

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
- LIGO -
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LIGO-L1000320-v2

2010/12/29

Linear motor specification

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1 Introduction

This specification is for an in vacuum linear motor. As detailed below, the motor must meet requirements for function, for materials, and for dimensions. The motor will be engineered and built by the vendor. The specifications listed here are not absolute, and we welcome discussion wherever modifications are necessary. The design package will include CAD models (SolidWorks preferred), machine drawings, and if necessary assembly procedures. The motor will be delivered dis-assembled for cleaning by LIGO.

We request a quotation for 18 units.

The linear motor will actuate a vertically moving mirror using a moving coil geometry. Both for efficiency and for shielding, the motor will have a substantial flux return for the magnet(s). A sketch of the motor and its intended use is shown in Figure 1. This design work includes the magnets, flux return, coil, and coil holder.

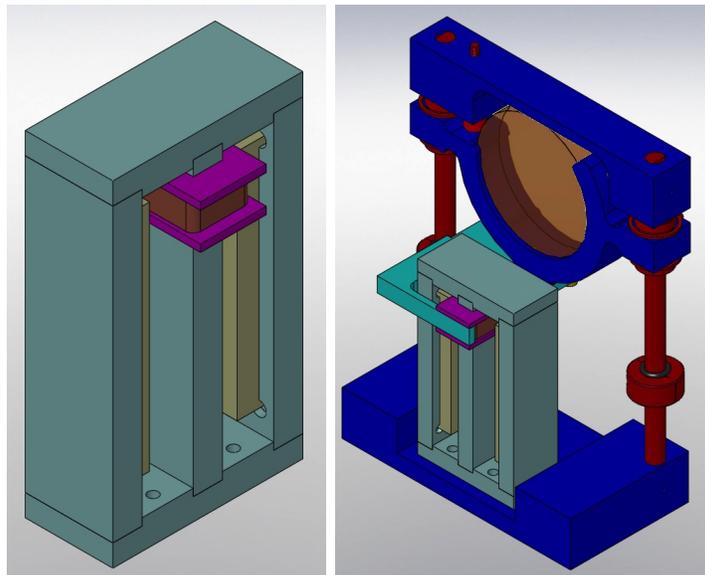


Figure 1: Left: A sketch of a linear motor with moving coil. Right: The motor integrated with the moving mirror. The interface piece is shown in cyan.

References

- [1] **LIGO vacuum compatible materials list** E960050-v5
- [2] **Qualifying Parts for LIGO UHV Service** E1000088-v1
- [3] **Metal components intended for use in the Adv LIGO Vacuum System.** E0900364-v3
- [4] **Galling Tendencies and Particles Produced by Ultra Clean Screw Threads.** T040111-v1

2 Requirements

1. Approximately 2" of travel. Minimum travel of 1.5".
2. 0.5 lbs. of force or greater.
3. Less than 10 W power dissipation.
4. Total foot print less than 1.5" wide and 3" long. Total height less than 3.0". Best effort for 0.75" x 1.75" x 2.75".
5. Preference for MWS Wire Industries 32HML or 32QML polyimide insulated copper wire.
6. All materials must be compatible with the LIGO UHV service. Such materials include:
 - ceramics: alumina, boron nitride, macor
 - wire: MWS Wire industries 32HML or 32QML polyimide insulated copper wire.
 - Aluminum and aluminum alloys (wrought form)
 - Carbon steel (particularly if electroless nickel plated)
 - OFHC copper, copper nickel alloys, beryllium copper
 - NdFeB or SmCo magnets, bare or nickel coated
 - Stainless steels including A286 and 400 series. (No 303 stainless)
 - PEEK, Victrex grade TDS-450G

More materials, and a list of explicitly rejected materials can be found in Ref. [1].

7. All construction must be fabricated according to E0900354, Ref [3], summarized here:
 - Remove all sharp edges, R.02 min.
 - All machining fluids must be fully synthetic, fully water soluble and free of sulfur, silicone, and chlorine.
 - All surfaces must be machined to remove oxides and mill finish
 - Use of abrasive techniques is not allowed.
 - Surfaces should have 63 μ inch finish or better.
 - All holes should be vented and hardware chosen to minimize galling (eg. silver plated or dissimilar metals as required, See Ref. [4])

More details can be found in the (long) Ref. [2] or the (short) Ref. [3] if necessary.

