x 0.0098	0.79 [20]	0.039 [1]	26 [100]	0.012 [0.053] 48 (0.75*) [4800 (75*)]	0.017 [0.074] 120 (0.75*) [12000 (75*)]	0.021 [0.092] 240 (0.75*) [24000 (75*)]	0.03 [0.13] 330 (0.75*) [33000 (75*)]
0.5x0.25-22.2-P1 0.02 x 0.0098	0.91 [23.2]	0.0098 [0.25]	100 [400]	0.01 [0.046] 260 (0) [26000 (0)]	0.014 [0.063] 650 (0) [65000 (0)]	0.018 [0.079] 1300 (0) [130000 (0)]	0.026 [0.11] 1800 (0) [180000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.25-22.2-P2 0.02 x 0.0098	0.91 [23.2]	0.02 [0.5]	51 [200]	0.01 [0.046] 130 (0.5*) [13000 (50*)]	0.014 [0.063] 320 (0.5*) [32000 (50*)]	0.018 [0.079] 650 (0.5*) [65000 (50*)]	0.026 [0.11] 910 (0.5*) [91000 (50*)]
0.5x0.25-22.2-P3 0.02 x 0.0098	0.91 [23.2]	0.03 [0.75]	34 [130]	0.01 [0.046] 86 (0.67*) [8600 (67*)]	0.014 [0.063] 220 (0.67*) [22000 (67*)]	0.018 [0.079] 430 (0.67*) [43000 (67*)]	0.026 [0.11] 600 (0.67*) [60000 (67*)]
0.5x0.25-22.2-P4 0.02 x 0.0098	0.91 [23.2]	0.039 [1]	26 [100]	0.01 [0.046] 65 (0.75*) [6500 (75*)]	0.014 [0.063] 160 (0.75*) [16000 (75*)]	0.018 [0.079] 320 (0.75*) [32000 (75*)]	0.026 [0.11] 450 (0.75*) [45000 (75*)]
0.5x0.25-25.4-P1 0.02 x 0.0098	1 [26.4]	0.0098 [0.25]	100 [400]	0.009 [0.04] 340 (0) [34000 (0)]	0.012 [0.056] 840 (0) [84000 (0)]	0.016 [0.069] 1700 (0) [170000 (0)]	0.023 [0.1] 2400 (0) [240000 (0)]
0.5x0.25-25.4-P2 0.02 x 0.0098	1 [26.4]	0.02 [0.5]	51 [200]	0.009 [0.04] 170 (0.5*) [17000 (50*)]	0.012 [0.056] 420 (0.5*) [42000 (50*)]	0.016 [0.069] 840 (0.5*) [84000 (50*)]	0.023 [0.1] 1200 (0.5*) [120000 (50*)]
0.5x0.25-25.4-P3 0.02 x 0.0098	1 [26.4]	0.03 [0.75]	34 [130]	0.009 [0.04] 110 (0.67*) [11000 (67*)]	0.012 [0.056] 280 (0.67*) [28000 (67*)]	0.016 [0.069] 560 (0.67*) [56000 (67*)]	0.023 [0.1] 790 (0.67*) [79000 (67*)]
0.5x0.25-25.4-P4 0.02 x 0.0098	1 [26.4]	0.039 [1]	26 [100]	0.009 [0.04] 84 (0.75*) [8400 (75*)]	0.012 [0.056] 210 (0.75*) [21000 (75*)]	0.016 [0.069] 420 (0.75*) [42000 (75*)]	0.023 [0.1] 590 (0.75*) [59000 (75*)]
0.5x0.8-0.5-P1 0.02 x 0.031	0.059 [1.5]	0.031 [0.8]	32 [120]	2.4 [11] 0.048 (0) [4.8 (0)]	3.3 [15] 0.12 (0) [12 (0)]	4.1 [18] 0.24 (0) [24 (0)]	6 [27] 0.34 (0) [34 (0)]
0.5x0.8-0.5-P2 0.02 x 0.031	0.059 [1.5]	0.063 [1.6]	16 [62]	2.4 [11] 0.024 (0.024) [2.4 (2.4)]	3.3 [15] 0.06 (0.06) [6 (6)]	4.1 [18] 0.12 (0.12) [12 (12)]	6 [27] 0.17 (0.17) [17 (17)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.8-0.5-P3 0.02 x 0.031	0.059 [1.5]	0.094 [2.4]	11 [42]	2.4 [11] 0.016 (0.016) [1.6 (1.6)]	3.3 [15] 0.04 (0.04) [4 (4)]	4.1 [18] 0.08 (0.08) [8 (8)]	6 [27] 0.11 (0.11) [11 (11)]
0.5x0.8-0.5-P4 0.02 x 0.031	0.059 [1.5]	0.13 [3.2]	8 [31]	2.4 [11] 0.012 (0.012) [1.2 (1.2)]	3.3 [15] 0.03 (0.03) [3 (3)]	4.1 [18] 0.06 (0.06) [6 (6)]	6 [27] 0.084 (0.084) [8.4 (8.4)]
0.5x0.8-0.9-P1 0.02 x 0.031	0.075 [1.9]	0.031 [0.8]	32 [120]	1.7 [7.6] 0.096 (0) [9.6 (0)]	2.4 [11] 0.24 (0) [24 (0)]	2.9 [13] 0.48 (0) [48 (0)]	4.3 [19] 0.67 (0) [67 (0)]
0.5x0.8-0.9-P2 0.02 x 0.031	0.075 [1.9]	0.063 [1.6]	16 [62]	1.7 [7.6] 0.048 (0.048) [4.8 (4.8)]	2.4 [11] 0.12 (0.12) [12 (12)]	2.9 [13] 0.24 (0.24) [24 (24)]	4.3 [19] 0.34 (0.34) [34 (34)]
0.5x0.8-0.9-P3 0.02 x 0.031	0.075 [1.9]	0.094 [2.4]	11 [42]	1.7 [7.6] 0.032 (0.032) [3.2 (3.2)]	2.4 [11] 0.08 (0.08) [8 (8)]	2.9 [13] 0.16 (0.16) [16 (16)]	4.3 [19] 0.22 (0.22) [22 (22)]
0.5x0.8-0.9-P4 0.02 x 0.031	0.075 [1.9]	0.13 [3.2]	8 [31]	1.7 [7.6] 0.024 (0.024) [2.4 (2.4)]	2.4 [11] 0.06 (0.06) [6 (6)]	2.9 [13] 0.12 (0.12) [12 (12)]	4.3 [19] 0.17 (0.17) [17 (17)]
0.5x0.8-1.15-P1 0.02 x 0.031	0.085 [2.15]	0.031 [0.8]	32 [120]	1.5 [6.5] 0.13 (0) [13 (0)]	2 [8.9] 0.34 (0) [34 (0)]	2.5 [11] 0.67 (0) [67 (0)]	3.6 [16] 0.94 (0) [94 (0)]
0.5x0.8-1.15-P2 0.02 x 0.031	0.085 [2.15]	0.063 [1.6]	16 [62]	1.5 [6.5] 0.067 (0.067) [6.7 (6.7)]	2 [8.9] 0.17 (0.17) [17 (17)]	2.5 [11] 0.34 (0.34) [34 (34)]	3.6 [16] 0.47 (0.47) [47 (47)]
0.5x0.8-1.15-P3 0.02 x 0.031	0.085 [2.15]	0.094 [2.4]	11 [42]	1.5 [6.5] 0.045 (0.045) [4.5 (4.5)]	2 [8.9] 0.11 (0.11) [11 (11)]	2.5 [11] 0.22 (0.22) [22 (22)]	3.6 [16] 0.31 (0.31) [31 (31)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.8-1.15-P4 0.02 x 0.031	0.085 [2.15]	0.13 [3.2]	8 [31]	1.5 [6.5] 0.033 (0.033) [3.3 (3.3)]	2 [8.9] 0.084 (0.084) [8.4 (8.4)]	2.5 [11] 0.17 (0.17) [17 (17)]	3.6 [16] 0.23 (0.23) [23 (23)]
0.5x0.8-1.6-P1 0.02 x 0.031	0.1 [2.6]	0.031 [0.8]	32 [120]	1.1 [5.1] 0.22 (0) [22 (0)]	1.6 [7] 0.54 (0) [54 (0)]	2 [8.7] 1.1 (0) [110 (0)]	2.9 [13] 1.5 (0) [150 (0)]
0.5x0.8-1.6-P2 0.02 x 0.031	0.1 [2.6]	0.063 [1.6]	16 [62]	1.1 [5.1] 0.11 (0.11) [11 (11)]	1.6 [7] 0.27 (0.27) [27 (27)]	2 [8.7] 0.54 (0.5*) [54 (50*)]	2.9 [13] 0.76 (0.5*) [76 (50*)]
0.5x0.8-1.6-P3 0.02 x 0.031	0.1 [2.6]	0.094 [2.4]	11 [42]	1.1 [5.1] 0.072 (0.072) [7.2 (7.2)]	1.6 [7] 0.18 (0.18) [18 (18)]	2 [8.7] 0.36 (0.36) [36 (36)]	2.9 [13] 0.5 (0.5) [50 (50)]
0.5x0.8-1.6-P4 0.02 x 0.031	0.1 [2.6]	0.13 [3.2]	8 [31]	1.1 [5.1] 0.054 (0.054) [5.4 (5.4)]	1.6 [7] 0.14 (0.14) [14 (14)]	2 [8.7] 0.27 (0.27) [27 (27)]	2.9 [13] 0.38 (0.38) [38 (38)]
0.5x0.8-2.4-P1 0.02 x 0.031	0.13 [3.4]	0.031 [0.8]	32 [120]	0.83 [3.7] 0.41 (0) [41 (0)]	1.1 [5.1] 1 (0) [100 (0)]	1.4 [6.3] 2.1 (0) [210 (0)]	2.1 [9.2] 2.9 (0) [290 (0)]
0.5x0.8-2.4-P2 0.02 x 0.031	0.13 [3.4]	0.063 [1.6]	16 [62]	0.83 [3.7] 0.21 (0.21) [21 (21)]	1.1 [5.1] 0.52 (0.5*) [52 (50*)]	1.4 [6.3] 1 (0.5*) [100 (50*)]	2.1 [9.2] 1.4 (0.5*) [140 (50*)]
0.5x0.8-2.4-P3 0.02 x 0.031	0.13 [3.4]	0.094 [2.4]	11 [42]	0.83 [3.7] 0.14 (0.14) [14 (14)]	1.1 [5.1] 0.34 (0.34) [34 (34)]	1.4 [6.3] 0.69 (0.67*) [69 (67*)]	2.1 [9.2] 0.96 (0.67*) [96 (67*)]
0.5x0.8-2.4-P4 0.02 x 0.031	0.13 [3.4]	0.13 [3.2]	8 [31]	0.83 [3.7] 0.1 (0.1) [10 (10)]	1.1 [5.1] 0.26 (0.26) [26 (26)]	1.4 [6.3] 0.52 (0.52) [52 (52)]	2.1 [9.2] 0.72 (0.72) [72 (72)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.8-3.2-P1 0.02 x 0.031	0.17 [4.2]	0.031 [0.8]	32 [120]	0.65 [2.9] 0.67 (0) [67 (0)]	0.89 [4] 1.7 (0) [170 (0)]	1.1 [5] 3.4 (0) [340 (0)]	1.6 [7.2] 4.7 (0) [470 (0)]
0.5x0.8-3.2-P2 0.02 x 0.031	0.17 [4.2]	0.063 [1.6]	16 [62]	0.65 [2.9] 0.34 (0.34) [34 (34)]	0.89 [4] 0.84 (0.5*) [84 (50*)]	1.1 [5] 1.7 (0.5*) [170 (50*)]	1.6 [7.2] 2.4 (0.5*) [240 (50*)]
0.5x0.8-3.2-P3 0.02 x 0.031	0.17 [4.2]	0.094 [2.4]	11 [42]	0.65 [2.9] 0.22 (0.22) [22 (22)]	0.89 [4] 0.56 (0.56) [56 (56)]	1.1 [5] 1.1 (0.67*) [110 (67*)]	1.6 [7.2] 1.6 (0.67*) [160 (67*)]
0.5x0.8-3.2-P4 0.02 x 0.031	0.17 [4.2]	0.13 [3.2]	8 [31]	0.65 [2.9] 0.17 (0.17) [17 (17)]	0.89 [4] 0.42 (0.42) [42 (42)]	1.1 [5] 0.84 (0.75*) [84 (75*)]	1.6 [7.2] 1.2 (0.75*) [120 (75*)]
0.5x0.8-4.75-P1 0.02 x 0.031	0.23 [5.75]	0.031 [0.8]	32 [120]	0.46 [2] 1.4 (0) [140 (0)]	0.63 [2.8] 3.4 (0) [340 (0)]	0.79 [3.5] 6.8 (0) [680 (0)]	1.1 [5.1] 9.5 (0) [950 (0)]
0.5x0.8-4.75-P2 0.02 x 0.031	0.23 [5.75]	0.063 [1.6]	16 [62]	0.46 [2] 0.68 (0.5*) [68 (50*)]	0.63 [2.8] 1.7 (0.5*) [170 (50*)]	0.79 [3.5] 3.4 (0.5*) [340 (50*)]	1.1 [5.1] 4.7 (0.5*) [470 (50*)]
0.5x0.8-4.75-P3 0.02 x 0.031	0.23 [5.75]	0.094 [2.4]	11 [42]	0.46 [2] 0.45 (0.45) [45 (45)]	0.63 [2.8] 1.1 (0.67*) [110 (67*)]	0.79 [3.5] 2.3 (0.67*) [230 (67*)]	1.1 [5.1] 3.2 (0.67*) [320 (67*)]
0.5x0.8-4.75-P4 0.02 x 0.031	0.23 [5.75]	0.13 [3.2]	8 [31]	0.46 [2] 0.34 (0.34) [34 (34)]	0.63 [2.8] 0.84 (0.75*) [84 (75*)]	0.79 [3.5] 1.7 (0.75*) [170 (75*)]	1.1 [5.1] 2.4 (0.75*) [240 (75*)]
0.5x0.8-6-P1 0.02 x 0.031	0.28 [7]	0.031 [0.8]	32 [120]	0.37 [1.6] 2.1 (0) [210 (0)]	0.51 [2.3] 5.2 (0) [520 (0)]	0.63 [2.8] 10 (0) [1000 (0)]	0.92 [4.1] 15 (0) [1500 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.8-6-P2 0.02 x 0.031	0.28 [7]	0.063 [1.6]	16 [62]	0.37 [1.6] 1 (0.5*) [100 (50*)]	0.51 [2.3] 2.6 (0.5*) [260 (50*)]	0.63 [2.8] 5.2 (0.5*) [520 (50*)]	0.92 [4.1] 7.3 (0.5*) [730 (50*)]
0.5x0.8-6-P3 0.02 x 0.031	0.28 [7]	0.094 [2.4]	11 [42]	0.37 [1.6] 0.69 (0.67*) [69 (67*)]	0.51 [2.3] 1.7 (0.67*) [170 (67*)]	0.63 [2.8] 3.5 (0.67*) [350 (67*)]	0.92 [4.1] 4.8 (0.67*) [480 (67*)]
0.5x0.8-6-P4 0.02 x 0.031	0.28 [7]	0.13 [3.2]	8 [31]	0.37 [1.6] 0.52 (0.52) [52 (52)]	0.51 [2.3] 1.3 (0.75*) [130 (75*)]	0.63 [2.8] 2.6 (0.75*) [260 (75*)]	0.92 [4.1] 3.6 (0.75*) [360 (75*)]
0.5x0.8-8-P1 0.02 x 0.031	0.35 [9]	0.031 [0.8]	32 [120]	0.28 [1.3] 3.5 (0) [350 (0)]	0.39 [1.7] 8.9 (0) [890 (0)]	0.49 [2.2] 18 (0) [1800 (0)]	0.71 [3.1] 25 (0) [2500 (0)]
0.5x0.8-8-P2 0.02 x 0.031	0.35 [9]	0.063 [1.6]	16 [62]	0.28 [1.3] 1.8 (0.5*) [180 (50*)]	0.39 [1.7] 4.4 (0.5*) [440 (50*)]	0.49 [2.2] 8.9 (0.5*) [890 (50*)]	0.71 [3.1] 12 (0.5*) [1200 (50*)]
0.5x0.8-8-P3 0.02 x 0.031	0.35 [9]	0.094 [2.4]	11 [42]	0.28 [1.3] 1.2 (0.67*) [120 (67*)]	0.39 [1.7] 3 (0.67*) [300 (67*)]	0.49 [2.2] 5.9 (0.67*) [590 (67*)]	0.71 [3.1] 8.3 (0.67*) [830 (67*)]
0.5x0.8-8-P4 0.02 x 0.031	0.35 [9]	0.13 [3.2]	8 [31]	0.28 [1.3] 0.89 (0.75*) [89 (75*)]	0.39 [1.7] 2.2 (0.75*) [220 (75*)]	0.49 [2.2] 4.4 (0.75*) [440 (75*)]	0.71 [3.1] 6.2 (0.75*) [620 (75*)]
0.5x0.8-9.5-P1 0.02 x 0.031	0.41 [10.5]	0.031 [0.8]	32 [120]	0.24 [1.1] 4.9 (0) [490 (0)]	0.33 [1.5] 12 (0) [1200 (0)]	0.41 [1.8] 25 (0) [2500 (0)]	0.6 [2.7] 34 (0) [3400 (0)]
0.5x0.8-9.5-P2 0.02 x 0.031	0.41 [10.5]	0.063 [1.6]	16 [62]	0.24 [1.1] 2.5 (0.5*) [250 (50*)]	0.33 [1.5] 6.1 (0.5*) [610 (50*)]	0.41 [1.8] 12 (0.5*) [1200 (50*)]	0.6 [2.7] 17 (0.5*) [1700 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.8-9.5-P3 0.02 x 0.031	0.41 [10.5]	0.094 [2.4]	11 [42]	0.24 [1.1] 1.6 (0.67*) [160 (67*)]	0.33 [1.5] 4.1 (0.67*) [410 (67*)]	0.41 [1.8] 8.2 (0.67*) [820 (67*)]	0.6 [2.7] 11 (0.67*) [1100 (67*)]
0.5x0.8-9.5-P4 0.02 x 0.031	0.41 [10.5]	0.13 [3.2]	8 [31]	0.24 [1.1] 1.2 (0.75*) [120 (75*)]	0.33 [1.5] 3.1 (0.75*) [310 (75*)]	0.41 [1.8] 6.1 (0.75*) [610 (75*)]	0.6 [2.7] 8.6 (0.75*) [860 (75*)]
0.5x0.8-12.7-P1 0.02 x 0.031	0.54 [13.7]	0.031 [0.8]	32 [120]	0.18 [0.81] 8.6 (0) [860 (0)]	0.25 [1.1] 21 (0) [2100 (0)]	0.31 [1.4] 43 (0) [4300 (0)]	0.45 [2] 60 (0) [6000 (0)]
0.5x0.8-12.7-P2 0.02 x 0.031	0.54 [13.7]	0.063 [1.6]	16 [62]	0.18 [0.81] 4.3 (0.5*) [430 (50*)]	0.25 [1.1] 11 (0.5*) [1100 (50*)]	0.31 [1.4] 21 (0.5*) [2100 (50*)]	0.45 [2] 30 (0.5*) [3000 (50*)]
0.5x0.8-12.7-P3 0.02 x 0.031	0.54 [13.7]	0.094 [2.4]	11 [42]	0.18 [0.81] 2.9 (0.67*) [290 (67*)]	0.25 [1.1] 7.1 (0.67*) [710 (67*)]	0.31 [1.4] 14 (0.67*) [1400 (67*)]	0.45 [2] 20 (0.67*) [2000 (67*)]
0.5x0.8-12.7-P4 0.02 x 0.031	0.54 [13.7]	0.13 [3.2]	8 [31]	0.18 [0.81] 2.1 (0.75*) [210 (75*)]	0.25 [1.1] 5.3 (0.75*) [530 (75*)]	0.31 [1.4] 11 (0.75*) [1100 (75*)]	0.45 [2] 15 (0.75*) [1500 (75*)]
0.5x0.8-14.2-P1 0.02 x 0.031	0.6 [15.2]	0.031 [0.8]	32 [120]	0.16 [0.73] 11 (0) [1100 (0)]	0.23 [1] 27 (0) [2700 (0)]	0.28 [1.2] 53 (0) [5300 (0)]	0.41 [1.8] 74 (0) [7400 (0)]
0.5x0.8-14.2-P2 0.02 x 0.031	0.6 [15.2]	0.063 [1.6]	16 [62]	0.16 [0.73] 5.3 (0.5*) [530 (50*)]	0.23 [1] 13 (0.5*) [1300 (50*)]	0.28 [1.2] 27 (0.5*) [2700 (50*)]	0.41 [1.8] 37 (0.5*) [3700 (50*)]
0.5x0.8-14.2-P3 0.02 x 0.031	0.6 [15.2]	0.094 [2.4]	11 [42]	0.16 [0.73] 3.5 (0.67*) [350 (67*)]	0.23 [1] 8.8 (0.67*) [880 (67*)]	0.28 [1.2] 18 (0.67*) [1800 (67*)]	0.41 [1.8] 25 (0.67*) [2500 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.8-14.2-P4 0.02 x 0.031	0.6 [15.2]	0.13 [3.2]	8 [31]	0.16 [0.73] 2.7 (0.75*) [270 (75*)]	0.23 [1] 6.6 (0.75*) [660 (75*)]	0.28 [1.2] 13 (0.75*) [1300 (75*)]	0.41 [1.8] 19 (0.75*) [1900 (75*)]
0.5x0.8-16-P1 0.02 x 0.031	0.67 [17]	0.031 [0.8]	32 [120]	0.15 [0.65] 13 (0) [1300 (0)]	0.2 [0.89] 33 (0) [3300 (0)]	0.25 [1.1] 67 (0) [6700 (0)]	0.36 [1.6] 94 (0) [9400 (0)]
0.5x0.8-16-P2 0.02 x 0.031	0.67 [17]	0.063 [1.6]	16 [62]	0.15 [0.65] 6.7 (0.5*) [670 (50*)]	0.2 [0.89] 17 (0.5*) [1700 (50*)]	0.25 [1.1] 33 (0.5*) [3300 (50*)]	0.36 [1.6] 47 (0.5*) [4700 (50*)]
0.5x0.8-16-P3 0.02 x 0.031	0.67 [17]	0.094 [2.4]	11 [42]	0.15 [0.65] 4.5 (0.67*) [450 (67*)]	0.2 [0.89] 11 (0.67*) [1100 (67*)]	0.25 [1.1] 22 (0.67*) [2200 (67*)]	0.36 [1.6] 31 (0.67*) [3100 (67*)]
0.5x0.8-16-P4 0.02 x 0.031	0.67 [17]	0.13 [3.2]	8 [31]	0.15 [0.65] 3.3 (0.75*) [330 (75*)]	0.2 [0.89] 8.4 (0.75*) [840 (75*)]	0.25 [1.1] 17 (0.75*) [1700 (75*)]	0.36 [1.6] 23 (0.75*) [2300 (75*)]
0.5x0.8-19-P1 0.02 x 0.031	0.79 [20]	0.031 [0.8]	32 [120]	0.12 [0.55] 19 (0) [1900 (0)]	0.17 [0.75] 47 (0) [4700 (0)]	0.21 [0.94] 93 (0) [9300 (0)]	0.31 [1.4] 130 (0) [13000 (0)]
0.5x0.8-19-P2 0.02 x 0.031	0.79 [20]	0.063 [1.6]	16 [62]	0.12 [0.55] 9.3 (0.5*) [930 (50*)]	0.17 [0.75] 23 (0.5*) [2300 (50*)]	0.21 [0.94] 47 (0.5*) [4700 (50*)]	0.31 [1.4] 65 (0.5*) [6500 (50*)]
0.5x0.8-19-P3 0.02 x 0.031	0.79 [20]	0.094 [2.4]	11 [42]	0.12 [0.55] 6.2 (0.67*) [620 (67*)]	0.17 [0.75] 16 (0.67*) [1600 (67*)]	0.21 [0.94] 31 (0.67*) [3100 (67*)]	0.31 [1.4] 44 (0.67*) [4400 (67*)]
0.5x0.8-19-P4 0.02 x 0.031	0.79 [20]	0.13 [3.2]	8 [31]	0.12 [0.55] 4.7 (0.75*) [470 (75*)]	0.17 [0.75] 12 (0.75*) [1200 (75*)]	0.21 [0.94] 23 (0.75*) [2300 (75*)]	0.31 [1.4] 33 (0.75*) [3300 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.8-22.2-P1 0.02 x 0.031	0.91 [23.2]	0.031 [0.8]	32 [120]	0.11 [0.47] 25 (0) [2500 (0)]	0.15 [0.65] 63 (0) [6300 (0)]	0.18 [0.81] 130 (0) [13000 (0)]	0.26 [1.2] 180 (0) [18000 (0)]
0.5x0.8-22.2-P2 0.02 x 0.031	0.91 [23.2]	0.063 [1.6]	16 [62]	0.11 [0.47] 13 (0.5*) [1300 (50*)]	0.15 [0.65] 32 (0.5*) [3200 (50*)]	0.18 [0.81] 63 (0.5*) [6300 (50*)]	0.26 [1.2] 89 (0.5*) [8900 (50*)]
0.5x0.8-22.2-P3 0.02 x 0.031	0.91 [23.2]	0.094 [2.4]	11 [42]	0.11 [0.47] 8.4 (0.67*) [840 (67*)]	0.15 [0.65] 21 (0.67*) [2100 (67*)]	0.18 [0.81] 42 (0.67*) [4200 (67*)]	0.26 [1.2] 59 (0.67*) [5900 (67*)]
0.5x0.8-22.2-P4 0.02 x 0.031	0.91 [23.2]	0.13 [3.2]	8 [31]	0.11 [0.47] 6.3 (0.75*) [630 (75*)]	0.15 [0.65] 16 (0.75*) [1600 (75*)]	0.18 [0.81] 32 (0.75*) [3200 (75*)]	0.26 [1.2] 44 (0.75*) [4400 (75*)]
0.5x0.8-25.4-P1 0.02 x 0.031	1 [26.4]	0.031 [0.8]	32 [120]	0.093 [0.41] 33 (0) [3300 (0)]	0.13 [0.57] 82 (0) [8200 (0)]	0.16 [0.71] 160 (0) [16000 (0)]	0.23 [1] 230 (0) [23000 (0)]
0.5x0.8-25.4-P2 0.02 x 0.031	1 [26.4]	0.063 [1.6]	16 [62]	0.093 [0.41] 16 (0.5*) [1600 (50*)]	0.13 [0.57] 41 (0.5*) [4100 (50*)]	0.16 [0.71] 82 (0.5*) [8200 (50*)]	0.23 [1] 120 (0.5*) [12000 (50*)]
0.5x0.8-25.4-P3 0.02 x 0.031	1 [26.4]	0.094 [2.4]	11 [42]	0.093 [0.41] 11 (0.67*) [1100 (67*)]	0.13 [0.57] 27 (0.67*) [2700 (67*)]	0.16 [0.71] 55 (0.67*) [5500 (67*)]	0.23 [1] 77 (0.67*) [7700 (67*)]
0.5x0.8-25.4-P4 0.02 x 0.031	1 [26.4]	0.13 [3.2]	8 [31]	0.093 [0.41] 8.2 (0.75*) [820 (75*)]	0.13 [0.57] 21 (0.75*) [2100 (75*)]	0.16 [0.71] 41 (0.75*) [4100 (75*)]	0.23 [1] 58 (0.75*) [5800 (75*)]
0.55x1.4-0.5-P1 0.022 x 0.055	0.063 [1.6]	0.055 [1.4]	18 [71]	7.7 [34] 0.018 (0) [1.8 (0)]	11 [47] 0.044 (0) [4.4 (0)]	13 [59] 0.088 (0) [8.8 (0)]	19 [86] 0.12 (0) [12 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.55x1.4-0.5-P2 0.022 x 0.055	0.063 [1.6]	0.11 [2.8]	9 [36]	7.7 [34] 0.0088 (0.0088) [0.88 (0.88)]	11 [47] 0.022 (0.022) [2.2 (2.2)]	13 [59] 0.044 (0.044) [4.4 (4.4)]	19 [86] 0.062 (0.062) [6.2 (6.2)]
0.55x1.4-0.5-P3 0.022 x 0.055	0.063 [1.6]	0.17 [4.2]	6 [24]	7.7 [34] 0.0059 (0.0059) [0.59 (0.59)]	11 [47] 0.015 (0.015) [1.5 (1.5)]	13 [59] 0.029 (0.029) [2.9 (2.9)]	19 [86] 0.041 (0.041) [4.1 (4.1)]
0.55x1.4-0.5-P4 0.022 x 0.055	0.063 [1.6]	0.22 [5.6]	4.5 [18]	7.7 [34] 0.0044 (0.0044) [0.44 (0.44)]	11 [47] 0.011 (0.011) [1.1 (1.1)]	13 [59] 0.022 (0.022) [2.2 (2.2)]	19 [86] 0.031 (0.031) [3.1 (3.1)]
0.55x1.4-0.9-P1 0.022 x 0.055	0.079 [2]	0.055 [1.4]	18 [71]	5.6 [25] 0.034 (0) [3.4 (0)]	7.7 [34] 0.085 (0) [8.5 (0)]	9.6 [43] 0.17 (0) [17 (0)]	14 [62] 0.24 (0) [24 (0)]
0.55x1.4-0.9-P2 0.022 x 0.055	0.079 [2]	0.11 [2.8]	9 [36]	5.6 [25] 0.017 (0.017) [1.7 (1.7)]	7.7 [34] 0.043 (0.043) [4.2 (4.2)]	9.6 [43] 0.085 (0.085) [8.5 (8.5)]	14 [62] 0.12 (0.12) [12 (12)]
0.55x1.4-0.9-P3 0.022 x 0.055	0.079 [2]	0.17 [4.2]	6 [24]	5.6 [25] 0.011 (0.011) [1.1 (1.1)]	7.7 [34] 0.028 (0.028) [2.8 (2.8)]	9.6 [43] 0.057 (0.057) [5.7 (5.7)]	14 [62] 0.079 (0.079) [7.9 (7.9)]
0.55x1.4-0.9-P4 0.022 x 0.055	0.079 [2]	0.22 [5.6]	4.5 [18]	5.6 [25] 0.0085 (0.0085) [0.85 (0.85)]	7.7 [34] 0.021 (0.021) [2.1 (2.1)]	9.6 [43] 0.043 (0.043) [4.2 (4.2)]	14 [62] 0.06 (0.06) [6 (6)]
0.55x1.4-1.15-P1 0.022 x 0.055	0.089 [2.25]	0.055 [1.4]	18 [71]	4.8 [21] 0.046 (0) [4.6 (0)]	6.6 [29] 0.12 (0) [12 (0)]	8.2 [36] 0.23 (0) [23 (0)]	12 [53] 0.32 (0) [32 (0)]
0.55x1.4-1.15-P2 0.022 x 0.055	0.089 [2.25]	0.11 [2.8]	9 [36]	4.8 [21] 0.023 (0.023) [2.3 (2.3)]	6.6 [29] 0.058 (0.058) [5.8 (5.8)]	8.2 [36] 0.12 (0.12) [12 (12)]	12 [53] 0.16 (0.16) [16 (16)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.55x1.4-1.15-P3 0.022 x 0.055	0.089 [2.25]	0.17 [4.2]	6 [24]	4.8 [21] 0.015 (0.015) [1.5 (1.5)]	6.6 [29] 0.038 (0.038) [3.8 (3.8)]	8.2 [36] 0.077 (0.077) [7.7 (7.7)]	12 [53] 0.11 (0.11) [11 (11)]
0.55x1.4-1.15-P4 0.022 x 0.055	0.089 [2.25]	0.22 [5.6]	4.5 [18]	4.8 [21] 0.011 (0.011) [1.1 (1.1)]	6.6 [29] 0.029 (0.029) [2.9 (2.9)]	8.2 [36] 0.058 (0.058) [5.8 (5.8)]	12 [53] 0.081 (0.081) [8.1 (8.1)]
0.55x1.4-1.6-P1 0.022 x 0.055	0.11 [2.7]	0.055 [1.4]	18 [71]	3.8 [17] 0.074 (0) [7.4 (0)]	5.2 [23] 0.18 (0) [18 (0)]	6.5 [29] 0.37 (0) [37 (0)]	9.4 [42] 0.52 (0) [52 (0)]
0.55x1.4-1.6-P2 0.022 x 0.055	0.11 [2.7]	0.11 [2.8]	9 [36]	3.8 [17] 0.037 (0.037) [3.7 (3.7)]	5.2 [23] 0.092 (0.092) [9.2 (9.2)]	6.5 [29] 0.18 (0.18) [18 (18)]	9.4 [42] 0.26 (0.26) [26 (26)]
0.55x1.4-1.6-P3 0.022 x 0.055	0.11 [2.7]	0.17 [4.2]	6 [24]	3.8 [17] 0.025 (0.025) [2.5 (2.5)]	5.2 [23] 0.062 (0.062) [6.2 (6.2)]	6.5 [29] 0.12 (0.12) [12 (12)]	9.4 [42] 0.17 (0.17) [17 (17)]
0.55x1.4-1.6-P4 0.022 x 0.055	0.11 [2.7]	0.22 [5.6]	4.5 [18]	3.8 [17] 0.018 (0.018) [1.8 (1.8)]	5.2 [23] 0.046 (0.046) [4.6 (4.6)]	6.5 [29] 0.092 (0.092) [9.2 (9.2)]	9.4 [42] 0.13 (0.13) [13 (13)]
0.55x1.4-2.4-P1 0.022 x 0.055	0.14 [3.5]	0.055 [1.4]	18 [71]	2.7 [12] 0.14 (0) [14 (0)]	3.8 [17] 0.35 (0) [35 (0)]	4.7 [21] 0.7 (0) [70 (0)]	6.8 [30] 0.98 (0) [98 (0)]
0.55x1.4-2.4-P2 0.022 x 0.055	0.14 [3.5]	0.11 [2.8]	9 [36]	2.7 [12] 0.07 (0.07) [7 (7)]	3.8 [17] 0.17 (0.17) [18 (18)]	4.7 [21] 0.35 (0.35) [35 (35)]	6.8 [30] 0.49 (0.49) [49 (49)]
0.55x1.4-2.4-P3 0.022 x 0.055	0.14 [3.5]	0.17 [4.2]	6 [24]	2.7 [12] 0.047 (0.047) [4.7 (4.7)]	3.8 [17] 0.12 (0.12) [12 (12)]	4.7 [21] 0.23 (0.23) [23 (23)]	6.8 [30] 0.33 (0.33) [33 (33)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.55x1.4-2.4-P4 0.022 x 0.055	0.14 [3.5]	0.22 [5.6]	4.5 [18]	2.7 [12] 0.035 (0.035) [3.5 (3.5)]	3.8 [17] 0.087 (0.087) [8.8 (8.8)]	4.7 [21] 0.17 (0.17) [18 (18)]	6.8 [30] 0.25 (0.25) [25 (25)]
0.55x1.4-3.2-P1 0.022 x 0.055	0.17 [4.3]	0.055 [1.4]	18 [71]	2.2 [9.6] 0.23 (0) [23 (0)]	3 [13] 0.56 (0) [56 (0)]	3.7 [16] 1.1 (0) [110 (0)]	5.4 [24] 1.6 (0) [160 (0)]
0.55x1.4-3.2-P2 0.022 x 0.055	0.17 [4.3]	0.11 [2.8]	9 [36]	2.2 [9.6] 0.11 (0.11) [11 (11)]	3 [13] 0.28 (0.28) [28 (28)]	3.7 [16] 0.56 (0.5*) [56 (50*)]	5.4 [24] 0.79 (0.5*) [79 (50*)]
0.55x1.4-3.2-P3 0.022 x 0.055	0.17 [4.3]	0.17 [4.2]	6 [24]	2.2 [9.6] 0.075 (0.075) [7.5 (7.5)]	3 [13] 0.19 (0.19) [19 (19)]	3.7 [16] 0.38 (0.38) [38 (38)]	5.4 [24] 0.53 (0.53) [53 (53)]
0.55x1.4-3.2-P4 0.022 x 0.055	0.17 [4.3]	0.22 [5.6]	4.5 [18]	2.2 [9.6] 0.056 (0.056) [5.6 (5.6)]	3 [13] 0.14 (0.14) [14 (14)]	3.7 [16] 0.28 (0.28) [28 (28)]	5.4 [24] 0.4 (0.4) [40 (40)]
0.55x1.4-4.75-P1 0.022 x 0.055	0.23 [5.85]	0.055 [1.4]	18 [71]	1.5 [6.8] 0.45 (0) [45 (0)]	2.1 [9.4] 1.1 (0) [110 (0)]	2.6 [12] 2.2 (0) [220 (0)]	3.8 [17] 3.2 (0) [320 (0)]
0.55x1.4-4.75-P2 0.022 x 0.055	0.23 [5.85]	0.11 [2.8]	9 [36]	1.5 [6.8] 0.22 (0.22) [22 (22)]	2.1 [9.4] 0.56 (0.5*) [56 (50*)]	2.6 [12] 1.1 (0.5*) [110 (50*)]	3.8 [17] 1.6 (0.5*) [160 (50*)]
0.55x1.4-4.75-P3 0.022 x 0.055	0.23 [5.85]	0.17 [4.2]	6 [24]	1.5 [6.8] 0.15 (0.15) [15 (15)]	2.1 [9.4] 0.38 (0.38) [38 (38)]	2.6 [12] 0.75 (0.67*) [75 (67*)]	3.8 [17] 1.1 (0.67*) [110 (67*)]
0.55x1.4-4.75-P4 0.022 x 0.055	0.23 [5.85]	0.22 [5.6]	4.5 [18]	1.5 [6.8] 0.11 (0.11) [11 (11)]	2.1 [9.4] 0.28 (0.28) [28 (28)]	2.6 [12] 0.56 (0.56) [56 (56)]	3.8 [17] 0.79 (0.75*) [79 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.55x1.4-6-P1 0.022 x 0.055	0.28 [7.1]	0.055 [1.4]	18 [71]	1.2 [5.5] 0.69 (0) [69 (0)]	1.7 [7.6] 1.7 (0) [170 (0)]	2.1 [9.4] 3.4 (0) [340 (0)]	3.1 [14] 4.8 (0) [480 (0)]
0.55x1.4-6-P2 0.022 x 0.055	0.28 [7.1]	0.11 [2.8]	9 [36]	1.2 [5.5] 0.34 (0.34) [34 (34)]	1.7 [7.6] 0.86 (0.5*) [86 (50*)]	2.1 [9.4] 1.7 (0.5*) [170 (50*)]	3.1 [14] 2.4 (0.5*) [240 (50*)]
0.55x1.4-6-P3 0.022 x 0.055	0.28 [7.1]	0.17 [4.2]	6 [24]	1.2 [5.5] 0.23 (0.23) [23 (23)]	1.7 [7.6] 0.57 (0.57) [57 (57)]	2.1 [9.4] 1.1 (0.67*) [110 (67*)]	3.1 [14] 1.6 (0.67*) [160 (67*)]
0.55x1.4-6-P4 0.022 x 0.055	0.28 [7.1]	0.22 [5.6]	4.5 [18]	1.2 [5.5] 0.17 (0.17) [17 (17)]	1.7 [7.6] 0.43 (0.43) [43 (43)]	2.1 [9.4] 0.86 (0.75*) [86 (75*)]	3.1 [14] 1.2 (0.75*) [120 (75*)]
0.55x1.4-8-P1 0.022 x 0.055	0.36 [9.1]	0.055 [1.4]	18 [71]	0.94 [4.2] 1.2 (0) [120 (0)]	1.3 [5.8] 2.9 (0) [290 (0)]	1.6 [7.2] 5.9 (0) [590 (0)]	2.4 [11] 8.2 (0) [820 (0)]
0.55x1.4-8-P2 0.022 x 0.055	0.36 [9.1]	0.11 [2.8]	9 [36]	0.94 [4.2] 0.59 (0.5*) [59 (50*)]	1.3 [5.8] 1.5 (0.5*) [150 (50*)]	1.6 [7.2] 2.9 (0.5*) [290 (50*)]	2.4 [11] 4.1 (0.5*) [410 (50*)]
0.55x1.4-8-P3 0.022 x 0.055	0.36 [9.1]	0.17 [4.2]	6 [24]	0.94 [4.2] 0.39 (0.39) [39 (39)]	1.3 [5.8] 0.98 (0.67*) [98 (67*)]	1.6 [7.2] 2 (0.67*) [200 (67*)]	2.4 [11] 2.7 (0.67*) [270 (67*)]
0.55x1.4-8-P4 0.022 x 0.055	0.36 [9.1]	0.22 [5.6]	4.5 [18]	0.94 [4.2] 0.29 (0.29) [29 (29)]	1.3 [5.8] 0.73 (0.73) [73 (73)]	1.6 [7.2] 1.5 (0.75*) [150 (75*)]	2.4 [11] 2.1 (0.75*) [210 (75*)]
0.55x1.4-9.5-P1 0.022 x 0.055	0.42 [10.6]	0.055 [1.4]	18 [71]	0.8 [3.6] 1.6 (0) [160 (0)]	1.1 [4.9] 4 (0) [400 (0)]	1.4 [6.1] 8.1 (0) [810 (0)]	2 [8.9] 11 (0) [1100 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.55x1.4-9.5-P2 0.022 x 0.055	0.42 [10.6]	0.11 [2.8]	9 [36]	0.8 [3.6] 0.81 (0.5*) [81 (50*)]	1.1 [4.9] 2 (0.5*) [200 (50*)]	1.4 [6.1] 4 (0.5*) [400 (50*)]	2 [8.9] 5.7 (0.5*) [570 (50*)]
0.55x1.4-9.5-P3 0.022 x 0.055	0.42 [10.6]	0.17 [4.2]	6 [24]	0.8 [3.6] 0.54 (0.54) [54 (54)]	1.1 [4.9] 1.4 (0.67*) [140 (67*)]	1.4 [6.1] 2.7 (0.67*) [270 (67*)]	2 [8.9] 3.8 (0.67*) [380 (67*)]
0.55x1.4-9.5-P4 0.022 x 0.055	0.42 [10.6]	0.22 [5.6]	4.5 [18]	0.8 [3.6] 0.41 (0.41) [40 (40)]	1.1 [4.9] 1 (0.75*) [100 (75*)]	1.4 [6.1] 2 (0.75*) [200 (75*)]	2 [8.9] 2.8 (0.75*) [280 (75*)]
0.55x1.4-12.7-P1 0.022 x 0.055	0.54 [13.8]	0.055 [1.4]	18 [71]	0.61 [2.7] 2.8 (0) [280 (0)]	0.84 [3.7] 7 (0) [700 (0)]	1 [4.7] 14 (0) [1400 (0)]	1.5 [6.8] 20 (0) [2000 (0)]
0.55x1.4-12.7-P2 0.022 x 0.055	0.54 [13.8]	0.11 [2.8]	9 [36]	0.61 [2.7] 1.4 (0.5*) [140 (50*)]	0.84 [3.7] 3.5 (0.5*) [350 (50*)]	1 [4.7] 7 (0.5*) [700 (50*)]	1.5 [6.8] 9.8 (0.5*) [980 (50*)]
0.55x1.4-12.7-P3 0.022 x 0.055	0.54 [13.8]	0.17 [4.2]	6 [24]	0.61 [2.7] 0.94 (0.67*) [94 (67*)]	0.84 [3.7] 2.3 (0.67*) [230 (67*)]	1 [4.7] 4.7 (0.67*) [470 (67*)]	1.5 [6.8] 6.6 (0.67*) [660 (67*)]
0.55x1.4-12.7-P4 0.022 x 0.055	0.54 [13.8]	0.22 [5.6]	4.5 [18]	0.61 [2.7] 0.7 (0.7) [70 (70)]	0.84 [3.7] 1.8 (0.75*) [180 (75*)]	1 [4.7] 3.5 (0.75*) [350 (75*)]	1.5 [6.8] 4.9 (0.75*) [490 (75*)]
0.55x1.4-14.2-P1 0.022 x 0.055	0.6 [15.3]	0.055 [1.4]	18 [71]	0.55 [2.4] 3.5 (0) [350 (0)]	0.76 [3.4] 8.7 (0) [870 (0)]	0.94 [4.2] 17 (0) [1700 (0)]	1.4 [6.1] 24 (0) [2400 (0)]
0.55x1.4-14.2-P2 0.022 x 0.055	0.6 [15.3]	0.11 [2.8]	9 [36]	0.55 [2.4] 1.7 (0.5*) [170 (50*)]	0.76 [3.4] 4.4 (0.5*) [440 (50*)]	0.94 [4.2] 8.7 (0.5*) [870 (50*)]	1.4 [6.1] 12 (0.5*) [1200 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.55x1.4-14.2-P3 0.022 x 0.055	0.6 [15.3]	0.17 [4.2]	6 [24]	0.55 [2.4] 1.2 (0.67*) [120 (67*)]	0.76 [3.4] 2.9 (0.67*) [290 (67*)]	0.94 [4.2] 5.8 (0.67*) [580 (67*)]	1.4 [6.1] 8.1 (0.67*) [810 (67*)]
0.55x1.4-14.2-P4 0.022 x 0.055	0.6 [15.3]	0.22 [5.6]	4.5 [18]	0.55 [2.4] 0.87 (0.75*) [87 (75*)]	0.76 [3.4] 2.2 (0.75*) [220 (75*)]	0.94 [4.2] 4.4 (0.75*) [440 (75*)]	1.4 [6.1] 6.1 (0.75*) [610 (75*)]
0.55x1.4-16-P1 0.022 x 0.055	0.67 [17.1]	0.055 [1.4]	18 [71]	0.49 [2.2] 4.4 (0) [440 (0)]	0.67 [3] 11 (0) [1100 (0)]	0.84 [3.7] 22 (0) [2200 (0)]	1.2 [5.4] 31 (0) [3100 (0)]
0.55x1.4-16-P2 0.022 x 0.055	0.67 [17.1]	0.11 [2.8]	9 [36]	0.49 [2.2] 2.2 (0.5*) [220 (50*)]	0.67 [3] 5.5 (0.5*) [550 (50*)]	0.84 [3.7] 11 (0.5*) [1100 (50*)]	1.2 [5.4] 15 (0.5*) [1500 (50*)]
0.55x1.4-16-P3 0.022 x 0.055	0.67 [17.1]	0.17 [4.2]	6 [24]	0.49 [2.2] 1.5 (0.67*) [150 (67*)]	0.67 [3] 3.7 (0.67*) [370 (67*)]	0.84 [3.7] 7.3 (0.67*) [730 (67*)]	1.2 [5.4] 10 (0.67*) [1000 (67*)]
0.55x1.4-16-P4 0.022 x 0.055	0.67 [17.1]	0.22 [5.6]	4.5 [18]	0.49 [2.2] 1.1 (0.75*) [110 (75*)]	0.67 [3] 2.7 (0.75*) [270 (75*)]	0.84 [3.7] 5.5 (0.75*) [550 (75*)]	1.2 [5.4] 7.7 (0.75*) [770 (75*)]
0.55x1.4-19-P1 0.022 x 0.055	0.79 [20.1]	0.055 [1.4]	18 [71]	0.41 [1.8] 6.1 (0) [610 (0)]	0.57 [2.5] 15 (0) [1500 (0)]	0.71 [3.2] 31 (0) [3100 (0)]	1 [4.6] 43 (0) [4300 (0)]
0.55x1.4-19-P2 0.022 x 0.055	0.79 [20.1]	0.11 [2.8]	9 [36]	0.41 [1.8] 3.1 (0.5*) [310 (50*)]	0.57 [2.5] 7.7 (0.5*) [770 (50*)]	0.71 [3.2] 15 (0.5*) [1500 (50*)]	1 [4.6] 21 (0.5*) [2100 (50*)]
0.55x1.4-19-P3 0.022 x 0.055	0.79 [20.1]	0.17 [4.2]	6 [24]	0.41 [1.8] 2 (0.67*) [200 (67*)]	0.57 [2.5] 5.1 (0.67*) [510 (67*)]	0.71 [3.2] 10 (0.67*) [1000 (67*)]	1 [4.6] 14 (0.67*) [1400 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.55x1.4-19-P4 0.022 x 0.055	0.79 [20.1]	0.22 [5.6]	4.5 [18]	0.41 [1.8] 1.5 (0.75*) [150 (75*)]	0.57 [2.5] 3.8 (0.75*) [380 (75*)]	0.71 [3.2] 7.7 (0.75*) [770 (75*)]	1 [4.6] 11 (0.75*) [1100 (75*)]
0.55x1.4-22.2-P1 0.022 x 0.055	0.92 [23.3]	0.055 [1.4]	18 [71]	0.36 [1.6] 8.3 (0) [830 (0)]	0.49 [2.2] 21 (0) [2100 (0)]	0.61 [2.7] 41 (0) [4100 (0)]	0.89 [3.9] 58 (0) [5800 (0)]
0.55x1.4-22.2-P2 0.022 x 0.055	0.92 [23.3]	0.11 [2.8]	9 [36]	0.36 [1.6] 4.1 (0.5*) [410 (50*)]	0.49 [2.2] 10 (0.5*) [1000 (50*)]	0.61 [2.7] 21 (0.5*) [2100 (50*)]	0.89 [3.9] 29 (0.5*) [2900 (50*)]
0.55x1.4-22.2-P3 0.022 x 0.055	0.92 [23.3]	0.17 [4.2]	6 [24]	0.36 [1.6] 2.8 (0.67*) [280 (67*)]	0.49 [2.2] 6.9 (0.67*) [690 (67*)]	0.61 [2.7] 14 (0.67*) [1400 (67*)]	0.89 [3.9] 19 (0.67*) [1900 (67*)]
0.55x1.4-22.2-P4 0.022 x 0.055	0.92 [23.3]	0.22 [5.6]	4.5 [18]	0.36 [1.6] 2.1 (0.75*) [210 (75*)]	0.49 [2.2] 5.2 (0.75*) [520 (75*)]	0.61 [2.7] 10 (0.75*) [1000 (75*)]	0.89 [3.9] 15 (0.75*) [1500 (75*)]
0.55x1.4-25.4-P1 0.022 x 0.055	1 [26.5]	0.055 [1.4]	18 [71]	0.31 [1.4] 11 (0) [1100 (0)]	0.43 [1.9] 27 (0) [2700 (0)]	0.54 [2.4] 54 (0) [5400 (0)]	0.78 [3.5] 76 (0) [7600 (0)]
0.55x1.4-25.4-P2 0.022 x 0.055	1 [26.5]	0.11 [2.8]	9 [36]	0.31 [1.4] 5.4 (0.5*) [540 (50*)]	0.43 [1.9] 13 (0.5*) [1300 (50*)]	0.54 [2.4] 27 (0.5*) [2700 (50*)]	0.78 [3.5] 38 (0.5*) [3800 (50*)]
0.55x1.4-25.4-P3 0.022 x 0.055	1 [26.5]	0.17 [4.2]	6 [24]	0.31 [1.4] 3.6 (0.67*) [360 (67*)]	0.43 [1.9] 9 (0.67*) [900 (67*)]	0.54 [2.4] 18 (0.67*) [1800 (67*)]	0.78 [3.5] 25 (0.67*) [2500 (67*)]
0.55x1.4-25.4-P4 0.022 x 0.055	1 [26.5]	0.22 [5.6]	4.5 [18]	0.31 [1.4] 2.7 (0.75*) [270 (75*)]	0.43 [1.9] 6.7 (0.75*) [670 (75*)]	0.54 [2.4] 13 (0.75*) [1300 (75*)]	0.78 [3.5] 19 (0.75*) [1900 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.6x2.3-0.5-P1 0.024 x 0.091	0.067 [1.7]	0.091 [2.3]	11 [44]	22 [96] 0.0072 (0) [0.72 (0)]	30 [130] 0.018 (0) [1.8 (0)]	37 [160] 0.036 (0) [3.6 (0)]	54 [240] 0.05 (0) [5 (0)]
0.6x2.3-0.5-P2 0.024 x 0.091	0.067 [1.7]	0.18 [4.6]	5.5 [22]	22 [96] 0.0036 (0.0036) [0.36 (0.36)]	30 [130] 0.009 (0.009) [0.9 (0.9)]	37 [160] 0.018 (0.018) [1.8 (1.8)]	54 [240] 0.025 (0.025) [2.5 (2.5)]
0.6x2.3-0.5-P3 0.024 x 0.091	0.067 [1.7]	0.27 [6.9]	3.7 [15]	22 [96] 0.0024 (0.0024) [0.24 (0.24)]	30 [130] 0.006 (0.006) [0.6 (0.6)]	37 [160] 0.012 (0.012) [1.2 (1.2)]	54 [240] 0.017 (0.017) [1.7 (1.7)]
0.6x2.3-0.5-P4 0.024 x 0.091	0.067 [1.7]	0.36 [9.2]	2.8 [11]	22 [96] 0.0018 (0.0018) [0.18 (0.18)]	30 [130] 0.0045 (0.0045) [0.45 (0.45)]	37 [160] 0.009 (0.009) [0.9 (0.9)]	54 [240] 0.013 (0.013) [1.3 (1.3)]
0.6x2.3-0.9-P1 0.024 x 0.091	0.083 [2.1]	0.091 [2.3]	11 [44]	16 [71] 0.013 (0) [1.3 (0)]	22 [97] 0.034 (0) [3.4 (0)]	27 [120] 0.067 (0) [6.7 (0)]	40 [180] 0.094 (0) [9.4 (0)]
0.6x2.3-0.9-P2 0.024 x 0.091	0.083 [2.1]	0.18 [4.6]	5.5 [22]	16 [71] 0.0067 (0.0067) [0.67 (0.67)]	22 [97] 0.017 (0.017) [1.7 (1.7)]	27 [120] 0.034 (0.034) [3.4 (3.4)]	40 [180] 0.047 (0.047) [4.7 (4.7)]
0.6x2.3-0.9-P3 0.024 x 0.091	0.083 [2.1]	0.27 [6.9]	3.7 [15]	16 [71] 0.0045 (0.0045) [0.45 (0.45)]	22 [97] 0.011 (0.011) [1.1 (1.1)]	27 [120] 0.022 (0.022) [2.2 (2.2)]	40 [180] 0.031 (0.031) [3.1 (3.1)]
0.6x2.3-0.9-P4 0.024 x 0.091	0.083 [2.1]	0.36 [9.2]	2.8 [11]	16 [71] 0.0033 (0.0033) [0.33 (0.33)]	22 [97] 0.0084 (0.0084) [0.84 (0.84)]	27 [120] 0.017 (0.017) [1.7 (1.7)]	40 [180] 0.023 (0.023) [2.3 (2.3)]
0.6x2.3-1.15-P1 0.024 x 0.091	0.093 [2.35]	0.091 [2.3]	11 [44]	14 [60] 0.018 (0) [1.8 (0)]	19 [83] 0.045 (0) [4.5 (0)]	23 [100] 0.091 (0) [9.1 (0)]	34 [150] 0.13 (0) [13 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.6x2.3-1.15-P2 0.024 x 0.091	0.093 [2.35]	0.18 [4.6]	5.5 [22]	14 [60] 0.0091 (0.0091) [0.91 (0.91)]	19 [83] 0.023 (0.023) [2.3 (2.3)]	23 [100] 0.045 (0.045) [4.5 (4.5)]	34 [150] 0.064 (0.064) [6.4 (6.4)]
0.6x2.3-1.15-P3 0.024 x 0.091	0.093 [2.35]	0.27 [6.9]	3.7 [15]	14 [60] 0.0061 (0.0061) [0.61 (0.61)]	19 [83] 0.015 (0.015) [1.5 (1.5)]	23 [100] 0.03 (0.03) [3 (3)]	34 [150] 0.042 (0.042) [4.2 (4.2)]
0.6x2.3-1.15-P4 0.024 x 0.091	0.093 [2.35]	0.36 [9.2]	2.8 [11]	14 [60] 0.0045 (0.0045) [0.45 (0.45)]	19 [83] 0.011 (0.011) [1.1 (1.1)]	23 [100] 0.023 (0.023) [2.3 (2.3)]	34 [150] 0.032 (0.032) [3.2 (3.2)]
0.6x2.3-1.6-P1 0.024 x 0.091	0.11 [2.8]	0.091 [2.3]	11 [44]	11 [48] 0.028 (0) [2.8 (0)]	15 [66] 0.07 (0) [7 (0)]	19 [83] 0.14 (0) [14 (0)]	27 [120] 0.2 (0) [20 (0)]
0.6x2.3-1.6-P2 0.024 x 0.091	0.11 [2.8]	0.18 [4.6]	5.5 [22]	11 [48] 0.014 (0.014) [1.4 (1.4)]	15 [66] 0.035 (0.035) [3.5 (3.5)]	19 [83] 0.07 (0.07) [7 (7)]	27 [120] 0.098 (0.098) [9.8 (9.8)]
0.6x2.3-1.6-P3 0.024 x 0.091	0.11 [2.8]	0.27 [6.9]	3.7 [15]	11 [48] 0.0093 (0.0093) [0.93 (0.93)]	15 [66] 0.023 (0.023) [2.3 (2.3)]	19 [83] 0.047 (0.047) [4.7 (4.7)]	27 [120] 0.065 (0.065) [6.5 (6.5)]
0.6x2.3-1.6-P4 0.024 x 0.091	0.11 [2.8]	0.36 [9.2]	2.8 [11]	11 [48] 0.007 (0.007) [0.7 (0.7)]	15 [66] 0.018 (0.018) [1.8 (1.8)]	19 [83] 0.035 (0.035) [3.5 (3.5)]	27 [120] 0.049 (0.049) [4.9 (4.9)]
0.6x2.3-2.4-P1 0.024 x 0.091	0.14 [3.6]	0.091 [2.3]	11 [44]	7.9 [35] 0.054 (0) [5.4 (0)]	11 [49] 0.14 (0) [14 (0)]	14 [61] 0.27 (0) [27 (0)]	20 [88] 0.38 (0) [38 (0)]
0.6x2.3-2.4-P2 0.024 x 0.091	0.14 [3.6]	0.18 [4.6]	5.5 [22]	7.9 [35] 0.027 (0.027) [2.7 (2.7)]	11 [49] 0.068 (0.068) [6.8 (6.8)]	14 [61] 0.14 (0.14) [14 (14)]	20 [88] 0.19 (0.19) [19 (19)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.6x2.3-2.4-P3 0.024 x 0.091	0.14 [3.6]	0.27 [6.9]	3.7 [15]	7.9 [35] 0.018 (0.018) [1.8 (1.8)]	11 [49] 0.045 (0.045) [4.5 (4.5)]	14 [61] 0.09 (0.09) [9 (9)]	20 [88] 0.13 (0.13) [13 (13)]
0.6x2.3-2.4-P4 0.024 x 0.091	0.14 [3.6]	0.36 [9.2]	2.8 [11]	7.9 [35] 0.013 (0.013) [1.3 (1.3)]	11 [49] 0.034 (0.034) [3.4 (3.4)]	14 [61] 0.068 (0.068) [6.8 (6.8)]	20 [88] 0.095 (0.095) [9.5 (9.5)]
0.6x2.3-3.2-P1 0.024 x 0.091	0.17 [4.4]	0.091 [2.3]	11 [44]	6.3 [28] 0.086 (0) [8.6 (0)]	8.6 [38] 0.21 (0) [22 (0)]	11 [48] 0.43 (0) [43 (0)]	16 [70] 0.6 (0) [60 (0)]
0.6x2.3-3.2-P2 0.024 x 0.091	0.17 [4.4]	0.18 [4.6]	5.5 [22]	6.3 [28] 0.043 (0.043) [4.3 (4.3)]	8.6 [38] 0.11 (0.11) [11 (11)]	11 [48] 0.21 (0.21) [22 (22)]	16 [70] 0.3 (0.3) [30 (30)]
0.6x2.3-3.2-P3 0.024 x 0.091	0.17 [4.4]	0.27 [6.9]	3.7 [15]	6.3 [28] 0.029 (0.029) [2.9 (2.9)]	8.6 [38] 0.072 (0.072) [7.2 (7.2)]	11 [48] 0.14 (0.14) [14 (14)]	16 [70] 0.2 (0.2) [20 (20)]
0.6x2.3-3.2-P4 0.024 x 0.091	0.17 [4.4]	0.36 [9.2]	2.8 [11]	6.3 [28] 0.021 (0.021) [2.1 (2.1)]	8.6 [38] 0.054 (0.054) [5.4 (5.4)]	11 [48] 0.11 (0.11) [11 (11)]	16 [70] 0.15 (0.15) [15 (15)]
0.6x2.3-4.75-P1 0.024 x 0.091	0.23 [5.95]	0.091 [2.3]	11 [44]	4.4 [20] 0.17 (0) [17 (0)]	6.1 [27] 0.42 (0) [42 (0)]	7.6 [34] 0.85 (0) [85 (0)]	11 [49] 1.2 (0) [120 (0)]
0.6x2.3-4.75-P2 0.024 x 0.091	0.23 [5.95]	0.18 [4.6]	5.5 [22]	4.4 [20] 0.085 (0.085) [8.5 (8.5)]	6.1 [27] 0.21 (0.21) [21 (21)]	7.6 [34] 0.42 (0.42) [42 (42)]	11 [49] 0.6 (0.5*) [60 (50*)]
0.6x2.3-4.75-P3 0.024 x 0.091	0.23 [5.95]	0.27 [6.9]	3.7 [15]	4.4 [20] 0.057 (0.057) [5.7 (5.7)]	6.1 [27] 0.14 (0.14) [14 (14)]	7.6 [34] 0.28 (0.28) [28 (28)]	11 [49] 0.4 (0.4) [40 (40)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.6x2.3-4.75-P4 0.024 x 0.091	0.23 [5.95]	0.36 [9.2]	2.8 [11]	4.4 [20] 0.043 (0.043) [4.2 (4.2)]	6.1 [27] 0.11 (0.11) [11 (11)]	7.6 [34] 0.21 (0.21) [21 (21)]	11 [49] 0.3 (0.3) [30 (30)]
0.6x2.3-6-P1 0.024 x 0.091	0.28 [7.2]	0.091 [2.3]	11 [44]	3.6 [16] 0.26 (0) [26 (0)]	5 [22] 0.65 (0) [64 (0)]	6.2 [28] 1.3 (0) [130 (0)]	9 [40] 1.8 (0) [180 (0)]
0.6x2.3-6-P2 0.024 x 0.091	0.28 [7.2]	0.18 [4.6]	5.5 [22]	3.6 [16] 0.13 (0.13) [13 (13)]	5 [22] 0.32 (0.32) [32 (32)]	6.2 [28] 0.65 (0.5*) [64 (50*)]	9 [40] 0.9 (0.5*) [90 (50*)]
0.6x2.3-6-P3 0.024 x 0.091	0.28 [7.2]	0.27 [6.9]	3.7 [15]	3.6 [16] 0.086 (0.086) [8.6 (8.6)]	5 [22] 0.21 (0.21) [22 (22)]	6.2 [28] 0.43 (0.43) [43 (43)]	9 [40] 0.6 (0.6) [60 (60)]
0.6x2.3-6-P4 0.024 x 0.091	0.28 [7.2]	0.36 [9.2]	2.8 [11]	3.6 [16] 0.064 (0.064) [6.4 (6.4)]	5 [22] 0.16 (0.16) [16 (16)]	6.2 [28] 0.32 (0.32) [32 (32)]	9 [40] 0.45 (0.45) [45 (45)]
0.6x2.3-8-P1 0.024 x 0.091	0.36 [9.2]	0.091 [2.3]	11 [44]	2.8 [12] 0.44 (0) [44 (0)]	3.8 [17] 1.1 (0) [110 (0)]	4.8 [21] 2.2 (0) [220 (0)]	6.9 [31] 3.1 (0) [310 (0)]
0.6x2.3-8-P2 0.024 x 0.091	0.36 [9.2]	0.18 [4.6]	5.5 [22]	2.8 [12] 0.22 (0.22) [22 (22)]	3.8 [17] 0.55 (0.5*) [55 (50*)]	4.8 [21] 1.1 (0.5*) [110 (50*)]	6.9 [31] 1.5 (0.5*) [150 (50*)]
0.6x2.3-8-P3 0.024 x 0.091	0.36 [9.2]	0.27 [6.9]	3.7 [15]	2.8 [12] 0.15 (0.15) [15 (15)]	3.8 [17] 0.37 (0.37) [37 (37)]	4.8 [21] 0.73 (0.67*) [73 (67*)]	6.9 [31] 1 (0.67*) [100 (67*)]
0.6x2.3-8-P4 0.024 x 0.091	0.36 [9.2]	0.36 [9.2]	2.8 [11]	2.8 [12] 0.11 (0.11) [11 (11)]	3.8 [17] 0.28 (0.28) [28 (28)]	4.8 [21] 0.55 (0.55) [55 (55)]	6.9 [31] 0.77 (0.75*) [77 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.6x2.3-9.5-P1 0.024 x 0.091	0.42 [10.7]	0.091 [2.3]	11 [44]	2.4 [10] 0.61 (0) [61 (0)]	3.2 [14] 1.5 (0) [150 (0)]	4.1 [18] 3 (0) [300 (0)]	5.9 [26] 4.2 (0) [420 (0)]
0.6x2.3-9.5-P2 0.024 x 0.091	0.42 [10.7]	0.18 [4.6]	5.5 [22]	2.4 [10] 0.3 (0.3) [30 (30)]	3.2 [14] 0.76 (0.5*) [76 (50*)]	4.1 [18] 1.5 (0.5*) [150 (50*)]	5.9 [26] 2.1 (0.5*) [210 (50*)]
0.6x2.3-9.5-P3 0.024 x 0.091	0.42 [10.7]	0.27 [6.9]	3.7 [15]	2.4 [10] 0.2 (0.2) [20 (20)]	3.2 [14] 0.51 (0.51) [50 (50)]	4.1 [18] 1 (0.67*) [100 (67*)]	5.9 [26] 1.4 (0.67*) [140 (67*)]
0.6x2.3-9.5-P4 0.024 x 0.091	0.42 [10.7]	0.36 [9.2]	2.8 [11]	2.4 [10] 0.15 (0.15) [15 (15)]	3.2 [14] 0.38 (0.38) [38 (38)]	4.1 [18] 0.76 (0.75*) [76 (75*)]	5.9 [26] 1.1 (0.75*) [110 (75*)]
0.6x2.3-12.7-P1 0.024 x 0.091	0.55 [13.9]	0.091 [2.3]	11 [44]	1.8 [8] 1 (0) [100 (0)]	2.5 [11] 2.6 (0) [260 (0)]	3.1 [14] 5.2 (0) [520 (0)]	4.5 [20] 7.4 (0) [740 (0)]
0.6x2.3-12.7-P2 0.024 x 0.091	0.55 [13.9]	0.18 [4.6]	5.5 [22]	1.8 [8] 0.52 (0.5*) [52 (50*)]	2.5 [11] 1.3 (0.5*) [130 (50*)]	3.1 [14] 2.6 (0.5*) [260 (50*)]	4.5 [20] 3.7 (0.5*) [370 (50*)]
0.6x2.3-12.7-P3 0.024 x 0.091	0.55 [13.9]	0.27 [6.9]	3.7 [15]	1.8 [8] 0.35 (0.35) [35 (35)]	2.5 [11] 0.88 (0.67*) [88 (67*)]	3.1 [14] 1.8 (0.67*) [180 (67*)]	4.5 [20] 2.5 (0.67*) [250 (67*)]
0.6x2.3-12.7-P4 0.024 x 0.091	0.55 [13.9]	0.36 [9.2]	2.8 [11]	1.8 [8] 0.26 (0.26) [26 (26)]	2.5 [11] 0.66 (0.66) [66 (66)]	3.1 [14] 1.3 (0.75*) [130 (75*)]	4.5 [20] 1.8 (0.75*) [180 (75*)]
0.6x2.3-14.2-P1 0.024 x 0.091	0.61 [15.4]	0.091 [2.3]	11 [44]	1.6 [7.1] 1.3 (0) [130 (0)]	2.2 [9.9] 3.2 (0) [320 (0)]	2.8 [12] 6.5 (0) [650 (0)]	4 [18] 9.1 (0) [910 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.6x2.3-14.2-P2 0.024 x 0.091	0.61 [15.4]	0.18 [4.6]	5.5 [22]	1.6 [7.1] 0.65 (0.5*) [65 (50*)]	2.2 [9.9] 1.6 (0.5*) [160 (50*)]	2.8 [12] 3.2 (0.5*) [320 (50*)]	4 [18] 4.6 (0.5*) [460 (50*)]
0.6x2.3-14.2-P3 0.024 x 0.091	0.61 [15.4]	0.27 [6.9]	3.7 [15]	1.6 [7.1] 0.43 (0.43) [43 (43)]	2.2 [9.9] 1.1 (0.67*) [110 (67*)]	2.8 [12] 2.2 (0.67*) [220 (67*)]	4 [18] 3 (0.67*) [300 (67*)]
0.6x2.3-14.2-P4 0.024 x 0.091	0.61 [15.4]	0.36 [9.2]	2.8 [11]	1.6 [7.1] 0.33 (0.33) [32 (32)]	2.2 [9.9] 0.81 (0.75*) [81 (75*)]	2.8 [12] 1.6 (0.75*) [160 (75*)]	4 [18] 2.3 (0.75*) [230 (75*)]
0.6x2.3-16-P1 0.024 x 0.091	0.68 [17.2]	0.091 [2.3]	11 [44]	1.4 [6.4] 1.6 (0) [160 (0)]	2 [8.8] 4.1 (0) [410 (0)]	2.5 [11] 8.2 (0) [820 (0)]	3.6 [16] 11 (0) [1100 (0)]
0.6x2.3-16-P2 0.024 x 0.091	0.68 [17.2]	0.18 [4.6]	5.5 [22]	1.4 [6.4] 0.82 (0.5*) [82 (50*)]	2 [8.8] 2 (0.5*) [200 (50*)]	2.5 [11] 4.1 (0.5*) [410 (50*)]	3.6 [16] 5.7 (0.5*) [570 (50*)]
0.6x2.3-16-P3 0.024 x 0.091	0.68 [17.2]	0.27 [6.9]	3.7 [15]	1.4 [6.4] 0.55 (0.55) [55 (55)]	2 [8.8] 1.4 (0.67*) [140 (67*)]	2.5 [11] 2.7 (0.67*) [270 (67*)]	3.6 [16] 3.8 (0.67*) [380 (67*)]
0.6x2.3-16-P4 0.024 x 0.091	0.68 [17.2]	0.36 [9.2]	2.8 [11]	1.4 [6.4] 0.41 (0.41) [41 (41)]	2 [8.8] 1 (0.75*) [100 (75*)]	2.5 [11] 2 (0.75*) [200 (75*)]	3.6 [16] 2.9 (0.75*) [290 (75*)]
0.6x2.3-19-P1 0.024 x 0.091	0.8 [20.2]	0.091 [2.3]	11 [44]	1.2 [5.4] 2.3 (0) [230 (0)]	1.7 [7.4] 5.7 (0) [570 (0)]	2.1 [9.3] 11 (0) [1100 (0)]	3 [13] 16 (0) [1600 (0)]
0.6x2.3-19-P2 0.024 x 0.091	0.8 [20.2]	0.18 [4.6]	5.5 [22]	1.2 [5.4] 1.1 (0.5*) [110 (50*)]	1.7 [7.4] 2.9 (0.5*) [290 (50*)]	2.1 [9.3] 5.7 (0.5*) [570 (50*)]	3 [13] 8 (0.5*) [800 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.6x2.3-19-P3 0.024 x 0.091	0.8 [20.2]	0.27 [6.9]	3.7 [15]	1.2 [5.4] 0.76 (0.67*) [76 (67*)]	1.7 [7.4] 1.9 (0.67*) [190 (67*)]	2.1 [9.3] 3.8 (0.67*) [380 (67*)]	3 [13] 5.3 (0.67*) [530 (67*)]
0.6x2.3-19-P4 0.024 x 0.091	0.8 [20.2]	0.36 [9.2]	2.8 [11]	1.2 [5.4] 0.57 (0.57) [57 (57)]	1.7 [7.4] 1.4 (0.75*) [140 (75*)]	2.1 [9.3] 2.9 (0.75*) [290 (75*)]	3 [13] 4 (0.75*) [400 (75*)]
0.6x2.3-22.2-P1 0.024 x 0.091	0.92 [23.4]	0.091 [2.3]	11 [44]	1 [4.6] 3.1 (0) [310 (0)]	1.4 [6.4] 7.7 (0) [770 (0)]	1.8 [8] 15 (0) [1500 (0)]	2.6 [12] 22 (0) [2200 (0)]
0.6x2.3-22.2-P2 0.024 x 0.091	0.92 [23.4]	0.18 [4.6]	5.5 [22]	1 [4.6] 1.5 (0.5*) [150 (50*)]	1.4 [6.4] 3.9 (0.5*) [390 (50*)]	1.8 [8] 7.7 (0.5*) [770 (50*)]	2.6 [12] 11 (0.5*) [1100 (50*)]
0.6x2.3-22.2-P3 0.024 x 0.091	0.92 [23.4]	0.27 [6.9]	3.7 [15]	1 [4.6] 1 (0.67*) [100 (67*)]	1.4 [6.4] 2.6 (0.67*) [260 (67*)]	1.8 [8] 5.1 (0.67*) [510 (67*)]	2.6 [12] 7.2 (0.67*) [720 (67*)]
0.6x2.3-22.2-P4 0.024 x 0.091	0.92 [23.4]	0.36 [9.2]	2.8 [11]	1 [4.6] 0.77 (0.75*) [77 (75*)]	1.4 [6.4] 1.9 (0.75*) [190 (75*)]	1.8 [8] 3.9 (0.75*) [390 (75*)]	2.6 [12] 5.4 (0.75*) [540 (75*)]
0.6x2.3-25.4-P1 0.024 x 0.091	1 [26.6]	0.091 [2.3]	11 [44]	0.91 [4.1] 4 (0) [400 (0)]	1.3 [5.6] 10 (0) [1000 (0)]	1.6 [7] 20 (0) [2000 (0)]	2.3 [10] 28 (0) [2800 (0)]
0.6x2.3-25.4-P2 0.024 x 0.091	1 [26.6]	0.18 [4.6]	5.5 [22]	0.91 [4.1] 2 (0.5*) [200 (50*)]	1.3 [5.6] 5 (0.5*) [500 (50*)]	1.6 [7] 10 (0.5*) [1000 (50*)]	2.3 [10] 14 (0.5*) [1400 (50*)]
0.6x2.3-25.4-P3 0.024 x 0.091	1 [26.6]	0.27 [6.9]	3.7 [15]	0.91 [4.1] 1.3 (0.67*) [130 (67*)]	1.3 [5.6] 3.3 (0.67*) [330 (67*)]	1.6 [7] 6.7 (0.67*) [670 (67*)]	2.3 [10] 9.4 (0.67*) [940 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.6x2.3-25.4-P4 0.024 x 0.091	1 [26.6]	0.36 [9.2]	2.8 [11]	0.91 [4.1] 1 (0.75*) [100 (75*)]	1.3 [5.6] 2.5 (0.75*) [250 (75*)]	1.6 [7] 5 (0.75*) [500 (75*)]	2.3 [10] 7 (0.75*) [700 (75*)]
0.8x1.5-0.5-P1 0.031 x 0.059	0.083 [2.1]	0.059 [1.5]	17 [67]	10 [46] 0.024 (0) [2.4 (0)]	14 [64] 0.06 (0) [6 (0)]	18 [79] 0.12 (0) [12 (0)]	26 [120] 0.17 (0) [17 (0)]
0.8x1.5-0.5-P2 0.031 x 0.059	0.083 [2.1]	0.12 [3]	8.5 [34]	10 [46] 0.012 (0.012) [1.2 (1.2)]	14 [64] 0.03 (0.03) [3 (3)]	18 [79] 0.06 (0.06) [6 (6)]	26 [120] 0.084 (0.084) [8.4 (8.4)]
0.8x1.5-0.5-P3 0.031 x 0.059	0.083 [2.1]	0.18 [4.5]	5.7 [22]	10 [46] 0.008 (0.008) [0.8 (0.8)]	14 [64] 0.02 (0.02) [2 (2)]	18 [79] 0.04 (0.04) [4 (4)]	26 [120] 0.056 (0.056) [5.6 (5.6)]
0.8x1.5-0.5-P4 0.031 x 0.059	0.083 [2.1]	0.24 [6]	4.2 [17]	10 [46] 0.006 (0.006) [0.6 (0.6)]	14 [64] 0.015 (0.015) [1.5 (1.5)]	18 [79] 0.03 (0.03) [3 (3)]	26 [120] 0.042 (0.042) [4.2 (4.2)]
0.8x1.5-0.9-P1 0.031 x 0.059	0.098 [2.5]	0.059 [1.5]	17 [67]	7.9 [35] 0.04 (0) [4 (0)]	11 [49] 0.1 (0) [10 (0)]	14 [61] 0.2 (0) [20 (0)]	20 [88] 0.28 (0) [28 (0)]
0.8x1.5-0.9-P2 0.031 x 0.059	0.098 [2.5]	0.12 [3]	8.5 [34]	7.9 [35] 0.02 (0.02) [2 (2)]	11 [49] 0.05 (0.05) [5 (5)]	14 [61] 0.1 (0.1) [10 (10)]	20 [88] 0.14 (0.14) [14 (14)]
0.8x1.5-0.9-P3 0.031 x 0.059	0.098 [2.5]	0.18 [4.5]	5.7 [22]	7.9 [35] 0.013 (0.013) [1.3 (1.3)]	11 [49] 0.033 (0.033) [3.3 (3.3)]	14 [61] 0.067 (0.067) [6.7 (6.7)]	20 [88] 0.093 (0.093) [9.3 (9.3)]
0.8x1.5-0.9-P4 0.031 x 0.059	0.098 [2.5]	0.24 [6]	4.2 [17]	7.9 [35] 0.01 (0.01) [1 (1)]	11 [49] 0.025 (0.025) [2.5 (2.5)]	14 [61] 0.05 (0.05) [5 (5)]	20 [88] 0.07 (0.07) [7 (7)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.8x1.5-1.15-P1 0.031 x 0.059	0.11 [2.75]	0.059 [1.5]	17 [67]	6.9 [31] 0.052 (0) [5.2 (0)]	9.5 [42] 0.13 (0) [13 (0)]	12 [53] 0.26 (0) [26 (0)]	17 [77] 0.36 (0) [36 (0)]
0.8x1.5-1.15-P2 0.031 x 0.059	0.11 [2.75]	0.12 [3]	8.5 [34]	6.9 [31] 0.026 (0.026) [2.6 (2.6)]	9.5 [42] 0.065 (0.065) [6.5 (6.5)]	12 [53] 0.13 (0.13) [13 (13)]	17 [77] 0.18 (0.18) [18 (18)]
0.8x1.5-1.15-P3 0.031 x 0.059	0.11 [2.75]	0.18 [4.5]	5.7 [22]	6.9 [31] 0.017 (0.017) [1.7 (1.7)]	9.5 [42] 0.043 (0.043) [4.3 (4.3)]	12 [53] 0.087 (0.087) [8.7 (8.7)]	17 [77] 0.12 (0.12) [12 (12)]
0.8x1.5-1.15-P4 0.031 x 0.059	0.11 [2.75]	0.24 [6]	4.2 [17]	6.9 [31] 0.013 (0.013) [1.3 (1.3)]	9.5 [42] 0.033 (0.033) [3.2 (3.2)]	12 [53] 0.065 (0.065) [6.5 (6.5)]	17 [77] 0.091 (0.091) [9.1 (9.1)]
0.8x1.5-1.6-P1 0.031 x 0.059	0.13 [3.2]	0.059 [1.5]	17 [67]	5.6 [25] 0.08 (0) [8 (0)]	7.8 [34] 0.2 (0) [20 (0)]	9.7 [43] 0.4 (0) [40 (0)]	14 [62] 0.56 (0) [56 (0)]
0.8x1.5-1.6-P2 0.031 x 0.059	0.13 [3.2]	0.12 [3]	8.5 [34]	5.6 [25] 0.04 (0.04) [4 (4)]	7.8 [34] 0.1 (0.1) [10 (10)]	9.7 [43] 0.2 (0.2) [20 (20)]	14 [62] 0.28 (0.28) [28 (28)]
0.8x1.5-1.6-P3 0.031 x 0.059	0.13 [3.2]	0.18 [4.5]	5.7 [22]	5.6 [25] 0.027 (0.027) [2.7 (2.7)]	7.8 [34] 0.067 (0.067) [6.7 (6.7)]	9.7 [43] 0.13 (0.13) [13 (13)]	14 [62] 0.19 (0.19) [19 (19)]
0.8x1.5-1.6-P4 0.031 x 0.059	0.13 [3.2]	0.24 [6]	4.2 [17]	5.6 [25] 0.02 (0.02) [2 (2)]	7.8 [34] 0.05 (0.05) [5 (5)]	9.7 [43] 0.1 (0.1) [10 (10)]	14 [62] 0.14 (0.14) [14 (14)]
0.8x1.5-2.4-P1 0.031 x 0.059	0.16 [4]	0.059 [1.5]	17 [67]	4.2 [19] 0.14 (0) [14 (0)]	5.8 [26] 0.36 (0) [36 (0)]	7.3 [32] 0.72 (0) [72 (0)]	11 [47] 1 (0) [100 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.8x1.5-2.4-P2 0.031 x 0.059	0.16 [4]	0.12 [3]	8.5 [34]	4.2 [19] 0.072 (0.072) [7.2 (7.2)]	5.8 [26] 0.18 (0.18) [18 (18)]	7.3 [32] 0.36 (0.36) [36 (36)]	11 [47] 0.5 (0.5*) [50 (50*)]
0.8x1.5-2.4-P3 0.031 x 0.059	0.16 [4]	0.18 [4.5]	5.7 [22]	4.2 [19] 0.048 (0.048) [4.8 (4.8)]	5.8 [26] 0.12 (0.12) [12 (12)]	7.3 [32] 0.24 (0.24) [24 (24)]	11 [47] 0.34 (0.34) [34 (34)]
0.8x1.5-2.4-P4 0.031 x 0.059	0.16 [4]	0.24 [6]	4.2 [17]	4.2 [19] 0.036 (0.036) [3.6 (3.6)]	5.8 [26] 0.09 (0.09) [9 (9)]	7.3 [32] 0.18 (0.18) [18 (18)]	11 [47] 0.25 (0.25) [25 (25)]
0.8x1.5-3.2-P1 0.031 x 0.059	0.19 [4.8]	0.059 [1.5]	17 [67]	3.4 [15] 0.22 (0) [22 (0)]	4.7 [21] 0.56 (0) [56 (0)]	5.8 [26] 1.1 (0) [110 (0)]	8.4 [38] 1.6 (0) [160 (0)]
0.8x1.5-3.2-P2 0.031 x 0.059	0.19 [4.8]	0.12 [3]	8.5 [34]	3.4 [15] 0.11 (0.11) [11 (11)]	4.7 [21] 0.28 (0.28) [28 (28)]	5.8 [26] 0.56 (0.5*) [56 (50*)]	8.4 [38] 0.78 (0.5*) [78 (50*)]
0.8x1.5-3.2-P3 0.031 x 0.059	0.19 [4.8]	0.18 [4.5]	5.7 [22]	3.4 [15] 0.075 (0.075) [7.5 (7.5)]	4.7 [21] 0.19 (0.19) [19 (19)]	5.8 [26] 0.37 (0.37) [37 (37)]	8.4 [38] 0.52 (0.52) [52 (52)]
0.8x1.5-3.2-P4 0.031 x 0.059	0.19 [4.8]	0.24 [6]	4.2 [17]	3.4 [15] 0.056 (0.056) [5.6 (5.6)]	4.7 [21] 0.14 (0.14) [14 (14)]	5.8 [26] 0.28 (0.28) [28 (28)]	8.4 [38] 0.39 (0.39) [39 (39)]
0.8x1.5-4.75-P1 0.031 x 0.059	0.25 [6.35]	0.059 [1.5]	17 [67]	2.4 [11] 0.43 (0) [43 (0)]	3.4 [15] 1.1 (0) [110 (0)]	4.2 [19] 2.1 (0) [220 (0)]	6.1 [27] 3 (0) [300 (0)]
0.8x1.5-4.75-P2 0.031 x 0.059	0.25 [6.35]	0.12 [3]	8.5 [34]	2.4 [11] 0.21 (0.21) [21 (21)]	3.4 [15] 0.54 (0.5*) [54 (50*)]	4.2 [19] 1.1 (0.5*) [110 (50*)]	6.1 [27] 1.5 (0.5*) [150 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.8x1.5-4.75-P3 0.031 x 0.059	0.25 [6.35]	0.18 [4.5]	5.7 [22]	2.4 [11] 0.14 (0.14) [14 (14)]	3.4 [15] 0.36 (0.36) [36 (36)]	4.2 [19] 0.72 (0.67*) [72 (67*)]	6.1 [27] 1 (0.67*) [100 (67*)]
0.8x1.5-4.75-P4 0.031 x 0.059	0.25 [6.35]	0.24 [6]	4.2 [17]	2.4 [11] 0.11 (0.11) [11 (11)]	3.4 [15] 0.27 (0.27) [27 (27)]	4.2 [19] 0.54 (0.54) [54 (54)]	6.1 [27] 0.75 (0.75*) [75 (75*)]
0.8x1.5-6-P1 0.031 x 0.059	0.3 [7.6]	0.059 [1.5]	17 [67]	2 [8.8] 0.65 (0) [65 (0)]	2.7 [12] 1.6 (0) [160 (0)]	3.4 [15] 3.2 (0) [320 (0)]	5 [22] 4.5 (0) [450 (0)]
0.8x1.5-6-P2 0.031 x 0.059	0.3 [7.6]	0.12 [3]	8.5 [34]	2 [8.8] 0.32 (0.32) [32 (32)]	2.7 [12] 0.81 (0.5*) [81 (50*)]	3.4 [15] 1.6 (0.5*) [160 (50*)]	5 [22] 2.3 (0.5*) [230 (50*)]
0.8x1.5-6-P3 0.031 x 0.059	0.3 [7.6]	0.18 [4.5]	5.7 [22]	2 [8.8] 0.22 (0.22) [22 (22)]	2.7 [12] 0.54 (0.54) [54 (54)]	3.4 [15] 1.1 (0.67*) [110 (67*)]	5 [22] 1.5 (0.67*) [150 (67*)]
0.8x1.5-6-P4 0.031 x 0.059	0.3 [7.6]	0.24 [6]	4.2 [17]	2 [8.8] 0.16 (0.16) [16 (16)]	2.7 [12] 0.4 (0.4) [40 (40)]	3.4 [15] 0.81 (0.75*) [81 (75*)]	5 [22] 1.1 (0.75*) [110 (75*)]
0.8x1.5-8-P1 0.031 x 0.059	0.38 [9.6]	0.059 [1.5]	17 [67]	1.5 [6.8] 1.1 (0) [110 (0)]	2.1 [9.4] 2.7 (0) [270 (0)]	2.6 [12] 5.4 (0) [540 (0)]	3.8 [17] 7.6 (0) [760 (0)]
0.8x1.5-8-P2 0.031 x 0.059	0.38 [9.6]	0.12 [3]	8.5 [34]	1.5 [6.8] 0.54 (0.5*) [54 (50*)]	2.1 [9.4] 1.4 (0.5*) [140 (50*)]	2.6 [12] 2.7 (0.5*) [270 (50*)]	3.8 [17] 3.8 (0.5*) [380 (50*)]
0.8x1.5-8-P3 0.031 x 0.059	0.38 [9.6]	0.18 [4.5]	5.7 [22]	1.5 [6.8] 0.36 (0.36) [36 (36)]	2.1 [9.4] 0.9 (0.67*) [90 (67*)]	2.6 [12] 1.8 (0.67*) [180 (67*)]	3.8 [17] 2.5 (0.67*) [250 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.8x1.5-8-P4 0.031 x 0.059	0.38 [9.6]	0.24 [6]	4.2 [17]	1.5 [6.8] 0.27 (0.27) [27 (27)]	2.1 [9.4] 0.68 (0.68) [68 (68)]	2.6 [12] 1.4 (0.75*) [140 (75*)]	3.8 [17] 1.9 (0.75*) [190 (75*)]
0.8x1.5-9.5-P1 0.031 x 0.059	0.44 [11.1]	0.059 [1.5]	17 [67]	1.3 [5.8] 1.5 (0) [150 (0)]	1.8 [8] 3.7 (0) [370 (0)]	2.3 [10] 7.4 (0) [740 (0)]	3.3 [15] 10 (0) [1000 (0)]
0.8x1.5-9.5-P2 0.031 x 0.059	0.44 [11.1]	0.12 [3]	8.5 [34]	1.3 [5.8] 0.74 (0.5*) [74 (50*)]	1.8 [8] 1.9 (0.5*) [190 (50*)]	2.3 [10] 3.7 (0.5*) [370 (50*)]	3.3 [15] 5.2 (0.5*) [520 (50*)]
0.8x1.5-9.5-P3 0.031 x 0.059	0.44 [11.1]	0.18 [4.5]	5.7 [22]	1.3 [5.8] 0.49 (0.49) [49 (49)]	1.8 [8] 1.2 (0.67*) [120 (67*)]	2.3 [10] 2.5 (0.67*) [250 (67*)]	3.3 [15] 3.5 (0.67*) [350 (67*)]
0.8x1.5-9.5-P4 0.031 x 0.059	0.44 [11.1]	0.24 [6]	4.2 [17]	1.3 [5.8] 0.37 (0.37) [37 (37)]	1.8 [8] 0.93 (0.75*) [93 (75*)]	2.3 [10] 1.9 (0.75*) [190 (75*)]	3.3 [15] 2.6 (0.75*) [260 (75*)]
0.8x1.5-12.7-P1 0.031 x 0.059	0.56 [14.3]	0.059 [1.5]	17 [67]	1 [4.4] 2.5 (0) [250 (0)]	1.4 [6.1] 6.4 (0) [640 (0)]	1.7 [7.6] 13 (0) [1300 (0)]	2.5 [11] 18 (0) [1800 (0)]
0.8x1.5-12.7-P2 0.031 x 0.059	0.56 [14.3]	0.12 [3]	8.5 [34]	1 [4.4] 1.3 (0.5*) [130 (50*)]	1.4 [6.1] 3.2 (0.5*) [320 (50*)]	1.7 [7.6] 6.4 (0.5*) [640 (50*)]	2.5 [11] 8.9 (0.5*) [890 (50*)]
0.8x1.5-12.7-P3 0.031 x 0.059	0.56 [14.3]	0.18 [4.5]	5.7 [22]	1 [4.4] 0.85 (0.67*) [85 (67*)]	1.4 [6.1] 2.1 (0.67*) [210 (67*)]	1.7 [7.6] 4.2 (0.67*) [420 (67*)]	2.5 [11] 5.9 (0.67*) [590 (67*)]
0.8x1.5-12.7-P4 0.031 x 0.059	0.56 [14.3]	0.24 [6]	4.2 [17]	1 [4.4] 0.64 (0.64) [64 (64)]	1.4 [6.1] 1.6 (0.75*) [160 (75*)]	1.7 [7.6] 3.2 (0.75*) [320 (75*)]	2.5 [11] 4.5 (0.75*) [450 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.8x1.5-14.2-P1 0.031 x 0.059	0.62 [15.8]	0.059 [1.5]	17 [67]	0.9 [4] 3.1 (0) [310 (0)]	1.2 [5.5] 7.9 (0) [790 (0)]	1.5 [6.9] 16 (0) [1600 (0)]	2.2 [10] 22 (0) [2200 (0)]
0.8x1.5-14.2-P2 0.031 x 0.059	0.62 [15.8]	0.12 [3]	8.5 [34]	0.9 [4] 1.6 (0.5*) [160 (50*)]	1.2 [5.5] 3.9 (0.5*) [390 (50*)]	1.5 [6.9] 7.9 (0.5*) [790 (50*)]	2.2 [10] 11 (0.5*) [1100 (50*)]
0.8x1.5-14.2-P3 0.031 x 0.059	0.62 [15.8]	0.18 [4.5]	5.7 [22]	0.9 [4] 1 (0.67*) [100 (67*)]	1.2 [5.5] 2.6 (0.67*) [260 (67*)]	1.5 [6.9] 5.2 (0.67*) [520 (67*)]	2.2 [10] 7.3 (0.67*) [730 (67*)]
0.8x1.5-14.2-P4 0.031 x 0.059	0.62 [15.8]	0.24 [6]	4.2 [17]	0.9 [4] 0.79 (0.75*) [79 (75*)]	1.2 [5.5] 2 (0.75*) [200 (75*)]	1.5 [6.9] 3.9 (0.75*) [390 (75*)]	2.2 [10] 5.5 (0.75*) [550 (75*)]
0.8x1.5-16-P1 0.031 x 0.059	0.69 [17.6]	0.059 [1.5]	17 [67]	0.8 [3.6] 3.9 (0) [390 (0)]	1.1 [4.9] 9.8 (0) [980 (0)]	1.4 [6.1] 20 (0) [2000 (0)]	2 [8.9] 28 (0) [2800 (0)]
0.8x1.5-16-P2 0.031 x 0.059	0.69 [17.6]	0.12 [3]	8.5 [34]	0.8 [3.6] 2 (0.5*) [200 (50*)]	1.1 [4.9] 4.9 (0.5*) [490 (50*)]	1.4 [6.1] 9.8 (0.5*) [980 (50*)]	2 [8.9] 14 (0.5*) [1400 (50*)]
0.8x1.5-16-P3 0.031 x 0.059	0.69 [17.6]	0.18 [4.5]	5.7 [22]	0.8 [3.6] 1.3 (0.67*) [130 (67*)]	1.1 [4.9] 3.3 (0.67*) [330 (67*)]	1.4 [6.1] 6.6 (0.67*) [660 (67*)]	2 [8.9] 9.2 (0.67*) [920 (67*)]
0.8x1.5-16-P4 0.031 x 0.059	0.69 [17.6]	0.24 [6]	4.2 [17]	0.8 [3.6] 0.98 (0.75*) [98 (75*)]	1.1 [4.9] 2.5 (0.75*) [250 (75*)]	1.4 [6.1] 4.9 (0.75*) [490 (75*)]	2 [8.9] 6.9 (0.75*) [690 (75*)]
0.8x1.5-19-P1 0.031 x 0.059	0.81 [20.6]	0.059 [1.5]	17 [67]	0.68 [3] 5.5 (0) [550 (0)]	0.94 [4.2] 14 (0) [1400 (0)]	1.2 [5.2] 27 (0) [2700 (0)]	1.7 [7.6] 38 (0) [3800 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.8x1.5-19-P2 0.031 x 0.059	0.81 [20.6]	0.12 [3]	8.5 [34]	0.68 [3] 2.7 (0.5*) [270 (50*)]	0.94 [4.2] 6.8 (0.5*) [680 (50*)]	1.2 [5.2] 14 (0.5*) [1400 (50*)]	1.7 [7.6] 19 (0.5*) [1900 (50*)]
0.8x1.5-19-P3 0.031 x 0.059	0.81 [20.6]	0.18 [4.5]	5.7 [22]	0.68 [3] 1.8 (0.67*) [180 (67*)]	0.94 [4.2] 4.6 (0.67*) [460 (67*)]	1.2 [5.2] 9.1 (0.67*) [910 (67*)]	1.7 [7.6] 13 (0.67*) [1300 (67*)]
0.8x1.5-19-P4 0.031 x 0.059	0.81 [20.6]	0.24 [6]	4.2 [17]	0.68 [3] 1.4 (0.75*) [140 (75*)]	0.94 [4.2] 3.4 (0.75*) [340 (75*)]	1.2 [5.2] 6.8 (0.75*) [680 (75*)]	1.7 [7.6] 9.6 (0.75*) [960 (75*)]
0.8x1.5-22.2-P1 0.031 x 0.059	0.94 [23.8]	0.059 [1.5]	17 [67]	0.59 [2.6] 7.4 (0) [740 (0)]	0.81 [3.6] 18 (0) [1800 (0)]	1 [4.5] 37 (0) [3700 (0)]	1.5 [6.5] 52 (0) [5200 (0)]
0.8x1.5-22.2-P2 0.031 x 0.059	0.94 [23.8]	0.12 [3]	8.5 [34]	0.59 [2.6] 3.7 (0.5*) [370 (50*)]	0.81 [3.6] 9.2 (0.5*) [920 (50*)]	1 [4.5] 18 (0.5*) [1800 (50*)]	1.5 [6.5] 26 (0.5*) [2600 (50*)]
0.8x1.5-22.2-P3 0.031 x 0.059	0.94 [23.8]	0.18 [4.5]	5.7 [22]	0.59 [2.6] 2.5 (0.67*) [250 (67*)]	0.81 [3.6] 6.2 (0.67*) [620 (67*)]	1 [4.5] 12 (0.67*) [1200 (67*)]	1.5 [6.5] 17 (0.67*) [1700 (67*)]
0.8x1.5-22.2-P4 0.031 x 0.059	0.94 [23.8]	0.24 [6]	4.2 [17]	0.59 [2.6] 1.8 (0.75*) [180 (75*)]	0.81 [3.6] 4.6 (0.75*) [460 (75*)]	1 [4.5] 9.2 (0.75*) [920 (75*)]	1.5 [6.5] 13 (0.75*) [1300 (75*)]
0.8x1.5-25.4-P1 0.031 x 0.059	1.1 [27]	0.059 [1.5]	17 [67]	0.51 [2.3] 9.6 (0) [960 (0)]	0.71 [3.2] 24 (0) [2400 (0)]	0.89 [3.9] 48 (0) [4800 (0)]	1.3 [5.7] 67 (0) [6700 (0)]
0.8x1.5-25.4-P2 0.031 x 0.059	1.1 [27]	0.12 [3]	8.5 [34]	0.51 [2.3] 4.8 (0.5*) [480 (50*)]	0.71 [3.2] 12 (0.5*) [1200 (50*)]	0.89 [3.9] 24 (0.5*) [2400 (50*)]	1.3 [5.7] 34 (0.5*) [3400 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.8x1.5-25.4-P3 0.031 x 0.059	1.1 [27]	0.18 [4.5]	5.7 [22]	0.51 [2.3] 3.2 (0.67*) [320 (67*)]	0.71 [3.2] 8 (0.67*) [800 (67*)]	0.89 [3.9] 16 (0.67*) [1600 (67*)]	1.3 [5.7] 22 (0.67*) [2200 (67*)]
0.8x1.5-25.4-P4 0.031 x 0.059	1.1 [27]	0.24 [6]	4.2 [17]	0.51 [2.3] 2.4 (0.75*) [240 (75*)]	0.71 [3.2] 6 (0.75*) [600 (75*)]	0.89 [3.9] 12 (0.75*) [1200 (75*)]	1.3 [5.7] 17 (0.75*) [1700 (75*)]
1x2.6-0.5-P1 0.039 x 0.1	0.098 [2.5]	0.1 [2.6]	9.8 [38]	34 [150] 0.01 (0) [1 (0)]	47 [210] 0.026 (0) [2.6 (0)]	58 [260] 0.052 (0) [5.2 (0)]	84 [380] 0.073 (0) [7.3 (0)]
1x2.6-0.5-P2 0.039 x 0.1	0.098 [2.5]	0.2 [5.2]	4.9 [19]	34 [150] 0.0052 (0.0052) [0.52 (0.52)]	47 [210] 0.013 (0.013) [1.3 (1.3)]	58 [260] 0.026 (0.026) [2.6 (2.6)]	84 [380] 0.036 (0.036) [3.6 (3.6)]
1x2.6-0.5-P3 0.039 x 0.1	0.098 [2.5]	0.31 [7.8]	3.3 [13]	34 [150] 0.0035 (0.0035) [0.35 (0.35)]	47 [210] 0.0087 (0.0087) [0.87 (0.87)]	58 [260] 0.017 (0.017) [1.7 (1.7)]	84 [380] 0.024 (0.024) [2.4 (2.4)]
1x2.6-0.5-P4 0.039 x 0.1	0.098 [2.5]	0.41 [10.4]	2.5 [9.5]	34 [150] 0.0026 (0.0026) [0.26 (0.26)]	47 [210] 0.0065 (0.0065) [0.65 (0.65)]	58 [260] 0.013 (0.013) [1.3 (1.3)]	84 [380] 0.018 (0.018) [1.8 (1.8)]
1x2.6-0.9-P1 0.039 x 0.1	0.11 [2.9]	0.1 [2.6]	9.8 [38]	27 [120] 0.017 (0) [1.7 (0)]	37 [160] 0.042 (0) [4.2 (0)]	46 [200] 0.084 (0) [8.4 (0)]	67 [300] 0.12 (0) [12 (0)]
1x2.6-0.9-P2 0.039 x 0.1	0.11 [2.9]	0.2 [5.2]	4.9 [19]	27 [120] 0.0084 (0.0084) [0.84 (0.84)]	37 [160] 0.021 (0.021) [2.1 (2.1)]	46 [200] 0.042 (0.042) [4.2 (4.2)]	67 [300] 0.059 (0.059) [5.9 (5.9)]
1x2.6-0.9-P3 0.039 x 0.1	0.11 [2.9]	0.31 [7.8]	3.3 [13]	27 [120] 0.0056 (0.0056) [0.56 (0.56)]	37 [160] 0.014 (0.014) [1.4 (1.4)]	46 [200] 0.028 (0.028) [2.8 (2.8)]	67 [300] 0.039 (0.039) [3.9 (3.9)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1x2.6-0.9-P4 0.039 x 0.1	0.11 [2.9]	0.41 [10.4]	2.5 [9.5]	27 [120] 0.0042 (0.0042) [0.42 (0.42)]	37 [160] 0.011 (0.011) [1.1 (1.1)]	46 [200] 0.021 (0.021) [2.1 (2.1)]	67 [300] 0.029 (0.029) [2.9 (2.9)]
1x2.6-1.15-P1 0.039 x 0.1	0.12 [3.15]	0.1 [2.6]	9.8 [38]	24 [100] 0.022 (0) [2.2 (0)]	33 [140] 0.055 (0) [5.5 (0)]	41 [180] 0.11 (0) [11 (0)]	59 [260] 0.15 (0) [15 (0)]
1x2.6-1.15-P2 0.039 x 0.1	0.12 [3.15]	0.2 [5.2]	4.9 [19]	24 [100] 0.011 (0.011) [1.1 (1.1)]	33 [140] 0.028 (0.028) [2.8 (2.8)]	41 [180] 0.055 (0.055) [5.5 (5.5)]	59 [260] 0.077 (0.077) [7.7 (7.7)]
1x2.6-1.15-P3 0.039 x 0.1	0.12 [3.15]	0.31 [7.8]	3.3 [13]	24 [100] 0.0073 (0.0073) [0.73 (0.73)]	33 [140] 0.018 (0.018) [1.8 (1.8)]	41 [180] 0.037 (0.037) [3.7 (3.7)]	59 [260] 0.051 (0.051) [5.1 (5.1)]
1x2.6-1.15-P4 0.039 x 0.1	0.12 [3.15]	0.41 [10.4]	2.5 [9.5]	24 [100] 0.0055 (0.0055) [0.55 (0.55)]	33 [140] 0.014 (0.014) [1.4 (1.4)]	41 [180] 0.028 (0.028) [2.8 (2.8)]	59 [260] 0.039 (0.039) [3.9 (3.9)]
1x2.6-1.6-P1 0.039 x 0.1	0.14 [3.6]	0.1 [2.6]	9.8 [38]	19 [87] 0.032 (0) [3.2 (0)]	27 [120] 0.08 (0) [8 (0)]	34 [150] 0.16 (0) [16 (0)]	49 [220] 0.22 (0) [22 (0)]
1x2.6-1.6-P2 0.039 x 0.1	0.14 [3.6]	0.2 [5.2]	4.9 [19]	19 [87] 0.016 (0.016) [1.6 (1.6)]	27 [120] 0.04 (0.04) [4 (4)]	34 [150] 0.08 (0.08) [8 (8)]	49 [220] 0.11 (0.11) [11 (11)]
1x2.6-1.6-P3 0.039 x 0.1	0.14 [3.6]	0.31 [7.8]	3.3 [13]	19 [87] 0.011 (0.011) [1.1 (1.1)]	27 [120] 0.027 (0.027) [2.7 (2.7)]	34 [150] 0.053 (0.053) [5.3 (5.3)]	49 [220] 0.075 (0.075) [7.5 (7.5)]
1x2.6-1.6-P4 0.039 x 0.1	0.14 [3.6]	0.41 [10.4]	2.5 [9.5]	19 [87] 0.008 (0.008) [0.8 (0.8)]	27 [120] 0.02 (0.02) [2 (2)]	34 [150] 0.04 (0.04) [4 (4)]	49 [220] 0.056 (0.056) [5.6 (5.6)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1x2.6-2.4-P1 0.039 x 0.1	0.17 [4.4]	0.1 [2.6]	9.8 [38]	15 [66] 0.054 (0) [5.4 (0)]	21 [91] 0.14 (0) [14 (0)]	26 [110] 0.27 (0) [27 (0)]	37 [170] 0.38 (0) [38 (0)]
1x2.6-2.4-P2 0.039 x 0.1	0.17 [4.4]	0.2 [5.2]	4.9 [19]	15 [66] 0.027 (0.027) [2.7 (2.7)]	21 [91] 0.068 (0.068) [6.8 (6.8)]	26 [110] 0.14 (0.14) [14 (14)]	37 [170] 0.19 (0.19) [19 (19)]
1x2.6-2.4-P3 0.039 x 0.1	0.17 [4.4]	0.31 [7.8]	3.3 [13]	15 [66] 0.018 (0.018) [1.8 (1.8)]	21 [91] 0.045 (0.045) [4.5 (4.5)]	26 [110] 0.09 (0.09) [9 (9)]	37 [170] 0.13 (0.13) [13 (13)]
1x2.6-2.4-P4 0.039 x 0.1	0.17 [4.4]	0.41 [10.4]	2.5 [9.5]	15 [66] 0.013 (0.013) [1.3 (1.3)]	21 [91] 0.034 (0.034) [3.4 (3.4)]	26 [110] 0.068 (0.068) [6.8 (6.8)]	37 [170] 0.095 (0.095) [9.5 (9.5)]
1x2.6-3.2-P1 0.039 x 0.1	0.2 [5.2]	0.1 [2.6]	9.8 [38]	12 [54] 0.082 (0) [8.2 (0)]	17 [74] 0.2 (0) [20 (0)]	21 [92] 0.41 (0) [41 (0)]	30 [130] 0.57 (0) [57 (0)]
1x2.6-3.2-P2 0.039 x 0.1	0.2 [5.2]	0.2 [5.2]	4.9 [19]	12 [54] 0.041 (0.041) [4.1 (4.1)]	17 [74] 0.1 (0.1) [10 (10)]	21 [92] 0.2 (0.2) [20 (20)]	30 [130] 0.29 (0.29) [29 (29)]
1x2.6-3.2-P3 0.039 x 0.1	0.2 [5.2]	0.31 [7.8]	3.3 [13]	12 [54] 0.027 (0.027) [2.7 (2.7)]	17 [74] 0.068 (0.068) [6.8 (6.8)]	21 [92] 0.14 (0.14) [14 (14)]	30 [130] 0.19 (0.19) [19 (19)]
1x2.6-3.2-P4 0.039 x 0.1	0.2 [5.2]	0.41 [10.4]	2.5 [9.5]	12 [54] 0.02 (0.02) [2 (2)]	17 [74] 0.051 (0.051) [5.1 (5.1)]	21 [92] 0.1 (0.1) [10 (10)]	30 [130] 0.14 (0.14) [14 (14)]
1x2.6-4.75-P1 0.039 x 0.1	0.27 [6.75]	0.1 [2.6]	9.8 [38]	8.8 [39] 0.15 (0) [15 (0)]	12 [54] 0.39 (0) [38 (0)]	15 [67] 0.77 (0) [77 (0)]	22 [98] 1.1 (0) [110 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1x2.6-4.75-P2 0.039 x 0.1	0.27 [6.75]	0.2 [5.2]	4.9 [19]	8.8 [39] 0.077 (0.077) [7.7 (7.7)]	12 [54] 0.19 (0.19) [19 (19)]	15 [67] 0.39 (0.39) [38 (38)]	22 [98] 0.54 (0.5*) [54 (50*)]
1x2.6-4.75-P3 0.039 x 0.1	0.27 [6.75]	0.31 [7.8]	3.3 [13]	8.8 [39] 0.051 (0.051) [5.1 (5.1)]	12 [54] 0.13 (0.13) [13 (13)]	15 [67] 0.26 (0.26) [26 (26)]	22 [98] 0.36 (0.36) [36 (36)]
1x2.6-4.75-P4 0.039 x 0.1	0.27 [6.75]	0.41 [10.4]	2.5 [9.5]	8.8 [39] 0.038 (0.038) [3.8 (3.8)]	12 [54] 0.096 (0.096) [9.6 (9.6)]	15 [67] 0.19 (0.19) [19 (19)]	22 [98] 0.27 (0.27) [27 (27)]
1x2.6-6-P1 0.039 x 0.1	0.31 [8]	0.1 [2.6]	9.8 [38]	7.2 [32] 0.23 (0) [23 (0)]	10 [44] 0.57 (0) [57 (0)]	12 [55] 1.1 (0) [110 (0)]	18 [80] 1.6 (0) [160 (0)]
1x2.6-6-P2 0.039 x 0.1	0.31 [8]	0.2 [5.2]	4.9 [19]	7.2 [32] 0.11 (0.11) [11 (11)]	10 [44] 0.28 (0.28) [28 (28)]	12 [55] 0.57 (0.5*) [57 (50*)]	18 [80] 0.8 (0.5*) [80 (50*)]
1x2.6-6-P3 0.039 x 0.1	0.31 [8]	0.31 [7.8]	3.3 [13]	7.2 [32] 0.076 (0.076) [7.6 (7.6)]	10 [44] 0.19 (0.19) [19 (19)]	12 [55] 0.38 (0.38) [38 (38)]	18 [80] 0.53 (0.53) [53 (53)]
1x2.6-6-P4 0.039 x 0.1	0.31 [8]	0.41 [10.4]	2.5 [9.5]	7.2 [32] 0.057 (0.057) [5.7 (5.7)]	10 [44] 0.14 (0.14) [14 (14)]	12 [55] 0.28 (0.28) [28 (28)]	18 [80] 0.4 (0.4) [40 (40)]
1x2.6-8-P1 0.039 x 0.1	0.39 [10]	0.1 [2.6]	9.8 [38]	5.6 [25] 0.38 (0) [38 (0)]	7.8 [35] 0.94 (0) [94 (0)]	9.7 [43] 1.9 (0) [190 (0)]	14 [63] 2.6 (0) [260 (0)]
1x2.6-8-P2 0.039 x 0.1	0.39 [10]	0.2 [5.2]	4.9 [19]	5.6 [25] 0.19 (0.19) [19 (19)]	7.8 [35] 0.47 (0.47) [47 (47)]	9.7 [43] 0.94 (0.5*) [94 (50*)]	14 [63] 1.3 (0.5*) [130 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1x2.6-8-P3 0.039 x 0.1	0.39 [10]	0.31 [7.8]	3.3 [13]	5.6 [25] 0.13 (0.13) [13 (13)]	7.8 [35] 0.31 (0.31) [31 (31)]	9.7 [43] 0.63 (0.63) [63 (63)]	14 [63] 0.88 (0.67*) [88 (67*)]
1x2.6-8-P4 0.039 x 0.1	0.39 [10]	0.41 [10.4]	2.5 [9.5]	5.6 [25] 0.094 (0.094) [9.4 (9.4)]	7.8 [35] 0.23 (0.23) [24 (24)]	9.7 [43] 0.47 (0.47) [47 (47)]	14 [63] 0.66 (0.66) [66 (66)]
1x2.6-9.5-P1 0.039 x 0.1	0.45 [11.5]	0.1 [2.6]	9.8 [38]	4.8 [21] 0.51 (0) [51 (0)]	6.7 [30] 1.3 (0) [130 (0)]	8.3 [37] 2.6 (0) [260 (0)]	12 [54] 3.6 (0) [360 (0)]
1x2.6-9.5-P2 0.039 x 0.1	0.45 [11.5]	0.2 [5.2]	4.9 [19]	4.8 [21] 0.26 (0.26) [26 (26)]	6.7 [30] 0.64 (0.5*) [64 (50*)]	8.3 [37] 1.3 (0.5*) [130 (50*)]	12 [54] 1.8 (0.5*) [180 (50*)]
1x2.6-9.5-P3 0.039 x 0.1	0.45 [11.5]	0.31 [7.8]	3.3 [13]	4.8 [21] 0.17 (0.17) [17 (17)]	6.7 [30] 0.43 (0.43) [43 (43)]	8.3 [37] 0.85 (0.67*) [85 (67*)]	12 [54] 1.2 (0.67*) [120 (67*)]
1x2.6-9.5-P4 0.039 x 0.1	0.45 [11.5]	0.41 [10.4]	2.5 [9.5]	4.8 [21] 0.13 (0.13) [13 (13)]	6.7 [30] 0.32 (0.32) [32 (32)]	8.3 [37] 0.64 (0.64) [64 (64)]	12 [54] 0.9 (0.75*) [90 (75*)]
1x2.6-12.7-P1 0.039 x 0.1	0.58 [14.7]	0.1 [2.6]	9.8 [38]	3.7 [16] 0.87 (0) [87 (0)]	5.1 [23] 2.2 (0) [220 (0)]	6.4 [28] 4.4 (0) [440 (0)]	9.2 [41] 6.1 (0) [610 (0)]
1x2.6-12.7-P2 0.039 x 0.1	0.58 [14.7]	0.2 [5.2]	4.9 [19]	3.7 [16] 0.44 (0.44) [44 (44)]	5.1 [23] 1.1 (0.5*) [110 (50*)]	6.4 [28] 2.2 (0.5*) [220 (50*)]	9.2 [41] 3.1 (0.5*) [310 (50*)]
1x2.6-12.7-P3 0.039 x 0.1	0.58 [14.7]	0.31 [7.8]	3.3 [13]	3.7 [16] 0.29 (0.29) [29 (29)]	5.1 [23] 0.73 (0.67*) [73 (67*)]	6.4 [28] 1.5 (0.67*) [150 (67*)]	9.2 [41] 2 (0.67*) [200 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1x2.6-12.7-P4 0.039 x 0.1	0.58 [14.7]	0.41 [10.4]	2.5 [9.5]	3.7 [16] 0.22 (0.22) [22 (22)]	5.1 [23] 0.55 (0.55) [54 (54)]	6.4 [28] 1.1 (0.75*) [110 (75*)]	9.2 [41] 1.5 (0.75*) [150 (75*)]
1x2.6-14.2-P1 0.039 x 0.1	0.64 [16.2]	0.1 [2.6]	9.8 [38]	3.3 [15] 1.1 (0) [110 (0)]	4.6 [20] 2.7 (0) [270 (0)]	5.7 [25] 5.4 (0) [540 (0)]	8.3 [37] 7.5 (0) [750 (0)]
1x2.6-14.2-P2 0.039 x 0.1	0.64 [16.2]	0.2 [5.2]	4.9 [19]	3.3 [15] 0.54 (0.5*) [54 (50*)]	4.6 [20] 1.3 (0.5*) [130 (50*)]	5.7 [25] 2.7 (0.5*) [270 (50*)]	8.3 [37] 3.8 (0.5*) [380 (50*)]
1x2.6-14.2-P3 0.039 x 0.1	0.64 [16.2]	0.31 [7.8]	3.3 [13]	3.3 [15] 0.36 (0.36) [36 (36)]	4.6 [20] 0.9 (0.67*) [90 (67*)]	5.7 [25] 1.8 (0.67*) [180 (67*)]	8.3 [37] 2.5 (0.67*) [250 (67*)]
1x2.6-14.2-P4 0.039 x 0.1	0.64 [16.2]	0.41 [10.4]	2.5 [9.5]	3.3 [15] 0.27 (0.27) [27 (27)]	4.6 [20] 0.67 (0.67) [67 (67)]	5.7 [25] 1.3 (0.75*) [130 (75*)]	8.3 [37] 1.9 (0.75*) [190 (75*)]
1x2.6-16-P1 0.039 x 0.1	0.71 [18]	0.1 [2.6]	9.8 [38]	3 [13] 1.3 (0) [130 (0)]	4.1 [18] 3.4 (0) [340 (0)]	5.1 [23] 6.7 (0) [670 (0)]	7.4 [33] 9.4 (0) [940 (0)]
1x2.6-16-P2 0.039 x 0.1	0.71 [18]	0.2 [5.2]	4.9 [19]	3 [13] 0.67 (0.5*) [67 (50*)]	4.1 [18] 1.7 (0.5*) [170 (50*)]	5.1 [23] 3.4 (0.5*) [340 (50*)]	7.4 [33] 4.7 (0.5*) [470 (50*)]
1x2.6-16-P3 0.039 x 0.1	0.71 [18]	0.31 [7.8]	3.3 [13]	3 [13] 0.45 (0.45) [45 (45)]	4.1 [18] 1.1 (0.67*) [110 (67*)]	5.1 [23] 2.2 (0.67*) [220 (67*)]	7.4 [33] 3.1 (0.67*) [310 (67*)]
1x2.6-16-P4 0.039 x 0.1	0.71 [18]	0.41 [10.4]	2.5 [9.5]	3 [13] 0.34 (0.34) [34 (34)]	4.1 [18] 0.84 (0.75*) [84 (75*)]	5.1 [23] 1.7 (0.75*) [170 (75*)]	7.4 [33] 2.4 (0.75*) [240 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1x2.6-19-P1 0.039 x 0.1	0.83 [21]	0.1 [2.6]	9.8 [38]	2.5 [11] 1.9 (0) [190 (0)]	3.5 [16] 4.7 (0) [460 (0)]	4.4 [19] 9.3 (0) [930 (0)]	6.3 [28] 13 (0) [1300 (0)]
1x2.6-19-P2 0.039 x 0.1	0.83 [21]	0.2 [5.2]	4.9 [19]	2.5 [11] 0.93 (0.5*) [93 (50*)]	3.5 [16] 2.3 (0.5*) [230 (50*)]	4.4 [19] 4.7 (0.5*) [460 (50*)]	6.3 [28] 6.5 (0.5*) [650 (50*)]
1x2.6-19-P3 0.039 x 0.1	0.83 [21]	0.31 [7.8]	3.3 [13]	2.5 [11] 0.62 (0.62) [62 (62)]	3.5 [16] 1.6 (0.67*) [160 (67*)]	4.4 [19] 3.1 (0.67*) [310 (67*)]	6.3 [28] 4.3 (0.67*) [430 (67*)]
1x2.6-19-P4 0.039 x 0.1	0.83 [21]	0.41 [10.4]	2.5 [9.5]	2.5 [11] 0.46 (0.46) [46 (46)]	3.5 [16] 1.2 (0.75*) [120 (75*)]	4.4 [19] 2.3 (0.75*) [230 (75*)]	6.3 [28] 3.3 (0.75*) [330 (75*)]
1x2.6-22.2-P1 0.039 x 0.1	0.95 [24.2]	0.1 [2.6]	9.8 [38]	2.2 [9.7] 2.5 (0) [250 (0)]	3 [13] 6.3 (0) [630 (0)]	3.8 [17] 13 (0) [1300 (0)]	5.5 [24] 18 (0) [1800 (0)]
1x2.6-22.2-P2 0.039 x 0.1	0.95 [24.2]	0.2 [5.2]	4.9 [19]	2.2 [9.7] 1.3 (0.5*) [130 (50*)]	3 [13] 3.1 (0.5*) [310 (50*)]	3.8 [17] 6.3 (0.5*) [630 (50*)]	5.5 [24] 8.8 (0.5*) [880 (50*)]
1x2.6-22.2-P3 0.039 x 0.1	0.95 [24.2]	0.31 [7.8]	3.3 [13]	2.2 [9.7] 0.83 (0.67*) [83 (67*)]	3 [13] 2.1 (0.67*) [210 (67*)]	3.8 [17] 4.2 (0.67*) [420 (67*)]	5.5 [24] 5.8 (0.67*) [580 (67*)]
1x2.6-22.2-P4 0.039 x 0.1	0.95 [24.2]	0.41 [10.4]	2.5 [9.5]	2.2 [9.7] 0.63 (0.63) [63 (63)]	3 [13] 1.6 (0.75*) [160 (75*)]	3.8 [17] 3.1 (0.75*) [310 (75*)]	5.5 [24] 4.4 (0.75*) [440 (75*)]
1x2.6-25.4-P1 0.039 x 0.1	1.1 [27.4]	0.1 [2.6]	9.8 [38]	1.9 [8.5] 3.2 (0) [320 (0)]	2.6 [12] 8.1 (0) [810 (0)]	3.3 [15] 16 (0) [1600 (0)]	4.8 [21] 23 (0) [2300 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1x2.6-25.4-P2 0.039 x 0.1	1.1 [27.4]	0.2 [5.2]	4.9 [19]	1.9 [8.5] 1.6 (0.5*) [160 (50*)]	2.6 [12] 4 (0.5*) [400 (50*)]	3.3 [15] 8.1 (0.5*) [810 (50*)]	4.8 [21] 11 (0.5*) [1100 (50*)]
1x2.6-25.4-P3 0.039 x 0.1	1.1 [27.4]	0.31 [7.8]	3.3 [13]	1.9 [8.5] 1.1 (0.67*) [110 (67*)]	2.6 [12] 2.7 (0.67*) [270 (67*)]	3.3 [15] 5.4 (0.67*) [540 (67*)]	4.8 [21] 7.6 (0.67*) [760 (67*)]
1x2.6-25.4-P4 0.039 x 0.1	1.1 [27.4]	0.41 [10.4]	2.5 [9.5]	1.9 [8.5] 0.81 (0.75*) [81 (75*)]	2.6 [12] 2 (0.75*) [200 (75*)]	3.3 [15] 4 (0.75*) [400 (75*)]	4.8 [21] 5.7 (0.75*) [570 (75*)]
1.5x4-0.5-P1 0.059 x 0.16	0.14 [3.5]	0.16 [4]	6.3 [25]	90 [400] 0.0078 (0) [0.78 (0)]	120 [550] 0.019 (0) [1.9 (0)]	160 [690] 0.039 (0) [3.9 (0)]	220 [1000] 0.055 (0) [5.5 (0)]
1.5x4-0.5-P2 0.059 x 0.16	0.14 [3.5]	0.31 [8]	3.1 [12]	90 [400] 0.0039 (0.0039) [0.39 (0.39)]	120 [550] 0.0097 (0.0097) [0.97 (0.97)]	160 [690] 0.019 (0.019) [1.9 (1.9)]	220 [1000] 0.027 (0.027) [2.7 (2.7)]
1.5x4-0.5-P3 0.059 x 0.16	0.14 [3.5]	0.47 [12]	2.1 [8.3]	90 [400] 0.0026 (0.0026) [0.26 (0.26)]	120 [550] 0.0065 (0.0065) [0.65 (0.65)]	160 [690] 0.013 (0.013) [1.3 (1.3)]	220 [1000] 0.018 (0.018) [1.8 (1.8)]
1.5x4-0.5-P4 0.059 x 0.16	0.14 [3.5]	0.63 [16]	1.6 [6.2]	90 [400] 0.0019 (0.0019) [0.19 (0.19)]	120 [550] 0.0049 (0.0049) [0.49 (0.49)]	160 [690] 0.0097 (0.0097) [0.97 (0.97)]	220 [1000] 0.014 (0.014) [1.4 (1.4)]
1.5x4-0.9-P1 0.059 x 0.16	0.15 [3.9]	0.16 [4]	6.3 [25]	75 [330] 0.011 (0) [1.1 (0)]	100 [460] 0.029 (0) [2.9 (0)]	130 [570] 0.057 (0) [5.7 (0)]	190 [830] 0.08 (0) [8 (0)]
1.5x4-0.9-P2 0.059 x 0.16	0.15 [3.9]	0.31 [8]	3.1 [12]	75 [330] 0.0057 (0.0057) [0.57 (0.57)]	100 [460] 0.014 (0.014) [1.4 (1.4)]	130 [570] 0.029 (0.029) [2.9 (2.9)]	190 [830] 0.04 (0.04) [4 (4)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5x4-0.9-P3 0.059 x 0.16	0.15 [3.9]	0.47 [12]	2.1 [8.3]	75 [330] 0.0038 (0.0038) [0.38 (0.38)]	100 [460] 0.0095 (0.0095) [0.95 (0.95)]	130 [570] 0.019 (0.019) [1.9 (1.9)]	190 [830] 0.027 (0.027) [2.7 (2.7)]
1.5x4-0.9-P4 0.059 x 0.16	0.15 [3.9]	0.63 [16]	1.6 [6.2]	75 [330] 0.0028 (0.0028) [0.28 (0.28)]	100 [460] 0.0071 (0.0071) [0.71 (0.71)]	130 [570] 0.014 (0.014) [1.4 (1.4)]	190 [830] 0.02 (0.02) [2 (2)]
1.5x4-1.15-P1 0.059 x 0.16	0.16 [4.15]	0.16 [4]	6.3 [25]	68 [300] 0.014 (0) [1.4 (0)]	94 [420] 0.035 (0) [3.5 (0)]	120 [520] 0.069 (0) [6.9 (0)]	170 [760] 0.097 (0) [9.7 (0)]
1.5x4-1.15-P2 0.059 x 0.16	0.16 [4.15]	0.31 [8]	3.1 [12]	68 [300] 0.0069 (0.0069) [0.69 (0.69)]	94 [420] 0.017 (0.017) [1.7 (1.7)]	120 [520] 0.035 (0.035) [3.5 (3.5)]	170 [760] 0.048 (0.048) [4.8 (4.8)]
1.5x4-1.15-P3 0.059 x 0.16	0.16 [4.15]	0.47 [12]	2.1 [8.3]	68 [300] 0.0046 (0.0046) [0.46 (0.46)]	94 [420] 0.012 (0.012) [1.2 (1.2)]	120 [520] 0.023 (0.023) [2.3 (2.3)]	170 [760] 0.032 (0.032) [3.2 (3.2)]
1.5x4-1.15-P4 0.059 x 0.16	0.16 [4.15]	0.63 [16]	1.6 [6.2]	68 [300] 0.0034 (0.0034) [0.34 (0.34)]	94 [420] 0.0086 (0.0086) [0.86 (0.86)]	120 [520] 0.017 (0.017) [1.7 (1.7)]	170 [760] 0.024 (0.024) [2.4 (2.4)]
1.5x4-1.6-P1 0.059 x 0.16	0.18 [4.6]	0.16 [4]	6.3 [25]	58 [260] 0.019 (0) [1.9 (0)]	80 [360] 0.047 (0) [4.7 (0)]	100 [440] 0.094 (0) [9.4 (0)]	140 [640] 0.13 (0) [13 (0)]
1.5x4-1.6-P2 0.059 x 0.16	0.18 [4.6]	0.31 [8]	3.1 [12]	58 [260] 0.0094 (0.0094) [0.94 (0.94)]	80 [360] 0.024 (0.024) [2.4 (2.4)]	100 [440] 0.047 (0.047) [4.7 (4.7)]	140 [640] 0.066 (0.066) [6.6 (6.6)]
1.5x4-1.6-P3 0.059 x 0.16	0.18 [4.6]	0.47 [12]	2.1 [8.3]	58 [260] 0.0063 (0.0063) [0.63 (0.63)]	80 [360] 0.016 (0.016) [1.6 (1.6)]	100 [440] 0.031 (0.031) [3.1 (3.1)]	140 [640] 0.044 (0.044) [4.4 (4.4)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5x4-1.6-P4 0.059 x 0.16	0.18 [4.6]	0.63 [16]	1.6 [6.2]	58 [260] 0.0047 (0.0047) [0.47 (0.47)]	80 [360] 0.012 (0.012) [1.2 (1.2)]	100 [440] 0.024 (0.024) [2.4 (2.4)]	140 [640] 0.033 (0.033) [3.3 (3.3)]
1.5x4-2.4-P1 0.059 x 0.16	0.21 [5.4]	0.16 [4]	6.3 [25]	46 [200] 0.03 (0) [3 (0)]	64 [280] 0.075 (0) [7.5 (0)]	79 [350] 0.15 (0) [15 (0)]	120 [510] 0.21 (0) [21 (0)]
1.5x4-2.4-P2 0.059 x 0.16	0.21 [5.4]	0.31 [8]	3.1 [12]	46 [200] 0.015 (0.015) [1.5 (1.5)]	64 [280] 0.037 (0.037) [3.8 (3.8)]	79 [350] 0.075 (0.075) [7.5 (7.5)]	120 [510] 0.11 (0.11) [11 (11)]
1.5x4-2.4-P3 0.059 x 0.16	0.21 [5.4]	0.47 [12]	2.1 [8.3]	46 [200] 0.01 (0.01) [1 (1)]	64 [280] 0.025 (0.025) [2.5 (2.5)]	79 [350] 0.05 (0.05) [5 (5)]	120 [510] 0.07 (0.07) [7 (7)]
1.5x4-2.4-P4 0.059 x 0.16	0.21 [5.4]	0.63 [16]	1.6 [6.2]	46 [200] 0.0075 (0.0075) [0.75 (0.75)]	64 [280] 0.019 (0.019) [1.9 (1.9)]	79 [350] 0.037 (0.037) [3.8 (3.8)]	120 [510] 0.053 (0.053) [5.3 (5.3)]
1.5x4-3.2-P1 0.059 x 0.16	0.24 [6.2]	0.16 [4]	6.3 [25]	38 [170] 0.044 (0) [4.4 (0)]	53 [240] 0.11 (0) [11 (0)]	66 [290] 0.22 (0) [22 (0)]	96 [430] 0.31 (0) [31 (0)]
1.5x4-3.2-P2 0.059 x 0.16	0.24 [6.2]	0.31 [8]	3.1 [12]	38 [170] 0.022 (0.022) [2.2 (2.2)]	53 [240] 0.055 (0.055) [5.5 (5.5)]	66 [290] 0.11 (0.11) [11 (11)]	96 [430] 0.15 (0.15) [15 (15)]
1.5x4-3.2-P3 0.059 x 0.16	0.24 [6.2]	0.47 [12]	2.1 [8.3]	38 [170] 0.015 (0.015) [1.5 (1.5)]	53 [240] 0.037 (0.037) [3.7 (3.7)]	66 [290] 0.073 (0.073) [7.3 (7.3)]	96 [430] 0.1 (0.1) [10 (10)]
1.5x4-3.2-P4 0.059 x 0.16	0.24 [6.2]	0.63 [16]	1.6 [6.2]	38 [170] 0.011 (0.011) [1.1 (1.1)]	53 [240] 0.028 (0.028) [2.8 (2.8)]	66 [290] 0.055 (0.055) [5.5 (5.5)]	96 [430] 0.077 (0.077) [7.7 (7.7)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5x4-4.75-P1 0.059 x 0.16	0.31 [7.75]	0.16 [4]	6.3 [25]	29 [130] 0.076 (0) [7.6 (0)]	40 [180] 0.19 (0) [19 (0)]	50 [220] 0.38 (0) [38 (0)]	72 [320] 0.53 (0) [53 (0)]
1.5x4-4.75-P2 0.059 x 0.16	0.31 [7.75]	0.31 [8]	3.1 [12]	29 [130] 0.038 (0.038) [3.8 (3.8)]	40 [180] 0.095 (0.095) [9.5 (9.5)]	50 [220] 0.19 (0.19) [19 (19)]	72 [320] 0.27 (0.27) [27 (27)]
1.5x4-4.75-P3 0.059 x 0.16	0.31 [7.75]	0.47 [12]	2.1 [8.3]	29 [130] 0.025 (0.025) [2.5 (2.5)]	40 [180] 0.063 (0.063) [6.3 (6.3)]	50 [220] 0.13 (0.13) [13 (13)]	72 [320] 0.18 (0.18) [18 (18)]
1.5x4-4.75-P4 0.059 x 0.16	0.31 [7.75]	0.63 [16]	1.6 [6.2]	29 [130] 0.019 (0.019) [1.9 (1.9)]	40 [180] 0.048 (0.048) [4.8 (4.8)]	50 [220] 0.095 (0.095) [9.5 (9.5)]	72 [320] 0.13 (0.13) [13 (13)]
1.5x4-6-P1 0.059 x 0.16	0.35 [9]	0.16 [4]	6.3 [25]	24 [110] 0.11 (0) [11 (0)]	33 [150] 0.28 (0) [28 (0)]	41 [180] 0.55 (0) [55 (0)]	60 [270] 0.77 (0) [77 (0)]
1.5x4-6-P2 0.059 x 0.16	0.35 [9]	0.31 [8]	3.1 [12]	24 [110] 0.055 (0.055) [5.5 (5.5)]	33 [150] 0.14 (0.14) [14 (14)]	41 [180] 0.28 (0.28) [28 (28)]	60 [270] 0.39 (0.39) [39 (39)]
1.5x4-6-P3 0.059 x 0.16	0.35 [9]	0.47 [12]	2.1 [8.3]	24 [110] 0.037 (0.037) [3.7 (3.7)]	33 [150] 0.092 (0.092) [9.2 (9.2)]	41 [180] 0.18 (0.18) [18 (18)]	60 [270] 0.26 (0.26) [26 (26)]
1.5x4-6-P4 0.059 x 0.16	0.35 [9]	0.63 [16]	1.6 [6.2]	24 [110] 0.027 (0.027) [2.7 (2.7)]	33 [150] 0.069 (0.069) [6.9 (6.9)]	41 [180] 0.14 (0.14) [14 (14)]	60 [270] 0.19 (0.19) [19 (19)]
1.5x4-8-P1 0.059 x 0.16	0.43 [11]	0.16 [4]	6.3 [25]	19 [84] 0.18 (0) [18 (0)]	26 [120] 0.45 (0) [44 (0)]	33 [140] 0.89 (0) [89 (0)]	47 [210] 1.2 (0) [120 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5x4-8-P2 0.059 x 0.16	0.43 [11]	0.31 [8]	3.1 [12]	19 [84] 0.089 (0.089) [8.9 (8.9)]	26 [120] 0.22 (0.22) [22 (22)]	33 [140] 0.45 (0.45) [44 (44)]	47 [210] 0.62 (0.5*) [62 (50*)]
1.5x4-8-P3 0.059 x 0.16	0.43 [11]	0.47 [12]	2.1 [8.3]	19 [84] 0.059 (0.059) [5.9 (5.9)]	26 [120] 0.15 (0.15) [15 (15)]	33 [140] 0.3 (0.3) [30 (30)]	47 [210] 0.42 (0.42) [42 (42)]
1.5x4-8-P4 0.059 x 0.16	0.43 [11]	0.63 [16]	1.6 [6.2]	19 [84] 0.044 (0.044) [4.4 (4.4)]	26 [120] 0.11 (0.11) [11 (11)]	33 [140] 0.22 (0.22) [22 (22)]	47 [210] 0.31 (0.31) [31 (31)]
1.5x4-9.5-P1 0.059 x 0.16	0.49 [12.5]	0.16 [4]	6.3 [25]	16 [73] 0.24 (0) [24 (0)]	23 [100] 0.59 (0) [60 (0)]	28 [120] 1.2 (0) [120 (0)]	41 [180] 1.7 (0) [170 (0)]
1.5x4-9.5-P2 0.059 x 0.16	0.49 [12.5]	0.31 [8]	3.1 [12]	16 [73] 0.12 (0.12) [12 (12)]	23 [100] 0.3 (0.3) [30 (30)]	28 [120] 0.59 (0.5*) [60 (50*)]	41 [180] 0.83 (0.5*) [83 (50*)]
1.5x4-9.5-P3 0.059 x 0.16	0.49 [12.5]	0.47 [12]	2.1 [8.3]	16 [73] 0.079 (0.079) [7.9 (7.9)]	23 [100] 0.2 (0.2) [20 (20)]	28 [120] 0.4 (0.4) [40 (40)]	41 [180] 0.56 (0.56) [56 (56)]
1.5x4-9.5-P4 0.059 x 0.16	0.49 [12.5]	0.63 [16]	1.6 [6.2]	16 [73] 0.059 (0.059) [5.9 (5.9)]	23 [100] 0.15 (0.15) [15 (15)]	28 [120] 0.3 (0.3) [30 (30)]	41 [180] 0.42 (0.42) [42 (42)]
1.5x4-12.7-P1 0.059 x 0.16	0.62 [15.7]	0.16 [4]	6.3 [25]	13 [56] 0.4 (0) [40 (0)]	17 [78] 0.99 (0) [99 (0)]	22 [97] 2 (0) [200 (0)]	32 [140] 2.8 (0) [280 (0)]
1.5x4-12.7-P2 0.059 x 0.16	0.62 [15.7]	0.31 [8]	3.1 [12]	13 [56] 0.2 (0.2) [20 (20)]	17 [78] 0.49 (0.49) [50 (50)]	22 [97] 0.99 (0.5*) [99 (50*)]	32 [140] 1.4 (0.5*) [140 (50*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5x4-12.7-P3 0.059 x 0.16	0.62 [15.7]	0.47 [12]	2.1 [8.3]	13 [56] 0.13 (0.13) [13 (13)]	17 [78] 0.33 (0.33) [33 (33)]	22 [97] 0.66 (0.66) [66 (66)]	32 [140] 0.92 (0.67*) [92 (67*)]
1.5x4-12.7-P4 0.059 x 0.16	0.62 [15.7]	0.63 [16]	1.6 [6.2]	13 [56] 0.099 (0.099) [9.9 (9.9)]	17 [78] 0.25 (0.25) [25 (25)]	22 [97] 0.49 (0.49) [50 (50)]	32 [140] 0.69 (0.69) [69 (69)]
1.5x4-14.2-P1 0.059 x 0.16	0.68 [17.2]	0.16 [4]	6.3 [25]	11 [51] 0.48 (0) [48 (0)]	16 [70] 1.2 (0) [120 (0)]	20 [88] 2.4 (0) [240 (0)]	29 [130] 3.4 (0) [340 (0)]
1.5x4-14.2-P2 0.059 x 0.16	0.68 [17.2]	0.31 [8]	3.1 [12]	11 [51] 0.24 (0.24) [24 (24)]	16 [70] 0.6 (0.5*) [60 (50*)]	20 [88] 1.2 (0.5*) [120 (50*)]	29 [130] 1.7 (0.5*) [170 (50*)]
1.5x4-14.2-P3 0.059 x 0.16	0.68 [17.2]	0.47 [12]	2.1 [8.3]	11 [51] 0.16 (0.16) [16 (16)]	16 [70] 0.4 (0.4) [40 (40)]	20 [88] 0.81 (0.67*) [81 (67*)]	29 [130] 1.1 (0.67*) [110 (67*)]
1.5x4-14.2-P4 0.059 x 0.16	0.68 [17.2]	0.63 [16]	1.6 [6.2]	11 [51] 0.12 (0.12) [12 (12)]	16 [70] 0.3 (0.3) [30 (30)]	20 [88] 0.6 (0.6) [60 (60)]	29 [130] 0.85 (0.75*) [85 (75*)]
1.5x4-16-P1 0.059 x 0.16	0.75 [19]	0.16 [4]	6.3 [25]	10 [46] 0.6 (0) [60 (0)]	14 [63] 1.5 (0) [150 (0)]	18 [79] 3 (0) [300 (0)]	26 [110] 4.2 (0) [420 (0)]
1.5x4-16-P2 0.059 x 0.16	0.75 [19]	0.31 [8]	3.1 [12]	10 [46] 0.3 (0.3) [30 (30)]	14 [63] 0.75 (0.5*) [75 (50*)]	18 [79] 1.5 (0.5*) [150 (50*)]	26 [110] 2.1 (0.5*) [210 (50*)]
1.5x4-16-P3 0.059 x 0.16	0.75 [19]	0.47 [12]	2.1 [8.3]	10 [46] 0.2 (0.2) [20 (20)]	14 [63] 0.5 (0.5) [50 (50)]	18 [79] 1 (0.67*) [100 (67*)]	26 [110] 1.4 (0.67*) [140 (67*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5x4-16-P4 0.059 x 0.16	0.75 [19]	0.63 [16]	1.6 [6.2]	10 [46] 0.15 (0.15) [15 (15)]	14 [63] 0.38 (0.38) [38 (38)]	18 [79] 0.75 (0.75*) [75 (75*)]	26 [110] 1.1 (0.75*) [110 (75*)]
1.5x4-19-P1 0.059 x 0.16	0.87 [22]	0.16 [4]	6.3 [25]	8.8 [39] 0.83 (0) [83 (0)]	12 [54] 2.1 (0) [210 (0)]	15 [67] 4.1 (0) [410 (0)]	22 [98] 5.8 (0) [580 (0)]
1.5x4-19-P2 0.059 x 0.16	0.87 [22]	0.31 [8]	3.1 [12]	8.8 [39] 0.41 (0.41) [41 (41)]	12 [54] 1 (0.5*) [100 (50*)]	15 [67] 2.1 (0.5*) [210 (50*)]	22 [98] 2.9 (0.5*) [290 (50*)]
1.5x4-19-P3 0.059 x 0.16	0.87 [22]	0.47 [12]	2.1 [8.3]	8.8 [39] 0.28 (0.28) [28 (28)]	12 [54] 0.69 (0.67*) [69 (67*)]	15 [67] 1.4 (0.67*) [140 (67*)]	22 [98] 1.9 (0.67*) [190 (67*)]
1.5x4-19-P4 0.059 x 0.16	0.87 [22]	0.63 [16]	1.6 [6.2]	8.8 [39] 0.21 (0.21) [21 (21)]	12 [54] 0.52 (0.52) [52 (52)]	15 [67] 1 (0.75*) [100 (75*)]	22 [98] 1.4 (0.75*) [140 (75*)]
1.5x4-22.2-P1 0.059 x 0.16	0.99 [25.2]	0.16 [4]	6.3 [25]	7.6 [34] 1.1 (0) [110 (0)]	10 [47] 2.8 (0) [280 (0)]	13 [58] 5.5 (0) [550 (0)]	19 [84] 7.7 (0) [770 (0)]
1.5x4-22.2-P2 0.059 x 0.16	0.99 [25.2]	0.31 [8]	3.1 [12]	7.6 [34] 0.55 (0.5*) [55 (50*)]	10 [47] 1.4 (0.5*) [140 (50*)]	13 [58] 2.8 (0.5*) [280 (50*)]	19 [84] 3.9 (0.5*) [390 (50*)]
1.5x4-22.2-P3 0.059 x 0.16	0.99 [25.2]	0.47 [12]	2.1 [8.3]	7.6 [34] 0.37 (0.37) [37 (37)]	10 [47] 0.92 (0.67*) [92 (67*)]	13 [58] 1.8 (0.67*) [180 (67*)]	19 [84] 2.6 (0.67*) [260 (67*)]
1.5x4-22.2-P4 0.059 x 0.16	0.99 [25.2]	0.63 [16]	1.6 [6.2]	7.6 [34] 0.28 (0.28) [28 (28)]	10 [47] 0.69 (0.69) [69 (69)]	13 [58] 1.4 (0.75*) [140 (75*)]	19 [84] 1.9 (0.75*) [190 (75*)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — LINEAR output - force and stroke by strip, coil OD and pitch

