Product Catalogue

GEEPLUS

      

Geeplus Europe Limited
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Version 2.1

Contents

Company History and Structure

Geeplus was formed in 2004 as a Management Buyout of the electromechanical products business of Densitron Technologies PLC. The buyout involved the acquisition of Densitron Control Systems Ltd as a going concern and of the electromechanical products elements of business conducted by Densitron in Japan and in the United States of America.

The business is headquartered in the United Kingdom and is structured with a holding company Geeplus Holdings Ltd which wholly owns the three operating companies Geeplus Europe Ltd, Geeplus Asia Ltd, and Gee Plus Inc.

The principal activities of Geeplus are the design, manufacture, marketing, and sales of small electromechanical actuators – devices which develop linear force or rotational torque when stimulated with an electrical impulse.

Geeplus Europe quality systems are certified to ISO9001, we strive continuously to eliminate causes of faults or variation in our products and processes. Wherever possible parts, processes, and fixtures are designed to ensure repeatable assembly without errors.

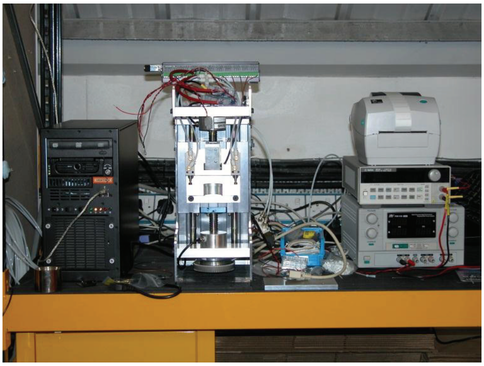
The main market for Geeplus products is in industrial and professional products, instrumentation and optical devices, medical, cash handling and security equipment. Our strength is in designing / supplying elegant and robust solutions for critical applications - those in which the consequences of device failure are very much greater than the cost of replacing the part. For regulating the flow and pressure of gases sustaining a patient in breathing systems, for counting and sorting banknotes, for deflecting or blocking laser beams, for sorting systems, or for access control, Geeplus has implemented designs for leading companies in all these areas.

We seek to visit customers early in the design process, in an era of e-communication we believe that face-to-face contact is important to understand our customers business and applications, to get a sense of scale which is not conveyed in electronic communications, and to understand what functionality is really needed to achieve the desired end result in a user's application.

Typical applications have requirements ranging from 10's to 10k's of pieces per year.

Resources

Design resources are based in the UK with manufacturing either in the UK or in Asia as appropriate to the nature, the complexity, and the production volumes of the product concerned. Whilst offshore manufacturing can have cost benefits, consideration is also given to the quality control exercised by offshore suppliers, to their volume capabilities, production line layout, and to lead time and delivery logistics. We have a few key manufacturing partners who have invested steadily over many years in tooling, fixtures, design and test capabilities, and quality systems, and with whom we have a long history of developing successful designs.



We have designed and developed in-house test systems for characterising force and displacement behaviour of devices for several years, recent developments in this area include digital force transducers to reduce the noise inherent to analogue sensors (valuable for hysteresis measurement where hysteresis values may be <0.1% of measured force values).

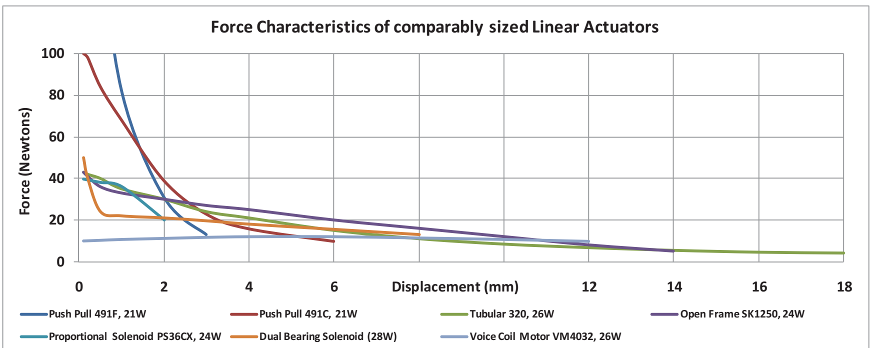
Geeplus has invested in key processes and resources to further our technical capabilities, recent additions include machining and measurement technology capable of machining bores with tolerances tighter than +/-1 micrometre, and cleanroom assembly area to exclude dust and contamination from sensitive assemblies. Currently we are developing over-moulding capabilities to facilitate encapsulation of fragile coil assemblies.

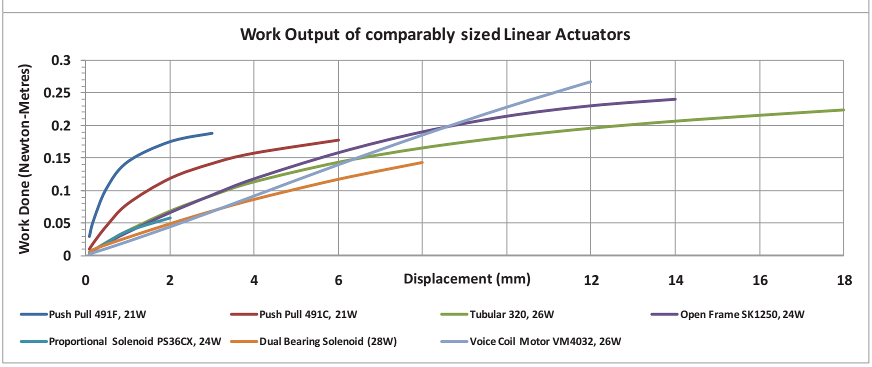
Linear actuators

There are many different factors that can influence the choice of a linear actuator, some of these are described, the selection process aims to identify the least expensive device which can satisfy requirements of the application.

Controllability, Force Characteristic & Mechanical Work

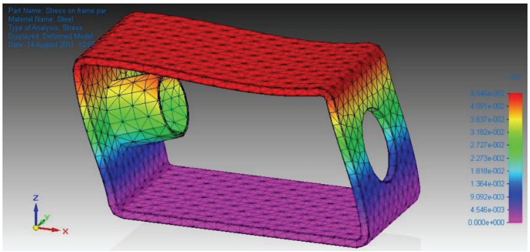
The graphs below show the force vs displacement, and work vs displacement characteristics for actuators of different types with similar weight and power input. It is clear that for short displacement the push-pull solenoids produce much higher force than other types. The flat force characteristic of proportional solenoid and voice-coil motor lends itself to control of force or of position, rather than simple 'on-off' function. Work carried out by the voice coil is higher because it can drive in both directions, other solenoids require a spring to return in the other direction.



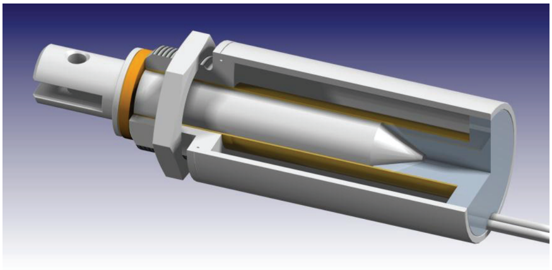


The high force developed by the push-pull solenoid in the energised position is due to the magnetic design, where at short displacement the radial flux in return path (which produces no force along the axis) is diverted to flow between the armature plate and case of the solenoid. The flux flow along this secondary flux path is parallel to the axis and contributes to the developed force. The large surface area of this secondary airgap also results in low reluctance of the magnetic circuit and increased magnetic flux, in combination these two effects result in more than twice approximately twice as much force being developed in the holding (0mm) position *[illustration or flux animation]*.

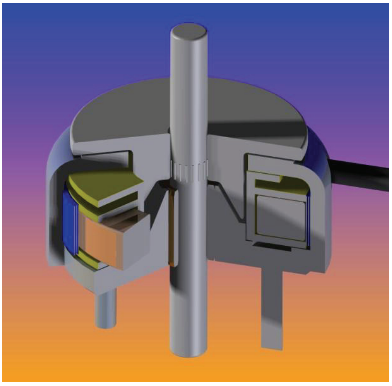
Life Expectancy



The life expectancy of a solenoid is affected by wear of sliding surfaces, and by fatigue and impact failure of component parts. For open-frame devices, life expectancy may be limited by fatigue of the steel frame which has limited rigidity, the image *[animation in powerpoint presentation]* shows in exaggerated form how the frame distorts when the plunger impacts the end stop of the solenoid, under repeated cycles the frame may fatigue and break, typically at the staked joints, or bends in the frame. This mode of failure is more likely to occur with large parts operating at high force and with heavy loads.



Both the open frame solenoid, and the tubular solenoid, employ a construction in which the plunger slides directly in the sleeve of the solenoid, which may be a brass or stainless steel sleeve, or in some cases the plunger may slide directly in the plastic coil former. The materials and surface finish of the bearing interface are performing many functions, and may not be optimum as bearing materials. Plunger and/or sleeve may be treated to reduce friction, treatments include molybdenum disulphide, nickel plating, Teflon coating and other. These treatments can prolong life considerably to many millions of cycles.



The push-pull solenoid and voice coil motor utilise a separate shaft as bearing surface, and bushes of purpose made bearing material. These materials, and the finish of these surfaces are designed to withstand wear. In the case of the solenoid, the radial magnetic field between armature and stator results in some side-forces being developed which will aggravate wear. The voice coil develops very little side-force, so bearing loading (ignoring application forces) can be very small and result in very low friction and wear. Life expectancy can be 10’s of millions, or even hundreds of millions of cycles.

Speed of Operation

The response speed of an actuator is limited by both electrical and mechanical factors.

When electrical power is applied to a device, it takes time for the current to increase due to inductance of the coil, this factor is commonly referred to as ‘electrical time constant’. For most devices, the force developed is proportional to the energising current and the device will not start to move until the electromagnetic force is greater than the load force (return spring, friction, mass) – the time taken to reach this condition is sometimes referred to as ‘time-to-engage’. These devices are not pure inductors, when the device begins to move the airgap may change, and ‘back-emf’ may influence behaviour.

For solenoids particularly the release characteristic may also be a limitation, as the airgap reduces (approaching the energised position), the inductance will increase. When the device is switched ‘off’ it may take more time for the current to decay due to higher inductance in this position.

Once the electromagnetic force overcomes the load force, the device will begin to move, and will accelerate at a rate determined by the excess force (over and above load resistance) and the load inertia (moving mass). These mechanical limitations are commonly characterised as 'mechanical time constant'. It should be noted however, that the force developed by most devices is not linear, most solenoids exhibit an exponential characteristic with force increasing as the device pulls in towards energised position, thus once the device starts to move, the airgap reduces, and force / acceleration increase.

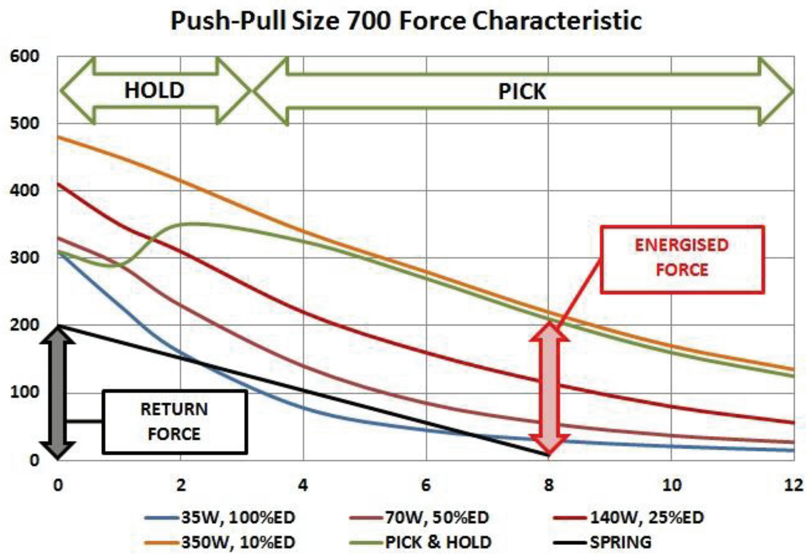
For solenoid devices in which the return force is provided by a spring, the spring force will subtract from the magnetic attraction force and reduce the excess force available to accelerate the load.

Electrical and mechanical factors interact, typically a device starts to move while current is still increasing, so not only is the force changing due to position, but also due to increasing current.

In order to achieve fastest possible response time, the following points need to be considered:

- Use a coil with low inductance, and a high excitation voltage, to minimise the electrical time constant
- Keep the moving mass of the load + solenoid armature as small as possible
- Maximise the starting force to obtain high initial acceleration. The graph illustrates how this works for the size 700 push-pull solenoid, in an implementation where starting force of >200N is achieved in both directions over 8mm displacement.
  - If a return spring is used, a rising rate spring with small extended force, and high compressed force will provide minimum load to the solenoid at start of 'energised' move, and will impart maximum force at start of the 'de-energised' move.
  - A high 'pick' current when the solenoid is first energised will allow high initial force and acceleration, this may then need to be reduced to avoid excessive power consumption and heat dissipation.

- If both the above measures are employed, the high holding force exhibited by the push-pull solenoid may be beneficial to hold the spring compressed with minimal excitation power. See technical note on 'Pick and Hold' for more details.



Latching (also known as bistable or self-holding) solenoids facilitate the same force and speed benefits that can be achieved through the use of a pick and hold drive configuration, but with simpler drive requirements. These devices also exhibit lower inductance in the energised position than conventional solenoids due to the properties of the permanent magnets employed in their construction. Latching solenoids are not generally suitable for use in applications requiring 'fail-safe' operation.

Summary of Characteristics of Linear Devices

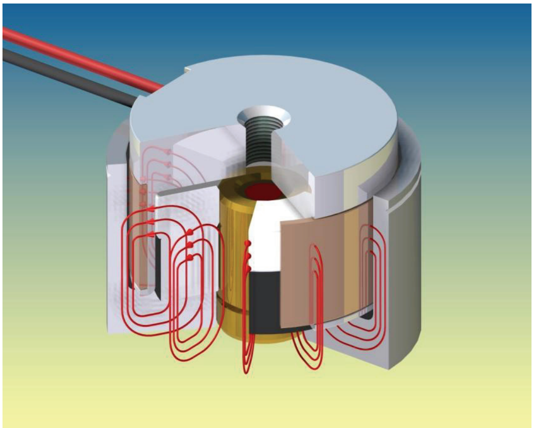
	Controllability	Displacement	Speed	Life Expectancy	Extended Force	Holding Force	Form Factor
VoiceCoil Motor	Best *(hysteresis typically <1% of force)*	>20mm	Fast - ability to drive in both directions, can accelerate >>100G	>100M cycles possible due to low side forces	Good linearity possible over working range		Large flexibility in shape possible
Proportional Solenoid	Second Best *(hysteresis typically <10% of force)*	<10mm		High - >10M cycles possible	Good linearity possible over working range		Usually cylindrical
Push Pull Solenoid		25mm	High speed possible in conjunction with 'Pick and Hold' drive	High - >10M cycles possible	High force possible with intermittent use, or in conjunction with 'Pick and Hold' drive	Highest after electromagnet	Cylindrical, short
Tubular Solenoid		>30mm		Moderate - >2M cycles typical	Good	Moderate	Cylindrical, long
Latching Solenoid		>10mm	Pulsed operation permits high power for high force and speed	<1M cycles	Moderate	Good	Cuboid
Open Frame Solenoid		>10mm		<1M cycles	Moderate	Poor	Cuboid
Electromagnet		<1mm	High inductance due to short airgap		Reduces very rapidly with increasing airgap	Highest	Cylindrical

Voice coil motors

Voice Coil Motor Characteristics

Voice Coil Motors are highly controllable electrical actuators suitable for applications needing only limited displacement. They offer the following features:

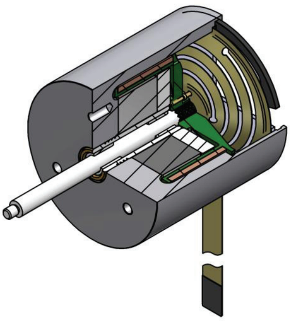
- Fast operation – Low electrical inductance, and low moving mass enable fast inflow of current and high acceleration. Acceleration of >500G is possible with custom devices
- Controllability – Force is proportional to applied current, and is uniform through a displacement that can be several 10's of mm or several 10's of degrees rotation
- Low hysteresis – The magnetic behaviour is free of hysteresis over typical operating areas, depending on the type of bearings used, very low hysteresis can be realised
- Reliability – side forces developed are negligible, so bearing loading can be very low to enable long life operation
- Simplicity – the voice coil motor is a single pole device requiring no commutation. Both the device itself, and the associated controller can be very simple and robust
- Flexible Configuration – the principle of operation lends itself to many different mechanical layouts allowing great flexibility in design of associated systems



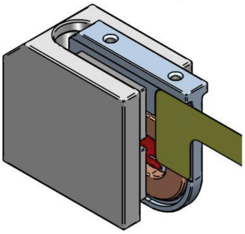
- Flexible Production – Most product configurations can be produced without requiring tooling for prototypes, or for limited production volumes – product design needs to allow for manufacturing methods appropriate to customer volume requirements

Custom Designs

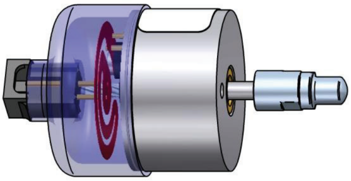
Custom designs can incorporate many different features including the following :



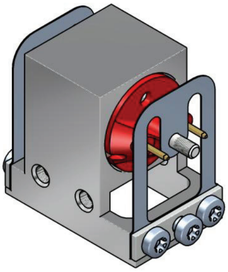
- Flexible circuit termination of the coil provides reliable electrical connection with repeatable low resistance to movement and low friction (hysteresis). Body is extended with end cover providing a sealed unit with easy electrical termination



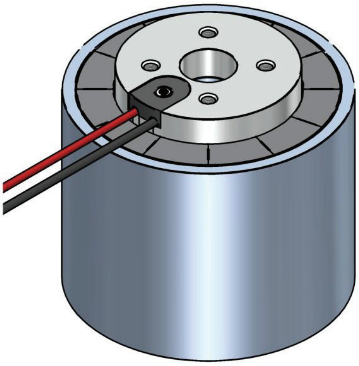
- Flat coil design allows pivoting motion and tolerance to some variation in position of the coil relative to magnet assembly.
- Flex circuit is used for easy termination

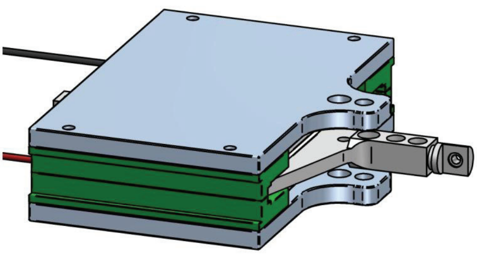


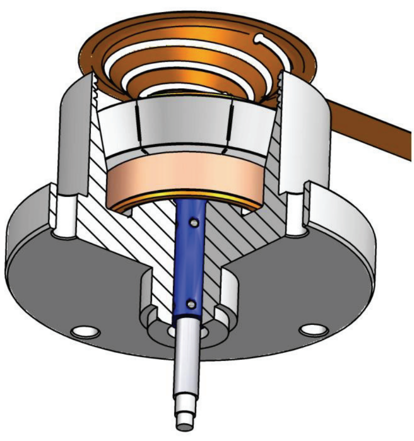
- End cover and flex circuit allow sealed unit with reliable, low-friction electrical connection. Connector allows easy installation and replacement.
- Special tip fitted to shaft



- Steel flexure guidance provides repeatable, friction-free guidance of the shaft with unlimited life expectancy

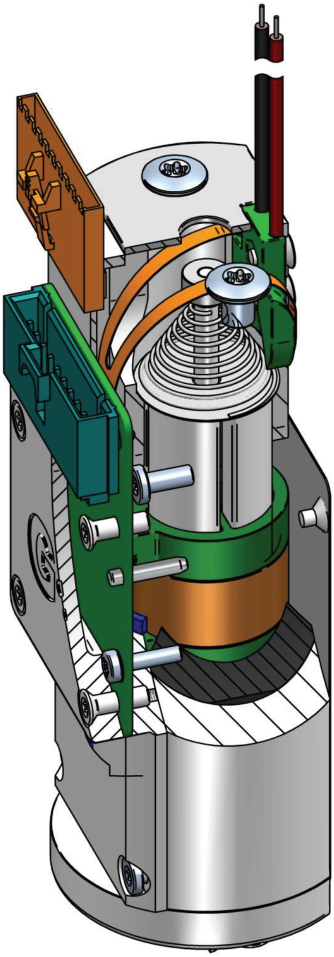






- Multiple poles for higher force and efficiency with reduced size and mass, use of multipole designs may be inappropriate to applications requiring large displacement
- Aluminium coil windings enable reduced moving mass for high acceleration, the flat design illustrated uses multiple poles and aluminium coil winding to achieve force capability >50N peak with coil mass <12g for acceleration capability >400G
- Rolling element bearings provide more precise guidance, and more repeatable friction behaviour when subjected to variable side loading, the part shown also employs flexible circuit termination and a focussed radial magnet assembly for higher force / mass and better dynamic performance

- Position encoder with resolution to <1µm for closed loop (servo) control
- Multiple coil and lightweight titanium shaft for high force / mass ratio
- Rolling element bearings for high precision, long life linear guidance
- Flex termination integrated within compact design



VM Series Description

Standard Voice Coil Motors of Geeplus VM series incorporate shafts and bearings to ensure accurate guidance of the coil assembly within the magnet assembly, and to facilitate easy installation in customer applications. For wear resistance and good surface finish along with required magnetic properties the shaft material is either stainless steel (hardenable stainless steel may be slightly magnetic and have a slight influence on the force characteristic, non-magnetic stainless steel is softer and more susceptible to damage) or titanium.

The magnet assembly of VM series is designed for good volumetric efficiency and useful linear stroke, these characteristics may be at the expense of some loss of linearity. High Energy Density magnets drive the material of the voice coil pot (housing) close to magnetic saturation to develop the strongest possible magnetic field. Custom designs can demonstrate better linearity at the expense of increased size / weight & cost.

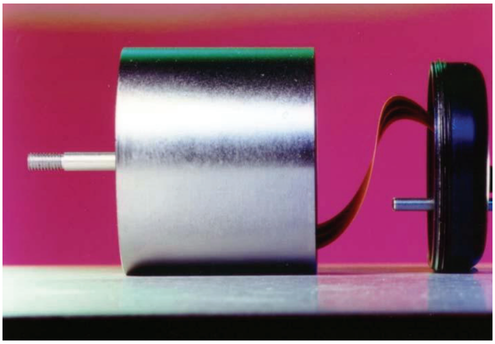
- Coils of standard VM series are normally designed to use the full depth of the pot assembly. This results in maximum mechanical work output capability, but may result in a force characteristic which is not ideally suited to a given application. The portion of the coil which lies outside the airgap field dissipates power (as heat) but develops no useful force.
- The linear range of a voice coil (the range within which developed force is >90% of peak force) will normally be roughly equal to the difference between the coil length, and the length of the pole.
- For maximum force, the coil length and pole length should be approximately equal in length, but the linear range with this configuration will be small.
- For best linearity, one of the coil and polepiece should be longer than the other by the linear range required. It is usually more cost effective to make the coil longer than the magnet assembly – making the coil shorter than the polepiece results in lower moving mass and faster dynamic response, but this may require a more massive and expensive magnet assembly to produce a required force characteristic.

Mechanical Integrity

The design of VM series devices ensures good concentricity and mechanical integrity of the complete device. Accurate fixtures are used in assembly to control assembly dimensions, and coil assemblies are individually measured to ensure concentricity and clearance with the magnet assembly. All devices are designed to ensure that finite clearances are maintained throughout an operating range from 0ºC to 130ºC.

Electrical Termination

Connection to the moving coil of a voice coil motor must be implemented with care to ensure reliable operation. Flexible cable with many fine strands and Silicone Rubber insulation can provide reliable termination, care should be taken that the leads are mechanically secured to the moving assembly preferably at some distance from the soldered joints (solder fuses the strands together, and leads to large stresses being applied to the termination pins, or to fatigue adjacent to the fused portion of the wire). The leads should be carefully routed to minimise stress. A more consistent means of termination is to use a flexible circuit, this option is offered for several of the VM series devices (see picture).



Voice Coil Motors offered by Geeplus are described in terms of the following Parameters and conventions:

Coil Resistance – resistance in Ohms

Coil Inductance – Inductance measured in milliHenrys

Force Constant

The force constant for the motor is a factor which multiplied by the excitation, gives the peak force developed (under 100% ED excitation condition).

> **K_{NI}** – The ratio between (peak) force in Newtons, and excitation in Ampere-turns. This value is a constant for a motor of a given form factor irrespective of the coil winding. Given this value, the K_I value (and other performance factors) can be calculated for alternative winding options.
>
> **K_I** - The ratio between (peak) force in Newtons, and excitation in Amperes. This value will vary for a motor of given form factor depending on the coil winding.

Velocity Constant

Kv – The velocity constant for the motor is a factor which multiplied by the motor velocity (in metres per second), gives the Back-EMF developed across the motor coil.

Force Parameters

> **F_{100}** – The peak force developed in N when an excitation current I_{100} is applied to the coil which applied continuously at an ambient temperature of 20°C will raise the coil temperature to temperature limit T_{max}.
>
> **F_{10}** - The peak force developed in N when an excitation current is applied to the coil applied at 10% ED duty cycle at an ambient temperature of 20°C will raise the coil temperature to temperature limit T_{max}.

T_{max} – The maximum safe operating temperature for the coil materials of the voice coil expressed in ^{o}C

Linear Region – the range of movement over which the force developed by the voice coil is >90% of the peak output force with 100% excitation

Useful Stroke – the range of movement over which the force developed by the voice coil is >50% of the peak output force with 100% excitation

Electrical Parameters

R_{20} – this is the nominal coil resistance of the motor measured at $20^{o}C$

I_{100} – this is the excitation current corresponding to 100% ED operation

A-t (Ampere-turns) – the force developed by a given voice coil is proportional to the applied current, however if the winding is changed the force developed for the same applied current will also change. Ampere-turns is the product of the excitation current multiplied by number of turns in the coil, it is useful in making comparisons because it is independent of the coil wire size.

Maximum 'On' Time – this is the time taken for the coil temperature to rise from $20^{o}C$ to T_{max} when energised under the stated duty condition. It is a simple (and easily measured) way to describe the thermal inertia of the coil assembly. Energising for longer than this under these conditions will lead to overheating, and could lead to failure.

Force and Acceleration

Direction of Operation – force is measured pushing against the end of shaft where this is fitted – in this case the force developed by the coil is pulling it into the magnet assembly, the coil field reinforces the field developed by the magnets and force is stronger in this direction. Where shaft is not fitted, force is measured pushing against the coil former, this is pushing out of the magnet assembly and the field due to coil excitation opposes the field developed by magnets resulting in weaker force. The relationship between force and current will become non-linear at high excitation levels due to this effect.

Acceleration – where high dynamic performance is required it may be beneficial to use aluminium coil wire to reduce moving mass in the system. It is important to note that while this can have a very beneficial effect in applications with low inertia, in systems where the load is heavy compared to the coil mass, the benefits of reduced mass may be offset by the higher electrical resistivity of aluminium. Geeplus provides a calculation tool 'Coil Calculator' which indicates the relative acceleration of a system with different coil materials for the same power input.

Guidance – most voice coil motors offered by Geeplus incorporate a shaft connected to the coil, and bearings for guidance. Unless otherwise stated, bearings are unlubricated polymer bushes without oil or grease lubrication. There are some parts which do not incorporate guidance, and which rely on guidance in the user application to maintain clearance between the coil and magnet assembly.

GEEPLUS VM1614

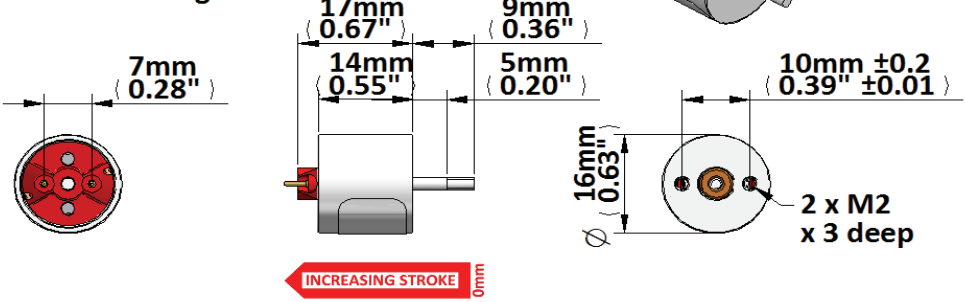
P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20°C

P_{100}	5 W	Total Mass	15 g
T_{max}	130 °C	Coil Mass	3 g

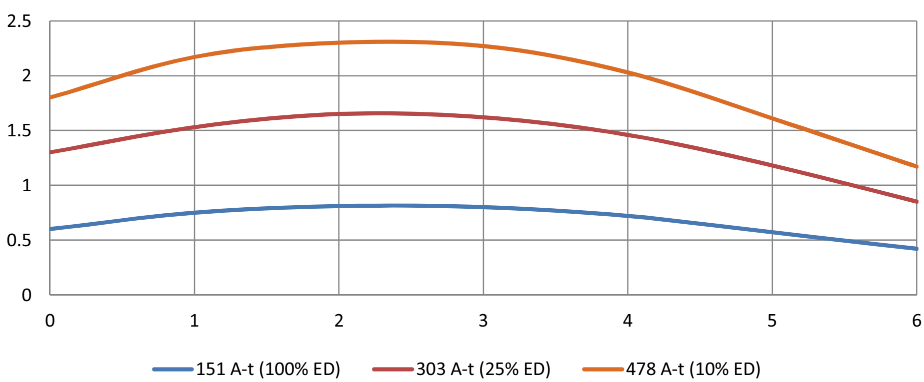
Model No.	Resistance R_{20}	Inductance	Force Constant	Velocity Constant	Current I_{100}
VM1614-200	2.8 Ω	0.2 mH	0.7 N/A	0.7 Vs/m	1129 mA
VM1614-180	4.5 Ω	0.3 mH	0.7 N/A	0.7 Vs/m	891 mA
VM1614-125	16.3 Ω	0.0 mH	1.5 N/A	1.5 Vs/m	468 mA
VM1614-100	43.0 Ω	4.0 mH	2.4 N/A	2.4 Vs/m	288 mA

Max 'ON' time		Peak Force
100% ED	∞	0.8 N
50% ED	22 s	1.1 N
25% ED	9 s	1.7 N
10% ED	3 s	2.3 N

This device uses Oilite sintered bronze bearings



Force (N) vs Displacement (mm)



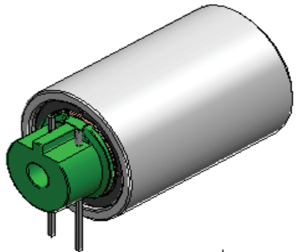
GEEPLUS VM2436

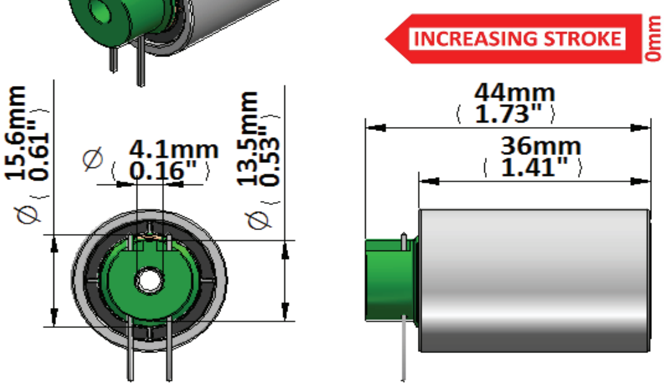
P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20°C

P_{100}	12.5 W	Total Mass	95 g
T_{max}	130 °C	Coil Mass	9 g

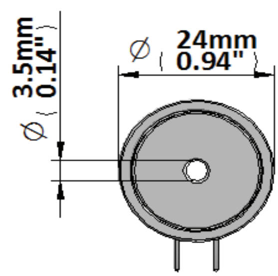
Model No.	Resistance R_{20}	Inductance	Force Constant	Velocity Constant	Current I_{100}
VM2436-375	1.0 Ω	0.2 mH	0.7 N/A	0.7 Vs/m	2.99 A
VM2436-180	17.8 Ω	3.6 mH	2.9 N/A	2.9 Vs/m	708 mA
VM2436-112	107.0 Ω	22.0 mH	6.7 N/A	6.7 Vs/m	289 mA

Max 'ON' time		Peak Force
100% ED	∞	2.7 N
50% ED	22 s	3.8 N
25% ED	9 s	5.2 N
10% ED	3 s	7.5 N

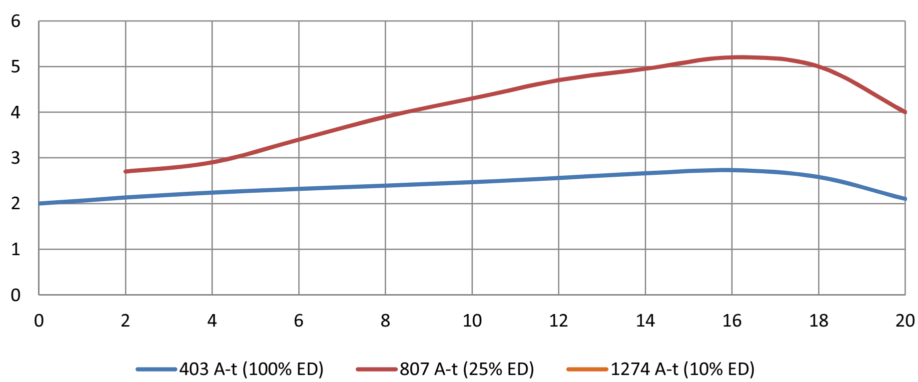




This part does not include bearings - guidance should be provided in customer application to maintain clearance between coil and magnet assembly



Force (N) vs Displacement (mm) [outwards direction]



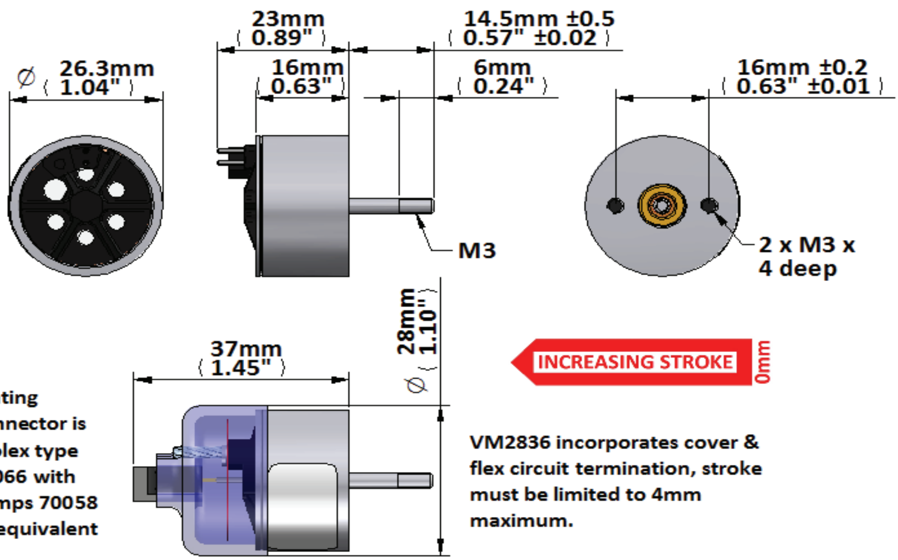
GEEPLUS VM2618 & VM2836

P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20°C

P_{100}	8 W	Total Mass	60 g
T_{max}	130 °C	Coil Mass	6 g

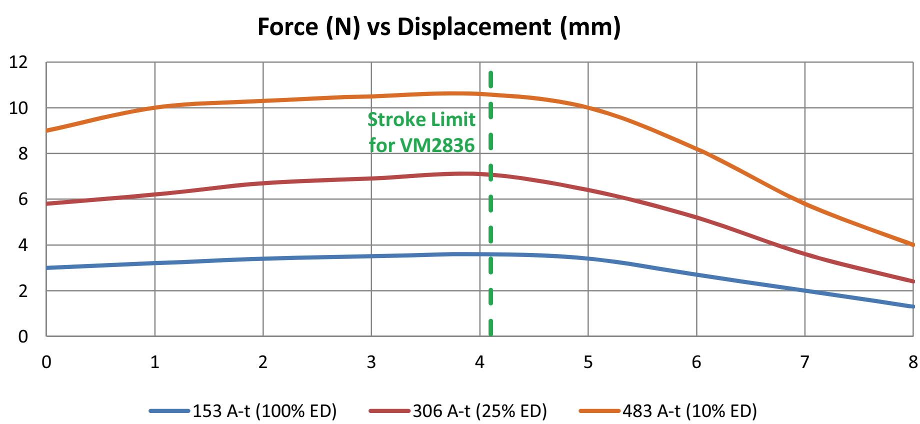
Model No.	Resistance R_{20}	Inductance	Force Constant	Velocity Constant	Current I_{100}
VM2xxx-180	9.6 Ω	1.3 mH	4 N/A	4 Vs/m	771 mA
VM2xxx-132	34.4 Ω	5.3 mH	8 N/A	8 Vs/m	407 mA
VM2xxx-112	55.0 Ω	7.3 mH	9 N/A	9 Vs/m	322 mA
VM2xxx-080	286.0 Ω	40.0 mH	21 N/A	21 Vs/m	141 mA

Max 'ON' time		Peak Force
100% ED	∞	3.4 N
50% ED	55 s	4.8 N
25% ED	12 s	7.0 N
10% ED	3 s	10.6 N



Mating connector is Molex type 70066 with crimps 70058 or equivalent

VM2836 incorporates cover & flex circuit termination, stroke must be limited to 4mm maximum.



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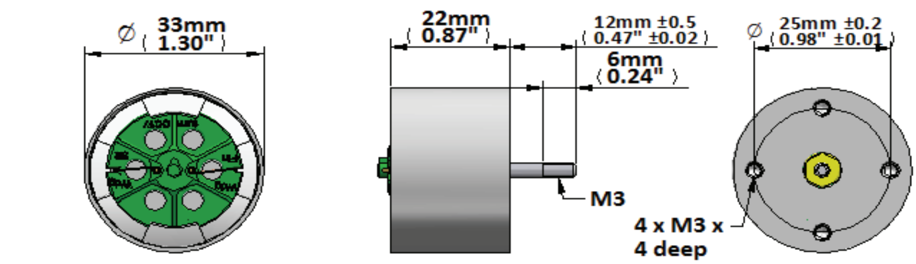
GEEPLUS VM3322 & VM3334

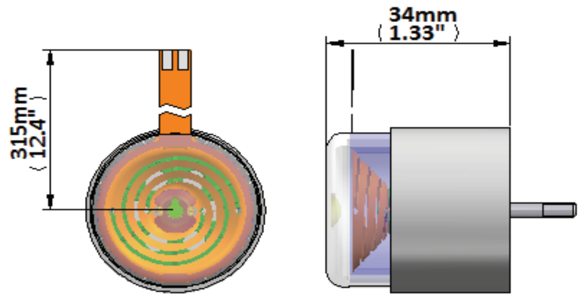
P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20°C

P_{100}	8 W	Total Mass	140 g
T_{max}	130 °C	Coil Mass	7 g

Model No.	Resistance R_{20}	Inductance	Force Constant	Velocity Constant	Current I_{100}
VM33xx-315	1.0 Ω	0.2 mH	2 N/A	2 Vs/m	2.4 A
VM33xx-180	10.9 Ω	3.0 mH	6 N/A	6 Vs/m	724 mA
VM33xx-125	47.7 Ω	13.0 mH	13 N/A	13 Vs/m	346 mA
VM33xx-090	173.0 Ω	44.0 mH	24 N/A	24 Vs/m	182 mA

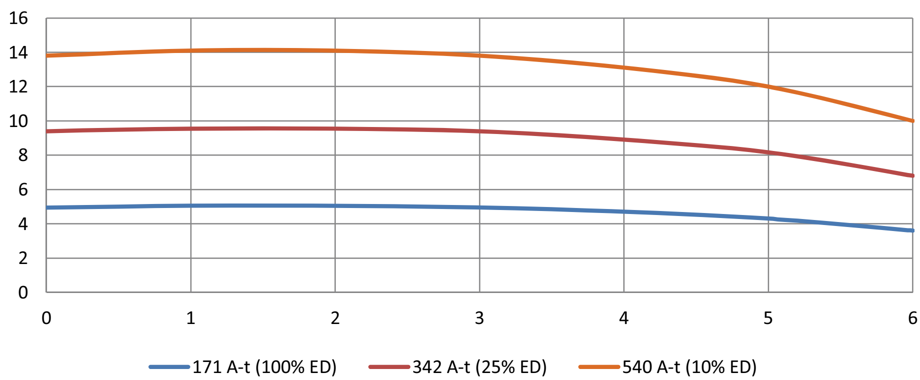
Max 'ON' time		Peak Force
100% ED	∞	5.0 N
50% ED	17 s	7.0 N
25% ED	6 s	9.5 N
10% ED	2 s	14.0 N





VM3334 incorporates flex termination to mate with 5-way FFC connector, Molex P/N 52207-0585 or similar
Centre pin is unused, 2 pins connect to each circuit of flex termination
Orientation of flex circuit exit position relative to mounting holes may vary

Force (N) vs Displacement (mm)



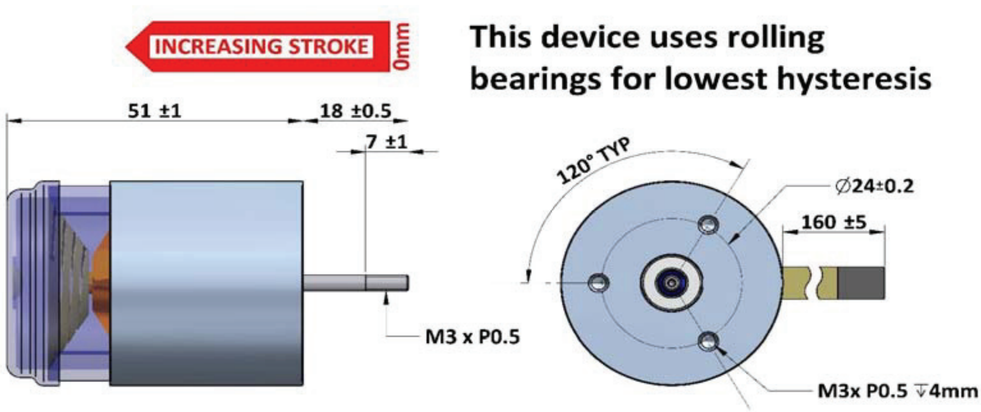
GEEPLUS VM3850RB

P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20ºC

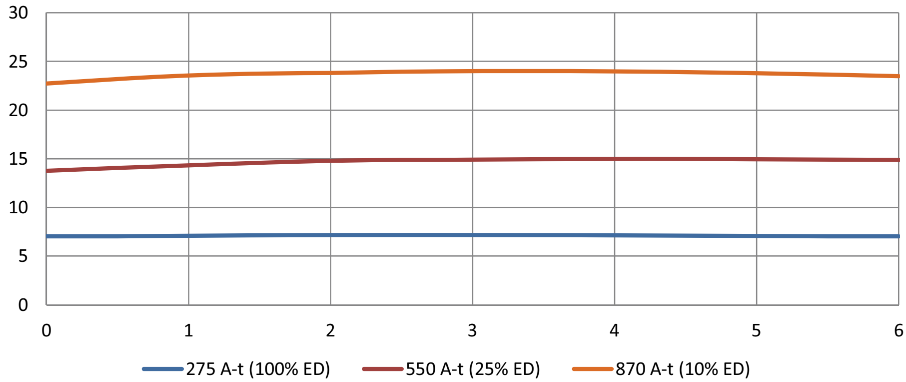
P_{100}	7.4 W	Total Mass	?g
T_{max}	130 ºC	Coil Mass	17 g

Model No.	Resistance R_{20}	Inductance	Force Constant	Velocity Constant	Current I_{100}
VM3850RB-200	22.6 Ω	0.0	13.8 N/A	13.8 Vs/m	0.48 A
VM3850RB-280	4.5 Ω	0.0	4.5 N/A	4.5 Vs/m	1.08 A

Max 'ON' time		Peak Force*
100% ED	∞	7.2 N
50% ED	105 s	10.0 N
25% ED	62 s	15.0 N
10% ED	11 s	24.0 N



Force (N) vs Displacement (mm)



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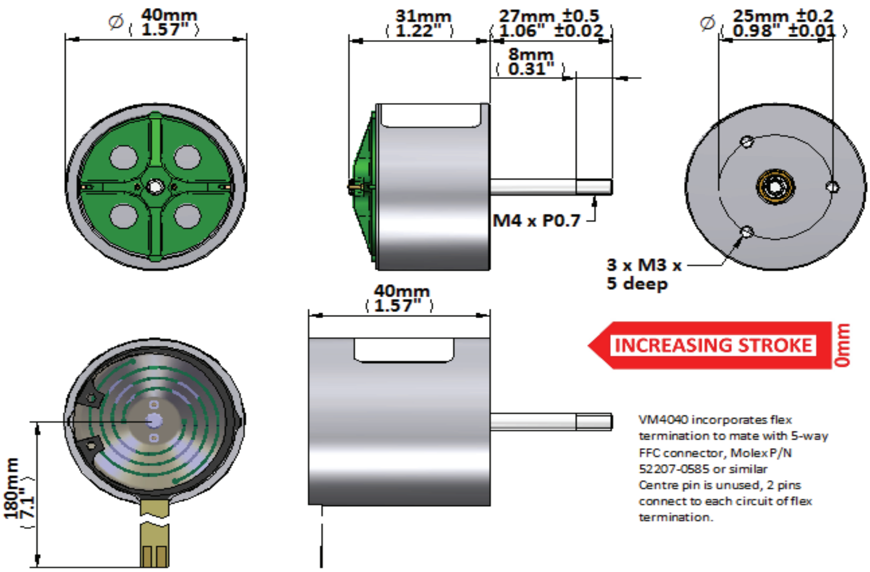
GEEPLUS VM4032 & VM4040

P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20°C

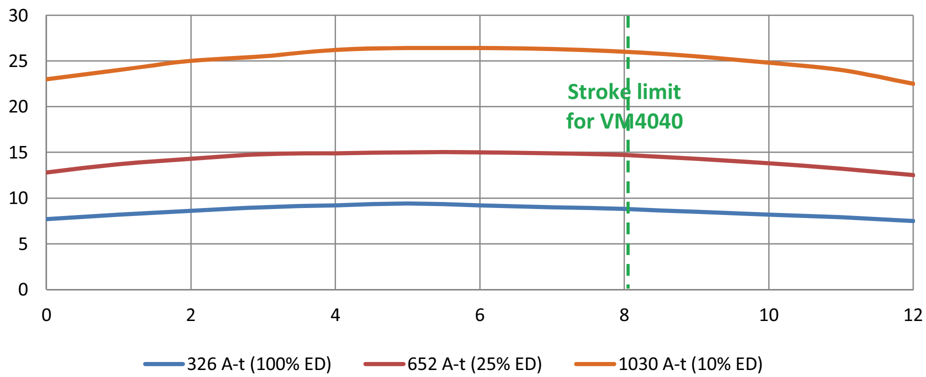
P_{100}	16 W	Total Mass	230 g
T_{max}	130 °C	Coil Mass	25 g

Model No.	Resistance R_{20}	Inductance	Force Constant	Velocity Constant	Current I_{100}
VM40xx-315	4.3 Ω	1.5 mH	5 N/A	5 Vs/m	1.6 A
VM40xx-250	12.8 Ω	5.2 mH	10 N/A	10 Vs/m	0.9 A
VM40xx-200	26.0 Ω	7.8 mH	12 N/A	12 Vs/m	0.7 A

Max 'ON' time		Peak Force
100% ED	∞	9.0 N
50% ED	90 s	12.0 N
25% ED	28 s	15.0 N
10% ED	8 s	26.0 N



Force (N) vs Displacement (mm)



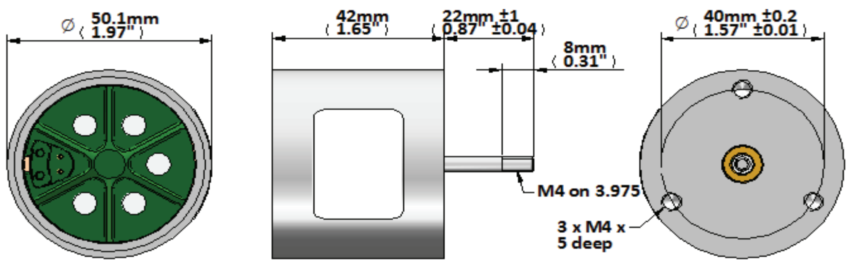
GEEPLUS VM5042 & VM5050

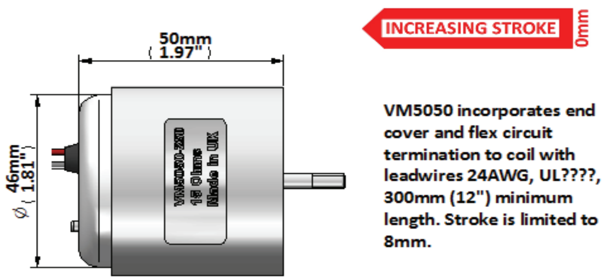
P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20°C

P_{100}	24 W	Total Mass	480 g
T_{max}	130 °C	Coil Mass	35 g

Model No.	Resistance R_{20}	Inductance	Force Constant	Velocity Constant	Current I_{100}
VM50xx-400	2.5 Ω	1.3 mH	7 N/A	7 Vs/m	2.6 A
VM50xx-250	15.0 Ω	5.6 mH	17 N/A	17 Vs/m	1.1 A
VM50xx-190	45.0 Ω	20.0 mH	30 N/A	30 Vs/m	0.6 A

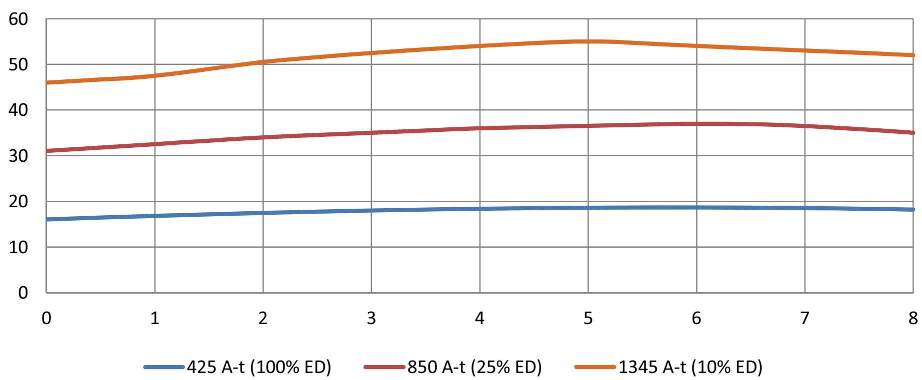
Max 'ON' time		Peak Force
100% ED	∞	19.0 N
50% ED	65 s	27.0 N
25% ED	12 s	37.0 N
10% ED	3 s	54.0 N





VM5050 incorporates end cover and flex circuit termination to coil with leadwires 24AWG, UL????, 300mm (12") minimum length. Stroke is limited to 8mm.

