

**LASER INTERFEROMETER GRAVITATIONAL WAVE
OBSERVATORY**

—LIGO—

**CALIFORNIA INSTITUTE OF TECHNOLOGY
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|--------------------------------------|-------------------------|
| Document Type | LIGO-E010226-A-C |
| PMC Servo Amplifier Test Plan | |
| R Karwoski | |

Serial Number: _____

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Date: _____

Test Engineer: _____

ATP-00- to Rev A Change Record

- *Article 3.4.1 – error in the original*
Was:
With PMCSW2 grounded, apply a 50 mVpk, 1000 Hz sinusoid to J1 (PD INPUT).
Is now:
With PMCSW1 grounded, apply a 20 mVpk, 1000 Hz sinusoid to J3 (FP1TEST)
- *Article 3.4.2 – Addition:*
Float PMCSW1 (P1-6A)
- *Article 3.4.2 – Table 3-8 reduction in test value*
From: 200 mv
To: 100 mv
- *Article 3.4.3 – Addition*
Remove the LO input
- *Article 3.4.3 – Change*
Was:
Apply a variable voltage...
Is Now:
Vary the voltage from –10 volts to ...

1.0 Introduction

The tests included in this document are required to verify correct operation of the PMC Servo D980352. The ATP is applicable to Rev D, E, C boards. The test set up is depicted in Figure 1:

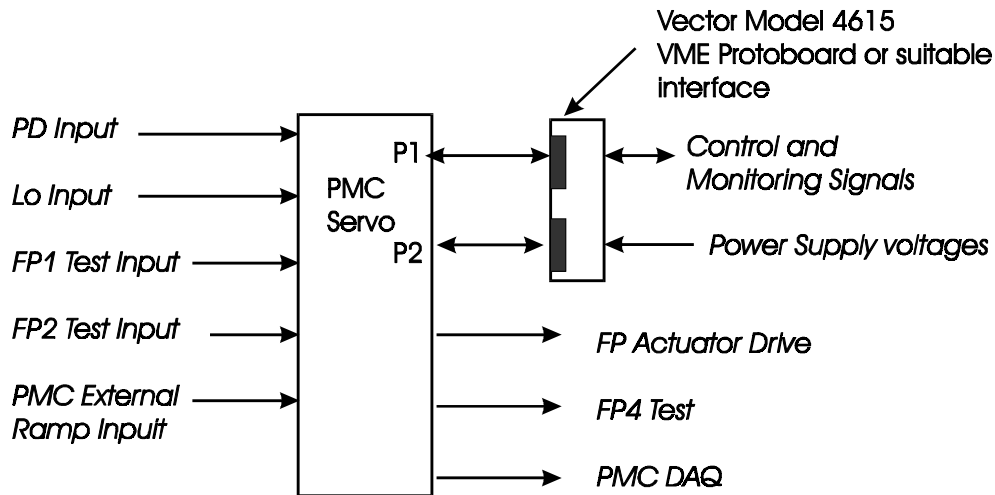


Figure 1
Test Setup Overview

2.0 Required Test Equipment

The following test equipment is necessary:

- A 2- or 4-channel Digital Oscilloscope (150MHz BW minimum)
- A general-purpose function generator capable with sinusoidal capability
- A Network Analyzer (Stanford SR785 or equivalent)
- ± 24 -V, 1-amp min power supply
- 200 volt 100 ma min power supply
- DVM
- Two Low voltage supplies (0-10 volts min) or a precision voltage source (DVC350A or equivalent)

3.0 Board Tests

There exists a header (H1) on Rev D and Rev E boards. Before beginning the tests, make certain a jumper is installed across pins 1 and 2.

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3.1 Power Supply tests

3.1.1 Supply Current Draw

- With ± 24 volts and +200 volts applied to the board record the supply currents in Table 3-1.
 1. Currents should be within 20% of nominal for acceptance.