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5x4-25.4-P1 0.059 x 0.16	1.1 [28.4]	0.16 [4]	6.3 [25]	6.7 [30] 1.4 (0) [140 (0)]	9.2 [41] 3.5 (0) [360 (0)]	11 [51] 7.1 (0) [710 (0)]	17 [74] 9.9 (0) [990 (0)]
1.5x4-25.4-P2 0.059 x 0.16	1.1 [28.4]	0.31 [8]	3.1 [12]	6.7 [30] 0.71 (0.5*) [71 (50*)]	9.2 [41] 1.8 (0.5*) [180 (50*)]	11 [51] 3.5 (0.5*) [360 (50*)]	17 [74] 5 (0.5*) [500 (50*)]
1.5x4-25.4-P3 0.059 x 0.16	1.1 [28.4]	0.47 [12]	2.1 [8.3]	6.7 [30] 0.47 (0.47) [47 (47)]	9.2 [41] 1.2 (0.67*) [120 (67*)]	11 [51] 2.4 (0.67*) [240 (67*)]	17 [74] 3.3 (0.67*) [330 (67*)]
1.5x4-25.4-P4 0.059 x 0.16	1.1 [28.4]	0.63 [16]	1.6 [6.2]	6.7 [30] 0.35 (0.35) [36 (36)]	9.2 [41] 0.89 (0.75*) [89 (75*)]	11 [51] 1.8 (0.75*) [180 (75*)]	17 [74] 2.5 (0.75*) [250 (75*)]

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.152x0.411-0.5-P1	0.006 x 0.016 [0.152 x 0.411]	0.032 [0.804]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	4800 [19000]	960 [3800]
0.152x0.411-0.9-P1	0.006 x 0.016 [0.152 x 0.411]	0.047 [1.2]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	7700 [30000]	960 [3800]
0.152x0.411-1.15-P1	0.006 x 0.016 [0.152 x 0.411]	0.057 [1.45]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	9500 [38000]	960 [3800]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.152x0.411-1.6-P1	0.006 x 0.016 [0.152 x 0.411]	0.075 [1.9]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	13000 [50000]	960 [3800]
0.152x0.411-2.4-P1	0.006 x 0.016 [0.152 x 0.411]	0.11 [2.7]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	19000 [74000]	960 [3800]
0.152x0.411-3.2-P1	0.006 x 0.016 [0.152 x 0.411]	0.14 [3.5]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	25000 [97000]	960 [3800]
0.152x0.411-4.75-P1	0.006 x 0.016 [0.152 x 0.411]	0.2 [5.05]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	36000 [140000]	960 [3800]
0.152x0.411-6-P1	0.006 x 0.016 [0.152 x 0.411]	0.25 [6.3]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	45000 [180000]	960 [3800]
0.152x0.411-8-P1	0.006 x 0.016 [0.152 x 0.411]	0.33 [8.3]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	60000 [230000]	960 [3800]
0.152x0.411-9.5-P1	0.006 x 0.016 [0.152 x 0.411]	0.39 [9.8]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	71000 [280000]	960 [3800]
0.152x0.411-12.7-P1	0.006 x 0.016 [0.152 x 0.411]	0.51 [13]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	94000 [370000]	960 [3800]
0.152x0.411-14.2-P1	0.006 x 0.016 [0.152 x 0.411]	0.57 [14.5]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	110000 [410000]	960 [3800]
0.152x0.411-16-P1	0.006 x 0.016 [0.152 x 0.411]	0.64 [16.3]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	120000 [470000]	960 [3800]
0.152x0.411-19-P1	0.006 x 0.016 [0.152 x 0.411]	0.76 [19.3]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	140000 [550000]	960 [3800]
0.152x0.411-22.2-P1	0.006 x 0.016 [0.152 x 0.411]	0.89 [22.5]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	160000 [640000]	960 [3800]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.152x0.411-25.4-P1	0.006 x 0.016 [0.152 x 0.411]	1 [25.7]	0.0014 [0.16]	0.0019 [0.22]	0.0024 [0.27]	0.0035 [0.4]	190000 [740000]	960 [3800]
0.152x0.813-0.5-P1	0.006 x 0.032 [0.152 x 0.813]	0.032 [0.804]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	2400 [9500]	960 [3800]
0.152x0.813-0.9-P1	0.006 x 0.032 [0.152 x 0.813]	0.047 [1.2]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	3900 [15000]	960 [3800]
0.152x0.813-1.15-P1	0.006 x 0.032 [0.152 x 0.813]	0.057 [1.45]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	4800 [19000]	960 [3800]
0.152x0.813-1.6-P1	0.006 x 0.032 [0.152 x 0.813]	0.075 [1.9]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	6500 [26000]	960 [3800]
0.152x0.813-2.4-P1	0.006 x 0.032 [0.152 x 0.813]	0.11 [2.7]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	9400 [37000]	960 [3800]
0.152x0.813-3.2-P1	0.006 x 0.032 [0.152 x 0.813]	0.14 [3.5]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	12000 [49000]	960 [3800]
0.152x0.813-4.75-P1	0.006 x 0.032 [0.152 x 0.813]	0.2 [5.05]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	18000 [71000]	960 [3800]
0.152x0.813-6-P1	0.006 x 0.032 [0.152 x 0.813]	0.25 [6.3]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	23000 [90000]	960 [3800]
0.152x0.813-8-P1	0.006 x 0.032 [0.152 x 0.813]	0.33 [8.3]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	30000 [120000]	960 [3800]
0.152x0.813-9.5-P1	0.006 x 0.032 [0.152 x 0.813]	0.39 [9.8]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	36000 [140000]	960 [3800]
0.152x0.813-12.7-P1	0.006 x 0.032 [0.152 x 0.813]	0.51 [13]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	48000 [190000]	960 [3800]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.152x0.813-14.2-P1	0.006 x 0.032 [0.152 x 0.813]	0.57 [14.5]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	53000 [210000]	960 [3800]
0.152x0.813-16-P1	0.006 x 0.032 [0.152 x 0.813]	0.64 [16.3]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	60000 [240000]	960 [3800]
0.152x0.813-19-P1	0.006 x 0.032 [0.152 x 0.813]	0.76 [19.3]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	71000 [280000]	960 [3800]
0.152x0.813-22.2-P1	0.006 x 0.032 [0.152 x 0.813]	0.89 [22.5]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	83000 [330000]	960 [3800]
0.152x0.813-25.4-P1	0.006 x 0.032 [0.152 x 0.813]	1 [25.7]	0.0028 [0.31]	0.0038 [0.43]	0.0048 [0.54]	0.0069 [0.78]	95000 [370000]	960 [3800]
0.25x0.5-0.5-P1	0.0098 x 0.02 [0.25 x 0.5]	0.039 [1]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	2700 [11000]	580 [2300]
0.25x0.5-0.9-P1	0.0098 x 0.02 [0.25 x 0.5]	0.055 [1.4]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	4200 [17000]	580 [2300]
0.25x0.5-1.15-P1	0.0098 x 0.02 [0.25 x 0.5]	0.065 [1.65]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	5100 [20000]	580 [2300]
0.25x0.5-1.6-P1	0.0098 x 0.02 [0.25 x 0.5]	0.083 [2.1]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	6800 [27000]	580 [2300]
0.25x0.5-2.4-P1	0.0098 x 0.02 [0.25 x 0.5]	0.11 [2.9]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	9700 [38000]	580 [2300]
0.25x0.5-3.2-P1	0.0098 x 0.02 [0.25 x 0.5]	0.15 [3.7]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	13000 [50000]	580 [2300]
0.25x0.5-4.75-P1	0.0098 x 0.02 [0.25 x 0.5]	0.21 [5.25]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	18000 [72000]	580 [2300]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.25x0.5-6-P1	0.0098 x 0.02 [0.25 x 0.5]	0.26 [6.5]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	23000 [90000]	580 [2300]
0.25x0.5-8-P1	0.0098 x 0.02 [0.25 x 0.5]	0.33 [8.5]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	30000 [120000]	580 [2300]
0.25x0.5-9.5-P1	0.0098 x 0.02 [0.25 x 0.5]	0.39 [10]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	36000 [140000]	580 [2300]
0.25x0.5-12.7-P1	0.0098 x 0.02 [0.25 x 0.5]	0.52 [13.2]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	47000 [190000]	580 [2300]
0.25x0.5-14.2-P1	0.0098 x 0.02 [0.25 x 0.5]	0.58 [14.7]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	53000 [210000]	580 [2300]
0.25x0.5-16-P1	0.0098 x 0.02 [0.25 x 0.5]	0.65 [16.5]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	59000 [230000]	580 [2300]
0.25x0.5-19-P1	0.0098 x 0.02 [0.25 x 0.5]	0.77 [19.5]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	70000 [280000]	580 [2300]
0.25x0.5-22.2-P1	0.0098 x 0.02 [0.25 x 0.5]	0.89 [22.7]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	82000 [320000]	580 [2300]
0.25x0.5-25.4-P1	0.0098 x 0.02 [0.25 x 0.5]	1 [25.9]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	94000 [370000]	580 [2300]
0.3x2-0.5-P1	0.012 x 0.079 [0.3 x 2]	0.043 [1.1]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	610 [2400]	480 [1900]
0.3x2-0.9-P1	0.012 x 0.079 [0.3 x 2]	0.059 [1.5]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	910 [3600]	480 [1900]
0.3x2-1.15-P1	0.012 x 0.079 [0.3 x 2]	0.069 [1.75]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	1100 [4400]	480 [1900]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.3x2-1.6-P1	0.012 x 0.079 [0.3 x 2]	0.087 [2.2]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	1400 [5700]	480 [1900]
0.3x2-2.4-P1	0.012 x 0.079 [0.3 x 2]	0.12 [3]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	2100 [8100]	480 [1900]
0.3x2-3.2-P1	0.012 x 0.079 [0.3 x 2]	0.15 [3.8]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	2700 [10000]	480 [1900]
0.3x2-4.75-P1	0.012 x 0.079 [0.3 x 2]	0.21 [5.35]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	3800 [15000]	480 [1900]
0.3x2-6-P1	0.012 x 0.079 [0.3 x 2]	0.26 [6.6]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	4800 [19000]	480 [1900]
0.3x2-8-P1	0.012 x 0.079 [0.3 x 2]	0.34 [8.6]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	6300 [25000]	480 [1900]
0.3x2-9.5-P1	0.012 x 0.079 [0.3 x 2]	0.4 [10.1]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	7500 [29000]	480 [1900]
0.3x2-12.7-P1	0.012 x 0.079 [0.3 x 2]	0.52 [13.3]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	9900 [39000]	480 [1900]
0.3x2-14.2-P1	0.012 x 0.079 [0.3 x 2]	0.58 [14.8]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	11000 [44000]	480 [1900]
0.3x2-16-P1	0.012 x 0.079 [0.3 x 2]	0.65 [16.6]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	12000 [49000]	480 [1900]
0.3x2-19-P1	0.012 x 0.079 [0.3 x 2]	0.77 [19.6]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	15000 [58000]	480 [1900]
0.3x2-22.2-P1	0.012 x 0.079 [0.3 x 2]	0.9 [22.8]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	17000 [68000]	480 [1900]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.3x2-25.4-P1	0.012 x 0.079 [0.3 x 2]	1 [26]	0.027 [3]	0.037 [4.1]	0.046 [5.2]	0.066 [7.5]	20000 [77000]	480 [1900]
0.4x0.8-0.5-P1	0.016 x 0.031 [0.4 x 0.8]	0.051 [1.3]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	1300 [5100]	360 [1400]
0.4x0.8-0.9-P1	0.016 x 0.031 [0.4 x 0.8]	0.067 [1.7]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	1900 [7300]	360 [1400]
0.4x0.8-1.15-P1	0.016 x 0.031 [0.4 x 0.8]	0.077 [1.95]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	2200 [8700]	360 [1400]
0.4x0.8-1.6-P1	0.016 x 0.031 [0.4 x 0.8]	0.094 [2.4]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	2900 [11000]	360 [1400]
0.4x0.8-2.4-P1	0.016 x 0.031 [0.4 x 0.8]	0.13 [3.2]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	4000 [16000]	360 [1400]
0.4x0.8-3.2-P1	0.016 x 0.031 [0.4 x 0.8]	0.16 [4]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	5100 [20000]	360 [1400]
0.4x0.8-4.75-P1	0.016 x 0.031 [0.4 x 0.8]	0.22 [5.55]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	7400 [29000]	360 [1400]
0.4x0.8-6-P1	0.016 x 0.031 [0.4 x 0.8]	0.27 [6.8]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	9100 [36000]	360 [1400]
0.4x0.8-8-P1	0.016 x 0.031 [0.4 x 0.8]	0.35 [8.8]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	12000 [47000]	360 [1400]
0.4x0.8-9.5-P1	0.016 x 0.031 [0.4 x 0.8]	0.41 [10.3]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	14000 [56000]	360 [1400]
0.4x0.8-12.7-P1	0.016 x 0.031 [0.4 x 0.8]	0.53 [13.5]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	19000 [74000]	360 [1400]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.4x0.8-14.2-P1	0.016 x 0.031 [0.4 x 0.8]	0.59 [15]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	21000 [82000]	360 [1400]
0.4x0.8-16-P1	0.016 x 0.031 [0.4 x 0.8]	0.66 [16.8]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	23000 [92000]	360 [1400]
0.4x0.8-19-P1	0.016 x 0.031 [0.4 x 0.8]	0.78 [19.8]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	28000 [110000]	360 [1400]
0.4x0.8-22.2-P1	0.016 x 0.031 [0.4 x 0.8]	0.91 [23]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	32000 [130000]	360 [1400]
0.4x0.8-25.4-P1	0.016 x 0.031 [0.4 x 0.8]	1 [26.2]	0.019 [2.1]	0.026 [2.9]	0.032 [3.7]	0.047 [5.3]	37000 [150000]	360 [1400]
0.4x1-0.5-P1	0.016 x 0.039 [0.4 x 1]	0.051 [1.3]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	1000 [4000]	360 [1400]
0.4x1-0.9-P1	0.016 x 0.039 [0.4 x 1]	0.067 [1.7]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	1500 [5800]	360 [1400]
0.4x1-1.15-P1	0.016 x 0.039 [0.4 x 1]	0.077 [1.95]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	1800 [7000]	360 [1400]
0.4x1-1.6-P1	0.016 x 0.039 [0.4 x 1]	0.094 [2.4]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	2300 [9000]	360 [1400]
0.4x1-2.4-P1	0.016 x 0.039 [0.4 x 1]	0.13 [3.2]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	3200 [13000]	360 [1400]
0.4x1-3.2-P1	0.016 x 0.039 [0.4 x 1]	0.16 [4]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	4100 [16000]	360 [1400]
0.4x1-4.75-P1	0.016 x 0.039 [0.4 x 1]	0.22 [5.55]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	5900 [23000]	360 [1400]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.4x1-6-P1	0.016 x 0.039 [0.4 x 1]	0.27 [6.8]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	7300 [29000]	360 [1400]
0.4x1-8-P1	0.016 x 0.039 [0.4 x 1]	0.35 [8.8]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	9600 [38000]	360 [1400]
0.4x1-9.5-P1	0.016 x 0.039 [0.4 x 1]	0.41 [10.3]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	11000 [45000]	360 [1400]
0.4x1-12.7-P1	0.016 x 0.039 [0.4 x 1]	0.53 [13.5]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	15000 [59000]	360 [1400]
0.4x1-14.2-P1	0.016 x 0.039 [0.4 x 1]	0.59 [15]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	17000 [66000]	360 [1400]
0.4x1-16-P1	0.016 x 0.039 [0.4 x 1]	0.66 [16.8]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	19000 [74000]	360 [1400]
0.4x1-19-P1	0.016 x 0.039 [0.4 x 1]	0.78 [19.8]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	22000 [87000]	360 [1400]
0.4x1-22.2-P1	0.016 x 0.039 [0.4 x 1]	0.91 [23]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	26000 [100000]	360 [1400]
0.4x1-25.4-P1	0.016 x 0.039 [0.4 x 1]	1 [26.2]	0.024 [2.7]	0.033 [3.7]	0.041 [4.6]	0.059 [6.7]	29000 [120000]	360 [1400]
0.5x0.25-0.5-P1	0.02 x 0.0098 [0.5 x 0.25]	0.059 [1.5]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	3700 [14000]	290 [1100]
0.5x0.25-0.9-P1	0.02 x 0.0098 [0.5 x 0.25]	0.075 [1.9]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	5100 [20000]	290 [1100]
0.5x0.25-1.15-P1	0.02 x 0.0098 [0.5 x 0.25]	0.085 [2.15]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	6000 [24000]	290 [1100]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.5x0.25-1.6-P1	0.02 x 0.0098 [0.5 x 0.25]	0.1 [2.6]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	7700 [30000]	290 [1100]
0.5x0.25-2.4-P1	0.02 x 0.0098 [0.5 x 0.25]	0.13 [3.4]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	11000 [42000]	290 [1100]
0.5x0.25-3.2-P1	0.02 x 0.0098 [0.5 x 0.25]	0.17 [4.2]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	14000 [53000]	290 [1100]
0.5x0.25-4.75-P1	0.02 x 0.0098 [0.5 x 0.25]	0.23 [5.75]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	19000 [76000]	290 [1100]
0.5x0.25-6-P1	0.02 x 0.0098 [0.5 x 0.25]	0.28 [7]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	24000 [94000]	290 [1100]
0.5x0.25-8-P1	0.02 x 0.0098 [0.5 x 0.25]	0.35 [9]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	31000 [120000]	290 [1100]
0.5x0.25-9.5-P1	0.02 x 0.0098 [0.5 x 0.25]	0.41 [10.5]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	37000 [140000]	290 [1100]
0.5x0.25-12.7-P1	0.02 x 0.0098 [0.5 x 0.25]	0.54 [13.7]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	48000 [190000]	290 [1100]
0.5x0.25-14.2-P1	0.02 x 0.0098 [0.5 x 0.25]	0.6 [15.2]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	54000 [210000]	290 [1100]
0.5x0.25-16-P1	0.02 x 0.0098 [0.5 x 0.25]	0.67 [17]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	60000 [240000]	290 [1100]
0.5x0.25-19-P1	0.02 x 0.0098 [0.5 x 0.25]	0.79 [20]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	71000 [280000]	290 [1100]
0.5x0.25-22.2-P1	0.02 x 0.0098 [0.5 x 0.25]	0.91 [23.2]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	83000 [330000]	290 [1100]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.5x0.25-25.4-P1	0.02 x 0.0098 [0.5 x 0.25]	1 [26.4]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	95000 [370000]	290 [1100]
0.5x0.8-0.5-P1	0.02 x 0.031 [0.5 x 0.8]	0.059 [1.5]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	1100 [4500]	290 [1100]
0.5x0.8-0.9-P1	0.02 x 0.031 [0.5 x 0.8]	0.075 [1.9]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	1600 [6300]	290 [1100]
0.5x0.8-1.15-P1	0.02 x 0.031 [0.5 x 0.8]	0.085 [2.15]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	1900 [7400]	290 [1100]
0.5x0.8-1.6-P1	0.02 x 0.031 [0.5 x 0.8]	0.1 [2.6]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	2400 [9400]	290 [1100]
0.5x0.8-2.4-P1	0.02 x 0.031 [0.5 x 0.8]	0.13 [3.4]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	3300 [13000]	290 [1100]
0.5x0.8-3.2-P1	0.02 x 0.031 [0.5 x 0.8]	0.17 [4.2]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	4200 [17000]	290 [1100]
0.5x0.8-4.75-P1	0.02 x 0.031 [0.5 x 0.8]	0.23 [5.75]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	6000 [24000]	290 [1100]
0.5x0.8-6-P1	0.02 x 0.031 [0.5 x 0.8]	0.28 [7]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	7400 [29000]	290 [1100]
0.5x0.8-8-P1	0.02 x 0.031 [0.5 x 0.8]	0.35 [9]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	9700 [38000]	290 [1100]
0.5x0.8-9.5-P1	0.02 x 0.031 [0.5 x 0.8]	0.41 [10.5]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	11000 [45000]	290 [1100]
0.5x0.8-12.7-P1	0.02 x 0.031 [0.5 x 0.8]	0.54 [13.7]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	15000 [59000]	290 [1100]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.5x0.8-14.2-P1	0.02 x 0.031 [0.5 x 0.8]	0.6 [15.2]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	17000 [66000]	290 [1100]
0.5x0.8-16-P1	0.02 x 0.031 [0.5 x 0.8]	0.67 [17]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	19000 [74000]	290 [1100]
0.5x0.8-19-P1	0.02 x 0.031 [0.5 x 0.8]	0.79 [20]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	22000 [88000]	290 [1100]
0.5x0.8-22.2-P1	0.02 x 0.031 [0.5 x 0.8]	0.91 [23.2]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	26000 [100000]	290 [1100]
0.5x0.8-25.4-P1	0.02 x 0.031 [0.5 x 0.8]	1 [26.4]	0.029 [3.3]	0.041 [4.6]	0.051 [5.7]	0.074 [8.3]	30000 [120000]	290 [1100]
0.55x1.4-0.5-P1	0.022 x 0.055 [0.55 x 1.4]	0.063 [1.6]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	620 [2500]	260 [1000]
0.55x1.4-0.9-P1	0.022 x 0.055 [0.55 x 1.4]	0.079 [2]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	860 [3400]	260 [1000]
0.55x1.4-1.15-P1	0.022 x 0.055 [0.55 x 1.4]	0.089 [2.25]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	1000 [4000]	260 [1000]
0.55x1.4-1.6-P1	0.022 x 0.055 [0.55 x 1.4]	0.11 [2.7]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	1300 [5000]	260 [1000]
0.55x1.4-2.4-P1	0.022 x 0.055 [0.55 x 1.4]	0.14 [3.5]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	1800 [6900]	260 [1000]
0.55x1.4-3.2-P1	0.022 x 0.055 [0.55 x 1.4]	0.17 [4.3]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	2200 [8800]	260 [1000]
0.55x1.4-4.75-P1	0.022 x 0.055 [0.55 x 1.4]	0.23 [5.85]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	3100 [12000]	260 [1000]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.55x1.4-6-P1	0.022 x 0.055 [0.55 x 1.4]	0.28 [7.1]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	3900 [15000]	260 [1000]
0.55x1.4-8-P1	0.022 x 0.055 [0.55 x 1.4]	0.36 [9.1]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	5100 [20000]	260 [1000]
0.55x1.4-9.5-P1	0.022 x 0.055 [0.55 x 1.4]	0.42 [10.6]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	6000 [23000]	260 [1000]
0.55x1.4-12.7-P1	0.022 x 0.055 [0.55 x 1.4]	0.54 [13.8]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	7900 [31000]	260 [1000]
0.55x1.4-14.2-P1	0.022 x 0.055 [0.55 x 1.4]	0.6 [15.3]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	8800 [34000]	260 [1000]
0.55x1.4-16-P1	0.022 x 0.055 [0.55 x 1.4]	0.67 [17.1]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	9800 [39000]	260 [1000]
0.55x1.4-19-P1	0.022 x 0.055 [0.55 x 1.4]	0.79 [20.1]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	12000 [46000]	260 [1000]
0.55x1.4-22.2-P1	0.022 x 0.055 [0.55 x 1.4]	0.92 [23.3]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	14000 [53000]	260 [1000]
0.55x1.4-25.4-P1	0.022 x 0.055 [0.55 x 1.4]	1 [26.5]	0.062 [7.1]	0.086 [9.7]	0.11 [12]	0.16 [18]	15000 [61000]	260 [1000]
0.6x2.3-0.5-P1	0.024 x 0.091 [0.6 x 2.3]	0.067 [1.7]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	360 [1400]	240 [960]
0.6x2.3-0.9-P1	0.024 x 0.091 [0.6 x 2.3]	0.083 [2.1]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	500 [2000]	240 [960]
0.6x2.3-1.15-P1	0.024 x 0.091 [0.6 x 2.3]	0.093 [2.35]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	580 [2300]	240 [960]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.6x2.3-1.6-P1	0.024 x 0.091 [0.6 x 2.3]	0.11 [2.8]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	730 [2900]	240 [960]
0.6x2.3-2.4-P1	0.024 x 0.091 [0.6 x 2.3]	0.14 [3.6]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	990 [3900]	240 [960]
0.6x2.3-3.2-P1	0.024 x 0.091 [0.6 x 2.3]	0.17 [4.4]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	1300 [5000]	240 [960]
0.6x2.3-4.75-P1	0.024 x 0.091 [0.6 x 2.3]	0.23 [5.95]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	1800 [7000]	240 [960]
0.6x2.3-6-P1	0.024 x 0.091 [0.6 x 2.3]	0.28 [7.2]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	2200 [8600]	240 [960]
0.6x2.3-8-P1	0.024 x 0.091 [0.6 x 2.3]	0.36 [9.2]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	2800 [11000]	240 [960]
0.6x2.3-9.5-P1	0.024 x 0.091 [0.6 x 2.3]	0.42 [10.7]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	3300 [13000]	240 [960]
0.6x2.3-12.7-P1	0.024 x 0.091 [0.6 x 2.3]	0.55 [13.9]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	4400 [17000]	240 [960]
0.6x2.3-14.2-P1	0.024 x 0.091 [0.6 x 2.3]	0.61 [15.4]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	4900 [19000]	240 [960]
0.6x2.3-16-P1	0.024 x 0.091 [0.6 x 2.3]	0.68 [17.2]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	5500 [22000]	240 [960]
0.6x2.3-19-P1	0.024 x 0.091 [0.6 x 2.3]	0.8 [20.2]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	6500 [26000]	240 [960]
0.6x2.3-22.2-P1	0.024 x 0.091 [0.6 x 2.3]	0.92 [23.4]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	7600 [30000]	240 [960]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.6x2.3-25.4-P1	0.024 x 0.091 [0.6 x 2.3]	1 [26.6]	0.12 [14]	0.17 [19]	0.21 [24]	0.31 [34]	8600 [34000]	240 [960]
0.8x1.5-0.5-P1	0.031 x 0.059 [0.8 x 1.5]	0.083 [2.1]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	500 [2000]	180 [720]
0.8x1.5-0.9-P1	0.031 x 0.059 [0.8 x 1.5]	0.098 [2.5]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	650 [2600]	180 [720]
0.8x1.5-1.15-P1	0.031 x 0.059 [0.8 x 1.5]	0.11 [2.75]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	740 [2900]	180 [720]
0.8x1.5-1.6-P1	0.031 x 0.059 [0.8 x 1.5]	0.13 [3.2]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	910 [3600]	180 [720]
0.8x1.5-2.4-P1	0.031 x 0.059 [0.8 x 1.5]	0.16 [4]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	1200 [4800]	180 [720]
0.8x1.5-3.2-P1	0.031 x 0.059 [0.8 x 1.5]	0.19 [4.8]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	1500 [6000]	180 [720]
0.8x1.5-4.75-P1	0.031 x 0.059 [0.8 x 1.5]	0.25 [6.35]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	2100 [8300]	180 [720]
0.8x1.5-6-P1	0.031 x 0.059 [0.8 x 1.5]	0.3 [7.6]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	2600 [10000]	180 [720]
0.8x1.5-8-P1	0.031 x 0.059 [0.8 x 1.5]	0.38 [9.6]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	3400 [13000]	180 [720]
0.8x1.5-9.5-P1	0.031 x 0.059 [0.8 x 1.5]	0.44 [11.1]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	3900 [15000]	180 [720]
0.8x1.5-12.7-P1	0.031 x 0.059 [0.8 x 1.5]	0.56 [14.3]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	5100 [20000]	180 [720]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.8x1.5-14.2-P1	0.031 x 0.059 [0.8 x 1.5]	0.62 [15.8]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	5700 [22000]	180 [720]
0.8x1.5-16-P1	0.031 x 0.059 [0.8 x 1.5]	0.69 [17.6]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	6400 [25000]	180 [720]
0.8x1.5-19-P1	0.031 x 0.059 [0.8 x 1.5]	0.81 [20.6]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	7500 [30000]	180 [720]
0.8x1.5-22.2-P1	0.031 x 0.059 [0.8 x 1.5]	0.94 [23.8]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	8800 [34000]	180 [720]
0.8x1.5-25.4-P1	0.031 x 0.059 [0.8 x 1.5]	1.1 [27]	0.14 [16]	0.2 [22]	0.24 [28]	0.35 [40]	10000 [39000]	180 [720]
1x2.6-0.5-P1	0.039 x 0.1 [1 x 2.6]	0.098 [2.5]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	260 [1000]	150 [570]
1x2.6-0.9-P1	0.039 x 0.1 [1 x 2.6]	0.11 [2.9]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	330 [1300]	150 [570]
1x2.6-1.15-P1	0.039 x 0.1 [1 x 2.6]	0.12 [3.15]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	380 [1500]	150 [570]
1x2.6-1.6-P1	0.039 x 0.1 [1 x 2.6]	0.14 [3.6]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	460 [1800]	150 [570]
1x2.6-2.4-P1	0.039 x 0.1 [1 x 2.6]	0.17 [4.4]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	600 [2400]	150 [570]
1x2.6-3.2-P1	0.039 x 0.1 [1 x 2.6]	0.2 [5.2]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	740 [2900]	150 [570]
1x2.6-4.75-P1	0.039 x 0.1 [1 x 2.6]	0.27 [6.75]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	1000 [4000]	150 [570]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
1x2.6-6-P1	0.039 x 0.1 [1 x 2.6]	0.31 [8]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	1200 [4800]	150 [570]
1x2.6-8-P1	0.039 x 0.1 [1 x 2.6]	0.39 [10]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	1600 [6200]	150 [570]
1x2.6-9.5-P1	0.039 x 0.1 [1 x 2.6]	0.45 [11.5]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	1800 [7300]	150 [570]
1x2.6-12.7-P1	0.039 x 0.1 [1 x 2.6]	0.58 [14.7]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	2400 [9500]	150 [570]
1x2.6-14.2-P1	0.039 x 0.1 [1 x 2.6]	0.64 [16.2]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	2700 [11000]	150 [570]
1x2.6-16-P1	0.039 x 0.1 [1 x 2.6]	0.71 [18]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	3000 [12000]	150 [570]
1x2.6-19-P1	0.039 x 0.1 [1 x 2.6]	0.83 [21]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	3500 [14000]	150 [570]
1x2.6-22.2-P1	0.039 x 0.1 [1 x 2.6]	0.95 [24.2]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	4100 [16000]	150 [570]
1x2.6-25.4-P1	0.039 x 0.1 [1 x 2.6]	1.1 [27.4]	0.38 [43]	0.53 [60]	0.66 [75]	0.96 [110]	4600 [18000]	150 [570]
1.5x4-0.5-P1	0.059 x 0.16 [1.5 x 4]	0.14 [3.5]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	150 [600]	97 [380]
1.5x4-0.9-P1	0.059 x 0.16 [1.5 x 4]	0.15 [3.9]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	180 [720]	97 [380]
1.5x4-1.15-P1	0.059 x 0.16 [1.5 x 4]	0.16 [4.15]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	200 [800]	97 [380]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
1.5x4-1.6-P1	0.059 x 0.16 [1.5 x 4]	0.18 [4.6]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	240 [930]	97 [380]
1.5x4-2.4-P1	0.059 x 0.16 [1.5 x 4]	0.21 [5.4]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	300 [1200]	97 [380]
1.5x4-3.2-P1	0.059 x 0.16 [1.5 x 4]	0.24 [6.2]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	360 [1400]	97 [380]
1.5x4-4.75-P1	0.059 x 0.16 [1.5 x 4]	0.31 [7.75]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	480 [1900]	97 [380]
1.5x4-6-P1	0.059 x 0.16 [1.5 x 4]	0.35 [9]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	570 [2200]	97 [380]
1.5x4-8-P1	0.059 x 0.16 [1.5 x 4]	0.43 [11]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	720 [2800]	97 [380]
1.5x4-9.5-P1	0.059 x 0.16 [1.5 x 4]	0.49 [12.5]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	840 [3300]	97 [380]
1.5x4-12.7-P1	0.059 x 0.16 [1.5 x 4]	0.62 [15.7]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	1100 [4300]	97 [380]
1.5x4-14.2-P1	0.059 x 0.16 [1.5 x 4]	0.68 [17.2]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	1200 [4700]	97 [380]
1.5x4-16-P1	0.059 x 0.16 [1.5 x 4]	0.75 [19]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	1300 [5200]	97 [380]
1.5x4-19-P1	0.059 x 0.16 [1.5 x 4]	0.87 [22]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	1600 [6200]	97 [380]
1.5x4-22.2-P1	0.059 x 0.16 [1.5 x 4]	0.99 [25.2]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	1800 [7100]	97 [380]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

FACE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
1.5x4-25.4-P1	0.059 x 0.16 [1.5 x 4]	1.1 [28.4]	1.3 [150]	1.8 [210]	2.3 [260]	3.3 [380]	2000 [8100]	97 [380]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

NOTES

NOTES

CHAPTER 6

Edge Wound Spring Actuators

The strip stood on its edge - very high travel actuators

An edge wound spring actuator is the same flat strip as the last chapter, wound round the same mandrel, but standing on its edge. Pull it along its axis and the strip only has to bend across its thickness, which is the easy way to bend it. A Slinky is an edge wound coil, and it is the picture to keep in mind: a great deal of travel for very little force.

Bending the easy way means each turn can open a long way before the strip reaches its strain limit, so the spring actuator travels a long way. It also means there is very little metal resisting, so it does not pull hard. You get travel instead of force. For the same strip on the same mandrel, roughly speaking, the movement goes up by the ratio of width to thickness and the force comes down by the same ratio.

That is the reason to choose it. When a job needs a long, soft travel from a wound strip, this is the shape.

Two outputs from one part

Like a face wound spring actuator, an edge wound spring actuator does two jobs depending on how you load it, and both are listed. Pull it along its axis and the coil opens out and you get a straight-line stroke. Hold one end and turn the other and it winds or unwinds and you get rotation. The ranking reverses between the two: as a linear actuator the edge wound spring actuator is the soft, long-travel one, but turned about its axis it bends the strip the hard way, so in rotary use it is the high-torque, small-angle one.

One part does two jobs for a reason worth understanding. Nitinol recovers a shape rather than producing a motion, and it recovers the whole shape at once. The coil is moving toward a particular length, a particular diameter and a particular number of turns at the same time. What you mount it in decides which of those you take. Hold the ends and take the length change and it is a linear actuator. Hold one end and let the other turn and it is a rotary one. Leave both free and you get both together: one heating event delivers a pull and a twist at the same time, and a mechanism built to use them can take work off each.

This handbook cannot size that part for you. The two modes are coupled. Twisting the coil changes its diameter, and the diameter is what sets how it behaves in linear mode, so neither set of figures holds while the other motion is happening. Every number in this chapter is for one mode at a time. If you want a part that does both at once, that is a conversation.

The same parts appear again in Chapter 7, listed as torsion spring actuators with their torque and angular sweep per wrap.

Getting it back

Like every shape in this handbook, a nitinol actuator moves one way when it is heated. Getting it back to where it started is the designer's problem, and there are three ways to solve it.

AN ANTAGONISTIC PAIR uses a second actuator working against the first. Heat one and it moves the mechanism and resets the other; heat the other and it goes back. You get powered motion in both directions with full output each way, at the cost of two actuators and a control scheme that never heats both at once.

A BIAS is a passive element, usually a conventional spring or a weight, that the actuator works against as it moves and that pushes it back as it cools. It is the simplest arrangement and the most common. The price is that the bias resists the actuator through the whole stroke, so part of the force in the table is spent returning the mechanism rather than doing the job. Size it to return the actuator and no more.

SYSTEM FORCES are the return you already have. If the mechanism pushes back on its own, if gravity closes the door, if the thing being clamped is springy, if line pressure acts on the valve, that force resets the actuator for nothing. It is the best answer when it is available, and worth looking for before adding parts.

Whichever you choose, the return has to be strong enough to reset the actuator while it is cool and weak enough not to stall it while it is hot. That window is what sizes a bias, and it is the most common thing to get wrong on a first build.

There is a fourth possibility. Any nitinol actuator can be given a two way set, so that it takes one shape hot and another cold and needs no return at all. Two way parts are made to order and are outside the scope of this handbook, so nothing here is rated for it, but it exists. Ask.

Overdriving an actuator

The figures in this handbook are conservative. Every force in every table is rated at a stress we are confident the part will deliver, cycle after cycle, at the fatigue life of its design level. A part will usually do more than the table says. We would rather you found that out in testing than the other way round.

The second reason a part will beat its table is that you can overdrive it, and this one is a feature you can design with. There are two ways to do it, and they add.

The first is to heat it further. Nitinol makes its force by changing phase, and the temperature at which it does that is the transition temperature we set for you. The force does not stop climbing when the part gets there. Keep heating it past the transition and the force keeps rising with temperature, well beyond the rated figure. The table gives you the force at a working temperature comfortably above transition. Drive the part hotter and there is more.

The second is to heat it faster. Heat the part slowly and it makes the force in the table. Heat it quickly, with a sharp pulse of current rather than a gentle ramp, and it makes more, and the harder the pulse, the bigger the difference. A part that is driven both fast and hot gets the gain from each, one on top of the other. The tables assume neither. They are the floor.

Emergency mode

That gives a nitinol actuator something most actuators do not have: a reserve. A motor or a solenoid has a rated output and a thermal limit close behind it. A nitinol actuator can be driven, briefly, to a force well above its rating simply by putting more heat into it, faster. Think of it as an emergency mode. A latch that normally needs a modest pull can, on the day something jams, be hit with a short

hard pulse and told to pull much harder. A release that must not fail gets a margin that costs nothing in size or weight.

Use it as a reserve, not as the rating, and know where the limits are. There is a temperature, called Md, above which the metal can no longer be pushed into martensite by stress; up to Md the material is still behaving as nitinol should. Overdriving up to Md costs some fatigue life, but it also does the part a favor: the extra heat drives out residual martensite that builds up over many cycles, a kind of rehabilitation in place, so a part that is occasionally run hard can come back sharper than one that never is. Above Md the accounting changes. Degradation is faster, and each hot cycle takes a larger bite out of the life. Above 350 °C (660 °F) the part is past saving: treat an actuator that has been driven that hot as spent and replace it. Used within those limits, for the rare event, emergency mode is one of the best arguments for the material.

Actuator safety

Most actuators fail badly when they are overdriven, and engineers know exactly how. Put too much current into a motor or a solenoid and it explodes. Overpressure a hydraulic cylinder and it bursts, or springs a pinhole leak, and a jet of oil at that pressure will cut through a glove and a hand, take a limb, and put oil into the ground and the water where it can be years being cleaned up. Every one of them has the same problem: the energy is stored in the actuator, and when something goes wrong it has nowhere to go but out. A nitinol actuator, very simply, does not carry these risks. It is a piece of metal with a current in it, and there is nothing in it to burst, nothing to leak, and nothing to poison.

A nitinol actuator fails the other way. Put too much power into it and it simply gets hotter. Past the working range the force keeps rising; past that, the part reaches the temperatures at which it was shape set, and at that point the metal lets go of its memory. The actuator loses its force, goes slack, and parts, which opens the circuit that was heating it. It shuts itself off. There is nothing stored in it to release: no pressure, no winding, no field. The failure mode is a dead part and an open circuit, not an event.

That is worth stating plainly for anyone writing a safety case. The worst thing an overdriven nitinol actuator does is stop.

What we supply

Strip sections	Thirteen, from 0.152 x 0.411 mm to 1.5 x 4 mm.
Mandrels	Sixteen, from 0.5 to 25.4 mm.
Pitch	Tight pitch only. That is what makes it pull and not push.
Transition temperatures	20 C, 35 C, 45 C and 80 C.
Sold as	Continuous length, by the inch.

Edge wound spring actuators are not yet a listed product. The sizes are shown because they are made from strip and mandrels we already hold, and because the comparison with face wound is the clearest illustration in this handbook of how much the shape decides. Ask us before designing one in.

Edge wound pulls, it does not push

Edge wound spring actuators are made tight pitch only. That falls out of winding a strip on its edge, and it puts the actuator's neutral position hard against one end of its travel: it is already at its solid height, with no room to compress into. The consequence is worth stating plainly. An edge wound spring actuator pulls and it does not push. If you need the pushing behavior described in the helical chapter, the part has to be face wound.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.411-0.5-P1 0.006 x 0.016	0.052 [1.32]	0.006 [0.152]	170 [660]	0.078 [0.35] 1.1 (0) [110 (0)]	0.11 [0.48] 2.8 (0) [280 (0)]	0.13 [0.6] 5.6 (0) [560 (0)]	0.2 [0.87] 7.9 (0) [790 (0)]
0.152x0.411-0.9-P1 0.006 x 0.016	0.068 [1.72]	0.006 [0.152]	170 [660]	0.054 [0.24] 2.3 (0) [230 (0)]	0.075 [0.33] 5.8 (0) [580 (0)]	0.093 [0.42] 12 (0) [1200 (0)]	0.14 [0.6] 16 (0) [1600 (0)]
0.152x0.411-1.15-P1 0.006 x 0.016	0.078 [1.97]	0.006 [0.152]	170 [660]	0.046 [0.2] 3.3 (0) [330 (0)]	0.063 [0.28] 8.3 (0) [830 (0)]	0.078 [0.35] 17 (0) [1700 (0)]	0.11 [0.51] 23 (0) [2300 (0)]
0.152x0.411-1.6-P1 0.006 x 0.016	0.095 [2.42]	0.006 [0.152]	170 [660]	0.035 [0.16] 5.5 (0) [550 (0)]	0.049 [0.22] 14 (0) [1400 (0)]	0.061 [0.27] 27 (0) [2700 (0)]	0.089 [0.39] 38 (0) [3800 (0)]
0.152x0.411-2.4-P1 0.006 x 0.016	0.13 [3.22]	0.006 [0.152]	170 [660]	0.025 [0.11] 11 (0) [1100 (0)]	0.035 [0.16] 27 (0) [2700 (0)]	0.044 [0.19] 54 (0) [5400 (0)]	0.063 [0.28] 75 (0) [7500 (0)]
0.152x0.411-3.2-P1 0.006 x 0.016	0.16 [4.02]	0.006 [0.152]	170 [660]	0.02 [0.088] 18 (0) [1800 (0)]	0.027 [0.12] 44 (0) [4400 (0)]	0.034 [0.15] 89 (0) [8900 (0)]	0.049 [0.22] 120 (0) [12000 (0)]
0.152x0.411-4.75-P1 0.006 x 0.016	0.22 [5.57]	0.006 [0.152]	170 [660]	0.014 [0.061] 36 (0) [3600 (0)]	0.019 [0.085] 91 (0) [9100 (0)]	0.024 [0.11] 180 (0) [18000 (0)]	0.034 [0.15] 250 (0) [25000 (0)]
0.152x0.411-6-P1 0.006 x 0.016	0.27 [6.82]	0.006 [0.152]	170 [660]	0.011 [0.049] 56 (0) [5600 (0)]	0.015 [0.068] 140 (0) [14000 (0)]	0.019 [0.085] 280 (0) [28000 (0)]	0.028 [0.12] 390 (0) [39000 (0)]
0.152x0.411-8-P1 0.006 x 0.016	0.35 [8.82]	0.006 [0.152]	170 [660]	0.0085 [0.038] 96 (0) [9600 (0)]	0.012 [0.052] 240 (0) [24000 (0)]	0.015 [0.065] 480 (0) [48000 (0)]	0.021 [0.094] 670 (0) [67000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.411-9.5-P1 0.006 x 0.016	0.41 [10.3]	0.006 [0.152]	170 [660]	0.0072 [0.032] 130 (0) [13000 (0)]	0.0099 [0.044] 330 (0) [33000 (0)]	0.012 [0.055] 670 (0) [67000 (0)]	0.018 [0.08] 930 (0) [93000 (0)]
0.152x0.411-12.7-P1 0.006 x 0.016	0.53 [13.5]	0.006 [0.152]	170 [660]	0.0054 [0.024] 230 (0) [23000 (0)]	0.0075 [0.033] 580 (0) [58000 (0)]	0.0093 [0.042] 1200 (0) [120000 (0)]	0.014 [0.06] 1600 (0) [160000 (0)]
0.152x0.411-14.2-P1 0.006 x 0.016	0.59 [15]	0.006 [0.152]	170 [660]	0.0049 [0.022] 290 (0) [29000 (0)]	0.0067 [0.03] 730 (0) [73000 (0)]	0.0084 [0.037] 1500 (0) [150000 (0)]	0.012 [0.054] 2000 (0) [200000 (0)]
0.152x0.411-16-P1 0.006 x 0.016	0.66 [16.8]	0.006 [0.152]	170 [660]	0.0043 [0.019] 370 (0) [37000 (0)]	0.006 [0.027] 920 (0) [92000 (0)]	0.0075 [0.033] 1800 (0) [180000 (0)]	0.011 [0.048] 2600 (0) [260000 (0)]
0.152x0.411-19-P1 0.006 x 0.016	0.78 [19.8]	0.006 [0.152]	170 [660]	0.0037 [0.016] 510 (0) [51000 (0)]	0.0051 [0.022] 1300 (0) [130000 (0)]	0.0063 [0.028] 2600 (0) [260000 (0)]	0.0092 [0.041] 3600 (0) [360000 (0)]
0.152x0.411-22.2-P1 0.006 x 0.016	0.91 [23]	0.006 [0.152]	170 [660]	0.0031 [0.014] 700 (0) [70000 (0)]	0.0043 [0.019] 1700 (0) [170000 (0)]	0.0054 [0.024] 3500 (0) [350000 (0)]	0.0079 [0.035] 4900 (0) [490000 (0)]
0.152x0.411-25.4-P1 0.006 x 0.016	1 [26.2]	0.006 [0.152]	170 [660]	0.0028 [0.012] 910 (0) [91000 (0)]	0.0038 [0.017] 2300 (0) [230000 (0)]	0.0047 [0.021] 4500 (0) [450000 (0)]	0.0069 [0.031] 6300 (0) [630000 (0)]
0.152x0.813-0.5-P1 0.006 x 0.032	0.084 [2.13]	0.006 [0.152]	170 [660]	0.11 [0.48] 2.3 (0) [230 (0)]	0.15 [0.66] 5.8 (0) [580 (0)]	0.18 [0.82] 12 (0) [1200 (0)]	0.27 [1.2] 16 (0) [1600 (0)]
0.152x0.813-0.9-P1 0.006 x 0.032	0.099 [2.53]	0.006 [0.152]	170 [660]	0.082 [0.37] 4 (0) [400 (0)]	0.11 [0.51] 9.9 (0) [990 (0)]	0.14 [0.63] 20 (0) [2000 (0)]	0.21 [0.92] 28 (0) [2800 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.813-1.15-P1 0.006 x 0.032	0.11 [2.78]	0.006 [0.152]	170 [660]	0.072 [0.32] 5.2 (0) [520 (0)]	0.099 [0.44] 13 (0) [1300 (0)]	0.12 [0.55] 26 (0) [2600 (0)]	0.18 [0.8] 37 (0) [3700 (0)]
0.152x0.813-1.6-P1 0.006 x 0.032	0.13 [3.23]	0.006 [0.152]	170 [660]	0.058 [0.26] 7.9 (0) [790 (0)]	0.081 [0.36] 20 (0) [2000 (0)]	0.1 [0.45] 39 (0) [3900 (0)]	0.15 [0.65] 55 (0) [5500 (0)]
0.152x0.813-2.4-P1 0.006 x 0.032	0.16 [4.03]	0.006 [0.152]	170 [660]	0.044 [0.2] 14 (0) [1400 (0)]	0.061 [0.27] 35 (0) [3500 (0)]	0.075 [0.34] 70 (0) [7000 (0)]	0.11 [0.49] 98 (0) [9800 (0)]
0.152x0.813-3.2-P1 0.006 x 0.032	0.19 [4.83]	0.006 [0.152]	170 [660]	0.035 [0.16] 22 (0) [2200 (0)]	0.048 [0.22] 55 (0) [5500 (0)]	0.06 [0.27] 110 (0) [11000 (0)]	0.088 [0.39] 150 (0) [15000 (0)]
0.152x0.813-4.75-P1 0.006 x 0.032	0.25 [6.38]	0.006 [0.152]	170 [660]	0.025 [0.11] 42 (0) [4200 (0)]	0.035 [0.16] 110 (0) [11000 (0)]	0.044 [0.19] 210 (0) [21000 (0)]	0.063 [0.28] 290 (0) [29000 (0)]
0.152x0.813-6-P1 0.006 x 0.032	0.3 [7.63]	0.006 [0.152]	170 [660]	0.021 [0.092] 63 (0) [6300 (0)]	0.029 [0.13] 160 (0) [16000 (0)]	0.036 [0.16] 320 (0) [32000 (0)]	0.052 [0.23] 440 (0) [44000 (0)]
0.152x0.813-8-P1 0.006 x 0.032	0.38 [9.63]	0.006 [0.152]	170 [660]	0.016 [0.071] 110 (0) [11000 (0)]	0.022 [0.098] 260 (0) [26000 (0)]	0.027 [0.12] 530 (0) [53000 (0)]	0.04 [0.18] 740 (0) [74000 (0)]
0.152x0.813-9.5-P1 0.006 x 0.032	0.44 [11.1]	0.006 [0.152]	170 [660]	0.014 [0.061] 140 (0) [14000 (0)]	0.019 [0.084] 360 (0) [36000 (0)]	0.023 [0.1] 720 (0) [72000 (0)]	0.034 [0.15] 1000 (0) [100000 (0)]
0.152x0.813-12.7-P1 0.006 x 0.032	0.56 [14.3]	0.006 [0.152]	170 [660]	0.01 [0.046] 250 (0) [25000 (0)]	0.014 [0.064] 620 (0) [62000 (0)]	0.018 [0.08] 1200 (0) [120000 (0)]	0.026 [0.12] 1700 (0) [170000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.152x0.813-14.2-P1 0.006 x 0.032	0.62 [15.8]	0.006 [0.152]	170 [660]	0.0094 [0.042] 310 (0) [31000 (0)]	0.013 [0.058] 770 (0) [77000 (0)]	0.016 [0.072] 1500 (0) [150000 (0)]	0.023 [0.1] 2100 (0) [210000 (0)]
0.152x0.813-16-P1 0.006 x 0.032	0.69 [17.6]	0.006 [0.152]	170 [660]	0.0084 [0.037] 380 (0) [38000 (0)]	0.012 [0.051] 960 (0) [96000 (0)]	0.014 [0.064] 1900 (0) [190000 (0)]	0.021 [0.093] 2700 (0) [270000 (0)]
0.152x0.813-19-P1 0.006 x 0.032	0.81 [20.6]	0.006 [0.152]	170 [660]	0.0071 [0.032] 530 (0) [53000 (0)]	0.0098 [0.044] 1300 (0) [130000 (0)]	0.012 [0.054] 2700 (0) [270000 (0)]	0.018 [0.079] 3700 (0) [370000 (0)]
0.152x0.813-22.2-P1 0.006 x 0.032	0.94 [23.8]	0.006 [0.152]	170 [660]	0.0061 [0.027] 720 (0) [72000 (0)]	0.0085 [0.038] 1800 (0) [180000 (0)]	0.011 [0.047] 3600 (0) [360000 (0)]	0.015 [0.068] 5000 (0) [500000 (0)]
0.152x0.813-25.4-P1 0.006 x 0.032	1.1 [27]	0.006 [0.152]	170 [660]	0.0054 [0.024] 930 (0) [93000 (0)]	0.0074 [0.033] 2300 (0) [230000 (0)]	0.0092 [0.041] 4700 (0) [470000 (0)]	0.013 [0.06] 6500 (0) [650000 (0)]
0.25x0.5-0.5-P1 0.0098 x 0.02	0.059 [1.5]	0.0098 [0.25]	100 [400]	0.23 [1] 0.5 (0) [50 (0)]	0.32 [1.4] 1.3 (0) [130 (0)]	0.4 [1.8] 2.5 (0) [250 (0)]	0.59 [2.6] 3.5 (0) [350 (0)]
0.25x0.5-0.9-P1 0.0098 x 0.02	0.075 [1.9]	0.0098 [0.25]	100 [400]	0.17 [0.74] 0.99 (0) [99 (0)]	0.23 [1] 2.5 (0) [250 (0)]	0.29 [1.3] 4.9 (0) [490 (0)]	0.42 [1.9] 6.9 (0) [690 (0)]
0.25x0.5-1.15-P1 0.0098 x 0.02	0.085 [2.15]	0.0098 [0.25]	100 [400]	0.14 [0.63] 1.4 (0) [140 (0)]	0.2 [0.87] 3.4 (0) [340 (0)]	0.24 [1.1] 6.8 (0) [680 (0)]	0.35 [1.6] 9.6 (0) [960 (0)]
0.25x0.5-1.6-P1 0.0098 x 0.02	0.1 [2.6]	0.0098 [0.25]	100 [400]	0.11 [0.5] 2.2 (0) [220 (0)]	0.15 [0.68] 5.5 (0) [550 (0)]	0.19 [0.85] 11 (0) [1100 (0)]	0.28 [1.2] 16 (0) [1600 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25x0.5-2.4-P1 0.0098 x 0.02	0.13 [3.4]	0.0098 [0.25]	100 [400]	0.081 [0.36] 4.2 (0) [420 (0)]	0.11 [0.5] 11 (0) [1100 (0)]	0.14 [0.62] 21 (0) [2100 (0)]	0.2 [0.9] 30 (0) [3000 (0)]
0.25x0.5-3.2-P1 0.0098 x 0.02	0.17 [4.2]	0.0098 [0.25]	100 [400]	0.063 [0.28] 6.9 (0) [690 (0)]	0.087 [0.39] 17 (0) [1700 (0)]	0.11 [0.48] 34 (0) [3400 (0)]	0.16 [0.7] 48 (0) [4800 (0)]
0.25x0.5-4.75-P1 0.0098 x 0.02	0.23 [5.75]	0.0098 [0.25]	100 [400]	0.045 [0.2] 14 (0) [1400 (0)]	0.062 [0.27] 35 (0) [3500 (0)]	0.077 [0.34] 69 (0) [6900 (0)]	0.11 [0.5] 97 (0) [9700 (0)]
0.25x0.5-6-P1 0.0098 x 0.02	0.28 [7]	0.0098 [0.25]	100 [400]	0.036 [0.16] 21 (0) [2100 (0)]	0.05 [0.22] 53 (0) [5300 (0)]	0.062 [0.28] 110 (0) [11000 (0)]	0.09 [0.4] 150 (0) [15000 (0)]
0.25x0.5-8-P1 0.0098 x 0.02	0.35 [9]	0.0098 [0.25]	100 [400]	0.028 [0.12] 36 (0) [3600 (0)]	0.038 [0.17] 91 (0) [9100 (0)]	0.047 [0.21] 180 (0) [18000 (0)]	0.069 [0.31] 250 (0) [25000 (0)]
0.25x0.5-9.5-P1 0.0098 x 0.02	0.41 [10.5]	0.0098 [0.25]	100 [400]	0.023 [0.1] 50 (0) [5000 (0)]	0.032 [0.14] 130 (0) [13000 (0)]	0.04 [0.18] 250 (0) [25000 (0)]	0.059 [0.26] 350 (0) [35000 (0)]
0.25x0.5-12.7-P1 0.0098 x 0.02	0.54 [13.7]	0.0098 [0.25]	100 [400]	0.018 [0.079] 88 (0) [8800 (0)]	0.024 [0.11] 220 (0) [22000 (0)]	0.031 [0.14] 440 (0) [44000 (0)]	0.044 [0.2] 610 (0) [61000 (0)]
0.25x0.5-14.2-P1 0.0098 x 0.02	0.6 [15.2]	0.0098 [0.25]	100 [400]	0.016 [0.071] 110 (0) [11000 (0)]	0.022 [0.098] 270 (0) [27000 (0)]	0.027 [0.12] 540 (0) [54000 (0)]	0.04 [0.18] 760 (0) [76000 (0)]
0.25x0.5-16-P1 0.0098 x 0.02	0.67 [17]	0.0098 [0.25]	100 [400]	0.014 [0.063] 140 (0) [14000 (0)]	0.02 [0.087] 340 (0) [34000 (0)]	0.024 [0.11] 680 (0) [68000 (0)]	0.035 [0.16] 960 (0) [96000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.25x0.5-19-P1 0.0098 x 0.02	0.79 [20]	0.0098 [0.25]	100 [400]	0.012 [0.053] 190 (0) [19000 (0)]	0.017 [0.074] 480 (0) [48000 (0)]	0.021 [0.092] 960 (0) [96000 (0)]	0.03 [0.13] 1300 (0) [130000 (0)]
0.25x0.5-22.2-P1 0.0098 x 0.02	0.91 [23.2]	0.0098 [0.25]	100 [400]	0.01 [0.046] 260 (0) [26000 (0)]	0.014 [0.063] 650 (0) [65000 (0)]	0.018 [0.079] 1300 (0) [130000 (0)]	0.026 [0.11] 1800 (0) [180000 (0)]
0.25x0.5-25.4-P1 0.0098 x 0.02	1 [26.4]	0.0098 [0.25]	100 [400]	0.009 [0.04] 340 (0) [34000 (0)]	0.012 [0.056] 840 (0) [84000 (0)]	0.016 [0.069] 1700 (0) [170000 (0)]	0.023 [0.1] 2400 (0) [240000 (0)]
0.3x2-0.5-P1 0.012 x 0.079	0.18 [4.5]	0.012 [0.3]	85 [330]	0.54 [2.4] 2.2 (0) [220 (0)]	0.74 [3.3] 5.5 (0) [550 (0)]	0.93 [4.1] 11 (0) [1100 (0)]	1.3 [6] 15 (0) [1500 (0)]
0.3x2-0.9-P1 0.012 x 0.079	0.19 [4.9]	0.012 [0.3]	85 [330]	0.47 [2.1] 2.9 (0) [290 (0)]	0.64 [2.9] 7.3 (0) [730 (0)]	0.8 [3.6] 15 (0) [1500 (0)]	1.2 [5.2] 21 (0) [2100 (0)]
0.3x2-1.15-P1 0.012 x 0.079	0.2 [5.15]	0.012 [0.3]	85 [330]	0.43 [1.9] 3.5 (0) [350 (0)]	0.59 [2.6] 8.7 (0) [870 (0)]	0.74 [3.3] 17 (0) [1700 (0)]	1.1 [4.8] 24 (0) [2400 (0)]
0.3x2-1.6-P1 0.012 x 0.079	0.22 [5.6]	0.012 [0.3]	85 [330]	0.37 [1.7] 4.5 (0) [450 (0)]	0.52 [2.3] 11 (0) [1100 (0)]	0.64 [2.9] 23 (0) [2300 (0)]	0.94 [4.2] 32 (0) [3200 (0)]
0.3x2-2.4-P1 0.012 x 0.079	0.25 [6.4]	0.012 [0.3]	85 [330]	0.31 [1.4] 6.8 (0) [680 (0)]	0.42 [1.9] 17 (0) [1700 (0)]	0.53 [2.3] 34 (0) [3400 (0)]	0.77 [3.4] 47 (0) [4700 (0)]
0.3x2-3.2-P1 0.012 x 0.079	0.28 [7.2]	0.012 [0.3]	85 [330]	0.26 [1.2] 9.4 (0) [940 (0)]	0.36 [1.6] 24 (0) [2400 (0)]	0.45 [2] 47 (0) [4700 (0)]	0.65 [2.9] 66 (0) [6600 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.3x2-4.75-P1 0.012 x 0.079	0.34 [8.75]	0.012 [0.3]	85 [330]	0.2 [0.89] 16 (0) [1600 (0)]	0.28 [1.2] 40 (0) [4000 (0)]	0.34 [1.5] 80 (0) [8000 (0)]	0.5 [2.2] 110 (0) [11000 (0)]
0.3x2-6-P1 0.012 x 0.079	0.39 [10]	0.012 [0.3]	85 [330]	0.17 [0.75] 22 (0) [2200 (0)]	0.23 [1] 56 (0) [5600 (0)]	0.29 [1.3] 110 (0) [11000 (0)]	0.42 [1.9] 160 (0) [16000 (0)]
0.3x2-8-P1 0.012 x 0.079	0.47 [12]	0.012 [0.3]	85 [330]	0.13 [0.6] 35 (0) [3500 (0)]	0.19 [0.83] 87 (0) [8700 (0)]	0.23 [1] 170 (0) [17000 (0)]	0.34 [1.5] 240 (0) [24000 (0)]
0.3x2-9.5-P1 0.012 x 0.079	0.53 [13.5]	0.012 [0.3]	85 [330]	0.12 [0.52] 46 (0) [4600 (0)]	0.16 [0.72] 120 (0) [12000 (0)]	0.2 [0.9] 230 (0) [23000 (0)]	0.29 [1.3] 320 (0) [32000 (0)]
0.3x2-12.7-P1 0.012 x 0.079	0.66 [16.7]	0.012 [0.3]	85 [330]	0.092 [0.41] 75 (0) [7500 (0)]	0.13 [0.56] 190 (0) [19000 (0)]	0.16 [0.7] 380 (0) [38000 (0)]	0.23 [1] 530 (0) [53000 (0)]
0.3x2-14.2-P1 0.012 x 0.079	0.72 [18.2]	0.012 [0.3]	85 [330]	0.083 [0.37] 92 (0) [9200 (0)]	0.11 [0.51] 230 (0) [23000 (0)]	0.14 [0.64] 460 (0) [46000 (0)]	0.21 [0.93] 640 (0) [64000 (0)]
0.3x2-16-P1 0.012 x 0.079	0.79 [20]	0.012 [0.3]	85 [330]	0.075 [0.33] 110 (0) [11000 (0)]	0.1 [0.46] 280 (0) [28000 (0)]	0.13 [0.57] 570 (0) [57000 (0)]	0.19 [0.83] 790 (0) [79000 (0)]
0.3x2-19-P1 0.012 x 0.079	0.91 [23]	0.012 [0.3]	85 [330]	0.064 [0.29] 150 (0) [15000 (0)]	0.089 [0.39] 380 (0) [38000 (0)]	0.11 [0.49] 770 (0) [77000 (0)]	0.16 [0.71] 1100 (0) [110000 (0)]
0.3x2-22.2-P1 0.012 x 0.079	1 [26.2]	0.012 [0.3]	85 [330]	0.056 [0.25] 200 (0) [20000 (0)]	0.077 [0.34] 510 (0) [51000 (0)]	0.096 [0.43] 1000 (0) [100000 (0)]	0.14 [0.62] 1400 (0) [140000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.3x2-25.4-P1 0.012 x 0.079	1.2 [29.4]	0.012 [0.3]	85 [330]	0.049 [0.22] 260 (0) [26000 (0)]	0.068 [0.3] 660 (0) [66000 (0)]	0.085 [0.38] 1300 (0) [130000 (0)]	0.12 [0.55] 1800 (0) [180000 (0)]
0.4x0.8-0.5-P1 0.016 x 0.031	0.083 [2.1]	0.016 [0.4]	64 [250]	0.74 [3.3] 0.33 (0) [33 (0)]	1 [4.5] 0.83 (0) [83 (0)]	1.3 [5.6] 1.7 (0) [170 (0)]	1.8 [8.2] 2.3 (0) [230 (0)]
0.4x0.8-0.9-P1 0.016 x 0.031	0.098 [2.5]	0.016 [0.4]	64 [250]	0.56 [2.5] 0.57 (0) [57 (0)]	0.78 [3.5] 1.4 (0) [140 (0)]	0.97 [4.3] 2.8 (0) [280 (0)]	1.4 [6.3] 4 (0) [400 (0)]
0.4x0.8-1.15-P1 0.016 x 0.031	0.11 [2.75]	0.016 [0.4]	64 [250]	0.49 [2.2] 0.75 (0) [75 (0)]	0.68 [3] 1.9 (0) [190 (0)]	0.85 [3.8] 3.7 (0) [370 (0)]	1.2 [5.5] 5.2 (0) [520 (0)]
0.4x0.8-1.6-P1 0.016 x 0.031	0.13 [3.2]	0.016 [0.4]	64 [250]	0.4 [1.8] 1.1 (0) [110 (0)]	0.55 [2.5] 2.8 (0) [280 (0)]	0.69 [3.1] 5.7 (0) [570 (0)]	1 [4.4] 7.9 (0) [790 (0)]
0.4x0.8-2.4-P1 0.016 x 0.031	0.16 [4]	0.016 [0.4]	64 [250]	0.3 [1.3] 2 (0) [200 (0)]	0.41 [1.8] 5 (0) [500 (0)]	0.52 [2.3] 10 (0) [1000 (0)]	0.75 [3.3] 14 (0) [1400 (0)]
0.4x0.8-3.2-P1 0.016 x 0.031	0.19 [4.8]	0.016 [0.4]	64 [250]	0.24 [1.1] 3.1 (0) [310 (0)]	0.33 [1.5] 7.9 (0) [790 (0)]	0.41 [1.8] 16 (0) [1600 (0)]	0.6 [2.7] 22 (0) [2200 (0)]
0.4x0.8-4.75-P1 0.016 x 0.031	0.25 [6.35]	0.016 [0.4]	64 [250]	0.17 [0.77] 6 (0) [600 (0)]	0.24 [1.1] 15 (0) [1500 (0)]	0.3 [1.3] 30 (0) [3000 (0)]	0.43 [1.9] 42 (0) [4200 (0)]
0.4x0.8-6-P1 0.016 x 0.031	0.3 [7.6]	0.016 [0.4]	64 [250]	0.14 [0.63] 9.1 (0) [910 (0)]	0.19 [0.87] 23 (0) [2300 (0)]	0.24 [1.1] 45 (0) [4500 (0)]	0.35 [1.6] 64 (0) [6400 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x0.8-8-P1 0.016 x 0.031	0.38 [9.6]	0.016 [0.4]	64 [250]	0.11 [0.48] 15 (0) [1500 (0)]	0.15 [0.67] 38 (0) [3800 (0)]	0.19 [0.83] 76 (0) [7600 (0)]	0.27 [1.2] 110 (0) [11000 (0)]
0.4x0.8-9.5-P1 0.016 x 0.031	0.44 [11.1]	0.016 [0.4]	64 [250]	0.093 [0.41] 21 (0) [2100 (0)]	0.13 [0.57] 52 (0) [5200 (0)]	0.16 [0.71] 100 (0) [10000 (0)]	0.23 [1] 150 (0) [15000 (0)]
0.4x0.8-12.7-P1 0.016 x 0.031	0.56 [14.3]	0.016 [0.4]	64 [250]	0.071 [0.32] 36 (0) [3600 (0)]	0.098 [0.44] 89 (0) [8900 (0)]	0.12 [0.54] 180 (0) [18000 (0)]	0.18 [0.79] 250 (0) [25000 (0)]
0.4x0.8-14.2-P1 0.016 x 0.031	0.62 [15.8]	0.016 [0.4]	64 [250]	0.064 [0.28] 44 (0) [4400 (0)]	0.088 [0.39] 110 (0) [11000 (0)]	0.11 [0.49] 220 (0) [22000 (0)]	0.16 [0.71] 310 (0) [31000 (0)]
0.4x0.8-16-P1 0.016 x 0.031	0.69 [17.6]	0.016 [0.4]	64 [250]	0.057 [0.25] 55 (0) [5500 (0)]	0.079 [0.35] 140 (0) [14000 (0)]	0.098 [0.44] 280 (0) [28000 (0)]	0.14 [0.63] 390 (0) [39000 (0)]
0.4x0.8-19-P1 0.016 x 0.031	0.81 [20.6]	0.016 [0.4]	64 [250]	0.048 [0.22] 77 (0) [7700 (0)]	0.067 [0.3] 190 (0) [19000 (0)]	0.083 [0.37] 380 (0) [38000 (0)]	0.12 [0.54] 540 (0) [54000 (0)]
0.4x0.8-22.2-P1 0.016 x 0.031	0.94 [23.8]	0.016 [0.4]	64 [250]	0.042 [0.19] 100 (0) [10000 (0)]	0.058 [0.26] 260 (0) [26000 (0)]	0.072 [0.32] 520 (0) [52000 (0)]	0.1 [0.46] 730 (0) [73000 (0)]
0.4x0.8-25.4-P1 0.016 x 0.031	1.1 [27]	0.016 [0.4]	64 [250]	0.037 [0.16] 130 (0) [13000 (0)]	0.051 [0.22] 340 (0) [34000 (0)]	0.063 [0.28] 670 (0) [67000 (0)]	0.092 [0.41] 940 (0) [94000 (0)]
0.4x1-0.5-P1 0.016 x 0.039	0.098 [2.5]	0.016 [0.4]	64 [250]	0.8 [3.6] 0.44 (0) [44 (0)]	1.1 [4.9] 1.1 (0) [110 (0)]	1.4 [6.1] 2.2 (0) [220 (0)]	2 [8.9] 3.1 (0) [310 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x1-0.9-P1 0.016 x 0.039	0.11 [2.9]	0.016 [0.4]	64 [250]	0.63 [2.8] 0.71 (0) [71 (0)]	0.87 [3.9] 1.8 (0) [180 (0)]	1.1 [4.8] 3.5 (0) [350 (0)]	1.6 [7] 5 (0) [500 (0)]
0.4x1-1.15-P1 0.016 x 0.039	0.12 [3.15]	0.016 [0.4]	64 [250]	0.56 [2.5] 0.91 (0) [91 (0)]	0.77 [3.4] 2.3 (0) [230 (0)]	0.96 [4.3] 4.5 (0) [450 (0)]	1.4 [6.2] 6.4 (0) [640 (0)]
0.4x1-1.6-P1 0.016 x 0.039	0.14 [3.6]	0.016 [0.4]	64 [250]	0.46 [2.1] 1.3 (0) [130 (0)]	0.64 [2.8] 3.3 (0) [330 (0)]	0.79 [3.5] 6.6 (0) [660 (0)]	1.2 [5.1] 9.3 (0) [930 (0)]
0.4x1-2.4-P1 0.016 x 0.039	0.17 [4.4]	0.016 [0.4]	64 [250]	0.35 [1.6] 2.3 (0) [230 (0)]	0.49 [2.2] 5.7 (0) [570 (0)]	0.61 [2.7] 11 (0) [1100 (0)]	0.88 [3.9] 16 (0) [1600 (0)]
0.4x1-3.2-P1 0.016 x 0.039	0.2 [5.2]	0.016 [0.4]	64 [250]	0.29 [1.3] 3.5 (0) [350 (0)]	0.39 [1.8] 8.7 (0) [870 (0)]	0.49 [2.2] 17 (0) [1700 (0)]	0.71 [3.2] 24 (0) [2400 (0)]
0.4x1-4.75-P1 0.016 x 0.039	0.27 [6.75]	0.016 [0.4]	64 [250]	0.21 [0.93] 6.5 (0) [650 (0)]	0.29 [1.3] 16 (0) [1600 (0)]	0.36 [1.6] 32 (0) [3200 (0)]	0.52 [2.3] 45 (0) [4500 (0)]
0.4x1-6-P1 0.016 x 0.039	0.31 [8]	0.016 [0.4]	64 [250]	0.17 [0.76] 9.6 (0) [960 (0)]	0.24 [1.1] 24 (0) [2400 (0)]	0.29 [1.3] 48 (0) [4800 (0)]	0.43 [1.9] 67 (0) [6700 (0)]
0.4x1-8-P1 0.016 x 0.039	0.39 [10]	0.016 [0.4]	64 [250]	0.13 [0.59] 16 (0) [1600 (0)]	0.18 [0.82] 40 (0) [4000 (0)]	0.23 [1] 80 (0) [8000 (0)]	0.33 [1.5] 110 (0) [11000 (0)]
0.4x1-9.5-P1 0.016 x 0.039	0.45 [11.5]	0.016 [0.4]	64 [250]	0.11 [0.51] 22 (0) [2200 (0)]	0.16 [0.7] 54 (0) [5400 (0)]	0.2 [0.87] 110 (0) [11000 (0)]	0.29 [1.3] 150 (0) [15000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.4x1-12.7-P1 0.016 x 0.039	0.58 [14.7]	0.016 [0.4]	64 [250]	0.088 [0.39] 37 (0) [3700 (0)]	0.12 [0.54] 92 (0) [9200 (0)]	0.15 [0.67] 180 (0) [18000 (0)]	0.22 [0.97] 260 (0) [26000 (0)]
0.4x1-14.2-P1 0.016 x 0.039	0.64 [16.2]	0.016 [0.4]	64 [250]	0.079 [0.35] 45 (0) [4500 (0)]	0.11 [0.48] 110 (0) [11000 (0)]	0.14 [0.6] 230 (0) [23000 (0)]	0.2 [0.88] 320 (0) [32000 (0)]
0.4x1-16-P1 0.016 x 0.039	0.71 [18]	0.016 [0.4]	64 [250]	0.071 [0.31] 57 (0) [5700 (0)]	0.097 [0.43] 140 (0) [14000 (0)]	0.12 [0.54] 280 (0) [28000 (0)]	0.18 [0.78] 400 (0) [40000 (0)]
0.4x1-19-P1 0.016 x 0.039	0.83 [21]	0.016 [0.4]	64 [250]	0.06 [0.27] 79 (0) [7900 (0)]	0.083 [0.37] 200 (0) [20000 (0)]	0.1 [0.46] 390 (0) [39000 (0)]	0.15 [0.67] 550 (0) [55000 (0)]
0.4x1-22.2-P1 0.016 x 0.039	0.95 [24.2]	0.016 [0.4]	64 [250]	0.052 [0.23] 110 (0) [11000 (0)]	0.071 [0.32] 260 (0) [26000 (0)]	0.089 [0.4] 530 (0) [53000 (0)]	0.13 [0.57] 740 (0) [74000 (0)]
0.4x1-25.4-P1 0.016 x 0.039	1.1 [27.4]	0.016 [0.4]	64 [250]	0.045 [0.2] 140 (0) [14000 (0)]	0.063 [0.28] 340 (0) [34000 (0)]	0.078 [0.35] 680 (0) [68000 (0)]	0.11 [0.51] 960 (0) [96000 (0)]
0.5x0.25-0.5-P1 0.02 x 0.0098	0.039 [1]	0.02 [0.5]	51 [200]	0.62 [2.8] 0.07 (0) [7 (0)]	0.86 [3.8] 0.17 (0) [18 (0)]	1.1 [4.8] 0.35 (0) [35 (0)]	1.6 [6.9] 0.49 (0) [49 (0)]
0.5x0.25-0.9-P1 0.02 x 0.0098	0.055 [1.4]	0.02 [0.5]	51 [200]	0.41 [1.8] 0.17 (0) [17 (0)]	0.56 [2.5] 0.41 (0) [42 (0)]	0.7 [3.1] 0.83 (0) [83 (0)]	1 [4.5] 1.2 (0) [120 (0)]
0.5x0.25-1.15-P1 0.02 x 0.0098	0.065 [1.65]	0.02 [0.5]	51 [200]	0.33 [1.5] 0.25 (0) [25 (0)]	0.46 [2.1] 0.61 (0) [62 (0)]	0.58 [2.6] 1.2 (0) [120 (0)]	0.84 [3.7] 1.7 (0) [170 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.25-1.6-P1 0.02 x 0.0098	0.083 [2.1]	0.02 [0.5]	51 [200]	0.25 [1.1] 0.43 (0) [43 (0)]	0.35 [1.6] 1.1 (0) [110 (0)]	0.44 [1.9] 2.1 (0) [220 (0)]	0.63 [2.8] 3 (0) [300 (0)]
0.5x0.25-2.4-P1 0.02 x 0.0098	0.11 [2.9]	0.02 [0.5]	51 [200]	0.18 [0.79] 0.88 (0) [88 (0)]	0.24 [1.1] 2.2 (0) [220 (0)]	0.3 [1.4] 4.4 (0) [440 (0)]	0.44 [2] 6.2 (0) [620 (0)]
0.5x0.25-3.2-P1 0.02 x 0.0098	0.15 [3.7]	0.02 [0.5]	51 [200]	0.14 [0.6] 1.5 (0) [150 (0)]	0.19 [0.83] 3.7 (0) [370 (0)]	0.23 [1] 7.5 (0) [750 (0)]	0.34 [1.5] 10 (0) [1000 (0)]
0.5x0.25-4.75-P1 0.02 x 0.0098	0.21 [5.25]	0.02 [0.5]	51 [200]	0.094 [0.42] 3.1 (0) [310 (0)]	0.13 [0.57] 7.9 (0) [790 (0)]	0.16 [0.72] 16 (0) [1600 (0)]	0.23 [1] 22 (0) [2200 (0)]
0.5x0.25-6-P1 0.02 x 0.0098	0.26 [6.5]	0.02 [0.5]	51 [200]	0.075 [0.33] 4.9 (0) [490 (0)]	0.1 [0.46] 12 (0) [1200 (0)]	0.13 [0.57] 25 (0) [2500 (0)]	0.19 [0.83] 34 (0) [3400 (0)]
0.5x0.25-8-P1 0.02 x 0.0098	0.33 [8.5]	0.02 [0.5]	51 [200]	0.057 [0.25] 8.6 (0) [860 (0)]	0.078 [0.35] 21 (0) [2100 (0)]	0.098 [0.43] 43 (0) [4300 (0)]	0.14 [0.63] 60 (0) [6000 (0)]
0.5x0.25-9.5-P1 0.02 x 0.0098	0.39 [10]	0.02 [0.5]	51 [200]	0.048 [0.21] 12 (0) [1200 (0)]	0.066 [0.29] 30 (0) [3000 (0)]	0.083 [0.37] 60 (0) [6000 (0)]	0.12 [0.53] 84 (0) [8400 (0)]
0.5x0.25-12.7-P1 0.02 x 0.0098	0.52 [13.2]	0.02 [0.5]	51 [200]	0.036 [0.16] 21 (0) [2100 (0)]	0.05 [0.22] 53 (0) [5300 (0)]	0.062 [0.28] 110 (0) [11000 (0)]	0.09 [0.4] 150 (0) [15000 (0)]
0.5x0.25-14.2-P1 0.02 x 0.0098	0.58 [14.7]	0.02 [0.5]	51 [200]	0.032 [0.14] 26 (0) [2600 (0)]	0.045 [0.2] 66 (0) [6600 (0)]	0.056 [0.25] 130 (0) [13000 (0)]	0.081 [0.36] 180 (0) [18000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.25-16-P1 0.02 x 0.0098	0.65 [16.5]	0.02 [0.5]	51 [200]	0.029 [0.13] 33 (0) [3300 (0)]	0.04 [0.18] 83 (0) [8300 (0)]	0.05 [0.22] 170 (0) [17000 (0)]	0.072 [0.32] 230 (0) [23000 (0)]
0.5x0.25-19-P1 0.02 x 0.0098	0.77 [19.5]	0.02 [0.5]	51 [200]	0.024 [0.11] 47 (0) [4700 (0)]	0.034 [0.15] 120 (0) [12000 (0)]	0.042 [0.19] 230 (0) [23000 (0)]	0.061 [0.27] 330 (0) [33000 (0)]
0.5x0.25-22.2-P1 0.02 x 0.0098	0.89 [22.7]	0.02 [0.5]	51 [200]	0.021 [0.093] 63 (0) [6300 (0)]	0.029 [0.13] 160 (0) [16000 (0)]	0.036 [0.16] 320 (0) [32000 (0)]	0.052 [0.23] 440 (0) [44000 (0)]
0.5x0.25-25.4-P1 0.02 x 0.0098	1 [25.9]	0.02 [0.5]	51 [200]	0.018 [0.081] 83 (0) [8300 (0)]	0.025 [0.11] 210 (0) [21000 (0)]	0.031 [0.14] 410 (0) [41000 (0)]	0.046 [0.2] 580 (0) [58000 (0)]
0.5x0.8-0.5-P1 0.02 x 0.031	0.083 [2.1]	0.02 [0.5]	51 [200]	1.2 [5.1] 0.21 (0) [21 (0)]	1.6 [7.1] 0.53 (0) [53 (0)]	2 [8.8] 1.1 (0) [110 (0)]	2.9 [13] 1.5 (0) [150 (0)]
0.5x0.8-0.9-P1 0.02 x 0.031	0.098 [2.5]	0.02 [0.5]	51 [200]	0.88 [3.9] 0.36 (0) [36 (0)]	1.2 [5.4] 0.91 (0) [91 (0)]	1.5 [6.7] 1.8 (0) [180 (0)]	2.2 [9.8] 2.5 (0) [250 (0)]
0.5x0.8-1.15-P1 0.02 x 0.031	0.11 [2.75]	0.02 [0.5]	51 [200]	0.77 [3.4] 0.48 (0) [48 (0)]	1.1 [4.7] 1.2 (0) [120 (0)]	1.3 [5.9] 2.4 (0) [240 (0)]	1.9 [8.5] 3.3 (0) [330 (0)]
0.5x0.8-1.6-P1 0.02 x 0.031	0.13 [3.2]	0.02 [0.5]	51 [200]	0.62 [2.8] 0.72 (0) [72 (0)]	0.86 [3.8] 1.8 (0) [180 (0)]	1.1 [4.8] 3.6 (0) [360 (0)]	1.6 [6.9] 5.1 (0) [510 (0)]
0.5x0.8-2.4-P1 0.02 x 0.031	0.16 [4]	0.02 [0.5]	51 [200]	0.47 [2.1] 1.3 (0) [130 (0)]	0.65 [2.9] 3.2 (0) [320 (0)]	0.81 [3.6] 6.4 (0) [640 (0)]	1.2 [5.2] 9 (0) [900 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.8-3.2-P1 0.02 x 0.031	0.19 [4.8]	0.02 [0.5]	51 [200]	0.37 [1.7] 2 (0) [200 (0)]	0.52 [2.3] 5 (0) [500 (0)]	0.64 [2.9] 10 (0) [1000 (0)]	0.94 [4.2] 14 (0) [1400 (0)]
0.5x0.8-4.75-P1 0.02 x 0.031	0.25 [6.35]	0.02 [0.5]	51 [200]	0.27 [1.2] 3.9 (0) [390 (0)]	0.37 [1.7] 9.7 (0) [970 (0)]	0.46 [2.1] 19 (0) [1900 (0)]	0.68 [3] 27 (0) [2700 (0)]
0.5x0.8-6-P1 0.02 x 0.031	0.3 [7.6]	0.02 [0.5]	51 [200]	0.22 [0.98] 5.8 (0) [580 (0)]	0.3 [1.4] 15 (0) [1500 (0)]	0.38 [1.7] 29 (0) [2900 (0)]	0.55 [2.5] 41 (0) [4100 (0)]
0.5x0.8-8-P1 0.02 x 0.031	0.38 [9.6]	0.02 [0.5]	51 [200]	0.17 [0.76] 9.7 (0) [970 (0)]	0.24 [1] 24 (0) [2400 (0)]	0.29 [1.3] 49 (0) [4900 (0)]	0.43 [1.9] 68 (0) [6800 (0)]
0.5x0.8-9.5-P1 0.02 x 0.031	0.44 [11.1]	0.02 [0.5]	51 [200]	0.15 [0.65] 13 (0) [1300 (0)]	0.2 [0.89] 33 (0) [3300 (0)]	0.25 [1.1] 67 (0) [6700 (0)]	0.36 [1.6] 93 (0) [9300 (0)]
0.5x0.8-12.7-P1 0.02 x 0.031	0.56 [14.3]	0.02 [0.5]	51 [200]	0.11 [0.49] 23 (0) [2300 (0)]	0.15 [0.68] 57 (0) [5700 (0)]	0.19 [0.85] 110 (0) [11000 (0)]	0.28 [1.2] 160 (0) [16000 (0)]
0.5x0.8-14.2-P1 0.02 x 0.031	0.62 [15.8]	0.02 [0.5]	51 [200]	0.1 [0.44] 28 (0) [2800 (0)]	0.14 [0.61] 71 (0) [7100 (0)]	0.17 [0.76] 140 (0) [14000 (0)]	0.25 [1.1] 200 (0) [20000 (0)]
0.5x0.8-16-P1 0.02 x 0.031	0.69 [17.6]	0.02 [0.5]	51 [200]	0.089 [0.4] 35 (0) [3500 (0)]	0.12 [0.55] 89 (0) [8900 (0)]	0.15 [0.68] 180 (0) [18000 (0)]	0.22 [0.99] 250 (0) [25000 (0)]
0.5x0.8-19-P1 0.02 x 0.031	0.81 [20.6]	0.02 [0.5]	51 [200]	0.076 [0.34] 49 (0) [4900 (0)]	0.1 [0.46] 120 (0) [12000 (0)]	0.13 [0.58] 250 (0) [25000 (0)]	0.19 [0.84] 340 (0) [34000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.5x0.8-22.2-P1 0.02 x 0.031	0.94 [23.8]	0.02 [0.5]	51 [200]	0.065 [0.29] 66 (0) [6600 (0)]	0.09 [0.4] 170 (0) [17000 (0)]	0.11 [0.5] 330 (0) [33000 (0)]	0.16 [0.72] 470 (0) [47000 (0)]
0.5x0.8-25.4-P1 0.02 x 0.031	1.1 [27]	0.02 [0.5]	51 [200]	0.057 [0.25] 86 (0) [8600 (0)]	0.079 [0.35] 220 (0) [22000 (0)]	0.098 [0.44] 430 (0) [43000 (0)]	0.14 [0.64] 600 (0) [60000 (0)]
0.55x1.4-0.5-P1 0.022 x 0.055	0.13 [3.3]	0.022 [0.55]	46 [180]	1.7 [7.4] 0.38 (0) [38 (0)]	2.3 [10] 0.94 (0) [94 (0)]	2.9 [13] 1.9 (0) [190 (0)]	4.2 [19] 2.6 (0) [260 (0)]
0.55x1.4-0.9-P1 0.022 x 0.055	0.15 [3.7]	0.022 [0.55]	46 [180]	1.4 [6.1] 0.55 (0) [55 (0)]	1.9 [8.5] 1.4 (0) [140 (0)]	2.4 [11] 2.8 (0) [280 (0)]	3.4 [15] 3.9 (0) [390 (0)]
0.55x1.4-1.15-P1 0.022 x 0.055	0.16 [3.95]	0.022 [0.55]	46 [180]	1.2 [5.5] 0.68 (0) [68 (0)]	1.7 [7.6] 1.7 (0) [170 (0)]	2.1 [9.5] 3.4 (0) [340 (0)]	3.1 [14] 4.7 (0) [470 (0)]
0.55x1.4-1.6-P1 0.022 x 0.055	0.17 [4.4]	0.022 [0.55]	46 [180]	1.1 [4.7] 0.93 (0) [93 (0)]	1.5 [6.5] 2.3 (0) [230 (0)]	1.8 [8.1] 4.7 (0) [470 (0)]	2.6 [12] 6.5 (0) [650 (0)]
0.55x1.4-2.4-P1 0.022 x 0.055	0.2 [5.2]	0.022 [0.55]	46 [180]	0.84 [3.7] 1.5 (0) [150 (0)]	1.2 [5.1] 3.8 (0) [380 (0)]	1.4 [6.4] 7.5 (0) [750 (0)]	2.1 [9.3] 10 (0) [1000 (0)]
0.55x1.4-3.2-P1 0.022 x 0.055	0.24 [6]	0.022 [0.55]	46 [180]	0.69 [3.1] 2.2 (0) [220 (0)]	0.95 [4.2] 5.5 (0) [550 (0)]	1.2 [5.3] 11 (0) [1100 (0)]	1.7 [7.7] 15 (0) [1500 (0)]
0.55x1.4-4.75-P1 0.022 x 0.055	0.3 [7.55]	0.022 [0.55]	46 [180]	0.52 [2.3] 3.9 (0) [390 (0)]	0.71 [3.2] 9.8 (0) [980 (0)]	0.89 [3.9] 20 (0) [2000 (0)]	1.3 [5.7] 27 (0) [2700 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.55x1.4-6-P1 0.022 x 0.055	0.35 [8.8]	0.022 [0.55]	46 [180]	0.43 [1.9] 5.7 (0) [570 (0)]	0.59 [2.6] 14 (0) [1400 (0)]	0.74 [3.3] 28 (0) [2800 (0)]	1.1 [4.8] 40 (0) [4000 (0)]
0.55x1.4-8-P1 0.022 x 0.055	0.43 [10.8]	0.022 [0.55]	46 [180]	0.34 [1.5] 9.2 (0) [920 (0)]	0.47 [2.1] 23 (0) [2300 (0)]	0.58 [2.6] 46 (0) [4600 (0)]	0.84 [3.8] 64 (0) [6400 (0)]
0.55x1.4-9.5-P1 0.022 x 0.055	0.48 [12.3]	0.022 [0.55]	46 [180]	0.29 [1.3] 12 (0) [1200 (0)]	0.4 [1.8] 31 (0) [3100 (0)]	0.5 [2.2] 62 (0) [6200 (0)]	0.73 [3.2] 86 (0) [8600 (0)]
0.55x1.4-12.7-P1 0.022 x 0.055	0.61 [15.5]	0.022 [0.55]	46 [180]	0.23 [1] 21 (0) [2100 (0)]	0.31 [1.4] 52 (0) [5200 (0)]	0.39 [1.7] 100 (0) [10000 (0)]	0.56 [2.5] 140 (0) [14000 (0)]
0.55x1.4-14.2-P1 0.022 x 0.055	0.67 [17]	0.022 [0.55]	46 [180]	0.2 [0.9] 25 (0) [2500 (0)]	0.28 [1.2] 63 (0) [6300 (0)]	0.35 [1.6] 130 (0) [13000 (0)]	0.51 [2.3] 180 (0) [18000 (0)]
0.55x1.4-16-P1 0.022 x 0.055	0.74 [18.8]	0.022 [0.55]	46 [180]	0.18 [0.81] 31 (0) [3100 (0)]	0.25 [1.1] 79 (0) [7900 (0)]	0.31 [1.4] 160 (0) [16000 (0)]	0.46 [2] 220 (0) [22000 (0)]
0.55x1.4-19-P1 0.022 x 0.055	0.86 [21.8]	0.022 [0.55]	46 [180]	0.16 [0.69] 43 (0) [4300 (0)]	0.21 [0.95] 110 (0) [11000 (0)]	0.27 [1.2] 220 (0) [22000 (0)]	0.39 [1.7] 300 (0) [30000 (0)]
0.55x1.4-22.2-P1 0.022 x 0.055	0.98 [25]	0.022 [0.55]	46 [180]	0.13 [0.6] 58 (0) [5800 (0)]	0.19 [0.83] 140 (0) [14000 (0)]	0.23 [1] 290 (0) [29000 (0)]	0.34 [1.5] 400 (0) [40000 (0)]
0.55x1.4-25.4-P1 0.022 x 0.055	1.1 [28.2]	0.022 [0.55]	46 [180]	0.12 [0.53] 75 (0) [7500 (0)]	0.16 [0.73] 190 (0) [19000 (0)]	0.2 [0.91] 370 (0) [37000 (0)]	0.3 [1.3] 520 (0) [52000 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.6x2.3-0.5-P1 0.024 x 0.091	0.2 [5.1]	0.024 [0.6]	42 [170]	2.2 [9.9] 0.68 (0) [68 (0)]	3.1 [14] 1.7 (0) [170 (0)]	3.8 [17] 3.4 (0) [340 (0)]	5.5 [25] 4.8 (0) [480 (0)]
0.6x2.3-0.9-P1 0.024 x 0.091	0.22 [5.5]	0.024 [0.6]	42 [170]	1.9 [8.6] 0.89 (0) [89 (0)]	2.7 [12] 2.2 (0) [220 (0)]	3.3 [15] 4.5 (0) [450 (0)]	4.8 [22] 6.3 (0) [630 (0)]
0.6x2.3-1.15-P1 0.024 x 0.091	0.23 [5.75]	0.024 [0.6]	42 [170]	1.8 [8] 1 (0) [100 (0)]	2.5 [11] 2.6 (0) [260 (0)]	3.1 [14] 5.2 (0) [520 (0)]	4.5 [20] 7.3 (0) [730 (0)]
0.6x2.3-1.6-P1 0.024 x 0.091	0.24 [6.2]	0.024 [0.6]	42 [170]	1.6 [7.1] 1.3 (0) [130 (0)]	2.2 [9.8] 3.3 (0) [330 (0)]	2.7 [12] 6.6 (0) [660 (0)]	4 [18] 9.3 (0) [930 (0)]
0.6x2.3-2.4-P1 0.024 x 0.091	0.28 [7]	0.024 [0.6]	42 [170]	1.3 [5.9] 1.9 (0) [190 (0)]	1.8 [8.1] 4.8 (0) [480 (0)]	2.3 [10] 9.6 (0) [960 (0)]	3.3 [15] 13 (0) [1300 (0)]
0.6x2.3-3.2-P1 0.024 x 0.091	0.31 [7.8]	0.024 [0.6]	42 [170]	1.1 [5] 2.6 (0) [260 (0)]	1.6 [6.9] 6.6 (0) [660 (0)]	1.9 [8.6] 13 (0) [1300 (0)]	2.8 [13] 18 (0) [1800 (0)]
0.6x2.3-4.75-P1 0.024 x 0.091	0.37 [9.35]	0.024 [0.6]	42 [170]	0.88 [3.9] 4.3 (0) [430 (0)]	1.2 [5.4] 11 (0) [1100 (0)]	1.5 [6.7] 22 (0) [2200 (0)]	2.2 [9.8] 30 (0) [3000 (0)]
0.6x2.3-6-P1 0.024 x 0.091	0.42 [10.6]	0.024 [0.6]	42 [170]	0.75 [3.3] 6 (0) [600 (0)]	1 [4.6] 15 (0) [1500 (0)]	1.3 [5.7] 30 (0) [3000 (0)]	1.9 [8.3] 42 (0) [4200 (0)]
0.6x2.3-8-P1 0.024 x 0.091	0.5 [12.6]	0.024 [0.6]	42 [170]	0.6 [2.7] 9.3 (0) [930 (0)]	0.83 [3.7] 23 (0) [2300 (0)]	1 [4.6] 46 (0) [4600 (0)]	1.5 [6.7] 65 (0) [6500 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.6x2.3-9.5-P1 0.024 x 0.091	0.56 [14.1]	0.024 [0.6]	42 [170]	0.53 [2.3] 12 (0) [1200 (0)]	0.73 [3.2] 30 (0) [3000 (0)]	0.9 [4] 61 (0) [6100 (0)]	1.3 [5.8] 85 (0) [8500 (0)]
0.6x2.3-12.7-P1 0.024 x 0.091	0.68 [17.3]	0.024 [0.6]	42 [170]	0.41 [1.8] 20 (0) [2000 (0)]	0.57 [2.5] 49 (0) [4900 (0)]	0.71 [3.2] 98 (0) [9800 (0)]	1 [4.6] 140 (0) [14000 (0)]
0.6x2.3-14.2-P1 0.024 x 0.091	0.74 [18.8]	0.024 [0.6]	42 [170]	0.38 [1.7] 24 (0) [2400 (0)]	0.52 [2.3] 59 (0) [5900 (0)]	0.65 [2.9] 120 (0) [12000 (0)]	0.94 [4.2] 170 (0) [17000 (0)]
0.6x2.3-16-P1 0.024 x 0.091	0.81 [20.6]	0.024 [0.6]	42 [170]	0.34 [1.5] 29 (0) [2900 (0)]	0.47 [2.1] 73 (0) [7300 (0)]	0.58 [2.6] 150 (0) [15000 (0)]	0.85 [3.8] 200 (0) [20000 (0)]
0.6x2.3-19-P1 0.024 x 0.091	0.93 [23.6]	0.024 [0.6]	42 [170]	0.29 [1.3] 40 (0) [4000 (0)]	0.4 [1.8] 99 (0) [9900 (0)]	0.5 [2.2] 200 (0) [20000 (0)]	0.73 [3.2] 280 (0) [28000 (0)]
0.6x2.3-22.2-P1 0.024 x 0.091	1.1 [26.8]	0.024 [0.6]	42 [170]	0.25 [1.1] 52 (0) [5200 (0)]	0.35 [1.6] 130 (0) [13000 (0)]	0.44 [1.9] 260 (0) [26000 (0)]	0.63 [2.8] 370 (0) [37000 (0)]
0.6x2.3-25.4-P1 0.024 x 0.091	1.2 [30]	0.024 [0.6]	42 [170]	0.22 [1] 67 (0) [6700 (0)]	0.31 [1.4] 170 (0) [17000 (0)]	0.39 [1.7] 330 (0) [33000 (0)]	0.56 [2.5] 470 (0) [47000 (0)]
0.8x1.5-0.5-P1 0.031 x 0.059	0.14 [3.5]	0.031 [0.8]	32 [120]	3.6 [16] 0.2 (0) [20 (0)]	5 [22] 0.49 (0) [49 (0)]	6.2 [28] 0.98 (0) [98 (0)]	9 [40] 1.4 (0) [140 (0)]
0.8x1.5-0.9-P1 0.031 x 0.059	0.15 [3.9]	0.031 [0.8]	32 [120]	3 [13] 0.28 (0) [28 (0)]	4.1 [18] 0.7 (0) [70 (0)]	5.2 [23] 1.4 (0) [140 (0)]	7.5 [33] 2 (0) [200 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.8x1.5-1.15-P1 0.031 x 0.059	0.16 [4.15]	0.031 [0.8]	32 [120]	2.7 [12] 0.34 (0) [34 (0)]	3.7 [17] 0.86 (0) [86 (0)]	4.7 [21] 1.7 (0) [170 (0)]	6.8 [30] 2.4 (0) [240 (0)]
0.8x1.5-1.6-P1 0.031 x 0.059	0.18 [4.6]	0.031 [0.8]	32 [120]	2.3 [10] 0.47 (0) [47 (0)]	3.2 [14] 1.2 (0) [120 (0)]	4 [18] 2.4 (0) [240 (0)]	5.8 [26] 3.3 (0) [330 (0)]
0.8x1.5-2.4-P1 0.031 x 0.059	0.21 [5.4]	0.031 [0.8]	32 [120]	1.8 [8.2] 0.75 (0) [75 (0)]	2.5 [11] 1.9 (0) [190 (0)]	3.2 [14] 3.7 (0) [370 (0)]	4.6 [21] 5.2 (0) [520 (0)]
0.8x1.5-3.2-P1 0.031 x 0.059	0.24 [6.2]	0.031 [0.8]	32 [120]	1.5 [6.8] 1.1 (0) [110 (0)]	2.1 [9.4] 2.7 (0) [270 (0)]	2.6 [12] 5.4 (0) [540 (0)]	3.8 [17] 7.6 (0) [760 (0)]
0.8x1.5-4.75-P1 0.031 x 0.059	0.31 [7.75]	0.031 [0.8]	32 [120]	1.2 [5.1] 1.9 (0) [190 (0)]	1.6 [7.1] 4.8 (0) [480 (0)]	2 [8.8] 9.6 (0) [960 (0)]	2.9 [13] 13 (0) [1300 (0)]
0.8x1.5-6-P1 0.031 x 0.059	0.35 [9]	0.031 [0.8]	32 [120]	0.96 [4.3] 2.8 (0) [280 (0)]	1.3 [5.9] 6.9 (0) [690 (0)]	1.6 [7.3] 14 (0) [1400 (0)]	2.4 [11] 19 (0) [1900 (0)]
0.8x1.5-8-P1 0.031 x 0.059	0.43 [11]	0.031 [0.8]	32 [120]	0.76 [3.4] 4.4 (0) [440 (0)]	1 [4.6] 11 (0) [1100 (0)]	1.3 [5.8] 22 (0) [2200 (0)]	1.9 [8.4] 31 (0) [3100 (0)]
0.8x1.5-9.5-P1 0.031 x 0.059	0.49 [12.5]	0.031 [0.8]	32 [120]	0.65 [2.9] 5.9 (0) [590 (0)]	0.9 [4] 15 (0) [1500 (0)]	1.1 [5] 30 (0) [3000 (0)]	1.6 [7.3] 42 (0) [4200 (0)]
0.8x1.5-12.7-P1 0.031 x 0.059	0.62 [15.7]	0.031 [0.8]	32 [120]	0.51 [2.3] 9.9 (0) [990 (0)]	0.7 [3.1] 25 (0) [2500 (0)]	0.87 [3.9] 49 (0) [4900 (0)]	1.3 [5.6] 69 (0) [6900 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
0.8x1.5-14.2-P1 0.031 x 0.059	0.68 [17.2]	0.031 [0.8]	32 [120]	0.46 [2] 12 (0) [1200 (0)]	0.63 [2.8] 30 (0) [3000 (0)]	0.79 [3.5] 60 (0) [6000 (0)]	1.1 [5.1] 85 (0) [8500 (0)]
0.8x1.5-16-P1 0.031 x 0.059	0.75 [19]	0.031 [0.8]	32 [120]	0.41 [1.8] 15 (0) [1500 (0)]	0.57 [2.5] 38 (0) [3800 (0)]	0.71 [3.1] 75 (0) [7500 (0)]	1 [4.6] 110 (0) [11000 (0)]
0.8x1.5-19-P1 0.031 x 0.059	0.87 [22]	0.031 [0.8]	32 [120]	0.35 [1.6] 21 (0) [2100 (0)]	0.48 [2.2] 52 (0) [5200 (0)]	0.6 [2.7] 100 (0) [10000 (0)]	0.88 [3.9] 140 (0) [14000 (0)]
0.8x1.5-22.2-P1 0.031 x 0.059	0.99 [25.2]	0.031 [0.8]	32 [120]	0.3 [1.4] 28 (0) [2800 (0)]	0.42 [1.9] 69 (0) [6900 (0)]	0.52 [2.3] 140 (0) [14000 (0)]	0.76 [3.4] 190 (0) [19000 (0)]
0.8x1.5-25.4-P1 0.031 x 0.059	1.1 [28.4]	0.031 [0.8]	32 [120]	0.27 [1.2] 36 (0) [3600 (0)]	0.37 [1.6] 89 (0) [8900 (0)]	0.46 [2] 180 (0) [18000 (0)]	0.67 [3] 250 (0) [25000 (0)]
1x2.6-0.5-P1 0.039 x 0.1	0.22 [5.7]	0.039 [1]	25 [100]	6.3 [28] 0.3 (0) [30 (0)]	8.7 [39] 0.76 (0) [76 (0)]	11 [48] 1.5 (0) [150 (0)]	16 [70] 2.1 (0) [210 (0)]
1x2.6-0.9-P1 0.039 x 0.1	0.24 [6.1]	0.039 [1]	25 [100]	5.6 [25] 0.38 (0) [38 (0)]	7.7 [34] 0.96 (0) [96 (0)]	9.6 [43] 1.9 (0) [190 (0)]	14 [62] 2.7 (0) [270 (0)]
1x2.6-1.15-P1 0.039 x 0.1	0.25 [6.35]	0.039 [1]	25 [100]	5.2 [23] 0.44 (0) [44 (0)]	7.2 [32] 1.1 (0) [110 (0)]	8.9 [40] 2.2 (0) [220 (0)]	13 [58] 3.1 (0) [310 (0)]
1x2.6-1.6-P1 0.039 x 0.1	0.27 [6.8]	0.039 [1]	25 [100]	4.6 [21] 0.55 (0) [55 (0)]	6.4 [28] 1.4 (0) [140 (0)]	8 [35] 2.8 (0) [280 (0)]	12 [52] 3.9 (0) [390 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1x2.6-2.4-P1 0.039 x 0.1	0.3 [7.6]	0.039 [1]	25 [100]	3.9 [17] 0.79 (0) [79 (0)]	5.4 [24] 2 (0) [200 (0)]	6.7 [30] 3.9 (0) [390 (0)]	9.7 [43] 5.5 (0) [550 (0)]
1x2.6-3.2-P1 0.039 x 0.1	0.33 [8.4]	0.039 [1]	25 [100]	3.4 [15] 1.1 (0) [110 (0)]	4.6 [21] 2.6 (0) [260 (0)]	5.8 [26] 5.3 (0) [530 (0)]	8.4 [37] 7.4 (0) [740 (0)]
1x2.6-4.75-P1 0.039 x 0.1	0.39 [9.95]	0.039 [1]	25 [100]	2.7 [12] 1.7 (0) [170 (0)]	3.7 [16] 4.2 (0) [420 (0)]	4.6 [20] 8.5 (0) [850 (0)]	6.6 [29] 12 (0) [1200 (0)]
1x2.6-6-P1 0.039 x 0.1	0.44 [11.2]	0.039 [1]	25 [100]	2.3 [10] 2.3 (0) [230 (0)]	3.1 [14] 5.8 (0) [580 (0)]	3.9 [17] 12 (0) [1200 (0)]	5.7 [25] 16 (0) [1600 (0)]
1x2.6-8-P1 0.039 x 0.1	0.52 [13.2]	0.039 [1]	25 [100]	1.8 [8.2] 3.5 (0) [350 (0)]	2.5 [11] 8.8 (0) [880 (0)]	3.2 [14] 18 (0) [1800 (0)]	4.6 [20] 25 (0) [2500 (0)]
1x2.6-9.5-P1 0.039 x 0.1	0.58 [14.7]	0.039 [1]	25 [100]	1.6 [7.2] 4.6 (0) [460 (0)]	2.2 [9.9] 12 (0) [1200 (0)]	2.8 [12] 23 (0) [2300 (0)]	4 [18] 32 (0) [3200 (0)]
1x2.6-12.7-P1 0.039 x 0.1	0.7 [17.9]	0.039 [1]	25 [100]	1.3 [5.7] 7.4 (0) [740 (0)]	1.8 [7.8] 18 (0) [1800 (0)]	2.2 [9.7] 37 (0) [3700 (0)]	3.2 [14] 51 (0) [5100 (0)]
1x2.6-14.2-P1 0.039 x 0.1	0.76 [19.4]	0.039 [1]	25 [100]	1.2 [5.2] 8.9 (0) [890 (0)]	1.6 [7.1] 22 (0) [2200 (0)]	2 [8.9] 44 (0) [4400 (0)]	2.9 [13] 62 (0) [6200 (0)]
1x2.6-16-P1 0.039 x 0.1	0.83 [21.2]	0.039 [1]	25 [100]	1 [4.7] 11 (0) [1100 (0)]	1.4 [6.4] 27 (0) [2700 (0)]	1.8 [8] 54 (0) [5400 (0)]	2.6 [12] 76 (0) [7600 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1x2.6-19-P1 0.039 x 0.1	0.95 [24.2]	0.039 [1]	25 [100]	0.9 [4] 15 (0) [1500 (0)]	1.2 [5.5] 37 (0) [3700 (0)]	1.6 [6.9] 73 (0) [7300 (0)]	2.3 [10] 100 (0) [10000 (0)]
1x2.6-22.2-P1 0.039 x 0.1	1.1 [27.4]	0.039 [1]	25 [100]	0.79 [3.5] 19 (0) [1900 (0)]	1.1 [4.8] 48 (0) [4800 (0)]	1.4 [6] 97 (0) [9700 (0)]	2 [8.7] 140 (0) [14000 (0)]
1x2.6-25.4-P1 0.039 x 0.1	1.2 [30.6]	0.039 [1]	25 [100]	0.7 [3.1] 25 (0) [2500 (0)]	0.96 [4.3] 62 (0) [6200 (0)]	1.2 [5.3] 120 (0) [12000 (0)]	1.7 [7.7] 170 (0) [17000 (0)]
1.5x4-0.5-P1 0.059 x 0.16	0.33 [8.5]	0.059 [1.5]	17 [67]	15 [67] 0.28 (0) [28 (0)]	21 [92] 0.7 (0) [70 (0)]	26 [120] 1.4 (0) [140 (0)]	37 [170] 2 (0) [200 (0)]
1.5x4-0.9-P1 0.059 x 0.16	0.35 [8.9]	0.059 [1.5]	17 [67]	14 [61] 0.34 (0) [34 (0)]	19 [84] 0.84 (0) [84 (0)]	24 [100] 1.7 (0) [170 (0)]	34 [150] 2.4 (0) [240 (0)]
1.5x4-1.15-P1 0.059 x 0.16	0.36 [9.15]	0.059 [1.5]	17 [67]	13 [58] 0.37 (0) [37 (0)]	18 [80] 0.93 (0) [92 (0)]	23 [100] 1.9 (0) [180 (0)]	33 [150] 2.6 (0) [260 (0)]
1.5x4-1.6-P1 0.059 x 0.16	0.38 [9.6]	0.059 [1.5]	17 [67]	12 [54] 0.44 (0) [44 (0)]	17 [74] 1.1 (0) [110 (0)]	21 [92] 2.2 (0) [220 (0)]	30 [130] 3.1 (0) [310 (0)]
1.5x4-2.4-P1 0.059 x 0.16	0.41 [10.4]	0.059 [1.5]	17 [67]	11 [47] 0.57 (0) [57 (0)]	15 [65] 1.4 (0) [140 (0)]	18 [81] 2.9 (0) [290 (0)]	26 [120] 4 (0) [400 (0)]
1.5x4-3.2-P1 0.059 x 0.16	0.44 [11.2]	0.059 [1.5]	17 [67]	9.4 [42] 0.72 (0) [72 (0)]	13 [58] 1.8 (0) [180 (0)]	16 [72] 3.6 (0) [360 (0)]	23 [100] 5.1 (0) [510 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5x4-4.75-P1 0.059 x 0.16	0.5 [12.8]	0.059 [1.5]	17 [67]	7.7 [34] 1.1 (0) [110 (0)]	11 [47] 2.7 (0) [270 (0)]	13 [59] 5.3 (0) [530 (0)]	19 [86] 7.5 (0) [750 (0)]
1.5x4-6-P1 0.059 x 0.16	0.55 [14]	0.059 [1.5]	17 [67]	6.7 [30] 1.4 (0) [140 (0)]	9.3 [41] 3.5 (0) [350 (0)]	12 [52] 7 (0) [700 (0)]	17 [75] 9.8 (0) [980 (0)]
1.5x4-8-P1 0.059 x 0.16	0.63 [16]	0.059 [1.5]	17 [67]	5.6 [25] 2 (0) [200 (0)]	7.8 [34] 5 (0) [500 (0)]	9.7 [43] 10 (0) [1000 (0)]	14 [62] 14 (0) [1400 (0)]
1.5x4-9.5-P1 0.059 x 0.16	0.69 [17.5]	0.059 [1.5]	17 [67]	5 [22] 2.5 (0) [250 (0)]	6.9 [31] 6.4 (0) [640 (0)]	8.6 [38] 13 (0) [1300 (0)]	12 [56] 18 (0) [1800 (0)]
1.5x4-12.7-P1 0.059 x 0.16	0.81 [20.7]	0.059 [1.5]	17 [67]	4 [18] 3.9 (0) [390 (0)]	5.6 [25] 9.7 (0) [970 (0)]	6.9 [31] 19 (0) [1900 (0)]	10 [45] 27 (0) [2700 (0)]
1.5x4-14.2-P1 0.059 x 0.16	0.87 [22.2]	0.059 [1.5]	17 [67]	3.7 [16] 4.6 (0) [460 (0)]	5.1 [23] 12 (0) [1200 (0)]	6.4 [28] 23 (0) [2300 (0)]	9.3 [41] 32 (0) [3200 (0)]
1.5x4-16-P1 0.059 x 0.16	0.94 [24]	0.059 [1.5]	17 [67]	3.4 [15] 5.6 (0) [560 (0)]	4.7 [21] 14 (0) [1400 (0)]	5.8 [26] 28 (0) [2800 (0)]	8.4 [38] 39 (0) [3900 (0)]
1.5x4-19-P1 0.059 x 0.16	1.1 [27]	0.059 [1.5]	17 [67]	2.9 [13] 7.4 (0) [740 (0)]	4 [18] 18 (0) [1800 (0)]	5 [22] 37 (0) [3700 (0)]	7.3 [33] 52 (0) [5200 (0)]
1.5x4-22.2-P1 0.059 x 0.16	1.2 [30.2]	0.059 [1.5]	17 [67]	2.6 [11] 9.6 (0) [960 (0)]	3.6 [16] 24 (0) [2400 (0)]	4.4 [20] 48 (0) [4800 (0)]	6.4 [29] 67 (0) [6700 (0)]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — LINEAR output - tight pitch only, so this spring actuator pulls and does not push

Part reference / strip, in	Coil OD, in [mm]	Pitch, in [mm]	Turns per in [per 100 mm]	Level A: force, lbf [N] / stroke, in [mm]**, pull (push)	Level B: force, lbf [N] / stroke, in [mm]**, pull (push)	Level C: force, lbf [N] / stroke, in [mm]**, pull (push)	Level D: force, lbf [N] / stroke, in [mm]**, pull (push)
1.5x4-25.4-P1 0.059 x 0.16	1.3 [33.4]	0.059 [1.5]	17 [67]	2.3 [10] 12 (0) [1200 (0)]	3.2 [14] 30 (0) [3000 (0)]	3.9 [18] 60 (0) [6000 (0)]	5.7 [26] 84 (0) [8400 (0)]

