1S120M Linear Reciprocating Motor/Alternator

General Arrangement

The RIX 1S102M linear motor provides approximately 100W mechanical power at its integral piston, when operated at full stroke in a resonant condition at 60 Hz. Off-resonant operation increases the reactive portion of the back EMF, decreasing the available output. Typically, some pressurized fluid is required at the piston to absorb the developed power and tune resonance to 60 Hz. The natural frequency in open air operation is approximately 39 Hz.

Physical Description

The 1S102M resonant linear base motor consists of an iron and copper wound stator, a permanent moving magnet plunger, a flexure suspension, and enclosing mounts that also provide over stroke stops. A standard piston is integral with the motor plunger, but custom pistons may be user-specified upon request. The 1S102M may be used with any combination of inert gases, such as helium and argon, and other common gases such as air and nitrogen, within its normal operating temperatures. Hydrogen should not be used with the 1S102M as the magnets will be compromised.

The linear motor, if enclosed in an inert atmosphere, has an expected lifetime of at least 100,000 hours, barring any trauma to the flexures or magnets. There are no wearing parts in the motor and no traditional bearings or sliding seals.

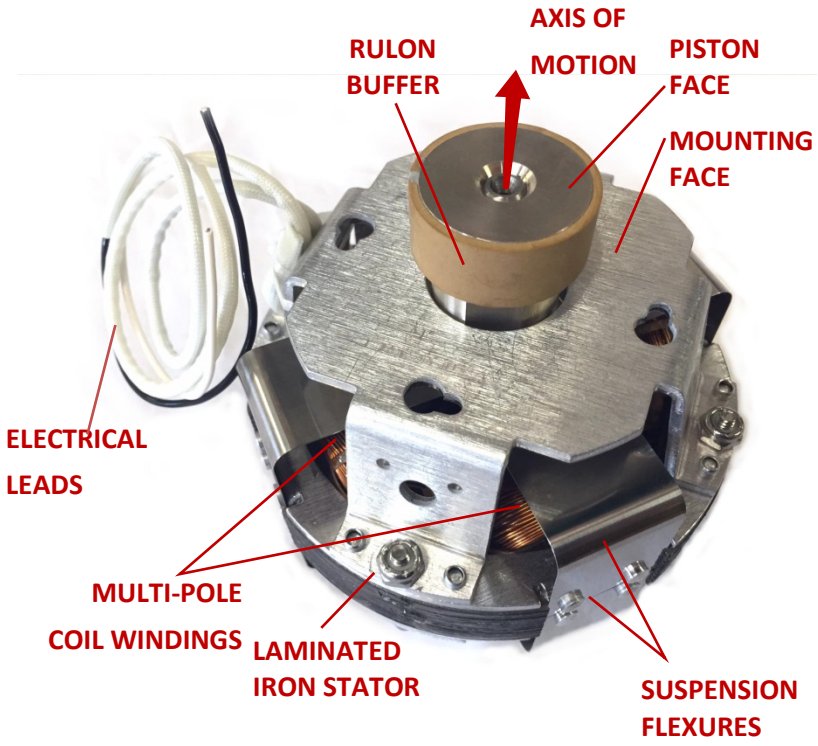

Figure 1 - Motor Components

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Connections & Components

The connections and major components for the 1S102M are described in Table 1 & Figure 2.

Table 1: 1S102M Motor Connections

No.	Item	Functions
1	Mounting Face	Provides surface perpendicular to motor motion
2	Pilot Diameter	Provides reference surface parallel to motion, concentric with piston outside diameter
3	Keyholes	Provides attachment points for #6 screws
4	Electrical Leads	Deliver power to motor: • White is positive (+) • Black is negative (–) Positive voltage makes piston move "forward"
5	Piston	Delivers Output Power

