COMPONENT SPECIFICATION

FARADAY ISOLATOR, 20mm

APPROVALS:	DATE	REV	DCN NO	BY	CHK	DCC	DATE
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CHECKED:							
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1 SCOPE

This is a specification for a Faraday Isolator Assembly, which consists of 1) a housing with external mounting brackets, 2) a permanent magnet subassembly, 3) a Faraday optic subassembly, 4) input/output polarizers, 5) a return beam port cover, and 6) a polarization rotation plate. The Faraday Isolator Assembly will provide isolation of orthogonal polarization of a collimated laser beam and will restore the polarization orientation.

2 LIGO DOCUMENTS

LIGO-L970196, Part Numbers and Serialization of Detector Hardware
- *http://ligo.caltech.edu/LIGO_web/dcc/docs/L970196.pdf*

LIGO-E960022-A, Vacuum Compatibility, Cleaning Methods and Compatibility Procedures
- *http://ligo.caltech.edu/LIGO_web/dcc/docs/E960022-03.pdf*

LIGO-E960050-A, Vacuum Compatible materials list
- *http://ligo.caltech.edu/LIGO_web/dcc/docs/E960050-A.pdf*

2.1. Non-LIGO Documents

MIL-C-675C, Coating Adhesion and Durability
EOT Mod. No. 1845-20 data sheet

3 REQUIREMENTS

3.1. PERFORMANCE CHARACTERISTICS

3.1.1. Faraday Isolator Performance

3.1.1.1 Transmitted Beam

Wavelength	1064 nm
Clear Aperture	20 mm
Transmissivity across clear aperture	>98.5%
Extinction ratio across clear aperture	>30dB
Wavefront distortion	<0.7λ @ 633 nm wavelength
Height of output beam above mounting surface	4.09 inches

3.1.2. Return Beam Port Cover

An optical port shall be provided to allow a return beam, which enters the output end, to exit from the polarizer housing. The port shall be covered with a movable cover to block the return beam.

3.1.3. Optical Reference Surface

The input side of the mechanical housing shall have a flat, optical reference surface which is perpendicular to the optical axis within <0.5 degrees. A removable mirror will be mounted against the reference surface to retroreflect an autocollimator beam for alignment purposes. The flat reference surface shall have fiducial marks which define the center of the input optical axis within <0.5mm.

3.1.4. Polarizer Alignment

The polarization axis of both polarizers shall be rotatable about the optical axis to any angle with respect to the horizontal mounting surface of the Faraday isolator assembly, with an angle reproducibility of <0.5 degree.

3.1.4.1 Polarization Rotation

The half-wave polarization retardation plate shall be rotatable about the optical axis to any angle with respect to the horizontal mounting surface of the Faraday isolator assembly, with an angle reproducibility of <0.5 degree.

3.2. DESIGN AND CONSTRUCTION

3.2.1. Materials

3.2.1.1 Faraday Rotator Optic

material	TGG crystal.
input and output surface wedges angle	>1 deg,

An antireflection coating shall be applied to both surfaces of the Faraday optic; to be purchased from REO (Research Electro Optics).

Wavelength	1064 nm
Transmissivity per surface	>99.9%
Durability	MIL-C-675C

3.2.1.2 Input/output Polarizer

material	optical quality calcite.
surface orientation	Brewster's angle @ 1060nm, all surfaces
wavefront distortion	<1/2 waves, @ 633 nm

3.2.1.3 Polarization Rotation Plate

material	quartz
phase retardation	1/2 wave @ 1064 nm

retardation order	zero order

An antireflection coating, to be purchased from REO (Research Electro Optics), shall be applied to all four surfaces of the half-wave plate,.

Wavelength	1064 nm
Transmissivity per surface	>99.9%
Durability	MIL-C-675C

3.2.1.4 Allowed materials

The standard materials used in EOT Model No. 1845-20 shall be allowed, except for the listed disallowed materials. See “Disallowed Materials” on page 3. It is desirable that materials conform to LIGO document “LIGO-E960050, Vacuum Compatible materials list”. Some elastomers may be allowed subject to approval by cognizant technical personnel.