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.152x0.411-0.5-P1	0.006 x 0.016 [0.152 x 0.411]	0.052 [1.32]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	6700 [26000]	350 [1400]
0.152x0.411-0.9-P1	0.006 x 0.016 [0.152 x 0.411]	0.068 [1.72]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	9600 [38000]	350 [1400]
0.152x0.411-1.15-P1	0.006 x 0.016 [0.152 x 0.411]	0.078 [1.97]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	11000 [45000]	350 [1400]
0.152x0.411-1.6-P1	0.006 x 0.016 [0.152 x 0.411]	0.095 [2.42]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	15000 [58000]	350 [1400]
0.152x0.411-2.4-P1	0.006 x 0.016 [0.152 x 0.411]	0.13 [3.22]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	21000 [81000]	350 [1400]
0.152x0.411-3.2-P1	0.006 x 0.016 [0.152 x 0.411]	0.16 [4.02]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	26000 [100000]	350 [1400]
0.152x0.411-4.75-P1	0.006 x 0.016 [0.152 x 0.411]	0.22 [5.57]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	38000 [150000]	350 [1400]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.152x0.411-6-P1	0.006 x 0.016 [0.152 x 0.411]	0.27 [6.82]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	47000 [180000]	350 [1400]
0.152x0.411-8-P1	0.006 x 0.016 [0.152 x 0.411]	0.35 [8.82]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	62000 [240000]	350 [1400]
0.152x0.411-9.5-P1	0.006 x 0.016 [0.152 x 0.411]	0.41 [10.3]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	73000 [290000]	350 [1400]
0.152x0.411-12.7-P1	0.006 x 0.016 [0.152 x 0.411]	0.53 [13.5]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	96000 [380000]	350 [1400]
0.152x0.411-14.2-P1	0.006 x 0.016 [0.152 x 0.411]	0.59 [15]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	110000 [420000]	350 [1400]
0.152x0.411-16-P1	0.006 x 0.016 [0.152 x 0.411]	0.66 [16.8]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	120000 [470000]	350 [1400]
0.152x0.411-19-P1	0.006 x 0.016 [0.152 x 0.411]	0.78 [19.8]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	140000 [560000]	350 [1400]
0.152x0.411-22.2-P1	0.006 x 0.016 [0.152 x 0.411]	0.91 [23]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	170000 [650000]	350 [1400]
0.152x0.411-25.4-P1	0.006 x 0.016 [0.152 x 0.411]	1 [26.2]	0.0038 [0.43]	0.0052 [0.59]	0.0065 [0.74]	0.0095 [1.1]	190000 [740000]	350 [1400]
0.152x0.813-0.5-P1	0.006 x 0.032 [0.152 x 0.813]	0.084 [2.13]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	4900 [19000]	180 [700]
0.152x0.813-0.9-P1	0.006 x 0.032 [0.152 x 0.813]	0.099 [2.53]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	6300 [25000]	180 [700]
0.152x0.813-1.15-P1	0.006 x 0.032 [0.152 x 0.813]	0.11 [2.78]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	7300 [29000]	180 [700]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.152x0.813-1.6-P1	0.006 x 0.032 [0.152 x 0.813]	0.13 [3.23]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	8900 [35000]	180 [700]
0.152x0.813-2.4-P1	0.006 x 0.032 [0.152 x 0.813]	0.16 [4.03]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	12000 [47000]	180 [700]
0.152x0.813-3.2-P1	0.006 x 0.032 [0.152 x 0.813]	0.19 [4.83]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	15000 [58000]	180 [700]
0.152x0.813-4.75-P1	0.006 x 0.032 [0.152 x 0.813]	0.25 [6.38]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	21000 [81000]	180 [700]
0.152x0.813-6-P1	0.006 x 0.032 [0.152 x 0.813]	0.3 [7.63]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	25000 [99000]	180 [700]
0.152x0.813-8-P1	0.006 x 0.032 [0.152 x 0.813]	0.38 [9.63]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	33000 [130000]	180 [700]
0.152x0.813-9.5-P1	0.006 x 0.032 [0.152 x 0.813]	0.44 [11.1]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	38000 [150000]	180 [700]
0.152x0.813-12.7-P1	0.006 x 0.032 [0.152 x 0.813]	0.56 [14.3]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	50000 [200000]	180 [700]
0.152x0.813-14.2-P1	0.006 x 0.032 [0.152 x 0.813]	0.62 [15.8]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	56000 [220000]	180 [700]
0.152x0.813-16-P1	0.006 x 0.032 [0.152 x 0.813]	0.69 [17.6]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	62000 [240000]	180 [700]
0.152x0.813-19-P1	0.006 x 0.032 [0.152 x 0.813]	0.81 [20.6]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	73000 [290000]	180 [700]
0.152x0.813-22.2-P1	0.006 x 0.032 [0.152 x 0.813]	0.94 [23.8]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	85000 [340000]	180 [700]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.152x0.813-25.4-P1	0.006 x 0.032 [0.152 x 0.813]	1.1 [27]	0.015 [1.7]	0.02 [2.3]	0.025 [2.9]	0.037 [4.2]	97000 [380000]	180 [700]
0.25x0.5-0.5-P1	0.0098 x 0.02 [0.25 x 0.5]	0.059 [1.5]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	3700 [14000]	290 [1100]
0.25x0.5-0.9-P1	0.0098 x 0.02 [0.25 x 0.5]	0.075 [1.9]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	5100 [20000]	290 [1100]
0.25x0.5-1.15-P1	0.0098 x 0.02 [0.25 x 0.5]	0.085 [2.15]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	6000 [24000]	290 [1100]
0.25x0.5-1.6-P1	0.0098 x 0.02 [0.25 x 0.5]	0.1 [2.6]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	7700 [30000]	290 [1100]
0.25x0.5-2.4-P1	0.0098 x 0.02 [0.25 x 0.5]	0.13 [3.4]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	11000 [42000]	290 [1100]
0.25x0.5-3.2-P1	0.0098 x 0.02 [0.25 x 0.5]	0.17 [4.2]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	14000 [53000]	290 [1100]
0.25x0.5-4.75-P1	0.0098 x 0.02 [0.25 x 0.5]	0.23 [5.75]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	19000 [76000]	290 [1100]
0.25x0.5-6-P1	0.0098 x 0.02 [0.25 x 0.5]	0.28 [7]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	24000 [94000]	290 [1100]
0.25x0.5-8-P1	0.0098 x 0.02 [0.25 x 0.5]	0.35 [9]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	31000 [120000]	290 [1100]
0.25x0.5-9.5-P1	0.0098 x 0.02 [0.25 x 0.5]	0.41 [10.5]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	37000 [140000]	290 [1100]
0.25x0.5-12.7-P1	0.0098 x 0.02 [0.25 x 0.5]	0.54 [13.7]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	48000 [190000]	290 [1100]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.25x0.5-14.2-P1	0.0098 x 0.02 [0.25 x 0.5]	0.6 [15.2]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	54000 [210000]	290 [1100]
0.25x0.5-16-P1	0.0098 x 0.02 [0.25 x 0.5]	0.67 [17]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	60000 [240000]	290 [1100]
0.25x0.5-19-P1	0.0098 x 0.02 [0.25 x 0.5]	0.79 [20]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	71000 [280000]	290 [1100]
0.25x0.5-22.2-P1	0.0098 x 0.02 [0.25 x 0.5]	0.91 [23.2]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	83000 [330000]	290 [1100]
0.25x0.5-25.4-P1	0.0098 x 0.02 [0.25 x 0.5]	1 [26.4]	0.0092 [1]	0.013 [1.4]	0.016 [1.8]	0.023 [2.6]	95000 [370000]	290 [1100]
0.3x2-0.5-P1	0.012 x 0.079 [0.3 x 2]	0.18 [4.5]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	1900 [7500]	73 [290]
0.3x2-0.9-P1	0.012 x 0.079 [0.3 x 2]	0.19 [4.9]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	2200 [8700]	73 [290]
0.3x2-1.15-P1	0.012 x 0.079 [0.3 x 2]	0.2 [5.15]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	2400 [9400]	73 [290]
0.3x2-1.6-P1	0.012 x 0.079 [0.3 x 2]	0.22 [5.6]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	2700 [11000]	73 [290]
0.3x2-2.4-P1	0.012 x 0.079 [0.3 x 2]	0.25 [6.4]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	3400 [13000]	73 [290]
0.3x2-3.2-P1	0.012 x 0.079 [0.3 x 2]	0.28 [7.2]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	4000 [16000]	73 [290]
0.3x2-4.75-P1	0.012 x 0.079 [0.3 x 2]	0.34 [8.75]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	5100 [20000]	73 [290]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.3x2-6-P1	0.012 x 0.079 [0.3 x 2]	0.39 [10]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	6100 [24000]	73 [290]
0.3x2-8-P1	0.012 x 0.079 [0.3 x 2]	0.47 [12]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	7600 [30000]	73 [290]
0.3x2-9.5-P1	0.012 x 0.079 [0.3 x 2]	0.53 [13.5]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	8800 [34000]	73 [290]
0.3x2-12.7-P1	0.012 x 0.079 [0.3 x 2]	0.66 [16.7]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	11000 [44000]	73 [290]
0.3x2-14.2-P1	0.012 x 0.079 [0.3 x 2]	0.72 [18.2]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	12000 [49000]	73 [290]
0.3x2-16-P1	0.012 x 0.079 [0.3 x 2]	0.79 [20]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	14000 [54000]	73 [290]
0.3x2-19-P1	0.012 x 0.079 [0.3 x 2]	0.91 [23]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	16000 [63000]	73 [290]
0.3x2-22.2-P1	0.012 x 0.079 [0.3 x 2]	1 [26.2]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	18000 [73000]	73 [290]
0.3x2-25.4-P1	0.012 x 0.079 [0.3 x 2]	1.2 [29.4]	0.18 [20]	0.24 [28]	0.3 [34]	0.44 [50]	21000 [82000]	73 [290]
0.4x0.8-0.5-P1	0.016 x 0.031 [0.4 x 0.8]	0.083 [2.1]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	1900 [7300]	180 [720]
0.4x0.8-0.9-P1	0.016 x 0.031 [0.4 x 0.8]	0.098 [2.5]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	2400 [9600]	180 [720]
0.4x0.8-1.15-P1	0.016 x 0.031 [0.4 x 0.8]	0.11 [2.75]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	2800 [11000]	180 [720]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.4x0.8-1.6-P1	0.016 x 0.031 [0.4 x 0.8]	0.13 [3.2]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	3400 [14000]	180 [720]
0.4x0.8-2.4-P1	0.016 x 0.031 [0.4 x 0.8]	0.16 [4]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	4600 [18000]	180 [720]
0.4x0.8-3.2-P1	0.016 x 0.031 [0.4 x 0.8]	0.19 [4.8]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	5700 [22000]	180 [720]
0.4x0.8-4.75-P1	0.016 x 0.031 [0.4 x 0.8]	0.25 [6.35]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	7900 [31000]	180 [720]
0.4x0.8-6-P1	0.016 x 0.031 [0.4 x 0.8]	0.3 [7.6]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	9700 [38000]	180 [720]
0.4x0.8-8-P1	0.016 x 0.031 [0.4 x 0.8]	0.38 [9.6]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	13000 [50000]	180 [720]
0.4x0.8-9.5-P1	0.016 x 0.031 [0.4 x 0.8]	0.44 [11.1]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	15000 [58000]	180 [720]
0.4x0.8-12.7-P1	0.016 x 0.031 [0.4 x 0.8]	0.56 [14.3]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	19000 [76000]	180 [720]
0.4x0.8-14.2-P1	0.016 x 0.031 [0.4 x 0.8]	0.62 [15.8]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	21000 [84000]	180 [720]
0.4x0.8-16-P1	0.016 x 0.031 [0.4 x 0.8]	0.69 [17.6]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	24000 [94000]	180 [720]
0.4x0.8-19-P1	0.016 x 0.031 [0.4 x 0.8]	0.81 [20.6]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	28000 [110000]	180 [720]
0.4x0.8-22.2-P1	0.016 x 0.031 [0.4 x 0.8]	0.94 [23.8]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	33000 [130000]	180 [720]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.4x0.8-25.4-P1	0.016 x 0.031 [0.4 x 0.8]	1.1 [27]	0.038 [4.3]	0.052 [5.9]	0.065 [7.3]	0.094 [11]	37000 [150000]	180 [720]
0.4x1-0.5-P1	0.016 x 0.039 [0.4 x 1]	0.098 [2.5]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	1700 [6800]	150 [570]
0.4x1-0.9-P1	0.016 x 0.039 [0.4 x 1]	0.11 [2.9]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	2200 [8600]	150 [570]
0.4x1-1.15-P1	0.016 x 0.039 [0.4 x 1]	0.12 [3.15]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	2500 [9700]	150 [570]
0.4x1-1.6-P1	0.016 x 0.039 [0.4 x 1]	0.14 [3.6]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	3000 [12000]	150 [570]
0.4x1-2.4-P1	0.016 x 0.039 [0.4 x 1]	0.17 [4.4]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	3900 [15000]	150 [570]
0.4x1-3.2-P1	0.016 x 0.039 [0.4 x 1]	0.2 [5.2]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	4800 [19000]	150 [570]
0.4x1-4.75-P1	0.016 x 0.039 [0.4 x 1]	0.27 [6.75]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	6600 [26000]	150 [570]
0.4x1-6-P1	0.016 x 0.039 [0.4 x 1]	0.31 [8]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	8000 [32000]	150 [570]
0.4x1-8-P1	0.016 x 0.039 [0.4 x 1]	0.39 [10]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	10000 [40000]	150 [570]
0.4x1-9.5-P1	0.016 x 0.039 [0.4 x 1]	0.45 [11.5]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	12000 [47000]	150 [570]
0.4x1-12.7-P1	0.016 x 0.039 [0.4 x 1]	0.58 [14.7]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	16000 [62000]	150 [570]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.4x1-14.2-P1	0.016 x 0.039 [0.4 x 1]	0.64 [16.2]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	17000 [68000]	150 [570]
0.4x1-16-P1	0.016 x 0.039 [0.4 x 1]	0.71 [18]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	19000 [76000]	150 [570]
0.4x1-19-P1	0.016 x 0.039 [0.4 x 1]	0.83 [21]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	23000 [90000]	150 [570]
0.4x1-22.2-P1	0.016 x 0.039 [0.4 x 1]	0.95 [24.2]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	27000 [100000]	150 [570]
0.4x1-25.4-P1	0.016 x 0.039 [0.4 x 1]	1.1 [27.4]	0.059 [6.7]	0.081 [9.2]	0.1 [11]	0.15 [17]	30000 [120000]	150 [570]
0.5x0.25-0.5-P1	0.02 x 0.0098 [0.5 x 0.25]	0.039 [1]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	2700 [11000]	580 [2300]
0.5x0.25-0.9-P1	0.02 x 0.0098 [0.5 x 0.25]	0.055 [1.4]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	4200 [17000]	580 [2300]
0.5x0.25-1.15-P1	0.02 x 0.0098 [0.5 x 0.25]	0.065 [1.65]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	5100 [20000]	580 [2300]
0.5x0.25-1.6-P1	0.02 x 0.0098 [0.5 x 0.25]	0.083 [2.1]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	6800 [27000]	580 [2300]
0.5x0.25-2.4-P1	0.02 x 0.0098 [0.5 x 0.25]	0.11 [2.9]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	9700 [38000]	580 [2300]
0.5x0.25-3.2-P1	0.02 x 0.0098 [0.5 x 0.25]	0.15 [3.7]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	13000 [50000]	580 [2300]
0.5x0.25-4.75-P1	0.02 x 0.0098 [0.5 x 0.25]	0.21 [5.25]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	18000 [72000]	580 [2300]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.5x0.25-6-P1	0.02 x 0.0098 [0.5 x 0.25]	0.26 [6.5]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	23000 [90000]	580 [2300]
0.5x0.25-8-P1	0.02 x 0.0098 [0.5 x 0.25]	0.33 [8.5]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	30000 [120000]	580 [2300]
0.5x0.25-9.5-P1	0.02 x 0.0098 [0.5 x 0.25]	0.39 [10]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	36000 [140000]	580 [2300]
0.5x0.25-12.7-P1	0.02 x 0.0098 [0.5 x 0.25]	0.52 [13.2]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	47000 [190000]	580 [2300]
0.5x0.25-14.2-P1	0.02 x 0.0098 [0.5 x 0.25]	0.58 [14.7]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	53000 [210000]	580 [2300]
0.5x0.25-16-P1	0.02 x 0.0098 [0.5 x 0.25]	0.65 [16.5]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	59000 [230000]	580 [2300]
0.5x0.25-19-P1	0.02 x 0.0098 [0.5 x 0.25]	0.77 [19.5]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	70000 [280000]	580 [2300]
0.5x0.25-22.2-P1	0.02 x 0.0098 [0.5 x 0.25]	0.89 [22.7]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	82000 [320000]	580 [2300]
0.5x0.25-25.4-P1	0.02 x 0.0098 [0.5 x 0.25]	1 [25.9]	0.0046 [0.52]	0.0064 [0.72]	0.0079 [0.9]	0.012 [1.3]	94000 [370000]	580 [2300]
0.5x0.8-0.5-P1	0.02 x 0.031 [0.5 x 0.8]	0.083 [2.1]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	1500 [5800]	180 [720]
0.5x0.8-0.9-P1	0.02 x 0.031 [0.5 x 0.8]	0.098 [2.5]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	1900 [7600]	180 [720]
0.5x0.8-1.15-P1	0.02 x 0.031 [0.5 x 0.8]	0.11 [2.75]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	2200 [8800]	180 [720]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.5x0.8-1.6-P1	0.02 x 0.031 [0.5 x 0.8]	0.13 [3.2]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	2700 [11000]	180 [720]
0.5x0.8-2.4-P1	0.02 x 0.031 [0.5 x 0.8]	0.16 [4]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	3700 [14000]	180 [720]
0.5x0.8-3.2-P1	0.02 x 0.031 [0.5 x 0.8]	0.19 [4.8]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	4600 [18000]	180 [720]
0.5x0.8-4.75-P1	0.02 x 0.031 [0.5 x 0.8]	0.25 [6.35]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	6300 [25000]	180 [720]
0.5x0.8-6-P1	0.02 x 0.031 [0.5 x 0.8]	0.3 [7.6]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	7800 [31000]	180 [720]
0.5x0.8-8-P1	0.02 x 0.031 [0.5 x 0.8]	0.38 [9.6]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	10000 [40000]	180 [720]
0.5x0.8-9.5-P1	0.02 x 0.031 [0.5 x 0.8]	0.44 [11.1]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	12000 [46000]	180 [720]
0.5x0.8-12.7-P1	0.02 x 0.031 [0.5 x 0.8]	0.56 [14.3]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	15000 [61000]	180 [720]
0.5x0.8-14.2-P1	0.02 x 0.031 [0.5 x 0.8]	0.62 [15.8]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	17000 [68000]	180 [720]
0.5x0.8-16-P1	0.02 x 0.031 [0.5 x 0.8]	0.69 [17.6]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	19000 [76000]	180 [720]
0.5x0.8-19-P1	0.02 x 0.031 [0.5 x 0.8]	0.81 [20.6]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	23000 [89000]	180 [720]
0.5x0.8-22.2-P1	0.02 x 0.031 [0.5 x 0.8]	0.94 [23.8]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	26000 [100000]	180 [720]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.5x0.8-25.4-P1	0.02 x 0.031 [0.5 x 0.8]	1.1 [27]	0.047 [5.3]	0.065 [7.4]	0.081 [9.2]	0.12 [13]	30000 [120000]	180 [720]
0.55x1.4-0.5-P1	0.022 x 0.055 [0.55 x 1.4]	0.13 [3.3]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	1100 [4400]	100 [410]
0.55x1.4-0.9-P1	0.022 x 0.055 [0.55 x 1.4]	0.15 [3.7]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	1400 [5400]	100 [410]
0.55x1.4-1.15-P1	0.022 x 0.055 [0.55 x 1.4]	0.16 [3.95]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	1500 [6000]	100 [410]
0.55x1.4-1.6-P1	0.022 x 0.055 [0.55 x 1.4]	0.17 [4.4]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	1800 [7000]	100 [410]
0.55x1.4-2.4-P1	0.022 x 0.055 [0.55 x 1.4]	0.2 [5.2]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	2300 [8900]	100 [410]
0.55x1.4-3.2-P1	0.022 x 0.055 [0.55 x 1.4]	0.24 [6]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	2700 [11000]	100 [410]
0.55x1.4-4.75-P1	0.022 x 0.055 [0.55 x 1.4]	0.3 [7.55]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	3700 [14000]	100 [410]
0.55x1.4-6-P1	0.022 x 0.055 [0.55 x 1.4]	0.35 [8.8]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	4400 [17000]	100 [410]
0.55x1.4-8-P1	0.022 x 0.055 [0.55 x 1.4]	0.43 [10.8]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	5600 [22000]	100 [410]
0.55x1.4-9.5-P1	0.022 x 0.055 [0.55 x 1.4]	0.48 [12.3]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	6500 [25000]	100 [410]
0.55x1.4-12.7-P1	0.022 x 0.055 [0.55 x 1.4]	0.61 [15.5]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	8400 [33000]	100 [410]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.55x1.4-14.2-P1	0.022 x 0.055 [0.55 x 1.4]	0.67 [17]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	9300 [36000]	100 [410]
0.55x1.4-16-P1	0.022 x 0.055 [0.55 x 1.4]	0.74 [18.8]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	10000 [41000]	100 [410]
0.55x1.4-19-P1	0.022 x 0.055 [0.55 x 1.4]	0.86 [21.8]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	12000 [48000]	100 [410]
0.55x1.4-22.2-P1	0.022 x 0.055 [0.55 x 1.4]	0.98 [25]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	14000 [55000]	100 [410]
0.55x1.4-25.4-P1	0.022 x 0.055 [0.55 x 1.4]	1.1 [28.2]	0.16 [18]	0.22 [25]	0.27 [31]	0.4 [45]	16000 [63000]	100 [410]
0.6x2.3-0.5-P1	0.024 x 0.091 [0.6 x 2.3]	0.2 [5.1]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	930 [3700]	63 [250]
0.6x2.3-0.9-P1	0.024 x 0.091 [0.6 x 2.3]	0.22 [5.5]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	1100 [4200]	63 [250]
0.6x2.3-1.15-P1	0.024 x 0.091 [0.6 x 2.3]	0.23 [5.75]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	1100 [4500]	63 [250]
0.6x2.3-1.6-P1	0.024 x 0.091 [0.6 x 2.3]	0.24 [6.2]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	1300 [5100]	63 [250]
0.6x2.3-2.4-P1	0.024 x 0.091 [0.6 x 2.3]	0.28 [7]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	1600 [6100]	63 [250]
0.6x2.3-3.2-P1	0.024 x 0.091 [0.6 x 2.3]	0.31 [7.8]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	1800 [7200]	63 [250]
0.6x2.3-4.75-P1	0.024 x 0.091 [0.6 x 2.3]	0.37 [9.35]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	2300 [9200]	63 [250]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.6x2.3-6-P1	0.024 x 0.091 [0.6 x 2.3]	0.42 [10.6]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	2800 [11000]	63 [250]
0.6x2.3-8-P1	0.024 x 0.091 [0.6 x 2.3]	0.5 [12.6]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	3400 [13000]	63 [250]
0.6x2.3-9.5-P1	0.024 x 0.091 [0.6 x 2.3]	0.56 [14.1]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	3900 [15000]	63 [250]
0.6x2.3-12.7-P1	0.024 x 0.091 [0.6 x 2.3]	0.68 [17.3]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	5000 [20000]	63 [250]
0.6x2.3-14.2-P1	0.024 x 0.091 [0.6 x 2.3]	0.74 [18.8]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	5500 [22000]	63 [250]
0.6x2.3-16-P1	0.024 x 0.091 [0.6 x 2.3]	0.81 [20.6]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	6100 [24000]	63 [250]
0.6x2.3-19-P1	0.024 x 0.091 [0.6 x 2.3]	0.93 [23.6]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	7100 [28000]	63 [250]
0.6x2.3-22.2-P1	0.024 x 0.091 [0.6 x 2.3]	1.1 [26.8]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	8100 [32000]	63 [250]
0.6x2.3-25.4-P1	0.024 x 0.091 [0.6 x 2.3]	1.2 [30]	0.47 [53]	0.65 [73]	0.81 [91]	1.2 [130]	9200 [36000]	63 [250]
0.8x1.5-0.5-P1	0.031 x 0.059 [0.8 x 1.5]	0.14 [3.5]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	760 [3000]	97 [380]
0.8x1.5-0.9-P1	0.031 x 0.059 [0.8 x 1.5]	0.15 [3.9]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	910 [3600]	97 [380]
0.8x1.5-1.15-P1	0.031 x 0.059 [0.8 x 1.5]	0.16 [4.15]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	1000 [4000]	97 [380]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.8x1.5-1.6-P1	0.031 x 0.059 [0.8 x 1.5]	0.18 [4.6]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	1200 [4600]	97 [380]
0.8x1.5-2.4-P1	0.031 x 0.059 [0.8 x 1.5]	0.21 [5.4]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	1500 [5800]	97 [380]
0.8x1.5-3.2-P1	0.031 x 0.059 [0.8 x 1.5]	0.24 [6.2]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	1800 [7000]	97 [380]
0.8x1.5-4.75-P1	0.031 x 0.059 [0.8 x 1.5]	0.31 [7.75]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	2400 [9400]	97 [380]
0.8x1.5-6-P1	0.031 x 0.059 [0.8 x 1.5]	0.35 [9]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	2900 [11000]	97 [380]
0.8x1.5-8-P1	0.031 x 0.059 [0.8 x 1.5]	0.43 [11]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	3600 [14000]	97 [380]
0.8x1.5-9.5-P1	0.031 x 0.059 [0.8 x 1.5]	0.49 [12.5]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	4200 [16000]	97 [380]
0.8x1.5-12.7-P1	0.031 x 0.059 [0.8 x 1.5]	0.62 [15.7]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	5400 [21000]	97 [380]
0.8x1.5-14.2-P1	0.031 x 0.059 [0.8 x 1.5]	0.68 [17.2]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	6000 [24000]	97 [380]
0.8x1.5-16-P1	0.031 x 0.059 [0.8 x 1.5]	0.75 [19]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	6700 [26000]	97 [380]
0.8x1.5-19-P1	0.031 x 0.059 [0.8 x 1.5]	0.87 [22]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	7800 [31000]	97 [380]
0.8x1.5-22.2-P1	0.031 x 0.059 [0.8 x 1.5]	0.99 [25.2]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	9000 [36000]	97 [380]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
0.8x1.5-25.4-P1	0.031 x 0.059 [0.8 x 1.5]	1.1 [28.4]	0.27 [30]	0.37 [41]	0.46 [52]	0.66 [75]	10000 [40000]	97 [380]
1x2.6-0.5-P1	0.039 x 0.1 [1 x 2.6]	0.22 [5.7]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	540 [2100]	56 [220]
1x2.6-0.9-P1	0.039 x 0.1 [1 x 2.6]	0.24 [6.1]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	620 [2400]	56 [220]
1x2.6-1.15-P1	0.039 x 0.1 [1 x 2.6]	0.25 [6.35]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	660 [2600]	56 [220]
1x2.6-1.6-P1	0.039 x 0.1 [1 x 2.6]	0.27 [6.8]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	740 [2900]	56 [220]
1x2.6-2.4-P1	0.039 x 0.1 [1 x 2.6]	0.3 [7.6]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	880 [3500]	56 [220]
1x2.6-3.2-P1	0.039 x 0.1 [1 x 2.6]	0.33 [8.4]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	1000 [4000]	56 [220]
1x2.6-4.75-P1	0.039 x 0.1 [1 x 2.6]	0.39 [9.95]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	1300 [5100]	56 [220]
1x2.6-6-P1	0.039 x 0.1 [1 x 2.6]	0.44 [11.2]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	1500 [6000]	56 [220]
1x2.6-8-P1	0.039 x 0.1 [1 x 2.6]	0.52 [13.2]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	1900 [7300]	56 [220]
1x2.6-9.5-P1	0.039 x 0.1 [1 x 2.6]	0.58 [14.7]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	2100 [8400]	56 [220]
1x2.6-12.7-P1	0.039 x 0.1 [1 x 2.6]	0.7 [17.9]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	2700 [11000]	56 [220]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
1x2.6-14.2-P1	0.039 x 0.1 [1 x 2.6]	0.76 [19.4]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	3000 [12000]	56 [220]
1x2.6-16-P1	0.039 x 0.1 [1 x 2.6]	0.83 [21.2]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	3300 [13000]	56 [220]
1x2.6-19-P1	0.039 x 0.1 [1 x 2.6]	0.95 [24.2]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	3800 [15000]	56 [220]
1x2.6-22.2-P1	0.039 x 0.1 [1 x 2.6]	1.1 [27.4]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	4400 [17000]	56 [220]
1x2.6-25.4-P1	0.039 x 0.1 [1 x 2.6]	1.2 [30.6]	1 [110]	1.4 [160]	1.7 [190]	2.5 [280]	4900 [19000]	56 [220]
1.5x4-0.5-P1	0.059 x 0.16 [1.5 x 4]	0.33 [8.5]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	340 [1400]	36 [140]
1.5x4-0.9-P1	0.059 x 0.16 [1.5 x 4]	0.35 [8.9]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	370 [1500]	36 [140]
1.5x4-1.15-P1	0.059 x 0.16 [1.5 x 4]	0.36 [9.15]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	390 [1500]	36 [140]
1.5x4-1.6-P1	0.059 x 0.16 [1.5 x 4]	0.38 [9.6]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	430 [1700]	36 [140]
1.5x4-2.4-P1	0.059 x 0.16 [1.5 x 4]	0.41 [10.4]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	490 [1900]	36 [140]
1.5x4-3.2-P1	0.059 x 0.16 [1.5 x 4]	0.44 [11.2]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	550 [2200]	36 [140]
1.5x4-4.75-P1	0.059 x 0.16 [1.5 x 4]	0.5 [12.8]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	670 [2600]	36 [140]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

EDGE WOUND SPRING ACTUATORS — ROTARY output - tight pitch

Part reference	Strip, in [mm]	Coil OD, in [mm]	Torque A, in·lbf [N·mm]	Torque B, in·lbf [N·mm]	Torque C, in·lbf [N·mm]	Torque D, in·lbf [N·mm]	Deg C per in of spring actuator [per 100 mm]	Deg C per in of strip [per 100 mm]
1.5x4-6-P1	0.059 x 0.16 [1.5 x 4]	0.55 [14]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	760 [3000]	36 [140]
1.5x4-8-P1	0.059 x 0.16 [1.5 x 4]	0.63 [16]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	910 [3600]	36 [140]
1.5x4-9.5-P1	0.059 x 0.16 [1.5 x 4]	0.69 [17.5]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	1000 [4000]	36 [140]
1.5x4-12.7-P1	0.059 x 0.16 [1.5 x 4]	0.81 [20.7]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	1300 [5000]	36 [140]
1.5x4-14.2-P1	0.059 x 0.16 [1.5 x 4]	0.87 [22.2]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	1400 [5500]	36 [140]
1.5x4-16-P1	0.059 x 0.16 [1.5 x 4]	0.94 [24]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	1500 [6000]	36 [140]
1.5x4-19-P1	0.059 x 0.16 [1.5 x 4]	1.1 [27]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	1800 [6900]	36 [140]
1.5x4-22.2-P1	0.059 x 0.16 [1.5 x 4]	1.2 [30.2]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	2000 [7900]	36 [140]
1.5x4-25.4-P1	0.059 x 0.16 [1.5 x 4]	1.3 [33.4]	3.5 [400]	4.9 [550]	6.1 [690]	8.9 [1000]	2200 [8800]	36 [140]

** Stroke is per 1" [100mm] of spring. * Push limited by solid height.

NOTES

NOTES

CHAPTER 7

Torsion Spring Actuators

Rotation about the coil axis

A torsion spring actuator turns. Not along its axis like a helical spring actuator, but about it, the way a clock spring or a mousetrap turns.

It is a wire wrapped around a mandrel a number of times, with the two ends arranged to be held. Heat it and it winds or unwinds, and whatever is attached to the ends rotates. If your mechanism needs a hinge that closes itself, a lid that lifts, a flap that swings or a latch that rotates home, this is the shape that does it without a motor and without a linkage.

What sets the torque, and what sets the angle

TORQUE comes from the section of the wire. Thicker wire, more torque, and it climbs steeply: the torque of a round wire goes with the cube of its diameter.

ANGLE comes from how much wire is wrapped. Each wrap contributes the same sweep, so two wraps give twice the angle of one, and ten give ten times. Nothing else in the design changes it.

That is why this chapter is laid out the way it is. Rather than list every possible number of wraps, the tables give you the sweep from ONE WRAP. Decide how many degrees you need, divide by the figure in the table, and that is how many wraps to order. The wire length that each wrap uses is listed beside it so you can work out the material as well.

Flat wire gives you a choice

If the spring actuator is wound from flat wire rather than round, the same decision appears as in the face wound and edge wound chapters. Wound on its face the strip bends about its thin dimension and gives a large angle at modest torque. Wound on its edge it bends about its wide dimension and gives high torque over a small angle. The two are listed next to each other so you can read across.

These are the same parts that Chapters 5 and 6 list as wound spring actuators. Nothing about the part changes; only the way you hold it does. Pull one along its axis and you have a linear actuator, and it is listed there. Hold one end and let the other turn and you have the torsion spring actuator listed here. If you are choosing between the two, read both chapters for the same part reference.

Pitch, and what it does here

Pitch in a helical spring actuator decides which directions the part can work in. In a torsion spring actuator it does nothing of the kind. Torque comes from the section of the wire, sweep comes from the number of wraps, and neither one changes when you open or close the wind. What pitch decides is where the two ends sit.

That is a packaging question, and on most drawings it is the one that actually matters. The ends have to reach whatever they are turning, at the separation and the angle your mechanism leaves for them. Tell us where they need to be and we wind to suit.

This is why pitch is not a column in these tables. The figures are per wrap and they hold whichever wind you choose. The tightest is tape wound, where each wrap sits on top of the one before rather than beside it, so the coil takes almost no length along its axis; from there the pitch opens as far as you need, spending axial length to put the ends where the work is. For the wrap counts most designs use, treating every wrap as contributing equally is a fair approximation, and that is what the tables do.

What to watch

The ends do the work, so tell us how you intend to hold them. Straight legs, hooks and tangs all change what the spring actuator can be attached to and none of them are in the table. They also change the section, and a change in section concentrates strain. The figures in these tables are strain figures, so an actuator working at level C is at five percent through the wrapped length and can be at considerably more where a leg is formed or a tang is bent, and that is where it will fail first. Tell us the load and how you intend to hold it and we will design the ends with the actuator.

Getting it back

Like every shape in this handbook, a nitinol actuator moves one way when it is heated. Getting it back to where it started is the designer's problem, and there are three ways to solve it.

AN ANTAGONISTIC PAIR uses a second actuator working against the first. Heat one and it moves the mechanism and resets the other; heat the other and it goes back. You get powered motion in both directions with full output each way, at the cost of two actuators and a control scheme that never heats both at once.

A BIAS is a passive element, usually a conventional spring or a weight, that the actuator works against as it moves and that pushes it back as it cools. It is the simplest arrangement and the most common. The price is that the bias resists the actuator through the whole stroke, so part of the force in the table is spent returning the mechanism rather than doing the job. Size it to return the actuator and no more.

SYSTEM FORCES are the return you already have. If the mechanism pushes back on its own, if gravity closes the door, if the thing being clamped is springy, if line pressure acts on the valve, that force resets the actuator for nothing. It is the best answer when it is available, and worth looking for before adding parts.

Whichever you choose, the return has to be strong enough to reset the actuator while it is cool and weak enough not to stall it while it is hot. That window is what sizes a bias, and it is the most common thing to get wrong on a first build.

There is a fourth possibility. Any nitinol actuator can be given a two way set, so that it takes one shape hot and another cold and needs no return at all. Two way parts are made to order and are outside the scope of this handbook, so nothing here is rated for it, but it exists. Ask.

Overdriving an actuator

The figures in this handbook are conservative. Every force in every table is rated at a stress we are confident the part will deliver, cycle after cycle, at the fatigue life of its design level. A part will usually do more than the table says. We would rather you found that out in testing than the other way round.

The second reason a part will beat its table is that you can overdrive it, and this one is a feature you can design with. There are two ways to do it, and they add.

The first is to heat it further. Nitinol makes its force by changing phase, and the temperature at which it does that is the transition temperature we set for you. The force does not stop climbing when the part gets there. Keep heating it past the transition and the force keeps rising with temperature, well beyond the rated figure. The table gives you the force at a working temperature comfortably above transition. Drive the part hotter and there is more.

The second is to heat it faster. Heat the part slowly and it makes the force in the table. Heat it quickly, with a sharp pulse of current rather than a gentle ramp, and it makes more, and the harder the pulse, the bigger the difference. A part that is driven both fast and hot gets the gain from each, one on top of the other. The tables assume neither. They are the floor.

Emergency mode

That gives a nitinol actuator something most actuators do not have: a reserve. A motor or a solenoid has a rated output and a thermal limit close behind it. A nitinol actuator can be driven, briefly, to a force well above its rating simply by putting more heat into it, faster. Think of it as an emergency mode. A latch that normally needs a modest pull can, on the day something jams, be hit with a short hard pulse and told to pull much harder. A release that must not fail gets a margin that costs nothing in size or weight.

Use it as a reserve, not as the rating, and know where the limits are. There is a temperature, called Md, above which the metal can no longer be pushed into martensite by stress; up to Md the material is still behaving as nitinol should. Overdriving up to Md costs some fatigue life, but it also does the part a favor: the extra heat drives out residual martensite that builds up over many cycles, a kind of rehabilitation in place, so a part that is occasionally run hard can come back sharper than one that never is. Above Md the accounting changes. Degradation is faster, and each hot cycle takes a larger bite out of the life. Above 350 °C (660 °F) the part is past saving: treat an actuator that has been driven that hot as spent and replace it. Used within those limits, for the rare event, emergency mode is one of the best arguments for the material.

Actuator safety

Most actuators fail badly when they are overdriven, and engineers know exactly how. Put too much current into a motor or a solenoid and it explodes. Overpressure a hydraulic cylinder and it bursts, or springs a pinhole leak, and a jet of oil at that pressure will cut through a glove and a hand, take a limb, and put oil into the ground and the water where it can be years being cleaned up. Every one of them has the same problem: the energy is stored in the actuator, and when something goes wrong it has nowhere to go but out. A nitinol actuator, very simply, does not carry these risks. It is a piece of metal with a current in it, and there is nothing in it to burst, nothing to leak, and nothing to poison.

A nitinol actuator fails the other way. Put too much power into it and it simply gets hotter. Past the working range the force keeps rising; past that, the part reaches the temperatures at which it was shape set, and at that point the metal lets go of its memory. The actuator loses its force, goes slack, and parts, which opens the circuit that was heating it. It shuts itself off. There is nothing stored in it to release: no pressure, no winding, no field. The failure mode is a dead part and an open circuit, not an event.

That is worth stating plainly for anyone writing a safety case. The worst thing an overdriven nitinol actuator does is stop.

What we supply

Wire	Every round wire size we stock, from 0.15 to 5 mm, and every flat section.
Mandrels	Sixteen, from 0.5 to 25.4 mm.
Wraps	Any number. Choose from the degrees-per-wrap figure in the table.
Transition temperatures	Minus 15 C, 20 C, 35 C, 45 C and 80 C.

Sold as	Made to order.

TORSION SPRING ACTUATORS — ROUND WIRE — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.15-0.5	0.0059 x 0.0059 [0.15 x 0.15]	0.031 [0.8]	0.079 [2]	0.00029 [0.033] 16	0.0004 [0.046] 39	0.0005 [0.057] 78	0.00073 [0.083] 110
0.15-0.9	0.0059 x 0.0059 [0.15 x 0.15]	0.047 [1.2]	0.13 [3.3]	0.00029 [0.033] 25	0.0004 [0.046] 63	0.0005 [0.057] 130	0.00073 [0.083] 180
0.15-1.15	0.0059 x 0.0059 [0.15 x 0.15]	0.057 [1.45]	0.16 [4.1]	0.00029 [0.033] 31	0.0004 [0.046] 78	0.0005 [0.057] 160	0.00073 [0.083] 220
0.15-1.6	0.0059 x 0.0059 [0.15 x 0.15]	0.075 [1.9]	0.22 [5.5]	0.00029 [0.033] 42	0.0004 [0.046] 100	0.0005 [0.057] 210	0.00073 [0.083] 290
0.15-2.4	0.0059 x 0.0059 [0.15 x 0.15]	0.11 [2.7]	0.31 [8]	0.00029 [0.033] 61	0.0004 [0.046] 150	0.0005 [0.057] 310	0.00073 [0.083] 430
0.15-3.2	0.0059 x 0.0059 [0.15 x 0.15]	0.14 [3.5]	0.41 [10]	0.00029 [0.033] 80	0.0004 [0.046] 200	0.0005 [0.057] 400	0.00073 [0.083] 560
0.15-4.75	0.0059 x 0.0059 [0.15 x 0.15]	0.2 [5.05]	0.61 [15]	0.00029 [0.033] 120	0.0004 [0.046] 290	0.0005 [0.057] 590	0.00073 [0.083] 820
0.15-6	0.0059 x 0.0059 [0.15 x 0.15]	0.25 [6.3]	0.76 [19]	0.00029 [0.033] 150	0.0004 [0.046] 370	0.0005 [0.057] 740	0.00073 [0.083] 1000
0.15-8	0.0059 x 0.0059 [0.15 x 0.15]	0.33 [8.3]	1 [26]	0.00029 [0.033] 200	0.0004 [0.046] 490	0.0005 [0.057] 980	0.00073 [0.083] 1400
0.15-9.5	0.0059 x 0.0059 [0.15 x 0.15]	0.39 [9.8]	1.2 [30]	0.00029 [0.033] 230	0.0004 [0.046] 580	0.0005 [0.057] 1200	0.00073 [0.083] 1600
0.15-12.7	0.0059 x 0.0059 [0.15 x 0.15]	0.51 [13]	1.6 [40]	0.00029 [0.033] 310	0.0004 [0.046] 770	0.0005 [0.057] 1500	0.00073 [0.083] 2200
0.15-14.2	0.0059 x 0.0059 [0.15 x 0.15]	0.57 [14.5]	1.8 [45]	0.00029 [0.033] 340	0.0004 [0.046] 860	0.0005 [0.057] 1700	0.00073 [0.083] 2400
0.15-16	0.0059 x 0.0059 [0.15 x 0.15]	0.64 [16.3]	2 [51]	0.00029 [0.033] 390	0.0004 [0.046] 970	0.0005 [0.057] 1900	0.00073 [0.083] 2700

TORSION SPRING ACTUATORS — ROUND WIRE — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.15-19	0.0059 x 0.0059 [0.15 x 0.15]	0.76 [19.3]	2.4 [60]	0.00029 [0.033] 460	0.0004 [0.046] 1100	0.0005 [0.057] 2300	0.00073 [0.083] 3200
0.15-22.2	0.0059 x 0.0059 [0.15 x 0.15]	0.89 [22.5]	2.8 [70]	0.00029 [0.033] 540	0.0004 [0.046] 1300	0.0005 [0.057] 2700	0.00073 [0.083] 3800
0.15-25.4	0.0059 x 0.0059 [0.15 x 0.15]	1 [25.7]	3.2 [80]	0.00029 [0.033] 610	0.0004 [0.046] 1500	0.0005 [0.057] 3100	0.00073 [0.083] 4300
0.25-0.5	0.0098 x 0.0098 [0.25 x 0.25]	0.039 [1]	0.094 [2.4]	0.0014 [0.15] 11	0.0019 [0.21] 27	0.0023 [0.26] 54	0.0034 [0.38] 76
0.25-0.9	0.0098 x 0.0098 [0.25 x 0.25]	0.055 [1.4]	0.14 [3.6]	0.0014 [0.15] 17	0.0019 [0.21] 41	0.0023 [0.26] 83	0.0034 [0.38] 120
0.25-1.15	0.0098 x 0.0098 [0.25 x 0.25]	0.065 [1.65]	0.17 [4.4]	0.0014 [0.15] 20	0.0019 [0.21] 50	0.0023 [0.26] 100	0.0034 [0.38] 140
0.25-1.6	0.0098 x 0.0098 [0.25 x 0.25]	0.083 [2.1]	0.23 [5.8]	0.0014 [0.15] 27	0.0019 [0.21] 67	0.0023 [0.26] 130	0.0034 [0.38] 190
0.25-2.4	0.0098 x 0.0098 [0.25 x 0.25]	0.11 [2.9]	0.33 [8.3]	0.0014 [0.15] 38	0.0019 [0.21] 95	0.0023 [0.26] 190	0.0034 [0.38] 270
0.25-3.2	0.0098 x 0.0098 [0.25 x 0.25]	0.15 [3.7]	0.43 [11]	0.0014 [0.15] 50	0.0019 [0.21] 120	0.0023 [0.26] 250	0.0034 [0.38] 350
0.25-4.75	0.0098 x 0.0098 [0.25 x 0.25]	0.21 [5.25]	0.62 [16]	0.0014 [0.15] 72	0.0019 [0.21] 180	0.0023 [0.26] 360	0.0034 [0.38] 500
0.25-6	0.0098 x 0.0098 [0.25 x 0.25]	0.26 [6.5]	0.77 [20]	0.0014 [0.15] 90	0.0019 [0.21] 220	0.0023 [0.26] 450	0.0034 [0.38] 630
0.25-8	0.0098 x 0.0098 [0.25 x 0.25]	0.33 [8.5]	1 [26]	0.0014 [0.15] 120	0.0019 [0.21] 300	0.0023 [0.26] 590	0.0034 [0.38] 830
0.25-9.5	0.0098 x 0.0098 [0.25 x 0.25]	0.39 [10]	1.2 [31]	0.0014 [0.15] 140	0.0019 [0.21] 350	0.0023 [0.26] 700	0.0034 [0.38] 980

TORSION SPRING ACTUATORS — ROUND WIRE — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.25-12.7	0.0098 x 0.0098 [0.25 x 0.25]	0.52 [13.2]	1.6 [41]	0.0014 [0.15] 190	0.0019 [0.21] 470	0.0023 [0.26] 930	0.0034 [0.38] 1300
0.25-14.2	0.0098 x 0.0098 [0.25 x 0.25]	0.58 [14.7]	1.8 [45]	0.0014 [0.15] 210	0.0019 [0.21] 520	0.0023 [0.26] 1000	0.0034 [0.38] 1500
0.25-16	0.0098 x 0.0098 [0.25 x 0.25]	0.65 [16.5]	2 [51]	0.0014 [0.15] 230	0.0019 [0.21] 580	0.0023 [0.26] 1200	0.0034 [0.38] 1600
0.25-19	0.0098 x 0.0098 [0.25 x 0.25]	0.77 [19.5]	2.4 [60]	0.0014 [0.15] 280	0.0019 [0.21] 690	0.0023 [0.26] 1400	0.0034 [0.38] 1900
0.25-22.2	0.0098 x 0.0098 [0.25 x 0.25]	0.89 [22.7]	2.8 [70]	0.0014 [0.15] 320	0.0019 [0.21] 810	0.0023 [0.26] 1600	0.0034 [0.38] 2300
0.25-25.4	0.0098 x 0.0098 [0.25 x 0.25]	1 [25.9]	3.2 [81]	0.0014 [0.15] 370	0.0019 [0.21] 920	0.0023 [0.26] 1800	0.0034 [0.38] 2600
0.4-0.5	0.016 x 0.016 [0.4 x 0.4]	0.051 [1.3]	0.11 [2.8]	0.0056 [0.63] 8.1	0.0077 [0.87] 20	0.0096 [1.1] 40	0.014 [1.6] 57
0.4-0.9	0.016 x 0.016 [0.4 x 0.4]	0.067 [1.7]	0.16 [4.1]	0.0056 [0.63] 12	0.0077 [0.87] 29	0.0096 [1.1] 58	0.014 [1.6] 82
0.4-1.15	0.016 x 0.016 [0.4 x 0.4]	0.077 [1.95]	0.19 [4.9]	0.0056 [0.63] 14	0.0077 [0.87] 35	0.0096 [1.1] 70	0.014 [1.6] 98
0.4-1.6	0.016 x 0.016 [0.4 x 0.4]	0.094 [2.4]	0.25 [6.3]	0.0056 [0.63] 18	0.0077 [0.87] 45	0.0096 [1.1] 90	0.014 [1.6] 130
0.4-2.4	0.016 x 0.016 [0.4 x 0.4]	0.13 [3.2]	0.35 [8.8]	0.0056 [0.63] 25	0.0077 [0.87] 63	0.0096 [1.1] 130	0.014 [1.6] 180
0.4-3.2	0.016 x 0.016 [0.4 x 0.4]	0.16 [4]	0.44 [11]	0.0056 [0.63] 32	0.0077 [0.87] 81	0.0096 [1.1] 160	0.014 [1.6] 230
0.4-4.75	0.016 x 0.016 [0.4 x 0.4]	0.22 [5.55]	0.64 [16]	0.0056 [0.63] 46	0.0077 [0.87] 120	0.0096 [1.1] 230	0.014 [1.6] 320

TORSION SPRING ACTUATORS — ROUND WIRE — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.4-6	0.016 x 0.016 [0.4 x 0.4]	0.27 [6.8]	0.79 [20]	0.0056 [0.63] 58	0.0077 [0.87] 140	0.0096 [1.1] 290	0.014 [1.6] 400
0.4-8	0.016 x 0.016 [0.4 x 0.4]	0.35 [8.8]	1 [26]	0.0056 [0.63] 76	0.0077 [0.87] 190	0.0096 [1.1] 380	0.014 [1.6] 530
0.4-9.5	0.016 x 0.016 [0.4 x 0.4]	0.41 [10.3]	1.2 [31]	0.0056 [0.63] 89	0.0077 [0.87] 220	0.0096 [1.1] 450	0.014 [1.6] 620
0.4-12.7	0.016 x 0.016 [0.4 x 0.4]	0.53 [13.5]	1.6 [41]	0.0056 [0.63] 120	0.0077 [0.87] 290	0.0096 [1.1] 590	0.014 [1.6] 830
0.4-14.2	0.016 x 0.016 [0.4 x 0.4]	0.59 [15]	1.8 [46]	0.0056 [0.63] 130	0.0077 [0.87] 330	0.0096 [1.1] 660	0.014 [1.6] 920
0.4-16	0.016 x 0.016 [0.4 x 0.4]	0.66 [16.8]	2 [52]	0.0056 [0.63] 150	0.0077 [0.87] 370	0.0096 [1.1] 740	0.014 [1.6] 1000
0.4-19	0.016 x 0.016 [0.4 x 0.4]	0.78 [19.8]	2.4 [61]	0.0056 [0.63] 170	0.0077 [0.87] 440	0.0096 [1.1] 870	0.014 [1.6] 1200
0.4-22.2	0.016 x 0.016 [0.4 x 0.4]	0.91 [23]	2.8 [71]	0.0056 [0.63] 200	0.0077 [0.87] 510	0.0096 [1.1] 1000	0.014 [1.6] 1400
0.4-25.4	0.016 x 0.016 [0.4 x 0.4]	1 [26.2]	3.2 [81]	0.0056 [0.63] 230	0.0077 [0.87] 580	0.0096 [1.1] 1200	0.014 [1.6] 1600
0.5-0.5	0.02 x 0.02 [0.5 x 0.5]	0.059 [1.5]	0.12 [3.1]	0.011 [1.2] 7.2	0.015 [1.7] 18	0.019 [2.1] 36	0.027 [3.1] 50
0.5-0.9	0.02 x 0.02 [0.5 x 0.5]	0.075 [1.9]	0.17 [4.4]	0.011 [1.2] 10	0.015 [1.7] 25	0.019 [2.1] 50	0.027 [3.1] 71
0.5-1.15	0.02 x 0.02 [0.5 x 0.5]	0.085 [2.15]	0.2 [5.2]	0.011 [1.2] 12	0.015 [1.7] 30	0.019 [2.1] 59	0.027 [3.1] 83
0.5-1.6	0.02 x 0.02 [0.5 x 0.5]	0.1 [2.6]	0.26 [6.6]	0.011 [1.2] 15	0.015 [1.7] 38	0.019 [2.1] 76	0.027 [3.1] 110

TORSION SPRING ACTUATORS — ROUND WIRE — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.5-2.4	0.02 x 0.02 [0.5 x 0.5]	0.13 [3.4]	0.36 [9.1]	0.011 [1.2] 21	0.015 [1.7] 52	0.019 [2.1] 100	0.027 [3.1] 150
0.5-3.2	0.02 x 0.02 [0.5 x 0.5]	0.17 [4.2]	0.46 [12]	0.011 [1.2] 27	0.015 [1.7] 67	0.019 [2.1] 130	0.027 [3.1] 190
0.5-4.75	0.02 x 0.02 [0.5 x 0.5]	0.23 [5.75]	0.65 [16]	0.011 [1.2] 38	0.015 [1.7] 94	0.019 [2.1] 190	0.027 [3.1] 260
0.5-6	0.02 x 0.02 [0.5 x 0.5]	0.28 [7]	0.8 [20]	0.011 [1.2] 47	0.015 [1.7] 120	0.019 [2.1] 230	0.027 [3.1] 330
0.5-8	0.02 x 0.02 [0.5 x 0.5]	0.35 [9]	1.1 [27]	0.011 [1.2] 61	0.015 [1.7] 150	0.019 [2.1] 310	0.027 [3.1] 430
0.5-9.5	0.02 x 0.02 [0.5 x 0.5]	0.41 [10.5]	1.2 [31]	0.011 [1.2] 72	0.015 [1.7] 180	0.019 [2.1] 360	0.027 [3.1] 500
0.5-12.7	0.02 x 0.02 [0.5 x 0.5]	0.54 [13.7]	1.6 [42]	0.011 [1.2] 95	0.015 [1.7] 240	0.019 [2.1] 480	0.027 [3.1] 670
0.5-14.2	0.02 x 0.02 [0.5 x 0.5]	0.6 [15.2]	1.8 [46]	0.011 [1.2] 110	0.015 [1.7] 260	0.019 [2.1] 530	0.027 [3.1] 740
0.5-16	0.02 x 0.02 [0.5 x 0.5]	0.67 [17]	2 [52]	0.011 [1.2] 120	0.015 [1.7] 300	0.019 [2.1] 590	0.027 [3.1] 830
0.5-19	0.02 x 0.02 [0.5 x 0.5]	0.79 [20]	2.4 [61]	0.011 [1.2] 140	0.015 [1.7] 350	0.019 [2.1] 700	0.027 [3.1] 980
0.5-22.2	0.02 x 0.02 [0.5 x 0.5]	0.91 [23.2]	2.8 [71]	0.011 [1.2] 160	0.015 [1.7] 410	0.019 [2.1] 820	0.027 [3.1] 1100
0.5-25.4	0.02 x 0.02 [0.5 x 0.5]	1 [26.4]	3.2 [81]	0.011 [1.2] 190	0.015 [1.7] 470	0.019 [2.1] 930	0.027 [3.1] 1300
0.75-0.5	0.03 x 0.03 [0.75 x 0.75]	0.079 [2]	0.15 [3.9]	0.037 [4.1] 6	0.051 [5.7] 15	0.063 [7.1] 30	0.092 [10] 42

TORSION SPRING ACTUATORS — ROUND WIRE — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.75-0.9	0.03 x 0.03 [0.75 x 0.75]	0.094 [2.4]	0.2 [5.2]	0.037 [4.1] 7.9	0.051 [5.7] 20	0.063 [7.1] 40	0.092 [10] 55
0.75-1.15	0.03 x 0.03 [0.75 x 0.75]	0.1 [2.65]	0.24 [6]	0.037 [4.1] 9.1	0.051 [5.7] 23	0.063 [7.1] 46	0.092 [10] 64
0.75-1.6	0.03 x 0.03 [0.75 x 0.75]	0.12 [3.1]	0.29 [7.4]	0.037 [4.1] 11	0.051 [5.7] 28	0.063 [7.1] 56	0.092 [10] 79
0.75-2.4	0.03 x 0.03 [0.75 x 0.75]	0.15 [3.9]	0.39 [9.9]	0.037 [4.1] 15	0.051 [5.7] 38	0.063 [7.1] 76	0.092 [10] 110
0.75-3.2	0.03 x 0.03 [0.75 x 0.75]	0.19 [4.7]	0.49 [12]	0.037 [4.1] 19	0.051 [5.7] 47	0.063 [7.1] 95	0.092 [10] 130
0.75-4.75	0.03 x 0.03 [0.75 x 0.75]	0.25 [6.25]	0.68 [17]	0.037 [4.1] 26	0.051 [5.7] 66	0.063 [7.1] 130	0.092 [10] 180
0.75-6	0.03 x 0.03 [0.75 x 0.75]	0.3 [7.5]	0.83 [21]	0.037 [4.1] 32	0.051 [5.7] 81	0.063 [7.1] 160	0.092 [10] 230
0.75-8	0.03 x 0.03 [0.75 x 0.75]	0.37 [9.5]	1.1 [28]	0.037 [4.1] 42	0.051 [5.7] 100	0.063 [7.1] 210	0.092 [10] 290
0.75-9.5	0.03 x 0.03 [0.75 x 0.75]	0.43 [11]	1.3 [32]	0.037 [4.1] 49	0.051 [5.7] 120	0.063 [7.1] 250	0.092 [10] 340
0.75-12.7	0.03 x 0.03 [0.75 x 0.75]	0.56 [14.2]	1.7 [42]	0.037 [4.1] 65	0.051 [5.7] 160	0.063 [7.1] 320	0.092 [10] 450
0.75-14.2	0.03 x 0.03 [0.75 x 0.75]	0.62 [15.7]	1.9 [47]	0.037 [4.1] 72	0.051 [5.7] 180	0.063 [7.1] 360	0.092 [10] 500
0.75-16	0.03 x 0.03 [0.75 x 0.75]	0.69 [17.5]	2.1 [53]	0.037 [4.1] 80	0.051 [5.7] 200	0.063 [7.1] 400	0.092 [10] 560
0.75-19	0.03 x 0.03 [0.75 x 0.75]	0.81 [20.5]	2.4 [62]	0.037 [4.1] 95	0.051 [5.7] 240	0.063 [7.1] 470	0.092 [10] 660

TORSION SPRING ACTUATORS — ROUND WIRE — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.75-22.2	0.03 x 0.03 [0.75 x 0.75]	0.93 [23.7]	2.8 [72]	0.037 [4.1] 110	0.051 [5.7] 280	0.063 [7.1] 550	0.092 [10] 770
0.75-25.4	0.03 x 0.03 [0.75 x 0.75]	1.1 [26.9]	3.2 [82]	0.037 [4.1] 130	0.051 [5.7] 310	0.063 [7.1] 630	0.092 [10] 880
1-0.5	0.039 x 0.039 [1 x 1]	0.098 [2.5]	0.19 [4.7]	0.087 [9.8] 5.4	0.12 [14] 14	0.15 [17] 27	0.22 [25] 38
1-0.9	0.039 x 0.039 [1 x 1]	0.11 [2.9]	0.24 [6]	0.087 [9.8] 6.8	0.12 [14] 17	0.15 [17] 34	0.22 [25] 48
1-1.15	0.039 x 0.039 [1 x 1]	0.12 [3.15]	0.27 [6.8]	0.087 [9.8] 7.7	0.12 [14] 19	0.15 [17] 39	0.22 [25] 54
1-1.6	0.039 x 0.039 [1 x 1]	0.14 [3.6]	0.32 [8.2]	0.087 [9.8] 9.4	0.12 [14] 23	0.15 [17] 47	0.22 [25] 66
1-2.4	0.039 x 0.039 [1 x 1]	0.17 [4.4]	0.42 [11]	0.087 [9.8] 12	0.12 [14] 31	0.15 [17] 61	0.22 [25] 86
1-3.2	0.039 x 0.039 [1 x 1]	0.2 [5.2]	0.52 [13]	0.087 [9.8] 15	0.12 [14] 38	0.15 [17] 76	0.22 [25] 110
1-4.75	0.039 x 0.039 [1 x 1]	0.27 [6.75]	0.71 [18]	0.087 [9.8] 21	0.12 [14] 52	0.15 [17] 100	0.22 [25] 140
1-6	0.039 x 0.039 [1 x 1]	0.31 [8]	0.87 [22]	0.087 [9.8] 25	0.12 [14] 63	0.15 [17] 130	0.22 [25] 180
1-8	0.039 x 0.039 [1 x 1]	0.39 [10]	1.1 [28]	0.087 [9.8] 32	0.12 [14] 81	0.15 [17] 160	0.22 [25] 230
1-9.5	0.039 x 0.039 [1 x 1]	0.45 [11.5]	1.3 [33]	0.087 [9.8] 38	0.12 [14] 94	0.15 [17] 190	0.22 [25] 260
1-12.7	0.039 x 0.039 [1 x 1]	0.58 [14.7]	1.7 [43]	0.087 [9.8] 49	0.12 [14] 120	0.15 [17] 250	0.22 [25] 350

TORSION SPRING ACTUATORS — ROUND WIRE — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
1-14.2	0.039 x 0.039 [1 x 1]	0.64 [16.2]	1.9 [48]	0.087 [9.8] 55	0.12 [14] 140	0.15 [17] 270	0.22 [25] 380
1-16	0.039 x 0.039 [1 x 1]	0.71 [18]	2.1 [53]	0.087 [9.8] 61	0.12 [14] 150	0.15 [17] 310	0.22 [25] 430
1-19	0.039 x 0.039 [1 x 1]	0.83 [21]	2.5 [63]	0.087 [9.8] 72	0.12 [14] 180	0.15 [17] 360	0.22 [25] 500
1-22.2	0.039 x 0.039 [1 x 1]	0.95 [24.2]	2.9 [73]	0.087 [9.8] 84	0.12 [14] 210	0.15 [17] 420	0.22 [25] 580
1-25.4	0.039 x 0.039 [1 x 1]	1.1 [27.4]	3.3 [83]	0.087 [9.8] 95	0.12 [14] 240	0.15 [17] 480	0.22 [25] 670
1.25-0.5	0.049 x 0.049 [1.25 x 1.25]	0.12 [3]	0.22 [5.5]	0.17 [19] 5	0.23 [26] 13	0.29 [33] 25	0.42 [48] 35
1.25-0.9	0.049 x 0.049 [1.25 x 1.25]	0.13 [3.4]	0.27 [6.8]	0.17 [19] 6.2	0.23 [26] 16	0.29 [33] 31	0.42 [48] 43
1.25-1.15	0.049 x 0.049 [1.25 x 1.25]	0.14 [3.65]	0.3 [7.5]	0.17 [19] 6.9	0.23 [26] 17	0.29 [33] 35	0.42 [48] 48
1.25-1.6	0.049 x 0.049 [1.25 x 1.25]	0.16 [4.1]	0.35 [9]	0.17 [19] 8.2	0.23 [26] 20	0.29 [33] 41	0.42 [48] 58
1.25-2.4	0.049 x 0.049 [1.25 x 1.25]	0.19 [4.9]	0.45 [12]	0.17 [19] 11	0.23 [26] 26	0.29 [33] 53	0.42 [48] 74
1.25-3.2	0.049 x 0.049 [1.25 x 1.25]	0.22 [5.7]	0.55 [14]	0.17 [19] 13	0.23 [26] 32	0.29 [33] 64	0.42 [48] 90
1.25-4.75	0.049 x 0.049 [1.25 x 1.25]	0.29 [7.25]	0.74 [19]	0.17 [19] 17	0.23 [26] 43	0.29 [33] 86	0.42 [48] 120
1.25-6	0.049 x 0.049 [1.25 x 1.25]	0.33 [8.5]	0.9 [23]	0.17 [19] 21	0.23 [26] 52	0.29 [33] 100	0.42 [48] 150

TORSION SPRING ACTUATORS — ROUND WIRE — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
1.25-8	0.049 x 0.049 [1.25 x 1.25]	0.41 [10.5]	1.1 [29]	0.17 [19] 27	0.23 [26] 67	0.29 [33] 130	0.42 [48] 190
1.25-9.5	0.049 x 0.049 [1.25 x 1.25]	0.47 [12]	1.3 [34]	0.17 [19] 31	0.23 [26] 77	0.29 [33] 150	0.42 [48] 220
1.25-12.7	0.049 x 0.049 [1.25 x 1.25]	0.6 [15.2]	1.7 [44]	0.17 [19] 40	0.23 [26] 100	0.29 [33] 200	0.42 [48] 280
1.25-14.2	0.049 x 0.049 [1.25 x 1.25]	0.66 [16.7]	1.9 [48]	0.17 [19] 44	0.23 [26] 110	0.29 [33] 220	0.42 [48] 310
1.25-16	0.049 x 0.049 [1.25 x 1.25]	0.73 [18.5]	2.1 [54]	0.17 [19] 50	0.23 [26] 120	0.29 [33] 250	0.42 [48] 350
1.25-19	0.049 x 0.049 [1.25 x 1.25]	0.85 [21.5]	2.5 [64]	0.17 [19] 58	0.23 [26] 150	0.29 [33] 290	0.42 [48] 410
1.25-22.2	0.049 x 0.049 [1.25 x 1.25]	0.97 [24.7]	2.9 [74]	0.17 [19] 68	0.23 [26] 170	0.29 [33] 340	0.42 [48] 470
1.25-25.4	0.049 x 0.049 [1.25 x 1.25]	1.1 [27.9]	3.3 [84]	0.17 [19] 77	0.23 [26] 190	0.29 [33] 380	0.42 [48] 540
1.5-0.5	0.059 x 0.059 [1.5 x 1.5]	0.14 [3.5]	0.25 [6.3]	0.29 [33] 4.8	0.4 [46] 12	0.5 [57] 24	0.73 [83] 34
1.5-0.9	0.059 x 0.059 [1.5 x 1.5]	0.15 [3.9]	0.3 [7.5]	0.29 [33] 5.8	0.4 [46] 14	0.5 [57] 29	0.73 [83] 40
1.5-1.15	0.059 x 0.059 [1.5 x 1.5]	0.16 [4.15]	0.33 [8.3]	0.29 [33] 6.4	0.4 [46] 16	0.5 [57] 32	0.73 [83] 44
1.5-1.6	0.059 x 0.059 [1.5 x 1.5]	0.18 [4.6]	0.38 [9.7]	0.29 [33] 7.4	0.4 [46] 19	0.5 [57] 37	0.73 [83] 52
1.5-2.4	0.059 x 0.059 [1.5 x 1.5]	0.21 [5.4]	0.48 [12]	0.29 [33] 9.4	0.4 [46] 23	0.5 [57] 47	0.73 [83] 66

TORSION SPRING ACTUATORS — ROUND WIRE — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
1.5-3.2	0.059 x 0.059 [1.5 x 1.5]	0.24 [6.2]	0.58 [15]	0.29 [33] 11	0.4 [46] 28	0.5 [57] 56	0.73 [83] 79
1.5-4.75	0.059 x 0.059 [1.5 x 1.5]	0.31 [7.75]	0.77 [20]	0.29 [33] 15	0.4 [46] 38	0.5 [57] 75	0.73 [83] 100
1.5-6	0.059 x 0.059 [1.5 x 1.5]	0.35 [9]	0.93 [24]	0.29 [33] 18	0.4 [46] 45	0.5 [57] 90	0.73 [83] 130
1.5-8	0.059 x 0.059 [1.5 x 1.5]	0.43 [11]	1.2 [30]	0.29 [33] 23	0.4 [46] 57	0.5 [57] 110	0.73 [83] 160
1.5-9.5	0.059 x 0.059 [1.5 x 1.5]	0.49 [12.5]	1.4 [35]	0.29 [33] 26	0.4 [46] 66	0.5 [57] 130	0.73 [83] 180
1.5-12.7	0.059 x 0.059 [1.5 x 1.5]	0.62 [15.7]	1.8 [45]	0.29 [33] 34	0.4 [46] 85	0.5 [57] 170	0.73 [83] 240
1.5-14.2	0.059 x 0.059 [1.5 x 1.5]	0.68 [17.2]	1.9 [49]	0.29 [33] 38	0.4 [46] 94	0.5 [57] 190	0.73 [83] 260
1.5-16	0.059 x 0.059 [1.5 x 1.5]	0.75 [19]	2.2 [55]	0.29 [33] 42	0.4 [46] 100	0.5 [57] 210	0.73 [83] 290
1.5-19	0.059 x 0.059 [1.5 x 1.5]	0.87 [22]	2.5 [64]	0.29 [33] 49	0.4 [46] 120	0.5 [57] 250	0.73 [83] 340
1.5-22.2	0.059 x 0.059 [1.5 x 1.5]	0.99 [25.2]	2.9 [74]	0.29 [33] 57	0.4 [46] 140	0.5 [57] 280	0.73 [83] 400
1.5-25.4	0.059 x 0.059 [1.5 x 1.5]	1.1 [28.4]	3.3 [84]	0.29 [33] 65	0.4 [46] 160	0.5 [57] 320	0.73 [83] 450
2-0.5	0.079 x 0.079 [2 x 2]	0.18 [4.5]	0.31 [7.9]	0.7 [79] 4.5	0.96 [110] 11	1.2 [140] 22	1.7 [200] 32
2-0.9	0.079 x 0.079 [2 x 2]	0.19 [4.9]	0.36 [9.1]	0.7 [79] 5.2	0.96 [110] 13	1.2 [140] 26	1.7 [200] 36

TORSION SPRING ACTUATORS — ROUND WIRE — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
2-1.15	0.079 x 0.079 [2 x 2]	0.2 [5.15]	0.39 [9.9]	0.7 [79] 5.7	0.96 [110] 14	1.2 [140] 28	1.7 [200] 40
2-1.6	0.079 x 0.079 [2 x 2]	0.22 [5.6]	0.44 [11]	0.7 [79] 6.5	0.96 [110] 16	1.2 [140] 32	1.7 [200] 45
2-2.4	0.079 x 0.079 [2 x 2]	0.25 [6.4]	0.54 [14]	0.7 [79] 7.9	0.96 [110] 20	1.2 [140] 40	1.7 [200] 55
2-3.2	0.079 x 0.079 [2 x 2]	0.28 [7.2]	0.64 [16]	0.7 [79] 9.4	0.96 [110] 23	1.2 [140] 47	1.7 [200] 66
2-4.75	0.079 x 0.079 [2 x 2]	0.34 [8.75]	0.83 [21]	0.7 [79] 12	0.96 [110] 30	1.2 [140] 61	1.7 [200] 85
2-6	0.079 x 0.079 [2 x 2]	0.39 [10]	0.99 [25]	0.7 [79] 14	0.96 [110] 36	1.2 [140] 72	1.7 [200] 100
2-8	0.079 x 0.079 [2 x 2]	0.47 [12]	1.2 [31]	0.7 [79] 18	0.96 [110] 45	1.2 [140] 90	1.7 [200] 130
2-9.5	0.079 x 0.079 [2 x 2]	0.53 [13.5]	1.4 [36]	0.7 [79] 21	0.96 [110] 52	1.2 [140] 100	1.7 [200] 140
2-12.7	0.079 x 0.079 [2 x 2]	0.66 [16.7]	1.8 [46]	0.7 [79] 26	0.96 [110] 66	1.2 [140] 130	1.7 [200] 190
2-14.2	0.079 x 0.079 [2 x 2]	0.72 [18.2]	2 [51]	0.7 [79] 29	0.96 [110] 73	1.2 [140] 150	1.7 [200] 200
2-16	0.079 x 0.079 [2 x 2]	0.79 [20]	2.2 [56]	0.7 [79] 32	0.96 [110] 81	1.2 [140] 160	1.7 [200] 230
2-19	0.079 x 0.079 [2 x 2]	0.91 [23]	2.6 [66]	0.7 [79] 38	0.96 [110] 94	1.2 [140] 190	1.7 [200] 260
2-22.2	0.079 x 0.079 [2 x 2]	1 [26.2]	3 [76]	0.7 [79] 44	0.96 [110] 110	1.2 [140] 220	1.7 [200] 300

TORSION SPRING ACTUATORS — ROUND WIRE — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
2-25.4	0.079 x 0.079 [2 x 2]	1.2 [29.4]	3.4 [86]	0.7 [79] 49	0.96 [110] 120	1.2 [140] 250	1.7 [200] 350
3-0.5	0.12 x 0.12 [3 x 3]	0.26 [6.5]	0.43 [11]	2.3 [260] 4.2	3.2 [370] 10	4 [460] 21	5.9 [660] 29
3-0.9	0.12 x 0.12 [3 x 3]	0.27 [6.9]	0.48 [12]	2.3 [260] 4.7	3.2 [370] 12	4 [460] 23	5.9 [660] 33
3-1.15	0.12 x 0.12 [3 x 3]	0.28 [7.15]	0.51 [13]	2.3 [260] 5	3.2 [370] 12	4 [460] 25	5.9 [660] 35
3-1.6	0.12 x 0.12 [3 x 3]	0.3 [7.6]	0.57 [14]	2.3 [260] 5.5	3.2 [370] 14	4 [460] 28	5.9 [660] 39
3-2.4	0.12 x 0.12 [3 x 3]	0.33 [8.4]	0.67 [17]	2.3 [260] 6.5	3.2 [370] 16	4 [460] 32	5.9 [660] 45
3-3.2	0.12 x 0.12 [3 x 3]	0.36 [9.2]	0.77 [20]	2.3 [260] 7.4	3.2 [370] 19	4 [460] 37	5.9 [660] 52
3-4.75	0.12 x 0.12 [3 x 3]	0.42 [10.8]	0.96 [24]	2.3 [260] 9.3	3.2 [370] 23	4 [460] 46	5.9 [660] 65
3-6	0.12 x 0.12 [3 x 3]	0.47 [12]	1.1 [28]	2.3 [260] 11	3.2 [370] 27	4 [460] 54	5.9 [660] 76
3-8	0.12 x 0.12 [3 x 3]	0.55 [14]	1.4 [35]	2.3 [260] 13	3.2 [370] 33	4 [460] 66	5.9 [660] 92
3-9.5	0.12 x 0.12 [3 x 3]	0.61 [15.5]	1.5 [39]	2.3 [260] 15	3.2 [370] 38	4 [460] 75	5.9 [660] 100
3-12.7	0.12 x 0.12 [3 x 3]	0.74 [18.7]	1.9 [49]	2.3 [260] 19	3.2 [370] 47	4 [460] 94	5.9 [660] 130
3-14.2	0.12 x 0.12 [3 x 3]	0.8 [20.2]	2.1 [54]	2.3 [260] 21	3.2 [370] 52	4 [460] 100	5.9 [660] 140

TORSION SPRING ACTUATORS — ROUND WIRE — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
3-16	0.12 x 0.12 [3 x 3]	0.87 [22]	2.4 [60]	2.3 [260] 23	3.2 [370] 57	4 [460] 110	5.9 [660] 160
3-19	0.12 x 0.12 [3 x 3]	0.98 [25]	2.7 [69]	2.3 [260] 26	3.2 [370] 66	4 [460] 130	5.9 [660] 180
3-22.2	0.12 x 0.12 [3 x 3]	1.1 [28.2]	3.1 [79]	2.3 [260] 30	3.2 [370] 76	4 [460] 150	5.9 [660] 210
3-25.4	0.12 x 0.12 [3 x 3]	1.2 [31.4]	3.5 [89]	2.3 [260] 34	3.2 [370] 85	4 [460] 170	5.9 [660] 240
5-0.5	0.2 x 0.2 [5 x 5]	0.41 [10.5]	0.68 [17]	11 [1200] 4	15 [1700] 9.9	19 [2100] 20	27 [3100] 28
5-0.9	0.2 x 0.2 [5 x 5]	0.43 [10.9]	0.73 [18]	11 [1200] 4.2	15 [1700] 11	19 [2100] 21	27 [3100] 30
5-1.15	0.2 x 0.2 [5 x 5]	0.44 [11.2]	0.76 [19]	11 [1200] 4.4	15 [1700] 11	19 [2100] 22	27 [3100] 31
5-1.6	0.2 x 0.2 [5 x 5]	0.46 [11.6]	0.81 [21]	11 [1200] 4.8	15 [1700] 12	19 [2100] 24	27 [3100] 33
5-2.4	0.2 x 0.2 [5 x 5]	0.49 [12.4]	0.91 [23]	11 [1200] 5.3	15 [1700] 13	19 [2100] 27	27 [3100] 37
5-3.2	0.2 x 0.2 [5 x 5]	0.52 [13.2]	1 [26]	11 [1200] 5.9	15 [1700] 15	19 [2100] 30	27 [3100] 41
5-4.75	0.2 x 0.2 [5 x 5]	0.58 [14.8]	1.2 [31]	11 [1200] 7	15 [1700] 18	19 [2100] 35	27 [3100] 49
5-6	0.2 x 0.2 [5 x 5]	0.63 [16]	1.4 [35]	11 [1200] 7.9	15 [1700] 20	19 [2100] 40	27 [3100] 55
5-8	0.2 x 0.2 [5 x 5]	0.71 [18]	1.6 [41]	11 [1200] 9.4	15 [1700] 23	19 [2100] 47	27 [3100] 66

TORSION SPRING ACTUATORS — ROUND WIRE — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
5-9.5	0.2 x 0.2 [5 x 5]	0.77 [19.5]	1.8 [46]	11 [1200] 10	15 [1700] 26	19 [2100] 52	27 [3100] 73
5-12.7	0.2 x 0.2 [5 x 5]	0.89 [22.7]	2.2 [56]	11 [1200] 13	15 [1700] 32	19 [2100] 64	27 [3100] 89
5-14.2	0.2 x 0.2 [5 x 5]	0.95 [24.2]	2.4 [60]	11 [1200] 14	15 [1700] 35	19 [2100] 69	27 [3100] 97
5-16	0.2 x 0.2 [5 x 5]	1 [26]	2.6 [66]	11 [1200] 15	15 [1700] 38	19 [2100] 76	27 [3100] 110
5-19	0.2 x 0.2 [5 x 5]	1.1 [29]	3 [75]	11 [1200] 17	15 [1700] 43	19 [2100] 86	27 [3100] 120
5-22.2	0.2 x 0.2 [5 x 5]	1.3 [32.2]	3.4 [86]	11 [1200] 20	15 [1700] 49	19 [2100] 98	27 [3100] 140
5-25.4	0.2 x 0.2 [5 x 5]	1.4 [35.4]	3.8 [96]	11 [1200] 22	15 [1700] 55	19 [2100] 110	27 [3100] 150

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.152x0.411-0.5	0.006 x 0.016 [0.152 x 0.411]	0.032 [0.804]	0.079 [2]	0.0014 [0.16] 15	0.0019 [0.22] 39	0.0024 [0.27] 77	0.0035 [0.4] 110
0.152x0.411-0.9	0.006 x 0.016 [0.152 x 0.411]	0.047 [1.2]	0.13 [3.3]	0.0014 [0.16] 25	0.0019 [0.22] 62	0.0024 [0.27] 120	0.0035 [0.4] 170

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.152x0.411-1.15	0.006 x 0.016 [0.152 x 0.411]	0.057 [1.45]	0.16 [4.1]	0.0014 [0.16] 31	0.0019 [0.22] 77	0.0024 [0.27] 150	0.0035 [0.4] 220
0.152x0.411-1.6	0.006 x 0.016 [0.152 x 0.411]	0.075 [1.9]	0.22 [5.5]	0.0014 [0.16] 42	0.0019 [0.22] 100	0.0024 [0.27] 210	0.0035 [0.4] 290
0.152x0.411-2.4	0.006 x 0.016 [0.152 x 0.411]	0.11 [2.7]	0.31 [8]	0.0014 [0.16] 60	0.0019 [0.22] 150	0.0024 [0.27] 300	0.0035 [0.4] 420
0.152x0.411-3.2	0.006 x 0.016 [0.152 x 0.411]	0.14 [3.5]	0.41 [10]	0.0014 [0.16] 79	0.0019 [0.22] 200	0.0024 [0.27] 400	0.0035 [0.4] 560
0.152x0.411-4.75	0.006 x 0.016 [0.152 x 0.411]	0.2 [5.05]	0.61 [15]	0.0014 [0.16] 120	0.0019 [0.22] 290	0.0024 [0.27] 580	0.0035 [0.4] 810
0.152x0.411-6	0.006 x 0.016 [0.152 x 0.411]	0.25 [6.3]	0.76 [19]	0.0014 [0.16] 150	0.0019 [0.22] 360	0.0024 [0.27] 730	0.0035 [0.4] 1000
0.152x0.411-8	0.006 x 0.016 [0.152 x 0.411]	0.33 [8.3]	1 [26]	0.0014 [0.16] 190	0.0019 [0.22] 480	0.0024 [0.27] 970	0.0035 [0.4] 1400
0.152x0.411-9.5	0.006 x 0.016 [0.152 x 0.411]	0.39 [9.8]	1.2 [30]	0.0014 [0.16] 230	0.0019 [0.22] 570	0.0024 [0.27] 1100	0.0035 [0.4] 1600
0.152x0.411-12.7	0.006 x 0.016 [0.152 x 0.411]	0.51 [13]	1.6 [40]	0.0014 [0.16] 300	0.0019 [0.22] 760	0.0024 [0.27] 1500	0.0035 [0.4] 2100
0.152x0.411-14.2	0.006 x 0.016 [0.152 x 0.411]	0.57 [14.5]	1.8 [45]	0.0014 [0.16] 340	0.0019 [0.22] 850	0.0024 [0.27] 1700	0.0035 [0.4] 2400
0.152x0.411-16	0.006 x 0.016 [0.152 x 0.411]	0.64 [16.3]	2 [51]	0.0014 [0.16] 380	0.0019 [0.22] 960	0.0024 [0.27] 1900	0.0035 [0.4] 2700
0.152x0.411-19	0.006 x 0.016 [0.152 x 0.411]	0.76 [19.3]	2.4 [60]	0.0014 [0.16] 450	0.0019 [0.22] 1100	0.0024 [0.27] 2300	0.0035 [0.4] 3200
0.152x0.411-22.2	0.006 x 0.016 [0.152 x 0.411]	0.89 [22.5]	2.8 [70]	0.0014 [0.16] 530	0.0019 [0.22] 1300	0.0024 [0.27] 2600	0.0035 [0.4] 3700

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.152x0.411-25.4	0.006 x 0.016 [0.152 x 0.411]	1 [25.7]	3.2 [80]	0.0014 [0.16] 610	0.0019 [0.22] 1500	0.0024 [0.27] 3000	0.0035 [0.4] 4200
0.152x0.813-0.5	0.006 x 0.032 [0.152 x 0.813]	0.032 [0.804]	0.079 [2]	0.0028 [0.31] 15	0.0038 [0.43] 39	0.0048 [0.54] 77	0.0069 [0.78] 110
0.152x0.813-0.9	0.006 x 0.032 [0.152 x 0.813]	0.047 [1.2]	0.13 [3.3]	0.0028 [0.31] 25	0.0038 [0.43] 62	0.0048 [0.54] 120	0.0069 [0.78] 170
0.152x0.813-1.15	0.006 x 0.032 [0.152 x 0.813]	0.057 [1.45]	0.16 [4.1]	0.0028 [0.31] 31	0.0038 [0.43] 77	0.0048 [0.54] 150	0.0069 [0.78] 220
0.152x0.813-1.6	0.006 x 0.032 [0.152 x 0.813]	0.075 [1.9]	0.22 [5.5]	0.0028 [0.31] 42	0.0038 [0.43] 100	0.0048 [0.54] 210	0.0069 [0.78] 290
0.152x0.813-2.4	0.006 x 0.032 [0.152 x 0.813]	0.11 [2.7]	0.31 [8]	0.0028 [0.31] 60	0.0038 [0.43] 150	0.0048 [0.54] 300	0.0069 [0.78] 420
0.152x0.813-3.2	0.006 x 0.032 [0.152 x 0.813]	0.14 [3.5]	0.41 [10]	0.0028 [0.31] 79	0.0038 [0.43] 200	0.0048 [0.54] 400	0.0069 [0.78] 560
0.152x0.813-4.75	0.006 x 0.032 [0.152 x 0.813]	0.2 [5.05]	0.61 [15]	0.0028 [0.31] 120	0.0038 [0.43] 290	0.0048 [0.54] 580	0.0069 [0.78] 810
0.152x0.813-6	0.006 x 0.032 [0.152 x 0.813]	0.25 [6.3]	0.76 [19]	0.0028 [0.31] 150	0.0038 [0.43] 360	0.0048 [0.54] 730	0.0069 [0.78] 1000
0.152x0.813-8	0.006 x 0.032 [0.152 x 0.813]	0.33 [8.3]	1 [26]	0.0028 [0.31] 190	0.0038 [0.43] 480	0.0048 [0.54] 970	0.0069 [0.78] 1400
0.152x0.813-9.5	0.006 x 0.032 [0.152 x 0.813]	0.39 [9.8]	1.2 [30]	0.0028 [0.31] 230	0.0038 [0.43] 570	0.0048 [0.54] 1100	0.0069 [0.78] 1600
0.152x0.813-12.7	0.006 x 0.032 [0.152 x 0.813]	0.51 [13]	1.6 [40]	0.0028 [0.31] 300	0.0038 [0.43] 760	0.0048 [0.54] 1500	0.0069 [0.78] 2100
0.152x0.813-14.2	0.006 x 0.032 [0.152 x 0.813]	0.57 [14.5]	1.8 [45]	0.0028 [0.31] 340	0.0038 [0.43] 850	0.0048 [0.54] 1700	0.0069 [0.78] 2400

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.152x0.813-16	0.006 x 0.032 [0.152 x 0.813]	0.64 [16.3]	2 [51]	0.0028 [0.31] 380	0.0038 [0.43] 960	0.0048 [0.54] 1900	0.0069 [0.78] 2700
0.152x0.813-19	0.006 x 0.032 [0.152 x 0.813]	0.76 [19.3]	2.4 [60]	0.0028 [0.31] 450	0.0038 [0.43] 1100	0.0048 [0.54] 2300	0.0069 [0.78] 3200
0.152x0.813-22.2	0.006 x 0.032 [0.152 x 0.813]	0.89 [22.5]	2.8 [70]	0.0028 [0.31] 530	0.0038 [0.43] 1300	0.0048 [0.54] 2600	0.0069 [0.78] 3700
0.152x0.813-25.4	0.006 x 0.032 [0.152 x 0.813]	1 [25.7]	3.2 [80]	0.0028 [0.31] 610	0.0038 [0.43] 1500	0.0048 [0.54] 3000	0.0069 [0.78] 4200
0.25x0.5-0.5	0.0098 x 0.02 [0.25 x 0.5]	0.039 [1]	0.094 [2.4]	0.0046 [0.52] 11	0.0064 [0.72] 27	0.0079 [0.9] 54	0.012 [1.3] 76
0.25x0.5-0.9	0.0098 x 0.02 [0.25 x 0.5]	0.055 [1.4]	0.14 [3.6]	0.0046 [0.52] 17	0.0064 [0.72] 41	0.0079 [0.9] 83	0.012 [1.3] 120
0.25x0.5-1.15	0.0098 x 0.02 [0.25 x 0.5]	0.065 [1.65]	0.17 [4.4]	0.0046 [0.52] 20	0.0064 [0.72] 50	0.0079 [0.9] 100	0.012 [1.3] 140
0.25x0.5-1.6	0.0098 x 0.02 [0.25 x 0.5]	0.083 [2.1]	0.23 [5.8]	0.0046 [0.52] 27	0.0064 [0.72] 67	0.0079 [0.9] 130	0.012 [1.3] 190
0.25x0.5-2.4	0.0098 x 0.02 [0.25 x 0.5]	0.11 [2.9]	0.33 [8.3]	0.0046 [0.52] 38	0.0064 [0.72] 95	0.0079 [0.9] 190	0.012 [1.3] 270
0.25x0.5-3.2	0.0098 x 0.02 [0.25 x 0.5]	0.15 [3.7]	0.43 [11]	0.0046 [0.52] 50	0.0064 [0.72] 120	0.0079 [0.9] 250	0.012 [1.3] 350
0.25x0.5-4.75	0.0098 x 0.02 [0.25 x 0.5]	0.21 [5.25]	0.62 [16]	0.0046 [0.52] 72	0.0064 [0.72] 180	0.0079 [0.9] 360	0.012 [1.3] 500
0.25x0.5-6	0.0098 x 0.02 [0.25 x 0.5]	0.26 [6.5]	0.77 [20]	0.0046 [0.52] 90	0.0064 [0.72] 220	0.0079 [0.9] 450	0.012 [1.3] 630
0.25x0.5-8	0.0098 x 0.02 [0.25 x 0.5]	0.33 [8.5]	1 [26]	0.0046 [0.52] 120	0.0064 [0.72] 300	0.0079 [0.9] 590	0.012 [1.3] 830

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.25x0.5-9.5	0.0098 x 0.02 [0.25 x 0.5]	0.39 [10]	1.2 [31]	0.0046 [0.52] 140	0.0064 [0.72] 350	0.0079 [0.9] 700	0.012 [1.3] 980
0.25x0.5-12.7	0.0098 x 0.02 [0.25 x 0.5]	0.52 [13.2]	1.6 [41]	0.0046 [0.52] 190	0.0064 [0.72] 470	0.0079 [0.9] 930	0.012 [1.3] 1300
0.25x0.5-14.2	0.0098 x 0.02 [0.25 x 0.5]	0.58 [14.7]	1.8 [45]	0.0046 [0.52] 210	0.0064 [0.72] 520	0.0079 [0.9] 1000	0.012 [1.3] 1500
0.25x0.5-16	0.0098 x 0.02 [0.25 x 0.5]	0.65 [16.5]	2 [51]	0.0046 [0.52] 230	0.0064 [0.72] 580	0.0079 [0.9] 1200	0.012 [1.3] 1600
0.25x0.5-19	0.0098 x 0.02 [0.25 x 0.5]	0.77 [19.5]	2.4 [60]	0.0046 [0.52] 280	0.0064 [0.72] 690	0.0079 [0.9] 1400	0.012 [1.3] 1900
0.25x0.5-22.2	0.0098 x 0.02 [0.25 x 0.5]	0.89 [22.7]	2.8 [70]	0.0046 [0.52] 320	0.0064 [0.72] 810	0.0079 [0.9] 1600	0.012 [1.3] 2300
0.25x0.5-25.4	0.0098 x 0.02 [0.25 x 0.5]	1 [25.9]	3.2 [81]	0.0046 [0.52] 370	0.0064 [0.72] 920	0.0079 [0.9] 1800	0.012 [1.3] 2600
0.3x2-0.5	0.012 x 0.079 [0.3 x 2]	0.043 [1.1]	0.098 [2.5]	0.027 [3] 9.6	0.037 [4.1] 24	0.046 [5.2] 48	0.066 [7.5] 67
0.3x2-0.9	0.012 x 0.079 [0.3 x 2]	0.059 [1.5]	0.15 [3.8]	0.027 [3] 14	0.037 [4.1] 36	0.046 [5.2] 72	0.066 [7.5] 100
0.3x2-1.15	0.012 x 0.079 [0.3 x 2]	0.069 [1.75]	0.18 [4.6]	0.027 [3] 17	0.037 [4.1] 44	0.046 [5.2] 87	0.066 [7.5] 120
0.3x2-1.6	0.012 x 0.079 [0.3 x 2]	0.087 [2.2]	0.24 [6]	0.027 [3] 23	0.037 [4.1] 57	0.046 [5.2] 110	0.066 [7.5] 160
0.3x2-2.4	0.012 x 0.079 [0.3 x 2]	0.12 [3]	0.33 [8.5]	0.027 [3] 32	0.037 [4.1] 81	0.046 [5.2] 160	0.066 [7.5] 230
0.3x2-3.2	0.012 x 0.079 [0.3 x 2]	0.15 [3.8]	0.43 [11]	0.027 [3] 42	0.037 [4.1] 100	0.046 [5.2] 210	0.066 [7.5] 290

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.3x2-4.75	0.012 x 0.079 [0.3 x 2]	0.21 [5.35]	0.63 [16]	0.027 [3] 61	0.037 [4.1] 150	0.046 [5.2] 300	0.066 [7.5] 420
0.3x2-6	0.012 x 0.079 [0.3 x 2]	0.26 [6.6]	0.78 [20]	0.027 [3] 76	0.037 [4.1] 190	0.046 [5.2] 380	0.066 [7.5] 530
0.3x2-8	0.012 x 0.079 [0.3 x 2]	0.34 [8.6]	1 [26]	0.027 [3] 100	0.037 [4.1] 250	0.046 [5.2] 500	0.066 [7.5] 700
0.3x2-9.5	0.012 x 0.079 [0.3 x 2]	0.4 [10.1]	1.2 [31]	0.027 [3] 120	0.037 [4.1] 290	0.046 [5.2] 590	0.066 [7.5] 820
0.3x2-12.7	0.012 x 0.079 [0.3 x 2]	0.52 [13.3]	1.6 [41]	0.027 [3] 160	0.037 [4.1] 390	0.046 [5.2] 780	0.066 [7.5] 1100
0.3x2-14.2	0.012 x 0.079 [0.3 x 2]	0.58 [14.8]	1.8 [46]	0.027 [3] 170	0.037 [4.1] 440	0.046 [5.2] 870	0.066 [7.5] 1200
0.3x2-16	0.012 x 0.079 [0.3 x 2]	0.65 [16.6]	2 [51]	0.027 [3] 200	0.037 [4.1] 490	0.046 [5.2] 980	0.066 [7.5] 1400
0.3x2-19	0.012 x 0.079 [0.3 x 2]	0.77 [19.6]	2.4 [61]	0.027 [3] 230	0.037 [4.1] 580	0.046 [5.2] 1200	0.066 [7.5] 1600
0.3x2-22.2	0.012 x 0.079 [0.3 x 2]	0.9 [22.8]	2.8 [71]	0.027 [3] 270	0.037 [4.1] 680	0.046 [5.2] 1400	0.066 [7.5] 1900
0.3x2-25.4	0.012 x 0.079 [0.3 x 2]	1 [26]	3.2 [81]	0.027 [3] 310	0.037 [4.1] 770	0.046 [5.2] 1500	0.066 [7.5] 2200
0.406x0.559-0.5	0.016 x 0.022 [0.406 x 0.559]	0.052 [1.31]	0.11 [2.8]	0.014 [1.5] 8	0.019 [2.1] 20	0.023 [2.6] 40	0.034 [3.8] 56
0.406x0.559-0.9	0.016 x 0.022 [0.406 x 0.559]	0.067 [1.71]	0.16 [4.1]	0.014 [1.5] 12	0.019 [2.1] 29	0.023 [2.6] 58	0.034 [3.8] 81
0.406x0.559-1.15	0.016 x 0.022 [0.406 x 0.559]	0.077 [1.96]	0.19 [4.9]	0.014 [1.5] 14	0.019 [2.1] 34	0.023 [2.6] 69	0.034 [3.8] 97

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.406x0.559-1.6	0.016 x 0.022 [0.406 x 0.559]	0.095 [2.41]	0.25 [6.3]	0.014 [1.5] 18	0.019 [2.1] 44	0.023 [2.6] 89	0.034 [3.8] 120
0.406x0.559-2.4	0.016 x 0.022 [0.406 x 0.559]	0.13 [3.21]	0.35 [8.8]	0.014 [1.5] 25	0.019 [2.1] 62	0.023 [2.6] 120	0.034 [3.8] 170
0.406x0.559-3.2	0.016 x 0.022 [0.406 x 0.559]	0.16 [4.01]	0.44 [11]	0.014 [1.5] 32	0.019 [2.1] 80	0.023 [2.6] 160	0.034 [3.8] 220
0.406x0.559-4.75	0.016 x 0.022 [0.406 x 0.559]	0.22 [5.56]	0.64 [16]	0.014 [1.5] 46	0.019 [2.1] 110	0.023 [2.6] 230	0.034 [3.8] 320
0.406x0.559-6	0.016 x 0.022 [0.406 x 0.559]	0.27 [6.81]	0.79 [20]	0.014 [1.5] 57	0.019 [2.1] 140	0.023 [2.6] 280	0.034 [3.8] 400
0.406x0.559-8	0.016 x 0.022 [0.406 x 0.559]	0.35 [8.81]	1 [26]	0.014 [1.5] 75	0.019 [2.1] 190	0.023 [2.6] 370	0.034 [3.8] 520
0.406x0.559-9.5	0.016 x 0.022 [0.406 x 0.559]	0.41 [10.3]	1.2 [31]	0.014 [1.5] 88	0.019 [2.1] 220	0.023 [2.6] 440	0.034 [3.8] 610
0.406x0.559-12.7	0.016 x 0.022 [0.406 x 0.559]	0.53 [13.5]	1.6 [41]	0.014 [1.5] 120	0.019 [2.1] 290	0.023 [2.6] 580	0.034 [3.8] 810
0.406x0.559-14.2	0.016 x 0.022 [0.406 x 0.559]	0.59 [15]	1.8 [46]	0.014 [1.5] 130	0.019 [2.1] 320	0.023 [2.6] 650	0.034 [3.8] 910
0.406x0.559-16	0.016 x 0.022 [0.406 x 0.559]	0.66 [16.8]	2 [52]	0.014 [1.5] 150	0.019 [2.1] 360	0.023 [2.6] 730	0.034 [3.8] 1000
0.406x0.559-19	0.016 x 0.022 [0.406 x 0.559]	0.78 [19.8]	2.4 [61]	0.014 [1.5] 170	0.019 [2.1] 430	0.023 [2.6] 860	0.034 [3.8] 1200
0.406x0.559-22.2	0.016 x 0.022 [0.406 x 0.559]	0.91 [23]	2.8 [71]	0.014 [1.5] 200	0.019 [2.1] 500	0.023 [2.6] 1000	0.034 [3.8] 1400
0.406x0.559-25.4	0.016 x 0.022 [0.406 x 0.559]	1 [26.2]	3.2 [81]	0.014 [1.5] 230	0.019 [2.1] 570	0.023 [2.6] 1100	0.034 [3.8] 1600

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.4x0.8-0.5	0.016 x 0.031 [0.4 x 0.8]	0.051 [1.3]	0.11 [2.8]	0.019 [2.1] 8.1	0.026 [2.9] 20	0.032 [3.7] 40	0.047 [5.3] 57
0.4x0.8-0.9	0.016 x 0.031 [0.4 x 0.8]	0.067 [1.7]	0.16 [4.1]	0.019 [2.1] 12	0.026 [2.9] 29	0.032 [3.7] 58	0.047 [5.3] 82
0.4x0.8-1.15	0.016 x 0.031 [0.4 x 0.8]	0.077 [1.95]	0.19 [4.9]	0.019 [2.1] 14	0.026 [2.9] 35	0.032 [3.7] 70	0.047 [5.3] 98
0.4x0.8-1.6	0.016 x 0.031 [0.4 x 0.8]	0.094 [2.4]	0.25 [6.3]	0.019 [2.1] 18	0.026 [2.9] 45	0.032 [3.7] 90	0.047 [5.3] 130
0.4x0.8-2.4	0.016 x 0.031 [0.4 x 0.8]	0.13 [3.2]	0.35 [8.8]	0.019 [2.1] 25	0.026 [2.9] 63	0.032 [3.7] 130	0.047 [5.3] 180
0.4x0.8-3.2	0.016 x 0.031 [0.4 x 0.8]	0.16 [4]	0.44 [11]	0.019 [2.1] 32	0.026 [2.9] 81	0.032 [3.7] 160	0.047 [5.3] 230
0.4x0.8-4.75	0.016 x 0.031 [0.4 x 0.8]	0.22 [5.55]	0.64 [16]	0.019 [2.1] 46	0.026 [2.9] 120	0.032 [3.7] 230	0.047 [5.3] 320
0.4x0.8-6	0.016 x 0.031 [0.4 x 0.8]	0.27 [6.8]	0.79 [20]	0.019 [2.1] 58	0.026 [2.9] 140	0.032 [3.7] 290	0.047 [5.3] 400
0.4x0.8-8	0.016 x 0.031 [0.4 x 0.8]	0.35 [8.8]	1 [26]	0.019 [2.1] 76	0.026 [2.9] 190	0.032 [3.7] 380	0.047 [5.3] 530
0.4x0.8-9.5	0.016 x 0.031 [0.4 x 0.8]	0.41 [10.3]	1.2 [31]	0.019 [2.1] 89	0.026 [2.9] 220	0.032 [3.7] 450	0.047 [5.3] 620
0.4x0.8-12.7	0.016 x 0.031 [0.4 x 0.8]	0.53 [13.5]	1.6 [41]	0.019 [2.1] 120	0.026 [2.9] 290	0.032 [3.7] 590	0.047 [5.3] 830
0.4x0.8-14.2	0.016 x 0.031 [0.4 x 0.8]	0.59 [15]	1.8 [46]	0.019 [2.1] 130	0.026 [2.9] 330	0.032 [3.7] 660	0.047 [5.3] 920
0.4x0.8-16	0.016 x 0.031 [0.4 x 0.8]	0.66 [16.8]	2 [52]	0.019 [2.1] 150	0.026 [2.9] 370	0.032 [3.7] 740	0.047 [5.3] 1000

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.4x0.8-19	0.016 x 0.031 [0.4 x 0.8]	0.78 [19.8]	2.4 [61]	0.019 [2.1] 170	0.026 [2.9] 440	0.032 [3.7] 870	0.047 [5.3] 1200
0.4x0.8-22.2	0.016 x 0.031 [0.4 x 0.8]	0.91 [23]	2.8 [71]	0.019 [2.1] 200	0.026 [2.9] 510	0.032 [3.7] 1000	0.047 [5.3] 1400
0.4x0.8-25.4	0.016 x 0.031 [0.4 x 0.8]	1 [26.2]	3.2 [81]	0.019 [2.1] 230	0.026 [2.9] 580	0.032 [3.7] 1200	0.047 [5.3] 1600
0.4x1-0.5	0.016 x 0.039 [0.4 x 1]	0.051 [1.3]	0.11 [2.8]	0.024 [2.7] 8.1	0.033 [3.7] 20	0.041 [4.6] 40	0.059 [6.7] 57
0.4x1-0.9	0.016 x 0.039 [0.4 x 1]	0.067 [1.7]	0.16 [4.1]	0.024 [2.7] 12	0.033 [3.7] 29	0.041 [4.6] 58	0.059 [6.7] 82
0.4x1-1.15	0.016 x 0.039 [0.4 x 1]	0.077 [1.95]	0.19 [4.9]	0.024 [2.7] 14	0.033 [3.7] 35	0.041 [4.6] 70	0.059 [6.7] 98
0.4x1-1.6	0.016 x 0.039 [0.4 x 1]	0.094 [2.4]	0.25 [6.3]	0.024 [2.7] 18	0.033 [3.7] 45	0.041 [4.6] 90	0.059 [6.7] 130
0.4x1-2.4	0.016 x 0.039 [0.4 x 1]	0.13 [3.2]	0.35 [8.8]	0.024 [2.7] 25	0.033 [3.7] 63	0.041 [4.6] 130	0.059 [6.7] 180
0.4x1-3.2	0.016 x 0.039 [0.4 x 1]	0.16 [4]	0.44 [11]	0.024 [2.7] 32	0.033 [3.7] 81	0.041 [4.6] 160	0.059 [6.7] 230
0.4x1-4.75	0.016 x 0.039 [0.4 x 1]	0.22 [5.55]	0.64 [16]	0.024 [2.7] 46	0.033 [3.7] 120	0.041 [4.6] 230	0.059 [6.7] 320
0.4x1-6	0.016 x 0.039 [0.4 x 1]	0.27 [6.8]	0.79 [20]	0.024 [2.7] 58	0.033 [3.7] 140	0.041 [4.6] 290	0.059 [6.7] 400
0.4x1-8	0.016 x 0.039 [0.4 x 1]	0.35 [8.8]	1 [26]	0.024 [2.7] 76	0.033 [3.7] 190	0.041 [4.6] 380	0.059 [6.7] 530
0.4x1-9.5	0.016 x 0.039 [0.4 x 1]	0.41 [10.3]	1.2 [31]	0.024 [2.7] 89	0.033 [3.7] 220	0.041 [4.6] 450	0.059 [6.7] 620

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.4x1-12.7	0.016 x 0.039 [0.4 x 1]	0.53 [13.5]	1.6 [41]	0.024 [2.7] 120	0.033 [3.7] 290	0.041 [4.6] 590	0.059 [6.7] 830
0.4x1-14.2	0.016 x 0.039 [0.4 x 1]	0.59 [15]	1.8 [46]	0.024 [2.7] 130	0.033 [3.7] 330	0.041 [4.6] 660	0.059 [6.7] 920
0.4x1-16	0.016 x 0.039 [0.4 x 1]	0.66 [16.8]	2 [52]	0.024 [2.7] 150	0.033 [3.7] 370	0.041 [4.6] 740	0.059 [6.7] 1000
0.4x1-19	0.016 x 0.039 [0.4 x 1]	0.78 [19.8]	2.4 [61]	0.024 [2.7] 170	0.033 [3.7] 440	0.041 [4.6] 870	0.059 [6.7] 1200
0.4x1-22.2	0.016 x 0.039 [0.4 x 1]	0.91 [23]	2.8 [71]	0.024 [2.7] 200	0.033 [3.7] 510	0.041 [4.6] 1000	0.059 [6.7] 1400
0.4x1-25.4	0.016 x 0.039 [0.4 x 1]	1 [26.2]	3.2 [81]	0.024 [2.7] 230	0.033 [3.7] 580	0.041 [4.6] 1200	0.059 [6.7] 1600
0.5x0.25-0.5	0.02 x 0.0098 [0.5 x 0.25]	0.059 [1.5]	0.12 [3.1]	0.0092 [1] 7.2	0.013 [1.4] 18	0.016 [1.8] 36	0.023 [2.6] 50
0.5x0.25-0.9	0.02 x 0.0098 [0.5 x 0.25]	0.075 [1.9]	0.17 [4.4]	0.0092 [1] 10	0.013 [1.4] 25	0.016 [1.8] 50	0.023 [2.6] 71
0.5x0.25-1.15	0.02 x 0.0098 [0.5 x 0.25]	0.085 [2.15]	0.2 [5.2]	0.0092 [1] 12	0.013 [1.4] 30	0.016 [1.8] 59	0.023 [2.6] 83
0.5x0.25-1.6	0.02 x 0.0098 [0.5 x 0.25]	0.1 [2.6]	0.26 [6.6]	0.0092 [1] 15	0.013 [1.4] 38	0.016 [1.8] 76	0.023 [2.6] 110
0.5x0.25-2.4	0.02 x 0.0098 [0.5 x 0.25]	0.13 [3.4]	0.36 [9.1]	0.0092 [1] 21	0.013 [1.4] 52	0.016 [1.8] 100	0.023 [2.6] 150
0.5x0.25-3.2	0.02 x 0.0098 [0.5 x 0.25]	0.17 [4.2]	0.46 [12]	0.0092 [1] 27	0.013 [1.4] 67	0.016 [1.8] 130	0.023 [2.6] 190
0.5x0.25-4.75	0.02 x 0.0098 [0.5 x 0.25]	0.23 [5.75]	0.65 [16]	0.0092 [1] 38	0.013 [1.4] 94	0.016 [1.8] 190	0.023 [2.6] 260

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.5x0.25-6	0.02 x 0.0098 [0.5 x 0.25]	0.28 [7]	0.8 [20]	0.0092 [1] 47	0.013 [1.4] 120	0.016 [1.8] 230	0.023 [2.6] 330
0.5x0.25-8	0.02 x 0.0098 [0.5 x 0.25]	0.35 [9]	1.1 [27]	0.0092 [1] 61	0.013 [1.4] 150	0.016 [1.8] 310	0.023 [2.6] 430
0.5x0.25-9.5	0.02 x 0.0098 [0.5 x 0.25]	0.41 [10.5]	1.2 [31]	0.0092 [1] 72	0.013 [1.4] 180	0.016 [1.8] 360	0.023 [2.6] 500
0.5x0.25-12.7	0.02 x 0.0098 [0.5 x 0.25]	0.54 [13.7]	1.6 [42]	0.0092 [1] 95	0.013 [1.4] 240	0.016 [1.8] 480	0.023 [2.6] 670
0.5x0.25-14.2	0.02 x 0.0098 [0.5 x 0.25]	0.6 [15.2]	1.8 [46]	0.0092 [1] 110	0.013 [1.4] 260	0.016 [1.8] 530	0.023 [2.6] 740
0.5x0.25-16	0.02 x 0.0098 [0.5 x 0.25]	0.67 [17]	2 [52]	0.0092 [1] 120	0.013 [1.4] 300	0.016 [1.8] 590	0.023 [2.6] 830
0.5x0.25-19	0.02 x 0.0098 [0.5 x 0.25]	0.79 [20]	2.4 [61]	0.0092 [1] 140	0.013 [1.4] 350	0.016 [1.8] 700	0.023 [2.6] 980
0.5x0.25-22.2	0.02 x 0.0098 [0.5 x 0.25]	0.91 [23.2]	2.8 [71]	0.0092 [1] 160	0.013 [1.4] 410	0.016 [1.8] 820	0.023 [2.6] 1100
0.5x0.25-25.4	0.02 x 0.0098 [0.5 x 0.25]	1 [26.4]	3.2 [81]	0.0092 [1] 190	0.013 [1.4] 470	0.016 [1.8] 930	0.023 [2.6] 1300
0.55x1.4-0.5	0.022 x 0.055 [0.55 x 1.4]	0.063 [1.6]	0.13 [3.3]	0.062 [7.1] 6.9	0.086 [9.7] 17	0.11 [12] 34	0.16 [18] 48
0.55x1.4-0.9	0.022 x 0.055 [0.55 x 1.4]	0.079 [2]	0.18 [4.6]	0.062 [7.1] 9.5	0.086 [9.7] 24	0.11 [12] 48	0.16 [18] 66
0.55x1.4-1.15	0.022 x 0.055 [0.55 x 1.4]	0.089 [2.25]	0.21 [5.3]	0.062 [7.1] 11	0.086 [9.7] 28	0.11 [12] 56	0.16 [18] 78
0.55x1.4-1.6	0.022 x 0.055 [0.55 x 1.4]	0.11 [2.7]	0.27 [6.8]	0.062 [7.1] 14	0.086 [9.7] 35	0.11 [12] 70	0.16 [18] 98

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.55x1.4-2.4	0.022 x 0.055 [0.55 x 1.4]	0.14 [3.5]	0.37 [9.3]	0.062 [7.1] 19	0.086 [9.7] 48	0.11 [12] 96	0.16 [18] 140
0.55x1.4-3.2	0.022 x 0.055 [0.55 x 1.4]	0.17 [4.3]	0.46 [12]	0.062 [7.1] 25	0.086 [9.7] 61	0.11 [12] 120	0.16 [18] 170
0.55x1.4-4.75	0.022 x 0.055 [0.55 x 1.4]	0.23 [5.85]	0.65 [17]	0.062 [7.1] 35	0.086 [9.7] 87	0.11 [12] 170	0.16 [18] 240
0.55x1.4-6	0.022 x 0.055 [0.55 x 1.4]	0.28 [7.1]	0.81 [21]	0.062 [7.1] 43	0.086 [9.7] 110	0.11 [12] 210	0.16 [18] 300
0.55x1.4-8	0.022 x 0.055 [0.55 x 1.4]	0.36 [9.1]	1.1 [27]	0.062 [7.1] 56	0.086 [9.7] 140	0.11 [12] 280	0.16 [18] 390
0.55x1.4-9.5	0.022 x 0.055 [0.55 x 1.4]	0.42 [10.6]	1.2 [32]	0.062 [7.1] 66	0.086 [9.7] 160	0.11 [12] 330	0.16 [18] 460
0.55x1.4-12.7	0.022 x 0.055 [0.55 x 1.4]	0.54 [13.8]	1.6 [42]	0.062 [7.1] 87	0.086 [9.7] 220	0.11 [12] 430	0.16 [18] 610
0.55x1.4-14.2	0.022 x 0.055 [0.55 x 1.4]	0.6 [15.3]	1.8 [46]	0.062 [7.1] 97	0.086 [9.7] 240	0.11 [12] 480	0.16 [18] 680
0.55x1.4-16	0.022 x 0.055 [0.55 x 1.4]	0.67 [17.1]	2 [52]	0.062 [7.1] 110	0.086 [9.7] 270	0.11 [12] 540	0.16 [18] 760
0.55x1.4-19	0.022 x 0.055 [0.55 x 1.4]	0.79 [20.1]	2.4 [61]	0.062 [7.1] 130	0.086 [9.7] 320	0.11 [12] 640	0.16 [18] 900
0.55x1.4-22.2	0.022 x 0.055 [0.55 x 1.4]	0.92 [23.3]	2.8 [72]	0.062 [7.1] 150	0.086 [9.7] 370	0.11 [12] 740	0.16 [18] 1000
0.55x1.4-25.4	0.022 x 0.055 [0.55 x 1.4]	1 [26.5]	3.2 [82]	0.062 [7.1] 170	0.086 [9.7] 420	0.11 [12] 850	0.16 [18] 1200
0.5x0.8-0.5	0.02 x 0.031 [0.5 x 0.8]	0.059 [1.5]	0.12 [3.1]	0.029 [3.3] 7.2	0.041 [4.6] 18	0.051 [5.7] 36	0.074 [8.3] 50

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.5x0.8-0.9	0.02 x 0.031 [0.5 x 0.8]	0.075 [1.9]	0.17 [4.4]	0.029 [3.3] 10	0.041 [4.6] 25	0.051 [5.7] 50	0.074 [8.3] 71
0.5x0.8-1.15	0.02 x 0.031 [0.5 x 0.8]	0.085 [2.15]	0.2 [5.2]	0.029 [3.3] 12	0.041 [4.6] 30	0.051 [5.7] 59	0.074 [8.3] 83
0.5x0.8-1.6	0.02 x 0.031 [0.5 x 0.8]	0.1 [2.6]	0.26 [6.6]	0.029 [3.3] 15	0.041 [4.6] 38	0.051 [5.7] 76	0.074 [8.3] 110
0.5x0.8-2.4	0.02 x 0.031 [0.5 x 0.8]	0.13 [3.4]	0.36 [9.1]	0.029 [3.3] 21	0.041 [4.6] 52	0.051 [5.7] 100	0.074 [8.3] 150
0.5x0.8-3.2	0.02 x 0.031 [0.5 x 0.8]	0.17 [4.2]	0.46 [12]	0.029 [3.3] 27	0.041 [4.6] 67	0.051 [5.7] 130	0.074 [8.3] 190
0.5x0.8-4.75	0.02 x 0.031 [0.5 x 0.8]	0.23 [5.75]	0.65 [16]	0.029 [3.3] 38	0.041 [4.6] 94	0.051 [5.7] 190	0.074 [8.3] 260
0.5x0.8-6	0.02 x 0.031 [0.5 x 0.8]	0.28 [7]	0.8 [20]	0.029 [3.3] 47	0.041 [4.6] 120	0.051 [5.7] 230	0.074 [8.3] 330
0.5x0.8-8	0.02 x 0.031 [0.5 x 0.8]	0.35 [9]	1.1 [27]	0.029 [3.3] 61	0.041 [4.6] 150	0.051 [5.7] 310	0.074 [8.3] 430
0.5x0.8-9.5	0.02 x 0.031 [0.5 x 0.8]	0.41 [10.5]	1.2 [31]	0.029 [3.3] 72	0.041 [4.6] 180	0.051 [5.7] 360	0.074 [8.3] 500
0.5x0.8-12.7	0.02 x 0.031 [0.5 x 0.8]	0.54 [13.7]	1.6 [42]	0.029 [3.3] 95	0.041 [4.6] 240	0.051 [5.7] 480	0.074 [8.3] 670
0.5x0.8-14.2	0.02 x 0.031 [0.5 x 0.8]	0.6 [15.2]	1.8 [46]	0.029 [3.3] 110	0.041 [4.6] 260	0.051 [5.7] 530	0.074 [8.3] 740
0.5x0.8-16	0.02 x 0.031 [0.5 x 0.8]	0.67 [17]	2 [52]	0.029 [3.3] 120	0.041 [4.6] 300	0.051 [5.7] 590	0.074 [8.3] 830
0.5x0.8-19	0.02 x 0.031 [0.5 x 0.8]	0.79 [20]	2.4 [61]	0.029 [3.3] 140	0.041 [4.6] 350	0.051 [5.7] 700	0.074 [8.3] 980

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.5x0.8-22.2	0.02 x 0.031 [0.5 x 0.8]	0.91 [23.2]	2.8 [71]	0.029 [3.3] 160	0.041 [4.6] 410	0.051 [5.7] 820	0.074 [8.3] 1100
0.5x0.8-25.4	0.02 x 0.031 [0.5 x 0.8]	1 [26.4]	3.2 [81]	0.029 [3.3] 190	0.041 [4.6] 470	0.051 [5.7] 930	0.074 [8.3] 1300
0.6x2.3-0.5	0.024 x 0.091 [0.6 x 2.3]	0.067 [1.7]	0.14 [3.5]	0.12 [14] 6.6	0.17 [19] 16	0.21 [24] 33	0.31 [34] 46
0.6x2.3-0.9	0.024 x 0.091 [0.6 x 2.3]	0.083 [2.1]	0.19 [4.7]	0.12 [14] 9	0.17 [19] 22	0.21 [24] 45	0.31 [34] 63
0.6x2.3-1.15	0.024 x 0.091 [0.6 x 2.3]	0.093 [2.35]	0.22 [5.5]	0.12 [14] 10	0.17 [19] 26	0.21 [24] 52	0.31 [34] 74
0.6x2.3-1.6	0.024 x 0.091 [0.6 x 2.3]	0.11 [2.8]	0.27 [6.9]	0.12 [14] 13	0.17 [19] 33	0.21 [24] 66	0.31 [34] 92
0.6x2.3-2.4	0.024 x 0.091 [0.6 x 2.3]	0.14 [3.6]	0.37 [9.4]	0.12 [14] 18	0.17 [19] 45	0.21 [24] 90	0.31 [34] 130
0.6x2.3-3.2	0.024 x 0.091 [0.6 x 2.3]	0.17 [4.4]	0.47 [12]	0.12 [14] 23	0.17 [19] 57	0.21 [24] 110	0.31 [34] 160
0.6x2.3-4.75	0.024 x 0.091 [0.6 x 2.3]	0.23 [5.95]	0.66 [17]	0.12 [14] 32	0.17 [19] 80	0.21 [24] 160	0.31 [34] 220
0.6x2.3-6	0.024 x 0.091 [0.6 x 2.3]	0.28 [7.2]	0.81 [21]	0.12 [14] 40	0.17 [19] 99	0.21 [24] 200	0.31 [34] 280
0.6x2.3-8	0.024 x 0.091 [0.6 x 2.3]	0.36 [9.2]	1.1 [27]	0.12 [14] 52	0.17 [19] 130	0.21 [24] 260	0.31 [34] 360
0.6x2.3-9.5	0.024 x 0.091 [0.6 x 2.3]	0.42 [10.7]	1.2 [32]	0.12 [14] 61	0.17 [19] 150	0.21 [24] 300	0.31 [34] 420
0.6x2.3-12.7	0.024 x 0.091 [0.6 x 2.3]	0.55 [13.9]	1.6 [42]	0.12 [14] 80	0.17 [19] 200	0.21 [24] 400	0.31 [34] 560

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.6x2.3-14.2	0.024 x 0.091 [0.6 x 2.3]	0.61 [15.4]	1.8 [46]	0.12 [14] 89	0.17 [19] 220	0.21 [24] 440	0.31 [34] 620
0.6x2.3-16	0.024 x 0.091 [0.6 x 2.3]	0.68 [17.2]	2.1 [52]	0.12 [14] 100	0.17 [19] 250	0.21 [24] 500	0.31 [34] 700
0.6x2.3-19	0.024 x 0.091 [0.6 x 2.3]	0.8 [20.2]	2.4 [62]	0.12 [14] 120	0.17 [19] 290	0.21 [24] 590	0.31 [34] 820
0.6x2.3-22.2	0.024 x 0.091 [0.6 x 2.3]	0.92 [23.4]	2.8 [72]	0.12 [14] 140	0.17 [19] 340	0.21 [24] 680	0.31 [34] 960
0.6x2.3-25.4	0.024 x 0.091 [0.6 x 2.3]	1 [26.6]	3.2 [82]	0.12 [14] 160	0.17 [19] 390	0.21 [24] 780	0.31 [34] 1100
0.8x1.5-0.5	0.031 x 0.059 [0.8 x 1.5]	0.083 [2.1]	0.16 [4.1]	0.14 [16] 5.8	0.2 [22] 15	0.24 [28] 29	0.35 [40] 41
0.8x1.5-0.9	0.031 x 0.059 [0.8 x 1.5]	0.098 [2.5]	0.21 [5.3]	0.14 [16] 7.6	0.2 [22] 19	0.24 [28] 38	0.35 [40] 54
0.8x1.5-1.15	0.031 x 0.059 [0.8 x 1.5]	0.11 [2.75]	0.24 [6.1]	0.14 [16] 8.8	0.2 [22] 22	0.24 [28] 44	0.35 [40] 61
0.8x1.5-1.6	0.031 x 0.059 [0.8 x 1.5]	0.13 [3.2]	0.3 [7.5]	0.14 [16] 11	0.2 [22] 27	0.24 [28] 54	0.35 [40] 76
0.8x1.5-2.4	0.031 x 0.059 [0.8 x 1.5]	0.16 [4]	0.4 [10]	0.14 [16] 14	0.2 [22] 36	0.24 [28] 72	0.35 [40] 100
0.8x1.5-3.2	0.031 x 0.059 [0.8 x 1.5]	0.19 [4.8]	0.5 [13]	0.14 [16] 18	0.2 [22] 45	0.24 [28] 90	0.35 [40] 130
0.8x1.5-4.75	0.031 x 0.059 [0.8 x 1.5]	0.25 [6.35]	0.69 [17]	0.14 [16] 25	0.2 [22] 62	0.24 [28] 120	0.35 [40] 170
0.8x1.5-6	0.031 x 0.059 [0.8 x 1.5]	0.3 [7.6]	0.84 [21]	0.14 [16] 31	0.2 [22] 76	0.24 [28] 150	0.35 [40] 210

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.8x1.5-8	0.031 x 0.059 [0.8 x 1.5]	0.38 [9.6]	1.1 [28]	0.14 [16] 40	0.2 [22] 99	0.24 [28] 200	0.35 [40] 280
0.8x1.5-9.5	0.031 x 0.059 [0.8 x 1.5]	0.44 [11.1]	1.3 [32]	0.14 [16] 46	0.2 [22] 120	0.24 [28] 230	0.35 [40] 320
0.8x1.5-12.7	0.031 x 0.059 [0.8 x 1.5]	0.56 [14.3]	1.7 [42]	0.14 [16] 61	0.2 [22] 150	0.24 [28] 300	0.35 [40] 430
0.8x1.5-14.2	0.031 x 0.059 [0.8 x 1.5]	0.62 [15.8]	1.9 [47]	0.14 [16] 68	0.2 [22] 170	0.24 [28] 340	0.35 [40] 470
0.8x1.5-16	0.031 x 0.059 [0.8 x 1.5]	0.69 [17.6]	2.1 [53]	0.14 [16] 76	0.2 [22] 190	0.24 [28] 380	0.35 [40] 530
0.8x1.5-19	0.031 x 0.059 [0.8 x 1.5]	0.81 [20.6]	2.4 [62]	0.14 [16] 89	0.2 [22] 220	0.24 [28] 450	0.35 [40] 620
0.8x1.5-22.2	0.031 x 0.059 [0.8 x 1.5]	0.94 [23.8]	2.8 [72]	0.14 [16] 100	0.2 [22] 260	0.24 [28] 520	0.35 [40] 720
0.8x1.5-25.4	0.031 x 0.059 [0.8 x 1.5]	1.1 [27]	3.2 [82]	0.14 [16] 120	0.2 [22] 290	0.24 [28] 590	0.35 [40] 830
1x2.6-0.5	0.039 x 0.1 [1 x 2.6]	0.098 [2.5]	0.19 [4.7]	0.38 [43] 5.4	0.53 [60] 14	0.66 [75] 27	0.96 [110] 38
1x2.6-0.9	0.039 x 0.1 [1 x 2.6]	0.11 [2.9]	0.24 [6]	0.38 [43] 6.8	0.53 [60] 17	0.66 [75] 34	0.96 [110] 48
1x2.6-1.15	0.039 x 0.1 [1 x 2.6]	0.12 [3.15]	0.27 [6.8]	0.38 [43] 7.7	0.53 [60] 19	0.66 [75] 39	0.96 [110] 54
1x2.6-1.6	0.039 x 0.1 [1 x 2.6]	0.14 [3.6]	0.32 [8.2]	0.38 [43] 9.4	0.53 [60] 23	0.66 [75] 47	0.96 [110] 66
1x2.6-2.4	0.039 x 0.1 [1 x 2.6]	0.17 [4.4]	0.42 [11]	0.38 [43] 12	0.53 [60] 31	0.66 [75] 61	0.96 [110] 86

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
1x2.6-3.2	0.039 x 0.1 [1 x 2.6]	0.2 [5.2]	0.52 [13]	0.38 [43] 15	0.53 [60] 38	0.66 [75] 76	0.96 [110] 110
1x2.6-4.75	0.039 x 0.1 [1 x 2.6]	0.27 [6.75]	0.71 [18]	0.38 [43] 21	0.53 [60] 52	0.66 [75] 100	0.96 [110] 140
1x2.6-6	0.039 x 0.1 [1 x 2.6]	0.31 [8]	0.87 [22]	0.38 [43] 25	0.53 [60] 63	0.66 [75] 130	0.96 [110] 180
1x2.6-8	0.039 x 0.1 [1 x 2.6]	0.39 [10]	1.1 [28]	0.38 [43] 32	0.53 [60] 81	0.66 [75] 160	0.96 [110] 230
1x2.6-9.5	0.039 x 0.1 [1 x 2.6]	0.45 [11.5]	1.3 [33]	0.38 [43] 38	0.53 [60] 94	0.66 [75] 190	0.96 [110] 260
1x2.6-12.7	0.039 x 0.1 [1 x 2.6]	0.58 [14.7]	1.7 [43]	0.38 [43] 49	0.53 [60] 120	0.66 [75] 250	0.96 [110] 350
1x2.6-14.2	0.039 x 0.1 [1 x 2.6]	0.64 [16.2]	1.9 [48]	0.38 [43] 55	0.53 [60] 140	0.66 [75] 270	0.96 [110] 380
1x2.6-16	0.039 x 0.1 [1 x 2.6]	0.71 [18]	2.1 [53]	0.38 [43] 61	0.53 [60] 150	0.66 [75] 310	0.96 [110] 430
1x2.6-19	0.039 x 0.1 [1 x 2.6]	0.83 [21]	2.5 [63]	0.38 [43] 72	0.53 [60] 180	0.66 [75] 360	0.96 [110] 500
1x2.6-22.2	0.039 x 0.1 [1 x 2.6]	0.95 [24.2]	2.9 [73]	0.38 [43] 84	0.53 [60] 210	0.66 [75] 420	0.96 [110] 580
1x2.6-25.4	0.039 x 0.1 [1 x 2.6]	1.1 [27.4]	3.3 [83]	0.38 [43] 95	0.53 [60] 240	0.66 [75] 480	0.96 [110] 670
1.5x4-0.5	0.059 x 0.16 [1.5 x 4]	0.14 [3.5]	0.25 [6.3]	1.3 [150] 4.8	1.8 [210] 12	2.3 [260] 24	3.3 [380] 34
1.5x4-0.9	0.059 x 0.16 [1.5 x 4]	0.15 [3.9]	0.3 [7.5]	1.3 [150] 5.8	1.8 [210] 14	2.3 [260] 29	3.3 [380] 40

