LIGO Laboratory / LIGO Scientific Collaboration

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Triple Acquisition Driver Unit Test Report

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This is an internal working note
of the Advanced LIGO Project, prepared by members of the UK team.

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http://www.sr.bham.ac.uk/research/gravity/rh,d,2.html
http://www.eng-external.rl.ac.uk/advligo/papers_public/ALUK_Homepage.htm

TRIPLE ACQUISITION DRIVER UNIT BOARD TEST REPORT

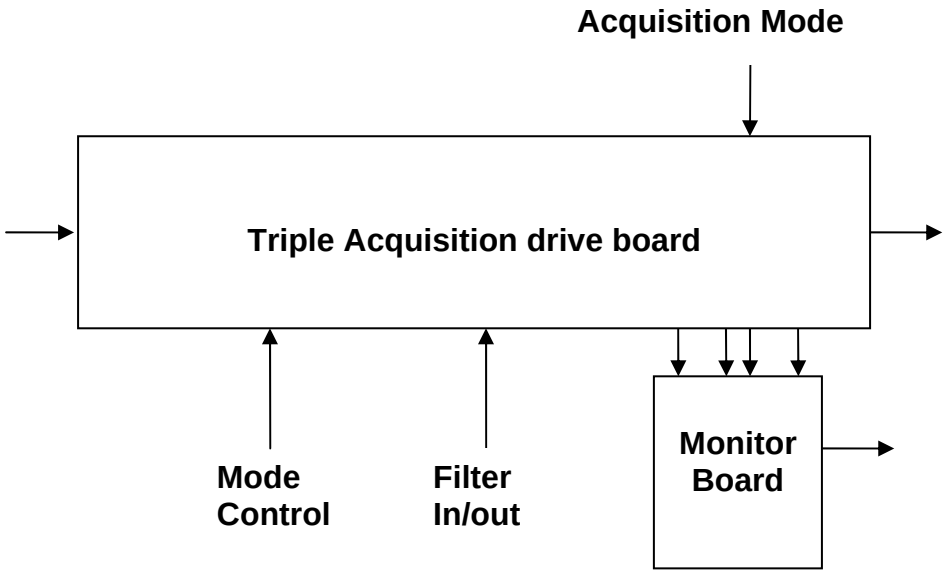
Unit……Serial No ……
Test Engineer ……
Date ……

Drive Card ID……
Monitor Card ID ……..

Contents

1. Description

Block diagram



Description

The Acquisition unit consists of four identical channels and the power regulators which provide regulated power to the four channels. Each channel consists of a coil drive channel, and monitor circuitry.

The driver has 3 main modes of operation, selectable by two external relay commands: Noisy Mode, Quiet Mode and Acquisition Mode. There is also a mode which switches the channel off.

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Date ……

2. Test equipment

Power supplies (At least +/- 20v variable, 1A)
Signal generator (capable of delivering 10v peak, 0.1Hz to 10 KHz))
Analogue oscilloscope
Agilent Dynamic Signal Analyser (or similar)
Low noise Balanced Driver circuit
Relay test box

Record the Models and serial numbers of the test equipment used below.

Unit (e.g. DVM)	Manufacturer	Model	Serial Number

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3. Inspection

Workmanship
Inspect the general workmanship standard and comment:

Links:
Check that the links W2 and W4 are present on each channel.