3.2.1.4.1 Part Machining

3.2.1.4.1.1 Liquid contaminants/Machining Lubricants

Liquids containing hydrocarbons or other contaminants, other than the machining fluids specified herein, shall not be allowed to come into contact with suspension material at any time. All machining fluids shall be water soluble and free of sulfur, chlorine and silicone; such as Cincinnati Milacron’s Cimtech 410 (stainless steel).

3.2.1.4.1.2 Grinding & Abrasive Cloth/Paper

Grinding (with abrasive wheels, cloth, or stones), or use of abrasive cloth or paper, is permitted, except where noted, if the ground or impacted surface is subsequently skimmed with a carbide tool to remove any residual contaminants. The use of oil free Arkansas stones are also approved to remove slight imperfections in the machined surfaces.

3.2.1.5 Disallowed Materials

The following materials shall not be used: organic materials, vacuum grease, adhesives including epoxy, anodizing, lubricants.

3.2.2. Physical Dimensions

3.2.2.1 Overall Size

The overall envelope size shall not exceed 4.0in width X 6.0in height X 13.0in length. See figure 1.

3.3. Quality Assurance/Control

3.3.1. Identification

Separate (non-welded) parts and assemblies shall be marked with laser marking or acid etch techniques. A vibratory tool with a minimum tip radius of 0.0005” is acceptable for marking on surfaces which are not hidden from view. Engraving is also permitted.

Separate (non-welded) parts and assemblies to be serialized according to the document titled Part Numbers and Serialization of Detector Hardware, LIGO-L970196. This document allows for “bag-and-tag” type of identification for small parts.

3.3.1.1 Serial Number

3.3.1.1.1 Serial Number

3.3.1.1.2 A serial number shall be etched, embossed, or marked with a stylus on each fabricated piece part of the assembly.

3.3.1.1.3 Serial Number Format

The Serial number shall be of the format:
Dxxxxxx-y S/N *nnn* Where

Dxxxxxx-y is the LIGO piece part or assembly drawing number, Dxxxxxx, including the revision letter, -y, to which the hardware item was built, and

nnn is the sequential serial number, 001 through 999, in the order produced.

3.3.2. Quality Assurance Provisions

A first article shall be produced and inspected for form, dimensions and workmanship.

3.3.3. Purchaser Access

Non-escort privileges for the buyer, owner, government and owner representatives to all areas of the facilities where work is being performed shall be arranged. This will include access to all areas where material is being processed and stored. The purchaser shall have the right to witness all manufacturing processes.

3.3.4. QA Approval

LIGO QA reserves the right to inspect and approve vendor/fabricator QA plan and processes.

4 TEST PROCEDURES

4.1. Optical Surfaces

4.1.1. Visual Surface Inspection Test

All optical surfaces shall be free of visible stains and surface defects, when illuminated with a high-intensity lightsource and viewed in a darkened environment with the unaided eye.

4.1.2. Extinction Ratio Test

Extinction ratio for orthogonal polarizations shall be measured, using the specified light source. See “Light Source” on page 5.

4.1.2.1 Light Source

A collimated laser beam with 1064 nm wavelength and >9.0 mm Gaussian beam waist diameter measured at $1/e^2$ power diameter shall fill the clear aperture when making transmissivity and extinction ratio measurements.

4.1.3. Transmissivity Test

Transmissivity through the clear aperture shall be measured with the specified light source. See “Light Source” on page 5.

4.1.4. Wavefront Distortion Test

Wavefront distortion over the clear aperture shall be measured at 633 nm wavelength with an appropriate interferometer.

4.2. Mechanical Component Cleanliness Test

4.2.1. Ultrasonic Cleaning Test

The mechanical components of the Faraday Isolator Assembly shall yield no visible debris in an ultrasonic bath after a single cleaning, done in the following manner.