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
1.5x4-1.15	0.059 x 0.16 [1.5 x 4]	0.16 [4.15]	0.33 [8.3]	1.3 [150] 6.4	1.8 [210] 16	2.3 [260] 32	3.3 [380] 44
1.5x4-1.6	0.059 x 0.16 [1.5 x 4]	0.18 [4.6]	0.38 [9.7]	1.3 [150] 7.4	1.8 [210] 19	2.3 [260] 37	3.3 [380] 52
1.5x4-2.4	0.059 x 0.16 [1.5 x 4]	0.21 [5.4]	0.48 [12]	1.3 [150] 9.4	1.8 [210] 23	2.3 [260] 47	3.3 [380] 66
1.5x4-3.2	0.059 x 0.16 [1.5 x 4]	0.24 [6.2]	0.58 [15]	1.3 [150] 11	1.8 [210] 28	2.3 [260] 56	3.3 [380] 79
1.5x4-4.75	0.059 x 0.16 [1.5 x 4]	0.31 [7.75]	0.77 [20]	1.3 [150] 15	1.8 [210] 38	2.3 [260] 75	3.3 [380] 100
1.5x4-6	0.059 x 0.16 [1.5 x 4]	0.35 [9]	0.93 [24]	1.3 [150] 18	1.8 [210] 45	2.3 [260] 90	3.3 [380] 130
1.5x4-8	0.059 x 0.16 [1.5 x 4]	0.43 [11]	1.2 [30]	1.3 [150] 23	1.8 [210] 57	2.3 [260] 110	3.3 [380] 160
1.5x4-9.5	0.059 x 0.16 [1.5 x 4]	0.49 [12.5]	1.4 [35]	1.3 [150] 26	1.8 [210] 66	2.3 [260] 130	3.3 [380] 180
1.5x4-12.7	0.059 x 0.16 [1.5 x 4]	0.62 [15.7]	1.8 [45]	1.3 [150] 34	1.8 [210] 85	2.3 [260] 170	3.3 [380] 240
1.5x4-14.2	0.059 x 0.16 [1.5 x 4]	0.68 [17.2]	1.9 [49]	1.3 [150] 38	1.8 [210] 94	2.3 [260] 190	3.3 [380] 260
1.5x4-16	0.059 x 0.16 [1.5 x 4]	0.75 [19]	2.2 [55]	1.3 [150] 42	1.8 [210] 100	2.3 [260] 210	3.3 [380] 290
1.5x4-19	0.059 x 0.16 [1.5 x 4]	0.87 [22]	2.5 [64]	1.3 [150] 49	1.8 [210] 120	2.3 [260] 250	3.3 [380] 340
1.5x4-22.2	0.059 x 0.16 [1.5 x 4]	0.99 [25.2]	2.9 [74]	1.3 [150] 57	1.8 [210] 140	2.3 [260] 280	3.3 [380] 400

TORSION SPRING ACTUATORS — FLAT WIRE, FACE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
1.5x4-25.4	0.059 x 0.16 [1.5 x 4]	1.1 [28.4]	3.3 [84]	1.3 [150] 65	1.8 [210] 160	2.3 [260] 320	3.3 [380] 450

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.152x0.411-0.5	0.006 x 0.016 [0.152 x 0.411]	0.052 [1.32]	0.11 [2.9]	0.0038 [0.43] 8	0.0052 [0.59] 20	0.0065 [0.74] 40	0.0095 [1.1] 56
0.152x0.411-0.9	0.006 x 0.016 [0.152 x 0.411]	0.068 [1.72]	0.16 [4.1]	0.0038 [0.43] 11	0.0052 [0.59] 29	0.0065 [0.74] 57	0.0095 [1.1] 80
0.152x0.411-1.15	0.006 x 0.016 [0.152 x 0.411]	0.078 [1.97]	0.19 [4.9]	0.0038 [0.43] 14	0.0052 [0.59] 34	0.0065 [0.74] 68	0.0095 [1.1] 96
0.152x0.411-1.6	0.006 x 0.016 [0.152 x 0.411]	0.095 [2.42]	0.25 [6.3]	0.0038 [0.43] 18	0.0052 [0.59] 44	0.0065 [0.74] 88	0.0095 [1.1] 120
0.152x0.411-2.4	0.006 x 0.016 [0.152 x 0.411]	0.13 [3.22]	0.35 [8.8]	0.0038 [0.43] 25	0.0052 [0.59] 62	0.0065 [0.74] 120	0.0095 [1.1] 170
0.152x0.411-3.2	0.006 x 0.016 [0.152 x 0.411]	0.16 [4.02]	0.44 [11]	0.0038 [0.43] 32	0.0052 [0.59] 79	0.0065 [0.74] 160	0.0095 [1.1] 220
0.152x0.411-4.75	0.006 x 0.016 [0.152 x 0.411]	0.22 [5.57]	0.64 [16]	0.0038 [0.43] 45	0.0052 [0.59] 110	0.0065 [0.74] 230	0.0095 [1.1] 320
0.152x0.411-6	0.006 x 0.016 [0.152 x 0.411]	0.27 [6.82]	0.79 [20]	0.0038 [0.43] 56	0.0052 [0.59] 140	0.0065 [0.74] 280	0.0095 [1.1] 390

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.152x0.411-8	0.006 x 0.016 [0.152 x 0.411]	0.35 [8.82]	1 [26]	0.0038 [0.43] 74	0.0052 [0.59] 180	0.0065 [0.74] 370	0.0095 [1.1] 520
0.152x0.411-9.5	0.006 x 0.016 [0.152 x 0.411]	0.41 [10.3]	1.2 [31]	0.0038 [0.43] 87	0.0052 [0.59] 220	0.0065 [0.74] 430	0.0095 [1.1] 610
0.152x0.411-12.7	0.006 x 0.016 [0.152 x 0.411]	0.53 [13.5]	1.6 [41]	0.0038 [0.43] 110	0.0052 [0.59] 290	0.0065 [0.74] 570	0.0095 [1.1] 800
0.152x0.411-14.2	0.006 x 0.016 [0.152 x 0.411]	0.59 [15]	1.8 [46]	0.0038 [0.43] 130	0.0052 [0.59] 320	0.0065 [0.74] 640	0.0095 [1.1] 900
0.152x0.411-16	0.006 x 0.016 [0.152 x 0.411]	0.66 [16.8]	2 [52]	0.0038 [0.43] 140	0.0052 [0.59] 360	0.0065 [0.74] 720	0.0095 [1.1] 1000
0.152x0.411-19	0.006 x 0.016 [0.152 x 0.411]	0.78 [19.8]	2.4 [61]	0.0038 [0.43] 170	0.0052 [0.59] 430	0.0065 [0.74] 850	0.0095 [1.1] 1200
0.152x0.411-22.2	0.006 x 0.016 [0.152 x 0.411]	0.91 [23]	2.8 [71]	0.0038 [0.43] 200	0.0052 [0.59] 500	0.0065 [0.74] 990	0.0095 [1.1] 1400
0.152x0.411-25.4	0.006 x 0.016 [0.152 x 0.411]	1 [26.2]	3.2 [81]	0.0038 [0.43] 230	0.0052 [0.59] 570	0.0065 [0.74] 1100	0.0095 [1.1] 1600
0.152x0.813-0.5	0.006 x 0.032 [0.152 x 0.813]	0.084 [2.13]	0.16 [4.1]	0.015 [1.7] 5.8	0.02 [2.3] 15	0.025 [2.9] 29	0.037 [4.2] 41
0.152x0.813-0.9	0.006 x 0.032 [0.152 x 0.813]	0.099 [2.53]	0.21 [5.4]	0.015 [1.7] 7.6	0.02 [2.3] 19	0.025 [2.9] 38	0.037 [4.2] 53
0.152x0.813-1.15	0.006 x 0.032 [0.152 x 0.813]	0.11 [2.78]	0.24 [6.2]	0.015 [1.7] 8.7	0.02 [2.3] 22	0.025 [2.9] 44	0.037 [4.2] 61
0.152x0.813-1.6	0.006 x 0.032 [0.152 x 0.813]	0.13 [3.23]	0.3 [7.6]	0.015 [1.7] 11	0.02 [2.3] 27	0.025 [2.9] 53	0.037 [4.2] 75
0.152x0.813-2.4	0.006 x 0.032 [0.152 x 0.813]	0.16 [4.03]	0.4 [10]	0.015 [1.7] 14	0.02 [2.3] 36	0.025 [2.9] 71	0.037 [4.2] 100

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.152x0.813-3.2	0.006 x 0.032 [0.152 x 0.813]	0.19 [4.83]	0.5 [13]	0.015 [1.7] 18	0.02 [2.3] 44	0.025 [2.9] 89	0.037 [4.2] 120
0.152x0.813-4.75	0.006 x 0.032 [0.152 x 0.813]	0.25 [6.38]	0.69 [18]	0.015 [1.7] 25	0.02 [2.3] 62	0.025 [2.9] 120	0.037 [4.2] 170
0.152x0.813-6	0.006 x 0.032 [0.152 x 0.813]	0.3 [7.63]	0.84 [21]	0.015 [1.7] 30	0.02 [2.3] 75	0.025 [2.9] 150	0.037 [4.2] 210
0.152x0.813-8	0.006 x 0.032 [0.152 x 0.813]	0.38 [9.63]	1.1 [28]	0.015 [1.7] 39	0.02 [2.3] 98	0.025 [2.9] 200	0.037 [4.2] 270
0.152x0.813-9.5	0.006 x 0.032 [0.152 x 0.813]	0.44 [11.1]	1.3 [32]	0.015 [1.7] 46	0.02 [2.3] 110	0.025 [2.9] 230	0.037 [4.2] 320
0.152x0.813-12.7	0.006 x 0.032 [0.152 x 0.813]	0.56 [14.3]	1.7 [42]	0.015 [1.7] 60	0.02 [2.3] 150	0.025 [2.9] 300	0.037 [4.2] 420
0.152x0.813-14.2	0.006 x 0.032 [0.152 x 0.813]	0.62 [15.8]	1.9 [47]	0.015 [1.7] 66	0.02 [2.3] 170	0.025 [2.9] 330	0.037 [4.2] 470
0.152x0.813-16	0.006 x 0.032 [0.152 x 0.813]	0.69 [17.6]	2.1 [53]	0.015 [1.7] 74	0.02 [2.3] 190	0.025 [2.9] 370	0.037 [4.2] 520
0.152x0.813-19	0.006 x 0.032 [0.152 x 0.813]	0.81 [20.6]	2.4 [62]	0.015 [1.7] 88	0.02 [2.3] 220	0.025 [2.9] 440	0.037 [4.2] 610
0.152x0.813-22.2	0.006 x 0.032 [0.152 x 0.813]	0.94 [23.8]	2.8 [72]	0.015 [1.7] 100	0.02 [2.3] 250	0.025 [2.9] 510	0.037 [4.2] 710
0.152x0.813-25.4	0.006 x 0.032 [0.152 x 0.813]	1.1 [27]	3.2 [82]	0.015 [1.7] 120	0.02 [2.3] 290	0.025 [2.9] 580	0.037 [4.2] 810
0.25x0.5-0.5	0.0098 x 0.02 [0.25 x 0.5]	0.059 [1.5]	0.12 [3.1]	0.0092 [1] 7.2	0.013 [1.4] 18	0.016 [1.8] 36	0.023 [2.6] 50
0.25x0.5-0.9	0.0098 x 0.02 [0.25 x 0.5]	0.075 [1.9]	0.17 [4.4]	0.0092 [1] 10	0.013 [1.4] 25	0.016 [1.8] 50	0.023 [2.6] 71

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.25x0.5-1.15	0.0098 x 0.02 [0.25 x 0.5]	0.085 [2.15]	0.2 [5.2]	0.0092 [1] 12	0.013 [1.4] 30	0.016 [1.8] 59	0.023 [2.6] 83
0.25x0.5-1.6	0.0098 x 0.02 [0.25 x 0.5]	0.1 [2.6]	0.26 [6.6]	0.0092 [1] 15	0.013 [1.4] 38	0.016 [1.8] 76	0.023 [2.6] 110
0.25x0.5-2.4	0.0098 x 0.02 [0.25 x 0.5]	0.13 [3.4]	0.36 [9.1]	0.0092 [1] 21	0.013 [1.4] 52	0.016 [1.8] 100	0.023 [2.6] 150
0.25x0.5-3.2	0.0098 x 0.02 [0.25 x 0.5]	0.17 [4.2]	0.46 [12]	0.0092 [1] 27	0.013 [1.4] 67	0.016 [1.8] 130	0.023 [2.6] 190
0.25x0.5-4.75	0.0098 x 0.02 [0.25 x 0.5]	0.23 [5.75]	0.65 [16]	0.0092 [1] 38	0.013 [1.4] 94	0.016 [1.8] 190	0.023 [2.6] 260
0.25x0.5-6	0.0098 x 0.02 [0.25 x 0.5]	0.28 [7]	0.8 [20]	0.0092 [1] 47	0.013 [1.4] 120	0.016 [1.8] 230	0.023 [2.6] 330
0.25x0.5-8	0.0098 x 0.02 [0.25 x 0.5]	0.35 [9]	1.1 [27]	0.0092 [1] 61	0.013 [1.4] 150	0.016 [1.8] 310	0.023 [2.6] 430
0.25x0.5-9.5	0.0098 x 0.02 [0.25 x 0.5]	0.41 [10.5]	1.2 [31]	0.0092 [1] 72	0.013 [1.4] 180	0.016 [1.8] 360	0.023 [2.6] 500
0.25x0.5-12.7	0.0098 x 0.02 [0.25 x 0.5]	0.54 [13.7]	1.6 [42]	0.0092 [1] 95	0.013 [1.4] 240	0.016 [1.8] 480	0.023 [2.6] 670
0.25x0.5-14.2	0.0098 x 0.02 [0.25 x 0.5]	0.6 [15.2]	1.8 [46]	0.0092 [1] 110	0.013 [1.4] 260	0.016 [1.8] 530	0.023 [2.6] 740
0.25x0.5-16	0.0098 x 0.02 [0.25 x 0.5]	0.67 [17]	2 [52]	0.0092 [1] 120	0.013 [1.4] 300	0.016 [1.8] 590	0.023 [2.6] 830
0.25x0.5-19	0.0098 x 0.02 [0.25 x 0.5]	0.79 [20]	2.4 [61]	0.0092 [1] 140	0.013 [1.4] 350	0.016 [1.8] 700	0.023 [2.6] 980
0.25x0.5-22.2	0.0098 x 0.02 [0.25 x 0.5]	0.91 [23.2]	2.8 [71]	0.0092 [1] 160	0.013 [1.4] 410	0.016 [1.8] 820	0.023 [2.6] 1100

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.25x0.5-25.4	0.0098 x 0.02 [0.25 x 0.5]	1 [26.4]	3.2 [81]	0.0092 [1] 190	0.013 [1.4] 470	0.016 [1.8] 930	0.023 [2.6] 1300
0.3x2-0.5	0.012 x 0.079 [0.3 x 2]	0.18 [4.5]	0.31 [7.9]	0.18 [20] 4.5	0.24 [28] 11	0.3 [34] 22	0.44 [50] 32
0.3x2-0.9	0.012 x 0.079 [0.3 x 2]	0.19 [4.9]	0.36 [9.1]	0.18 [20] 5.2	0.24 [28] 13	0.3 [34] 26	0.44 [50] 36
0.3x2-1.15	0.012 x 0.079 [0.3 x 2]	0.2 [5.15]	0.39 [9.9]	0.18 [20] 5.7	0.24 [28] 14	0.3 [34] 28	0.44 [50] 40
0.3x2-1.6	0.012 x 0.079 [0.3 x 2]	0.22 [5.6]	0.44 [11]	0.18 [20] 6.5	0.24 [28] 16	0.3 [34] 32	0.44 [50] 45
0.3x2-2.4	0.012 x 0.079 [0.3 x 2]	0.25 [6.4]	0.54 [14]	0.18 [20] 7.9	0.24 [28] 20	0.3 [34] 40	0.44 [50] 55
0.3x2-3.2	0.012 x 0.079 [0.3 x 2]	0.28 [7.2]	0.64 [16]	0.18 [20] 9.4	0.24 [28] 23	0.3 [34] 47	0.44 [50] 66
0.3x2-4.75	0.012 x 0.079 [0.3 x 2]	0.34 [8.75]	0.83 [21]	0.18 [20] 12	0.24 [28] 30	0.3 [34] 61	0.44 [50] 85
0.3x2-6	0.012 x 0.079 [0.3 x 2]	0.39 [10]	0.99 [25]	0.18 [20] 14	0.24 [28] 36	0.3 [34] 72	0.44 [50] 100
0.3x2-8	0.012 x 0.079 [0.3 x 2]	0.47 [12]	1.2 [31]	0.18 [20] 18	0.24 [28] 45	0.3 [34] 90	0.44 [50] 130
0.3x2-9.5	0.012 x 0.079 [0.3 x 2]	0.53 [13.5]	1.4 [36]	0.18 [20] 21	0.24 [28] 52	0.3 [34] 100	0.44 [50] 140
0.3x2-12.7	0.012 x 0.079 [0.3 x 2]	0.66 [16.7]	1.8 [46]	0.18 [20] 26	0.24 [28] 66	0.3 [34] 130	0.44 [50] 190
0.3x2-14.2	0.012 x 0.079 [0.3 x 2]	0.72 [18.2]	2 [51]	0.18 [20] 29	0.24 [28] 73	0.3 [34] 150	0.44 [50] 200

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.3x2-16	0.012 x 0.079 [0.3 x 2]	0.79 [20]	2.2 [56]	0.18 [20] 32	0.24 [28] 81	0.3 [34] 160	0.44 [50] 230
0.3x2-19	0.012 x 0.079 [0.3 x 2]	0.91 [23]	2.6 [66]	0.18 [20] 38	0.24 [28] 94	0.3 [34] 190	0.44 [50] 260
0.3x2-22.2	0.012 x 0.079 [0.3 x 2]	1 [26.2]	3 [76]	0.18 [20] 44	0.24 [28] 110	0.3 [34] 220	0.44 [50] 300
0.3x2-25.4	0.012 x 0.079 [0.3 x 2]	1.2 [29.4]	3.4 [86]	0.18 [20] 49	0.24 [28] 120	0.3 [34] 250	0.44 [50] 350
0.406x0.559-0.5	0.016 x 0.022 [0.406 x 0.559]	0.064 [1.62]	0.13 [3.3]	0.019 [2.1] 6.8	0.026 [2.9] 17	0.032 [3.6] 34	0.047 [5.3] 48
0.406x0.559-0.9	0.016 x 0.022 [0.406 x 0.559]	0.079 [2.02]	0.18 [4.6]	0.019 [2.1] 9.4	0.026 [2.9] 24	0.032 [3.6] 47	0.047 [5.3] 66
0.406x0.559-1.15	0.016 x 0.022 [0.406 x 0.559]	0.089 [2.27]	0.21 [5.4]	0.019 [2.1] 11	0.026 [2.9] 28	0.032 [3.6] 55	0.047 [5.3] 77
0.406x0.559-1.6	0.016 x 0.022 [0.406 x 0.559]	0.11 [2.72]	0.27 [6.8]	0.019 [2.1] 14	0.026 [2.9] 35	0.032 [3.6] 70	0.047 [5.3] 97
0.406x0.559-2.4	0.016 x 0.022 [0.406 x 0.559]	0.14 [3.52]	0.37 [9.3]	0.019 [2.1] 19	0.026 [2.9] 48	0.032 [3.6] 95	0.047 [5.3] 130
0.406x0.559-3.2	0.016 x 0.022 [0.406 x 0.559]	0.17 [4.32]	0.46 [12]	0.019 [2.1] 24	0.026 [2.9] 60	0.032 [3.6] 120	0.047 [5.3] 170
0.406x0.559-4.75	0.016 x 0.022 [0.406 x 0.559]	0.23 [5.87]	0.66 [17]	0.019 [2.1] 34	0.026 [2.9] 85	0.032 [3.6] 170	0.047 [5.3] 240
0.406x0.559-6	0.016 x 0.022 [0.406 x 0.559]	0.28 [7.12]	0.81 [21]	0.019 [2.1] 42	0.026 [2.9] 110	0.032 [3.6] 210	0.047 [5.3] 300
0.406x0.559-8	0.016 x 0.022 [0.406 x 0.559]	0.36 [9.12]	1.1 [27]	0.019 [2.1] 55	0.026 [2.9] 140	0.032 [3.6] 280	0.047 [5.3] 390

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.406x0.559-9.5	0.016 x 0.022 [0.406 x 0.559]	0.42 [10.6]	1.2 [32]	0.019 [2.1] 65	0.026 [2.9] 160	0.032 [3.6] 320	0.047 [5.3] 450
0.406x0.559-12.7	0.016 x 0.022 [0.406 x 0.559]	0.54 [13.8]	1.6 [42]	0.019 [2.1] 85	0.026 [2.9] 210	0.032 [3.6] 430	0.047 [5.3] 600
0.406x0.559-14.2	0.016 x 0.022 [0.406 x 0.559]	0.6 [15.3]	1.8 [46]	0.019 [2.1] 95	0.026 [2.9] 240	0.032 [3.6] 480	0.047 [5.3] 670
0.406x0.559-16	0.016 x 0.022 [0.406 x 0.559]	0.67 [17.1]	2 [52]	0.019 [2.1] 110	0.026 [2.9] 270	0.032 [3.6] 530	0.047 [5.3] 750
0.406x0.559-19	0.016 x 0.022 [0.406 x 0.559]	0.79 [20.1]	2.4 [61]	0.019 [2.1] 130	0.026 [2.9] 310	0.032 [3.6] 630	0.047 [5.3] 880
0.406x0.559-22.2	0.016 x 0.022 [0.406 x 0.559]	0.92 [23.3]	2.8 [72]	0.019 [2.1] 150	0.026 [2.9] 370	0.032 [3.6] 730	0.047 [5.3] 1000
0.406x0.559-25.4	0.016 x 0.022 [0.406 x 0.559]	1 [26.5]	3.2 [82]	0.019 [2.1] 170	0.026 [2.9] 420	0.032 [3.6] 840	0.047 [5.3] 1200
0.4x0.8-0.5	0.016 x 0.031 [0.4 x 0.8]	0.083 [2.1]	0.16 [4.1]	0.038 [4.3] 5.8	0.052 [5.9] 15	0.065 [7.3] 29	0.094 [11] 41
0.4x0.8-0.9	0.016 x 0.031 [0.4 x 0.8]	0.098 [2.5]	0.21 [5.3]	0.038 [4.3] 7.6	0.052 [5.9] 19	0.065 [7.3] 38	0.094 [11] 54
0.4x0.8-1.15	0.016 x 0.031 [0.4 x 0.8]	0.11 [2.75]	0.24 [6.1]	0.038 [4.3] 8.8	0.052 [5.9] 22	0.065 [7.3] 44	0.094 [11] 61
0.4x0.8-1.6	0.016 x 0.031 [0.4 x 0.8]	0.13 [3.2]	0.3 [7.5]	0.038 [4.3] 11	0.052 [5.9] 27	0.065 [7.3] 54	0.094 [11] 76
0.4x0.8-2.4	0.016 x 0.031 [0.4 x 0.8]	0.16 [4]	0.4 [10]	0.038 [4.3] 14	0.052 [5.9] 36	0.065 [7.3] 72	0.094 [11] 100
0.4x0.8-3.2	0.016 x 0.031 [0.4 x 0.8]	0.19 [4.8]	0.5 [13]	0.038 [4.3] 18	0.052 [5.9] 45	0.065 [7.3] 90	0.094 [11] 130

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.4x0.8-4.75	0.016 x 0.031 [0.4 x 0.8]	0.25 [6.35]	0.69 [17]	0.038 [4.3] 25	0.052 [5.9] 62	0.065 [7.3] 120	0.094 [11] 170
0.4x0.8-6	0.016 x 0.031 [0.4 x 0.8]	0.3 [7.6]	0.84 [21]	0.038 [4.3] 31	0.052 [5.9] 76	0.065 [7.3] 150	0.094 [11] 210
0.4x0.8-8	0.016 x 0.031 [0.4 x 0.8]	0.38 [9.6]	1.1 [28]	0.038 [4.3] 40	0.052 [5.9] 99	0.065 [7.3] 200	0.094 [11] 280
0.4x0.8-9.5	0.016 x 0.031 [0.4 x 0.8]	0.44 [11.1]	1.3 [32]	0.038 [4.3] 46	0.052 [5.9] 120	0.065 [7.3] 230	0.094 [11] 320
0.4x0.8-12.7	0.016 x 0.031 [0.4 x 0.8]	0.56 [14.3]	1.7 [42]	0.038 [4.3] 61	0.052 [5.9] 150	0.065 [7.3] 300	0.094 [11] 430
0.4x0.8-14.2	0.016 x 0.031 [0.4 x 0.8]	0.62 [15.8]	1.9 [47]	0.038 [4.3] 68	0.052 [5.9] 170	0.065 [7.3] 340	0.094 [11] 470
0.4x0.8-16	0.016 x 0.031 [0.4 x 0.8]	0.69 [17.6]	2.1 [53]	0.038 [4.3] 76	0.052 [5.9] 190	0.065 [7.3] 380	0.094 [11] 530
0.4x0.8-19	0.016 x 0.031 [0.4 x 0.8]	0.81 [20.6]	2.4 [62]	0.038 [4.3] 89	0.052 [5.9] 220	0.065 [7.3] 450	0.094 [11] 620
0.4x0.8-22.2	0.016 x 0.031 [0.4 x 0.8]	0.94 [23.8]	2.8 [72]	0.038 [4.3] 100	0.052 [5.9] 260	0.065 [7.3] 520	0.094 [11] 720
0.4x0.8-25.4	0.016 x 0.031 [0.4 x 0.8]	1.1 [27]	3.2 [82]	0.038 [4.3] 120	0.052 [5.9] 290	0.065 [7.3] 590	0.094 [11] 830
0.4x1-0.5	0.016 x 0.039 [0.4 x 1]	0.098 [2.5]	0.19 [4.7]	0.059 [6.7] 5.4	0.081 [9.2] 14	0.1 [11] 27	0.15 [17] 38
0.4x1-0.9	0.016 x 0.039 [0.4 x 1]	0.11 [2.9]	0.24 [6]	0.059 [6.7] 6.8	0.081 [9.2] 17	0.1 [11] 34	0.15 [17] 48
0.4x1-1.15	0.016 x 0.039 [0.4 x 1]	0.12 [3.15]	0.27 [6.8]	0.059 [6.7] 7.7	0.081 [9.2] 19	0.1 [11] 39	0.15 [17] 54

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.4x1-1.6	0.016 x 0.039 [0.4 x 1]	0.14 [3.6]	0.32 [8.2]	0.059 [6.7] 9.4	0.081 [9.2] 23	0.1 [11] 47	0.15 [17] 66
0.4x1-2.4	0.016 x 0.039 [0.4 x 1]	0.17 [4.4]	0.42 [11]	0.059 [6.7] 12	0.081 [9.2] 31	0.1 [11] 61	0.15 [17] 86
0.4x1-3.2	0.016 x 0.039 [0.4 x 1]	0.2 [5.2]	0.52 [13]	0.059 [6.7] 15	0.081 [9.2] 38	0.1 [11] 76	0.15 [17] 110
0.4x1-4.75	0.016 x 0.039 [0.4 x 1]	0.27 [6.75]	0.71 [18]	0.059 [6.7] 21	0.081 [9.2] 52	0.1 [11] 100	0.15 [17] 140
0.4x1-6	0.016 x 0.039 [0.4 x 1]	0.31 [8]	0.87 [22]	0.059 [6.7] 25	0.081 [9.2] 63	0.1 [11] 130	0.15 [17] 180
0.4x1-8	0.016 x 0.039 [0.4 x 1]	0.39 [10]	1.1 [28]	0.059 [6.7] 32	0.081 [9.2] 81	0.1 [11] 160	0.15 [17] 230
0.4x1-9.5	0.016 x 0.039 [0.4 x 1]	0.45 [11.5]	1.3 [33]	0.059 [6.7] 38	0.081 [9.2] 94	0.1 [11] 190	0.15 [17] 260
0.4x1-12.7	0.016 x 0.039 [0.4 x 1]	0.58 [14.7]	1.7 [43]	0.059 [6.7] 49	0.081 [9.2] 120	0.1 [11] 250	0.15 [17] 350
0.4x1-14.2	0.016 x 0.039 [0.4 x 1]	0.64 [16.2]	1.9 [48]	0.059 [6.7] 55	0.081 [9.2] 140	0.1 [11] 270	0.15 [17] 380
0.4x1-16	0.016 x 0.039 [0.4 x 1]	0.71 [18]	2.1 [53]	0.059 [6.7] 61	0.081 [9.2] 150	0.1 [11] 310	0.15 [17] 430
0.4x1-19	0.016 x 0.039 [0.4 x 1]	0.83 [21]	2.5 [63]	0.059 [6.7] 72	0.081 [9.2] 180	0.1 [11] 360	0.15 [17] 500
0.4x1-22.2	0.016 x 0.039 [0.4 x 1]	0.95 [24.2]	2.9 [73]	0.059 [6.7] 84	0.081 [9.2] 210	0.1 [11] 420	0.15 [17] 580
0.4x1-25.4	0.016 x 0.039 [0.4 x 1]	1.1 [27.4]	3.3 [83]	0.059 [6.7] 95	0.081 [9.2] 240	0.1 [11] 480	0.15 [17] 670

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.5x0.25-0.5	0.02 x 0.0098 [0.5 x 0.25]	0.039 [1]	0.094 [2.4]	0.0046 [0.52] 11	0.0064 [0.72] 27	0.0079 [0.9] 54	0.012 [1.3] 76
0.5x0.25-0.9	0.02 x 0.0098 [0.5 x 0.25]	0.055 [1.4]	0.14 [3.6]	0.0046 [0.52] 17	0.0064 [0.72] 41	0.0079 [0.9] 83	0.012 [1.3] 120
0.5x0.25-1.15	0.02 x 0.0098 [0.5 x 0.25]	0.065 [1.65]	0.17 [4.4]	0.0046 [0.52] 20	0.0064 [0.72] 50	0.0079 [0.9] 100	0.012 [1.3] 140
0.5x0.25-1.6	0.02 x 0.0098 [0.5 x 0.25]	0.083 [2.1]	0.23 [5.8]	0.0046 [0.52] 27	0.0064 [0.72] 67	0.0079 [0.9] 130	0.012 [1.3] 190
0.5x0.25-2.4	0.02 x 0.0098 [0.5 x 0.25]	0.11 [2.9]	0.33 [8.3]	0.0046 [0.52] 38	0.0064 [0.72] 95	0.0079 [0.9] 190	0.012 [1.3] 270
0.5x0.25-3.2	0.02 x 0.0098 [0.5 x 0.25]	0.15 [3.7]	0.43 [11]	0.0046 [0.52] 50	0.0064 [0.72] 120	0.0079 [0.9] 250	0.012 [1.3] 350
0.5x0.25-4.75	0.02 x 0.0098 [0.5 x 0.25]	0.21 [5.25]	0.62 [16]	0.0046 [0.52] 72	0.0064 [0.72] 180	0.0079 [0.9] 360	0.012 [1.3] 500
0.5x0.25-6	0.02 x 0.0098 [0.5 x 0.25]	0.26 [6.5]	0.77 [20]	0.0046 [0.52] 90	0.0064 [0.72] 220	0.0079 [0.9] 450	0.012 [1.3] 630
0.5x0.25-8	0.02 x 0.0098 [0.5 x 0.25]	0.33 [8.5]	1 [26]	0.0046 [0.52] 120	0.0064 [0.72] 300	0.0079 [0.9] 590	0.012 [1.3] 830
0.5x0.25-9.5	0.02 x 0.0098 [0.5 x 0.25]	0.39 [10]	1.2 [31]	0.0046 [0.52] 140	0.0064 [0.72] 350	0.0079 [0.9] 700	0.012 [1.3] 980
0.5x0.25-12.7	0.02 x 0.0098 [0.5 x 0.25]	0.52 [13.2]	1.6 [41]	0.0046 [0.52] 190	0.0064 [0.72] 470	0.0079 [0.9] 930	0.012 [1.3] 1300
0.5x0.25-14.2	0.02 x 0.0098 [0.5 x 0.25]	0.58 [14.7]	1.8 [45]	0.0046 [0.52] 210	0.0064 [0.72] 520	0.0079 [0.9] 1000	0.012 [1.3] 1500
0.5x0.25-16	0.02 x 0.0098 [0.5 x 0.25]	0.65 [16.5]	2 [51]	0.0046 [0.52] 230	0.0064 [0.72] 580	0.0079 [0.9] 1200	0.012 [1.3] 1600

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.5x0.25-19	0.02 x 0.0098 [0.5 x 0.25]	0.77 [19.5]	2.4 [60]	0.0046 [0.52] 280	0.0064 [0.72] 690	0.0079 [0.9] 1400	0.012 [1.3] 1900
0.5x0.25-22.2	0.02 x 0.0098 [0.5 x 0.25]	0.89 [22.7]	2.8 [70]	0.0046 [0.52] 320	0.0064 [0.72] 810	0.0079 [0.9] 1600	0.012 [1.3] 2300
0.5x0.25-25.4	0.02 x 0.0098 [0.5 x 0.25]	1 [25.9]	3.2 [81]	0.0046 [0.52] 370	0.0064 [0.72] 920	0.0079 [0.9] 1800	0.012 [1.3] 2600
0.55x1.4-0.5	0.022 x 0.055 [0.55 x 1.4]	0.13 [3.3]	0.24 [6]	0.16 [18] 4.9	0.22 [25] 12	0.27 [31] 24	0.4 [45] 34
0.55x1.4-0.9	0.022 x 0.055 [0.55 x 1.4]	0.15 [3.7]	0.28 [7.2]	0.16 [18] 5.9	0.22 [25] 15	0.27 [31] 30	0.4 [45] 41
0.55x1.4-1.15	0.022 x 0.055 [0.55 x 1.4]	0.16 [3.95]	0.31 [8]	0.16 [18] 6.6	0.22 [25] 16	0.27 [31] 33	0.4 [45] 46
0.55x1.4-1.6	0.022 x 0.055 [0.55 x 1.4]	0.17 [4.4]	0.37 [9.4]	0.16 [18] 7.7	0.22 [25] 19	0.27 [31] 39	0.4 [45] 54
0.55x1.4-2.4	0.022 x 0.055 [0.55 x 1.4]	0.2 [5.2]	0.47 [12]	0.16 [18] 9.8	0.22 [25] 24	0.27 [31] 49	0.4 [45] 68
0.55x1.4-3.2	0.022 x 0.055 [0.55 x 1.4]	0.24 [6]	0.57 [14]	0.16 [18] 12	0.22 [25] 30	0.27 [31] 59	0.4 [45] 83
0.55x1.4-4.75	0.022 x 0.055 [0.55 x 1.4]	0.3 [7.55]	0.76 [19]	0.16 [18] 16	0.22 [25] 40	0.27 [31] 79	0.4 [45] 110
0.55x1.4-6	0.022 x 0.055 [0.55 x 1.4]	0.35 [8.8]	0.91 [23]	0.16 [18] 19	0.22 [25] 48	0.27 [31] 95	0.4 [45] 130
0.55x1.4-8	0.022 x 0.055 [0.55 x 1.4]	0.43 [10.8]	1.2 [30]	0.16 [18] 24	0.22 [25] 60	0.27 [31] 120	0.4 [45] 170
0.55x1.4-9.5	0.022 x 0.055 [0.55 x 1.4]	0.48 [12.3]	1.3 [34]	0.16 [18] 28	0.22 [25] 70	0.27 [31] 140	0.4 [45] 200

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.55x1.4-12.7	0.022 x 0.055 [0.55 x 1.4]	0.61 [15.5]	1.7 [44]	0.16 [18] 36	0.22 [25] 91	0.27 [31] 180	0.4 [45] 250
0.55x1.4-14.2	0.022 x 0.055 [0.55 x 1.4]	0.67 [17]	1.9 [49]	0.16 [18] 40	0.22 [25] 100	0.27 [31] 200	0.4 [45] 280
0.55x1.4-16	0.022 x 0.055 [0.55 x 1.4]	0.74 [18.8]	2.2 [55]	0.16 [18] 45	0.22 [25] 110	0.27 [31] 220	0.4 [45] 310
0.55x1.4-19	0.022 x 0.055 [0.55 x 1.4]	0.86 [21.8]	2.5 [64]	0.16 [18] 52	0.22 [25] 130	0.27 [31] 260	0.4 [45] 370
0.55x1.4-22.2	0.022 x 0.055 [0.55 x 1.4]	0.98 [25]	2.9 [74]	0.16 [18] 61	0.22 [25] 150	0.27 [31] 300	0.4 [45] 420
0.55x1.4-25.4	0.022 x 0.055 [0.55 x 1.4]	1.1 [28.2]	3.3 [84]	0.16 [18] 69	0.22 [25] 170	0.27 [31] 340	0.4 [45] 480
0.5x0.8-0.5	0.02 x 0.031 [0.5 x 0.8]	0.083 [2.1]	0.16 [4.1]	0.047 [5.3] 5.8	0.065 [7.4] 15	0.081 [9.2] 29	0.12 [13] 41
0.5x0.8-0.9	0.02 x 0.031 [0.5 x 0.8]	0.098 [2.5]	0.21 [5.3]	0.047 [5.3] 7.6	0.065 [7.4] 19	0.081 [9.2] 38	0.12 [13] 54
0.5x0.8-1.15	0.02 x 0.031 [0.5 x 0.8]	0.11 [2.75]	0.24 [6.1]	0.047 [5.3] 8.8	0.065 [7.4] 22	0.081 [9.2] 44	0.12 [13] 61
0.5x0.8-1.6	0.02 x 0.031 [0.5 x 0.8]	0.13 [3.2]	0.3 [7.5]	0.047 [5.3] 11	0.065 [7.4] 27	0.081 [9.2] 54	0.12 [13] 76
0.5x0.8-2.4	0.02 x 0.031 [0.5 x 0.8]	0.16 [4]	0.4 [10]	0.047 [5.3] 14	0.065 [7.4] 36	0.081 [9.2] 72	0.12 [13] 100
0.5x0.8-3.2	0.02 x 0.031 [0.5 x 0.8]	0.19 [4.8]	0.5 [13]	0.047 [5.3] 18	0.065 [7.4] 45	0.081 [9.2] 90	0.12 [13] 130
0.5x0.8-4.75	0.02 x 0.031 [0.5 x 0.8]	0.25 [6.35]	0.69 [17]	0.047 [5.3] 25	0.065 [7.4] 62	0.081 [9.2] 120	0.12 [13] 170

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.5x0.8-6	0.02 x 0.031 [0.5 x 0.8]	0.3 [7.6]	0.84 [21]	0.047 [5.3] 31	0.065 [7.4] 76	0.081 [9.2] 150	0.12 [13] 210
0.5x0.8-8	0.02 x 0.031 [0.5 x 0.8]	0.38 [9.6]	1.1 [28]	0.047 [5.3] 40	0.065 [7.4] 99	0.081 [9.2] 200	0.12 [13] 280
0.5x0.8-9.5	0.02 x 0.031 [0.5 x 0.8]	0.44 [11.1]	1.3 [32]	0.047 [5.3] 46	0.065 [7.4] 120	0.081 [9.2] 230	0.12 [13] 320
0.5x0.8-12.7	0.02 x 0.031 [0.5 x 0.8]	0.56 [14.3]	1.7 [42]	0.047 [5.3] 61	0.065 [7.4] 150	0.081 [9.2] 300	0.12 [13] 430
0.5x0.8-14.2	0.02 x 0.031 [0.5 x 0.8]	0.62 [15.8]	1.9 [47]	0.047 [5.3] 68	0.065 [7.4] 170	0.081 [9.2] 340	0.12 [13] 470
0.5x0.8-16	0.02 x 0.031 [0.5 x 0.8]	0.69 [17.6]	2.1 [53]	0.047 [5.3] 76	0.065 [7.4] 190	0.081 [9.2] 380	0.12 [13] 530
0.5x0.8-19	0.02 x 0.031 [0.5 x 0.8]	0.81 [20.6]	2.4 [62]	0.047 [5.3] 89	0.065 [7.4] 220	0.081 [9.2] 450	0.12 [13] 620
0.5x0.8-22.2	0.02 x 0.031 [0.5 x 0.8]	0.94 [23.8]	2.8 [72]	0.047 [5.3] 100	0.065 [7.4] 260	0.081 [9.2] 520	0.12 [13] 720
0.5x0.8-25.4	0.02 x 0.031 [0.5 x 0.8]	1.1 [27]	3.2 [82]	0.047 [5.3] 120	0.065 [7.4] 290	0.081 [9.2] 590	0.12 [13] 830
0.6x2.3-0.5	0.024 x 0.091 [0.6 x 2.3]	0.2 [5.1]	0.35 [8.8]	0.47 [53] 4.4	0.65 [73] 11	0.81 [91] 22	1.2 [130] 31
0.6x2.3-0.9	0.024 x 0.091 [0.6 x 2.3]	0.22 [5.5]	0.4 [10]	0.47 [53] 5	0.65 [73] 12	0.81 [91] 25	1.2 [130] 35
0.6x2.3-1.15	0.024 x 0.091 [0.6 x 2.3]	0.23 [5.75]	0.43 [11]	0.47 [53] 5.4	0.65 [73] 14	0.81 [91] 27	1.2 [130] 38
0.6x2.3-1.6	0.024 x 0.091 [0.6 x 2.3]	0.24 [6.2]	0.48 [12]	0.47 [53] 6.1	0.65 [73] 15	0.81 [91] 30	1.2 [130] 43

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.6x2.3-2.4	0.024 x 0.091 [0.6 x 2.3]	0.28 [7]	0.58 [15]	0.47 [53] 7.4	0.65 [73] 18	0.81 [91] 37	1.2 [130] 52
0.6x2.3-3.2	0.024 x 0.091 [0.6 x 2.3]	0.31 [7.8]	0.68 [17]	0.47 [53] 8.6	0.65 [73] 22	0.81 [91] 43	1.2 [130] 60
0.6x2.3-4.75	0.024 x 0.091 [0.6 x 2.3]	0.37 [9.35]	0.87 [22]	0.47 [53] 11	0.65 [73] 28	0.81 [91] 55	1.2 [130] 77
0.6x2.3-6	0.024 x 0.091 [0.6 x 2.3]	0.42 [10.6]	1 [26]	0.47 [53] 13	0.65 [73] 32	0.81 [91] 65	1.2 [130] 91
0.6x2.3-8	0.024 x 0.091 [0.6 x 2.3]	0.5 [12.6]	1.3 [32]	0.47 [53] 16	0.65 [73] 40	0.81 [91] 81	1.2 [130] 110
0.6x2.3-9.5	0.024 x 0.091 [0.6 x 2.3]	0.56 [14.1]	1.5 [37]	0.47 [53] 18	0.65 [73] 46	0.81 [91] 92	1.2 [130] 130
0.6x2.3-12.7	0.024 x 0.091 [0.6 x 2.3]	0.68 [17.3]	1.9 [47]	0.47 [53] 23	0.65 [73] 59	0.81 [91] 120	1.2 [130] 160
0.6x2.3-14.2	0.024 x 0.091 [0.6 x 2.3]	0.74 [18.8]	2 [52]	0.47 [53] 26	0.65 [73] 65	0.81 [91] 130	1.2 [130] 180
0.6x2.3-16	0.024 x 0.091 [0.6 x 2.3]	0.81 [20.6]	2.3 [58]	0.47 [53] 29	0.65 [73] 72	0.81 [91] 140	1.2 [130] 200
0.6x2.3-19	0.024 x 0.091 [0.6 x 2.3]	0.93 [23.6]	2.6 [67]	0.47 [53] 33	0.65 [73] 83	0.81 [91] 170	1.2 [130] 230
0.6x2.3-22.2	0.024 x 0.091 [0.6 x 2.3]	1.1 [26.8]	3 [77]	0.47 [53] 38	0.65 [73] 96	0.81 [91] 190	1.2 [130] 270
0.6x2.3-25.4	0.024 x 0.091 [0.6 x 2.3]	1.2 [30]	3.4 [87]	0.47 [53] 43	0.65 [73] 110	0.81 [91] 220	1.2 [130] 300
0.8x1.5-0.5	0.031 x 0.059 [0.8 x 1.5]	0.14 [3.5]	0.25 [6.3]	0.27 [30] 4.8	0.37 [41] 12	0.46 [52] 24	0.66 [75] 34

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.8x1.5-0.9	0.031 x 0.059 [0.8 x 1.5]	0.15 [3.9]	0.3 [7.5]	0.27 [30] 5.8	0.37 [41] 14	0.46 [52] 29	0.66 [75] 40
0.8x1.5-1.15	0.031 x 0.059 [0.8 x 1.5]	0.16 [4.15]	0.33 [8.3]	0.27 [30] 6.4	0.37 [41] 16	0.46 [52] 32	0.66 [75] 44
0.8x1.5-1.6	0.031 x 0.059 [0.8 x 1.5]	0.18 [4.6]	0.38 [9.7]	0.27 [30] 7.4	0.37 [41] 19	0.46 [52] 37	0.66 [75] 52
0.8x1.5-2.4	0.031 x 0.059 [0.8 x 1.5]	0.21 [5.4]	0.48 [12]	0.27 [30] 9.4	0.37 [41] 23	0.46 [52] 47	0.66 [75] 66
0.8x1.5-3.2	0.031 x 0.059 [0.8 x 1.5]	0.24 [6.2]	0.58 [15]	0.27 [30] 11	0.37 [41] 28	0.46 [52] 56	0.66 [75] 79
0.8x1.5-4.75	0.031 x 0.059 [0.8 x 1.5]	0.31 [7.75]	0.77 [20]	0.27 [30] 15	0.37 [41] 38	0.46 [52] 75	0.66 [75] 100
0.8x1.5-6	0.031 x 0.059 [0.8 x 1.5]	0.35 [9]	0.93 [24]	0.27 [30] 18	0.37 [41] 45	0.46 [52] 90	0.66 [75] 130
0.8x1.5-8	0.031 x 0.059 [0.8 x 1.5]	0.43 [11]	1.2 [30]	0.27 [30] 23	0.37 [41] 57	0.46 [52] 110	0.66 [75] 160
0.8x1.5-9.5	0.031 x 0.059 [0.8 x 1.5]	0.49 [12.5]	1.4 [35]	0.27 [30] 26	0.37 [41] 66	0.46 [52] 130	0.66 [75] 180
0.8x1.5-12.7	0.031 x 0.059 [0.8 x 1.5]	0.62 [15.7]	1.8 [45]	0.27 [30] 34	0.37 [41] 85	0.46 [52] 170	0.66 [75] 240
0.8x1.5-14.2	0.031 x 0.059 [0.8 x 1.5]	0.68 [17.2]	1.9 [49]	0.27 [30] 38	0.37 [41] 94	0.46 [52] 190	0.66 [75] 260
0.8x1.5-16	0.031 x 0.059 [0.8 x 1.5]	0.75 [19]	2.2 [55]	0.27 [30] 42	0.37 [41] 100	0.46 [52] 210	0.66 [75] 290
0.8x1.5-19	0.031 x 0.059 [0.8 x 1.5]	0.87 [22]	2.5 [64]	0.27 [30] 49	0.37 [41] 120	0.46 [52] 250	0.66 [75] 340

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
0.8x1.5-22.2	0.031 x 0.059 [0.8 x 1.5]	0.99 [25.2]	2.9 [74]	0.27 [30] 57	0.37 [41] 140	0.46 [52] 280	0.66 [75] 400
0.8x1.5-25.4	0.031 x 0.059 [0.8 x 1.5]	1.1 [28.4]	3.3 [84]	0.27 [30] 65	0.37 [41] 160	0.46 [52] 320	0.66 [75] 450
1x2.6-0.5	0.039 x 0.1 [1 x 2.6]	0.22 [5.7]	0.38 [9.7]	1 [110] 4.3	1.4 [160] 11	1.7 [190] 22	2.5 [280] 30
1x2.6-0.9	0.039 x 0.1 [1 x 2.6]	0.24 [6.1]	0.43 [11]	1 [110] 4.8	1.4 [160] 12	1.7 [190] 24	2.5 [280] 34
1x2.6-1.15	0.039 x 0.1 [1 x 2.6]	0.25 [6.35]	0.46 [12]	1 [110] 5.2	1.4 [160] 13	1.7 [190] 26	2.5 [280] 36
1x2.6-1.6	0.039 x 0.1 [1 x 2.6]	0.27 [6.8]	0.52 [13]	1 [110] 5.8	1.4 [160] 15	1.7 [190] 29	2.5 [280] 41
1x2.6-2.4	0.039 x 0.1 [1 x 2.6]	0.3 [7.6]	0.62 [16]	1 [110] 6.9	1.4 [160] 17	1.7 [190] 35	2.5 [280] 48
1x2.6-3.2	0.039 x 0.1 [1 x 2.6]	0.33 [8.4]	0.72 [18]	1 [110] 8	1.4 [160] 20	1.7 [190] 40	2.5 [280] 56
1x2.6-4.75	0.039 x 0.1 [1 x 2.6]	0.39 [9.95]	0.91 [23]	1 [110] 10	1.4 [160] 25	1.7 [190] 51	2.5 [280] 71
1x2.6-6	0.039 x 0.1 [1 x 2.6]	0.44 [11.2]	1.1 [27]	1 [110] 12	1.4 [160] 30	1.7 [190] 60	2.5 [280] 83
1x2.6-8	0.039 x 0.1 [1 x 2.6]	0.52 [13.2]	1.3 [33]	1 [110] 15	1.4 [160] 37	1.7 [190] 73	2.5 [280] 100
1x2.6-9.5	0.039 x 0.1 [1 x 2.6]	0.58 [14.7]	1.5 [38]	1 [110] 17	1.4 [160] 42	1.7 [190] 84	2.5 [280] 120
1x2.6-12.7	0.039 x 0.1 [1 x 2.6]	0.7 [17.9]	1.9 [48]	1 [110] 21	1.4 [160] 53	1.7 [190] 110	2.5 [280] 150

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
1x2.6-14.2	0.039 x 0.1 [1 x 2.6]	0.76 [19.4]	2.1 [53]	1 [110] 23	1.4 [160] 58	1.7 [190] 120	2.5 [280] 160
1x2.6-16	0.039 x 0.1 [1 x 2.6]	0.83 [21.2]	2.3 [58]	1 [110] 26	1.4 [160] 64	1.7 [190] 130	2.5 [280] 180
1x2.6-19	0.039 x 0.1 [1 x 2.6]	0.95 [24.2]	2.7 [68]	1 [110] 30	1.4 [160] 75	1.7 [190] 150	2.5 [280] 210
1x2.6-22.2	0.039 x 0.1 [1 x 2.6]	1.1 [27.4]	3.1 [78]	1 [110] 34	1.4 [160] 86	1.7 [190] 170	2.5 [280] 240
1x2.6-25.4	0.039 x 0.1 [1 x 2.6]	1.2 [30.6]	3.5 [88]	1 [110] 39	1.4 [160] 97	1.7 [190] 190	2.5 [280] 270
1.5x4-0.5	0.059 x 0.16 [1.5 x 4]	0.33 [8.5]	0.56 [14]	3.5 [400] 4	4.9 [550] 10	6.1 [690] 20	8.9 [1000] 28
1.5x4-0.9	0.059 x 0.16 [1.5 x 4]	0.35 [8.9]	0.61 [15]	3.5 [400] 4.4	4.9 [550] 11	6.1 [690] 22	8.9 [1000] 31
1.5x4-1.15	0.059 x 0.16 [1.5 x 4]	0.36 [9.15]	0.64 [16]	3.5 [400] 4.6	4.9 [550] 12	6.1 [690] 23	8.9 [1000] 32
1.5x4-1.6	0.059 x 0.16 [1.5 x 4]	0.38 [9.6]	0.69 [18]	3.5 [400] 5	4.9 [550] 13	6.1 [690] 25	8.9 [1000] 35
1.5x4-2.4	0.059 x 0.16 [1.5 x 4]	0.41 [10.4]	0.79 [20]	3.5 [400] 5.8	4.9 [550] 14	6.1 [690] 29	8.9 [1000] 40
1.5x4-3.2	0.059 x 0.16 [1.5 x 4]	0.44 [11.2]	0.89 [23]	3.5 [400] 6.5	4.9 [550] 16	6.1 [690] 32	8.9 [1000] 45
1.5x4-4.75	0.059 x 0.16 [1.5 x 4]	0.5 [12.8]	1.1 [28]	3.5 [400] 7.9	4.9 [550] 20	6.1 [690] 39	8.9 [1000] 55
1.5x4-6	0.059 x 0.16 [1.5 x 4]	0.55 [14]	1.2 [31]	3.5 [400] 9	4.9 [550] 22	6.1 [690] 45	8.9 [1000] 63

TORSION SPRING ACTUATORS — FLAT WIRE, EDGE WOUND — Torque and angular sweep per wrap

Part reference	Section, in [mm]	Coil OD, in [mm]	Wire per wrap, in [mm]	Level A: torque, in·lbf [N·mm] / sweep, deg per wrap	Level B: torque, in·lbf [N·mm] / sweep, deg per wrap	Level C: torque, in·lbf [N·mm] / sweep, deg per wrap	Level D: torque, in·lbf [N·mm] / sweep, deg per wrap
1.5x4-8	0.059 x 0.16 [1.5 x 4]	0.63 [16]	1.5 [38]	3.5 [400] 11	4.9 [550] 27	6.1 [690] 54	8.9 [1000] 76
1.5x4-9.5	0.059 x 0.16 [1.5 x 4]	0.69 [17.5]	1.7 [42]	3.5 [400] 12	4.9 [550] 30	6.1 [690] 61	8.9 [1000] 85
1.5x4-12.7	0.059 x 0.16 [1.5 x 4]	0.81 [20.7]	2.1 [52]	3.5 [400] 15	4.9 [550] 38	6.1 [690] 75	8.9 [1000] 110
1.5x4-14.2	0.059 x 0.16 [1.5 x 4]	0.87 [22.2]	2.3 [57]	3.5 [400] 16	4.9 [550] 41	6.1 [690] 82	8.9 [1000] 110
1.5x4-16	0.059 x 0.16 [1.5 x 4]	0.94 [24]	2.5 [63]	3.5 [400] 18	4.9 [550] 45	6.1 [690] 90	8.9 [1000] 130
1.5x4-19	0.059 x 0.16 [1.5 x 4]	1.1 [27]	2.8 [72]	3.5 [400] 21	4.9 [550] 52	6.1 [690] 100	8.9 [1000] 140
1.5x4-22.2	0.059 x 0.16 [1.5 x 4]	1.2 [30.2]	3.2 [82]	3.5 [400] 24	4.9 [550] 59	6.1 [690] 120	8.9 [1000] 170
1.5x4-25.4	0.059 x 0.16 [1.5 x 4]	1.3 [33.4]	3.6 [92]	3.5 [400] 26	4.9 [550] 66	6.1 [690] 130	8.9 [1000] 190

NOTES

NOTES

CHAPTER 8

Flat Spring Actuators

A wave in a slot - long stroke from a flat package

A flat spring actuator is a wire bent into a wave. It does what a helical spring actuator does, but it lies in a plane instead of taking up a cylinder, so it will go into a slot, a keyway or a gap between two plates where a coil would not fit.

Heat it and the wave flattens out. As it flattens, the spring actuator gets longer, and that lengthening is the stroke. Let it cool and it returns to the wave.

Counted by the wave

A flat spring actuator is made of a repeating shape, so the useful unit is one wave. The tables give the stroke from a single sinusoid. Work out how much travel you need, divide by the figure in the table, and that is how many waves to order. A spring actuator with six waves gives six times the stroke of a spring actuator with one.

This is the same idea as counting wraps on a torsion spring actuator, and for the same reason: it keeps the choice in your hands rather than forcing you to pick from a fixed list of lengths.

Three things to choose

WIRE SIZE sets the force. As with everything else in this handbook, a bigger section pulls harder.

AMPLITUDE is how tall the wave is. It is usually decided for you by the slot the spring actuator has to sit in. It also affects force, because the height of the wave is the lever the wire works through: a taller wave gives a gentler push.

PITCH is how long one wave is. A longer pitch gives more stroke from each wave, but fewer waves fit in a given length.

Amplitude and pitch together set the shape of the wave, and the ratio between them is worth watching. While the amplitude stays below the pitch you have a sinusoid. Take it above and the wave becomes a serpentine: straight legs joined by radiused returns, where the bend radius is set by the pitch rather than by the height. We supply both, and both are in the tables. The stroke figures are worked out from the sinusoid, which understates a serpentine rather than overstating it.

The wave does not have to flatten completely

It is tempting to assume the spring actuator goes flat and the stroke is whatever that gives. It usually does not, and it usually should not.

Flattening a wave all the way uses up the whole of the material's bending allowance in one movement. Do that and you are at the short-life end of the range. Most designs take part of the wave instead, and the tables show how much stroke each design level gives from one wave.

Flat wire, laid two ways

As with wound spring actuators and torsion spring actuators, a flat wire can be waved in either of two orientations, and they behave very differently. Laid flat the wave bends about the thin dimension and gives a long stroke at low force. Stood on edge it bends about the wide dimension and gives a short stroke at high force. Both are listed.

Getting it back

Like every shape in this handbook, a nitinol actuator moves one way when it is heated. Getting it back to where it started is the designer's problem, and there are three ways to solve it.

AN ANTAGONISTIC PAIR uses a second actuator working against the first. Heat one and it moves the mechanism and resets the other; heat the other and it goes back. You get powered motion in both directions with full output each way, at the cost of two actuators and a control scheme that never heats both at once.

A BIAS is a passive element, usually a conventional spring or a weight, that the actuator works against as it moves and that pushes it back as it cools. It is the simplest arrangement and the most common. The price is that the bias resists the actuator through the whole stroke, so part of the force in the table is spent returning the mechanism rather than doing the job. Size it to return the actuator and no more.

SYSTEM FORCES are the return you already have. If the mechanism pushes back on its own, if gravity closes the door, if the thing being clamped is springy, if line pressure acts on the valve, that force resets the actuator for nothing. It is the best answer when it is available, and worth looking for before adding parts.

Whichever you choose, the return has to be strong enough to reset the actuator while it is cool and weak enough not to stall it while it is hot. That window is what sizes a bias, and it is the most common thing to get wrong on a first build.

There is a fourth possibility. Any nitinol actuator can be given a two way set, so that it takes one shape hot and another cold and needs no return at all. Two way parts are made to order and are outside the scope of this handbook, so nothing here is rated for it, but it exists. Ask.

Overdriving an actuator

The figures in this handbook are conservative. Every force in every table is rated at a stress we are confident the part will deliver, cycle after cycle, at the fatigue life of its design level. A part will usually do more than the table says. We would rather you found that out in testing than the other way round.

The second reason a part will beat its table is that you can overdrive it, and this one is a feature you can design with. There are two ways to do it, and they add.

The first is to heat it further. Nitinol makes its force by changing phase, and the temperature at which it does that is the transition temperature we set for you. The force does not stop climbing when the part gets there. Keep heating it past the transition and the force keeps rising with temperature, well beyond the rated figure. The table gives you the force at a working temperature comfortably above transition. Drive the part hotter and there is more.

The second is to heat it faster. Heat the part slowly and it makes the force in the table. Heat it quickly, with a sharp pulse of current rather than a gentle ramp, and it makes more, and the harder the pulse, the bigger the difference. A part that is driven both fast and hot gets the gain from each, one on top of the other. The tables assume neither. They are the floor.

Emergency mode

That gives a nitinol actuator something most actuators do not have: a reserve. A motor or a solenoid has a rated output and a thermal limit close behind it. A nitinol actuator can be driven, briefly, to a force well above its rating simply by putting more heat into it, faster. Think of it as an emergency mode. A latch that normally needs a modest pull can, on the day something jams, be hit with a short hard pulse and told to pull much harder. A release that must not fail gets a margin that costs nothing in size or weight.

Use it as a reserve, not as the rating, and know where the limits are. There is a temperature, called Md, above which the metal can no longer be pushed into martensite by stress; up to Md the material is still behaving as nitinol should. Overdriving up to Md costs some fatigue life, but it also does the part a favor: the extra heat drives out residual martensite that builds up over many cycles, a kind of rehabilitation in place, so a part that is occasionally run hard can come back sharper than one that never is. Above Md the accounting changes. Degradation is faster, and each hot cycle takes a larger bite out of the life. Above 350 °C (660 °F) the part is past saving: treat an actuator that has been driven that hot as spent and replace it. Used within those limits, for the rare event, emergency mode is one of the best arguments for the material.

Actuator safety

Most actuators fail badly when they are overdriven, and engineers know exactly how. Put too much current into a motor or a solenoid and it explodes. Overpressure a hydraulic cylinder and it bursts, or springs a pinhole leak, and a jet of oil at that pressure will cut through a glove and a hand, take a limb, and put oil into the ground and the water where it can be years being cleaned up. Every one of them has the same problem: the energy is stored in the actuator, and when something goes wrong it has nowhere to go but out. A nitinol actuator, very simply, does not carry these risks. It is a piece of metal with a current in it, and there is nothing in it to burst, nothing to leak, and nothing to poison.

A nitinol actuator fails the other way. Put too much power into it and it simply gets hotter. Past the working range the force keeps rising; past that, the part reaches the temperatures at which it was shape set, and at that point the metal lets go of its memory. The actuator loses its force, goes slack, and parts, which opens the circuit that was heating it. It shuts itself off. There is nothing stored in it to release: no pressure, no winding, no field. The failure mode is a dead part and an open circuit, not an event.

That is worth stating plainly for anyone writing a safety case. The worst thing an overdriven nitinol actuator does is stop.

What we supply

Wire	Every round size from 0.15 to 5 mm, and every flat section, laid either way.
Pitch	10 to 100 mm.
Amplitude	10 to 300 mm.
Transition temperatures	20 C, 35 C, 45 C and 80 C.
Sold as	Made to order, to the length and wave count you specify.

One geometry rule applies: the wire cannot be more than a fifth of the amplitude. Below that the wave is too tight to form around a wire of that size.

The table that follows is a representative grid rather than a complete list, because these spring actuators are made to order and any combination inside the ranges above can be supplied. Find the nearest entry to size your design, then talk to us about the exact figures.

FLAT SPRING ACTUATORS — ROUND WIRE — Representative grid. Flat spring actuators are made to order, so any pitch from 10 to 100 mm and any amplitude from 10 to 300 mm can be supplied; the method on the previous page gives any combination not listed here.

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.15-10-10 0.0059 x 0.0059	0.39 [10]	0.39 [10]	0.00074 [0.0033] 0.0065 [0.17]	0.001 [0.0046] 0.017 [0.43]	0.0013 [0.0057] 0.036 [0.92]	0.0019 [0.0083] 0.054 [1.4]
0.25-10-10 0.0098 x 0.0098	0.39 [10]	0.39 [10]	0.0034 [0.015] 0.0039 [0.099]	0.0048 [0.021] 0.0098 [0.25]	0.0059 [0.026] 0.02 [0.52]	0.0086 [0.038] 0.03 [0.76]
0.4-10-10 0.016 x 0.016	0.39 [10]	0.39 [10]	0.014 [0.063] 0.0024 [0.061]	0.019 [0.087] 0.0063 [0.16]	0.024 [0.11] 0.013 [0.32]	0.035 [0.16] 0.018 [0.45]
0.5-10-10 0.02 x 0.02	0.39 [10]	0.39 [10]	0.028 [0.12] 0.0019 [0.049]	0.038 [0.17] 0.0047 [0.12]	0.047 [0.21] 0.0098 [0.25]	0.069 [0.31] 0.014 [0.36]
0.75-10-10 0.03 x 0.03	0.39 [10]	0.39 [10]	0.093 [0.41] 0.0013 [0.033]	0.13 [0.57] 0.0031 [0.08]	0.16 [0.71] 0.0067 [0.17]	0.23 [1] 0.0091 [0.23]
1-10-10 0.039 x 0.039	0.39 [10]	0.39 [10]	0.22 [0.98] 0.00096 [0.024]	0.3 [1.4] 0.0024 [0.06]	0.38 [1.7] 0.0047 [0.12]	0.55 [2.5] 0.0067 [0.17]
1.25-10-10 0.049 x 0.049	0.39 [10]	0.39 [10]	0.43 [1.9] 0.00077 [0.02]	0.59 [2.6] 0.002 [0.05]	0.74 [3.3] 0.0039 [0.1]	1.1 [4.8] 0.0055 [0.14]
1.5-10-10 0.059 x 0.059	0.39 [10]	0.39 [10]	0.74 [3.3] 0.00064 [0.016]	1 [4.6] 0.0016 [0.04]	1.3 [5.7] 0.0031 [0.08]	1.9 [8.3] 0.0047 [0.12]
2-10-10 0.079 x 0.079	0.39 [10]	0.39 [10]	1.8 [7.9] 0.00048 [0.012]	2.4 [11] 0.0012 [0.03]	3 [14] 0.0024 [0.06]	4.4 [20] 0.0035 [0.09]
0.15-10-25 0.0059 x 0.0059	0.39 [10]	0.98 [25]	0.0003 [0.0013] 0.0027 [0.068]	0.00041 [0.0018] 0.0067 [0.17]	0.00051 [0.0023] 0.014 [0.35]	0.00074 [0.0033] 0.02 [0.5]
0.25-10-25 0.0098 x 0.0098	0.39 [10]	0.98 [25]	0.0014 [0.0061] 0.0016 [0.04]	0.0019 [0.0085] 0.0039 [0.1]	0.0024 [0.011] 0.0083 [0.21]	0.0034 [0.015] 0.011 [0.29]
0.4-10-25 0.016 x 0.016	0.39 [10]	0.98 [25]	0.0056 [0.025] 0.00099 [0.025]	0.0078 [0.035] 0.0024 [0.06]	0.0097 [0.043] 0.0051 [0.13]	0.014 [0.063] 0.0071 [0.18]
0.5-10-25 0.02 x 0.02	0.39 [10]	0.98 [25]	0.011 [0.049] 0.00079 [0.02]	0.015 [0.068] 0.002 [0.05]	0.019 [0.084] 0.0039 [0.1]	0.028 [0.12] 0.0055 [0.14]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.75-10-25 0.03 x 0.03	0.39 [10]	0.98 [25]	0.037 [0.17] 0.00053 [0.013]	0.051 [0.23] 0.0012 [0.03]	0.064 [0.28] 0.0028 [0.07]	0.093 [0.41] 0.0039 [0.1]
1-10-25 0.039 x 0.039	0.39 [10]	0.98 [25]	0.088 [0.39] 0.0004 [0.01]	0.12 [0.54] 0.0012 [0.03]	0.15 [0.68] 0.002 [0.05]	0.22 [0.98] 0.0028 [0.07]
1.25-10-25 0.049 x 0.049	0.39 [10]	0.98 [25]	0.17 [0.77] 0.00032 [0.008]	0.24 [1.1] 0.00079 [0.02]	0.3 [1.3] 0.0016 [0.04]	0.43 [1.9] 0.0024 [0.06]
1.5-10-25 0.059 x 0.059	0.39 [10]	0.98 [25]	0.3 [1.3] 0.00026 [0.0067]	0.41 [1.8] 0.00079 [0.02]	0.51 [2.3] 0.0012 [0.03]	0.74 [3.3] 0.002 [0.05]
2-10-25 0.079 x 0.079	0.39 [10]	0.98 [25]	0.71 [3.1] 0.0002 [0.005]	0.97 [4.3] 0.00039 [0.01]	1.2 [5.4] 0.0012 [0.03]	1.8 [7.9] 0.0016 [0.04]
3-10-25 0.12 x 0.12	0.39 [10]	0.98 [25]	2.4 [11] 0.00013 [0.0034]	3.3 [15] 0.00039 [0.01]	4.1 [18] 0.00079 [0.02]	6 [27] 0.00079 [0.02]
5-10-25 0.2 x 0.2	0.39 [10]	0.98 [25]	11 [49] 0.000079 [0.002]	15 [68] 0.00039 [0.01]	19 [84] 0.00039 [0.01]	28 [120] 0.00039 [0.01]
0.15-10-50 0.0059 x 0.0059	0.39 [10]	2 [50]	0.00015 [0.00066] 0.0013 [0.034]	0.0002 [0.00091] 0.0035 [0.09]	0.00026 [0.0011] 0.0067 [0.17]	0.00037 [0.0017] 0.0094 [0.24]
0.25-10-50 0.0098 x 0.0098	0.39 [10]	2 [50]	0.00069 [0.0031] 0.0008 [0.02]	0.00095 [0.0042] 0.002 [0.05]	0.0012 [0.0053] 0.0039 [0.1]	0.0017 [0.0077] 0.0055 [0.14]
0.4-10-50 0.016 x 0.016	0.39 [10]	2 [50]	0.0028 [0.013] 0.0005 [0.013]	0.0039 [0.017] 0.0012 [0.03]	0.0049 [0.022] 0.0024 [0.06]	0.0071 [0.031] 0.0035 [0.09]
0.5-10-50 0.02 x 0.02	0.39 [10]	2 [50]	0.0055 [0.025] 0.0004 [0.01]	0.0076 [0.034] 0.0012 [0.03]	0.0095 [0.042] 0.002 [0.05]	0.014 [0.061] 0.0028 [0.07]
0.75-10-50 0.03 x 0.03	0.39 [10]	2 [50]	0.019 [0.083] 0.00027 [0.0067]	0.026 [0.11] 0.00079 [0.02]	0.032 [0.14] 0.0012 [0.03]	0.047 [0.21] 0.002 [0.05]
1-10-50 0.039 x 0.039	0.39 [10]	2 [50]	0.044 [0.2] 0.0002 [0.0051]	0.061 [0.27] 0.00039 [0.01]	0.076 [0.34] 0.0012 [0.03]	0.11 [0.49] 0.0016 [0.04]
1.25-10-50 0.049 x 0.049	0.39 [10]	2 [50]	0.086 [0.38] 0.00016 [0.004]	0.12 [0.53] 0.00039 [0.01]	0.15 [0.66] 0.00079 [0.02]	0.22 [0.96] 0.0012 [0.03]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
1.5-10-50 0.059 x 0.059	0.39 [10]	2 [50]	0.15 [0.66] 0.00013 [0.0034]	0.21 [0.91] 0.00039 [0.01]	0.26 [1.1] 0.00079 [0.02]	0.37 [1.7] 0.00079 [0.02]
2-10-50 0.079 x 0.079	0.39 [10]	2 [50]	0.35 [1.6] 0.0001 [0.0025]	0.49 [2.2] 0.00039 [0.01]	0.61 [2.7] 0.00039 [0.01]	0.88 [3.9] 0.00079 [0.02]
3-10-50 0.12 x 0.12	0.39 [10]	2 [50]	1.2 [5.3] 0.000066 [0.0017]	1.6 [7.3] 0 [0]	2 [9.1] 0.00039 [0.01]	3 [13] 0.00039 [0.01]
5-10-50 0.2 x 0.2	0.39 [10]	2 [50]	5.5 [25] 0.00004 [0.001]	7.6 [34] 0 [0]	9.5 [42] 0.00039 [0.01]	14 [61] 0.00039 [0.01]
0.15-10-100 0.0059 x 0.0059	0.39 [10]	3.9 [100]	0.000074 [0.00033] 0.00067 [0.017]	0.0001 [0.00046] 0.0016 [0.04]	0.00013 [0.00057] 0.0035 [0.09]	0.00019 [0.00083] 0.0047 [0.12]
0.25-10-100 0.0098 x 0.0098	0.39 [10]	3.9 [100]	0.00034 [0.0015] 0.0004 [0.01]	0.00048 [0.0021] 0.0012 [0.03]	0.00059 [0.0026] 0.002 [0.05]	0.00086 [0.0038] 0.0028 [0.07]
0.4-10-100 0.016 x 0.016	0.39 [10]	3.9 [100]	0.0014 [0.0063] 0.00025 [0.0063]	0.0019 [0.0087] 0.00079 [0.02]	0.0024 [0.011] 0.0012 [0.03]	0.0035 [0.016] 0.0016 [0.04]
0.5-10-100 0.02 x 0.02	0.39 [10]	3.9 [100]	0.0028 [0.012] 0.0002 [0.0051]	0.0038 [0.017] 0.00039 [0.01]	0.0047 [0.021] 0.0012 [0.03]	0.0069 [0.031] 0.0016 [0.04]
0.75-10-100 0.03 x 0.03	0.39 [10]	3.9 [100]	0.0093 [0.041] 0.00013 [0.0034]	0.013 [0.057] 0.00039 [0.01]	0.016 [0.071] 0.00079 [0.02]	0.023 [0.1] 0.00079 [0.02]
1-10-100 0.039 x 0.039	0.39 [10]	3.9 [100]	0.022 [0.098] 0.0001 [0.0025]	0.03 [0.14] 0.00039 [0.01]	0.038 [0.17] 0.00039 [0.01]	0.055 [0.25] 0.00079 [0.02]
1.25-10-100 0.049 x 0.049	0.39 [10]	3.9 [100]	0.043 [0.19] 0.00008 [0.002]	0.059 [0.26] 0.00039 [0.01]	0.074 [0.33] 0.00039 [0.01]	0.11 [0.48] 0.00039 [0.01]
1.5-10-100 0.059 x 0.059	0.39 [10]	3.9 [100]	0.074 [0.33] 0.000066 [0.0017]	0.1 [0.46] 0 [0]	0.13 [0.57] 0.00039 [0.01]	0.19 [0.83] 0.00039 [0.01]
2-10-100 0.079 x 0.079	0.39 [10]	3.9 [100]	0.18 [0.79] 0.00005 [0.0013]	0.24 [1.1] 0 [0]	0.3 [1.4] 0.00039 [0.01]	0.44 [2] 0.00039 [0.01]
3-10-100 0.12 x 0.12	0.39 [10]	3.9 [100]	0.6 [2.7] 0.000033 [0.00084]	0.82 [3.7] 0 [0]	1 [4.6] 0 [0]	1.5 [6.6] 0.00039 [0.01]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
5-10-100 0.2 x 0.2	0.39 [10]	3.9 [100]	2.8 [12] 0.00002 [0.00051]	3.8 [17] 0 [0]	4.7 [21] 0 [0]	6.9 [31] 0 [0]
0.15-10-200 0.0059 x 0.0059	0.39 [10]	7.9 [200]	0.000038 [0.00017] 0.00033 [0.0085]	0.000052 [0.00023] 0.00079 [0.02]	0.000063 [0.00028] 0.0016 [0.04]	0.000092 [0.00041] 0.0024 [0.06]
0.25-10-200 0.0098 x 0.0098	0.39 [10]	7.9 [200]	0.00017 [0.00077] 0.0002 [0.0051]	0.00024 [0.0011] 0.00039 [0.01]	0.0003 [0.0013] 0.0012 [0.03]	0.00043 [0.0019] 0.0016 [0.04]
0.4-10-200 0.016 x 0.016	0.39 [10]	7.9 [200]	0.00071 [0.0031] 0.00012 [0.0032]	0.00098 [0.0043] 0.00039 [0.01]	0.0012 [0.0054] 0.00079 [0.02]	0.0018 [0.0078] 0.00079 [0.02]
0.5-10-200 0.02 x 0.02	0.39 [10]	7.9 [200]	0.0014 [0.0061] 0.0001 [0.0025]	0.0019 [0.0085] 0.00039 [0.01]	0.0024 [0.011] 0.00039 [0.01]	0.0034 [0.015] 0.00079 [0.02]
0.75-10-200 0.03 x 0.03	0.39 [10]	7.9 [200]	0.0047 [0.021] 0.000066 [0.0017]	0.0064 [0.029] 0 [0]	0.008 [0.036] 0.00039 [0.01]	0.012 [0.052] 0.00039 [0.01]
1-10-200 0.039 x 0.039	0.39 [10]	7.9 [200]	0.011 [0.049] 0.00005 [0.0013]	0.015 [0.068] 0 [0]	0.019 [0.084] 0.00039 [0.01]	0.028 [0.12] 0.00039 [0.01]
1.25-10-200 0.049 x 0.049	0.39 [10]	7.9 [200]	0.022 [0.096] 0.00004 [0.001]	0.03 [0.13] 0 [0]	0.037 [0.16] 0.00039 [0.01]	0.054 [0.24] 0.00039 [0.01]
1.5-10-200 0.059 x 0.059	0.39 [10]	7.9 [200]	0.037 [0.17] 0.000033 [0.00084]	0.051 [0.23] 0 [0]	0.064 [0.28] 0 [0]	0.093 [0.41] 0.00039 [0.01]
2-10-200 0.079 x 0.079	0.39 [10]	7.9 [200]	0.088 [0.39] 0.000025 [0.00063]	0.12 [0.54] 0 [0]	0.15 [0.68] 0 [0]	0.22 [0.98] 0 [0]
3-10-200 0.12 x 0.12	0.39 [10]	7.9 [200]	0.3 [1.3] 0.000017 [0.00042]	0.41 [1.8] 0 [0]	0.51 [2.3] 0 [0]	0.74 [3.3] 0 [0]
5-10-200 0.2 x 0.2	0.39 [10]	7.9 [200]	1.4 [6.1] 0.00001 [0.00025]	1.9 [8.5] 0 [0]	2.4 [11] 0 [0]	3.4 [15] 0 [0]
0.15-25-10 0.0059 x 0.0059	0.98 [25]	0.39 [10]	0.00074 [0.0033] 0.099 [2.5]	0.001 [0.0046] 0.32 [8.2]	0.0013 [0.0057] 0.94 [24]	0.0019 [0.0083] 0.94 [24]
0.25-25-10 0.0098 x 0.0098	0.98 [25]	0.39 [10]	0.0034 [0.015] 0.056 [1.4]	0.0048 [0.021] 0.16 [4.1]	0.0059 [0.026] 0.44 [11]	0.0086 [0.038] 0.82 [21]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.4-25-10 0.016 x 0.016	0.98 [25]	0.39 [10]	0.014 [0.063] 0.034 [0.86]	0.019 [0.087] 0.092 [2.3]	0.024 [0.11] 0.22 [5.5]	0.035 [0.16] 0.35 [8.9]
0.5-25-10 0.02 x 0.02	0.98 [25]	0.39 [10]	0.028 [0.12] 0.027 [0.68]	0.038 [0.17] 0.072 [1.8]	0.047 [0.21] 0.16 [4.1]	0.069 [0.31] 0.25 [6.4]
0.75-25-10 0.03 x 0.03	0.98 [25]	0.39 [10]	0.093 [0.41] 0.018 [0.45]	0.13 [0.57] 0.046 [1.2]	0.16 [0.71] 0.099 [2.5]	0.23 [1] 0.15 [3.8]
1-25-10 0.039 x 0.039	0.98 [25]	0.39 [10]	0.22 [0.98] 0.013 [0.33]	0.3 [1.4] 0.034 [0.86]	0.38 [1.7] 0.072 [1.8]	0.55 [2.5] 0.11 [2.7]
1.25-25-10 0.049 x 0.049	0.98 [25]	0.39 [10]	0.43 [1.9] 0.01 [0.27]	0.59 [2.6] 0.027 [0.68]	0.74 [3.3] 0.056 [1.4]	1.1 [4.8] 0.081 [2.1]
1.5-25-10 0.059 x 0.059	0.98 [25]	0.39 [10]	0.74 [3.3] 0.0087 [0.22]	1 [4.6] 0.022 [0.56]	1.3 [5.7] 0.046 [1.2]	1.9 [8.3] 0.067 [1.7]
2-25-10 0.079 x 0.079	0.98 [25]	0.39 [10]	1.8 [7.9] 0.0065 [0.17]	2.4 [11] 0.017 [0.42]	3 [14] 0.034 [0.86]	4.4 [20] 0.048 [1.2]
0.15-25-25 0.0059 x 0.0059	0.98 [25]	0.98 [25]	0.0003 [0.0013] 0.042 [1.1]	0.00041 [0.0018] 0.12 [3]	0.00051 [0.0023] 0.29 [7.4]	0.00074 [0.0033] 0.51 [13]
0.25-25-25 0.0098 x 0.0098	0.98 [25]	0.98 [25]	0.0014 [0.0061] 0.025 [0.63]	0.0019 [0.0085] 0.066 [1.7]	0.0024 [0.011] 0.15 [3.7]	0.0034 [0.015] 0.23 [5.8]
0.4-25-25 0.016 x 0.016	0.98 [25]	0.98 [25]	0.0056 [0.025] 0.015 [0.39]	0.0078 [0.035] 0.04 [1]	0.0097 [0.043] 0.085 [2.1]	0.014 [0.063] 0.13 [3.2]
0.5-25-25 0.02 x 0.02	0.98 [25]	0.98 [25]	0.011 [0.049] 0.012 [0.31]	0.015 [0.068] 0.031 [0.8]	0.019 [0.084] 0.066 [1.7]	0.028 [0.12] 0.096 [2.4]
0.75-25-25 0.03 x 0.03	0.98 [25]	0.98 [25]	0.037 [0.17] 0.0081 [0.21]	0.051 [0.23] 0.02 [0.52]	0.064 [0.28] 0.043 [1.1]	0.093 [0.41] 0.061 [1.6]
1-25-25 0.039 x 0.039	0.98 [25]	0.98 [25]	0.088 [0.39] 0.006 [0.15]	0.12 [0.54] 0.015 [0.39]	0.15 [0.68] 0.031 [0.8]	0.22 [0.98] 0.045 [1.1]
1.25-25-25 0.049 x 0.049	0.98 [25]	0.98 [25]	0.17 [0.77] 0.0048 [0.12]	0.24 [1.1] 0.012 [0.31]	0.3 [1.3] 0.025 [0.63]	0.43 [1.9] 0.035 [0.9]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
1.5-25-25 0.059 x 0.059	0.98 [25]	0.98 [25]	0.3 [1.3] 0.004 [0.1]	0.41 [1.8] 0.01 [0.26]	0.51 [2.3] 0.02 [0.52]	0.74 [3.3] 0.029 [0.74]
2-25-25 0.079 x 0.079	0.98 [25]	0.98 [25]	0.71 [3.1] 0.003 [0.076]	0.97 [4.3] 0.0075 [0.19]	1.2 [5.4] 0.015 [0.39]	1.8 [7.9] 0.022 [0.55]
3-25-25 0.12 x 0.12	0.98 [25]	0.98 [25]	2.4 [11] 0.002 [0.051]	3.3 [15] 0.0051 [0.13]	4.1 [18] 0.01 [0.26]	6 [27] 0.014 [0.36]
5-25-25 0.2 x 0.2	0.98 [25]	0.98 [25]	11 [49] 0.0012 [0.03]	15 [68] 0.0031 [0.08]	19 [84] 0.0059 [0.15]	28 [120] 0.0087 [0.22]
0.15-25-50 0.0059 x 0.0059	0.98 [25]	2 [50]	0.00015 [0.00066] 0.021 [0.54]	0.0002 [0.00091] 0.056 [1.4]	0.00026 [0.0011] 0.12 [3.1]	0.00037 [0.0017] 0.19 [4.7]
0.25-25-50 0.0098 x 0.0098	0.98 [25]	2 [50]	0.00069 [0.0031] 0.013 [0.32]	0.00095 [0.0042] 0.032 [0.82]	0.0012 [0.0053] 0.068 [1.7]	0.0017 [0.0077] 0.1 [2.5]
0.4-25-50 0.016 x 0.016	0.98 [25]	2 [50]	0.0028 [0.013] 0.0078 [0.2]	0.0039 [0.017] 0.02 [0.5]	0.0049 [0.022] 0.041 [1]	0.0071 [0.031] 0.059 [1.5]
0.5-25-50 0.02 x 0.02	0.98 [25]	2 [50]	0.0055 [0.025] 0.0062 [0.16]	0.0076 [0.034] 0.016 [0.4]	0.0095 [0.042] 0.032 [0.82]	0.014 [0.061] 0.046 [1.2]
0.75-25-50 0.03 x 0.03	0.98 [25]	2 [50]	0.019 [0.083] 0.0041 [0.1]	0.026 [0.11] 0.01 [0.26]	0.032 [0.14] 0.021 [0.54]	0.047 [0.21] 0.03 [0.76]
1-25-50 0.039 x 0.039	0.98 [25]	2 [50]	0.044 [0.2] 0.0031 [0.079]	0.061 [0.27] 0.0079 [0.2]	0.076 [0.34] 0.016 [0.4]	0.11 [0.49] 0.022 [0.57]
1.25-25-50 0.049 x 0.049	0.98 [25]	2 [50]	0.086 [0.38] 0.0025 [0.063]	0.12 [0.53] 0.0063 [0.16]	0.15 [0.66] 0.013 [0.32]	0.22 [0.96] 0.018 [0.45]
1.5-25-50 0.059 x 0.059	0.98 [25]	2 [50]	0.15 [0.66] 0.0021 [0.052]	0.21 [0.91] 0.0051 [0.13]	0.26 [1.1] 0.01 [0.26]	0.37 [1.7] 0.015 [0.37]
2-25-50 0.079 x 0.079	0.98 [25]	2 [50]	0.35 [1.6] 0.0015 [0.039]	0.49 [2.2] 0.0039 [0.1]	0.61 [2.7] 0.0079 [0.2]	0.88 [3.9] 0.011 [0.28]
3-25-50 0.12 x 0.12	0.98 [25]	2 [50]	1.2 [5.3] 0.001 [0.026]	1.6 [7.3] 0.0028 [0.07]	2 [9.1] 0.0051 [0.13]	3 [13] 0.0071 [0.18]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
5-25-50 0.2 x 0.2	0.98 [25]	2 [50]	5.5 [25] 0.00062 [0.016]	7.6 [34] 0.0016 [0.04]	9.5 [42] 0.0031 [0.08]	14 [61] 0.0043 [0.11]
0.15-25-100 0.0059 x 0.0059	0.98 [25]	3.9 [100]	0.000074 [0.00033] 0.011 [0.27]	0.0001 [0.00046] 0.027 [0.68]	0.00013 [0.00057] 0.056 [1.4]	0.00019 [0.00083] 0.081 [2.1]
0.25-25-100 0.0098 x 0.0098	0.98 [25]	3.9 [100]	0.00034 [0.0015] 0.0063 [0.16]	0.00048 [0.0021] 0.016 [0.4]	0.00059 [0.0026] 0.033 [0.83]	0.00086 [0.0038] 0.046 [1.2]
0.4-25-100 0.016 x 0.016	0.98 [25]	3.9 [100]	0.0014 [0.0063] 0.0039 [0.099]	0.0019 [0.0087] 0.0098 [0.25]	0.0024 [0.011] 0.02 [0.51]	0.0035 [0.016] 0.028 [0.72]
0.5-25-100 0.02 x 0.02	0.98 [25]	3.9 [100]	0.0028 [0.012] 0.0031 [0.079]	0.0038 [0.017] 0.0079 [0.2]	0.0047 [0.021] 0.016 [0.4]	0.0069 [0.031] 0.022 [0.57]
0.75-25-100 0.03 x 0.03	0.98 [25]	3.9 [100]	0.0093 [0.041] 0.0021 [0.053]	0.013 [0.057] 0.0051 [0.13]	0.016 [0.071] 0.011 [0.27]	0.023 [0.1] 0.015 [0.38]
1-25-100 0.039 x 0.039	0.98 [25]	3.9 [100]	0.022 [0.098] 0.0016 [0.04]	0.03 [0.14] 0.0039 [0.1]	0.038 [0.17] 0.0079 [0.2]	0.055 [0.25] 0.011 [0.28]
1.25-25-100 0.049 x 0.049	0.98 [25]	3.9 [100]	0.043 [0.19] 0.0012 [0.032]	0.059 [0.26] 0.0031 [0.08]	0.074 [0.33] 0.0063 [0.16]	0.11 [0.48] 0.0087 [0.22]
1.5-25-100 0.059 x 0.059	0.98 [25]	3.9 [100]	0.074 [0.33] 0.001 [0.026]	0.1 [0.46] 0.0028 [0.07]	0.13 [0.57] 0.0051 [0.13]	0.19 [0.83] 0.0075 [0.19]
2-25-100 0.079 x 0.079	0.98 [25]	3.9 [100]	0.18 [0.79] 0.00078 [0.02]	0.24 [1.1] 0.002 [0.05]	0.3 [1.4] 0.0039 [0.1]	0.44 [2] 0.0055 [0.14]
3-25-100 0.12 x 0.12	0.98 [25]	3.9 [100]	0.6 [2.7] 0.00052 [0.013]	0.82 [3.7] 0.0012 [0.03]	1 [4.6] 0.0028 [0.07]	1.5 [6.6] 0.0035 [0.09]
5-25-100 0.2 x 0.2	0.98 [25]	3.9 [100]	2.8 [12] 0.00031 [0.0079]	3.8 [17] 0.00079 [0.02]	4.7 [21] 0.0016 [0.04]	6.9 [31] 0.0024 [0.06]
0.15-25-200 0.0059 x 0.0059	0.98 [25]	7.9 [200]	0.000038 [0.00017] 0.0052 [0.13]	0.000052 [0.00023] 0.013 [0.34]	0.000063 [0.00028] 0.027 [0.69]	0.000092 [0.00041] 0.039 [0.98]
0.25-25-200 0.0098 x 0.0098	0.98 [25]	7.9 [200]	0.00017 [0.00077] 0.0031 [0.079]	0.00024 [0.0011] 0.0079 [0.2]	0.0003 [0.0013] 0.016 [0.41]	0.00043 [0.0019] 0.022 [0.57]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.4-25-200 0.016 x 0.016	0.98 [25]	7.9 [200]	0.00071 [0.0031] 0.002 [0.05]	0.00098 [0.0043] 0.0047 [0.12]	0.0012 [0.0054] 0.0098 [0.25]	0.0018 [0.0078] 0.014 [0.35]
0.5-25-200 0.02 x 0.02	0.98 [25]	7.9 [200]	0.0014 [0.0061] 0.0016 [0.04]	0.0019 [0.0085] 0.0039 [0.1]	0.0024 [0.011] 0.0079 [0.2]	0.0034 [0.015] 0.011 [0.28]
0.75-25-200 0.03 x 0.03	0.98 [25]	7.9 [200]	0.0047 [0.021] 0.001 [0.026]	0.0064 [0.029] 0.0028 [0.07]	0.008 [0.036] 0.0051 [0.13]	0.012 [0.052] 0.0075 [0.19]
1-25-200 0.039 x 0.039	0.98 [25]	7.9 [200]	0.011 [0.049] 0.00078 [0.02]	0.015 [0.068] 0.002 [0.05]	0.019 [0.084] 0.0039 [0.1]	0.028 [0.12] 0.0055 [0.14]
1.25-25-200 0.049 x 0.049	0.98 [25]	7.9 [200]	0.022 [0.096] 0.00062 [0.016]	0.03 [0.13] 0.0016 [0.04]	0.037 [0.16] 0.0031 [0.08]	0.054 [0.24] 0.0043 [0.11]
1.5-25-200 0.059 x 0.059	0.98 [25]	7.9 [200]	0.037 [0.17] 0.00052 [0.013]	0.051 [0.23] 0.0012 [0.03]	0.064 [0.28] 0.0028 [0.07]	0.093 [0.41] 0.0035 [0.09]
2-25-200 0.079 x 0.079	0.98 [25]	7.9 [200]	0.088 [0.39] 0.00039 [0.0099]	0.12 [0.54] 0.00079 [0.02]	0.15 [0.68] 0.002 [0.05]	0.22 [0.98] 0.0028 [0.07]
3-25-200 0.12 x 0.12	0.98 [25]	7.9 [200]	0.3 [1.3] 0.00026 [0.0066]	0.41 [1.8] 0.00079 [0.02]	0.51 [2.3] 0.0012 [0.03]	0.74 [3.3] 0.002 [0.05]
5-25-200 0.2 x 0.2	0.98 [25]	7.9 [200]	1.4 [6.1] 0.00016 [0.004]	1.9 [8.5] 0.00039 [0.01]	2.4 [11] 0.00079 [0.02]	3.4 [15] 0.0012 [0.03]
0.15-50-10 0.0059 x 0.0059	2 [50]	0.39 [10]	0.00074 [0.0033] 0.59 [15]	0.001 [0.0046] 0.63 [16]	0.0013 [0.0057] 0.63 [16]	0.0019 [0.0083] 0.63 [16]
0.25-50-10 0.0098 x 0.0098	2 [50]	0.39 [10]	0.0034 [0.015] 0.35 [8.8]	0.0048 [0.021] 0.63 [16]	0.0059 [0.026] 0.63 [16]	0.0086 [0.038] 0.63 [16]
0.4-50-10 0.016 x 0.016	2 [50]	0.39 [10]	0.014 [0.063] 0.2 [5.2]	0.019 [0.087] 0.56 [14]	0.024 [0.11] 0.63 [16]	0.035 [0.16] 0.63 [16]
0.5-50-10 0.02 x 0.02	2 [50]	0.39 [10]	0.028 [0.12] 0.16 [4.1]	0.038 [0.17] 0.45 [11]	0.047 [0.21] 0.63 [16]	0.069 [0.31] 0.63 [16]
0.75-50-10 0.03 x 0.03	2 [50]	0.39 [10]	0.093 [0.41] 0.1 [2.6]	0.13 [0.57] 0.28 [7.2]	0.16 [0.71] 0.59 [15]	0.23 [1] 0.63 [16]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
1-50-10 0.039 x 0.039	2 [50]	0.39 [10]	0.22 [0.98] 0.076 [1.9]	0.3 [1.4] 0.2 [5.2]	0.38 [1.7] 0.45 [11]	0.55 [2.5] 0.61 [15]
1.25-50-10 0.049 x 0.049	2 [50]	0.39 [10]	0.43 [1.9] 0.06 [1.5]	0.59 [2.6] 0.16 [4.1]	0.74 [3.3] 0.35 [8.8]	1.1 [4.8] 0.51 [13]
1.5-50-10 0.059 x 0.059	2 [50]	0.39 [10]	0.74 [3.3] 0.05 [1.3]	1 [4.6] 0.13 [3.3]	1.3 [5.7] 0.28 [7.2]	1.9 [8.3] 0.41 [11]
2-50-10 0.079 x 0.079	2 [50]	0.39 [10]	1.8 [7.9] 0.037 [0.94]	2.4 [11] 0.096 [2.5]	3 [14] 0.2 [5.2]	4.4 [20] 0.3 [7.6]
0.15-50-25 0.0059 x 0.0059	2 [50]	0.98 [25]	0.0003 [0.0013] 0.38 [9.6]	0.00041 [0.0018] 1.8 [46]	0.00051 [0.0023] 2.6 [65]	0.00074 [0.0033] 2.6 [65]
0.25-50-25 0.0098 x 0.0098	2 [50]	0.98 [25]	0.0014 [0.0061] 0.2 [5.1]	0.0019 [0.0085] 0.67 [17]	0.0024 [0.011] 2.6 [65]	0.0034 [0.015] 2.6 [65]
0.4-50-25 0.016 x 0.016	2 [50]	0.98 [25]	0.0056 [0.025] 0.12 [3]	0.0078 [0.035] 0.35 [8.8]	0.0097 [0.043] 0.98 [25]	0.014 [0.063] 2.1 [53]
0.5-50-25 0.02 x 0.02	2 [50]	0.98 [25]	0.011 [0.049] 0.094 [2.4]	0.015 [0.068] 0.26 [6.7]	0.019 [0.084] 0.67 [17]	0.028 [0.12] 1.2 [31]
0.75-50-25 0.03 x 0.03	2 [50]	0.98 [25]	0.037 [0.17] 0.061 [1.6]	0.051 [0.23] 0.16 [4.2]	0.064 [0.28] 0.38 [9.6]	0.093 [0.41] 0.6 [15]
1-50-25 0.039 x 0.039	2 [50]	0.98 [25]	0.088 [0.39] 0.045 [1.1]	0.12 [0.54] 0.12 [3]	0.15 [0.68] 0.26 [6.7]	0.22 [0.98] 0.4 [10]
1.25-50-25 0.049 x 0.049	2 [50]	0.98 [25]	0.17 [0.77] 0.036 [0.91]	0.24 [1.1] 0.094 [2.4]	0.3 [1.3] 0.2 [5.1]	0.43 [1.9] 0.3 [7.7]
1.5-50-25 0.059 x 0.059	2 [50]	0.98 [25]	0.3 [1.3] 0.03 [0.76]	0.41 [1.8] 0.077 [2]	0.51 [2.3] 0.16 [4.2]	0.74 [3.3] 0.24 [6.2]
2-50-25 0.079 x 0.079	2 [50]	0.98 [25]	0.71 [3.1] 0.022 [0.56]	0.97 [4.3] 0.057 [1.4]	1.2 [5.4] 0.12 [3]	1.8 [7.9] 0.17 [4.4]
3-50-25 0.12 x 0.12	2 [50]	0.98 [25]	2.4 [11] 0.015 [0.37]	3.3 [15] 0.037 [0.95]	4.1 [18] 0.077 [2]	6 [27] 0.11 [2.8]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
5-50-25 0.2 x 0.2	2 [50]	0.98 [25]	11 [49] 0.0088 [0.22]	15 [68] 0.022 [0.56]	19 [84] 0.045 [1.1]	28 [120] 0.064 [1.6]
0.15-50-50 0.0059 x 0.0059	2 [50]	2 [50]	0.00015 [0.00066] 0.18 [4.6]	0.0002 [0.00091] 0.58 [15]	0.00026 [0.0011] 2.6 [65]	0.00037 [0.0017] 6.3 [160]
0.25-50-50 0.0098 x 0.0098	2 [50]	2 [50]	0.00069 [0.0031] 0.1 [2.6]	0.00095 [0.0042] 0.29 [7.5]	0.0012 [0.0053] 0.78 [20]	0.0017 [0.0077] 1.5 [39]
0.4-50-50 0.016 x 0.016	2 [50]	2 [50]	0.0028 [0.013] 0.063 [1.6]	0.0039 [0.017] 0.17 [4.3]	0.0049 [0.022] 0.39 [9.9]	0.0071 [0.031] 0.63 [16]
0.5-50-50 0.02 x 0.02	2 [50]	2 [50]	0.0055 [0.025] 0.05 [1.3]	0.0076 [0.034] 0.13 [3.4]	0.0095 [0.042] 0.29 [7.5]	0.014 [0.061] 0.46 [12]
0.75-50-50 0.03 x 0.03	2 [50]	2 [50]	0.019 [0.083] 0.033 [0.83]	0.026 [0.11] 0.085 [2.2]	0.032 [0.14] 0.18 [4.6]	0.047 [0.21] 0.27 [6.9]
1-50-50 0.039 x 0.039	2 [50]	2 [50]	0.044 [0.2] 0.024 [0.62]	0.061 [0.27] 0.063 [1.6]	0.076 [0.34] 0.13 [3.4]	0.11 [0.49] 0.19 [4.9]
1.25-50-50 0.049 x 0.049	2 [50]	2 [50]	0.086 [0.38] 0.019 [0.49]	0.12 [0.53] 0.05 [1.3]	0.15 [0.66] 0.1 [2.6]	0.22 [0.96] 0.15 [3.8]
1.5-50-50 0.059 x 0.059	2 [50]	2 [50]	0.15 [0.66] 0.016 [0.41]	0.21 [0.91] 0.041 [1]	0.26 [1.1] 0.085 [2.2]	0.37 [1.7] 0.12 [3.1]
2-50-50 0.079 x 0.079	2 [50]	2 [50]	0.35 [1.6] 0.012 [0.31]	0.49 [2.2] 0.031 [0.78]	0.61 [2.7] 0.063 [1.6]	0.88 [3.9] 0.089 [2.3]
3-50-50 0.12 x 0.12	2 [50]	2 [50]	1.2 [5.3] 0.008 [0.2]	1.6 [7.3] 0.02 [0.51]	2 [9.1] 0.041 [1]	3 [13] 0.058 [1.5]
5-50-50 0.2 x 0.2	2 [50]	2 [50]	5.5 [25] 0.0048 [0.12]	7.6 [34] 0.012 [0.31]	9.5 [42] 0.024 [0.62]	14 [61] 0.034 [0.87]
0.15-50-100 0.0059 x 0.0059	2 [50]	3.9 [100]	0.000074 [0.00033] 0.088 [2.2]	0.0001 [0.00046] 0.24 [6.2]	0.00013 [0.00057] 0.61 [15]	0.00019 [0.00083] 1.1 [28]
0.25-50-100 0.0098 x 0.0098	2 [50]	3.9 [100]	0.00034 [0.0015] 0.051 [1.3]	0.00048 [0.0021] 0.14 [3.5]	0.00059 [0.0026] 0.3 [7.7]	0.00086 [0.0038] 0.47 [12]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.4-50-100 0.016 x 0.016	2 [50]	3.9 [100]	0.0014 [0.0063] 0.032 [0.8]	0.0019 [0.0087] 0.082 [2.1]	0.0024 [0.011] 0.17 [4.4]	0.0035 [0.016] 0.26 [6.6]
0.5-50-100 0.02 x 0.02	2 [50]	3.9 [100]	0.0028 [0.012] 0.025 [0.64]	0.0038 [0.017] 0.065 [1.6]	0.0047 [0.021] 0.14 [3.5]	0.0069 [0.031] 0.2 [5]
0.75-50-100 0.03 x 0.03	2 [50]	3.9 [100]	0.0093 [0.041] 0.017 [0.42]	0.013 [0.057] 0.043 [1.1]	0.016 [0.071] 0.088 [2.2]	0.023 [0.1] 0.13 [3.2]
1-50-100 0.039 x 0.039	2 [50]	3.9 [100]	0.022 [0.098] 0.012 [0.32]	0.03 [0.14] 0.031 [0.8]	0.038 [0.17] 0.065 [1.6]	0.055 [0.25] 0.092 [2.3]
1.25-50-100 0.049 x 0.049	2 [50]	3.9 [100]	0.043 [0.19] 0.0099 [0.25]	0.059 [0.26] 0.025 [0.64]	0.074 [0.33] 0.051 [1.3]	0.11 [0.48] 0.073 [1.9]
1.5-50-100 0.059 x 0.059	2 [50]	3.9 [100]	0.074 [0.33] 0.0083 [0.21]	0.1 [0.46] 0.021 [0.53]	0.13 [0.57] 0.043 [1.1]	0.19 [0.83] 0.06 [1.5]
2-50-100 0.079 x 0.079	2 [50]	3.9 [100]	0.18 [0.79] 0.0062 [0.16]	0.24 [1.1] 0.016 [0.4]	0.3 [1.4] 0.031 [0.8]	0.44 [2] 0.044 [1.1]
3-50-100 0.12 x 0.12	2 [50]	3.9 [100]	0.6 [2.7] 0.0041 [0.1]	0.82 [3.7] 0.01 [0.26]	1 [4.6] 0.021 [0.53]	1.5 [6.6] 0.03 [0.75]
5-50-100 0.2 x 0.2	2 [50]	3.9 [100]	2.8 [12] 0.0025 [0.063]	3.8 [17] 0.0063 [0.16]	4.7 [21] 0.013 [0.32]	6.9 [31] 0.017 [0.44]
0.15-50-200 0.0059 x 0.0059	2 [50]	7.9 [200]	0.000038 [0.00017] 0.043 [1.1]	0.000052 [0.00023] 0.11 [2.9]	0.000063 [0.00028] 0.25 [6.3]	0.000092 [0.00041] 0.38 [9.5]
0.25-50-200 0.0098 x 0.0098	2 [50]	7.9 [200]	0.00017 [0.00077] 0.025 [0.64]	0.00024 [0.0011] 0.065 [1.7]	0.0003 [0.0013] 0.14 [3.5]	0.00043 [0.0019] 0.2 [5.1]
0.4-50-200 0.016 x 0.016	2 [50]	7.9 [200]	0.00071 [0.0031] 0.016 [0.4]	0.00098 [0.0043] 0.04 [1]	0.0012 [0.0054] 0.083 [2.1]	0.0018 [0.0078] 0.12 [3]
0.5-50-200 0.02 x 0.02	2 [50]	7.9 [200]	0.0014 [0.0061] 0.013 [0.32]	0.0019 [0.0085] 0.032 [0.81]	0.0024 [0.011] 0.065 [1.7]	0.0034 [0.015] 0.093 [2.4]
0.75-50-200 0.03 x 0.03	2 [50]	7.9 [200]	0.0047 [0.021] 0.0083 [0.21]	0.0064 [0.029] 0.021 [0.53]	0.008 [0.036] 0.043 [1.1]	0.012 [0.052] 0.061 [1.5]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
1-50-200 0.039 x 0.039	2 [50]	7.9 [200]	0.011 [0.049] 0.0062 [0.16]	0.015 [0.068] 0.016 [0.4]	0.019 [0.084] 0.032 [0.81]	0.028 [0.12] 0.045 [1.1]
1.25-50-200 0.049 x 0.049	2 [50]	7.9 [200]	0.022 [0.096] 0.005 [0.13]	0.03 [0.13] 0.013 [0.32]	0.037 [0.16] 0.025 [0.64]	0.054 [0.24] 0.036 [0.91]
1.5-50-200 0.059 x 0.059	2 [50]	7.9 [200]	0.037 [0.17] 0.0042 [0.11]	0.051 [0.23] 0.01 [0.26]	0.064 [0.28] 0.021 [0.53]	0.093 [0.41] 0.03 [0.75]
2-50-200 0.079 x 0.079	2 [50]	7.9 [200]	0.088 [0.39] 0.0031 [0.079]	0.12 [0.54] 0.0079 [0.2]	0.15 [0.68] 0.016 [0.4]	0.22 [0.98] 0.022 [0.56]
3-50-200 0.12 x 0.12	2 [50]	7.9 [200]	0.3 [1.3] 0.0021 [0.053]	0.41 [1.8] 0.0051 [0.13]	0.51 [2.3] 0.01 [0.26]	0.74 [3.3] 0.015 [0.37]
5-50-200 0.2 x 0.2	2 [50]	7.9 [200]	1.4 [6.1] 0.0012 [0.032]	1.9 [8.5] 0.0031 [0.08]	2.4 [11] 0.0063 [0.16]	3.4 [15] 0.0087 [0.22]
0.15-100-10 0.0059 x 0.0059	3.9 [100]	0.39 [10]	0.00074 [0.0033] 0.36 [9.2]	0.001 [0.0046] 0.36 [9.2]	0.0013 [0.0057] 0.36 [9.2]	0.0019 [0.0083] 0.36 [9.2]
0.25-100-10 0.0098 x 0.0098	3.9 [100]	0.39 [10]	0.0034 [0.015] 0.36 [9.2]	0.0048 [0.021] 0.36 [9.2]	0.0059 [0.026] 0.36 [9.2]	0.0086 [0.038] 0.36 [9.2]
0.4-100-10 0.016 x 0.016	3.9 [100]	0.39 [10]	0.014 [0.063] 0.36 [9.2]	0.019 [0.087] 0.36 [9.2]	0.024 [0.11] 0.36 [9.2]	0.035 [0.16] 0.36 [9.2]
0.5-100-10 0.02 x 0.02	3.9 [100]	0.39 [10]	0.028 [0.12] 0.36 [9.2]	0.038 [0.17] 0.36 [9.2]	0.047 [0.21] 0.36 [9.2]	0.069 [0.31] 0.36 [9.2]
0.75-100-10 0.03 x 0.03	3.9 [100]	0.39 [10]	0.093 [0.41] 0.31 [7.9]	0.13 [0.57] 0.36 [9.2]	0.16 [0.71] 0.36 [9.2]	0.23 [1] 0.36 [9.2]
1-100-10 0.039 x 0.039	3.9 [100]	0.39 [10]	0.22 [0.98] 0.25 [6.4]	0.3 [1.4] 0.36 [9.2]	0.38 [1.7] 0.36 [9.2]	0.55 [2.5] 0.36 [9.2]
1.25-100-10 0.049 x 0.049	3.9 [100]	0.39 [10]	0.43 [1.9] 0.21 [5.3]	0.59 [2.6] 0.36 [9.2]	0.74 [3.3] 0.36 [9.2]	1.1 [4.8] 0.36 [9.2]
1.5-100-10 0.059 x 0.059	3.9 [100]	0.39 [10]	0.74 [3.3] 0.18 [4.5]	1 [4.6] 0.35 [8.9]	1.3 [5.7] 0.36 [9.2]	1.9 [8.3] 0.36 [9.2]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
2-100-10 0.079 x 0.079	3.9 [100]	0.39 [10]	1.8 [7.9] 0.13 [3.4]	2.4 [11] 0.3 [7.6]	3 [14] 0.36 [9.2]	4.4 [20] 0.36 [9.2]
0.15-100-25 0.0059 x 0.0059	3.9 [100]	0.98 [25]	0.0003 [0.0013] 1.8 [46]	0.00041 [0.0018] 1.8 [46]	0.00051 [0.0023] 1.8 [46]	0.00074 [0.0033] 1.8 [46]
0.25-100-25 0.0098 x 0.0098	3.9 [100]	0.98 [25]	0.0014 [0.0061] 1.6 [40]	0.0019 [0.0085] 1.8 [46]	0.0024 [0.011] 1.8 [46]	0.0034 [0.015] 1.8 [46]
0.4-100-25 0.016 x 0.016	3.9 [100]	0.98 [25]	0.0056 [0.025] 0.88 [22]	0.0078 [0.035] 1.8 [46]	0.0097 [0.043] 1.8 [46]	0.014 [0.063] 1.8 [46]
0.5-100-25 0.02 x 0.02	3.9 [100]	0.98 [25]	0.011 [0.049] 0.67 [17]	0.015 [0.068] 1.8 [46]	0.019 [0.084] 1.8 [46]	0.028 [0.12] 1.8 [46]
0.75-100-25 0.03 x 0.03	3.9 [100]	0.98 [25]	0.037 [0.17] 0.41 [10]	0.051 [0.23] 1.3 [32]	0.064 [0.28] 1.8 [46]	0.093 [0.41] 1.8 [46]
1-100-25 0.039 x 0.039	3.9 [100]	0.98 [25]	0.088 [0.39] 0.3 [7.6]	0.12 [0.54] 0.88 [22]	0.15 [0.68] 1.8 [46]	0.22 [0.98] 1.8 [46]
1.25-100-25 0.049 x 0.049	3.9 [100]	0.98 [25]	0.17 [0.77] 0.23 [5.9]	0.24 [1.1] 0.67 [17]	0.3 [1.3] 1.6 [40]	0.43 [1.9] 1.8 [46]
1.5-100-25 0.059 x 0.059	3.9 [100]	0.98 [25]	0.3 [1.3] 0.19 [4.9]	0.41 [1.8] 0.53 [14]	0.51 [2.3] 1.3 [32]	0.74 [3.3] 1.8 [46]
2-100-25 0.079 x 0.079	3.9 [100]	0.98 [25]	0.71 [3.1] 0.14 [3.6]	0.97 [4.3] 0.38 [9.7]	1.2 [5.4] 0.88 [22]	1.8 [7.9] 1.4 [34]
3-100-25 0.12 x 0.12	3.9 [100]	0.98 [25]	2.4 [11] 0.093 [2.4]	3.3 [15] 0.24 [6.2]	4.1 [18] 0.53 [14]	6 [27] 0.81 [20]
5-100-25 0.2 x 0.2	3.9 [100]	0.98 [25]	11 [49] 0.055 [1.4]	15 [68] 0.14 [3.6]	19 [84] 0.3 [7.6]	28 [120] 0.44 [11]
0.15-100-50 0.0059 x 0.0059	3.9 [100]	2 [50]	0.00015 [0.00066] 2.2 [56]	0.0002 [0.00091] 5.1 [130]	0.00026 [0.0011] 5.1 [130]	0.00037 [0.0017] 5.1 [130]
0.25-100-50 0.0098 x 0.0098	3.9 [100]	2 [50]	0.00069 [0.0031] 0.97 [25]	0.00095 [0.0042] 5.1 [130]	0.0012 [0.0053] 5.1 [130]	0.0017 [0.0077] 5.1 [130]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.4-100-50 0.016 x 0.016	3.9 [100]	2 [50]	0.0028 [0.013] 0.53 [13]	0.0039 [0.017] 2 [50]	0.0049 [0.022] 5.1 [130]	0.0071 [0.031] 5.1 [130]
0.5-100-50 0.02 x 0.02	3.9 [100]	2 [50]	0.0055 [0.025] 0.4 [10]	0.0076 [0.034] 1.3 [34]	0.0095 [0.042] 5.1 [130]	0.014 [0.061] 5.1 [130]
0.75-100-50 0.03 x 0.03	3.9 [100]	2 [50]	0.019 [0.083] 0.26 [6.5]	0.026 [0.11] 0.76 [19]	0.032 [0.14] 2.2 [56]	0.047 [0.21] 4.8 [120]
1-100-50 0.039 x 0.039	3.9 [100]	2 [50]	0.044 [0.2] 0.19 [4.8]	0.061 [0.27] 0.53 [13]	0.076 [0.34] 1.3 [34]	0.11 [0.49] 2.4 [62]
1.25-100-50 0.049 x 0.049	3.9 [100]	2 [50]	0.086 [0.38] 0.15 [3.8]	0.12 [0.53] 0.4 [10]	0.15 [0.66] 0.97 [25]	0.22 [0.96] 1.6 [41]
1.5-100-50 0.059 x 0.059	3.9 [100]	2 [50]	0.15 [0.66] 0.12 [3.1]	0.21 [0.91] 0.33 [8.3]	0.26 [1.1] 0.76 [19]	0.37 [1.7] 1.2 [31]
2-100-50 0.079 x 0.079	3.9 [100]	2 [50]	0.35 [1.6] 0.09 [2.3]	0.49 [2.2] 0.24 [6.1]	0.61 [2.7] 0.53 [13]	0.88 [3.9] 0.81 [20]
3-100-50 0.12 x 0.12	3.9 [100]	2 [50]	1.2 [5.3] 0.06 [1.5]	1.6 [7.3] 0.15 [3.9]	2 [9.1] 0.33 [8.3]	3 [13] 0.49 [12]
5-100-50 0.2 x 0.2	3.9 [100]	2 [50]	5.5 [25] 0.035 [0.9]	7.6 [34] 0.091 [2.3]	9.5 [42] 0.19 [4.8]	14 [61] 0.27 [6.9]
0.15-100-100 0.0059 x 0.0059	3.9 [100]	3.9 [100]	0.000074 [0.00033] 0.85 [22]	0.0001 [0.00046] 5.2 [130]	0.00013 [0.00057] 13 [320]	0.00019 [0.00083] 13 [320]
0.25-100-100 0.0098 x 0.0098	3.9 [100]	3.9 [100]	0.00034 [0.0015] 0.45 [11]	0.00048 [0.0021] 1.6 [40]	0.00059 [0.0026] 13 [320]	0.00086 [0.0038] 13 [320]
0.4-100-100 0.016 x 0.016	3.9 [100]	3.9 [100]	0.0014 [0.0063] 0.26 [6.7]	0.0019 [0.0087] 0.78 [20]	0.0024 [0.011] 2.4 [60]	0.0035 [0.016] 6.3 [160]
0.5-100-100 0.02 x 0.02	3.9 [100]	3.9 [100]	0.0028 [0.012] 0.21 [5.2]	0.0038 [0.017] 0.59 [15]	0.0047 [0.021] 1.6 [40]	0.0069 [0.031] 3 [77]
0.75-100-100 0.03 x 0.03	3.9 [100]	3.9 [100]	0.0093 [0.041] 0.13 [3.4]	0.013 [0.057] 0.36 [9.2]	0.016 [0.071] 0.85 [22]	0.023 [0.1] 1.4 [35]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
1-100-100 0.039 x 0.039	3.9 [100]	3.9 [100]	0.022 [0.098] 0.099 [2.5]	0.03 [0.14] 0.26 [6.7]	0.038 [0.17] 0.59 [15]	0.055 [0.25] 0.91 [23]
1.25-100-100 0.049 x 0.049	3.9 [100]	3.9 [100]	0.043 [0.19] 0.079 [2]	0.059 [0.26] 0.21 [5.2]	0.074 [0.33] 0.45 [11]	0.11 [0.48] 0.68 [17]
1.5-100-100 0.059 x 0.059	3.9 [100]	3.9 [100]	0.074 [0.33] 0.065 [1.7]	0.1 [0.46] 0.17 [4.3]	0.13 [0.57] 0.36 [9.2]	0.19 [0.83] 0.54 [14]
2-100-100 0.079 x 0.079	3.9 [100]	3.9 [100]	0.18 [0.79] 0.049 [1.2]	0.24 [1.1] 0.13 [3.2]	0.3 [1.4] 0.26 [6.7]	0.44 [2] 0.39 [9.8]
3-100-100 0.12 x 0.12	3.9 [100]	3.9 [100]	0.6 [2.7] 0.032 [0.82]	0.82 [3.7] 0.082 [2.1]	1 [4.6] 0.17 [4.3]	1.5 [6.6] 0.24 [6.2]
5-100-100 0.2 x 0.2	3.9 [100]	3.9 [100]	2.8 [12] 0.019 [0.49]	3.8 [17] 0.049 [1.2]	4.7 [21] 0.099 [2.5]	6.9 [31] 0.14 [3.6]
0.15-100-200 0.0059 x 0.0059	3.9 [100]	7.9 [200]	0.000038 [0.00017] 0.38 [9.6]	0.000052 [0.00023] 1.2 [31]	0.000063 [0.00028] 5.8 [150]	0.000092 [0.00041] 28 [710]
0.25-100-200 0.0098 x 0.0098	3.9 [100]	7.9 [200]	0.00017 [0.00077] 0.21 [5.4]	0.00024 [0.0011] 0.61 [15]	0.0003 [0.0013] 1.6 [42]	0.00043 [0.0019] 3.3 [83]
0.4-100-200 0.016 x 0.016	3.9 [100]	7.9 [200]	0.00071 [0.0031] 0.13 [3.3]	0.00098 [0.0043] 0.35 [8.9]	0.0012 [0.0054] 0.81 [21]	0.0018 [0.0078] 1.3 [33]
0.5-100-200 0.02 x 0.02	3.9 [100]	7.9 [200]	0.0014 [0.0061] 0.1 [2.6]	0.0019 [0.0085] 0.27 [6.9]	0.0024 [0.011] 0.61 [15]	0.0034 [0.015] 0.95 [24]
0.75-100-200 0.03 x 0.03	3.9 [100]	7.9 [200]	0.0047 [0.021] 0.067 [1.7]	0.0064 [0.029] 0.18 [4.5]	0.008 [0.036] 0.38 [9.6]	0.012 [0.052] 0.56 [14]
1-100-200 0.039 x 0.039	3.9 [100]	7.9 [200]	0.011 [0.049] 0.05 [1.3]	0.015 [0.068] 0.13 [3.3]	0.019 [0.084] 0.27 [6.9]	0.028 [0.12] 0.4 [10]
1.25-100-200 0.049 x 0.049	3.9 [100]	7.9 [200]	0.022 [0.096] 0.04 [1]	0.03 [0.13] 0.1 [2.6]	0.037 [0.16] 0.21 [5.4]	0.054 [0.24] 0.31 [7.8]
1.5-100-200 0.059 x 0.059	3.9 [100]	7.9 [200]	0.037 [0.17] 0.033 [0.84]	0.051 [0.23] 0.085 [2.1]	0.064 [0.28] 0.18 [4.5]	0.093 [0.41] 0.25 [6.4]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
2-100-200 0.079 x 0.079	3.9 [100]	7.9 [200]	0.088 [0.39] 0.025 [0.63]	0.12 [0.54] 0.063 [1.6]	0.15 [0.68] 0.13 [3.3]	0.22 [0.98] 0.18 [4.7]
3-100-200 0.12 x 0.12	3.9 [100]	7.9 [200]	0.3 [1.3] 0.017 [0.42]	0.41 [1.8] 0.042 [1.1]	0.51 [2.3] 0.085 [2.1]	0.74 [3.3] 0.12 [3]
5-100-200 0.2 x 0.2	3.9 [100]	7.9 [200]	1.4 [6.1] 0.0099 [0.25]	1.9 [8.5] 0.025 [0.63]	2.4 [11] 0.05 [1.3]	3.4 [15] 0.071 [1.8]

FLAT SPRING ACTUATORS — FLAT WIRE, FACE — Representative grid. Flat spring actuators are made to order, so any pitch from 10 to 100 mm and any amplitude from 10 to 300 mm can be supplied; the method on the previous page gives any combination not listed here.