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4. Continuity Checks

Continuity to the V, I and R.M.S Monitor (J1)

PD out to AA

PIN	SIGNAL	DESCRIPTION	To J1 PIN	OK?
1	PD1P	Photodiode A+	1	
2	PD2P	Photodiode B+	2	
3	PD3P	Photodiode C+	3	
4	PD4P	Photodiode D+	4	
5	0V			
6	PD1N	Photodiode A-	14	
7	PD2N	Photodiode B-	15	
8	PD3N	Photodiode C-	16	
9	PD4N	Photodiode D-	17	

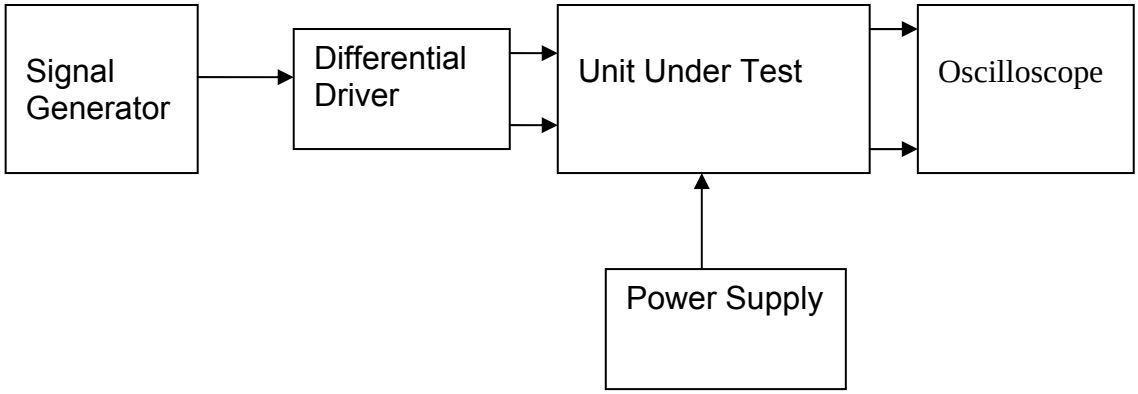
LED Mon

PIN	SIGNAL		To J1 PIN	OK?
1	Imon1P		5	
2	Imon2P		6	
3	Imon3P		7	
4	Imon4P		8	
5	0V			
6	Imon1N		18	
7	Imon2N		19	
8	Imon3N		20	
9	Imon4N		21	

Pd from Sat

PIN	SIGNAL	DESCRIPTION	OK?
9	V+ (TP1)	+17v Supply	
10	V+ (TP1)	+17v Supply	
11	V- (TP2)	-17v Supply	
12	V- (TP2)	-17v Supply	
13	0V (TP3)		
22	0V (TP3)		
23	0V (TP3)		
24	0V (TP3)		
25	0V (TP3)		

5. TEST SET UP



Note:
(1) Input signal to differential amplifier is generally stated in the tests below. There is therefore an inherent gain of 2 in the system.

(2) Some signal generators will indicate 1vpk/pk when the output is in fact 1v Peak into the high impedance Differential driver used. The test procedure refers to the actual voltage out of the signal generator.

Connections:

Differential signal inputs to the board under test:
Drive Input J3 pins 1, 2, 3, 4 = positive input
Drive Input J3 pins 6, 7, 8, 9 = negative input
Drive Input J3 pin 5 = ground

Power
DC IN J1 pin 9, 10 = +16.5v
DC IN J1 pin 11,12 = -16.5
DC IN J1 pins 22, 23, 24, 25 = 0v

Outputs
Coil Out to Sat (J4)

Ch1+ = J4 pin 1	Ch1- = J4 pin 9
Ch2+ = J4 pin 3	Ch2- = J4 pin 11
Ch3+ = J4 pin 5	Ch3- = J4 pin 13
Ch4+ = J4 pin 7	Ch4- = J4 pin 15

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6. Power

Check that the 3 pin power connector is wired correctly: A1 positive, A2 return, A3 Negative.

Set the power supply outputs to zero.
Connect power to the unit
Increase the voltages on the supplies to +/-3V.
Determine that the supply polarities are correct on TP1 and TP2.
If they are, increase input voltages to +/- 16.5v.
Record the output voltages, measured on a DVM with 4 or more digits, from each regulator
Observe the output on an analogue oscilloscope, set to AC. Measure and record the peak to peak noise on each regulator output.
Record regulator outputs:

Regulator	**Output voltage**	**Nominal +/- 0.5v?**	**Output noise**
+12v TP5			
+15v TP4			
-15v TP6			

All Outputs smooth DC, no oscillation?	

