AdL Low Current Triple Driver Design

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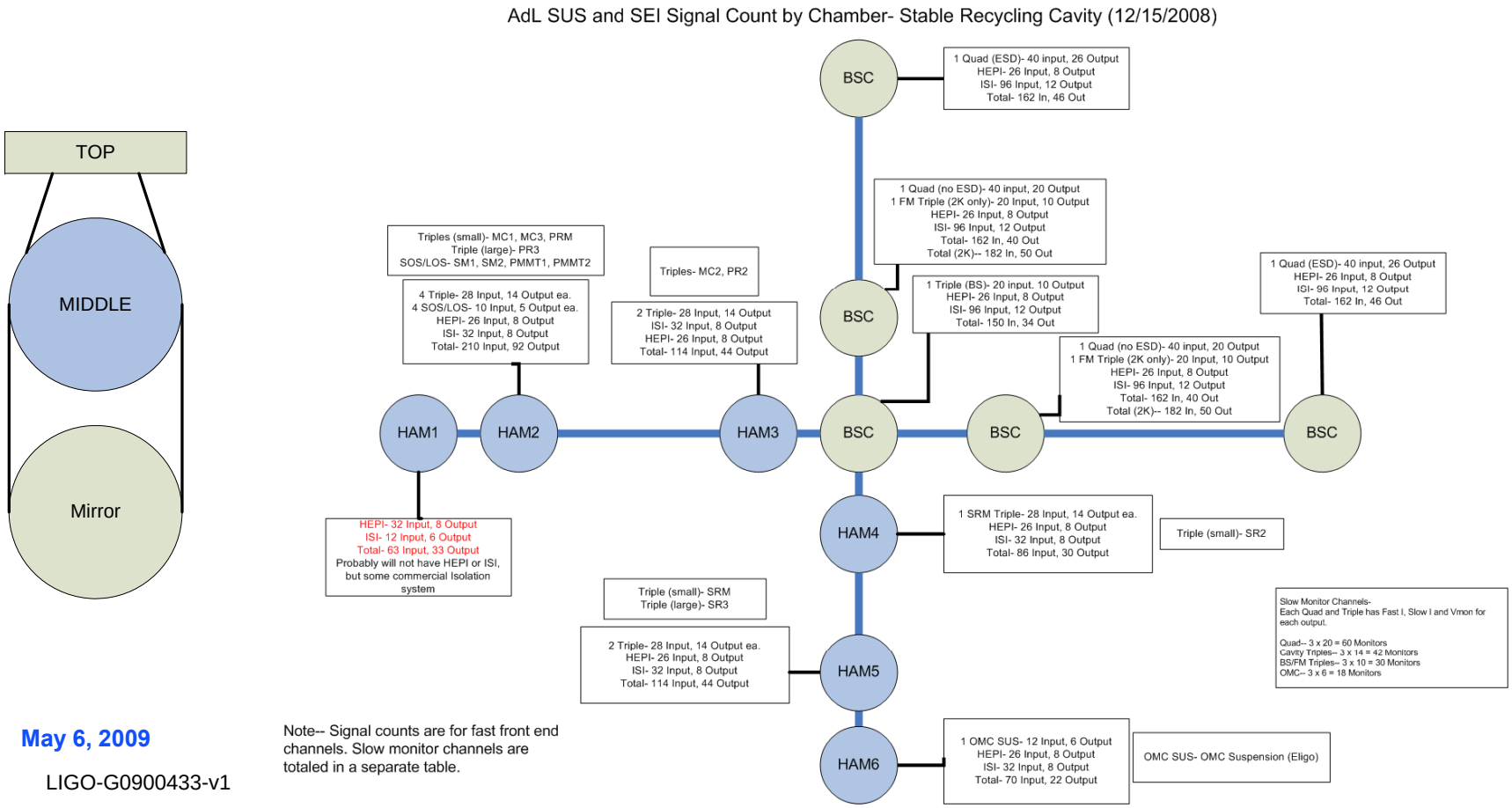
Introduction