Force (N) vs Displacement (mm)



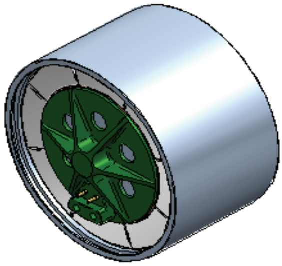
GEEPLUS VM6340

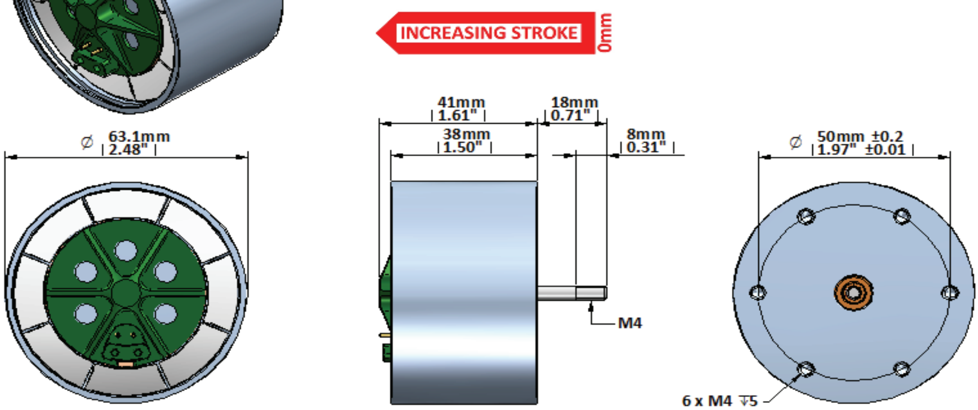
P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20°C

P_{100}	24 W	Total Mass	750 g
T_{max}	130 °C	Coil Mass	40 g

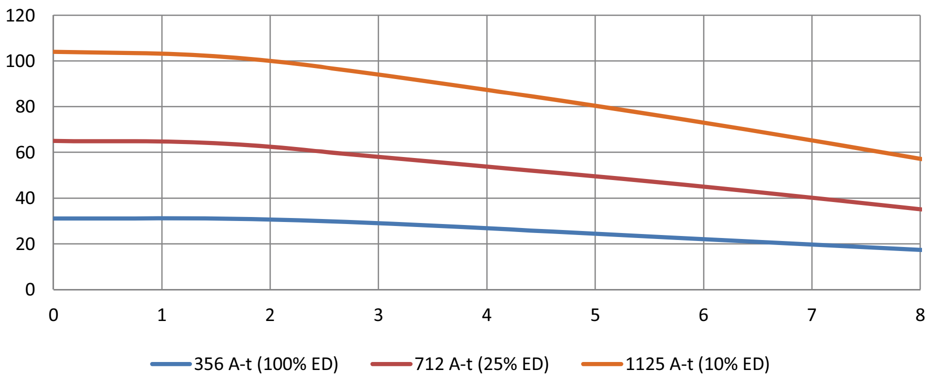
Model No.	Resistance R_{20}	Inductance	Force Constant	Velocity Constant	Current I_{100}
VM6340-400	2.5 Ω	1.3 mH	12 N/A	12 Vs/m	2.6 A
VM6340-250	15.3 Ω	7.8 mH	29 N/A	29 Vs/m	1.1 A
VM6340-190	45.0 Ω	20.0 mH	51 N/A	51 Vs/m	0.6 A

Max 'ON' time		Peak Force
100% ED	∞	31.0 N
50% ED	65 s	46.0 N
25% ED	12 s	65.0 N
10% ED	3 s	104.0 N





Force (N) vs Displacement (mm)



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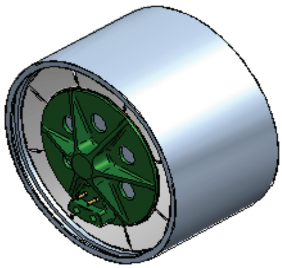
GEEPLUS VM6340L

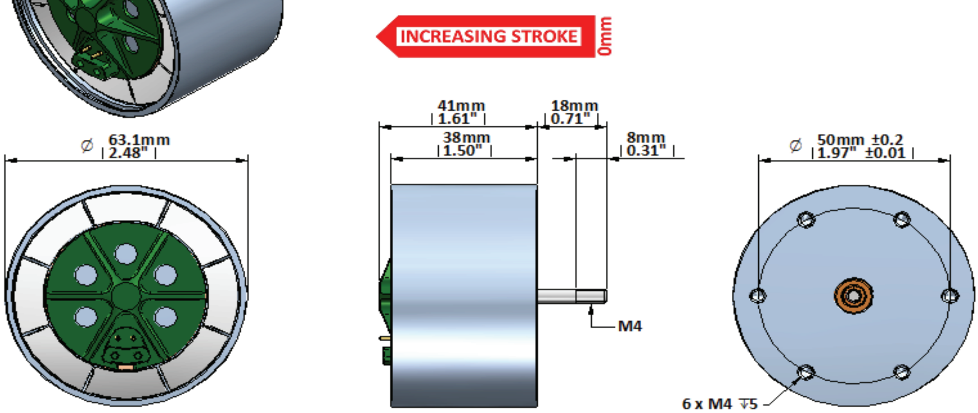
P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20°C

P_{100}	28 W	Total Mass	750 g
T_{max}	130 °C	Coil Mass	43 g

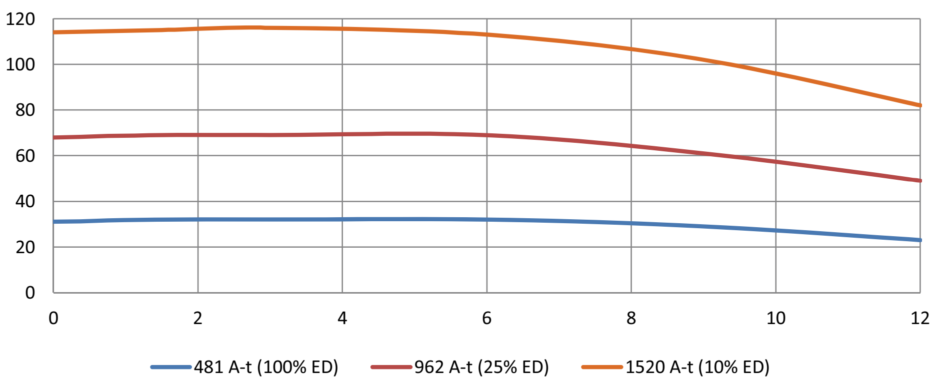
Model No.	Resistance R_{20}	Inductance	Force Constant	Velocity Constant	Current I_{100}
VM6340L-400	3.7 Ω	1.8 mH	14 N/A	14 Vs/m	2.3 A
VM6340L-250	22.0 Ω	10 mH	33 N/A	33 Vs/m	1.0 A
VM6340L-190	67.0 Ω	31 mH	57 N/A	57 Vs/m	0.5 A

Max 'ON' time		Peak Force
100% ED	∞	32.0 N
50% ED	65 s	48.0 N
25% ED	12 s	69.0 N
10% ED	3 s	116.0 N





Force (N) vs Displacement (mm)



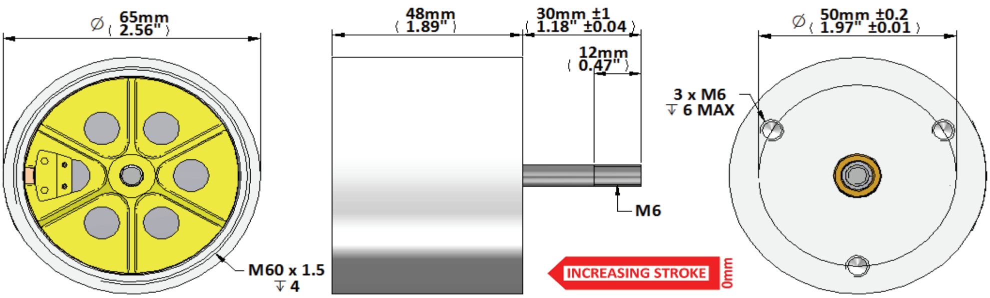
GEEPLUS VM6548

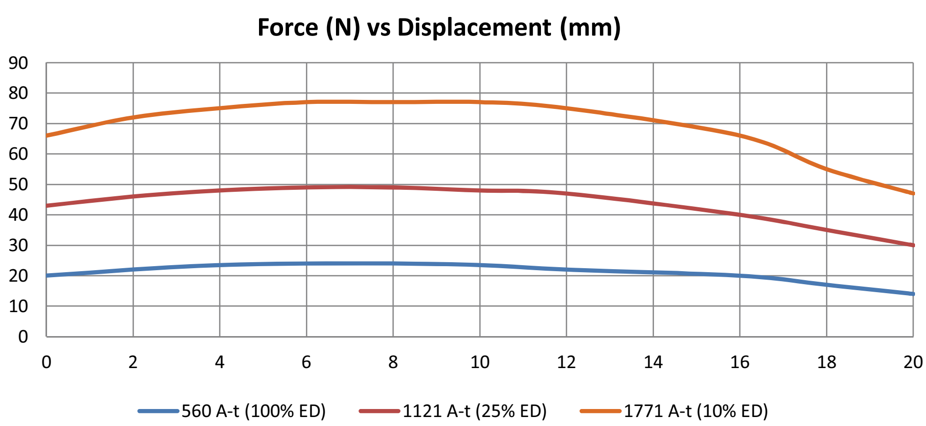
P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20°C

P_{100}	28 W	Total Mass	950 g
T_{max}	130 °C	Coil Mass	90 g

Model No.	Resistance R_{20}	Inductance	Force Constant	Velocity Constant	Current I_{100}
VM6548-400	7.8 Ω	7.4 mH	19 N/A	19 Vs/m	1.6 A
VM6548-315	23.3 Ω	12.0 mH	32 N/A	32 Vs/m	0.9 A
VM6548-200	121.0 Ω	96.0 mH	72 N/A	72 Vs/m	0.4 A

Max 'ON' time		Peak Force
100% ED	∞	24.0 N
50% ED	90 s	34.0 N
25% ED	35 s	49.0 N
10% ED	13 s	77.0 N





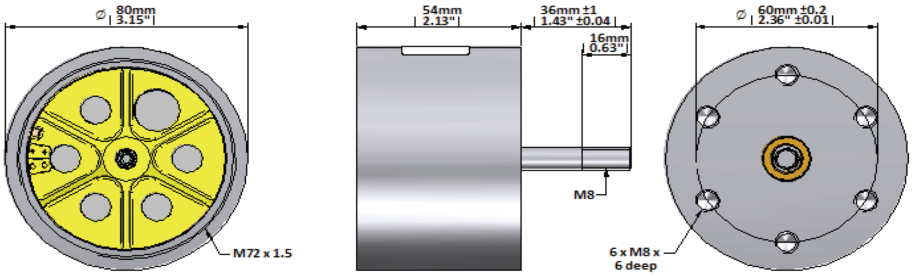
GEEPLUS VM8054 & VM8080

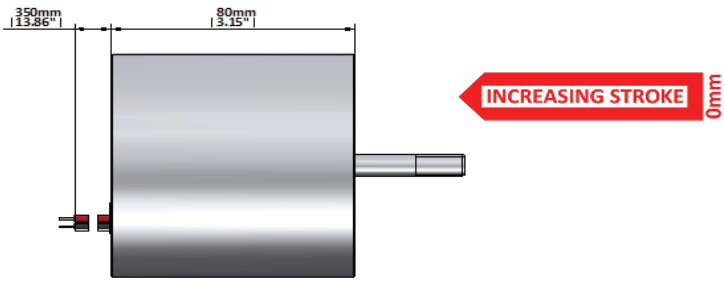
P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20°C

P_{100}	50 W	VM8054 1.7kg / VM8080 2kg	
T_{max}	130 °C	Coil Mass	150 g

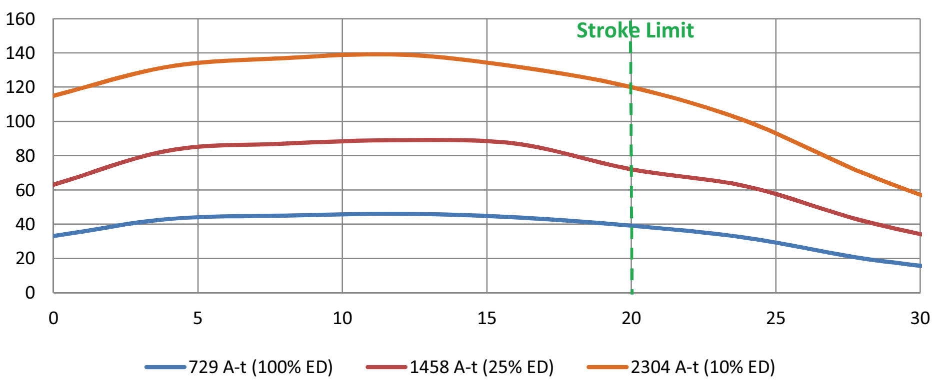
Model No.	Resistance R_{20}	Inductance	Force Constant	Velocity Constant	Current I_{100}
VM80xx-630	2.3 Ω		10 N/A	10 Vs/m	3.9 A
VM80xx-400	11.5 Ω	10.6 mH	24 N/A	24 Vs/m	1.8 A
VM80xx-250	85.0 Ω	77.0 mH	62 N/A	62 Vs/m	0.6 A

Max 'ON' time		Peak Force
100% ED	∞	43.0 N
50% ED	100 s	62.0 N
25% ED	100 s	85.0 N
10% ED	0 s	130.0 N





Force (N) vs Displacement (mm)



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GEEPLUS VM102P2

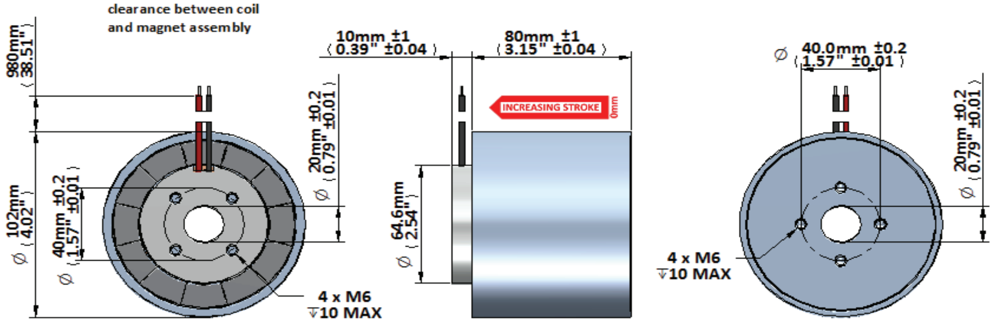
P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20°C

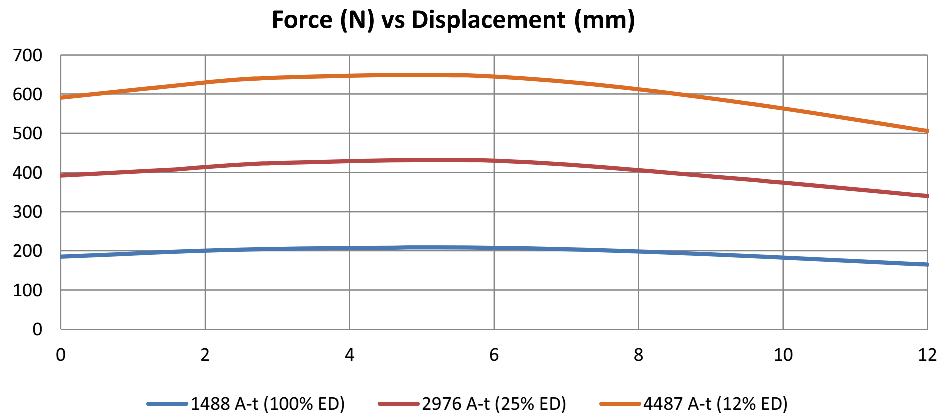
P_{100}	105 W	Total Mass	4200 g
T_{max}	130 °C	Coil Mass	325 g

Model No.	Resistance R_{20}	Inductance	Force Constant	Velocity Constant	Current I_{100}
VM102P2-710	2.1 Ω	0.6 mH	35 N/A	35 Vs/m	6.0 A
VM102P2-475	10.5 Ω	3.0 mH	78 N/A	78 Vs/m	2.7 A
VM102P2-355	33.4 Ω	9.5 mH	138 N/A	138 Vs/m	1.5 A

Max 'ON' time		Peak Force
100% ED	∞	208.0 N
50% ED	100 s	297.0 N
25% ED	35 s	430.0 N
10% ED	12 s	645.0 N

This part does not include bearings - guidance should be provided in customer application to maintain clearance between coil and magnet assembly





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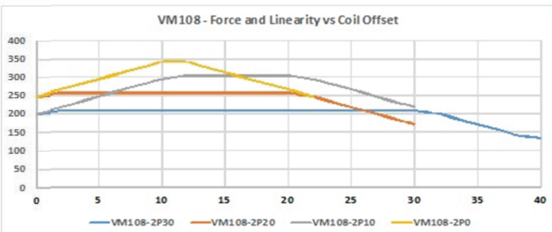
GEEPLUS VM108-2P30

P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20°C

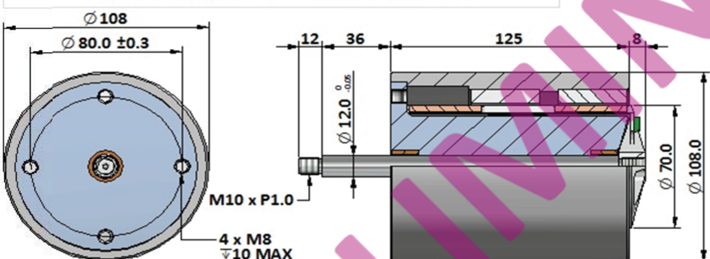
P_{100}	108 W	Total Mass	8 kg
T_{max}	120 °C	Coil Mass	750 g

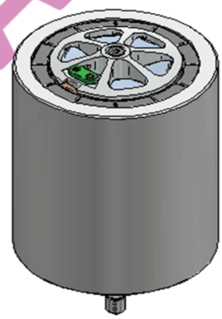
Model No.	Resistance R_{20}	Inductance	Force Constant	Velocity Constant	Current I_{100}
VM108-2P30-1000	1.3 Ω	0.0 mH	25 N/A	25 Vs/m	7.7 A
VM108-2P30-670	6.4 Ω	0.0 mH	56 N/A	56 Vs/m	3.5 A
VM108-2P30-500	20.2 Ω	0.0 mH	99 N/A	99 Vs/m	2.0 A

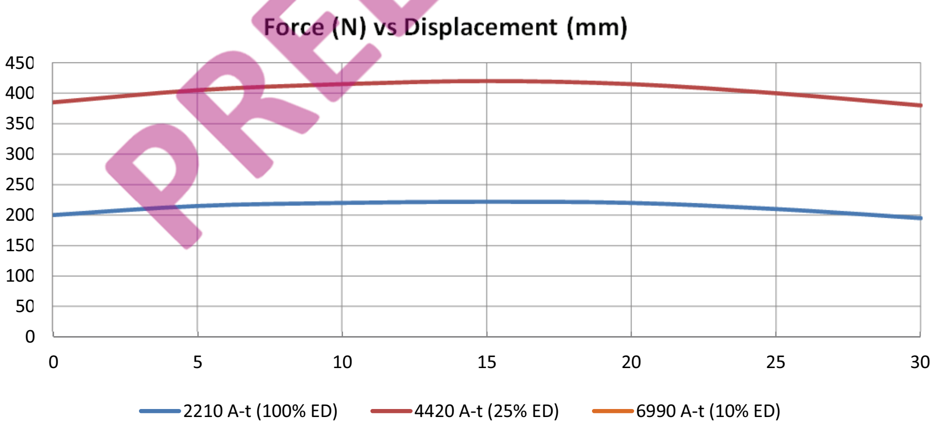
Max 'ON' time		Peak Force
100% ED	∞	230.0 N
50% ED	100 s	300.0 N
25% ED	35 s	440.0 N
10% ED	11 s	700.0 N



The VM108-2P voice coil motor can be configured with different coil geometry to provide more force over a shorter linear range. The graph gives an approximate indication of what is possible. Call Geeplus if other







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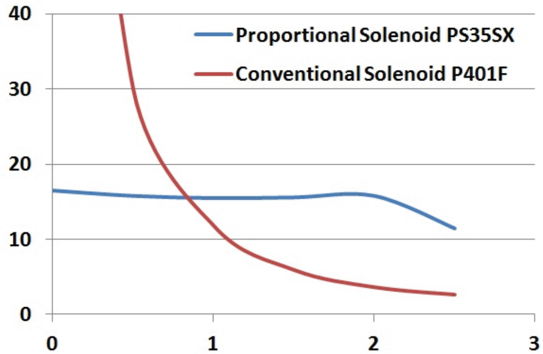
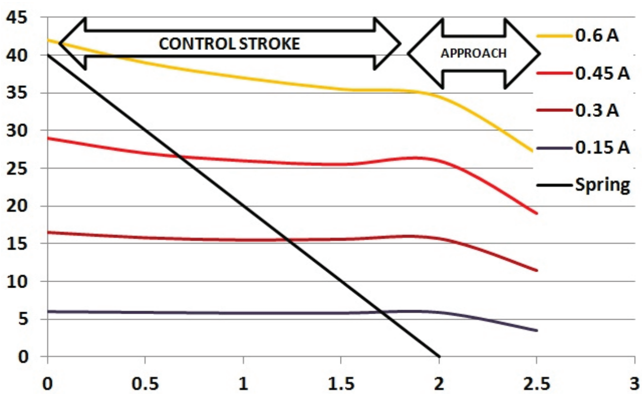
Proportional and hydraulic solenoids

Proportional Solenoid

Most solenoids are simple 2-position 'digital' devices, the proportional solenoid however is an analogue device capable of incremental positioning. The design of the polepiece of the proportional solenoid results in a force being developed which is constant over some displacement (the 'control stroke'), and which is proportional to the excitation current. Proportional solenoids can be used to develop a force which is directly proportional to current, or with the addition of a rising-rate spring to extend to a position which is proportional to current.

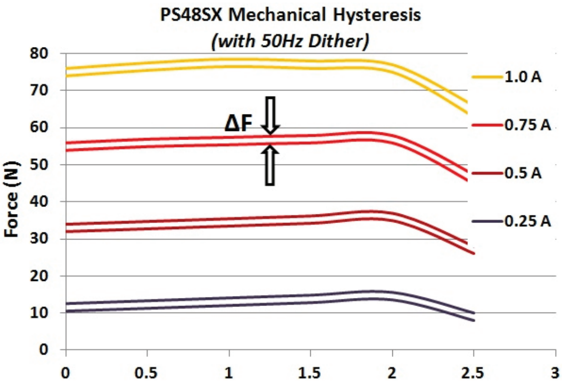


As the excitation current increases, the force developed by the solenoid increases. The solenoid plunger pulls in until the magnetic force is balanced by the opposing spring force. As the current is increased, it will pull in further to attain a new equilibrium position. In this way, a system is realised in which the position is proportional to the applied excitation current. As a simple analogy, increasing the current is like adding additional mass to a spring balance, as the mass increases, the spring is extended further until an equilibrium is reached.

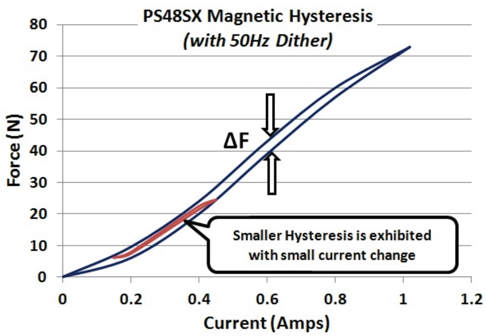


Hysteresis

The force characteristic for a proportional solenoid is typically shown as a pair of lines to take account of a property known as hysteresis. If the solenoid is tested by pushing the plunger against the direction in which force is developed, the measured force includes some friction which opposes the movement and adds to the developed force, if the plunger is then allowed to return in the direction of force the friction retards this movement and results in the measured force being less than the developed force, the difference between these two curves is a measure of (mostly *) mechanical hysteresis.



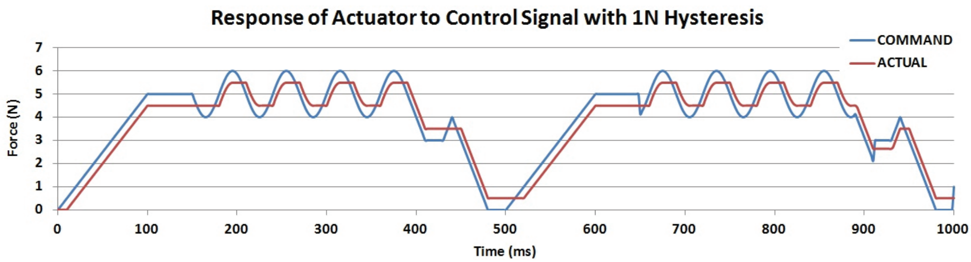
If the force developed by the solenoid is measured in a fixed position as the current is increased, another curve can be plotted which is a loop as shown, the force difference between upper and lower curves in this case represents (mostly *) magnetic hysteresis caused by losses in the magnetic steel material.



Hysteresis losses will limit the precision to which force or position can be accomplished using a proportional solenoid. Mechanical hysteresis will vary for different bearing types, for dry / maintenance free bearings it will typically be 10-20% of the developed force, for lubricated bearings, or for flexure supports it can be smaller.

*Note * - some care should be taken in describing these parameters as 'mechanical' or as 'magnetic' as measurement of either will include some element of the other parameter.*

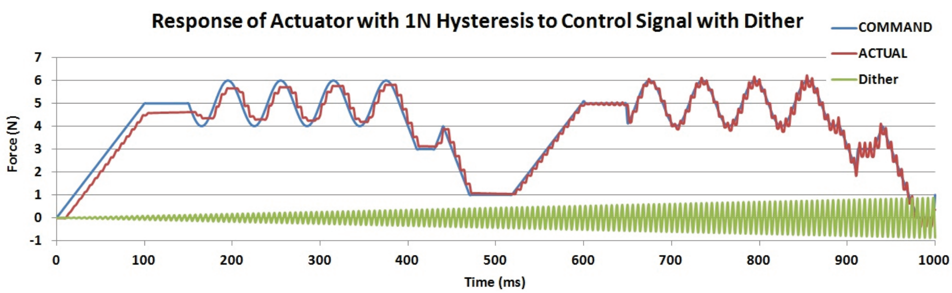
The effect of Hysteresis on control of the solenoid is described with reference to the graph below.



The 'COMMAND' line represents the force developed by a perfect solenoid, without friction or magnetic hysteresis. The 'ACTUAL' line represents the force that would be measured in practise at the output shaft of the device.

Dither

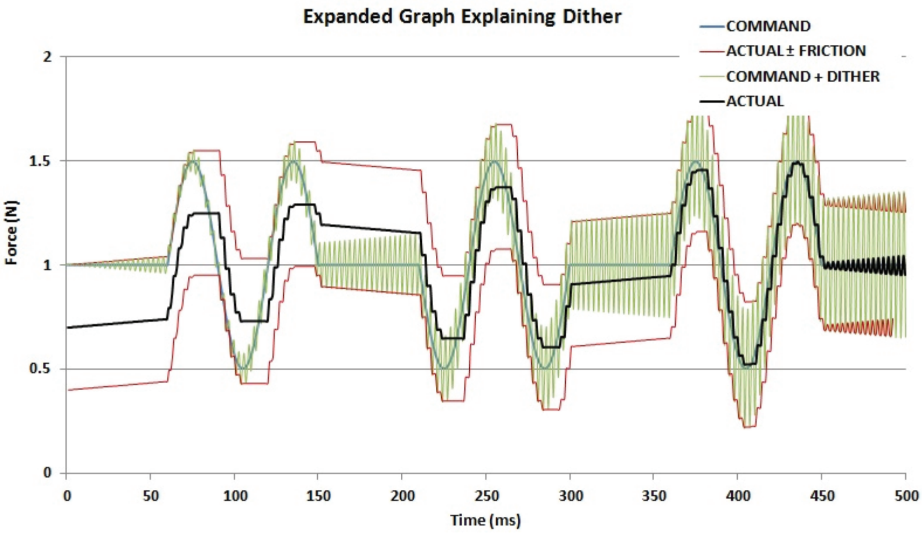
Dither is an electronic signal superimposed on the signal driving a proportional (or other) solenoid, which can mitigate some of the effects of hysteresis. An AC signal (the 'Dither' signal) is superimposed on the 'COMMAND' signal applied to the solenoid. The effect is shown in the graph below.



As the amplitude of the dither signal increases, the deviation of the 'ACTUAL' force from commanded value will reduce, reaching a minimum when the peak-to-peak amplitude of the dither signal corresponds to the solenoid hysteresis. If dither amplitude is increased further, the solenoid will begin to exhibit some oscillation about the commanded value.

Dither can be a very effective way to mitigate the effects of hysteresis, provided the amplitude and frequency can be matched to characteristics of the solenoid used.

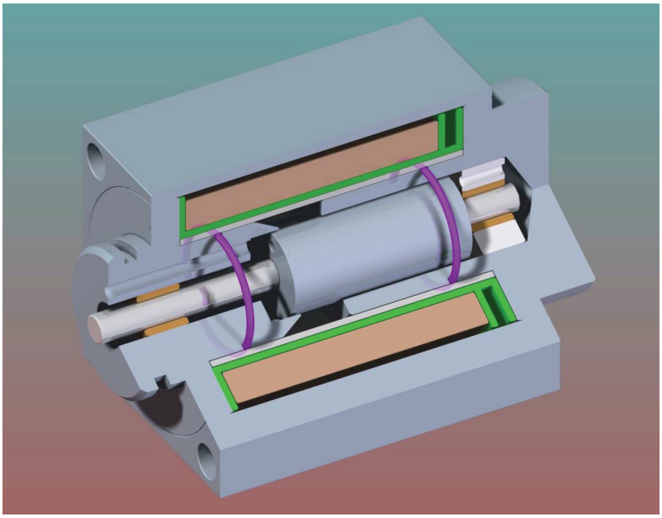
The way in which dither works may be better illustrated with reference to the graph below.



The two red lines represent the actual output force of the solenoid plus or minus friction (half of the hysteresis value). Without dither the actual force will lag the 'commanded' force by this amount. As dither is added to the command signal. It causes the upper and lower values of the resultant signal to vary, as the signal increases, the 'high' value of the signal nudges the output force upwards, as the signal decreases the low value does this, with the result that the actual force or position more closely follows the commanded value. When the amplitude of the dither signal corresponds to the hysteresis value, the actual output will accurately follow the commanded value. If dither is increased more than this, the average value of the actual force will follow the commanded value, but will have an oscillating component corresponding to the frequency of dither.

Hydraulic Solenoid

Solenoids can be constructed with a sealed cavity connecting the mounting

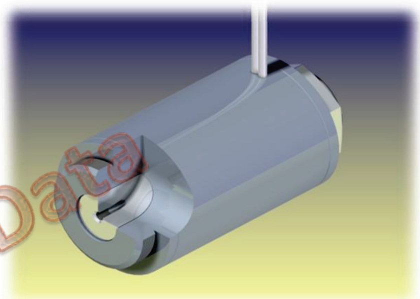


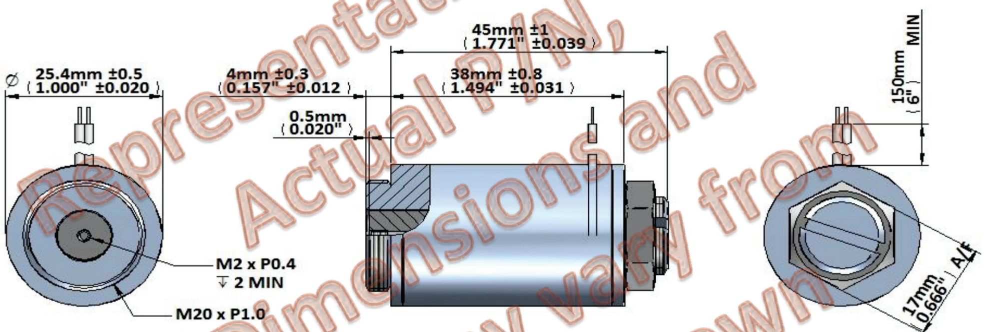
face of the solenoid to the base pole piece. The image shows a proportional solenoid which is constructed in this way. In this case the device is shown as having o-ring seals sealing the front and rear pole pieces into a metal tube, alternatively these may also be assembled using a welded, brazed, or glued construction to seal and fix the parts of the pressure assembly. Hydraulic solenoids can be constructed capable of operating at pressure of 20MPa / 3000PSI or more. The plunger and pole pieces typically incorporate channels to allow the free passage of fluid throughout the device. Because the fluid is able to flow around all moving parts of the assembly at equal pressure, the fluid pressure does not affect the force characteristics of the solenoid.

Hydraulic solenoids can be produced with either proportional, or with simple 2-position 'ON-OFF' function.

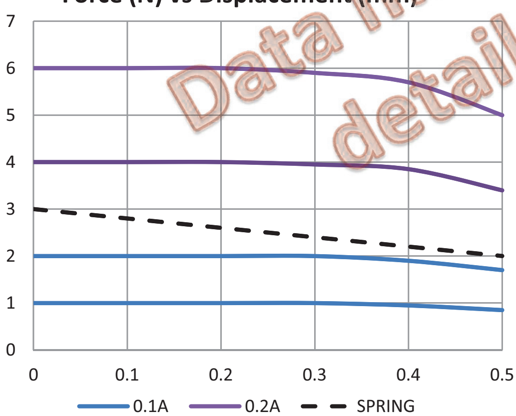
GEEPLUS PS26C

Specifications	
Parameter	**Value**
Rated Voltage	15 Volts
Current	0.2 Amps Max
Resistance	50 Ω
Nominal Power	2 Watts
Insulation Class	Class B (130°C)
Rated Pressure	0.35 MPa / 50PSI
Burst Pressure	1.03MPa / 150PSI
Dielectric Strength	AC 1000 V, 1 minute
Insulation Resistance	>100MΩ @ DC 500V

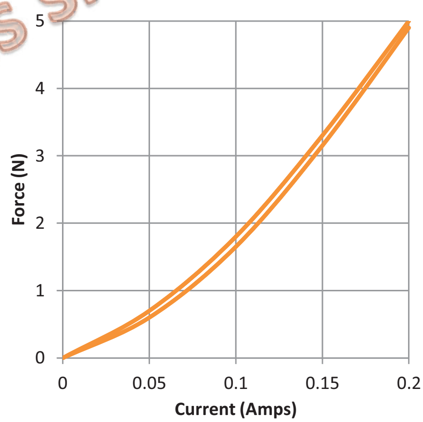




Force (N) vs Displacement (mm)



Hysteresis @ Stroke 0.3mm (.012")



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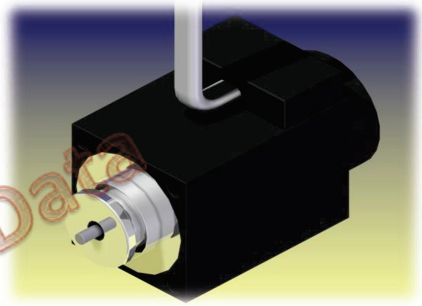
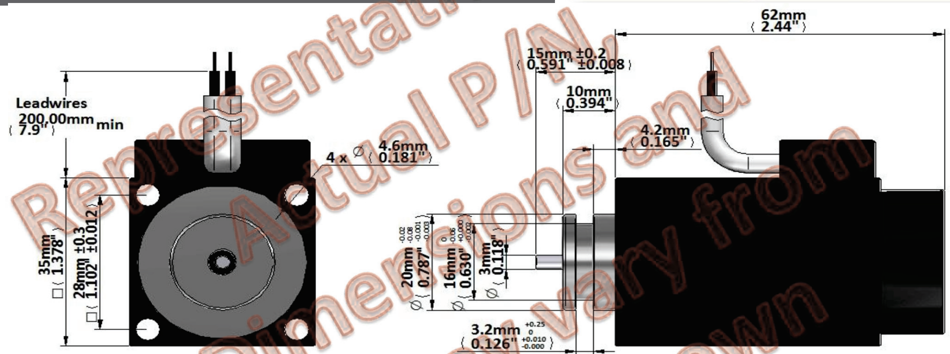
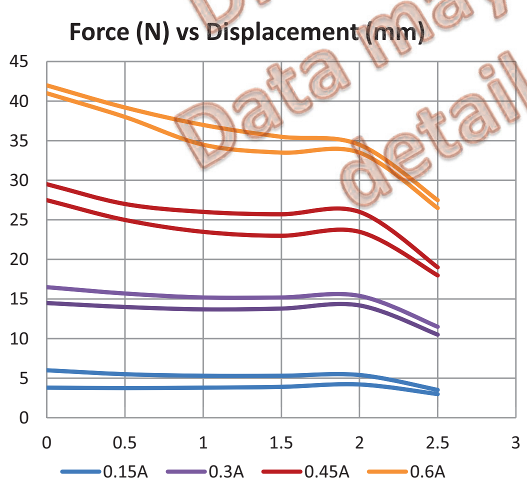
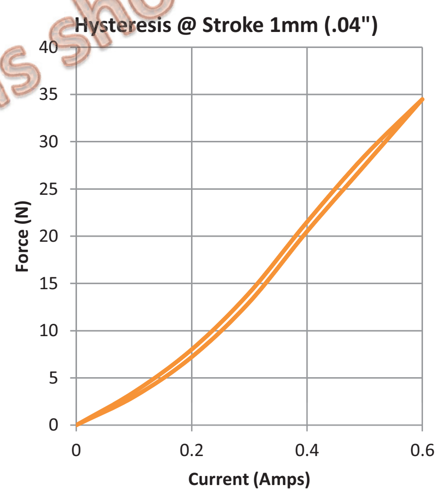
GEEPLUS PS35SX-0203

Specifications	
Parameter	**Value**
Rated Voltage	24 Volts
Current	0.6 Amps Max
Resistance	22 Ω
Nominal Power	7.9 Watts
Insulation Class	Class F (155°C)
Rated Pressure	0.35 MPa / 50PSI
Burst Pressure	1.03MPa / 150PSI
Dielectric Strength	AC 1000 V, 1 minute
Insulation Resistance	>100MΩ @ DC 500V









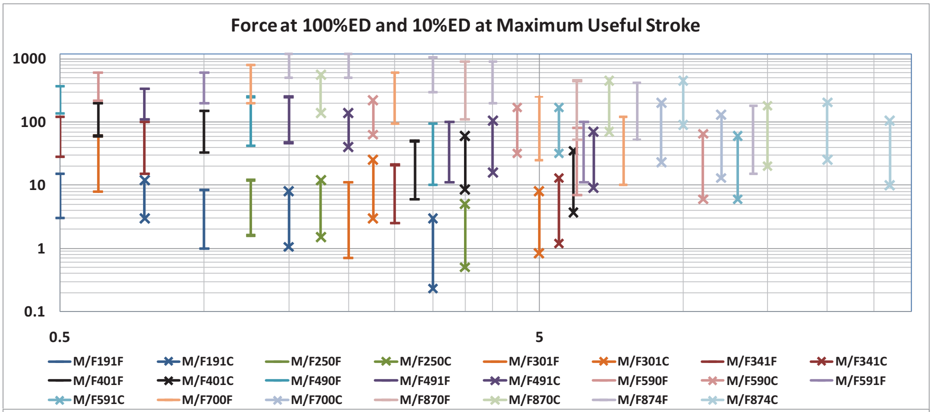
Push-pull solenoids

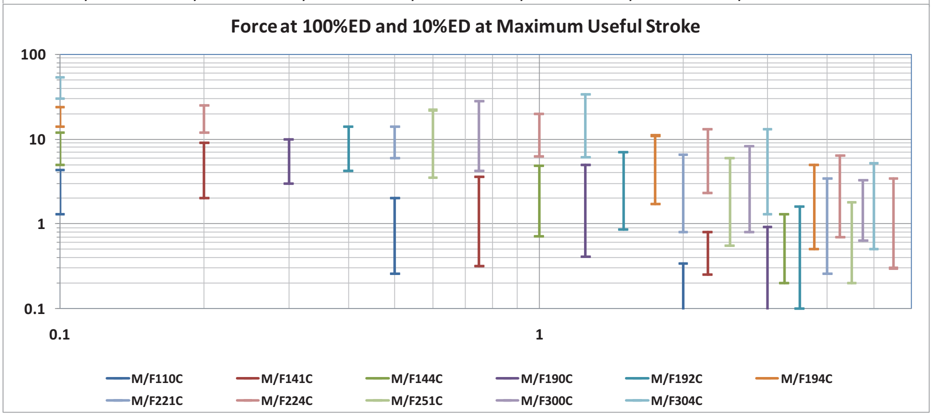
Selection Process for Push-Pull Solenoid

1. Metric (M prefix) and SAE (F prefix) screw thread options are available
2. The solenoid size is determined based on required force, displacement, and duty cycle from force-stroke characteristic graphs in the solenoid datasheets. Note that this may also be influenced by available power and speed requirements, for a given force requirement a larger solenoid will develop the required force with lower power input, however the higher moving mass may make this slower in operation than a smaller device
3. The pole piece form is also selected from the characteristic graphs, some sizes are available with either flat or conical polepiece design as standard options (note that intermediate or other force characteristic may be possible with polepiece geometry customisation)
4. The coil requirements are determined from tables of coil gauge / duty cycle for the chosen size of device. Coil rating is specified as AWG size of the coil wire
5. The life expectancy of the solenoid is specified by the suffix, P is standard life (2M-5M cycles), PE is extended (5M-10M cycles), PL is long life (20M-50M cycles). For the small push-pull solenoids a different bearing construction is used with special heat-treatment of the bore for nominal 10-20M cycles. Life will be reduced by long stroke, excessive side loading, particulate contamination, corrosive or otherwise aggressive environments. Life expectancy may be increased by short stroke, low side loading, clean operating conditions. Life expectancy should be verified under real operating conditions in the customer application to ensure this is sufficient for purpose.

Size Determination

Device size is determined for the required force, displacement, and duty cycle from the tables below, more detailed force data is shown graphically in the datasheet for each solenoid. These charts show force at maximum useful stroke (the stroke at which force falls to 10% of the holding force at 0mm position) for 100% or 10% duty excitation





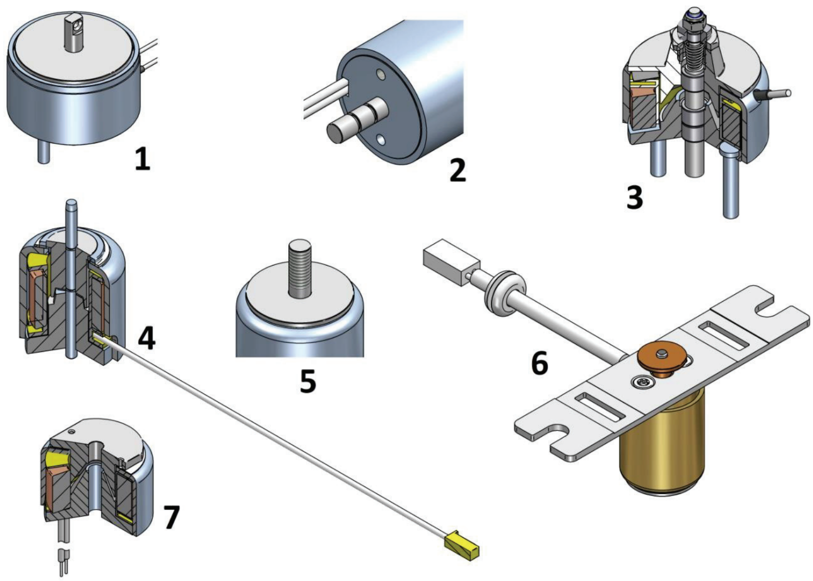
Specifying Coil AWG

Duty Cycle			100%	50%	25%	10%
Maximum 'ON' time			∞	100	36	7
Watts at 20º C			7	14	28	70
ampere-turns at 20º C			425	602	849	1350
AWG no	Resistance	no. turns	Nominal Voltage			
26	1.96	231	3.5	5	7.1	11
27	3.16	296	4.5	6.3	8.9	14
28	5.1	378	5.6	8	11	18
29	6.94	423	7.1	10	14	22
30	11	530	8.9	13	18	28
31	16.9	649	11	16	22	36
32	28.3	858	14	20	28	45

- The coil AWG is determined from tables of coil data for the given part, in the column corresponding to chosen duty cycle, the voltage closest to user supply is picked, and coil AWG corresponding to this is indicated in the LH column (example shows selection for a part operated from 12v supply at 25% duty cycle)
    - In the example illustrated, the selection of a device having higher nominal voltage than the supply is conservative, for maximum torque and speed the 28AWG coil might be more appropriate (see also point below)
    - Allowance should be made for voltage drops in switching devices, and resistive drops in wiring harness when determining the nominal voltage which will be applied to the solenoid

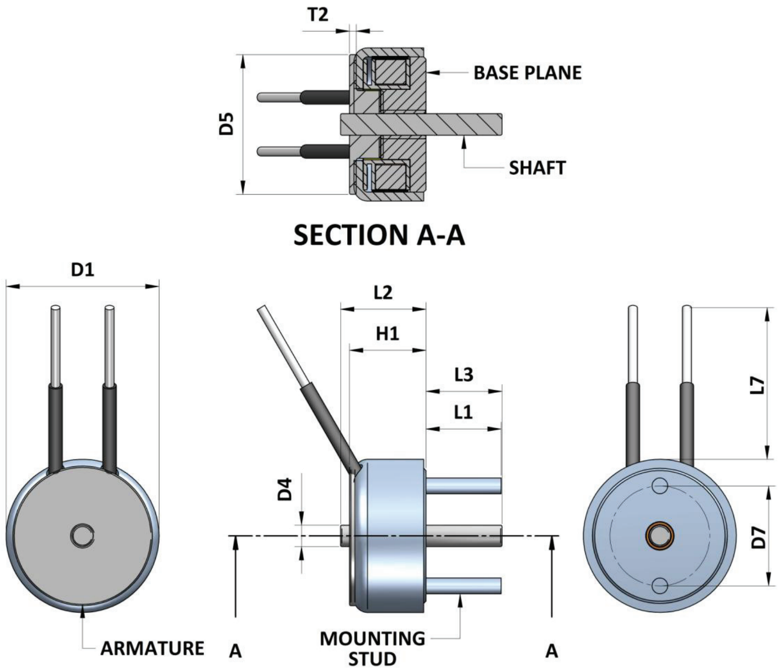
Customisation of the Push-Pull Solenoid

Most of the attachment components of the push-pull solenoid are produced by machining and are amenable to modification even in small (100's or less) quantity. Some typical examples are illustrated below.



1. Flats and cross-hole machined in shaft at armature side
2. Grooves machined in shaft at base side
3. Shaft decoupled from plunger by spring, maintenance-free bearings
4. Modified plunger with shallow angle for increased force at extended position, shaft hardened with sphere end on base side tapered on armature side, and lead wire assembly with connector
5. Screw threads machined on shaft on armature side
6. Mounting plate, bronze bush pressed on shaft, custom lead assembly
7. Modified armature with flat sides and threaded holes, no shaft

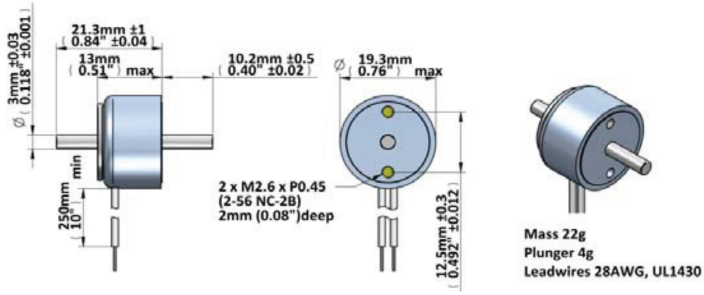
Mechanical modifications are best described with a sketch or drawing, when defining dimensions along the axis these are normally defined relative to the base plane of the solenoid, and described with reference to major components as described below.