Record Power Supply Currents

Supply	**Current**
+16.5v	
-16.5v	

If the supplies are correct, proceed to the next test.

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7. Relay Operation

Operate each relay in turn.
Observe its operation. LEDs should illuminate when the relays are operated.

Filter

Channel	Indicator		OK?
	ON	OFF	
Ch1			
Ch2			
Ch3			
Ch4			

TEST RELAYS

Channel	Indicator		OK?
	ON	OFF	
Ch1			
Ch2			
Ch3			
Ch4			

ACQUISITION RELAYS

Channel	Indicator		OK?
	ON	OFF	
Ch1			
Ch2			
Ch3			
Ch4			

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8. Monitor Outputs

Switch out the filters and set the unit to Acquisition Mode.
With a 20 ohm dummy load on each channel, apply an input from the signal generator at 1 KHz, and adjust the amplitude until the output is 1vr r.m.s as measured between TP4 and TP5.
Measure the Voltage Monitor outputs with respect to 0v for each channel.

8.1 Voltage Monitors

Ch.	Output:	V, I and R.M.S Monitor	Expected value	Pass/Fail: Equal? (+/- 0.1v)
1		10	0.33v	
2		7	0.33v	
3		4	0.33v	
4		1	0.33v	

Adjust the input voltage until the voltage across the load resistor = 1v rms. Record the current monitor output values.

8.2 Current Monitors

Ch.	Output	V, I and R.M.S Monitor	Expected Value	Pass/Fail: Equal? (+/- 0.1v)
1		11	1.86v r.m.s	
2		8	1.86v r.m.s	
3		5	1.86v r.m.s	
4		2	1.86v r.m.s	

8.3 R.M.S Monitors

Ch.	Output	V, I and R.M.S Monitor	Expected Value	Pass/Fail: Equal? (+/- 0.1v)
1		12	1.86v dc	
2		9	1.86v dc	
3		6	1.86v dc	
4		3	1.86v dc	

8.4 Noise Monitors

Using the Pre-Amplifier with a gain of 10 and Dynamic Signal Analyser, measure the noise monitor outputs in uV/√Hz on the noise monitor outputs. Correct for the pre-amplifier gain. 10pA/rt Hz should give 0.825µV/µHz out.

Ch.	Output	/(Pre-amplifier gain)	Expected Value	Comparison
1			0.825µV/µHz	
2			0.825µV/µHz	
3			0.825µV/µHz	
4			0.825µV/µHz	

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9. Distortion

Switch the filters out. Increase input voltage to 5v peak, f = 1KHz. Use 20 Ohm loads. Observe the voltage across each load with an oscilloscope in both Acquisition and Non-Acquisition modes.

	Acquisition Mode: Distortion Free?	**Non-Acquisition Mode: Distortion Free?**
Ch1		
Ch2		
Ch3		
Ch4		

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10 Load tests and Frequency response check

Plug in the 20 Ohm 5W loads. Ensure the links W4 are in place.

10.1 Noisy Mode

With the acquisition mode switched out, and filters switched out, apply 5v peak at the input to the drive unit. Measure the r.m.s differential voltage across each load resistor in turn using a true r.m.s meter, at the frequencies below. Calculate the output current in each case (Vout/20).

