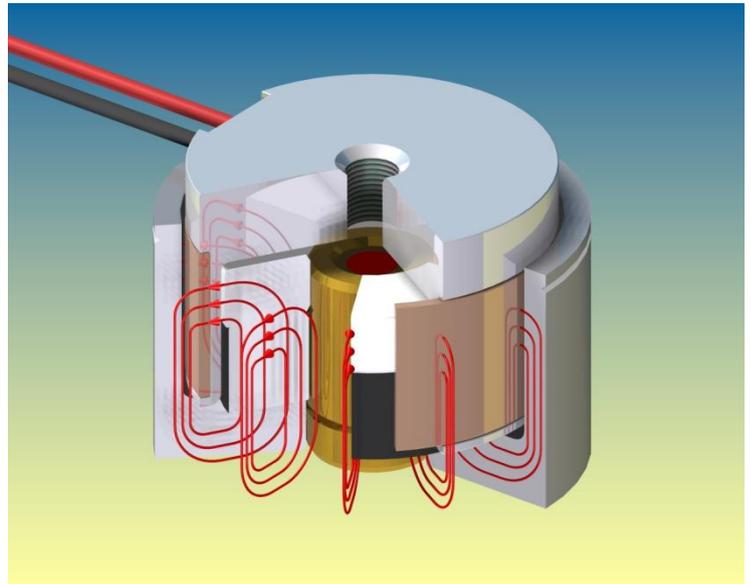




Voice Coil Motor Characteristics

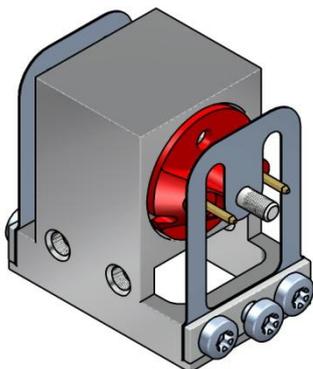
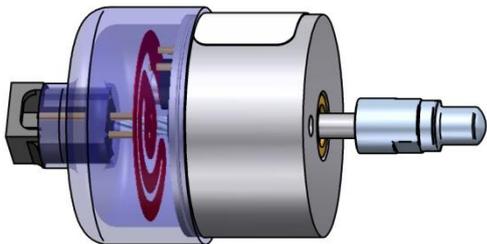
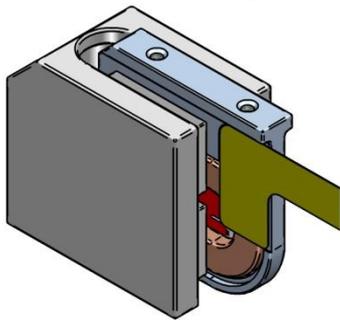
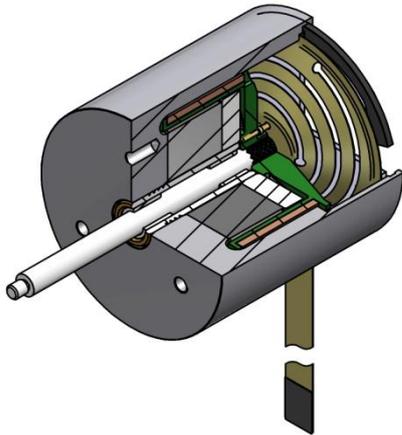
Voice Coil Motors are highly controllable electrical actuators suitable for applications needing only limited displacement. They offer the following features:

- 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

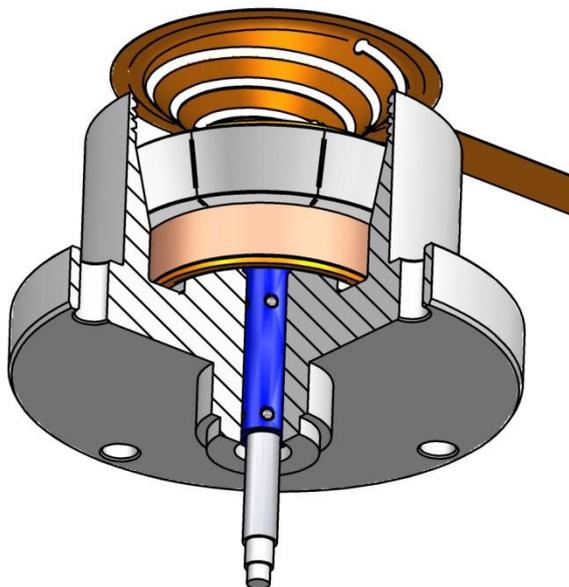
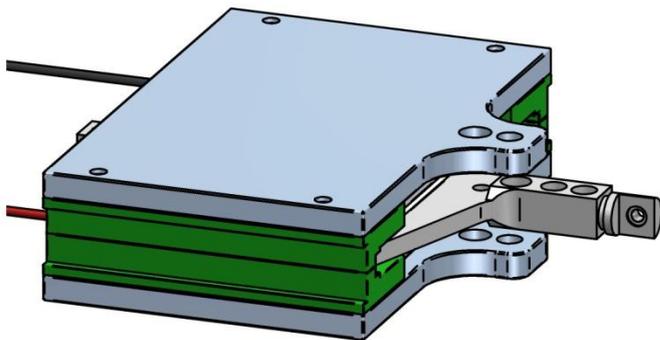
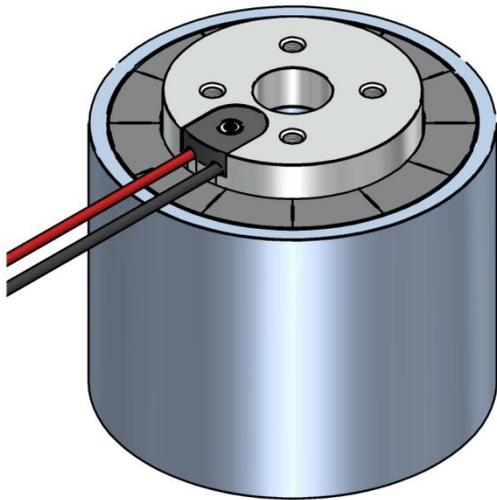


Custom Designs

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

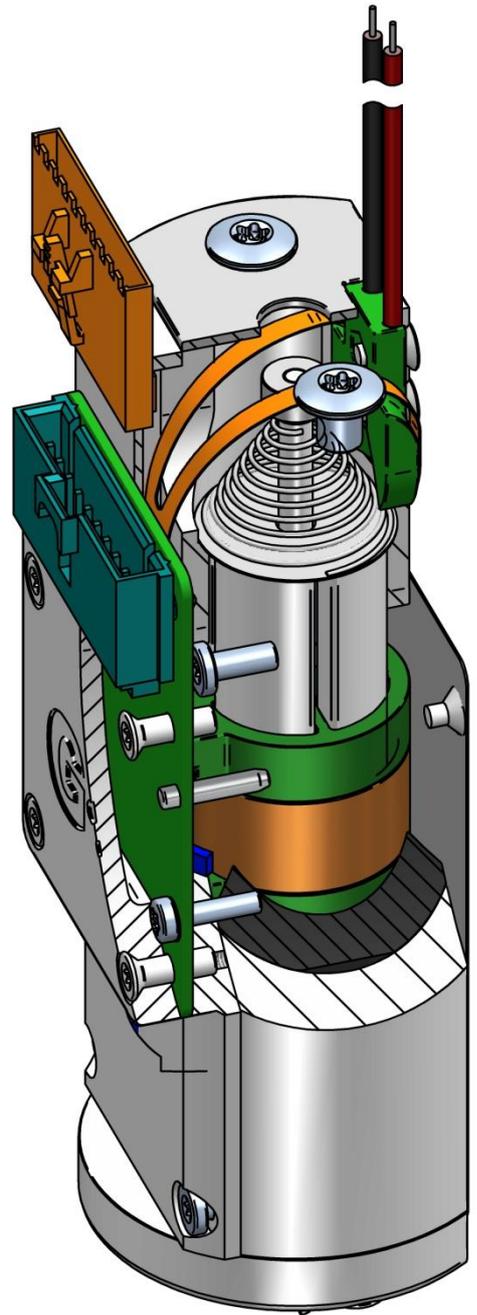


- Multiple poles for higher force and efficiency with reduced size and mass, use of multipole designs may be inappropriate to applications requiring large displacement

- 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 $>50\text{N}$ peak with coil mass $<12\text{g}$ for acceleration capability $>400\text{G}$

- 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 $<1\mu\text{m}$ 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 0°C to 130°C.

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).