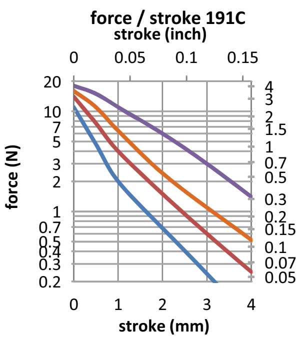


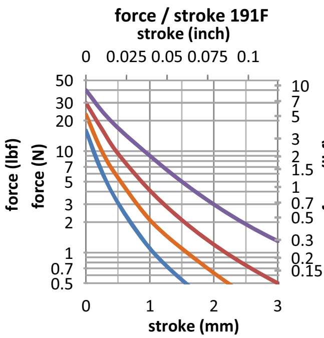
GEEPLUS Push Pull Solenoid size 191

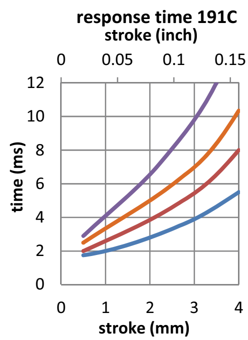
Device drawn in energised condition
plunger options: conical (191C) / flat (191F)
Life Expectancy (cycles): >2M (-P), >10M (-PE)

Available mechanical options:
M: metric thread
F: SAE thread









45W (10%ED) 18W (25%ED) 9W (50%ED) 4,5W (100%ED)

Data at 20°C , device connected to heatsink 50x50x3mm aluminum

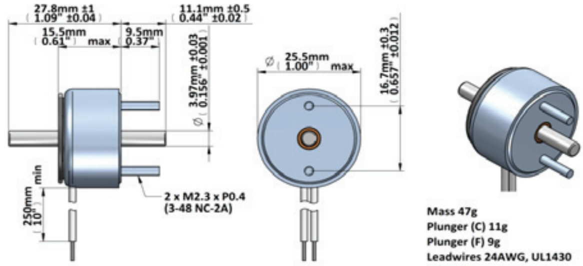
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	7
watts at 20°C			4.5	9	18	45
ampere-turns at 20°			285	403	570	901
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
30	4.0	288	4.1	5.7	8.0	12.1
31	5.6	324	5.0	7.1	9.9	15.8
32	9.1	544	6.3	8.9	12.4	19.7
33	15.0	684	8.0	11.3	15.7	25
34	24.1	840	10.2	14.4	20	32
35	37.1	1056	12.8	18.1	25	40
36	58.5	1109	16.1	23	32	50
37	75.7	1370	19.8	28	39	62
38	118	1761	25	35	49	78
39	199	2283	33	46	64	103
40	328	4200	42	59	82	131

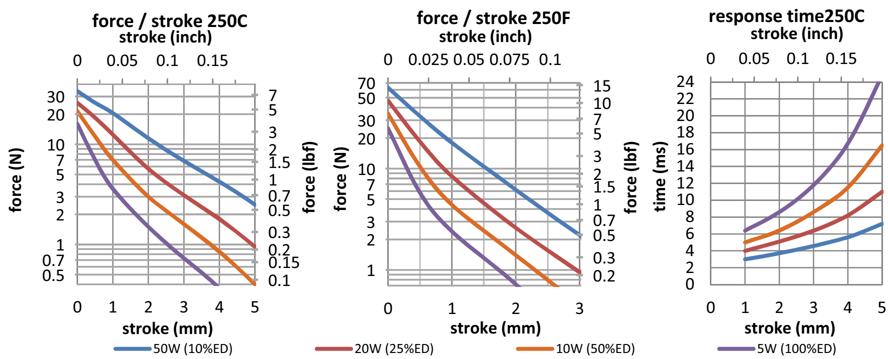
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Push Pull Solenoid size 250

Device drawn in energised condition
plunger options: conical (250C) / flat (250F)
Life Expectancy (cycles): >2M (-P), >10M (-PE)

Available mechanical options:
M: metric thread
F: SAE thread





Data at 20°C , device connected to heatsink 80x80x3mm aluminum

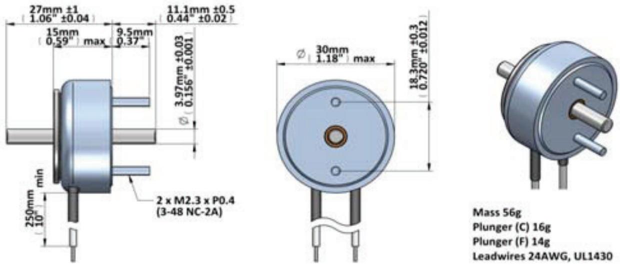
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	7
watts at 20°C			5	10	20	50
ampere-turns at 20°			340	480	680	1075
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
25	0.85	138	2.1	3.0	4.2	6.6
26	1.42	184	2.6	3.7	5.2	8.3
27	1.90	197	3.3	4.6	6.6	10.4
28	3.21	272	4.0	5.7	8.0	12.7
29	5.11	340	5.1	7.2	10.2	16.2
30	8.03	439	6.2	8.8	12.4	19.7
31	12.95	560	7.9	11.1	15.7	25
32	20.25	690	10.0	14.1	20	32
33	29.97	839	12.1	17.1	24	38
34	49.60	1097	15.4	22	31	49
35	82.64	1396	20	28	40	64
36	110	1551	24	34	48	76
37	157	1776	30	42	60	95
38	237	2180	37	52	74	117
39	426	3110	47	66	93	147
40	698	3802	62	88	125	197

Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

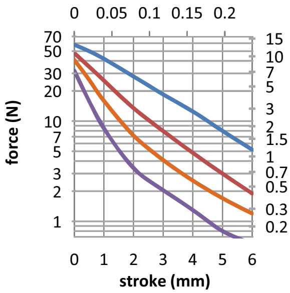
GEEPLUS Push Pull Solenoid size 301

Device drawn in energised condition
plunger options: conical (301C) / flat (301F)
Life Expectancy (cycles): >2M (-P), >10M (-PE)

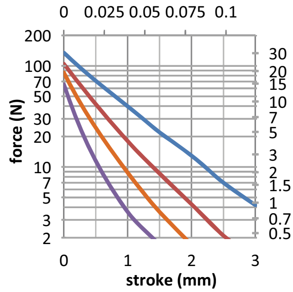
Available mechanical options:
M: metric thread
F: SAE thread



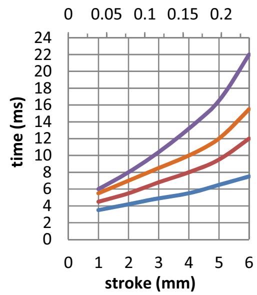
force / stroke 301C



force / stroke 1301F



response time 301C



70W (10%ED) 28W (25%ED) 14W (50%ED) 7W (100%ED)

Data at 20°C , device connected to heatsink 90x90x3mm aluminum

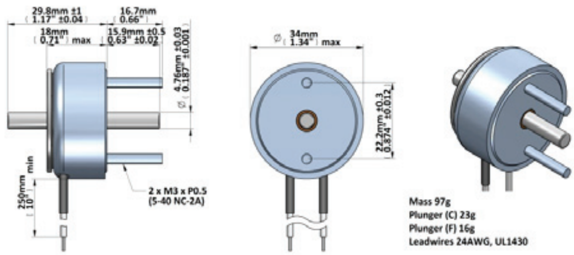
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	7
watts at 20°C			7	14	28	70
ampere-turns at 20°			425	602	849	1350
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
26	1.96	231	3.5	5.0	7.1	11
27	3.16	296	4.5	6.3	8.9	14
28	5.10	378	5.6	8.0	11	18
29	6.94	423	7.1	10	14	22
30	11.0	530	8.9	13	18	28
31	16.9	649	11	16	22	36
32	28.3	858	14	20	28	45
33	42.8	1036	18	25	35	56
34	69.6	1312	22	32	45	71
35	112	1674	28	39	56	89
36	148	1765	35	50	71	112
37	221	2090	45	63	89	142
38	352	2650	56	80	112	178
39	568	3380	71	100	141	224
40	882	4200	89	126	178	283

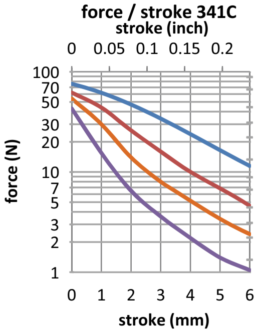
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

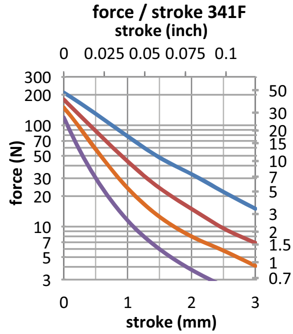
Push Pull Solenoid size 341

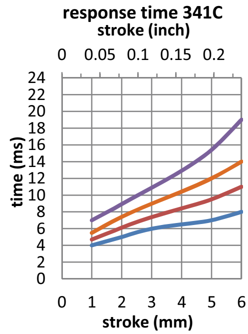
Device drawn in energised condition
plunger options: conical (341C) / flat (341F)
Life Expectancy (cycles): >2M (-P), >10M (-PE)

Available mechanical options:
M: metric thread
F: SAE thread









90W (10%ED) 36W (25%ED) 18W (50%ED) 9W (100%ED)

Data at 20°C , device connected to heatsink 120x120x3mm aluminum

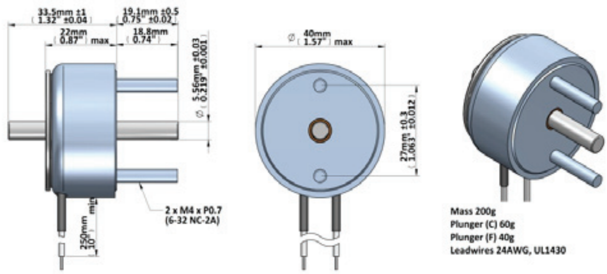
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	8
watts at 20°C			9	18	36	90
ampere-turns at 20°			535	756	1070	1690
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
25	1.97	252	4.2	5.9	8.4	13
26	3.26	328	5.3	7.5	11	17
27	5.04	405	6.7	9.4	13	21
28	8.02	510	8.4	12	17	26
29	12.2	627	10	15	21	33
30	19.2	780	13	19	26	42
31	31.8	1008	17	24	33	53
32	47.0	1215	21	30	42	66
33	75.3	1530	26	37	53	84
34	120.5	1900	33	47	67	105
35	198	2486	42	59	84	133
36	280	2700	53	75	106	167
37	426	3350	67	94	133	210
38	648	4050	84	118	168	264
39	1020	5050	105	149	211	333
40	1667	6590	133	187	265	419

Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

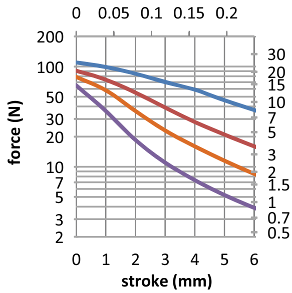
GEEPLUS Push Pull Solenoid size 401

Device drawn in energised condition
plunger options: conical (401C) / flat (401F)
Life Expectancy (cycles): >2M (-P), >10M (-PE)

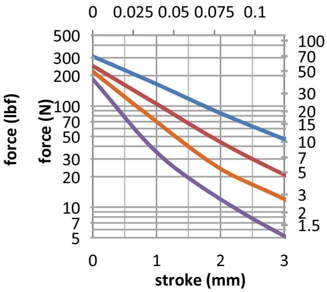
Available mechanical options:
M: metric thread
F: SAE thread



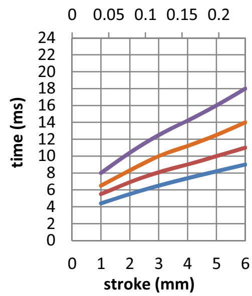
force / stroke 401C



force / stroke 401F



response time 401C



125W (10%ED) — 50W (25%ED) — 25W (50%ED) — 12,5W (100%ED)

Data at 20°C , device connected to heatsink 160x160x3mm aluminum

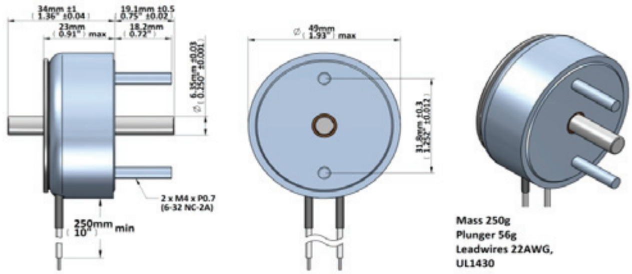
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	9
watts at 20°C			12.5	25	50	125
ampere-turns at 20°			714	1000	1425	2250
AWG no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**			
25	3.50	384	6.6	9.5	13	21
26	5.67	486	8.4	12	17	27
27	8.76	600	11	16	22	35
28	13.8	748	13	18	26	42
29	22.6	975	17	23	33	52
30	34.8	1190	21	30	42	67
31	56.7	1520	27	38	54	85
32	88.3	1908	35	49	70	110
33	138	2360	43	60	86	138
34	216	2904	53	75	106	168
35	351	3725	67	95	132	213
36	480	4000	85	119	169	268
37	720	4950	105	147	210	332
38	1150	6200	132	185	264	-
39	1920	8350	166	232	332	-
40	3000	10000	210	300	-	-

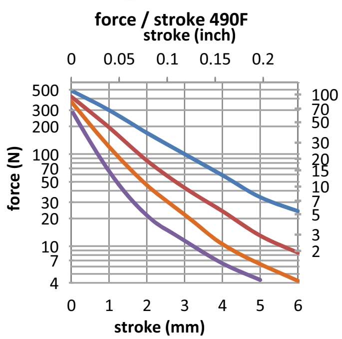
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

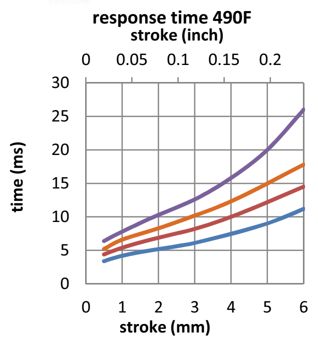
GEEPLUS Push Pull Solenoid size 490

Device drawn in energised condition
plunger options: flat (490F)
Life Expectancy (cycles): >2M (-P), >10M (-PE)

Available mechanical options:
M: metric thread
F: SAE thread







45W (10%ED) 18W (25%ED) 9W (50%ED) 4,5W (100%ED)

Data at 20°C , device connected to heatsink 190x190x3mm aluminum

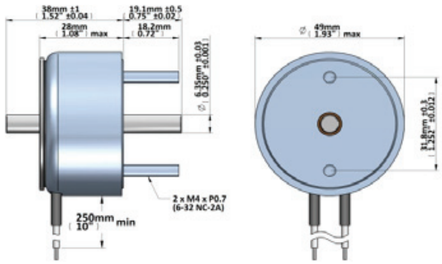
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	10
watts at 20°C			21	42	84	210
ampere-turns at 20°			842	1190	1685	2660
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
24	3.20	360	7.6	11	15	24
25	4.91	440	9.5	13	19	30
26	7.72	550	12	17	24	38
27	11.1	636	15	21	30	48
28	18.8	840	19	27	38	60
29	30.5	1088	24	34	48	76
30	44.9	1275	30	43	60	95
31	70.9	1596	38	54	76	120
32	109	1974	48	67	95	150
33	175	2496	60	85	120	190
34	270	3042	76	107	151	239
35	414	3600	95	134	190	301
36	610	4200	122	173	245	386
37	940	5200	151	213	301	-
38	1560	6820	190	268	379	-

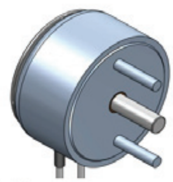
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Push Pull Solenoid size 491

Device drawn in energised condition
plunger options: conical (491C) / flat (491F)
Life Expectancy (cycles): >2M (-P), >10M (-PE)

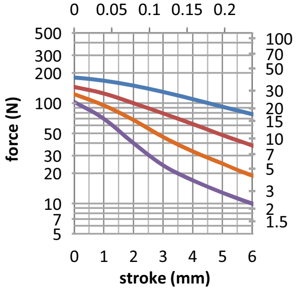
Available mechanical options:
M: metric thread
F: SAE thread



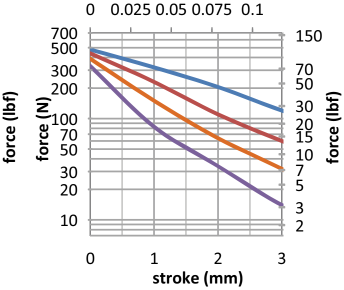


Mass 265g
Plunger (C) 70g
Plunger (F) 60g
Leadwires 22AWG, UL1430

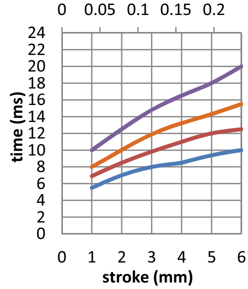
force / stroke 491C



force / stroke 491F



response time 491C



210W (10%ED) 84W (25%ED) 42W (50%ED) 21W (100%ED)

Data at 20°C , device connected to heatsink 190x190x3mm aluminum

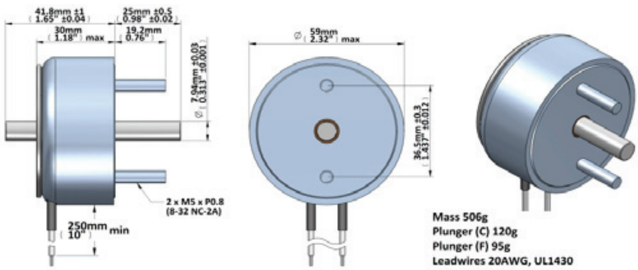
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	10
watts at 20°C			21	42	84	210
ampere-turns at 20°			1015	1440	2030	3210
AWG no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**			
21	1.00	228	4.5	6.4	8.9	14.1
22	1.68	301	5.7	8.1	11.4	17.9
23	2.70	384	7.2	10.1	14.3	23
24	4.30	486	9.0	12.7	18	28
25	6.66	590	11.5	16.2	23	36
26	10.3	737	14.0	20	28	44
27	15.7	900	17.7	25	35	56
28	26.6	1190	23	32	45	72
29	38.0	1380	28	40	56	89
30	62.1	1768	36	51	71	113
31	96.1	2166	45	64	90	143
32	157	2816	57	80	113	179
33	241	3432	71	101	143	226
34	364	4108	90	128	180	285
35	566	4920	117	166	234	370
36	910	6340	146	207	392	462
37	1224	6800	183	260	366	-

Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

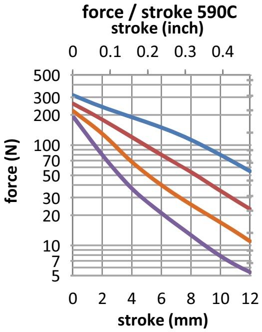
GEEPLUS Push Pull Solenoid size 590

Device drawn in energised condition
plunger options: conical (590C) / flat (590F)
Life Expectancy (cycles): >2M (-P), >10M (-PE)

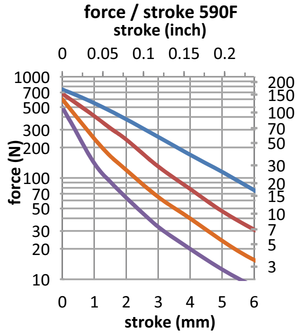
Available mechanical options:
M: metric thread
F: SAE thread



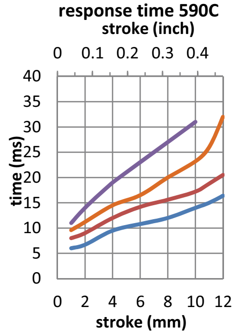
force / stroke 590C



force / stroke 590F



response time 590C



290W (10%ED) — 116W (25%ED) — 58W (50%ED) — 29W (100%ED)

Data at 20°C , device connected to heatsink 310x310x3mm aluminum

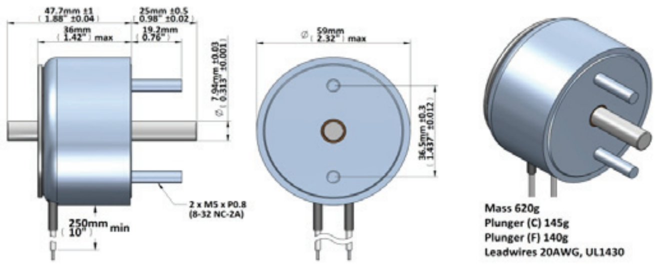
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	87	36	13
watts at 20°C			29	58	116	290
ampere-turns at 20°			1240	1760	2490	3920
AWG no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**			
22	2.23	336	8.3	12	16	26
23	3.60	432	10	15	21	33
24	5.24	500	13	18	26	41
25	9.51	708	16	23	33	52
26	14.4	858	21	29	41	66
27	23.7	1110	26	37	52	83
28	38.2	1411	33	47	66	104
29	54.7	1638	41	59	83	131
30	93.7	2184	52	74	104	165
31	143	2645	66	93	131	207
32	223	3328	83	117	165	261
33	338	4004	104	147	208	329
34	550	5088	131	185	262	-
35	790	5860	165	233	330	-
36	1233	7260	208	294	-	-

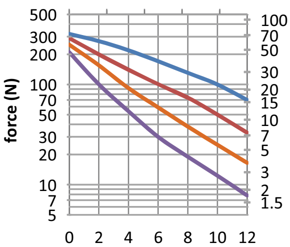
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

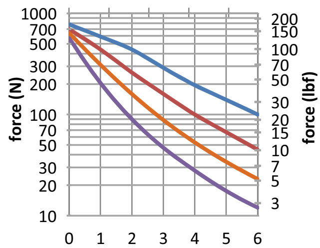
GEEPLUS Push Pull Solenoid size 591

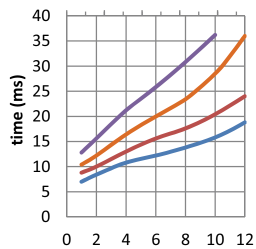
Device drawn in energised condition
plunger options: conical (591C) / flat (591F)
Life Expectancy (cycles): >2M (-P), >10M (-PE)

Available mechanical options:
M: metric thread
F: SAE thread









320W (10%ED) — 128W (25%ED) — 64W (50%ED) — 32W (100%ED)

Data at 20°C , device connected to heatsink 310x310x3mm aluminum

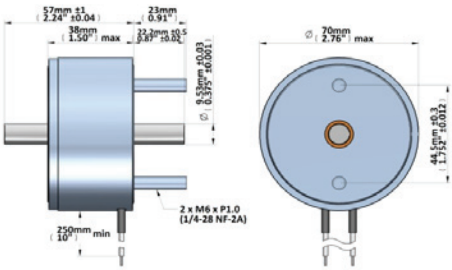
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	87	36	13
watts at 20°C			32	64	128	320
ampere-turns at 20°			1480	2080	2940	4620
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
20	1.23	295	6.2	8.7	12.3	19.3
21	1.75	340	7.6	10.7	15.1	24
22	2.79	446	9.3	13.0	18.4	29
23	4.54	567	11.9	16.7	24	37
24	6.93	690	14.9	21	30	46
25	12.5	910	20	29	40	63
26	18.4	1120	24	34	48	76
27	33.4	1500	33	46	65	103
28	46.3	1750	39	55	78	122
29	74.5	2232	49	69	98	154
30	125.5	2940	63	89	126	197
31	199	3611	82	115	162	255
32	302	4350	103	144	204	321
33	417	5010	123	173	245	385

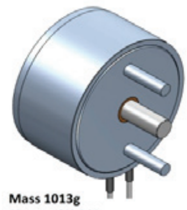
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Push Pull Solenoid size 700

Device drawn in energised condition
plunger options: conical (700C) / flat (700F)
Life Expectancy (cycles): >2M (-P), >10M (-PE)

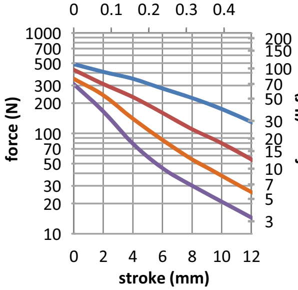
Available mechanical options:
M: metric thread
F: SAE thread



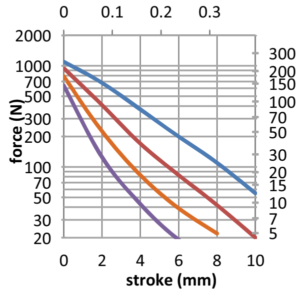


Mass 1013g
Plunger (C) 268g
Plunger (F) 285g
Leadwires 20AWG, UL1430

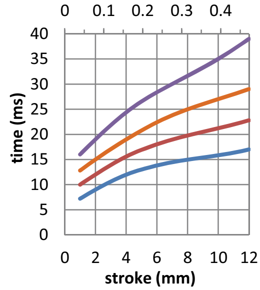
force / stroke 700C



force / stroke 700F



response time 700C



350W (10%ED) 140W (25%ED) 70W (50%ED) 35W (100%ED)

Data at 20°C , device connected to heatsink 390x390x3mm aluminum

duty cycle = "on" time / ("on" time + "off" time) x 100%	100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds	∞	80	38	16
watts at 20°C	35	70	140	350
ampere-turns at 20°	1570	2230	3150	5000

AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
20	1.88	368	8	11	16	26
21	3.01	468	10	14	20	32
22	4.82	580	13	18	26	41
23	8.1	780	16	23	33	52
24	12.3	949	20	29	41	65
25	19.0	1148	26	37	52	83
26	30.8	1472	33	46	66	105
27	48.8	1854	41	59	83	132
28	81.1	2436	52	75	105	166
29	121	2944	64	92	130	206
30	190	3650	82	118	166	264
31	275	4175	104	147	209	331
32	440	5792	119	170	240	-
33	735	7000	165	235	331	-
34	995	7600	204	288	-	-

Insulation Resistance >100MΩ, 500VDC Megger

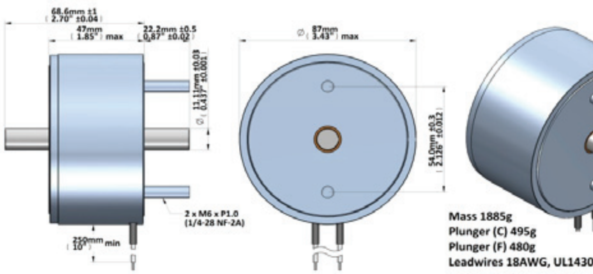
Dielectric Strength 1000VAC, 50/60Hz, 1 minute

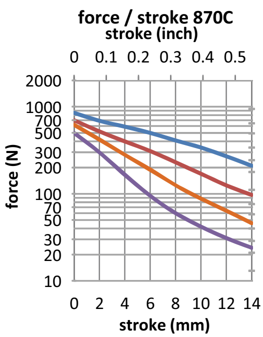
Class E (120°C) insulation class

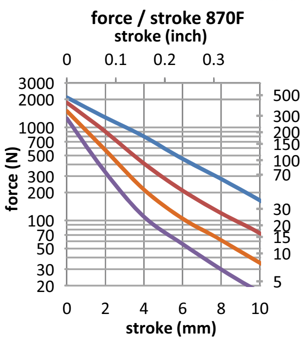
GEEPLUS Push Pull Solenoid size 870

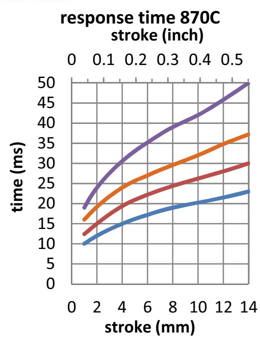
Device drawn in energised condition
plunger options: conical (870C) / flat (870F)
Life Expectancy (cycles): >2M (-P), >10M (-PE)

Available mechanical options:
M: metric thread
F: SAE thread









410W (10%ED) 164W (25%ED) 82W (50%ED) 41W (100%ED)

Data at 20°C , device connected to heatsink 520x520x3mm aluminum

duty cycle = "on" time / ("on" time + "off" time) x 100%	100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds	∞	72	43	20
watts at 20°C	41	82	164	410
ampere-turns at 20°	1910	2750	3810	5950

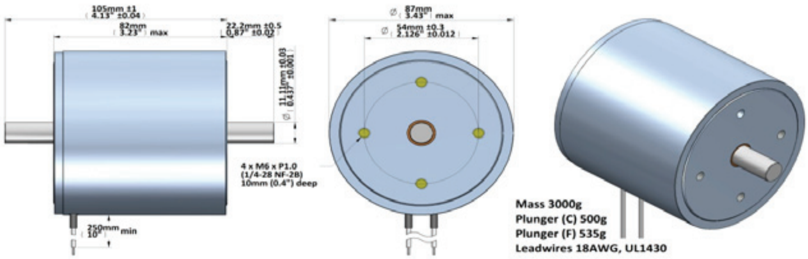
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
18	1.47	368	7.6	11	15	24
19	2.30	459	9.6	14	19	30
20	3.64	580	12	17	24	37
21	5.57	704	15	22	30	47
22	9.50	936	19	28	39	60
23	14.3	1134	24	35	48	75
24	23.3	1456	30	44	61	95
25	37.1	1836	39	56	77	120
26	58.6	2300	49	70	97	152
27	89.8	2816	61	88	121	189
28	139	3456	76	111	153	239
29	227	4480	98	138	193	300
30	376	5792	124	177	248	387
31	515	6600	148	212	297	-
32	785	7850	188	275	385	-
33	1130	9050	237	339	-	-

Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

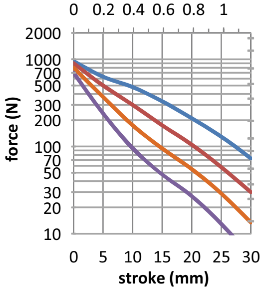
GEEPLUS Push Pull Solenoid size 874

Device drawn in energised condition
plunger options: conical (874C) / flat (874F)
Life Expectancy (cycles): >2M (-P), >10M (-PE)

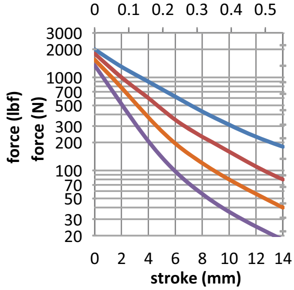
Available mechanical options:
M: metric thread
F: SAE thread



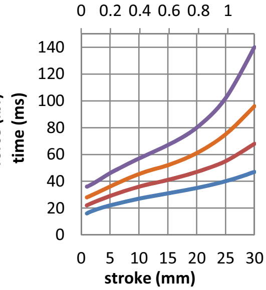
force / stroke 874C



force / stroke 874F



response time 874C



410W (10%ED) — 164W (25%ED) — 82W (50%ED) — 41W (100%ED)

Data at 20°C , device connected to heatsink 520x520x3mm aluminum

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	72	43	20
watts at 20°C			41	82	164	410
ampere-turns at 20°			2590	3663	5180	8190
AWG no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**			
18	2.54	630	10	15	21	33
19	4.15	828	13	18	26	41
20	6.38	1047	16	22	32	50
21	11.14	1408	20	29	41	65
22	16.8	1723	25	36	51	80
23	25.8	2046	33	46	65	103
24	42.5	2711	41	57	81	128
25	66.3	3279	52	74	105	166
26	105	4151	66	93	131	207
27	165	5190	82	116	165	260
28	261	6500	104	147	208	329
29	422	8340	131	185	262	-
30	664	10230	168	238	336	-
31	968	12410	202	286	-	-
32	1520	15200	259	366	-	-

Insulation Resistance >100MΩ, 500VDC Megger — Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

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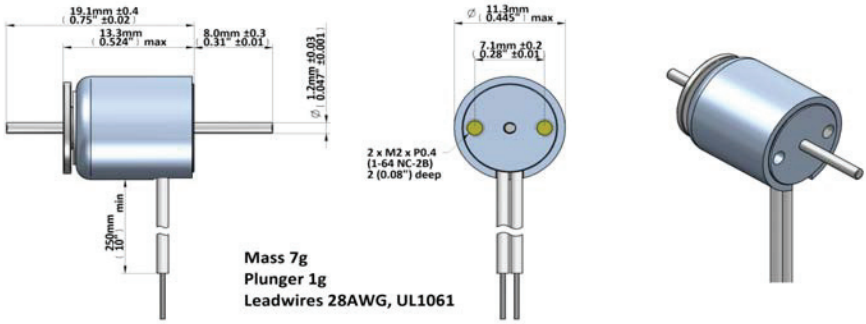
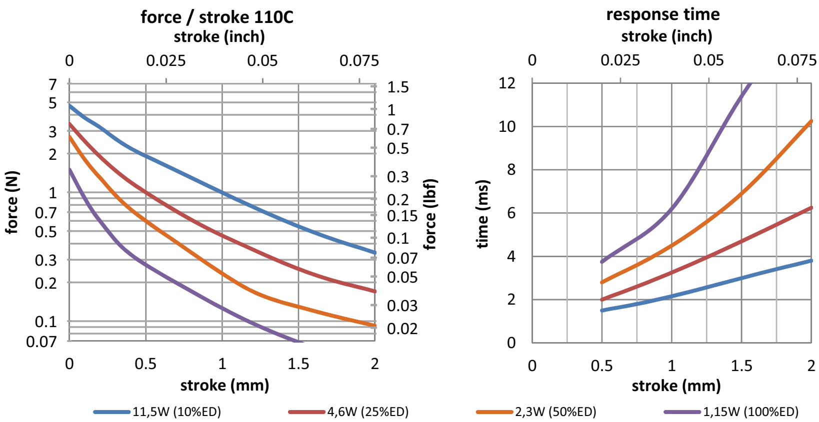
GEEPLUS Small Push Pull Solenoid size 110

Device drawn in energised condition
conical plunger
Life Expectancy (cycles): >5M

Available mechanical options:
M: metric thread
F: SAE thread





Data at 20°C , without heatsink

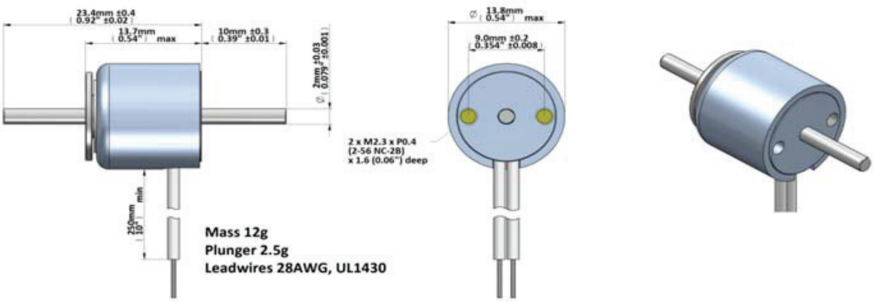
duty cycle = $\frac{\text{"on" time}}{\text{"on" time + "off" time}}$ x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	7
watts at 20°C			1.15	2.3	4.6	11.5
ampere-turns at 20°			105	148	210	332
type no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
M110C-3V F110C-3V	10.5	390	3.0	4.2	6.0	9.5
M110C-6V F110C-6V	31.5	700	6.0	8.5	12	19
M110C-12V F110C-12V	143.0	1450	12	17	24	38

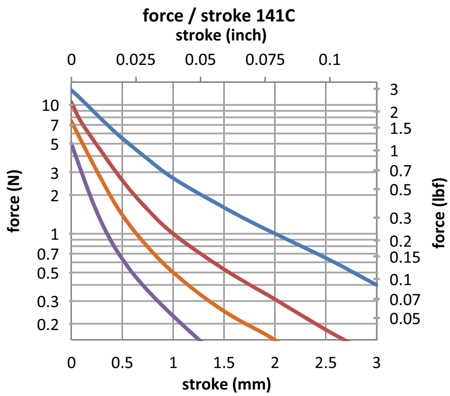
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class A (105°C) insulation class

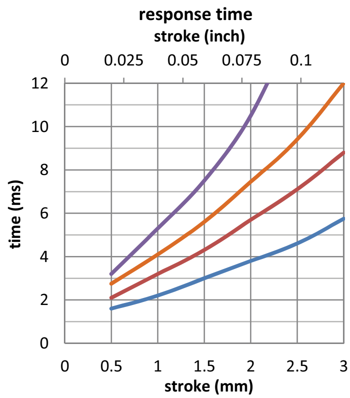
GEEPLUS Small Push Pull Solenoid size 141

Device drawn in energised condition
conical plunger
Life Expectancy (cycles): >5M

Available mechanical options:
M: metric thread
F: SAE thread







13,3W (10%ED) 5,32W (25%ED) 2,66W (50%ED) 1,33W (100%ED)

Data at 20°C , without heatsink

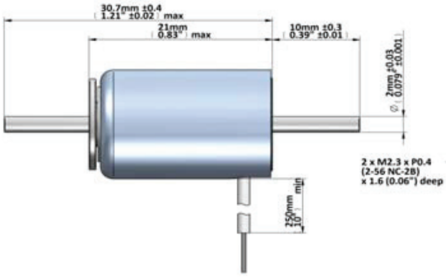
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	7
watts at 20°C			1.33	2.66	5.32	13.3
ampere-turns at 20°			133	189	267	422
type no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
M141C-3V F141C-3V	6.5	330	3.0	4.2	6.0	9.5
M141C-6V F141C-6V	30	700	6.0	8.5	12	19
M141C-12V F141C-12V	97	1200	12	17	24	38
M141C-24V F141C-24V	468	2600	24	34	48	76

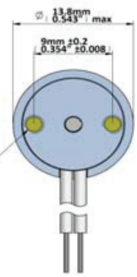
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

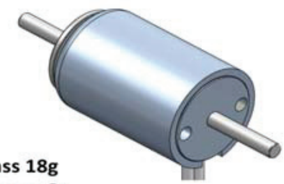
GEEPLUS Small Push Pull Solenoid size 144

Device drawn in energised condition
conical plunger
Life Expectancy (cycles): >5M

Available mechanical options:
M: metric thread
F: SAE thread

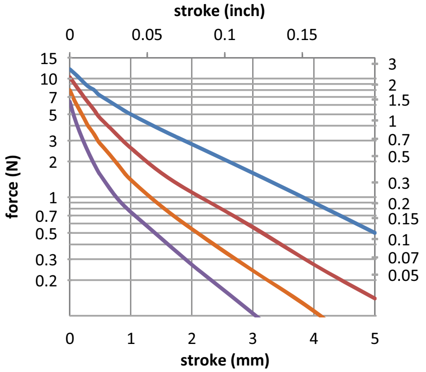




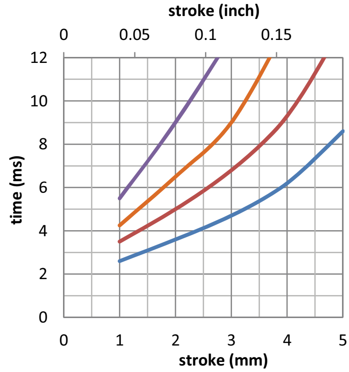


Mass 18g
Plunger 3g
Leadwires 28AWG, UL1430

force / stroke 144C



response time



Data at 20°C , without heatsink

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	7
watts at 20°C			1.83	3.66	7.32	18.3
ampere-turns at 20°			236	334	472	746
type no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
M144C-3V F144C-3V	5.0	415	3.0	4.2	6.0	9.5
M144C-6V F144C-6V	22.7	910	6.0	8.5	12	19
M144C-12V F144C-12V	91.5	1750	12	17	24	38
M144C-24V F144C-24V	329	3150	24	34	48	76

Insulation Resistance >100MΩ, 500VDC Megger

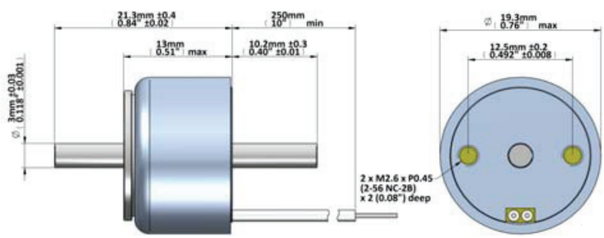
Dielectric Strength 1000VAC, 50/60Hz, 1 minute

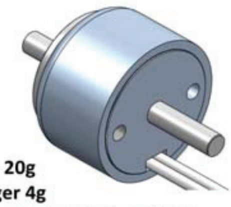
Class E (120°C) insulation class

GEEPLUS Small Push Pull Solenoid size 190

Device drawn in energised condition
conical plunger
Life Expectancy (cycles): >5M

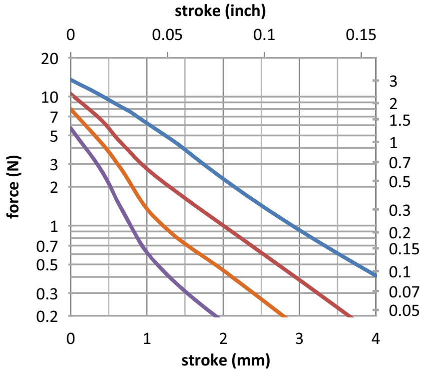
Available mechanical options:
M: metric thread
F: SAE thread



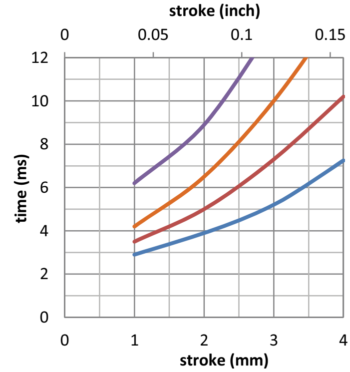


Mass 20g
Plunger 4g
Leadwires 28AWG, UL1430

force / stroke 190C



response time



20W (10%ED) 8W (25%ED) 4W (50%ED) 2W (100%ED)

Data at 20°C , without heatsink

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	7
watts at 20°C			2	4	8	20
ampere-turns at 20°			170	240	340	537
type no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**			
M190C-3V F190C-3V	4.9	295	3.0	4.2	6.0	9.5
M190C-6V F190C-6V	21.5	620	6.0	8.5	12	19
M190C-12V F190C-12V	89	1230	12	17	24	38
M190C-24V F190C-24V	307	2120	24	34	48	76

Insulation Resistance >100MΩ, 500VDC Megger

Dielectric Strength 1000VAC, 50/60Hz, 1 minute

Class E (120°C) insulation class

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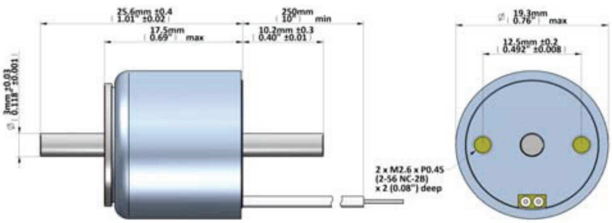
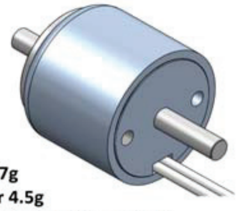
GEEPLUS Small Push Pull Solenoid size 192

Device drawn in energised condition
conical plunger
Life Expectancy (cycles): >5M

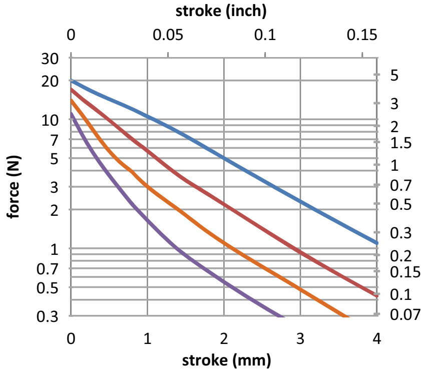
Available mechanical options:
M: metric thread
F: SAE thread



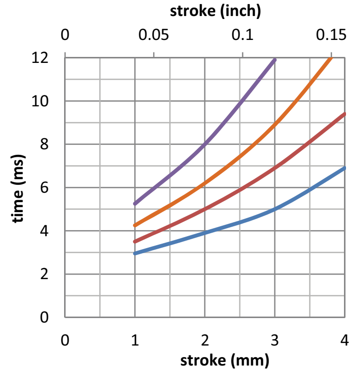


Mass 27g
Plunger 4.5g
Leadwires 28AWG, UL1430

force / stroke 192C



response time



23W (10%ED) 9,2W (25%ED) 4,6W (50%ED) 2,3W (100%ED)

Data at 20°C , without heatsink

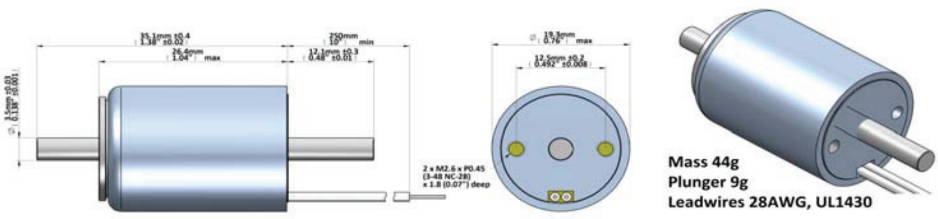
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	7
watts at 20°C			2.3	4.6	9.2	23
ampere-turns at 20°			265	374	530	838
type no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**			
M192C-3V F192C-3V	4.3	380	3.0	4.2	6.0	9.5
M192C-6V F192C-6V	16	735	6.0	8.5	12	19
M192C-12V F192C-12V	68	1500	12	17	24	38
M192C-24V F192C-24V	242	2770	24	34	48	76

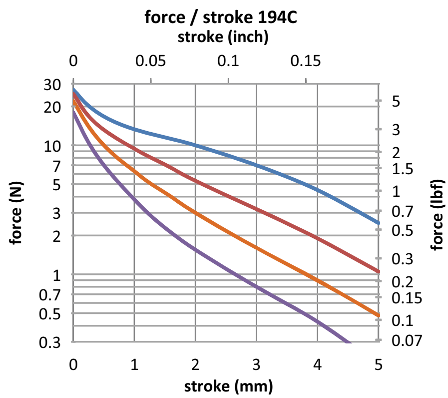
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120^{o}C) insulation class

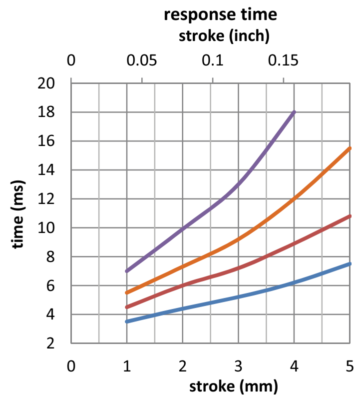
GEEPLUS Small Push Pull Solenoid size 194

Device drawn in energised condition
conical plunger
Life Expectancy (cycles): >5M

Available mechanical options:
M: metric thread
F: SAE thread







30W (10%ED) 12W (25%ED) 6W (50%ED) 3W (100%ED)

Data at 20°C , without heatsink

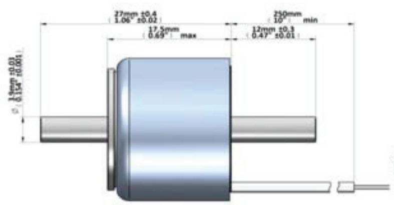
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	7
watts at 20°C			3	6	12	30
ampere-turns at 20°			382	542	765	1211
type no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
M194C-3V F194C-3V	2.7	360	3.0	4.2	6.0	9.5
M194C-6V F194-6V	11.8	770	6.0	8.5	12	19
M194C-12V F194C-12V	49.5	1620	12	17	24	38
M194C-24V F194C-24V	185	2950	24	34	48	76

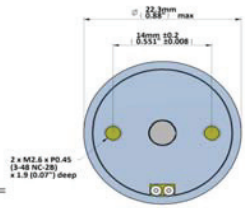
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

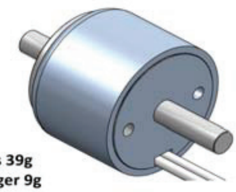
GEEPLUS Small Push Pull Solenoid size 221

Device drawn in energised condition
conical plunger
Life Expectancy (cycles): >5M

Available mechanical options:
M: metric thread
F: SAE thread

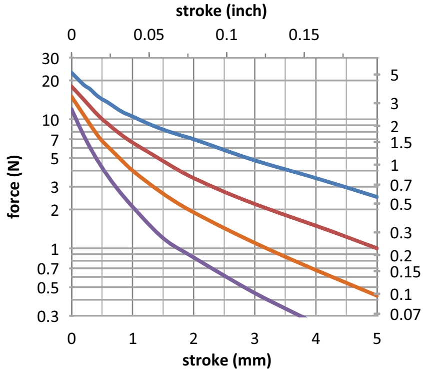




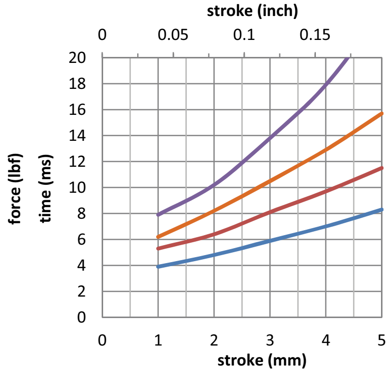


Mass 39g
Plunger 9g
Leadwires 26AWG, UL1430

force / stroke 221C



response time



25W (10%ED) — 10W (25%ED) — 5W (50%ED) — 2,5W (100%ED)

Data at 20°C , without heatsink

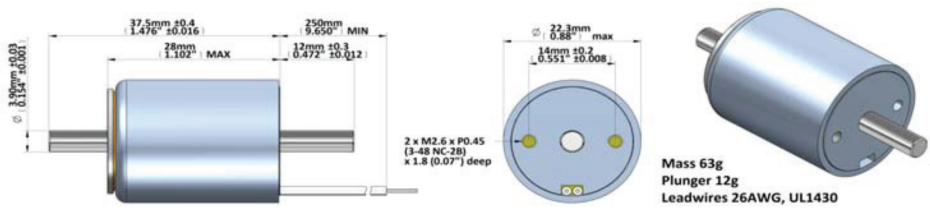
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	7
watts at 20°C			2.5	5	10	25
ampere-turns at 20°			253	358	507	803
type no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**			
M221C-3V F221C-3V	3.8	325	3.0	4.2	6.0	9.5
M221C-6V F221C-6V	13.8	620	6.0	8.5	12	19
M221C-12V F221C-12V	59	1260	12	17	24	38
M221C-24V F221C-24V	226	2200	24	34	48	76

Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

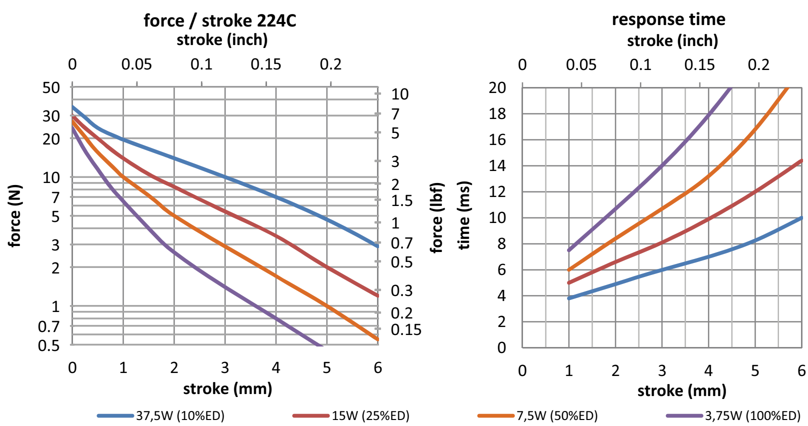
GEEPLUS Small Push Pull Solenoid size 224

Device drawn in energised condition
conical plunger
Life Expectancy (cycles): >5M

Available mechanical options:
M: metric thread
F: SAE thread



Mass 63g
Plunger 12g
Leadwires 26AWG, UL1430



Data at 20°C , without heatsink

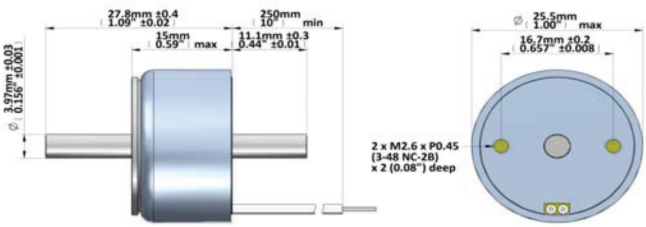
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	7
watts at 20°C			3.75	7.5	15	37.5
ampere-turns at 20°			440	623	880	1393
type no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
M224C-3V F224C-3V	2.3	350	3.0	4.2	6.0	9.5
M224C-6V F224C-6V	10	750	6.0	8.5	12	19
M224C-12V F224C-12V	38	1460	12	17	24	38
M224C-24V F224C-24V	167	3060	24	34	48	76

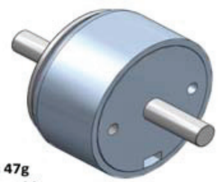
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Small Push Pull Solenoid size 251

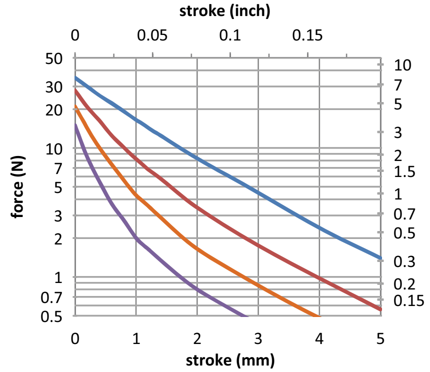
Device drawn in energised condition
conical plunger
Life Expectancy (cycles): >5M

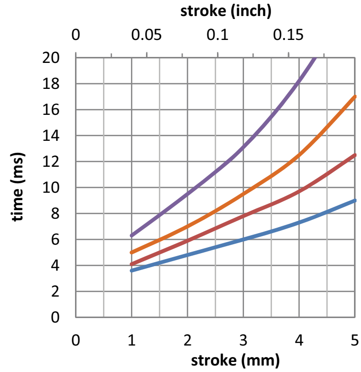
Available mechanical options:
M: metric thread
F: SAE thread





Mass 47g
Plunger 11g
Leadwires 24AWG, UL1430





30W (10%ED) 12W (25%ED) 6W (50%ED) 3W (100%ED)

Data at 20°C , without heatsink

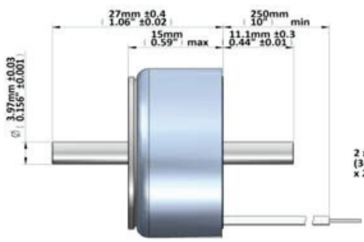
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	7
watts at 20°C			3	6	12	30
ampere-turns at 20°			240	339	480	758
type no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
M251C-3V F251C-3V	3.3	285	3.0	4.2	6.0	9.5
M251C-6V F251C-6V	13	570	6.0	8.5	12	19
M251C-12V F251C-12V	51	1090	12	17	24	38
M251C-24V F251C-24V	228	2250	24	34	48	76

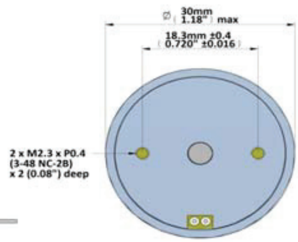
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

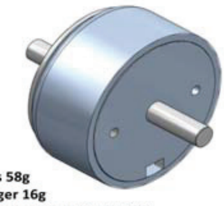
GEEPLUS Small Push Pull Solenoid size 300

Device drawn in energised condition
conical plunger
Life Expectancy (cycles): >5M

Available mechanical options:
M: metric thread
F: SAE thread

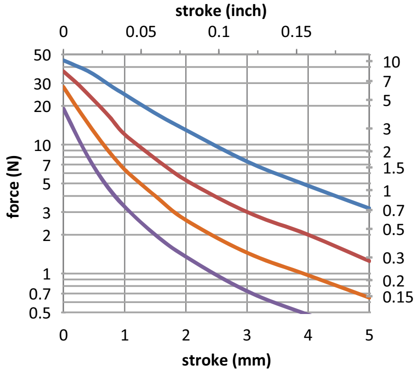




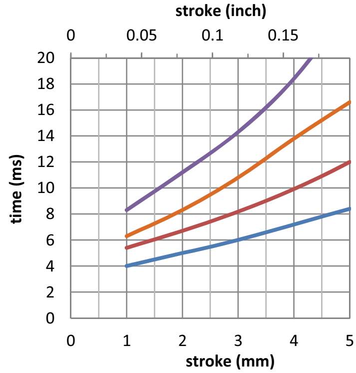


Mass 58g
Plunger 16g
Leadwires 28AWG, UL1430

force / stroke 300C



response time



35W (10%ED) 14W (25%ED) 7W (50%ED) 3,5W (100%ED)

Data at 20°C , without heatsink

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	7
watts at 20°C			3.5	7	14	35
ampere-turns at 20°			272	385	545	864
type no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
M300C-3V F300C-3V	2.6	235	3.0	4.2	6.0	9.5
M300C-6V F300C-6V	10.4	485	6.0	8.5	12	19
M300C-12V F300C-12V	41.8	990	12	17	24	38
M300C-24V F300C-24V	166	1780	24	34	48	76

Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

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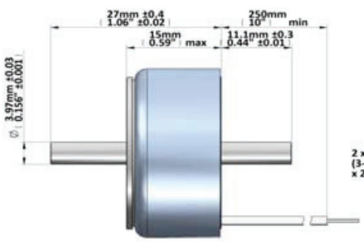
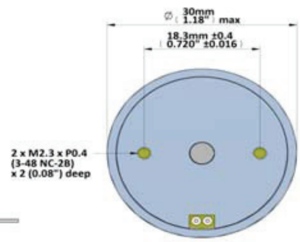
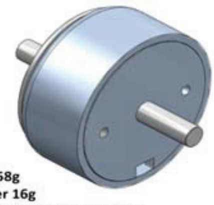
GEEPLUS Small Push Pull Solenoid size 304

Device drawn in energised condition
conical plunger
Life Expectancy (cycles): >5M

Available mechanical options:
M: metric thread
F: SAE thread

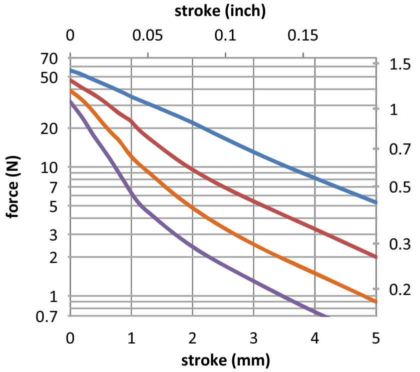




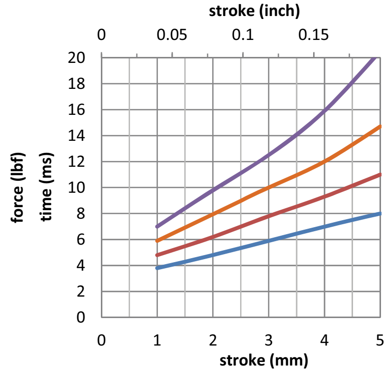


Mass 58g
Plunger 16g
Leadwires 28AWG, UL1430

force / stroke 304C



response time



37W (10%ED) 14,8W (25%ED) 7,4W (50%ED) 3,7W (100%ED)