1Hz

	Vo r.m.s	**Peak Io (Vo/20) x 1.414**	**Specification**	**Pass/Fail**
Ch1			**2.5 mA peak**	
Ch2			**2.5 mA peak**	
Ch3			**2.5 mA peak**	
Ch4			**2.5 mA peak**	

10Hz

	Vo r.m.s	**Peak Io (Vo/20) x 1.414**	**Specification**	**Pass/Fail**
Ch1			**2.5 mA peak**	
Ch2			**2.5 mA peak**	
Ch3			**2.5 mA peak**	
Ch4			**2.5 mA peak**	

100Hz

	Vo r.m.s	**Peak Io (Vo/20) x 1.414**	**Specification**	**Pass/Fail**
Ch1			**2.5 mA peak**	
Ch2			**2.5 mA peak**	
Ch3			**2.5 mA peak**	
Ch4			**2.5 mA peak**	

200Hz

	Vo r.m.s	**Peak Io (Vo/20) x 1.414**	**Specification**	**Pass/Fail**
Ch1			**2.5 mA peak**	
Ch2			**2.5 mA peak**	
Ch3			**2.5 mA peak**	
Ch4			**2.5 mA peak**	

1 KHz

	Vo r.m.s	**Peak Io (Vo/20) x 1.414**	**Specification**	**Pass/Fail**
Ch1			**2.5 mA peak**	
Ch2			**2.5 mA peak**	
Ch3			**2.5 mA peak**	
Ch4			**2.5 mA peak**	

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10.2 Low noise Mode

With the acquisition mode switched out and filters switched in, apply 5v peak at the input to the drive unit. Measure the r.m.s differential voltage across each load resistor in turn using a true r.m.s, at the frequencies below.
Calculate the output current in each case (Vout/20).

1Hz

	Vo r.m.s	Peak Io (Vo/20) x 1.414	Specification	Pass/Fail
Ch1			2.5 mA peak	
Ch2			2.5 mA peak	
Ch3			2.5 mA peak	
Ch4			2.5 mA peak	

10Hz

	Vo r.m.s	Peak Io (Vo/20) x 1.414	Specification	Pass/Fail
Ch1			2.5 mA peak	
Ch2			2.5 mA peak	
Ch3			2.5 mA peak	
Ch4			2.5 mA peak	

100Hz

	Vo r.m.s	Peak Io (Vo/20) x 1.414	Specification	Pass/Fail
Ch1			2.5 mA peak	
Ch2			2.5 mA peak	
Ch3			2.5 mA peak	
Ch4			2.5 mA peak	

200Hz

	Vo r.m.s	Peak Io (Vo/20) x 1.414	Specification	Pass/Fail
Ch1			2.5 mA peak	
Ch2			2.5 mA peak	
Ch3			2.5 mA peak	
Ch4			2.5 mA peak	

1 KHz

	Vo r.m.s	Peak Io (Vo/20) x 1.414	Specification	Pass/Fail
Ch1			2.5 mA peak	
Ch2			2.5 mA peak	
Ch3			2.5 mA peak	
Ch4			2.5 mA peak	

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Date ……

10.3 Acquisition Mode

With the acquisition mode switched in, and filters switched out, apply 5v peak at the input to the drive unit. Measure the r.m.s differential voltage across each load resistor in turn using a true r.m.s meter at the frequencies below. Calculate the peak voltages, then the peak output current in each case (Vout/20).

100Hz

	Vo r.m.s	Vo pk.	Peak Io (Vo/20) x 1.414	Specification	Pass/Fail
Ch1				125mA peak	
Ch2				125mA peak	
Ch3				125mA peak	
Ch4				125mA peak	

200Hz

	Vo r.m.s	Vo pk.	Peak Io (Vo/20) x 1.414	Specification	Pass/Fail
Ch1				125mA peak	
Ch2				125mA peak	
Ch3				125mA peak	
Ch4				125mA peak	

1 KHz

	Vo r.m.s	Vo pk.	Peak Io (Vo/20) x 1.414	Specification	Pass/Fail
Ch1				125mA peak	
Ch2				125mA peak	
Ch3				125mA peak	
Ch4				125mA peak	

5 KHz

	Vo r.m.s	Vo pk.	Peak Io (Vo/20) x 1.414	Specification	Pass/Fail
Ch1				125mA peak	
Ch2				125mA peak	
Ch3				125mA peak	
Ch4				125mA peak	

