LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Noise Prototype OSEM Design Change Log

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This is an internal working note
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1 Introduction and Scope

This document, which should be read in conjunction with reference [1], captures key changes to the OSEM design that have been made since the initial OSEM and Electronics Reviews that took place in July 2005.

1.1 Version History

Rev. 00 - Initial release. Providing input to July 2006 PDR. 14th June 2006 (SMA)

Rev. 01 - Updated. Providing input to January 2008 FRR. 22nd January 2006 (SMA)

1.2 References

(1) S. Aston, “Noise Prototype OSEM Design Document & Test Report”, T050111

(2) S. Aston, “IRLED Lens Retainer”, D060115-C-K

(3) S. Aston, “Adjuster Nut”, D060110-C-K

(4) J. Heefner, “AdL SUS Noise Prototype Temporary Controls Wiring”, D070448

(5) B. Shapiro, “Final Quad Controls Prototype Results”, T070272-00

2 OSEM Design Changes - July 2006 PDR

Highlighted within this section are detailed changes to the Noise Prototype OSEM design that occurred up to the July 2006 PDR. These represent changes between revisions 00 and 01 of the design document (reference [1]). For further descriptions, relevant sections of the design document have also been referenced:-

- **{Section 2.1.3 - Sensor Assembly}** Initial LIGO OSEMs included a 1064ηm filter coating on the receiver side of the sensor assembly. This feature is now understood to be unnecessary and will not be installed.

- **{Section 2.2.1 - Actuator Properties}** To accommodate the need for stronger actuators the coil dimensions have changed (double length) from what was originally designed for use in the Controls Prototype OSEMs. The number of turns on the coil has increased from 400 to 800.

- **{Section 2.2.2 - Actuator Wind-off Assembly}** The peek pin plate has been eliminated from the design in favour of a small PFA part. This is to simplify the routing of the coil wind-off and reduce the risk of a short to the metal body of the OSEM.

- **{Section 2.3 - Magnet and Flag Assembly}** Due to the change in the coil dimensions the operating point or 'sweet-spot' of the magnet and actuator coil has to be recalculated. As a consequence of the stronger actuator requirements we also detail the dimensions of the magnets to be used at the various stages.

- **{Section 2.4 - Mounting and Adjustment Assemblies}** Concerns regarding access to adjustment 'thumbscrews' at the rear of the OSEM has lead to a change to a PFA part with a conventional hexagonal head.

- **{Section 3.2.1 - OSEM Connector}** Aiming for standardisation, the Noise Prototype OSEM head connector pin-out assignment has been changed to be compatible with the existing Controls Prototype pin-out convention. This has lead to a re-routing of the flexi-circuit interconnect.

- **{Section 4.3 - Unwanted Eddy Current Damping}** A RODA clarifying the status of OSEM sensors at the penultimate stages of the ITM / ETM has been generated.

- **{Section 4.5 - Thermal Considerations}** Due to the changes to the coil geometry i.e. increase in number of turns of the coil; the maximum power dissipated by the OSEM has increased.

- **{Section 5.1 - Material List and UHV Conformance}** Virtually all of the materials used in the construction of the Noise Prototype OSEM have been approved for use in Advanced LIGO. The exception being the flexi-circuit, which is still undergoing testing. It is not anticipated that this will be a concern. All aluminium parts are now to be fabricated using 6082 grade.

- **{Section 5.2 - OSEM Cleaning Procedure}** For the completed assemblies final low temperature bake out we need to ensure that the materials used in the construction of the Noise Prototype OSEM can withstand the elevated temperatures. This bake-out process aims to be carried out at as higher temperature as is possible, so list of OSEM parts with storage temperature limits is provided.

- **{Section 7.3 - Prototype OSEM Fabrication}** OSEM prototype devices have now been fabricated using the required oversize tapping technique for all aluminium parts.

3 OSEM Design Changes - January 2008 FRR

Highlighted within this section are detailed changes to the Noise Prototype OSEM design that occurred up to the January 2008 FRR. These represent changes between revisions 01 and 02 of the design document (reference [1]). For further descriptions, relevant sections of the design document have also been referenced:-

- **{Section 2.1.3 - Sensor Assembly}** The design of the phosphor bronze spring clip (reference [2]) has been radically changed. This part is responsible for retaining the lens in the IRLED assembly against the mask. It had been observed that with the previous design of this part, the lens could potentially become loose during shipping. The revised part mitigates this issue.

- **{Section 2.4 - Mounting and Adjustment Assemblies}** There has been a material change for the OSEM adjuster nuts (reference [3]). These were originally manufactured from PFA 440HP material. However, feedback obtained from OSEMs employed in the OMC suspension work, has raised concerns about the robustness of this part (some heads having being stripped). As an alternative, PEEK 450G is now to be used for all parts that were previously manufactured from PFA 440HP. (n.b. this also includes two minor parts of the sensor assemblies, the sensor retainers).

- **{Section 3.2.2 - SEI Mating Connector}** The connector description has been revised from a 25W μ-D to a 25W sub-D, to be compatible with the US interface (as seen in reference [4]).

- **{Section 3.2.3 - OSEM Cable Harness Lengths}** Harness lengths for the quad suspension have been revised now that our understanding of the routing scheme has matured (in addition to the lessons learned from the Controls Prototype work, seen in reference [5]). (n.b. Noise Prototype OSEM harnesses have been provided thus far unshielded, due to cable stiffness concerns).

- **{Section 4.4.1 - Degradation of Emitter Output}** The burn-in process has defined, with test equipment fabricated and burn-in tests conducted on all 2000 IRLED devices procured.

- **{Section 4.4.2 - IRLED Screening}** After rigorous noise performance testing of early ‘prototype’ Noise Prototype OSEM units, it became clear that we needed to reconsider our approach to screening. We therefore undertook to screen all IRLED devices prior to installation into the OSEM. As a consequence, the surface mount resistor located onboard the flexi-circuit, was removed from the design.

- **{Section 5.1 - Material List and UHV Conformance}** With the UHV approval of the flexi-circuits, all of the materials used in the construction of the Noise Prototype OSEM and harnesses have now been approved.

- **{Section 5.2 - OSEM Cleaning Procedure}** The OSEM cleaning process has been revised in light of RGA scan results obtained for a ‘dirty’ OSEM. Paraffin contamination of the magnet wire was suspected. This has led to the inclusion of an additional pre-cleaning step for the magnet wire.

- **{Section 7.4 - Noise Prototype OSEM Test Results}** This section has now been added to the design document and shows test results obtained at both Birmingham and Strathclyde for the observed OSEM sensor performance. Range (section 7.4.1) and sensitivity (section 7.4.2) plots are given for a ‘prototype’ Noise Prototype OSEM. In addition some in vacuum thermal tests on the OSEM have been carried out and are discussed in section 7.4.3.