

**LASER INTERFEROMETER GRAVITATIONAL WAVE
OBSERVATORY**

—LIGO—

**CALIFORNIA INSTITUTE OF TECHNOLOGY
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PMC Servo Amplifier Test Plan	
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1.0 Introduction

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

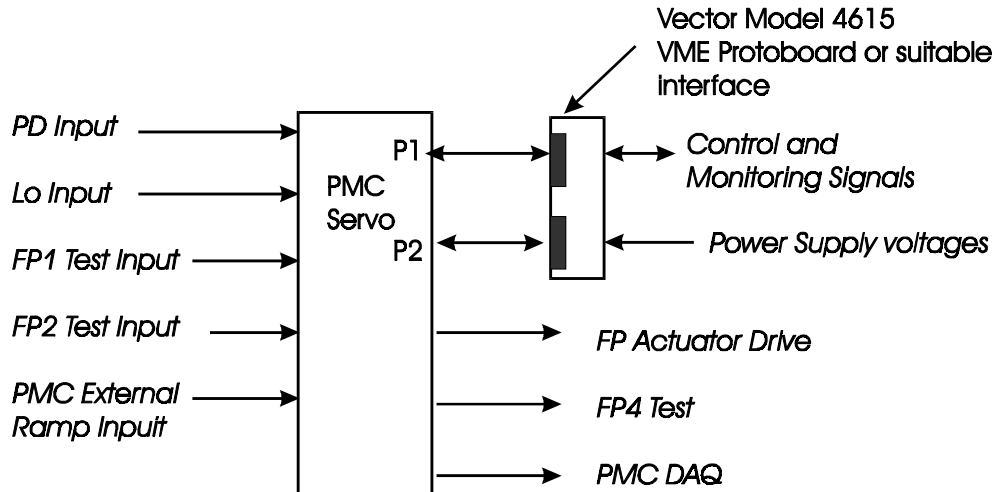


Figure 1
Test Setup Overview

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

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. 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 PMCSW2 grounded, apply a 50 mVpk, 1000 Hz sinusoid to J1 (PD INPUT).
- 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
5 volts \pm 5%		

3.4.2 Mixer Offset Tests

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
\pm 200 mv max		

3.4.3 Front-end Offset Adjustment Test

- Apply a variable voltage to INOFFSET2 and measure the voltage at TP1 according to Table 3-9.

**Table 3-9
 Input Offset Readings**

P1-5A Voltage	Nominal Reading at TP1	TP1 Reading	Pass/Fail
0	0 mV \pm 10 mV		
-10	-90 mV \pm 20 mV		
+10	+90 mV \pm 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).
- 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.

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**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