

# LIGO Laboratory / LIGO Scientific Collaboration

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**Advanced LIGO UK**

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Response to the PUM Evaluation Report T0900313-v1

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This is an internal working note  
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## **RESPONSE TO THE PUM EVALUATION REPORT T0900313-v1**

### **INTRODUCTION**

The relevant comments from the Caltech Evaluation Report, T0900313-v1 are listed, followed by the University of Birmingham responses.

#### **Comment 1**

The over current protection circuit is not designed to be totally fail-safe. If the cable from the monitor board to the driver is disconnected, the shutdown circuit inputs go to zero, which enables the output driver. A large value pull up resistor should be added to the SC input that will charge the cap if the connector is open. These resistors could be added to the connections on P3 on input side of R5, R6, R7 and R8.

#### **Response to Comment 1**

1 Meg pull up resistors have been added to the circuit P3 on input side of R5, R6, R7 and R8.

#### **Comment 2**

Bias return resistors should be added to the inputs of the channels. If the channel is disabled, the inputs will float up and cause a signal on the output. 10K on each leg to ground should be sufficient.

#### **Response to Comment 2**

10 K resistors to ground have been added on the inputs so that if the inputs are not terminated they are biased to ground. Links are provided enabling the grounds to be removed if there is ground induced noise is present.

#### **Comment 3**

Mode switching will need to be done in a specific order so that we don't violate the 20dB gain change rule. The order will need to be Acquire Mode switches only, and then Run and Acquire mode switches together, then Run mode switch only.

#### **Response to Comment 3**

This is an operational consideration rather than a hardware issue.

#### **Comment 4**

There are multiple wires and components that have been added to both the driver board and the monitor board. These design changes should be incorporated into the production boards prior to production.

#### **Response to Comment 4**

Numerous modifications were necessary to the Pre-production prototype PUM unit. All these modifications will be incorporated into the artwork of the production units.

**Comment 5**

The Monitor board was manufactured in a similar fashion and the only circuit board issues observed are the wires added from TP8 to R24 of each channel. These wires were added after circuit board manufacture to correct an omission. Production models of the Monitor board should be corrected so that these wires are not necessary.

**Response to Comment 5**

The modifications to the monitor board have now been incorporated on to the PCBs, and will be verified during the testing of the first Production monitor Board.

**Comment 6**

Although a complete bill of materials was not provided, a check of the availability of the capacitors used in the critical portions of the circuit showed that they might not be readily available in the US. If this is the case, then an adequate number of spares need to be provided with the production units. The same can be said of any other components used in the designs. This possibility will need to be evaluated when a complete set of documentation is supplied.

**Response to Comment 6**

It is expected that components with similar footprints and specifications will be obtainable in the USA. If this is not the case, suitable numbers of spares will be supplied by agreement between the USA and UK.

**Comment 7**

The circuit boards are attached to the chassis using standoffs that stick to the bottom panel of the chassis. These temporary standoffs were used in place of the permanently mounted standoffs planned for the production chassis. Permanently mounted standoffs are a requirement for production units as previous experience has shown that the adhesive used for the temporary standoffs will give way during shipping and/or over the life of the chassis.

**Response to Comment 7**

The UK plan to use metal screws and pillars to secure the production PCBs.

**Comment 8****2.3 Adequacy of Documentation**

A complete set of schematics was provided with the pre-production units. No bill of materials was supplied with the unit. Test Plans for the driver board (T0900291-v1) and the full driver chassis (T0900292-v1) have been provided along with test results for the pre-production unit. A user's guide (T0900290-v1) for the chassis was also provided. Prior to production all materials listed in Electronics Requirements document (T060067) and LIGO document T000053-04-D, "Universal Suspension Subsystem Design Requirements Document" will need to be evaluated. Additionally it is preferred that all Altium schematics, Gerber files, and other documentation be provided electronically. The most efficient way of providing all schematic files, Gerber files, library files

and pcb files for future production is to use the Altium Project Packager feature. It is strongly recommended that this feature be utilized and entire packaged project be saved in the LIGO DCC.

### **Response to Comment 8**

It is intended to supply all documentation required.

### **Comment 9**

#### 3.2 Test Inputs and Monitoring

The design of the PUM PP Driver includes test inputs for each channel. These test inputs are connected to the input and can be enabled or disabled via an external control signal or a local board connection. When the test input is connected, the input from the control system is disconnected and visa versa. The use of the normally closed contact for the test input allows this relay to be used as a fail-safe enable/disable for the control input. For every relay used in the design there is a separate read back of the actual relay position in accordance with the requirements. One observation worthy of mentioning is that when the test inputs are enabled and there is no signal source connected, amplifiers IC3 and IC4 do not have a bias return path and the inputs tend to float up causing an output signal. This may not be acceptable in AdL. It is recommended that bias return resistors be added to the input leg of each channel. 10K ohms to circuit ground should be adequate.

### **Response to Comment 9**

See Response to Comment 2.

### **Comment 10**

#### 4.1.2 Monitor Noise

The noise measured at the output of the noise monitor circuit should be less than 2.3uV/√Hz at 10Hz in order to meet the requirement. The actual measurement values are repeated in the table below.

<b>Channel Number</b>	<b>Measured Noise at 10Hz</b>
1	5.0 $\mu\text{V}/\sqrt{\text{Hz}}$
2	2.67 $\mu\text{V}/\sqrt{\text{Hz}}$
3	2.8 $\mu\text{V}/\sqrt{\text{Hz}}$
4	2.6 $\mu\text{V}/\sqrt{\text{Hz}}$

Note that the measurements for channels 2, 3 and 4 appear to be very close to the requirement, while the measurement for channel 1 is approximately a factor of two above the requirement. Prior to production the source of this discrepancy should be investigated.

### **Response to Comment 10**

It is expected that this anomaly is due to a one off problem on the prototype. The test results from the other two prototype units will be compared with these results in order to determine if this is the case.

**Comment 11**

During the testing it was discovered that disconnecting the cable from the driver board to the monitor board could defeat the protection circuitry designed to prevent the driver from exceeding the maximum continuous RMS current for the OSEM. It is recommended that large value pull up resistors be added to the SC inputs of the driver so that the inputs will be pulled up if the cable to the monitor board is disconnected. These resistors should be added on the input connector side of R5, R6, R7 and R8.

**Response to Comment 11**

See response to Comment 1