LIGO Laboratory

California Institute of Technology
MS 18-34, 1200 E. California Blvd.
Pasadena CA 91125 USA
TEL: 626.395.2129
FAX: 626.304.9834
www.ligo.caltech.edu

LIGO Livingston Observatory
P.O. Box 940
Livingston LA 70754 USA
TEL: 225.686.3100
FAX: 225.686.7189
www.ligo-la.caltech.edu

LIGO Hanford Observatory
P.O. Box 159
Richland WA 99352 USA
TEL: 509.372.8106
FAX: 509.372.8137
www.ligo-wa.caltech.edu

Massachusetts Institute of Technology
MIT NW22 – 295, 185 Albany St.
Cambridge MA 02139 USA
TEL: 617.253.4824
FAX: 617.253.7014
www.ligo.mit.edu

Date:	February 26, 2010	Refer to:	L1000094-v1
Subject:	Design Review for ISC demodulator and in-vacuum quad detector		
To:	Advanced LIGO management		
From:	Mick Flanigan, Hartmut Grote, Eric Gustafson, David McClelland, David Nolting, Robert Schofield, David Shoemaker, Daniel Sigg (chair)	Tel:	

Announcement

Subject: ISC final design mini review (demodulator and in-vacuum quadrant photodiode)

The ISC team feels they are ready for production with the demodulator design and the in-vacuum quadrant photodiode. I would like to review these 2 modules now before the full FDR, so they can go into production.

There are wiki pages for each:
I/Q demodulator: advligo/IQ_Demodulator
TransMon Quad PDs: advligo/TransMon_Quad_Detectors
For the latter, there are some mechanical drawings and schematics that will be added within a few days. The I/Q demodulator material should be complete.

I would like to do this by email. If you have comments, require additional information, or prefer a different process, please let me know within a week. Let's put a deadline for getting back to me on Wed., Feb 17.

Demodulator

The presented demodulator design presents a new approach using FET switches instead of a ring diode mixer. We feel the design is sound and has an improved dynamic range and improved out-of-band rejection. Some detailed comments:

1) The bandwidth of the current design is not sufficient for the mode cleaner servo and maybe even the common mode servo. However, it should be straight forward to make a high speed variant by changing some of the component values.
2) The gain on the IF outputs seems high. The outputs will saturate with 0dBm of RF input. We recommend reducing the gain by at least a factor of 4.

3) The design uses a differential design to amplify the IF signal. It then uses a differential OpAmp to yield a single ended monitor output. Finally, it uses a differential driver for the I and Q outputs. Wouldn't it be simpler to drive the I and Q outputs directly with the IF amplifiers? For the mode cleaner servo chain this would also prevent the differential amplifier to be the slowest amplifier with the slowest slew rate.

4) What is the experience with the differential amplifier driving long cables loads? The design implements series damping resistors, but equips them with zero Ohms.

5) The bundling of 4 channels into a single chassis poses a packaging challenge. We recommend reordering the rear panel signals, so that the fast I and Q phase signals are separated from the slow RF monitors. We also recommend using N connectors (or at least TNC) for the rear mounted LO inputs. This would make it possible to directly terminate a heliax cable. Otherwise, one will have to terminate both the LO and the heliax in a patch panel and jumper in between.

6) Both the mode cleaner and common mode servo use TNC input connectors. This will require the use of a breakout panel. Maybe a better approach for this application would be to make a dual channel chassis with the appropriate connectors; see for example D1000181.

7) What's the effect on the I and Q phase signals when connecting a load to the RF monitor output? Do we require these outputs to be terminated when not used?

8) Are there any plans to minimize and test coupling of audio frequency magnetic fields and vibrations to the demodulator boards?

9) We wish to see a test protocol.

In-Vacuum Quadrant Photodetector

The presented design for an in-vacuum quadrant photodetector is simple and straight forward. Some detailed comments:

10) Using a fork clamp is convenient but is not the best attachment method when considering post resonances.

11) What's the orientation of the diode relative to the incoming beam? We assume that they are angled off to prevent direct back scattering. Past experience in the field has shown that there is a tendency to align detectors square. It would be an advantage to have the deflection angle built into the mount, so that reproducible orientations can be expected. This would also allow for a fixed beam dump of the direct reflected beam.

12) The recessed photodiode design worries us a little because of large angle scattering of stray light onto the diodes and backscattering of light scattered from the diodes. Also, it limits the angle of any cameras focusing on the diodes.

13) We wish to see a test protocol.

Recommendations

The presented designs are excellent and we recommend to go forward with production.