8. Any additional ferromagnetic material not listed here should be low phosphorous electroless nickel plated to prevent corrosion

3 Mechanical interface

There will be two mechanical interfaces: 1. at the base of the linear motor to mount the motor, and 2. to attach the moving coil to the mirror. The linear motor will be mounted at its base with 2x 8-32 tapped holes as shown in Figure 2.

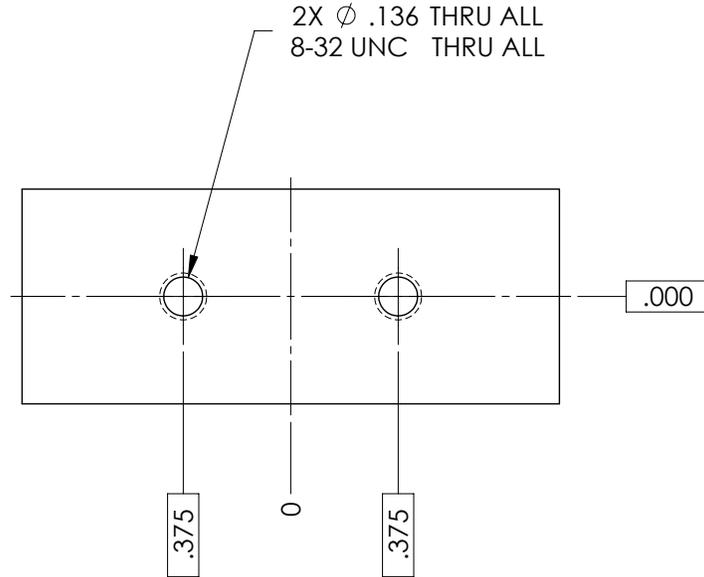


Figure 2: Location of the mounting holes on the base of the linear motor.

The moving coil will connect to the assembly with 4x 4-40 thru holes, as shown in Figure 3. The holes will be through the top surface of the coil form. Note that the coil form should be no longer than 1.625 inches.

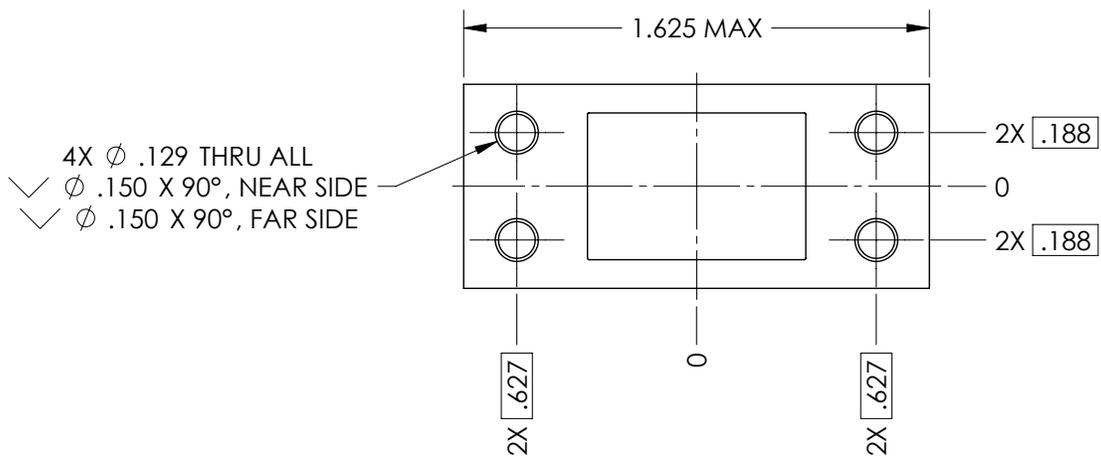


Figure 3: Location of the mounting holes on the moving coil.