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.152x0.411-10-10 0.006 x 0.016	0.39 [10]	0.39 [10]	0.0036 [0.016] 0.0065 [0.16]	0.0049 [0.022] 0.017 [0.43]	0.0061 [0.027] 0.036 [0.91]	0.0089 [0.04] 0.053 [1.4]
0.152x0.813-10-10 0.006 x 0.032	0.39 [10]	0.39 [10]	0.007 [0.031] 0.0065 [0.16]	0.0097 [0.043] 0.017 [0.43]	0.012 [0.054] 0.036 [0.91]	0.018 [0.078] 0.053 [1.4]
0.25x0.5-10-10 0.0098 x 0.02	0.39 [10]	0.39 [10]	0.012 [0.052] 0.0039 [0.099]	0.016 [0.072] 0.0098 [0.25]	0.02 [0.09] 0.02 [0.52]	0.029 [0.13] 0.03 [0.76]
0.3x2-10-10 0.012 x 0.079	0.39 [10]	0.39 [10]	0.067 [0.3] 0.0032 [0.082]	0.093 [0.41] 0.0083 [0.21]	0.12 [0.52] 0.017 [0.43]	0.17 [0.75] 0.024 [0.62]
0.4x0.8-10-10 0.016 x 0.031	0.39 [10]	0.39 [10]	0.048 [0.21] 0.0024 [0.061]	0.066 [0.29] 0.0063 [0.16]	0.082 [0.37] 0.013 [0.32]	0.12 [0.53] 0.018 [0.45]
0.4x1-10-10 0.016 x 0.039	0.39 [10]	0.39 [10]	0.06 [0.27] 0.0024 [0.061]	0.083 [0.37] 0.0063 [0.16]	0.1 [0.46] 0.013 [0.32]	0.15 [0.67] 0.018 [0.45]
0.406x0.559-10-10 0.016 x 0.022	0.39 [10]	0.39 [10]	0.035 [0.15] 0.0024 [0.06]	0.048 [0.21] 0.0059 [0.15]	0.059 [0.26] 0.012 [0.31]	0.086 [0.38] 0.018 [0.45]
0.5x0.25-10-10 0.02 x 0.0098	0.39 [10]	0.39 [10]	0.023 [0.1] 0.0019 [0.049]	0.032 [0.14] 0.0047 [0.12]	0.04 [0.18] 0.0098 [0.25]	0.059 [0.26] 0.014 [0.36]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-10-10 0.02 x 0.031	0.39 [10]	0.39 [10]	0.075 [0.33] 0.0019 [0.049]	0.1 [0.46] 0.0047 [0.12]	0.13 [0.57] 0.0098 [0.25]	0.19 [0.83] 0.014 [0.36]
0.55x1.4-10-10 0.022 x 0.055	0.39 [10]	0.39 [10]	0.16 [0.71] 0.0018 [0.044]	0.22 [0.97] 0.0043 [0.11]	0.27 [1.2] 0.0091 [0.23]	0.4 [1.8] 0.013 [0.32]
0.6x2.3-10-10 0.024 x 0.091	0.39 [10]	0.39 [10]	0.31 [1.4] 0.0016 [0.041]	0.43 [1.9] 0.0039 [0.1]	0.53 [2.4] 0.0083 [0.21]	0.78 [3.5] 0.012 [0.3]
0.8x1.5-10-10 0.031 x 0.059	0.39 [10]	0.39 [10]	0.36 [1.6] 0.0012 [0.031]	0.5 [2.2] 0.0031 [0.08]	0.62 [2.8] 0.0063 [0.16]	0.9 [4] 0.0087 [0.22]
1x2.6-10-10 0.039 x 0.1	0.39 [10]	0.39 [10]	0.97 [4.3] 0.00096 [0.024]	1.3 [6] 0.0024 [0.06]	1.7 [7.5] 0.0047 [0.12]	2.4 [11] 0.0067 [0.17]
1.5x4-10-10 0.059 x 0.16	0.39 [10]	0.39 [10]	3.4 [15] 0.00064 [0.016]	4.7 [21] 0.0016 [0.04]	5.8 [26] 0.0031 [0.08]	8.4 [38] 0.0047 [0.12]
0.152x0.411-10-25 0.006 x 0.016	0.39 [10]	0.98 [25]	0.0014 [0.0063] 0.0026 [0.067]	0.002 [0.0087] 0.0067 [0.17]	0.0024 [0.011] 0.014 [0.35]	0.0036 [0.016] 0.02 [0.5]
0.152x0.813-10-25 0.006 x 0.032	0.39 [10]	0.98 [25]	0.0028 [0.013] 0.0026 [0.067]	0.0039 [0.017] 0.0067 [0.17]	0.0048 [0.022] 0.014 [0.35]	0.007 [0.031] 0.02 [0.5]
0.25x0.5-10-25 0.0098 x 0.02	0.39 [10]	0.98 [25]	0.0047 [0.021] 0.0016 [0.04]	0.0065 [0.029] 0.0039 [0.1]	0.0081 [0.036] 0.0083 [0.21]	0.012 [0.052] 0.011 [0.29]
0.3x2-10-25 0.012 x 0.079	0.39 [10]	0.98 [25]	0.027 [0.12] 0.0013 [0.034]	0.037 [0.17] 0.0031 [0.08]	0.046 [0.21] 0.0067 [0.17]	0.067 [0.3] 0.0094 [0.24]
0.4x0.8-10-25 0.016 x 0.031	0.39 [10]	0.98 [25]	0.019 [0.085] 0.00099 [0.025]	0.026 [0.12] 0.0024 [0.06]	0.033 [0.15] 0.0051 [0.13]	0.048 [0.21] 0.0071 [0.18]
0.4x1-10-25 0.016 x 0.039	0.39 [10]	0.98 [25]	0.024 [0.11] 0.00099 [0.025]	0.033 [0.15] 0.0024 [0.06]	0.041 [0.18] 0.0051 [0.13]	0.06 [0.27] 0.0071 [0.18]
0.406x0.559-10-25 0.016 x 0.022	0.39 [10]	0.98 [25]	0.014 [0.061] 0.00098 [0.025]	0.019 [0.085] 0.0024 [0.06]	0.024 [0.11] 0.0051 [0.13]	0.035 [0.15] 0.0071 [0.18]
0.5x0.25-10-25 0.02 x 0.0098	0.39 [10]	0.98 [25]	0.0094 [0.042] 0.00079 [0.02]	0.013 [0.058] 0.002 [0.05]	0.016 [0.072] 0.0039 [0.1]	0.023 [0.1] 0.0055 [0.14]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-10-25 0.02 x 0.031	0.39 [10]	0.98 [25]	0.03 [0.13] 0.00079 [0.02]	0.041 [0.18] 0.002 [0.05]	0.052 [0.23] 0.0039 [0.1]	0.075 [0.33] 0.0055 [0.14]
0.55x1.4-10-25 0.022 x 0.055	0.39 [10]	0.98 [25]	0.063 [0.28] 0.00072 [0.018]	0.088 [0.39] 0.002 [0.05]	0.11 [0.49] 0.0035 [0.09]	0.16 [0.71] 0.0051 [0.13]
0.6x2.3-10-25 0.024 x 0.091	0.39 [10]	0.98 [25]	0.12 [0.55] 0.00066 [0.017]	0.17 [0.76] 0.0016 [0.04]	0.21 [0.95] 0.0031 [0.08]	0.31 [1.4] 0.0047 [0.12]
0.8x1.5-10-25 0.031 x 0.059	0.39 [10]	0.98 [25]	0.14 [0.64] 0.0005 [0.013]	0.2 [0.88] 0.0012 [0.03]	0.25 [1.1] 0.0024 [0.06]	0.36 [1.6] 0.0035 [0.09]
1x2.6-10-25 0.039 x 0.1	0.39 [10]	0.98 [25]	0.39 [1.7] 0.0004 [0.01]	0.54 [2.4] 0.0012 [0.03]	0.67 [3] 0.002 [0.05]	0.97 [4.3] 0.0028 [0.07]
1.5x4-10-25 0.059 x 0.16	0.39 [10]	0.98 [25]	1.3 [6] 0.00026 [0.0067]	1.9 [8.3] 0.00079 [0.02]	2.3 [10] 0.0012 [0.03]	3.4 [15] 0.002 [0.05]
0.152x0.411-10-50 0.006 x 0.016	0.39 [10]	2 [50]	0.00071 [0.0032] 0.0013 [0.033]	0.00098 [0.0044] 0.0031 [0.08]	0.0012 [0.0054] 0.0067 [0.17]	0.0018 [0.0079] 0.0094 [0.24]
0.152x0.813-10-50 0.006 x 0.032	0.39 [10]	2 [50]	0.0014 [0.0063] 0.0013 [0.033]	0.0019 [0.0086] 0.0031 [0.08]	0.0024 [0.011] 0.0067 [0.17]	0.0035 [0.016] 0.0094 [0.24]
0.25x0.5-10-50 0.0098 x 0.02	0.39 [10]	2 [50]	0.0023 [0.01] 0.0008 [0.02]	0.0032 [0.014] 0.002 [0.05]	0.004 [0.018] 0.0039 [0.1]	0.0059 [0.026] 0.0055 [0.14]
0.3x2-10-50 0.012 x 0.079	0.39 [10]	2 [50]	0.013 [0.06] 0.00066 [0.017]	0.019 [0.083] 0.0016 [0.04]	0.023 [0.1] 0.0035 [0.09]	0.034 [0.15] 0.0047 [0.12]
0.4x0.8-10-50 0.016 x 0.031	0.39 [10]	2 [50]	0.0096 [0.043] 0.0005 [0.013]	0.013 [0.059] 0.0012 [0.03]	0.016 [0.073] 0.0024 [0.06]	0.024 [0.11] 0.0035 [0.09]
0.4x1-10-50 0.016 x 0.039	0.39 [10]	2 [50]	0.012 [0.053] 0.0005 [0.013]	0.017 [0.074] 0.0012 [0.03]	0.021 [0.092] 0.0024 [0.06]	0.03 [0.13] 0.0035 [0.09]
0.406x0.559-10-50 0.016 x 0.022	0.39 [10]	2 [50]	0.0069 [0.031] 0.00049 [0.012]	0.0095 [0.042] 0.0012 [0.03]	0.012 [0.053] 0.0024 [0.06]	0.017 [0.077] 0.0035 [0.09]
0.5x0.25-10-50 0.02 x 0.0098	0.39 [10]	2 [50]	0.0047 [0.021] 0.0004 [0.01]	0.0065 [0.029] 0.0012 [0.03]	0.0081 [0.036] 0.002 [0.05]	0.012 [0.052] 0.0028 [0.07]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-10-50 0.02 x 0.031	0.39 [10]	2 [50]	0.015 [0.067] 0.0004 [0.01]	0.021 [0.092] 0.0012 [0.03]	0.026 [0.11] 0.002 [0.05]	0.037 [0.17] 0.0028 [0.07]
0.55x1.4-10-50 0.022 x 0.055	0.39 [10]	2 [50]	0.032 [0.14] 0.00036 [0.0092]	0.044 [0.19] 0.00079 [0.02]	0.055 [0.24] 0.002 [0.05]	0.079 [0.35] 0.0024 [0.06]
0.6x2.3-10-50 0.024 x 0.091	0.39 [10]	2 [50]	0.062 [0.28] 0.00033 [0.0084]	0.086 [0.38] 0.00079 [0.02]	0.11 [0.47] 0.0016 [0.04]	0.16 [0.69] 0.0024 [0.06]
0.8x1.5-10-50 0.031 x 0.059	0.39 [10]	2 [50]	0.072 [0.32] 0.00025 [0.0063]	0.099 [0.44] 0.00079 [0.02]	0.12 [0.55] 0.0012 [0.03]	0.18 [0.8] 0.0016 [0.04]
1x2.6-10-50 0.039 x 0.1	0.39 [10]	2 [50]	0.19 [0.87] 0.0002 [0.0051]	0.27 [1.2] 0.00039 [0.01]	0.34 [1.5] 0.0012 [0.03]	0.49 [2.2] 0.0016 [0.04]
1.5x4-10-50 0.059 x 0.16	0.39 [10]	2 [50]	0.67 [3] 0.00013 [0.0034]	0.93 [4.1] 0.00039 [0.01]	1.2 [5.2] 0.00079 [0.02]	1.7 [7.5] 0.00079 [0.02]
0.152x0.411-10-100 0.006 x 0.016	0.39 [10]	3.9 [100]	0.00036 [0.0016] 0.00066 [0.017]	0.00049 [0.0022] 0.0016 [0.04]	0.00061 [0.0027] 0.0031 [0.08]	0.00089 [0.004] 0.0047 [0.12]
0.152x0.813-10-100 0.006 x 0.032	0.39 [10]	3.9 [100]	0.0007 [0.0031] 0.00066 [0.017]	0.00097 [0.0043] 0.0016 [0.04]	0.0012 [0.0054] 0.0031 [0.08]	0.0018 [0.0078] 0.0047 [0.12]
0.25x0.5-10-100 0.0098 x 0.02	0.39 [10]	3.9 [100]	0.0012 [0.0052] 0.0004 [0.01]	0.0016 [0.0072] 0.0012 [0.03]	0.002 [0.009] 0.002 [0.05]	0.0029 [0.013] 0.0028 [0.07]
0.3x2-10-100 0.012 x 0.079	0.39 [10]	3.9 [100]	0.0067 [0.03] 0.00033 [0.0084]	0.0093 [0.041] 0.00079 [0.02]	0.012 [0.052] 0.0016 [0.04]	0.017 [0.075] 0.0024 [0.06]
0.4x0.8-10-100 0.016 x 0.031	0.39 [10]	3.9 [100]	0.0048 [0.021] 0.00025 [0.0063]	0.0066 [0.029] 0.00079 [0.02]	0.0082 [0.037] 0.0012 [0.03]	0.012 [0.053] 0.0016 [0.04]
0.4x1-10-100 0.016 x 0.039	0.39 [10]	3.9 [100]	0.006 [0.027] 0.00025 [0.0063]	0.0083 [0.037] 0.00079 [0.02]	0.01 [0.046] 0.0012 [0.03]	0.015 [0.067] 0.0016 [0.04]
0.406x0.559-10-100 0.016 x 0.022	0.39 [10]	3.9 [100]	0.0035 [0.015] 0.00025 [0.0062]	0.0048 [0.021] 0.00079 [0.02]	0.0059 [0.026] 0.0012 [0.03]	0.0086 [0.038] 0.0016 [0.04]
0.5x0.25-10-100 0.02 x 0.0098	0.39 [10]	3.9 [100]	0.0023 [0.01] 0.0002 [0.0051]	0.0032 [0.014] 0.00039 [0.01]	0.004 [0.018] 0.0012 [0.03]	0.0059 [0.026] 0.0016 [0.04]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-10-100 0.02 x 0.031	0.39 [10]	3.9 [100]	0.0075 [0.033] 0.0002 [0.0051]	0.01 [0.046] 0.00039 [0.01]	0.013 [0.057] 0.0012 [0.03]	0.019 [0.083] 0.0016 [0.04]
0.55x1.4-10-100 0.022 x 0.055	0.39 [10]	3.9 [100]	0.016 [0.071] 0.00018 [0.0046]	0.022 [0.097] 0.00039 [0.01]	0.027 [0.12] 0.00079 [0.02]	0.04 [0.18] 0.0012 [0.03]
0.6x2.3-10-100 0.024 x 0.091	0.39 [10]	3.9 [100]	0.031 [0.14] 0.00017 [0.0042]	0.043 [0.19] 0.00039 [0.01]	0.053 [0.24] 0.00079 [0.02]	0.078 [0.34] 0.0012 [0.03]
0.8x1.5-10-100 0.031 x 0.059	0.39 [10]	3.9 [100]	0.036 [0.16] 0.00012 [0.0032]	0.05 [0.22] 0.00039 [0.01]	0.062 [0.28] 0.00079 [0.02]	0.09 [0.4] 0.00079 [0.02]
1x2.6-10-100 0.039 x 0.1	0.39 [10]	3.9 [100]	0.097 [0.43] 0.0001 [0.0025]	0.13 [0.6] 0.00039 [0.01]	0.17 [0.75] 0.00039 [0.01]	0.24 [1.1] 0.00079 [0.02]
1.5x4-10-100 0.059 x 0.16	0.39 [10]	3.9 [100]	0.34 [1.5] 0.000066 [0.0017]	0.47 [2.1] 0 [0]	0.58 [2.6] 0.00039 [0.01]	0.84 [3.8] 0.00039 [0.01]
0.152x0.411-10-200 0.006 x 0.016	0.39 [10]	7.9 [200]	0.00018 [0.00079] 0.00033 [0.0083]	0.00025 [0.0011] 0.00079 [0.02]	0.00031 [0.0014] 0.0016 [0.04]	0.00045 [0.002] 0.0024 [0.06]
0.152x0.813-10-200 0.006 x 0.032	0.39 [10]	7.9 [200]	0.00035 [0.0016] 0.00033 [0.0083]	0.00049 [0.0022] 0.00079 [0.02]	0.0006 [0.0027] 0.0016 [0.04]	0.00088 [0.0039] 0.0024 [0.06]
0.25x0.5-10-200 0.0098 x 0.02	0.39 [10]	7.9 [200]	0.00058 [0.0026] 0.0002 [0.0051]	0.00081 [0.0036] 0.00039 [0.01]	0.001 [0.0045] 0.0012 [0.03]	0.0015 [0.0065] 0.0016 [0.04]
0.3x2-10-200 0.012 x 0.079	0.39 [10]	7.9 [200]	0.0034 [0.015] 0.00017 [0.0042]	0.0047 [0.021] 0.00039 [0.01]	0.0058 [0.026] 0.00079 [0.02]	0.0084 [0.037] 0.0012 [0.03]
0.4x0.8-10-200 0.016 x 0.031	0.39 [10]	7.9 [200]	0.0024 [0.011] 0.00012 [0.0032]	0.0033 [0.015] 0.00039 [0.01]	0.0041 [0.018] 0.00079 [0.02]	0.006 [0.027] 0.00079 [0.02]
0.4x1-10-200 0.016 x 0.039	0.39 [10]	7.9 [200]	0.003 [0.013] 0.00012 [0.0032]	0.0041 [0.018] 0.00039 [0.01]	0.0052 [0.023] 0.00079 [0.02]	0.0075 [0.033] 0.00079 [0.02]
0.406x0.559-10-200 0.016 x 0.022	0.39 [10]	7.9 [200]	0.0017 [0.0077] 0.00012 [0.0031]	0.0024 [0.011] 0.00039 [0.01]	0.003 [0.013] 0.00079 [0.02]	0.0043 [0.019] 0.00079 [0.02]
0.5x0.25-10-200 0.02 x 0.0098	0.39 [10]	7.9 [200]	0.0012 [0.0052] 0.0001 [0.0025]	0.0016 [0.0072] 0.00039 [0.01]	0.002 [0.009] 0.00039 [0.01]	0.0029 [0.013] 0.00079 [0.02]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-10-200 0.02 x 0.031	0.39 [10]	7.9 [200]	0.0037 [0.017] 0.0001 [0.0025]	0.0052 [0.023] 0.00039 [0.01]	0.0064 [0.029] 0.00039 [0.01]	0.0094 [0.042] 0.00079 [0.02]
0.55x1.4-10-200 0.022 x 0.055	0.39 [10]	7.9 [200]	0.0079 [0.035] 0.000091 [0.0023]	0.011 [0.049] 0.00039 [0.01]	0.014 [0.061] 0.00039 [0.01]	0.02 [0.088] 0.00079 [0.02]
0.6x2.3-10-200 0.024 x 0.091	0.39 [10]	7.9 [200]	0.016 [0.069] 0.000083 [0.0021]	0.021 [0.095] 0.00039 [0.01]	0.027 [0.12] 0.00039 [0.01]	0.039 [0.17] 0.00039 [0.01]
0.8x1.5-10-200 0.031 x 0.059	0.39 [10]	7.9 [200]	0.018 [0.08] 0.000062 [0.0016]	0.025 [0.11] 0 [0]	0.031 [0.14] 0.00039 [0.01]	0.045 [0.2] 0.00039 [0.01]
1x2.6-10-200 0.039 x 0.1	0.39 [10]	7.9 [200]	0.049 [0.22] 0.00005 [0.0013]	0.067 [0.3] 0 [0]	0.084 [0.37] 0.00039 [0.01]	0.12 [0.54] 0.00039 [0.01]
1.5x4-10-200 0.059 x 0.16	0.39 [10]	7.9 [200]	0.17 [0.75] 0.000033 [0.00084]	0.23 [1] 0 [0]	0.29 [1.3] 0 [0]	0.42 [1.9] 0.00039 [0.01]
0.152x0.411-25-10 0.006 x 0.016	0.98 [25]	0.39 [10]	0.0036 [0.016] 0.098 [2.5]	0.0049 [0.022] 0.32 [8.1]	0.0061 [0.027] 0.94 [24]	0.0089 [0.04] 0.94 [24]
0.152x0.813-25-10 0.006 x 0.032	0.98 [25]	0.39 [10]	0.007 [0.031] 0.098 [2.5]	0.0097 [0.043] 0.32 [8.1]	0.012 [0.054] 0.94 [24]	0.018 [0.078] 0.94 [24]
0.25x0.5-25-10 0.0098 x 0.02	0.98 [25]	0.39 [10]	0.012 [0.052] 0.056 [1.4]	0.016 [0.072] 0.16 [4.1]	0.02 [0.09] 0.44 [11]	0.029 [0.13] 0.82 [21]
0.3x2-25-10 0.012 x 0.079	0.98 [25]	0.39 [10]	0.067 [0.3] 0.046 [1.2]	0.093 [0.41] 0.13 [3.3]	0.12 [0.52] 0.32 [8.2]	0.17 [0.75] 0.58 [15]
0.4x0.8-25-10 0.016 x 0.031	0.98 [25]	0.39 [10]	0.048 [0.21] 0.034 [0.86]	0.066 [0.29] 0.092 [2.3]	0.082 [0.37] 0.22 [5.5]	0.12 [0.53] 0.35 [8.9]
0.4x1-25-10 0.016 x 0.039	0.98 [25]	0.39 [10]	0.06 [0.27] 0.034 [0.86]	0.083 [0.37] 0.092 [2.3]	0.1 [0.46] 0.22 [5.5]	0.15 [0.67] 0.35 [8.9]
0.406x0.559-25-10 0.016 x 0.022	0.98 [25]	0.39 [10]	0.035 [0.15] 0.033 [0.85]	0.048 [0.21] 0.091 [2.3]	0.059 [0.26] 0.21 [5.4]	0.086 [0.38] 0.34 [8.7]
0.5x0.25-25-10 0.02 x 0.0098	0.98 [25]	0.39 [10]	0.023 [0.1] 0.027 [0.68]	0.032 [0.14] 0.072 [1.8]	0.04 [0.18] 0.16 [4.1]	0.059 [0.26] 0.25 [6.4]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-25-10 0.02 x 0.031	0.98 [25]	0.39 [10]	0.075 [0.33] 0.027 [0.68]	0.1 [0.46] 0.072 [1.8]	0.13 [0.57] 0.16 [4.1]	0.19 [0.83] 0.25 [6.4]
0.55x1.4-25-10 0.022 x 0.055	0.98 [25]	0.39 [10]	0.16 [0.71] 0.024 [0.62]	0.22 [0.97] 0.065 [1.6]	0.27 [1.2] 0.14 [3.6]	0.4 [1.8] 0.22 [5.6]
0.6x2.3-25-10 0.024 x 0.091	0.98 [25]	0.39 [10]	0.31 [1.4] 0.022 [0.56]	0.43 [1.9] 0.059 [1.5]	0.53 [2.4] 0.13 [3.3]	0.78 [3.5] 0.2 [5]
0.8x1.5-25-10 0.031 x 0.059	0.98 [25]	0.39 [10]	0.36 [1.6] 0.017 [0.42]	0.5 [2.2] 0.043 [1.1]	0.62 [2.8] 0.092 [2.3]	0.9 [4] 0.14 [3.5]
1x2.6-25-10 0.039 x 0.1	0.98 [25]	0.39 [10]	0.97 [4.3] 0.013 [0.33]	1.3 [6] 0.034 [0.86]	1.7 [7.5] 0.072 [1.8]	2.4 [11] 0.11 [2.7]
1.5x4-25-10 0.059 x 0.16	0.98 [25]	0.39 [10]	3.4 [15] 0.0087 [0.22]	4.7 [21] 0.022 [0.56]	5.8 [26] 0.046 [1.2]	8.4 [38] 0.067 [1.7]
0.152x0.411-25-25 0.006 x 0.016	0.98 [25]	0.98 [25]	0.0014 [0.0063] 0.042 [1.1]	0.002 [0.0087] 0.12 [3]	0.0024 [0.011] 0.29 [7.3]	0.0036 [0.016] 0.5 [13]
0.152x0.813-25-25 0.006 x 0.032	0.98 [25]	0.98 [25]	0.0028 [0.013] 0.042 [1.1]	0.0039 [0.017] 0.12 [3]	0.0048 [0.022] 0.29 [7.3]	0.007 [0.031] 0.5 [13]
0.25x0.5-25-25 0.0098 x 0.02	0.98 [25]	0.98 [25]	0.0047 [0.021] 0.025 [0.63]	0.0065 [0.029] 0.066 [1.7]	0.0081 [0.036] 0.15 [3.7]	0.012 [0.052] 0.23 [5.8]
0.3x2-25-25 0.012 x 0.079	0.98 [25]	0.98 [25]	0.027 [0.12] 0.021 [0.52]	0.037 [0.17] 0.054 [1.4]	0.046 [0.21] 0.12 [3]	0.067 [0.3] 0.18 [4.5]
0.4x0.8-25-25 0.016 x 0.031	0.98 [25]	0.98 [25]	0.019 [0.085] 0.015 [0.39]	0.026 [0.12] 0.04 [1]	0.033 [0.15] 0.085 [2.1]	0.048 [0.21] 0.13 [3.2]
0.4x1-25-25 0.016 x 0.039	0.98 [25]	0.98 [25]	0.024 [0.11] 0.015 [0.39]	0.033 [0.15] 0.04 [1]	0.041 [0.18] 0.085 [2.1]	0.06 [0.27] 0.13 [3.2]
0.406x0.559-25-25 0.016 x 0.022	0.98 [25]	0.98 [25]	0.014 [0.061] 0.015 [0.38]	0.019 [0.085] 0.039 [0.99]	0.024 [0.11] 0.083 [2.1]	0.035 [0.15] 0.12 [3.1]
0.5x0.25-25-25 0.02 x 0.0098	0.98 [25]	0.98 [25]	0.0094 [0.042] 0.012 [0.31]	0.013 [0.058] 0.031 [0.8]	0.016 [0.072] 0.066 [1.7]	0.023 [0.1] 0.096 [2.4]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-25-25 0.02 x 0.031	0.98 [25]	0.98 [25]	0.03 [0.13] 0.012 [0.31]	0.041 [0.18] 0.031 [0.8]	0.052 [0.23] 0.066 [1.7]	0.075 [0.33] 0.096 [2.4]
0.55x1.4-25-25 0.022 x 0.055	0.98 [25]	0.98 [25]	0.063 [0.28] 0.011 [0.28]	0.088 [0.39] 0.028 [0.72]	0.11 [0.49] 0.059 [1.5]	0.16 [0.71] 0.086 [2.2]
0.6x2.3-25-25 0.024 x 0.091	0.98 [25]	0.98 [25]	0.12 [0.55] 0.01 [0.26]	0.17 [0.76] 0.026 [0.66]	0.21 [0.95] 0.054 [1.4]	0.31 [1.4] 0.078 [2]
0.8x1.5-25-25 0.031 x 0.059	0.98 [25]	0.98 [25]	0.14 [0.64] 0.0076 [0.19]	0.2 [0.88] 0.019 [0.49]	0.25 [1.1] 0.04 [1]	0.36 [1.6] 0.057 [1.4]
1x2.6-25-25 0.039 x 0.1	0.98 [25]	0.98 [25]	0.39 [1.7] 0.006 [0.15]	0.54 [2.4] 0.015 [0.39]	0.67 [3] 0.031 [0.8]	0.97 [4.3] 0.045 [1.1]
1.5x4-25-25 0.059 x 0.16	0.98 [25]	0.98 [25]	1.3 [6] 0.004 [0.1]	1.9 [8.3] 0.01 [0.26]	2.3 [10] 0.02 [0.52]	3.4 [15] 0.029 [0.74]
0.152x0.411-25-50 0.006 x 0.016	0.98 [25]	2 [50]	0.00071 [0.0032] 0.021 [0.53]	0.00098 [0.0044] 0.055 [1.4]	0.0012 [0.0054] 0.12 [3]	0.0018 [0.0079] 0.18 [4.6]
0.152x0.813-25-50 0.006 x 0.032	0.98 [25]	2 [50]	0.0014 [0.0063] 0.021 [0.53]	0.0019 [0.0086] 0.055 [1.4]	0.0024 [0.011] 0.12 [3]	0.0035 [0.016] 0.18 [4.6]
0.25x0.5-25-50 0.0098 x 0.02	0.98 [25]	2 [50]	0.0023 [0.01] 0.013 [0.32]	0.0032 [0.014] 0.032 [0.82]	0.004 [0.018] 0.068 [1.7]	0.0059 [0.026] 0.1 [2.5]
0.3x2-25-50 0.012 x 0.079	0.98 [25]	2 [50]	0.013 [0.06] 0.01 [0.26]	0.019 [0.083] 0.027 [0.68]	0.023 [0.1] 0.056 [1.4]	0.034 [0.15] 0.081 [2]
0.4x0.8-25-50 0.016 x 0.031	0.98 [25]	2 [50]	0.0096 [0.043] 0.0078 [0.2]	0.013 [0.059] 0.02 [0.5]	0.016 [0.073] 0.041 [1]	0.024 [0.11] 0.059 [1.5]
0.4x1-25-50 0.016 x 0.039	0.98 [25]	2 [50]	0.012 [0.053] 0.0078 [0.2]	0.017 [0.074] 0.02 [0.5]	0.021 [0.092] 0.041 [1]	0.03 [0.13] 0.059 [1.5]
0.406x0.559-25-50 0.016 x 0.022	0.98 [25]	2 [50]	0.0069 [0.031] 0.0077 [0.19]	0.0095 [0.042] 0.02 [0.5]	0.012 [0.053] 0.04 [1]	0.017 [0.077] 0.058 [1.5]
0.5x0.25-25-50 0.02 x 0.0098	0.98 [25]	2 [50]	0.0047 [0.021] 0.0062 [0.16]	0.0065 [0.029] 0.016 [0.4]	0.0081 [0.036] 0.032 [0.82]	0.012 [0.052] 0.046 [1.2]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-25-50 0.02 x 0.031	0.98 [25]	2 [50]	0.015 [0.067] 0.0062 [0.16]	0.021 [0.092] 0.016 [0.4]	0.026 [0.11] 0.032 [0.82]	0.037 [0.17] 0.046 [1.2]
0.55x1.4-25-50 0.022 x 0.055	0.98 [25]	2 [50]	0.032 [0.14] 0.0056 [0.14]	0.044 [0.19] 0.014 [0.36]	0.055 [0.24] 0.029 [0.74]	0.079 [0.35] 0.042 [1.1]
0.6x2.3-25-50 0.024 x 0.091	0.98 [25]	2 [50]	0.062 [0.28] 0.0052 [0.13]	0.086 [0.38] 0.013 [0.33]	0.11 [0.47] 0.027 [0.68]	0.16 [0.69] 0.038 [0.97]
0.8x1.5-25-50 0.031 x 0.059	0.98 [25]	2 [50]	0.072 [0.32] 0.0039 [0.098]	0.099 [0.44] 0.0098 [0.25]	0.12 [0.55] 0.02 [0.5]	0.18 [0.8] 0.028 [0.71]
1x2.6-25-50 0.039 x 0.1	0.98 [25]	2 [50]	0.19 [0.87] 0.0031 [0.079]	0.27 [1.2] 0.0079 [0.2]	0.34 [1.5] 0.016 [0.4]	0.49 [2.2] 0.022 [0.57]
1.5x4-25-50 0.059 x 0.16	0.98 [25]	2 [50]	0.67 [3] 0.0021 [0.052]	0.93 [4.1] 0.0051 [0.13]	1.2 [5.2] 0.01 [0.26]	1.7 [7.5] 0.015 [0.37]
0.152x0.411-25-100 0.006 x 0.016	0.98 [25]	3.9 [100]	0.00036 [0.0016] 0.01 [0.26]	0.00049 [0.0022] 0.026 [0.67]	0.00061 [0.0027] 0.056 [1.4]	0.00089 [0.004] 0.08 [2]
0.152x0.813-25-100 0.006 x 0.032	0.98 [25]	3.9 [100]	0.0007 [0.0031] 0.01 [0.26]	0.00097 [0.0043] 0.026 [0.67]	0.0012 [0.0054] 0.056 [1.4]	0.0018 [0.0078] 0.08 [2]
0.25x0.5-25-100 0.0098 x 0.02	0.98 [25]	3.9 [100]	0.0012 [0.0052] 0.0063 [0.16]	0.0016 [0.0072] 0.016 [0.4]	0.002 [0.009] 0.033 [0.83]	0.0029 [0.013] 0.046 [1.2]
0.3x2-25-100 0.012 x 0.079	0.98 [25]	3.9 [100]	0.0067 [0.03] 0.0052 [0.13]	0.0093 [0.041] 0.013 [0.34]	0.012 [0.052] 0.027 [0.68]	0.017 [0.075] 0.038 [0.97]
0.4x0.8-25-100 0.016 x 0.031	0.98 [25]	3.9 [100]	0.0048 [0.021] 0.0039 [0.099]	0.0066 [0.029] 0.0098 [0.25]	0.0082 [0.037] 0.02 [0.51]	0.012 [0.053] 0.028 [0.72]
0.4x1-25-100 0.016 x 0.039	0.98 [25]	3.9 [100]	0.006 [0.027] 0.0039 [0.099]	0.0083 [0.037] 0.0098 [0.25]	0.01 [0.046] 0.02 [0.51]	0.015 [0.067] 0.028 [0.72]
0.406x0.559-25-100 0.016 x 0.022	0.98 [25]	3.9 [100]	0.0035 [0.015] 0.0038 [0.098]	0.0048 [0.021] 0.0098 [0.25]	0.0059 [0.026] 0.02 [0.5]	0.0086 [0.038] 0.028 [0.71]
0.5x0.25-25-100 0.02 x 0.0098	0.98 [25]	3.9 [100]	0.0023 [0.01] 0.0031 [0.079]	0.0032 [0.014] 0.0079 [0.2]	0.004 [0.018] 0.016 [0.4]	0.0059 [0.026] 0.022 [0.57]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-25-100 0.02 x 0.031	0.98 [25]	3.9 [100]	0.0075 [0.033] 0.0031 [0.079]	0.01 [0.046] 0.0079 [0.2]	0.013 [0.057] 0.016 [0.4]	0.019 [0.083] 0.022 [0.57]
0.55x1.4-25-100 0.022 x 0.055	0.98 [25]	3.9 [100]	0.016 [0.071] 0.0028 [0.072]	0.022 [0.097] 0.0071 [0.18]	0.027 [0.12] 0.015 [0.37]	0.04 [0.18] 0.02 [0.52]
0.6x2.3-25-100 0.024 x 0.091	0.98 [25]	3.9 [100]	0.031 [0.14] 0.0026 [0.066]	0.043 [0.19] 0.0067 [0.17]	0.053 [0.24] 0.013 [0.34]	0.078 [0.34] 0.019 [0.47]
0.8x1.5-25-100 0.031 x 0.059	0.98 [25]	3.9 [100]	0.036 [0.16] 0.0019 [0.049]	0.05 [0.22] 0.0047 [0.12]	0.062 [0.28] 0.0098 [0.25]	0.09 [0.4] 0.014 [0.35]
1x2.6-25-100 0.039 x 0.1	0.98 [25]	3.9 [100]	0.097 [0.43] 0.0016 [0.04]	0.13 [0.6] 0.0039 [0.1]	0.17 [0.75] 0.0079 [0.2]	0.24 [1.1] 0.011 [0.28]
1.5x4-25-100 0.059 x 0.16	0.98 [25]	3.9 [100]	0.34 [1.5] 0.001 [0.026]	0.47 [2.1] 0.0028 [0.07]	0.58 [2.6] 0.0051 [0.13]	0.84 [3.8] 0.0075 [0.19]
0.152x0.411-25-200 0.006 x 0.016	0.98 [25]	7.9 [200]	0.00018 [0.00079] 0.0052 [0.13]	0.00025 [0.0011] 0.013 [0.33]	0.00031 [0.0014] 0.027 [0.68]	0.00045 [0.002] 0.038 [0.96]
0.152x0.813-25-200 0.006 x 0.032	0.98 [25]	7.9 [200]	0.00035 [0.0016] 0.0052 [0.13]	0.00049 [0.0022] 0.013 [0.33]	0.0006 [0.0027] 0.027 [0.68]	0.00088 [0.0039] 0.038 [0.96]
0.25x0.5-25-200 0.0098 x 0.02	0.98 [25]	7.9 [200]	0.00058 [0.0026] 0.0031 [0.079]	0.00081 [0.0036] 0.0079 [0.2]	0.001 [0.0045] 0.016 [0.41]	0.0015 [0.0065] 0.022 [0.57]
0.3x2-25-200 0.012 x 0.079	0.98 [25]	7.9 [200]	0.0034 [0.015] 0.0026 [0.066]	0.0047 [0.021] 0.0067 [0.17]	0.0058 [0.026] 0.013 [0.34]	0.0084 [0.037] 0.019 [0.47]
0.4x0.8-25-200 0.016 x 0.031	0.98 [25]	7.9 [200]	0.0024 [0.011] 0.002 [0.05]	0.0033 [0.015] 0.0047 [0.12]	0.0041 [0.018] 0.0098 [0.25]	0.006 [0.027] 0.014 [0.35]
0.4x1-25-200 0.016 x 0.039	0.98 [25]	7.9 [200]	0.003 [0.013] 0.002 [0.05]	0.0041 [0.018] 0.0047 [0.12]	0.0052 [0.023] 0.0098 [0.25]	0.0075 [0.033] 0.014 [0.35]
0.406x0.559-25-200 0.016 x 0.022	0.98 [25]	7.9 [200]	0.0017 [0.0077] 0.0019 [0.049]	0.0024 [0.011] 0.0047 [0.12]	0.003 [0.013] 0.0098 [0.25]	0.0043 [0.019] 0.014 [0.35]
0.5x0.25-25-200 0.02 x 0.0098	0.98 [25]	7.9 [200]	0.0012 [0.0052] 0.0016 [0.04]	0.0016 [0.0072] 0.0039 [0.1]	0.002 [0.009] 0.0079 [0.2]	0.0029 [0.013] 0.011 [0.28]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-25-200 0.02 x 0.031	0.98 [25]	7.9 [200]	0.0037 [0.017] 0.0016 [0.04]	0.0052 [0.023] 0.0039 [0.1]	0.0064 [0.029] 0.0079 [0.2]	0.0094 [0.042] 0.011 [0.28]
0.55x1.4-25-200 0.022 x 0.055	0.98 [25]	7.9 [200]	0.0079 [0.035] 0.0014 [0.036]	0.011 [0.049] 0.0035 [0.09]	0.014 [0.061] 0.0071 [0.18]	0.02 [0.088] 0.01 [0.26]
0.6x2.3-25-200 0.024 x 0.091	0.98 [25]	7.9 [200]	0.016 [0.069] 0.0013 [0.033]	0.021 [0.095] 0.0031 [0.08]	0.027 [0.12] 0.0067 [0.17]	0.039 [0.17] 0.0091 [0.23]
0.8x1.5-25-200 0.031 x 0.059	0.98 [25]	7.9 [200]	0.018 [0.08] 0.00097 [0.025]	0.025 [0.11] 0.0024 [0.06]	0.031 [0.14] 0.0047 [0.12]	0.045 [0.2] 0.0067 [0.17]
1x2.6-25-200 0.039 x 0.1	0.98 [25]	7.9 [200]	0.049 [0.22] 0.00078 [0.02]	0.067 [0.3] 0.002 [0.05]	0.084 [0.37] 0.0039 [0.1]	0.12 [0.54] 0.0055 [0.14]
1.5x4-25-200 0.059 x 0.16	0.98 [25]	7.9 [200]	0.17 [0.75] 0.00052 [0.013]	0.23 [1] 0.0012 [0.03]	0.29 [1.3] 0.0028 [0.07]	0.42 [1.9] 0.0035 [0.09]
0.152x0.411-50-10 0.006 x 0.016	2 [50]	0.39 [10]	0.0036 [0.016] 0.58 [15]	0.0049 [0.022] 0.63 [16]	0.0061 [0.027] 0.63 [16]	0.0089 [0.04] 0.63 [16]
0.152x0.813-50-10 0.006 x 0.032	2 [50]	0.39 [10]	0.007 [0.031] 0.58 [15]	0.0097 [0.043] 0.63 [16]	0.012 [0.054] 0.63 [16]	0.018 [0.078] 0.63 [16]
0.25x0.5-50-10 0.0098 x 0.02	2 [50]	0.39 [10]	0.012 [0.052] 0.35 [8.8]	0.016 [0.072] 0.63 [16]	0.02 [0.09] 0.63 [16]	0.029 [0.13] 0.63 [16]
0.3x2-50-10 0.012 x 0.079	2 [50]	0.39 [10]	0.067 [0.3] 0.28 [7.2]	0.093 [0.41] 0.63 [16]	0.12 [0.52] 0.63 [16]	0.17 [0.75] 0.63 [16]
0.4x0.8-50-10 0.016 x 0.031	2 [50]	0.39 [10]	0.048 [0.21] 0.2 [5.2]	0.066 [0.29] 0.56 [14]	0.082 [0.37] 0.63 [16]	0.12 [0.53] 0.63 [16]
0.4x1-50-10 0.016 x 0.039	2 [50]	0.39 [10]	0.06 [0.27] 0.2 [5.2]	0.083 [0.37] 0.56 [14]	0.1 [0.46] 0.63 [16]	0.15 [0.67] 0.63 [16]
0.406x0.559-50-10 0.016 x 0.022	2 [50]	0.39 [10]	0.035 [0.15] 0.2 [5.1]	0.048 [0.21] 0.55 [14]	0.059 [0.26] 0.63 [16]	0.086 [0.38] 0.63 [16]
0.5x0.25-50-10 0.02 x 0.0098	2 [50]	0.39 [10]	0.023 [0.1] 0.16 [4.1]	0.032 [0.14] 0.45 [11]	0.04 [0.18] 0.63 [16]	0.059 [0.26] 0.63 [16]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-50-10 0.02 x 0.031	2 [50]	0.39 [10]	0.075 [0.33] 0.16 [4.1]	0.1 [0.46] 0.45 [11]	0.13 [0.57] 0.63 [16]	0.19 [0.83] 0.63 [16]
0.55x1.4-50-10 0.022 x 0.055	2 [50]	0.39 [10]	0.16 [0.71] 0.14 [3.7]	0.22 [0.97] 0.4 [10]	0.27 [1.2] 0.63 [16]	0.4 [1.8] 0.63 [16]
0.6x2.3-50-10 0.024 x 0.091	2 [50]	0.39 [10]	0.31 [1.4] 0.13 [3.3]	0.43 [1.9] 0.36 [9.3]	0.53 [2.4] 0.63 [16]	0.78 [3.5] 0.63 [16]
0.8x1.5-50-10 0.031 x 0.059	2 [50]	0.39 [10]	0.36 [1.6] 0.096 [2.4]	0.5 [2.2] 0.26 [6.7]	0.62 [2.8] 0.56 [14]	0.9 [4] 0.63 [16]
1x2.6-50-10 0.039 x 0.1	2 [50]	0.39 [10]	0.97 [4.3] 0.076 [1.9]	1.3 [6] 0.2 [5.2]	1.7 [7.5] 0.45 [11]	2.4 [11] 0.61 [15]
1.5x4-50-10 0.059 x 0.16	2 [50]	0.39 [10]	3.4 [15] 0.05 [1.3]	4.7 [21] 0.13 [3.3]	5.8 [26] 0.28 [7.2]	8.4 [38] 0.41 [11]
0.152x0.411-50-25 0.006 x 0.016	2 [50]	0.98 [25]	0.0014 [0.0063] 0.37 [9.4]	0.002 [0.0087] 1.8 [45]	0.0024 [0.011] 2.6 [65]	0.0036 [0.016] 2.6 [65]
0.152x0.813-50-25 0.006 x 0.032	2 [50]	0.98 [25]	0.0028 [0.013] 0.37 [9.4]	0.0039 [0.017] 1.8 [45]	0.0048 [0.022] 2.6 [65]	0.007 [0.031] 2.6 [65]
0.25x0.5-50-25 0.0098 x 0.02	2 [50]	0.98 [25]	0.0047 [0.021] 0.2 [5.1]	0.0065 [0.029] 0.67 [17]	0.0081 [0.036] 2.6 [65]	0.012 [0.052] 2.6 [65]
0.3x2-50-25 0.012 x 0.079	2 [50]	0.98 [25]	0.027 [0.12] 0.16 [4.2]	0.037 [0.17] 0.51 [13]	0.046 [0.21] 1.8 [46]	0.067 [0.3] 2.6 [65]
0.4x0.8-50-25 0.016 x 0.031	2 [50]	0.98 [25]	0.019 [0.085] 0.12 [3]	0.026 [0.12] 0.35 [8.8]	0.033 [0.15] 0.98 [25]	0.048 [0.21] 2.1 [53]
0.4x1-50-25 0.016 x 0.039	2 [50]	0.98 [25]	0.024 [0.11] 0.12 [3]	0.033 [0.15] 0.35 [8.8]	0.041 [0.18] 0.98 [25]	0.06 [0.27] 2.1 [53]
0.406x0.559-50-25 0.016 x 0.022	2 [50]	0.98 [25]	0.014 [0.061] 0.12 [3]	0.019 [0.085] 0.34 [8.7]	0.024 [0.11] 0.95 [24]	0.035 [0.15] 2 [51]
0.5x0.25-50-25 0.02 x 0.0098	2 [50]	0.98 [25]	0.0094 [0.042] 0.094 [2.4]	0.013 [0.058] 0.26 [6.7]	0.016 [0.072] 0.67 [17]	0.023 [0.1] 1.2 [31]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-50-25 0.02 x 0.031	2 [50]	0.98 [25]	0.03 [0.13] 0.094 [2.4]	0.041 [0.18] 0.26 [6.7]	0.052 [0.23] 0.67 [17]	0.075 [0.33] 1.2 [31]
0.55x1.4-50-25 0.022 x 0.055	2 [50]	0.98 [25]	0.063 [0.28] 0.085 [2.2]	0.088 [0.39] 0.24 [6]	0.11 [0.49] 0.58 [15]	0.16 [0.71] 1 [26]
0.6x2.3-50-25 0.024 x 0.091	2 [50]	0.98 [25]	0.12 [0.55] 0.077 [2]	0.17 [0.76] 0.21 [5.4]	0.21 [0.95] 0.51 [13]	0.31 [1.4] 0.87 [22]
0.8x1.5-50-25 0.031 x 0.059	2 [50]	0.98 [25]	0.14 [0.64] 0.057 [1.4]	0.2 [0.88] 0.15 [3.9]	0.25 [1.1] 0.35 [8.8]	0.36 [1.6] 0.55 [14]
1x2.6-50-25 0.039 x 0.1	2 [50]	0.98 [25]	0.39 [1.7] 0.045 [1.1]	0.54 [2.4] 0.12 [3]	0.67 [3] 0.26 [6.7]	0.97 [4.3] 0.4 [10]
1.5x4-50-25 0.059 x 0.16	2 [50]	0.98 [25]	1.3 [6] 0.03 [0.76]	1.9 [8.3] 0.077 [2]	2.3 [10] 0.16 [4.2]	3.4 [15] 0.24 [6.2]
0.152x0.411-50-50 0.006 x 0.016	2 [50]	2 [50]	0.00071 [0.0032] 0.18 [4.6]	0.00098 [0.0044] 0.57 [15]	0.0012 [0.0054] 2.5 [62]	0.0018 [0.0079] 6.3 [160]
0.152x0.813-50-50 0.006 x 0.032	2 [50]	2 [50]	0.0014 [0.0063] 0.18 [4.6]	0.0019 [0.0086] 0.57 [15]	0.0024 [0.011] 2.5 [62]	0.0035 [0.016] 6.3 [160]
0.25x0.5-50-50 0.0098 x 0.02	2 [50]	2 [50]	0.0023 [0.01] 0.1 [2.6]	0.0032 [0.014] 0.29 [7.5]	0.004 [0.018] 0.78 [20]	0.0059 [0.026] 1.5 [39]
0.3x2-50-50 0.012 x 0.079	2 [50]	2 [50]	0.013 [0.06] 0.085 [2.2]	0.019 [0.083] 0.24 [6]	0.023 [0.1] 0.58 [15]	0.034 [0.15] 1 [26]
0.4x0.8-50-50 0.016 x 0.031	2 [50]	2 [50]	0.0096 [0.043] 0.063 [1.6]	0.013 [0.059] 0.17 [4.3]	0.016 [0.073] 0.39 [9.9]	0.024 [0.11] 0.63 [16]
0.4x1-50-50 0.016 x 0.039	2 [50]	2 [50]	0.012 [0.053] 0.063 [1.6]	0.017 [0.074] 0.17 [4.3]	0.021 [0.092] 0.39 [9.9]	0.03 [0.13] 0.63 [16]
0.406x0.559-50-50 0.016 x 0.022	2 [50]	2 [50]	0.0069 [0.031] 0.062 [1.6]	0.0095 [0.042] 0.17 [4.2]	0.012 [0.053] 0.38 [9.7]	0.017 [0.077] 0.62 [16]
0.5x0.25-50-50 0.02 x 0.0098	2 [50]	2 [50]	0.0047 [0.021] 0.05 [1.3]	0.0065 [0.029] 0.13 [3.4]	0.0081 [0.036] 0.29 [7.5]	0.012 [0.052] 0.46 [12]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-50-50 0.02 x 0.031	2 [50]	2 [50]	0.015 [0.067] 0.05 [1.3]	0.021 [0.092] 0.13 [3.4]	0.026 [0.11] 0.29 [7.5]	0.037 [0.17] 0.46 [12]
0.55x1.4-50-50 0.022 x 0.055	2 [50]	2 [50]	0.032 [0.14] 0.045 [1.1]	0.044 [0.19] 0.12 [3]	0.055 [0.24] 0.26 [6.7]	0.079 [0.35] 0.4 [10]
0.6x2.3-50-50 0.024 x 0.091	2 [50]	2 [50]	0.062 [0.28] 0.041 [1]	0.086 [0.38] 0.11 [2.7]	0.11 [0.47] 0.24 [6]	0.16 [0.69] 0.36 [9.1]
0.8x1.5-50-50 0.031 x 0.059	2 [50]	2 [50]	0.072 [0.32] 0.031 [0.78]	0.099 [0.44] 0.079 [2]	0.12 [0.55] 0.17 [4.3]	0.18 [0.8] 0.25 [6.3]
1x2.6-50-50 0.039 x 0.1	2 [50]	2 [50]	0.19 [0.87] 0.024 [0.62]	0.27 [1.2] 0.063 [1.6]	0.34 [1.5] 0.13 [3.4]	0.49 [2.2] 0.19 [4.9]
1.5x4-50-50 0.059 x 0.16	2 [50]	2 [50]	0.67 [3] 0.016 [0.41]	0.93 [4.1] 0.041 [1]	1.2 [5.2] 0.085 [2.2]	1.7 [7.5] 0.12 [3.1]
0.152x0.411-50-100 0.006 x 0.016	2 [50]	3.9 [100]	0.00036 [0.0016] 0.086 [2.2]	0.00049 [0.0022] 0.24 [6.1]	0.00061 [0.0027] 0.6 [15]	0.00089 [0.004] 1.1 [27]
0.152x0.813-50-100 0.006 x 0.032	2 [50]	3.9 [100]	0.0007 [0.0031] 0.086 [2.2]	0.00097 [0.0043] 0.24 [6.1]	0.0012 [0.0054] 0.6 [15]	0.0018 [0.0078] 1.1 [27]
0.25x0.5-50-100 0.0098 x 0.02	2 [50]	3.9 [100]	0.0012 [0.0052] 0.051 [1.3]	0.0016 [0.0072] 0.14 [3.5]	0.002 [0.009] 0.3 [7.7]	0.0029 [0.013] 0.47 [12]
0.3x2-50-100 0.012 x 0.079	2 [50]	3.9 [100]	0.0067 [0.03] 0.042 [1.1]	0.0093 [0.041] 0.11 [2.8]	0.012 [0.052] 0.24 [6.2]	0.017 [0.075] 0.37 [9.4]
0.4x0.8-50-100 0.016 x 0.031	2 [50]	3.9 [100]	0.0048 [0.021] 0.032 [0.8]	0.0066 [0.029] 0.082 [2.1]	0.0082 [0.037] 0.17 [4.4]	0.012 [0.053] 0.26 [6.6]
0.4x1-50-100 0.016 x 0.039	2 [50]	3.9 [100]	0.006 [0.027] 0.032 [0.8]	0.0083 [0.037] 0.082 [2.1]	0.01 [0.046] 0.17 [4.4]	0.015 [0.067] 0.26 [6.6]
0.406x0.559-50-100 0.016 x 0.022	2 [50]	3.9 [100]	0.0035 [0.015] 0.031 [0.79]	0.0048 [0.021] 0.08 [2]	0.0059 [0.026] 0.17 [4.4]	0.0086 [0.038] 0.25 [6.5]
0.5x0.25-50-100 0.02 x 0.0098	2 [50]	3.9 [100]	0.0023 [0.01] 0.025 [0.64]	0.0032 [0.014] 0.065 [1.6]	0.004 [0.018] 0.14 [3.5]	0.0059 [0.026] 0.2 [5]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-50-100 0.02 x 0.031	2 [50]	3.9 [100]	0.0075 [0.033] 0.025 [0.64]	0.01 [0.046] 0.065 [1.6]	0.013 [0.057] 0.14 [3.5]	0.019 [0.083] 0.2 [5]
0.55x1.4-50-100 0.022 x 0.055	2 [50]	3.9 [100]	0.016 [0.071] 0.023 [0.58]	0.022 [0.097] 0.059 [1.5]	0.027 [0.12] 0.12 [3.1]	0.04 [0.18] 0.18 [4.5]
0.6x2.3-50-100 0.024 x 0.091	2 [50]	3.9 [100]	0.031 [0.14] 0.021 [0.53]	0.043 [0.19] 0.054 [1.4]	0.053 [0.24] 0.11 [2.8]	0.078 [0.34] 0.16 [4.1]
0.8x1.5-50-100 0.031 x 0.059	2 [50]	3.9 [100]	0.036 [0.16] 0.016 [0.4]	0.05 [0.22] 0.04 [1]	0.062 [0.28] 0.082 [2.1]	0.09 [0.4] 0.12 [3]
1x2.6-50-100 0.039 x 0.1	2 [50]	3.9 [100]	0.097 [0.43] 0.012 [0.32]	0.13 [0.6] 0.031 [0.8]	0.17 [0.75] 0.065 [1.6]	0.24 [1.1] 0.092 [2.3]
1.5x4-50-100 0.059 x 0.16	2 [50]	3.9 [100]	0.34 [1.5] 0.0083 [0.21]	0.47 [2.1] 0.021 [0.53]	0.58 [2.6] 0.043 [1.1]	0.84 [3.8] 0.06 [1.5]
0.152x0.411-50-200 0.006 x 0.016	2 [50]	7.9 [200]	0.00018 [0.00079] 0.042 [1.1]	0.00025 [0.0011] 0.11 [2.8]	0.00031 [0.0014] 0.24 [6.2]	0.00045 [0.002] 0.37 [9.4]
0.152x0.813-50-200 0.006 x 0.032	2 [50]	7.9 [200]	0.00035 [0.0016] 0.042 [1.1]	0.00049 [0.0022] 0.11 [2.8]	0.0006 [0.0027] 0.24 [6.2]	0.00088 [0.0039] 0.37 [9.4]
0.25x0.5-50-200 0.0098 x 0.02	2 [50]	7.9 [200]	0.00058 [0.0026] 0.025 [0.64]	0.00081 [0.0036] 0.065 [1.7]	0.001 [0.0045] 0.14 [3.5]	0.0015 [0.0065] 0.2 [5.1]
0.3x2-50-200 0.012 x 0.079	2 [50]	7.9 [200]	0.0034 [0.015] 0.021 [0.53]	0.0047 [0.021] 0.054 [1.4]	0.0058 [0.026] 0.11 [2.9]	0.0084 [0.037] 0.16 [4.1]
0.4x0.8-50-200 0.016 x 0.031	2 [50]	7.9 [200]	0.0024 [0.011] 0.016 [0.4]	0.0033 [0.015] 0.04 [1]	0.0041 [0.018] 0.083 [2.1]	0.006 [0.027] 0.12 [3]
0.4x1-50-200 0.016 x 0.039	2 [50]	7.9 [200]	0.003 [0.013] 0.016 [0.4]	0.0041 [0.018] 0.04 [1]	0.0052 [0.023] 0.083 [2.1]	0.0075 [0.033] 0.12 [3]
0.406x0.559-50-200 0.016 x 0.022	2 [50]	7.9 [200]	0.0017 [0.0077] 0.015 [0.39]	0.0024 [0.011] 0.039 [1]	0.003 [0.013] 0.081 [2.1]	0.0043 [0.019] 0.12 [3]
0.5x0.25-50-200 0.02 x 0.0098	2 [50]	7.9 [200]	0.0012 [0.0052] 0.013 [0.32]	0.0016 [0.0072] 0.032 [0.81]	0.002 [0.009] 0.065 [1.7]	0.0029 [0.013] 0.093 [2.4]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-50-200 0.02 x 0.031	2 [50]	7.9 [200]	0.0037 [0.017] 0.013 [0.32]	0.0052 [0.023] 0.032 [0.81]	0.0064 [0.029] 0.065 [1.7]	0.0094 [0.042] 0.093 [2.4]
0.55x1.4-50-200 0.022 x 0.055	2 [50]	7.9 [200]	0.0079 [0.035] 0.011 [0.29]	0.011 [0.049] 0.029 [0.73]	0.014 [0.061] 0.059 [1.5]	0.02 [0.088] 0.084 [2.1]
0.6x2.3-50-200 0.024 x 0.091	2 [50]	7.9 [200]	0.016 [0.069] 0.01 [0.26]	0.021 [0.095] 0.026 [0.67]	0.027 [0.12] 0.054 [1.4]	0.039 [0.17] 0.077 [1.9]
0.8x1.5-50-200 0.031 x 0.059	2 [50]	7.9 [200]	0.018 [0.08] 0.0078 [0.2]	0.025 [0.11] 0.02 [0.5]	0.031 [0.14] 0.04 [1]	0.045 [0.2] 0.057 [1.4]
1x2.6-50-200 0.039 x 0.1	2 [50]	7.9 [200]	0.049 [0.22] 0.0062 [0.16]	0.067 [0.3] 0.016 [0.4]	0.084 [0.37] 0.032 [0.81]	0.12 [0.54] 0.045 [1.1]
1.5x4-50-200 0.059 x 0.16	2 [50]	7.9 [200]	0.17 [0.75] 0.0042 [0.11]	0.23 [1] 0.01 [0.26]	0.29 [1.3] 0.021 [0.53]	0.42 [1.9] 0.03 [0.75]
0.152x0.411-100-10 0.006 x 0.016	3.9 [100]	0.39 [10]	0.0036 [0.016] 0.36 [9.2]	0.0049 [0.022] 0.36 [9.2]	0.0061 [0.027] 0.36 [9.2]	0.0089 [0.04] 0.36 [9.2]
0.152x0.813-100-10 0.006 x 0.032	3.9 [100]	0.39 [10]	0.007 [0.031] 0.36 [9.2]	0.0097 [0.043] 0.36 [9.2]	0.012 [0.054] 0.36 [9.2]	0.018 [0.078] 0.36 [9.2]
0.25x0.5-100-10 0.0098 x 0.02	3.9 [100]	0.39 [10]	0.012 [0.052] 0.36 [9.2]	0.016 [0.072] 0.36 [9.2]	0.02 [0.09] 0.36 [9.2]	0.029 [0.13] 0.36 [9.2]
0.3x2-100-10 0.012 x 0.079	3.9 [100]	0.39 [10]	0.067 [0.3] 0.36 [9.2]	0.093 [0.41] 0.36 [9.2]	0.12 [0.52] 0.36 [9.2]	0.17 [0.75] 0.36 [9.2]
0.4x0.8-100-10 0.016 x 0.031	3.9 [100]	0.39 [10]	0.048 [0.21] 0.36 [9.2]	0.066 [0.29] 0.36 [9.2]	0.082 [0.37] 0.36 [9.2]	0.12 [0.53] 0.36 [9.2]
0.4x1-100-10 0.016 x 0.039	3.9 [100]	0.39 [10]	0.06 [0.27] 0.36 [9.2]	0.083 [0.37] 0.36 [9.2]	0.1 [0.46] 0.36 [9.2]	0.15 [0.67] 0.36 [9.2]
0.406x0.559-100-10 0.016 x 0.022	3.9 [100]	0.39 [10]	0.035 [0.15] 0.36 [9.2]	0.048 [0.21] 0.36 [9.2]	0.059 [0.26] 0.36 [9.2]	0.086 [0.38] 0.36 [9.2]
0.5x0.25-100-10 0.02 x 0.0098	3.9 [100]	0.39 [10]	0.023 [0.1] 0.36 [9.2]	0.032 [0.14] 0.36 [9.2]	0.04 [0.18] 0.36 [9.2]	0.059 [0.26] 0.36 [9.2]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-100-10 0.02 x 0.031	3.9 [100]	0.39 [10]	0.075 [0.33] 0.36 [9.2]	0.1 [0.46] 0.36 [9.2]	0.13 [0.57] 0.36 [9.2]	0.19 [0.83] 0.36 [9.2]
0.55x1.4-100-10 0.022 x 0.055	3.9 [100]	0.39 [10]	0.16 [0.71] 0.36 [9.2]	0.22 [0.97] 0.36 [9.2]	0.27 [1.2] 0.36 [9.2]	0.4 [1.8] 0.36 [9.2]
0.6x2.3-100-10 0.024 x 0.091	3.9 [100]	0.39 [10]	0.31 [1.4] 0.35 [8.9]	0.43 [1.9] 0.36 [9.2]	0.53 [2.4] 0.36 [9.2]	0.78 [3.5] 0.36 [9.2]
0.8x1.5-100-10 0.031 x 0.059	3.9 [100]	0.39 [10]	0.36 [1.6] 0.3 [7.6]	0.5 [2.2] 0.36 [9.2]	0.62 [2.8] 0.36 [9.2]	0.9 [4] 0.36 [9.2]
1x2.6-100-10 0.039 x 0.1	3.9 [100]	0.39 [10]	0.97 [4.3] 0.25 [6.4]	1.3 [6] 0.36 [9.2]	1.7 [7.5] 0.36 [9.2]	2.4 [11] 0.36 [9.2]
1.5x4-100-10 0.059 x 0.16	3.9 [100]	0.39 [10]	3.4 [15] 0.18 [4.5]	4.7 [21] 0.35 [8.9]	5.8 [26] 0.36 [9.2]	8.4 [38] 0.36 [9.2]
0.152x0.411-100-25 0.006 x 0.016	3.9 [100]	0.98 [25]	0.0014 [0.0063] 1.8 [46]	0.002 [0.0087] 1.8 [46]	0.0024 [0.011] 1.8 [46]	0.0036 [0.016] 1.8 [46]
0.152x0.813-100-25 0.006 x 0.032	3.9 [100]	0.98 [25]	0.0028 [0.013] 1.8 [46]	0.0039 [0.017] 1.8 [46]	0.0048 [0.022] 1.8 [46]	0.007 [0.031] 1.8 [46]
0.25x0.5-100-25 0.0098 x 0.02	3.9 [100]	0.98 [25]	0.0047 [0.021] 1.6 [40]	0.0065 [0.029] 1.8 [46]	0.0081 [0.036] 1.8 [46]	0.012 [0.052] 1.8 [46]
0.3x2-100-25 0.012 x 0.079	3.9 [100]	0.98 [25]	0.027 [0.12] 1.3 [32]	0.037 [0.17] 1.8 [46]	0.046 [0.21] 1.8 [46]	0.067 [0.3] 1.8 [46]
0.4x0.8-100-25 0.016 x 0.031	3.9 [100]	0.98 [25]	0.019 [0.085] 0.88 [22]	0.026 [0.12] 1.8 [46]	0.033 [0.15] 1.8 [46]	0.048 [0.21] 1.8 [46]
0.4x1-100-25 0.016 x 0.039	3.9 [100]	0.98 [25]	0.024 [0.11] 0.88 [22]	0.033 [0.15] 1.8 [46]	0.041 [0.18] 1.8 [46]	0.06 [0.27] 1.8 [46]
0.406x0.559-100-25 0.016 x 0.022	3.9 [100]	0.98 [25]	0.014 [0.061] 0.86 [22]	0.019 [0.085] 1.8 [46]	0.024 [0.11] 1.8 [46]	0.035 [0.15] 1.8 [46]
0.5x0.25-100-25 0.02 x 0.0098	3.9 [100]	0.98 [25]	0.0094 [0.042] 0.67 [17]	0.013 [0.058] 1.8 [46]	0.016 [0.072] 1.8 [46]	0.023 [0.1] 1.8 [46]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-100-25 0.02 x 0.031	3.9 [100]	0.98 [25]	0.03 [0.13] 0.67 [17]	0.041 [0.18] 1.8 [46]	0.052 [0.23] 1.8 [46]	0.075 [0.33] 1.8 [46]
0.55x1.4-100-25 0.022 x 0.055	3.9 [100]	0.98 [25]	0.063 [0.28] 0.59 [15]	0.088 [0.39] 1.8 [45]	0.11 [0.49] 1.8 [46]	0.16 [0.71] 1.8 [46]
0.6x2.3-100-25 0.024 x 0.091	3.9 [100]	0.98 [25]	0.12 [0.55] 0.53 [14]	0.17 [0.76] 1.7 [42]	0.21 [0.95] 1.8 [46]	0.31 [1.4] 1.8 [46]
0.8x1.5-100-25 0.031 x 0.059	3.9 [100]	0.98 [25]	0.14 [0.64] 0.38 [9.7]	0.2 [0.88] 1.2 [30]	0.25 [1.1] 1.8 [46]	0.36 [1.6] 1.8 [46]
1x2.6-100-25 0.039 x 0.1	3.9 [100]	0.98 [25]	0.39 [1.7] 0.3 [7.6]	0.54 [2.4] 0.88 [22]	0.67 [3] 1.8 [46]	0.97 [4.3] 1.8 [46]
1.5x4-100-25 0.059 x 0.16	3.9 [100]	0.98 [25]	1.3 [6] 0.19 [4.9]	1.9 [8.3] 0.53 [14]	2.3 [10] 1.3 [32]	3.4 [15] 1.8 [46]
0.152x0.411-100-50 0.006 x 0.016	3.9 [100]	2 [50]	0.00071 [0.0032] 2.2 [55]	0.00098 [0.0044] 5.1 [130]	0.0012 [0.0054] 5.1 [130]	0.0018 [0.0079] 5.1 [130]
0.152x0.813-100-50 0.006 x 0.032	3.9 [100]	2 [50]	0.0014 [0.0063] 2.2 [55]	0.0019 [0.0086] 5.1 [130]	0.0024 [0.011] 5.1 [130]	0.0035 [0.016] 5.1 [130]
0.25x0.5-100-50 0.0098 x 0.02	3.9 [100]	2 [50]	0.0023 [0.01] 0.97 [25]	0.0032 [0.014] 5.1 [130]	0.004 [0.018] 5.1 [130]	0.0059 [0.026] 5.1 [130]
0.3x2-100-50 0.012 x 0.079	3.9 [100]	2 [50]	0.013 [0.06] 0.76 [19]	0.019 [0.083] 3.7 [93]	0.023 [0.1] 5.1 [130]	0.034 [0.15] 5.1 [130]
0.4x0.8-100-50 0.016 x 0.031	3.9 [100]	2 [50]	0.0096 [0.043] 0.53 [13]	0.013 [0.059] 2 [50]	0.016 [0.073] 5.1 [130]	0.024 [0.11] 5.1 [130]
0.4x1-100-50 0.016 x 0.039	3.9 [100]	2 [50]	0.012 [0.053] 0.53 [13]	0.017 [0.074] 2 [50]	0.021 [0.092] 5.1 [130]	0.03 [0.13] 5.1 [130]
0.406x0.559-100-50 0.016 x 0.022	3.9 [100]	2 [50]	0.0069 [0.031] 0.52 [13]	0.0095 [0.042] 1.9 [48]	0.012 [0.053] 5.1 [130]	0.017 [0.077] 5.1 [130]
0.5x0.25-100-50 0.02 x 0.0098	3.9 [100]	2 [50]	0.0047 [0.021] 0.4 [10]	0.0065 [0.029] 1.3 [34]	0.0081 [0.036] 5.1 [130]	0.012 [0.052] 5.1 [130]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-100-50 0.02 x 0.031	3.9 [100]	2 [50]	0.015 [0.067] 0.4 [10]	0.021 [0.092] 1.3 [34]	0.026 [0.11] 5.1 [130]	0.037 [0.17] 5.1 [130]
0.55x1.4-100-50 0.022 x 0.055	3.9 [100]	2 [50]	0.032 [0.14] 0.36 [9.2]	0.044 [0.19] 1.2 [30]	0.055 [0.24] 4.6 [120]	0.079 [0.35] 5.1 [130]
0.6x2.3-100-50 0.024 x 0.091	3.9 [100]	2 [50]	0.062 [0.28] 0.33 [8.3]	0.086 [0.38] 1 [26]	0.11 [0.47] 3.7 [93]	0.16 [0.69] 5.1 [130]
0.8x1.5-100-50 0.031 x 0.059	3.9 [100]	2 [50]	0.072 [0.32] 0.24 [6.1]	0.099 [0.44] 0.7 [18]	0.12 [0.55] 2 [50]	0.18 [0.8] 4.1 [100]
1x2.6-100-50 0.039 x 0.1	3.9 [100]	2 [50]	0.19 [0.87] 0.19 [4.8]	0.27 [1.2] 0.53 [13]	0.34 [1.5] 1.3 [34]	0.49 [2.2] 2.4 [62]
1.5x4-100-50 0.059 x 0.16	3.9 [100]	2 [50]	0.67 [3] 0.12 [3.1]	0.93 [4.1] 0.33 [8.3]	1.2 [5.2] 0.76 [19]	1.7 [7.5] 1.2 [31]
0.152x0.411-100-100 0.006 x 0.016	3.9 [100]	3.9 [100]	0.00036 [0.0016] 0.84 [21]	0.00049 [0.0022] 4.9 [120]	0.00061 [0.0027] 13 [320]	0.00089 [0.004] 13 [320]
0.152x0.813-100-100 0.006 x 0.032	3.9 [100]	3.9 [100]	0.0007 [0.0031] 0.84 [21]	0.00097 [0.0043] 4.9 [120]	0.0012 [0.0054] 13 [320]	0.0018 [0.0078] 13 [320]
0.25x0.5-100-100 0.0098 x 0.02	3.9 [100]	3.9 [100]	0.0012 [0.0052] 0.45 [11]	0.0016 [0.0072] 1.6 [40]	0.002 [0.009] 13 [320]	0.0029 [0.013] 13 [320]
0.3x2-100-100 0.012 x 0.079	3.9 [100]	3.9 [100]	0.0067 [0.03] 0.36 [9.2]	0.0093 [0.041] 1.2 [30]	0.012 [0.052] 5.2 [130]	0.017 [0.075] 13 [320]
0.4x0.8-100-100 0.016 x 0.031	3.9 [100]	3.9 [100]	0.0048 [0.021] 0.26 [6.7]	0.0066 [0.029] 0.78 [20]	0.0082 [0.037] 2.4 [60]	0.012 [0.053] 6.3 [160]
0.4x1-100-100 0.016 x 0.039	3.9 [100]	3.9 [100]	0.006 [0.027] 0.26 [6.7]	0.0083 [0.037] 0.78 [20]	0.01 [0.046] 2.4 [60]	0.015 [0.067] 6.3 [160]
0.406x0.559-100-100 0.016 x 0.022	3.9 [100]	3.9 [100]	0.0035 [0.015] 0.26 [6.6]	0.0048 [0.021] 0.77 [19]	0.0059 [0.026] 2.3 [58]	0.0086 [0.038] 5.9 [150]
0.5x0.25-100-100 0.02 x 0.0098	3.9 [100]	3.9 [100]	0.0023 [0.01] 0.21 [5.2]	0.0032 [0.014] 0.59 [15]	0.004 [0.018] 1.6 [40]	0.0059 [0.026] 3 [77]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-100-100 0.02 x 0.031	3.9 [100]	3.9 [100]	0.0075 [0.033] 0.21 [5.2]	0.01 [0.046] 0.59 [15]	0.013 [0.057] 1.6 [40]	0.019 [0.083] 3 [77]
0.55x1.4-100-100 0.022 x 0.055	3.9 [100]	3.9 [100]	0.016 [0.071] 0.19 [4.7]	0.022 [0.097] 0.52 [13]	0.027 [0.12] 1.3 [34]	0.04 [0.18] 2.4 [62]
0.6x2.3-100-100 0.024 x 0.091	3.9 [100]	3.9 [100]	0.031 [0.14] 0.17 [4.3]	0.043 [0.19] 0.47 [12]	0.053 [0.24] 1.2 [30]	0.078 [0.34] 2.1 [52]
0.8x1.5-100-100 0.031 x 0.059	3.9 [100]	3.9 [100]	0.036 [0.16] 0.13 [3.2]	0.05 [0.22] 0.34 [8.6]	0.062 [0.28] 0.78 [20]	0.09 [0.4] 1.3 [32]
1x2.6-100-100 0.039 x 0.1	3.9 [100]	3.9 [100]	0.097 [0.43] 0.099 [2.5]	0.13 [0.6] 0.26 [6.7]	0.17 [0.75] 0.59 [15]	0.24 [1.1] 0.91 [23]
1.5x4-100-100 0.059 x 0.16	3.9 [100]	3.9 [100]	0.34 [1.5] 0.065 [1.7]	0.47 [2.1] 0.17 [4.3]	0.58 [2.6] 0.36 [9.2]	0.84 [3.8] 0.54 [14]
0.152x0.411-100-200 0.006 x 0.016	3.9 [100]	7.9 [200]	0.00018 [0.00079] 0.37 [9.4]	0.00025 [0.0011] 1.2 [30]	0.00031 [0.0014] 5.4 [140]	0.00045 [0.002] 28 [710]
0.152x0.813-100-200 0.006 x 0.032	3.9 [100]	7.9 [200]	0.00035 [0.0016] 0.37 [9.4]	0.00049 [0.0022] 1.2 [30]	0.0006 [0.0027] 5.4 [140]	0.00088 [0.0039] 28 [710]
0.25x0.5-100-200 0.0098 x 0.02	3.9 [100]	7.9 [200]	0.00058 [0.0026] 0.21 [5.4]	0.00081 [0.0036] 0.61 [15]	0.001 [0.0045] 1.6 [42]	0.0015 [0.0065] 3.3 [83]
0.3x2-100-200 0.012 x 0.079	3.9 [100]	7.9 [200]	0.0034 [0.015] 0.18 [4.5]	0.0047 [0.021] 0.49 [12]	0.0058 [0.026] 1.2 [31]	0.0084 [0.037] 2.2 [55]
0.4x0.8-100-200 0.016 x 0.031	3.9 [100]	7.9 [200]	0.0024 [0.011] 0.13 [3.3]	0.0033 [0.015] 0.35 [8.9]	0.0041 [0.018] 0.81 [21]	0.006 [0.027] 1.3 [33]
0.4x1-100-200 0.016 x 0.039	3.9 [100]	7.9 [200]	0.003 [0.013] 0.13 [3.3]	0.0041 [0.018] 0.35 [8.9]	0.0052 [0.023] 0.81 [21]	0.0075 [0.033] 1.3 [33]
0.406x0.559-100-200 0.016 x 0.022	3.9 [100]	7.9 [200]	0.0017 [0.0077] 0.13 [3.2]	0.0024 [0.011] 0.34 [8.7]	0.003 [0.013] 0.8 [20]	0.0043 [0.019] 1.3 [33]
0.5x0.25-100-200 0.02 x 0.0098	3.9 [100]	7.9 [200]	0.0012 [0.0052] 0.1 [2.6]	0.0016 [0.0072] 0.27 [6.9]	0.002 [0.009] 0.61 [15]	0.0029 [0.013] 0.95 [24]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-100-200 0.02 x 0.031	3.9 [100]	7.9 [200]	0.0037 [0.017] 0.1 [2.6]	0.0052 [0.023] 0.27 [6.9]	0.0064 [0.029] 0.61 [15]	0.0094 [0.042] 0.95 [24]
0.55x1.4-100-200 0.022 x 0.055	3.9 [100]	7.9 [200]	0.0079 [0.035] 0.093 [2.4]	0.011 [0.049] 0.24 [6.2]	0.014 [0.061] 0.54 [14]	0.02 [0.088] 0.83 [21]
0.6x2.3-100-200 0.024 x 0.091	3.9 [100]	7.9 [200]	0.016 [0.069] 0.085 [2.2]	0.021 [0.095] 0.22 [5.7]	0.027 [0.12] 0.49 [12]	0.039 [0.17] 0.74 [19]
0.8x1.5-100-200 0.031 x 0.059	3.9 [100]	7.9 [200]	0.018 [0.08] 0.063 [1.6]	0.025 [0.11] 0.16 [4.2]	0.031 [0.14] 0.35 [8.9]	0.045 [0.2] 0.52 [13]
1x2.6-100-200 0.039 x 0.1	3.9 [100]	7.9 [200]	0.049 [0.22] 0.05 [1.3]	0.067 [0.3] 0.13 [3.3]	0.084 [0.37] 0.27 [6.9]	0.12 [0.54] 0.4 [10]
1.5x4-100-200 0.059 x 0.16	3.9 [100]	7.9 [200]	0.17 [0.75] 0.033 [0.84]	0.23 [1] 0.085 [2.1]	0.29 [1.3] 0.18 [4.5]	0.42 [1.9] 0.25 [6.4]

FLAT SPRING ACTUATORS — FLAT WIRE, EDGE — Representative grid. Flat spring actuators are made to order, so any pitch from 10 to 100 mm and any amplitude from 10 to 300 mm can be supplied; the method on the previous page gives any combination not listed here.

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.152x0.411-10-10 0.006 x 0.016	0.39 [10]	0.39 [10]	0.0096 [0.043] 0.0023 [0.06]	0.013 [0.059] 0.0059 [0.15]	0.017 [0.074] 0.012 [0.31]	0.024 [0.11] 0.017 [0.44]
0.152x0.813-10-10 0.006 x 0.032	0.39 [10]	0.39 [10]	0.038 [0.17] 0.0012 [0.03]	0.052 [0.23] 0.0031 [0.08]	0.065 [0.29] 0.0059 [0.15]	0.094 [0.42] 0.0087 [0.22]
0.25x0.5-10-10 0.0098 x 0.02	0.39 [10]	0.39 [10]	0.023 [0.1] 0.0019 [0.049]	0.032 [0.14] 0.0047 [0.12]	0.04 [0.18] 0.0098 [0.25]	0.059 [0.26] 0.014 [0.36]
0.3x2-10-10 0.012 x 0.079	0.39 [10]	0.39 [10]	0.45 [2] 0.00048 [0.012]	0.62 [2.8] 0.0012 [0.03]	0.77 [3.4] 0.0024 [0.06]	1.1 [5] 0.0035 [0.09]
0.4x0.8-10-10 0.016 x 0.031	0.39 [10]	0.39 [10]	0.096 [0.43] 0.0012 [0.031]	0.13 [0.59] 0.0031 [0.08]	0.16 [0.73] 0.0063 [0.16]	0.24 [1.1] 0.0087 [0.22]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.4x1-10-10 0.016 x 0.039	0.39 [10]	0.39 [10]	0.15 [0.67] 0.00096 [0.024]	0.21 [0.92] 0.0024 [0.06]	0.26 [1.1] 0.0047 [0.12]	0.37 [1.7] 0.0067 [0.17]
0.406x0.559-10-10 0.016 x 0.022	0.39 [10]	0.39 [10]	0.048 [0.21] 0.0017 [0.044]	0.066 [0.29] 0.0043 [0.11]	0.082 [0.36] 0.0087 [0.22]	0.12 [0.53] 0.013 [0.32]
0.5x0.25-10-10 0.02 x 0.0098	0.39 [10]	0.39 [10]	0.012 [0.052] 0.0039 [0.099]	0.016 [0.072] 0.0098 [0.25]	0.02 [0.09] 0.02 [0.52]	0.029 [0.13] 0.03 [0.76]
0.5x0.8-10-10 0.02 x 0.031	0.39 [10]	0.39 [10]	0.12 [0.53] 0.0012 [0.031]	0.17 [0.74] 0.0031 [0.08]	0.21 [0.92] 0.0063 [0.16]	0.3 [1.3] 0.0087 [0.22]
0.55x1.4-10-10 0.022 x 0.055	0.39 [10]	0.39 [10]	0.4 [1.8] 0.00069 [0.017]	0.56 [2.5] 0.0016 [0.04]	0.69 [3.1] 0.0035 [0.09]	1 [4.5] 0.0047 [0.12]
0.8x1.5-10-10 0.031 x 0.059	0.39 [10]	0.39 [10]	0.67 [3] 0.00064 [0.016]	0.93 [4.1] 0.0016 [0.04]	1.2 [5.2] 0.0031 [0.08]	1.7 [7.5] 0.0047 [0.12]
0.152x0.411-10-25 0.006 x 0.016	0.39 [10]	0.98 [25]	0.0038 [0.017] 0.00097 [0.025]	0.0053 [0.024] 0.0024 [0.06]	0.0066 [0.029] 0.0047 [0.12]	0.0096 [0.043] 0.0071 [0.18]
0.152x0.813-10-25 0.006 x 0.032	0.39 [10]	0.98 [25]	0.015 [0.067] 0.00049 [0.012]	0.021 [0.092] 0.0012 [0.03]	0.026 [0.12] 0.0024 [0.06]	0.038 [0.17] 0.0035 [0.09]
0.25x0.5-10-25 0.0098 x 0.02	0.39 [10]	0.98 [25]	0.0094 [0.042] 0.00079 [0.02]	0.013 [0.058] 0.002 [0.05]	0.016 [0.072] 0.0039 [0.1]	0.023 [0.1] 0.0055 [0.14]
0.3x2-10-25 0.012 x 0.079	0.39 [10]	0.98 [25]	0.18 [0.8] 0.0002 [0.005]	0.25 [1.1] 0.00039 [0.01]	0.31 [1.4] 0.0012 [0.03]	0.45 [2] 0.0016 [0.04]
0.4x0.8-10-25 0.016 x 0.031	0.39 [10]	0.98 [25]	0.038 [0.17] 0.0005 [0.013]	0.053 [0.24] 0.0012 [0.03]	0.066 [0.29] 0.0024 [0.06]	0.096 [0.43] 0.0035 [0.09]
0.4x1-10-25 0.016 x 0.039	0.39 [10]	0.98 [25]	0.06 [0.27] 0.0004 [0.01]	0.083 [0.37] 0.0012 [0.03]	0.1 [0.46] 0.002 [0.05]	0.15 [0.67] 0.0028 [0.07]
0.406x0.559-10-25 0.016 x 0.022	0.39 [10]	0.98 [25]	0.019 [0.085] 0.00071 [0.018]	0.026 [0.12] 0.002 [0.05]	0.033 [0.15] 0.0035 [0.09]	0.048 [0.21] 0.0051 [0.13]
0.5x0.25-10-25 0.02 x 0.0098	0.39 [10]	0.98 [25]	0.0047 [0.021] 0.0016 [0.04]	0.0065 [0.029] 0.0039 [0.1]	0.0081 [0.036] 0.0083 [0.21]	0.012 [0.052] 0.011 [0.29]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-10-25 0.02 x 0.031	0.39 [10]	0.98 [25]	0.048 [0.21] 0.0005 [0.013]	0.066 [0.29] 0.0012 [0.03]	0.082 [0.37] 0.0024 [0.06]	0.12 [0.53] 0.0035 [0.09]
0.55x1.4-10-25 0.022 x 0.055	0.39 [10]	0.98 [25]	0.16 [0.72] 0.00028 [0.0072]	0.22 [0.99] 0.00079 [0.02]	0.28 [1.2] 0.0016 [0.04]	0.4 [1.8] 0.002 [0.05]
0.6x2.3-10-25 0.024 x 0.091	0.39 [10]	0.98 [25]	0.48 [2.1] 0.00017 [0.0044]	0.66 [2.9] 0.00039 [0.01]	0.82 [3.6] 0.00079 [0.02]	1.2 [5.3] 0.0012 [0.03]
0.8x1.5-10-25 0.031 x 0.059	0.39 [10]	0.98 [25]	0.27 [1.2] 0.00026 [0.0067]	0.37 [1.7] 0.00079 [0.02]	0.46 [2.1] 0.0012 [0.03]	0.67 [3] 0.002 [0.05]
1x2.6-10-25 0.039 x 0.1	0.39 [10]	0.98 [25]	1 [4.5] 0.00015 [0.0039]	1.4 [6.2] 0.00039 [0.01]	1.7 [7.8] 0.00079 [0.02]	2.5 [11] 0.0012 [0.03]
1.5x4-10-25 0.059 x 0.16	0.39 [10]	0.98 [25]	3.6 [16] 0.000099 [0.0025]	5 [22] 0.00039 [0.01]	6.2 [28] 0.00039 [0.01]	9 [40] 0.00079 [0.02]
0.152x0.411-10-50 0.006 x 0.016	0.39 [10]	2 [50]	0.0019 [0.0086] 0.00048 [0.012]	0.0027 [0.012] 0.0012 [0.03]	0.0033 [0.015] 0.0024 [0.06]	0.0048 [0.021] 0.0035 [0.09]
0.152x0.813-10-50 0.006 x 0.032	0.39 [10]	2 [50]	0.0075 [0.033] 0.00024 [0.0062]	0.01 [0.046] 0.00079 [0.02]	0.013 [0.058] 0.0012 [0.03]	0.019 [0.084] 0.0016 [0.04]
0.25x0.5-10-50 0.0098 x 0.02	0.39 [10]	2 [50]	0.0047 [0.021] 0.0004 [0.01]	0.0065 [0.029] 0.0012 [0.03]	0.0081 [0.036] 0.002 [0.05]	0.012 [0.052] 0.0028 [0.07]
0.3x2-10-50 0.012 x 0.079	0.39 [10]	2 [50]	0.09 [0.4] 0.0001 [0.0025]	0.12 [0.55] 0.00039 [0.01]	0.15 [0.69] 0.00039 [0.01]	0.22 [1] 0.00079 [0.02]
0.4x0.8-10-50 0.016 x 0.031	0.39 [10]	2 [50]	0.019 [0.085] 0.00025 [0.0063]	0.026 [0.12] 0.00079 [0.02]	0.033 [0.15] 0.0012 [0.03]	0.048 [0.21] 0.0016 [0.04]
0.4x1-10-50 0.016 x 0.039	0.39 [10]	2 [50]	0.03 [0.13] 0.0002 [0.0051]	0.041 [0.18] 0.00039 [0.01]	0.052 [0.23] 0.0012 [0.03]	0.075 [0.33] 0.0016 [0.04]
0.406x0.559-10-50 0.016 x 0.022	0.39 [10]	2 [50]	0.0095 [0.042] 0.00036 [0.0091]	0.013 [0.058] 0.00079 [0.02]	0.016 [0.073] 0.002 [0.05]	0.024 [0.11] 0.0024 [0.06]
0.5x0.25-10-50 0.02 x 0.0098	0.39 [10]	2 [50]	0.0023 [0.01] 0.0008 [0.02]	0.0032 [0.014] 0.002 [0.05]	0.004 [0.018] 0.0039 [0.1]	0.0059 [0.026] 0.0055 [0.14]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-10-50 0.02 x 0.031	0.39 [10]	2 [50]	0.024 [0.11] 0.00025 [0.0063]	0.033 [0.15] 0.00079 [0.02]	0.041 [0.18] 0.0012 [0.03]	0.06 [0.27] 0.0016 [0.04]
0.55x1.4-10-50 0.022 x 0.055	0.39 [10]	2 [50]	0.081 [0.36] 0.00014 [0.0036]	0.11 [0.5] 0.00039 [0.01]	0.14 [0.62] 0.00079 [0.02]	0.2 [0.9] 0.0012 [0.03]
0.6x2.3-10-50 0.024 x 0.091	0.39 [10]	2 [50]	0.24 [1.1] 0.000087 [0.0022]	0.33 [1.5] 0.00039 [0.01]	0.41 [1.8] 0.00039 [0.01]	0.59 [2.6] 0.00079 [0.02]
0.8x1.5-10-50 0.031 x 0.059	0.39 [10]	2 [50]	0.13 [0.6] 0.00013 [0.0034]	0.19 [0.83] 0.00039 [0.01]	0.23 [1] 0.00079 [0.02]	0.34 [1.5] 0.00079 [0.02]
1x2.6-10-50 0.039 x 0.1	0.39 [10]	2 [50]	0.51 [2.3] 0.000077 [0.0019]	0.7 [3.1] 0 [0]	0.87 [3.9] 0.00039 [0.01]	1.3 [5.6] 0.00039 [0.01]
1.5x4-10-50 0.059 x 0.16	0.39 [10]	2 [50]	1.8 [8] 0.00005 [0.0013]	2.5 [11] 0 [0]	3.1 [14] 0.00039 [0.01]	4.5 [20] 0.00039 [0.01]
0.152x0.411-10-100 0.006 x 0.016	0.39 [10]	3.9 [100]	0.00096 [0.0043] 0.00024 [0.0062]	0.0013 [0.0059] 0.00079 [0.02]	0.0017 [0.0074] 0.0012 [0.03]	0.0024 [0.011] 0.0016 [0.04]
0.152x0.813-10-100 0.006 x 0.032	0.39 [10]	3.9 [100]	0.0038 [0.017] 0.00012 [0.0031]	0.0052 [0.023] 0.00039 [0.01]	0.0065 [0.029] 0.00079 [0.02]	0.0094 [0.042] 0.00079 [0.02]
0.25x0.5-10-100 0.0098 x 0.02	0.39 [10]	3.9 [100]	0.0023 [0.01] 0.0002 [0.0051]	0.0032 [0.014] 0.00039 [0.01]	0.004 [0.018] 0.0012 [0.03]	0.0059 [0.026] 0.0016 [0.04]
0.3x2-10-100 0.012 x 0.079	0.39 [10]	3.9 [100]	0.045 [0.2] 0.00005 [0.0013]	0.062 [0.28] 0 [0]	0.077 [0.34] 0.00039 [0.01]	0.11 [0.5] 0.00039 [0.01]
0.4x0.8-10-100 0.016 x 0.031	0.39 [10]	3.9 [100]	0.0096 [0.043] 0.00012 [0.0032]	0.013 [0.059] 0.00039 [0.01]	0.016 [0.073] 0.00079 [0.02]	0.024 [0.11] 0.00079 [0.02]
0.4x1-10-100 0.016 x 0.039	0.39 [10]	3.9 [100]	0.015 [0.067] 0.0001 [0.0025]	0.021 [0.092] 0.00039 [0.01]	0.026 [0.11] 0.00039 [0.01]	0.037 [0.17] 0.00079 [0.02]
0.406x0.559-10-100 0.016 x 0.022	0.39 [10]	3.9 [100]	0.0048 [0.021] 0.00018 [0.0045]	0.0066 [0.029] 0.00039 [0.01]	0.0082 [0.036] 0.00079 [0.02]	0.012 [0.053] 0.0012 [0.03]
0.5x0.25-10-100 0.02 x 0.0098	0.39 [10]	3.9 [100]	0.0012 [0.0052] 0.0004 [0.01]	0.0016 [0.0072] 0.0012 [0.03]	0.002 [0.009] 0.002 [0.05]	0.0029 [0.013] 0.0028 [0.07]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-10-100 0.02 x 0.031	0.39 [10]	3.9 [100]	0.012 [0.053] 0.00012 [0.0032]	0.017 [0.074] 0.00039 [0.01]	0.021 [0.092] 0.00079 [0.02]	0.03 [0.13] 0.00079 [0.02]
0.55x1.4-10-100 0.022 x 0.055	0.39 [10]	3.9 [100]	0.04 [0.18] 0.000071 [0.0018]	0.056 [0.25] 0 [0]	0.069 [0.31] 0.00039 [0.01]	0.1 [0.45] 0.00039 [0.01]
0.6x2.3-10-100 0.024 x 0.091	0.39 [10]	3.9 [100]	0.12 [0.53] 0.000043 [0.0011]	0.16 [0.73] 0 [0]	0.2 [0.91] 0.00039 [0.01]	0.3 [1.3] 0.00039 [0.01]
0.8x1.5-10-100 0.031 x 0.059	0.39 [10]	3.9 [100]	0.067 [0.3] 0.000066 [0.0017]	0.093 [0.41] 0 [0]	0.12 [0.52] 0.00039 [0.01]	0.17 [0.75] 0.00039 [0.01]
1x2.6-10-100 0.039 x 0.1	0.39 [10]	3.9 [100]	0.25 [1.1] 0.000038 [0.00097]	0.35 [1.6] 0 [0]	0.44 [1.9] 0 [0]	0.63 [2.8] 0.00039 [0.01]
1.5x4-10-100 0.059 x 0.16	0.39 [10]	3.9 [100]	0.9 [4] 0.000025 [0.00063]	1.2 [5.5] 0 [0]	1.5 [6.9] 0 [0]	2.2 [10] 0 [0]
0.152x0.411-10-200 0.006 x 0.016	0.39 [10]	7.9 [200]	0.00048 [0.0021] 0.00012 [0.0031]	0.00066 [0.0029] 0.00039 [0.01]	0.00083 [0.0037] 0.00079 [0.02]	0.0012 [0.0053] 0.00079 [0.02]
0.152x0.813-10-200 0.006 x 0.032	0.39 [10]	7.9 [200]	0.0019 [0.0084] 0.000061 [0.0016]	0.0026 [0.012] 0 [0]	0.0032 [0.014] 0.00039 [0.01]	0.0047 [0.021] 0.00039 [0.01]
0.25x0.5-10-200 0.0098 x 0.02	0.39 [10]	7.9 [200]	0.0012 [0.0052] 0.0001 [0.0025]	0.0016 [0.0072] 0.00039 [0.01]	0.002 [0.009] 0.00039 [0.01]	0.0029 [0.013] 0.00079 [0.02]
0.3x2-10-200 0.012 x 0.079	0.39 [10]	7.9 [200]	0.022 [0.1] 0.000025 [0.00063]	0.031 [0.14] 0 [0]	0.039 [0.17] 0 [0]	0.056 [0.25] 0 [0]
0.4x0.8-10-200 0.016 x 0.031	0.39 [10]	7.9 [200]	0.0048 [0.021] 0.000062 [0.0016]	0.0066 [0.029] 0 [0]	0.0082 [0.037] 0.00039 [0.01]	0.012 [0.053] 0.00039 [0.01]
0.4x1-10-200 0.016 x 0.039	0.39 [10]	7.9 [200]	0.0075 [0.033] 0.00005 [0.0013]	0.01 [0.046] 0 [0]	0.013 [0.057] 0.00039 [0.01]	0.019 [0.083] 0.00039 [0.01]
0.406x0.559-10-200 0.016 x 0.022	0.39 [10]	7.9 [200]	0.0024 [0.011] 0.000089 [0.0023]	0.0033 [0.015] 0.00039 [0.01]	0.0041 [0.018] 0.00039 [0.01]	0.0059 [0.026] 0.00079 [0.02]
0.5x0.25-10-200 0.02 x 0.0098	0.39 [10]	7.9 [200]	0.00058 [0.0026] 0.0002 [0.0051]	0.00081 [0.0036] 0.00039 [0.01]	0.001 [0.0045] 0.0012 [0.03]	0.0015 [0.0065] 0.0016 [0.04]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-10-200 0.02 x 0.031	0.39 [10]	7.9 [200]	0.006 [0.027] 0.000062 [0.0016]	0.0083 [0.037] 0 [0]	0.01 [0.046] 0.00039 [0.01]	0.015 [0.067] 0.00039 [0.01]
0.55x1.4-10-200 0.022 x 0.055	0.39 [10]	7.9 [200]	0.02 [0.09] 0.000036 [0.0009]	0.028 [0.12] 0 [0]	0.035 [0.15] 0 [0]	0.05 [0.22] 0.00039 [0.01]
0.6x2.3-10-200 0.024 x 0.091	0.39 [10]	7.9 [200]	0.059 [0.26] 0.000022 [0.00055]	0.082 [0.36] 0 [0]	0.1 [0.45] 0 [0]	0.15 [0.66] 0 [0]
0.8x1.5-10-200 0.031 x 0.059	0.39 [10]	7.9 [200]	0.034 [0.15] 0.000033 [0.00084]	0.047 [0.21] 0 [0]	0.058 [0.26] 0 [0]	0.084 [0.38] 0.00039 [0.01]
1x2.6-10-200 0.039 x 0.1	0.39 [10]	7.9 [200]	0.13 [0.56] 0.000019 [0.00049]	0.17 [0.78] 0 [0]	0.22 [0.97] 0 [0]	0.32 [1.4] 0 [0]
1.5x4-10-200 0.059 x 0.16	0.39 [10]	7.9 [200]	0.45 [2] 0.000012 [0.00032]	0.62 [2.8] 0 [0]	0.77 [3.4] 0 [0]	1.1 [5] 0 [0]
0.152x0.411-25-10 0.006 x 0.016	0.98 [25]	0.39 [10]	0.0096 [0.043] 0.033 [0.84]	0.013 [0.059] 0.089 [2.3]	0.017 [0.074] 0.21 [5.3]	0.024 [0.11] 0.34 [8.5]
0.152x0.813-25-10 0.006 x 0.032	0.98 [25]	0.39 [10]	0.038 [0.17] 0.016 [0.41]	0.052 [0.23] 0.042 [1.1]	0.065 [0.29] 0.091 [2.3]	0.094 [0.42] 0.13 [3.4]
0.25x0.5-25-10 0.0098 x 0.02	0.98 [25]	0.39 [10]	0.023 [0.1] 0.027 [0.68]	0.032 [0.14] 0.072 [1.8]	0.04 [0.18] 0.16 [4.1]	0.059 [0.26] 0.25 [6.4]
0.3x2-25-10 0.012 x 0.079	0.98 [25]	0.39 [10]	0.45 [2] 0.0065 [0.17]	0.62 [2.8] 0.017 [0.42]	0.77 [3.4] 0.034 [0.86]	1.1 [5] 0.048 [1.2]
0.4x0.8-25-10 0.016 x 0.031	0.98 [25]	0.39 [10]	0.096 [0.43] 0.017 [0.42]	0.13 [0.59] 0.043 [1.1]	0.16 [0.73] 0.092 [2.3]	0.24 [1.1] 0.14 [3.5]
0.4x1-25-10 0.016 x 0.039	0.98 [25]	0.39 [10]	0.15 [0.67] 0.013 [0.33]	0.21 [0.92] 0.034 [0.86]	0.26 [1.1] 0.072 [1.8]	0.37 [1.7] 0.11 [2.7]
0.406x0.559-25-10 0.016 x 0.022	0.98 [25]	0.39 [10]	0.048 [0.21] 0.024 [0.61]	0.066 [0.29] 0.063 [1.6]	0.082 [0.36] 0.14 [3.6]	0.12 [0.53] 0.22 [5.5]
0.5x0.25-25-10 0.02 x 0.0098	0.98 [25]	0.39 [10]	0.012 [0.052] 0.056 [1.4]	0.016 [0.072] 0.16 [4.1]	0.02 [0.09] 0.44 [11]	0.029 [0.13] 0.82 [21]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.5x0.8-25-10 0.02 x 0.031	0.98 [25]	0.39 [10]	0.12 [0.53] 0.017 [0.42]	0.17 [0.74] 0.043 [1.1]	0.21 [0.92] 0.092 [2.3]	0.3 [1.3] 0.14 [3.5]
0.55x1.4-25-10 0.022 x 0.055	0.98 [25]	0.39 [10]	0.4 [1.8] 0.0093 [0.24]	0.56 [2.5] 0.024 [0.61]	0.69 [3.1] 0.05 [1.3]	1 [4.5] 0.072 [1.8]
0.8x1.5-25-10 0.031 x 0.059	0.98 [25]	0.39 [10]	0.67 [3] 0.0087 [0.22]	0.93 [4.1] 0.022 [0.56]	1.2 [5.2] 0.046 [1.2]	1.7 [7.5] 0.067 [1.7]
0.152x0.411-25-25 0.006 x 0.016	0.98 [25]	0.98 [25]	0.0038 [0.017] 0.015 [0.38]	0.0053 [0.024] 0.039 [0.98]	0.0066 [0.029] 0.082 [2.1]	0.0096 [0.043] 0.12 [3.1]
0.152x0.813-25-25 0.006 x 0.032	0.98 [25]	0.98 [25]	0.015 [0.067] 0.0074 [0.19]	0.021 [0.092] 0.019 [0.48]	0.026 [0.12] 0.039 [0.99]	0.038 [0.17] 0.056 [1.4]
0.25x0.5-25-25 0.0098 x 0.02	0.98 [25]	0.98 [25]	0.0094 [0.042] 0.012 [0.31]	0.013 [0.058] 0.031 [0.8]	0.016 [0.072] 0.066 [1.7]	0.023 [0.1] 0.096 [2.4]
0.3x2-25-25 0.012 x 0.079	0.98 [25]	0.98 [25]	0.18 [0.8] 0.003 [0.076]	0.25 [1.1] 0.0075 [0.19]	0.31 [1.4] 0.015 [0.39]	0.45 [2] 0.022 [0.55]
0.4x0.8-25-25 0.016 x 0.031	0.98 [25]	0.98 [25]	0.038 [0.17] 0.0076 [0.19]	0.053 [0.24] 0.019 [0.49]	0.066 [0.29] 0.04 [1]	0.096 [0.43] 0.057 [1.4]
0.4x1-25-25 0.016 x 0.039	0.98 [25]	0.98 [25]	0.06 [0.27] 0.006 [0.15]	0.083 [0.37] 0.015 [0.39]	0.1 [0.46] 0.031 [0.8]	0.15 [0.67] 0.045 [1.1]
0.406x0.559-25-25 0.016 x 0.022	0.98 [25]	0.98 [25]	0.019 [0.085] 0.011 [0.28]	0.026 [0.12] 0.028 [0.71]	0.033 [0.15] 0.058 [1.5]	0.048 [0.21] 0.085 [2.1]
0.5x0.25-25-25 0.02 x 0.0098	0.98 [25]	0.98 [25]	0.0047 [0.021] 0.025 [0.63]	0.0065 [0.029] 0.066 [1.7]	0.0081 [0.036] 0.15 [3.7]	0.012 [0.052] 0.23 [5.8]
0.5x0.8-25-25 0.02 x 0.031	0.98 [25]	0.98 [25]	0.048 [0.21] 0.0076 [0.19]	0.066 [0.29] 0.019 [0.49]	0.082 [0.37] 0.04 [1]	0.12 [0.53] 0.057 [1.4]
0.55x1.4-25-25 0.022 x 0.055	0.98 [25]	0.98 [25]	0.16 [0.72] 0.0043 [0.11]	0.22 [0.99] 0.011 [0.28]	0.28 [1.2] 0.022 [0.56]	0.4 [1.8] 0.031 [0.8]
0.6x2.3-25-25 0.024 x 0.091	0.98 [25]	0.98 [25]	0.48 [2.1] 0.0026 [0.066]	0.66 [2.9] 0.0067 [0.17]	0.82 [3.6] 0.013 [0.34]	1.2 [5.3] 0.019 [0.48]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.8x1.5-25-25 0.031 x 0.059	0.98 [25]	0.98 [25]	0.27 [1.2] 0.004 [0.1]	0.37 [1.7] 0.01 [0.26]	0.46 [2.1] 0.02 [0.52]	0.67 [3] 0.029 [0.74]
1x2.6-25-25 0.039 x 0.1	0.98 [25]	0.98 [25]	1 [4.5] 0.0023 [0.059]	1.4 [6.2] 0.0059 [0.15]	1.7 [7.8] 0.012 [0.3]	2.5 [11] 0.017 [0.42]
1.5x4-25-25 0.059 x 0.16	0.98 [25]	0.98 [25]	3.6 [16] 0.0015 [0.038]	5 [22] 0.0039 [0.1]	6.2 [28] 0.0075 [0.19]	9 [40] 0.011 [0.27]
0.152x0.411-25-50 0.006 x 0.016	0.98 [25]	2 [50]	0.0019 [0.0086] 0.0076 [0.19]	0.0027 [0.012] 0.019 [0.49]	0.0033 [0.015] 0.04 [1]	0.0048 [0.021] 0.057 [1.4]
0.152x0.813-25-50 0.006 x 0.032	0.98 [25]	2 [50]	0.0075 [0.033] 0.0038 [0.097]	0.01 [0.046] 0.0094 [0.24]	0.013 [0.058] 0.02 [0.5]	0.019 [0.084] 0.028 [0.7]
0.25x0.5-25-50 0.0098 x 0.02	0.98 [25]	2 [50]	0.0047 [0.021] 0.0062 [0.16]	0.0065 [0.029] 0.016 [0.4]	0.0081 [0.036] 0.032 [0.82]	0.012 [0.052] 0.046 [1.2]
0.3x2-25-50 0.012 x 0.079	0.98 [25]	2 [50]	0.09 [0.4] 0.0015 [0.039]	0.12 [0.55] 0.0039 [0.1]	0.15 [0.69] 0.0079 [0.2]	0.22 [1] 0.011 [0.28]
0.4x0.8-25-50 0.016 x 0.031	0.98 [25]	2 [50]	0.019 [0.085] 0.0039 [0.098]	0.026 [0.12] 0.0098 [0.25]	0.033 [0.15] 0.02 [0.5]	0.048 [0.21] 0.028 [0.71]
0.4x1-25-50 0.016 x 0.039	0.98 [25]	2 [50]	0.03 [0.13] 0.0031 [0.079]	0.041 [0.18] 0.0079 [0.2]	0.052 [0.23] 0.016 [0.4]	0.075 [0.33] 0.022 [0.57]
0.406x0.559-25-50 0.016 x 0.022	0.98 [25]	2 [50]	0.0095 [0.042] 0.0056 [0.14]	0.013 [0.058] 0.014 [0.36]	0.016 [0.073] 0.029 [0.73]	0.024 [0.11] 0.041 [1]
0.5x0.25-25-50 0.02 x 0.0098	0.98 [25]	2 [50]	0.0023 [0.01] 0.013 [0.32]	0.0032 [0.014] 0.032 [0.82]	0.004 [0.018] 0.068 [1.7]	0.0059 [0.026] 0.1 [2.5]
0.5x0.8-25-50 0.02 x 0.031	0.98 [25]	2 [50]	0.024 [0.11] 0.0039 [0.098]	0.033 [0.15] 0.0098 [0.25]	0.041 [0.18] 0.02 [0.5]	0.06 [0.27] 0.028 [0.71]
0.55x1.4-25-50 0.022 x 0.055	0.98 [25]	2 [50]	0.081 [0.36] 0.0022 [0.056]	0.11 [0.5] 0.0055 [0.14]	0.14 [0.62] 0.011 [0.28]	0.2 [0.9] 0.016 [0.4]
0.6x2.3-25-50 0.024 x 0.091	0.98 [25]	2 [50]	0.24 [1.1] 0.0013 [0.034]	0.33 [1.5] 0.0035 [0.09]	0.41 [1.8] 0.0067 [0.17]	0.59 [2.6] 0.0094 [0.24]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.8x1.5-25-50 0.031 x 0.059	0.98 [25]	2 [50]	0.13 [0.6] 0.0021 [0.052]	0.19 [0.83] 0.0051 [0.13]	0.23 [1] 0.01 [0.26]	0.34 [1.5] 0.015 [0.37]
1x2.6-25-50 0.039 x 0.1	0.98 [25]	2 [50]	0.51 [2.3] 0.0012 [0.03]	0.7 [3.1] 0.0031 [0.08]	0.87 [3.9] 0.0059 [0.15]	1.3 [5.6] 0.0083 [0.21]
1.5x4-25-50 0.059 x 0.16	0.98 [25]	2 [50]	1.8 [8] 0.00077 [0.02]	2.5 [11] 0.002 [0.05]	3.1 [14] 0.0039 [0.1]	4.5 [20] 0.0055 [0.14]
0.152x0.411-25-100 0.006 x 0.016	0.98 [25]	3.9 [100]	0.00096 [0.0043] 0.0038 [0.097]	0.0013 [0.0059] 0.0094 [0.24]	0.0017 [0.0074] 0.019 [0.49]	0.0024 [0.011] 0.028 [0.7]
0.152x0.813-25-100 0.006 x 0.032	0.98 [25]	3.9 [100]	0.0038 [0.017] 0.0019 [0.049]	0.0052 [0.023] 0.0047 [0.12]	0.0065 [0.029] 0.0098 [0.25]	0.0094 [0.042] 0.014 [0.35]
0.25x0.5-25-100 0.0098 x 0.02	0.98 [25]	3.9 [100]	0.0023 [0.01] 0.0031 [0.079]	0.0032 [0.014] 0.0079 [0.2]	0.004 [0.018] 0.016 [0.4]	0.0059 [0.026] 0.022 [0.57]
0.3x2-25-100 0.012 x 0.079	0.98 [25]	3.9 [100]	0.045 [0.2] 0.00078 [0.02]	0.062 [0.28] 0.002 [0.05]	0.077 [0.34] 0.0039 [0.1]	0.11 [0.5] 0.0055 [0.14]
0.4x0.8-25-100 0.016 x 0.031	0.98 [25]	3.9 [100]	0.0096 [0.043] 0.0019 [0.049]	0.013 [0.059] 0.0047 [0.12]	0.016 [0.073] 0.0098 [0.25]	0.024 [0.11] 0.014 [0.35]
0.4x1-25-100 0.016 x 0.039	0.98 [25]	3.9 [100]	0.015 [0.067] 0.0016 [0.04]	0.021 [0.092] 0.0039 [0.1]	0.026 [0.11] 0.0079 [0.2]	0.037 [0.17] 0.011 [0.28]
0.406x0.559-25-100 0.016 x 0.022	0.98 [25]	3.9 [100]	0.0048 [0.021] 0.0028 [0.071]	0.0066 [0.029] 0.0071 [0.18]	0.0082 [0.036] 0.014 [0.36]	0.012 [0.053] 0.02 [0.51]
0.5x0.25-25-100 0.02 x 0.0098	0.98 [25]	3.9 [100]	0.0012 [0.0052] 0.0063 [0.16]	0.0016 [0.0072] 0.016 [0.4]	0.002 [0.009] 0.033 [0.83]	0.0029 [0.013] 0.046 [1.2]
0.5x0.8-25-100 0.02 x 0.031	0.98 [25]	3.9 [100]	0.012 [0.053] 0.0019 [0.049]	0.017 [0.074] 0.0047 [0.12]	0.021 [0.092] 0.0098 [0.25]	0.03 [0.13] 0.014 [0.35]
0.55x1.4-25-100 0.022 x 0.055	0.98 [25]	3.9 [100]	0.04 [0.18] 0.0011 [0.028]	0.056 [0.25] 0.0028 [0.07]	0.069 [0.31] 0.0055 [0.14]	0.1 [0.45] 0.0079 [0.2]
0.6x2.3-25-100 0.024 x 0.091	0.98 [25]	3.9 [100]	0.12 [0.53] 0.00068 [0.017]	0.16 [0.73] 0.0016 [0.04]	0.2 [0.91] 0.0035 [0.09]	0.3 [1.3] 0.0047 [0.12]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.8x1.5-25-100 0.031 x 0.059	0.98 [25]	3.9 [100]	0.067 [0.3] 0.001 [0.026]	0.093 [0.41] 0.0028 [0.07]	0.12 [0.52] 0.0051 [0.13]	0.17 [0.75] 0.0075 [0.19]
1x2.6-25-100 0.039 x 0.1	0.98 [25]	3.9 [100]	0.25 [1.1] 0.0006 [0.015]	0.35 [1.6] 0.0016 [0.04]	0.44 [1.9] 0.0031 [0.08]	0.63 [2.8] 0.0043 [0.11]
1.5x4-25-100 0.059 x 0.16	0.98 [25]	3.9 [100]	0.9 [4] 0.00039 [0.0099]	1.2 [5.5] 0.00079 [0.02]	1.5 [6.9] 0.002 [0.05]	2.2 [10] 0.0028 [0.07]
0.152x0.411-25-200 0.006 x 0.016	0.98 [25]	7.9 [200]	0.00048 [0.0021] 0.0019 [0.048]	0.00066 [0.0029] 0.0047 [0.12]	0.00083 [0.0037] 0.0094 [0.24]	0.0012 [0.0053] 0.013 [0.34]
0.152x0.813-25-200 0.006 x 0.032	0.98 [25]	7.9 [200]	0.0019 [0.0084] 0.00096 [0.024]	0.0026 [0.012] 0.0024 [0.06]	0.0032 [0.014] 0.0047 [0.12]	0.0047 [0.021] 0.0067 [0.17]
0.25x0.5-25-200 0.0098 x 0.02	0.98 [25]	7.9 [200]	0.0012 [0.0052] 0.0016 [0.04]	0.0016 [0.0072] 0.0039 [0.1]	0.002 [0.009] 0.0079 [0.2]	0.0029 [0.013] 0.011 [0.28]
0.3x2-25-200 0.012 x 0.079	0.98 [25]	7.9 [200]	0.022 [0.1] 0.00039 [0.0099]	0.031 [0.14] 0.00079 [0.02]	0.039 [0.17] 0.002 [0.05]	0.056 [0.25] 0.0028 [0.07]
0.4x0.8-25-200 0.016 x 0.031	0.98 [25]	7.9 [200]	0.0048 [0.021] 0.00097 [0.025]	0.0066 [0.029] 0.0024 [0.06]	0.0082 [0.037] 0.0047 [0.12]	0.012 [0.053] 0.0067 [0.17]
0.4x1-25-200 0.016 x 0.039	0.98 [25]	7.9 [200]	0.0075 [0.033] 0.00078 [0.02]	0.01 [0.046] 0.002 [0.05]	0.013 [0.057] 0.0039 [0.1]	0.019 [0.083] 0.0055 [0.14]
0.406x0.559-25-200 0.016 x 0.022	0.98 [25]	7.9 [200]	0.0024 [0.011] 0.0014 [0.035]	0.0033 [0.015] 0.0035 [0.09]	0.0041 [0.018] 0.0071 [0.18]	0.0059 [0.026] 0.0098 [0.25]
0.5x0.25-25-200 0.02 x 0.0098	0.98 [25]	7.9 [200]	0.00058 [0.0026] 0.0031 [0.079]	0.00081 [0.0036] 0.0079 [0.2]	0.001 [0.0045] 0.016 [0.41]	0.0015 [0.0065] 0.022 [0.57]
0.5x0.8-25-200 0.02 x 0.031	0.98 [25]	7.9 [200]	0.006 [0.027] 0.00097 [0.025]	0.0083 [0.037] 0.0024 [0.06]	0.01 [0.046] 0.0047 [0.12]	0.015 [0.067] 0.0067 [0.17]
0.55x1.4-25-200 0.022 x 0.055	0.98 [25]	7.9 [200]	0.02 [0.09] 0.00056 [0.014]	0.028 [0.12] 0.0016 [0.04]	0.035 [0.15] 0.0028 [0.07]	0.05 [0.22] 0.0039 [0.1]
0.6x2.3-25-200 0.024 x 0.091	0.98 [25]	7.9 [200]	0.059 [0.26] 0.00034 [0.0086]	0.082 [0.36] 0.00079 [0.02]	0.1 [0.45] 0.0016 [0.04]	0.15 [0.66] 0.0024 [0.06]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.8x1.5-25-200 0.031 x 0.059	0.98 [25]	7.9 [200]	0.034 [0.15] 0.00052 [0.013]	0.047 [0.21] 0.0012 [0.03]	0.058 [0.26] 0.0028 [0.07]	0.084 [0.38] 0.0035 [0.09]
1x2.6-25-200 0.039 x 0.1	0.98 [25]	7.9 [200]	0.13 [0.56] 0.0003 [0.0076]	0.17 [0.78] 0.00079 [0.02]	0.22 [0.97] 0.0016 [0.04]	0.32 [1.4] 0.002 [0.05]
1.5x4-25-200 0.059 x 0.16	0.98 [25]	7.9 [200]	0.45 [2] 0.00019 [0.0049]	0.62 [2.8] 0.00039 [0.01]	0.77 [3.4] 0.00079 [0.02]	1.1 [5] 0.0012 [0.03]
0.152x0.411-50-10 0.006 x 0.016	2 [50]	0.39 [10]	0.0096 [0.043] 0.2 [5]	0.013 [0.059] 0.55 [14]	0.017 [0.074] 0.63 [16]	0.024 [0.11] 0.63 [16]
0.152x0.813-50-10 0.006 x 0.032	2 [50]	0.39 [10]	0.038 [0.17] 0.095 [2.4]	0.052 [0.23] 0.26 [6.5]	0.065 [0.29] 0.55 [14]	0.094 [0.42] 0.63 [16]
0.25x0.5-50-10 0.0098 x 0.02	2 [50]	0.39 [10]	0.023 [0.1] 0.16 [4.1]	0.032 [0.14] 0.45 [11]	0.04 [0.18] 0.63 [16]	0.059 [0.26] 0.63 [16]
0.3x2-50-10 0.012 x 0.079	2 [50]	0.39 [10]	0.45 [2] 0.037 [0.94]	0.62 [2.8] 0.096 [2.5]	0.77 [3.4] 0.2 [5.2]	1.1 [5] 0.3 [7.6]
0.4x0.8-50-10 0.016 x 0.031	2 [50]	0.39 [10]	0.096 [0.43] 0.096 [2.4]	0.13 [0.59] 0.26 [6.7]	0.16 [0.73] 0.56 [14]	0.24 [1.1] 0.63 [16]
0.4x1-50-10 0.016 x 0.039	2 [50]	0.39 [10]	0.15 [0.67] 0.076 [1.9]	0.21 [0.92] 0.2 [5.2]	0.26 [1.1] 0.45 [11]	0.37 [1.7] 0.61 [15]
0.406x0.559-50-10 0.016 x 0.022	2 [50]	0.39 [10]	0.048 [0.21] 0.14 [3.6]	0.066 [0.29] 0.4 [10]	0.082 [0.36] 0.63 [16]	0.12 [0.53] 0.63 [16]
0.5x0.25-50-10 0.02 x 0.0098	2 [50]	0.39 [10]	0.012 [0.052] 0.35 [8.8]	0.016 [0.072] 0.63 [16]	0.02 [0.09] 0.63 [16]	0.029 [0.13] 0.63 [16]
0.5x0.8-50-10 0.02 x 0.031	2 [50]	0.39 [10]	0.12 [0.53] 0.096 [2.4]	0.17 [0.74] 0.26 [6.7]	0.21 [0.92] 0.56 [14]	0.3 [1.3] 0.63 [16]
0.55x1.4-50-10 0.022 x 0.055	2 [50]	0.39 [10]	0.4 [1.8] 0.054 [1.4]	0.56 [2.5] 0.14 [3.6]	0.69 [3.1] 0.31 [7.8]	1 [4.5] 0.45 [11]
0.8x1.5-50-10 0.031 x 0.059	2 [50]	0.39 [10]	0.67 [3] 0.05 [1.3]	0.93 [4.1] 0.13 [3.3]	1.2 [5.2] 0.28 [7.2]	1.7 [7.5] 0.41 [11]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.152x0.411-50-25 0.006 x 0.016	2 [50]	0.98 [25]	0.0038 [0.017] 0.12 [2.9]	0.0053 [0.024] 0.34 [8.5]	0.0066 [0.029] 0.93 [24]	0.0096 [0.043] 1.9 [49]
0.152x0.813-50-25 0.006 x 0.032	2 [50]	0.98 [25]	0.015 [0.067] 0.056 [1.4]	0.021 [0.092] 0.15 [3.8]	0.026 [0.12] 0.34 [8.7]	0.038 [0.17] 0.54 [14]
0.25x0.5-50-25 0.0098 x 0.02	2 [50]	0.98 [25]	0.0094 [0.042] 0.094 [2.4]	0.013 [0.058] 0.26 [6.7]	0.016 [0.072] 0.67 [17]	0.023 [0.1] 1.2 [31]
0.3x2-50-25 0.012 x 0.079	2 [50]	0.98 [25]	0.18 [0.8] 0.022 [0.56]	0.25 [1.1] 0.057 [1.4]	0.31 [1.4] 0.12 [3]	0.45 [2] 0.17 [4.4]
0.4x0.8-50-25 0.016 x 0.031	2 [50]	0.98 [25]	0.038 [0.17] 0.057 [1.4]	0.053 [0.24] 0.15 [3.9]	0.066 [0.29] 0.35 [8.8]	0.096 [0.43] 0.55 [14]
0.4x1-50-25 0.016 x 0.039	2 [50]	0.98 [25]	0.06 [0.27] 0.045 [1.1]	0.083 [0.37] 0.12 [3]	0.1 [0.46] 0.26 [6.7]	0.15 [0.67] 0.4 [10]
0.406x0.559-50-25 0.016 x 0.022	2 [50]	0.98 [25]	0.019 [0.085] 0.083 [2.1]	0.026 [0.12] 0.23 [5.9]	0.033 [0.15] 0.57 [14]	0.048 [0.21] 0.98 [25]
0.5x0.25-50-25 0.02 x 0.0098	2 [50]	0.98 [25]	0.0047 [0.021] 0.2 [5.1]	0.0065 [0.029] 0.67 [17]	0.0081 [0.036] 2.6 [65]	0.012 [0.052] 2.6 [65]
0.5x0.8-50-25 0.02 x 0.031	2 [50]	0.98 [25]	0.048 [0.21] 0.057 [1.4]	0.066 [0.29] 0.15 [3.9]	0.082 [0.37] 0.35 [8.8]	0.12 [0.53] 0.55 [14]
0.55x1.4-50-25 0.022 x 0.055	2 [50]	0.98 [25]	0.16 [0.72] 0.032 [0.81]	0.22 [0.99] 0.083 [2.1]	0.28 [1.2] 0.18 [4.5]	0.4 [1.8] 0.26 [6.7]
0.6x2.3-50-25 0.024 x 0.091	2 [50]	0.98 [25]	0.48 [2.1] 0.019 [0.49]	0.66 [2.9] 0.049 [1.2]	0.82 [3.6] 0.1 [2.6]	1.2 [5.3] 0.15 [3.8]
0.8x1.5-50-25 0.031 x 0.059	2 [50]	0.98 [25]	0.27 [1.2] 0.03 [0.76]	0.37 [1.7] 0.077 [2]	0.46 [2.1] 0.16 [4.2]	0.67 [3] 0.24 [6.2]
1x2.6-50-25 0.039 x 0.1	2 [50]	0.98 [25]	1 [4.5] 0.017 [0.43]	1.4 [6.2] 0.043 [1.1]	1.7 [7.8] 0.09 [2.3]	2.5 [11] 0.13 [3.3]
1.5x4-50-25 0.059 x 0.16	2 [50]	0.98 [25]	3.6 [16] 0.011 [0.28]	5 [22] 0.028 [0.71]	6.2 [28] 0.057 [1.4]	9 [40] 0.081 [2.1]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.152x0.411-50-50 0.006 x 0.016	2 [50]	2 [50]	0.0019 [0.0086] 0.061 [1.5]	0.0027 [0.012] 0.16 [4.2]	0.0033 [0.015] 0.38 [9.6]	0.0048 [0.021] 0.6 [15]
0.152x0.813-50-50 0.006 x 0.032	2 [50]	2 [50]	0.0075 [0.033] 0.03 [0.76]	0.01 [0.046] 0.078 [2]	0.013 [0.058] 0.17 [4.2]	0.019 [0.084] 0.25 [6.2]
0.25x0.5-50-50 0.0098 x 0.02	2 [50]	2 [50]	0.0047 [0.021] 0.05 [1.3]	0.0065 [0.029] 0.13 [3.4]	0.0081 [0.036] 0.29 [7.5]	0.012 [0.052] 0.46 [12]
0.3x2-50-50 0.012 x 0.079	2 [50]	2 [50]	0.09 [0.4] 0.012 [0.31]	0.12 [0.55] 0.031 [0.78]	0.15 [0.69] 0.063 [1.6]	0.22 [1] 0.089 [2.3]
0.4x0.8-50-50 0.016 x 0.031	2 [50]	2 [50]	0.019 [0.085] 0.031 [0.78]	0.026 [0.12] 0.079 [2]	0.033 [0.15] 0.17 [4.3]	0.048 [0.21] 0.25 [6.3]
0.4x1-50-50 0.016 x 0.039	2 [50]	2 [50]	0.03 [0.13] 0.024 [0.62]	0.041 [0.18] 0.063 [1.6]	0.052 [0.23] 0.13 [3.4]	0.075 [0.33] 0.19 [4.9]
0.406x0.559-50-50 0.016 x 0.022	2 [50]	2 [50]	0.0095 [0.042] 0.044 [1.1]	0.013 [0.058] 0.12 [3]	0.016 [0.073] 0.26 [6.5]	0.024 [0.11] 0.39 [10]
0.5x0.25-50-50 0.02 x 0.0098	2 [50]	2 [50]	0.0023 [0.01] 0.1 [2.6]	0.0032 [0.014] 0.29 [7.5]	0.004 [0.018] 0.78 [20]	0.0059 [0.026] 1.5 [39]
0.5x0.8-50-50 0.02 x 0.031	2 [50]	2 [50]	0.024 [0.11] 0.031 [0.78]	0.033 [0.15] 0.079 [2]	0.041 [0.18] 0.17 [4.3]	0.06 [0.27] 0.25 [6.3]
0.55x1.4-50-50 0.022 x 0.055	2 [50]	2 [50]	0.081 [0.36] 0.017 [0.44]	0.11 [0.5] 0.044 [1.1]	0.14 [0.62] 0.091 [2.3]	0.2 [0.9] 0.13 [3.4]
0.6x2.3-50-50 0.024 x 0.091	2 [50]	2 [50]	0.24 [1.1] 0.01 [0.27]	0.33 [1.5] 0.026 [0.67]	0.41 [1.8] 0.054 [1.4]	0.59 [2.6] 0.077 [2]
0.8x1.5-50-50 0.031 x 0.059	2 [50]	2 [50]	0.13 [0.6] 0.016 [0.41]	0.19 [0.83] 0.041 [1]	0.23 [1] 0.085 [2.2]	0.34 [1.5] 0.12 [3.1]
1x2.6-50-50 0.039 x 0.1	2 [50]	2 [50]	0.51 [2.3] 0.0093 [0.24]	0.7 [3.1] 0.023 [0.59]	0.87 [3.9] 0.048 [1.2]	1.3 [5.6] 0.068 [1.7]
1.5x4-50-50 0.059 x 0.16	2 [50]	2 [50]	1.8 [8] 0.006 [0.15]	2.5 [11] 0.015 [0.38]	3.1 [14] 0.031 [0.78]	4.5 [20] 0.043 [1.1]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.152x0.411-50-100 0.006 x 0.016	2 [50]	3.9 [100]	0.00096 [0.0043] 0.031 [0.78]	0.0013 [0.0059] 0.08 [2]	0.0017 [0.0074] 0.17 [4.3]	0.0024 [0.011] 0.25 [6.4]
0.152x0.813-50-100 0.006 x 0.032	2 [50]	3.9 [100]	0.0038 [0.017] 0.015 [0.39]	0.0052 [0.023] 0.039 [0.99]	0.0065 [0.029] 0.08 [2]	0.0094 [0.042] 0.12 [2.9]
0.25x0.5-50-100 0.0098 x 0.02	2 [50]	3.9 [100]	0.0023 [0.01] 0.025 [0.64]	0.0032 [0.014] 0.065 [1.6]	0.004 [0.018] 0.14 [3.5]	0.0059 [0.026] 0.2 [5]
0.3x2-50-100 0.012 x 0.079	2 [50]	3.9 [100]	0.045 [0.2] 0.0062 [0.16]	0.062 [0.28] 0.016 [0.4]	0.077 [0.34] 0.031 [0.8]	0.11 [0.5] 0.044 [1.1]
0.4x0.8-50-100 0.016 x 0.031	2 [50]	3.9 [100]	0.0096 [0.043] 0.016 [0.4]	0.013 [0.059] 0.04 [1]	0.016 [0.073] 0.082 [2.1]	0.024 [0.11] 0.12 [3]
0.4x1-50-100 0.016 x 0.039	2 [50]	3.9 [100]	0.015 [0.067] 0.012 [0.32]	0.021 [0.092] 0.031 [0.8]	0.026 [0.11] 0.065 [1.6]	0.037 [0.17] 0.092 [2.3]
0.406x0.559-50-100 0.016 x 0.022	2 [50]	3.9 [100]	0.0048 [0.021] 0.022 [0.57]	0.0066 [0.029] 0.057 [1.5]	0.0082 [0.036] 0.12 [3.1]	0.012 [0.053] 0.18 [4.5]
0.5x0.25-50-100 0.02 x 0.0098	2 [50]	3.9 [100]	0.0012 [0.0052] 0.051 [1.3]	0.0016 [0.0072] 0.14 [3.5]	0.002 [0.009] 0.3 [7.7]	0.0029 [0.013] 0.47 [12]
0.5x0.8-50-100 0.02 x 0.031	2 [50]	3.9 [100]	0.012 [0.053] 0.016 [0.4]	0.017 [0.074] 0.04 [1]	0.021 [0.092] 0.082 [2.1]	0.03 [0.13] 0.12 [3]
0.55x1.4-50-100 0.022 x 0.055	2 [50]	3.9 [100]	0.04 [0.18] 0.0089 [0.22]	0.056 [0.25] 0.022 [0.57]	0.069 [0.31] 0.046 [1.2]	0.1 [0.45] 0.065 [1.6]
0.6x2.3-50-100 0.024 x 0.091	2 [50]	3.9 [100]	0.12 [0.53] 0.0054 [0.14]	0.16 [0.73] 0.013 [0.34]	0.2 [0.91] 0.027 [0.69]	0.3 [1.3] 0.039 [0.98]
0.8x1.5-50-100 0.031 x 0.059	2 [50]	3.9 [100]	0.067 [0.3] 0.0083 [0.21]	0.093 [0.41] 0.021 [0.53]	0.12 [0.52] 0.043 [1.1]	0.17 [0.75] 0.06 [1.5]
1x2.6-50-100 0.039 x 0.1	2 [50]	3.9 [100]	0.25 [1.1] 0.0048 [0.12]	0.35 [1.6] 0.012 [0.3]	0.44 [1.9] 0.024 [0.61]	0.63 [2.8] 0.034 [0.86]
1.5x4-50-100 0.059 x 0.16	2 [50]	3.9 [100]	0.9 [4] 0.0031 [0.078]	1.2 [5.5] 0.0079 [0.2]	1.5 [6.9] 0.016 [0.4]	2.2 [10] 0.022 [0.56]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.152x0.411-50-200 0.006 x 0.016	2 [50]	7.9 [200]	0.00048 [0.0021] 0.015 [0.39]	0.00066 [0.0029] 0.039 [0.99]	0.00083 [0.0037] 0.08 [2]	0.0012 [0.0053] 0.11 [2.9]
0.152x0.813-50-200 0.006 x 0.032	2 [50]	7.9 [200]	0.0019 [0.0084] 0.0077 [0.2]	0.0026 [0.012] 0.019 [0.49]	0.0032 [0.014] 0.039 [1]	0.0047 [0.021] 0.056 [1.4]
0.25x0.5-50-200 0.0098 x 0.02	2 [50]	7.9 [200]	0.0012 [0.0052] 0.013 [0.32]	0.0016 [0.0072] 0.032 [0.81]	0.002 [0.009] 0.065 [1.7]	0.0029 [0.013] 0.093 [2.4]
0.3x2-50-200 0.012 x 0.079	2 [50]	7.9 [200]	0.022 [0.1] 0.0031 [0.079]	0.031 [0.14] 0.0079 [0.2]	0.039 [0.17] 0.016 [0.4]	0.056 [0.25] 0.022 [0.56]
0.4x0.8-50-200 0.016 x 0.031	2 [50]	7.9 [200]	0.0048 [0.021] 0.0078 [0.2]	0.0066 [0.029] 0.02 [0.5]	0.0082 [0.037] 0.04 [1]	0.012 [0.053] 0.057 [1.4]
0.4x1-50-200 0.016 x 0.039	2 [50]	7.9 [200]	0.0075 [0.033] 0.0062 [0.16]	0.01 [0.046] 0.016 [0.4]	0.013 [0.057] 0.032 [0.81]	0.019 [0.083] 0.045 [1.1]
0.406x0.559-50-200 0.016 x 0.022	2 [50]	7.9 [200]	0.0024 [0.011] 0.011 [0.28]	0.0033 [0.015] 0.028 [0.72]	0.0041 [0.018] 0.058 [1.5]	0.0059 [0.026] 0.083 [2.1]
0.5x0.25-50-200 0.02 x 0.0098	2 [50]	7.9 [200]	0.00058 [0.0026] 0.025 [0.64]	0.00081 [0.0036] 0.065 [1.7]	0.001 [0.0045] 0.14 [3.5]	0.0015 [0.0065] 0.2 [5.1]
0.5x0.8-50-200 0.02 x 0.031	2 [50]	7.9 [200]	0.006 [0.027] 0.0078 [0.2]	0.0083 [0.037] 0.02 [0.5]	0.01 [0.046] 0.04 [1]	0.015 [0.067] 0.057 [1.4]
0.55x1.4-50-200 0.022 x 0.055	2 [50]	7.9 [200]	0.02 [0.09] 0.0045 [0.11]	0.028 [0.12] 0.011 [0.28]	0.035 [0.15] 0.022 [0.57]	0.05 [0.22] 0.032 [0.81]
0.6x2.3-50-200 0.024 x 0.091	2 [50]	7.9 [200]	0.059 [0.26] 0.0027 [0.069]	0.082 [0.36] 0.0067 [0.17]	0.1 [0.45] 0.014 [0.35]	0.15 [0.66] 0.019 [0.49]
0.8x1.5-50-200 0.031 x 0.059	2 [50]	7.9 [200]	0.034 [0.15] 0.0042 [0.11]	0.047 [0.21] 0.01 [0.26]	0.058 [0.26] 0.021 [0.53]	0.084 [0.38] 0.03 [0.75]
1x2.6-50-200 0.039 x 0.1	2 [50]	7.9 [200]	0.13 [0.56] 0.0024 [0.061]	0.17 [0.78] 0.0059 [0.15]	0.22 [0.97] 0.012 [0.31]	0.32 [1.4] 0.017 [0.43]
1.5x4-50-200 0.059 x 0.16	2 [50]	7.9 [200]	0.45 [2] 0.0016 [0.039]	0.62 [2.8] 0.0039 [0.1]	0.77 [3.4] 0.0079 [0.2]	1.1 [5] 0.011 [0.28]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.152x0.411-100-10 0.006 x 0.016	3.9 [100]	0.39 [10]	0.0096 [0.043] 0.36 [9.2]	0.013 [0.059] 0.36 [9.2]	0.017 [0.074] 0.36 [9.2]	0.024 [0.11] 0.36 [9.2]
0.152x0.813-100-10 0.006 x 0.032	3.9 [100]	0.39 [10]	0.038 [0.17] 0.3 [7.5]	0.052 [0.23] 0.36 [9.2]	0.065 [0.29] 0.36 [9.2]	0.094 [0.42] 0.36 [9.2]
0.25x0.5-100-10 0.0098 x 0.02	3.9 [100]	0.39 [10]	0.023 [0.1] 0.36 [9.2]	0.032 [0.14] 0.36 [9.2]	0.04 [0.18] 0.36 [9.2]	0.059 [0.26] 0.36 [9.2]
0.3x2-100-10 0.012 x 0.079	3.9 [100]	0.39 [10]	0.45 [2] 0.13 [3.4]	0.62 [2.8] 0.3 [7.6]	0.77 [3.4] 0.36 [9.2]	1.1 [5] 0.36 [9.2]
0.4x0.8-100-10 0.016 x 0.031	3.9 [100]	0.39 [10]	0.096 [0.43] 0.3 [7.6]	0.13 [0.59] 0.36 [9.2]	0.16 [0.73] 0.36 [9.2]	0.24 [1.1] 0.36 [9.2]
0.4x1-100-10 0.016 x 0.039	3.9 [100]	0.39 [10]	0.15 [0.67] 0.25 [6.4]	0.21 [0.92] 0.36 [9.2]	0.26 [1.1] 0.36 [9.2]	0.37 [1.7] 0.36 [9.2]
0.406x0.559-100-10 0.016 x 0.022	3.9 [100]	0.39 [10]	0.048 [0.21] 0.36 [9.1]	0.066 [0.29] 0.36 [9.2]	0.082 [0.36] 0.36 [9.2]	0.12 [0.53] 0.36 [9.2]
0.5x0.25-100-10 0.02 x 0.0098	3.9 [100]	0.39 [10]	0.012 [0.052] 0.36 [9.2]	0.016 [0.072] 0.36 [9.2]	0.02 [0.09] 0.36 [9.2]	0.029 [0.13] 0.36 [9.2]
0.5x0.8-100-10 0.02 x 0.031	3.9 [100]	0.39 [10]	0.12 [0.53] 0.3 [7.6]	0.17 [0.74] 0.36 [9.2]	0.21 [0.92] 0.36 [9.2]	0.3 [1.3] 0.36 [9.2]
0.55x1.4-100-10 0.022 x 0.055	3.9 [100]	0.39 [10]	0.4 [1.8] 0.19 [4.8]	0.56 [2.5] 0.36 [9.1]	0.69 [3.1] 0.36 [9.2]	1 [4.5] 0.36 [9.2]
0.8x1.5-100-10 0.031 x 0.059	3.9 [100]	0.39 [10]	0.67 [3] 0.18 [4.5]	0.93 [4.1] 0.35 [8.9]	1.2 [5.2] 0.36 [9.2]	1.7 [7.5] 0.36 [9.2]
0.152x0.411-100-25 0.006 x 0.016	3.9 [100]	0.98 [25]	0.0038 [0.017] 0.85 [22]	0.0053 [0.024] 1.8 [46]	0.0066 [0.029] 1.8 [46]	0.0096 [0.043] 1.8 [46]
0.152x0.813-100-25 0.006 x 0.032	3.9 [100]	0.98 [25]	0.015 [0.067] 0.38 [9.6]	0.021 [0.092] 1.1 [29]	0.026 [0.12] 1.8 [46]	0.038 [0.17] 1.8 [46]
0.25x0.5-100-25 0.0098 x 0.02	3.9 [100]	0.98 [25]	0.0094 [0.042] 0.67 [17]	0.013 [0.058] 1.8 [46]	0.016 [0.072] 1.8 [46]	0.023 [0.1] 1.8 [46]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.3x2-100-25 0.012 x 0.079	3.9 [100]	0.98 [25]	0.18 [0.8] 0.14 [3.6]	0.25 [1.1] 0.38 [9.7]	0.31 [1.4] 0.88 [22]	0.45 [2] 1.4 [34]
0.4x0.8-100-25 0.016 x 0.031	3.9 [100]	0.98 [25]	0.038 [0.17] 0.38 [9.7]	0.053 [0.24] 1.2 [30]	0.066 [0.29] 1.8 [46]	0.096 [0.43] 1.8 [46]
0.4x1-100-25 0.016 x 0.039	3.9 [100]	0.98 [25]	0.06 [0.27] 0.3 [7.6]	0.083 [0.37] 0.88 [22]	0.1 [0.46] 1.8 [46]	0.15 [0.67] 1.8 [46]
0.406x0.559-100-25 0.016 x 0.022	3.9 [100]	0.98 [25]	0.019 [0.085] 0.58 [15]	0.026 [0.12] 1.8 [45]	0.033 [0.15] 1.8 [46]	0.048 [0.21] 1.8 [46]
0.5x0.25-100-25 0.02 x 0.0098	3.9 [100]	0.98 [25]	0.0047 [0.021] 1.6 [40]	0.0065 [0.029] 1.8 [46]	0.0081 [0.036] 1.8 [46]	0.012 [0.052] 1.8 [46]
0.5x0.8-100-25 0.02 x 0.031	3.9 [100]	0.98 [25]	0.048 [0.21] 0.38 [9.7]	0.066 [0.29] 1.2 [30]	0.082 [0.37] 1.8 [46]	0.12 [0.53] 1.8 [46]
0.55x1.4-100-25 0.022 x 0.055	3.9 [100]	0.98 [25]	0.16 [0.72] 0.21 [5.3]	0.22 [0.99] 0.58 [15]	0.28 [1.2] 1.4 [35]	0.4 [1.8] 1.8 [46]
0.6x2.3-100-25 0.024 x 0.091	3.9 [100]	0.98 [25]	0.48 [2.1] 0.12 [3.1]	0.66 [2.9] 0.33 [8.3]	0.82 [3.6] 0.74 [19]	1.2 [5.3] 1.1 [29]
0.8x1.5-100-25 0.031 x 0.059	3.9 [100]	0.98 [25]	0.27 [1.2] 0.19 [4.9]	0.37 [1.7] 0.53 [14]	0.46 [2.1] 1.3 [32]	0.67 [3] 1.8 [46]
1x2.6-100-25 0.039 x 0.1	3.9 [100]	0.98 [25]	1 [4.5] 0.11 [2.7]	1.4 [6.2] 0.29 [7.3]	1.7 [7.8] 0.63 [16]	2.5 [11] 0.97 [25]
1.5x4-100-25 0.059 x 0.16	3.9 [100]	0.98 [25]	3.6 [16] 0.069 [1.8]	5 [22] 0.18 [4.6]	6.2 [28] 0.38 [9.7]	9 [40] 0.57 [14]
0.152x0.411-100-50 0.006 x 0.016	3.9 [100]	2 [50]	0.0019 [0.0086] 0.51 [13]	0.0027 [0.012] 1.9 [47]	0.0033 [0.015] 5.1 [130]	0.0048 [0.021] 5.1 [130]
0.152x0.813-100-50 0.006 x 0.032	3.9 [100]	2 [50]	0.0075 [0.033] 0.23 [6]	0.01 [0.046] 0.68 [17]	0.013 [0.058] 1.9 [48]	0.019 [0.084] 4 [100]
0.25x0.5-100-50 0.0098 x 0.02	3.9 [100]	2 [50]	0.0047 [0.021] 0.4 [10]	0.0065 [0.029] 1.3 [34]	0.0081 [0.036] 5.1 [130]	0.012 [0.052] 5.1 [130]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.3x2-100-50 0.012 x 0.079	3.9 [100]	2 [50]	0.09 [0.4] 0.09 [2.3]	0.12 [0.55] 0.24 [6.1]	0.15 [0.69] 0.53 [13]	0.22 [1] 0.81 [20]
0.4x0.8-100-50 0.016 x 0.031	3.9 [100]	2 [50]	0.019 [0.085] 0.24 [6.1]	0.026 [0.12] 0.7 [18]	0.033 [0.15] 2 [50]	0.048 [0.21] 4.1 [100]
0.4x1-100-50 0.016 x 0.039	3.9 [100]	2 [50]	0.03 [0.13] 0.19 [4.8]	0.041 [0.18] 0.53 [13]	0.052 [0.23] 1.3 [34]	0.075 [0.33] 2.4 [62]
0.406x0.559-100-50 0.016 x 0.022	3.9 [100]	2 [50]	0.0095 [0.042] 0.36 [9]	0.013 [0.058] 1.1 [29]	0.016 [0.073] 4.4 [110]	0.024 [0.11] 5.1 [130]
0.5x0.25-100-50 0.02 x 0.0098	3.9 [100]	2 [50]	0.0023 [0.01] 0.97 [25]	0.0032 [0.014] 5.1 [130]	0.004 [0.018] 5.1 [130]	0.0059 [0.026] 5.1 [130]
0.5x0.8-100-50 0.02 x 0.031	3.9 [100]	2 [50]	0.024 [0.11] 0.24 [6.1]	0.033 [0.15] 0.7 [18]	0.041 [0.18] 2 [50]	0.06 [0.27] 4.1 [100]
0.55x1.4-100-50 0.022 x 0.055	3.9 [100]	2 [50]	0.081 [0.36] 0.13 [3.3]	0.11 [0.5] 0.36 [9]	0.14 [0.62] 0.83 [21]	0.2 [0.9] 1.3 [34]
0.6x2.3-100-50 0.024 x 0.091	3.9 [100]	2 [50]	0.24 [1.1] 0.078 [2]	0.33 [1.5] 0.21 [5.2]	0.41 [1.8] 0.45 [11]	0.59 [2.6] 0.67 [17]
0.8x1.5-100-50 0.031 x 0.059	3.9 [100]	2 [50]	0.13 [0.6] 0.12 [3.1]	0.19 [0.83] 0.33 [8.3]	0.23 [1] 0.76 [19]	0.34 [1.5] 1.2 [31]
1x2.6-100-50 0.039 x 0.1	3.9 [100]	2 [50]	0.51 [2.3] 0.069 [1.8]	0.7 [3.1] 0.18 [4.6]	0.87 [3.9] 0.39 [9.8]	1.3 [5.6] 0.58 [15]
1.5x4-100-50 0.059 x 0.16	3.9 [100]	2 [50]	1.8 [8] 0.044 [1.1]	2.5 [11] 0.11 [2.9]	3.1 [14] 0.24 [6.1]	4.5 [20] 0.35 [8.8]
0.152x0.411-100-100 0.006 x 0.016	3.9 [100]	3.9 [100]	0.00096 [0.0043] 0.26 [6.5]	0.0013 [0.0059] 0.76 [19]	0.0017 [0.0074] 2.2 [57]	0.0024 [0.011] 5.6 [140]
0.152x0.813-100-100 0.006 x 0.032	3.9 [100]	3.9 [100]	0.0038 [0.017] 0.12 [3.1]	0.0052 [0.023] 0.33 [8.4]	0.0065 [0.029] 0.77 [19]	0.0094 [0.042] 1.2 [31]
0.25x0.5-100-100 0.0098 x 0.02	3.9 [100]	3.9 [100]	0.0023 [0.01] 0.21 [5.2]	0.0032 [0.014] 0.59 [15]	0.004 [0.018] 1.6 [40]	0.0059 [0.026] 3 [77]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.3x2-100-100 0.012 x 0.079	3.9 [100]	3.9 [100]	0.045 [0.2] 0.049 [1.2]	0.062 [0.28] 0.13 [3.2]	0.077 [0.34] 0.26 [6.7]	0.11 [0.5] 0.39 [9.8]
0.4x0.8-100-100 0.016 x 0.031	3.9 [100]	3.9 [100]	0.0096 [0.043] 0.13 [3.2]	0.013 [0.059] 0.34 [8.6]	0.016 [0.073] 0.78 [20]	0.024 [0.11] 1.3 [32]
0.4x1-100-100 0.016 x 0.039	3.9 [100]	3.9 [100]	0.015 [0.067] 0.099 [2.5]	0.021 [0.092] 0.26 [6.7]	0.026 [0.11] 0.59 [15]	0.037 [0.17] 0.91 [23]
0.406x0.559-100-100 0.016 x 0.022	3.9 [100]	3.9 [100]	0.0048 [0.021] 0.18 [4.7]	0.0066 [0.029] 0.51 [13]	0.0082 [0.036] 1.3 [33]	0.012 [0.053] 2.4 [60]
0.5x0.25-100-100 0.02 x 0.0098	3.9 [100]	3.9 [100]	0.0012 [0.0052] 0.45 [11]	0.0016 [0.0072] 1.6 [40]	0.002 [0.009] 13 [320]	0.0029 [0.013] 13 [320]
0.5x0.8-100-100 0.02 x 0.031	3.9 [100]	3.9 [100]	0.012 [0.053] 0.13 [3.2]	0.017 [0.074] 0.34 [8.6]	0.021 [0.092] 0.78 [20]	0.03 [0.13] 1.3 [32]
0.55x1.4-100-100 0.022 x 0.055	3.9 [100]	3.9 [100]	0.04 [0.18] 0.07 [1.8]	0.056 [0.25] 0.18 [4.7]	0.069 [0.31] 0.39 [10]	0.1 [0.45] 0.59 [15]
0.6x2.3-100-100 0.024 x 0.091	3.9 [100]	3.9 [100]	0.12 [0.53] 0.042 [1.1]	0.16 [0.73] 0.11 [2.8]	0.2 [0.91] 0.23 [5.8]	0.3 [1.3] 0.33 [8.3]
0.8x1.5-100-100 0.031 x 0.059	3.9 [100]	3.9 [100]	0.067 [0.3] 0.065 [1.7]	0.093 [0.41] 0.17 [4.3]	0.12 [0.52] 0.36 [9.2]	0.17 [0.75] 0.54 [14]
1x2.6-100-100 0.039 x 0.1	3.9 [100]	3.9 [100]	0.25 [1.1] 0.037 [0.95]	0.35 [1.6] 0.095 [2.4]	0.44 [1.9] 0.2 [5]	0.63 [2.8] 0.29 [7.3]
1.5x4-100-100 0.059 x 0.16	3.9 [100]	3.9 [100]	0.9 [4] 0.024 [0.61]	1.2 [5.5] 0.061 [1.6]	1.5 [6.9] 0.13 [3.2]	2.2 [10] 0.18 [4.5]
0.152x0.411-100-200 0.006 x 0.016	3.9 [100]	7.9 [200]	0.00048 [0.0021] 0.13 [3.2]	0.00066 [0.0029] 0.34 [8.6]	0.00083 [0.0037] 0.78 [20]	0.0012 [0.0053] 1.3 [32]
0.152x0.813-100-200 0.006 x 0.032	3.9 [100]	7.9 [200]	0.0019 [0.0084] 0.062 [1.6]	0.0026 [0.012] 0.16 [4.1]	0.0032 [0.014] 0.34 [8.7]	0.0047 [0.021] 0.51 [13]
0.25x0.5-100-200 0.0098 x 0.02	3.9 [100]	7.9 [200]	0.0012 [0.0052] 0.1 [2.6]	0.0016 [0.0072] 0.27 [6.9]	0.002 [0.009] 0.61 [15]	0.0029 [0.013] 0.95 [24]

Part reference / section, in	Pitch, in [mm]	Amplitude, in [mm]	Level A: force, lbf [N] / stroke per wave, in [mm]	Level B: force, lbf [N] / stroke per wave, in [mm]	Level C: force, lbf [N] / stroke per wave, in [mm]	Level D: force, lbf [N] / stroke per wave, in [mm]
0.3x2-100-200 0.012 x 0.079	3.9 [100]	7.9 [200]	0.022 [0.1] 0.025 [0.63]	0.031 [0.14] 0.063 [1.6]	0.039 [0.17] 0.13 [3.3]	0.056 [0.25] 0.18 [4.7]
0.4x0.8-100-200 0.016 x 0.031	3.9 [100]	7.9 [200]	0.0048 [0.021] 0.063 [1.6]	0.0066 [0.029] 0.16 [4.2]	0.0082 [0.037] 0.35 [8.9]	0.012 [0.053] 0.52 [13]
0.4x1-100-200 0.016 x 0.039	3.9 [100]	7.9 [200]	0.0075 [0.033] 0.05 [1.3]	0.01 [0.046] 0.13 [3.3]	0.013 [0.057] 0.27 [6.9]	0.019 [0.083] 0.4 [10]
0.406x0.559-100-200 0.016 x 0.022	3.9 [100]	7.9 [200]	0.0024 [0.011] 0.091 [2.3]	0.0033 [0.015] 0.24 [6.1]	0.0041 [0.018] 0.53 [14]	0.0059 [0.026] 0.81 [21]
0.5x0.25-100-200 0.02 x 0.0098	3.9 [100]	7.9 [200]	0.00058 [0.0026] 0.21 [5.4]	0.00081 [0.0036] 0.61 [15]	0.001 [0.0045] 1.6 [42]	0.0015 [0.0065] 3.3 [83]
0.5x0.8-100-200 0.02 x 0.031	3.9 [100]	7.9 [200]	0.006 [0.027] 0.063 [1.6]	0.0083 [0.037] 0.16 [4.2]	0.01 [0.046] 0.35 [8.9]	0.015 [0.067] 0.52 [13]
0.55x1.4-100-200 0.022 x 0.055	3.9 [100]	7.9 [200]	0.02 [0.09] 0.036 [0.91]	0.028 [0.12] 0.091 [2.3]	0.035 [0.15] 0.19 [4.8]	0.05 [0.22] 0.27 [6.9]
0.6x2.3-100-200 0.024 x 0.091	3.9 [100]	7.9 [200]	0.059 [0.26] 0.022 [0.55]	0.082 [0.36] 0.055 [1.4]	0.1 [0.45] 0.11 [2.8]	0.15 [0.66] 0.16 [4]
0.8x1.5-100-200 0.031 x 0.059	3.9 [100]	7.9 [200]	0.034 [0.15] 0.033 [0.84]	0.047 [0.21] 0.085 [2.1]	0.058 [0.26] 0.18 [4.5]	0.084 [0.38] 0.25 [6.4]
1x2.6-100-200 0.039 x 0.1	3.9 [100]	7.9 [200]	0.13 [0.56] 0.019 [0.48]	0.17 [0.78] 0.048 [1.2]	0.22 [0.97] 0.098 [2.5]	0.32 [1.4] 0.14 [3.5]
1.5x4-100-200 0.059 x 0.16	3.9 [100]	7.9 [200]	0.45 [2] 0.012 [0.31]	0.62 [2.8] 0.031 [0.79]	0.77 [3.4] 0.063 [1.6]	1.1 [5] 0.089 [2.3]

NOTES

NOTES

CHAPTER 9

Belleville Actuators

Very high force over a very small stroke

A Belleville actuator is a washer with a cone pressed into it. Heat it and the cone tries to flatten, and while it does that it pushes extremely hard over an extremely short distance.