- Ultrasonic clean in Alconox (1 tbs to 1 gal water) or Liquinox for 10 minutes
- Rinse in distilled water
- Ultrasonic clean in ethanol for 10 minutes
- Rinse in distilled water

4.2.2. Q-Tip test

The mechanical components of the Faraday Isolator Assembly shall yield no debris or visible contamination to a manually applied Q-Tip wipe, following the ultrasonic cleaning procedure. See “Ultrasonic Cleaning Test” on page 5.

5 DOCUMENTATION

1) Interferogram of transmitted wavefront across clear aperture. See “Wavefront Distortion Test” on page 5.
2) Transmissivity through clear aperture. See “Transmissivity Test” on page 5.
3) Extinction ratio for orthogonal polarizations through clear aperture. See “Extinction Ratio Test” on page 5.
4) Compliance Certification for this specification
5) Calibration certification for the test equipment, as appropriate
6) Inspection report
- dimensional verification
- test results
- materials list
- vacuum bakeout results
- inspection test procedure

6 ENVIRONMENTAL CHARACTERISTICS

The PO Telescope will operate in a non-vibrational, ultra high vacuum environment, at room temperature (68F,+/-4F).

7 HANDLING AND SHIPPING PROCEDURES

7.1. Cleaning

Approved cleaning procedures for UHV components are detailed in LIGO-E960022, Vacuum Compatibility, Cleaning Methods and Compatibility Procedures.

7.1.1. Disassembly for Cleaning

The Faraday Isolator assembly will be disassembled for cleaning of the components including: 1)housing with magnet, 2) Faraday optic, 3) polarizers, and 4) half-wave plate

7.1.2. Magnet and Housing

The Magnet housing with assembled magnet shall be ultrasonically cleaned in appropriate solvents and vacuum baked at 50 deg C with a pressure < 1×10^{-6} Torr for 24 hours.

7.1.3. Optical Surfaces

All optical surfaces shall be cleaned in accordance with good commercial practice. Nothing shall contact the optical surfaces after cleaning, except for lint-free lens tissue.

7.1.4. Mechanical Parts

Mechanical parts shall be degreased in a clean solvent and shall be subsequently cleaned in an ultrasonic bath in the following manner.

- Ultrasonic clean in Alconox (1 tbs to 1 gal water) or Liquinox for 10 minutes
- Rinse in distilled water
- Ultrasonic clean in ethanol for 10 minutes
- Rinse in distilled water

7.2. Packaging for Shipment

7.2.1. Optical Parts

The cleaned optical components shall be protected with 6 layers of lint-free lens tissue. In addition, all components shall be wrapped in UHV quality aluminum foil and placed in a sealed, clean polyethylene bag before shipping, as described in 7.2.2.

7.2.2. Mechanical Parts

Cleaned mechanical parts shall be wrapped for shipping as follows:

(a) wrap the part(s) with UHV quality aluminum foil
(b) Place each part(s) in a clean polyethylene bag. Optionally use an anti-static bag fabricated from “CP Stat 100(TM) ESD poly sheet cleaned to Class 100".
(c) Place “PRE-CLEAN PART...” and identification labels outside bag.
(f) Place the bagged part(s) in an appropriate shipping container, using care to not puncture or cut the bag. Seal the shipping container closed. Attach a label with the LIGO part number (drawing number(s), including revision letter) and serial number(s) to the outside of the container.

The shipping containers must be such that they insure that the bag does not get punctured and that the parts are properly supported during transit.

The CP Stat material is ordered as follows:

FARADAY ISOLATOR, 20mm

CP Stat 100 ESD sheeting cleaned to Class 100 with CFC certification that it passes JPL specifications. At the time of this writing, it is available in various sheet and bag sizes from: Caltex Plastics, Inc.