- **The UK group at University of Birmingham is responsible for the design and fabrication of all analog electronics for the AdL Triple Suspensions**
  - **Schedule and manpower pressures required LIGO to help out with the design**
  - **A starting design for the Low Current Driver was supplied to LIGO. This design was then refined and a prototype built.**
  - **Once the design is finalized it will be passed back the UK group for fabrication**
  - **This provided a couple of problems- component availability, extra effort on our part, etc.**
  - **But it also provides an opportunity– add dewhitening to design and other considerations from the total system point of view.**

Introduction

- **The driver will be used as the driver electronics for the middle stage of the IMC and Cavity (HLTS and HSTS) Triple Suspensions used in AdLIGO.**



Requirements

- The full requirements for AdL Triple Suspension Electronics are in T080065-E1-C, “AdL Beam Splitter, Input Mode Cleaner, Large Recycling and Small Recycling Triple Suspension Electronics Requirements”.
- The “important” requirements (noise and dynamic range) are:
  - Output Current Noise Requirement: 125 pA/√Hz, for 10Hz<freq<15Hz
  - Dynamic Range: 3mA$_{peak}$, for freq<1KHz.
- Other, more mundane, requirements can be found in the requirements document.

Design

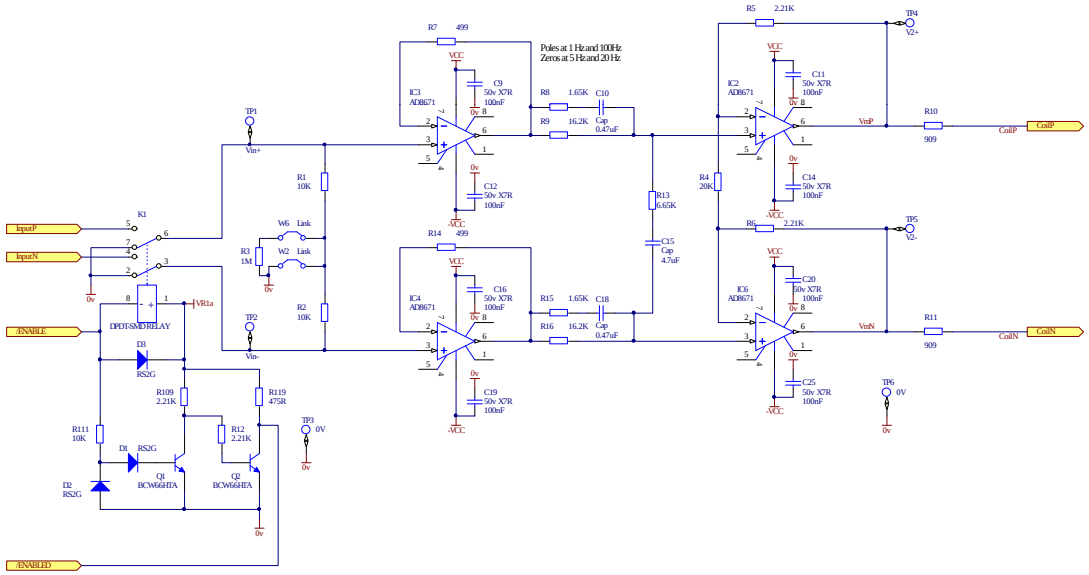
- If the coil driver were the only consideration the design would be very simple– probably an op amp.
- It is when you take the system (DAC) into consideration that things get interesting.
- The DAC presently used for AdL has a dynamic range of 10Vpeak and an output-referred noise on the order of 700nV/√Hz. This leads to:
  - FOM_{DAC} = 10Vpeak/700nV/√Hz = 143 dB
- The requirements FOM is:
  - FOM_{req} = 3mApeak/125pAV/√Hz = 148 dB
- Therefore----