Data at 20°C , without heatsink

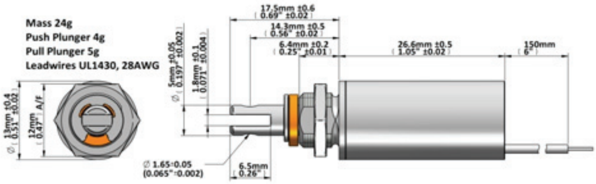
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	100	36	7
watts at 20°C			3.7	7.4	14.8	37
ampere-turns at 20°			320	452	640	1012
type no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**			
M304C-3V F304C-3V	3.15	320	3.0	4.2	6.0	9.5
M304C-6V F304C-6V	10.7	575	6.0	8.5	12	19
M304C-12V F304C-12V	43	1150	12	17	24	38
M304C-24V F304C-24V	150	2140	24	34	48	76

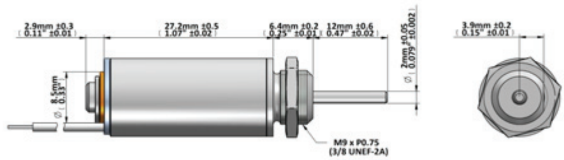
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

Tubular & Super Stroke solenoids

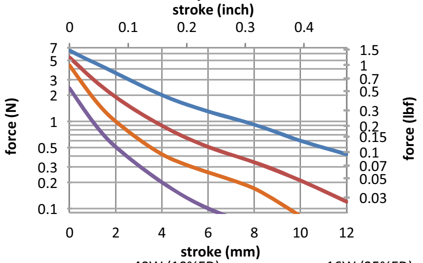
GEEPLUS Tubular Solenoid size 130

Device drawn in energised condition
Available plunger options:
pull (-Lx) / push (-Hx)
Life Expectancy (cycles):
>2M (-L, ;-H),
>5M (-LE, ;-HE),
>10M (-LL, -HL)
Available mechanical options:
M: metric thread
F: SAE thread

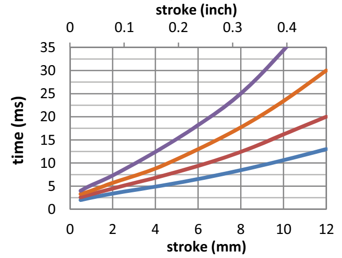




force / stroke 130



response time



40W (10%ED) — 16W (25%ED) — 8W (50%ED) — 4W (100%ED)

Data at 20°C , device connected to heatsink 50x50x3mm aluminum

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	50	5	2
watts at 20°C			4	8	16	40
ampere-turns at 20°			453	640	905	1440
AWG no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**			
29	2.68	372	3.3	4.5	6.5	10.4
30	3.94	426	4.2	5.9	8.4	13.3
31	7.36	632	5.3	7.4	10.5	16.8
32	10.1	704	6.5	9.2	13.0	21
33	18.1	990	8.3	11.7	16.5	26
34	25.6	1100	10.6	14.9	21	34
35	44.2	1500	13.6	19.2	27	43
36	71.3	1932	16.9	24	34	54
37	99.0	2170	21	29	41	66
38	159.5	2768	26	37	52	83
39	300	3980	34	48	68	109
40	469	4884	44	61	87	138
41	709	6024	53	75	107	170
42	1152	7784	67	95	134	213
43	1780	9330	87	112	173	275

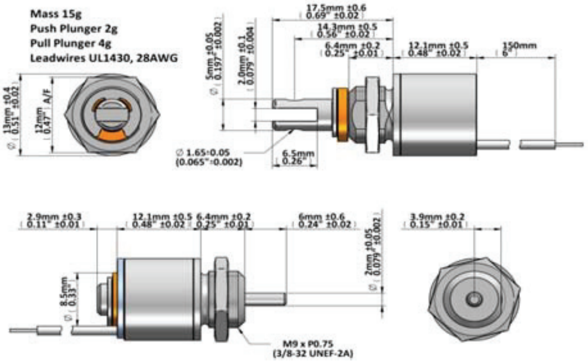
Insulation Resistance >100MΩ, 500VDC Megger

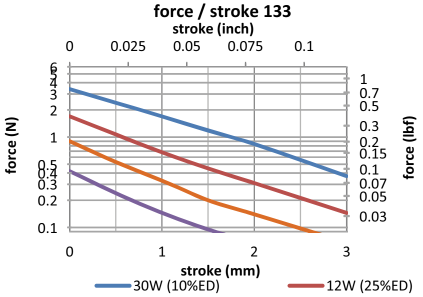
Dielectric Strength 1000VAC, 50/60Hz, 1 minute

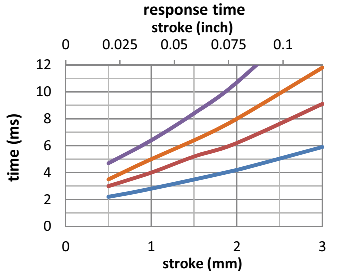
Class E (120°C) insulation class

GEEPLUS Tubular Solenoid size 133

Device drawn in energised condition
Available plunger options:
pull (-Lx) / push (-Hx)
Life Expectancy (cycles):
>2M (-L, ;-H),
>5M (-LE, ;-HE),
>10M (-LL, -HL)
Available mechanical options:
M: metric thread
F: SAE thread







Data at 20°C , device connected to heatsink 50x50x3mm aluminum

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	38	4	1
watts at 20°C			3	6	12	30
ampere-turns at 20°			232	330	465	735
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
29	1.0	141	1.7	2.4	3.4	5.0
30	1.6	175	2.0	3.0	4.3	7.0
31	2.5	217	2.7	3.8	5.4	9.0
32	3.9	268	3.4	4.8	7.0	11
33	6.1	332	4.3	6.0	9.0	14
34	9.5	410	5.4	7.7	11	17
35	14.8	506	6.8	10	14	22
36	23.0	625	8.5	12	17	27
37	35.8	770	10.8	15	22	34
38	55.7	949	13.6	19	27	43
39	86.5	1169	17.0	24	34	54
40	134	1440	21.6	31	43	68
41	209	1774	27.0	39	55	87
42	324	2184	34.5	49	69	109
43	503	2688	43.5	62	87	137

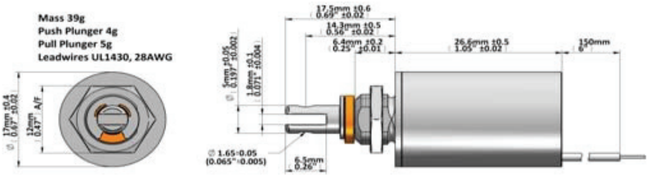
Insulation Resistance >100MΩ, 500VDC Megger

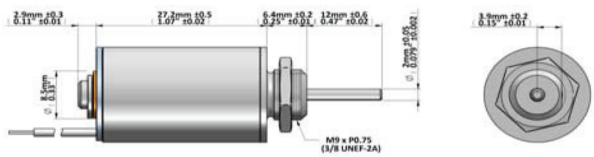
Dielectric Strength 1000VAC, 50/60Hz, 1 minute

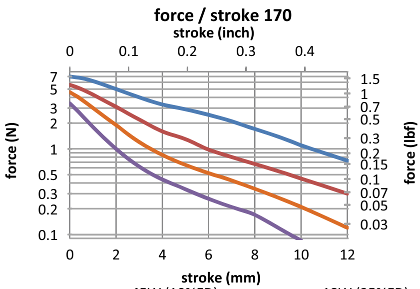
Class E (120°C) insulation class

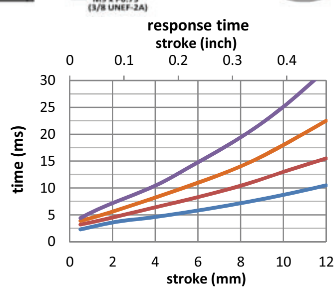
Tubular Solenoid size 170

Device drawn in energised condition
Available plunger options:
pull (-Lx) / push (-Hx)
Life Expectancy (cycles):
>2M (-L, ;-H),
>5M (-LE, ;-HE),
>10M (-LL, -HL)
Available mechanical options:
M: metric thread
F: SAE thread









45W (10%ED) 18W (25%ED) 9W (50%ED) 4,5W (100%ED)

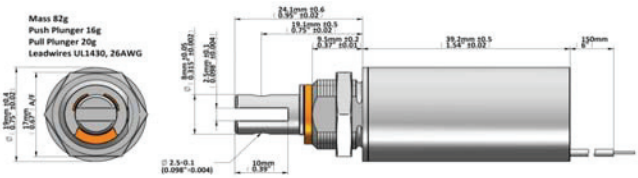
Data at 20°C , device connected to heatsink 50x50x3mm aluminum

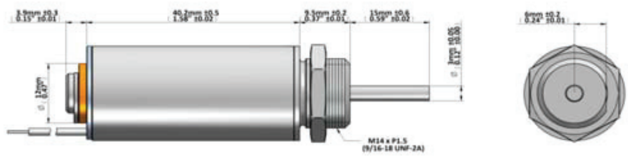
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	50	5	2
watts at 20°C			4.5	9	18	45
ampere-turns at 20°			631	892	1262	1995
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
27	2.83	520	3.4	4.9	6.9	10.9
28	4.90	695	4.4	6.3	8.9	14.1
29	6.59	760	5.5	7.7	10.9	17.3
30	11.0	985	7.0	10.0	14.1	22
31	18.0	1246	9.1	12.9	18.2	29
32	28.2	1580	11.3	15.9	23	36
33	46.3	2080	14.0	19.9	28	44
34	69	2460	17.6	25	35	56
35	119	3260	23	33	46	73
36	177	3700	30	43	60	95
37	280	5000	35	50	71	112
38	408	6000	43	61	86	136
39	715	8080	56	79	112	177
40	1108	9700	72	102	144	228
41	1763	12000	93	131	185	293

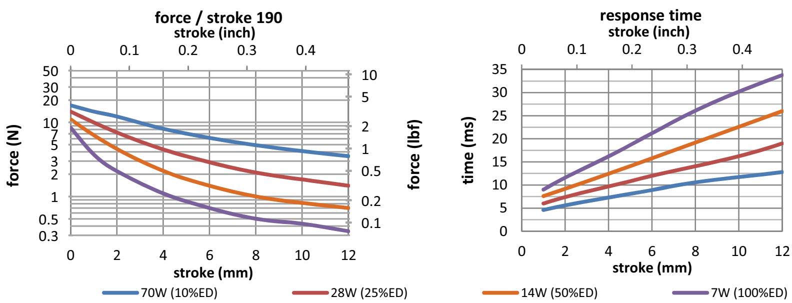
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Tubular Solenoid size 190

Device drawn in energised condition
Available plunger options:
pull (-Lx) / push (-Hx)
Life Expectancy (cycles):
>2M (-L, ;-H),
>5M (-LE, ;-HE),
>10M (-LL, -HL)
Available mechanical options:
M: metric thread
F: SAE thread







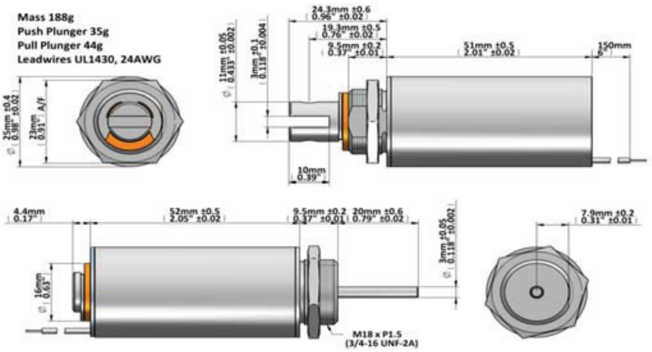
Data at 20°C , device connected to heatsink 80x80x3mm aluminum

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	230	25	6
watts at 20°C			7	14	28	70
ampere-turns at 20°			760	1075	1520	2403
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
25	1.65	372	3.4	4.9	6.9	10.9
26	3.10	551	4.4	6.2	8.7	13.8
27	4.33	615	5.4	7.7	10.9	17.2
28	7.78	870	6.9	9.8	13.8	22
29	10.7	960	8.6	12.2	17.2	27
30	18.6	1308	11.0	15.6	22	35
31	30.9	1722	13.9	19.6	28	44
32	41.6	1890	17	24	34	54
33	69.0	2448	22	31	44	69
34	110	3060	28	39	56	88
35	176	3860	35	50	70	111
36	266	4686	44	62	88	139
37	435	6214	54	77	109	172
38	658	7420	69	97	137	217
39	1135	9792	90	127	180	284
40	1815	12210	115	162	229	362

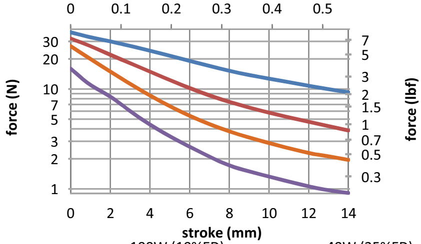
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Tubular Solenoid size 250

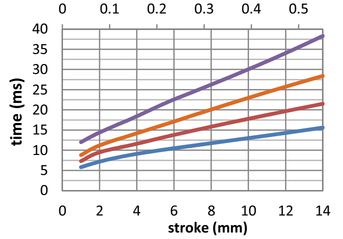
Device drawn in energised condition
Available plunger options:
pull (-Lx) / push (-Hx)
Life Expectancy (cycles):
>2M (-L, ;-H),
>5M (-LE, ;-HE),
>10M (-LL, -HL)
Available mechanical options:
M: metric thread
F: SAE thread



force / stroke 250



response time



100W (10%ED) 40W (25%ED) 20W (50%ED) 10W (100%ED)

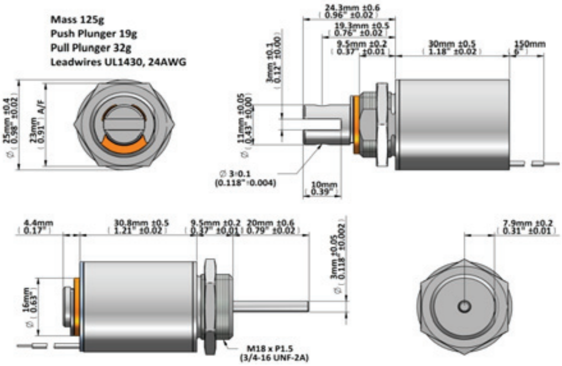
Data at 20°C , device connected to heatsink 100x100x3mm aluminum

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	360	32	8
watts at 20°C			10	20	40	100
ampere-turns at 20°			1090	1541	2180	3447
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
23	1.49	402	4.1	5.8	8.2	13.0
24	2.87	600	5.2	7.4	10.4	16.4
25	3.98	672	6.6	9.3	13.1	21
26	7.06	940	8.3	11.7	16.6	26
27	9.8	1050	10.4	14.6	21	33
28	16.9	1415	13.2	18.6	26	42
29	27.0	1820	16.4	23	33	52
30	45.0	2365	21	30	42	66
31	71.6	2990	26	37	53	84
32	107	3660	32	46	65	102
33	172	4550	42	59	83	132
34	265	5550	53	75	106	167
35	443	7310	67	95	134	212
37	1032	11000	104	147	207	328
38	1535	12930	131	185	262	415

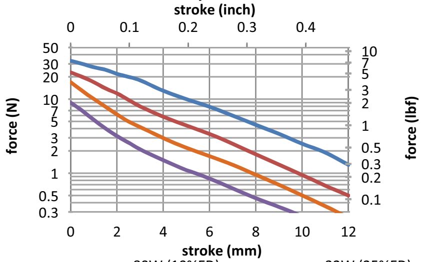
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Tubular Solenoid size 253

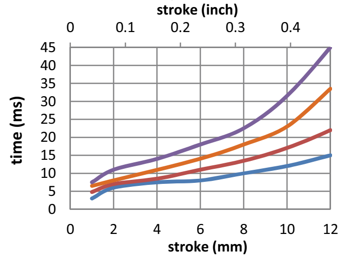
Device drawn in energised condition
Available plunger options:
pull (-Lx) / push (-Hx)
Life Expectancy (cycles):
>2M (-L, ;-H),
>5M (-LE, ;-HE),
>10M (-LL, -HL)
Available mechanical options:
M: metric thread
F: SAE thread



force / stroke 253



response time



80W (10%ED) 32W (25%ED) 16W (50%ED) 8W (100%ED)

Data at 20°C , device connected to heatsink 100x100x3mm aluminum

duty cycle = "on" time / ("on" time + "off" time) x 100%	100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds	∞	360	32	8
watts at 20°C	8	16	32	80
ampere-turns at 20°	666	942	1332	2106

AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
25	1.91	328	3.9	5.5	7.8	12.3
26	3.49	460	5.1	8.7	12.3	19.4
27	4.79	520	6.1	8.7	12.3	19.4
28	8.27	696	7.9	11.2	15.8	25
29	14.7	910	10.8	15.2	22	34
30	18.6	1020	12.1	17.2	24	38
31	31.3	1360	15.3	22	31	48
32	50.3	1620	21	29	41	65
33	76.8	2060	25	35	50	79
34	121	2570	31	44	63	99
35	207	3350	41	58	82	130
36	308	4100	50	71	100	158
37	490	5100	64	91	128	202
38	720	6000	80	113	160	253
39	1320	8550	103	145	206	325
40	2040	10500	129	183	259	409

Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

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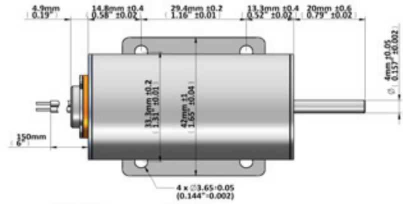
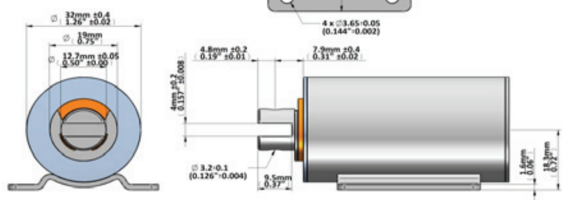
GEEPLUS Tubular Solenoid size 320

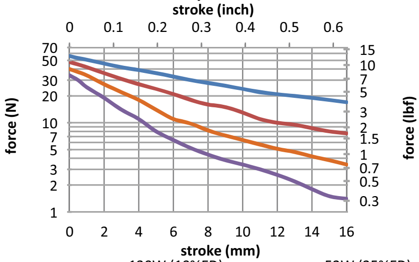
Device drawn in energised condition
Available plunger options:
pull (-Lx) / push (-Hx)
Life Expectancy (cycles):
>2M (-L, ;-H),
>5M (-LE, ;-HE),
>10M (-LL, -HL)
Available mechanical options:
M: metric thread
F: SAE thread

Mass 299g
Push Plunger 53g
Pull Plunger 54g
Leadwires UL1430, 22AWG

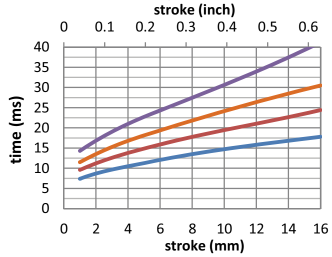




force / stroke 320



response time



130W (10%ED) 52W (25%ED) 26W (50%ED) 13W (100%ED)

Data at 20°C , device connected to heatsink 130x130x3mm aluminum

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	390	60	18
watts at 20°C			13	26	52	130
ampere-turns at 20°			1500	2121	3000	4743
AWG no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**			
21	1.40	496	4.3	6.1	8.6	13.5
22	2.52	700	5.4	7.7	10.9	17.2
23	3.52	780	6.8	9.6	13.6	22
24	6.04	1056	8.6	12.2	17.2	27
25	8.5	1176	10.9	15.4	22	34
26	14.1	1540	13.8	19.5	28	44
27	22.5	1970	17.3	24	35	55
28	36.1	2484	22	31	44	69
29	55.1	3060	27	38	54	86
30	88.1	3805	35	49	70	110
31	147	5044	44	62	88	139
32	214	5992	54	76	107	170
33	354	7744	69	98	138	218
34	566	9730	88	124	175	277
35	900	12200	111	157	222	351
36	1310	14150	139	197	278	440
37	2060	18100	172	243	344	544

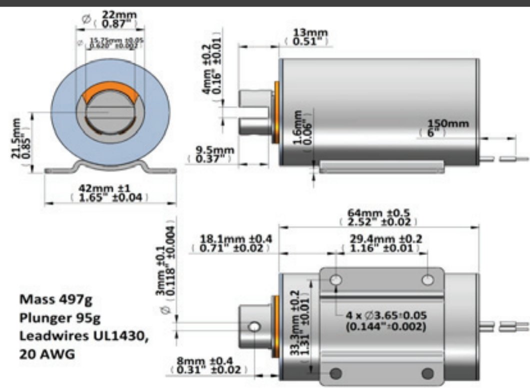
Insulation Resistance >100MΩ, 500VDC Megger
Class E (120°C) insulation class

Dielectric Strength 1000VAC, 50/60Hz, 1 minute

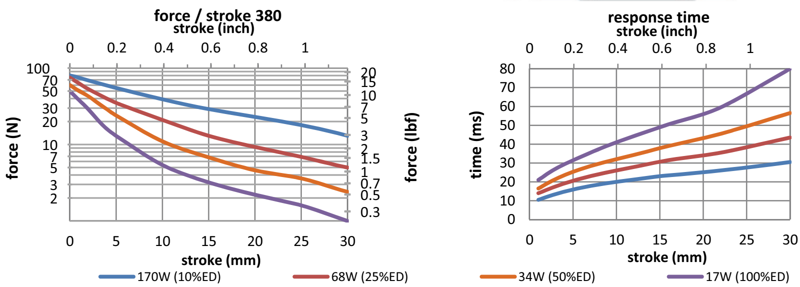
Tubular Solenoid size 380

GEEPLUS

Device drawn in energised condition
Available plunger options:
pull (-Lx)
Life Expectancy (cycles):
>2M (-L),
>5M (-LE),
>10M (-LL)
Available mechanical options:
M: metric thread
F: SAE thread



Mass 497g
Plunger 95g
Leadwires UL1430,
20 AWG



Data at 20°C , device connected to heatsink 150x150x3mm aluminum

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	420	100	25
watts at 20°C			17	34	68	170
ampere-turns at 20°			1800	2546	3600	5692
AWG no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**			
19	0.93	432	3.9	5.5	7.8	12.4
20	1.34	488	4.9	6.9	9.8	15.5
21	2.34	680	6.2	8.7	12.3	19.5
22	3.35	770	7.8	11.1	15.7	25
23	5.6	1030	9.8	13.9	19.7	31
24	9.30	1344	12.4	17.6	25	39
25	14.9	1712	15.7	22	31	50
26	24.0	2180	19.9	28	40	63
27	36.9	2680	25	35	50	79
28	58.4	3322	32	45	63	100
29	87.5	4008	39	56	79	124
30	148	5292	50	71	101	159
31	224	6360	63	90	127	200
32	344	7956	78	110	155	246
33	554	10070	100	141	199	315
34	871	12400	127	179	253	401
35	1360	15300	160	227	320	507
36	2140	19200	201	284	402	636

Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

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Super stroke solenoids

Super Stroke Solenoid

Description

The super stroke solenoid is a special implementation of the tubular solenoid design, modifications have been made to the geometry of the pole-piece and magnetic return path to produce a device which develops useful force over an exceptionally long stroke, with high efficiency, and with a flat force characteristic having many of the characteristics of a proportional solenoid allowing approximate position control over a large linear stroke.

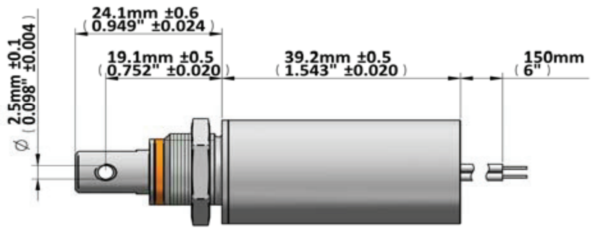
The use of many of the components of the tubular solenoid range makes the super stroke solenoid a cost-effective solution compared to other long-stroke actuators or proportional solenoid designs.

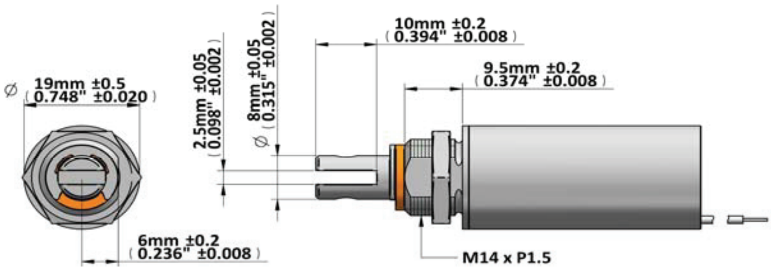
The long stroke with flat force characteristic makes the super stroke solenoid a good replacement for small air cylinders in applications where a few linear actuators are needed, but where air supply is otherwise not required, machinery can be made independent of air supply with elimination of compressors, airline, and air preparation equipment and associated maintenance.

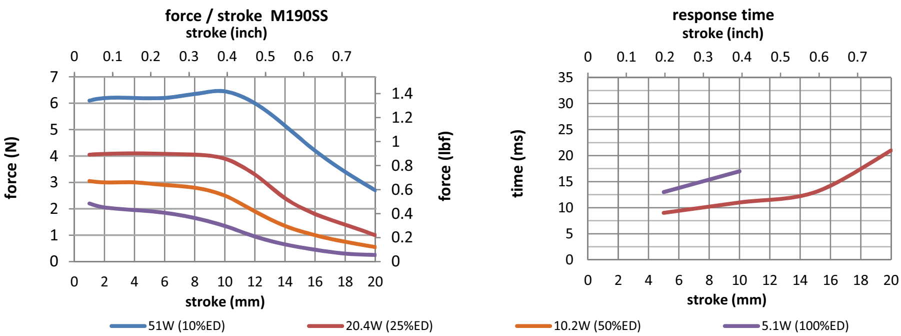
The super stroke solenoid allows approximate proportional control over a long linear stroke, the force is approximately proportional to applied current, and is uniform over the operating stroke. This characteristic can be used to control tension of wire, fibres, or web material, or can be applied against a spring to realise an actuation system where position can be controlled proportional to the applied current.

Super Stroke Solenoid M190SS-XXv

Device drawn in energised condition
Life Expectancy >2M cycles
Leadwires UL1430, 22AWG
Plunger Mass 20 grammes
Mass 81 grammes







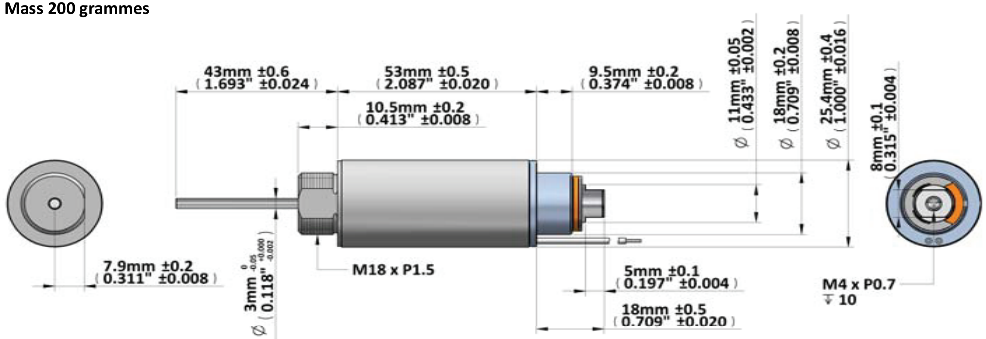
Data at 20°C , device performance measured without heat sink

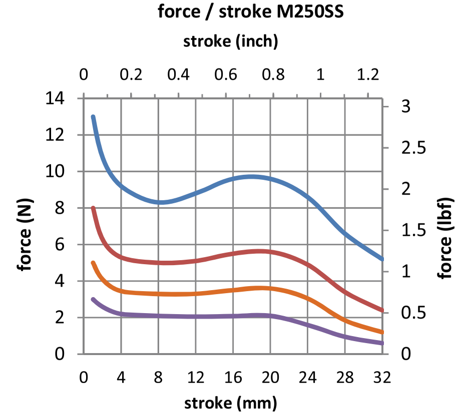
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	180	20	5
watts at 20°C			5.1	10.2	20.4	51
ampere-turns at 20°			646	914	1292	2043
AWG no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**			
M190SS-12v	30.9	1722	12.0	17.0	24.0	38.0
M190SS-24v	110	3060	24.0	34.0	48.0	76.0
M190SS-48v	435	6214	48.0	68.0	96.0	152.0
M190SS-96v	1815	12210	96.0	136.0	192	304

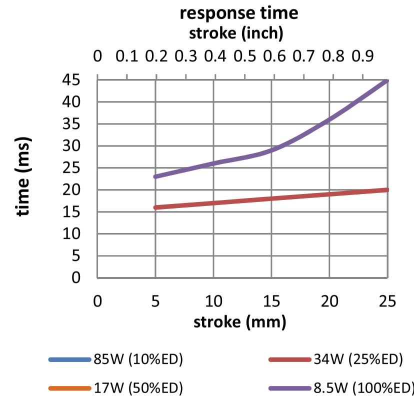
Insulation Resistance >100MΩ, 500VDC Megger
Class E (120°C) insulation class
Dielectric Strength 1000VAC, 50/60Hz, 1 minute

GEEPLUS Super Stroke Solenoid M250SS-XXv

Device drawn in energised condition
Life Expectancy >2M cycles
Leadwires UL1430, 22AWG
Plunger Mass 46 grammes
Mass 200 grammes







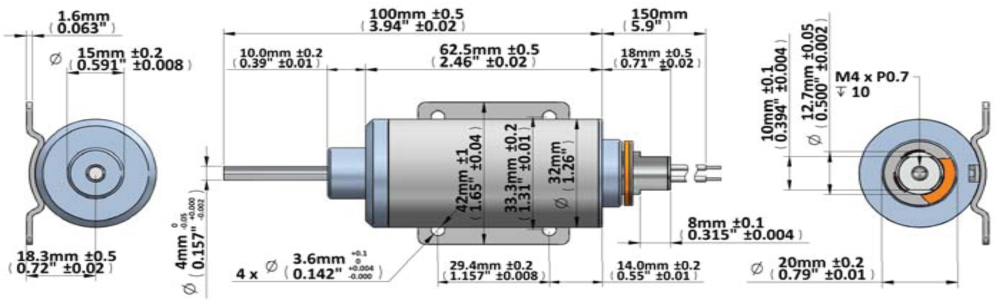
Data at 20°C , device performance measured without heat sink

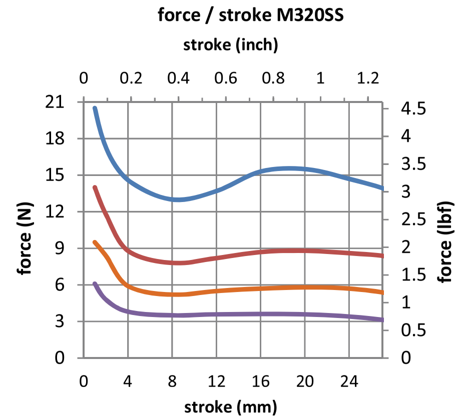
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	290	26	6
watts at 20°C			8.5	17	34	85
ampere-turns at 20°			983	1390	1966	3109
AWG no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**			
M250SS-12v	17	1392	12.0	17.0	24.0	38.0
M250SS-24v	66	2686	24.0	34.0	48.0	76.0
M250SS-48v	260	5380	48.0	68.0	96.0	152.0
M250SS-96v	1170	11400	96.0	136.0	192	304

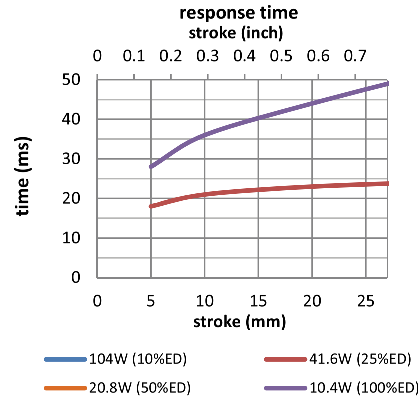
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Super Stroke Solenoid M320SS-XXv

Device drawn in energised condition
Life Expectancy >2M cycles
Leadwires UL1430, 22AWG
Plunger Mass 69 grammes
Mass 355 grammes







Data at 20°C , device performance measured without heat sink

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	310	48	14
watts at 20°C			10.4	20.8	41.6	104
ampere-turns at 20°			1335	1888	2670	4222
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
M320SS-12v	14	1541	12.0	17.0	24.0	38.0
M320SS-24v	55	3060	24.0	34.0	48.0	76.0
M320SS-48v	214	5992	48.0	68.0	96.0	152.0
M320SS-96v	900	12200	96.0	136.0	192	304

Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

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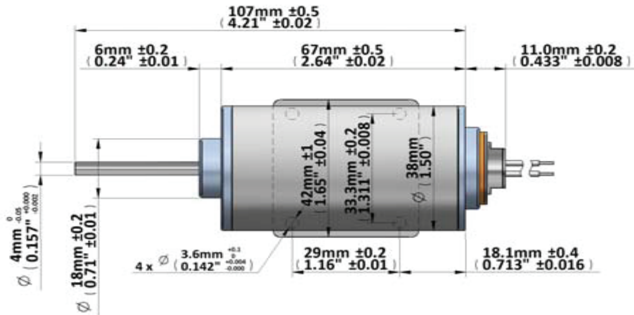
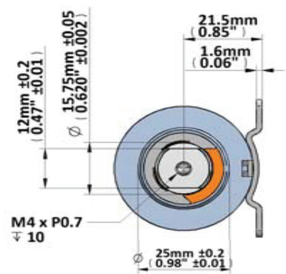
GEEPLUS Super Stroke Solenoid M380SS-XXv

Device drawn in energised condition
Life Expectancy >2M cycles
Leadwires UL1430, 22AWG
Plunger Mass 91 grammes
Mass 535 grammes

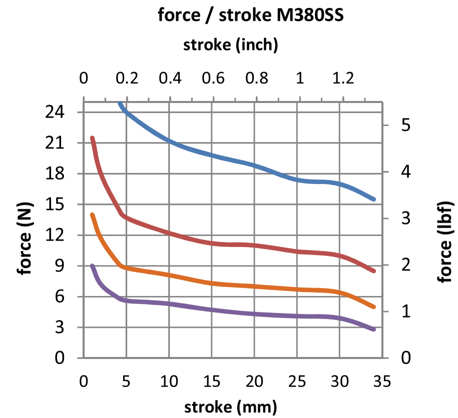


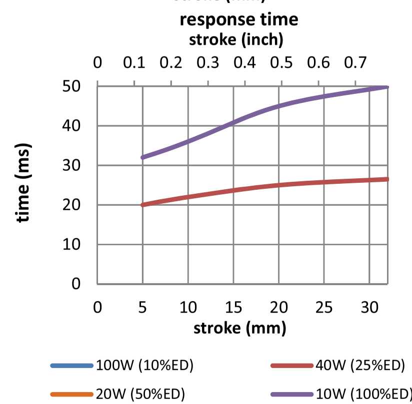


Data at 20°C , device performance measured without heat sink

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	330	80	20
watts at 20°C			10	20	40	100
ampere-turns at 20°			1360	1923	2720	4300
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
M380SS-12v	15	1712	12.0	17.0	24.0	38.0
M380SS-24v	58	3322	24.0	34.0	48.0	76.0
M380SS-48v	224	6360	48.0	68.0	96.0	152.0
M380SS-96v	871	12400	96.0	136.0	192	304

Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class





Latching solenoid

Properties of the Latching Solenoid

With a spring or other load providing return force, the latching solenoid requires only a momentary excitation pulse to change position conferring the following advantages on these devices:

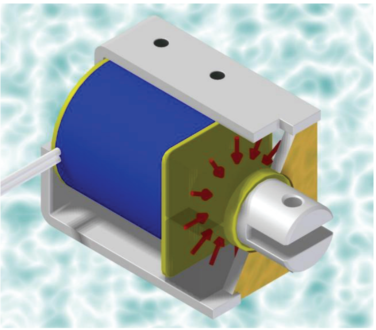
- Power consumption is zero to hold in either end position – this is advantageous for systems with limited power supply such as battery powered devices, or devices powered by telephone line power, or solar power.
- Power dissipation (heat) is zero in the holding condition – this is advantageous to handling temperature-sensitive materials such as photochemicals, blood products, or chemical reagents.
- There is no radiated electrical noise in the holding condition (there is a fixed magnetic field due to permanent magnets), this can be advantageous in sensitive measuring circuits.
- The ability to hold end position without power, can allow higher ower to be applied during the excitation pulse for a given size of device without causing heating problems, this can allow higher operating speed to be realised, or allow a smaller device to be used to move the load in a given application.

The latching solenoid is ideally suited to applications where the ‘moving’ time is very short compared to holding time in the end position, and where the system may be required to maintain either end position for a prolonged period.

It should be recognised that latching solenoids are unsuited to applications requiring ‘fail-safe’ operation (where the system should move to a known state in the event of power failure) unless complex drive circuits with energy storage are employed. Where fail-safe operation is required alternative solutions (such as pick & hold circuit) should be considered.

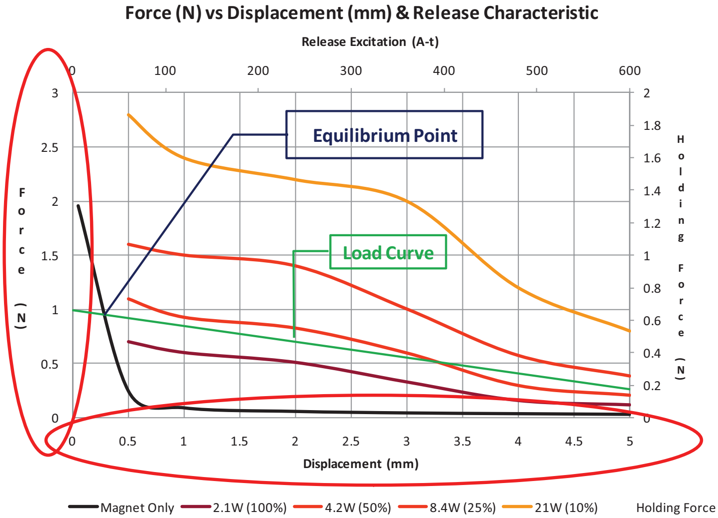
Construction of the Latching Solenoid

The Latching Solenoid incorporates permanent magnets within it’s construction, in such a manner that these drive flux around the magnetic circuit when the device is in a de-energised condition developing force without any externally applied excitation. The most common configuration based on an open-frame construction is illustrated, with cutaway sections, and with the magnet blocks drawn as transparent material to clarify the construction. The red arrows represent flux developed by the permanent magnets.



Forward excitation of the Latching Solenoid

In the de-energised condition the permanent magnets drive magnetic flux around the solenoid, this is sufficient to develop useful holding force when the airgap between plunger and pole piece is very small, but only to develop a small pull-in force from an extended position. This is represented by the black line in the characteristic graph. These curves are interpreted with reference to the Force and Displacement axes of the graph.



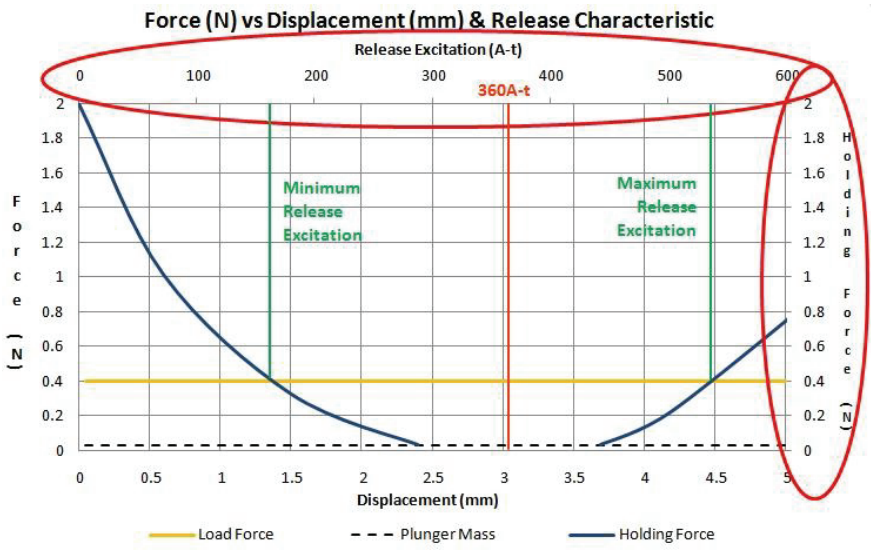
When the latching solenoid is energised with current in the forward direction, the excitation of the coil induces magnetic flux reinforcing the field due to the permanent magnets. As the excitation current increases, the force developed increases.

Bistable Operation

The characteristic graph also shows a load line as would typically be produced by a spring, it should be noted that this would normally be acting in the opposite direction from the magnetic attraction force. It is evident that at short displacement – to the left of the equilibrium point – the magnetic attraction force due to the magnets alone is stronger than this load force, in this region the plunger will be held in the solenoid with no external power being applied. To the right of the equilibrium point, the outward force developed by the spring is greater than the magnetic attraction force, the plunger will move out to the extended position. In the de-energised state this solenoid / load system is bistable and will hold either end position without external power. The solenoid can be driven from the extended to the retracted position by the application of a forward current sufficient to develop magnetic attraction greater than the load force, in this case >8.4W.

Release Operation of the Latching Solenoid

When excitation current is applied to a latching solenoid in the reverse direction, it opposes and neutralises the field developed by the magnets. As current is increased, the flux flowing due to the permanent magnets decreases until at some point flux ceases to flow around the magnetic circuit and attraction force between plunger and pole piece falls to zero, as current is increased further flux begins to flow around the magnetic circuit in the reverse direction and attraction force is again developed between the plunger and pole piece.



The Holding force characteristic is interpreted with reference to the Holding Force and Release Excitation axes on a characteristic graph. If the load force acting on the solenoid plunger is known, a line corresponding to this can be plotted on the characteristic. The solenoid will release the load when reverse excitation is in the region between the two green lines drawn from intersection between the load and holding force curves. The release characteristic is normally plotted to intersection with a line corresponding to the plunger mass. A release current may be specified in data for the solenoid which is in the middle of the range in which the plunger will drop out with the solenoid mounted vertically and with no additional load.

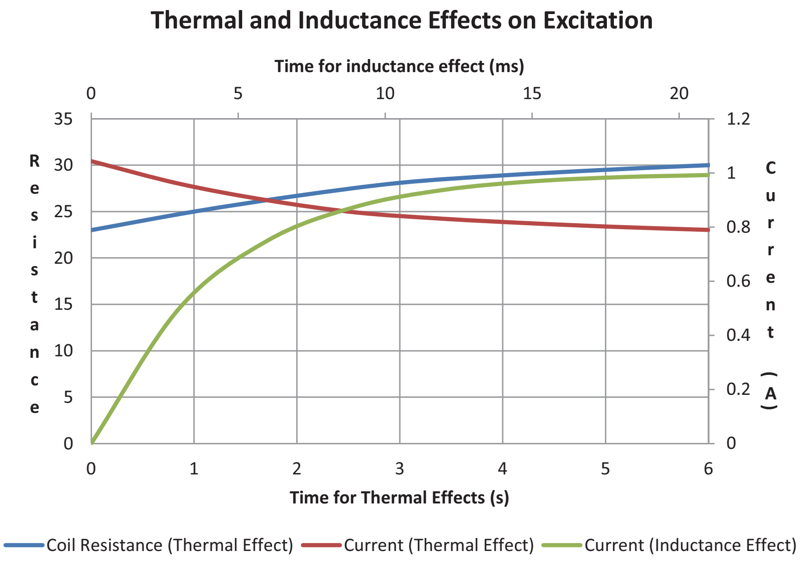
It should be noted that with a higher load force, the range of excitation current at which the solenoid will release will be wider.

The graphical data for release characteristic shows excitation in Ampere-turns (this is independent of temperature or winding option), this value should be divided by the number of coil turns to determine the release current required for a specific winding option.

Determining Release Current for Latching Solenoid

There are several additional factors which should be considered when determining the appropriate release current for a latching solenoid.

- The solenoid is an inductive load. When connected to a voltage source, the current will rise exponentially towards a stable value, due to this characteristic it will not instantaneously reach the 'target' level. To ensure current rises quickly to the level needed for release, it may be desirable to aim for a target level for the release current which is near the top of the release range.
- If the coil is energised for a prolonged period, it will heat up due to ohmic dissipation, as it does so the coil resistance will increase. If the solenoid is energised from a voltage source, the current will decrease in inverse proportion to the increase in resistance. In this case, or if ambient temperature is exceptionally high or low, then the target excitation should be revised accordingly.

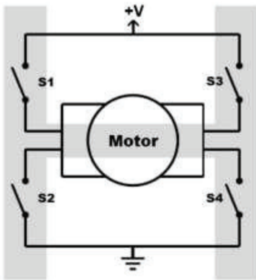


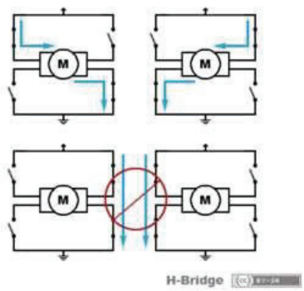
If excitation is from a current source, susceptibility to temperature variation will be eliminated, susceptibility to variation in source voltage will also be lessened.

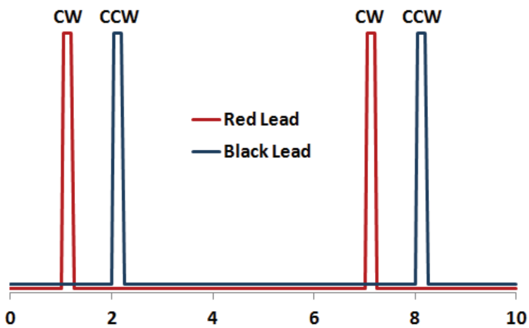
If the application is subject to higher or lower ambient temperature conditions, then the target release current may need to be modified accordingly.

Electrical Drive

To drive a bistable rotary solenoid, a circuit configuration known as an H-Bridge is normally required. This is shown schematically. This is normally implemented using solid state switches (transistors), a number of integrated devices are available to simplify implementation of such a circuit.







By closing either S1 and S4, or S2 and S3 while the other switches are open, the current can be caused to flow through the solenoid coil in either the forward or the reverse direction. With momentary excitation pulses as depicted in the timing diagram the solenoid can be pulled in or released, remaining in either position with no power applied in between.

