



*LIGO Laboratory / LIGO Scientific Collaboration*

LIGO-T1000192-v3

*LIGO*

1/15/13

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Output Faraday Isolator Test Plan

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of the LIGO Laboratory.

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**CHANGE LOG**

<b>Date, version</b>	<b>Summary of Changes</b>
V3_1/15/13	<ul style="list-style-type: none"><li>• Added Change Log</li><li>• Incorporated changes from Final Design Review committee</li></ul>

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**Abstract**

This document describes the plan for acceptance testing of the OFI subassemblies, and for aligning and testing the final assembly before installing in the aLIGO chambers.

## 1 Introduction

This document describes the plan for acceptance testing of the OFI subassemblies, and for aligning and testing the final assembly before installing in the aLIGO chambers.

## 2 Tests

### 2.1 Vendor Tests

#### 2.1.1 Faraday Rotator Test

LIGO will not witness the tests. The vendor will certify that they have complied with the tests, and will provide calibration certification for the test equipment, as appropriate. The vendor will supply the following test documentation: 1) Interferogram of transmitted wavefront across the clear aperture, 2) Optical transmissivity through the clear aperture, 3) Extinction ratio for orthogonal polarizations through the clear aperture.

The acceptance values for the tested quantities are detailed in E1000116-v1.

##### 2.1.1.1 Visual Surface Inspection Test

Both faces of the TGG crystal shall be free of visible stains and surface defects when the window is illuminated with a high-intensity light source and viewed in a darkened environment with the unaided eye.

##### 2.1.1.2 Extinction Ratio Test

Extinction ratio between crossed polarizers for orthogonal polarizations shall be measured, using the test light source.

##### 2.1.1.3 Optical Transmissivity Test

Optical transmissivity through the clear aperture shall be measured with the test light source.

##### 2.1.1.4 Test Light Source

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

##### 2.1.1.5 Wavefront Distortion Test

The transmitted wavefront distortion over the clear aperture shall be measured at 632.8 nm wavelength with an appropriate interferometer.

### **2.1.2 Brewster's Prism Polarizer, Half Wave Plate, Thin Film Polarizer**

LIGO will not witness the tests. The vendors will certify that they have complied with the tests, and will provide calibration certification for the test equipment, as appropriate. The vendors will supply the following test documentation: 1) Interferogram of transmitted wavefront across the clear aperture, 2) Optical transmissivity through the clear aperture, 3) Extinction ratio for orthogonal polarizations through the clear aperture.

The acceptance values for the tested quantities are listed either in the product catalog of the vendor, or in LIGO specifications for the purchased component.

#### **2.1.2.1 Visual Surface Inspection Test**

All faces of the optics shall have equal to or better than a 40-20 scratch dig surface quality over the clear aperture. The optical substrates shall be free of visible bubbles.

#### **2.1.2.2 Extinction Ratio Test**

Extinction ratio between crossed polarizers for orthogonal polarizations shall be measured, using an appropriately polarized coherent light source.

#### **2.1.2.3 Optical Transmissivity Test**

Optical transmissivity through the clear aperture shall be measured with an appropriately polarized coherent light source..

#### **2.1.2.4 Wavefront Distortion Test**

The transmitted wavefront distortion over the clear aperture shall be measured at 632.8 nm wavelength with an appropriate interferometer.

#### **2.1.2.5 Retardation of Half Wave Plate Test**

The optical phase retardation of the half wave plate shall be measured.

## **2.2 LIGO Tests**

AOS will conduct final performance tests of the assembled OFI to verify that the OFI meets the LIGO requirements.

### **2.2.1 Output Faraday Isolator Pre-alignment Test**

The OFI will be pre-aligned using the procedure described in T000083-01 and tested prior to installation in the chamber.

The acceptable values of the tested parameters are detailed in E1000116-v1, sec. 3.1

The following parameters will be measured and recorded in ICS as a test record assigned to the OFI: 1) Optical transmissivity in the forward direction, and 2) extinction ratio in the backward direction. Wavefront distortion of the OFI assembly will not be measured.

The total wavefront distortion of the OFI assembly will be calculated from the measured values of the individual in-line components. The acceptance criteria for wavefront distortion is specified at the component level.

The acceptable transmission in the forward direction is calculated from the acceptable values of the individual components. The minimum allowed extinction ratio is specified in E1000116-v1, sec. 3.1.

### **2.2.2 Final Assembly Suspension Test**

The OFI and suspension assembly will be impulse-tested and a ring-down performed to confirm that the Q of the suspended OFI meets the damping requirements.

### **2.2.3 Final Assembly Wavefront Distortion Test**

The wavefront distortion of the entire OFI optical train will be measured with a Shack-Hartmann sensor.