» **PROBLEM**

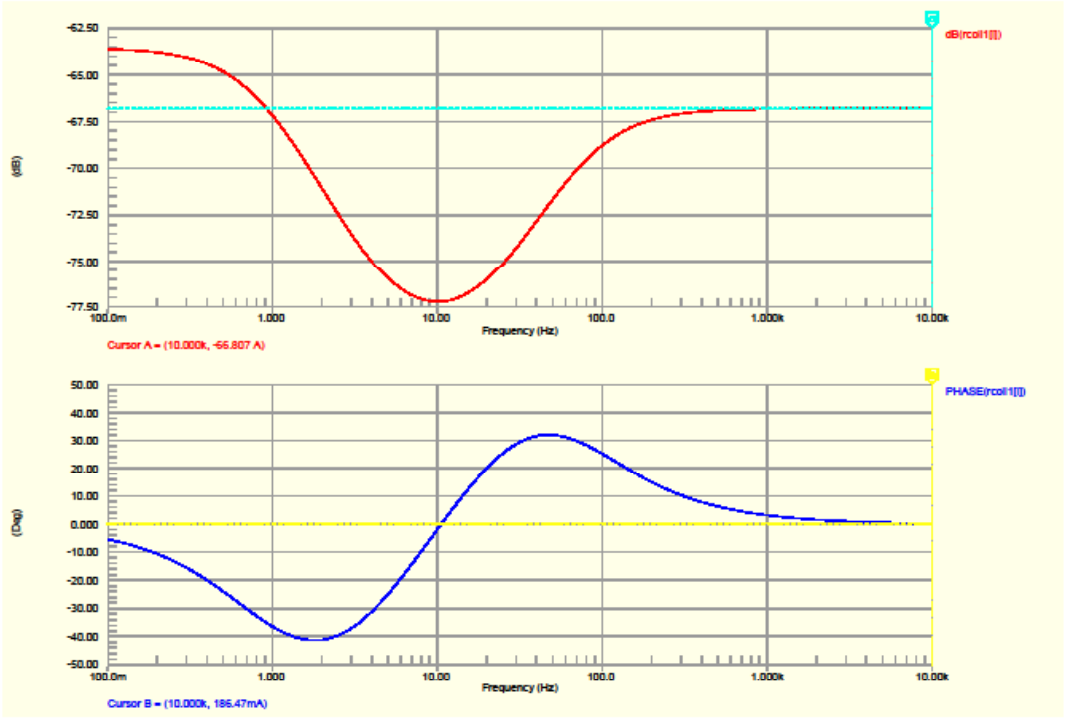
  - The noise and dynamic range requirements cannot be met simultaneously at 10Hz

Design

- I chose to meet the noise requirement at 10Hz and maximize the region where the dynamic range requirement could be met– without going to extraordinary measures