GEEPLUS T1L-0420-xxV

Coil Data

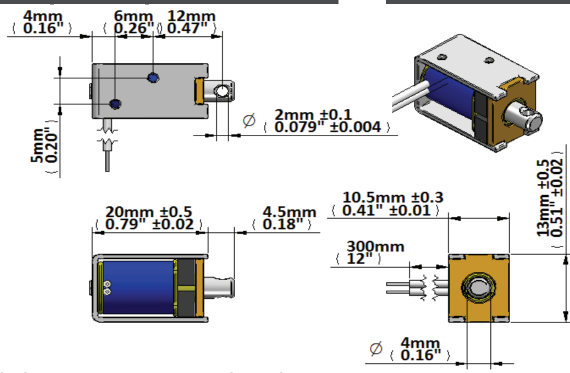
Duty Cycle = "on" time / ("on" time + "off" time) x 100% — 100% ED

Maximum "on" time in seconds	∞
Watts at 20°C	1
Ampere-Turns at 20°C	153

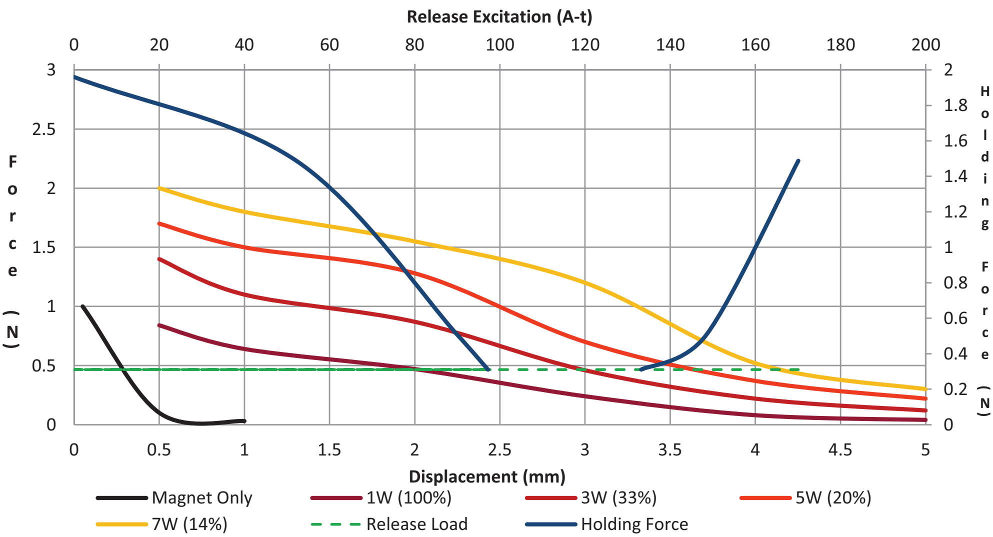
P/N	Resistance ±10% @ 20°C	Coil Turns	Volts DC	Release Current
T1L-0420-6v	36.0 Ω	900	6	170 mA
T1L-0420-12v	144.0 Ω	1850	12	80 mA
T1L-0420-24v	576.0 Ω	3450	24	40 mA

General Parameters

Life Expectancy (Cycles)	200,000
Mass	12.3 grammes
Plunger Mass	1.7 grammes
Leadwires 250mm (10")min, UL1007, AWG28	
Isolation Class	A (105°C)
Dielectric Strength 1000V AC, 50/60Hz, 1min	
Insulation Res >100MΩ, 500V DC Megger	



Force (N) vs Displacement (mm) & Release Characteristic



GEEPLUS T1L-0422-xxV

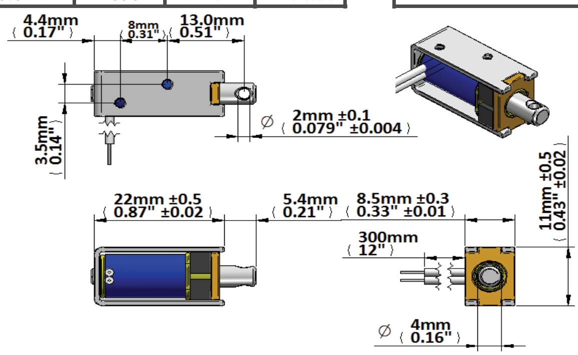
Coil Data

Duty Cycle = "on" time / ("on" time + "off" time) x 100%	100% ED
Maximum "on" time in seconds	∞
Watts at 20°C	2.8
Ampere-Turns at 20°C	225

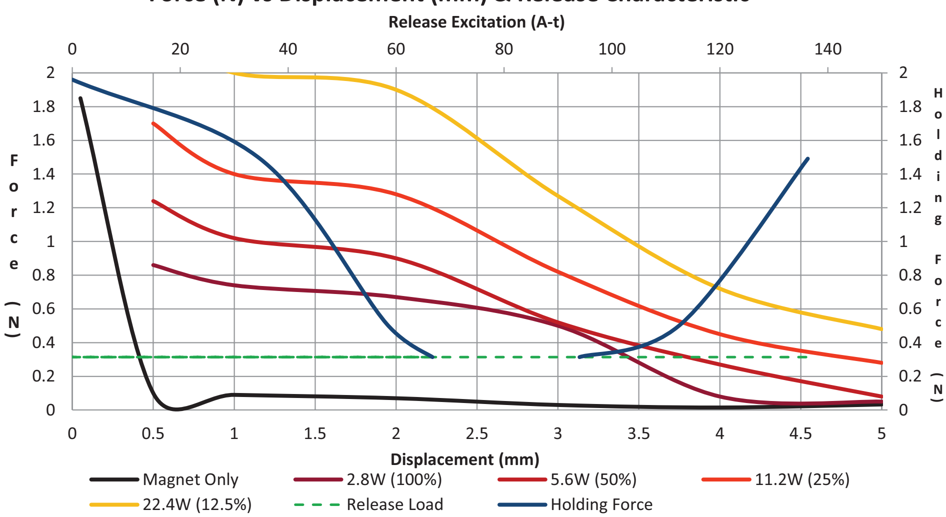
P/N	Resistance ±10% @ 20°C	Coil Turns	Volts DC	Release Current
T1L-0422-6v	12.8 Ω	480	6	469 mA
T1L-0422-12v	51.4 Ω	940	12	233 mA
T1L-0422-24v	205.0 Ω	1890	24	117 mA

General Parameters

Life Expectancy (Cycles)	200,000
Mass	10.0 grammes
Plunger Mass	2.0 grammes
Leadwires 250mm (10")min, UL1007, AWG28	
Isolation Class	A (105°C)
Dielectric Strength 1000V AC, 50/60Hz, 1min	
Insulation Res >100MΩ, 500V DC Megger	



Force (N) vs Displacement (mm) & Release Characteristic



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GEEPLUS T1L-0625-xxV

Coil Data

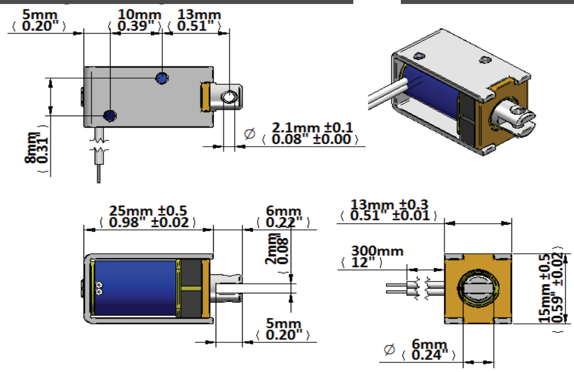
Duty Cycle = "on" time / ("on" time + "off" time) x 100% — 50% ED

Maximum "on" time in seconds	8
Watts at 20°C	5.3
Ampere-Turns at 20°C	402

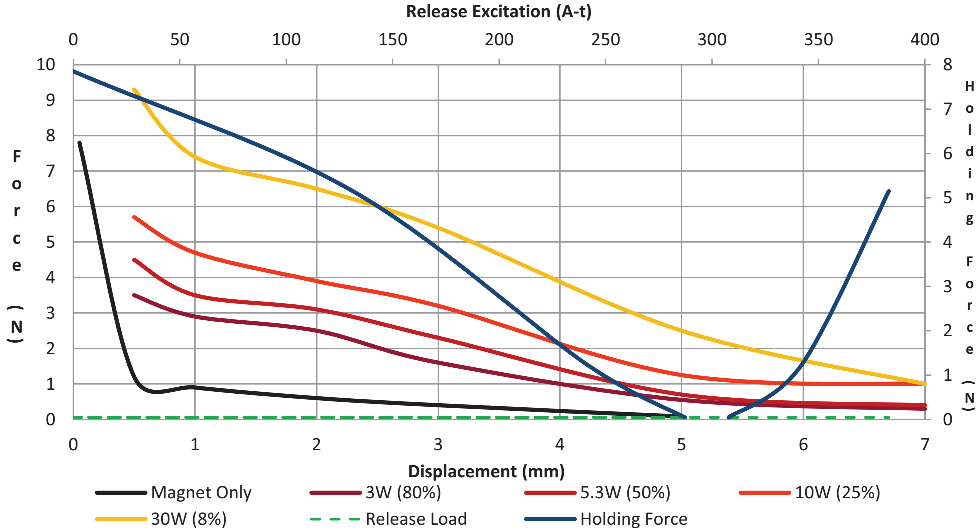
P/N	Resistance ±10% @ 20°C	Coil Turns	Volts DC	Release Current
T1L-0625-6v	6.8 Ω	456	6	880 mA
T1L-0625-12v	27.0 Ω	896	12	440 mA
T1L-0625-24v	108.0 Ω	1790	24	220 mA

General Parameters

Life Expectancy (Cycles)	200,000
Mass	26 grammes
Plunger Mass	4.6 grammes
Leadwires 250mm (10")min, UL1007, AWG26	
Isolation Class	A (105°C)
Dielectric Strength 1000V AC, 50/60Hz, 1min	
Insulation Res >100MΩ, 500V DC Megger	



Force (N) vs Displacement (mm) & Release Characteristic



GEEPLUS T1L-0730-xxV

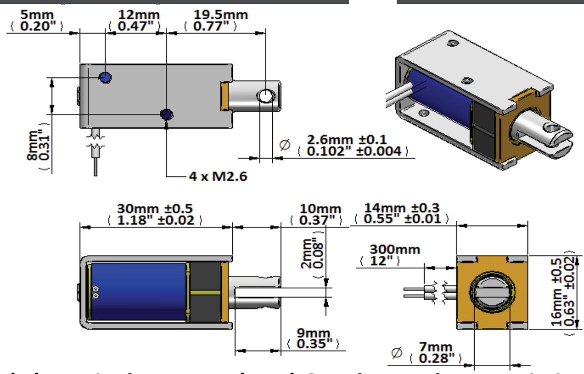
Coil Data

Duty Cycle = "on" time / ("on" time + "off" time) x 100%

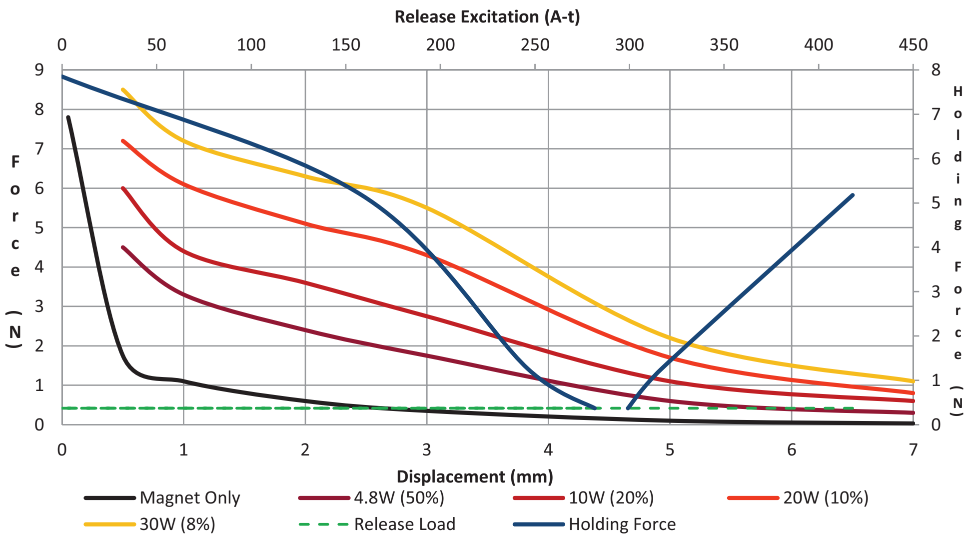
	Duty Cycle			50% ED
	Maximum "on" time in seconds			10
	Watts at 20°C			4.8
	Ampere-Turns at 20°C			360
P/N	Resistance ±10% @ 20°C	Coil Turns	Volts DC	Release Current
T1L-0730-6v	7.5 Ω	450	6	800 mA
T1L-0730-12v	30.0 Ω	880	12	400 mA
T1L-0730-24v	120.0 Ω	1860	24	200 mA

General Parameters

Life Expectancy (Cycles)	200,000
Mass	34 grammes
Plunger Mass	7.7 grammes
Leadwires 250mm (10")min, UL1007, AWG26	
Isolation Class	A (105°C)
Dielectric Strength 1000V AC, 50/60Hz, 1min	
Insulation Res >100MΩ, 500V DC Megger	



Force (N) vs Displacement (mm) & Release Characteristic



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GEEPLUS T1L-0742-xxV

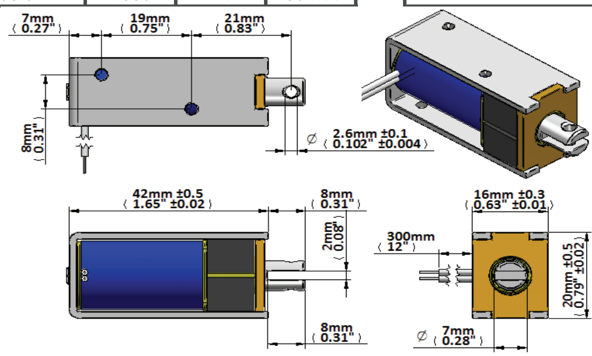
Coil Data

Duty Cycle = "on" time / ("on" time + "off" time) x 100%	100% ED
Maximum "on" time in seconds	∞
Watts at 20°C	2
Ampere-Turns at 20°C	363

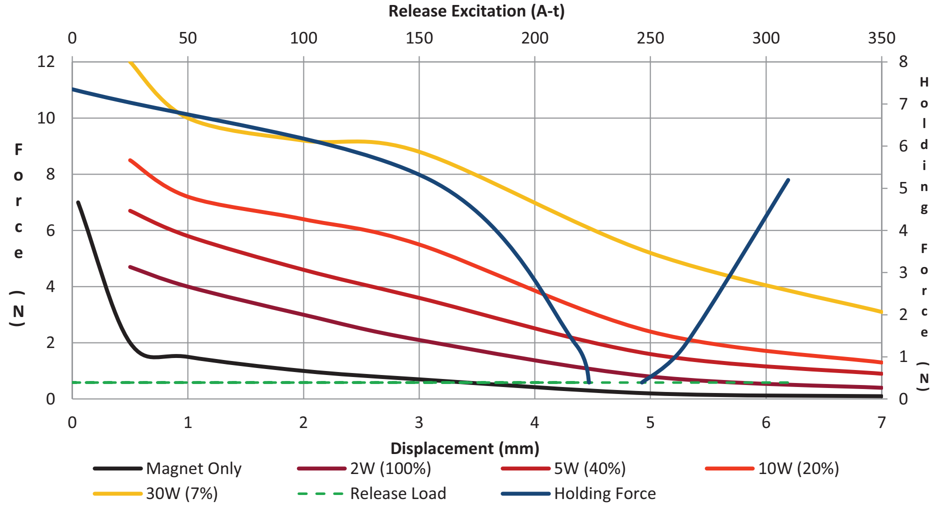
P/N	Resistance ±10% @ 20°C	Coil Turns	Volts DC	Release Current
T1L-0742-6v	18.0 Ω	1090	6	333 mA
T1L-0742-12v	72.0 Ω	2080	12	167 mA
T1L-0742-24v	288.0 Ω	4086	24	83 mA

General Parameters

Life Expectancy (Cycles)	200,000
Mass	58.0 grammes
Plunger Mass	9.9 grammes
Leadwires 250mm (10")min, UL1007, AWG26	
Isolation Class	A (105°C)
Dielectric Strength 1000V AC, 50/60Hz, 1min	
Insulation Res >100MΩ, 500V DC Megger	



Force (N) vs Displacement (mm) & Release Characteristic



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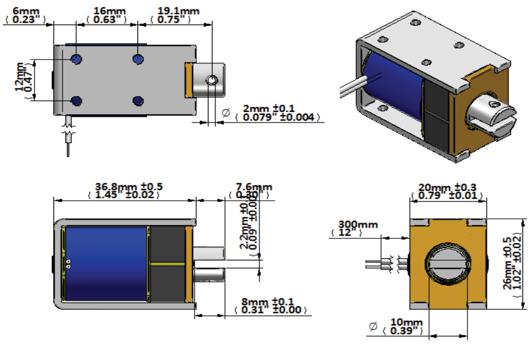
GEEPLUS T1L-1037-xxV

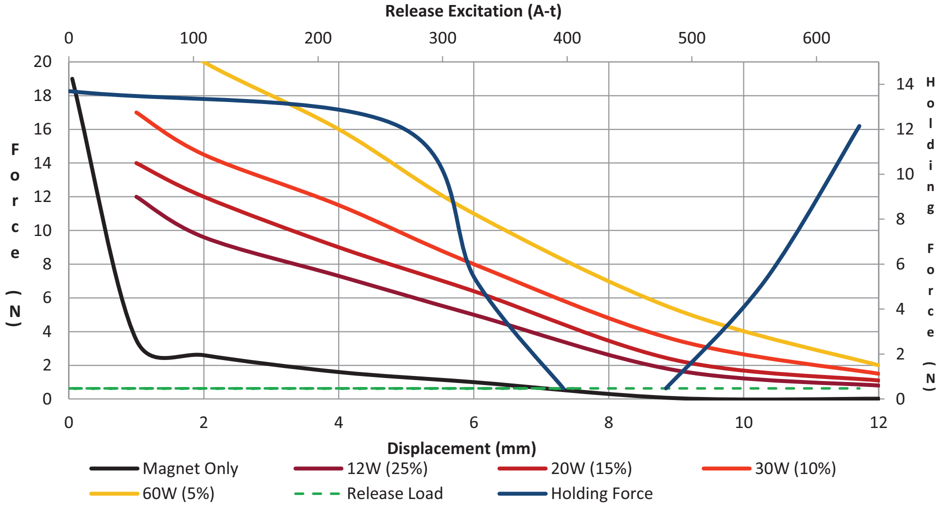
Coil Data				
	Duty Cycle = "on" time / ("on" time + "off" time) x 100%			25% ED
	Maximum "on" time in seconds			7
	Watts at 20°C			12
	Ampere-Turns at 20°C			675
P/N	Resistance ±10% @ 20°C	Coil Turns	Volts DC	Release Current
T1L-1037-6v	3.0 Ω	333	6	2000 mA
T1L-1037-12v	12.0 Ω	680	12	1000 mA
T1L-1037-24v	48.0 Ω	1350	24	500 mA

General Parameters

Life Expectancy (Cycles)	200,000
Mass	95 grammes
Plunger Mass	18.3 grammes
Leadwires 250mm (10")min, UL1007, AWG26	
Isolation Class	A (105°C)
Dielectric Strength 1000V AC, 50/60Hz, 1min	
Insulation Res >100MΩ, 500V DC Megger	



Force (N) vs Displacement (mm) & Release Characteristic



GEEPLUS T1L-1240-xxV

Coil Data

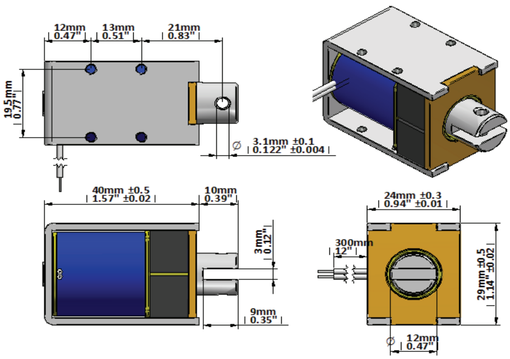
Duty Cycle = "on" time / ("on" time + "off" time) x 100% — 50% ED

Maximum "on" time in seconds	15
Watts at 20°C	8
Ampere-Turns at 20°C	620

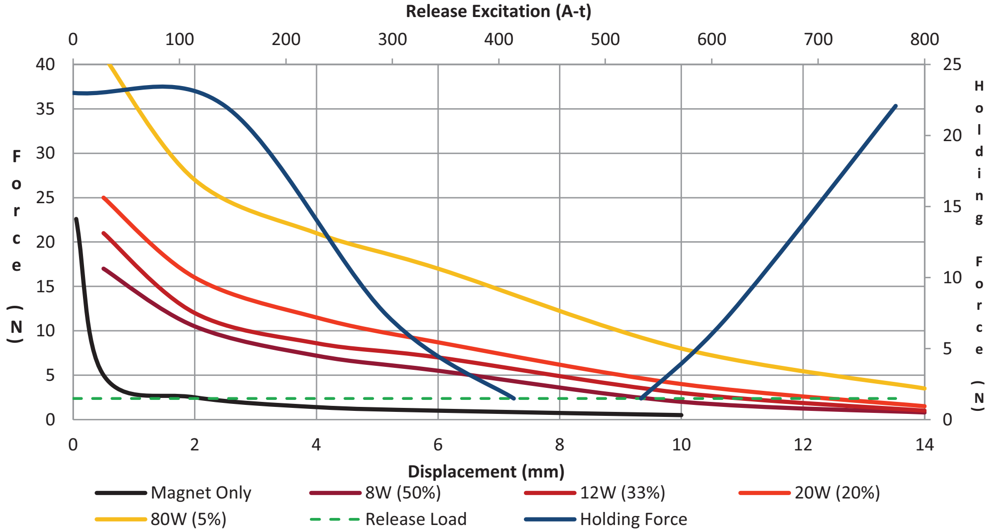
P/N	Resistance ±10% @ 20°C	Coil Turns	Volts DC	Release Current
T1L-1240-6v	4.5 Ω	450	6	1330 mA
T1L-1240-12v	18.0 Ω	920	12	670 mA
T1L-1240-24v	72.0 Ω	1900	24	330 mA

General Parameters

Life Expectancy (Cycles)	200,000
Mass	133 grammes
Plunger Mass	31.1 grammes
Leadwires 250mm (10")min, UL1007, AWG24	
Isolation Class	A (105°C)
Dielectric Strength 1000V AC, 50/60Hz, 1min	
Insulation Res >100MΩ, 500V DC Megger	



Force (N) vs Displacement (mm) & Release Characteristic

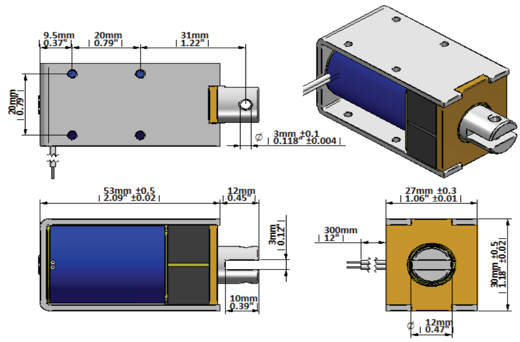


GEEPLUS T1L-1253-xxV

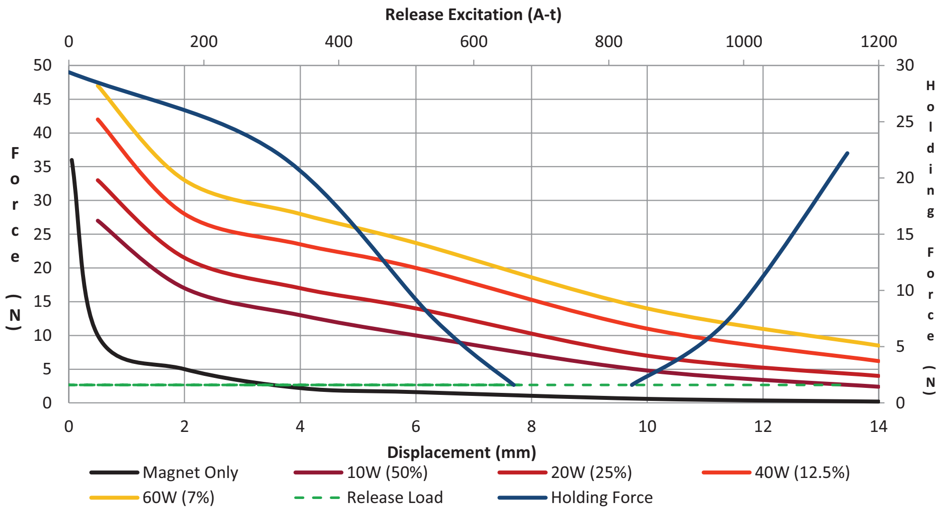
Coil Data				
	Duty Cycle = "on" time / ("on" time + "off" time) x 100%			50% ED
	Maximum "on" time in seconds			20
	Watts at 20°C			10
	Ampere-Turns at 20°C			840
P/N	**Resistance ±10% @ 20°C**	**Coil Turns**	**Volts DC**	**Release Current**
T1L-1253-6v	3.6 Ω	515	6	1670 mA
T1L-1253-12v	14.4 Ω	1020	12	830 mA
T1L-1253-24v	57.6 Ω	2050	24	420 mA

General Parameters

Life Expectancy (Cycles)	200,000
Mass	211 grammes
Plunger Mass	42.9 grammes
Leadwires 250mm (10")min, UL1007, AWG24	
Isolation Class	A (105°C)
Dielectric Strength 1000V AC, 50/60Hz, 1min	
Insulation Res >100MΩ, 500V DC Megger	



Force (N) vs Displacement (mm) & Release Characteristic



SH1LC-0524-xx

Coil Data

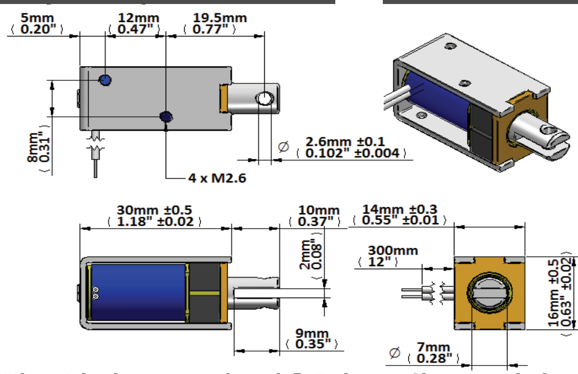
Duty Cycle = "on" time / ("on" time + "off" time) x 100%: 25% ED

Maximum "on" time in seconds	5
Watts at 20°C	8.4
Ampere-Turns at 20°C	452

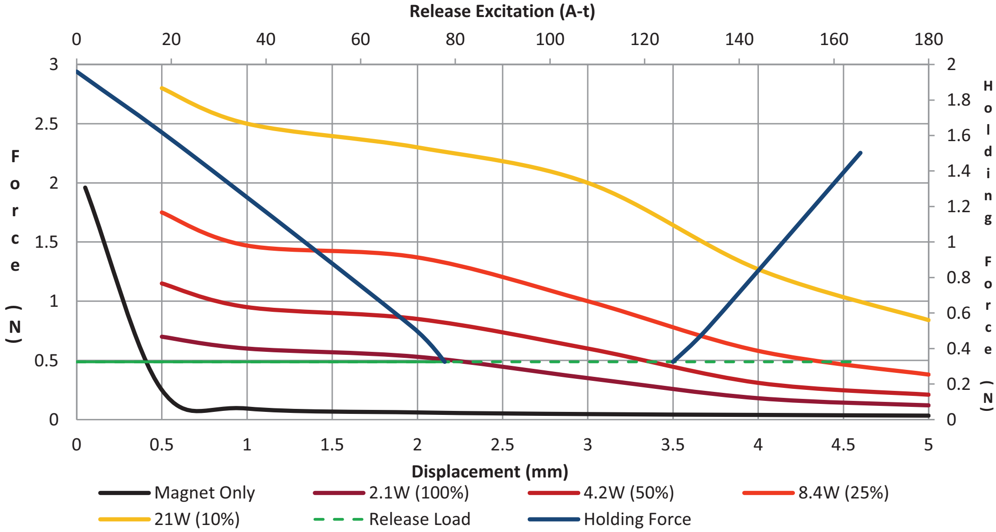
P/N	Resistance ±10% @ 20°C	Coil Turns	Volts DC	Release Current
SH1LC-0524-06	4.3 Ω	340	6	360 mA
SH1LC-0524-12	17.1 Ω	630	12	200 mA
SH1LC-0524-24	68.6 Ω	1260	24	100 mA

General Parameters

Life Expectancy (Cycles)	200,000
Mass	14.0 grammes
Plunger Mass	3.1 grammes
Leadwires 250mm (10")min, UL1007, AWG28	
Isolation Class	A (105°C)
Dielectric Strength 1000V AC, 50/60Hz, 1min	
Insulation Res >100MΩ, 500V DC Megger	



Force (N) vs Displacement (mm) & Release Characteristic



GEEPLUS SH1LF-0730-xx

Coil Data

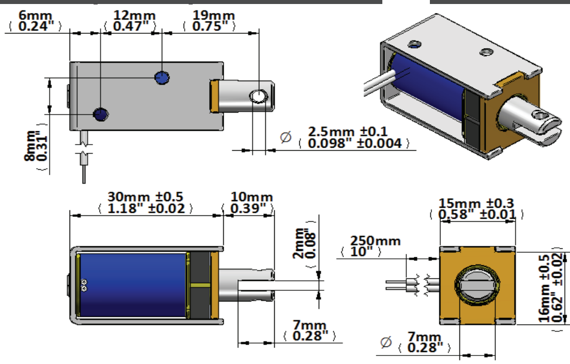
Duty Cycle = "on" time / ("on" time + "off" time) x 100%: 25% ED

Maximum "on" time in seconds	10
Watts at 20°C	9.6
Ampere-Turns at 20°C	614

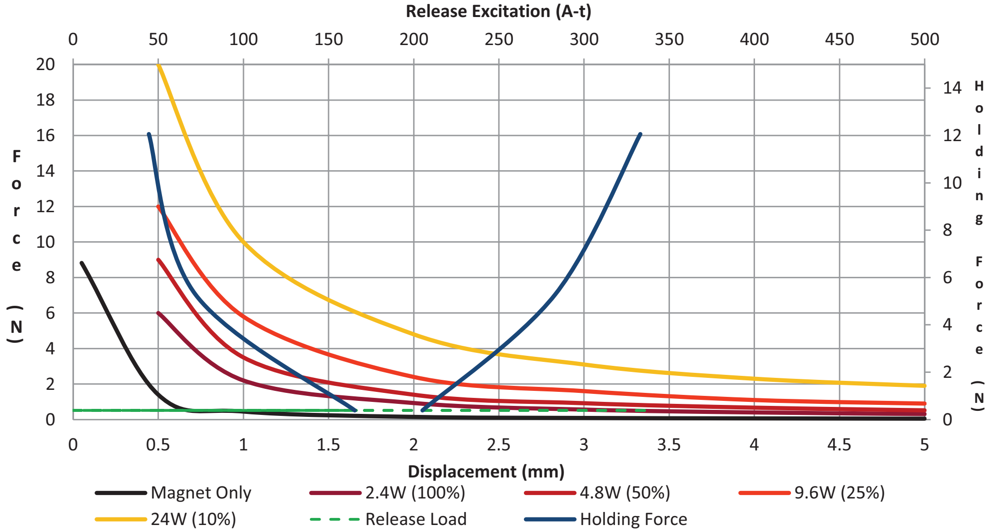
P/N	Resistance ±10% @ 20°C	Coil Turns	Volts DC	Release Current
SH1LF-0730-06	3.8 Ω	385	6	650 mA
SH1LF-0730-12	15.0 Ω	780	12	320 mA
SH1LF-0730-24	60.0 Ω	1530	24	160 mA

General Parameters

Life Expectancy (Cycles)	200,000
Mass	38.0 grammes
Plunger Mass	9.4 grammes
Leadwires 250mm (10")min, UL1007, AWG26	
Isolation Class	A (105°C)
Dielectric Strength 1000V AC, 50/60Hz, 1min	
Insulation Res >100MΩ, 500V DC Megger	



Force (N) vs Displacement (mm) & Release Characteristic



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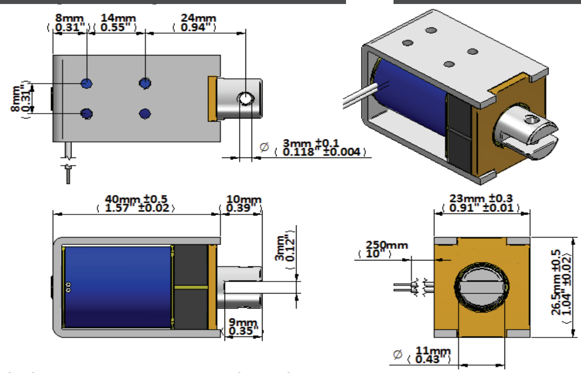
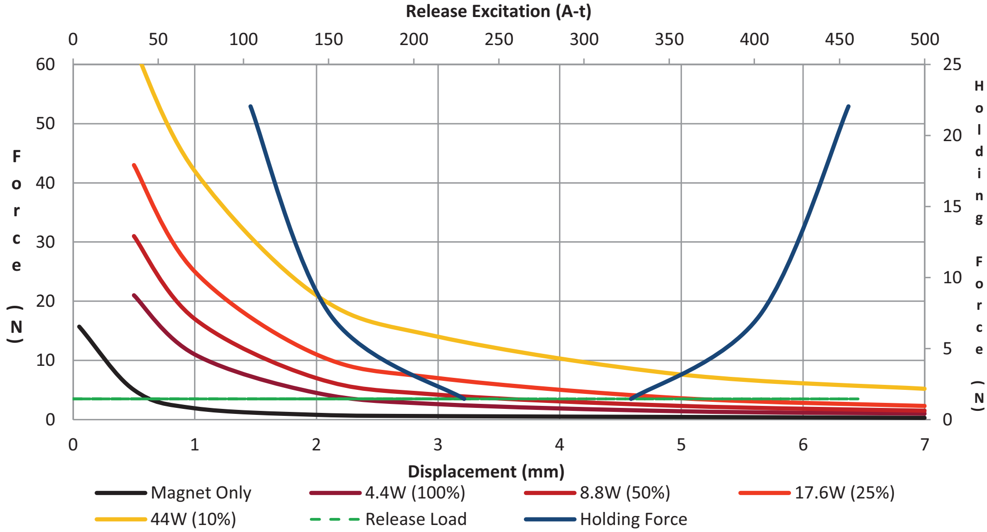
GEEPLUS SH1LF-1140-xx

Coil Data				
	Duty Cycle = "on" time / ("on" time + "off" time) x 100%			25% ED
	Maximum "on" time in seconds			20
	Watts at 20°C			17.6
	Ampere-Turns at 20°C			968
P/N	Resistance ±10% @ 20°C	Coil Turns	Volts DC	Release Current
SH1LF-1140-06	2.1 Ω	340	6	1060 mA
SH1LF-1140-12	8.2 Ω	640	12	560 mA
SH1LF-1140-24	32.7 Ω	1360	24	260 mA

General Parameters	
Life Expectancy (Cycles)	200,000
Mass	120 grammes
Plunger Mass	28 grammes
Leadwires 250mm (10")min, UL1007, AWG26	
Isolation Class	A (105°C)
Dielectric Strength 1000V AC, 50/60Hz, 1min	
Insulation Res >100MΩ, 500V DC Megger	



Force (N) vs Displacement (mm) & Release Characteristic



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GEEPLUS SH1LF-1240-xx

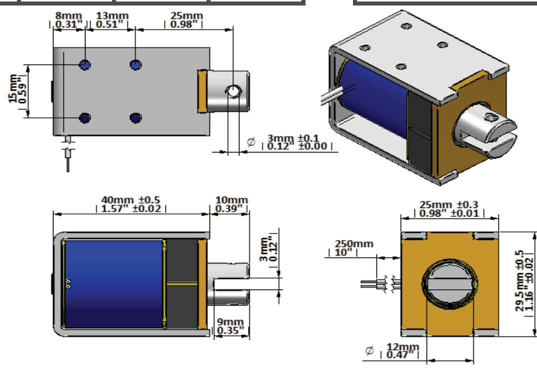
Coil Data

Duty Cycle = "on" time / ("on" time + "off" time) x 100%		25% ED
Maximum "on" time in seconds		20
Watts at 20°C		18.4
Ampere-Turns at 20°C		979

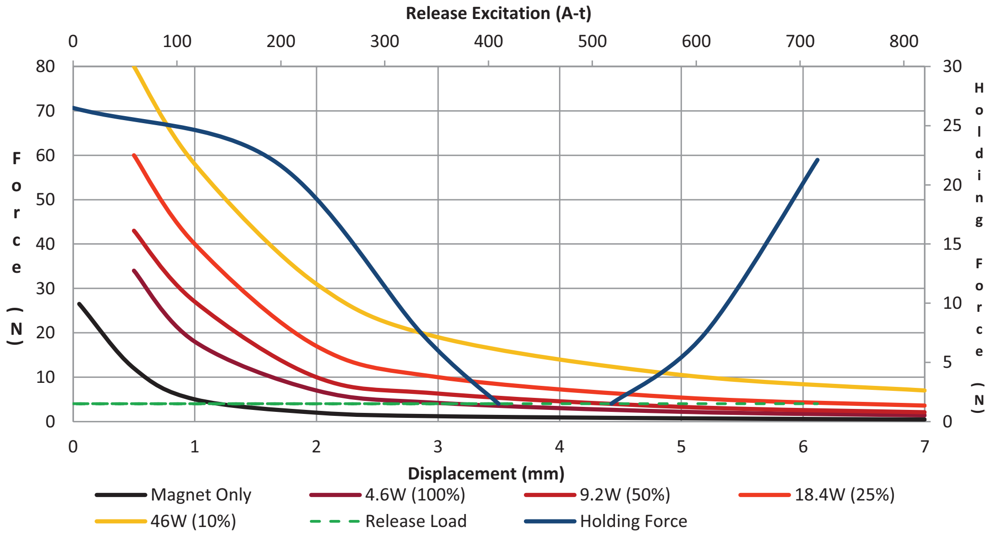
P/N	Resistance ±10% @ 20°C	Coil Turns	Volts DC	Release Current
SH1LF-1240-06	2.0 Ω	320	6	1620 mA
SH1LF-1240-12	7.8 Ω	630	12	820 mA
SH1LF-1240-24	31.3 Ω	1315	24	400 mA

General Parameters

Life Expectancy (Cycles)	200,000
Mass	145 grammes
Plunger Mass	34 grammes
Leadwires 250mm (10")min, UL1007, AWG24	
Isolation Class	A (105°C)
Dielectric Strength 1000V AC, 50/60Hz, 1min	
Insulation Res >100MΩ, 500V DC Megger	



Force (N) vs Displacement (mm) & Release Characteristic



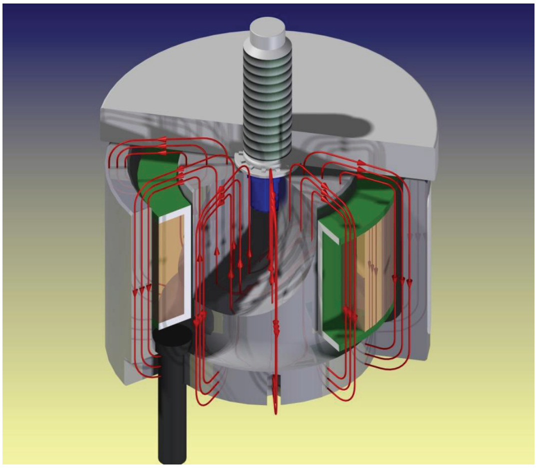
Electromagnets

Electromagnet

The electromagnet is a simple holding device, when energised it will attach itself to a flat steel surface with high force. When de-energised the attracting force is switched off. Related devices include the following:

- Holding magnets – employ a permanent magnet to attach to a flat ferromagnetic surface with high force
- HMER (Holding Magnet Electrical Release) – combines the function of holding and electromagnet to hold to a flat ferromagnetic surface with high force when no power is applied, and release from the surface when energised

Construction



The most common construction for electromagnets is illustrated, the device comprises of a steel pot core with a coil fitted in an annular groove in the face of the electromagnet, the coil is commonly potted in place for environmental protection and improved thermal contact with the pot.

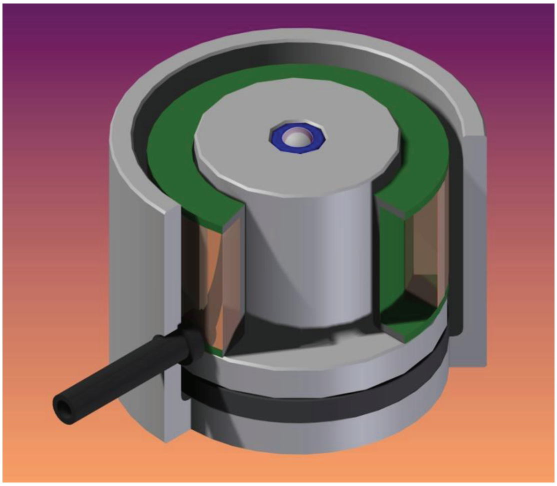
The armature plate shown on top of the device is an optional accessory, as is the ejector pin fitted in the centre of the part illustrated.

The electromagnet is not intended to act over an extended distance, very high force is developed when in direct contact with a flat steel component, this force will reduce rapidly as separation between the electromagnet and steel surface increases.

The surface of the mating component should be made as flat as possible, and should be kept free of contamination which may cause separation of the two parts and consequent reduction in holding force.

When de-energised, some residual magnetism may remain, in cases where this is problematic a spring-loaded ejector pin can be fitted to the device to separate this from the electromagnet when de-energised.

HMER – Holding Magnet Electrical Release



HMER devices incorporate a permanent magnet so that high holding force is developed to a flat ferromagnetic component without external power being applied. Power is applied to the device with reverse polarity to counter the field due to the permanent magnet and release the ‘keeper’ component.

Applications

Electromagnets find application as holding devices in machinery, as latching devices in security systems, and as door holdback devices in large buildings such as hospitals where doors are held open to permit easy access, but must be released to close if fire alarms are triggered, or in the case of power failure.

HMER devices are used in applications such as cash drawers, drug dispensing trolleys, or key boxes / safes in secure environments where a limited level of security is needed to trace use of materials or prevent misappropriation.

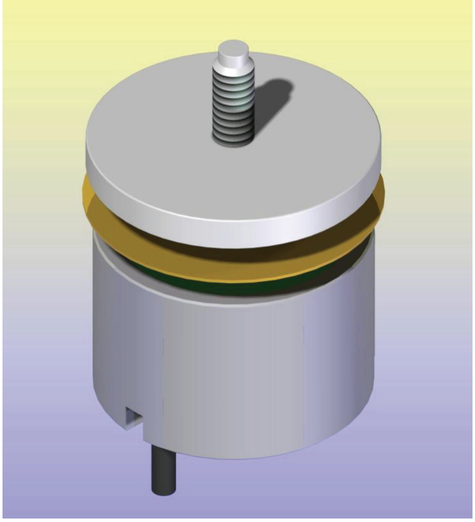
Due to the high forces and low power requirements, both constructions can find use as selection elements in applications where power is limited, or heat dissipation a problem such as shutter mechanisms, or selection mechanisms in textiles machinery.

In handling and installation, and in many of the applications where they are employed, the device can be subject to harsh treatment which can deform the surface and impair holding force. Geeplus electromagnets can be supplied with a hardened surface finish which makes them highly resistant to such damage, this will become standard for most such devices for future production.

Installation Precautions

It is important that the Electromagnet and/or armature plate have some compliance in mounting allowing them to align parallel and ensure forces act normal to the interface between them.

Testing



Electromagnets are tested with a shim of non-magnetic material inserted between holding face of the electromagnet and the armature (or a flat steel surface) to simulate a gap between the two. The electromagnet is energised, and increasing force applied until the two parts separate, the maximum force recorded is taken as the holding force. The influence of the gap represented by the shim is similar to that of dirt, paint, or contamination on either surface, or to separation caused by damage to the surface. The influence of any likely contamination and separation this could cause should be considered when evaluating data on parts, in environments where contamination causing separation is likely, it may be desirable to choose a larger device which can achieve the required force at a separation corresponding to that caused by expected contamination.

Data

For most parts data is shown for 3 different current levels. The current value shown for 100% ED operation is the (HOT) current value achieved once the internal coil temperature stabilises with rated voltage applied, at a temperature approximately 60°C above ambient temperature (worst case), corresponding to an absolute coil temperature of 80°C in an ambient temperature of 20°C. The excitation current, power consumption, and holding force will be higher in the cold condition. The current value shown as 200% ED corresponds to excitation with half as much power, and 400% ED corresponds to quarter as much power, and are included to give some indication of performance at these reduced power levels if this is necessary due to high ambient temperature, or low supply power conditions.

Modification

The following modifications are possible to electromagnets:

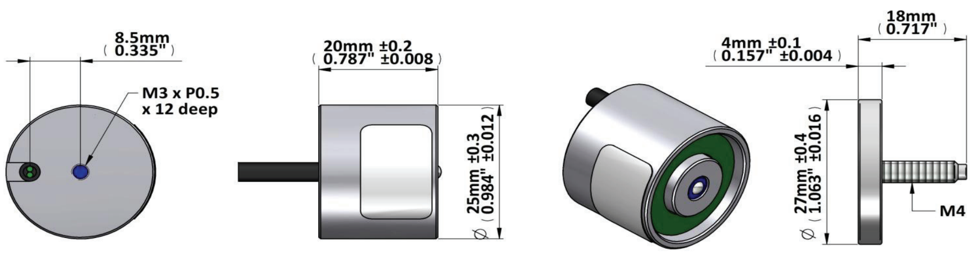
- High Force / Efficiency – by grinding the mating faces of both electromagnet pot, and of the armature plate used to a very fine finish, the effective airgap can be reduced, enabling higher force to be achieved for a given input power.

GEEPLUS EM0025 & AP27

General Specifications	
Insulation Class	Class A (105°C)
Insulation Resistance >50MΩ, 500V DC	
Dielectric Strength 500V AC, 50/60 Hz, 1 minute	

Mass
EM0025
60g
AP27
20g

Part Number	Coil Resistance	Voltage	Included Options
EM0025-12	56 Ω	12 V	
EM0025-24	220 Ω	24 V	
EME0025-12	56 Ω	12 V	Ejector Pin
EME0025-24	220 Ω	24 V	Ejector Pin



Holding Force Data

Separation (Airgap)	0.00 mm	0.05 mm	0.10 mm	0.20 mm	0.50 mm	1.00 mm
2.2W (100% ED)	110	105	40	14		
1.1W (200% ED)	85	77	18	6		
0.6W (400% ED)	80	51	5	3		

Holding force measured at 20°C to steel plate 8mm thick with surface Ra <1µm

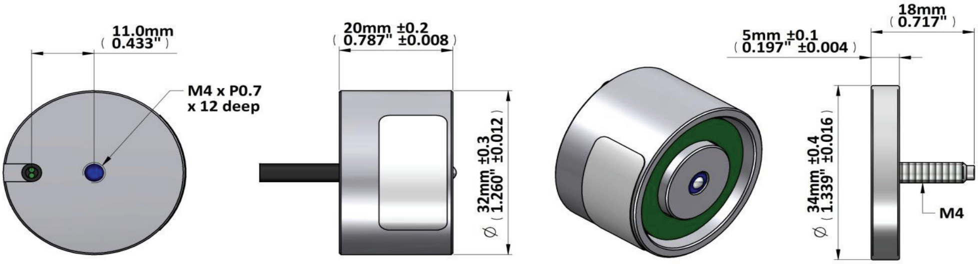
100% ED Power rating results in coil temperature rise of 65°C max with good heatsinking

Force exerted by ejector pin in fully compressed condition 5N

GEEPLUS EM0032 & AP34

General Specifications			Mass
Insulation Class	Class A (105°C)		EM0032
Insulation Resistance >50MΩ, 500V DC			95g
Dielectric Strength 500V AC, 50/60 Hz, 1 minute			AP34
			40g

Part Number	Coil Resistance	Voltage	Included Options
EM0032-12	48 Ω	12 V	
EM0032-24	190 Ω	24 V	
EME0032-12	48 Ω	12 V	Ejector Pin
EME0032-24	190 Ω	24 V	Ejector Pin



Holding Force Data

Separation (Airgap)	0.00 mm	0.05 mm	0.10 mm	0.20 mm	0.50 mm	1.00 mm
3W (100% ED)	170	115	97	33	2	0.8
1.5W (200% ED)	150	60	37	15		
0.75W (400% ED)	80	60	21	5		

Holding force measured at 20°C to steel plate 8mm thick with surface Ra <1µm

100% ED Power rating results in coil temperature rise of 65°C max with good heatsinking

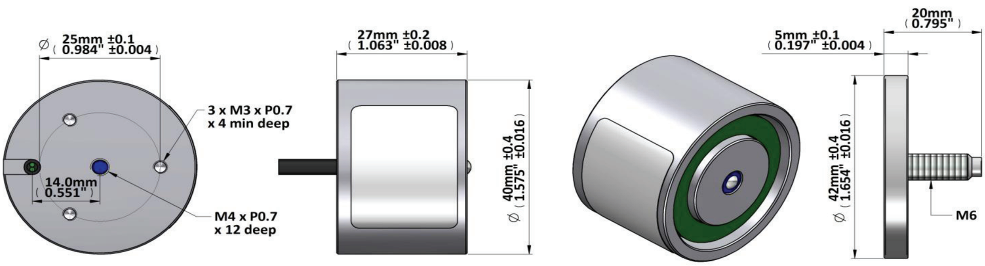
Force exerted by ejector pin in fully compressed condition 5N

GEEPLUS EM0040 & AP42

General Specifications	
Insulation Class	Class A (105^{o}C)
Insulation Resistance >50MΩ, 500V DC	
Dielectric Strength 500V AC, 50/60 Hz, 1 minute	

Mass
EM0040
220g
AP42
60g

Part Number	Coil Resistance	Voltage	Included Options
EM0040-12	34 Ω	12 V	
EM0040-24	135 Ω	24 V	
EME0040-12	34 Ω	12 V	Ejector Pin
EME0040-24	135 Ω	24 V	Ejector Pin



Holding Force Data

Separation (Airgap)	0.00 mm	0.05 mm	0.10 mm	0.20 mm	0.50 mm	1.00 mm
4.3W (100% ED)	440	350	168	101	17	5
2.15W (200% ED)	350	120	85	52	8	2
1.1W (400% ED)	280	90	85	16		

Holding force measured at 20^{o}C to steel plate 8mm thick with surface Ra <1µm
100% ED Power rating results in coil temperature rise of 65°C max with good heatsinking
Force exerted by ejector pin in fully compressed condition 7N

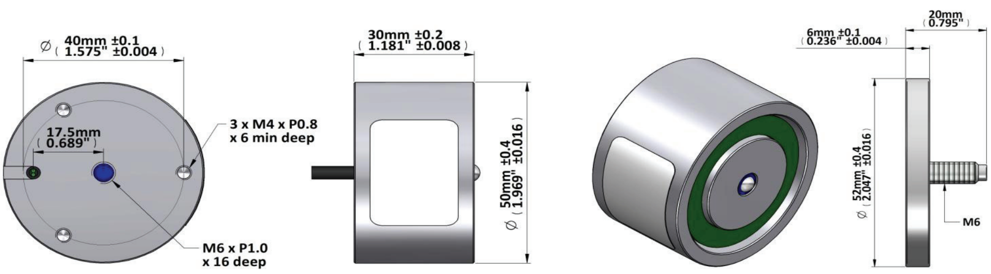
GEEPLUS EM0050 & AP52

General Specifications

Insulation Class	Class A (105^{o}C)
Insulation Resistance >50MΩ, 500V DC	
Dielectric Strength 500V AC, 50/60 Hz, 1 minute	

Mass
EM0050
0.38kg
AP52
0.11kg

Part Number	Coil Resistance	Voltage	Included Options
EM0050-12	32 Ω	12 V	
EM0050-24	130 Ω	24 V	
EME0050-12	32 Ω	12 V	Ejector Pin
EME0050-24	130 Ω	24 V	Ejector Pin



Holding Force Data

Separation (Airgap)	0.00 mm	0.05 mm	0.10 mm	0.20 mm	0.50 mm	1.00 mm
4.5W (100% ED)	875	800	435	170	20	7.7
2.25W (200% ED)	750	670	264	85	8	2.4
1.13W (400% ED)	630	420	84	54	3	

Holding force measured at 20^{o}C to steel plate 8mm thick with surface Ra <1µm
100% ED Power rating results in coil temperature rise of 65°C max with good heatsinking
Force exerted by ejector pin in fully compressed condition 10N

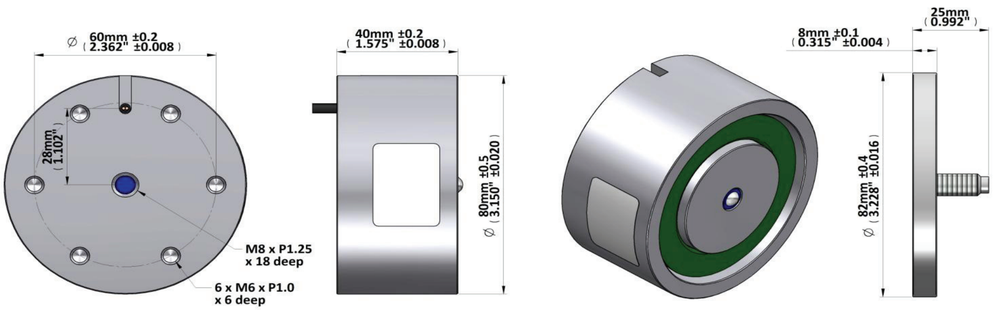
GEEPLUS EM0080 & AP82

General Specifications

Insulation Class	Class A (105°C)
Insulation Resistance >50MΩ, 500V DC	
Dielectric Strength 500V AC, 50/60 Hz, 1 minute	

Mass
EM0080
1.30kg
AP82
0.34kg

Part Number	Coil Resistance	Voltage	Included Options
EM0080-12	15 Ω	12 V	
EM0080-24	60 Ω	24 V	
EME0080-12	15 Ω	12 V	Ejector Pin
EME0080-24	60 Ω	24 V	Ejector Pin



Holding Force Data

Separation (Airgap)	0.00 mm	0.05 mm	0.10 mm	0.20 mm	0.50 mm	1.00 mm
9.5W (100% ED)	2400	2130	1640	1300	325	230
4.8W (200% ED)	2140	1780	1430	1000	240	108
2.4W (400% ED)	2000	1400	1030	550	85	29

Holding force measured at 20°C to steel plate 8mm thick with surface Ra <1µm

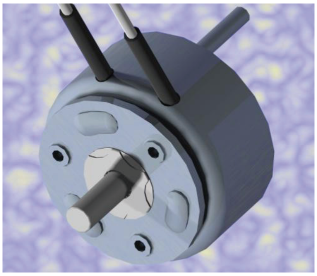
100% ED Power rating results in coil temperature rise of 65°C max with good heatsinking

Force exerted by ejector pin in fully compressed condition 13N

Rotary actuators

Selection Process for 3-Ball Rotary Solenoid

1. Metric (M prefix) and SAE (F prefix) screw thread options are available
2. The solenoid size is determined from consideration of required torque and effective duty cycle from graphs for the required angle of rotation. This may also be influenced by available power, for a given angle, a larger solenoid will develop the required torque with less electrical power than a smaller device
3. The coil requirements are determined from tables of coil gauge / duty cycle for the chosen size of device. Coil rating is specified as AWG size of the coil wire
4. The mechanical configuration options are chosen to suit the mounting and mechanical attachment of load to the solenoid in the application. These are illustrated later in this selection guide, along with a table which shows how the mechanical options, angle, and direction of rotation are translated into a 3-digit sequence in the solenoid part number. Direction of rotation is defined looking towards the armature plate as shown in attached drawing.

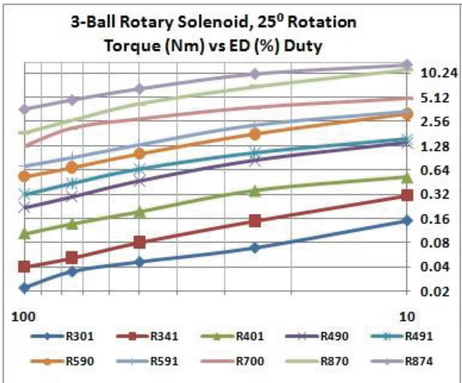


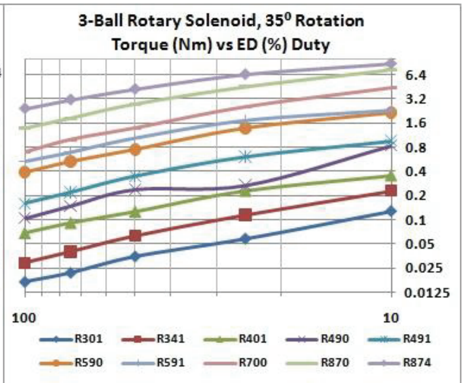
5. The life expectancy of the solenoid is specified by the suffix, R is standard life (2M-5M cycles), RE is extended (5M-10M cycles), RL is long life (20M-50M cycles). Life will be reduced by excessive side loading, particulate contamination, corrosive or otherwise aggressive environments. Life expectancy should be verified under real operating conditions in the customer application to ensure this is sufficient for purpose.