This is the shape to use when the problem is force and the movement is almost incidental. Clamping. Preloading a joint. Holding a seal shut. Locking something in place and releasing it on command. A twenty five millimeter washer three millimeters thick will push with tens of kilonewtons through less than a millimeter, in a package the size of a coin.

Stack them for stroke or for force

One washer gives a small stroke and a large force. Stacking is how you get more of either, and which way you stack decides which one you get.

Stacked in series, each washer faces opposite to the one before, so the stack is a row of hourglass shapes meeting rim to rim and bore to bore. The strokes add. Ten washers in series give ten times the travel at the same force.

Stacked in parallel, each washer nests into the one before with all of them facing the same way, like a stack of saucers. The forces add. Ten washers in parallel give ten times the push through the same travel.

The two can be mixed. A stack built from nested pairs, with each pair reversed against the next, doubles the force and multiplies the travel by the number of pairs. That is how most real stacks are built: you choose the pairing for the force you need and the number of sets for the stroke.

The figures in the table are per washer, so you scale them by counting, which is why the table is laid out per piece rather than per assembly.

The cone angle is a fatigue decision, not just a stroke decision

This is the one thing about a Belleville actuator that catches people out, so it is worth being direct about it.

A steeper cone gives more possible travel. But all of that extra travel has to be paid for out of the same bending allowance the material has, so a steeper cone also means a shorter life. A washer coned at sixty degrees has far more stroke available than the same washer at thirty degrees, and it will survive far fewer cycles if you use all of it.

> *The cone angle buys stroke and it costs fatigue life. Nothing about it is free.*

The tables handle this for you. For each of the four design levels you get the stroke that washer will actually deliver at that life. Read down the column for the life you need, not across to the biggest number.

Getting it back

Like every shape in this handbook, a nitinol actuator moves one way when it is heated. Getting it back to where it started is the designer's problem, and there are three ways to solve it.

AN ANTAGONISTIC PAIR uses a second actuator working against the first. Heat one and it moves the mechanism and resets the other; heat the other and it goes back. You get powered motion in both directions with full output each way, at the cost of two actuators and a control scheme that never heats both at once.

A BIAS is a passive element, usually a conventional spring or a weight, that the actuator works against as it moves and that pushes it back as it cools. It is the simplest arrangement and the most common. The price is that the bias resists the actuator through the whole stroke, so part of the force in the table is spent returning the mechanism rather than doing the job. Size it to return the actuator and no more.

SYSTEM FORCES are the return you already have. If the mechanism pushes back on its own, if gravity closes the door, if the thing being clamped is springy, if line pressure acts on the valve, that force resets the actuator for nothing. It is the best answer when it is available, and worth looking for before adding parts.

Whichever you choose, the return has to be strong enough to reset the actuator while it is cool and weak enough not to stall it while it is hot. That window is what sizes a bias, and it is the most common thing to get wrong on a first build.

There is a fourth possibility. Any nitinol actuator can be given a two way set, so that it takes one shape hot and another cold and needs no return at all. Two way parts are made to order and are outside the scope of this handbook, so nothing here is rated for it, but it exists. Ask.

Overdriving an actuator

The figures in this handbook are conservative. Every force in every table is rated at a stress we are confident the part will deliver, cycle after cycle, at the fatigue life of its design level. A part will usually do more than the table says. We would rather you found that out in testing than the other way round.

The second reason a part will beat its table is that you can overdrive it, and this one is a feature you can design with. There are two ways to do it, and they add.

The first is to heat it further. Nitinol makes its force by changing phase, and the temperature at which it does that is the transition temperature we set for you. The force does not stop climbing when the part gets there. Keep heating it past the transition and the force keeps rising with temperature, well beyond the rated figure. The table gives you the force at a working temperature comfortably above transition. Drive the part hotter and there is more.

The second is to heat it faster. Heat the part slowly and it makes the force in the table. Heat it quickly, with a sharp pulse of current rather than a gentle ramp, and it makes more, and the harder the pulse, the bigger the difference. A part that is driven both fast and hot gets the gain from each, one on top of the other. The tables assume neither. They are the floor.

Emergency mode

That gives a nitinol actuator something most actuators do not have: a reserve. A motor or a solenoid has a rated output and a thermal limit close behind it. A nitinol actuator can be driven, briefly, to a force well above its rating simply by putting more heat into it, faster. Think of it as an emergency mode. A latch that normally needs a modest pull can, on the day something jams, be hit with a short hard pulse and told to pull much harder. A release that must not fail gets a margin that costs nothing in size or weight.

Use it as a reserve, not as the rating, and know where the limits are. There is a temperature, called Md, above which the metal can no longer be pushed into martensite by stress; up to Md the material is still behaving as nitinol should. Overdriving up to Md costs some fatigue life, but it also does the part a favor: the extra heat drives out residual martensite that builds up over many cycles, a kind of rehabilitation in place, so a part that is occasionally run hard can come back sharper than one that never is. Above Md the accounting changes. Degradation is faster, and each hot cycle takes a larger bite out of the life. Above 350 °C (660 °F) the part is past saving: treat an actuator that has been driven that hot as spent and replace it. Used within those limits, for the rare event, emergency mode is one of the best arguments for the material.

Actuator safety

Most actuators fail badly when they are overdriven, and engineers know exactly how. Put too much current into a motor or a solenoid and it explodes. Overpressure a hydraulic cylinder and it bursts, or springs a pinhole leak, and a jet of oil at that pressure will cut through a glove and a hand, take a limb, and put oil into the ground and the water where it can be years being cleaned up. Every one of them has the same problem: the energy is stored in the actuator, and when something goes wrong it has nowhere to go but out. A nitinol actuator, very simply, does not carry these risks. It is a piece of metal with a current in it, and there is nothing in it to burst, nothing to leak, and nothing to poison.

A nitinol actuator fails the other way. Put too much power into it and it simply gets hotter. Past the working range the force keeps rising; past that, the part reaches the temperatures at which it was shape set, and at that point the metal lets go of its memory. The actuator loses its force, goes slack, and parts, which opens the circuit that was heating it. It shuts itself off. There is nothing stored in it to release: no pressure, no winding, no field. The failure mode is a dead part and an open circuit, not an event.

That is worth stating plainly for anyone writing a safety case. The worst thing an overdriven nitinol actuator does is stop.

What we supply

Outside diameters	9 to 100 mm.
Inside diameters	A quarter, a half or three quarters of the outside diameter.
Thickness	1 to 10 mm.
Cone angles	30, 45 and 60 degrees.
Transition temperature	Our standard blank set is made at 65 C and above. Other temperatures to order.

Sold as	By the piece.

Two geometry rules apply to keep the parts makeable: the bore is never less than three times the material thickness, and the outside diameter is never more than fifty times it. Combinations that break either rule are not listed.

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
9-5-1-30deg	0.35 [9]	0.2 [5]	0.039 [1]	30	41 [0.18] 0.0041 [0.1]	57 [0.25] 0.01 [0.25]	71 [0.32] 0.019 [0.48]	100 [0.46] 0.026 [0.66]
9-5-1-45deg	0.35 [9]	0.2 [5]	0.039 [1]	45	41 [0.18] 0.0061 [0.15]	57 [0.25] 0.014 [0.36]	71 [0.32] 0.027 [0.67]	100 [0.46] 0.035 [0.89]
9-5-1-60deg	0.35 [9]	0.2 [5]	0.039 [1]	60	41 [0.18] 0.012 [0.3]	57 [0.25] 0.027 [0.68]	71 [0.32] 0.047 [1.2]	100 [0.46] 0.06 [1.5]
9-5-1.3-30deg	0.35 [9]	0.2 [5]	0.051 [1.3]	30	70 [0.31] 0.0032 [0.081]	96 [0.43] 0.0078 [0.2]	120 [0.53] 0.015 [0.38]	170 [0.77] 0.02 [0.52]
9-5-1.3-45deg	0.35 [9]	0.2 [5]	0.051 [1.3]	45	70 [0.31] 0.0047 [0.12]	96 [0.43] 0.011 [0.29]	120 [0.53] 0.021 [0.54]	170 [0.77] 0.028 [0.72]
9-5-1.3-60deg	0.35 [9]	0.2 [5]	0.051 [1.3]	60	70 [0.31] 0.0092 [0.23]	96 [0.43] 0.021 [0.54]	120 [0.53] 0.039 [0.98]	170 [0.77] 0.05 [1.3]
9-5-1.5-30deg	0.35 [9]	0.2 [5]	0.059 [1.5]	30	93 [0.41] 0.0028 [0.07]	130 [0.57] 0.0067 [0.17]	160 [0.71] 0.013 [0.33]	230 [1] 0.018 [0.45]
9-5-1.5-45deg	0.35 [9]	0.2 [5]	0.059 [1.5]	45	93 [0.41] 0.0041 [0.1]	130 [0.57] 0.0098 [0.25]	160 [0.71] 0.019 [0.47]	230 [1] 0.025 [0.64]
9-5-1.5-60deg	0.35 [9]	0.2 [5]	0.059 [1.5]	60	93 [0.41] 0.008 [0.2]	130 [0.57] 0.019 [0.48]	160 [0.71] 0.034 [0.87]	230 [1] 0.045 [1.1]
9-7-1-30deg	0.35 [9]	0.28 [7]	0.039 [1]	30	94 [0.42] 0.001 [0.026]	130 [0.58] 0.0026 [0.065]	160 [0.72] 0.005 [0.13]	240 [1] 0.0069 [0.17]
9-7-1-45deg	0.35 [9]	0.28 [7]	0.039 [1]	45	94 [0.42] 0.0015 [0.039]	130 [0.58] 0.0037 [0.095]	160 [0.72] 0.0072 [0.18]	240 [1] 0.0097 [0.25]
9-7-1-60deg	0.35 [9]	0.28 [7]	0.039 [1]	60	94 [0.42] 0.003 [0.077]	130 [0.58] 0.0072 [0.18]	160 [0.72] 0.013 [0.34]	240 [1] 0.018 [0.45]
9-7-1.3-30deg	0.35 [9]	0.28 [7]	0.051 [1.3]	30	160 [0.71] 0.00079 [0.02]	220 [0.98] 0.002 [0.05]	270 [1.2] 0.0039 [0.098]	400 [1.8] 0.0054 [0.14]
9-7-1.3-45deg	0.35 [9]	0.28 [7]	0.051 [1.3]	45	160 [0.71] 0.0012 [0.03]	220 [0.98] 0.0029 [0.074]	270 [1.2] 0.0056 [0.14]	400 [1.8] 0.0077 [0.2]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
9-7-1.3-60deg	0.35 [9]	0.28 [7]	0.051 [1.3]	60	160 [0.71] 0.0024 [0.06]	220 [0.98] 0.0057 [0.14]	270 [1.2] 0.011 [0.27]	400 [1.8] 0.014 [0.36]
9-7-1.5-30deg	0.35 [9]	0.28 [7]	0.059 [1.5]	30	210 [0.94] 0.00071 [0.018]	290 [1.3] 0.0017 [0.044]	360 [1.6] 0.0034 [0.086]	530 [2.4] 0.0046 [0.12]
9-7-1.5-45deg	0.35 [9]	0.28 [7]	0.059 [1.5]	45	210 [0.94] 0.001 [0.026]	290 [1.3] 0.0026 [0.065]	360 [1.6] 0.0049 [0.12]	530 [2.4] 0.0067 [0.17]
9-7-1.5-60deg	0.35 [9]	0.28 [7]	0.059 [1.5]	60	210 [0.94] 0.002 [0.052]	290 [1.3] 0.005 [0.13]	360 [1.6] 0.0094 [0.24]	530 [2.4] 0.013 [0.32]
9-7-2-30deg	0.35 [9]	0.28 [7]	0.079 [2]	30	380 [1.7] 0.00051 [0.013]	520 [2.3] 0.0013 [0.033]	650 [2.9] 0.0026 [0.065]	940 [4.2] 0.0035 [0.09]
9-7-2-45deg	0.35 [9]	0.28 [7]	0.079 [2]	45	380 [1.7] 0.00079 [0.02]	520 [2.3] 0.0019 [0.049]	650 [2.9] 0.0037 [0.095]	940 [4.2] 0.0052 [0.13]
9-7-2-60deg	0.35 [9]	0.28 [7]	0.079 [2]	60	380 [1.7] 0.0015 [0.039]	520 [2.3] 0.0038 [0.096]	650 [2.9] 0.0072 [0.18]	940 [4.2] 0.0098 [0.25]
12-3-1-30deg	0.47 [12]	0.12 [3]	0.039 [1]	30	20 [0.087] 0.02 [0.52]	27 [0.12] 0.048 [1.2]	34 [0.15] 0.089 [2.3]	49 [0.22] 0.1 [2.6]
12-3-1-45deg	0.47 [12]	0.12 [3]	0.039 [1]	45	20 [0.087] 0.029 [0.74]	27 [0.12] 0.066 [1.7]	34 [0.15] 0.12 [2.9]	49 [0.22] 0.15 [3.8]
12-3-1-60deg	0.47 [12]	0.12 [3]	0.039 [1]	60	20 [0.087] 0.055 [1.4]	27 [0.12] 0.12 [3]	34 [0.15] 0.19 [4.7]	49 [0.22] 0.23 [5.8]
12-6-1-30deg	0.47 [12]	0.24 [6]	0.039 [1]	30	35 [0.16] 0.0091 [0.23]	49 [0.22] 0.022 [0.56]	61 [0.27] 0.041 [1.1]	88 [0.39] 0.056 [1.4]
12-6-1-45deg	0.47 [12]	0.24 [6]	0.039 [1]	45	35 [0.16] 0.013 [0.34]	49 [0.22] 0.031 [0.79]	61 [0.27] 0.056 [1.4]	88 [0.39] 0.073 [1.9]
12-6-1-60deg	0.47 [12]	0.24 [6]	0.039 [1]	60	35 [0.16] 0.026 [0.65]	49 [0.22] 0.057 [1.4]	61 [0.27] 0.095 [2.4]	88 [0.39] 0.12 [3]
12-6-1.3-30deg	0.47 [12]	0.24 [6]	0.051 [1.3]	30	60 [0.27] 0.0071 [0.18]	82 [0.37] 0.017 [0.43]	100 [0.46] 0.033 [0.83]	150 [0.66] 0.044 [1.1]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
12-6-1.3-45deg	0.47 [12]	0.24 [6]	0.051 [1.3]	45	60 [0.27] 0.01 [0.27]	82 [0.37] 0.025 [0.62]	100 [0.46] 0.045 [1.1]	150 [0.66] 0.059 [1.5]
12-6-1.3-60deg	0.47 [12]	0.24 [6]	0.051 [1.3]	60	60 [0.27] 0.02 [0.51]	82 [0.37] 0.046 [1.2]	100 [0.46] 0.079 [2]	150 [0.66] 0.1 [2.5]
12-6-1.5-30deg	0.47 [12]	0.24 [6]	0.059 [1.5]	30	79 [0.35] 0.0061 [0.16]	110 [0.49] 0.015 [0.38]	140 [0.61] 0.029 [0.73]	200 [0.88] 0.039 [0.99]
12-6-1.5-45deg	0.47 [12]	0.24 [6]	0.059 [1.5]	45	79 [0.35] 0.0091 [0.23]	110 [0.49] 0.022 [0.55]	140 [0.61] 0.04 [1]	200 [0.88] 0.053 [1.3]
12-6-1.5-60deg	0.47 [12]	0.24 [6]	0.059 [1.5]	60	79 [0.35] 0.018 [0.45]	110 [0.49] 0.04 [1]	140 [0.61] 0.071 [1.8]	200 [0.88] 0.091 [2.3]
12-6-2-30deg	0.47 [12]	0.24 [6]	0.079 [2]	30	140 [0.63] 0.0046 [0.12]	200 [0.87] 0.011 [0.29]	240 [1.1] 0.022 [0.56]	350 [1.6] 0.03 [0.76]
12-6-2-45deg	0.47 [12]	0.24 [6]	0.079 [2]	45	140 [0.63] 0.0069 [0.17]	200 [0.87] 0.016 [0.42]	240 [1.1] 0.031 [0.79]	350 [1.6] 0.041 [1.1]
12-6-2-60deg	0.47 [12]	0.24 [6]	0.079 [2]	60	140 [0.63] 0.013 [0.34]	200 [0.87] 0.031 [0.8]	240 [1.1] 0.057 [1.4]	350 [1.6] 0.074 [1.9]
12-9-1-30deg	0.47 [12]	0.35 [9]	0.039 [1]	30	83 [0.37] 0.0023 [0.059]	110 [0.51] 0.0057 [0.14]	140 [0.63] 0.011 [0.28]	210 [0.92] 0.015 [0.38]
12-9-1-45deg	0.47 [12]	0.35 [9]	0.039 [1]	45	83 [0.37] 0.0034 [0.087]	110 [0.51] 0.0083 [0.21]	140 [0.63] 0.016 [0.39]	210 [0.92] 0.021 [0.53]
12-9-1-60deg	0.47 [12]	0.35 [9]	0.039 [1]	60	83 [0.37] 0.0067 [0.17]	110 [0.51] 0.016 [0.4]	140 [0.63] 0.028 [0.72]	210 [0.92] 0.037 [0.93]
12-9-1.3-30deg	0.47 [12]	0.35 [9]	0.051 [1.3]	30	140 [0.62] 0.0018 [0.046]	190 [0.85] 0.0044 [0.11]	240 [1.1] 0.0085 [0.22]	350 [1.5] 0.012 [0.3]
12-9-1.3-45deg	0.47 [12]	0.35 [9]	0.051 [1.3]	45	140 [0.62] 0.0027 [0.068]	190 [0.85] 0.0065 [0.16]	240 [1.1] 0.012 [0.31]	350 [1.5] 0.017 [0.42]
12-9-1.3-60deg	0.47 [12]	0.35 [9]	0.051 [1.3]	60	140 [0.62] 0.0052 [0.13]	190 [0.85] 0.012 [0.32]	240 [1.1] 0.023 [0.58]	350 [1.5] 0.03 [0.76]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
12-9-1.5-30deg	0.47 [12]	0.35 [9]	0.059 [1.5]	30	180 [0.82] 0.0016 [0.04]	260 [1.1] 0.0038 [0.097]	320 [1.4] 0.0075 [0.19]	460 [2.1] 0.01 [0.26]
12-9-1.5-45deg	0.47 [12]	0.35 [9]	0.059 [1.5]	45	180 [0.82] 0.0023 [0.059]	260 [1.1] 0.0056 [0.14]	320 [1.4] 0.011 [0.27]	460 [2.1] 0.015 [0.37]
12-9-1.5-60deg	0.47 [12]	0.35 [9]	0.059 [1.5]	60	180 [0.82] 0.0046 [0.12]	260 [1.1] 0.011 [0.28]	320 [1.4] 0.02 [0.51]	460 [2.1] 0.027 [0.68]
12-9-2-30deg	0.47 [12]	0.35 [9]	0.079 [2]	30	330 [1.5] 0.0012 [0.03]	460 [2] 0.0029 [0.073]	570 [2.5] 0.0057 [0.14]	820 [3.7] 0.0078 [0.2]
12-9-2-45deg	0.47 [12]	0.35 [9]	0.079 [2]	45	330 [1.5] 0.0017 [0.044]	460 [2] 0.0043 [0.11]	570 [2.5] 0.0083 [0.21]	820 [3.7] 0.011 [0.29]
12-9-2-60deg	0.47 [12]	0.35 [9]	0.079 [2]	60	330 [1.5] 0.0035 [0.088]	460 [2] 0.0083 [0.21]	570 [2.5] 0.016 [0.4]	820 [3.7] 0.021 [0.54]
12-9-2.5-30deg	0.47 [12]	0.35 [9]	0.098 [2.5]	30	520 [2.3] 0.00094 [0.024]	710 [3.2] 0.0023 [0.059]	890 [3.9] 0.0046 [0.12]	1300 [5.7] 0.0063 [0.16]
12-9-2.5-45deg	0.47 [12]	0.35 [9]	0.098 [2.5]	45	520 [2.3] 0.0014 [0.036]	710 [3.2] 0.0034 [0.087]	890 [3.9] 0.0067 [0.17]	1300 [5.7] 0.0092 [0.23]
12-9-2.5-60deg	0.47 [12]	0.35 [9]	0.098 [2.5]	60	520 [2.3] 0.0028 [0.071]	710 [3.2] 0.0067 [0.17]	890 [3.9] 0.013 [0.33]	1300 [5.7] 0.017 [0.44]
12-9-3-30deg	0.47 [12]	0.35 [9]	0.12 [3]	30	740 [3.3] 0.00079 [0.02]	1000 [4.6] 0.0019 [0.049]	1300 [5.7] 0.0038 [0.097]	1900 [8.2] 0.0053 [0.14]
12-9-3-45deg	0.47 [12]	0.35 [9]	0.12 [3]	45	740 [3.3] 0.0012 [0.03]	1000 [4.6] 0.0029 [0.073]	1300 [5.7] 0.0056 [0.14]	1900 [8.2] 0.0078 [0.2]
12-9-3-60deg	0.47 [12]	0.35 [9]	0.12 [3]	60	740 [3.3] 0.0023 [0.059]	1000 [4.6] 0.0057 [0.14]	1300 [5.7] 0.011 [0.28]	1900 [8.2] 0.015 [0.38]
18-6-1-30deg	0.71 [18]	0.24 [6]	0.039 [1]	30	24 [0.1] 0.036 [0.9]	33 [0.14] 0.083 [2.1]	40 [0.18] 0.14 [3.5]	59 [0.26] 0.14 [3.5]
18-6-1-45deg	0.71 [18]	0.24 [6]	0.039 [1]	45	24 [0.1] 0.051 [1.3]	33 [0.14] 0.11 [2.8]	40 [0.18] 0.19 [4.9]	59 [0.26] 0.24 [6]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
18-6-1-60deg	0.71 [18]	0.24 [6]	0.039 [1]	60	24 [0.1] 0.094 [2.4]	33 [0.14] 0.19 [4.8]	40 [0.18] 0.3 [7.5]	59 [0.26] 0.36 [9.1]
18-6-1.3-30deg	0.71 [18]	0.24 [6]	0.051 [1.3]	30	40 [0.18] 0.028 [0.7]	55 [0.24] 0.065 [1.7]	68 [0.3] 0.12 [3.1]	99 [0.44] 0.14 [3.5]
18-6-1.3-45deg	0.71 [18]	0.24 [6]	0.051 [1.3]	45	40 [0.18] 0.04 [1]	55 [0.24] 0.09 [2.3]	68 [0.3] 0.16 [4]	99 [0.44] 0.2 [5.2]
18-6-1.3-60deg	0.71 [18]	0.24 [6]	0.051 [1.3]	60	40 [0.18] 0.075 [1.9]	55 [0.24] 0.16 [4]	68 [0.3] 0.25 [6.4]	99 [0.44] 0.31 [7.8]
18-6-1.5-30deg	0.71 [18]	0.24 [6]	0.059 [1.5]	30	53 [0.24] 0.024 [0.61]	73 [0.33] 0.057 [1.5]	91 [0.41] 0.11 [2.7]	130 [0.59] 0.14 [3.5]
18-6-1.5-45deg	0.71 [18]	0.24 [6]	0.059 [1.5]	45	53 [0.24] 0.035 [0.89]	73 [0.33] 0.08 [2]	91 [0.41] 0.14 [3.6]	130 [0.59] 0.18 [4.6]
18-6-1.5-60deg	0.71 [18]	0.24 [6]	0.059 [1.5]	60	53 [0.24] 0.067 [1.7]	73 [0.33] 0.14 [3.6]	91 [0.41] 0.23 [5.9]	130 [0.59] 0.28 [7.2]
18-6-2-30deg	0.71 [18]	0.24 [6]	0.079 [2]	30	94 [0.42] 0.018 [0.46]	130 [0.58] 0.044 [1.1]	160 [0.72] 0.083 [2.1]	240 [1] 0.11 [2.8]
18-6-2-45deg	0.71 [18]	0.24 [6]	0.079 [2]	45	94 [0.42] 0.027 [0.68]	130 [0.58] 0.062 [1.6]	160 [0.72] 0.11 [2.8]	240 [1] 0.15 [3.7]
18-6-2-60deg	0.71 [18]	0.24 [6]	0.079 [2]	60	94 [0.42] 0.051 [1.3]	130 [0.58] 0.11 [2.9]	160 [0.72] 0.19 [4.8]	240 [1] 0.24 [6]
18-12-1-30deg	0.71 [18]	0.47 [12]	0.039 [1]	30	59 [0.26] 0.0091 [0.23]	81 [0.36] 0.022 [0.56]	100 [0.45] 0.041 [1.1]	150 [0.65] 0.056 [1.4]
18-12-1-45deg	0.71 [18]	0.47 [12]	0.039 [1]	45	59 [0.26] 0.013 [0.34]	81 [0.36] 0.031 [0.79]	100 [0.45] 0.056 [1.4]	150 [0.65] 0.073 [1.9]
18-12-1-60deg	0.71 [18]	0.47 [12]	0.039 [1]	60	59 [0.26] 0.026 [0.65]	81 [0.36] 0.057 [1.4]	100 [0.45] 0.095 [2.4]	150 [0.65] 0.12 [3]
18-12-1.3-30deg	0.71 [18]	0.47 [12]	0.051 [1.3]	30	99 [0.44] 0.0071 [0.18]	140 [0.61] 0.017 [0.43]	170 [0.76] 0.033 [0.83]	250 [1.1] 0.044 [1.1]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
18-12-1.3-45deg	0.71 [18]	0.47 [12]	0.051 [1.3]	45	99 [0.44] 0.01 [0.27]	140 [0.61] 0.025 [0.62]	170 [0.76] 0.045 [1.1]	250 [1.1] 0.059 [1.5]
18-12-1.3-60deg	0.71 [18]	0.47 [12]	0.051 [1.3]	60	99 [0.44] 0.02 [0.51]	140 [0.61] 0.046 [1.2]	170 [0.76] 0.079 [2]	250 [1.1] 0.1 [2.5]
18-12-1.5-30deg	0.71 [18]	0.47 [12]	0.059 [1.5]	30	130 [0.59] 0.0061 [0.16]	180 [0.81] 0.015 [0.38]	230 [1] 0.029 [0.73]	330 [1.5] 0.039 [0.99]
18-12-1.5-45deg	0.71 [18]	0.47 [12]	0.059 [1.5]	45	130 [0.59] 0.0091 [0.23]	180 [0.81] 0.022 [0.55]	230 [1] 0.04 [1]	330 [1.5] 0.053 [1.3]
18-12-1.5-60deg	0.71 [18]	0.47 [12]	0.059 [1.5]	60	130 [0.59] 0.018 [0.45]	180 [0.81] 0.04 [1]	230 [1] 0.071 [1.8]	330 [1.5] 0.091 [2.3]
18-12-2-30deg	0.71 [18]	0.47 [12]	0.079 [2]	30	240 [1] 0.0046 [0.12]	320 [1.4] 0.011 [0.29]	400 [1.8] 0.022 [0.56]	590 [2.6] 0.03 [0.76]
18-12-2-45deg	0.71 [18]	0.47 [12]	0.079 [2]	45	240 [1] 0.0069 [0.17]	320 [1.4] 0.016 [0.42]	400 [1.8] 0.031 [0.79]	590 [2.6] 0.041 [1.1]
18-12-2-60deg	0.71 [18]	0.47 [12]	0.079 [2]	60	240 [1] 0.013 [0.34]	320 [1.4] 0.031 [0.8]	400 [1.8] 0.057 [1.4]	590 [2.6] 0.074 [1.9]
18-12-2.5-30deg	0.71 [18]	0.47 [12]	0.098 [2.5]	30	370 [1.6] 0.0037 [0.095]	510 [2.3] 0.0091 [0.23]	630 [2.8] 0.018 [0.45]	920 [4.1] 0.024 [0.62]
18-12-2.5-45deg	0.71 [18]	0.47 [12]	0.098 [2.5]	45	370 [1.6] 0.0056 [0.14]	510 [2.3] 0.013 [0.34]	630 [2.8] 0.025 [0.65]	920 [4.1] 0.034 [0.87]
18-12-2.5-60deg	0.71 [18]	0.47 [12]	0.098 [2.5]	60	370 [1.6] 0.011 [0.28]	510 [2.3] 0.026 [0.65]	630 [2.8] 0.047 [1.2]	920 [4.1] 0.062 [1.6]
18-12-3-30deg	0.71 [18]	0.47 [12]	0.12 [3]	30	530 [2.4] 0.0031 [0.079]	730 [3.3] 0.0077 [0.2]	910 [4.1] 0.015 [0.38]	1300 [5.9] 0.021 [0.52]
18-12-3-45deg	0.71 [18]	0.47 [12]	0.12 [3]	45	530 [2.4] 0.0046 [0.12]	730 [3.3] 0.011 [0.29]	910 [4.1] 0.022 [0.55]	1300 [5.9] 0.029 [0.74]
18-12-3-60deg	0.71 [18]	0.47 [12]	0.12 [3]	60	530 [2.4] 0.0091 [0.23]	730 [3.3] 0.022 [0.55]	910 [4.1] 0.04 [1]	1300 [5.9] 0.054 [1.4]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
18-12-4-30deg	0.71 [18]	0.47 [12]	0.16 [4]	30	940 [4.2] 0.0023 [0.059]	1300 [5.8] 0.0058 [0.15]	1600 [7.2] 0.011 [0.29]	2400 [10] 0.016 [0.4]
18-12-4-45deg	0.71 [18]	0.47 [12]	0.16 [4]	45	940 [4.2] 0.0035 [0.089]	1300 [5.8] 0.0085 [0.22]	1600 [7.2] 0.016 [0.42]	2400 [10] 0.023 [0.57]
18-12-4-60deg	0.71 [18]	0.47 [12]	0.16 [4]	60	940 [4.2] 0.0069 [0.17]	1300 [5.8] 0.017 [0.42]	1600 [7.2] 0.031 [0.8]	2400 [10] 0.042 [1.1]
25-6-1-30deg	0.98 [25]	0.24 [6]	0.039 [1]	30	19 [0.085] 0.086 [2.2]	27 [0.12] 0.2 [5]	33 [0.15] 0.22 [5.5]	48 [0.21] 0.22 [5.5]
25-6-1-45deg	0.98 [25]	0.24 [6]	0.039 [1]	45	19 [0.085] 0.12 [3.1]	27 [0.12] 0.25 [6.5]	33 [0.15] 0.37 [9.5]	48 [0.21] 0.37 [9.5]
25-6-1-60deg	0.98 [25]	0.24 [6]	0.039 [1]	60	19 [0.085] 0.22 [5.5]	27 [0.12] 0.41 [10]	33 [0.15] 0.61 [16]	48 [0.21] 0.65 [16]
25-6-1.3-30deg	0.98 [25]	0.24 [6]	0.051 [1.3]	30	32 [0.14] 0.068 [1.7]	45 [0.2] 0.16 [4]	56 [0.25] 0.22 [5.5]	81 [0.36] 0.22 [5.5]
25-6-1.3-45deg	0.98 [25]	0.24 [6]	0.051 [1.3]	45	32 [0.14] 0.096 [2.4]	45 [0.2] 0.21 [5.3]	56 [0.25] 0.35 [9]	81 [0.36] 0.37 [9.5]
25-6-1.3-60deg	0.98 [25]	0.24 [6]	0.051 [1.3]	60	32 [0.14] 0.18 [4.5]	45 [0.2] 0.34 [8.7]	56 [0.25] 0.53 [13]	81 [0.36] 0.64 [16]
25-6-1.5-30deg	0.98 [25]	0.24 [6]	0.059 [1.5]	30	43 [0.19] 0.059 [1.5]	60 [0.27] 0.14 [3.5]	74 [0.33] 0.22 [5.5]	110 [0.48] 0.22 [5.5]
25-6-1.5-45deg	0.98 [25]	0.24 [6]	0.059 [1.5]	45	43 [0.19] 0.084 [2.1]	60 [0.27] 0.18 [4.7]	74 [0.33] 0.32 [8]	110 [0.48] 0.37 [9.5]
25-6-1.5-60deg	0.98 [25]	0.24 [6]	0.059 [1.5]	60	43 [0.19] 0.16 [4]	60 [0.27] 0.31 [7.9]	74 [0.33] 0.48 [12]	110 [0.48] 0.59 [15]
25-6-2-30deg	0.98 [25]	0.24 [6]	0.079 [2]	30	77 [0.34] 0.045 [1.1]	110 [0.47] 0.11 [2.7]	130 [0.59] 0.2 [5]	190 [0.85] 0.22 [5.5]
25-6-2-45deg	0.98 [25]	0.24 [6]	0.079 [2]	45	77 [0.34] 0.065 [1.7]	110 [0.47] 0.15 [3.7]	130 [0.59] 0.25 [6.5]	190 [0.85] 0.33 [8.4]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
25-6-2-60deg	0.98 [25]	0.24 [6]	0.079 [2]	60	77 [0.34] 0.12 [3.1]	110 [0.47] 0.26 [6.5]	130 [0.59] 0.41 [10]	190 [0.85] 0.5 [13]
25-12-1-30deg	0.98 [25]	0.47 [12]	0.039 [1]	30	33 [0.15] 0.041 [1.1]	46 [0.21] 0.096 [2.4]	58 [0.26] 0.15 [3.8]	84 [0.37] 0.15 [3.8]
25-12-1-45deg	0.98 [25]	0.47 [12]	0.039 [1]	45	33 [0.15] 0.059 [1.5]	46 [0.21] 0.13 [3.3]	58 [0.26] 0.22 [5.6]	84 [0.37] 0.26 [6.5]
25-12-1-60deg	0.98 [25]	0.47 [12]	0.039 [1]	60	33 [0.15] 0.11 [2.8]	46 [0.21] 0.22 [5.5]	58 [0.26] 0.34 [8.5]	84 [0.37] 0.41 [10]
25-12-1.3-30deg	0.98 [25]	0.47 [12]	0.051 [1.3]	30	57 [0.25] 0.032 [0.82]	78 [0.35] 0.076 [1.9]	97 [0.43] 0.14 [3.6]	140 [0.63] 0.15 [3.8]
25-12-1.3-45deg	0.98 [25]	0.47 [12]	0.051 [1.3]	45	57 [0.25] 0.047 [1.2]	78 [0.35] 0.1 [2.6]	97 [0.43] 0.18 [4.6]	140 [0.63] 0.23 [5.9]
25-12-1.3-60deg	0.98 [25]	0.47 [12]	0.051 [1.3]	60	57 [0.25] 0.087 [2.2]	78 [0.35] 0.18 [4.6]	97 [0.43] 0.29 [7.3]	140 [0.63] 0.35 [8.9]
25-12-1.5-30deg	0.98 [25]	0.47 [12]	0.059 [1.5]	30	75 [0.34] 0.028 [0.72]	100 [0.46] 0.067 [1.7]	130 [0.58] 0.12 [3.2]	190 [0.84] 0.15 [3.8]
25-12-1.5-45deg	0.98 [25]	0.47 [12]	0.059 [1.5]	45	75 [0.34] 0.041 [1]	100 [0.46] 0.092 [2.3]	130 [0.58] 0.16 [4.1]	190 [0.84] 0.21 [5.3]
25-12-1.5-60deg	0.98 [25]	0.47 [12]	0.059 [1.5]	60	75 [0.34] 0.077 [2]	100 [0.46] 0.16 [4.1]	130 [0.58] 0.26 [6.7]	190 [0.84] 0.32 [8.2]
25-12-2-30deg	0.98 [25]	0.47 [12]	0.079 [2]	30	130 [0.6] 0.021 [0.54]	180 [0.82] 0.051 [1.3]	230 [1] 0.096 [2.4]	340 [1.5] 0.13 [3.3]
25-12-2-45deg	0.98 [25]	0.47 [12]	0.079 [2]	45	130 [0.6] 0.031 [0.79]	180 [0.82] 0.072 [1.8]	230 [1] 0.13 [3.3]	340 [1.5] 0.17 [4.3]
25-12-2-60deg	0.98 [25]	0.47 [12]	0.079 [2]	60	130 [0.6] 0.06 [1.5]	180 [0.82] 0.13 [3.3]	230 [1] 0.22 [5.5]	340 [1.5] 0.27 [6.9]
25-12-2.5-30deg	0.98 [25]	0.47 [12]	0.098 [2.5]	30	210 [0.93] 0.017 [0.44]	290 [1.3] 0.041 [1.1]	360 [1.6] 0.079 [2]	520 [2.3] 0.11 [2.7]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
25-12-2.5-45deg	0.98 [25]	0.47 [12]	0.098 [2.5]	45	210 [0.93] 0.025 [0.64]	290 [1.3] 0.059 [1.5]	360 [1.6] 0.11 [2.7]	520 [2.3] 0.14 [3.6]
25-12-2.5-60deg	0.98 [25]	0.47 [12]	0.098 [2.5]	60	210 [0.93] 0.049 [1.2]	290 [1.3] 0.11 [2.8]	360 [1.6] 0.19 [4.7]	520 [2.3] 0.23 [6]
25-12-3-30deg	0.98 [25]	0.47 [12]	0.12 [3]	30	300 [1.3] 0.014 [0.37]	420 [1.9] 0.035 [0.89]	520 [2.3] 0.067 [1.7]	750 [3.4] 0.09 [2.3]
25-12-3-45deg	0.98 [25]	0.47 [12]	0.12 [3]	45	300 [1.3] 0.021 [0.54]	420 [1.9] 0.05 [1.3]	520 [2.3] 0.092 [2.3]	750 [3.4] 0.12 [3.1]
25-12-3-60deg	0.98 [25]	0.47 [12]	0.12 [3]	60	300 [1.3] 0.041 [1]	420 [1.9] 0.094 [2.4]	520 [2.3] 0.16 [4.1]	750 [3.4] 0.21 [5.3]
25-12-4-30deg	0.98 [25]	0.47 [12]	0.16 [4]	30	540 [2.4] 0.011 [0.28]	740 [3.3] 0.027 [0.67]	920 [4.1] 0.051 [1.3]	1300 [6] 0.07 [1.8]
25-12-4-45deg	0.98 [25]	0.47 [12]	0.16 [4]	45	540 [2.4] 0.016 [0.41]	740 [3.3] 0.039 [0.98]	920 [4.1] 0.072 [1.8]	1300 [6] 0.096 [2.4]
25-12-4-60deg	0.98 [25]	0.47 [12]	0.16 [4]	60	540 [2.4] 0.031 [0.8]	740 [3.3] 0.073 [1.9]	920 [4.1] 0.13 [3.3]	1300 [6] 0.17 [4.3]
25-18-1-30deg	0.98 [25]	0.71 [18]	0.039 [1]	30	72 [0.32] 0.012 [0.31]	100 [0.44] 0.029 [0.75]	120 [0.55] 0.055 [1.4]	180 [0.8] 0.075 [1.9]
25-18-1-45deg	0.98 [25]	0.71 [18]	0.039 [1]	45	72 [0.32] 0.018 [0.46]	100 [0.44] 0.041 [1.1]	120 [0.55] 0.074 [1.9]	180 [0.8] 0.096 [2.4]
25-18-1-60deg	0.98 [25]	0.71 [18]	0.039 [1]	60	72 [0.32] 0.034 [0.88]	100 [0.44] 0.075 [1.9]	120 [0.55] 0.12 [3.1]	180 [0.8] 0.15 [3.9]
25-18-1.3-30deg	0.98 [25]	0.71 [18]	0.051 [1.3]	30	120 [0.54] 0.0096 [0.24]	170 [0.75] 0.023 [0.59]	210 [0.94] 0.044 [1.1]	310 [1.4] 0.059 [1.5]
25-18-1.3-45deg	0.98 [25]	0.71 [18]	0.051 [1.3]	45	120 [0.54] 0.014 [0.36]	170 [0.75] 0.033 [0.83]	210 [0.94] 0.06 [1.5]	310 [1.4] 0.078 [2]
25-18-1.3-60deg	0.98 [25]	0.71 [18]	0.051 [1.3]	60	120 [0.54] 0.027 [0.69]	170 [0.75] 0.06 [1.5]	210 [0.94] 0.1 [2.6]	310 [1.4] 0.13 [3.3]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
25-18-1.5-30deg	0.98 [25]	0.71 [18]	0.059 [1.5]	30	160 [0.72] 0.0083 [0.21]	220 [1] 0.02 [0.51]	280 [1.2] 0.038 [0.97]	410 [1.8] 0.052 [1.3]
25-18-1.5-45deg	0.98 [25]	0.71 [18]	0.059 [1.5]	45	160 [0.72] 0.012 [0.31]	220 [1] 0.029 [0.73]	280 [1.2] 0.053 [1.3]	410 [1.8] 0.07 [1.8]
25-18-1.5-60deg	0.98 [25]	0.71 [18]	0.059 [1.5]	60	160 [0.72] 0.024 [0.6]	220 [1] 0.054 [1.4]	280 [1.2] 0.093 [2.4]	410 [1.8] 0.12 [3]
25-18-2-30deg	0.98 [25]	0.71 [18]	0.079 [2]	30	290 [1.3] 0.0063 [0.16]	400 [1.8] 0.015 [0.39]	500 [2.2] 0.029 [0.75]	720 [3.2] 0.04 [1]
25-18-2-45deg	0.98 [25]	0.71 [18]	0.079 [2]	45	290 [1.3] 0.0093 [0.24]	400 [1.8] 0.022 [0.56]	500 [2.2] 0.041 [1.1]	720 [3.2] 0.055 [1.4]
25-18-2-60deg	0.98 [25]	0.71 [18]	0.079 [2]	60	290 [1.3] 0.018 [0.46]	400 [1.8] 0.042 [1.1]	500 [2.2] 0.075 [1.9]	720 [3.2] 0.096 [2.4]
25-18-2.5-30deg	0.98 [25]	0.71 [18]	0.098 [2.5]	30	450 [2] 0.0051 [0.13]	620 [2.8] 0.012 [0.31]	780 [3.5] 0.024 [0.61]	1100 [5] 0.033 [0.83]
25-18-2.5-45deg	0.98 [25]	0.71 [18]	0.098 [2.5]	45	450 [2] 0.0075 [0.19]	620 [2.8] 0.018 [0.46]	780 [3.5] 0.034 [0.86]	1100 [5] 0.046 [1.2]
25-18-2.5-60deg	0.98 [25]	0.71 [18]	0.098 [2.5]	60	450 [2] 0.015 [0.37]	620 [2.8] 0.034 [0.88]	780 [3.5] 0.062 [1.6]	1100 [5] 0.081 [2.1]
25-18-3-30deg	0.98 [25]	0.71 [18]	0.12 [3]	30	650 [2.9] 0.0042 [0.11]	900 [4] 0.01 [0.26]	1100 [5] 0.02 [0.51]	1600 [7.2] 0.028 [0.7]
25-18-3-45deg	0.98 [25]	0.71 [18]	0.12 [3]	45	650 [2.9] 0.0063 [0.16]	900 [4] 0.015 [0.39]	1100 [5] 0.029 [0.73]	1600 [7.2] 0.039 [0.99]
25-18-3-60deg	0.98 [25]	0.71 [18]	0.12 [3]	60	650 [2.9] 0.012 [0.31]	900 [4] 0.029 [0.74]	1100 [5] 0.054 [1.4]	1600 [7.2] 0.071 [1.8]
25-18-4-30deg	0.98 [25]	0.71 [18]	0.16 [4]	30	1200 [5.1] 0.0032 [0.081]	1600 [7.1] 0.0078 [0.2]	2000 [8.9] 0.015 [0.39]	2900 [13] 0.021 [0.54]
25-18-4-45deg	0.98 [25]	0.71 [18]	0.16 [4]	45	1200 [5.1] 0.0047 [0.12]	1600 [7.1] 0.012 [0.29]	2000 [8.9] 0.022 [0.56]	2900 [13] 0.03 [0.77]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
25-18-4-60deg	0.98 [25]	0.71 [18]	0.16 [4]	60	1200 [5.1] 0.0094 [0.24]	1600 [7.1] 0.022 [0.57]	2000 [8.9] 0.042 [1.1]	2900 [13] 0.056 [1.4]
25-18-5-30deg	0.98 [25]	0.71 [18]	0.2 [5]	30	1800 [8] 0.0026 [0.065]	2500 [11] 0.0063 [0.16]	3100 [14] 0.012 [0.31]	4500 [20] 0.017 [0.43]
25-18-5-45deg	0.98 [25]	0.71 [18]	0.2 [5]	45	1800 [8] 0.0038 [0.097]	2500 [11] 0.0093 [0.24]	3100 [14] 0.018 [0.46]	4500 [20] 0.025 [0.63]
25-18-5-60deg	0.98 [25]	0.71 [18]	0.2 [5]	60	1800 [8] 0.0075 [0.19]	2500 [11] 0.018 [0.46]	3100 [14] 0.034 [0.88]	4500 [20] 0.046 [1.2]
25-18-6-30deg	0.98 [25]	0.71 [18]	0.24 [6]	30	2600 [12] 0.0021 [0.054]	3600 [16] 0.0053 [0.13]	4500 [20] 0.01 [0.26]	6500 [29] 0.014 [0.36]
25-18-6-45deg	0.98 [25]	0.71 [18]	0.24 [6]	45	2600 [12] 0.0032 [0.081]	3600 [16] 0.0078 [0.2]	4500 [20] 0.015 [0.39]	6500 [29] 0.021 [0.53]
25-18-6-60deg	0.98 [25]	0.71 [18]	0.24 [6]	60	2600 [12] 0.0063 [0.16]	3600 [16] 0.015 [0.39]	4500 [20] 0.029 [0.74]	6500 [29] 0.04 [1]
32-8-1-30deg	1.3 [32]	0.31 [8]	0.039 [1]	30	20 [0.087] 0.14 [3.4]	27 [0.12] 0.27 [6.9]	34 [0.15] 0.27 [6.9]	49 [0.22] 0.27 [6.9]
32-8-1-45deg	1.3 [32]	0.31 [8]	0.039 [1]	45	20 [0.087] 0.19 [4.7]	27 [0.12] 0.38 [9.7]	34 [0.15] 0.47 [12]	49 [0.22] 0.47 [12]
32-8-1-60deg	1.3 [32]	0.31 [8]	0.039 [1]	60	20 [0.087] 0.32 [8.2]	27 [0.12] 0.59 [15]	34 [0.15] 0.82 [21]	49 [0.22] 0.82 [21]
32-8-1.3-30deg	1.3 [32]	0.31 [8]	0.051 [1.3]	30	33 [0.15] 0.11 [2.7]	46 [0.2] 0.24 [6.2]	57 [0.25] 0.27 [6.9]	83 [0.37] 0.27 [6.9]
32-8-1.3-45deg	1.3 [32]	0.31 [8]	0.051 [1.3]	45	33 [0.15] 0.15 [3.8]	46 [0.2] 0.31 [8]	57 [0.25] 0.47 [12]	83 [0.37] 0.47 [12]
32-8-1.3-60deg	1.3 [32]	0.31 [8]	0.051 [1.3]	60	33 [0.15] 0.27 [6.8]	46 [0.2] 0.5 [13]	57 [0.25] 0.76 [19]	83 [0.37] 0.82 [21]
32-8-1.5-30deg	1.3 [32]	0.31 [8]	0.059 [1.5]	30	44 [0.2] 0.093 [2.4]	61 [0.27] 0.21 [5.4]	76 [0.34] 0.27 [6.9]	110 [0.49] 0.27 [6.9]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
32-8-1.5-45deg	1.3 [32]	0.31 [8]	0.059 [1.5]	45	44 [0.2] 0.13 [3.3]	61 [0.27] 0.28 [7.1]	76 [0.34] 0.47 [12]	110 [0.49] 0.47 [12]
32-8-1.5-60deg	1.3 [32]	0.31 [8]	0.059 [1.5]	60	44 [0.2] 0.24 [6.1]	61 [0.27] 0.46 [12]	76 [0.34] 0.7 [18]	110 [0.49] 0.82 [21]
32-8-2-30deg	1.3 [32]	0.31 [8]	0.079 [2]	30	78 [0.35] 0.071 [1.8]	110 [0.48] 0.17 [4.2]	140 [0.6] 0.27 [6.9]	200 [0.87] 0.27 [6.9]
32-8-2-45deg	1.3 [32]	0.31 [8]	0.079 [2]	45	78 [0.35] 0.1 [2.6]	110 [0.48] 0.22 [5.7]	140 [0.6] 0.38 [9.7]	200 [0.87] 0.47 [12]
32-8-2-60deg	1.3 [32]	0.31 [8]	0.079 [2]	60	78 [0.35] 0.19 [4.8]	110 [0.48] 0.38 [9.7]	140 [0.6] 0.59 [15]	200 [0.87] 0.72 [18]
32-8-2.5-30deg	1.3 [32]	0.31 [8]	0.098 [2.5]	30	120 [0.55] 0.057 [1.5]	170 [0.75] 0.14 [3.4]	210 [0.94] 0.25 [6.4]	310 [1.4] 0.27 [6.9]
32-8-2.5-45deg	1.3 [32]	0.31 [8]	0.098 [2.5]	45	120 [0.55] 0.083 [2.1]	170 [0.75] 0.19 [4.7]	210 [0.94] 0.32 [8.2]	310 [1.4] 0.42 [11]
32-8-2.5-60deg	1.3 [32]	0.31 [8]	0.098 [2.5]	60	120 [0.55] 0.16 [4]	170 [0.75] 0.32 [8.2]	210 [0.94] 0.52 [13]	310 [1.4] 0.63 [16]
32-16-1-30deg	1.3 [32]	0.63 [16]	0.039 [1]	30	35 [0.16] 0.062 [1.6]	49 [0.22] 0.14 [3.6]	61 [0.27] 0.18 [4.6]	88 [0.39] 0.18 [4.6]
32-16-1-45deg	1.3 [32]	0.63 [16]	0.039 [1]	45	35 [0.16] 0.088 [2.2]	49 [0.22] 0.19 [4.8]	61 [0.27] 0.31 [8]	88 [0.39] 0.31 [8]
32-16-1-60deg	1.3 [32]	0.63 [16]	0.039 [1]	60	35 [0.16] 0.16 [4]	49 [0.22] 0.31 [7.8]	61 [0.27] 0.47 [12]	88 [0.39] 0.55 [14]
32-16-1.3-30deg	1.3 [32]	0.63 [16]	0.051 [1.3]	30	60 [0.27] 0.049 [1.2]	82 [0.37] 0.11 [2.9]	100 [0.46] 0.18 [4.6]	150 [0.66] 0.18 [4.6]
32-16-1.3-45deg	1.3 [32]	0.63 [16]	0.051 [1.3]	45	60 [0.27] 0.069 [1.8]	82 [0.37] 0.15 [3.9]	100 [0.46] 0.26 [6.6]	150 [0.66] 0.31 [8]
32-16-1.3-60deg	1.3 [32]	0.63 [16]	0.051 [1.3]	60	60 [0.27] 0.13 [3.3]	82 [0.37] 0.26 [6.6]	100 [0.46] 0.4 [10]	150 [0.66] 0.49 [12]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
32-16-1.5-30deg	1.3 [32]	0.63 [16]	0.059 [1.5]	30	79 [0.35] 0.042 [1.1]	110 [0.49] 0.099 [2.5]	140 [0.61] 0.18 [4.6]	200 [0.88] 0.18 [4.6]
32-16-1.5-45deg	1.3 [32]	0.63 [16]	0.059 [1.5]	45	79 [0.35] 0.061 [1.5]	110 [0.49] 0.14 [3.4]	140 [0.61] 0.23 [5.9]	200 [0.88] 0.3 [7.7]
32-16-1.5-60deg	1.3 [32]	0.63 [16]	0.059 [1.5]	60	79 [0.35] 0.11 [2.9]	110 [0.49] 0.23 [5.9]	140 [0.61] 0.37 [9.3]	200 [0.88] 0.45 [11]
32-16-2-30deg	1.3 [32]	0.63 [16]	0.079 [2]	30	140 [0.63] 0.032 [0.82]	200 [0.87] 0.076 [1.9]	240 [1.1] 0.14 [3.6]	350 [1.6] 0.18 [4.6]
32-16-2-45deg	1.3 [32]	0.63 [16]	0.079 [2]	45	140 [0.63] 0.047 [1.2]	200 [0.87] 0.11 [2.7]	240 [1.1] 0.19 [4.8]	350 [1.6] 0.24 [6.2]
32-16-2-60deg	1.3 [32]	0.63 [16]	0.079 [2]	60	140 [0.63] 0.089 [2.3]	200 [0.87] 0.19 [4.8]	240 [1.1] 0.31 [7.8]	350 [1.6] 0.38 [9.6]
32-16-2.5-30deg	1.3 [32]	0.63 [16]	0.098 [2.5]	30	220 [0.98] 0.026 [0.66]	300 [1.4] 0.062 [1.6]	380 [1.7] 0.12 [3]	550 [2.5] 0.16 [4]
32-16-2.5-45deg	1.3 [32]	0.63 [16]	0.098 [2.5]	45	220 [0.98] 0.038 [0.96]	300 [1.4] 0.088 [2.2]	380 [1.7] 0.16 [4]	550 [2.5] 0.2 [5.2]
32-16-2.5-60deg	1.3 [32]	0.63 [16]	0.098 [2.5]	60	220 [0.98] 0.073 [1.8]	300 [1.4] 0.16 [4]	380 [1.7] 0.27 [6.7]	550 [2.5] 0.33 [8.4]
32-16-3-30deg	1.3 [32]	0.63 [16]	0.12 [3]	30	320 [1.4] 0.022 [0.55]	440 [2] 0.052 [1.3]	550 [2.4] 0.099 [2.5]	790 [3.5] 0.13 [3.4]
32-16-3-45deg	1.3 [32]	0.63 [16]	0.12 [3]	45	320 [1.4] 0.032 [0.81]	440 [2] 0.074 [1.9]	550 [2.4] 0.14 [3.4]	790 [3.5] 0.18 [4.5]
32-16-3-60deg	1.3 [32]	0.63 [16]	0.12 [3]	60	320 [1.4] 0.062 [1.6]	440 [2] 0.14 [3.5]	550 [2.4] 0.23 [5.9]	790 [3.5] 0.29 [7.5]
32-16-4-30deg	1.3 [32]	0.63 [16]	0.16 [4]	30	560 [2.5] 0.016 [0.42]	780 [3.5] 0.04 [1]	970 [4.3] 0.076 [1.9]	1400 [6.3] 0.1 [2.6]
32-16-4-45deg	1.3 [32]	0.63 [16]	0.16 [4]	45	560 [2.5] 0.024 [0.62]	780 [3.5] 0.057 [1.5]	970 [4.3] 0.11 [2.7]	1400 [6.3] 0.14 [3.6]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
32-16-4-60deg	1.3 [32]	0.63 [16]	0.16 [4]	60	560 [2.5] 0.047 [1.2]	780 [3.5] 0.11 [2.7]	970 [4.3] 0.19 [4.8]	1400 [6.3] 0.24 [6.1]
32-16-5-30deg	1.3 [32]	0.63 [16]	0.2 [5]	30	880 [3.9] 0.013 [0.34]	1200 [5.4] 0.032 [0.82]	1500 [6.8] 0.062 [1.6]	2200 [9.8] 0.085 [2.1]
32-16-5-45deg	1.3 [32]	0.63 [16]	0.2 [5]	45	880 [3.9] 0.02 [0.5]	1200 [5.4] 0.047 [1.2]	1500 [6.8] 0.088 [2.2]	2200 [9.8] 0.12 [3]
32-16-5-60deg	1.3 [32]	0.63 [16]	0.2 [5]	60	880 [3.9] 0.038 [0.97]	1200 [5.4] 0.089 [2.3]	1500 [6.8] 0.16 [4]	2200 [9.8] 0.21 [5.2]
32-24-1-30deg	1.3 [32]	0.94 [24]	0.039 [1]	30	83 [0.37] 0.016 [0.41]	110 [0.51] 0.038 [0.97]	140 [0.63] 0.071 [1.8]	210 [0.92] 0.091 [2.3]
32-24-1-45deg	1.3 [32]	0.94 [24]	0.039 [1]	45	83 [0.37] 0.023 [0.59]	110 [0.51] 0.053 [1.3]	140 [0.63] 0.094 [2.4]	210 [0.92] 0.12 [3.1]
32-24-1-60deg	1.3 [32]	0.94 [24]	0.039 [1]	60	83 [0.37] 0.044 [1.1]	110 [0.51] 0.095 [2.4]	140 [0.63] 0.15 [3.9]	210 [0.92] 0.19 [4.8]
32-24-1.3-30deg	1.3 [32]	0.94 [24]	0.051 [1.3]	30	140 [0.62] 0.012 [0.32]	190 [0.85] 0.03 [0.76]	240 [1.1] 0.056 [1.4]	350 [1.5] 0.076 [1.9]
32-24-1.3-45deg	1.3 [32]	0.94 [24]	0.051 [1.3]	45	140 [0.62] 0.018 [0.46]	190 [0.85] 0.042 [1.1]	240 [1.1] 0.076 [1.9]	350 [1.5] 0.099 [2.5]
32-24-1.3-60deg	1.3 [32]	0.94 [24]	0.051 [1.3]	60	140 [0.62] 0.035 [0.89]	190 [0.85] 0.077 [2]	240 [1.1] 0.13 [3.3]	350 [1.5] 0.16 [4.1]
32-24-1.5-30deg	1.3 [32]	0.94 [24]	0.059 [1.5]	30	180 [0.82] 0.011 [0.28]	260 [1.1] 0.026 [0.66]	320 [1.4] 0.05 [1.3]	460 [2.1] 0.067 [1.7]
32-24-1.5-45deg	1.3 [32]	0.94 [24]	0.059 [1.5]	45	180 [0.82] 0.016 [0.41]	260 [1.1] 0.037 [0.95]	320 [1.4] 0.068 [1.7]	460 [2.1] 0.089 [2.3]
32-24-1.5-60deg	1.3 [32]	0.94 [24]	0.059 [1.5]	60	180 [0.82] 0.031 [0.78]	260 [1.1] 0.069 [1.7]	320 [1.4] 0.12 [3]	460 [2.1] 0.15 [3.7]
32-24-2-30deg	1.3 [32]	0.94 [24]	0.079 [2]	30	330 [1.5] 0.0082 [0.21]	460 [2] 0.02 [0.51]	570 [2.5] 0.038 [0.97]	820 [3.7] 0.052 [1.3]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
32-24-2-45deg	1.3 [32]	0.94 [24]	0.079 [2]	45	330 [1.5] 0.012 [0.31]	460 [2] 0.029 [0.73]	570 [2.5] 0.053 [1.3]	820 [3.7] 0.07 [1.8]
32-24-2-60deg	1.3 [32]	0.94 [24]	0.079 [2]	60	330 [1.5] 0.024 [0.6]	460 [2] 0.054 [1.4]	570 [2.5] 0.095 [2.4]	820 [3.7] 0.12 [3.1]
32-24-2.5-30deg	1.3 [32]	0.94 [24]	0.098 [2.5]	30	520 [2.3] 0.0066 [0.17]	710 [3.2] 0.016 [0.41]	890 [3.9] 0.031 [0.79]	1300 [5.7] 0.042 [1.1]
32-24-2.5-45deg	1.3 [32]	0.94 [24]	0.098 [2.5]	45	520 [2.3] 0.0098 [0.25]	710 [3.2] 0.023 [0.59]	890 [3.9] 0.044 [1.1]	1300 [5.7] 0.058 [1.5]
32-24-2.5-60deg	1.3 [32]	0.94 [24]	0.098 [2.5]	60	520 [2.3] 0.019 [0.48]	710 [3.2] 0.044 [1.1]	890 [3.9] 0.079 [2]	1300 [5.7] 0.1 [2.6]
32-24-3-30deg	1.3 [32]	0.94 [24]	0.12 [3]	30	740 [3.3] 0.0055 [0.14]	1000 [4.6] 0.014 [0.34]	1300 [5.7] 0.026 [0.66]	1900 [8.2] 0.036 [0.91]
32-24-3-45deg	1.3 [32]	0.94 [24]	0.12 [3]	45	740 [3.3] 0.0082 [0.21]	1000 [4.6] 0.02 [0.5]	1300 [5.7] 0.037 [0.95]	1900 [8.2] 0.05 [1.3]
32-24-3-60deg	1.3 [32]	0.94 [24]	0.12 [3]	60	740 [3.3] 0.016 [0.41]	1000 [4.6] 0.038 [0.96]	1300 [5.7] 0.069 [1.7]	1900 [8.2] 0.09 [2.3]
32-24-4-30deg	1.3 [32]	0.94 [24]	0.16 [4]	30	1300 [5.9] 0.0041 [0.1]	1800 [8.1] 0.01 [0.26]	2300 [10] 0.02 [0.51]	3300 [15] 0.027 [0.69]
32-24-4-45deg	1.3 [32]	0.94 [24]	0.16 [4]	45	1300 [5.9] 0.0062 [0.16]	1800 [8.1] 0.015 [0.38]	2300 [10] 0.029 [0.73]	3300 [15] 0.039 [0.99]
32-24-4-60deg	1.3 [32]	0.94 [24]	0.16 [4]	60	1300 [5.9] 0.012 [0.31]	1800 [8.1] 0.029 [0.74]	2300 [10] 0.054 [1.4]	3300 [15] 0.071 [1.8]
32-24-5-30deg	1.3 [32]	0.94 [24]	0.2 [5]	30	2100 [9.2] 0.0033 [0.085]	2800 [13] 0.0082 [0.21]	3500 [16] 0.016 [0.41]	5200 [23] 0.022 [0.56]
32-24-5-45deg	1.3 [32]	0.94 [24]	0.2 [5]	45	2100 [9.2] 0.005 [0.13]	2800 [13] 0.012 [0.31]	3500 [16] 0.023 [0.59]	5200 [23] 0.032 [0.81]
32-24-5-60deg	1.3 [32]	0.94 [24]	0.2 [5]	60	2100 [9.2] 0.0098 [0.25]	2800 [13] 0.024 [0.6]	3500 [16] 0.044 [1.1]	5200 [23] 0.059 [1.5]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
32-24-6-30deg	1.3 [32]	0.94 [24]	0.24 [6]	30	3000 [13] 0.0028 [0.071]	4100 [18] 0.0069 [0.17]	5100 [23] 0.014 [0.34]	7400 [33] 0.019 [0.47]
32-24-6-45deg	1.3 [32]	0.94 [24]	0.24 [6]	45	3000 [13] 0.0041 [0.1]	4100 [18] 0.01 [0.26]	5100 [23] 0.02 [0.5]	7400 [33] 0.027 [0.69]
32-24-6-60deg	1.3 [32]	0.94 [24]	0.24 [6]	60	3000 [13] 0.0082 [0.21]	4100 [18] 0.02 [0.5]	5100 [23] 0.038 [0.96]	7400 [33] 0.051 [1.3]
32-24-8-30deg	1.3 [32]	0.94 [24]	0.31 [8]	30	5300 [23] 0.0021 [0.053]	7300 [32] 0.0052 [0.13]	9100 [40] 0.01 [0.26]	13000 [59] 0.014 [0.36]
32-24-8-45deg	1.3 [32]	0.94 [24]	0.31 [8]	45	5300 [23] 0.0031 [0.079]	7300 [32] 0.0077 [0.2]	9100 [40] 0.015 [0.38]	13000 [59] 0.021 [0.52]
32-24-8-60deg	1.3 [32]	0.94 [24]	0.31 [8]	60	5300 [23] 0.0062 [0.16]	7300 [32] 0.015 [0.38]	9100 [40] 0.029 [0.74]	13000 [59] 0.039 [1]
40-10-1-30deg	1.6 [40]	0.39 [10]	0.039 [1]	30	20 [0.087] 0.21 [5.2]	27 [0.12] 0.34 [8.7]	34 [0.15] 0.34 [8.7]	49 [0.22] 0.34 [8.7]
40-10-1-45deg	1.6 [40]	0.39 [10]	0.039 [1]	45	20 [0.087] 0.28 [7.1]	27 [0.12] 0.57 [14]	34 [0.15] 0.59 [15]	49 [0.22] 0.59 [15]
40-10-1-60deg	1.6 [40]	0.39 [10]	0.039 [1]	60	20 [0.087] 0.48 [12]	27 [0.12] 0.84 [21]	34 [0.15] 1 [26]	49 [0.22] 1 [26]
40-10-1.3-30deg	1.6 [40]	0.39 [10]	0.051 [1.3]	30	33 [0.15] 0.16 [4.1]	46 [0.2] 0.34 [8.7]	57 [0.25] 0.34 [8.7]	83 [0.37] 0.34 [8.7]
40-10-1.3-45deg	1.6 [40]	0.39 [10]	0.051 [1.3]	45	33 [0.15] 0.22 [5.7]	46 [0.2] 0.47 [12]	57 [0.25] 0.59 [15]	83 [0.37] 0.59 [15]
40-10-1.3-60deg	1.6 [40]	0.39 [10]	0.051 [1.3]	60	33 [0.15] 0.39 [10]	46 [0.2] 0.72 [18]	57 [0.25] 1 [26]	83 [0.37] 1 [26]
40-10-1.5-30deg	1.6 [40]	0.39 [10]	0.059 [1.5]	30	44 [0.2] 0.14 [3.6]	61 [0.27] 0.33 [8.3]	76 [0.34] 0.34 [8.7]	110 [0.49] 0.34 [8.7]
40-10-1.5-45deg	1.6 [40]	0.39 [10]	0.059 [1.5]	45	44 [0.2] 0.2 [5.1]	61 [0.27] 0.42 [11]	76 [0.34] 0.59 [15]	110 [0.49] 0.59 [15]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
40-10-1.5-60deg	1.6 [40]	0.39 [10]	0.059 [1.5]	60	44 [0.2] 0.35 [9]	61 [0.27] 0.66 [17]	76 [0.34] 0.99 [25]	110 [0.49] 1 [26]
40-10-2-30deg	1.6 [40]	0.39 [10]	0.079 [2]	30	78 [0.35] 0.11 [2.8]	110 [0.48] 0.25 [6.4]	140 [0.6] 0.34 [8.7]	200 [0.87] 0.34 [8.7]
40-10-2-45deg	1.6 [40]	0.39 [10]	0.079 [2]	45	78 [0.35] 0.16 [3.9]	110 [0.48] 0.33 [8.5]	140 [0.6] 0.57 [14]	200 [0.87] 0.59 [15]
40-10-2-60deg	1.6 [40]	0.39 [10]	0.079 [2]	60	78 [0.35] 0.28 [7.2]	110 [0.48] 0.55 [14]	140 [0.6] 0.84 [21]	200 [0.87] 1 [26]
40-10-2.5-30deg	1.6 [40]	0.39 [10]	0.098 [2.5]	30	120 [0.55] 0.089 [2.3]	170 [0.75] 0.21 [5.2]	210 [0.94] 0.34 [8.7]	310 [1.4] 0.34 [8.7]
40-10-2.5-45deg	1.6 [40]	0.39 [10]	0.098 [2.5]	45	120 [0.55] 0.13 [3.2]	170 [0.75] 0.28 [7.1]	210 [0.94] 0.48 [12]	310 [1.4] 0.59 [15]
40-10-2.5-60deg	1.6 [40]	0.39 [10]	0.098 [2.5]	60	120 [0.55] 0.24 [6]	170 [0.75] 0.48 [12]	210 [0.94] 0.74 [19]	310 [1.4] 0.9 [23]
40-10-3-30deg	1.6 [40]	0.39 [10]	0.12 [3]	30	180 [0.79] 0.075 [1.9]	240 [1.1] 0.18 [4.5]	300 [1.4] 0.33 [8.3]	440 [2] 0.34 [8.7]
40-10-3-45deg	1.6 [40]	0.39 [10]	0.12 [3]	45	180 [0.79] 0.11 [2.7]	240 [1.1] 0.24 [6.1]	300 [1.4] 0.42 [11]	440 [2] 0.54 [14]
40-10-3-60deg	1.6 [40]	0.39 [10]	0.12 [3]	60	180 [0.79] 0.2 [5.1]	240 [1.1] 0.42 [11]	300 [1.4] 0.66 [17]	440 [2] 0.81 [21]
40-20-1-30deg	1.6 [40]	0.79 [20]	0.039 [1]	30	35 [0.16] 0.095 [2.4]	49 [0.22] 0.22 [5.5]	61 [0.27] 0.23 [5.8]	88 [0.39] 0.23 [5.8]
40-20-1-45deg	1.6 [40]	0.79 [20]	0.039 [1]	45	35 [0.16] 0.13 [3.4]	49 [0.22] 0.28 [7.1]	61 [0.27] 0.39 [10]	88 [0.39] 0.39 [10]
40-20-1-60deg	1.6 [40]	0.79 [20]	0.039 [1]	60	35 [0.16] 0.24 [6]	49 [0.22] 0.44 [11]	61 [0.27] 0.66 [17]	88 [0.39] 0.68 [17]
40-20-1.3-30deg	1.6 [40]	0.79 [20]	0.051 [1.3]	30	60 [0.27] 0.075 [1.9]	82 [0.37] 0.17 [4.4]	100 [0.46] 0.23 [5.8]	150 [0.66] 0.23 [5.8]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
40-20-1.3-45deg	1.6 [40]	0.79 [20]	0.051 [1.3]	45	60 [0.27] 0.11 [2.7]	82 [0.37] 0.23 [5.8]	100 [0.46] 0.39 [9.8]	150 [0.66] 0.39 [10]
40-20-1.3-60deg	1.6 [40]	0.79 [20]	0.051 [1.3]	60	60 [0.27] 0.19 [4.9]	82 [0.37] 0.37 [9.5]	100 [0.46] 0.57 [14]	150 [0.66] 0.68 [17]
40-20-1.5-30deg	1.6 [40]	0.79 [20]	0.059 [1.5]	30	79 [0.35] 0.065 [1.7]	110 [0.49] 0.15 [3.8]	140 [0.61] 0.23 [5.8]	200 [0.88] 0.23 [5.8]
40-20-1.5-45deg	1.6 [40]	0.79 [20]	0.059 [1.5]	45	79 [0.35] 0.093 [2.4]	110 [0.49] 0.2 [5.1]	140 [0.61] 0.35 [8.8]	200 [0.88] 0.39 [10]
40-20-1.5-60deg	1.6 [40]	0.79 [20]	0.059 [1.5]	60	79 [0.35] 0.17 [4.4]	110 [0.49] 0.34 [8.7]	140 [0.61] 0.52 [13]	200 [0.88] 0.64 [16]
40-20-2-30deg	1.6 [40]	0.79 [20]	0.079 [2]	30	140 [0.63] 0.05 [1.3]	200 [0.87] 0.12 [3]	240 [1.1] 0.22 [5.5]	350 [1.6] 0.23 [5.8]
40-20-2-45deg	1.6 [40]	0.79 [20]	0.079 [2]	45	140 [0.63] 0.072 [1.8]	200 [0.87] 0.16 [4.1]	240 [1.1] 0.28 [7.1]	350 [1.6] 0.36 [9.1]
40-20-2-60deg	1.6 [40]	0.79 [20]	0.079 [2]	60	140 [0.63] 0.13 [3.4]	200 [0.87] 0.28 [7.1]	240 [1.1] 0.44 [11]	350 [1.6] 0.54 [14]
40-20-2.5-30deg	1.6 [40]	0.79 [20]	0.098 [2.5]	30	220 [0.98] 0.04 [1]	300 [1.4] 0.095 [2.4]	380 [1.7] 0.18 [4.5]	550 [2.5] 0.23 [5.8]
40-20-2.5-45deg	1.6 [40]	0.79 [20]	0.098 [2.5]	45	220 [0.98] 0.058 [1.5]	300 [1.4] 0.13 [3.4]	380 [1.7] 0.23 [5.9]	550 [2.5] 0.3 [7.7]
40-20-2.5-60deg	1.6 [40]	0.79 [20]	0.098 [2.5]	60	220 [0.98] 0.11 [2.8]	300 [1.4] 0.24 [6]	380 [1.7] 0.38 [9.8]	550 [2.5] 0.47 [12]
40-20-3-30deg	1.6 [40]	0.79 [20]	0.12 [3]	30	320 [1.4] 0.034 [0.86]	440 [2] 0.08 [2]	550 [2.4] 0.15 [3.8]	790 [3.5] 0.2 [5.2]
40-20-3-45deg	1.6 [40]	0.79 [20]	0.12 [3]	45	320 [1.4] 0.049 [1.3]	440 [2] 0.11 [2.9]	550 [2.4] 0.2 [5.1]	790 [3.5] 0.26 [6.7]
40-20-3-60deg	1.6 [40]	0.79 [20]	0.12 [3]	60	320 [1.4] 0.094 [2.4]	440 [2] 0.21 [5.2]	550 [2.4] 0.34 [8.7]	790 [3.5] 0.42 [11]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
40-20-4-30deg	1.6 [40]	0.79 [20]	0.16 [4]	30	560 [2.5] 0.026 [0.65]	780 [3.5] 0.061 [1.6]	970 [4.3] 0.12 [3]	1400 [6.3] 0.16 [4]
40-20-4-45deg	1.6 [40]	0.79 [20]	0.16 [4]	45	560 [2.5] 0.038 [0.95]	780 [3.5] 0.088 [2.2]	970 [4.3] 0.16 [4.1]	1400 [6.3] 0.21 [5.3]
40-20-4-60deg	1.6 [40]	0.79 [20]	0.16 [4]	60	560 [2.5] 0.073 [1.8]	780 [3.5] 0.16 [4.1]	970 [4.3] 0.28 [7.1]	1400 [6.3] 0.35 [8.9]
40-20-5-30deg	1.6 [40]	0.79 [20]	0.2 [5]	30	880 [3.9] 0.021 [0.52]	1200 [5.4] 0.05 [1.3]	1500 [6.8] 0.095 [2.4]	2200 [9.8] 0.13 [3.3]
40-20-5-45deg	1.6 [40]	0.79 [20]	0.2 [5]	45	880 [3.9] 0.03 [0.77]	1200 [5.4] 0.072 [1.8]	1500 [6.8] 0.13 [3.4]	2200 [9.8] 0.18 [4.5]
40-20-5-60deg	1.6 [40]	0.79 [20]	0.2 [5]	60	880 [3.9] 0.059 [1.5]	1200 [5.4] 0.13 [3.4]	1500 [6.8] 0.24 [6]	2200 [9.8] 0.3 [7.7]
40-20-6-30deg	1.6 [40]	0.79 [20]	0.24 [6]	30	1300 [5.7] 0.017 [0.44]	1800 [7.8] 0.042 [1.1]	2200 [9.7] 0.08 [2]	3200 [14] 0.11 [2.8]
40-20-6-45deg	1.6 [40]	0.79 [20]	0.24 [6]	45	1300 [5.7] 0.025 [0.65]	1800 [7.8] 0.061 [1.5]	2200 [9.7] 0.11 [2.9]	3200 [14] 0.15 [3.8]
40-20-6-60deg	1.6 [40]	0.79 [20]	0.24 [6]	60	1300 [5.7] 0.05 [1.3]	1800 [7.8] 0.11 [2.9]	2200 [9.7] 0.21 [5.2]	3200 [14] 0.27 [6.7]
40-30-1-30deg	1.6 [40]	1.2 [30]	0.039 [1]	30	83 [0.37] 0.025 [0.63]	110 [0.51] 0.058 [1.5]	140 [0.63] 0.11 [2.8]	210 [0.92] 0.11 [2.9]
40-30-1-45deg	1.6 [40]	1.2 [30]	0.039 [1]	45	83 [0.37] 0.036 [0.91]	110 [0.51] 0.08 [2]	140 [0.63] 0.14 [3.5]	210 [0.92] 0.18 [4.6]
40-30-1-60deg	1.6 [40]	1.2 [30]	0.039 [1]	60	83 [0.37] 0.067 [1.7]	110 [0.51] 0.14 [3.5]	140 [0.63] 0.22 [5.6]	210 [0.92] 0.27 [6.9]
40-30-1.3-30deg	1.6 [40]	1.2 [30]	0.051 [1.3]	30	140 [0.62] 0.019 [0.49]	190 [0.85] 0.046 [1.2]	240 [1.1] 0.086 [2.2]	350 [1.5] 0.11 [2.9]
40-30-1.3-45deg	1.6 [40]	1.2 [30]	0.051 [1.3]	45	140 [0.62] 0.028 [0.72]	190 [0.85] 0.064 [1.6]	240 [1.1] 0.11 [2.9]	350 [1.5] 0.15 [3.7]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
40-30-1.3-60deg	1.6 [40]	1.2 [30]	0.051 [1.3]	60	140 [0.62] 0.054 [1.4]	190 [0.85] 0.11 [2.9]	240 [1.1] 0.19 [4.8]	350 [1.5] 0.23 [5.9]
40-30-1.5-30deg	1.6 [40]	1.2 [30]	0.059 [1.5]	30	180 [0.82] 0.017 [0.43]	260 [1.1] 0.04 [1]	320 [1.4] 0.076 [1.9]	460 [2.1] 0.1 [2.6]
40-30-1.5-45deg	1.6 [40]	1.2 [30]	0.059 [1.5]	45	180 [0.82] 0.025 [0.63]	260 [1.1] 0.057 [1.4]	320 [1.4] 0.1 [2.6]	460 [2.1] 0.13 [3.4]
40-30-1.5-60deg	1.6 [40]	1.2 [30]	0.059 [1.5]	60	180 [0.82] 0.047 [1.2]	260 [1.1] 0.1 [2.6]	320 [1.4] 0.17 [4.3]	460 [2.1] 0.21 [5.4]
40-30-2-30deg	1.6 [40]	1.2 [30]	0.079 [2]	30	330 [1.5] 0.013 [0.32]	460 [2] 0.031 [0.78]	570 [2.5] 0.058 [1.5]	820 [3.7] 0.079 [2]
40-30-2-45deg	1.6 [40]	1.2 [30]	0.079 [2]	45	330 [1.5] 0.019 [0.48]	460 [2] 0.044 [1.1]	570 [2.5] 0.08 [2]	820 [3.7] 0.11 [2.7]
40-30-2-60deg	1.6 [40]	1.2 [30]	0.079 [2]	60	330 [1.5] 0.036 [0.92]	460 [2] 0.081 [2.1]	570 [2.5] 0.14 [3.5]	820 [3.7] 0.18 [4.5]
40-30-2.5-30deg	1.6 [40]	1.2 [30]	0.098 [2.5]	30	520 [2.3] 0.01 [0.26]	710 [3.2] 0.025 [0.63]	890 [3.9] 0.048 [1.2]	1300 [5.7] 0.065 [1.6]
40-30-2.5-45deg	1.6 [40]	1.2 [30]	0.098 [2.5]	45	520 [2.3] 0.015 [0.39]	710 [3.2] 0.036 [0.91]	890 [3.9] 0.066 [1.7]	1300 [5.7] 0.088 [2.2]
40-30-2.5-60deg	1.6 [40]	1.2 [30]	0.098 [2.5]	60	520 [2.3] 0.029 [0.75]	710 [3.2] 0.067 [1.7]	890 [3.9] 0.12 [3]	1300 [5.7] 0.15 [3.8]
40-30-3-30deg	1.6 [40]	1.2 [30]	0.12 [3]	30	740 [3.3] 0.0086 [0.22]	1000 [4.6] 0.021 [0.53]	1300 [5.7] 0.04 [1]	1900 [8.2] 0.055 [1.4]
40-30-3-45deg	1.6 [40]	1.2 [30]	0.12 [3]	45	740 [3.3] 0.013 [0.32]	1000 [4.6] 0.03 [0.77]	1300 [5.7] 0.057 [1.4]	1900 [8.2] 0.076 [1.9]
40-30-3-60deg	1.6 [40]	1.2 [30]	0.12 [3]	60	740 [3.3] 0.025 [0.63]	1000 [4.6] 0.057 [1.5]	1300 [5.7] 0.1 [2.6]	1900 [8.2] 0.13 [3.4]
40-30-4-30deg	1.6 [40]	1.2 [30]	0.16 [4]	30	1300 [5.9] 0.0065 [0.16]	1800 [8.1] 0.016 [0.4]	2300 [10] 0.031 [0.78]	3300 [15] 0.042 [1.1]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
40-30-4-45deg	1.6 [40]	1.2 [30]	0.16 [4]	45	1300 [5.9] 0.0096 [0.24]	1800 [8.1] 0.023 [0.59]	2300 [10] 0.044 [1.1]	3300 [15] 0.059 [1.5]
40-30-4-60deg	1.6 [40]	1.2 [30]	0.16 [4]	60	1300 [5.9] 0.019 [0.48]	1800 [8.1] 0.044 [1.1]	2300 [10] 0.081 [2.1]	3300 [15] 0.11 [2.7]
40-30-5-30deg	1.6 [40]	1.2 [30]	0.2 [5]	30	2100 [9.2] 0.0052 [0.13]	2800 [13] 0.013 [0.32]	3500 [16] 0.025 [0.63]	5200 [23] 0.034 [0.87]
40-30-5-45deg	1.6 [40]	1.2 [30]	0.2 [5]	45	2100 [9.2] 0.0077 [0.2]	2800 [13] 0.019 [0.48]	3500 [16] 0.036 [0.91]	5200 [23] 0.049 [1.2]
40-30-5-60deg	1.6 [40]	1.2 [30]	0.2 [5]	60	2100 [9.2] 0.015 [0.39]	2800 [13] 0.036 [0.92]	3500 [16] 0.067 [1.7]	5200 [23] 0.089 [2.3]
40-30-6-30deg	1.6 [40]	1.2 [30]	0.24 [6]	30	3000 [13] 0.0043 [0.11]	4100 [18] 0.011 [0.27]	5100 [23] 0.021 [0.53]	7400 [33] 0.029 [0.73]
40-30-6-45deg	1.6 [40]	1.2 [30]	0.24 [6]	45	3000 [13] 0.0065 [0.16]	4100 [18] 0.016 [0.4]	5100 [23] 0.03 [0.77]	7400 [33] 0.041 [1]
40-30-6-60deg	1.6 [40]	1.2 [30]	0.24 [6]	60	3000 [13] 0.013 [0.32]	4100 [18] 0.031 [0.78]	5100 [23] 0.057 [1.5]	7400 [33] 0.077 [1.9]
40-30-8-30deg	1.6 [40]	1.2 [30]	0.31 [8]	30	5300 [23] 0.0033 [0.083]	7300 [32] 0.0081 [0.2]	9100 [40] 0.016 [0.4]	13000 [59] 0.022 [0.56]
40-30-8-45deg	1.6 [40]	1.2 [30]	0.31 [8]	45	5300 [23] 0.0048 [0.12]	7300 [32] 0.012 [0.3]	9100 [40] 0.023 [0.59]	13000 [59] 0.032 [0.81]
40-30-8-60deg	1.6 [40]	1.2 [30]	0.31 [8]	60	5300 [23] 0.0096 [0.24]	7300 [32] 0.023 [0.59]	9100 [40] 0.044 [1.1]	13000 [59] 0.06 [1.5]
40-30-10-30deg	1.6 [40]	1.2 [30]	0.39 [10]	30	8200 [37] 0.0026 [0.066]	11000 [51] 0.0065 [0.16]	14000 [63] 0.013 [0.32]	21000 [92] 0.018 [0.45]
40-30-10-45deg	1.6 [40]	1.2 [30]	0.39 [10]	45	8200 [37] 0.0039 [0.099]	11000 [51] 0.0096 [0.24]	14000 [63] 0.019 [0.48]	21000 [92] 0.026 [0.66]
40-30-10-60deg	1.6 [40]	1.2 [30]	0.39 [10]	60	8200 [37] 0.0078 [0.2]	11000 [51] 0.019 [0.48]	14000 [63] 0.036 [0.92]	21000 [92] 0.049 [1.2]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
50-13-1-30deg	2 [50]	0.51 [13]	0.039 [1]	30	20 [0.089] 0.31 [7.8]	28 [0.12] 0.42 [11]	34 [0.15] 0.42 [11]	50 [0.22] 0.42 [11]
50-13-1-45deg	2 [50]	0.51 [13]	0.039 [1]	45	20 [0.089] 0.41 [10]	28 [0.12] 0.73 [18]	34 [0.15] 0.73 [18]	50 [0.22] 0.73 [18]
50-13-1-60deg	2 [50]	0.51 [13]	0.039 [1]	60	20 [0.089] 0.68 [17]	28 [0.12] 1.2 [30]	34 [0.15] 1.3 [32]	50 [0.22] 1.3 [32]
50-13-1.3-30deg	2 [50]	0.51 [13]	0.051 [1.3]	30	34 [0.15] 0.24 [6.2]	47 [0.21] 0.42 [11]	58 [0.26] 0.42 [11]	85 [0.38] 0.42 [11]
50-13-1.3-45deg	2 [50]	0.51 [13]	0.051 [1.3]	45	34 [0.15] 0.33 [8.4]	47 [0.21] 0.67 [17]	58 [0.26] 0.73 [18]	85 [0.38] 0.73 [18]
50-13-1.3-60deg	2 [50]	0.51 [13]	0.051 [1.3]	60	34 [0.15] 0.57 [14]	47 [0.21] 1 [26]	58 [0.26] 1.3 [32]	85 [0.38] 1.3 [32]
50-13-1.5-30deg	2 [50]	0.51 [13]	0.059 [1.5]	30	45 [0.2] 0.21 [5.4]	62 [0.28] 0.42 [11]	78 [0.34] 0.42 [11]	110 [0.5] 0.42 [11]
50-13-1.5-45deg	2 [50]	0.51 [13]	0.059 [1.5]	45	45 [0.2] 0.29 [7.4]	62 [0.28] 0.6 [15]	78 [0.34] 0.73 [18]	110 [0.5] 0.73 [18]
50-13-1.5-60deg	2 [50]	0.51 [13]	0.059 [1.5]	60	45 [0.2] 0.51 [13]	62 [0.28] 0.93 [24]	78 [0.34] 1.3 [32]	110 [0.5] 1.3 [32]
50-13-2-30deg	2 [50]	0.51 [13]	0.079 [2]	30	80 [0.36] 0.16 [4.2]	110 [0.49] 0.38 [9.5]	140 [0.61] 0.42 [11]	200 [0.89] 0.42 [11]
50-13-2-45deg	2 [50]	0.51 [13]	0.079 [2]	45	80 [0.36] 0.23 [5.8]	110 [0.49] 0.48 [12]	140 [0.61] 0.73 [18]	200 [0.89] 0.73 [18]
50-13-2-60deg	2 [50]	0.51 [13]	0.079 [2]	60	80 [0.36] 0.41 [10]	110 [0.49] 0.78 [20]	140 [0.61] 1.2 [30]	200 [0.89] 1.3 [32]
50-13-2.5-30deg	2 [50]	0.51 [13]	0.098 [2.5]	30	120 [0.56] 0.13 [3.4]	170 [0.77] 0.31 [7.8]	220 [0.96] 0.42 [11]	310 [1.4] 0.42 [11]
50-13-2.5-45deg	2 [50]	0.51 [13]	0.098 [2.5]	45	120 [0.56] 0.19 [4.8]	170 [0.77] 0.41 [10]	220 [0.96] 0.7 [18]	310 [1.4] 0.73 [18]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
50-13-2.5-60deg	2 [50]	0.51 [13]	0.098 [2.5]	60	120 [0.56] 0.35 [8.8]	170 [0.77] 0.68 [17]	220 [0.96] 1 [26]	310 [1.4] 1.3 [32]
50-13-3-30deg	2 [50]	0.51 [13]	0.12 [3]	30	180 [0.8] 0.11 [2.9]	250 [1.1] 0.26 [6.6]	310 [1.4] 0.42 [11]	450 [2] 0.42 [11]
50-13-3-45deg	2 [50]	0.51 [13]	0.12 [3]	45	180 [0.8] 0.16 [4.1]	250 [1.1] 0.35 [8.9]	310 [1.4] 0.6 [15]	450 [2] 0.73 [18]
50-13-3-60deg	2 [50]	0.51 [13]	0.12 [3]	60	180 [0.8] 0.3 [7.6]	250 [1.1] 0.6 [15]	310 [1.4] 0.93 [24]	450 [2] 1.1 [29]
50-13-4-30deg	2 [50]	0.51 [13]	0.16 [4]	30	320 [1.4] 0.086 [2.2]	440 [2] 0.2 [5.1]	550 [2.5] 0.38 [9.5]	800 [3.6] 0.42 [11]
50-13-4-45deg	2 [50]	0.51 [13]	0.16 [4]	45	320 [1.4] 0.12 [3.1]	440 [2] 0.28 [7.1]	550 [2.5] 0.48 [12]	800 [3.6] 0.63 [16]
50-13-4-60deg	2 [50]	0.51 [13]	0.16 [4]	60	320 [1.4] 0.23 [5.9]	440 [2] 0.49 [12]	550 [2.5] 0.78 [20]	800 [3.6] 0.95 [24]
50-25-1-30deg	2 [50]	0.98 [25]	0.039 [1]	30	35 [0.16] 0.15 [3.7]	49 [0.22] 0.28 [7.2]	61 [0.27] 0.28 [7.2]	88 [0.39] 0.28 [7.2]
50-25-1-45deg	2 [50]	0.98 [25]	0.039 [1]	45	35 [0.16] 0.2 [5.1]	49 [0.22] 0.41 [10]	61 [0.27] 0.49 [12]	88 [0.39] 0.49 [12]
50-25-1-60deg	2 [50]	0.98 [25]	0.039 [1]	60	35 [0.16] 0.35 [8.9]	49 [0.22] 0.63 [16]	61 [0.27] 0.85 [22]	88 [0.39] 0.85 [22]
50-25-1.3-30deg	2 [50]	0.98 [25]	0.051 [1.3]	30	60 [0.27] 0.11 [2.9]	82 [0.37] 0.26 [6.7]	100 [0.46] 0.28 [7.2]	150 [0.66] 0.28 [7.2]
50-25-1.3-45deg	2 [50]	0.98 [25]	0.051 [1.3]	45	60 [0.27] 0.16 [4.1]	82 [0.37] 0.34 [8.6]	100 [0.46] 0.49 [12]	150 [0.66] 0.49 [12]
50-25-1.3-60deg	2 [50]	0.98 [25]	0.051 [1.3]	60	60 [0.27] 0.29 [7.3]	82 [0.37] 0.54 [14]	100 [0.46] 0.81 [21]	150 [0.66] 0.85 [22]
50-25-1.5-30deg	2 [50]	0.98 [25]	0.059 [1.5]	30	79 [0.35] 0.1 [2.6]	110 [0.49] 0.23 [5.9]	140 [0.61] 0.28 [7.2]	200 [0.88] 0.28 [7.2]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
50-25-1.5-45deg	2 [50]	0.98 [25]	0.059 [1.5]	45	79 [0.35] 0.14 [3.6]	110 [0.49] 0.3 [7.7]	140 [0.61] 0.49 [12]	200 [0.88] 0.49 [12]
50-25-1.5-60deg	2 [50]	0.98 [25]	0.059 [1.5]	60	79 [0.35] 0.26 [6.5]	110 [0.49] 0.49 [13]	140 [0.61] 0.75 [19]	200 [0.88] 0.85 [22]
50-25-2-30deg	2 [50]	0.98 [25]	0.079 [2]	30	140 [0.63] 0.077 [2]	200 [0.87] 0.18 [4.5]	240 [1.1] 0.28 [7.2]	350 [1.6] 0.28 [7.2]
50-25-2-45deg	2 [50]	0.98 [25]	0.079 [2]	45	140 [0.63] 0.11 [2.8]	200 [0.87] 0.24 [6.1]	240 [1.1] 0.41 [10]	350 [1.6] 0.49 [12]
50-25-2-60deg	2 [50]	0.98 [25]	0.079 [2]	60	140 [0.63] 0.2 [5.2]	200 [0.87] 0.41 [10]	240 [1.1] 0.63 [16]	350 [1.6] 0.77 [19]
50-25-2.5-30deg	2 [50]	0.98 [25]	0.098 [2.5]	30	220 [0.98] 0.062 [1.6]	300 [1.4] 0.15 [3.7]	380 [1.7] 0.27 [6.9]	550 [2.5] 0.28 [7.2]
50-25-2.5-45deg	2 [50]	0.98 [25]	0.098 [2.5]	45	220 [0.98] 0.09 [2.3]	300 [1.4] 0.2 [5.1]	380 [1.7] 0.35 [8.8]	550 [2.5] 0.45 [11]
50-25-2.5-60deg	2 [50]	0.98 [25]	0.098 [2.5]	60	220 [0.98] 0.17 [4.3]	300 [1.4] 0.35 [8.9]	380 [1.7] 0.55 [14]	550 [2.5] 0.67 [17]
50-25-3-30deg	2 [50]	0.98 [25]	0.12 [3]	30	320 [1.4] 0.052 [1.3]	440 [2] 0.12 [3.1]	550 [2.4] 0.23 [5.9]	790 [3.5] 0.28 [7.2]
50-25-3-45deg	2 [50]	0.98 [25]	0.12 [3]	45	320 [1.4] 0.076 [1.9]	440 [2] 0.17 [4.4]	550 [2.4] 0.3 [7.7]	790 [3.5] 0.39 [9.9]
50-25-3-60deg	2 [50]	0.98 [25]	0.12 [3]	60	320 [1.4] 0.14 [3.6]	440 [2] 0.3 [7.7]	550 [2.4] 0.49 [13]	790 [3.5] 0.61 [15]
50-25-4-30deg	2 [50]	0.98 [25]	0.16 [4]	30	560 [2.5] 0.04 [1]	780 [3.5] 0.095 [2.4]	970 [4.3] 0.18 [4.5]	1400 [6.3] 0.24 [6.1]
50-25-4-45deg	2 [50]	0.98 [25]	0.16 [4]	45	560 [2.5] 0.058 [1.5]	780 [3.5] 0.13 [3.4]	970 [4.3] 0.24 [6.1]	1400 [6.3] 0.31 [8]
50-25-4-60deg	2 [50]	0.98 [25]	0.16 [4]	60	560 [2.5] 0.11 [2.8]	780 [3.5] 0.24 [6.2]	970 [4.3] 0.41 [10]	1400 [6.3] 0.51 [13]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
50-25-5-30deg	2 [50]	0.98 [25]	0.2 [5]	30	880 [3.9] 0.032 [0.81]	1200 [5.4] 0.077 [2]	1500 [6.8] 0.15 [3.7]	2200 [9.8] 0.2 [5]
50-25-5-45deg	2 [50]	0.98 [25]	0.2 [5]	45	880 [3.9] 0.047 [1.2]	1200 [5.4] 0.11 [2.8]	1500 [6.8] 0.2 [5.1]	2200 [9.8] 0.26 [6.7]
50-25-5-60deg	2 [50]	0.98 [25]	0.2 [5]	60	880 [3.9] 0.091 [2.3]	1200 [5.4] 0.2 [5.2]	1500 [6.8] 0.35 [8.9]	2200 [9.8] 0.44 [11]
50-25-6-30deg	2 [50]	0.98 [25]	0.24 [6]	30	1300 [5.7] 0.027 [0.68]	1800 [7.8] 0.065 [1.6]	2200 [9.7] 0.12 [3.1]	3200 [14] 0.17 [4.3]
50-25-6-45deg	2 [50]	0.98 [25]	0.24 [6]	45	1300 [5.7] 0.039 [1]	1800 [7.8] 0.093 [2.4]	2200 [9.7] 0.17 [4.4]	3200 [14] 0.23 [5.8]
50-25-6-60deg	2 [50]	0.98 [25]	0.24 [6]	60	1300 [5.7] 0.077 [1.9]	1800 [7.8] 0.17 [4.4]	2200 [9.7] 0.3 [7.7]	3200 [14] 0.39 [9.9]
50-25-8-30deg	2 [50]	0.98 [25]	0.31 [8]	30	2300 [10] 0.02 [0.51]	3100 [14] 0.049 [1.2]	3900 [17] 0.095 [2.4]	5600 [25] 0.13 [3.3]
50-25-8-45deg	2 [50]	0.98 [25]	0.31 [8]	45	2300 [10] 0.03 [0.76]	3100 [14] 0.071 [1.8]	3900 [17] 0.13 [3.4]	5600 [25] 0.18 [4.5]
50-25-8-60deg	2 [50]	0.98 [25]	0.31 [8]	60	2300 [10] 0.058 [1.5]	3100 [14] 0.14 [3.4]	3900 [17] 0.24 [6.2]	5600 [25] 0.32 [8]
50-38-1-30deg	2 [50]	1.5 [38]	0.039 [1]	30	86 [0.38] 0.036 [0.9]	120 [0.53] 0.083 [2.1]	150 [0.66] 0.14 [3.5]	220 [0.96] 0.14 [3.5]
50-38-1-45deg	2 [50]	1.5 [38]	0.039 [1]	45	86 [0.38] 0.051 [1.3]	120 [0.53] 0.11 [2.8]	150 [0.66] 0.19 [4.9]	220 [0.96] 0.24 [6]
50-38-1-60deg	2 [50]	1.5 [38]	0.039 [1]	60	86 [0.38] 0.094 [2.4]	120 [0.53] 0.19 [4.8]	150 [0.66] 0.3 [7.5]	220 [0.96] 0.36 [9.1]
50-38-1.3-30deg	2 [50]	1.5 [38]	0.051 [1.3]	30	150 [0.65] 0.028 [0.7]	200 [0.9] 0.065 [1.7]	250 [1.1] 0.12 [3.1]	360 [1.6] 0.14 [3.5]
50-38-1.3-45deg	2 [50]	1.5 [38]	0.051 [1.3]	45	150 [0.65] 0.04 [1]	200 [0.9] 0.09 [2.3]	250 [1.1] 0.16 [4]	360 [1.6] 0.2 [5.2]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
50-38-1.3-60deg	2 [50]	1.5 [38]	0.051 [1.3]	60	150 [0.65] 0.075 [1.9]	200 [0.9] 0.16 [4]	250 [1.1] 0.25 [6.4]	360 [1.6] 0.31 [7.8]
50-38-1.5-30deg	2 [50]	1.5 [38]	0.059 [1.5]	30	190 [0.86] 0.024 [0.61]	270 [1.2] 0.057 [1.5]	330 [1.5] 0.11 [2.7]	490 [2.2] 0.14 [3.5]
50-38-1.5-45deg	2 [50]	1.5 [38]	0.059 [1.5]	45	190 [0.86] 0.035 [0.89]	270 [1.2] 0.08 [2]	330 [1.5] 0.14 [3.6]	490 [2.2] 0.18 [4.6]
50-38-1.5-60deg	2 [50]	1.5 [38]	0.059 [1.5]	60	190 [0.86] 0.067 [1.7]	270 [1.2] 0.14 [3.6]	330 [1.5] 0.23 [5.9]	490 [2.2] 0.28 [7.2]
50-38-2-30deg	2 [50]	1.5 [38]	0.079 [2]	30	340 [1.5] 0.018 [0.46]	480 [2.1] 0.044 [1.1]	590 [2.6] 0.083 [2.1]	860 [3.8] 0.11 [2.8]
50-38-2-45deg	2 [50]	1.5 [38]	0.079 [2]	45	340 [1.5] 0.027 [0.68]	480 [2.1] 0.062 [1.6]	590 [2.6] 0.11 [2.8]	860 [3.8] 0.15 [3.7]
50-38-2-60deg	2 [50]	1.5 [38]	0.079 [2]	60	340 [1.5] 0.051 [1.3]	480 [2.1] 0.11 [2.9]	590 [2.6] 0.19 [4.8]	860 [3.8] 0.24 [6]
50-38-2.5-30deg	2 [50]	1.5 [38]	0.098 [2.5]	30	540 [2.4] 0.015 [0.37]	740 [3.3] 0.036 [0.9]	930 [4.1] 0.068 [1.7]	1300 [6] 0.092 [2.3]
50-38-2.5-45deg	2 [50]	1.5 [38]	0.098 [2.5]	45	540 [2.4] 0.022 [0.55]	740 [3.3] 0.051 [1.3]	930 [4.1] 0.093 [2.4]	1300 [6] 0.12 [3.1]
50-38-2.5-60deg	2 [50]	1.5 [38]	0.098 [2.5]	60	540 [2.4] 0.042 [1.1]	740 [3.3] 0.094 [2.4]	930 [4.1] 0.16 [4.1]	1300 [6] 0.21 [5.2]
50-38-3-30deg	2 [50]	1.5 [38]	0.12 [3]	30	780 [3.5] 0.012 [0.31]	1100 [4.8] 0.03 [0.76]	1300 [5.9] 0.057 [1.5]	1900 [8.6] 0.078 [2]
50-38-3-45deg	2 [50]	1.5 [38]	0.12 [3]	45	780 [3.5] 0.018 [0.46]	1100 [4.8] 0.043 [1.1]	1300 [5.9] 0.08 [2]	1900 [8.6] 0.11 [2.7]
50-38-3-60deg	2 [50]	1.5 [38]	0.12 [3]	60	780 [3.5] 0.035 [0.9]	1100 [4.8] 0.081 [2.1]	1300 [5.9] 0.14 [3.6]	1900 [8.6] 0.18 [4.6]
50-38-4-30deg	2 [50]	1.5 [38]	0.16 [4]	30	1400 [6.1] 0.0093 [0.24]	1900 [8.5] 0.023 [0.58]	2400 [11] 0.044 [1.1]	3500 [15] 0.06 [1.5]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
50-38-4-45deg	2 [50]	1.5 [38]	0.16 [4]	45	1400 [6.1] 0.014 [0.35]	1900 [8.5] 0.033 [0.84]	2400 [11] 0.062 [1.6]	3500 [15] 0.083 [2.1]
50-38-4-60deg	2 [50]	1.5 [38]	0.16 [4]	60	1400 [6.1] 0.027 [0.69]	1900 [8.5] 0.063 [1.6]	2400 [11] 0.11 [2.9]	3500 [15] 0.15 [3.7]
50-38-5-30deg	2 [50]	1.5 [38]	0.2 [5]	30	2200 [9.6] 0.0074 [0.19]	3000 [13] 0.018 [0.46]	3700 [17] 0.036 [0.9]	5400 [24] 0.049 [1.2]
50-38-5-45deg	2 [50]	1.5 [38]	0.2 [5]	45	2200 [9.6] 0.011 [0.28]	3000 [13] 0.027 [0.68]	3700 [17] 0.051 [1.3]	5400 [24] 0.069 [1.7]
50-38-5-60deg	2 [50]	1.5 [38]	0.2 [5]	60	2200 [9.6] 0.022 [0.55]	3000 [13] 0.051 [1.3]	3700 [17] 0.094 [2.4]	5400 [24] 0.12 [3.1]
50-38-6-30deg	2 [50]	1.5 [38]	0.24 [6]	30	3100 [14] 0.0062 [0.16]	4300 [19] 0.015 [0.39]	5300 [24] 0.03 [0.76]	7800 [35] 0.041 [1]
50-38-6-45deg	2 [50]	1.5 [38]	0.24 [6]	45	3100 [14] 0.0093 [0.23]	4300 [19] 0.023 [0.57]	5300 [24] 0.043 [1.1]	7800 [35] 0.058 [1.5]
50-38-6-60deg	2 [50]	1.5 [38]	0.24 [6]	60	3100 [14] 0.018 [0.46]	4300 [19] 0.044 [1.1]	5300 [24] 0.081 [2.1]	7800 [35] 0.11 [2.7]
50-38-8-30deg	2 [50]	1.5 [38]	0.31 [8]	30	5500 [25] 0.0047 [0.12]	7600 [34] 0.012 [0.29]	9500 [42] 0.023 [0.58]	14000 [61] 0.031 [0.8]
50-38-8-45deg	2 [50]	1.5 [38]	0.31 [8]	45	5500 [25] 0.007 [0.18]	7600 [34] 0.017 [0.43]	9500 [42] 0.033 [0.84]	14000 [61] 0.045 [1.1]
50-38-8-60deg	2 [50]	1.5 [38]	0.31 [8]	60	5500 [25] 0.014 [0.35]	7600 [34] 0.033 [0.84]	9500 [42] 0.063 [1.6]	14000 [61] 0.084 [2.1]
50-38-10-30deg	2 [50]	1.5 [38]	0.39 [10]	30	8600 [38] 0.0037 [0.095]	12000 [53] 0.0093 [0.24]	15000 [66] 0.018 [0.46]	22000 [96] 0.025 [0.64]
50-38-10-45deg	2 [50]	1.5 [38]	0.39 [10]	45	8600 [38] 0.0056 [0.14]	12000 [53] 0.014 [0.35]	15000 [66] 0.027 [0.68]	22000 [96] 0.037 [0.93]
50-38-10-60deg	2 [50]	1.5 [38]	0.39 [10]	60	8600 [38] 0.011 [0.28]	12000 [53] 0.027 [0.69]	15000 [66] 0.051 [1.3]	22000 [96] 0.069 [1.8]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
63-16-1.3-30deg	2.5 [63]	0.63 [16]	0.051 [1.3]	30	33 [0.15] 0.38 [9.7]	46 [0.2] 0.53 [14]	58 [0.26] 0.53 [14]	84 [0.37] 0.53 [14]
63-16-1.3-45deg	2.5 [63]	0.63 [16]	0.051 [1.3]	45	33 [0.15] 0.51 [13]	46 [0.2] 0.93 [24]	58 [0.26] 0.93 [24]	84 [0.37] 0.93 [24]
63-16-1.3-60deg	2.5 [63]	0.63 [16]	0.051 [1.3]	60	33 [0.15] 0.85 [21]	46 [0.2] 1.5 [37]	58 [0.26] 1.6 [41]	84 [0.37] 1.6 [41]
63-16-1.5-30deg	2.5 [63]	0.63 [16]	0.059 [1.5]	30	45 [0.2] 0.34 [8.6]	61 [0.27] 0.53 [14]	77 [0.34] 0.53 [14]	110 [0.49] 0.53 [14]
63-16-1.5-45deg	2.5 [63]	0.63 [16]	0.059 [1.5]	45	45 [0.2] 0.45 [12]	61 [0.27] 0.92 [23]	77 [0.34] 0.93 [24]	110 [0.49] 0.93 [24]
63-16-1.5-60deg	2.5 [63]	0.63 [16]	0.059 [1.5]	60	45 [0.2] 0.77 [20]	61 [0.27] 1.4 [34]	77 [0.34] 1.6 [41]	110 [0.49] 1.6 [41]
63-16-2-30deg	2.5 [63]	0.63 [16]	0.079 [2]	30	79 [0.35] 0.26 [6.6]	110 [0.49] 0.53 [14]	140 [0.61] 0.53 [14]	200 [0.88] 0.53 [14]
63-16-2-45deg	2.5 [63]	0.63 [16]	0.079 [2]	45	79 [0.35] 0.36 [9.1]	110 [0.49] 0.74 [19]	140 [0.61] 0.93 [24]	200 [0.88] 0.93 [24]
63-16-2-60deg	2.5 [63]	0.63 [16]	0.079 [2]	60	79 [0.35] 0.63 [16]	110 [0.49] 1.1 [29]	140 [0.61] 1.6 [41]	200 [0.88] 1.6 [41]
63-16-2.5-30deg	2.5 [63]	0.63 [16]	0.098 [2.5]	30	120 [0.55] 0.21 [5.4]	170 [0.76] 0.48 [12]	210 [0.95] 0.53 [14]	310 [1.4] 0.53 [14]
63-16-2.5-45deg	2.5 [63]	0.63 [16]	0.098 [2.5]	45	120 [0.55] 0.3 [7.5]	170 [0.76] 0.62 [16]	210 [0.95] 0.93 [24]	310 [1.4] 0.93 [24]
63-16-2.5-60deg	2.5 [63]	0.63 [16]	0.098 [2.5]	60	120 [0.55] 0.53 [13]	170 [0.76] 1 [25]	210 [0.95] 1.5 [38]	310 [1.4] 1.6 [41]
63-16-3-30deg	2.5 [63]	0.63 [16]	0.12 [3]	30	180 [0.79] 0.18 [4.5]	250 [1.1] 0.41 [10]	310 [1.4] 0.53 [14]	440 [2] 0.53 [14]
63-16-3-45deg	2.5 [63]	0.63 [16]	0.12 [3]	45	180 [0.79] 0.25 [6.4]	250 [1.1] 0.54 [14]	310 [1.4] 0.92 [23]	440 [2] 0.93 [24]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
63-16-3-60deg	2.5 [63]	0.63 [16]	0.12 [3]	60	180 [0.79] 0.46 [12]	250 [1.1] 0.89 [23]	310 [1.4] 1.4 [34]	440 [2] 1.6 [41]
63-16-4-30deg	2.5 [63]	0.63 [16]	0.16 [4]	30	320 [1.4] 0.14 [3.5]	440 [1.9] 0.32 [8.1]	540 [2.4] 0.53 [14]	790 [3.5] 0.53 [14]
63-16-4-45deg	2.5 [63]	0.63 [16]	0.16 [4]	45	320 [1.4] 0.2 [5]	440 [1.9] 0.43 [11]	540 [2.4] 0.74 [19]	790 [3.5] 0.93 [24]
63-16-4-60deg	2.5 [63]	0.63 [16]	0.16 [4]	60	320 [1.4] 0.36 [9.2]	440 [1.9] 0.73 [19]	540 [2.4] 1.1 [29]	790 [3.5] 1.4 [35]
63-16-5-30deg	2.5 [63]	0.63 [16]	0.2 [5]	30	500 [2.2] 0.11 [2.8]	680 [3] 0.26 [6.6]	850 [3.8] 0.48 [12]	1200 [5.5] 0.53 [14]
63-16-5-45deg	2.5 [63]	0.63 [16]	0.2 [5]	45	500 [2.2] 0.16 [4]	680 [3] 0.36 [9.1]	850 [3.8] 0.62 [16]	1200 [5.5] 0.81 [20]
63-16-5-60deg	2.5 [63]	0.63 [16]	0.2 [5]	60	500 [2.2] 0.3 [7.6]	680 [3] 0.63 [16]	850 [3.8] 1 [25]	1200 [5.5] 1.2 [31]
63-32-1.3-30deg	2.5 [63]	1.3 [32]	0.051 [1.3]	30	61 [0.27] 0.17 [4.4]	84 [0.37] 0.35 [8.9]	100 [0.47] 0.35 [8.9]	150 [0.68] 0.35 [8.9]
63-32-1.3-45deg	2.5 [63]	1.3 [32]	0.051 [1.3]	45	61 [0.27] 0.24 [6.1]	84 [0.37] 0.49 [13]	100 [0.47] 0.61 [16]	150 [0.68] 0.61 [16]
63-32-1.3-60deg	2.5 [63]	1.3 [32]	0.051 [1.3]	60	61 [0.27] 0.42 [11]	84 [0.37] 0.76 [19]	100 [0.47] 1.1 [27]	150 [0.68] 1.1 [27]
63-32-1.5-30deg	2.5 [63]	1.3 [32]	0.059 [1.5]	30	81 [0.36] 0.15 [3.9]	110 [0.5] 0.35 [8.8]	140 [0.62] 0.35 [8.9]	200 [0.9] 0.35 [8.9]
63-32-1.5-45deg	2.5 [63]	1.3 [32]	0.059 [1.5]	45	81 [0.36] 0.21 [5.4]	110 [0.5] 0.44 [11]	140 [0.62] 0.61 [16]	200 [0.9] 0.61 [16]
63-32-1.5-60deg	2.5 [63]	1.3 [32]	0.059 [1.5]	60	81 [0.36] 0.38 [9.5]	110 [0.5] 0.7 [18]	140 [0.62] 1 [27]	200 [0.9] 1.1 [27]
63-32-2-30deg	2.5 [63]	1.3 [32]	0.079 [2]	30	140 [0.64] 0.12 [3]	200 [0.89] 0.27 [6.8]	250 [1.1] 0.35 [8.9]	360 [1.6] 0.35 [8.9]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
63-32-2-45deg	2.5 [63]	1.3 [32]	0.079 [2]	45	140 [0.64] 0.16 [4.2]	200 [0.89] 0.35 [9]	250 [1.1] 0.6 [15]	360 [1.6] 0.61 [16]
63-32-2-60deg	2.5 [63]	1.3 [32]	0.079 [2]	60	140 [0.64] 0.3 [7.6]	200 [0.89] 0.58 [15]	250 [1.1] 0.89 [23]	360 [1.6] 1.1 [27]
63-32-2.5-30deg	2.5 [63]	1.3 [32]	0.098 [2.5]	30	220 [1] 0.095 [2.4]	310 [1.4] 0.22 [5.6]	390 [1.7] 0.35 [8.9]	560 [2.5] 0.35 [8.9]
63-32-2.5-45deg	2.5 [63]	1.3 [32]	0.098 [2.5]	45	220 [1] 0.14 [3.4]	310 [1.4] 0.3 [7.5]	390 [1.7] 0.51 [13]	560 [2.5] 0.61 [16]
63-32-2.5-60deg	2.5 [63]	1.3 [32]	0.098 [2.5]	60	220 [1] 0.25 [6.4]	310 [1.4] 0.5 [13]	390 [1.7] 0.78 [20]	560 [2.5] 0.95 [24]
63-32-3-30deg	2.5 [63]	1.3 [32]	0.12 [3]	30	320 [1.4] 0.08 [2]	450 [2] 0.19 [4.7]	560 [2.5] 0.35 [8.8]	810 [3.6] 0.35 [8.9]
63-32-3-45deg	2.5 [63]	1.3 [32]	0.12 [3]	45	320 [1.4] 0.11 [2.9]	450 [2] 0.26 [6.5]	560 [2.5] 0.44 [11]	810 [3.6] 0.57 [15]
63-32-3-60deg	2.5 [63]	1.3 [32]	0.12 [3]	60	320 [1.4] 0.21 [5.5]	450 [2] 0.44 [11]	560 [2.5] 0.7 [18]	810 [3.6] 0.85 [22]
63-32-4-30deg	2.5 [63]	1.3 [32]	0.16 [4]	30	580 [2.6] 0.06 [1.5]	800 [3.5] 0.14 [3.6]	990 [4.4] 0.27 [6.8]	1400 [6.4] 0.35 [8.9]
63-32-4-45deg	2.5 [63]	1.3 [32]	0.16 [4]	45	580 [2.6] 0.088 [2.2]	800 [3.5] 0.2 [5.1]	990 [4.4] 0.35 [9]	1400 [6.4] 0.46 [12]
63-32-4-60deg	2.5 [63]	1.3 [32]	0.16 [4]	60	580 [2.6] 0.17 [4.2]	800 [3.5] 0.36 [9.1]	990 [4.4] 0.58 [15]	1400 [6.4] 0.72 [18]
63-32-5-30deg	2.5 [63]	1.3 [32]	0.2 [5]	30	900 [4] 0.049 [1.2]	1200 [5.5] 0.12 [3]	1600 [6.9] 0.22 [5.6]	2300 [10] 0.3 [7.6]
63-32-5-45deg	2.5 [63]	1.3 [32]	0.2 [5]	45	900 [4] 0.071 [1.8]	1200 [5.5] 0.16 [4.2]	1600 [6.9] 0.3 [7.5]	2300 [10] 0.39 [9.8]
63-32-5-60deg	2.5 [63]	1.3 [32]	0.2 [5]	60	900 [4] 0.14 [3.5]	1200 [5.5] 0.3 [7.6]	1600 [6.9] 0.5 [13]	2300 [10] 0.63 [16]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
63-32-6-30deg	2.5 [63]	1.3 [32]	0.24 [6]	30	1300 [5.8] 0.041 [1]	1800 [8] 0.098 [2.5]	2200 [9.9] 0.19 [4.7]	3200 [14] 0.25 [6.4]
63-32-6-45deg	2.5 [63]	1.3 [32]	0.24 [6]	45	1300 [5.8] 0.06 [1.5]	1800 [8] 0.14 [3.6]	2200 [9.9] 0.26 [6.5]	3200 [14] 0.34 [8.5]
63-32-6-60deg	2.5 [63]	1.3 [32]	0.24 [6]	60	1300 [5.8] 0.12 [2.9]	1800 [8] 0.26 [6.6]	2200 [9.9] 0.44 [11]	3200 [14] 0.56 [14]
63-32-8-30deg	2.5 [63]	1.3 [32]	0.31 [8]	30	2300 [10] 0.031 [0.78]	3200 [14] 0.075 [1.9]	4000 [18] 0.14 [3.6]	5800 [26] 0.19 [5]
63-32-8-45deg	2.5 [63]	1.3 [32]	0.31 [8]	45	2300 [10] 0.046 [1.2]	3200 [14] 0.11 [2.7]	4000 [18] 0.2 [5.1]	5800 [26] 0.27 [6.7]
63-32-8-60deg	2.5 [63]	1.3 [32]	0.31 [8]	60	2300 [10] 0.089 [2.3]	3200 [14] 0.2 [5.2]	4000 [18] 0.36 [9.1]	5800 [26] 0.46 [12]
63-32-10-30deg	2.5 [63]	1.3 [32]	0.39 [10]	30	3600 [16] 0.025 [0.63]	5000 [22] 0.06 [1.5]	6200 [28] 0.12 [3]	9000 [40] 0.16 [4]
63-32-10-45deg	2.5 [63]	1.3 [32]	0.39 [10]	45	3600 [16] 0.037 [0.93]	5000 [22] 0.088 [2.2]	6200 [28] 0.16 [4.2]	9000 [40] 0.22 [5.6]
63-32-10-60deg	2.5 [63]	1.3 [32]	0.39 [10]	60	3600 [16] 0.072 [1.8]	5000 [22] 0.17 [4.2]	6200 [28] 0.3 [7.6]	9000 [40] 0.39 [9.9]
63-47-1.3-30deg	2.5 [63]	1.9 [47]	0.051 [1.3]	30	140 [0.61] 0.049 [1.2]	190 [0.84] 0.11 [2.9]	240 [1] 0.18 [4.6]	340 [1.5] 0.18 [4.6]
63-47-1.3-45deg	2.5 [63]	1.9 [47]	0.051 [1.3]	45	140 [0.61] 0.069 [1.8]	190 [0.84] 0.15 [3.9]	240 [1] 0.26 [6.6]	340 [1.5] 0.31 [8]
63-47-1.3-60deg	2.5 [63]	1.9 [47]	0.051 [1.3]	60	140 [0.61] 0.13 [3.3]	190 [0.84] 0.26 [6.6]	240 [1] 0.4 [10]	340 [1.5] 0.49 [12]
63-47-1.5-30deg	2.5 [63]	1.9 [47]	0.059 [1.5]	30	180 [0.81] 0.042 [1.1]	250 [1.1] 0.099 [2.5]	310 [1.4] 0.18 [4.6]	460 [2] 0.18 [4.6]
63-47-1.5-45deg	2.5 [63]	1.9 [47]	0.059 [1.5]	45	180 [0.81] 0.061 [1.5]	250 [1.1] 0.14 [3.4]	310 [1.4] 0.23 [5.9]	460 [2] 0.3 [7.7]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
63-47-1.5-60deg	2.5 [63]	1.9 [47]	0.059 [1.5]	60	180 [0.81] 0.11 [2.9]	250 [1.1] 0.23 [5.9]	310 [1.4] 0.37 [9.3]	460 [2] 0.45 [11]
63-47-2-30deg	2.5 [63]	1.9 [47]	0.079 [2]	30	320 [1.4] 0.032 [0.82]	450 [2] 0.076 [1.9]	560 [2.5] 0.14 [3.6]	810 [3.6] 0.18 [4.6]
63-47-2-45deg	2.5 [63]	1.9 [47]	0.079 [2]	45	320 [1.4] 0.047 [1.2]	450 [2] 0.11 [2.7]	560 [2.5] 0.19 [4.8]	810 [3.6] 0.24 [6.2]
63-47-2-60deg	2.5 [63]	1.9 [47]	0.079 [2]	60	320 [1.4] 0.089 [2.3]	450 [2] 0.19 [4.8]	560 [2.5] 0.31 [7.8]	810 [3.6] 0.38 [9.6]
63-47-2.5-30deg	2.5 [63]	1.9 [47]	0.098 [2.5]	30	510 [2.2] 0.026 [0.66]	700 [3.1] 0.062 [1.6]	870 [3.9] 0.12 [3]	1300 [5.6] 0.16 [4]
63-47-2.5-45deg	2.5 [63]	1.9 [47]	0.098 [2.5]	45	510 [2.2] 0.038 [0.96]	700 [3.1] 0.088 [2.2]	870 [3.9] 0.16 [4]	1300 [5.6] 0.2 [5.2]
63-47-2.5-60deg	2.5 [63]	1.9 [47]	0.098 [2.5]	60	510 [2.2] 0.073 [1.8]	700 [3.1] 0.16 [4]	870 [3.9] 0.27 [6.7]	1300 [5.6] 0.33 [8.4]
63-47-3-30deg	2.5 [63]	1.9 [47]	0.12 [3]	30	730 [3.2] 0.022 [0.55]	1000 [4.5] 0.052 [1.3]	1300 [5.6] 0.099 [2.5]	1800 [8.1] 0.13 [3.4]
63-47-3-45deg	2.5 [63]	1.9 [47]	0.12 [3]	45	730 [3.2] 0.032 [0.81]	1000 [4.5] 0.074 [1.9]	1300 [5.6] 0.14 [3.4]	1800 [8.1] 0.18 [4.5]
63-47-3-60deg	2.5 [63]	1.9 [47]	0.12 [3]	60	730 [3.2] 0.062 [1.6]	1000 [4.5] 0.14 [3.5]	1300 [5.6] 0.23 [5.9]	1800 [8.1] 0.29 [7.5]
63-47-4-30deg	2.5 [63]	1.9 [47]	0.16 [4]	30	1300 [5.8] 0.016 [0.42]	1800 [7.9] 0.04 [1]	2200 [9.9] 0.076 [1.9]	3200 [14] 0.1 [2.6]
63-47-4-45deg	2.5 [63]	1.9 [47]	0.16 [4]	45	1300 [5.8] 0.024 [0.62]	1800 [7.9] 0.057 [1.5]	2200 [9.9] 0.11 [2.7]	3200 [14] 0.14 [3.6]
63-47-4-60deg	2.5 [63]	1.9 [47]	0.16 [4]	60	1300 [5.8] 0.047 [1.2]	1800 [7.9] 0.11 [2.7]	2200 [9.9] 0.19 [4.8]	3200 [14] 0.24 [6.1]
63-47-5-30deg	2.5 [63]	1.9 [47]	0.2 [5]	30	2000 [9] 0.013 [0.34]	2800 [12] 0.032 [0.82]	3500 [15] 0.062 [1.6]	5100 [22] 0.085 [2.1]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
63-47-5-45deg	2.5 [63]	1.9 [47]	0.2 [5]	45	2000 [9] 0.02 [0.5]	2800 [12] 0.047 [1.2]	3500 [15] 0.088 [2.2]	5100 [22] 0.12 [3]
63-47-5-60deg	2.5 [63]	1.9 [47]	0.2 [5]	60	2000 [9] 0.038 [0.97]	2800 [12] 0.089 [2.3]	3500 [15] 0.16 [4]	5100 [22] 0.21 [5.2]
63-47-6-30deg	2.5 [63]	1.9 [47]	0.24 [6]	30	2900 [13] 0.011 [0.28]	4000 [18] 0.027 [0.69]	5000 [22] 0.052 [1.3]	7300 [32] 0.071 [1.8]
63-47-6-45deg	2.5 [63]	1.9 [47]	0.24 [6]	45	2900 [13] 0.016 [0.42]	4000 [18] 0.039 [1]	5000 [22] 0.074 [1.9]	7300 [32] 0.1 [2.5]
63-47-6-60deg	2.5 [63]	1.9 [47]	0.24 [6]	60	2900 [13] 0.032 [0.82]	4000 [18] 0.075 [1.9]	5000 [22] 0.14 [3.5]	7300 [32] 0.18 [4.6]
63-47-8-30deg	2.5 [63]	1.9 [47]	0.31 [8]	30	5200 [23] 0.0083 [0.21]	7100 [32] 0.02 [0.52]	8900 [40] 0.04 [1]	13000 [58] 0.055 [1.4]
63-47-8-45deg	2.5 [63]	1.9 [47]	0.31 [8]	45	5200 [23] 0.012 [0.31]	7100 [32] 0.03 [0.76]	8900 [40] 0.057 [1.5]	13000 [58] 0.078 [2]
63-47-8-60deg	2.5 [63]	1.9 [47]	0.31 [8]	60	5200 [23] 0.024 [0.62]	7100 [32] 0.058 [1.5]	8900 [40] 0.11 [2.7]	13000 [58] 0.14 [3.6]
63-47-10-30deg	2.5 [63]	1.9 [47]	0.39 [10]	30	8100 [36] 0.0067 [0.17]	11000 [50] 0.016 [0.42]	14000 [62] 0.032 [0.82]	20000 [90] 0.044 [1.1]
63-47-10-45deg	2.5 [63]	1.9 [47]	0.39 [10]	45	8100 [36] 0.0099 [0.25]	11000 [50] 0.024 [0.62]	14000 [62] 0.047 [1.2]	20000 [90] 0.064 [1.6]
63-47-10-60deg	2.5 [63]	1.9 [47]	0.39 [10]	60	8100 [36] 0.02 [0.5]	11000 [50] 0.047 [1.2]	14000 [62] 0.089 [2.3]	20000 [90] 0.12 [3]
80-20-2-30deg	3.1 [80]	0.79 [20]	0.079 [2]	30	78 [0.35] 0.41 [10]	110 [0.48] 0.68 [17]	140 [0.6] 0.68 [17]	200 [0.87] 0.68 [17]
80-20-2-45deg	3.1 [80]	0.79 [20]	0.079 [2]	45	78 [0.35] 0.56 [14]	110 [0.48] 1.1 [29]	140 [0.6] 1.2 [30]	200 [0.87] 1.2 [30]
80-20-2-60deg	3.1 [80]	0.79 [20]	0.079 [2]	60	78 [0.35] 0.95 [24]	110 [0.48] 1.7 [43]	140 [0.6] 2 [52]	200 [0.87] 2 [52]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
80-20-2.5-30deg	3.1 [80]	0.79 [20]	0.098 [2.5]	30	120 [0.55] 0.34 [8.6]	170 [0.75] 0.68 [17]	210 [0.94] 0.68 [17]	310 [1.4] 0.68 [17]
80-20-2.5-45deg	3.1 [80]	0.79 [20]	0.098 [2.5]	45	120 [0.55] 0.46 [12]	170 [0.75] 0.96 [24]	210 [0.94] 1.2 [30]	310 [1.4] 1.2 [30]
80-20-2.5-60deg	3.1 [80]	0.79 [20]	0.098 [2.5]	60	120 [0.55] 0.81 [21]	170 [0.75] 1.5 [38]	210 [0.94] 2 [52]	310 [1.4] 2 [52]
80-20-3-30deg	3.1 [80]	0.79 [20]	0.12 [3]	30	180 [0.79] 0.29 [7.3]	240 [1.1] 0.65 [17]	300 [1.4] 0.68 [17]	440 [2] 0.68 [17]
80-20-3-45deg	3.1 [80]	0.79 [20]	0.12 [3]	45	180 [0.79] 0.4 [10]	240 [1.1] 0.83 [21]	300 [1.4] 1.2 [30]	440 [2] 1.2 [30]
80-20-3-60deg	3.1 [80]	0.79 [20]	0.12 [3]	60	180 [0.79] 0.71 [18]	240 [1.1] 1.3 [34]	300 [1.4] 2 [51]	440 [2] 2 [52]
80-20-4-30deg	3.1 [80]	0.79 [20]	0.16 [4]	30	310 [1.4] 0.22 [5.6]	430 [1.9] 0.51 [13]	540 [2.4] 0.68 [17]	780 [3.5] 0.68 [17]
80-20-4-45deg	3.1 [80]	0.79 [20]	0.16 [4]	45	310 [1.4] 0.31 [7.9]	430 [1.9] 0.67 [17]	540 [2.4] 1.1 [29]	780 [3.5] 1.2 [30]
80-20-4-60deg	3.1 [80]	0.79 [20]	0.16 [4]	60	310 [1.4] 0.57 [14]	430 [1.9] 1.1 [28]	540 [2.4] 1.7 [43]	780 [3.5] 2 [52]
80-20-5-30deg	3.1 [80]	0.79 [20]	0.2 [5]	30	490 [2.2] 0.18 [4.5]	680 [3] 0.41 [10]	840 [3.8] 0.68 [17]	1200 [5.5] 0.68 [17]
80-20-5-45deg	3.1 [80]	0.79 [20]	0.2 [5]	45	490 [2.2] 0.25 [6.5]	680 [3] 0.56 [14]	840 [3.8] 0.96 [24]	1200 [5.5] 1.2 [30]
80-20-5-60deg	3.1 [80]	0.79 [20]	0.2 [5]	60	490 [2.2] 0.47 [12]	680 [3] 0.95 [24]	840 [3.8] 1.5 [38]	1200 [5.5] 1.8 [46]
80-20-6-30deg	3.1 [80]	0.79 [20]	0.24 [6]	30	710 [3.1] 0.15 [3.8]	980 [4.3] 0.35 [8.9]	1200 [5.4] 0.65 [17]	1800 [7.9] 0.68 [17]
80-20-6-45deg	3.1 [80]	0.79 [20]	0.24 [6]	45	710 [3.1] 0.22 [5.5]	980 [4.3] 0.48 [12]	1200 [5.4] 0.83 [21]	1800 [7.9] 1.1 [27]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
80-20-6-60deg	3.1 [80]	0.79 [20]	0.24 [6]	60	710 [3.1] 0.4 [10]	980 [4.3] 0.84 [21]	1200 [5.4] 1.3 [34]	1800 [7.9] 1.6 [41]
80-40-2-30deg	3.1 [80]	1.6 [40]	0.079 [2]	30	140 [0.63] 0.19 [4.8]	200 [0.87] 0.44 [11]	240 [1.1] 0.45 [12]	350 [1.6] 0.45 [12]
80-40-2-45deg	3.1 [80]	1.6 [40]	0.079 [2]	45	140 [0.63] 0.27 [6.7]	200 [0.87] 0.56 [14]	240 [1.1] 0.79 [20]	350 [1.6] 0.79 [20]
80-40-2-60deg	3.1 [80]	1.6 [40]	0.079 [2]	60	140 [0.63] 0.47 [12]	200 [0.87] 0.88 [22]	240 [1.1] 1.3 [34]	350 [1.6] 1.4 [35]
80-40-2.5-30deg	3.1 [80]	1.6 [40]	0.098 [2.5]	30	220 [0.98] 0.15 [3.9]	300 [1.4] 0.36 [9.1]	380 [1.7] 0.45 [12]	550 [2.5] 0.45 [12]
80-40-2.5-45deg	3.1 [80]	1.6 [40]	0.098 [2.5]	45	220 [0.98] 0.22 [5.6]	300 [1.4] 0.47 [12]	380 [1.7] 0.79 [20]	550 [2.5] 0.79 [20]
80-40-2.5-60deg	3.1 [80]	1.6 [40]	0.098 [2.5]	60	220 [0.98] 0.4 [10]	300 [1.4] 0.77 [20]	380 [1.7] 1.2 [30]	550 [2.5] 1.4 [35]
80-40-3-30deg	3.1 [80]	1.6 [40]	0.12 [3]	30	320 [1.4] 0.13 [3.3]	440 [2] 0.3 [7.7]	550 [2.4] 0.45 [12]	790 [3.5] 0.45 [12]
80-40-3-45deg	3.1 [80]	1.6 [40]	0.12 [3]	45	320 [1.4] 0.19 [4.7]	440 [2] 0.41 [10]	550 [2.4] 0.69 [18]	790 [3.5] 0.79 [20]
80-40-3-60deg	3.1 [80]	1.6 [40]	0.12 [3]	60	320 [1.4] 0.34 [8.7]	440 [2] 0.68 [17]	550 [2.4] 1 [27]	790 [3.5] 1.3 [32]
80-40-4-30deg	3.1 [80]	1.6 [40]	0.16 [4]	30	560 [2.5] 0.1 [2.5]	780 [3.5] 0.23 [5.9]	970 [4.3] 0.44 [11]	1400 [6.3] 0.45 [12]
80-40-4-45deg	3.1 [80]	1.6 [40]	0.16 [4]	45	560 [2.5] 0.14 [3.6]	780 [3.5] 0.32 [8.1]	970 [4.3] 0.56 [14]	1400 [6.3] 0.72 [18]
80-40-4-60deg	3.1 [80]	1.6 [40]	0.16 [4]	60	560 [2.5] 0.27 [6.8]	780 [3.5] 0.56 [14]	970 [4.3] 0.88 [22]	1400 [6.3] 1.1 [27]
80-40-5-30deg	3.1 [80]	1.6 [40]	0.2 [5]	30	880 [3.9] 0.08 [2]	1200 [5.4] 0.19 [4.8]	1500 [6.8] 0.36 [9.1]	2200 [9.8] 0.45 [12]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
80-40-5-45deg	3.1 [80]	1.6 [40]	0.2 [5]	45	880 [3.9] 0.12 [3]	1200 [5.4] 0.27 [6.7]	1500 [6.8] 0.47 [12]	2200 [9.8] 0.61 [15]
80-40-5-60deg	3.1 [80]	1.6 [40]	0.2 [5]	60	880 [3.9] 0.22 [5.6]	1200 [5.4] 0.47 [12]	1500 [6.8] 0.77 [20]	2200 [9.8] 0.95 [24]
80-40-6-30deg	3.1 [80]	1.6 [40]	0.24 [6]	30	1300 [5.7] 0.067 [1.7]	1800 [7.8] 0.16 [4.1]	2200 [9.7] 0.3 [7.7]	3200 [14] 0.41 [10]
80-40-6-45deg	3.1 [80]	1.6 [40]	0.24 [6]	45	1300 [5.7] 0.099 [2.5]	1800 [7.8] 0.23 [5.8]	2200 [9.7] 0.41 [10]	3200 [14] 0.53 [13]
80-40-6-60deg	3.1 [80]	1.6 [40]	0.24 [6]	60	1300 [5.7] 0.19 [4.8]	1800 [7.8] 0.41 [10]	2200 [9.7] 0.68 [17]	3200 [14] 0.85 [22]
80-40-8-30deg	3.1 [80]	1.6 [40]	0.31 [8]	30	2300 [10] 0.051 [1.3]	3100 [14] 0.12 [3.1]	3900 [17] 0.23 [5.9]	5600 [25] 0.32 [8]
80-40-8-45deg	3.1 [80]	1.6 [40]	0.31 [8]	45	2300 [10] 0.075 [1.9]	3100 [14] 0.18 [4.5]	3900 [17] 0.32 [8.1]	5600 [25] 0.42 [11]
80-40-8-60deg	3.1 [80]	1.6 [40]	0.31 [8]	60	2300 [10] 0.15 [3.7]	3100 [14] 0.33 [8.3]	3900 [17] 0.56 [14]	5600 [25] 0.7 [18]
80-40-10-30deg	3.1 [80]	1.6 [40]	0.39 [10]	30	3500 [16] 0.041 [1]	4900 [22] 0.1 [2.5]	6100 [27] 0.19 [4.8]	8800 [39] 0.26 [6.6]
80-40-10-45deg	3.1 [80]	1.6 [40]	0.39 [10]	45	3500 [16] 0.061 [1.5]	4900 [22] 0.14 [3.6]	6100 [27] 0.27 [6.7]	8800 [39] 0.35 [8.9]
80-40-10-60deg	3.1 [80]	1.6 [40]	0.39 [10]	60	3500 [16] 0.12 [3]	4900 [22] 0.27 [6.8]	6100 [27] 0.47 [12]	8800 [39] 0.6 [15]
80-60-2-30deg	3.1 [80]	2.4 [60]	0.079 [2]	30	330 [1.5] 0.05 [1.3]	460 [2] 0.12 [3]	570 [2.5] 0.22 [5.5]	820 [3.7] 0.23 [5.8]
80-60-2-45deg	3.1 [80]	2.4 [60]	0.079 [2]	45	330 [1.5] 0.072 [1.8]	460 [2] 0.16 [4.1]	570 [2.5] 0.28 [7.1]	820 [3.7] 0.36 [9.1]
80-60-2-60deg	3.1 [80]	2.4 [60]	0.079 [2]	60	330 [1.5] 0.13 [3.4]	460 [2] 0.28 [7.1]	570 [2.5] 0.44 [11]	820 [3.7] 0.54 [14]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
80-60-2.5-30deg	3.1 [80]	2.4 [60]	0.098 [2.5]	30	520 [2.3] 0.04 [1]	710 [3.2] 0.095 [2.4]	890 [3.9] 0.18 [4.5]	1300 [5.7] 0.23 [5.8]
80-60-2.5-45deg	3.1 [80]	2.4 [60]	0.098 [2.5]	45	520 [2.3] 0.058 [1.5]	710 [3.2] 0.13 [3.4]	890 [3.9] 0.23 [5.9]	1300 [5.7] 0.3 [7.7]
80-60-2.5-60deg	3.1 [80]	2.4 [60]	0.098 [2.5]	60	520 [2.3] 0.11 [2.8]	710 [3.2] 0.24 [6]	890 [3.9] 0.38 [9.8]	1300 [5.7] 0.47 [12]
80-60-3-30deg	3.1 [80]	2.4 [60]	0.12 [3]	30	740 [3.3] 0.034 [0.86]	1000 [4.6] 0.08 [2]	1300 [5.7] 0.15 [3.8]	1900 [8.2] 0.2 [5.2]
80-60-3-45deg	3.1 [80]	2.4 [60]	0.12 [3]	45	740 [3.3] 0.049 [1.3]	1000 [4.6] 0.11 [2.9]	1300 [5.7] 0.2 [5.1]	1900 [8.2] 0.26 [6.7]
80-60-3-60deg	3.1 [80]	2.4 [60]	0.12 [3]	60	740 [3.3] 0.094 [2.4]	1000 [4.6] 0.21 [5.2]	1300 [5.7] 0.34 [8.7]	1900 [8.2] 0.42 [11]
80-60-4-30deg	3.1 [80]	2.4 [60]	0.16 [4]	30	1300 [5.9] 0.026 [0.65]	1800 [8.1] 0.061 [1.6]	2300 [10] 0.12 [3]	3300 [15] 0.16 [4]
80-60-4-45deg	3.1 [80]	2.4 [60]	0.16 [4]	45	1300 [5.9] 0.038 [0.95]	1800 [8.1] 0.088 [2.2]	2300 [10] 0.16 [4.1]	3300 [15] 0.21 [5.3]
80-60-4-60deg	3.1 [80]	2.4 [60]	0.16 [4]	60	1300 [5.9] 0.073 [1.8]	1800 [8.1] 0.16 [4.1]	2300 [10] 0.28 [7.1]	3300 [15] 0.35 [8.9]
80-60-5-30deg	3.1 [80]	2.4 [60]	0.2 [5]	30	2100 [9.2] 0.021 [0.52]	2800 [13] 0.05 [1.3]	3500 [16] 0.095 [2.4]	5200 [23] 0.13 [3.3]
80-60-5-45deg	3.1 [80]	2.4 [60]	0.2 [5]	45	2100 [9.2] 0.03 [0.77]	2800 [13] 0.072 [1.8]	3500 [16] 0.13 [3.4]	5200 [23] 0.18 [4.5]
80-60-5-60deg	3.1 [80]	2.4 [60]	0.2 [5]	60	2100 [9.2] 0.059 [1.5]	2800 [13] 0.13 [3.4]	3500 [16] 0.24 [6]	5200 [23] 0.3 [7.7]
80-60-6-30deg	3.1 [80]	2.4 [60]	0.24 [6]	30	3000 [13] 0.017 [0.44]	4100 [18] 0.042 [1.1]	5100 [23] 0.08 [2]	7400 [33] 0.11 [2.8]
80-60-6-45deg	3.1 [80]	2.4 [60]	0.24 [6]	45	3000 [13] 0.025 [0.65]	4100 [18] 0.061 [1.5]	5100 [23] 0.11 [2.9]	7400 [33] 0.15 [3.8]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
80-60-6-60deg	3.1 [80]	2.4 [60]	0.24 [6]	60	3000 [13] 0.05 [1.3]	4100 [18] 0.11 [2.9]	5100 [23] 0.21 [5.2]	7400 [33] 0.27 [6.7]
80-60-8-30deg	3.1 [80]	2.4 [60]	0.31 [8]	30	5300 [23] 0.013 [0.33]	7300 [32] 0.032 [0.81]	9100 [40] 0.061 [1.6]	13000 [59] 0.084 [2.1]
80-60-8-45deg	3.1 [80]	2.4 [60]	0.31 [8]	45	5300 [23] 0.019 [0.49]	7300 [32] 0.046 [1.2]	9100 [40] 0.088 [2.2]	13000 [59] 0.12 [3]
80-60-8-60deg	3.1 [80]	2.4 [60]	0.31 [8]	60	5300 [23] 0.038 [0.96]	7300 [32] 0.089 [2.3]	9100 [40] 0.16 [4.1]	13000 [59] 0.21 [5.4]
80-60-10-30deg	3.1 [80]	2.4 [60]	0.39 [10]	30	8200 [37] 0.01 [0.26]	11000 [51] 0.026 [0.65]	14000 [63] 0.05 [1.3]	21000 [92] 0.068 [1.7]
80-60-10-45deg	3.1 [80]	2.4 [60]	0.39 [10]	45	8200 [37] 0.015 [0.39]	11000 [51] 0.038 [0.95]	14000 [63] 0.072 [1.8]	21000 [92] 0.097 [2.5]
80-60-10-60deg	3.1 [80]	2.4 [60]	0.39 [10]	60	8200 [37] 0.03 [0.77]	11000 [51] 0.073 [1.8]	14000 [63] 0.13 [3.4]	21000 [92] 0.18 [4.5]
100-25-2-30deg	3.9 [100]	0.98 [25]	0.079 [2]	30	78 [0.35] 0.63 [16]	110 [0.48] 0.85 [22]	140 [0.6] 0.85 [22]	200 [0.87] 0.85 [22]
100-25-2-45deg	3.9 [100]	0.98 [25]	0.079 [2]	45	78 [0.35] 0.83 [21]	110 [0.48] 1.5 [38]	140 [0.6] 1.5 [38]	200 [0.87] 1.5 [38]
100-25-2-60deg	3.9 [100]	0.98 [25]	0.079 [2]	60	78 [0.35] 1.4 [35]	110 [0.48] 2.4 [61]	140 [0.6] 2.6 [65]	200 [0.87] 2.6 [65]
100-25-2.5-30deg	3.9 [100]	0.98 [25]	0.098 [2.5]	30	120 [0.55] 0.52 [13]	170 [0.75] 0.85 [22]	210 [0.94] 0.85 [22]	310 [1.4] 0.85 [22]
100-25-2.5-45deg	3.9 [100]	0.98 [25]	0.098 [2.5]	45	120 [0.55] 0.7 [18]	170 [0.75] 1.4 [36]	210 [0.94] 1.5 [38]	310 [1.4] 1.5 [38]
100-25-2.5-60deg	3.9 [100]	0.98 [25]	0.098 [2.5]	60	120 [0.55] 1.2 [30]	170 [0.75] 2.1 [53]	210 [0.94] 2.6 [65]	310 [1.4] 2.6 [65]
100-25-3-30deg	3.9 [100]	0.98 [25]	0.12 [3]	30	180 [0.79] 0.44 [11]	240 [1.1] 0.85 [22]	300 [1.4] 0.85 [22]	440 [2] 0.85 [22]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
100-25-3-45deg	3.9 [100]	0.98 [25]	0.12 [3]	45	180 [0.79] 0.6 [15]	240 [1.1] 1.2 [31]	300 [1.4] 1.5 [38]	440 [2] 1.5 [38]
100-25-3-60deg	3.9 [100]	0.98 [25]	0.12 [3]	60	180 [0.79] 1 [27]	240 [1.1] 1.9 [48]	300 [1.4] 2.6 [65]	440 [2] 2.6 [65]
100-25-4-30deg	3.9 [100]	0.98 [25]	0.16 [4]	30	310 [1.4] 0.34 [8.6]	430 [1.9] 0.77 [20]	540 [2.4] 0.85 [22]	780 [3.5] 0.85 [22]
100-25-4-45deg	3.9 [100]	0.98 [25]	0.16 [4]	45	310 [1.4] 0.47 [12]	430 [1.9] 0.99 [25]	540 [2.4] 1.5 [38]	780 [3.5] 1.5 [38]
100-25-4-60deg	3.9 [100]	0.98 [25]	0.16 [4]	60	310 [1.4] 0.84 [21]	430 [1.9] 1.6 [40]	540 [2.4] 2.4 [61]	780 [3.5] 2.6 [65]
100-25-5-30deg	3.9 [100]	0.98 [25]	0.2 [5]	30	490 [2.2] 0.27 [7]	680 [3] 0.63 [16]	840 [3.8] 0.85 [22]	1200 [5.5] 0.85 [22]
100-25-5-45deg	3.9 [100]	0.98 [25]	0.2 [5]	45	490 [2.2] 0.39 [9.8]	680 [3] 0.83 [21]	840 [3.8] 1.4 [36]	1200 [5.5] 1.5 [38]
100-25-5-60deg	3.9 [100]	0.98 [25]	0.2 [5]	60	490 [2.2] 0.71 [18]	680 [3] 1.4 [35]	840 [3.8] 2.1 [53]	1200 [5.5] 2.6 [65]
100-25-6-30deg	3.9 [100]	0.98 [25]	0.24 [6]	30	710 [3.1] 0.23 [5.9]	980 [4.3] 0.54 [14]	1200 [5.4] 0.85 [22]	1800 [7.9] 0.85 [22]
100-25-6-45deg	3.9 [100]	0.98 [25]	0.24 [6]	45	710 [3.1] 0.33 [8.4]	980 [4.3] 0.72 [18]	1200 [5.4] 1.2 [31]	1800 [7.9] 1.5 [38]
100-25-6-60deg	3.9 [100]	0.98 [25]	0.24 [6]	60	710 [3.1] 0.61 [15]	980 [4.3] 1.2 [31]	1200 [5.4] 1.9 [48]	1800 [7.9] 2.3 [58]
100-25-8-30deg	3.9 [100]	0.98 [25]	0.31 [8]	30	1300 [5.6] 0.18 [4.5]	1700 [7.7] 0.41 [10]	2200 [9.6] 0.77 [20]	3100 [14] 0.85 [22]
100-25-8-45deg	3.9 [100]	0.98 [25]	0.31 [8]	45	1300 [5.6] 0.25 [6.4]	1700 [7.7] 0.57 [14]	2200 [9.6] 0.99 [25]	3100 [14] 1.3 [33]
100-25-8-60deg	3.9 [100]	0.98 [25]	0.31 [8]	60	1300 [5.6] 0.48 [12]	1700 [7.7] 1 [25]	2200 [9.6] 1.6 [40]	3100 [14] 1.9 [49]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
100-50-2-30deg	3.9 [100]	2 [50]	0.079 [2]	30	140 [0.63] 0.29 [7.4]	200 [0.87] 0.57 [14]	240 [1.1] 0.57 [14]	350 [1.6] 0.57 [14]
100-50-2-45deg	3.9 [100]	2 [50]	0.079 [2]	45	140 [0.63] 0.4 [10]	200 [0.87] 0.82 [21]	240 [1.1] 0.98 [25]	350 [1.6] 0.98 [25]
100-50-2-60deg	3.9 [100]	2 [50]	0.079 [2]	60	140 [0.63] 0.7 [18]	200 [0.87] 1.3 [32]	240 [1.1] 1.7 [43]	350 [1.6] 1.7 [43]
100-50-2.5-30deg	3.9 [100]	2 [50]	0.098 [2.5]	30	220 [0.98] 0.24 [6]	300 [1.4] 0.55 [14]	380 [1.7] 0.57 [14]	550 [2.5] 0.57 [14]
100-50-2.5-45deg	3.9 [100]	2 [50]	0.098 [2.5]	45	220 [0.98] 0.33 [8.4]	300 [1.4] 0.7 [18]	380 [1.7] 0.98 [25]	550 [2.5] 0.98 [25]
100-50-2.5-60deg	3.9 [100]	2 [50]	0.098 [2.5]	60	220 [0.98] 0.59 [15]	300 [1.4] 1.1 [28]	380 [1.7] 1.7 [42]	550 [2.5] 1.7 [43]
100-50-3-30deg	3.9 [100]	2 [50]	0.12 [3]	30	320 [1.4] 0.2 [5.1]	440 [2] 0.46 [12]	550 [2.4] 0.57 [14]	790 [3.5] 0.57 [14]
100-50-3-45deg	3.9 [100]	2 [50]	0.12 [3]	45	320 [1.4] 0.28 [7.2]	440 [2] 0.6 [15]	550 [2.4] 0.98 [25]	790 [3.5] 0.98 [25]
100-50-3-60deg	3.9 [100]	2 [50]	0.12 [3]	60	320 [1.4] 0.51 [13]	440 [2] 0.99 [25]	550 [2.4] 1.5 [38]	790 [3.5] 1.7 [43]
100-50-4-30deg	3.9 [100]	2 [50]	0.16 [4]	30	560 [2.5] 0.15 [3.9]	780 [3.5] 0.36 [9.1]	970 [4.3] 0.57 [14]	1400 [6.3] 0.57 [14]
100-50-4-45deg	3.9 [100]	2 [50]	0.16 [4]	45	560 [2.5] 0.22 [5.6]	780 [3.5] 0.48 [12]	970 [4.3] 0.82 [21]	1400 [6.3] 0.98 [25]
100-50-4-60deg	3.9 [100]	2 [50]	0.16 [4]	60	560 [2.5] 0.41 [10]	780 [3.5] 0.82 [21]	970 [4.3] 1.3 [32]	1400 [6.3] 1.5 [39]
100-50-5-30deg	3.9 [100]	2 [50]	0.2 [5]	30	880 [3.9] 0.12 [3.2]	1200 [5.4] 0.29 [7.4]	1500 [6.8] 0.55 [14]	2200 [9.8] 0.57 [14]
100-50-5-45deg	3.9 [100]	2 [50]	0.2 [5]	45	880 [3.9] 0.18 [4.6]	1200 [5.4] 0.4 [10]	1500 [6.8] 0.7 [18]	2200 [9.8] 0.9 [23]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
100-50-5-60deg	3.9 [100]	2 [50]	0.2 [5]	60	880 [3.9] 0.34 [8.5]	1200 [5.4] 0.7 [18]	1500 [6.8] 1.1 [28]	2200 [9.8] 1.3 [34]
100-50-6-30deg	3.9 [100]	2 [50]	0.24 [6]	30	1300 [5.7] 0.1 [2.7]	1800 [7.8] 0.25 [6.3]	2200 [9.7] 0.46 [12]	3200 [14] 0.57 [14]
100-50-6-45deg	3.9 [100]	2 [50]	0.24 [6]	45	1300 [5.7] 0.15 [3.9]	1800 [7.8] 0.34 [8.7]	2200 [9.7] 0.6 [15]	3200 [14] 0.78 [20]
100-50-6-60deg	3.9 [100]	2 [50]	0.24 [6]	60	1300 [5.7] 0.29 [7.3]	1800 [7.8] 0.61 [15]	2200 [9.7] 0.99 [25]	3200 [14] 1.2 [31]
100-50-8-30deg	3.9 [100]	2 [50]	0.31 [8]	30	2300 [10] 0.079 [2]	3100 [14] 0.19 [4.8]	3900 [17] 0.36 [9.1]	5600 [25] 0.48 [12]
100-50-8-45deg	3.9 [100]	2 [50]	0.31 [8]	45	2300 [10] 0.12 [2.9]	3100 [14] 0.27 [6.8]	3900 [17] 0.48 [12]	5600 [25] 0.63 [16]
100-50-8-60deg	3.9 [100]	2 [50]	0.31 [8]	60	2300 [10] 0.22 [5.6]	3100 [14] 0.49 [12]	3900 [17] 0.82 [21]	5600 [25] 1 [26]
100-50-10-30deg	3.9 [100]	2 [50]	0.39 [10]	30	3500 [16] 0.064 [1.6]	4900 [22] 0.15 [3.9]	6100 [27] 0.29 [7.4]	8800 [39] 0.4 [10]
100-50-10-45deg	3.9 [100]	2 [50]	0.39 [10]	45	3500 [16] 0.094 [2.4]	4900 [22] 0.22 [5.6]	6100 [27] 0.4 [10]	8800 [39] 0.53 [13]
100-50-10-60deg	3.9 [100]	2 [50]	0.39 [10]	60	3500 [16] 0.18 [4.6]	4900 [22] 0.41 [10]	6100 [27] 0.7 [18]	8800 [39] 0.88 [22]
100-75-2-30deg	3.9 [100]	3 [75]	0.079 [2]	30	330 [1.5] 0.077 [2]	460 [2] 0.18 [4.5]	570 [2.5] 0.28 [7.2]	820 [3.7] 0.28 [7.2]
100-75-2-45deg	3.9 [100]	3 [75]	0.079 [2]	45	330 [1.5] 0.11 [2.8]	460 [2] 0.24 [6.1]	570 [2.5] 0.41 [10]	820 [3.7] 0.49 [12]
100-75-2-60deg	3.9 [100]	3 [75]	0.079 [2]	60	330 [1.5] 0.2 [5.2]	460 [2] 0.41 [10]	570 [2.5] 0.63 [16]	820 [3.7] 0.77 [19]
100-75-2.5-30deg	3.9 [100]	3 [75]	0.098 [2.5]	30	520 [2.3] 0.062 [1.6]	710 [3.2] 0.15 [3.7]	890 [3.9] 0.27 [6.9]	1300 [5.7] 0.28 [7.2]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
100-75-2.5-45deg	3.9 [100]	3 [75]	0.098 [2.5]	45	520 [2.3] 0.09 [2.3]	710 [3.2] 0.2 [5.1]	890 [3.9] 0.35 [8.8]	1300 [5.7] 0.45 [11]
100-75-2.5-60deg	3.9 [100]	3 [75]	0.098 [2.5]	60	520 [2.3] 0.17 [4.3]	710 [3.2] 0.35 [8.9]	890 [3.9] 0.55 [14]	1300 [5.7] 0.67 [17]
100-75-3-30deg	3.9 [100]	3 [75]	0.12 [3]	30	740 [3.3] 0.052 [1.3]	1000 [4.6] 0.12 [3.1]	1300 [5.7] 0.23 [5.9]	1900 [8.2] 0.28 [7.2]
100-75-3-45deg	3.9 [100]	3 [75]	0.12 [3]	45	740 [3.3] 0.076 [1.9]	1000 [4.6] 0.17 [4.4]	1300 [5.7] 0.3 [7.7]	1900 [8.2] 0.39 [9.9]
100-75-3-60deg	3.9 [100]	3 [75]	0.12 [3]	60	740 [3.3] 0.14 [3.6]	1000 [4.6] 0.3 [7.7]	1300 [5.7] 0.49 [13]	1900 [8.2] 0.61 [15]
100-75-4-30deg	3.9 [100]	3 [75]	0.16 [4]	30	1300 [5.9] 0.04 [1]	1800 [8.1] 0.095 [2.4]	2300 [10] 0.18 [4.5]	3300 [15] 0.24 [6.1]
100-75-4-45deg	3.9 [100]	3 [75]	0.16 [4]	45	1300 [5.9] 0.058 [1.5]	1800 [8.1] 0.13 [3.4]	2300 [10] 0.24 [6.1]	3300 [15] 0.31 [8]
100-75-4-60deg	3.9 [100]	3 [75]	0.16 [4]	60	1300 [5.9] 0.11 [2.8]	1800 [8.1] 0.24 [6.2]	2300 [10] 0.41 [10]	3300 [15] 0.51 [13]
100-75-5-30deg	3.9 [100]	3 [75]	0.2 [5]	30	2100 [9.2] 0.032 [0.81]	2800 [13] 0.077 [2]	3500 [16] 0.15 [3.7]	5200 [23] 0.2 [5]
100-75-5-45deg	3.9 [100]	3 [75]	0.2 [5]	45	2100 [9.2] 0.047 [1.2]	2800 [13] 0.11 [2.8]	3500 [16] 0.2 [5.1]	5200 [23] 0.26 [6.7]
100-75-5-60deg	3.9 [100]	3 [75]	0.2 [5]	60	2100 [9.2] 0.091 [2.3]	2800 [13] 0.2 [5.2]	3500 [16] 0.35 [8.9]	5200 [23] 0.44 [11]
100-75-6-30deg	3.9 [100]	3 [75]	0.24 [6]	30	3000 [13] 0.027 [0.68]	4100 [18] 0.065 [1.6]	5100 [23] 0.12 [3.1]	7400 [33] 0.17 [4.3]
100-75-6-45deg	3.9 [100]	3 [75]	0.24 [6]	45	3000 [13] 0.039 [1]	4100 [18] 0.093 [2.4]	5100 [23] 0.17 [4.4]	7400 [33] 0.23 [5.8]
100-75-6-60deg	3.9 [100]	3 [75]	0.24 [6]	60	3000 [13] 0.077 [1.9]	4100 [18] 0.17 [4.4]	5100 [23] 0.3 [7.7]	7400 [33] 0.39 [9.9]