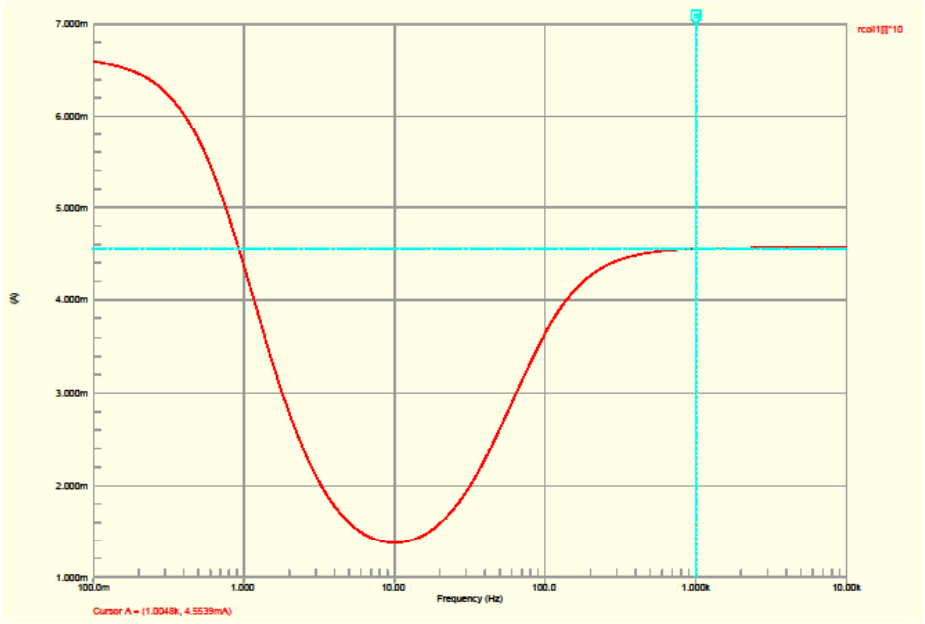


Driver Response



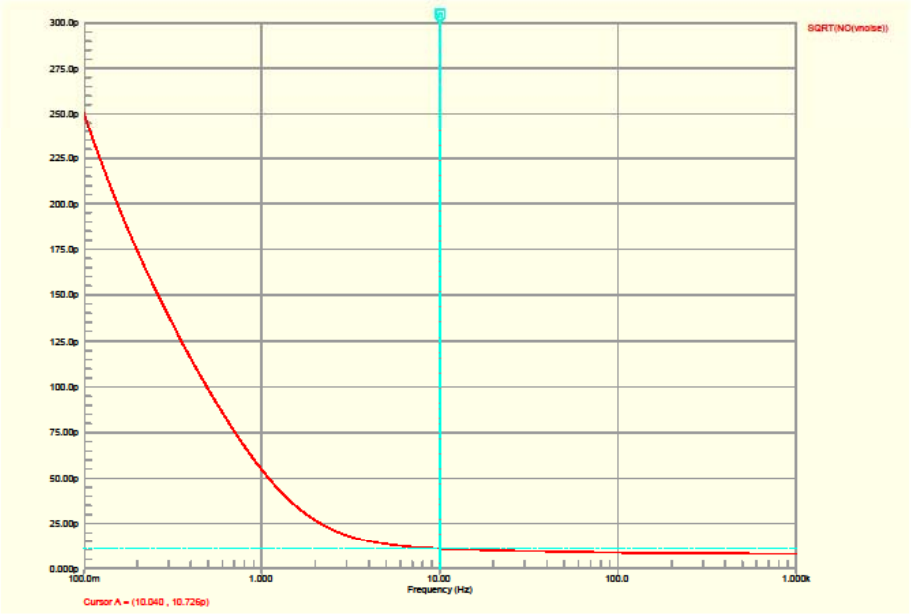
Driver Dynamic Range

- **The dynamic range requirement is met for 65Hz<freq<1KHz and for frequencies below 1.8Hz**



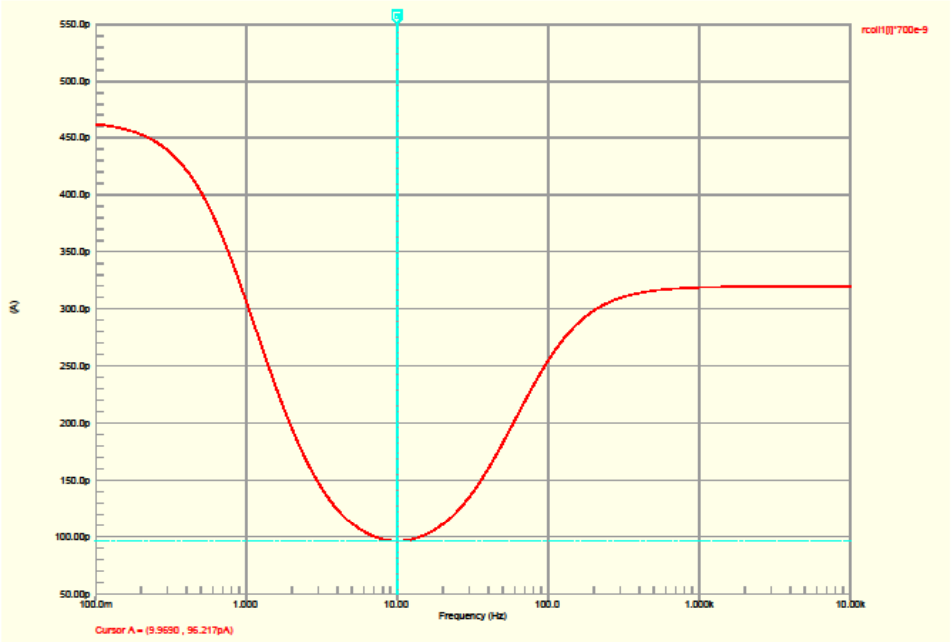
Driver Noise

- **Noise from the driver alone is well below the requirement of 125 pA/√Hz, for 10Hz<freq<15Hz.**