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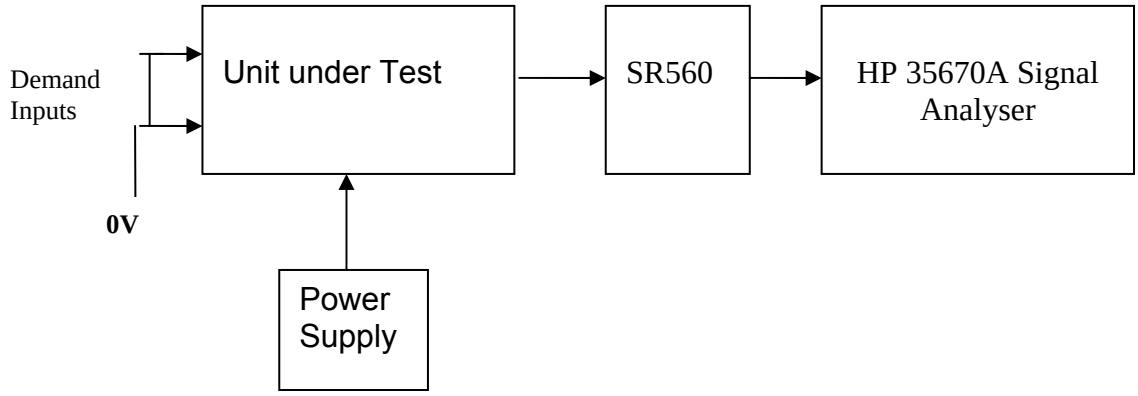
11. Noise Measurements

As the previous test involves non – representative temperature rises, allow the unit to cool before performing this test.
Replace the filter links W4, on each channel.
Connect the filter test box, and switch in all filters.
Switch it out of Test Mode and out of the Acquisition mode
Use the HP 35670A Dynamic Signal Analyser.
Connect a shorting plug to the demand input to short all positive and negative demands together and to 0v. Connect 20 Ohm loads to the outputs.
Use Stuart Aston's noise measurement set up, loaded from disc.
Measure the noise output from each channel in turn at the amplifier outputs (TP4 and TP5). The Low Pass filter on the SR650 may be used to reduce mains interference, to prevent the Signal Analyser from overloading. Ideally the filter corner frequency should be set to 3 KHz. Set the amplifier gain to 1000, and check that the overload light is not on before each measurement.



Measure the noise output at 10 Hz.

	Spec in dB V/√Hz	Measured @ 10Hz	-60dB =	Measured in nV/√Hz	OK?
Ch1	-143.5				
Ch2	-143.5				
Ch3	-143.5				
Ch4	-143.5				

Notes:
Specified noise output current at 10 Hz = 10pA/root Hz (worst case)
Total resistance at 10Hz, in Low noise mode = 6.7K
Amplifier noise voltage should therefore be = 67 nV/√Hz
67 nV/√Hz = -143.5 dB/√Hz

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12. Final Assembly Tests

1. Remove the lid of the box.

2. Unplug all external connections.

3. Check that the 9mm pillars are in place in the corners of the Monitor Board towards the centre of the box.

4. Check that all internal connectors are firmly mated.

5. Tighten the screw-locks holding all the external connectors.

6. Check that the nuts holding the tabs of the power drivers are secure – tighten as necessary. Test with a DVM that none of the tabs are shorted to chassis.

7. Check that all the LEDs are nicely centred.

8. Check that all links W4 and W2 are in place.

9. Check that the boards are labelled with their Drawing Number, Issue Number, and serial number. Record below:

UoB box ID	
Driver board ID	
Driver board Drawing No/Issue No	
Driver board Serial Number	
Monitor board ID	
Monitor board Drawing No/Issue No	
Monitor board Serial Number	

10. Check the security of any modification wires.

11. Visually inspect.

12. Put the lid on and fasten all screws,

    Check all external screws for tightness.