Table 3-1
Power Supply Readings

| Supply | Nominal Current | Actual | Pass/Fail |
|------------|-----------------|--------|-----------|
| +24 volts | 100 ma max | | |
| -24 volts | 100 ma max | | |
| +200 volts | 25 ma max | | |

3.2 High-voltage Output Test

These test verify proper functionality of the PA85, high-voltage output stage (U9)

3.2.1 DC Test

- Apply -2.1 volts to PMCRAMP (P1-9A). Record the voltages at J6 (FP ACTUATOR DRIVE), J9 (FP4TEST) and the differential voltage RactDr+ – RactDr- (P2-8A/P2-8C) in Table 3-2. Measure the differential voltage between pins 2 and 3 of J10 (PMCOU DAQ) and record the results in Table 3-2.

Table 3-2
High-Voltage Amplifier DC Test

| Outputs | Nominal Reading | Actual Reading | Pass/Fail |
|----------------------------|---------------------|----------------|-----------|
| J6-1 (FP ACTUATOR DRIVE) | 100 volts \pm 10% | | |
| J9-1 (FP4TEST) | 2 volts \pm 10% | | |
| P2-8A-to-P2-8C | 2 volts \pm 10% | | |
| J10-2-to-J10-3 (PMCOU DAQ) | 2 volts \pm 10% | | |
| P1-3A (PMCOU) | 2 volts \pm 10% | | |

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3.2.2 High-voltage Amplifier AC Test

- With -2.1V still applied to P1-9A, apply a 2500 Hz sinusoid of 1.0 volts peak to J5 (FP PMC External Ramp Input). Measure the peak voltage at the FP ACTUATOR DRIVE output.
- Connect a high-voltage 1000 pf capacitor across the output and measure the peak voltage. Record the values in Table 3-2 below

**Table 3-3
 High-voltage Amplifier Readings**

| FP ACTUATOR DRIVE | Nominal Reading | Actual Reading | Pass/Fail |
|-------------------|---------------------|----------------|-----------|
| No Capacitor | 25 Volts Peak 10% | | |
| Capacitor added | 17.7 Volts Peak 10% | | |

3.3 Signal Path Tests

3.3.1 U2 Signal Path Tests

These tests verify proper operation of U2, U10, U14 and continuity to J10 and P2.

- Apply a 1.5 V peak sinusoid J4 (FP2Test)
- Verify sinewave amplitudes as specified in Table 3-4.

**Table 3-4
 U10 Test Voltages**

| Test Location | Nominal Value | Reading | Pass/Fail |
|---|--------------------------|---------|-----------|
| TP1 | 1.5 Volts peak $\pm 5\%$ | | |
| J8 (FP3TEST) | 1.5 Volts peak $\pm 5\%$ | | |
| P1-2A (PMCERR) | 1.5 Volts peak $\pm 5\%$ | | |
| J10-4-to-J10-1 ([BMxOut+] – [BMxOut-]) | 1.5 Volts peak $\pm 5\%$ | | |
| P2-8A-to-P2-8C ([BMxOut+] – [BMxOut-]) | 1.5 Volts peak $\pm 5\%$ | | |

3.3.2 Variable Gain Test

This test verifies proper operation of U5, the variable gain stage.

- Ground P1-9A (Blanking) and float P1-7A (PMCSW2).
- With a 1-Vpk, 1000 Hz sinusoid applied to FP2Test, reduce MGAIN until the peak voltage at TP2 is also 1-Vpk. Record the MGAIN2 voltage in Table 3-4. This voltage is referred to as the *unity gain setting*.

**Table 3-4
 MGAIN2 Voltage**

| Peak voltage @ FP2TEST & TP2 | Nominal MGAIN@ Voltage | Actual MGAIN@ Voltage Reading | Pass/Fail |
|------------------------------|------------------------|-------------------------------|-----------|
| 1 Vpk. | -3.125 ±10% | | |

- Float P1-9A and confirm that the signal at TP2 disappears.

| |
|------------------|
| Pass/Fail |
| |

3.3.3 Frequency Response Test

This test confirms proper frequency response of the U6 compensator stage.

- With MGAIN2 unaltered (unity gain setting), use the analyzer and apply to J4 a 1 Vpk swept sinusoid from 0.25 Hz to 5 KHz signal.
- Observe the signal at TP4 with the analyzer.
- Verify the relative frequency response per Table 3-5.