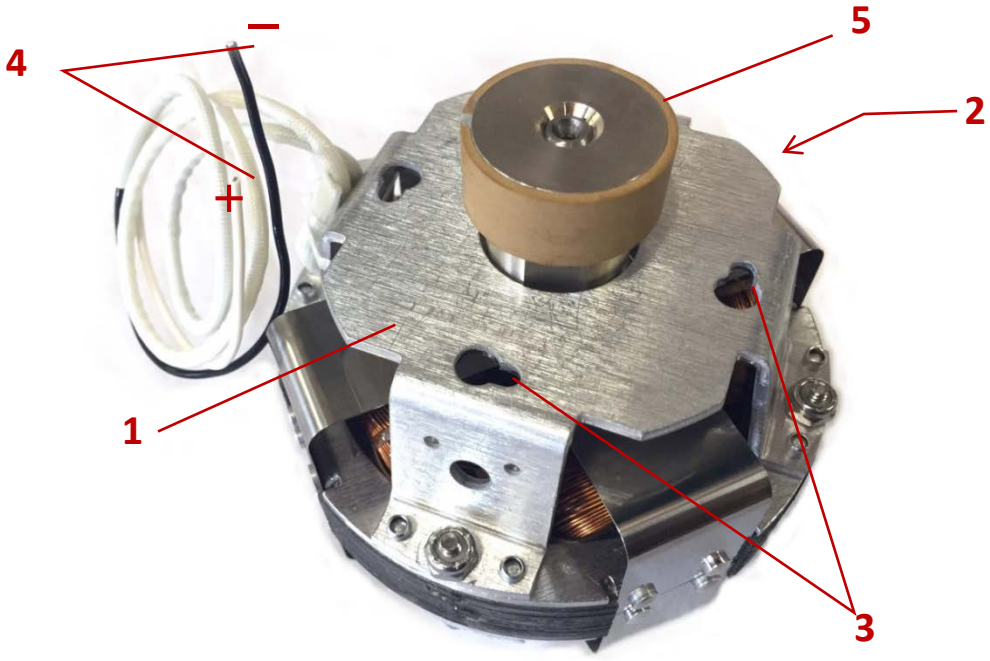

Figure 2 - 1S102M Connections. Note that the mounting surface, pilot diameter, and the piston's rulon buffer are all unfinished in this view.

Operation Principle

- An AC voltage is applied to the leads of the mounted motor.
- Current flows through the coils, inducing an alternating magnetic field in the iron stator.

- The stator field alternately attracts and repels permanent magnets on the plunger, which are arranged in two axial layers of opposing polarity, such that a positive current and stator field attracts one layer and repels the other; and a negative field attracts the other and repels the first.
- The driven motion of the magnets is shared by their supporting structure, which includes the piston. Power is delivered to that piston for practical application.

Mounting

The motor must be mounted before operation. This is done by providing a flat surface with four socket-head cap screws (size 6) equally spaced on a 2.31 inch (5.87 cm) circle, concentric to the piston axis (and mating bore if provided). The screws must have sufficient length to remain engaged when their heads are 0.1 inch (2.5 mm) from contact with the mounting surface.

To mount the motor, install all four screws, leaving 0.08 to 0.10 inch (2.0-2.5 mm) of exposed shank under their heads. Do not tighten yet. Place the motor over the screws, guiding the heads into the larger ends of the four keyhole opening on the motor mounting face. Rotate the motor to bring the screw shanks to the small ends of the keyholes. Insert a long hex key through the keyholes at the opposite end of the motor at tighten the screws. Take care not to damage the flexures or insulation on motor windings (wires) with the hex key tip during insertion or removal.

Load attachments

Normally, this type of motor is used to drive an *acoustic* load. The most common means is a close-fit clearance-seal cylinder that is coupled to some acoustically-driven component such as an acoustic ('pulse-tube') cryocooler. Such clearance-seal/cylinder couplings can be used to adapt these motors for use in Stirling systems, and they can also be used to drive reed valves in oil-free compressors. Contact RIX for further advice on how to adapt one of these motors to a given acoustic load, or how to properly prepare a matching cylinder to mate with the motor.

Direct mechanical attachments to the moving piston are possible in principle, although the standard motor has no provision for such attachments. **Great care must be taken if directly attaching mechanical loads**, because the flexure suspension defines an axis of motion for the plunger, as implied in Figure 1. If the mechanical load attached to the piston/plunger has its own defined axis of motion (as is the case with most mechanical linkages, or guided bearings) it will most likely compete with the motor's own defined axis of motion unless great care is taken to align them. For this same reason, **we strongly discourage the use of mechanical springs** to alter the natural resonance of the motor, because nearly all spring types impose their own radial or lateral forces, in addition to the axial spring force. **Competing axes of motion will risk damaging the motor suspension and shortening the life of the motor**.

The actual motor test parameters will be provided at time of shipment. Estimated parameters for RIX's standard 1s102M motor are as follows:

Nominal Input Power Rating	125 W at 60 Hz, 10 mm stroke
Rated Acoustic Output (@ 60 Hz)	Acoustic power as driver – 90 W
Stator Resistance	7 ohm
Stator Inductance	84 mH @110 VAC RMS
Rated Voltage/Current (0.85 power factor)	110 VAC 1ø rms @ 60 Hz/2.0 A rms
Stroke Limit (centered within 1 mm)	12 mm
Nominal BL Product at Maximum Voltage	46.5 N/Ampere
Intrinsic Stiffness (approximate)	31 kN/m
Damping, Rm	5.0 N-s/m
Total Mass	1.896 kg (incl. piston & shaft)
Moving Mass	0.49 kg (with 1.15” piston)
Outside Diameter	102 mm