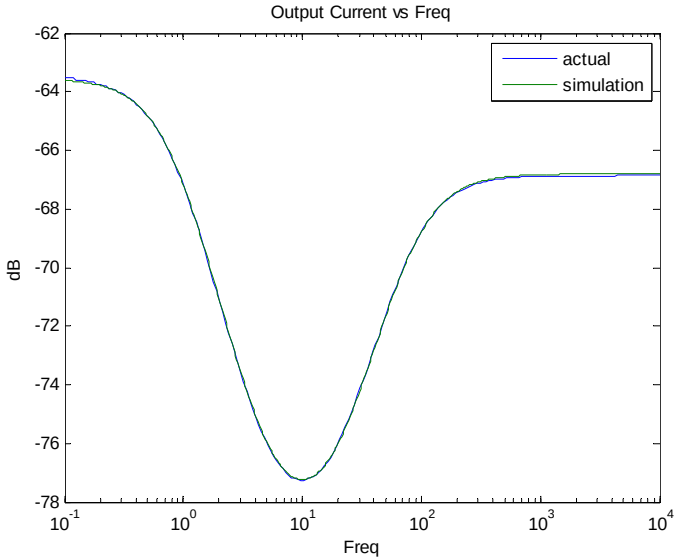
Driver plus DAC Noise

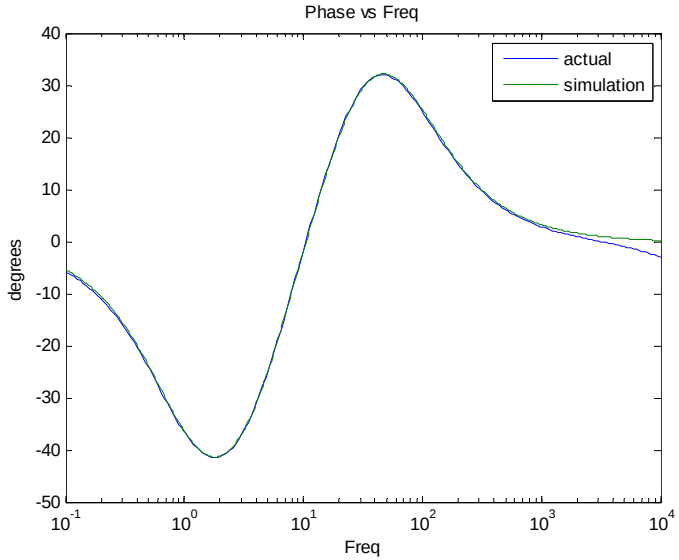
- **The dewhitening provided by the circuit allows the system to meet the noise requirement.**



Prototype Test Results

- A fully functional 4 channel prototype was built and tested according to T0900190-v1.
- The schematic for the board is D0900884-v1.
- The design was found to match the simulations very well.
  - Transfer function– below
  - Noise- 20nV/√Hz → 11pA/√Hz





Other Monitors and Circuitry

- **Board designed to be used with standard UK monitor board**
  - Low noise monitor
  - Fast current monitor
  - rms current monitor
- **Channel Enable/Disable**
  - Normally open contacts used
  - Status provided to CDS
- **PD and LED Signal Pass Through**
  - Compatible with UK and US satellite amps
  - Signal pass through and power to satellite amps

Status

- Only a few minor changes to the circuit boards were necessary during the prototyping phase. They were:
  - TP3 needs to be labeled as a return for each channel
  - The diode footprint for the RS2G diodes needs to be changed from SMC to SMB
- Presently there are 4 boards that can be used in the recycling mirror test stand and as spares for the AdL. One of these boards is mounted in a chassis with a monitor board, but chassis and front and rear panels exist for all 4.
- Once the changes above are made to artwork, the full Altium design package for the project will be made available to the UK. The cross referenced UK part numbers for all components needs to be confirmed on the final bill of materials prior to procurement of components.

Status

- The design is flexible enough that future changes are relatively easy to accommodate
  - Better DACs
  - Rather meet the dynamic range requirement at 10Hz and sacrifice noise
  - Others?
- Final Design report being written– T0900207-v1.