**Table 3-5
 U6 Relative Frequency Response**

| Frequency (Hz) | Nominal Relative Magnitude Response (db) | Nominal Relative Phase (degrees) | Measured Relative Magnitude Response (db) | Measured Relative Phase (degrees) | Pass/Fail |
|----------------|--|----------------------------------|---|-----------------------------------|-----------|
| 2 | 17 ±1 | -45±10 | | | |
| 482 | -27.6 ±2 | -45±10 | | | |

3.3.4 FP2 test input-to-Output

Verification of FP2-to-Output

- Remove the capacitor from J6. Make sure there is no signal applied to J5.
- Leave MGAIN2 (P1-4A) at its unity gain setting.
- Float PMCSW2
- With -2.1 volts applied to PMCRAMP (J4), inject a 20-Hz, 1.5 V peak sinusoid to J4 (FP2Test).
- Verify no AC signal exists at J6.

| |
|------------------|
| Pass/Fail |
| |

- Now ground PMCSW2 (P1-7A)
- On J6, verify the 20 Hz sinusoid amplitude and phase relative to the input as defined in Table 3-6.
- Record the results in the table.

**Table 3-6
Signal Thru-put**

| FP ACTUATOR DRIVE | Nominal Value | Reading | Pass/Fail |
|--|------------------|---------|-----------|
| <i>P1-7A grounded...</i> Sinusoid Amplitude | 35.6 volts ± 10% | | |
| Relative Phase | -90° ± 20% | | |
| <i>P1-7A floating...</i> Sinusoid Amplitude | 0 volts | | |

3.4 Mixer Functionality and Front-End Tests

3.4.1 Mixer Pre-amp Gain

- With PMCSW1 grounded, apply a 20 mVpk, 1000 Hz sinusoid to J3 (FP1TEST).
- Measure the peak voltage at TP1 and record the value in Table 3-7.

**Table 3-7
 Pre-amp Gain**

| Nominal Peak Reading at TP1 | TP1 Reading | Pass/Fail |
|-----------------------------|-------------|-----------|
| 2 volts $\pm 5\%$ | | |

3.4.2 Mixer Offset Tests

- Float PMCSW1 (P1-6A)
- Apply 10 dbm, 35.5 MHz sinusoid to the LO INPUT, measure the amplified mixer DC offset at TP1 and record the value in Table 3-8.

**Table 3-8
 Mixer Output**

| Nominal Reading at TP1 | TP1 Reading | Pass/Fail |
|------------------------|-------------|-----------|
| ± 200 mv max | | |

3.4.3 Front-end Offset Adjustment Test

- Remove the LO input
- Vary the voltage to INOFFSET2 from -10 volts to +10 volts and record the voltages at TP1 in Table 3-9.

**Table 3-9
 Input Offset Readings**

| P1-5A Voltage | Nominal Reading at TP1 | TP1 Reading | Pass/Fail |
|---------------|------------------------|-------------|-----------|
| 0 | 0 mV ± 10 mV | | |
| -10 | -90 mV ± 20 mV | | |
| +10 | +90 mV ± 20 mV | | |

3.4.4 Mixer Functionality

- Float PMCSW2 and apply a -8.0 dbm, 35.5 MHz sinusoidal signal to J1 (PD Input), and a +10 dbm 35.55 MHz signal to J2 (Lo Input).

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- With the network analyzer measure the amplified IF signal amplitude at TP1 and record the value in Table 3-10. The IF frequency should be 50 KHz.

**Table 3-10
Mixer Output**

| Nominal Reading at TP1 | TP1 Reading | Pass/Fail |
|-------------------------------|--------------------|------------------|
| 13 dbm \pm 2 dbm | | |

Note: This test should be done using two RF signal generators connected through four feet of RG58 coax. 50 Ω terminations should be applied at the PMC front panel. The input power readings are nominal signal generator readings and are not measured.

3.4.5 LO Detection

- Apply +20 dbm 35.5 MHz signal to J2 (Lo Input). Record the voltage at P1-1A in Table 3-11.

LO Detect Output

| Nominal Reading at TP1 | P1-1A Reading | Pass/Fail |
|-------------------------------|----------------------|------------------|
| 700 mv \pm 200 mv | | |

End of Test Procedure