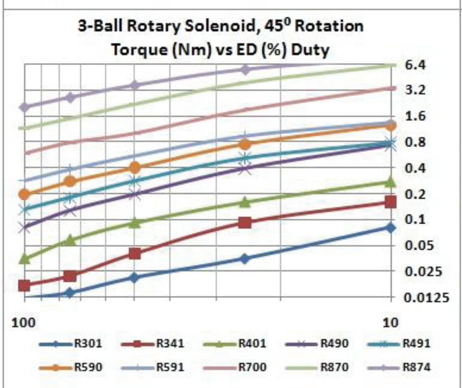
Part Number for 3-Ball Rotary Solenoids				
Example : **M491-28-282RE**				
Thread	**Size**	**Coil AWG**	**Options**	**Life**
M - Metric thread F - SAE thread	491	28	283	R - Standard Life RE - Extended Life RL - Long Life

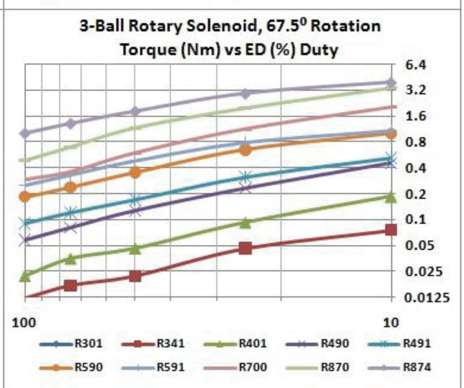
Size Determination

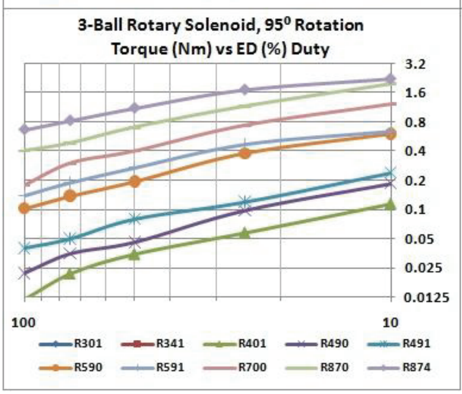
Device size is determined for the required torque and duty cycle from the tables below, torque is shown on the vertical axis vs ED on the horizontal











Specifying Coil AWG

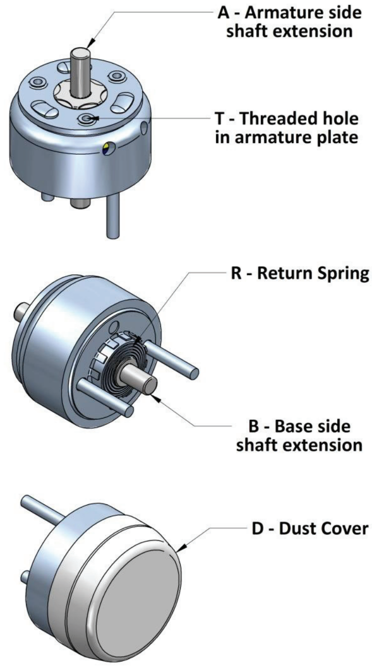
Duty Cycle			100%	50%	25%	10%
Maximum 'ON' time			∞	100	36	7
Watts at 20º C			7	14	28	70
ampere-turns at 20º C			425	602	849	1350
AWG no	Resistance	no. turns	Nominal Voltage			
26	1.96	231	3.5	5	7.1	11
27	3.16	296	4.5	6.3	8.9	14
28	5.1	378	5.6	8	11	18
29	6.94	423	7.1	10	14	22
30	11	530	8.9	13	18	28
31	16.9	649	11	16	22	36
32	28.3	858	14	20	28	45

- The coil AWG is determined from tables of coil data for the given part, in the column corresponding to chosen duty cycle, the voltage closest to user supply is picked, and coil AWG corresponding to this is indicated in the LH column (example shows selection for a part operated from 12v supply at 25% duty cycle)
  - In the example illustrated, the selection of a device having higher nominal voltage than the supply is conservative, for maximum torque and speed the 28AWG coil might be more appropriate (see also point below)
  - Allowance should be made for voltage drops in switching devices, and resistive drops in wiring harness when determining the nominal voltage which will be applied to the solenoid

Mechanical Configuration

- The direction of rotation of the solenoid is defined looking at the armature plate
- The standard accessories are shown in the adjacent drawing
- The dust-cover option is reccomended in any application where the solenoid is exposed to dust which can clog or cause abrasive wear to the inclined raceways. This precludes use of the T option

When you have selected mechanical options required, the last 3 numbers of solenoid P/N can be determined from the table below



Accessories	25º CW	35º CW*	45º CW	67.5º CW	95º CW	25º CCW	35º CCW	45º CCW	67.5º CCW	95º CCW
A	070	071	072	073	074	075	076	077	078	079
A,T	100	101	102	103	104	105	106	107	108	109
A,T,R	110	111	112	113	114	115	116	117	118	119
A,D	120	121	122	123	124	125	126	127	128	129
A,D,R	130	131	132	133	134	135	136	137	138	139
A,R	140	141	142	143	144	145	146	147	148	149
T	170	171	172	173	174	175	176	177	178	179
T,R	180	181	182	183	184	185	186	187	188	189
B	220	221	222	223	224	225	226	227	228	229
A,B	230	231	232	233	234	235	236	237	238	239
A,B,T	260	261	262	263	264	265	266	267	268	269
A,B,T,R	280	281	282	283	284	285	286	287	288	289
A,B.D	290	291	292	293	294	295	296	297	298	299
A,B,D,R	300	301	302	303	304	305	306	307	308	309
A,B,R	310	311	312	313	314	315	316	317	318	319
B,T	340	341	342	343	344	345	346	347	348	349
B,T,R	360	361	362	363	364	365	366	367	368	369
B,D	370	371	372	373	374	375	376	377	378	379
B,D,R	380	381	382	383	384	385	386	387	388	389
B,R	390	391	392	393	394	395	396	397	398	399

* 30º rotation in the case of the 191 solenoid

Thermal Considerations

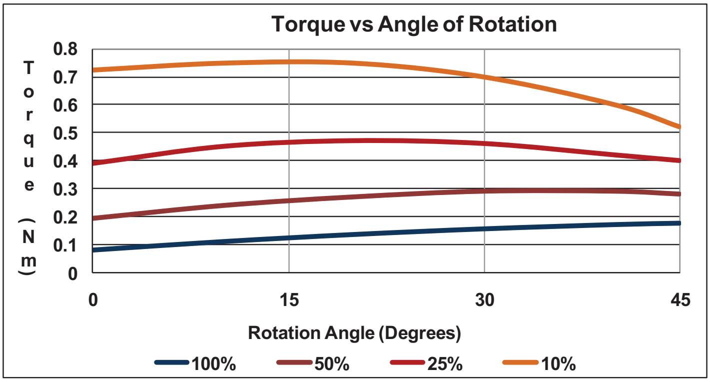
The coil data for rotary solenoids is based on performance at an ambient temperature of $20^{o}C$, with the solenoid mounted on a heatsink equivalent to that specified in data. When the solenoid is energised with voltage and duty cycle as specified in the data tables, the coil will reach thermal equilibrium with a coil temperature rise of $85^{o}C$ above ambient temperature. Standard materials will withstand operation at temperatures of up to $120^{o}C$. If ambient temperature or heatsinking conditions are other than indicated, it is advisable that coil temperature is measured under worst case operating conditions by measurement of coil resistance rise in the energised condition.

Starting Torque

Figures given for starting torque in the solenoid data are gross starting torque with the solenoid energised at $20^{o}C$. When a return spring is fitted, the net starting torque will be equal to the gross starting torque minus the spring torque.

Torque vs Angle Characteristic

The 3-Ball Rotary Solenoid develops rotary torque through mechanical conversion, magnetically the solenoid develops high linear pull-in force along the axis over a short displacement. The rotary torque is produced by 3 helical ball races between the case and armature plate of the solenoid. The inclination of the ball races is not constant, the interaction of this and the magnetic attraction produces a torque which is approximately constant with rotation angle at 25% ED, at 100%ED torque increases as angle increases, at 10%ED torque decreases as rotation angle increases, this is illustrated by the graph below and is typical of all sizes / angles.



Axial Displacement

A small axial displacement is associated with the rotation of the 3-Ball Rotary Solenoid. The axial displacement developed in different sizes is given in the table below. This is inherent to the design of the 3-Ball rotary solenoid and must be accommodated in the end application.

Axial Displacement of 3-Ball Rotary Solenoid								
Solenoid Size	**190**	**301**	**341**	**401**	**490,491**	**590,591**	**700**	**870,874**
Axial Displacement (mm)		0.7	0.9	1.2	1.5	1.6	2.3	2.6
Axial Displacement (")	0.00	0.03	0.04	0.05	0.06	0.06	0.09	0.10

Restricting the Angle of Rotation

If an application requires an operating angle intermediate to the standard options available, it is possible to limit the rotation angle of the solenoid with an external end-stop, however the following precautions must be observed:

- The external stop should be fitted to limit rotation in the energised direction
- The solenoid must be allowed to return fully to the de-energised position, end stops must not under any circumstances to limit rotation in both directions of rotation

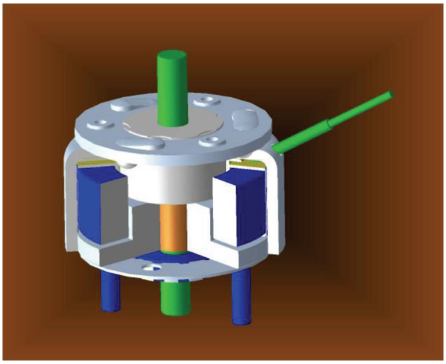
Failure to observe these precautions will result in accelerated failure and invalidates any warranty on the life expectancy of the solenoid.

Use of threaded (A) holes in the Armature Plate

Where the threaded holes in the armature plate are used to attach accessories to the solenoid, caution must be taken that screws are not too long, and do not protrude through the armature plate where they can inhibit linear travel and rotation of the solenoid.

Customisation of the 3-Ball Rotary Solenoid

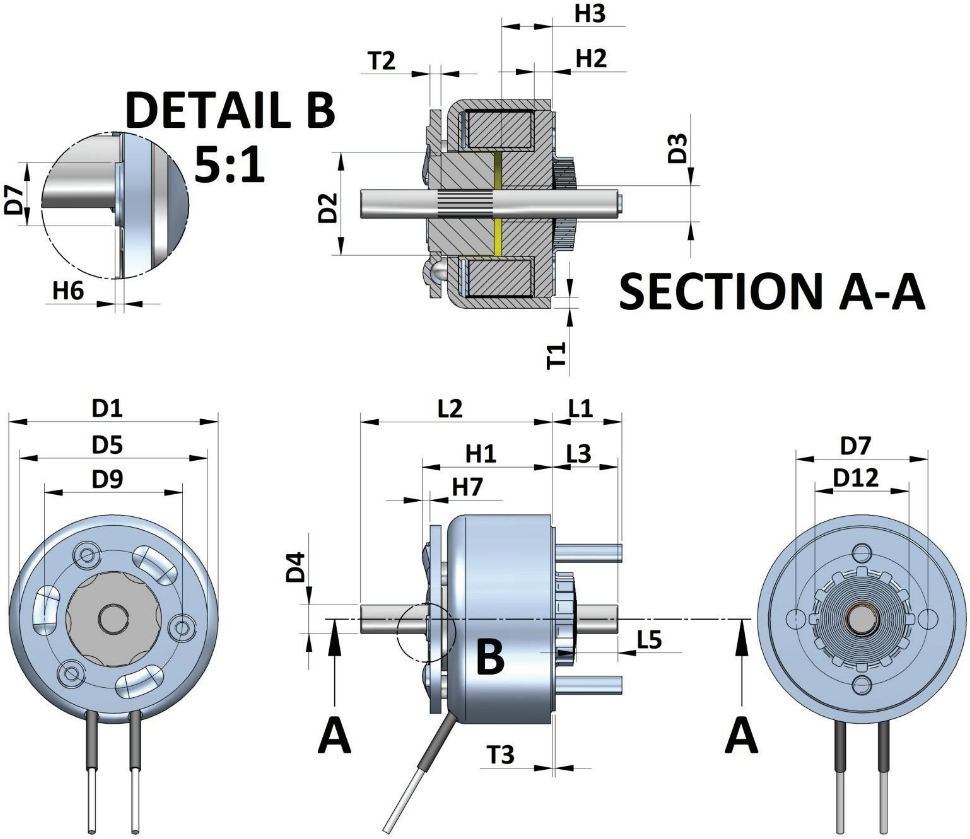
- The drawing indicates which components can be easily modified
    - Parts shown in green can be readily modified to customer requirement
    - Parts shown in Blue can be modified subject to selection from a range of available components limited by material size (eg length and thread size of mounting studs is constrained by standard sizes available)



- Modified Shaft – shaft modification is a common requirement, and is possible for qty >100pcs
    - Longer / shorter shaft
    - Flat (D-cut) on shaft
    - Cross-hole through shaft
    - External screw thread
    - Internal screw thread
    - Circlip (E-ring) grooves
    - Splines / knurling for press-fit to load
- Mounting Studs – longer or shorter mounting studs or other thread forms can be supplied subject to availability of suitable materials for qty >100pcs
- Coil Modification – the following are possible subject to confirmation
    - Higher or lower winding resistance
    - Double winding for pick & hold operation
    - High temperature windings up to 180^{o}C
- Return Spring – weaker or stronger return springs are available for qty >100pcs
- Different angle of rotation – this requires significant tooling modification, but may be possible on request for qty >5k-10k pcs
- Leadwires – longer or shorter leadwires can be offered for qty >100pcs
- Modified Armature plate – modification to the armature plate to add crank arms, tabs or other feature is possible for qty >5k-10k pcs
- Drive Pin – addition of drive pins to the armature plate for linkage to the load may be possible for qty >100pcs

Specifying Modifications

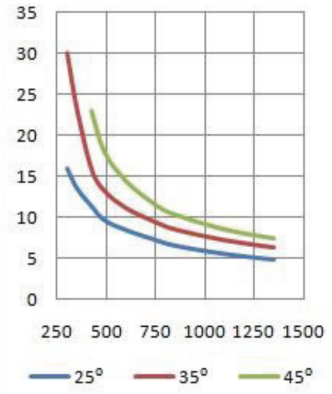
If requesting mechanical modifications to a rotary solenoid, it will be helpful if changes can be specified based on the drawing below. For normal tolerances on different parameters, please refer to tolerances for the standard part on which design is based.



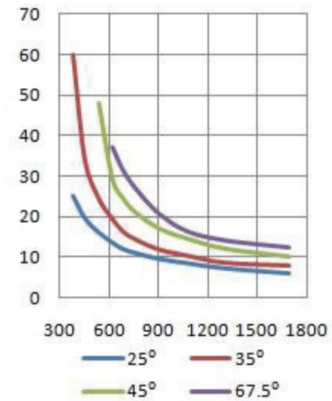
GEEPLUS

Rotary Solenoid Response Time

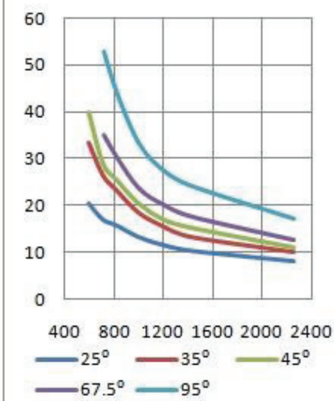
Size 301



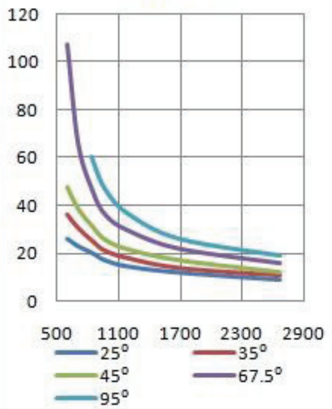
Size 341



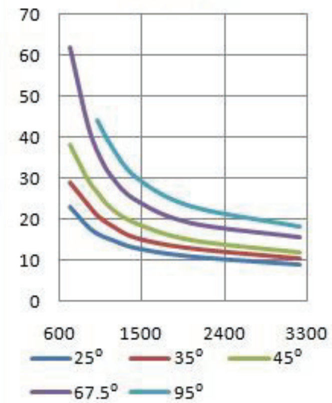
Size 401



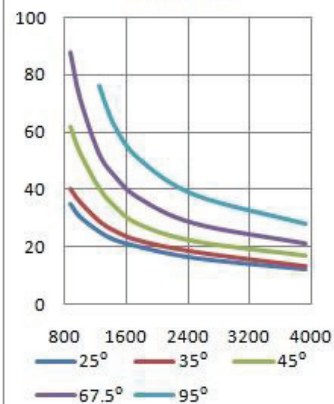
Size 490



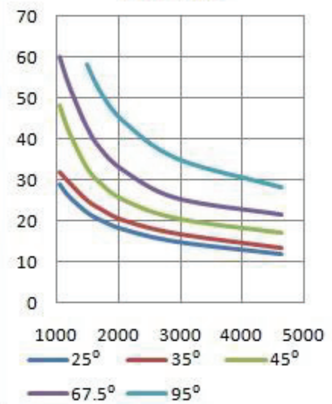
Size 491



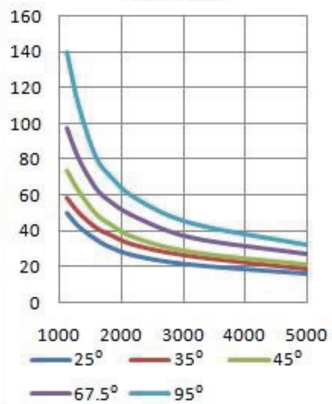
Size 590



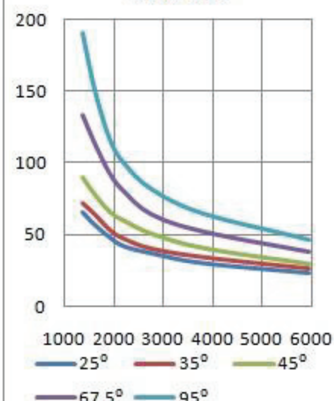
Size 591



Size 700



Size 870

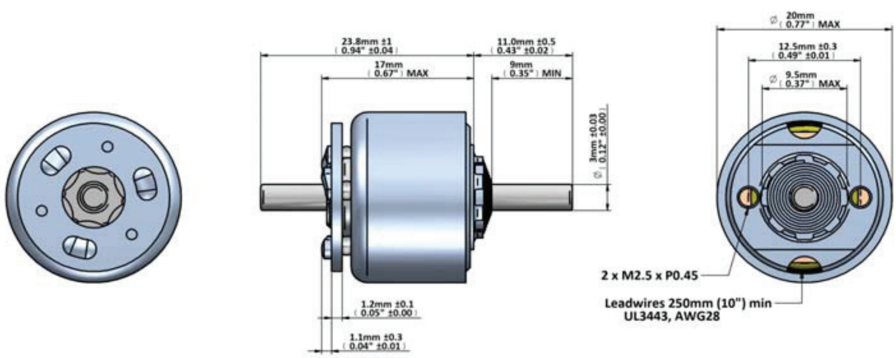


GEEPLUS Rotary Solenoid size 190

Device drawn in de-energised condition
Life Expectancy (cycles):
>2M (-R)

Available angle options:
30° (CW)
Mass 27 grammes

Note: the M190R rotary solenoid is only manufactured with a 30° rotation angl in mechanical options designated M190-xx-311R, M190-xx-231R & M190-xx-181R, where xx denotes nominal supply voltage at 25% duty cycle.



Data at 20°C , device connected to heatsink 60x60x3mm aluminum — return spring 2 ~ 4 mNm

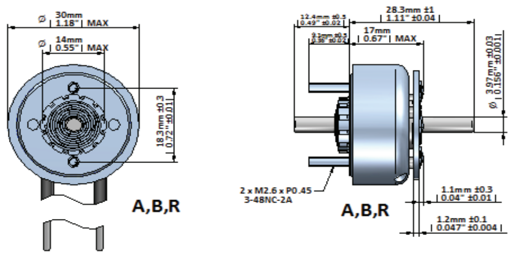
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	50% or less	25% or less	10% or less
Max. "on" time in seconds			-			
watts at 20°C			-	8	16	40
ampere-turns at 20°			-	382	540	854
Gross starting torque at 20°C (Nm)		30°	-	0.01	0.02	0.04
type no.	resistance Ω±10% (at 20°C)	number of turns	volts DC			
M190-6V-xxxR F190-6V-xxxR	2.3	210	-	4.2	6.0	9.5
M190-12V-xxxR F190-12V-xxxR	9.0	420	-	8.5	12	19
M190-24V-xxxR F190-24V-xxxR	36	800	-	17	24	38
M190-48V-xxxR F190-48V-xxxR	144	1600	-	34	48	76

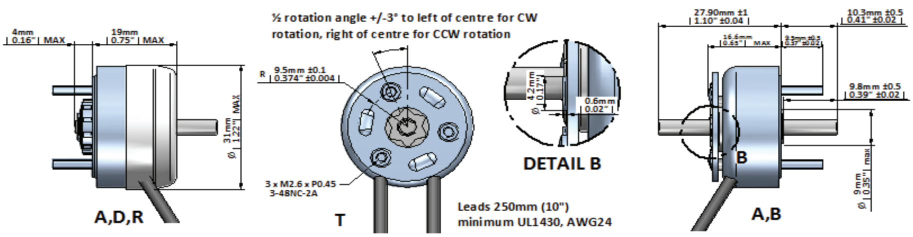
Insulation Resistance >100MΩ, 500VDC Megger — Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Rotary Solenoid size 301

Device drawn in de-energised condition Life Expectancy (cycles): >2M (-R), >10M (-RE), >50M (-RL)
Available mechanical options:
A: shaft extension(armature side)
B: shaft extension (base side)
D: dust cover over the armature

Available angle options:
25°, 35°, 45° (CW/CCW)
Mass 56 grammes





Data at 20°C , device connected to heatsink 90x90x3mm aluminum — return spring 5,5 ~ 9 mNm

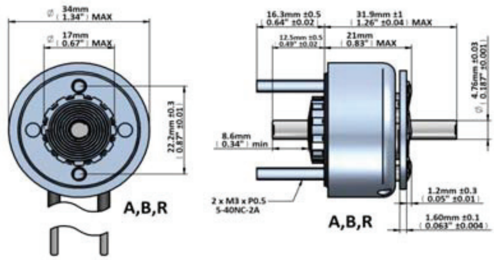
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	75% or less	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	105	100	36	7
watts at 20°C			7	9.3	14	28	70
ampere-turns at 20°			425	490	602	849	1350
Gross starting torque at 20°C (Nm)		25°	0.022	0.035	0.046	0.069	0.150
		35°	0.017	0.022	0.035	0.058	0.127
		45°	0.012	0.014	0.021	0.035	0.081
		67,5°	-	-	-	-	-
		95°	-	-	-	-	-
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC				
26	1.96	231	3.5	4.1	5.0	7.1	11
27	3.16	296	4.5	5.1	6.3	8.9	14
28	5.10	378	5.6	6.5	8.0	11	18
29	6.94	423	7.1	8.1	10	14	22
30	11.0	530	8.9	10	13	18	28
31	16.9	649	11	12	16	22	36
32	28.3	858	14	16	20	28	45
33	42.8	1036	18	20	25	35	56
34	69.6	1312	22	26	32	45	71
35	112	1674	28	32	39	56	89
36	148	1765	35	41	50	71	112
37	221	2090	35	51	63	89	142
38	352	2650	56	65	80	112	178
39	568	3380	71	81	100	141	224
40	882	4200	89	102	126	178	283

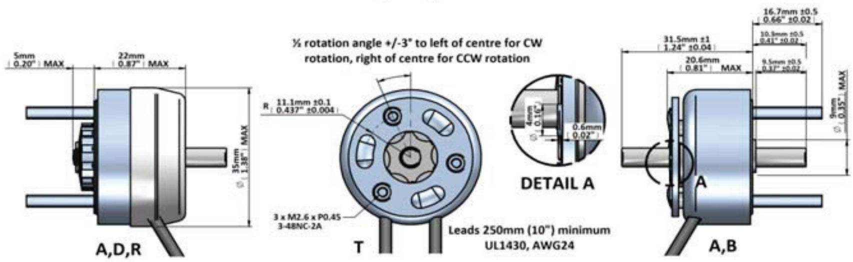
Insulation Resistance >100MΩ, 500VDC Megger — Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Rotary Solenoid size 341

Device drawn in de-energised condition
Life Expectancy (cycles): >2M (-R), >10M (-RE), >50M (-RL)
Available mechanical options:
A: shaft extension(armature side)
B: shaft extension (base side)
D: dust cover over the armature
R: return spring
T: tapped holes in armature plate

Available angle options:
25°, 35°, 45°, 67,5° (CW/CCW)
Mass 97 grammes





Data at 20°C , device connected to heatsink 120x120x3mm aluminum   return spring 11 ~ 17 mNm

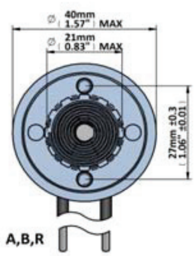
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	75% or less	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	107	100	36	8
watts at 20°C			9	12	18	36	90
ampere-turns at 20°			535	618	756	1070	1690
Gross starting torque at 20°C (Nm)		25°	0.040	0.052	0.081	0.150	0.310
		35°	0.029	0.040	0.063	0.115	0.230
		45°	0.017	0.022	0.040	0.092	0.16
		67,5°	0.012	0.017	0.022	0.046	0.075
		95°	-	-	-	-	-
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC				
25	1.97	252	4.2	4.8	5.9	8.4	13
26	3.26	328	5.3	6.1	7.5	11.0	17.0
27	5.04	405	6.7	7.7	9.4	13.0	21.0
28	8.02	510	8.4	9.7	12.0	17	26
29	12.21	627	10	12	15	21	33
30	19.2	780	13	15	19	26	42
31	31.8	1008	17	19	24	33	53
32	47.0	1215	21	24	30	42	66
33	75.3	1530	26	31	37	53	84
34	120.5	1900	33	38	40	67	105
35	198	2486	42	48	59	84	133
36	280	2700	53	61	75	106	167
37	426	3350	67	77	94	133	210
38	648	4050	84	97	118	168	264
39	1020	5050	105	122	149	211	333
40	1667	6590	133	153	187	265	419

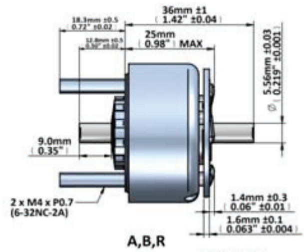
Insulation Resistance >100MΩ, 500VDC Megger   Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

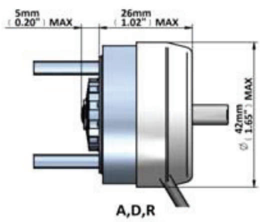
GEEPLUS Rotary Solenoid size 401

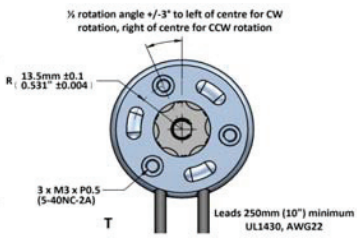
Device drawn in de-energised condition
Life Expectancy (cycles): >2M (-R), >10M (-RE), >50M (-RL)
Available mechanical options:
A: shaft extension(armature side)
B: shaft extension (base side)
D: dust cover over the armature
R: return spring
T: tapped holes in armature plate

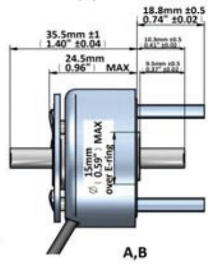
Available angle options:
25°, 35°, 45°, 67,5°, 95° (CW/CCW)
Mass 200 grammes











Data at 20°C , device connected to heatsink 160x160x3mm aluminum — return spring 16,5 ~ 24 mNm

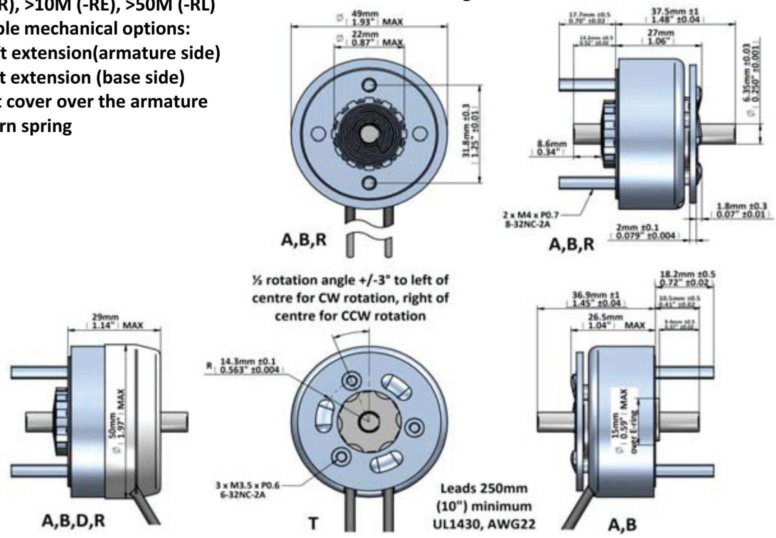
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	75% or less	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	108	100	36	9
watts at 20°C			12.5	16.5	25	50	125
ampere-turns at 20°			714	825	1000	1425	2250
Gross starting torque at 20°C (Nm)		25°	0.104	0.138	0.195	0.355	0.520
		35°	0.069	0.092	0.127	0.230	0.355
		45°	0.035	0.058	0.092	0.160	0.276
		67,5°	0.022	0.035	0.046	0.092	0.185
		95°	0.012	0.022	0.035	0.058	0.115
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC				
25	3.50	384	6.6	7.8	9.5	13	21
26	5.67	486	8.4	9.7	12	17	27
27	8.76	600	11	13	16	22	35
28	13.8	748	13	15	18	26	42
29	22.6	975	17	19	23	33	52
30	34.8	1190	21	25	30	42	67
31	56.7	1520	27	31	38	54	85
32	88.3	1908	35	41	49	70	110
33	138	2360	43	50	60	86	138
34	216	2904	53	61	75	106	168
35	351	3725	67	78	95	132	213
36	480	4000	85	98	119	169	268
37	720	9450	105	121	147	210	332
38	1150	6200	132	153	185	264	-
39	1920	8350	166	191	232	332	-
40	3000	10000	210	250	300	-	-

Insulation Resistance >100MΩ, 500VDC Megger — Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Rotary Solenoid size 490

Device drawn in de-energised condition Life Expectancy (cycles): >2M (-R), >10M (-RE), >50M (-RL)
Available mechanical options:
A: shaft extension(armature side)
B: shaft extension (base side)
D: dust cover over the armature
R: return spring

Available angle options:
25°, 35°, 45°, 67,5°, 95° (CW/CCW)
Mass 250 grammes



Data at 20°C , device connected to heatsink 190x190x3mm aluminum   return spring 26 ~ 35 mNm

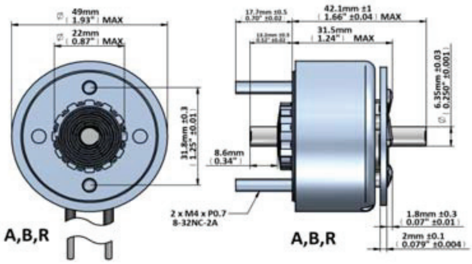
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	75% or less	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	110	100	36	10
watts at 20°C			21	28	42	84	210
ampere-turns at 20°			842	966	1190	1685	2660
Gross starting torque at 20°C (Nm)		25°	0.220	0.3	0.47	0.84	1.39
		35°	0.104	0.15	0.24	0.47	0.84
		45°	0.081	0.127	0.195	0.390	0.725
		67,5°	0.058	0.081	0.127	0.230	0.450
		95°	0.022	0.035	0.046	0.098	0.185
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC				
24	3.20	360	7.6	8.7	11	15	24
25	4.91	440	9.5	11	13	19	30
26	7.72	550	12	14	17	24	38
27	11.1	636	15	17	21	30	48
28	18.8	840	19	22	27	38	60
29	30.5	1088	24	28	34	48	76
30	44.9	1275	30	34	43	60	95
31	70.9	1596	38	43	54	76	120
32	109	1974	48	56	67	95	150
33	175	2496	60	69	85	120	190
34	270	3042	76	87	107	151	239
35	414	3600	95	109	134	190	301
36	610	4200	122	140	173	245	386
37	940	5200	151	174	213	301	-
38	1560	6820	190	219	268	379	-

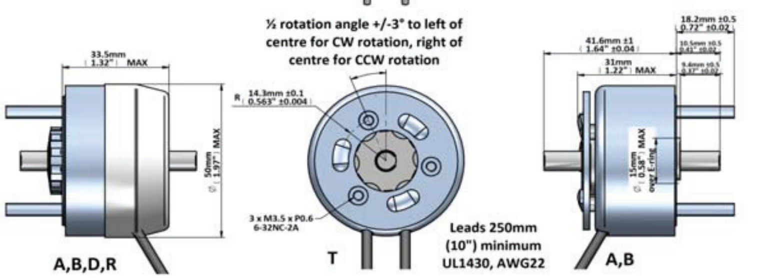
Insulation Resistance >100MΩ, 500VDC Megger   Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Rotary Solenoid size 491

Device drawn in de-energised condition
Life Expectancy (cycles): >2M (-R), >10M (-RE), >50M (-RL)
Available mechanical options:
A: shaft extension(armature side)
B: shaft extension (base side)
D: dust cover over the armature
R: return spring
T: tapped holes in armature plate

Available angle options:
25°, 35°, 45°, 67,5°, 95° (CW/CCW)
Mass 330 grammes





Data at 20°C , device connected to heatsink 190x190x3mm aluminum | return spring 26 ~ 35 mNm

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	75% or less	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	110	100	36	10
watts at 20°C			21	28	42	84	210
ampere-turns at 20°			1015	1172	1440	2030	3210
Gross starting torque at 20°C (Nm)		**25°**	0.32	0.44	0.66	1.04	1.54
		35°	0.16	0.22	0.35	0.61	0.96
		45°	0.13	0.18	0.28	0.52	0.79
		67,5°	0.09	0.12	0.17	0.31	0.52
		95°	0.04	0.05	0.08	0.12	0.24
AWG no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**				
21	1.00	228	4.5	5.2	6.4	8.9	14.1
22	1.68	301	5.7	6.6	8.1	11.4	17.9
23	2.70	384	7.2	8.3	10.1	14.3	23
24	4.30	486	9.0	10.4	12.7	18	28
25	6.66	590	11.5	13.2	16.2	23	36
26	10.3	737	14.0	16.1	20	28	44
27	15.7	900	17.7	20.4	25	35	56
28	26.6	1190	23	27	32	45	72
29	38.0	1380	28	32	40	56	89
30	62.1	1768	36	41	51	71	113
31	96.1	2166	45	52	64	90	143
32	157	2816	57	66	80	113	179
33	241	3432	71	82	101	143	226
34	364	4108	90	104	128	180	285
35	566	4920	117	136	166	234	370
36	910	6340	146	168	207	292	462
37	1224	6800	183	211	260	366	-

Insulation Resistance >100MΩ, 500VDC Megger | Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

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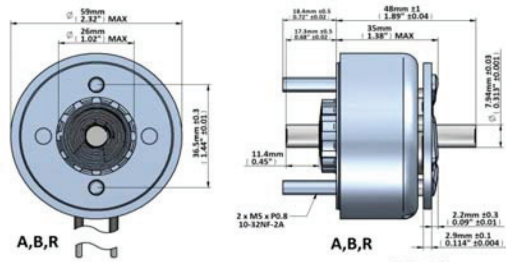
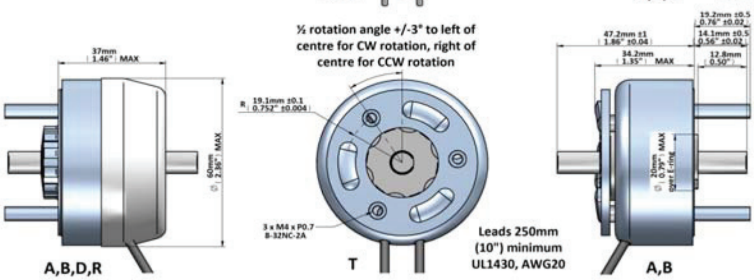
GEEPLUS Rotary Solenoid size 590

Device drawn in de-energised condition
Life Expectancy (cycles): >2M (-R), >10M (-RE), >50M (-RL)
Available mechanical options:
A: shaft extension(armature side)
B: shaft extension (base side)
D: dust cover over the armature
R: return spring

Available angle options:
25°, 35°, 45°, 67,5°, 95° (CW/CCW)
Mass 506 grammes





Data at 20°C , device connected to heatsink 310x310x3mm aluminum return spring 45 ~ 65 mNm

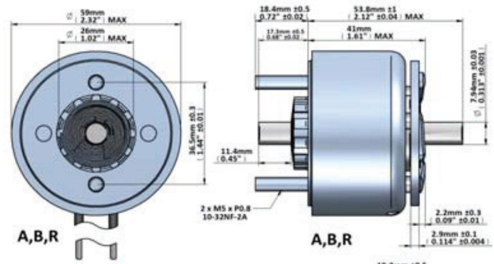
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	75% or less	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	115	87	36	13
watts at 20°C			29	38.5	58	116	290
ampere-turns at 20°			1240	1440	1760	2490	3920
Gross starting torque at 20°C (Nm)		**25°**	0.53	0.69	1.02	1.8	3.2
		35°	0.39	0.53	0.75	1.38	2.14
		45°	0.195	0.276	0.40	0.75	1.26
		67,5°	0.184	0.240	0.355	0.65	1.00
		95°	0.103	0.138	0.195	0.38	0.60
AWG no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**				
22	2.23	336	8.3	9.6	12	16	26
23	3.60	432	10	12	15	21	33
24	5.24	500	13	15	18	26	41
25	9.51	708	16	19	23	33	52
26	14.4	858	21	24	29	41	66
27	23.7	1110	26	30	37	52	83
28	38.2	1411	33	38	47	66	104
29	54.7	1638	41	48	59	83	131
30	93.7	2184	52	61	74	104	165
31	143	2645	66	76	93	131	207
32	223	3328	83	96	117	165	261
33	338	4004	104	121	147	208	329
34	550	5088	131	152	185	262	-
35	790	5860	165	192	233	330	-
36	1233	7260	208	242	294	-	-

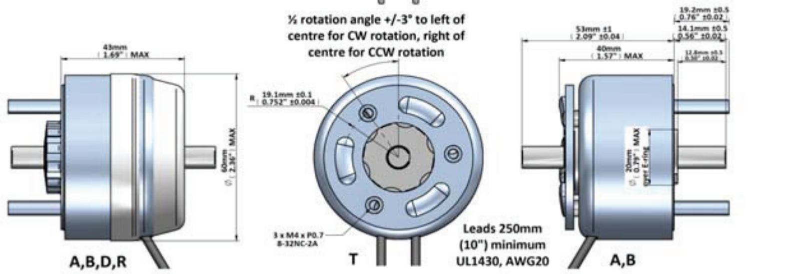
Insulation Resistance >100MΩ, 500VDC Megger Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Rotary Solenoid size 591

Device drawn in de-energised condition
Life Expectancy (cycles): >2M (-R), >10M (-RE), >50M (-RL)
Available mechanical options:
A: shaft extension(armature side)
B: shaft extension (base side)
D: dust cover over the armature
R: return spring
T: tapped holes in armature plate

Available angle options:
25°, 35°, 45°, 67,5°, 95° (CW/CCW)
Mass 615 grammes





Data at 20°C , device connected to heatsink 310x310x3mm aluminum — return spring 45 ~ 65 mNm

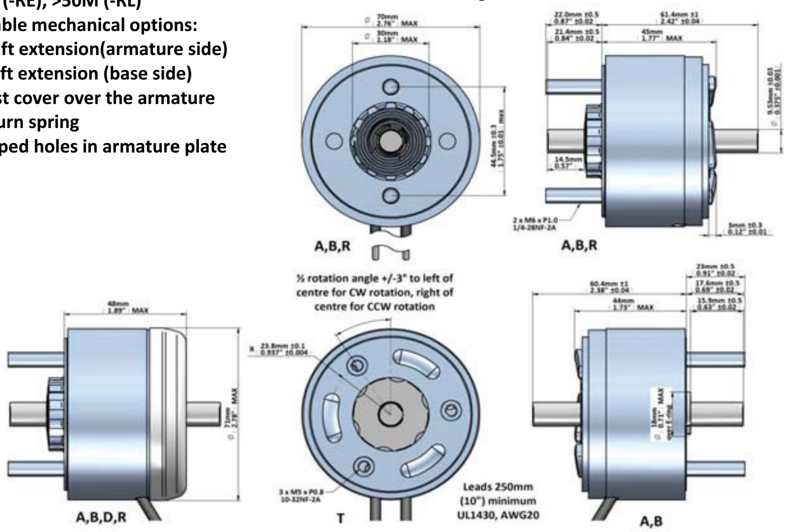
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	75% or less	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	95	87	36	13
watts at 20°C			32	43	64	128	320
ampere-turns at 20°			1480	1710	2080	2940	4620
Gross starting torque at 20°C (Nm)		25°	0.72	0.92	1.33	2.33	3.45
		35°	0.53	0.69	1.03	1.70	2.27
		45°	0.28	0.38	0.55	0.94	1.36
		67,5°	0.25	0.33	0.48	0.78	1.07
		95°	0.14	0.19	0.27	0.47	0.64
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC				
20	1.23	295	6.2	7.1	8.7	12.3	19.3
21	1.75	340	7.6	8.8	10.7	15.1	24
22	2.79	446	9.3	10.7	13.0	18.4	29
23	4.54	567	11.9	13.7	16.7	24	37
24	6.93	690	14.9	17.2	21	30	46
25	12.5	910	20	24	29	40	63
26	18.4	1120	24	28	34	48	76
27	33.4	1500	33	38	46	65	103
28	36.4	1750	39	45	55	78	122
29	74.5	2232	49	57	69	98	154
30	125.5	2940	63	73	89	126	197
31	199	3611	82	94	115	162	255
32	302	4350	103	119	144	204	321
33	417	5010	123	142	173	245	385

Insulation Resistance >100MΩ, 500VDC Megger — Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Rotary Solenoid size 700

Device drawn in de-energised condition
Life Expectancy (cycles): >2M (-R), >10M (-RE), >50M (-RL)
Available mechanical options:
A: shaft extension(armature side)
B: shaft extension (base side)
D: dust cover over the armature
R: return spring
T: tapped holes in armature plate

Available angle options:
25°, 35°, 45°, 67,5°, 95° (CW/CCW)
Mass 1013 grammes



Data at 20°C , device connected to heatsink 390x390x3mm aluminum — return spring 75 ~ 105 mNm

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	75% or less	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	112	80	37	16
watts at 20°C			35	46.5	70	140	350
ampere-turns at 20°			1570	1800	2230	3150	5000
Gross starting torque at 20°C (Nm)		25°	1.27	2.12	2.74	3.8	4.9
		35°	0.69	0.99	1.38	2.53	4.37
		45°	0.58	0.78	1.0	1.88	3.42
		67,5°	0.288	0.355	0.59	1.12	2.01
		95°	0.178	0.3	0.4	0.735	1.21
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC				
20	1.88	368	8	9.3	11	16	26
21	3.01	468	10	11	14	20	32
22	4.82	580	13	15	18	26	41
23	8.1	780	16	19	23	33	52
24	12.3	949	20	23	29	41	65
25	19	1148	26	30	37	52	83
26	30.8	1472	33	38	46	66	105
27	48.8	1854	41	47	59	83	132
28	81.1	2436	52	60	75	105	166
29	121	2944	64	74	92	130	206
30	190	3650	82	94	118	166	264
31	275	4175	104	119	147	209	331
32	440	5792	119	137	170	240	-
33	735	7000	165	191	235	331	-
34	995	7600	204	239	288	-	-

Dielectric Strength 1000VAC, 50/60Hz, 1 minute

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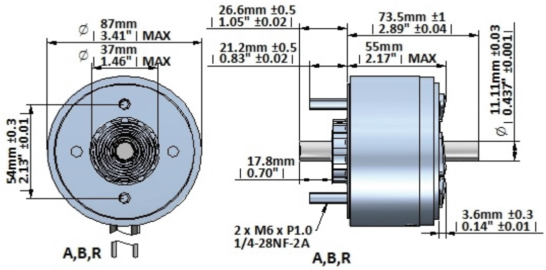
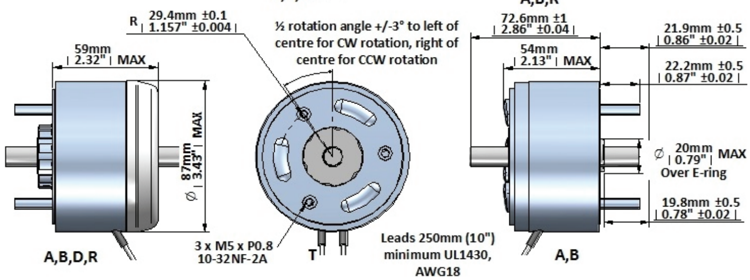
GEEPLUS Rotary Solenoid size 870

Device drawn in de-energised condition
Life Expectancy (cycles): >2M (-R), >10M (-RE), >50M (-RL)
Available mechanical options:
A: shaft extension(armature side)
B: shaft extension (base side)
D: dust cover over the armature
R: return spring

Available angle options:
25°, 35°, 45°, 67,5°, 95° (CW/CCW)
Mass 1885 grammes





Data at 20°C , device connected to heatsink 520x520x3mm aluminum — return spring 90 ~ 140 mNm

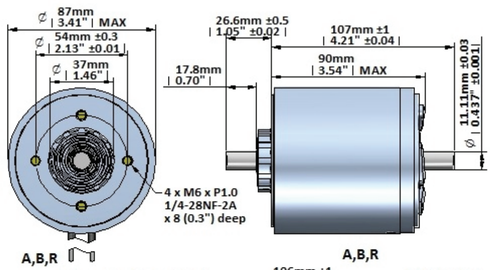
duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	75% or less	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	85	72	43	20
watts at 20°C			41	54.5	82	164	410
ampere-turns at 20°			1910	2190	2750	3810	5950
Gross starting torque at 20°C (Nm)		**25°**	1.84	2.65	4.25	6.9	11.300
		35°	1.38	1.84	2.76	4.5	7.35
		45°	1.15	1.5	2.2	3.9	6.2
		67,5°	0.48	0.69	1.15	1.95	3.34
		95°	0.4	0.48	0.7	1.15	1.95
AWG no.	**resistance Ω±10% (at 20°C)**	**number of turns**	**volts DC**				
18	1.47	368	7.6	8.7	11	15.0	24.0
19	2.3	459	9.6	11	14	19.0	30.0
20	3.64	580	12	14	17.0	24.0	37.0
21	5.57	704	15	17	22	30	47
22	9.5	936	19	22	28	39	30
23	14.3	1134	24	28	35	48	75
24	23.3	1456	30	35	44	61	95
25	37.1	1836	39	44	56	77	120
26	58.6	2300	49	56	70	97	152
27	89.8	2816	61	70	88	121	189
28	139	3456	76	88	111	153	239
29	227	4480	98	111	138	193	300
30	376	5792	124	143	177	248	387
31	515	6600	148	170	212	297	-
32	785	7850	188	220	275	385	-
33	1130	9050	237	271	339	-	-

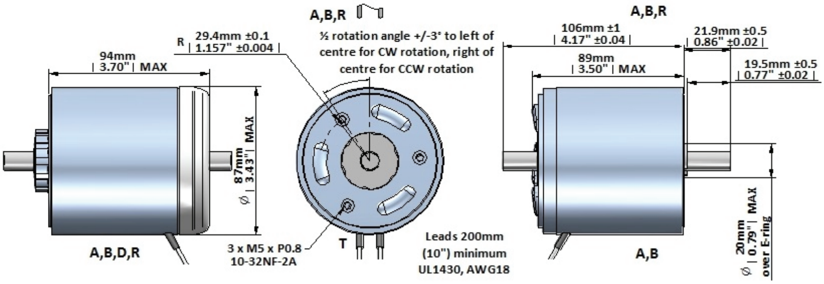
Insulation Resistance >100MΩ, 500VDC Megger — Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

GEEPLUS Rotary Solenoid size 874

Device drawn in de-energised condition
Life Expectancy (cycles): >2M (-R), >10M (-RE), >50M (-RL)
Available mechanical options:
A: shaft extension(armature side)
B: shaft extension (base side)
D: dust cover over the armature
R: return spring
T: tapped holes in armature plate

Available angle options:
25°, 35°, 45°, 67,5°, 95° (CW/CCW)
Mass 3056 grammes





Data at 20°C , device connected to heatsink 520x520x3mm aluminum return spring 190 ~ 140 mNm

duty cycle = "on" time / ("on" time + "off" time) x 100%			100% cont.	75% or less	50% or less	25% or less	10% or less
Max. "on" time in seconds			∞	85	72	43	20
watts at 20°C			41	54.5	82	164	410
ampere-turns at 20°			2590	2990	3663	5180	8190
Gross starting torque at 20°C (Nm)		25°	3.6	4.7	6.5	10	13
		35°	2.4	3.1	4.2	6.4	8.7
		45°	2.0	2.6	3.6	5.5	7.4
		67,5°	1.0	1.3	1.8	2.9	3.9
		95°	0.66	0.82	1.1	1.7	2.2
AWG no.	resistance Ω±10% (at 20°C)	number of turns	volts DC				
18	2.54	630	10	12	15	21	33
19	4.15	828	13	15	18	26	41
20	6.38	1047	16	18	22	32	50
21	11.14	1408	20	24	29	41	65
22	16.8	1723	25	29	36	51	80
23	25.8	2046	33	38	46	65	103
24	42.5	2711	41	47	57	81	128
25	66.3	3279	52	60	74	105	166
26	105	4151	66	76	93	131	207
27	165	5190	82	95	116	165	260
28	261	6500	104	120	147	208	329
29	422	8340	131	151	185	262	-
30	664	10230	168	194	238	336	-
31	968	12410	202	233	286	-	-
32	1520	15200	259	299	366	-	-

Insulation Resistance >100MΩ, 500VDC Megger Dielectric Strength 1000VAC, 50/60Hz, 1 minute
Class E (120°C) insulation class

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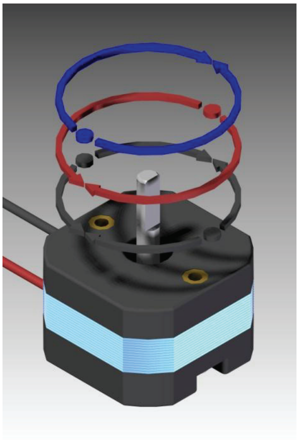
Bi-stable rotary solenoids

2014-07-02

Bistable Rotary Solenoid

The bistable rotary solenoid changes state with the application of a momentary pulse of electricity, and then remains in the changed state without power applied until a further pulse of reverse polarity is applied to drive it in the opposite direction. Because energy is only applied in short pulses, high power can be applied to develop high torque for fast operation without leading to heating problems. Response time of <<10ms is possible for some of these devices.

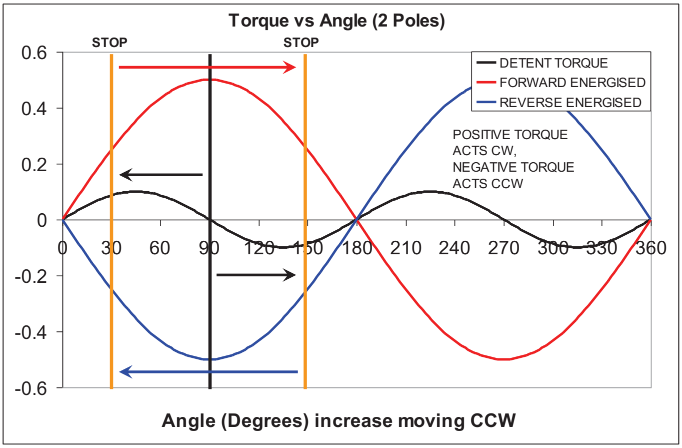


Referring to the image and graph, the device is drawn in the mid-position (90° on graph), torque in the de-energised condition is represented by the black curve and arrows. Without stops, the device will try to turn towards stable equilibrium points (where two arrow heads meet) located at 0° and at 180°, and away from unstable equilibrium points (represented as a black dot) located at 90° and at 270°.

In the forward energised state, the device tries to turn towards a single stable equilibrium point at 180°, in the reverse energised state it tries to turn towards a single stable equilibrium point at 0°.

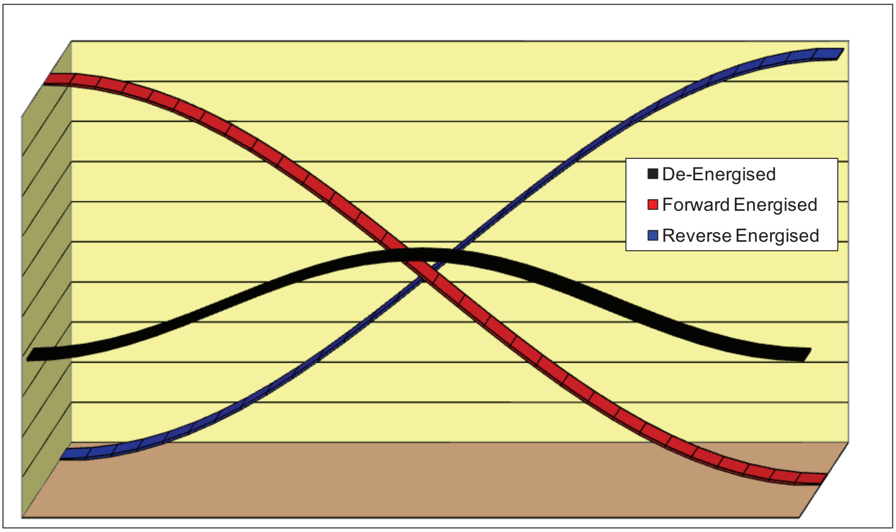
Bistable rotary solenoids do not normally incorporate end stops within the device, a stop should be incorporated externally in the customer application. The stop positions are represented as vertical orange lines in the graph.