BELLEVILLE ACTUATORS — Force and stroke per piece

Part reference	OD, in [mm]	ID, in [mm]	Thickness, in [mm]	Cone, deg	Level A: force, lbf [kN] / stroke, in [mm]	Level B: force, lbf [kN] / stroke, in [mm]	Level C: force, lbf [kN] / stroke, in [mm]	Level D: force, lbf [kN] / stroke, in [mm]
100-75-8-30deg	3.9 [100]	3 [75]	0.31 [8]	30	5300 [23] 0.02 [0.51]	7300 [32] 0.049 [1.2]	9100 [40] 0.095 [2.4]	13000 [59] 0.13 [3.3]
100-75-8-45deg	3.9 [100]	3 [75]	0.31 [8]	45	5300 [23] 0.03 [0.76]	7300 [32] 0.071 [1.8]	9100 [40] 0.13 [3.4]	13000 [59] 0.18 [4.5]
100-75-8-60deg	3.9 [100]	3 [75]	0.31 [8]	60	5300 [23] 0.058 [1.5]	7300 [32] 0.14 [3.4]	9100 [40] 0.24 [6.2]	13000 [59] 0.32 [8]
100-75-10-30deg	3.9 [100]	3 [75]	0.39 [10]	30	8200 [37] 0.016 [0.41]	11000 [51] 0.04 [1]	14000 [63] 0.077 [2]	21000 [92] 0.11 [2.7]
100-75-10-45deg	3.9 [100]	3 [75]	0.39 [10]	45	8200 [37] 0.024 [0.61]	11000 [51] 0.058 [1.5]	14000 [63] 0.11 [2.8]	21000 [92] 0.15 [3.8]
100-75-10-60deg	3.9 [100]	3 [75]	0.39 [10]	60	8200 [37] 0.047 [1.2]	11000 [51] 0.11 [2.8]	14000 [63] 0.2 [5.2]	21000 [92] 0.27 [6.8]

NOTES

NOTES

CHAPTER 10

Separation Actuators

Shears the head off a bolt on command

This one does a single job. It shears the head off a bolt on command. The bolt is spent when it fires; the actuator is not. If you can get it back, you compress it and use it again.

It replaces an explosive bolt. That comparison is the whole pitch. An explosive bolt works, but it is a pyrotechnic: it has to be handled, stored, certified and transported as one, it cannot be tested before use, and when it fires it produces debris. This does the same job with heat, leaves no debris behind, can be tested as many as a hundred times before you commit it, and is used again afterwards.

Anywhere something has to be held firmly for a long time and then let go on command, reliably, this is the part: spacecraft deployment, stage separation, emergency release, latches that must never open by accident and must never fail to open when told.

How it is used

The actuator is compressed and fitted around a notched bolt. The notch is a deliberate weak point, cut to one diameter deep and one diameter long. When the actuator is heated it expands with enormous force against the bolt head, and the bolt parts at the notch. Each size is listed by the bolt it takes.

It is compressed before each installation, so you need a vice or a simple press to set it, and since it is not consumed by firing, you get it back.

Reading the table

The figures in this chapter are measured ratings rather than calculated ones, so they are used exactly as published. Each size gives a load capacity and a maximum stroke, and the bolt it is matched to is listed beside it.

Sizes run from an M4 bolt up to a one inch bolt, with load capacities from sixteen and a half kilonewtons to three hundred and sixty one.

Getting it back

Like every shape in this handbook, a nitinol actuator moves one way when it is heated. Getting it back to where it started is the designer's problem, and there are three ways to solve it.

AN ANTAGONISTIC PAIR uses a second actuator working against the first. Heat one and it moves the mechanism and resets the other; heat the other and it goes back. You get powered motion in both directions with full output each way, at the cost of two actuators and a control scheme that never heats both at once.

A BIAS is a passive element, usually a conventional spring or a weight, that the actuator works against as it moves and that pushes it back as it cools. It is the simplest arrangement and the most common. The price is that the bias resists the actuator through the whole stroke, so part of the force in the table is spent returning the mechanism rather than doing the job. Size it to return the actuator and no more.

SYSTEM FORCES are the return you already have. If the mechanism pushes back on its own, if gravity closes the door, if the thing being clamped is springy, if line pressure acts on the valve, that force resets the actuator for nothing. It is the best answer when it is available, and worth looking for before adding parts.

Whichever you choose, the return has to be strong enough to reset the actuator while it is cool and weak enough not to stall it while it is hot. That window is what sizes a bias, and it is the most common thing to get wrong on a first build.

There is a fourth possibility. Any nitinol actuator can be given a two way set, so that it takes one shape hot and another cold and needs no return at all. Two way parts are made to order and are outside the scope of this handbook, so nothing here is rated for it, but it exists. Ask.

Overdriving an actuator

The figures in this handbook are conservative. Every force in every table is rated at a stress we are confident the part will deliver, cycle after cycle, at the fatigue life of its design level. A part will usually do more than the table says. We would rather you found that out in testing than the other way round.

The second reason a part will beat its table is that you can overdrive it, and this one is a feature you can design with. There are two ways to do it, and they add.

The first is to heat it further. Nitinol makes its force by changing phase, and the temperature at which it does that is the transition temperature we set for you. The force does not stop climbing when the part gets there. Keep heating it past the transition and the force keeps rising with temperature, well beyond the rated figure. The table gives you the force at a working temperature comfortably above transition. Drive the part hotter and there is more.

The second is to heat it faster. Heat the part slowly and it makes the force in the table. Heat it quickly, with a sharp pulse of current rather than a gentle ramp, and it makes more, and the harder the pulse, the bigger the difference. A part that is driven both fast and hot gets the gain from each, one on top of the other. The tables assume neither. They are the floor.

Emergency mode

That gives a nitinol actuator something most actuators do not have: a reserve. A motor or a solenoid has a rated output and a thermal limit close behind it. A nitinol actuator can be driven, briefly, to a force well above its rating simply by putting more heat into it, faster. Think of it as an emergency mode. A latch that normally needs a modest pull can, on the day something jams, be hit with a short hard pulse and told to pull much harder. A release that must not fail gets a margin that costs nothing in size or weight.

Use it as a reserve, not as the rating, and know where the limits are. There is a temperature, called Md, above which the metal can no longer be pushed into martensite by stress; up to Md the material is still behaving as nitinol should. Overdriving up to Md costs some fatigue life, but it also does the part a favor: the extra heat drives out residual martensite that builds up over many cycles, a kind of rehabilitation in place, so a part that is occasionally run hard can come back sharper than one that never is. Above Md the accounting changes. Degradation is faster, and each hot cycle takes a larger bite out of the life. Above 350 °C (660 °F) the part is past saving: treat an actuator that has been driven that hot as spent and replace it. Used within those limits, for the rare event, emergency mode is one of the best arguments for the material.

Actuator safety

Most actuators fail badly when they are overdriven, and engineers know exactly how. Put too much current into a motor or a solenoid and it explodes. Overpressure a hydraulic cylinder and it bursts, or springs a pinhole leak, and a jet of oil at that pressure will cut through a glove and a hand, take a limb, and put oil into the ground and the water where it can be years being cleaned up. Every one of them has the same problem: the energy is stored in the actuator, and when something goes wrong it has nowhere to go but out. A nitinol actuator, very simply, does not carry these risks. It is a piece of metal with a current in it, and there is nothing in it to burst, nothing to leak, and nothing to poison.

A nitinol actuator fails the other way. Put too much power into it and it simply gets hotter. Past the working range the force keeps rising; past that, the part reaches the temperatures at which it was shape set, and at that point the metal lets go of its memory. The actuator loses its force, goes slack, and parts, which opens the circuit that was heating it. It shuts itself off. There is nothing stored in it to release: no pressure, no winding, no field. The failure mode is a dead part and an open circuit, not an event.

That is worth stating plainly for anyone writing a safety case. The worst thing an overdriven nitinol actuator does is stop.

What we supply

Bolt sizes	A full imperial and metric range, from number 8 up to 1 inch and from M4 up to M25. Ratings are published for six shank diameters; ask for the others.
Rating	Rated for one hundred cycles. It is not consumed by firing: recover it, compress it, and use it again. How many times depends on the use case.
Debris	None.

Sold as	By the piece, with or without the matched bolt.

SEPARATION ACTUATORS — Published ratings

Part reference	Bolt size	Notch dia, in [mm]	Notch length, in [mm]	Load capacity, lbf [kN]	Max stroke, in [mm]	Rating
M4	M4 or #8	0.12 [3]	0.12 [3]	3700 [16]	0.015 [0.38]	Rated 100 cycles; reusable if recovered and reset
#10	#10	0.15 [3.8]	0.15 [3.8]	7400 [33]	0.022 [0.55]	Rated 100 cycles; reusable if recovered and reset
M6	M6 or 1/4-20	0.22 [5.7]	0.22 [5.7]	14000 [63]	0.028 [0.7]	Rated 100 cycles; reusable if recovered and reset
3/8-16	3/8-16	0.3 [7.6]	0.3 [7.6]	27000 [120]	0.039 [1]	Rated 100 cycles; reusable if recovered and reset
M12	M12 or 1/2-13	0.38 [9.7]	0.38 [9.7]	36000 [160]	0.043 [1.1]	Rated 100 cycles; reusable if recovered and reset
M24	M24 or 1-8	0.87 [22.2]	0.87 [22.2]	81000 [360]	0.052 [1.3]	Rated 100 cycles; reusable if recovered and reset

NOTES

NOTES

CHAPTER 11

Torque Tube Actuators

High torque in a small twist

A torque tube actuator is a thick walled tube that twists. Heat it and one end rotates relative to the other, with a great deal of torque behind it.

This is the shape that made shape memory alloy famous in aerospace. Boeing and NASA used nitinol torque tubes to fold the wingtips of an aircraft in flight, through seventy degrees, at about eighty percent less weight than the hydraulic system it replaced. No pumps, no lines, no motor. A tube that twists when you warm it.

The cleanest example of how this handbook works

Everything in this handbook rests on one idea: force and motion are set by different things, so you can choose them separately. The torque tube actuator shows that more plainly than any other shape.

THE OUTSIDE DIAMETER SETS THE TWIST. How many degrees a tube turns per unit of length depends on its outside diameter and on nothing else at all. Not the wall, not the bore, not the length.

THE WALL SETS THE TORQUE. How hard it twists depends almost entirely on how much metal is in the wall.

THE LENGTH SETS THE TOTAL ANGLE. Twist per unit length times length.

Look down any group of rows sharing an outside diameter and you will see the swing column repeat the same number while the torque column changes by a factor of three. A twenty millimeter tube at the middle design level swings 7.3 degrees per inch [29 per 100 mm] whether its wall is one millimeter or four. What the wall changes is whether it does so with 69 ft·lbf [93 N·m] or 170 ft·lbf [240 N·m].

> *Pick the diameter for the angle. Pick the wall for the torque. Pick the length for the total. Three choices that do not fight each other.*

What to watch

A tube does not have to be plain. Cutting a pattern into the wall, slots or spirals or kerfs, changes the section where the cuts are, and that changes what the tube does: more angle for less torque, motion concentrated in one region and not another, compliance in one direction while it stays stiff in another. It is a large subject and none of it is in this handbook. Every figure here is for a plain tube. For more sophisticated solutions, talk to us.

Getting it back

Like every shape in this handbook, a nitinol actuator moves one way when it is heated. Getting it back to where it started is the designer's problem, and there are three ways to solve it.

AN ANTAGONISTIC PAIR uses a second actuator working against the first. Heat one and it moves the mechanism and resets the other; heat the other and it goes back. You get powered motion in both directions with full output each way, at the cost of two actuators and a control scheme that never heats both at once.

A BIAS is a passive element, usually a conventional spring or a weight, that the actuator works against as it moves and that pushes it back as it cools. It is the simplest arrangement and the most common. The price is that the bias resists the actuator through the whole stroke, so part of the force in the table is spent returning the mechanism rather than doing the job. Size it to return the actuator and no more.

SYSTEM FORCES are the return you already have. If the mechanism pushes back on its own, if gravity closes the door, if the thing being clamped is springy, if line pressure acts on the valve, that force resets the actuator for nothing. It is the best answer when it is available, and worth looking for before adding parts.

Whichever you choose, the return has to be strong enough to reset the actuator while it is cool and weak enough not to stall it while it is hot. That window is what sizes a bias, and it is the most common thing to get wrong on a first build.

There is a fourth possibility. Any nitinol actuator can be given a two way set, so that it takes one shape hot and another cold and needs no return at all. Two way parts are made to order and are outside the scope of this handbook, so nothing here is rated for it, but it exists. Ask.

Overdriving an actuator

The figures in this handbook are conservative. Every force in every table is rated at a stress we are confident the part will deliver, cycle after cycle, at the fatigue life of its design level. A part will usually do more than the table says. We would rather you found that out in testing than the other way round.

The second reason a part will beat its table is that you can overdrive it, and this one is a feature you can design with. There are two ways to do it, and they add.

The first is to heat it further. Nitinol makes its force by changing phase, and the temperature at which it does that is the transition temperature we set for you. The force does not stop climbing when the part gets there. Keep heating it past the transition and the force keeps rising with temperature, well beyond the rated figure. The table gives you the force at a working temperature comfortably above transition. Drive the part hotter and there is more.

The second is to heat it faster. Heat the part slowly and it makes the force in the table. Heat it quickly, with a sharp pulse of current rather than a gentle ramp, and it makes more, and the harder the pulse, the bigger the difference. A part that is driven both fast and hot gets the gain from each, one on top of the other. The tables assume neither. They are the floor.

Emergency mode

That gives a nitinol actuator something most actuators do not have: a reserve. A motor or a solenoid has a rated output and a thermal limit close behind it. A nitinol actuator can be driven, briefly, to a force well above its rating simply by putting more heat into it, faster. Think of it as an emergency mode. A latch that normally needs a modest pull can, on the day something jams, be hit with a short hard pulse and told to pull much harder. A release that must not fail gets a margin that costs nothing in size or weight.

Use it as a reserve, not as the rating, and know where the limits are. There is a temperature, called Md, above which the metal can no longer be pushed into martensite by stress; up to Md the material is still behaving as nitinol should. Overdriving up to Md costs some fatigue life, but it also does the part a favor: the extra heat drives out residual martensite that builds up over many cycles, a kind of rehabilitation in place, so a part that is occasionally run hard can come back sharper than one that never is. Above Md the accounting changes. Degradation is faster, and each hot cycle takes a larger bite out of the life. Above 350 °C (660 °F) the part is past saving: treat an actuator that has been driven that hot as spent and replace it. Used within those limits, for the rare event, emergency mode is one of the best arguments for the material.

Actuator safety

Most actuators fail badly when they are overdriven, and engineers know exactly how. Put too much current into a motor or a solenoid and it explodes. Overpressure a hydraulic cylinder and it bursts, or springs a pinhole leak, and a jet of oil at that pressure will cut through a glove and a hand, take a limb, and put oil into the ground and the water where it can be years being cleaned up. Every one of them has the same problem: the energy is stored in the actuator, and when something goes wrong it has nowhere to go but out. A nitinol actuator, very simply, does not carry these risks. It is a piece of metal with a current in it, and there is nothing in it to burst, nothing to leak, and nothing to poison.

A nitinol actuator fails the other way. Put too much power into it and it simply gets hotter. Past the working range the force keeps rising; past that, the part reaches the temperatures at which it was shape set, and at that point the metal lets go of its memory. The actuator loses its force, goes slack, and parts, which opens the circuit that was heating it. It shuts itself off. There is nothing stored in it to release: no pressure, no winding, no field. The failure mode is a dead part and an open circuit, not an event.

That is worth stating plainly for anyone writing a safety case. The worst thing an overdriven nitinol actuator does is stop.

What we supply

Outside diameters	1 to 100 mm.
Bore	No less than sixty percent of the outside diameter.
Length	Up to one meter.
Transition temperatures	To order.
Sold as	Made to length.

TORQUE TUBE ACTUATORS — Torque by diameter and wall. Arc swing depends on the outside diameter alone, so every wall at one diameter swings the same.

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Torque A, ft·lbf [N·m]	Torque B, ft·lbf [N·m]	Torque C, ft·lbf [N·m]	Torque D, ft·lbf [N·m]	Swing C, deg/in [deg/100 mm]	Swing C, deg from a 39.4 in [1 m] tube
1-60	0.039 [1]	0.024 [0.6]	0.0079 [0.2]	0.013 [0.017]	0.018 [0.024]	0.021 [0.029]	0.032 [0.043]	150 [570]	5700
1-65	0.039 [1]	0.028 [0.7]	0.0067 [0.17]	0.012 [0.016]	0.016 [0.022]	0.021 [0.028]	0.03 [0.04]	150 [570]	5700
1-70	0.039 [1]	0.028 [0.7]	0.0059 [0.15]	0.011 [0.015]	0.015 [0.021]	0.019 [0.026]	0.027 [0.037]	150 [570]	5700
1-75	0.039 [1]	0.031 [0.8]	0.0047 [0.12]	0.0096 [0.013]	0.014 [0.019]	0.017 [0.023]	0.025 [0.034]	150 [570]	5700
1-80	0.039 [1]	0.031 [0.8]	0.0039 [0.1]	0.0089 [0.012]	0.012 [0.016]	0.015 [0.02]	0.021 [0.029]	150 [570]	5700
1-85	0.039 [1]	0.031 [0.8]	0.0028 [0.07]	0.0066 [0.009]	0.0096 [0.013]	0.012 [0.016]	0.017 [0.023]	150 [570]	5700
1-90	0.039 [1]	0.035 [0.9]	0.002 [0.05]	0.0052 [0.007]	0.0066 [0.009]	0.0089 [0.012]	0.013 [0.017]	150 [570]	5700
1.5-60	0.059 [1.5]	0.035 [0.9]	0.012 [0.3]	0.043 [0.058]	0.059 [0.08]	0.073 [0.099]	0.11 [0.14]	97 [380]	3800
1.5-65	0.059 [1.5]	0.039 [1]	0.01 [0.26]	0.04 [0.054]	0.055 [0.075]	0.069 [0.094]	0.1 [0.14]	97 [380]	3800
1.5-70	0.059 [1.5]	0.043 [1.1]	0.0091 [0.23]	0.037 [0.05]	0.051 [0.069]	0.064 [0.087]	0.093 [0.13]	97 [380]	3800
1.5-75	0.059 [1.5]	0.043 [1.1]	0.0075 [0.19]	0.033 [0.045]	0.046 [0.063]	0.058 [0.078]	0.083 [0.11]	97 [380]	3800
1.5-80	0.059 [1.5]	0.047 [1.2]	0.0059 [0.15]	0.029 [0.039]	0.04 [0.054]	0.049 [0.067]	0.072 [0.098]	97 [380]	3800

TORQUE TUBE ACTUATORS — Torque by diameter and wall. Arc swing depends on the outside diameter alone, so every wall at one diameter swings the same.

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Torque A, ft·lbf [N·m]	Torque B, ft·lbf [N·m]	Torque C, ft·lbf [N·m]	Torque D, ft·lbf [N·m]	Swing C, deg/in [deg/100 mm]	Swing C, deg from a 39.4 in [1 m] tube
1.5-85	0.059 [1.5]	0.051 [1.3]	0.0043 [0.11]	0.024 [0.032]	0.032 [0.044]	0.04 [0.054]	0.058 [0.079]	97 [380]	3800
1.5-90	0.059 [1.5]	0.055 [1.4]	0.0028 [0.07]	0.017 [0.023]	0.023 [0.031]	0.029 [0.039]	0.042 [0.057]	97 [380]	3800
2-60	0.079 [2]	0.047 [1.2]	0.016 [0.4]	0.1 [0.14]	0.14 [0.19]	0.17 [0.23]	0.25 [0.34]	73 [290]	2900
2-65	0.079 [2]	0.051 [1.3]	0.014 [0.35]	0.095 [0.13]	0.13 [0.18]	0.16 [0.22]	0.24 [0.32]	73 [290]	2900
2-70	0.079 [2]	0.055 [1.4]	0.012 [0.3]	0.088 [0.12]	0.12 [0.17]	0.15 [0.2]	0.22 [0.3]	73 [290]	2900
2-75	0.079 [2]	0.059 [1.5]	0.0098 [0.25]	0.079 [0.11]	0.11 [0.15]	0.14 [0.18]	0.2 [0.27]	73 [290]	2900
2-80	0.079 [2]	0.063 [1.6]	0.0079 [0.2]	0.069 [0.093]	0.094 [0.13]	0.12 [0.16]	0.17 [0.23]	73 [290]	2900
2-85	0.079 [2]	0.067 [1.7]	0.0059 [0.15]	0.055 [0.075]	0.077 [0.1]	0.095 [0.13]	0.14 [0.19]	73 [290]	2900
2-90	0.079 [2]	0.071 [1.8]	0.0039 [0.1]	0.04 [0.054]	0.055 [0.075]	0.069 [0.093]	0.1 [0.14]	73 [290]	2900
2.5-60	0.098 [2.5]	0.059 [1.5]	0.02 [0.5]	0.2 [0.27]	0.27 [0.37]	0.34 [0.46]	0.49 [0.67]	58 [230]	2300
2.5-65	0.098 [2.5]	0.063 [1.6]	0.017 [0.44]	0.19 [0.25]	0.26 [0.35]	0.32 [0.43]	0.46 [0.63]	58 [230]	2300
2.5-70	0.098 [2.5]	0.071 [1.8]	0.015 [0.38]	0.17 [0.23]	0.24 [0.32]	0.3 [0.4]	0.43 [0.58]	58 [230]	2300

TORQUE TUBE ACTUATORS — Torque by diameter and wall. Arc swing depends on the outside diameter alone, so every wall at one diameter swings the same.

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Torque A, ft·lbf [N·m]	Torque B, ft·lbf [N·m]	Torque C, ft·lbf [N·m]	Torque D, ft·lbf [N·m]	Swing C, deg/in [deg/100 mm]	Swing C, deg from a 39.4 in [1 m] tube
2.5-75	0.098 [2.5]	0.075 [1.9]	0.012 [0.31]	0.15 [0.21]	0.21 [0.29]	0.27 [0.36]	0.39 [0.52]	58 [230]	2300
2.5-80	0.098 [2.5]	0.079 [2]	0.0098 [0.25]	0.13 [0.18]	0.18 [0.25]	0.23 [0.31]	0.33 [0.45]	58 [230]	2300
2.5-85	0.098 [2.5]	0.083 [2.1]	0.0075 [0.19]	0.11 [0.15]	0.15 [0.2]	0.19 [0.25]	0.27 [0.37]	58 [230]	2300
2.5-90	0.098 [2.5]	0.087 [2.2]	0.0047 [0.12]	0.078 [0.11]	0.11 [0.15]	0.13 [0.18]	0.19 [0.26]	58 [230]	2300
3-60	0.12 [3]	0.071 [1.8]	0.024 [0.6]	0.34 [0.46]	0.47 [0.64]	0.59 [0.79]	0.85 [1.2]	49 [190]	1900
3-65	0.12 [3]	0.075 [1.9]	0.021 [0.53]	0.32 [0.44]	0.44 [0.6]	0.55 [0.75]	0.8 [1.1]	49 [190]	1900
3-70	0.12 [3]	0.083 [2.1]	0.018 [0.45]	0.3 [0.4]	0.41 [0.56]	0.51 [0.69]	0.74 [1]	49 [190]	1900
3-75	0.12 [3]	0.087 [2.2]	0.015 [0.38]	0.27 [0.36]	0.37 [0.5]	0.46 [0.62]	0.67 [0.91]	49 [190]	1900
3-80	0.12 [3]	0.094 [2.4]	0.012 [0.3]	0.23 [0.31]	0.32 [0.43]	0.4 [0.54]	0.58 [0.78]	49 [190]	1900
3-85	0.12 [3]	0.098 [2.5]	0.0091 [0.23]	0.19 [0.25]	0.26 [0.35]	0.32 [0.44]	0.47 [0.63]	49 [190]	1900
3-90	0.12 [3]	0.11 [2.7]	0.0059 [0.15]	0.13 [0.18]	0.19 [0.25]	0.23 [0.31]	0.34 [0.46]	49 [190]	1900
4-60	0.16 [4]	0.094 [2.4]	0.031 [0.8]	0.81 [1.1]	1.1 [1.5]	1.4 [1.9]	2 [2.7]	36 [140]	1400

TORQUE TUBE ACTUATORS — Torque by diameter and wall. Arc swing depends on the outside diameter alone, so every wall at one diameter swings the same.

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Torque A, ft·lbf [N·m]	Torque B, ft·lbf [N·m]	Torque C, ft·lbf [N·m]	Torque D, ft·lbf [N·m]	Swing C, deg/in [deg/100 mm]	Swing C, deg from a 39.4 in [1 m] tube
4-65	0.16 [4]	0.1 [2.6]	0.028 [0.7]	0.76 [1]	1.1 [1.4]	1.3 [1.8]	1.9 [2.6]	36 [140]	1400
4-70	0.16 [4]	0.11 [2.8]	0.024 [0.6]	0.7 [0.95]	0.97 [1.3]	1.2 [1.6]	1.8 [2.4]	36 [140]	1400
4-75	0.16 [4]	0.12 [3]	0.02 [0.5]	0.63 [0.86]	0.87 [1.2]	1.1 [1.5]	1.6 [2.1]	36 [140]	1400
4-80	0.16 [4]	0.13 [3.2]	0.016 [0.4]	0.55 [0.74]	0.76 [1]	0.94 [1.3]	1.4 [1.9]	36 [140]	1400
4-85	0.16 [4]	0.13 [3.4]	0.012 [0.3]	0.44 [0.6]	0.61 [0.83]	0.76 [1]	1.1 [1.5]	36 [140]	1400
4-90	0.16 [4]	0.14 [3.6]	0.0079 [0.2]	0.32 [0.43]	0.44 [0.6]	0.55 [0.74]	0.8 [1.1]	36 [140]	1400
5-60	0.2 [5]	0.12 [3]	0.039 [1]	1.6 [2.1]	2.2 [2.9]	2.7 [3.7]	3.9 [5.3]	29 [120]	1100
5-65	0.2 [5]	0.13 [3.2]	0.035 [0.88]	1.5 [2]	2.1 [2.8]	2.6 [3.5]	3.7 [5]	29 [120]	1100
5-70	0.2 [5]	0.14 [3.5]	0.03 [0.75]	1.4 [1.9]	1.9 [2.6]	2.4 [3.2]	3.4 [4.7]	29 [120]	1100
5-75	0.2 [5]	0.15 [3.8]	0.024 [0.62]	1.2 [1.7]	1.7 [2.3]	2.1 [2.9]	3.1 [4.2]	29 [120]	1100
5-80	0.2 [5]	0.16 [4]	0.02 [0.5]	1.1 [1.4]	1.5 [2]	1.8 [2.5]	2.7 [3.6]	29 [120]	1100
5-85	0.2 [5]	0.17 [4.2]	0.015 [0.38]	0.87 [1.2]	1.2 [1.6]	1.5 [2]	2.2 [2.9]	29 [120]	1100

TORQUE TUBE ACTUATORS — Torque by diameter and wall. Arc swing depends on the outside diameter alone, so every wall at one diameter swings the same.

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Torque A, ft·lbf [N·m]	Torque B, ft·lbf [N·m]	Torque C, ft·lbf [N·m]	Torque D, ft·lbf [N·m]	Swing C, deg/in [deg/100 mm]	Swing C, deg from a 39.4 in [1 m] tube
5-90	0.2 [5]	0.18 [4.5]	0.0098 [0.25]	0.62 [0.84]	0.86 [1.2]	1.1 [1.5]	1.6 [2.1]	29 [120]	1100
6-60	0.24 [6]	0.14 [3.6]	0.047 [1.2]	2.7 [3.7]	3.8 [5.1]	4.7 [6.3]	6.8 [9.2]	24 [95]	950
6-65	0.24 [6]	0.15 [3.9]	0.041 [1.05]	2.6 [3.5]	3.5 [4.8]	4.4 [6]	6.4 [8.7]	24 [95]	950
6-70	0.24 [6]	0.17 [4.2]	0.035 [0.9]	2.4 [3.2]	3.3 [4.4]	4.1 [5.5]	5.9 [8.1]	24 [95]	950
6-75	0.24 [6]	0.18 [4.5]	0.03 [0.75]	2.1 [2.9]	3 [4]	3.7 [5]	5.3 [7.2]	24 [95]	950
6-80	0.24 [6]	0.19 [4.8]	0.024 [0.6]	1.8 [2.5]	2.5 [3.5]	3.2 [4.3]	4.6 [6.3]	24 [95]	950
6-85	0.24 [6]	0.2 [5.1]	0.018 [0.45]	1.5 [2]	2.1 [2.8]	2.6 [3.5]	3.7 [5.1]	24 [95]	950
6-90	0.24 [6]	0.21 [5.4]	0.012 [0.3]	1.1 [1.5]	1.5 [2]	1.9 [2.5]	2.7 [3.6]	24 [95]	950
8-60	0.31 [8]	0.19 [4.8]	0.063 [1.6]	6.5 [8.8]	8.9 [12]	11 [15]	16 [22]	18 [72]	720
8-65	0.31 [8]	0.2 [5.2]	0.055 [1.4]	6.1 [8.3]	8.4 [11]	10 [14]	15 [21]	18 [72]	720
8-70	0.31 [8]	0.22 [5.6]	0.047 [1.2]	5.6 [7.6]	7.8 [11]	9.7 [13]	14 [19]	18 [72]	720
8-75	0.31 [8]	0.24 [6]	0.039 [1]	5.1 [6.9]	7 [9.5]	8.7 [12]	13 [17]	18 [72]	720

TORQUE TUBE ACTUATORS — Torque by diameter and wall. Arc swing depends on the outside diameter alone, so every wall at one diameter swings the same.

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Torque A, ft·lbf [N·m]	Torque B, ft·lbf [N·m]	Torque C, ft·lbf [N·m]	Torque D, ft·lbf [N·m]	Swing C, deg/in [deg/100 mm]	Swing C, deg from a 39.4 in [1 m] tube
8-80	0.31 [8]	0.25 [6.4]	0.031 [0.8]	4.4 [5.9]	6 [8.2]	7.5 [10]	11 [15]	18 [72]	720
8-85	0.31 [8]	0.27 [6.8]	0.024 [0.6]	3.5 [4.8]	4.9 [6.6]	6.1 [8.3]	8.9 [12]	18 [72]	720
8-90	0.31 [8]	0.28 [7.2]	0.016 [0.4]	2.5 [3.5]	3.5 [4.8]	4.4 [5.9]	6.4 [8.6]	18 [72]	720
10-60	0.39 [10]	0.24 [6]	0.079 [2]	13 [17]	17 [24]	22 [29]	32 [43]	15 [57]	570
10-65	0.39 [10]	0.26 [6.5]	0.069 [1.75]	12 [16]	16 [22]	20 [28]	30 [40]	15 [57]	570
10-70	0.39 [10]	0.28 [7]	0.059 [1.5]	11 [15]	15 [21]	19 [26]	28 [37]	15 [57]	570
10-75	0.39 [10]	0.3 [7.5]	0.049 [1.25]	9.9 [13]	14 [19]	17 [23]	25 [34]	15 [57]	570
10-80	0.39 [10]	0.31 [8]	0.039 [1]	8.5 [12]	12 [16]	15 [20]	21 [29]	15 [57]	570
10-85	0.39 [10]	0.33 [8.5]	0.03 [0.75]	6.9 [9.4]	9.6 [13]	12 [16]	17 [23]	15 [57]	570
10-90	0.39 [10]	0.35 [9]	0.02 [0.5]	5 [6.8]	6.9 [9.3]	8.6 [12]	12 [17]	15 [57]	570
12-60	0.47 [12]	0.28 [7.2]	0.094 [2.4]	22 [30]	30 [41]	37 [51]	54 [74]	12 [48]	480
12-65	0.47 [12]	0.31 [7.8]	0.083 [2.1]	21 [28]	28 [38]	35 [48]	51 [70]	12 [48]	480

TORQUE TUBE ACTUATORS — Torque by diameter and wall. Arc swing depends on the outside diameter alone, so every wall at one diameter swings the same.

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Torque A, ft·lbf [N·m]	Torque B, ft·lbf [N·m]	Torque C, ft·lbf [N·m]	Torque D, ft·lbf [N·m]	Swing C, deg/in [deg/100 mm]	Swing C, deg from a 39.4 in [1 m] tube
12-70	0.47 [12]	0.33 [8.4]	0.071 [1.8]	19 [26]	26 [36]	33 [44]	48 [64]	12 [48]	480
12-75	0.47 [12]	0.35 [9]	0.059 [1.5]	17 [23]	24 [32]	29 [40]	43 [58]	12 [48]	480
12-80	0.47 [12]	0.38 [9.6]	0.047 [1.2]	15 [20]	20 [28]	25 [34]	37 [50]	12 [48]	480
12-85	0.47 [12]	0.4 [10.2]	0.035 [0.9]	12 [16]	17 [22]	21 [28]	30 [41]	12 [48]	480
12-90	0.47 [12]	0.43 [10.8]	0.024 [0.6]	8.6 [12]	12 [16]	15 [20]	22 [29]	12 [48]	480
16-60	0.63 [16]	0.38 [9.6]	0.13 [3.2]	52 [70]	71 [97]	89 [120]	130 [180]	9.1 [36]	360
16-65	0.63 [16]	0.41 [10.4]	0.11 [2.8]	49 [66]	67 [91]	84 [110]	120 [160]	9.1 [36]	360
16-70	0.63 [16]	0.44 [11.2]	0.094 [2.4]	45 [61]	62 [84]	78 [100]	110 [150]	9.1 [36]	360
16-75	0.63 [16]	0.47 [12]	0.079 [2]	41 [55]	56 [76]	70 [95]	100 [140]	9.1 [36]	360
16-80	0.63 [16]	0.5 [12.8]	0.063 [1.6]	35 [47]	48 [66]	60 [82]	88 [120]	9.1 [36]	360
16-85	0.63 [16]	0.54 [13.6]	0.047 [1.2]	28 [38]	39 [53]	49 [66]	71 [96]	9.1 [36]	360
16-90	0.63 [16]	0.57 [14.4]	0.031 [0.8]	20 [28]	28 [38]	35 [48]	51 [69]	9.1 [36]	360

TORQUE TUBE ACTUATORS — Torque by diameter and wall. Arc swing depends on the outside diameter alone, so every wall at one diameter swings the same.

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Torque A, ft·lbf [N·m]	Torque B, ft·lbf [N·m]	Torque C, ft·lbf [N·m]	Torque D, ft·lbf [N·m]	Swing C, deg/in [deg/100 mm]	Swing C, deg from a 39.4 in [1 m] tube
20-60	0.79 [20]	0.47 [12]	0.16 [4]	100 [140]	140 [190]	170 [240]	250 [340]	7.3 [29]	290
20-65	0.79 [20]	0.51 [13]	0.14 [3.5]	95 [130]	130 [180]	160 [220]	240 [320]	7.3 [29]	290
20-70	0.79 [20]	0.55 [14]	0.12 [3]	88 [120]	120 [160]	150 [200]	220 [300]	7.3 [29]	290
20-75	0.79 [20]	0.59 [15]	0.098 [2.5]	79 [110]	110 [150]	140 [180]	200 [270]	7.3 [29]	290
20-80	0.79 [20]	0.63 [16]	0.079 [2]	68 [93]	94 [130]	120 [160]	170 [230]	7.3 [29]	290
20-85	0.79 [20]	0.67 [17]	0.059 [1.5]	55 [75]	76 [100]	95 [130]	140 [190]	7.3 [29]	290
20-90	0.79 [20]	0.71 [18]	0.039 [1]	40 [54]	55 [75]	69 [93]	100 [140]	7.3 [29]	290
25-60	0.98 [25]	0.59 [15]	0.2 [5]	200 [270]	270 [370]	340 [460]	490 [670]	5.8 [23]	230
25-65	0.98 [25]	0.64 [16.2]	0.17 [4.38]	190 [250]	260 [350]	320 [430]	460 [630]	5.8 [23]	230
25-70	0.98 [25]	0.69 [17.5]	0.15 [3.75]	170 [230]	240 [320]	300 [400]	430 [580]	5.8 [23]	230
25-75	0.98 [25]	0.74 [18.8]	0.12 [3.12]	160 [210]	210 [290]	270 [360]	390 [520]	5.8 [23]	230
25-80	0.98 [25]	0.79 [20]	0.098 [2.5]	130 [180]	180 [250]	230 [310]	330 [450]	5.8 [23]	230

TORQUE TUBE ACTUATORS — Torque by diameter and wall. Arc swing depends on the outside diameter alone, so every wall at one diameter swings the same.

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Torque A, ft·lbf [N·m]	Torque B, ft·lbf [N·m]	Torque C, ft·lbf [N·m]	Torque D, ft·lbf [N·m]	Swing C, deg/in [deg/100 mm]	Swing C, deg from a 39.4 in [1 m] tube
25-85	0.98 [25]	0.83 [21.2]	0.074 [1.88]	110 [150]	150 [200]	190 [250]	270 [370]	5.8 [23]	230
25-90	0.98 [25]	0.89 [22.5]	0.049 [1.25]	78 [110]	110 [150]	130 [180]	200 [260]	5.8 [23]	230
32-60	1.3 [32]	0.76 [19.2]	0.25 [6.4]	410 [560]	570 [770]	710 [960]	1000 [1400]	4.5 [18]	180
32-65	1.3 [32]	0.82 [20.8]	0.22 [5.6]	390 [530]	540 [730]	670 [910]	980 [1300]	4.5 [18]	180
32-70	1.3 [32]	0.88 [22.4]	0.19 [4.8]	360 [490]	500 [680]	620 [840]	900 [1200]	4.5 [18]	180
32-75	1.3 [32]	0.94 [24]	0.16 [4]	320 [440]	450 [610]	560 [760]	810 [1100]	4.5 [18]	180
32-80	1.3 [32]	1 [25.6]	0.13 [3.2]	280 [380]	390 [520]	480 [650]	700 [950]	4.5 [18]	180
32-85	1.3 [32]	1.1 [27.2]	0.094 [2.4]	230 [310]	310 [420]	390 [530]	570 [770]	4.5 [18]	180
32-90	1.3 [32]	1.1 [28.8]	0.063 [1.6]	160 [220]	220 [300]	280 [380]	410 [550]	4.5 [18]	180
40-60	1.6 [40]	0.94 [24]	0.31 [8]	810 [1100]	1100 [1500]	1400 [1900]	2000 [2700]	3.6 [14]	140
40-65	1.6 [40]	1 [26]	0.28 [7]	760 [1000]	1100 [1400]	1300 [1800]	1900 [2600]	3.6 [14]	140
40-70	1.6 [40]	1.1 [28]	0.24 [6]	700 [960]	970 [1300]	1200 [1600]	1800 [2400]	3.6 [14]	140

TORQUE TUBE ACTUATORS — Torque by diameter and wall. Arc swing depends on the outside diameter alone, so every wall at one diameter swings the same.

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Torque A, ft·lbf [N·m]	Torque B, ft·lbf [N·m]	Torque C, ft·lbf [N·m]	Torque D, ft·lbf [N·m]	Swing C, deg/in [deg/100 mm]	Swing C, deg from a 39.4 in [1 m] tube
40-75	1.6 [40]	1.2 [30]	0.2 [5]	630 [860]	870 [1200]	1100 [1500]	1600 [2100]	3.6 [14]	140
40-80	1.6 [40]	1.3 [32]	0.16 [4]	550 [740]	760 [1000]	940 [1300]	1400 [1900]	3.6 [14]	140
40-85	1.6 [40]	1.3 [34]	0.12 [3]	440 [600]	610 [830]	760 [1000]	1100 [1500]	3.6 [14]	140
40-90	1.6 [40]	1.4 [36]	0.079 [2]	320 [430]	440 [600]	550 [740]	800 [1100]	3.6 [14]	140
50-60	2 [50]	1.2 [30]	0.39 [10]	1600 [2100]	2200 [2900]	2700 [3700]	3900 [5300]	2.9 [11]	110
50-65	2 [50]	1.3 [32.5]	0.34 [8.75]	1500 [2000]	2100 [2800]	2600 [3500]	3700 [5000]	2.9 [11]	110
50-70	2 [50]	1.4 [35]	0.3 [7.5]	1400 [1900]	1900 [2600]	2400 [3200]	3400 [4700]	2.9 [11]	110
50-75	2 [50]	1.5 [37.5]	0.25 [6.25]	1200 [1700]	1700 [2300]	2100 [2900]	3100 [4200]	2.9 [11]	110
50-80	2 [50]	1.6 [40]	0.2 [5]	1100 [1400]	1500 [2000]	1800 [2500]	2700 [3600]	2.9 [11]	110
50-85	2 [50]	1.7 [42.5]	0.15 [3.75]	860 [1200]	1200 [1600]	1500 [2000]	2200 [2900]	2.9 [11]	110
50-90	2 [50]	1.8 [45]	0.098 [2.5]	620 [840]	860 [1200]	1100 [1500]	1600 [2100]	2.9 [11]	110
63-60	2.5 [63]	1.5 [37.8]	0.5 [12.6]	3200 [4300]	4400 [5900]	5400 [7400]	7900 [11000]	2.3 [9.1]	91

TORQUE TUBE ACTUATORS — Torque by diameter and wall. Arc swing depends on the outside diameter alone, so every wall at one diameter swings the same.

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Torque A, ft·lbf [N·m]	Torque B, ft·lbf [N·m]	Torque C, ft·lbf [N·m]	Torque D, ft·lbf [N·m]	Swing C, deg/in [deg/100 mm]	Swing C, deg from a 39.4 in [1 m] tube
63-65	2.5 [63]	1.6 [41]	0.43 [11.03]	3000 [4000]	4100 [5600]	5100 [6900]	7400 [10000]	2.3 [9.1]	91
63-70	2.5 [63]	1.7 [44.1]	0.37 [9.45]	2800 [3700]	3800 [5100]	4700 [6400]	6900 [9300]	2.3 [9.1]	91
63-75	2.5 [63]	1.9 [47.2]	0.31 [7.88]	2500 [3400]	3400 [4600]	4300 [5800]	6200 [8400]	2.3 [9.1]	91
63-80	2.5 [63]	2 [50.4]	0.25 [6.3]	2100 [2900]	3000 [4000]	3700 [5000]	5300 [7200]	2.3 [9.1]	91
63-85	2.5 [63]	2.1 [53.5]	0.19 [4.72]	1700 [2300]	2400 [3200]	3000 [4000]	4300 [5900]	2.3 [9.1]	91
63-90	2.5 [63]	2.2 [56.7]	0.12 [3.15]	1200 [1700]	1700 [2300]	2100 [2900]	3100 [4200]	2.3 [9.1]	91
80-60	3.1 [80]	1.9 [48]	0.63 [16]	6500 [8800]	8900 [12000]	11000 [15000]	16000 [22000]	1.8 [7.2]	72
80-65	3.1 [80]	2 [52]	0.55 [14]	6100 [8300]	8400 [11000]	10000 [14000]	15000 [21000]	1.8 [7.2]	72
80-70	3.1 [80]	2.2 [56]	0.47 [12]	5600 [7600]	7800 [11000]	9700 [13000]	14000 [19000]	1.8 [7.2]	72
80-75	3.1 [80]	2.4 [60]	0.39 [10]	5100 [6900]	7000 [9500]	8700 [12000]	13000 [17000]	1.8 [7.2]	72
80-80	3.1 [80]	2.5 [64]	0.31 [8]	4400 [5900]	6000 [8200]	7500 [10000]	11000 [15000]	1.8 [7.2]	72
80-85	3.1 [80]	2.7 [68]	0.24 [6]	3500 [4800]	4900 [6600]	6100 [8300]	8900 [12000]	1.8 [7.2]	72

TORQUE TUBE ACTUATORS — Torque by diameter and wall. Arc swing depends on the outside diameter alone, so every wall at one diameter swings the same.

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Torque A, ft·lbf [N·m]	Torque B, ft·lbf [N·m]	Torque C, ft·lbf [N·m]	Torque D, ft·lbf [N·m]	Swing C, deg/in [deg/100 mm]	Swing C, deg from a 39.4 in [1 m] tube
80-90	3.1 [80]	2.8 [72]	0.16 [4]	2600 [3500]	3500 [4800]	4400 [5900]	6400 [8600]	1.8 [7.2]	72
100-60	3.9 [100]	2.4 [60]	0.79 [20]	13000 [17000]	17000 [24000]	22000 [29000]	32000 [43000]	1.5 [5.7]	57
100-65	3.9 [100]	2.6 [65]	0.69 [17.5]	12000 [16000]	16000 [22000]	20000 [28000]	30000 [40000]	1.5 [5.7]	57
100-70	3.9 [100]	2.8 [70]	0.59 [15]	11000 [15000]	15000 [21000]	19000 [26000]	28000 [37000]	1.5 [5.7]	57
100-75	3.9 [100]	3 [75]	0.49 [12.5]	9900 [13000]	14000 [19000]	17000 [23000]	25000 [34000]	1.5 [5.7]	57
100-80	3.9 [100]	3.1 [80]	0.39 [10]	8600 [12000]	12000 [16000]	15000 [20000]	21000 [29000]	1.5 [5.7]	57
100-85	3.9 [100]	3.3 [85]	0.3 [7.5]	6900 [9400]	9600 [13000]	12000 [16000]	17000 [23000]	1.5 [5.7]	57
100-90	3.9 [100]	3.5 [90]	0.2 [5]	5000 [6800]	6900 [9300]	8600 [12000]	12000 [17000]	1.5 [5.7]	57

NOTES

NOTES

CHAPTER 12

Tube Actuators in Tension

The same tube, pulled instead of twisted

The same tube as the previous chapter, pulled instead of twisted.

It behaves like a rod, because it is one with the middle taken out. Force comes from the metal in the wall and stroke comes from the length, and both follow the same rules as every other straight pulling element in this handbook.

Why choose a tube over a solid rod

Three reasons, and the third is the one people miss.

IT IS LIGHTER for the same force, because the metal that does the least work in tension is the metal at the center, and there is none.

IT IS A HOUSING as well as an actuator. Something can pass through the middle. A cable, a shaft, a fluid line, a second actuator.

IT COOLS FROM BOTH SIDES. This is the important one. Cooling is what limits how fast any nitinol actuator can cycle, and a tube has an inside surface as well as an outside one. Push air or liquid through the bore and it will reset far faster than a solid rod of the same strength. If cycle rate is your problem, this is the shape that fixes it.

One tube, two jobs, or both

The geometry in this chapter is identical to the previous one. A twenty millimeter tube with a four millimeter wall gives 170 ft·lbf [240 N·m] of torque and 7.3 degrees per inch [29 per 100 mm] if you twist it, or 7,800 lbf [35 kN] and five percent of its length if you pull it. Same part, two different jobs.

It does not have to be one or the other. A nitinol actuator recovers a shape rather than producing a motion, and a tube that has been both twisted and stretched while cool will untwist and shorten when it is heated, at the same time, from one heating event. Anchor the ends against rotation and you harvest the pull. Let them turn freely and you harvest the twist. Build the mechanism to accept both and one tube drives a rotation and a linear stroke together: a valve that lifts and turns as it opens, a latch that retracts and swings clear, a fitting that backs itself out.

What you cannot have is all of both. The torque and the pull are drawn from the same strain budget in the same piece of metal, so a tube working hard in torsion has less left for tension and the other way round. The figures here and in the previous chapter are each for a tube doing one job only. Tell us the split you need and we will set the tube for it.

A tube does not have to be plain. Cutting a pattern into the wall, slots or spirals or kerfs, changes the section where the cuts are, and that changes what the tube does: more angle for less torque, motion concentrated in one region and not another, compliance in one direction while it stays stiff in another. It is a large subject and none of it is in this handbook. Every figure here is for a plain tube. For more sophisticated solutions, talk to us.

Getting it back

Like every shape in this handbook, a nitinol actuator moves one way when it is heated. Getting it back to where it started is the designer's problem, and there are three ways to solve it.

AN ANTAGONISTIC PAIR uses a second actuator working against the first. Heat one and it moves the mechanism and resets the other; heat the other and it goes back. You get powered motion in both directions with full output each way, at the cost of two actuators and a control scheme that never heats both at once.

A BIAS is a passive element, usually a conventional spring or a weight, that the actuator works against as it moves and that pushes it back as it cools. It is the simplest arrangement and the most common. The price is that the bias resists the actuator through the whole stroke, so part of the force in the table is spent returning the mechanism rather than doing the job. Size it to return the actuator and no more.

SYSTEM FORCES are the return you already have. If the mechanism pushes back on its own, if gravity closes the door, if the thing being clamped is springy, if line pressure acts on the valve, that force resets the actuator for nothing. It is the best answer when it is available, and worth looking for before adding parts.

Whichever you choose, the return has to be strong enough to reset the actuator while it is cool and weak enough not to stall it while it is hot. That window is what sizes a bias, and it is the most common thing to get wrong on a first build.

There is a fourth possibility. Any nitinol actuator can be given a two way set, so that it takes one shape hot and another cold and needs no return at all. Two way parts are made to order and are outside the scope of this handbook, so nothing here is rated for it, but it exists. Ask.

Overdriving an actuator

The figures in this handbook are conservative. Every force in every table is rated at a stress we are confident the part will deliver, cycle after cycle, at the fatigue life of its design level. A part will usually do more than the table says. We would rather you found that out in testing than the other way round.

The second reason a part will beat its table is that you can overdrive it, and this one is a feature you can design with. There are two ways to do it, and they add.

The first is to heat it further. Nitinol makes its force by changing phase, and the temperature at which it does that is the transition temperature we set for you. The force does not stop climbing when the part gets there. Keep heating it past the transition and the force keeps rising with temperature, well beyond the rated figure. The table gives you the force at a working temperature comfortably above transition. Drive the part hotter and there is more.

The second is to heat it faster. Heat the part slowly and it makes the force in the table. Heat it quickly, with a sharp pulse of current rather than a gentle ramp, and it makes more, and the harder the pulse, the bigger the difference. A part that is driven both fast and hot gets the gain from each, one on top of the other. The tables assume neither. They are the floor.

Emergency mode

That gives a nitinol actuator something most actuators do not have: a reserve. A motor or a solenoid has a rated output and a thermal limit close behind it. A nitinol actuator can be driven, briefly, to a force well above its rating simply by putting more heat into it, faster. Think of it as an emergency mode. A latch that normally needs a modest pull can, on the day something jams, be hit with a short hard pulse and told to pull much harder. A release that must not fail gets a margin that costs nothing in size or weight.

Use it as a reserve, not as the rating, and know where the limits are. There is a temperature, called Md, above which the metal can no longer be pushed into martensite by stress; up to Md the material is still behaving as nitinol should. Overdriving up to Md costs some fatigue life, but it also does the part a favor: the extra heat drives out residual martensite that builds up over many cycles, a kind of rehabilitation in place, so a part that is occasionally run hard can come back sharper than one that never is. Above Md the accounting changes. Degradation is faster, and each hot cycle takes a larger bite out of the life. Above 350 °C (660 °F) the part is past saving: treat an actuator that has been driven that hot as spent and replace it. Used within those limits, for the rare event, emergency mode is one of the best arguments for the material.

Actuator safety

Most actuators fail badly when they are overdriven, and engineers know exactly how. Put too much current into a motor or a solenoid and it explodes. Overpressure a hydraulic cylinder and it bursts, or springs a pinhole leak, and a jet of oil at that pressure will cut through a glove and a hand, take a limb, and put oil into the ground and the water where it can be years being cleaned up. Every one of them has the same problem: the energy is stored in the actuator, and when something goes wrong it has nowhere to go but out. A nitinol actuator, very simply, does not carry these risks. It is a piece of metal with a current in it, and there is nothing in it to burst, nothing to leak, and nothing to poison.

A nitinol actuator fails the other way. Put too much power into it and it simply gets hotter. Past the working range the force keeps rising; past that, the part reaches the temperatures at which it was shape set, and at that point the metal lets go of its memory. The actuator loses its force, goes slack, and parts, which opens the circuit that was heating it. It shuts itself off. There is nothing stored in it to release: no pressure, no winding, no field. The failure mode is a dead part and an open circuit, not an event.

That is worth stating plainly for anyone writing a safety case. The worst thing an overdriven nitinol actuator does is stop.

What we supply

Outside diameters	1 to 100 mm.
Bore	No less than sixty percent of the outside diameter.
Length	Up to one meter.
Transition temperatures	To order.
Sold as	Made to length, with custom termination options.

TUBE ACTUATORS IN TENSION — Pull force by diameter and wall

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Section area, in² [mm²]	Force A, lbf [kN]	Force B, lbf [kN]	Force C, lbf [kN]	Force D, lbf [kN]
1-60	0.039 [1]	0.024 [0.6]	0.0079 [0.2]	0.00078 [0.5]	11 [0.05]	16 [0.07]	20 [0.09]	29 [0.13]
1-65	0.039 [1]	0.028 [0.7]	0.0067 [0.17]	0.0007 [0.45]	11 [0.05]	13 [0.06]	18 [0.08]	25 [0.11]
1-70	0.039 [1]	0.028 [0.7]	0.0059 [0.15]	0.00062 [0.4]	9 [0.04]	13 [0.06]	16 [0.07]	22 [0.1]
1-75	0.039 [1]	0.031 [0.8]	0.0047 [0.12]	0.00053 [0.34]	6.7 [0.03]	11 [0.05]	13 [0.06]	20 [0.09]
1-80	0.039 [1]	0.031 [0.8]	0.0039 [0.1]	0.00043 [0.28]	6.7 [0.03]	9 [0.04]	11 [0.05]	16 [0.07]
1-85	0.039 [1]	0.031 [0.8]	0.0028 [0.07]	0.00034 [0.22]	4.5 [0.02]	6.7 [0.03]	9 [0.04]	11 [0.05]
1-90	0.039 [1]	0.035 [0.9]	0.002 [0.05]	0.00023 [0.15]	2.2 [0.01]	4.5 [0.02]	6.7 [0.03]	9 [0.04]
1.5-60	0.059 [1.5]	0.035 [0.9]	0.012 [0.3]	0.0018 [1.1]	25 [0.11]	36 [0.16]	43 [0.19]	63 [0.28]
1.5-65	0.059 [1.5]	0.039 [1]	0.01 [0.26]	0.0016 [1]	22 [0.1]	31 [0.14]	40 [0.18]	58 [0.26]
1.5-70	0.059 [1.5]	0.043 [1.1]	0.0091 [0.23]	0.0014 [0.9]	20 [0.09]	27 [0.12]	36 [0.16]	52 [0.23]
1.5-75	0.059 [1.5]	0.043 [1.1]	0.0075 [0.19]	0.0012 [0.77]	18 [0.08]	25 [0.11]	29 [0.13]	43 [0.19]
1.5-80	0.059 [1.5]	0.047 [1.2]	0.0059 [0.15]	0.00099 [0.64]	13 [0.06]	20 [0.09]	25 [0.11]	36 [0.16]
1.5-85	0.059 [1.5]	0.051 [1.3]	0.0043 [0.11]	0.00076 [0.49]	11 [0.05]	16 [0.07]	18 [0.08]	27 [0.12]
1.5-90	0.059 [1.5]	0.055 [1.4]	0.0028 [0.07]	0.00053 [0.34]	6.7 [0.03]	11 [0.05]	13 [0.06]	18 [0.08]

TUBE ACTUATORS IN TENSION — Pull force by diameter and wall

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Section area, in² [mm²]	Force A, lbf [kN]	Force B, lbf [kN]	Force C, lbf [kN]	Force D, lbf [kN]
2-60	0.079 [2]	0.047 [1.2]	0.016 [0.4]	0.0031 [2]	45 [0.2]	63 [0.28]	79 [0.35]	110 [0.5]
2-65	0.079 [2]	0.051 [1.3]	0.014 [0.35]	0.0028 [1.8]	40 [0.18]	56 [0.25]	70 [0.31]	100 [0.45]
2-70	0.079 [2]	0.055 [1.4]	0.012 [0.3]	0.0025 [1.6]	36 [0.16]	49 [0.22]	63 [0.28]	90 [0.4]
2-75	0.079 [2]	0.059 [1.5]	0.0098 [0.25]	0.0021 [1.4]	31 [0.14]	43 [0.19]	54 [0.24]	76 [0.34]
2-80	0.079 [2]	0.063 [1.6]	0.0079 [0.2]	0.0018 [1.1]	25 [0.11]	36 [0.16]	43 [0.19]	63 [0.28]
2-85	0.079 [2]	0.067 [1.7]	0.0059 [0.15]	0.0013 [0.87]	20 [0.09]	27 [0.12]	34 [0.15]	49 [0.22]
2-90	0.079 [2]	0.071 [1.8]	0.0039 [0.1]	0.00093 [0.6]	13 [0.06]	18 [0.08]	22 [0.1]	34 [0.15]
2.5-60	0.098 [2.5]	0.059 [1.5]	0.02 [0.5]	0.0049 [3.1]	70 [0.31]	97 [0.43]	120 [0.54]	180 [0.79]
2.5-65	0.098 [2.5]	0.063 [1.6]	0.017 [0.44]	0.0044 [2.8]	63 [0.28]	88 [0.39]	110 [0.49]	160 [0.71]
2.5-70	0.098 [2.5]	0.071 [1.8]	0.015 [0.38]	0.0039 [2.5]	56 [0.25]	79 [0.35]	97 [0.43]	140 [0.63]
2.5-75	0.098 [2.5]	0.075 [1.9]	0.012 [0.31]	0.0033 [2.1]	47 [0.21]	67 [0.3]	83 [0.37]	120 [0.54]
2.5-80	0.098 [2.5]	0.079 [2]	0.0098 [0.25]	0.0027 [1.8]	40 [0.18]	54 [0.24]	67 [0.3]	99 [0.44]
2.5-85	0.098 [2.5]	0.083 [2.1]	0.0075 [0.19]	0.0021 [1.4]	31 [0.14]	43 [0.19]	52 [0.23]	76 [0.34]
2.5-90	0.098 [2.5]	0.087 [2.2]	0.0047 [0.12]	0.0014 [0.93]	20 [0.09]	29 [0.13]	36 [0.16]	52 [0.23]

TUBE ACTUATORS IN TENSION — Pull force by diameter and wall

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Section area, in² [mm²]	Force A, lbf [kN]	Force B, lbf [kN]	Force C, lbf [kN]	Force D, lbf [kN]
3-60	0.12 [3]	0.071 [1.8]	0.024 [0.6]	0.007 [4.5]	100 [0.45]	140 [0.62]	180 [0.78]	250 [1.1]
3-65	0.12 [3]	0.075 [1.9]	0.021 [0.53]	0.0063 [4.1]	92 [0.41]	130 [0.56]	160 [0.7]	230 [1]
3-70	0.12 [3]	0.083 [2.1]	0.018 [0.45]	0.0056 [3.6]	81 [0.36]	110 [0.5]	140 [0.62]	200 [0.9]
3-75	0.12 [3]	0.087 [2.2]	0.015 [0.38]	0.0048 [3.1]	70 [0.31]	97 [0.43]	120 [0.53]	170 [0.77]
3-80	0.12 [3]	0.094 [2.4]	0.012 [0.3]	0.0039 [2.5]	56 [0.25]	79 [0.35]	99 [0.44]	140 [0.64]
3-85	0.12 [3]	0.098 [2.5]	0.0091 [0.23]	0.003 [2]	45 [0.2]	61 [0.27]	76 [0.34]	110 [0.49]
3-90	0.12 [3]	0.11 [2.7]	0.0059 [0.15]	0.0021 [1.3]	29 [0.13]	43 [0.19]	52 [0.23]	76 [0.34]
4-60	0.16 [4]	0.094 [2.4]	0.031 [0.8]	0.012 [8]	180 [0.8]	250 [1.1]	310 [1.4]	450 [2]
4-65	0.16 [4]	0.1 [2.6]	0.028 [0.7]	0.011 [7.3]	160 [0.73]	220 [1]	280 [1.2]	410 [1.8]
4-70	0.16 [4]	0.11 [2.8]	0.024 [0.6]	0.0099 [6.4]	140 [0.64]	200 [0.88]	250 [1.1]	360 [1.6]
4-75	0.16 [4]	0.12 [3]	0.02 [0.5]	0.0085 [5.5]	120 [0.55]	170 [0.76]	210 [0.95]	310 [1.4]
4-80	0.16 [4]	0.13 [3.2]	0.016 [0.4]	0.007 [4.5]	100 [0.45]	140 [0.62]	180 [0.78]	250 [1.1]
4-85	0.16 [4]	0.13 [3.4]	0.012 [0.3]	0.0054 [3.5]	79 [0.35]	110 [0.48]	140 [0.6]	200 [0.87]
4-90	0.16 [4]	0.14 [3.6]	0.0079 [0.2]	0.0037 [2.4]	54 [0.24]	74 [0.33]	92 [0.41]	140 [0.6]

TUBE ACTUATORS IN TENSION — Pull force by diameter and wall

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Section area, in² [mm²]	Force A, lbf [kN]	Force B, lbf [kN]	Force C, lbf [kN]	Force D, lbf [kN]
5-60	0.2 [5]	0.12 [3]	0.039 [1]	0.019 [13]	280 [1.3]	390 [1.7]	490 [2.2]	710 [3.1]
5-65	0.2 [5]	0.13 [3.2]	0.035 [0.88]	0.018 [11]	250 [1.1]	350 [1.6]	440 [1.9]	640 [2.8]
5-70	0.2 [5]	0.14 [3.5]	0.03 [0.75]	0.016 [10]	220 [1]	310 [1.4]	390 [1.7]	560 [2.5]
5-75	0.2 [5]	0.15 [3.8]	0.024 [0.62]	0.013 [8.6]	190 [0.86]	270 [1.2]	330 [1.5]	480 [2.1]
5-80	0.2 [5]	0.16 [4]	0.02 [0.5]	0.011 [7.1]	160 [0.71]	220 [0.98]	270 [1.2]	400 [1.8]
5-85	0.2 [5]	0.17 [4.2]	0.015 [0.38]	0.0084 [5.5]	120 [0.54]	170 [0.75]	210 [0.94]	310 [1.4]
5-90	0.2 [5]	0.18 [4.5]	0.0098 [0.25]	0.0058 [3.7]	83 [0.37]	120 [0.51]	140 [0.64]	210 [0.93]
6-60	0.24 [6]	0.14 [3.6]	0.047 [1.2]	0.028 [18]	410 [1.8]	560 [2.5]	700 [3.1]	1000 [4.5]
6-65	0.24 [6]	0.15 [3.9]	0.041 [1.05]	0.025 [16]	370 [1.6]	510 [2.2]	630 [2.8]	920 [4.1]
6-70	0.24 [6]	0.17 [4.2]	0.035 [0.9]	0.022 [14]	320 [1.4]	450 [2]	560 [2.5]	810 [3.6]
6-75	0.24 [6]	0.18 [4.5]	0.03 [0.75]	0.019 [12]	280 [1.2]	380 [1.7]	480 [2.1]	700 [3.1]
6-80	0.24 [6]	0.19 [4.8]	0.024 [0.6]	0.016 [10]	230 [1]	320 [1.4]	390 [1.8]	570 [2.5]
6-85	0.24 [6]	0.2 [5.1]	0.018 [0.45]	0.012 [7.8]	180 [0.78]	240 [1.1]	300 [1.4]	440 [2]
6-90	0.24 [6]	0.21 [5.4]	0.012 [0.3]	0.0083 [5.4]	120 [0.54]	170 [0.74]	210 [0.92]	300 [1.3]

TUBE ACTUATORS IN TENSION — Pull force by diameter and wall

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Section area, in² [mm²]	Force A, lbf [kN]	Force B, lbf [kN]	Force C, lbf [kN]	Force D, lbf [kN]
8-60	0.31 [8]	0.19 [4.8]	0.063 [1.6]	0.05 [32]	720 [3.2]	1000 [4.4]	1200 [5.5]	1800 [8]
8-65	0.31 [8]	0.2 [5.2]	0.055 [1.4]	0.045 [29]	650 [2.9]	900 [4]	1100 [5]	1600 [7.3]
8-70	0.31 [8]	0.22 [5.6]	0.047 [1.2]	0.04 [26]	580 [2.6]	800 [3.5]	990 [4.4]	1400 [6.4]
8-75	0.31 [8]	0.24 [6]	0.039 [1]	0.034 [22]	500 [2.2]	680 [3]	850 [3.8]	1200 [5.5]
8-80	0.31 [8]	0.25 [6.4]	0.031 [0.8]	0.028 [18]	410 [1.8]	560 [2.5]	700 [3.1]	1000 [4.5]
8-85	0.31 [8]	0.27 [6.8]	0.024 [0.6]	0.022 [14]	310 [1.4]	430 [1.9]	540 [2.4]	780 [3.5]
8-90	0.31 [8]	0.28 [7.2]	0.016 [0.4]	0.015 [9.6]	220 [0.96]	300 [1.3]	370 [1.6]	540 [2.4]
10-60	0.39 [10]	0.24 [6]	0.079 [2]	0.078 [50]	1100 [5]	1600 [6.9]	1900 [8.7]	2800 [13]
10-65	0.39 [10]	0.26 [6.5]	0.069 [1.75]	0.07 [45]	1000 [4.5]	1400 [6.3]	1800 [7.8]	2500 [11]
10-70	0.39 [10]	0.28 [7]	0.059 [1.5]	0.062 [40]	900 [4]	1200 [5.5]	1500 [6.9]	2200 [10]
10-75	0.39 [10]	0.3 [7.5]	0.049 [1.25]	0.053 [34]	770 [3.4]	1100 [4.7]	1300 [5.9]	1900 [8.6]
10-80	0.39 [10]	0.31 [8]	0.039 [1]	0.044 [28]	640 [2.8]	880 [3.9]	1100 [4.9]	1600 [7.1]
10-85	0.39 [10]	0.33 [8.5]	0.03 [0.75]	0.034 [22]	490 [2.2]	680 [3]	840 [3.8]	1200 [5.5]
10-90	0.39 [10]	0.35 [9]	0.02 [0.5]	0.023 [15]	340 [1.5]	460 [2.1]	580 [2.6]	840 [3.7]

TUBE ACTUATORS IN TENSION — Pull force by diameter and wall

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Section area, in² [mm²]	Force A, lbf [kN]	Force B, lbf [kN]	Force C, lbf [kN]	Force D, lbf [kN]
12-60	0.47 [12]	0.28 [7.2]	0.094 [2.4]	0.11 [72]	1600 [7.2]	2200 [10]	2800 [12]	4100 [18]
12-65	0.47 [12]	0.31 [7.8]	0.083 [2.1]	0.1 [65]	1500 [6.5]	2000 [9]	2500 [11]	3700 [16]
12-70	0.47 [12]	0.33 [8.4]	0.071 [1.8]	0.089 [58]	1300 [5.8]	1800 [8]	2200 [9.9]	3200 [14]
12-75	0.47 [12]	0.35 [9]	0.059 [1.5]	0.077 [49]	1100 [5]	1500 [6.8]	1900 [8.5]	2800 [12]
12-80	0.47 [12]	0.38 [9.6]	0.047 [1.2]	0.063 [41]	920 [4.1]	1300 [5.6]	1600 [7]	2300 [10]
12-85	0.47 [12]	0.4 [10.2]	0.035 [0.9]	0.049 [31]	710 [3.1]	970 [4.3]	1200 [5.4]	1800 [7.8]
12-90	0.47 [12]	0.43 [10.8]	0.024 [0.6]	0.033 [21]	480 [2.1]	670 [3]	830 [3.7]	1200 [5.4]
16-60	0.63 [16]	0.38 [9.6]	0.13 [3.2]	0.2 [130]	2900 [13]	4000 [18]	5000 [22]	7200 [32]
16-65	0.63 [16]	0.41 [10.4]	0.11 [2.8]	0.18 [120]	2600 [12]	3600 [16]	4500 [20]	6500 [29]
16-70	0.63 [16]	0.44 [11.2]	0.094 [2.4]	0.16 [100]	2300 [10]	3200 [14]	4000 [18]	5800 [26]
16-75	0.63 [16]	0.47 [12]	0.079 [2]	0.14 [88]	2000 [8.8]	2700 [12]	3400 [15]	4900 [22]
16-80	0.63 [16]	0.5 [12.8]	0.063 [1.6]	0.11 [72]	1600 [7.2]	2200 [10]	2800 [12]	4100 [18]
16-85	0.63 [16]	0.54 [13.6]	0.047 [1.2]	0.086 [56]	1300 [5.6]	1700 [7.7]	2200 [9.6]	3100 [14]
16-90	0.63 [16]	0.57 [14.4]	0.031 [0.8]	0.059 [38]	860 [3.8]	1200 [5.3]	1500 [6.6]	2100 [9.6]

TUBE ACTUATORS IN TENSION — Pull force by diameter and wall

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Section area, in² [mm²]	Force A, lbf [kN]	Force B, lbf [kN]	Force C, lbf [kN]	Force D, lbf [kN]
20-60	0.79 [20]	0.47 [12]	0.16 [4]	0.31 [200]	4500 [20]	6200 [28]	7800 [35]	11000 [50]
20-65	0.79 [20]	0.51 [13]	0.14 [3.5]	0.28 [180]	4100 [18]	5600 [25]	7000 [31]	10000 [45]
20-70	0.79 [20]	0.55 [14]	0.12 [3]	0.25 [160]	3600 [16]	5000 [22]	6200 [28]	9000 [40]
20-75	0.79 [20]	0.59 [15]	0.098 [2.5]	0.21 [140]	3100 [14]	4300 [19]	5300 [24]	7700 [34]
20-80	0.79 [20]	0.63 [16]	0.079 [2]	0.18 [110]	2500 [11]	3500 [16]	4400 [19]	6400 [28]
20-85	0.79 [20]	0.67 [17]	0.059 [1.5]	0.14 [87]	2000 [8.7]	2700 [12]	3400 [15]	4900 [22]
20-90	0.79 [20]	0.71 [18]	0.039 [1]	0.093 [60]	1300 [6]	1900 [8.2]	2300 [10]	3400 [15]
25-60	0.98 [25]	0.59 [15]	0.2 [5]	0.49 [310]	7100 [31]	9700 [43]	12000 [54]	18000 [79]
25-65	0.98 [25]	0.64 [16.2]	0.17 [4.38]	0.44 [280]	6400 [28]	8800 [39]	11000 [49]	16000 [71]
25-70	0.98 [25]	0.69 [17.5]	0.15 [3.75]	0.39 [250]	5600 [25]	7800 [35]	9700 [43]	14000 [63]
25-75	0.98 [25]	0.74 [18.8]	0.12 [3.12]	0.33 [220]	4800 [21]	6700 [30]	8300 [37]	12000 [54]
25-80	0.98 [25]	0.79 [20]	0.098 [2.5]	0.27 [180]	4000 [18]	5500 [24]	6800 [30]	9900 [44]
25-85	0.98 [25]	0.83 [21.2]	0.074 [1.88]	0.21 [140]	3100 [14]	4200 [19]	5300 [23]	7700 [34]
25-90	0.98 [25]	0.89 [22.5]	0.049 [1.25]	0.14 [93]	2100 [9.3]	2900 [13]	3600 [16]	5200 [23]

TUBE ACTUATORS IN TENSION — Pull force by diameter and wall

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Section area, in² [mm²]	Force A, lbf [kN]	Force B, lbf [kN]	Force C, lbf [kN]	Force D, lbf [kN]
32-60	1.3 [32]	0.76 [19.2]	0.25 [6.4]	0.8 [520]	12000 [51]	16000 [71]	20000 [89]	29000 [130]
32-65	1.3 [32]	0.82 [20.8]	0.22 [5.6]	0.72 [460]	10000 [46]	14000 [64]	18000 [80]	26000 [120]
32-70	1.3 [32]	0.88 [22.4]	0.19 [4.8]	0.64 [410]	9200 [41]	13000 [57]	16000 [71]	23000 [100]
32-75	1.3 [32]	0.94 [24]	0.16 [4]	0.55 [350]	7900 [35]	11000 [49]	14000 [61]	20000 [88]
32-80	1.3 [32]	1 [25.6]	0.13 [3.2]	0.45 [290]	6500 [29]	9000 [40]	11000 [50]	16000 [72]
32-85	1.3 [32]	1.1 [27.2]	0.094 [2.4]	0.35 [220]	5000 [22]	6900 [31]	8600 [38]	13000 [56]
32-90	1.3 [32]	1.1 [28.8]	0.063 [1.6]	0.24 [150]	3400 [15]	4700 [21]	5900 [26]	8600 [38]
40-60	1.6 [40]	0.94 [24]	0.31 [8]	1.2 [800]	18000 [80]	25000 [110]	31000 [140]	45000 [200]
40-65	1.6 [40]	1 [26]	0.28 [7]	1.1 [730]	16000 [73]	23000 [100]	28000 [120]	41000 [180]
40-70	1.6 [40]	1.1 [28]	0.24 [6]	0.99 [640]	14000 [64]	20000 [88]	25000 [110]	36000 [160]
40-75	1.6 [40]	1.2 [30]	0.2 [5]	0.85 [550]	12000 [55]	17000 [76]	21000 [95]	31000 [140]
40-80	1.6 [40]	1.3 [32]	0.16 [4]	0.7 [450]	10000 [45]	14000 [62]	17000 [78]	25000 [110]
40-85	1.6 [40]	1.3 [34]	0.12 [3]	0.54 [350]	7800 [35]	11000 [48]	13000 [60]	20000 [87]
40-90	1.6 [40]	1.4 [36]	0.079 [2]	0.37 [240]	5400 [24]	7400 [33]	9200 [41]	13000 [60]

TUBE ACTUATORS IN TENSION — Pull force by diameter and wall

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Section area, in² [mm²]	Force A, lbf [kN]	Force B, lbf [kN]	Force C, lbf [kN]	Force D, lbf [kN]
50-60	2 [50]	1.2 [30]	0.39 [10]	1.9 [1300]	28000 [130]	39000 [170]	49000 [220]	71000 [310]
50-65	2 [50]	1.3 [32.5]	0.34 [8.75]	1.8 [1100]	25000 [110]	35000 [160]	44000 [200]	64000 [280]
50-70	2 [50]	1.4 [35]	0.3 [7.5]	1.6 [1000]	23000 [100]	31000 [140]	39000 [170]	56000 [250]
50-75	2 [50]	1.5 [37.5]	0.25 [6.25]	1.3 [860]	19000 [86]	27000 [120]	33000 [150]	48000 [220]
50-80	2 [50]	1.6 [40]	0.2 [5]	1.1 [710]	16000 [71]	22000 [98]	27000 [120]	40000 [180]
50-85	2 [50]	1.7 [42.5]	0.15 [3.75]	0.84 [540]	12000 [54]	17000 [75]	21000 [94]	31000 [140]
50-90	2 [50]	1.8 [45]	0.098 [2.5]	0.58 [370]	8400 [37]	12000 [51]	14000 [64]	21000 [93]
63-60	2.5 [63]	1.5 [37.8]	0.5 [12.6]	3.1 [2000]	45000 [200]	62000 [280]	77000 [340]	110000 [500]
63-65	2.5 [63]	1.6 [41]	0.43 [11.03]	2.8 [1800]	40000 [180]	56000 [250]	70000 [310]	100000 [450]
63-70	2.5 [63]	1.7 [44.1]	0.37 [9.45]	2.5 [1600]	36000 [160]	49000 [220]	61000 [270]	89000 [400]
63-75	2.5 [63]	1.9 [47.2]	0.31 [7.88]	2.1 [1400]	31000 [140]	42000 [190]	53000 [240]	77000 [340]
63-80	2.5 [63]	2 [50.4]	0.25 [6.3]	1.7 [1100]	25000 [110]	35000 [160]	43000 [190]	63000 [280]
63-85	2.5 [63]	2.1 [53.5]	0.19 [4.72]	1.3 [860]	19000 [86]	27000 [120]	33000 [150]	49000 [220]
63-90	2.5 [63]	2.2 [56.7]	0.12 [3.15]	0.92 [590]	13000 [59]	18000 [82]	23000 [100]	33000 [150]

TUBE ACTUATORS IN TENSION — Pull force by diameter and wall

Part reference	OD, in [mm]	ID, in [mm]	Wall, in [mm]	Section area, in² [mm²]	Force A, lbf [kN]	Force B, lbf [kN]	Force C, lbf [kN]	Force D, lbf [kN]
80-60	3.1 [80]	1.9 [48]	0.63 [16]	5 [3200]	72000 [320]	100000 [440]	120000 [550]	180000 [800]
80-65	3.1 [80]	2 [52]	0.55 [14]	4.5 [2900]	65000 [290]	90000 [400]	110000 [500]	160000 [730]
80-70	3.1 [80]	2.2 [56]	0.47 [12]	4 [2600]	58000 [260]	80000 [350]	99000 [440]	140000 [640]
80-75	3.1 [80]	2.4 [60]	0.39 [10]	3.4 [2200]	49000 [220]	68000 [300]	85000 [380]	120000 [550]
80-80	3.1 [80]	2.5 [64]	0.31 [8]	2.8 [1800]	41000 [180]	56000 [250]	70000 [310]	100000 [450]
80-85	3.1 [80]	2.7 [68]	0.24 [6]	2.2 [1400]	31000 [140]	43000 [190]	54000 [240]	78000 [350]
80-90	3.1 [80]	2.8 [72]	0.16 [4]	1.5 [960]	21000 [96]	30000 [130]	37000 [160]	54000 [240]
100-60	3.9 [100]	2.4 [60]	0.79 [20]	7.8 [5000]	110000 [500]	160000 [690]	190000 [860]	280000 [1300]
100-65	3.9 [100]	2.6 [65]	0.69 [17.5]	7 [4500]	100000 [450]	140000 [630]	180000 [780]	250000 [1100]
100-70	3.9 [100]	2.8 [70]	0.59 [15]	6.2 [4000]	90000 [400]	120000 [550]	150000 [690]	230000 [1000]
100-75	3.9 [100]	3 [75]	0.49 [12.5]	5.3 [3400]	77000 [340]	110000 [470]	130000 [590]	190000 [860]
100-80	3.9 [100]	3.1 [80]	0.39 [10]	4.4 [2800]	64000 [280]	88000 [390]	110000 [490]	160000 [710]
100-85	3.9 [100]	3.3 [85]	0.3 [7.5]	3.4 [2200]	49000 [220]	68000 [300]	84000 [380]	120000 [540]
100-90	3.9 [100]	3.5 [90]	0.2 [5]	2.3 [1500]	34000 [150]	46000 [210]	58000 [260]	84000 [370]

TUBE ACTUATORS IN TENSION — Stroke - the same for every tube, because stroke is set by length

Design level	Stroke, in per ft [mm per 100 mm]	Tube length per unit of stroke (same in any unit)	Stroke from a 39.4 in [1 m] tube, in [mm]
A - 1% strain, 1,000,000 cycles	0.12 [1]	100	0.39 [10]
B - 2.5% strain, 100,000 cycles	0.3 [2.5]	40	0.98 [25]
C - 5% strain, 10,000 cycles	0.6 [5]	20	2 [50]
D - 7% strain, 100 cycles	0.84 [7]	14	2.8 [70]

NOTES

NOTES

CHAPTER 13

Curl Actuators

A motion no motor makes

Every other chapter in this handbook answers a question you already know how to ask. How much force. How much travel. How many cycles. You can look up the answer, compare it with a motor or a cylinder, and decide.

This chapter is different. There is nothing to compare it with.

A curl actuator is a straight wire, bar or tube that has been set to a curve. Cold, it is straight. Heat it and it rolls up. No motor does that. No cylinder does that. There is no conventional part you would be replacing, which is why it is worth reading even if you came here looking for something else.

Three motions from one piece, at the same time

When a straight element curls, three useful things happen at once.

IT WRAPS. It closes around whatever is inside it, so it grips, winds, or coils.

IT SHORTENS. Its two ends come closer together, so it pulls. A straight-line stroke out of a part that is only bending.

IT SWEEPS. Its free end travels sideways through a wide arc, so it reaches.

To get those three motions today you would buy three actuators and build the linkages between them. Here it is one piece of wire with no moving parts at all, and everything it does it does simultaneously.

One number sets the whole shape

A curl actuator is the simplest thing in this handbook to specify, because the radius it rolls to depends on one dimension and nothing else.

Not the length. Not the wall. Not the width. Just the thickness of the thing that is bending. A 0.0059 in [0.15 mm] wire rolls to a 0.059 in [1.5 mm] radius. A 1 in [25 mm] bar rolls to 9.8 in [250 mm]. Halve the section and you halve the radius.

Everything else follows from that. The length decides how many turns you get, because a full turn always uses the same amount of material. The section decides how hard it pulls while doing it.

> *Choose the section for the radius. Choose the length for the number of turns.*

Where it is most interesting

At the small end. The radius follows the section, so the finest wire gives the tightest coil, and a 0.0059 in [0.15 mm] wire completes a full turn out of 0.37 in [9.4 mm] of material. That is a mechanism at a size where no assembly of separate parts can go.

Flat wire gives you the same choice it gives everywhere else. Set to curl about its thin dimension it rolls up like a tape measure, tightly and gently. Set to curl about its wide dimension it coils in its own plane, loosely and strongly. Both are listed.

A tube behaves as it does in Chapter 11: the outside diameter sets the radius, the wall sets the strength.

Please talk to us before you design one in

Nothing in this chapter is a stock part. The figures come from the same material behavior as the rest of the handbook and they are sound, but we have not measured a curled part against them yet, and there is a practical limit on how tightly any given section can be set that we would want to confirm for your case.

There is also the question of whether it has to uncurl again. A curl actuator that only has to close once is straightforward; one that must open and close repeatedly is a design conversation, and the section above on getting it back is where that starts.

This chapter exists to show you what is possible. Bring us the motion you need and we will tell you whether a curl actuator is the way to get it.