P.O. Box 58546
2380 E. 51st Street
Vernon, CA 90058
(213) 583-4140

At the time of this writing, one source for UHV Quality Aluminum Foil is:

ASTM B-479 Dry Annealed A Allfoil
4597 Vanepps Rd.
Brooklyn, OH 44131
(216) 661-0211

8 OUTLINE DRAWING

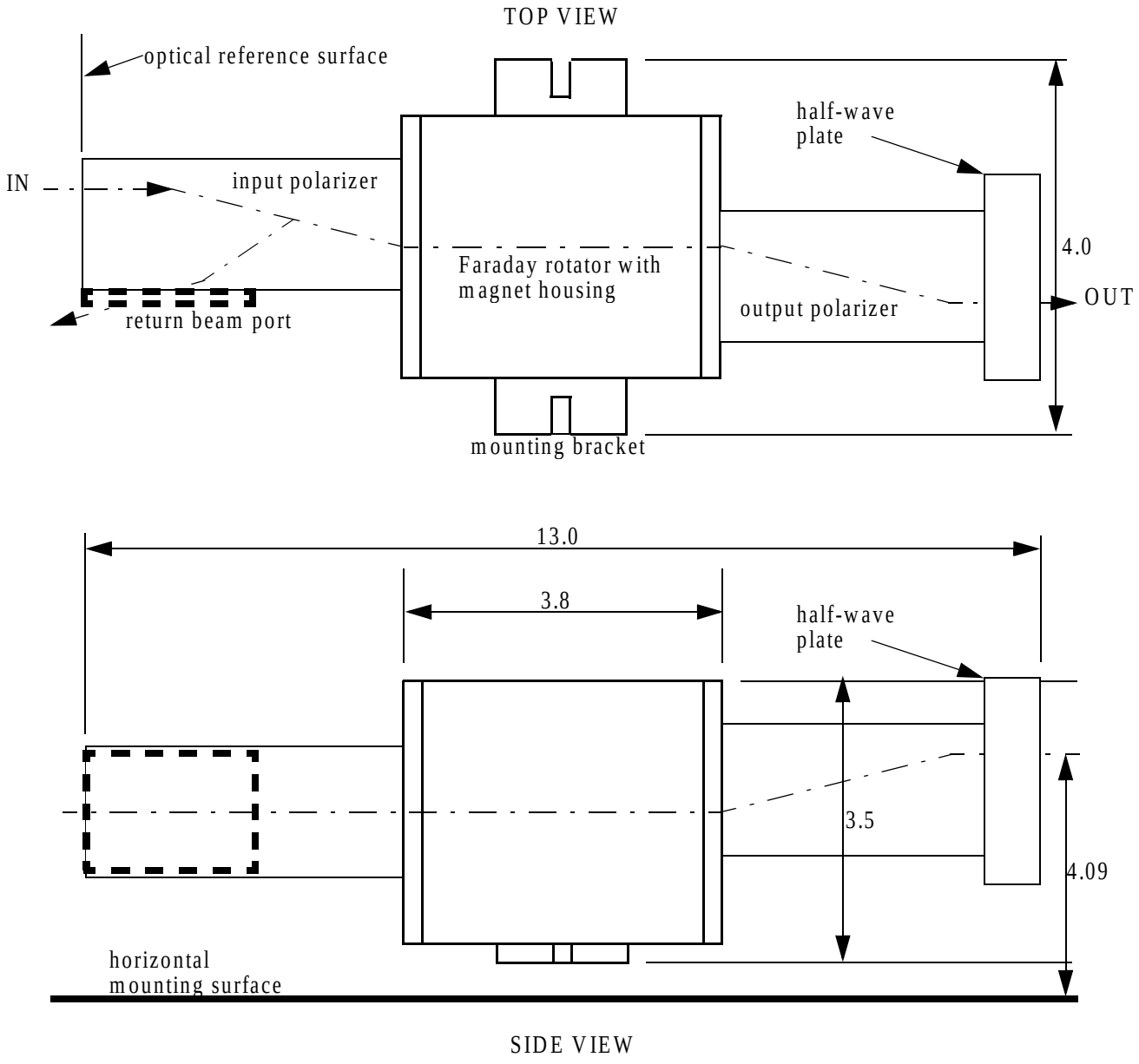

Figure 1: Figure 1: Approximate outline dimensions of Faraday Rotator Assembly