The mechanical limit stops restrict rotation so the device cannot turn all the way to the equilibrium points (which are zero torque points), they should restrict motion to a region where developed torque is sufficient to turn the load at required speed, or to hold the load. For more efficient operation, shape of the torque curves may be modified to optimise behaviour for a particular rotation angle.



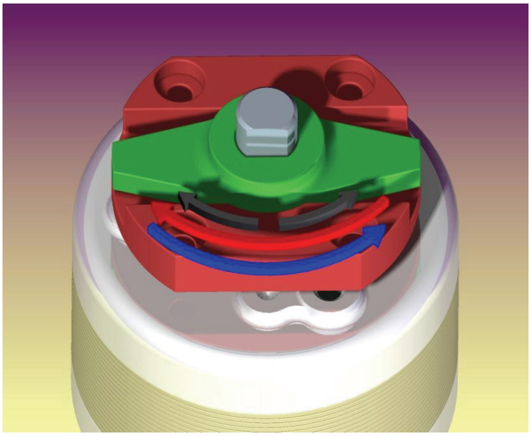
Subjectively, the torque behaviour may more easily understood by considering the analogy of a surface down which a ball bearing is rolled. The surfaces representing the different excitation states of the solenoid are illustrated below, in the case of a 2-pole device this would represent 180° of movement.

- The de-energised state is represented by the black surface, the ball-bearing will try to roll towards either end-position. As it is moved further from the end position, the force trying to restore it will initially increase, but will then reduce as it approaches the mid-position. This is an unstable equilibrium point where no force is developed, however if displaced to either side it will roll away from this point towards the end position.
- The Forward energised condition is represented by the red surface, the ball-bearing will try to roll to the right. The end positions are zero-force points, the force moving it rightwards will be a maximum somewhere close to the mid-position.
- The Reverse energised condition is represented by the blue surface, this is a mirror image of the red surface, the ball-bearing will try to roll to the left.



Installation and Use

The illustration shows a BRS5045 solenoid in it’s mid-position. The solenoid has a stop fitted (the green part mounted on the shaft, and red part mounted to the body of the solenoid) which limits the range of movement to 30°, 15° to either side of the mid-position (shown in this position).

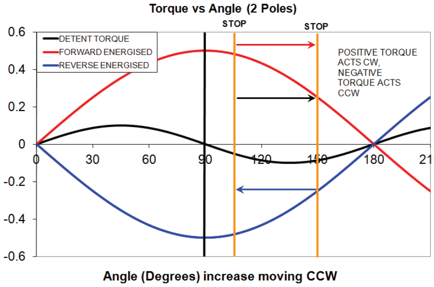


Without any power applied, this is an unstable position, if the shaft is turned in either direction from this mid-position, the residual torque will drive the solenoid further away from the mid position until it comes to rest against the end-stop. This is represented by the black arrows.

A pulse of electrical power applied in the forward direction, will cause the solenoid to develop torque acting in the clockwise direction, and to turn in this sense until it comes to rest against the stop. This excitation condition is represented by the red arrow. If power is then removed the detent torque will cause the solenoid to remain in this position.

A pulse of electrical power applied in the reverse direction, will cause the solenoid to develop torque acting in the counter-clockwise direction, and to turn in this sense until it comes to rest against the stop. This excitation condition is represented by the blue arrow. If power is then removed the detent torque will cause the solenoid to remain in this position.

- For bistable operation it is important that the solenoid is mounted so that the mid-position (parts are normally drawn in this position) is located mid-way between the end stops
- End stops are normally required to be fitted by the customer. These devices are not normally supplied with internal stops, although these may be offered as an option for some models
- Without end-stops to limit rotation of the solenoid, it will naturally try to turn into a magnetic detent position, these positions are zero-torque positions, the solenoid will develop little or no torque if energised in these positions.
- If both end stops are positioned to the same side of the mid-position, a ‘fail-safe’ design can be realised. As shown in the graph, in the case of power failure, the detent torque will drive the device clockwise, it can be energised with forward excitation to drive more quickly to this position. The device must be energised in the reverse direction to drive to the CCW position, and must be kept energised to hold in this position.



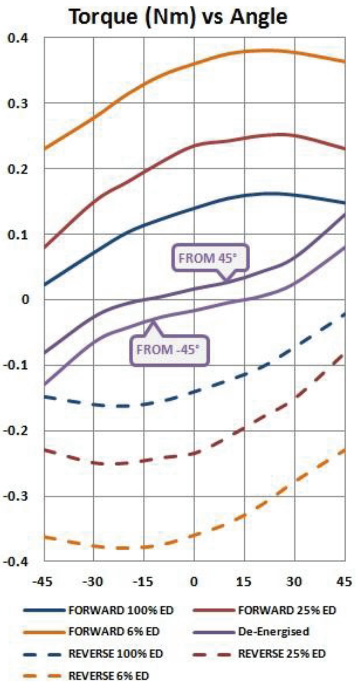
Torque Data

Torque data is measured statically, the solenoid is mounted to a rotary table with a torque arm acting against a load cell to measure torque. To obtain stable data, response time is measured with

the part energised from a regulated current source. Current regulation stabilises the response time of the solenoid against variations in supply voltage or operating temperature. The solenoid is energised with specified current condition, and is rotated whilst monitoring torque output to derive the torque curves. The torque is measured turning in either direction, and the lower of the two measured values taken for data to allow for hysteresis (a combination of mechanical friction and magnetic hysteresis)

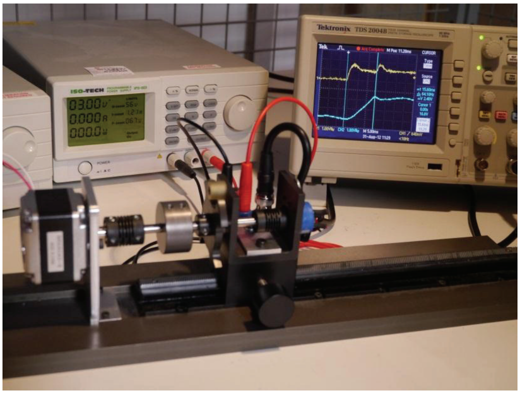
A typical torque characteristic is shown, the graph illustrating this shows torque in both the forward energised (+ve torque acting CW), and reverse energised (-ve torque acting CCW) states. The behaviour in either direction is symmetrical, so is only normally shown for the forward energised condition.

There are two curves representing torque in the de-energised condition. Due to magnetic hysteresis, after the solenoid is driven to either end position, there will be some residual magnetism in the steel which causes the solenoid to favour this end position even moving slightly beyond the centre position towards the other end – this phenomenon aids stability of bistable operation.



Response Time Data

To obtain stable data, response time is measured with the part energised from a regulated current source with a current of 80% of the nominal value (the current drawn by the solenoid in the cold 20°C condition when the stated voltage is applied). Current regulation stabilises the response time of the solenoid against variations in supply voltage or operating temperature. The stated voltage in response speed data is the source voltage from which the current regulator works. The measured performance corresponds to the behaviour that will be achieved with excitation at the nominal voltage when the coil temperature is elevated to approximately 80°C. It should be noted that the source voltage influences the rise-time of the current to reach rated value – a high source voltage will enable shorter electrical rise time and faster actuation times.



End stops are positioned equidistant either side of the mid-position of the solenoid under test.

In addition to the moment of inertia of the shaft and stop configuration of the test rig, additional masses may be mounted to the shaft to measure response time under different load conditions.

A resistor of low ohmic value relative to the coil resistance of the device under test is installed in series with the coil, and voltage across this (corresponding to the coil excitation current) is measured with an oscilloscope.

In most cases a potentiometer is mounted to the test rig with a constant voltage applied across the end terminals, the potential measured on the wiper of the potentiometer (corresponding to position) is displayed on another channel of the oscilloscope (this may be omitted for very small devices where friction in the potentiometer has a significant impact on response speed of the device)

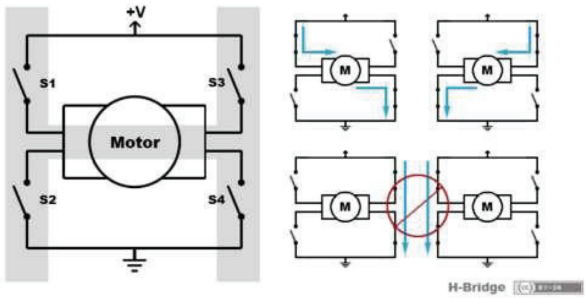
When the device is energised, the current waveform will show an exponential curve as current rises, and will show a ‘spike’ in this curve as the rotor of the actuator impacts the end stop and bounces.

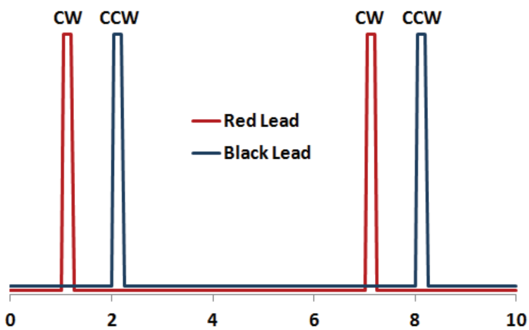
Response time data is usually given in the form of a graph plotting response time against load inertia, with several lines representing different rotation angle and excitation conditions.

The response time is taken to be the time taken from application of power to the solenoid, until the assembly first contacts the end-stop at limit of rotation, this is judged as the point where the assembly is seen to start decelerating. This does not include time taken for the device to settle and for any rebound to die down, as the end-stop conditions will vary with customer implementation and are not under Geeplus control.

Electrical Drive

To drive a bistable rotary solenoid, a circuit configuration known as an H-Bridge is normally required. This is shown schematically. This is normally implemented using solid state switches (transistors), a number of integrated devices are available to simplify implementation of such a circuit.

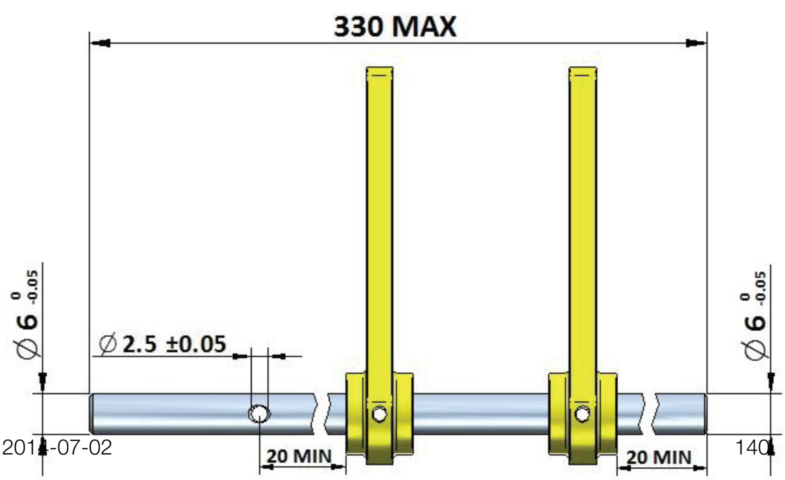




By closing either S1 and S4, or S2 and S3 while the other switches are open, the current can be caused to flow through the solenoid coil in either the forward or the reverse direction. With momentary excitation pulses as depicted in the timing diagram the solenoid can be driven CW or CCW, remaining in either position with no power applied in between.

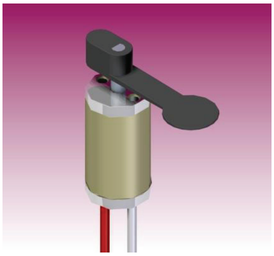
Response Speed Testing with Customer Diverter

As a chargeable service, if a diverter gate and end-stop are supplied with appropriate mounting features to mount on Geeplus test fixtures, we can undertake a series of response tests for a solenoid with user supplied load mounted, with results supplied as an oscillogram showing position vs time. Mechanical mounting features should be as below. For test purposes parts can be energised with supply voltage in the range 0v-60v, current in the range 0A-10A.

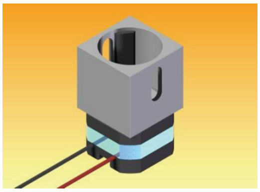


Shutter Actuation – Small Actuators

Rotary Actuators



Geeplus offers small rotary actuators in several types suited to actuation of small shutter mechanisms. These typically require rotation of a small 'flag' to block or pass a light beam, or of a small mirror to deflect a light beam down another path.

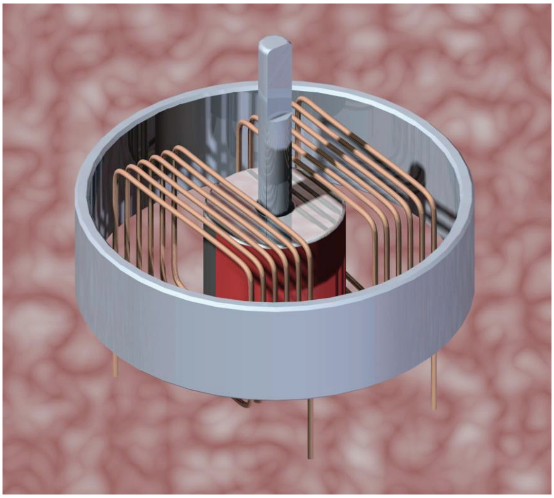


WHAT APPLICATION/S DOES IT SUIT?

These rotary actuators are suited to small shutter mechanisms where the mass of moving elements is small, and is balanced about the axis of rotation. Fast actuation (<2ms) is possible for small angles and loads

WHAT DIFFERENTIATES IT FROM OTHER SOLUTIONS?

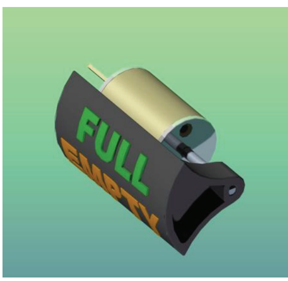
- These devices are brushless with a fixed coil and moving magnet rotor, so do not exhibit the wear and reliability concerns associated with brushed motors, and can endure high pulse currents without damage for high torque / fast operation.
- Bistable operation allows the device to be driven from open to closed position or vice versa with a short excitation pulse, and then to hold this end position without power being applied.
  - This reduces power consumption in battery powered systems.
  - In applications such as thermal imaging, the reduction of heat dissipation from the actuator reduces disturbance of the sensors in the imaging system.
  - If 'fail-safe' operation is required where the device must return to a known state in the event of power failure, bistable operation may not be appropriate
- By balancing the moving elements about the axis of rotation, the mechanism can be made highly resistant to shock applied in a linear direction, and friction can be minimised with inexpensive bearings.

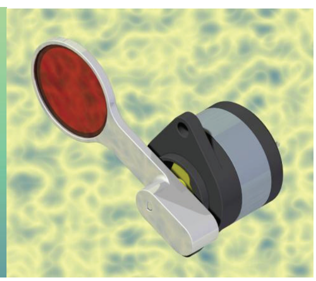


DESIGN

The most widely used actuators are moving magnet galvanometers or bistable rotary solenoids, the typical construction of these is shown in the accompanying image. A permanent magnet rotor is supported within a coil, when the coil is energised, the rotor tries to turn to align itself with the field developed by the coil, developing a torque proportional to the excitation current. An iron case helps concentrate the magnetic field, and reduces susceptibility to disturbance by external fields. By modifying the shape of this case, the device can be made bistable, so that it turns away from the centre position towards either end position without power applied – the bistable rotary solenoid is an extreme example of this where proportionality is sacrificed for better efficiency and bistable function.

KEY PARAMETERS (SIZE / FORCE / POWER / ETC)

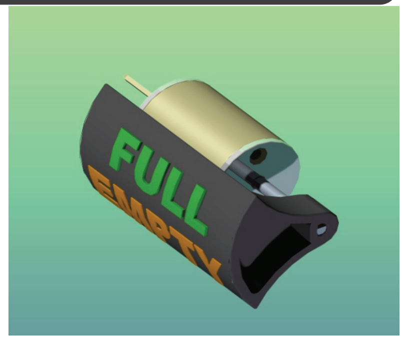


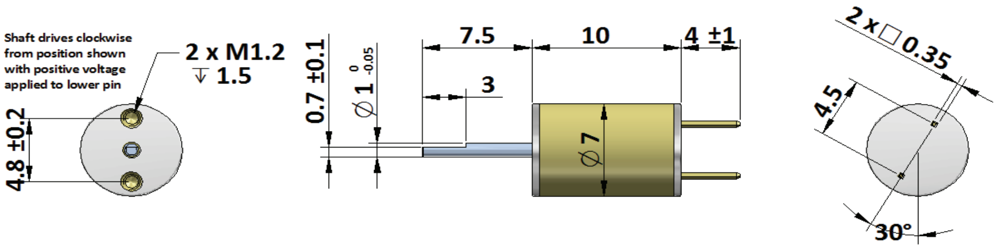


Devices are produced in sizes from 7mm diameter as standard, and up to 50mm diameter , smaller or larger sizes may be possible for high-volume applications

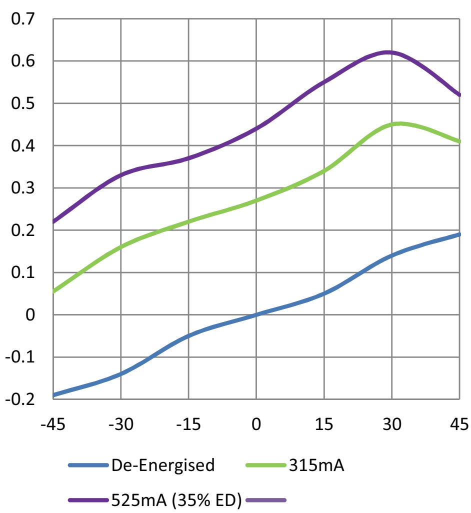
GEEPLUS BRS0710-9.5

Device drawn with shaft aligned to mid position
Nominal 9.5Ω, 180mH for operation at 315mA, 100%ED
Rotor Inertia 0.15 gmm²
Life Expectancy >10M cycles, no load, 60⁰ rotation
Mass 1.5 grammes
Insulation Resistance >5MΩ, 500VDC Megger
Dielectric Strength 250vAC, 50/60Hz, 1 minute

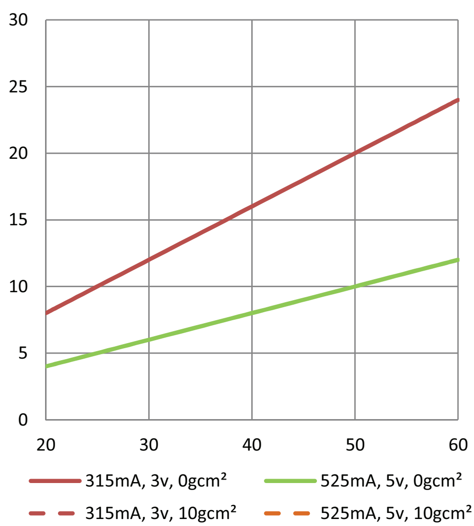




Torque (mNm) vs Angle

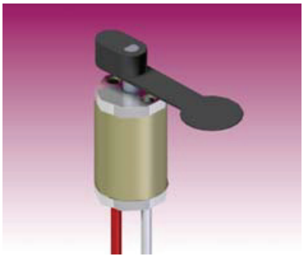


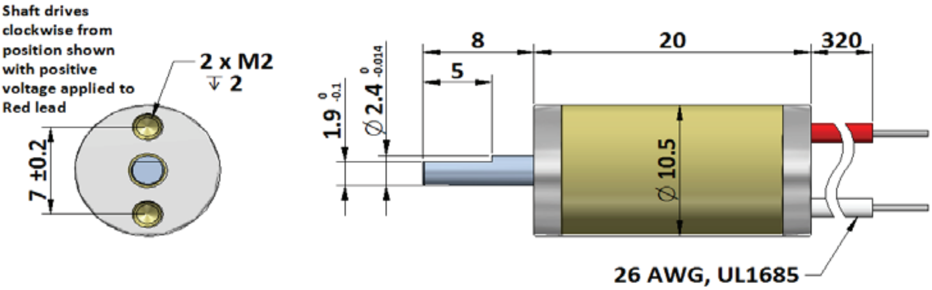
Response (ms) vs Angle

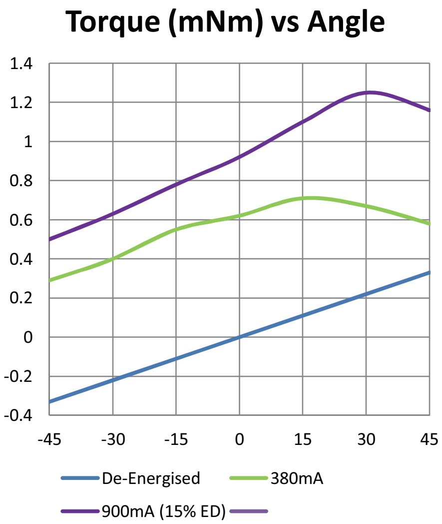


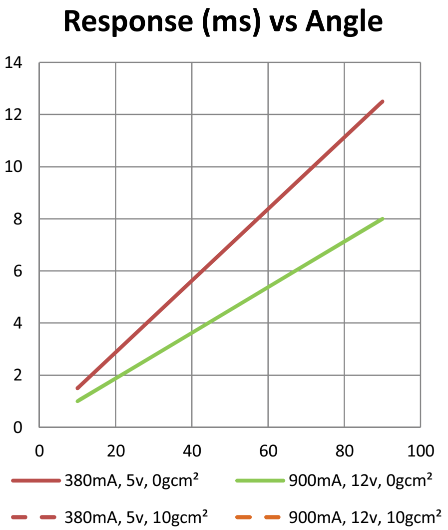
GEEPLUS BRS1020-13

Device drawn with shaft aligned to mid position
Nominal 13Ω, 0.6mH for operation at 380mA, 100%ED
Rotor Inertia 0.017 gcm²
Life Expectancy >10M cycles, no load, 60⁰ rotation
Mass 8 grammes
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 500vAC, 50/60Hz, 1 minute

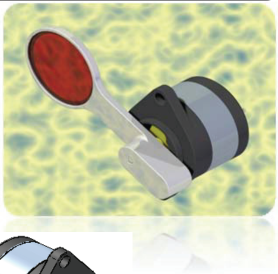




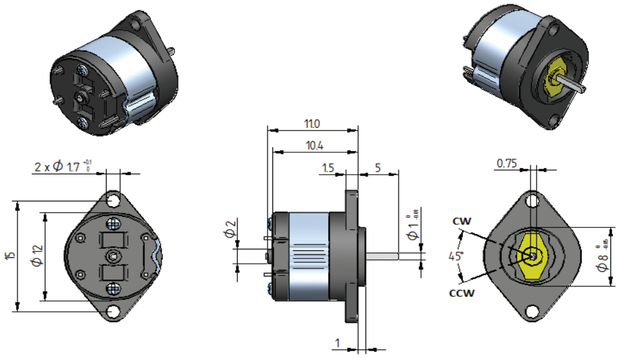




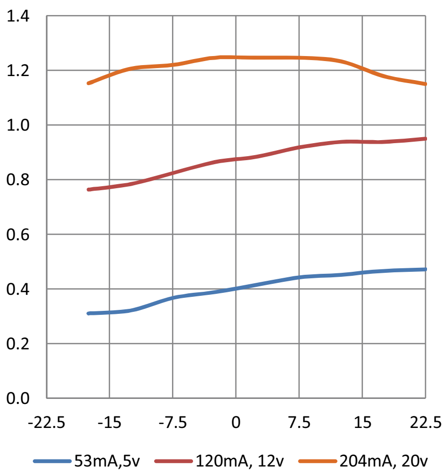
GEEPLUS BRS1212-95



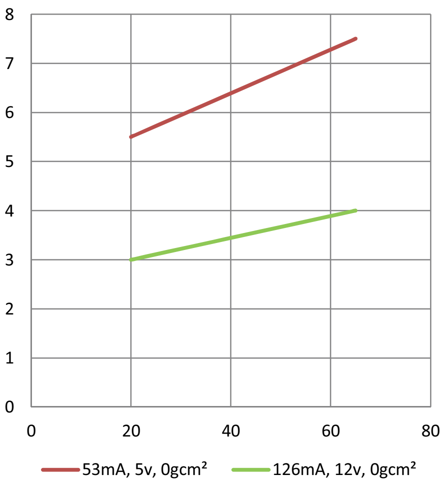
Device drawn with shaft aligned to mid position
Nominal 95Ω parallel, 380Ω series connection
Rotor Inertia 0.xxx gcm²
Life Expectancy >1M cycles, no load, 30⁰ rotation
Mass 3.5 grammes
Insulation Resistance >50MΩ, 500VDC Megger
Dielectric Strength 300vAC, 50/60Hz, 1 second



Torque (mNm) vs Angle



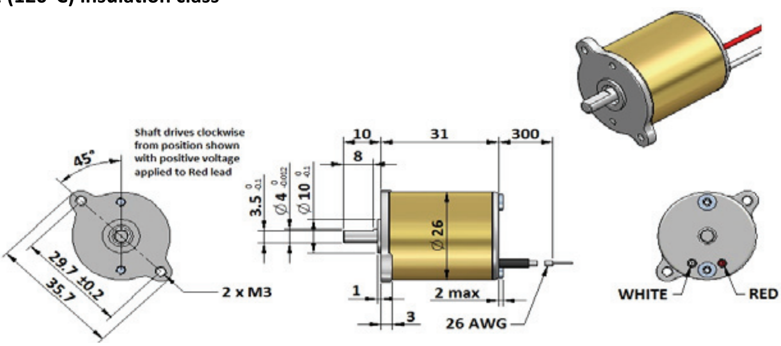
Response (ms) vs Angle



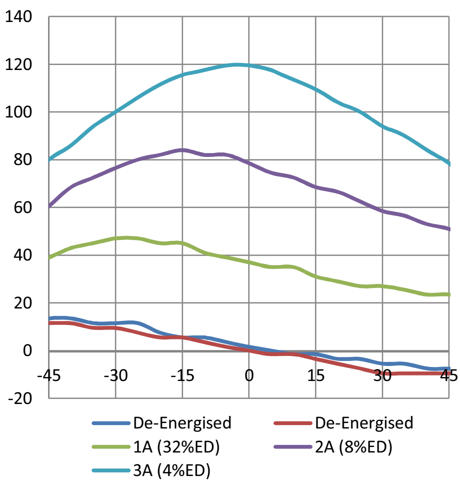
Geeplus reserves the right to change specifications without notice

GEEPLUS BRS2631

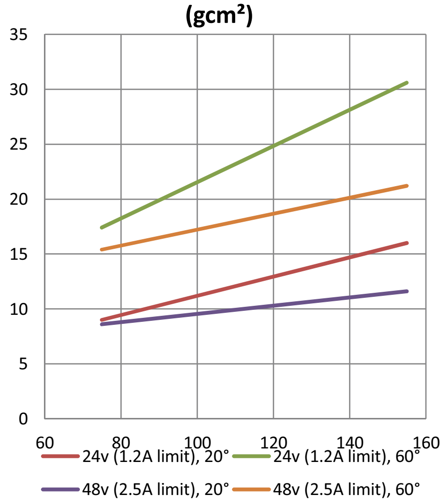
Device drawn with shaft aligned to mid position
Nominal 15.6Ω, 3.8mH for operation at 12V, 40%ED
Rotor Inertia 2.1 gcm²
Life Expectancy >10M cycles, no load, 60⁰ rotation
Mass 70 grammes
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000vAC, 50/60Hz, 1 minute
Class E (120⁰C) insulation class



Torque (mNm) vs Angle



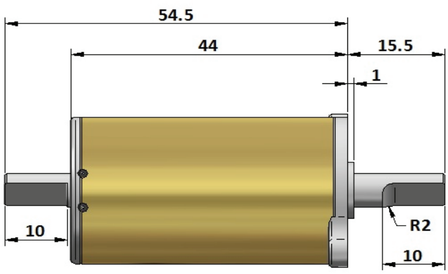
Response (ms) vs Load Inertia (gcm²)

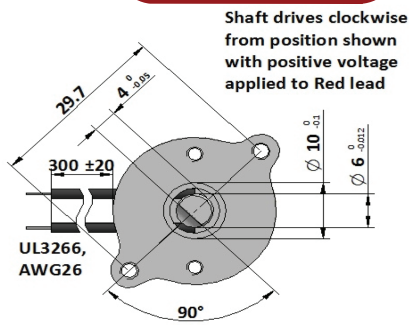


Geeplus reserves the right to change specifications without notice

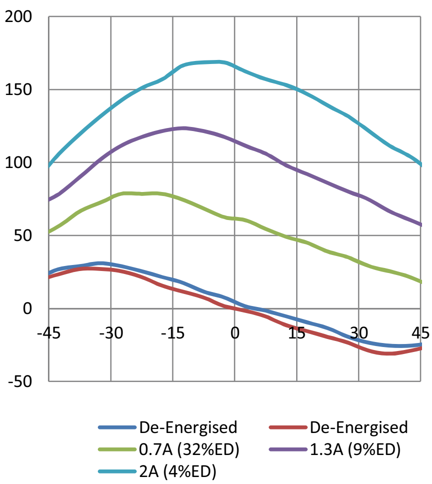
GEEPLUS BRS2644

Device drawn with shaft aligned to mid position
Nominal 32Ω, 140mH for operation at 12V, 100%ED
Rotor Inertia 2.1 gcm²
Life Expectancy >10M cycles, no load, 60⁰ rotation
Mass 80 grammes
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000vAC, 50/60Hz, 1 minute
Class E (120⁰C) insulation class

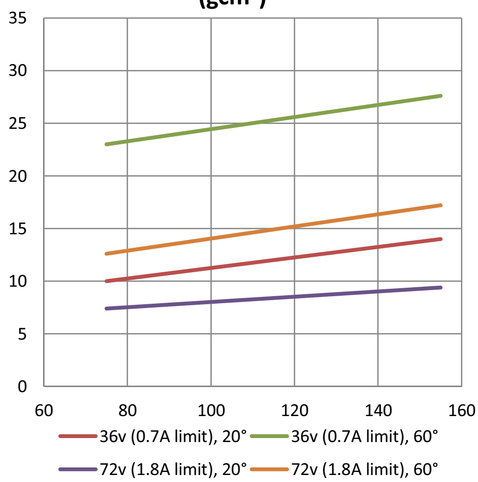




Torque (mNm) vs Angle

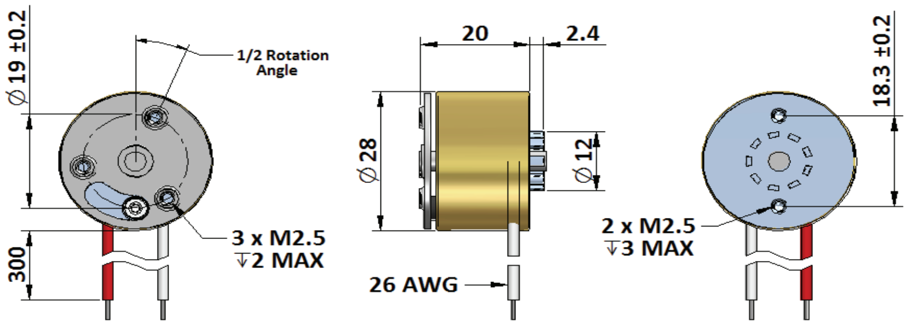


Response (ms) vs Load Inertia (gcm²)

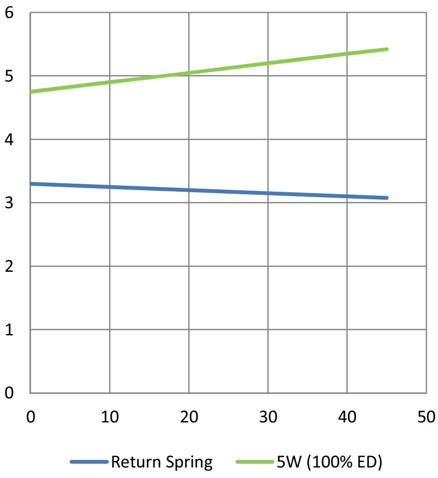


GEEPLUS BRS2820-xxCCW-yy

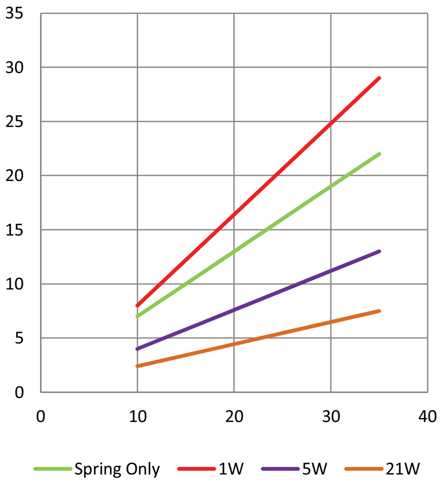
xx in P/N is rotation angle (25, 35, 45 CW & CCW)
yy in P/N is nominal voltage (12v, 27.5Ω or 24v, 110Ω)
Rotor Inertia 1.8 gcm²
Life Expectancy >10M cycles, no load
Mass 50 grammes
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000vAC, 50/60Hz, 1 minute
Class E (120°C) insulation class



Torque (mNm) vs Angle

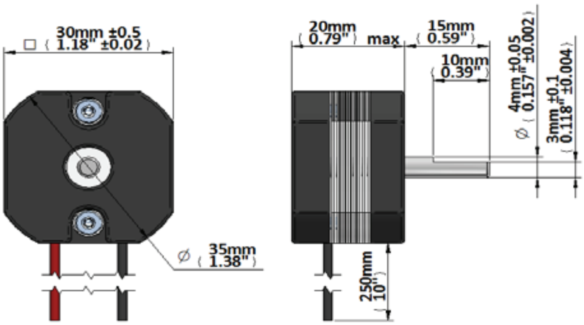


Response (ms) vs Angle

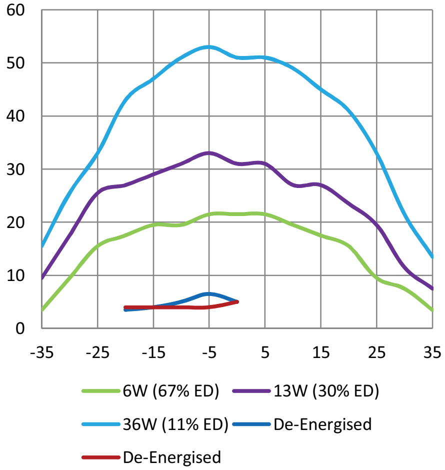


RM301-4P-06

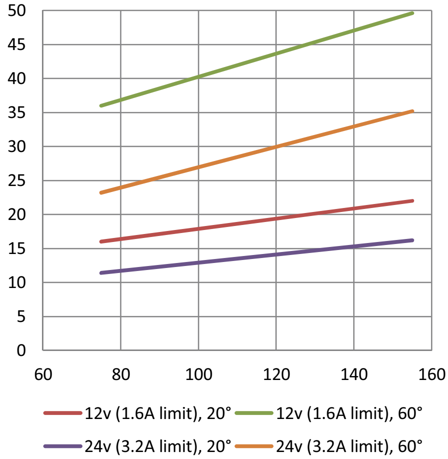
Device drawn with shaft aligned to mid position
Suffix 06, 12, 24 for operation at 6v, 12v, 24v, 100%ED
Rotor Inertia 2.1 gcm²
Life Expectancy >10M cycles, no load, 30° rotation
Mass 62 grammes
Insulation Resistance >50MΩ, 500VDC Megger
Dielectric Strength 500vAC, 50/60Hz, 1 minute
Class E (120°C) insulation class



Torque (mNm) vs Angle

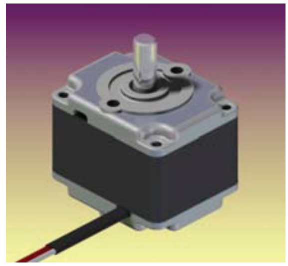


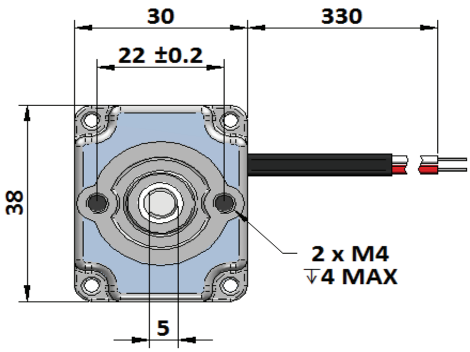
Response (ms) vs Load Inertia (gcm²)

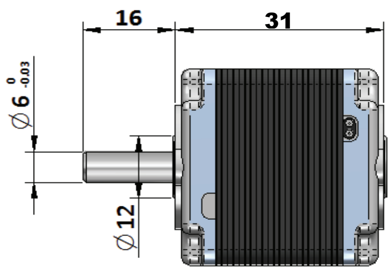


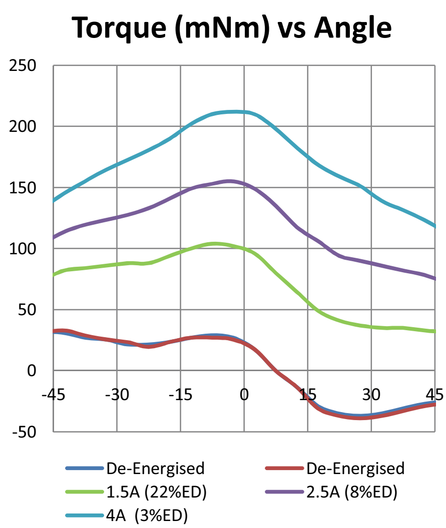
Geeplus reserves the right to change specifications without notice

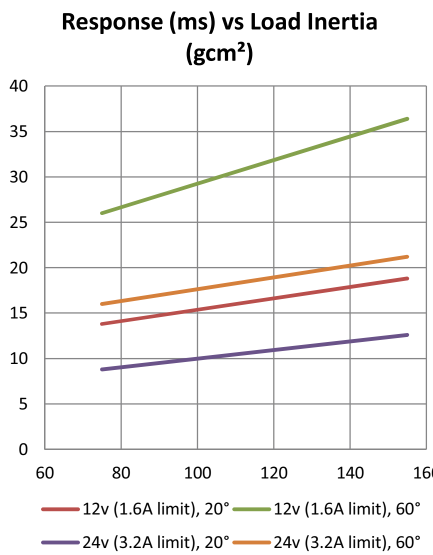
- Device drawn with shaft aligned to mid position
- Nominal 10Ω, 10mH (at 0°)for operation at 24v, 9%ED
- Rotor Inertia 6.5 gcm²
- Life Expectancy >10M cycles, no load, 30⁰ rotation
- Turns CW from position shown, +ve applied to Red lead
- Leadwires AWG24 stranded leads
- Mass 190 grammes





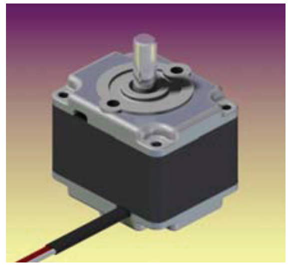


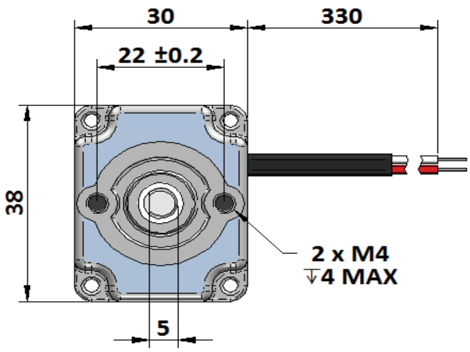


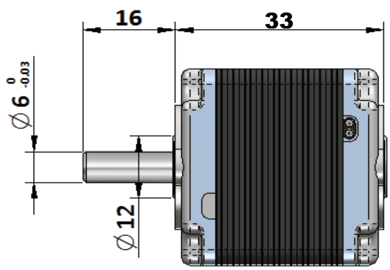


GEEPLUS BRS3833-8

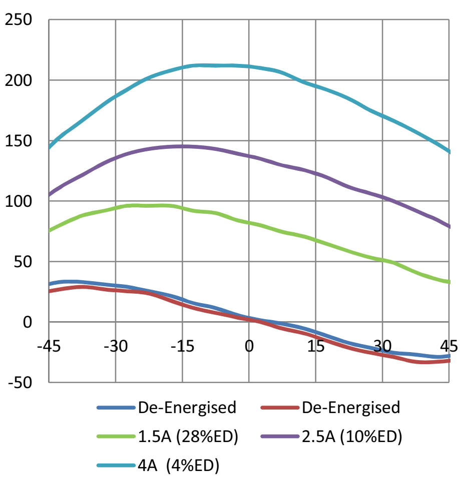
Device drawn with shaft aligned to mid position
Nominal 8Ω, 9mH(at 0°) for operation at 24v, 7%ED
Rotor Inertia 7.2 gcm²
Life Expectancy >10M cycles, no load, 30° rotation
Turns CW from position shown, +ve applied to Red lead
Leadwires AWG24 stranded leads
Mass 190 grammes



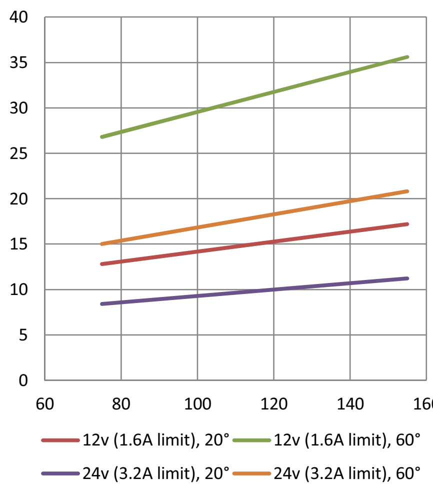


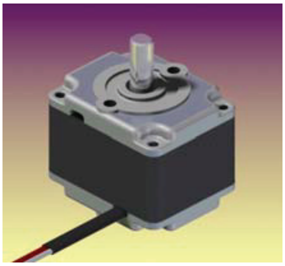


Torque (mNm) vs Angle

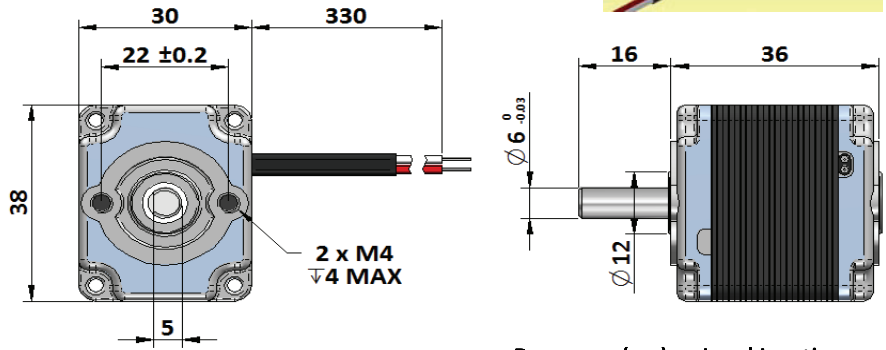


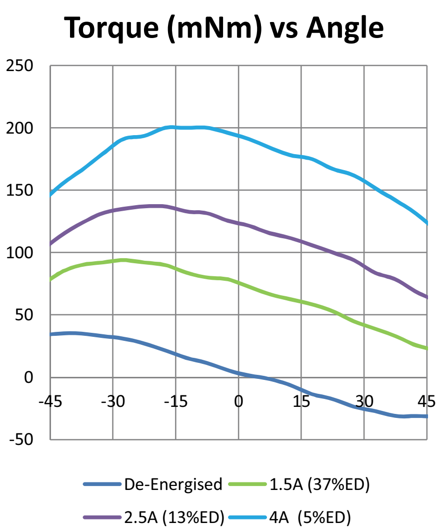
Response (ms) vs Load Inertia (gcm²)

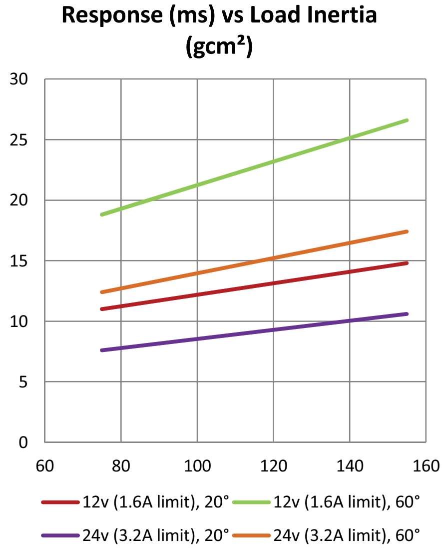




Device drawn with shaft aligned to mid position
Nominal 6Ω, 6mH (At 0°) for operation at 24v, 5%ED
Rotor Inertia 8.4 gcm²
Life Expectancy >10M cycles, no load, 30⁰ rotation
Turns CW from position shown, +ve applied to Red lead
Leadwires AWG24 stranded leads
Mass 190 grammes

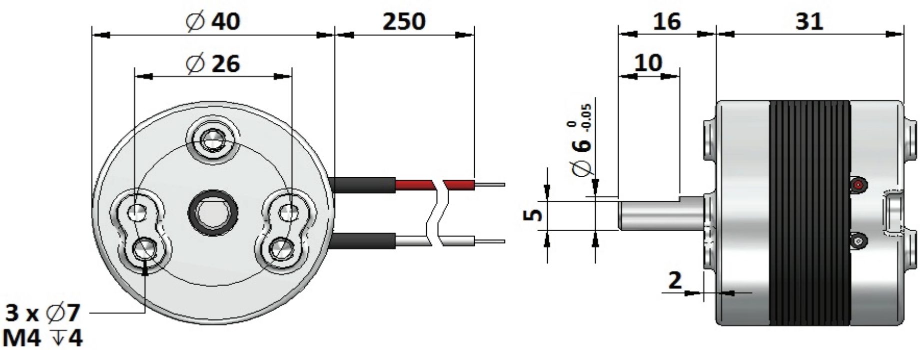




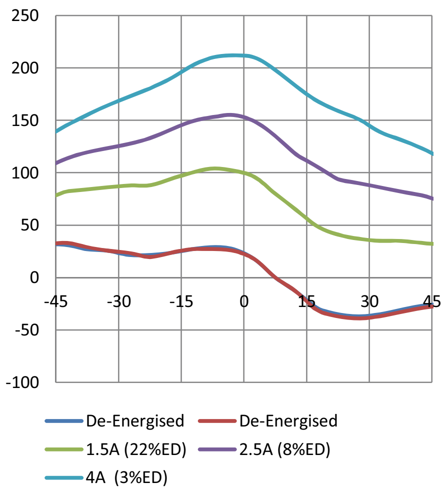


GEEPLUS BRS40C31-10

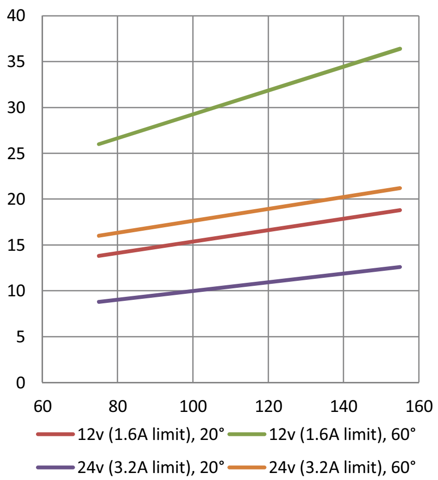
Device drawn with shaft aligned to mid position
Nominal 10Ω, 8mH (At 0°) for operation at 24v, 9%ED
Rotor Inertia 6.5 gcm²
Life Expectancy >10M cycles, no load, 30° rotation
Turns CW from position shown, +ve applied to Red lead
Leadwires AWG24 stranded leads
Mass 155 grammes



Torque (mNm) vs Angle



Response (ms) vs Load Inertia (gcm²)



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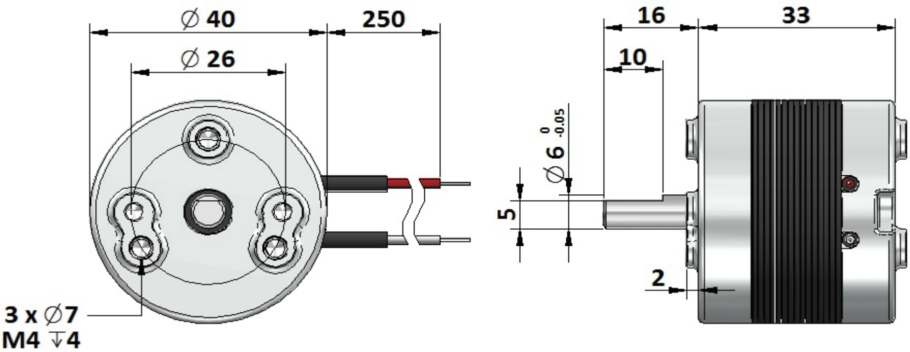
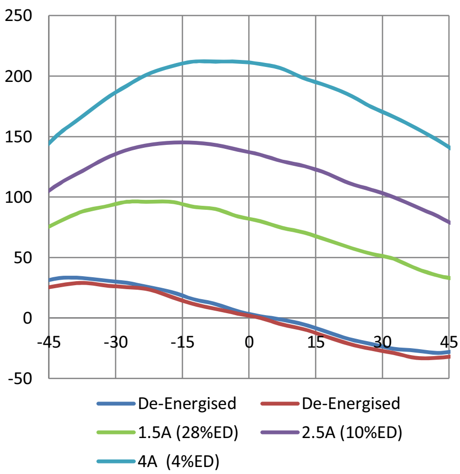
GEEPLUS BRS40C33-8

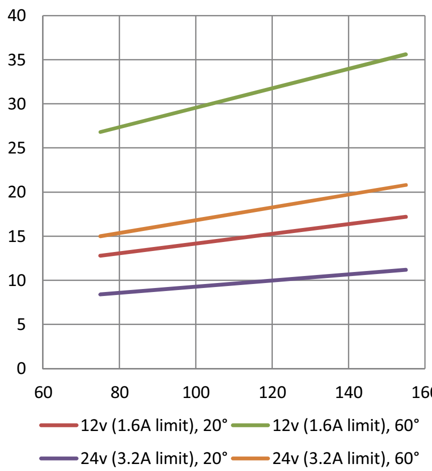
Device drawn with shaft aligned to mid position
Nominal 8Ω, 7mH (At 0°) for operation at 24v, 7%ED
Rotor Inertia 7.2 gcm²
Life Expectancy >10M cycles, no load, 30⁰ rotation
Turns CW from position shown, +ve applied to Red lead
Leadwires AWG24 stranded leads
Mass 165 grammes



Torque (mNm) vs Angle

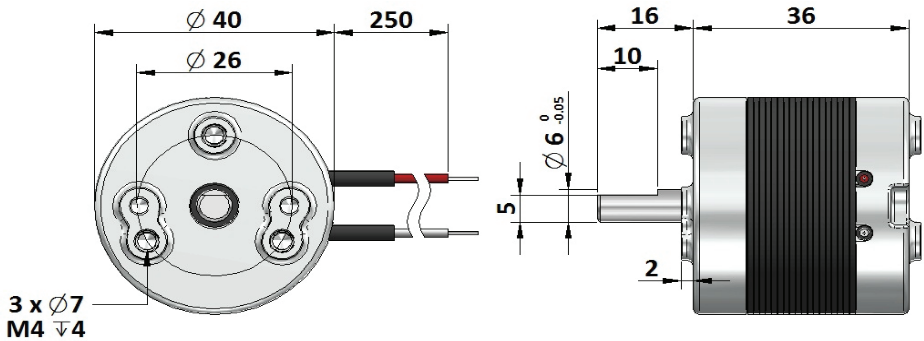


Response (ms) vs Load Inertia (gcm²)

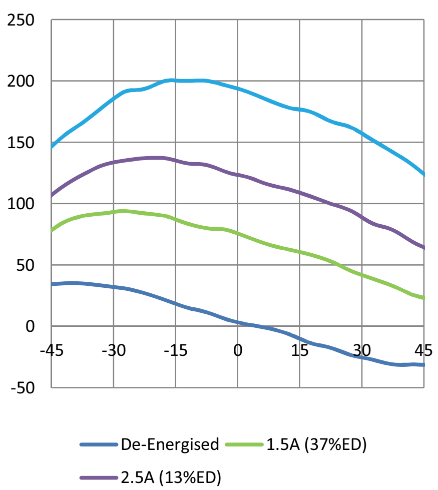


GEEPLUS BRS40C36-6

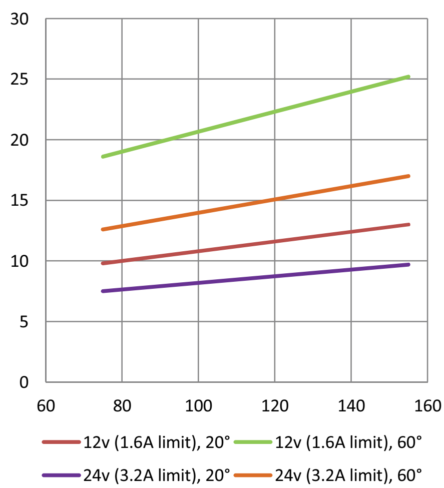
Device drawn with shaft aligned to mid position
Nominal 6Ω, 5mH for operation at 24v, 5%ED
Rotor Inertia 8.4 gcm²
Life Expectancy >10M cycles, no load, 30° rotation
Turns CW from position shown, +ve applied to Red lead
Leadwires AWG24 stranded leads
Mass 175 grammes



Torque (mNm) vs Angle

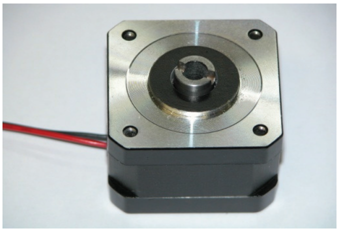


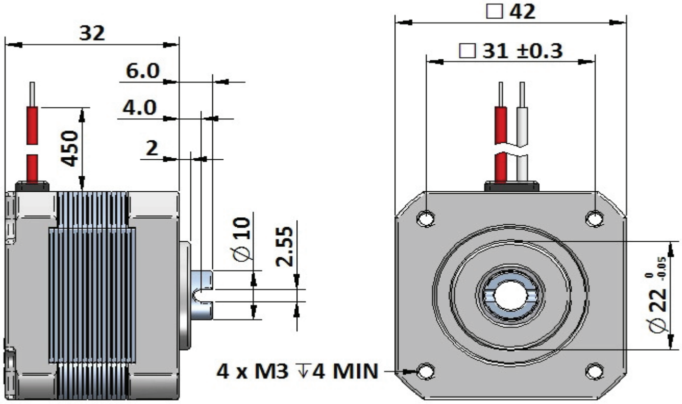
Response (ms) vs Load Inertia (gcm²)



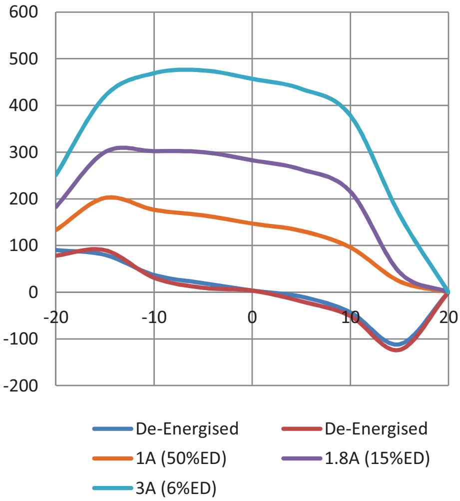
GEEPLUS BRS4232-6-10

Device drawn with shaft aligned to mid position
Nominal 10Ω, ??mH for operation at 12v, 50%ED
Rotor Inertia 36 gcm²
Life Expectancy >20M cycles, no load, 20° rotation
Turns CW from position shown, +ve applied to Red lead
JST B2P-VH (Lead Assy supplied with 450mm, AWG20)
Mass 150 grammes

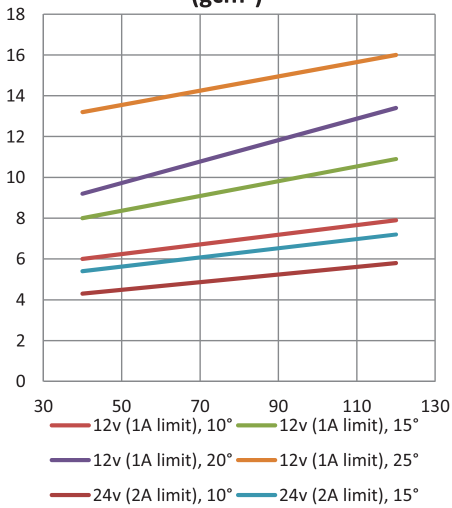




Torque (mNm) vs Angle

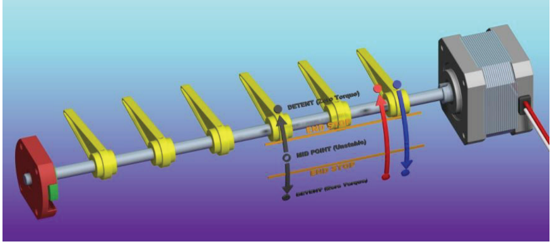


Response (ms) vs Load Inertia (gcm²)

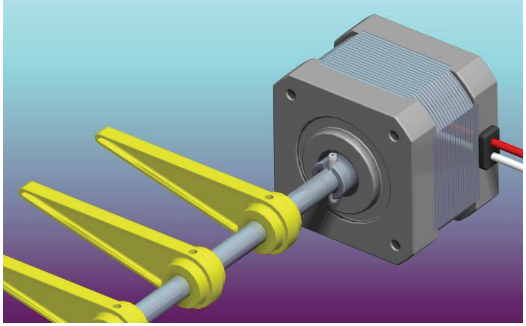


BRS42xx for Diverter Applications

The BRS42 Bistable Rotary Solenoid is designed for fast, limited angle actuation of diverter gates in paper, banknote, or document handling equipment.