Getting it back

Like every shape in this handbook, a nitinol actuator moves one way when it is heated. Getting it back to where it started is the designer's problem, and there are three ways to solve it.

AN ANTAGONISTIC PAIR uses a second actuator working against the first. Heat one and it moves the mechanism and resets the other; heat the other and it goes back. You get powered motion in both directions with full output each way, at the cost of two actuators and a control scheme that never heats both at once.

A BIAS is a passive element, usually a conventional spring or a weight, that the actuator works against as it moves and that pushes it back as it cools. It is the simplest arrangement and the most common. The price is that the bias resists the actuator through the whole stroke, so part of the force in the table is spent returning the mechanism rather than doing the job. Size it to return the actuator and no more.

SYSTEM FORCES are the return you already have. If the mechanism pushes back on its own, if gravity closes the door, if the thing being clamped is springy, if line pressure acts on the valve, that force resets the actuator for nothing. It is the best answer when it is available, and worth looking for before adding parts.

Whichever you choose, the return has to be strong enough to reset the actuator while it is cool and weak enough not to stall it while it is hot. That window is what sizes a bias, and it is the most common thing to get wrong on a first build.

There is a fourth possibility. Any nitinol actuator can be given a two way set, so that it takes one shape hot and another cold and needs no return at all. Two way parts are made to order and are outside the scope of this handbook, so nothing here is rated for it, but it exists. Ask.

Overdriving an actuator

The figures in this handbook are conservative. Every force in every table is rated at a stress we are confident the part will deliver, cycle after cycle, at the fatigue life of its design level. A part will usually do more than the table says. We would rather you found that out in testing than the other way round.

The second reason a part will beat its table is that you can overdrive it, and this one is a feature you can design with. There are two ways to do it, and they add.

The first is to heat it further. Nitinol makes its force by changing phase, and the temperature at which it does that is the transition temperature we set for you. The force does not stop climbing when the part gets there. Keep heating it past the transition and the force keeps rising with temperature, well beyond the rated figure. The table gives you the force at a working temperature comfortably above transition. Drive the part hotter and there is more.

The second is to heat it faster. Heat the part slowly and it makes the force in the table. Heat it quickly, with a sharp pulse of current rather than a gentle ramp, and it makes more, and the harder the pulse, the bigger the difference. A part that is driven both fast and hot gets the gain from each, one on top of the other. The tables assume neither. They are the floor.

Emergency mode

That gives a nitinol actuator something most actuators do not have: a reserve. A motor or a solenoid has a rated output and a thermal limit close behind it. A nitinol actuator can be driven, briefly, to a force well above its rating simply by putting more heat into it, faster. Think of it as an emergency mode. A latch that normally needs a modest pull can, on the day something jams, be hit with a short hard pulse and told to pull much harder. A release that must not fail gets a margin that costs nothing in size or weight.

Use it as a reserve, not as the rating, and know where the limits are. There is a temperature, called Md, above which the metal can no longer be pushed into martensite by stress; up to Md the material is still behaving as nitinol should. Overdriving up to Md costs some fatigue life, but it also does the part a favor: the extra heat drives out residual martensite that builds up over many cycles, a kind of rehabilitation in place, so a part that is occasionally run hard can come back sharper than one that never is. Above Md the accounting changes. Degradation is faster, and each hot cycle takes a larger bite out of the life. Above 350 °C (660 °F) the part is past saving: treat an actuator that has been driven that hot as spent and replace it. Used within those limits, for the rare event, emergency mode is one of the best arguments for the material.

Actuator safety

Most actuators fail badly when they are overdriven, and engineers know exactly how. Put too much current into a motor or a solenoid and it explodes. Overpressure a hydraulic cylinder and it bursts, or springs a pinhole leak, and a jet of oil at that pressure will cut through a glove and a hand, take a limb, and put oil into the ground and the water where it can be years being cleaned up. Every one of them has the same problem: the energy is stored in the actuator, and when something goes wrong it has nowhere to go but out. A nitinol actuator, very simply, does not carry these risks. It is a piece of metal with a current in it, and there is nothing in it to burst, nothing to leak, and nothing to poison.

A nitinol actuator fails the other way. Put too much power into it and it simply gets hotter. Past the working range the force keeps rising; past that, the part reaches the temperatures at which it was

shape set, and at that point the metal lets go of its memory. The actuator loses its force, goes slack, and parts, which opens the circuit that was heating it. It shuts itself off. There is nothing stored in it to release: no pressure, no winding, no field. The failure mode is a dead part and an open circuit, not an event.

That is worth stating plainly for anyone writing a safety case. The worst thing an overdriven nitinol actuator does is stop.

CURL ACTUATORS — ROUND WIRE — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
0.15	0.0059 dia [0.15 dia]	0.3 [7.5]	0.12 [3]	0.059 [1.5]	0.042 [1.1]	970 [3800]	0.37 [9.4]	0.0005 [0.057]
0.25	0.0098 dia [0.25 dia]	0.49 [12]	0.2 [5]	0.098 [2.5]	0.07 [1.8]	580 [2300]	0.62 [16]	0.0023 [0.26]
0.4	0.016 dia [0.4 dia]	0.79 [20]	0.31 [8]	0.16 [4]	0.11 [2.9]	360 [1400]	0.99 [25]	0.0096 [1.1]
0.5	0.02 dia [0.5 dia]	0.98 [25]	0.39 [10]	0.2 [5]	0.14 [3.6]	290 [1100]	1.2 [31]	0.019 [2.1]
0.75	0.03 dia [0.75 dia]	1.5 [38]	0.59 [15]	0.3 [7.5]	0.21 [5.4]	190 [760]	1.9 [47]	0.063 [7.1]
1	0.039 dia [1 dia]	2 [50]	0.79 [20]	0.39 [10]	0.28 [7.1]	150 [570]	2.5 [63]	0.15 [17]
1.25	0.049 dia [1.25 dia]	2.5 [62]	0.98 [25]	0.49 [12]	0.35 [8.9]	120 [460]	3.1 [78]	0.29 [33]
1.5	0.059 dia [1.5 dia]	3 [75]	1.2 [30]	0.59 [15]	0.42 [11]	97 [380]	3.7 [94]	0.5 [57]
2	0.079 dia [2 dia]	3.9 [100]	1.6 [40]	0.79 [20]	0.56 [14]	73 [290]	4.9 [130]	1.2 [140]
3	0.12 dia [3 dia]	5.9 [150]	2.4 [60]	1.2 [30]	0.84 [21]	49 [190]	7.4 [190]	4 [460]
5	0.2 dia [5 dia]	9.8 [250]	3.9 [100]	2 [50]	1.4 [36]	29 [120]	12 [310]	19 [2100]

CURL ACTUATORS — ROD AND BAR — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
2	0.079 dia [2 dia]	3.9 [100]	1.6 [40]	0.79 [20]	0.56 [14]	73 [290]	4.9 [130]	1.2 [140]
3	0.12 dia [3 dia]	5.9 [150]	2.4 [60]	1.2 [30]	0.84 [21]	49 [190]	7.4 [190]	4 [460]
4	0.16 dia [4 dia]	7.9 [200]	3.1 [80]	1.6 [40]	1.1 [29]	36 [140]	9.9 [250]	9.6 [1100]
5	0.2 dia [5 dia]	9.8 [250]	3.9 [100]	2 [50]	1.4 [36]	29 [120]	12 [310]	19 [2100]
6	0.24 dia [6 dia]	12 [300]	4.7 [120]	2.4 [60]	1.7 [43]	24 [95]	15 [380]	32 [3600]
7	0.28 dia [7 dia]	14 [350]	5.5 [140]	2.8 [70]	2 [50]	21 [82]	17 [440]	51 [5800]
8	0.31 dia [8 dia]	16 [400]	6.3 [160]	3.1 [80]	2.2 [57]	18 [72]	20 [500]	77 [8600]
9	0.35 dia [9 dia]	18 [450]	7.1 [180]	3.5 [90]	2.5 [64]	16 [64]	22 [570]	110 [12000]
10	0.39 dia [10 dia]	20 [500]	7.9 [200]	3.9 [100]	2.8 [71]	14 [57]	25 [630]	150 [17000]
11	0.43 dia [11 dia]	22 [550]	8.7 [220]	4.3 [110]	3.1 [79]	13 [52]	27 [690]	200 [22000]
12	0.47 dia [12 dia]	24 [600]	9.4 [240]	4.7 [120]	3.4 [86]	12 [48]	30 [750]	260 [29000]
16	0.63 dia [16 dia]	31 [800]	13 [320]	6.3 [160]	4.5 [110]	9.1 [36]	40 [1000]	610 [69000]
19	0.75 dia [19 dia]	37 [950]	15 [380]	7.5 [190]	5.3 [140]	7.6 [30]	47 [1200]	1000 [120000]

CURL ACTUATORS — ROD AND BAR — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
25	0.98 dia [25 dia]	49 [1200]	20 [500]	9.8 [250]	7 [180]	5.8 [23]	62 [1600]	2300 [260000]

CURL ACTUATORS — TUBE — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
1-60	0.039 dia / 0.024 bore [1 dia / 0.6 bore]	2 [50]	0.79 [20]	0.39 [10]	0.28 [7.1]	150 [570]	2.5 [63]	0.13 [15]
1-65	0.039 dia / 0.026 bore [1 dia / 0.65 bore]	2 [50]	0.79 [20]	0.39 [10]	0.28 [7.1]	150 [570]	2.5 [63]	0.12 [14]
1-70	0.039 dia / 0.028 bore [1 dia / 0.7 bore]	2 [50]	0.79 [20]	0.39 [10]	0.28 [7.1]	150 [570]	2.5 [63]	0.11 [13]
1-75	0.039 dia / 0.03 bore [1 dia / 0.75 bore]	2 [50]	0.79 [20]	0.39 [10]	0.28 [7.1]	150 [570]	2.5 [63]	0.1 [12]
1-80	0.039 dia / 0.031 bore [1 dia / 0.8 bore]	2 [50]	0.79 [20]	0.39 [10]	0.28 [7.1]	150 [570]	2.5 [63]	0.088 [10]
1-85	0.039 dia / 0.033 bore [1 dia / 0.85 bore]	2 [50]	0.79 [20]	0.39 [10]	0.28 [7.1]	150 [570]	2.5 [63]	0.071 [8.1]
1-90	0.039 dia / 0.035 bore [1 dia / 0.9 bore]	2 [50]	0.79 [20]	0.39 [10]	0.28 [7.1]	150 [570]	2.5 [63]	0.051 [5.8]
1.5-60	0.059 dia / 0.035 bore [1.5 dia / 0.9 bore]	3 [75]	1.2 [30]	0.59 [15]	0.42 [11]	97 [380]	3.7 [94]	0.44 [50]
1.5-65	0.059 dia / 0.038 bore [1.5 dia / 0.975 bore]	3 [75]	1.2 [30]	0.59 [15]	0.42 [11]	97 [380]	3.7 [94]	0.41 [47]

CURL ACTUATORS — TUBE — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
1.5-70	0.059 dia / 0.041 bore [1.5 dia / 1.05 bore]	3 [75]	1.2 [30]	0.59 [15]	0.42 [11]	97 [380]	3.7 [94]	0.38 [43]
1.5-75	0.059 dia / 0.044 bore [1.5 dia / 1.125 bore]	3 [75]	1.2 [30]	0.59 [15]	0.42 [11]	97 [380]	3.7 [94]	0.34 [39]
1.5-80	0.059 dia / 0.047 bore [1.5 dia / 1.2 bore]	3 [75]	1.2 [30]	0.59 [15]	0.42 [11]	97 [380]	3.7 [94]	0.3 [34]
1.5-85	0.059 dia / 0.05 bore [1.5 dia / 1.275 bore]	3 [75]	1.2 [30]	0.59 [15]	0.42 [11]	97 [380]	3.7 [94]	0.24 [27]
1.5-90	0.059 dia / 0.053 bore [1.5 dia / 1.35 bore]	3 [75]	1.2 [30]	0.59 [15]	0.42 [11]	97 [380]	3.7 [94]	0.17 [20]
2-60	0.079 dia / 0.047 bore [2 dia / 1.2 bore]	3.9 [100]	1.6 [40]	0.79 [20]	0.56 [14]	73 [290]	4.9 [130]	1 [120]
2-65	0.079 dia / 0.051 bore [2 dia / 1.3 bore]	3.9 [100]	1.6 [40]	0.79 [20]	0.56 [14]	73 [290]	4.9 [130]	0.98 [110]
2-70	0.079 dia / 0.055 bore [2 dia / 1.4 bore]	3.9 [100]	1.6 [40]	0.79 [20]	0.56 [14]	73 [290]	4.9 [130]	0.91 [100]
2-75	0.079 dia / 0.059 bore [2 dia / 1.5 bore]	3.9 [100]	1.6 [40]	0.79 [20]	0.56 [14]	73 [290]	4.9 [130]	0.82 [92]
2-80	0.079 dia / 0.063 bore [2 dia / 1.6 bore]	3.9 [100]	1.6 [40]	0.79 [20]	0.56 [14]	73 [290]	4.9 [130]	0.71 [80]
2-85	0.079 dia / 0.067 bore [2 dia / 1.7 bore]	3.9 [100]	1.6 [40]	0.79 [20]	0.56 [14]	73 [290]	4.9 [130]	0.57 [65]
2-90	0.079 dia / 0.071 bore [2 dia / 1.8 bore]	3.9 [100]	1.6 [40]	0.79 [20]	0.56 [14]	73 [290]	4.9 [130]	0.41 [46]
2.5-60	0.098 dia / 0.059 bore [2.5 dia / 1.5 bore]	4.9 [120]	2 [50]	0.98 [25]	0.7 [18]	58 [230]	6.2 [160]	2 [230]

CURL ACTUATORS — TUBE — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
2.5-65	0.098 dia / 0.064 bore [2.5 dia / 1.625 bore]	4.9 [120]	2 [50]	0.98 [25]	0.7 [18]	58 [230]	6.2 [160]	1.9 [220]
2.5-70	0.098 dia / 0.069 bore [2.5 dia / 1.75 bore]	4.9 [120]	2 [50]	0.98 [25]	0.7 [18]	58 [230]	6.2 [160]	1.8 [200]
2.5-75	0.098 dia / 0.074 bore [2.5 dia / 1.875 bore]	4.9 [120]	2 [50]	0.98 [25]	0.7 [18]	58 [230]	6.2 [160]	1.6 [180]
2.5-80	0.098 dia / 0.079 bore [2.5 dia / 2 bore]	4.9 [120]	2 [50]	0.98 [25]	0.7 [18]	58 [230]	6.2 [160]	1.4 [160]
2.5-85	0.098 dia / 0.084 bore [2.5 dia / 2.125 bore]	4.9 [120]	2 [50]	0.98 [25]	0.7 [18]	58 [230]	6.2 [160]	1.1 [130]
2.5-90	0.098 dia / 0.089 bore [2.5 dia / 2.25 bore]	4.9 [120]	2 [50]	0.98 [25]	0.7 [18]	58 [230]	6.2 [160]	0.8 [91]
3-60	0.12 dia / 0.071 bore [3 dia / 1.8 bore]	5.9 [150]	2.4 [60]	1.2 [30]	0.84 [21]	49 [190]	7.4 [190]	3.5 [400]
3-65	0.12 dia / 0.077 bore [3 dia / 1.95 bore]	5.9 [150]	2.4 [60]	1.2 [30]	0.84 [21]	49 [190]	7.4 [190]	3.3 [370]
3-70	0.12 dia / 0.083 bore [3 dia / 2.1 bore]	5.9 [150]	2.4 [60]	1.2 [30]	0.84 [21]	49 [190]	7.4 [190]	3.1 [350]
3-75	0.12 dia / 0.089 bore [3 dia / 2.25 bore]	5.9 [150]	2.4 [60]	1.2 [30]	0.84 [21]	49 [190]	7.4 [190]	2.8 [310]
3-80	0.12 dia / 0.094 bore [3 dia / 2.4 bore]	5.9 [150]	2.4 [60]	1.2 [30]	0.84 [21]	49 [190]	7.4 [190]	2.4 [270]
3-85	0.12 dia / 0.1 bore [3 dia / 2.55 bore]	5.9 [150]	2.4 [60]	1.2 [30]	0.84 [21]	49 [190]	7.4 [190]	1.9 [220]
3-90	0.12 dia / 0.11 bore [3 dia / 2.7 bore]	5.9 [150]	2.4 [60]	1.2 [30]	0.84 [21]	49 [190]	7.4 [190]	1.4 [160]

CURL ACTUATORS — TUBE — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
4-60	0.16 dia / 0.094 bore [4 dia / 2.4 bore]	7.9 [200]	3.1 [80]	1.6 [40]	1.1 [29]	36 [140]	9.9 [250]	8.3 [940]
4-65	0.16 dia / 0.1 bore [4 dia / 2.6 bore]	7.9 [200]	3.1 [80]	1.6 [40]	1.1 [29]	36 [140]	9.9 [250]	7.9 [890]
4-70	0.16 dia / 0.11 bore [4 dia / 2.8 bore]	7.9 [200]	3.1 [80]	1.6 [40]	1.1 [29]	36 [140]	9.9 [250]	7.3 [820]
4-75	0.16 dia / 0.12 bore [4 dia / 3 bore]	7.9 [200]	3.1 [80]	1.6 [40]	1.1 [29]	36 [140]	9.9 [250]	6.5 [740]
4-80	0.16 dia / 0.13 bore [4 dia / 3.2 bore]	7.9 [200]	3.1 [80]	1.6 [40]	1.1 [29]	36 [140]	9.9 [250]	5.6 [640]
4-85	0.16 dia / 0.13 bore [4 dia / 3.4 bore]	7.9 [200]	3.1 [80]	1.6 [40]	1.1 [29]	36 [140]	9.9 [250]	4.6 [520]
4-90	0.16 dia / 0.14 bore [4 dia / 3.6 bore]	7.9 [200]	3.1 [80]	1.6 [40]	1.1 [29]	36 [140]	9.9 [250]	3.3 [370]
5-60	0.2 dia / 0.12 bore [5 dia / 3 bore]	9.8 [250]	3.9 [100]	2 [50]	1.4 [36]	29 [120]	12 [310]	16 [1800]
5-65	0.2 dia / 0.13 bore [5 dia / 3.25 bore]	9.8 [250]	3.9 [100]	2 [50]	1.4 [36]	29 [120]	12 [310]	15 [1700]
5-70	0.2 dia / 0.14 bore [5 dia / 3.5 bore]	9.8 [250]	3.9 [100]	2 [50]	1.4 [36]	29 [120]	12 [310]	14 [1600]
5-75	0.2 dia / 0.15 bore [5 dia / 3.75 bore]	9.8 [250]	3.9 [100]	2 [50]	1.4 [36]	29 [120]	12 [310]	13 [1400]
5-80	0.2 dia / 0.16 bore [5 dia / 4 bore]	9.8 [250]	3.9 [100]	2 [50]	1.4 [36]	29 [120]	12 [310]	11 [1200]
5-85	0.2 dia / 0.17 bore [5 dia / 4.25 bore]	9.8 [250]	3.9 [100]	2 [50]	1.4 [36]	29 [120]	12 [310]	8.9 [1000]

CURL ACTUATORS — TUBE — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
5-90	0.2 dia / 0.18 bore [5 dia / 4.5 bore]	9.8 [250]	3.9 [100]	2 [50]	1.4 [36]	29 [120]	12 [310]	6.4 [730]
6-60	0.24 dia / 0.14 bore [6 dia / 3.6 bore]	12 [300]	4.7 [120]	2.4 [60]	1.7 [43]	24 [95]	15 [380]	28 [3200]
6-65	0.24 dia / 0.15 bore [6 dia / 3.9 bore]	12 [300]	4.7 [120]	2.4 [60]	1.7 [43]	24 [95]	15 [380]	27 [3000]
6-70	0.24 dia / 0.17 bore [6 dia / 4.2 bore]	12 [300]	4.7 [120]	2.4 [60]	1.7 [43]	24 [95]	15 [380]	25 [2800]
6-75	0.24 dia / 0.18 bore [6 dia / 4.5 bore]	12 [300]	4.7 [120]	2.4 [60]	1.7 [43]	24 [95]	15 [380]	22 [2500]
6-80	0.24 dia / 0.19 bore [6 dia / 4.8 bore]	12 [300]	4.7 [120]	2.4 [60]	1.7 [43]	24 [95]	15 [380]	19 [2200]
6-85	0.24 dia / 0.2 bore [6 dia / 5.1 bore]	12 [300]	4.7 [120]	2.4 [60]	1.7 [43]	24 [95]	15 [380]	15 [1700]
6-90	0.24 dia / 0.21 bore [6 dia / 5.4 bore]	12 [300]	4.7 [120]	2.4 [60]	1.7 [43]	24 [95]	15 [380]	11 [1300]
8-60	0.31 dia / 0.19 bore [8 dia / 4.8 bore]	16 [400]	6.3 [160]	3.1 [80]	2.2 [57]	18 [72]	20 [500]	67 [7500]
8-65	0.31 dia / 0.2 bore [8 dia / 5.2 bore]	16 [400]	6.3 [160]	3.1 [80]	2.2 [57]	18 [72]	20 [500]	63 [7100]
8-70	0.31 dia / 0.22 bore [8 dia / 5.6 bore]	16 [400]	6.3 [160]	3.1 [80]	2.2 [57]	18 [72]	20 [500]	58 [6600]
8-75	0.31 dia / 0.24 bore [8 dia / 6 bore]	16 [400]	6.3 [160]	3.1 [80]	2.2 [57]	18 [72]	20 [500]	52 [5900]
8-80	0.31 dia / 0.25 bore [8 dia / 6.4 bore]	16 [400]	6.3 [160]	3.1 [80]	2.2 [57]	18 [72]	20 [500]	45 [5100]

CURL ACTUATORS — TUBE — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
8-85	0.31 dia / 0.27 bore [8 dia / 6.8 bore]	16 [400]	6.3 [160]	3.1 [80]	2.2 [57]	18 [72]	20 [500]	37 [4100]
8-90	0.31 dia / 0.28 bore [8 dia / 7.2 bore]	16 [400]	6.3 [160]	3.1 [80]	2.2 [57]	18 [72]	20 [500]	26 [3000]
10-60	0.39 dia / 0.24 bore [10 dia / 6 bore]	20 [500]	7.9 [200]	3.9 [100]	2.8 [71]	14 [57]	25 [630]	130 [15000]
10-65	0.39 dia / 0.26 bore [10 dia / 6.5 bore]	20 [500]	7.9 [200]	3.9 [100]	2.8 [71]	14 [57]	25 [630]	120 [14000]
10-70	0.39 dia / 0.28 bore [10 dia / 7 bore]	20 [500]	7.9 [200]	3.9 [100]	2.8 [71]	14 [57]	25 [630]	110 [13000]
10-75	0.39 dia / 0.3 bore [10 dia / 7.5 bore]	20 [500]	7.9 [200]	3.9 [100]	2.8 [71]	14 [57]	25 [630]	100 [12000]
10-80	0.39 dia / 0.31 bore [10 dia / 8 bore]	20 [500]	7.9 [200]	3.9 [100]	2.8 [71]	14 [57]	25 [630]	88 [10000]
10-85	0.39 dia / 0.33 bore [10 dia / 8.5 bore]	20 [500]	7.9 [200]	3.9 [100]	2.8 [71]	14 [57]	25 [630]	71 [8100]
10-90	0.39 dia / 0.35 bore [10 dia / 9 bore]	20 [500]	7.9 [200]	3.9 [100]	2.8 [71]	14 [57]	25 [630]	51 [5800]
12-60	0.47 dia / 0.28 bore [12 dia / 7.2 bore]	24 [600]	9.4 [240]	4.7 [120]	3.4 [86]	12 [48]	30 [750]	220 [25000]
12-65	0.47 dia / 0.31 bore [12 dia / 7.8 bore]	24 [600]	9.4 [240]	4.7 [120]	3.4 [86]	12 [48]	30 [750]	210 [24000]
12-70	0.47 dia / 0.33 bore [12 dia / 8.4 bore]	24 [600]	9.4 [240]	4.7 [120]	3.4 [86]	12 [48]	30 [750]	200 [22000]
12-75	0.47 dia / 0.35 bore [12 dia / 9 bore]	24 [600]	9.4 [240]	4.7 [120]	3.4 [86]	12 [48]	30 [750]	180 [20000]

CURL ACTUATORS — TUBE — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
12-80	0.47 dia / 0.38 bore [12 dia / 9.6 bore]	24 [600]	9.4 [240]	4.7 [120]	3.4 [86]	12 [48]	30 [750]	150 [17000]
12-85	0.47 dia / 0.4 bore [12 dia / 10.2 bore]	24 [600]	9.4 [240]	4.7 [120]	3.4 [86]	12 [48]	30 [750]	120 [14000]
12-90	0.47 dia / 0.43 bore [12 dia / 10.8 bore]	24 [600]	9.4 [240]	4.7 [120]	3.4 [86]	12 [48]	30 [750]	89 [10000]
16-60	0.63 dia / 0.38 bore [16 dia / 9.6 bore]	31 [800]	13 [320]	6.3 [160]	4.5 [110]	9.1 [36]	40 [1000]	530 [60000]
16-65	0.63 dia / 0.41 bore [16 dia / 10.4 bore]	31 [800]	13 [320]	6.3 [160]	4.5 [110]	9.1 [36]	40 [1000]	500 [57000]
16-70	0.63 dia / 0.44 bore [16 dia / 11.2 bore]	31 [800]	13 [320]	6.3 [160]	4.5 [110]	9.1 [36]	40 [1000]	460 [53000]
16-75	0.63 dia / 0.47 bore [16 dia / 12 bore]	31 [800]	13 [320]	6.3 [160]	4.5 [110]	9.1 [36]	40 [1000]	420 [47000]
16-80	0.63 dia / 0.5 bore [16 dia / 12.8 bore]	31 [800]	13 [320]	6.3 [160]	4.5 [110]	9.1 [36]	40 [1000]	360 [41000]
16-85	0.63 dia / 0.54 bore [16 dia / 13.6 bore]	31 [800]	13 [320]	6.3 [160]	4.5 [110]	9.1 [36]	40 [1000]	290 [33000]
16-90	0.63 dia / 0.57 bore [16 dia / 14.4 bore]	31 [800]	13 [320]	6.3 [160]	4.5 [110]	9.1 [36]	40 [1000]	210 [24000]
20-60	0.79 dia / 0.47 bore [20 dia / 12 bore]	39 [1000]	16 [400]	7.9 [200]	5.6 [140]	7.4 [29]	49 [1300]	1000 [120000]
20-65	0.79 dia / 0.51 bore [20 dia / 13 bore]	39 [1000]	16 [400]	7.9 [200]	5.6 [140]	7.4 [29]	49 [1300]	980 [110000]
20-70	0.79 dia / 0.55 bore [20 dia / 14 bore]	39 [1000]	16 [400]	7.9 [200]	5.6 [140]	7.4 [29]	49 [1300]	910 [100000]

CURL ACTUATORS — TUBE — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
20-75	0.79 dia / 0.59 bore [20 dia / 15 bore]	39 [1000]	16 [400]	7.9 [200]	5.6 [140]	7.4 [29]	49 [1300]	820 [92000]
20-80	0.79 dia / 0.63 bore [20 dia / 16 bore]	39 [1000]	16 [400]	7.9 [200]	5.6 [140]	7.4 [29]	49 [1300]	710 [80000]
20-85	0.79 dia / 0.67 bore [20 dia / 17 bore]	39 [1000]	16 [400]	7.9 [200]	5.6 [140]	7.4 [29]	49 [1300]	570 [65000]
20-90	0.79 dia / 0.71 bore [20 dia / 18 bore]	39 [1000]	16 [400]	7.9 [200]	5.6 [140]	7.4 [29]	49 [1300]	410 [46000]
25-60	0.98 dia / 0.59 bore [25 dia / 15 bore]	49 [1200]	20 [500]	9.8 [250]	7 [180]	5.8 [23]	62 [1600]	2000 [230000]
25-65	0.98 dia / 0.64 bore [25 dia / 16.25 bore]	49 [1200]	20 [500]	9.8 [250]	7 [180]	5.8 [23]	62 [1600]	1900 [220000]
25-70	0.98 dia / 0.69 bore [25 dia / 17.5 bore]	49 [1200]	20 [500]	9.8 [250]	7 [180]	5.8 [23]	62 [1600]	1800 [200000]
25-75	0.98 dia / 0.74 bore [25 dia / 18.75 bore]	49 [1200]	20 [500]	9.8 [250]	7 [180]	5.8 [23]	62 [1600]	1600 [180000]
25-80	0.98 dia / 0.79 bore [25 dia / 20 bore]	49 [1200]	20 [500]	9.8 [250]	7 [180]	5.8 [23]	62 [1600]	1400 [160000]
25-85	0.98 dia / 0.84 bore [25 dia / 21.25 bore]	49 [1200]	20 [500]	9.8 [250]	7 [180]	5.8 [23]	62 [1600]	1100 [130000]
25-90	0.98 dia / 0.89 bore [25 dia / 22.5 bore]	49 [1200]	20 [500]	9.8 [250]	7 [180]	5.8 [23]	62 [1600]	800 [91000]
32-60	1.3 dia / 0.76 bore [32 dia / 19.2 bore]	63 [1600]	25 [640]	13 [320]	9 [230]	4.6 [18]	79 [2000]	4300 [480000]
32-65	1.3 dia / 0.82 bore [32 dia / 20.8 bore]	63 [1600]	25 [640]	13 [320]	9 [230]	4.6 [18]	79 [2000]	4000 [450000]

CURL ACTUATORS — TUBE — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
32-70	1.3 dia / 0.88 bore [32 dia / 22.4 bore]	63 [1600]	25 [640]	13 [320]	9 [230]	4.6 [18]	79 [2000]	3700 [420000]
32-75	1.3 dia / 0.94 bore [32 dia / 24 bore]	63 [1600]	25 [640]	13 [320]	9 [230]	4.6 [18]	79 [2000]	3300 [380000]
32-80	1.3 dia / 1 bore [32 dia / 25.6 bore]	63 [1600]	25 [640]	13 [320]	9 [230]	4.6 [18]	79 [2000]	2900 [330000]
32-85	1.3 dia / 1.1 bore [32 dia / 27.2 bore]	63 [1600]	25 [640]	13 [320]	9 [230]	4.6 [18]	79 [2000]	2300 [260000]
32-90	1.3 dia / 1.1 bore [32 dia / 28.8 bore]	63 [1600]	25 [640]	13 [320]	9 [230]	4.6 [18]	79 [2000]	1700 [190000]
40-60	1.6 dia / 0.94 bore [40 dia / 24 bore]	79 [2000]	31 [800]	16 [400]	11 [290]	3.6 [14]	99 [2500]	8300 [940000]
40-65	1.6 dia / 1 bore [40 dia / 26 bore]	79 [2000]	31 [800]	16 [400]	11 [290]	3.6 [14]	99 [2500]	7900 [890000]
40-70	1.6 dia / 1.1 bore [40 dia / 28 bore]	79 [2000]	31 [800]	16 [400]	11 [290]	3.6 [14]	99 [2500]	7300 [820000]
40-75	1.6 dia / 1.2 bore [40 dia / 30 bore]	79 [2000]	31 [800]	16 [400]	11 [290]	3.6 [14]	99 [2500]	6500 [740000]
40-80	1.6 dia / 1.3 bore [40 dia / 32 bore]	79 [2000]	31 [800]	16 [400]	11 [290]	3.6 [14]	99 [2500]	5600 [640000]
40-85	1.6 dia / 1.3 bore [40 dia / 34 bore]	79 [2000]	31 [800]	16 [400]	11 [290]	3.6 [14]	99 [2500]	4600 [520000]
40-90	1.6 dia / 1.4 bore [40 dia / 36 bore]	79 [2000]	31 [800]	16 [400]	11 [290]	3.6 [14]	99 [2500]	3300 [370000]
50-60	2 dia / 1.2 bore [50 dia / 30 bore]	98 [2500]	39 [1000]	20 [500]	14 [360]	2.8 [11]	120 [3100]	16000 [1800000]

CURL ACTUATORS — TUBE — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
50-65	2 dia / 1.3 bore [50 dia / 32.5 bore]	98 [2500]	39 [1000]	20 [500]	14 [360]	2.8 [11]	120 [3100]	15000 [1700000]
50-70	2 dia / 1.4 bore [50 dia / 35 bore]	98 [2500]	39 [1000]	20 [500]	14 [360]	2.8 [11]	120 [3100]	14000 [1600000]
50-75	2 dia / 1.5 bore [50 dia / 37.5 bore]	98 [2500]	39 [1000]	20 [500]	14 [360]	2.8 [11]	120 [3100]	13000 [1400000]
50-80	2 dia / 1.6 bore [50 dia / 40 bore]	98 [2500]	39 [1000]	20 [500]	14 [360]	2.8 [11]	120 [3100]	11000 [1200000]
50-85	2 dia / 1.7 bore [50 dia / 42.5 bore]	98 [2500]	39 [1000]	20 [500]	14 [360]	2.8 [11]	120 [3100]	8900 [1000000]
50-90	2 dia / 1.8 bore [50 dia / 45 bore]	98 [2500]	39 [1000]	20 [500]	14 [360]	2.8 [11]	120 [3100]	6400 [730000]
63-60	2.5 dia / 1.5 bore [63 dia / 37.8 bore]	120 [3200]	50 [1300]	25 [630]	18 [450]	2.3 [9]	160 [4000]	33000 [3700000]
63-65	2.5 dia / 1.6 bore [63 dia / 40.95 bore]	120 [3200]	50 [1300]	25 [630]	18 [450]	2.3 [9]	160 [4000]	31000 [3500000]
63-70	2.5 dia / 1.7 bore [63 dia / 44.1 bore]	120 [3200]	50 [1300]	25 [630]	18 [450]	2.3 [9]	160 [4000]	28000 [3200000]
63-75	2.5 dia / 1.9 bore [63 dia / 47.25 bore]	120 [3200]	50 [1300]	25 [630]	18 [450]	2.3 [9]	160 [4000]	26000 [2900000]
63-80	2.5 dia / 2 bore [63 dia / 50.4 bore]	120 [3200]	50 [1300]	25 [630]	18 [450]	2.3 [9]	160 [4000]	22000 [2500000]
63-85	2.5 dia / 2.1 bore [63 dia / 53.55 bore]	120 [3200]	50 [1300]	25 [630]	18 [450]	2.3 [9]	160 [4000]	18000 [2000000]
63-90	2.5 dia / 2.2 bore [63 dia / 56.7 bore]	120 [3200]	50 [1300]	25 [630]	18 [450]	2.3 [9]	160 [4000]	13000 [1500000]

CURL ACTUATORS — TUBE — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
80-60	3.1 dia / 1.9 bore [80 dia / 48 bore]	160 [4000]	63 [1600]	31 [800]	22 [570]	1.8 [7]	200 [5000]	67000 [7500000]
80-65	3.1 dia / 2 bore [80 dia / 52 bore]	160 [4000]	63 [1600]	31 [800]	22 [570]	1.8 [7]	200 [5000]	63000 [7100000]
80-70	3.1 dia / 2.2 bore [80 dia / 56 bore]	160 [4000]	63 [1600]	31 [800]	22 [570]	1.8 [7]	200 [5000]	58000 [6600000]
80-75	3.1 dia / 2.4 bore [80 dia / 60 bore]	160 [4000]	63 [1600]	31 [800]	22 [570]	1.8 [7]	200 [5000]	52000 [5900000]
80-80	3.1 dia / 2.5 bore [80 dia / 64 bore]	160 [4000]	63 [1600]	31 [800]	22 [570]	1.8 [7]	200 [5000]	45000 [5100000]
80-85	3.1 dia / 2.7 bore [80 dia / 68 bore]	160 [4000]	63 [1600]	31 [800]	22 [570]	1.8 [7]	200 [5000]	37000 [4100000]
80-90	3.1 dia / 2.8 bore [80 dia / 72 bore]	160 [4000]	63 [1600]	31 [800]	22 [570]	1.8 [7]	200 [5000]	26000 [3000000]
100-60	3.9 dia / 2.4 bore [100 dia / 60 bore]	200 [5000]	79 [2000]	39 [1000]	28 [710]	1.5 [6]	250 [6300]	130000 [15000000]
100-65	3.9 dia / 2.6 bore [100 dia / 65 bore]	200 [5000]	79 [2000]	39 [1000]	28 [710]	1.5 [6]	250 [6300]	120000 [14000000]
100-70	3.9 dia / 2.8 bore [100 dia / 70 bore]	200 [5000]	79 [2000]	39 [1000]	28 [710]	1.5 [6]	250 [6300]	110000 [13000000]
100-75	3.9 dia / 3 bore [100 dia / 75 bore]	200 [5000]	79 [2000]	39 [1000]	28 [710]	1.5 [6]	250 [6300]	100000 [12000000]
100-80	3.9 dia / 3.1 bore [100 dia / 80 bore]	200 [5000]	79 [2000]	39 [1000]	28 [710]	1.5 [6]	250 [6300]	88000 [10000000]
100-85	3.9 dia / 3.3 bore [100 dia / 85 bore]	200 [5000]	79 [2000]	39 [1000]	28 [710]	1.5 [6]	250 [6300]	71000 [8100000]

CURL ACTUATORS — TUBE — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
100-90	3.9 dia / 3.5 bore [100 dia / 90 bore]	200 [5000]	79 [2000]	39 [1000]	28 [710]	1.5 [6]	250 [6300]	51000 [5800000]

CURL ACTUATORS — FLAT WIRE, FACE (curls about t) — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
0.152x0.411	0.006 x 0.016 [0.152 x 0.411]	0.3 [7.6]	0.12 [3]	0.06 [1.5]	0.043 [1.1]	960 [3800]	0.38 [9.6]	0.0024 [0.27]
0.152x0.813	0.006 x 0.032 [0.152 x 0.813]	0.3 [7.6]	0.12 [3]	0.06 [1.5]	0.043 [1.1]	960 [3800]	0.38 [9.6]	0.0048 [0.54]
0.25x0.5	0.0098 x 0.02 [0.25 x 0.5]	0.49 [12]	0.2 [5]	0.098 [2.5]	0.07 [1.8]	580 [2300]	0.62 [16]	0.0079 [0.9]
0.3x2	0.012 x 0.079 [0.3 x 2]	0.59 [15]	0.24 [6]	0.12 [3]	0.084 [2.1]	480 [1900]	0.74 [19]	0.046 [5.2]
0.406x0.559	0.016 x 0.022 [0.406 x 0.559]	0.8 [20]	0.32 [8.1]	0.16 [4.1]	0.11 [2.9]	360 [1400]	1 [26]	0.023 [2.6]
0.4x0.8	0.016 x 0.031 [0.4 x 0.8]	0.79 [20]	0.31 [8]	0.16 [4]	0.11 [2.9]	360 [1400]	0.99 [25]	0.032 [3.7]
0.4x1	0.016 x 0.039 [0.4 x 1]	0.79 [20]	0.31 [8]	0.16 [4]	0.11 [2.9]	360 [1400]	0.99 [25]	0.041 [4.6]
0.5x0.25	0.02 x 0.0098 [0.5 x 0.25]	0.98 [25]	0.39 [10]	0.2 [5]	0.14 [3.6]	290 [1100]	1.2 [31]	0.016 [1.8]
0.55x1.4	0.022 x 0.055 [0.55 x 1.4]	1.1 [28]	0.43 [11]	0.22 [5.5]	0.15 [3.9]	260 [1000]	1.4 [35]	0.11 [12]

CURL ACTUATORS — FLAT WIRE, FACE (curls about t) — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
0.5x0.8	0.02 x 0.031 [0.5 x 0.8]	0.98 [25]	0.39 [10]	0.2 [5]	0.14 [3.6]	290 [1100]	1.2 [31]	0.051 [5.7]
0.6x2.3	0.024 x 0.091 [0.6 x 2.3]	1.2 [30]	0.47 [12]	0.24 [6]	0.17 [4.3]	240 [960]	1.5 [38]	0.21 [24]
0.8x1.5	0.031 x 0.059 [0.8 x 1.5]	1.6 [40]	0.63 [16]	0.31 [8]	0.22 [5.7]	180 [720]	2 [50]	0.24 [28]
1x2.6	0.039 x 0.1 [1 x 2.6]	2 [50]	0.79 [20]	0.39 [10]	0.28 [7.1]	150 [570]	2.5 [63]	0.66 [75]
1.5x4	0.059 x 0.16 [1.5 x 4]	3 [75]	1.2 [30]	0.59 [15]	0.42 [11]	97 [380]	3.7 [94]	2.3 [260]

CURL ACTUATORS — FLAT WIRE, EDGE (curls about w) — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
0.152x0.411	0.006 x 0.016 [0.152 x 0.411]	0.81 [21]	0.32 [8.2]	0.16 [4.1]	0.12 [2.9]	350 [1400]	1 [26]	0.0065 [0.74]
0.152x0.813	0.006 x 0.032 [0.152 x 0.813]	1.6 [41]	0.64 [16]	0.32 [8.1]	0.23 [5.8]	180 [700]	2 [51]	0.025 [2.9]
0.25x0.5	0.0098 x 0.02 [0.25 x 0.5]	0.98 [25]	0.39 [10]	0.2 [5]	0.14 [3.6]	290 [1100]	1.2 [31]	0.016 [1.8]
0.3x2	0.012 x 0.079 [0.3 x 2]	3.9 [100]	1.6 [40]	0.79 [20]	0.56 [14]	73 [290]	4.9 [130]	0.3 [34]
0.406x0.559	0.016 x 0.022 [0.406 x 0.559]	1.1 [28]	0.44 [11]	0.22 [5.6]	0.16 [4]	260 [1000]	1.4 [35]	0.032 [3.6]

CURL ACTUATORS — FLAT WIRE, EDGE (curls about w) — Curl radius, wrap and moment

Part reference	Section, in [mm]	Radius A, in [mm]	Radius B, in [mm]	Radius C, in [mm]	Radius D, in [mm]	Wrap C, deg/in [deg/100 mm]	One turn C, in [mm]	Moment C, in·lbf [N·mm]
0.4x0.8	0.016 x 0.031 [0.4 x 0.8]	1.6 [40]	0.63 [16]	0.31 [8]	0.22 [5.7]	180 [720]	2 [50]	0.065 [7.3]
0.4x1	0.016 x 0.039 [0.4 x 1]	2 [50]	0.79 [20]	0.39 [10]	0.28 [7.1]	150 [570]	2.5 [63]	0.1 [11]
0.5x0.25	0.02 x 0.0098 [0.5 x 0.25]	0.49 [12]	0.2 [5]	0.098 [2.5]	0.07 [1.8]	580 [2300]	0.62 [16]	0.0079 [0.9]
0.55x1.4	0.022 x 0.055 [0.55 x 1.4]	2.8 [70]	1.1 [28]	0.55 [14]	0.39 [10]	100 [410]	3.5 [88]	0.27 [31]
0.5x0.8	0.02 x 0.031 [0.5 x 0.8]	1.6 [40]	0.63 [16]	0.31 [8]	0.22 [5.7]	180 [720]	2 [50]	0.081 [9.2]
0.6x2.3	0.024 x 0.091 [0.6 x 2.3]	4.5 [120]	1.8 [46]	0.91 [23]	0.65 [16]	63 [250]	5.7 [140]	0.81 [91]
0.8x1.5	0.031 x 0.059 [0.8 x 1.5]	3 [75]	1.2 [30]	0.59 [15]	0.42 [11]	97 [380]	3.7 [94]	0.46 [52]
1x2.6	0.039 x 0.1 [1 x 2.6]	5.1 [130]	2 [52]	1 [26]	0.73 [19]	56 [220]	6.4 [160]	1.7 [190]
1.5x4	0.059 x 0.16 [1.5 x 4]	7.9 [200]	3.1 [80]	1.6 [40]	1.1 [29]	36 [140]	9.9 [250]	6.1 [690]

NOTES

NOTES

CHAPTER 14

Plates and Sheets

Bending driven by thickness

Sheet is the starting point for anything flat. It bends, it can be cut to any outline, and it actuates through its thickness.

Most of what it is used for is not in this table, because most of it is cut to a shape that only exists in one design. Clips, latches, hinges, blades, flexures, and the multi-axis parts where several motions are cut into a single piece. If you are designing one of those, the numbers here tell you what the material will do and the shape is up to you.

Thickness decides everything

In bending, the strain is set by how thick the material is and how tightly it is curved. That gives two numbers worth knowing.

THE MINIMUM BEND RADIUS is half the thickness divided by the strain you are willing to use. Thin sheet bends tightly, thick sheet does not. The table lists this for the gentlest and the middle design levels.

THE BEND ANGLE PER UNIT LENGTH is the reverse of that. A thin sheet gives many degrees over a short length; a thick one gives a few degrees over a long one.

MOMENT, which is what does the work, goes with the square of the thickness. Double the thickness and you get four times the bending moment and half the angle.

One plate, several temperatures

Everywhere else in this handbook the transition temperature is a single number chosen for the whole part, and it decides only when the part moves. A sheet does not have to work that way. A sheet is usually cut into a shape with several features in it, and those features do not have to share a temperature.

Different regions of one plate can be set to different transition temperatures. Warm the part and it no longer moves all at once. The lowest region goes first, then the next, then the next. One piece of metal, one heat source, no controller, and a sequence of motions in a fixed order.

That turns a plate into a mechanism. A clip that releases its grip before it swings clear. A panel that unfolds in stages. A latch that cocks itself before it fires.

Nor are you held to the temperatures in the spec panel. A sequenced plate is a custom part by definition, so each region is set to whatever its step in the sequence needs, at whatever spacing keeps the steps apart.

The same idea works the other way round. Give each region its own current path and heat them separately, and they become independent actuators that happen to share a piece of metal, with the order chosen while the part is running rather than fixed when it was made.

It is also a way to make a part that reports on its own history. Regions set to three temperatures of your choosing will tell you which of them the part has passed by what it has done, and if the motions are set one way so they do not reverse on cooling, that record survives the part cooling down again. No electronics at all.

None of this is in the table, which is for a plain sheet at one temperature. Sequenced parts are engineered to the job, so bring us the order of operations you need.

Getting it back

Like every shape in this handbook, a nitinol actuator moves one way when it is heated. Getting it back to where it started is the designer's problem, and there are three ways to solve it.

AN ANTAGONISTIC PAIR uses a second actuator working against the first. Heat one and it moves the mechanism and resets the other; heat the other and it goes back. You get powered motion in both directions with full output each way, at the cost of two actuators and a control scheme that never heats both at once.

A BIAS is a passive element, usually a conventional spring or a weight, that the actuator works against as it moves and that pushes it back as it cools. It is the simplest arrangement and the most common. The price is that the bias resists the actuator through the whole stroke, so part of the force in the table is spent returning the mechanism rather than doing the job. Size it to return the actuator and no more.

SYSTEM FORCES are the return you already have. If the mechanism pushes back on its own, if gravity closes the door, if the thing being clamped is springy, if line pressure acts on the valve, that force resets the actuator for nothing. It is the best answer when it is available, and worth looking for before adding parts.

Whichever you choose, the return has to be strong enough to reset the actuator while it is cool and weak enough not to stall it while it is hot. That window is what sizes a bias, and it is the most common thing to get wrong on a first build.

There is a fourth possibility. Any nitinol actuator can be given a two way set, so that it takes one shape hot and another cold and needs no return at all. Two way parts are made to order and are outside the scope of this handbook, so nothing here is rated for it, but it exists. Ask.

Overdriving an actuator

The figures in this handbook are conservative. Every force in every table is rated at a stress we are confident the part will deliver, cycle after cycle, at the fatigue life of its design level. A part will usually do more than the table says. We would rather you found that out in testing than the other way round.

The second reason a part will beat its table is that you can overdrive it, and this one is a feature you can design with. There are two ways to do it, and they add.

The first is to heat it further. Nitinol makes its force by changing phase, and the temperature at which it does that is the transition temperature we set for you. The force does not stop climbing when the part gets there. Keep heating it past the transition and the force keeps rising with temperature, well beyond the rated figure. The table gives you the force at a working temperature comfortably above transition. Drive the part hotter and there is more.

The second is to heat it faster. Heat the part slowly and it makes the force in the table. Heat it quickly, with a sharp pulse of current rather than a gentle ramp, and it makes more, and the harder the pulse, the bigger the difference. A part that is driven both fast and hot gets the gain from each, one on top of the other. The tables assume neither. They are the floor.

Emergency mode

That gives a nitinol actuator something most actuators do not have: a reserve. A motor or a solenoid has a rated output and a thermal limit close behind it. A nitinol actuator can be driven, briefly, to a force well above its rating simply by putting more heat into it, faster. Think of it as an emergency mode. A latch that normally needs a modest pull can, on the day something jams, be hit with a short hard pulse and told to pull much harder. A release that must not fail gets a margin that costs nothing in size or weight.

Use it as a reserve, not as the rating, and know where the limits are. There is a temperature, called Md, above which the metal can no longer be pushed into martensite by stress; up to Md the material is still behaving as nitinol should. Overdriving up to Md costs some fatigue life, but it also does the part a favor: the extra heat drives out residual martensite that builds up over many cycles, a kind of rehabilitation in place, so a part that is occasionally run hard can come back sharper than one that never is. Above Md the accounting changes. Degradation is faster, and each hot cycle takes a larger bite out of the life. Above 350 °C (660 °F) the part is past saving: treat an actuator that has been driven that hot as spent and replace it. Used within those limits, for the rare event, emergency mode is one of the best arguments for the material.

Actuator safety

Most actuators fail badly when they are overdriven, and engineers know exactly how. Put too much current into a motor or a solenoid and it explodes. Overpressure a hydraulic cylinder and it bursts, or springs a pinhole leak, and a jet of oil at that pressure will cut through a glove and a hand, take a limb, and put oil into the ground and the water where it can be years being cleaned up. Every one of them has the same problem: the energy is stored in the actuator, and when something goes wrong it has nowhere to go but out. A nitinol actuator, very simply, does not carry these risks. It is a piece of metal with a current in it, and there is nothing in it to burst, nothing to leak, and nothing to poison.

A nitinol actuator fails the other way. Put too much power into it and it simply gets hotter. Past the working range the force keeps rising; past that, the part reaches the temperatures at which it was shape set, and at that point the metal lets go of its memory. The actuator loses its force, goes slack, and parts, which opens the circuit that was heating it. It shuts itself off. There is nothing stored in it to release: no pressure, no winding, no field. The failure mode is a dead part and an open circuit, not an event.

That is worth stating plainly for anyone writing a safety case. The worst thing an overdriven nitinol actuator does is stop.

What we supply

Thickness	0.1 to 10 mm.
Width	150 mm as standard.
Length	Sold in 25 mm steps, continuous unless specified.
Transition temperatures	20 C, 35 C, 45 C and 80 C, plus super elastic.
Custom	Cut to your outline. Send us a drawing.

Note that the 20 C grade behaves as a super elastic material at room temperature rather than as an actuator. If you need the sheet to do work, choose 35 C or above.

PLATES AND SHEETS — Bending moment and bend angle. Width 150 mm, sold in 25 mm length steps.

Part reference	Thickness, in [mm]	Moment A, in·lbf [N·m]	Moment B, in·lbf [N·m]	Moment C, in·lbf [N·m]	Moment D, in·lbf [N·m]	Bend C, deg/in [deg/100 mm]	Min radius C, in [mm]	Min radius A, in [mm]
0.1	0.0039 [0.1]	0.27 [0.03]	0.27 [0.03]	0.35 [0.04]	0.53 [0.06]	1500 [5700]	0.039 [1]	0.2 [5]
0.15	0.0059 [0.15]	0.53 [0.06]	0.71 [0.08]	0.89 [0.1]	1.2 [0.14]	970 [3800]	0.059 [1.5]	0.3 [7.5]
0.25	0.0098 [0.25]	1.4 [0.16]	1.9 [0.22]	2.4 [0.27]	3.5 [0.39]	580 [2300]	0.098 [2.5]	0.49 [12]
0.5	0.02 [0.5]	5.5 [0.62]	7.6 [0.86]	9.5 [1.1]	14 [1.6]	290 [1100]	0.2 [5]	0.98 [25]
0.75	0.03 [0.75]	12 [1.4]	17 [1.9]	21 [2.4]	31 [3.5]	190 [760]	0.3 [7.5]	1.5 [38]
1	0.039 [1]	22 [2.5]	31 [3.5]	38 [4.3]	55 [6.2]	150 [570]	0.39 [10]	2 [50]
1.5	0.059 [1.5]	50 [5.6]	69 [7.8]	86 [9.7]	120 [14]	97 [380]	0.59 [15]	3 [75]
2	0.079 [2]	89 [10]	120 [14]	150 [17]	220 [25]	73 [290]	0.79 [20]	3.9 [100]
2.5	0.098 [2.5]	140 [16]	190 [22]	240 [27]	350 [39]	58 [230]	0.98 [25]	4.9 [120]
3	0.12 [3]	200 [22]	280 [31]	340 [39]	500 [56]	49 [190]	1.2 [30]	5.9 [150]
4	0.16 [4]	350 [40]	490 [55]	610 [69]	880 [100]	36 [140]	1.6 [40]	7.9 [200]
5	0.2 [5]	550 [62]	760 [86]	950 [110]	1400 [160]	29 [120]	2 [50]	9.8 [250]
10	0.39 [10]	2200 [250]	3100 [340]	3800 [430]	5500 [620]	15 [57]	3.9 [100]	20 [500]

NOTES

NOTES

APPENDIX A

One Thousand and One Nitinol Dad Jokes

Humor is a presentation tool. This is the toolbox.

Why this is in a handbook

Sooner or later the engineer who chose this material has to stand in front of the people who control the budget and explain it. That is a harder room than a design review. The mechanism has no motor, no gearbox, no pump and no hydraulic lines, which sounds less like an improvement and more like something is missing. The material is unfamiliar. The physics takes two minutes to explain, and the first ninety seconds are the ones where attention is lost.

A laugh solves a problem that another slide cannot. It buys back the attention of a room that has been in meetings all morning, it makes an unfamiliar material feel approachable rather than exotic, and it gives the person presenting something to do with the pause while the idea lands. A room that laughs once will ask a question, and a question is where the real conversation starts.

So this appendix is working material. The jokes are here to be stolen, put on a slide, dropped into an email above a quotation request, or used on the person at the next desk who asked what the wire was for. They are sorted by subject, which includes the holidays, for the presentation that lands the week of one.

How to use them

One joke per presentation. Two if the room is friendly. Put it where the attention sags: after the fatigue life numbers, before the budget slide, or at the point where someone is about to ask what happens when it fails. The answer to that one is in every chapter of this handbook, and it is funnier when the room is already smiling.

Some of these are edgy. You know your room and we do not, so read ahead before you read aloud. There are one thousand and one of them, which is one more than a round number, since a material that will not sit still at the shape you gave it should not have a handbook that does either.

The jokes

Core shape memory

1. Nitinol never holds a grudge. It holds a shape.
2. Why did the nitinol wire get invited back every year? It always remembers how things were.
3. My nitinol actuator started therapy. Turns out it can't let go of its original form.
4. I bent a nitinol wire completely out of shape. It warmed up to me anyway.
5. What do you call nitinol that forgot? Steel.
6. Nitinol is the only employee that reliably returns to the position it was hired for.
7. Nitinol doesn't carry baggage. It carries a shape set.
8. I asked the spring how it was doing. It said it had been through a lot, but it bounced back.

9. Nitinol is proof that you can go back to who you were. You just need the right temperature.
10. The wire and I had a falling out. Then things got heated, and it came right back to me.
11. Why is nitinol bad at moving on? Austenite is a hell of a drug.
12. Nitinol remembers everything, which makes it wonderful in a machine and terrible at parties.
13. What's a nitinol wire's favorite song? Anything with a good recovery.
14. Our competitor's actuator forgets its shape. We call that a rod.
15. Nitinol: the only material that improves after you push it around.
16. I told the nitinol wire to be flexible. It said it already was, then went right back to its old position.
17. The difference between nitinol and a goldfish is about three seconds and one phase transformation.
18. Nitinol was going to forgive and forget, but it only does one of those.
19. My wire has commitment issues. It commits too hard, to one shape, forever.
20. Nitinol doesn't need closure. It needs about eighty degrees.
21. He said, "Nice set." She said, "Shape set." They are still not talking about the same thing.

Superelastic

22. Superelastic nitinol has no memory and no regrets. We call that living in the moment.
23. The superelastic wire is the one at the party who bends over backwards and still won't take a hint.
24. Superelastic nitinol snaps back so fast it's technically a comeback artist.
25. What do you get when you kink superelastic nitinol? Disappointed, briefly.
26. Superelastic wire doesn't actuate. It just refuses to stay bent, which is its own kind of statement.
27. Superelastic is what nitinol is like before it's had its coffee heated.
28. Our superelastic wire has no memory. Our lawyers appreciate it.
29. Superelastic nitinol is the only thing in the shop more stubborn than the shop foreman.

Transition temperature

30. Why did the actuator refuse to work in the walk-in freezer? It hadn't reached its transition yet.
31. My nitinol wire is a morning person. It won't do a thing until it warms up.
32. Nitinol only performs under pressure and heat. So, a chef.
33. The 80 degree wire and the 35 degree wire broke up. Irreconcilable differences in when to act.
34. What's the difference between a nitinol actuator and my brother-in-law? The actuator does something when you heat it up.
35. Transition temperature is just nitinol's alarm clock.
36. I told my wire to stay cool. It just hung there, doing nothing. Perfect compliance.
37. Nitinol runs on hot takes.
38. The actuator doesn't procrastinate. It's waiting for the right temperature, which is a completely different thing.
39. A nitinol wire walks into a sauna and immediately gets to work. Unlike everyone else in there.

Fatigue and cycles

40. Level A gives you a million cycles. Level D gives you a hundred. Marriage counseling is somewhere in between.

41. What do you call an actuator with a hundred cycles left? Optimistic.
42. Nitinol at seven percent strain lives fast and dies young, but it moves beautifully.
43. My actuator ran a million cycles without complaining. I've had coworkers do fewer.
44. The wire asked for a raise. I gave it more strain instead. Now it has a shorter career.
45. Fatigue life is just nitinol's retirement plan.
46. How do you shorten an actuator's life? Overdrive it. How do you shorten an engineer's? Same answer.
47. Nitinol doesn't get tired. It gets fatigued. There's paperwork on the difference.
48. We rate it for a million cycles. After that it's not broken, it's emeritus.
49. Our actuators don't burn out, they fade away. Slowly. Over ten thousand cycles.

Shop floor and manufacturing

50. The fires of the shape setting furnace judge every wire. It emerges with a purpose it will never question and a temper it cannot lose.
51. We don't manufacture actuators. We give wire a childhood it can't escape.
52. What's shape setting? Parenting, but for metal.
53. Our shape set fixture has seen things. Mostly wire, but still.
54. Never tell nitinol it can be anything it wants. It'll pick one and never budge.
55. The forming press and the nitinol have an understanding: it goes where it's told, once.
56. How many engineers does it take to bend nitinol? One. Keeping it bent is the hard part.
57. I put a wire in the fixture and it came out with a personality.
58. Why do we heat treat in batches? Because group therapy is cheaper.
59. The apprentice asked why we anneal. I said so the metal forgets what we did to it earlier.

Aerospace

60. They fold a wingtip in flight with wire. Somewhere a hydraulics engineer is still explaining why his version needed a pump, a reservoir and a man with a mop.
61. Why did the satellite choose a nitinol actuator? It needed something that worked after eight years of doing nothing.
62. In space nobody can hear your solenoid fail. They can, however, see your nitinol work.
63. Aerospace loves nitinol: no pumps, no lines, no leaks, no lawyers.
64. The hydraulic cylinder asked the nitinol actuator its weight. The nitinol said, "A gentleman does not ask a lady her weight." The hydraulic cylinder, all forty pounds of it, apologized.
65. Nitinol is the only aerospace component that gets lighter when you remove the parts around it.
66. A wingtip that folds itself sounds like science fiction until you read the weight savings.
67. What do you call a deployment mechanism with no moving parts? Deployed.
68. Explosive bolts and nitinol separation actuators do the same job. One you can test in your hand.
69. The pyrotechnic guy and the nitinol guy walk into a bar. Only one of them gets through security.

Medical and surgical

70. A nitinol stent walks into an artery and immediately opens up. Best guest ever.
71. Superelastic wire in a catheter is the only thing in the operating room that doesn't take a set.

72. Nitinol in the body is the ultimate guest: it shows up cold, warms up, does the job, stays forever.
73. The surgeon asked for something that remembers its shape. I asked if she meant the wire or the resident.
74. Why do guidewires use nitinol? Because kinking is not a feature anyone wants mid-procedure.
75. Nitinol goes in small and gets big. So does the invoice.
76. A stainless guidewire takes a set. A nitinol guidewire takes the lead.
77. Our wire goes places I would rather not think about and comes back the same shape.
78. Body temperature is nitinol's favorite working environment. Ninety eight point six is a very reasonable request.
79. The difference between a nitinol implant and a New Year's resolution is that the implant actually reverts.

Dental and orthodontic

80. Braces made my teeth straight and my wallet flat. Only one of those had a shape memory.
81. Nitinol archwire: the only thing in high school with a clear plan for your future.
82. My orthodontist explained superelasticity. I explained my payment plan. Neither of us listened.
83. Nitinol in braces works slowly and relentlessly, like a mother-in-law.
84. Why are nitinol archwires so effective? They never stop gently insisting.
85. The archwire knows what your smile should look like and it will not be negotiated with.

Valves and oil and gas

86. A nitinol valve actuator has no motor, no gearbox, and no opinions about your control system.
87. Downhole is hot, dirty and unreachable. Nitinol does not care about two of those.
88. Why put nitinol in a wellhead? Because the nearest technician is four hours and a helicopter away.
89. A solenoid in a hazardous area is a permit. A nitinol actuator is a part.
90. The valve guy asked how many moving parts. I said one. He asked which one. I said the valve.
91. Our actuator is intrinsically boring, which in a refinery is the highest possible compliment.
92. Nothing says confidence like an actuator with no seals to fail.
93. An engineer walks into a valve conference and says "no hydraulics." The room goes quiet, then hostile, then interested.

Automotive

94. Why put nitinol in a car? Because every gram of actuator is a gram of not-battery.
95. Nitinol in the engine bay: already at temperature, already working.
96. A latch that weighs nothing and never rattles. That's the whole pitch.
97. Detroit asked what it costs. I said less than the four parts it replaces. They asked again anyway.
98. The louvers open themselves when the engine warms up. No sensor, no motor, no code, no recall.
99. Every car has thirty motors. At least six of them are auditioning for a wire.

Robotics and prosthetics

100. Muscle wire is the only actuator that flexes without going to the gym.

101. A robot hand with nitinol tendons is quiet, which is deeply unsettling.
102. Nitinol makes robots that move like living things and fail like metal. Best of both.
103. Why are nitinol fingers better? No gearbox whine, no backlash, no uncanny buzzing.
104. A prosthetic that pulls like a muscle instead of whirring like a printer. That's the difference.
105. The robot asked for a raise. I gave it a longer wire.

Cooling and elastocaloric

106. Elastocaloric cooling: squeezing metal until it gets cold. Not unlike the procurement process.
107. A refrigerator with no refrigerant sounds impossible until you remember metal has feelings about stress.
108. Nitinol gets cold when you let it relax. Same, honestly.
109. Solid state cooling, no gas, no compressor, no leak. Just a wire having a hard day.

Fire suppression and safety

110. A single use actuator does one job, once, perfectly, and then falls away. Like a groomsman.
111. Fire suppression needs a hold that lets go completely. Nitinol is very good at completely.
112. Two hundred fifty percent strain is a lot of commitment for one afternoon.
113. Why does nitinol fail safe? Because when it gets too hot it just gives up, which is the most reasonable response to a fire.
114. The best thing an overdriven nitinol actuator does is stop. Ask a hydraulic cylinder what it does.
115. Our failure mode is a dead part and an open circuit. The competition's failure mode has a blast radius.

Christmas

116. Santa checks his list twice. Nitinol only had to be told once.
117. Nitinol Christmas lights: they untangle themselves when you plug them in. Someday.
118. What do you get a nitinol wire for Christmas? Nothing. It already has everything it remembers.
119. The Christmas tree stand is nitinol. It opens when the room warms up and closes in January like everyone else.
120. Nitinol makes a terrible stocking stuffer and an excellent stocking hanger.
121. Our holiday party ended the way all our products do: everyone went back to their original position.
122. Why did the nitinol snowflake never melt? It just went superelastic and waited it out.
123. Grandma's fruitcake and nitinol have one thing in common: they both remember 1987.
124. Nitinol angels on top of the tree deploy themselves at room temperature. Slightly ominous, very efficient.
125. The reindeer harness is nitinol now. Turns out Rudolph runs hot enough to actuate it.

Hanukkah

126. Eight nights, one wire, and it went back to its original shape every single morning.
127. A nitinol menorah would be a fire hazard and an excellent actuator demo, in that order.
128. The oil lasted eight days. The nitinol actuator is rated for a million cycles. Miracles have gotten more industrial.

129. Nitinol dreidels always land on the same side. We shape set them that way. Do not play us for money.

Easter and Passover

130. Nitinol is the only metal with a documented resurrection at thirty five degrees.
131. Why hide nitinol Easter eggs? They come back to you anyway.
132. The seder plate is nitinol. It remembers everything, which is rather the point.
133. Four questions, one answer: because it remembers its shape.
134. Nitinol matzo would still be flat, but it would be flat on purpose.

Ramadan and Eid

135. Nitinol fasts all day and does all its work after the sun goes down and the temperature drops. Wait, that's backwards.
136. A wire that waits patiently and then acts decisively at exactly the right moment has more discipline than I do.

Diwali

137. Festival of lights, and every one of them warm enough to actuate something.
138. Nitinol diyas would hold their shape all night, which rather spoils the metaphor about impermanence.

Thanksgiving

139. The turkey pop up timer is a nitinol actuator's less ambitious cousin.
140. Thanksgiving is when the family gets heated, everyone reverts to their original form, and we call it tradition. Very nitinol.
141. I explained shape memory alloys at Thanksgiving dinner. My family also has a memory, and they bring it up every year.
142. Uncle Ray got bent out of shape at dinner and, unlike nitinol, stayed that way.
143. We deep fried a nitinol turkey lifter. It works, and it has opinions now.
144. What's the most nitinol thing about Thanksgiving? Everyone goes back to exactly who they were in high school.

New Year

145. New Year's resolutions and nitinol both revert to the original shape. One of them does it on purpose.
146. Ring in the new year with a metal that refuses to change. Wait.
147. My resolution is to be more like nitinol: work hard when things heat up, do nothing when they don't.
148. The ball drops, the crowd cheers, and somewhere a nitinol actuator quietly did its job without being thanked.

Fourth of July

149. Nitinol separation actuators: all the release, none of the shrapnel. Independence Day for your safety officer.
150. We replaced the explosive bolt with a nitinol actuator. The fireworks budget was reallocated to snacks.
151. Fourth of July is the one day a year our separation actuators feel underappreciated.
152. Nothing is more American than a part that works harder when you apply more power. Up to a point.

Memorial Day and Veterans Day

153. Nitinol goes into the aircraft that come home. That's the whole job.
154. A part that never fails to let go when it's told is the kind of reliability that matters more than a joke.

Labor Day

155. Labor Day: the one day nitinol and I have the same plan, which is to stay cool and do nothing.
156. Our actuators have no union, no breaks and no complaints, but they do have a hard stop at a million cycles.

Halloween

157. Nitinol is the only metal that comes back from the dead every time you warm it up.
158. The haunted house door closes by itself. It's nitinol. That's scarier, somehow.
159. What's a nitinol wire's costume? Whatever it was shape set as. It has no choice.
160. Frankenstein's monster was just a very large actuator with a heating problem.
161. Nitinol skeletons assemble themselves at room temperature. We do not sell these. Yet.
162. Trick or treat: heat the wire and see which one you get.

Valentine's Day

163. Nitinol always comes back to you. Set boundaries accordingly.
164. Roses are red, nitinol's gray, bend it all night and it'll still be the same shape in the morning.
165. My love is like a nitinol wire: it remembers everything and it will bring it up when things get heated.
166. A heart shaped nitinol wire that reforms when you hold it is either the sweetest gift or a restraining order waiting to happen.
167. Nitinol: hot enough to commit, cool enough to be pushed around.
168. Some couples grow apart. Nitinol contracts.
169. What do you call a nitinol wedding ring? A promise with a temperature rating.

Mother's Day

170. Nitinol has a memory like a mother: nothing is ever truly forgotten and it comes up when things get warm.
171. Mom always said I'd come back around eventually. She was describing shape memory alloys.
172. A mother's love and a nitinol actuator both pull you back no matter how far you stretch.

Father's Day

173. Dad jokes and nitinol have the same mechanism: apply heat, get the same reaction you got last year.
174. My father never changed his position on anything. Turns out he was shape set at the factory.
175. I told my dad about nitinol. He said "so it's stubborn metal." That is, annoyingly, the whole datasheet.

Weddings and anniversaries

176. Marriage is a two way shape memory effect: one shape when things are warm, another when they're cool.
177. Our anniversary gift guide says the first is paper and the fiftieth is gold. The million cycle is nitinol.
178. What do nitinol and a good marriage have in common? Both survive being bent, as long as nobody exceeds the strain limit.
179. The wedding toast: may you both return to your original shape, and may that shape be a good one.

Birthdays

180. Nitinol doesn't age, it accumulates cycles. Which is the same thing with better branding.
181. Happy birthday. You have used approximately zero point zero zero three percent of your fatigue life.
182. The candles are the actuator. The cake is the load. The wish is the control system.

St. Patrick's Day

183. Nitinol is not green, but it does bend, come back, and cause arguments. Close enough.
184. A nitinol shamrock stays shut until you warm it, which is the most Irish thing about it: it opens at the pub.

April Fools

185. April Fools: we told the intern nitinol has a memory, then asked him to apologize to a spring.
186. The prank is that the wire actually does remember. That's not a joke, that's the product.

Sales, procurement and engineering culture

187. The customer asked for something smaller, lighter, stronger and cheaper. I gave him three out of four and a phone number.
188. Every engineer says "that can't work" once, then orders samples twice.
189. The spec said "no moving parts." I said "how about no parts." They booked a meeting.
190. An engineer will spend six months designing around a motor rather than spend twenty minutes reading about a wire.
191. The RFQ asked for a solenoid. I sent a wire and an apology in advance.
192. What's the hardest part of selling nitinol? Convincing people the easy part is the easy part.
193. The purchasing agent asked why it costs more than a spring. Because it's not a spring, Gary.
194. We don't have a handbook problem, we have a five hundred page handbook and a fifteen second attention span.

Machine shop and maker

195. You can't machine nitinol so much as negotiate with it.
196. Nitinol work hardens faster than a new hire's attitude.
197. Every shop has one guy who insists he can drill it. Every shop has one broken drill to prove otherwise.
198. Cutting nitinol dulls your tools and your optimism at roughly the same rate.
199. EDM exists because somebody tried to mill nitinol and needed a new career path.
200. My tool crib has a special drawer for the bits that met nitinol.

Edgy

201. Nitinol is like an ex: you can move on, but the second things heat up it's right back where it was.
202. Our actuator has a hundred cycle rating. So does my patience.
203. The wire and I have the same problem: everyone wants to stretch us and nobody wants to warm us up first.
204. Nitinol works great under pressure, which is more than I can say for anyone in that meeting.
205. Overdrive it past three fifty and it's spent. Same as any of us after a trade show.
206. Hydraulics leak, motors burn, solenoids explode, and nitinol just quietly gives up. Guess which one I relate to.
207. We say the actuator is "rated for a hundred cycles." HR says I'm rated for about four.
208. The customer wanted something that works cold. I said so did I, and here we both are.
209. Nitinol has one setting and no capacity for growth, which is why it's employee of the month again.
210. My actuator has better boundaries than I do: it does one thing, once, and then it's done.
211. What's the difference between a nitinol actuator and a consultant? The actuator actually returns to its position.
212. The failure mode is graceful. Unlike mine.
213. Nitinol will take whatever you give it and come back for more, which is either resilience or a red flag.
214. I told the wire I needed space. It contracted.
215. The engineer asked if it could pull harder. I said yes but it'll die young. He said "so will I," and ordered.
216. It only performs when things get hot, and it's done in under a second. Design accordingly.
217. Our actuator does not know when to quit, which we sell as a feature and treat as a warning.
218. Nitinol is the only thing in this building that reverts cleanly after a bad quarter.
219. You can push it, pull it, twist it, and overheat it, and it'll still show up Monday. We should all be so employable.

Deep cuts for people who read the handbook

220. Face wound for force, edge wound for travel. Marriage advice, too, probably.
221. A Slinky is an edge wound coil that never found steady work.
222. The form is the gear ratio, which is a sentence that has cost me four dinners and won two contracts.
223. Solid height is where a spring's ambitions end.
224. Tight pitch pulls, open pitch pushes. Everything else is just personality.

225. Belleville washers: enormous force, almost no travel, exactly like an argument with my brother.
226. A torque tube's swing depends only on its outside diameter, which is the most reassuring sentence in engineering.
227. The curl actuator does three things at once and none of them have a competitor. That's not a joke, that's chapter thirteen.
228. The stroke column says seventeen times its own length. The assembly says absolutely not.

Deployable

229. Are you happy to see me, or is that nitinol in your pocket?
230. It's not a big actuator. It's just fully deployable.
231. My wire is compact until it isn't. We call that deployable.
232. Everything about me is deployable, given the right conditions and a little warmth.
233. She asked if it was always that size. I said no, it's deployable.
234. The best thing about a deployable actuator is that it knows exactly when to show up.
235. Deployable means it stays out of the way until the moment it matters. Be like the wire.
236. What's the difference between a deployable and a disappointment? About forty degrees.
237. Folded, it fits in a shoebox. Deployed, it fits your whole roof. That's the pitch and that's the joke.
238. A deployable structure is just an actuator with good posture.
239. It launched small and arrived enormous. Every satellite engineer's dream and every dating profile's lie.
240. Deployables: the only product line where "it grew on me" is a spec.
241. Nitinol deploys on warmth alone, no motors, no pyros, no excuses.
242. My antenna is deployable. My personality is not.
243. The whole thing packs flat and opens itself. If only luggage worked that way.
244. Deployable, reusable, and it remembers what you did to it. Two of those are selling points.
245. What do you call a deployable that won't deploy? A paperweight with a heritage.
246. In space, deployable is the difference between a mission and a very expensive brick.
247. Everything is deployable if you're brave enough about the temperature.
248. Our actuator is rated deployable. My back, as of last Tuesday, is not.

Edgy, in the same spirit

249. Is that a torque tube in your pocket or are you just glad the meeting ended?
250. It's not the size of the wire, it's the transition temperature.
251. She said she wanted something that lasts a million cycles. I said let's start with one.
252. My actuator performs best when things get hot and it's over in about a second. I've stopped taking it personally.
253. He asked if it gets bigger. I said only if you heat it. He booked a demo.
254. Buy the thick wire. Nobody ever complained about too much force.
255. The wire doesn't need encouragement, just a current.
256. It's small, it's quiet, and it does exactly what it's told. My wife asked if they make a husband version.
257. What do nitinol actuators and I have in common? We both need a warm environment and a firm mounting.

258. She said it was the smallest one she'd ever seen. I said thank you, that's the micro spring line.
259. My competitor's part is bigger. Mine actually does something.
260. It won't work cold and it won't stop once it's warm. I have the same review on my performance appraisal.
261. Some people need a motor, a gearbox and a controller. I just need heat and a good attitude.
262. A hundred cycles at seven percent, or a million at one. Everyone has to decide what kind of life they want.
263. The trade show booth next to ours had a motor running all day. Ours just quietly twitched and outsold them.
264. Our actuator has never once failed to rise to the occasion, provided the occasion is above thirty five degrees.
265. The datasheet says "contraction only." Sometimes you just have to work with what you've got.
266. I like my actuators like I like my arguments: short, forceful, and fully reversible.
267. It's not that it can't push. It's that nobody gave it the pitch to work with.
268. The wire is patient, silent, and absolutely relentless once it starts. Hire accordingly.

More holidays

269. Groundhog Day is just an actuator with a six week reset period.
270. On Groundhog Day, nitinol pops out, sees its own shadow, and goes right back to its original shape.
271. Leap Day: the one day every four years we admit the calendar has a fatigue life.
272. Tax Day is when everyone in this building reverts to their original form, and that form is panic.
273. Super Bowl Sunday: the only day of the year my actuator and my brother-in-law both fail to move.
274. Black Friday, when Americans demonstrate superelastic behavior in a doorway.
275. Cyber Monday: buy nitinol online, receive it in a shape you did not order, warm it, receive it again correctly.
276. Presidents Day: a day to honor leaders who never changed their position. Very nitinol.
277. Oktoberfest and nitinol both perform better warm and both leave you bent over.
278. Cinco de Mayo is the only holiday with a better transition temperature than our 35 C alloy.
279. Mardi Gras: everything gets heated, everyone reverts by morning, nobody remembers the shape set.
280. Boxing Day is when nitinol goes back in the box and, being nitinol, fits perfectly.
281. Arbor Day: plant a tree, or plant a wire and watch it grow at a controlled rate, your call.
282. Earth Day is our day. No hydraulic fluid, no refrigerant, no leaks, no spill kit.
283. Pi Day and nitinol both involve circles that do not end where you expect.
284. Talk Like a Pirate Day: our wire arrrrrrrctuates.
285. Daylight Savings is the world's largest uncontrolled transition event.
286. The Super Bowl halftime show and a nitinol actuator both peak fast and cool off slowly.

More industry

287. Eyewear frames are the one product where "it remembers its shape" is the entire marketing budget.
288. Sat on my glasses. They sat back up. Superelastic frames are the only apology I get these days.

289. Marine hardware and nitinol: salt water kills everything except the one alloy that doesn't care.
290. Nuclear likes nitinol because it does not need a person standing next to it with a wrench.
291. Semiconductor fab wants zero particles, zero outgassing and zero motors. Two out of three is a wire.
292. Agriculture asked for an actuator that survives mud, ice and a teenager driving the tractor.
293. Mining asked for something with no hydraulics underground. We said hello.
294. Textiles: a fabric that tightens when you get warm. Uncomfortable at first, then a business.
295. HVAC dampers that open themselves when the duct warms up. No wire run, no controller, no commissioning.
296. Packaging wanted a tamper seal that only opens once and only above a temperature. That's a single use actuator with a nicer name.
297. Firefighting gear that vents when it gets too hot is the kind of product that writes its own brochure.
298. The connector guys wanted a breakaway that resets. Nitinol said hold my coffee.
299. A 110 pin connector that disconnects itself in an emergency: either brilliant engineering or the world's most dramatic exit.
300. The demo car has nitinol in it. So does the demo car's repair bill, but for different reasons.
301. Consumer products want cheap. Aerospace wants light. Medical wants small. Nitinol says pick two and call me.
302. E-commerce taught me that a five hundred page handbook and a product listing are two very different animals.
303. Selling actuators on Amazon is like selling wine at a gas station: the right customer is out there, somewhere, confused.

Trade show and meeting

304. The booth demo is a wire, a battery and a paperclip. It has closed more deals than the brochure.
305. Nothing sells nitinol like handing someone a bent wire and a lighter.
306. Every trade show has one engineer who says "I've been waiting twenty years for someone to do this properly."
307. The other booths had screens. We had a wire that moved. Guess which one drew a crowd.
308. I've explained shape memory four hundred times this week and I still lead with "watch this."
309. A trade show is just a heat cycle for salespeople: apply pressure, apply heat, watch everyone revert by Friday.
310. The best question I got at the show: "so it's a muscle?" Yes. Yes it is.
311. My demo wire has more air miles than most of the sales team.

Handbook specific

312. Chapter one is wire. Chapter fourteen is sheet. Everything in between is the same idea wearing different hats.
313. Five hundred pages and the whole argument fits on one: cross section sets force, length and form set motion, temperature sets when.
314. If you only read one page of this handbook, read the one with the router table. If you read two, call us.
315. Notes pages at the back of every chapter, because we know what engineers do to a handbook.

316. The grid on the notes pages is a tenth of an inch, because we know which engineers we're talking to.
317. Every number in here is conservative. The good news is your part will beat it. The bad news is you'll never know by how much until you test it.
318. Level D is where the handbook stops being advice and starts being a dare.

Grower, not a shower (deployable)

319. I'm not small, I'm stowed.
320. It's not compact. It's pre-deployment.
321. Judge me at temperature or don't judge me at all.
322. I don't peak at rest. Nobody good does.
323. Packed volume is not performance. Ask any satellite.
324. It's not what it measures cold, it's what it does warm.
325. Every deployable looks unimpressive in the shipping crate.
326. Some parts are big. Ours is potential.
327. The impressive part happens after you plug it in.
328. My resting state is modest. My working state has a datasheet.
329. Don't ask what it is. Ask what it becomes.
330. It fits in your hand right up until it doesn't.
331. Stowed for launch, embarrassing for everyone at deployment.
332. Never trust a spec sheet that only lists the folded dimension.
333. She said "that's it?" I said "give it forty degrees."
334. Our competitors lead with size. We lead with deployed size.
335. Quiet in the box, loud on orbit.
336. It's not a late bloomer, it's a thermally triggered one.
337. There are growers, there are showers, and there are shape memory alloys, which are both on a schedule.
338. What arrives in an envelope and leaves in a flatbed? A deployable, eventually.
339. I've never once been disappointed by a deployable that was warm enough.
340. The folded state is the marketing. The deployed state is the product.
341. Small package, large reveal, no batteries.
342. It doesn't grow. It remembers being bigger.

Comes back to you (set boundaries accordingly)

343. Nitinol always comes back to you. Set boundaries accordingly.
344. Block it, bend it, bury it. Warm day comes, there it is.
345. My actuator and my ex have the same operating principle: leave it cold and it behaves.
346. The wire doesn't chase you. It just waits for the right temperature and then it's at your door.
347. Nitinol doesn't take a hint. Nitinol takes a shape set.
348. It's not obsessed, it's shape set. There's a difference, legally.
349. You can stretch it as far as you like. It has opinions about where this ends.
350. The most persistent thing in my shop has no motor and no eyes.

351. Nitinol: it's not that it can't move on, it's that moving on is thermodynamically unfavorable.
352. I gave it space. It contracted. I gave it more space. It contracted harder.
353. Every relationship has one party that remembers everything. In ours it's the metal.
354. What's the difference between nitinol and a stalker? The alloy has a published datasheet.
355. It came back. It always comes back. We rate it for a million comebacks.
356. The restraining order was denied on the grounds that the respondent is a wire.
357. You didn't break up with it. You just cooled off, which it interprets as a pause.
358. Nitinol's love language is thermal.
359. It will forget you the moment you exceed 350 C, and not one degree sooner.
360. The good news is it's loyal. The bad news is also that.
361. Nitinol doesn't hold grudges, it holds geometry, which lasts longer.
362. Bend it a thousand times and it still shows up warm and ready. That's either devotion or a diagnosis.
363. Cold, it'll go wherever you put it. Warm, it goes where it wants. Choose your working temperature carefully.
364. The wire has never once respected a boundary, and I've never once had to replace it.

Industry, more specific

365. The valve industry's favorite number is zero, as in zero seals, zero motors, zero permits.
366. An orthodontist and an aerospace engineer walk into a bar and order the same alloy.
367. Aerospace pays by the gram, medical pays by the millimeter, and consumer pays by the container.
368. The wellhead engineer asked what happens if it fails. I said it stops. He said "that's it?" I said yes. He signed.
369. Firefighters don't want a controller. They want a thing that lets go when the room is on fire.
370. A stent is just a deployable that never comes home.
371. Satellite people and surgeons have the same requirement: it has to work the first time, unattended, forever.
372. What does a machinist call nitinol? Expensive practice.
373. HVAC has been running on motors for a century because nobody told them a wire would do it.
374. The prosthetics lab wanted quiet. Every motor they tried sounded like a printer having a crisis.
375. Marine wanted something that survives salt. Nitinol said that's not even a challenge, give me a real one.
376. The connector guy asked for a breakaway that resets itself. He's now on his fourth prototype and his first good mood.
377. Nuclear asked for an actuator with no electronics. That narrowed the field to about one material.
378. Semiconductor asked what it outgasses. Nothing. They asked again, differently. Still nothing.
379. The drone guy weighed our actuator and then weighed his servo and then went very quiet.
380. Every industry thinks its requirements are unique until they see the same wire in the next booth.

Holidays, second pass

381. Christmas lights that deploy themselves would sell ten million units and end forty thousand marriages early.
382. Santa's sleigh is a deployable. That's the only way the physics works.

383. The advent calendar is a twenty four stage sequenced actuator with a chocolate payload.
384. Nitinol at Christmas: shows up cold, warms up, does one job, stays through January.
385. New Year's Eve and a nitinol actuator both peak at exactly midnight and then it's over.
386. My New Year's resolution has a hundred cycle fatigue life.
387. Valentine's Day is the only holiday where "it always comes back to you" is the pitch and the warning.
388. A heart shaped wire that reforms in your hand is romantic until you think about it for four seconds.
389. Mother's Day, Father's Day, and every day: it reverts to what it was raised to be.
390. Halloween costume idea: go as a nitinol wire. Stand in the corner. When someone warms up to you, change.
391. Thanksgiving is a transition temperature event disguised as a meal.
392. Easter and nitinol both have a well documented recovery.
393. The Fourth of July: we make the part that lets go without the bang, which is patriotic in a quieter way.

The handbook, but nitinol specific

394. Level A gives a million cycles and one percent. Level D gives a hundred cycles and seven. The handbook is just that argument, fourteen times.
395. The whole book is one sentence with five hundred pages of evidence.
396. Cross section, length, temperature. Everything else is decoration.
397. Tight pitch pulls. Open pitch pushes. That's the most useful thing in chapter four and it fits on a business card.
398. A face wound spring and an edge wound spring are the same strip having very different lives.

Martensite, austenite and the physics

399. Martensite and austenite walk into a bar. Same guy, different mood.
400. Austenite is nitinol with its life together. Martensite is nitinol on a Sunday.
401. I'm not lazy, I'm martensitic.
402. Hysteresis is just the metal taking the scenic route home.
403. The R-phase is nitinol's awkward teenage years.
404. Af, As, Ms, Mf: four letters that decide whether your product works in Minnesota.
405. What's the difference between martensite and austenite? About forty degrees and a complete personality change.
406. Nitinol has two phases, which is two more than most of my coworkers.
407. Twinning is how martensite deforms without committing. Very noncommittal, very martensite.
408. Detwinning sounds like a divorce and functionally it is one.
409. Austenite finish is the temperature at which the metal finally gets off the couch.
410. Hysteresis means it takes more to warm it up than to cool it down. Relatable.
411. The phase transformation is diffusionless, which means nothing moves anywhere and yet everything changes. Very zen, very inconvenient to explain.
412. Nitinol changes crystal structure without changing composition, which is the metallurgical version of a haircut.
413. Superelasticity is austenite refusing to be martensite under pressure. Admirable, honestly.

414. Md is the temperature above which stress can't make martensite. Everything has a limit.
415. Residual martensite is the stuff that never quite went home after the party.
416. Training drives out residual martensite, which is the most expensive way to say "settle down."
417. The lattice doesn't forget. The lattice files.
418. Shape memory is a crystallographic grudge with industrial applications.

Knock knock

419. Knock knock. Who's there? Nitinol. Nitinol who? Nitinol you five minutes ago, warm me up and I'll remind you.
420. Knock knock. Who's there? Austenite. Austenite who? Austenite for a good stretch, but it's cold out here.
421. Knock knock. Who's there? Deployable. Deployable who? Deployable I'll be once you open the door.
422. Knock knock. Who's there? Shape. Shape who? Shape memory, and yes, I remember what you said last time.
423. Knock knock. Who's there? Martensite. Martensite who? Martensite in, I'm not doing anything out here.
424. Knock knock. Who's there? Transition. Transition who? Transition temperature, and yours is clearly too low.
425. Knock knock. Who's there? Actuator. Actuator who? Actuator dinner and it still hasn't moved.
426. Knock knock. Who's there? Fatigue. Fatigue who? Fatigue life, and after this joke it's shorter.

What do you call

427. What do you call a nitinol wire that won't actuate? Decor.
428. What do you call a nitinol spring in Antarctica? Patient.
429. What do you call an actuator that pushes and pulls? Open pitch, and expensive.
430. What do you call a million cycles at one percent? A career.
431. What do you call a hundred cycles at seven percent? A weekend.
432. What do you call nitinol at 350 C? A souvenir.
433. What do you call a nitinol wire with no current? Wire.
434. What do you call a wire that forgets its shape? Fired.
435. What do you call a nitinol actuator in a freezer? Off the clock.
436. What do you call an edge wound spring? A Slinky with a resume.
437. What do you call a face wound spring? The one that actually pulls its weight.
438. What do you call a Belleville actuator? Enormous force with commitment issues about distance.
439. What do you call a torque tube? A driveshaft that went to graduate school.
440. What do you call a curl actuator? Three actuators that refused to be separated.
441. What do you call a flat spring? A wave with a job.
442. What do you call a separation actuator? An explosive bolt that took anger management.
443. What do you call a single use actuator? Committed.
444. What do you call a two way actuator? Ambitious and out of scope.
445. What do you call a superelastic wire? All the flex and none of the follow through.

446. What do you call a nitinol sheet with three transition temperatures? A machine that forgot to become a machine.

Bar jokes

447. A nitinol wire walks into a bar. The bartender says "we don't serve your kind." The wire says "warm up to me."
448. A nitinol wire walks into a bar and orders whatever's hot. Then it leaves exactly the way it came in.
449. A martensite and an austenite walk into a bar. The bartender says "I'll need to see some ID and a thermometer."
450. A nitinol actuator and a solenoid walk into a bar. The solenoid buys a round and then overheats and dies.
451. A hydraulic cylinder walks into a bar and leaks all over the floor. Nitinol just sits there being fine.
452. A superelastic wire walks into a bar, gets bent completely out of shape, and walks out perfectly normal. We all know that guy.
453. A wire walks into a bar. Nobody notices. Then the heater kicks on and everybody notices.
454. A nitinol spring walks into a bar and immediately takes up less room than expected. Bartender says "you shrink?" Spring says "I contract."
455. A separation actuator walks into a bar, shears the head off a bolt, and leaves without making a mess. The bouncer is impressed.
456. Two actuators walk into a bar. One works antagonistically. They order for each other.

Doctor, doctor

457. Doctor, doctor, I keep going back to my old shape. Congratulations, you're nitinol.
458. Doctor, doctor, I only work when things get heated. That's not a condition, that's a career.
459. Doctor, doctor, my actuator has fatigue. Have you tried working it less hard? No. Then that's the whole diagnosis.
460. Doctor, doctor, I can't stop remembering. Take two austenite and call me above transition.
461. Doctor, doctor, my wire won't push. Loosen the pitch.
462. Doctor, doctor, my spring reached solid height. Then it has nowhere left to go, and neither do we.

Light bulb

463. How many engineers does it take to change a nitinol actuator? None, it changes itself, that's the entire product.
464. How many nitinol wires does it take to change a light bulb? One, but it has to warm up to it first.
465. How many salespeople does it take to explain shape memory? One, plus a lighter and a paperclip.
466. How many procurement officers does it take to approve a wire? Six, and a year.

Family

467. My kid asked what I do. I said I sell metal that remembers things. He said "like Grandma." Yes. Exactly like Grandma.
468. My wife says I never change. I told her it's a feature and showed her the datasheet.
469. Explaining nitinol to my father in law: "so it's a spring." Twenty minutes later: "so it's a spring."

470. My daughter bent my demo wire into a heart and warmed it with her hands. Best sales pitch in company history and she's nine.
471. The kids fight, everyone gets heated, and by bedtime we're all back in our original positions. Nitinol household.
472. My son asked if nitinol can forget. I said only if you burn it. He looked thoughtful in a way that concerned me.
473. My mother has never once changed her position on anything, and now I know why I got into this material.
474. Family reunions are just large scale thermal cycling with potato salad.
475. I told my wife the actuator only performs when things get hot. She said she'd noticed the pattern.
476. Teaching my kid to ride a bike taught me more about fatigue life than any test rig.

Pets

477. My dog remembers where the treats are. My wire remembers where it was. Only one of them costs eighty dollars a foot.
478. Cats and nitinol: both come back when they feel like it, both ignore you when cold.
479. The shop cat sleeps on the annealing oven. She has excellent instincts and a slight smell.
480. My dog has better recall than most alloys.

Weather and seasons

481. Spring is when the nitinol in my car finally starts working again.
482. Winter in New Hampshire is nature's way of testing your transition temperature selection.
483. A 35 C actuator in a Minnesota January is a decoration.
484. Summer is when every nitinol product in the building starts working without being asked.
485. New England has four seasons and every one of them is a thermal cycle.
486. Humidity ruins everything except nitinol, which genuinely does not care.

Food

487. Nitinol is like a good steak: it needs heat, it rests afterward, and overcooking ruins it permanently.
488. Toast and nitinol both change state irreversibly above a certain temperature, but only one makes breakfast.
489. Our actuator pops up like a toaster, but with a fatigue rating.
490. Nitinol pasta would remember being straight, which would make the sauce very difficult.
491. The break room microwave has actuated more nitinol samples than the lab has.
492. Fondue is just an unplanned annealing cycle with cheese.

Sports

493. Nitinol golf clubs would remember every bad swing you ever made, which is why they don't sell them.
494. A nitinol tennis racket already knows what you did wrong.
495. Nitinol running shoes would give the energy back, which is the whole idea, and also the lawsuit.
496. Boxing and nitinol: both about what you do after you get bent.

497. Nitinol is the only athlete that performs better with a fever.
498. Our actuator does one rep, perfectly, a million times. That's not training, that's dominance.

More deployable

499. Every deployable has an awkward halfway point nobody photographs.
500. Deployment is the only part of the mission where "it just unfolded" is high praise.
501. A deployable that jams is just origami with a budget overrun.
502. The whole point of deployable is that the impressive version doesn't have to fit in the rocket.
503. Fold it, launch it, warm it, forget it.
504. Our deployables have no hinges, which means no hinges to seize.
505. What deploys quietly, weighs nothing, and has never once needed a lubricant?
506. The mechanism that isn't there can't jam.
507. I like deployables because the failure mode is "still folded" rather than "on fire."
508. Deployable antennas, deployable solar, deployable booms, and one deployable ego per launch campaign.
509. Stowed volume sells the launch. Deployed area sells the mission.
510. It's not that it gets bigger. It's that it stops pretending to be small.
511. If you can't impress them folded, impress them deployed.
512. Deployable is just a polite word for "you haven't seen anything yet."
513. The best deployable is the one nobody talks about after launch.
514. A good deployable is boring in every photo except one.

More comes-back-to-you

515. It doesn't need closure, it needs a heat source.
516. Every time I think I've straightened things out, the room warms up.
517. Nitinol is the only material with an emotional support temperature.
518. I've stretched it, twisted it, and left it in a drawer for two years. Warmed it up. There it was.
519. Time heals nothing. Heat, however.
520. You can't ghost a material with shape memory.
521. It remembers the good times, which in this case means one specific afternoon in a furnace.
522. Nitinol's whole personality is one event in its past and it will not be moving on.
523. The wire is not clingy, the wire is thermodynamically consistent.
524. Absence makes the alloy revert.
525. You never really leave nitinol, you just cool down for a while.
526. It has exactly one memory and it's load bearing.
527. Nitinol proves that going back isn't weakness, it's a material property.
528. Some people need years of therapy to return to who they were. Nitinol needs a hair dryer.

More edgy

529. Is that a Belleville stack in your pocket or are you just carrying enormous force in a very small package?

530. Our micro springs are small enough to be embarrassing and strong enough to be interesting.
531. She asked how long it takes. I said depends how fast you can heat it. She said that's the same answer everyone gives.
532. Buy a thicker wire. Solve two problems.
533. The pitch determines whether it can push. Read that again slowly.
534. A tight wind means it can only pull. Open it up and suddenly it has options.
535. Our actuator is rated for one hundred cycles at maximum effort or a million at a reasonable pace. Pick a lifestyle.
536. It's not performance anxiety, it's a transition temperature mismatch.
537. It works best warm, fails safe hot, and does nothing at all cold. Half this company is the same way.
538. The customer asked if it could go all night. I said yes, at one percent strain.
539. My actuator has never needed encouragement, a manual, or a talk about expectations.
540. Everything in this handbook either pulls, pushes, twists, or curls. We are aware of how that reads.
541. Chapter thirteen does three things at once and we get a lot of questions about chapter thirteen.
542. The torque tube swings, which is a sentence I've had to defend at two trade shows.
543. Face wound for force, edge wound for travel, and we've all made the obvious joke already.
544. Solid height is the technical term for "that's as far as this is going."
545. It gets hot, it gets hard to stop, and then it's over. Engineering is just physics with a straight face.
546. A wire that gets stiffer the harder you push it is either superelastic or extremely disciplined.

Aerospace, deeper

547. Every gram on a satellite costs more than my truck. That's why they listen to us.
548. Spacecraft engineers love nitinol for the same reason they love good friends: it shows up years later and does exactly what it promised.
549. A mechanism with no moving parts passes qualification in a way that makes reviewers suspicious.
550. Vibration testing is where mechanisms go to reveal their secrets. Wires have none.
551. Nitinol on a satellite is a part with no scheduled maintenance, which is the only kind allowed.
552. Deployment day is the shortest and most expensive second of the program.
553. The launch loads don't bother a wire. Nothing bothers a wire.
554. A hold down and release mechanism either works once or ends a career.
555. Nitinol is the only aerospace actuator that gets cheaper when you make it smaller.
556. Space is cold. That's the whole design problem in one word.

Medical, deeper

557. A stent goes in folded and opens where nobody can reach it. That's trust.
558. Nitinol in the body is the only implant that gets more comfortable as it warms.
559. The device has to work at 37 C and nowhere else. That's a very specific job description.
560. MRI compatibility is a conversation nitinol wins about half the time and we're honest about which half.
561. Guidewires are the only product where "it refuses to take a set" is the entire value proposition.
562. A surgeon's favorite kind of mechanism is one that doesn't need explaining twice.
563. Nitinol saved more arteries than it opened, which is the correct ratio.

564. Every medical meeting ends with "and it's biocompatible?" and then a very long silence while someone finds the report.

Shop, deeper

565. Nitinol machines like cheese, if cheese fought back.
566. The first rule of cutting nitinol is that you don't. The second rule is EDM.
567. Work hardening is nitinol's way of saying you've been at this too long.
568. Every new machinist tries a carbide end mill exactly once.
569. Our scrap bin is worth more than most shops' inventory, which is why it's bolted down.
570. Grinding nitinol produces sparks, smoke, and a lot of career reflection.
571. Nitinol doesn't chip, it smears, which is the difference between machining and wrestling.
572. The oven log is the most important document in this building and it lives on a clipboard.
573. Shape setting is one part temperature, one part time, and three parts nobody opening the door.
574. We measure twice, set once, and hope the fixture agreed with us.

Sales, deeper

575. Every sale starts the same way: "I didn't know metal could do that."
576. The demo is free. The engineering is not. The handbook is where you find out which one you need.
577. The hardest customer is the one who already tried nitinol in 1998 with bad wire and a worse supplier.
578. We don't compete with other nitinol companies. We compete with motors, and we're winning slowly.
579. Nobody budgets for shape memory alloy. Everybody budgets for solving the problem.
580. The phrase "we've always used a solenoid" has cost American industry more than any recession.
581. The good customers ask about fatigue life in the first ten minutes. The great ones ask about transition temperature.
582. My favorite question is "what's the catch." My favorite answer is "cooling."
583. Selling nitinol means explaining physics for free and charging for wire.
584. Every quote I send is a small act of optimism.

Cooling, the catch

585. Heating is easy. Cooling is the entire engineering discipline.
586. The actuator is fast. The wait is not.
587. Thin wire cools faster, which is why the small parts are the quick ones.
588. Everything about nitinol is simple until someone asks how fast it cycles.
589. Cooling is the reason your nitinol robot moves like it's thinking about it.
590. Want speed? Go thinner, go longer, go colder, go home.
591. A tube cools from both sides, which is the most underrated sentence in this handbook.
592. The limit isn't the metal, it's the air around it.

Holidays, final pass

593. Every holiday is a thermal cycle. Some just have better food.
594. Nitinol is the only guest that arrives cold, warms up, does something useful, and leaves no mess.
595. The holiday season is when everyone in this family demonstrates hysteresis.
596. We took the year off and came back exactly as we were. Corporate calls it culture, metallurgy calls it shape memory.
597. Resolutions are martensite. February is the transition temperature.
598. Happy holidays from a company whose entire product line is about coming home.

One product at a time: round wire

599. Round wire is the default answer and there is no shame in a default answer that works.
600. A straight wire is the cheapest way to move something hard in a straight line, and it fits where nothing else does.
601. Wire doesn't care what path it takes between its two ends, which makes it the only actuator you can route like a cable.
602. The thinner the wire, the faster it cools, which is the only place where less metal wins.
603. A wire pulls. It does not push. Everything after that sentence is a workaround.
604. Round wire is what every other chapter compares itself to.
605. Five thousandths of an inch is enough to move something you'd need two hands for.
606. Wire is the actuator you can post in an envelope.

Rod and bar

607. A rod is a wire that stopped being flexible and started being serious.
608. Twenty five millimeters of nitinol pulls with eighty five kilonewtons and takes all afternoon to cool down. Both facts matter.
609. Going from half a millimeter to twenty five multiplies the force by two and a half thousand and the stroke by exactly nothing.
610. The rod chapter is where the numbers stop being cute.
611. If your load is measured in tonnes and your space is measured in centimeters, we should talk.
612. Use several thin wires instead of one thick rod, unless you enjoy waiting.
613. A forged loop on the end of a bar is the only termination that's continuous with the part.
614. Terminations are where good actuators go to fail early.

Flat wire

615. Flat wire is round wire that decided to have a preferred direction.
616. Lay it flat or stand it on edge and it becomes two different products from one spool.
617. Flat wire sits in a slot and refuses to roll, which is worth more than it sounds.
618. The strip is the same metal having an identity crisis in two axes.

Helical springs

619. A spring is a wire that multiplies its own movement and charges nothing for the privilege.
620. Wind a wire into a spring and you trade force for travel at an exchange rate set at the winding machine.

621. Pitch decides which directions are open to it, which is the most useful thing in the chapter.
622. Tight pitch is already at the end of its travel, so it can only come back.
623. Open the pitch and the spring gets options.
624. Solid height is where ambition meets geometry.
625. A spring that computes to seventeen times its own length is a conversation, not a specification.
626. Micro springs are small enough that people don't believe the force until they feel it.

Face wound

627. Lay the strip flat and it bends the hard way, which is exactly what you want when you want force.
628. Face wound is the winding for people who need to move something heavy a short distance.
629. The strip laid flat packs a lot of metal into a very short spring.
630. Face wound in linear, low torque in rotary. The same part, two opposite reputations.

Edge wound

631. Stand the strip on edge and you get a Slinky with a fatigue rating.
632. Edge wound travels a long way and pulls like it's being asked a favor.
633. Tight pitch only, which means it pulls and it does not push, and no amount of hoping changes that.
634. Edge wound in linear is the soft one. Turned about its axis it's suddenly the strong one. Nothing about this material is loyal to a reputation.

Torsion springs

635. A torsion spring bends its wire despite the name, and that has caused more bad math than any other fact in this book.
636. Degrees per wrap is the most honest unit in the handbook: you decide how many you need.
637. Tape wound is where each wrap sits on the last, which takes almost no length and confuses everyone the first time.
638. The ends do the work, so the ends are where you should be worrying.

Flat springs

639. A flat spring is a wave that gets longer when you flatten it, which is the whole trick.
640. The stroke is the pitch growing, not the wire stretching. Nothing stretches. Read that again.
641. Above an amplitude to pitch ratio of one it stops being a sinusoid and starts being a serpentine.
642. A flat spring fits in a slot where a coil never could, which is the entire reason it exists.
643. Count the waves, get the stroke. It's the rare place where the arithmetic is kind.

Belleville

644. A Belleville is a washer with ambitions and a very short commute.
645. Tens of kilonewtons through less than a millimeter, in a package the size of a coin.
646. Stack them in series for stroke, parallel for force, and mixed for both, which is how real stacks get built.
647. A steeper cone buys travel and pays for it in fatigue life. Nothing about the cone angle is free.

648. Never assume the washer goes flat. It usually shouldn't.

Separation actuators

649. It shears the head off a bolt on command and then, unlike the bolt, it's still fine.

650. An explosive bolt you can test a hundred times before you commit is a different product entirely.

651. No debris, no pyrotechnic paperwork, no shipping restrictions, no bang.

652. The bolt is spent. The actuator is not. That distinction is worth a lot of money.

653. Recover it, compress it, use it again. How many times depends entirely on how the day went.

Torque tubes

654. The outside diameter sets the swing and nothing else does, which is the cleanest fact in this handbook.

655. Pick the diameter for the angle, the wall for the torque, and the length for the total. Three choices that don't fight.

656. A twenty millimeter tube swings the same degrees per inch whether its wall is one millimeter or four.

657. Boeing folded a wingtip with these. That sentence sells more than any table.

658. A tube that twists itself has no pumps, no lines and nothing to leak on the runway.

Tubes in tension

659. A tube is a rod with the lazy metal removed.

660. It cools from the inside and the outside, which is the fastest thing in the heavy end of this handbook.

661. It's an actuator and a conduit at the same time, and people always forget the second part.

662. Same tube, pulled instead of twisted, completely different chapter.

Curl

663. Curl is the only shape in this handbook that isn't replacing anything, because nothing else does it.

664. It wraps, it shortens and it sweeps, all at once, from one piece of wire with no joints.

665. The radius depends on the thickness and nothing else. Not length, not width, not wall.

666. A fifteen hundredths of a millimeter wire makes a full turn out of nine millimeters of material. That's a mechanism smaller than a grain of rice.

667. To do what a curl does with conventional parts you'd buy three actuators and build the linkages between them.

Plates and sheets

668. Sheet is where you stop buying parts and start cutting them.

669. Moment goes with the square of thickness, so double it and you get four times the push and half the bend.

670. Different regions, different transition temperatures, and suddenly a flat piece of metal has a sequence.

671. A plate that unfolds in stages with one heat source and no controller is the closest thing to magic in this book.

672. Cut whatever outline you like. The material doesn't care about your CAD.

Overdriving and safety

673. Every number in this handbook is a floor, not a ceiling.
674. Heat it further or heat it faster, and the two effects add.
675. Emergency mode is a reserve, not a rating, and the difference is your fatigue life.
676. Overdrive up to Md and it actually does the part some good. Past that, you're spending principal.
677. Above 350 C it's a souvenir.
678. A motor explodes, a cylinder bursts, and nitinol just quietly stops. Only one of those is a safety case.
679. The failure mode is a dead part and an open circuit. Put that in the risk register and go home early.
680. The worst thing an overdriven nitinol actuator does is nothing at all.

Getting it back

681. Antagonistic, bias, or system forces. Pick one before you order, not after.
682. The bias has to be strong enough to reset it cold and weak enough not to stall it hot. That window is the whole design.
683. The best return spring is the one your machine already has.
684. Gravity is free and it never fails inspection.
685. An antagonistic pair gives you power both ways and a control problem for life.
686. A two way set means no return at all, and a conversation with our engineers.

Office and workplace

687. The only thing in this office that reliably returns to its assigned position is the metal.
688. Our performance reviews should use design levels. Most of us are Level D pretending to be Level A.
689. HR asked what our actuators do when overworked. I said they lose their memory and go slack. HR went quiet.
690. The break room thermostat is set exactly between two of our transition temperatures and it has caused three arguments.
691. I keep a demo wire on my desk for the same reason other people keep a stress ball.
692. Every meeting could be replaced by one heated wire and a demonstration.
693. The intern asked if we could 3D print it. We're still discussing.
694. Casual Friday is when the engineers wear the shirts from trade shows they didn't enjoy.
695. The whiteboard has said "COOLING IS THE LIMIT" for four years and nobody erases it.
696. Our conference room is named after a phase transformation, which tells you everything.
697. Somebody put a nitinol wire in the office coffee maker as a prank and now we have a product idea.
698. Nothing motivates a team like a customer saying "nobody else can do this."

Competitors and other materials

699. Steel remembers nothing and is very proud of it.
700. Aluminum is light and forgetful, which explains a lot.

701. A piezo stack gives you nanometers and a power supply the size of a toaster.
702. Hydraulics: enormous force, enormous mess.
703. Pneumatics: enormous noise, enormous compressor bill.
704. A servo motor is four hundred parts pretending to be one.
705. Solenoids are the actuator equivalent of shouting.
706. A shape memory polymer is nitinol's cousin who went into the arts.
707. Bimetallic strips are shape memory for people who aren't serious.
708. Wax motors work great and slowly, like a very patient candle.
709. Every alternative technology has a moving part we don't have.
710. The nice thing about competing with motors is that motors have been the answer for a century and nobody's checked recently.

Time and patience

711. Nitinol has been waiting sixty years for people to design around it properly.
712. Our sales cycle is longer than our fatigue life at Level D.
713. The material was discovered in 1959 and is still being introduced.
714. Somebody finds nitinol for the first time every single day and their reaction is always the same.
715. It took four hours to explain and two seconds to demonstrate.
716. The demo takes a lighter and a paperclip. The adoption takes three years and a champion.

Very short ones

717. Metal with a memory. That's it. That's the pitch.
718. Warm it, watch it, buy it.
719. Muscle, without the biology.
720. It moves because it wants to be something else.
721. All the mechanism, none of the mechanism.
722. Hot equals shape. Cold equals whatever you like.
723. The part is the machine.
724. No motor. No gearbox. No excuses.
725. Bend it. Heat it. Believe it.
726. One part. One job. One million times.
727. Simple, until you ask about cooling.
728. It works, and then it works again.
729. Small, quiet, and completely unreasonable about its original shape.
730. A wire with a past.
731. The only alloy with a backstory.
732. Force from the cross section, motion from the form, timing from the heat. Everything else is noise.

Absurd and surreal

733. If humans had shape memory, the gym would be a furnace.
734. A nitinol suit would iron itself and also refuse to let you slouch.

735. Nitinol furniture would return to its original arrangement every time you turned the heat on, ending all design disputes.
736. A nitinol bookmark would find your page again, which is either useful or haunted.
737. Nitinol shoelaces would tie themselves at body temperature and untie themselves in the snow, which is exactly backwards.
738. A nitinol umbrella that opens in the rain would need the rain to be warm, so, a shower.
739. Nitinol handcuffs are a bad idea that somebody has definitely already tried.
740. A nitinol paperclip is just a regular paperclip with a grudge.
741. Nitinol dentures would smile whether you wanted to or not.
742. A nitinol tie would knot itself, which would save eleven seconds a day and cost you your dignity.
743. Nitinol wallpaper would flatten in summer and curl in winter, which is a feature in exactly zero buildings.
744. A nitinol whisk would remember every bad batter it ever met.
745. Nitinol garden hose that coils itself would end more marital disputes than counseling.
746. A nitinol zipper would close when you got warm, which is a design flaw with a very specific failure mode.
747. Nitinol chopsticks would have opinions about your grip.
748. A nitinol slinky is just an edge wound spring that got a book deal.

Engineering truths in joke form

749. The material is simple. The system is where it gets expensive.
750. Every nitinol failure I've investigated was a termination, a temperature, or an assumption.
751. Nobody has ever been disappointed by the force. Everybody has been surprised by the cooling.
752. Design for the strain you want, not the stroke you dream about.
753. The handbook gives you a starting point. The prototype gives you the truth.
754. The first article always teaches you something the datasheet didn't.
755. If your design only works at one temperature, congratulations, you've designed an actuator.
756. Pick the fatigue life first. Everything else is negotiable.
757. Cross section, length, temperature. If you get those three right the rest is packaging.
758. The best nitinol designs have fewer parts after the redesign, not more.
759. Every good actuator design is mostly about what it's attached to.
760. Nobody's first prototype cooled fast enough.

Customer service

761. "Does it work in a vacuum?" Better, actually.
762. "Will it rust?" No. "Are you sure?" It's mostly titanium. "Oh."
763. "Can I cut it with scissors?" Please don't.
764. "How do I attach it?" That is the entire conversation and I'm glad you asked first.
765. "Can you make it faster?" Yes. Make it thinner and stand closer to a fan.
766. "Can you make it stronger?" Yes. Make it thicker and bring a thermos.
767. "What's the lead time?" Shorter than your approval process.

768. "Is it expensive?" Compared to what it replaces, no. Compared to a spring, yes. What are you replacing?
769. "Can it be smaller?" Yes. "Smaller than that?" Also yes. "Smaller than THAT?" Now we're in chapter four.
770. The best support call is the one that starts "it worked, now I want more of them."

Wrap up

771. Sixty years old and still the newest idea in the room.
772. Most metals hold a load. This one holds a grudge and does the work anyway.
773. Every chapter in our handbook is the same wire deciding to be a different machine.
774. The form is the gear ratio, the temperature is the trigger, and the cross section pays for both.
775. We don't sell metal. We sell the part that isn't there anymore.
776. What can nitinol do for you? Everything a motor does, minus the motor.
777. The best actuator is the one nobody notices, and ours has never been noticed once.
778. If it moved and you can't find the mechanism, it was probably us.

Deployable, final run

779. Everything I own is deployable if you're patient and the room is warm.
780. It's not a small booth, it's a stowed booth.
781. Stowed dimensions are what you show accounting. Deployed dimensions are what you show engineering.
782. Nothing deploys on schedule except nitinol, which deploys on temperature.
783. The deployable succeeded and nobody clapped, which is how you know it worked.
784. Deployable: from luggage to landmark in about four seconds.
785. A deployable that only deploys once is a single use actuator with better branding.
786. Folded is a state of mind. Deployed is a state of matter. Neither of those is true but both sound good.
787. I've seen deployables that make grown program managers cry, in both directions.
788. The trick isn't deploying. The trick is deploying exactly once, exactly on time, eight years later.
789. A deployable with a motor is a mechanism. A deployable with a wire is a part.
790. Some things are impressive up front. Ours is impressive at the end.
791. It ships flat and arrives enormous, which is either a deployable or a bad IKEA experience.
792. Deployable structures and dad jokes both depend entirely on timing.

Comes-back-to-you, final run

793. Nitinol is a second chance with a temperature rating.
794. You can't outrun a material that only needs you to warm up.
795. Every alloy has a past. Only this one acts on it.
796. It doesn't reminisce. It reverts.
797. The past isn't dead, it isn't even past, it's just below the transition temperature.
798. Nitinol takes everything personally and does something about it at precisely 35 degrees.
799. The only material that gets closure by contracting.

800. Nothing in my life comes back as reliably as this wire, and I've thought about that.
801. It holds a shape the way other things hold a note: completely, until something changes.
802. The metal is faithful. The metal is patient. The metal is, frankly, a little intense.
803. You cannot hurt its feelings. You can only exceed its strain limit.
804. It forgives everything below seven percent.
805. Nitinol has never once needed to be told twice.
806. What it did once, it will do a million times, which is either loyalty or a lack of imagination.

Edgy, final run

807. Every actuator in this handbook is measured by how far it moves and how hard it pulls, and yes, we have heard that joke.
808. Our best seller is small, warm and persistent. Draw your own conclusions.
809. The customer asked for maximum performance. I asked how long he needed it to last. He said "does that matter?" It always matters.
810. The spec called for "quiet operation." Nitinol doesn't make a sound, which some people find unnerving.
811. Heat it too fast and it gives everything at once. That's a design choice, not an accident.
812. Nobody has ever complained that the stroke was too long.
813. The whole business is applying heat until metal does what you want. Some days it feels like management.
814. It responds to warmth and ignores you when you're cold. Everyone has dated this wire.
815. Our parts have a rated life and a real life, and the second one depends entirely on how you treat them.
816. The handbook says five percent. The customer always wants seven. We always warn them. They always want seven.
817. It goes rigid above a certain temperature, which is the most clinical way to describe our entire product line.
818. A part that gets harder to push the more you push it is either superelastic or married.

Industry, final run

819. Every industry has the same meeting: "why isn't this a wire yet?"
820. The aerospace guys ask about mass. The medical guys ask about size. The oil guys ask if it survives. The consumer guys ask about pennies.
821. Defense wants no signature. A wire has no signature.
822. Rail wanted something that survives thirty years outdoors with no maintenance. That's not a requirement, that's a dare, and nitinol took it.
823. Elevator safety wanted a fail safe that doesn't need power. Guess what doesn't need power.
824. Solar tracking wanted motion without motors in the desert. The desert supplies the heat for free.
825. Smart buildings want vents that open themselves. Buildings have been warm for centuries and nobody used it.
826. Wearables want silent, small and light, which is three quarters of a nitinol datasheet.
827. Toy companies want cheap and magical. We can only reliably supply one of those.
828. Every kitchen appliance with a pop up, a latch or a vent is a wire waiting to happen.

829. The lab equipment guys wanted a valve with no dead volume. Nitinol pinches the tube from outside. Meeting over.
830. Textile mills, packaging lines, and bottling plants all have the same problem: a hundred small motions and a thousand motors.

The long tail

831. My favorite thing about this material is that the physics does the marketing.
832. Nobody believes it until they hold it.
833. The best product demo in the world costs eleven cents and a match.
834. Nitinol is the only product I've sold where the sample converts better than the salesman.
835. It took me six years to stop saying "it's like a muscle" and I've started again because it works.
836. There are two kinds of engineers: the ones who have used nitinol and the ones who are about to.
837. The handbook exists because "call us and we'll tell you" was not a business model.
838. Five hundred pages later, the answer is still "it depends what you're trying to move."
839. We've built a handbook for a material that resists being cataloged, and that tension is the whole book.
840. The tables are conservative, the prose is honest, and the notes pages are where the real design happens.
841. Every part in here is a wire that went to finishing school.
842. If you're reading this appendix you've either finished the handbook or given up in a very specific way.
843. Congratulations on reaching the jokes. The engineering was the easy part.
844. Anyone who reads five hundred pages of actuator tables deserves at least one laugh.
845. If one of these made you groan, the handbook worked.
846. Thank you for reading. Now go bend something and warm it up.

Puns we held back

847. Nitinol is titanium and nickel, which makes it two metals with one memory.
848. Ni and Ti walked into a furnace and came out with a personality.
849. The alloy is fifty five percent nickel, which means it is mostly loose change with ambition.
850. Nitinol was named for Nickel Titanium Naval Ordnance Laboratory, which is the least funny thing about it.
851. The Navy discovered it and then spent twenty years explaining it to everyone else.
852. It's an alloy in the way a chord is two notes: technically correct and missing the point.
853. Fifty five nitinol and fifty six nitinol are one percent apart and forty degrees different, which should terrify you.
854. One percent composition changes the transition temperature by ten degrees. One percent. Think about your tolerances.
855. Nickel titanium: the only relationship where the ratio matters to a tenth of a percent.
856. Most alloys are a compromise. This one is a negotiation.

Failure modes, affectionately

857. Nitinol never fails dramatically, which is bad for stories and excellent for insurance.
858. The three ways to kill an actuator: overheat it, overstrain it, or attach it badly. Usually the third.
859. Nobody's nitinol broke in the middle. It broke where you gripped it.
860. Fatigue failure is just the material keeping score.
861. Overheat it and it forgets. That's not failure, that's amnesia with a temperature.
862. If it stopped working and it still looks fine, check the temperature before you check the wire.
863. The most common failure in the field is a design that never accounted for cooling.
864. A wire that worked on the bench and failed in the box was never a wire problem.

Numbers

865. One percent strain, a million cycles. Seven percent, one hundred. That's not a curve, that's a cliff with a view.
866. Two hundred fifty percent recovery on a single use part is a number that ends conversations.
867. Ten billion cycles is possible and nobody believes us until we show the data.
868. Eighty five kilonewtons from a bar you can hold in one hand.
869. A tenth of a gram of wire lifting a kilogram is the demo that sells the company.
870. Nine point four millimeters of wire makes one complete turn. That's the smallest mechanism you'll build this year.
871. Twenty eight point six degrees per hundred millimeters, regardless of wall thickness, is the kind of fact that makes engineers sit up.
872. Six and a half times the force in the same envelope, just by laying the strip flat.
873. Fourteen times the travel, just by standing it on edge.
874. Three independent variables and one material. That's the whole handbook.

Metaphors for the sales team

875. Nitinol is a muscle that runs on heat instead of sugar.
876. It's a spring that knows which shape is correct.
877. It's a motor with the moving parts removed and the motion left in.
878. It's a gearbox that was decided at the factory and weighs nothing.
879. Think of temperature as the switch and the shape as the program.
880. It's memory foam for people who need actual force.
881. It's the only material that does work on its way back to normal.
882. It's a battery for shape.
883. It's a thermostat and an actuator in the same piece of metal.
884. It's what happens when metallurgy accidentally invents a machine.

For the engineers who already know

885. Yes, we know about the hysteresis. That's why we ask about your duty cycle.
886. Yes, it's nonlinear. So is everything you actually build with.
887. Yes, the cooling limits the frequency. That's chapter one, page two, and every conversation since.
888. Yes, we can do a custom transition temperature. No, not to the degree. Yes, close.

889. Yes, it's more expensive than steel. It's also more expensive than not solving your problem, which is what you're doing now.
890. Yes, it can be welded. Ask carefully.
891. Yes, biocompatible. Yes, there's a report. No, I can't find it right now.
892. Yes, it works in vacuum. Yes, better. No, we don't know why you're surprised.
893. Yes, it's the same stuff as in your glasses. No, yours doesn't actuate. That's superelastic.
894. Yes, we've heard of the competitor. Yes, we know what happened in 1998.

Closing bits

895. My job is convincing people that a piece of wire is a machine, and the wire does most of the convincing.
896. There is no part of this business that isn't improved by handing somebody a sample.
897. The handbook took five hundred pages. The pitch takes eleven seconds and a lighter.
898. Every engineer who has ever watched a wire contract has made the same face, and that face is why I do this.
899. We sell the least impressive looking product with the most impressive behavior.
900. Nobody has ever said "wow" about a solenoid.
901. The wire does not care about your opinion, your schedule or your budget. It cares about temperature.
902. Design around the physics and the physics will do the work for you.
903. Nitinol rewards people who read the whole chapter.
904. If this appendix is the only part you read, at least you got the tone right.
905. The metal remembers. That's the product, the pitch and the punchline.
906. What can nitinol do for you? Ask it nicely and apply about forty degrees.
907. The whole company runs on a material that refuses to let go of the past. Make of that what you will.
908. Everything in this book is a wire that learned a trick and never forgot it.
909. A million cycles is a long time to do one thing well.
910. The best part about shape memory is that the metal never has to be reminded twice.
911. If we've done this right, you now know more about actuators than you wanted to and exactly as much as you needed.
912. There are no moving parts, which means there is nothing to go wrong, which means the only thing left to get wrong is the design. Good luck.
913. You have reached the end of the jokes. The tables start again on the next page, and they are not funny at all.

Assorted

914. Nitinol is the only material that has a favorite version of itself.
915. The wire doesn't work harder when you push it. It works harder when you warm it.
916. Steel yields. Nitinol negotiates.
917. Aluminum bends and stays bent. Nitinol bends and files an appeal.
918. Copper conducts, steel carries, nitinol decides.
919. Every other metal answers to force. This one answers to temperature.

920. Nitinol is the only alloy with an opinion about its own geometry.
921. If metals had personalities, nitinol would be the one who peaked in the furnace and never stopped talking about it.
922. A material that performs its own return stroke is doing half your engineering for free.
923. Shape memory is the only property that sounds like a superpower and bills like a commodity.
924. The wire is the actuator, the actuator is the mechanism, the mechanism is the product. Everything else is a bracket.
925. We build machines by removing everything except the part that moves.
926. The best mechanism is one part. The second best has two. After that you're just adding failure modes.
927. Nitinol turns a thermal problem into a mechanical solution, which is the opposite of what usually happens.
928. Heat is the cheapest actuator input in the world and almost nobody uses it on purpose.
929. Every hot surface in your machine is a wasted actuator.
930. Your engine bay is already at working temperature. You're welcome.
931. Waste heat is just unscheduled actuation.
932. The sun is a transition temperature source and it's free.
933. Somewhere out there is a device that should be nitinol and is currently four motors.
934. My whole career is finding the four motors and replacing them with one wire.
935. There are two hard problems in nitinol: cooling, and convincing people about cooling.
936. If it were easy, everyone would have done it in 1962.
937. Nitinol is a sixty year old overnight success.
938. The material didn't change. The manufacturing did.
939. Every decade somebody rediscovers shape memory alloys and writes an excited article. We just keep shipping.
940. The technology isn't new. The handbook is.
941. Nobody needed a five hundred page book about wire until somebody made one.
942. This book exists because "it depends" is a terrible answer to give four hundred times a year.
943. We wrote down what we knew so you could stop guessing.
944. The tables are the argument. The prose is the invitation.
945. If you find an error in this handbook, tell us, and we will thank you and fix it and probably hire you.
946. Every number in here came from the same three rules and a lot of arithmetic.
947. We rounded to two significant figures because our process varies more than that, and pretending otherwise would be flattering nobody.
948. A handbook that admits its own tolerances is a handbook you can design from.
949. Conservative numbers make happy customers and boring lawsuits.
950. We would rather you were surprised by how well it works than by how badly.
951. Underpromise, overdeliver, and let the metal do the talking.
952. If your part beats the table, that's the design working as intended.
953. Nothing in here is a maximum. Everything in here is a promise.
954. The best compliment we get is "it did more than you said it would."
955. The second best is "I didn't have to call you."
956. The third best is "can I get five hundred."

957. A good actuator is one you forget you specified.
958. The finest engineering disappears into the product.
959. Nobody admires the wire. Everybody admires what it did.
960. Invisible mechanisms are the highest form of the art.
961. If they can see the mechanism, you haven't finished.
962. Take out the gearbox. Take out the motor. Take out the linkage. What's left is the idea.
963. Subtraction is the whole design method.
964. Every part you delete is a part that can't fail.
965. Reliability is mostly an absence.
966. The most reliable component in any machine is the one that isn't in it.
967. Nitinol is what you get when you delete everything and keep the motion.
968. Motion without machinery still feels like cheating.
969. It looks like nothing happening until it looks like magic.
970. The gap between "that's just a wire" and "how did you do that" is about forty degrees.
971. The demo never gets old because the reaction never changes.
972. I have watched a thousand people see this for the first time and not one of them looked away.
973. That reaction is the product. The wire is just how we deliver it.
974. Sell the reaction, ship the wire.
975. Some materials are useful. This one is delightful, which is rarer and sells better.
976. Delight is an engineering property and nobody puts it on the datasheet.
977. If your actuator makes people smile, charge more.
978. The best thing about nitinol is that it's fun, and the second best is that it's true.
979. A material that keeps its promises is worth a premium.
980. Shape memory is the only warranty written into the atoms.
981. The metal signed a contract in the furnace and has never once broken it.
982. Everything we sell was decided at one temperature on one afternoon and honored forever after.
983. That's not manufacturing, that's a vow.
984. Nitinol: bent by circumstance, restored by conviction, rated for a million cycles.
985. If you only remember one thing, remember that the shape comes back.
986. And if you remember two, remember that cooling is the limit.
987. And if you remember three, call us, because you're ready to design something.
988. The wire is patient. We are patient. The physics is not going anywhere.
989. Sixty years in, and the best is still ahead of the material.
990. Every new application looks impossible right up until somebody warms it up.
991. The next big nitinol product is currently a sketch on a notes page in the back of this book.
992. That's what the grid is for.
993. Use it. That's the whole reason we printed it at a tenth of an inch.
994. If this handbook ends up covered in pencil, we did our job.
995. The best handbooks get worn out, not shelved.
996. Bend the corner of the page you need. It won't come back, but the wire will.
997. The only thing in this building with a longer memory than the alloy is the person who wrote the handbook.

998. Nitinol has exactly one regret and it spends its whole life fixing it.

999. A wire that works for sixty years and asks for nothing is the best hire we ever made.

1000. Thank you for reading all the way to the end. Most people stop at the tables.

1001. What can nitinol do for you? Turn the page and find out. Or call. Calling is faster.