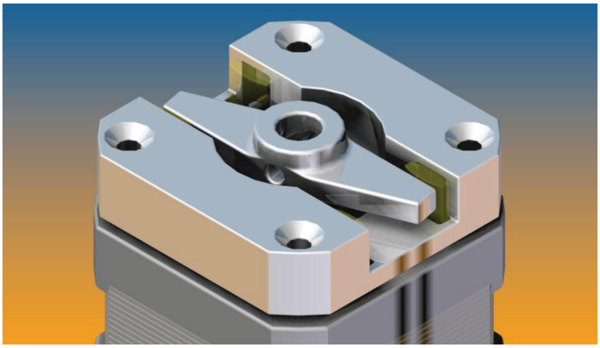


Implementation of diverter designs is simplified with reduced installation time and cost, and with reduced energy consumption reducing system heat dissipation and running costs.



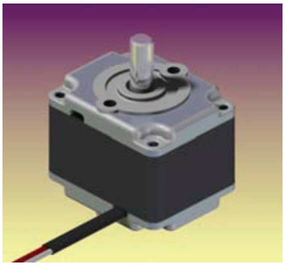
The solenoid incorporates bearings to support the shaft of diverter mechanism on one side of the machine, and is designed for simple assembly where the solenoid is fitted over the end of the diverter shaft, and engages with a roll pin fitted through the shaft to transmit torque.

The user must implement end stops within the diverter mechanism to limit rotation within the operating region of the solenoid. End stop design needs to take consideration of rebound of the diverter gate from the stop which can compromise operation.

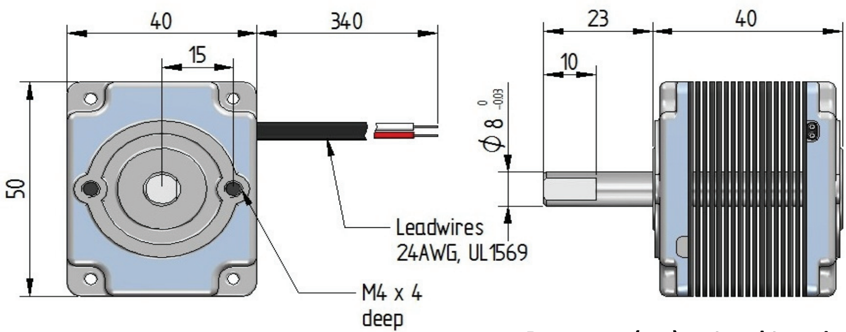


For most consistent operation the device should be energised with a constant current driver.

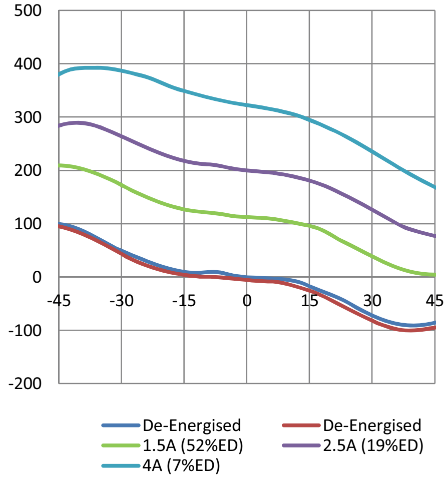
GEEPLUS BRS5040-6



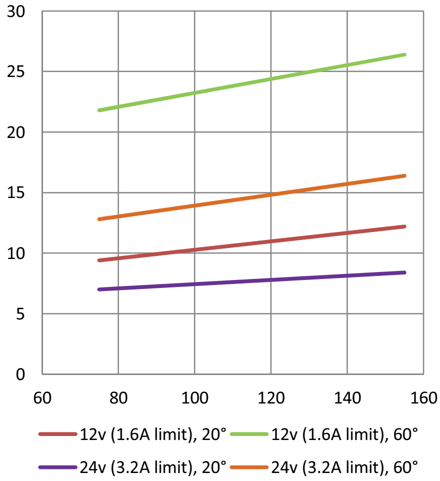
Device drawn with shaft aligned to mid position
Nominal 6Ω, 5mH for operation at 24v, 7%ED
Rotor Inertia ? gcm²
Life Expectancy >10M cycles, no load, 30⁰ rotation
Turns CW from position shown, +ve applied to Red lead
Leadwires AWG24 stranded leads
Mass 190 grammes



Torque (mNm) vs Angle



Response (ms) vs Load Inertia (gcm²)



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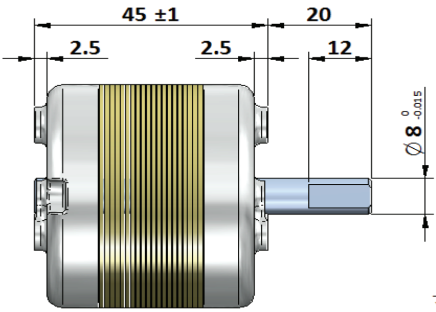
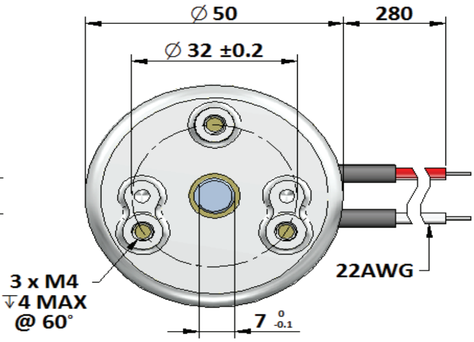
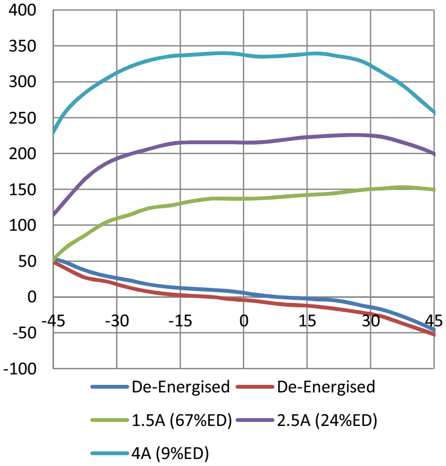
Device drawn with shaft aligned to mid position
Nominal 6.2Ω, 15mH for operation at 12V, 40%ED
Rotor Inertia 18 gcm²
Life Expectancy >10M cycles, no load, 60⁰ rotation
Mass 280 grammes
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000vAC, 50/60Hz, 1 minute
Class E (120⁰C) insulation class

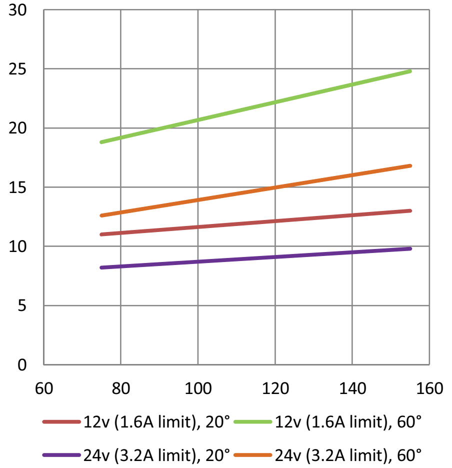




Torque (mNm) vs Angle

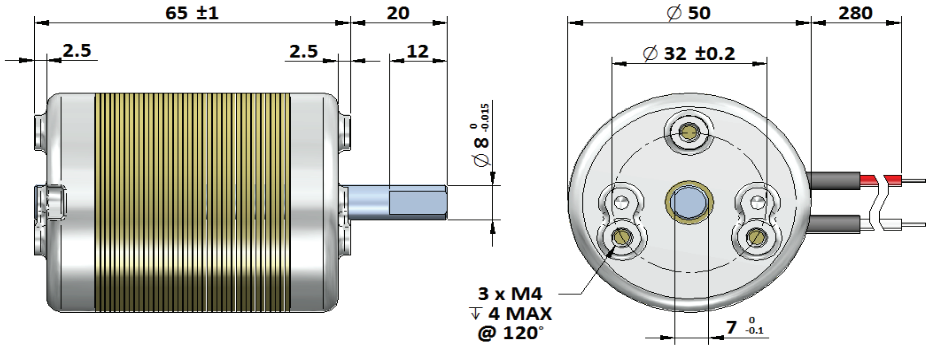


Response (ms) vs Load Inertia (gcm²)

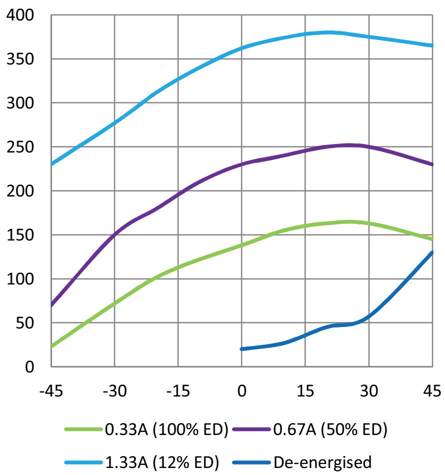


GEEPLUS BRS5065

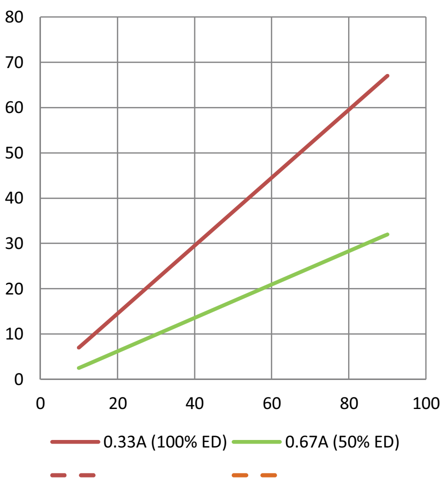
Device drawn with shaft aligned to mid position
Nominal 36Ω, 102mH for operation at 24V, 50%ED
Rotor Inertia 36 gcm²
Life Expectancy >10M cycles, no load, 60⁰ rotation
Mass 500 grammes
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000vAC, 50/60Hz, 1 minute
Class E (120⁰C) insulation class



Torque (mNm) vs Angle



Response (ms) vs Angle



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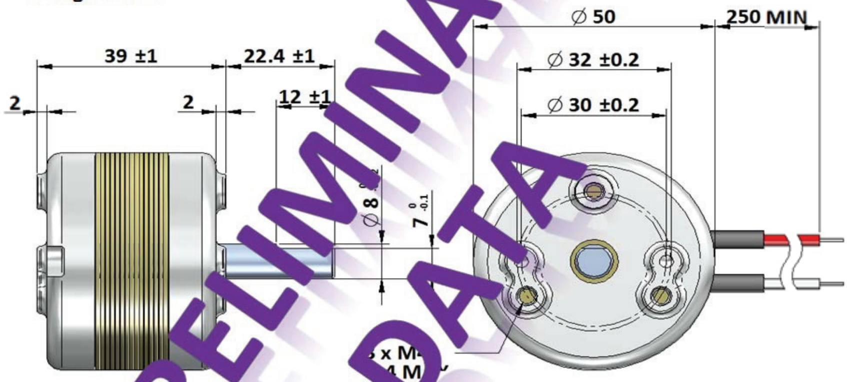
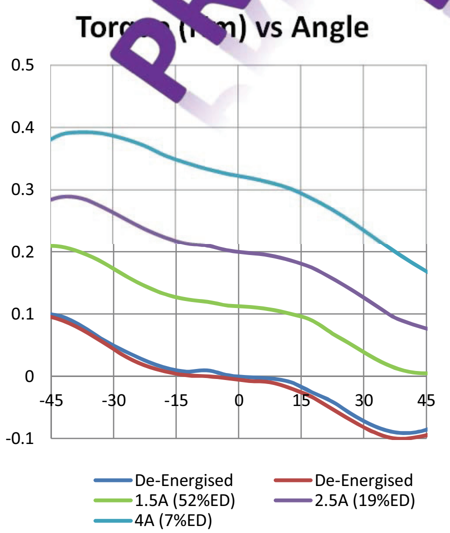
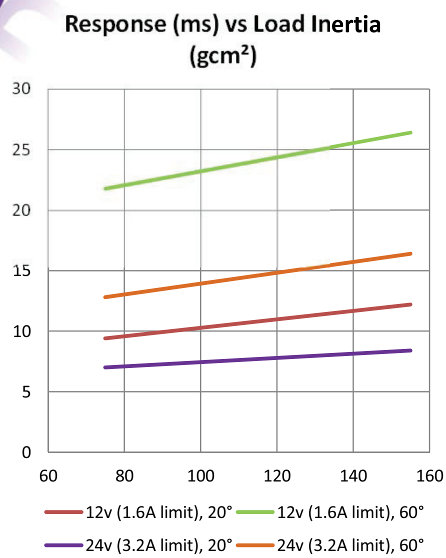
Device drawn with shaft aligned to mid position
Nominal 6Ω, 5mH for operation at 24v, 7%ED
Rotor Inertia ? gcm²
Life Expectancy >10M cycles, no load, 30° rotation
Turns CW from position shown, +ve applied to Red lead
Leadwires AWG24 stranded leads
Mass 190 grammes

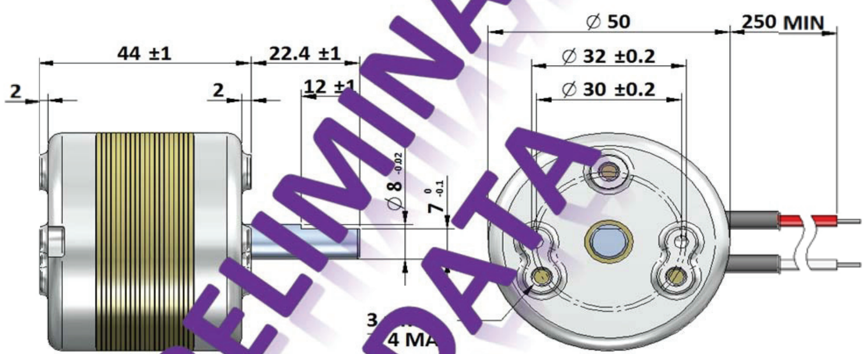




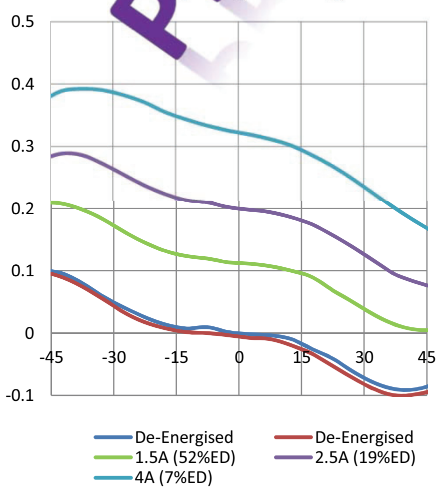


GEEPLUS BRS50C44-6

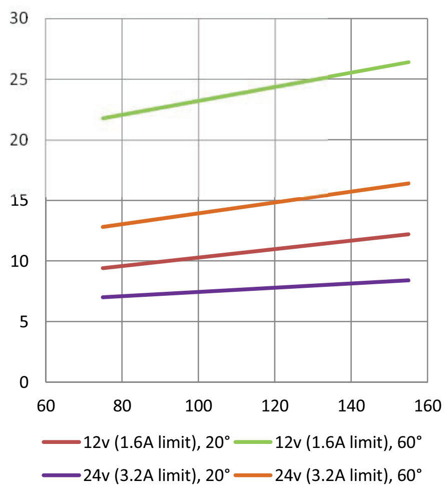
Device drawn with shaft aligned to mid position
Nominal 6Ω, 5mH for operation at 24v, 7%ED
Rotor Inertia ? gcm²
Life Expectancy >10M cycles, no load, 30° rotation
Turns CW from position shown, +ve applied to Red lead
Leadwires AWG24 stranded leads
Mass 190 grammes



Torque (Nm) vs Angle

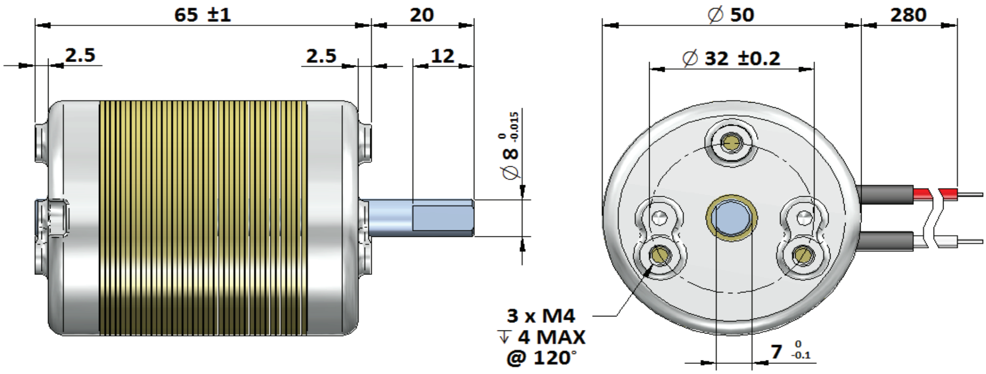


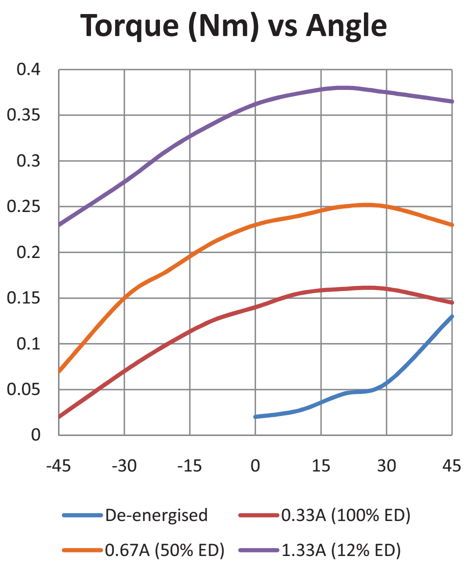
Response (ms) vs Load Inertia (gcm²)

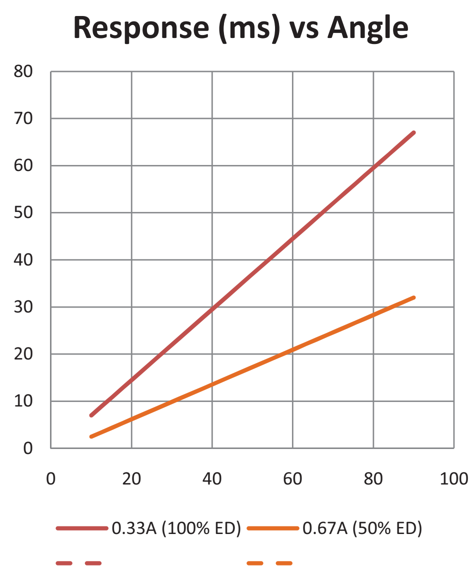


GEEPLUS BRS5065

Device drawn with shaft aligned to mid position
Nominal 36Ω, 102mH for operation at 12V, 40%ED
Rotor Inertia 36 gcm²
Life Expectancy >10M cycles, no load, 60º rotation
Mass 500 grammes
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000vAC, 50/60Hz, 1 minute
Class E (120ºC) insulation class

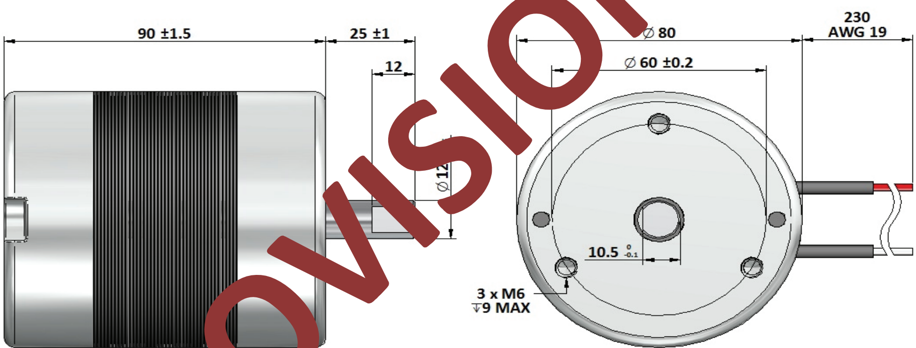




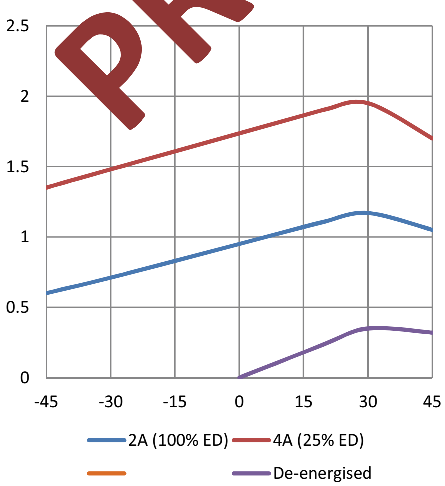


GEEPLUS BRS8090

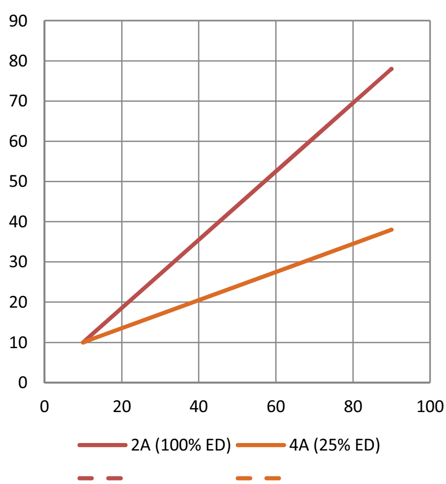
Device drawn with shaft aligned to mid position
Nominal 6Ω, 28mH for operation at 24V, 25%ED
Rotor Inertia 350 gcm²
Life Expectancy >10M cycles, no load, 60° rotation
Mass 1700 grammes
Insulation Resistance >100MΩ, 500VDC Megger
Dielectric Strength 1000vAC, 50/60Hz, 1 minute
Class E (120°C) insulation class



Torque (Nm) vs Angle



Response (ms) vs Angle



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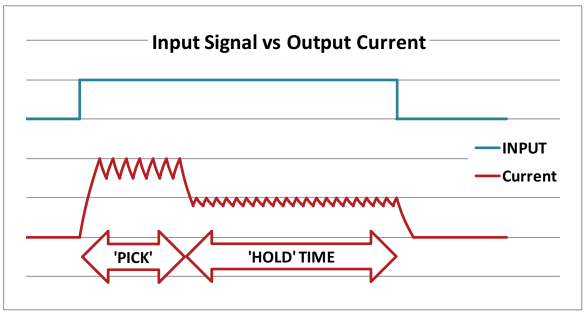
Control Circuits

PHu Pick & Hold Module

DESCRIPTION

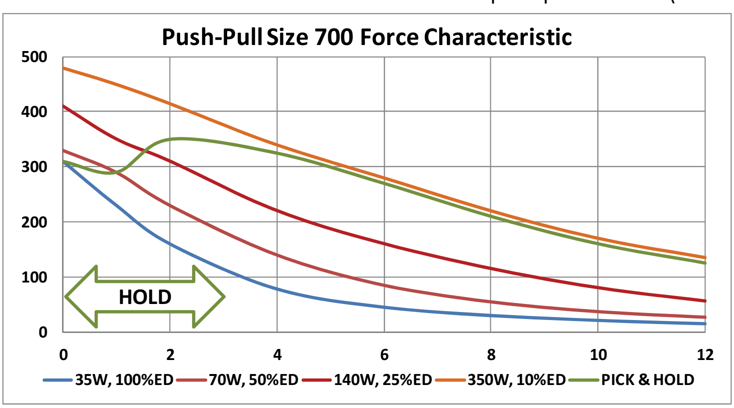
A Pick & Hold circuit regulates current applied to a solenoid or motor, applying high initial current (PICK) to develop high initial force/torque for fast response, then reducing this after a preset time (PICK TIME) to a lower level (HOLD) to maintain operation. It can be used to reduce power consumption in applications with restricted power supply (eg battery or line-powered systems), to reduce heat and power dissipation (systems handling temperature-sensitive materials, or susceptible to thermal distortion), or to stabilise performance of systems against fluctuations in supply voltage or ambient temperature.



Geeplus PHu modules are microprocessor controlled pick & hold modules which use intelligent algorithms to control a wide range of devices with simple user control of current and time parameters.

The PHu modules can be used to implement control of large solenoids in an end-user application, the user-friendly interface also makes them a superb development tool to explore the maximum performance achievable from a wide range of solenoids during product development.

The graph below shows the characteristic force curves for a push-pull solenoid (the curves



at different excitation power showing greater force with increasing excitation power, and the shape of the curve with force increasing as displacement reduces towards zero are similar for most linear solenoids), the use of a pick and hold circuit enables force to be realised at the extended position similar to an intermittent duty curve, with continuing excitation power comparable to (or even lower than) that of the 100% duty curve.

Product Table

Available versions are detailed below.

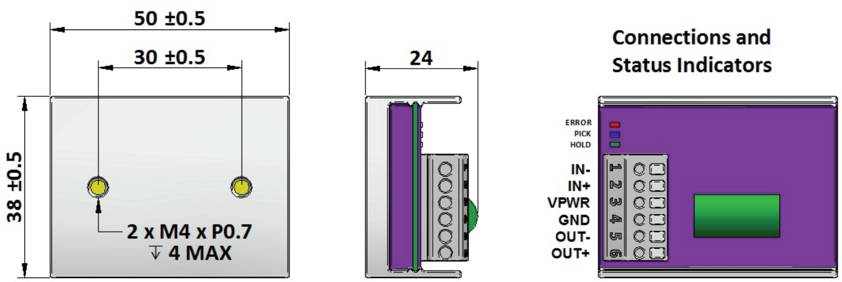
Module P/N	Supply Range (V)	Load Constraints	Pick Current	Hold Current	Pick Time (ms)	Input	Mating Connector
PHu-24	6-27 VDC	1mH MIN	0.1-25 Amps	0.1-25 Amps	2-512 ms	5-24V isolated	Not Required
Phu-24-Kit	Comprises Phu-24 module, USB Cable, and USB with SW						
Phu-24-ANA	Comprises Analytical version of Phu-24 module, USB Cable, and USB with SW						
Accessories							
PHu-CAB1	USB cable for changing parameters or monitoring						

Please note that the continuous excitation (Hold) current may be limited by heat dissipation.

Warning – if maximum Supply Voltage is exceeded by more than 10% permanent damage may be caused to the module

PHu24 – Mechanical Dimensions

Standard module configuration is mounted in extrusion and potted (encapsulated) with epoxy resin.



The module should be set up before use using the USB cable which is available as an accessory. A user friendly interface allows current and time parameters to be set up and saved, and also allows monitoring of the switching device temperature to confirm operation is within safe limits in a wide range of ambient conditions.

PHu Application Note

REQUIREMENTS

A PHu module is required, with programming cable, and PC with programming Software. Other than these items a load device is required, and Power Supply able to supply voltage and current appropriate to the application, and within the limitations of the PHu module being used.

SOFTWARE INSTALLATION

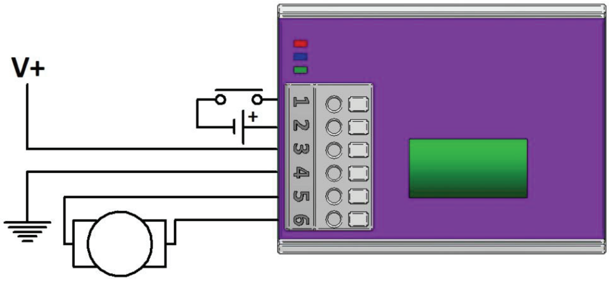
The folder containing software should be copied to the PC being used for programming. It is recommended that the complete folder is copied as it is important that all the programmes are in the same folder on your PC.

The Setup programme "CDM20828_Setup.exe" should be run to install the drivers required to programme the PHu module.

Double clicking the ‘Programmer’ icon will start the programming software.

PHu CONNECTION

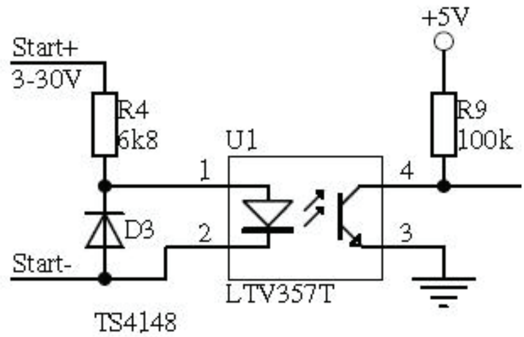
The PHu module has six connections on a WAGO terminal block, to connect to these simply push down the white button on top of the terminal block as stripped lead is inserted in the corresponding hole.



The load is connected between terminals 5 & 6.

The positive supply is connected to terminal 3, and ground to terminal 4. ***DO NOT apply voltage greater than 27v DC as this will damage the module.***

Terminals 1 (Positive) and 2 (Negative) are opto-isolated inputs. The input circuit is as shown below, Applying 5v-28v to this will switch the circuit 'ON'. Higher control voltage may be used if appropriate resistance is inserted to limit current (see LTV357T data for details).

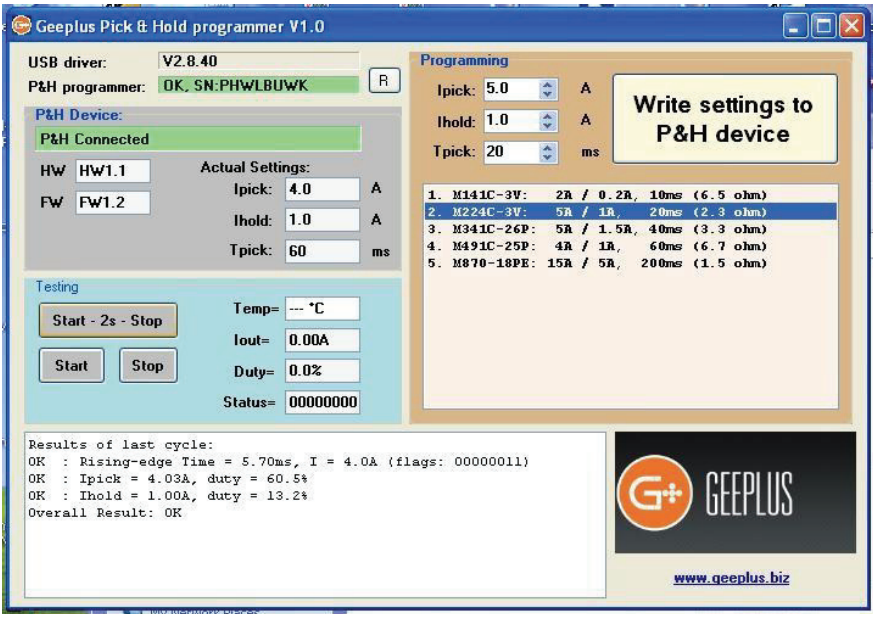


For setup & testing while the module is connected to a PC it is possible to switch the solenoid on ('START') and off ('STOP') from the PC without using the control input.

In addition to 'START' and 'STOP' control buttons, the software also has a timed BUTTON 'START – 2s – STOP' which energises the test device for 2 seconds only. This function is recommended for initial testing of force as the timed pulse limits the amount of energy delivered, and so limits the self-heating and reduces the possibility of overheating and damaging the solenoid'. Once it has been established that sufficient force can be developed, the thermal behaviour of the system should be considered to ensure the chosen device will not overheat.

PROGRAMMING

The programming cable plugs into a Molex connector above the WAGO terminal block, this connector is polarised and connection should be self-evident. With a load and power supply connected and turned on, the programming software is run. The programme should recognise if a PHu module is connected and powered, if this is not recognised click on the button labelled ‘R’ to reconnect. You should see a screen as below.



As it opens up, the programmer defaults to the smallest values for safety, you can pick a device of appropriate size as a starting point, press the button ‘Write Settings to P&H Device’ to store these settings in the module.

You can edit the ‘Pick’ and ‘Hold’ current settings and ‘Pick Time’ as desired before writing settings to the module.

For setting up current values, you can use the grey buttons to switch the load device ‘On’ and ‘Off’ without using the control input connections.

MONITORING

While the solenoid is energised ('ON' condition), the programme interface monitors the operating conditions.

Temp – this is the internal junction temperature of the switching device, this should not exceed 120 degC when the module is being used in worst-case conditions. If the junction gets much hotter than this internal protection will shut the device down

IOut – the output current

Duty – The duty cycle of PWM waveform

After de-energising the solenoid ('STOP' condition), the operating current and duty cycle for both pick and hold conditions of the last 'ON' cycle are summarised in the white text box.

If the programmed current is too high, then the current will not be able to reach this value as it will be limited by supply voltage and / or coil resistance of the load. Either a lower resistance device, or higher supply voltage may be required. It should be noted that although a device may work OK in the cold condition, as it heats up the coil resistance will rise. In the cold condition, the duty cycle should typically be 70% or less to allow for this.

STATUS INDICATORS

Three LED's provide status indication.

The **BLUE** LED illuminates during 'PICK' operation

The **GREEN** LED illuminates during 'HOLD' operation

The **RED** LED indicates an 'ERROR' conditions.

SELECTION OF SOLENOID FOR PICK & HOLD

This is a general guide as requirements of an application may dictate other constraints on Pick and Hold current levels.

As a very rough guide, a solenoid should be selected which is operating at about 5-10% duty cycle at the system voltage. If the solenoid coil is specified by voltage (at 100% ED), then the coil voltage chosen should correspond to $V_{supply} / \sqrt{10}$, if the solenoid coil parameters are presented in a table then pick a coil which provides operation at 10% ED at the rated supply voltage.

Ideally, the solenoid should be mounted in the end application, and set up with worst-case operating conditions (maximum ambient temperature, minimum supply voltage).

With the circuit connected to a PC, the 'Pick' and 'Hold' currents and 'Pick Time' duration can be adjusted to determine conditions which satisfy the force, speed, and power requirements of the application.

For applications where high force is required to overcome a large load, the pick time may need to be sufficiently long for the solenoid to pull in to the energised position and settle before current is reduced to the holding level.

For applications requiring high speed, it may be preferable to drive with maximum possible power for a very short 'pick' time, as the initial acceleration has greatest influence on the overall response time.

When the device is switched off, the text box in programming software will display the current and duty cycle for both pick and hold operation. Ideally the duty cycle should be within the range of 10-90%, the module can operate outside this range but this leaves some leeway for variation in supply or temperature conditions.

While the solenoid is 'on' the junction temperature of the switching device is displayed, this should not exceed 130°C max under worst case conditions.

There are four typical application areas where pick and hold circuits offer benefits.

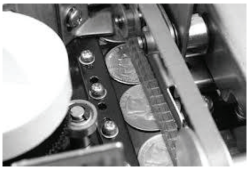
Distributed Systems

Locking systems for railway carriage doors would be a good example of a distributed system, the actuators are distributed through the length of a train, with large voltage

fluctuations possible and big variation in ambient temperature conditions. The Pick and Hold circuit stabilises performance due to these fluctuations, and reduces power consumption and heat dissipation. Other examples could be mail sorting, fruit sorting, or car stacking parking systems.

Fast Actuation

Cash sorting equipment requires very fast actuation and frequent cycling. A high current is applied to achieve high force and rapid acceleration and current is then reduced to avoid excessive heat dissipation.

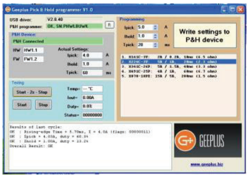


Reduce Heat Dissipation

Pinch valves are used to control flow of blood in dialysis equipment, or chemical reagents. High force is needed to clamp shut the tubing in these devices. Because blood products and chemicals are very sensitive to heat, pick and hold drive helps maximise the force obtainable with minimal heat generation.

Development Tool

The extreme ease of use of Geeplus PHu module makes it invaluable as a development tool, it allows device excitation conditions to be easily adjusted without hardware changes to establish suitability of a solenoid, and determine optimum driving conditions.



Vibration actuators

GEEPLUS Vibration Actuators

There are a number of applications where vibrating motion is required, for which simple solenoid actuators are not ideally suited, and for which moving coil actuators although technically suitable are a costly option. Geeplus offers some simple bidirectional actuators to address such requirements.

These devices are based on a laminated stator assembly with multiple poles for good force generation, and a simple armature assembly comprising a steel plate with multiple magnets forming the poles.

The devices are offered as a set of stator and armature parts for incorporation into customers own assembly, or as an integrated module with steel flexures allowing linear motion and maintaining separation between the two.

Where separate stator and armature are used, it should be noted that a strong attraction force is developed between these, and support structure must withstand this force and maintain separation between the two parts.

Amplitude will be larger if the assembly is driven near to its resonant frequency. Applications include linear conveyors, liquid mixing, or powder compacting devices.

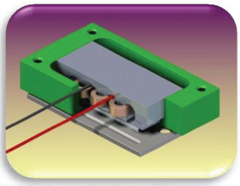
GEEPLUS Vibration Actuator

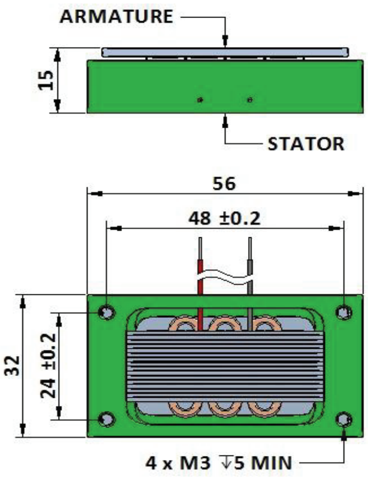
P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20°C

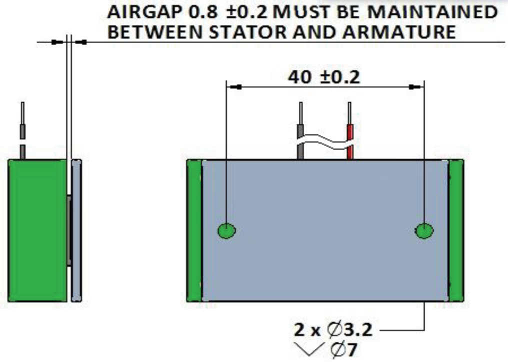
P_{100}	**2.5 W**	**Total Mass**	**86 g**
T_{max}	**80 °C**	**Armature Mass**	**30 g**

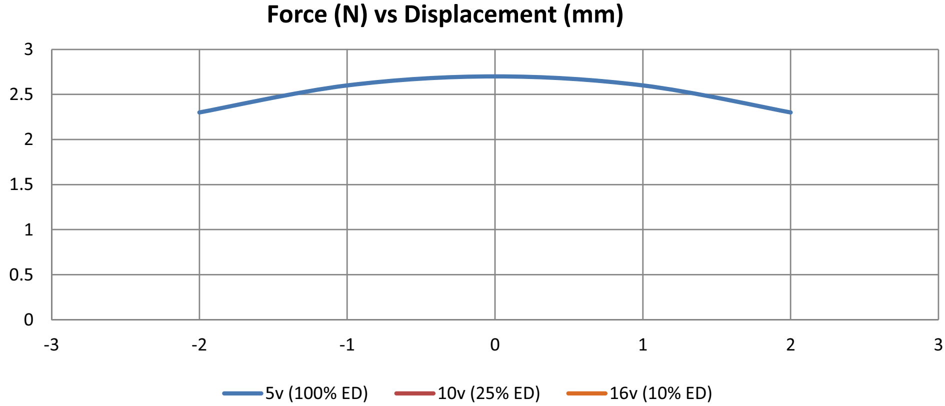
Model No.	Resistance R_{20}	Inductance
HAP56-10	**10.0 Ω**	**0.6 mH**

The HAP56 actuator is designed to generate linear vibration when energised with an AC signal. It will develop a high force over displacement of 3-4mm for excitation power of only a few watts. It can be used to generate tactile feedback for MMI applications, or as a motion generator for linear conveyors / component feeders









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www.geeplus.biz e-mail: info@geeplus.biz

GEEPLUS VIBRO1

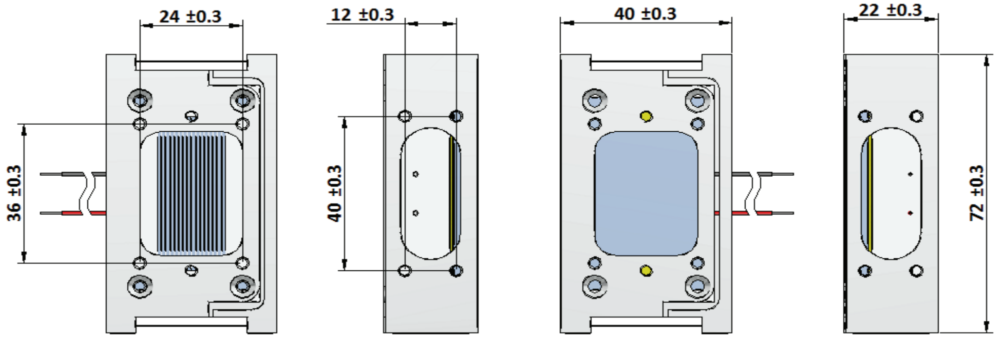
P_{100} is the continuous (100% ED) excitation power at which the coil attains temperature T_{max} with the part mounted to a massive heatsink at 20^{o}C

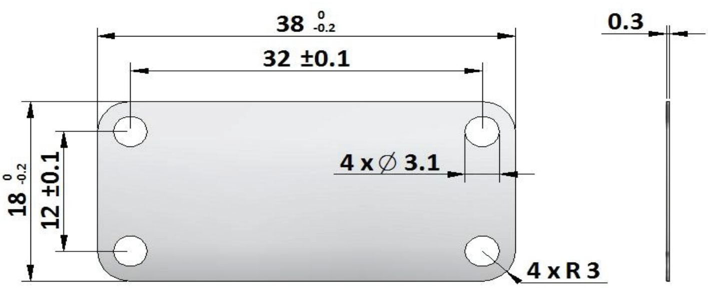
P_{100}	**2.5 W**	**Total Mass**	**150 g**
T_{max}	**80 ^{o}C**		

Model No.	Resistance R_{20}	Inductance
VIBRO1-10	10.0 Ω	0.6 mH

The VIBRO1 incorporates a HAP56 actuator in an easily mounted cast body with steel flexures for support. The VIBRO1 facilitates simple implementation of small vibratory assemblies.

4 x mounting holes in each face are M3 x P0.5, maximum 3 deep





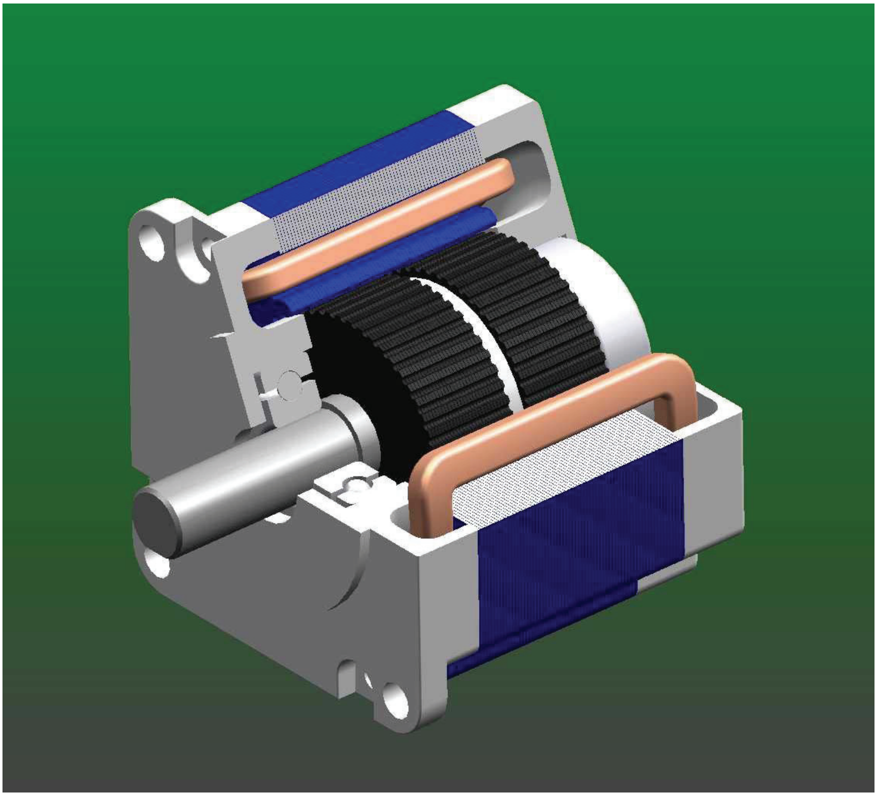
87-1044

The steel flexure 87-1044 can be used to provide support to vibrating loads driven by the VIBRO1 or HAP56 actuator devices. Either end should be securely clamped between flat surfaces.

Hybrid Stepping Motors

Hybrid Stepping Motors

Hybrid motors employ a design in which the polepieces are subdivided into smaller ‘sub-poles’. The large number of these sub-poles imbues these devices with high torque and a small basic step size allowing precise positioning.



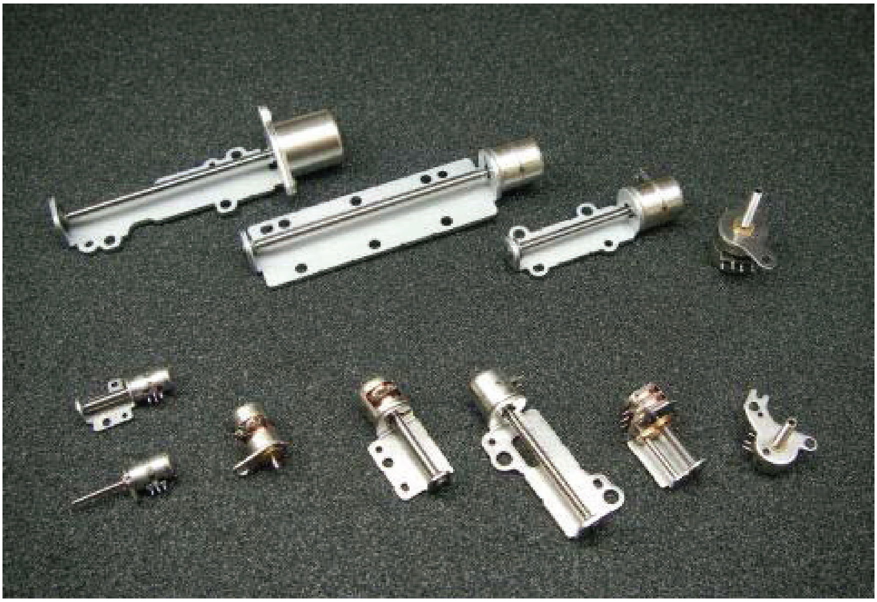
The large number of sub-poles also means that the polarity of the magnetic field in each pole must be reversed many times to complete revolution, as the speed of rotation, and frequency of these polarity reversals increases, magnetic losses in the stator assembly increase. This limits the maximum rotational speed of stepping motors.

Geeplus offers hybrid stepping motors in the following types / sizes.

- 2-phase motors are offered in a range of sizes from Nema size 08 (20mm square) to Nema size 42 (110mm square)
- 3-phase motors are offered in sizes from Nema size 17 (42mm square) up to Nema size 42 (110mm square)
- 3 degree step angle – a few motors are offered with 3 degree step angle in Nemasize 23 (57mm square). This larger angle may permit higher rotational speeds.

PM micro stepping motors with leadscrew

For high volume applications, Geeplus can offer small PM stepping motors in size from 4.3mm up to 10mm with integrated leadscrew assembly. These are intended for mechanisms such as focussing assembly in cameras. MOQ for these items is 10k pcs / lot.



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