18 March 2014

LIGO-T1400223-v1

# UIM Coil Driver modifications for larger range

P. Fritschel

## 1 Motivation

More actuation range is desired at the UIM stage of the ETM suspensions, for greater control authority at low frequencies. Currently the UIM coil driver (D070481-v4) has a DC actuation range of 6.55 microns-pk (test mass motion). This does not give sufficient headroom at times of high microseism or high tilt-coupling amplification in the ISI.
Part of the problem is the ubiquitous factor-of-2 interface mismatch between the DAC output and all UK coil drivers: the UK designs were based on having twice the actual DAC output voltage, so the full output range of the drivers cannot be reached. But there is also room to further increase the current range and still keep the noise below the technical noise limit. The proposed modifications increase the low-frequency drive range by a factor of 4, for a DC test mass displacement maximum of 26 microns-pk.

## 2 Circuit modifications

The UIM driver is D070481-v4. The modifications are in the differential output stages, as shown below.

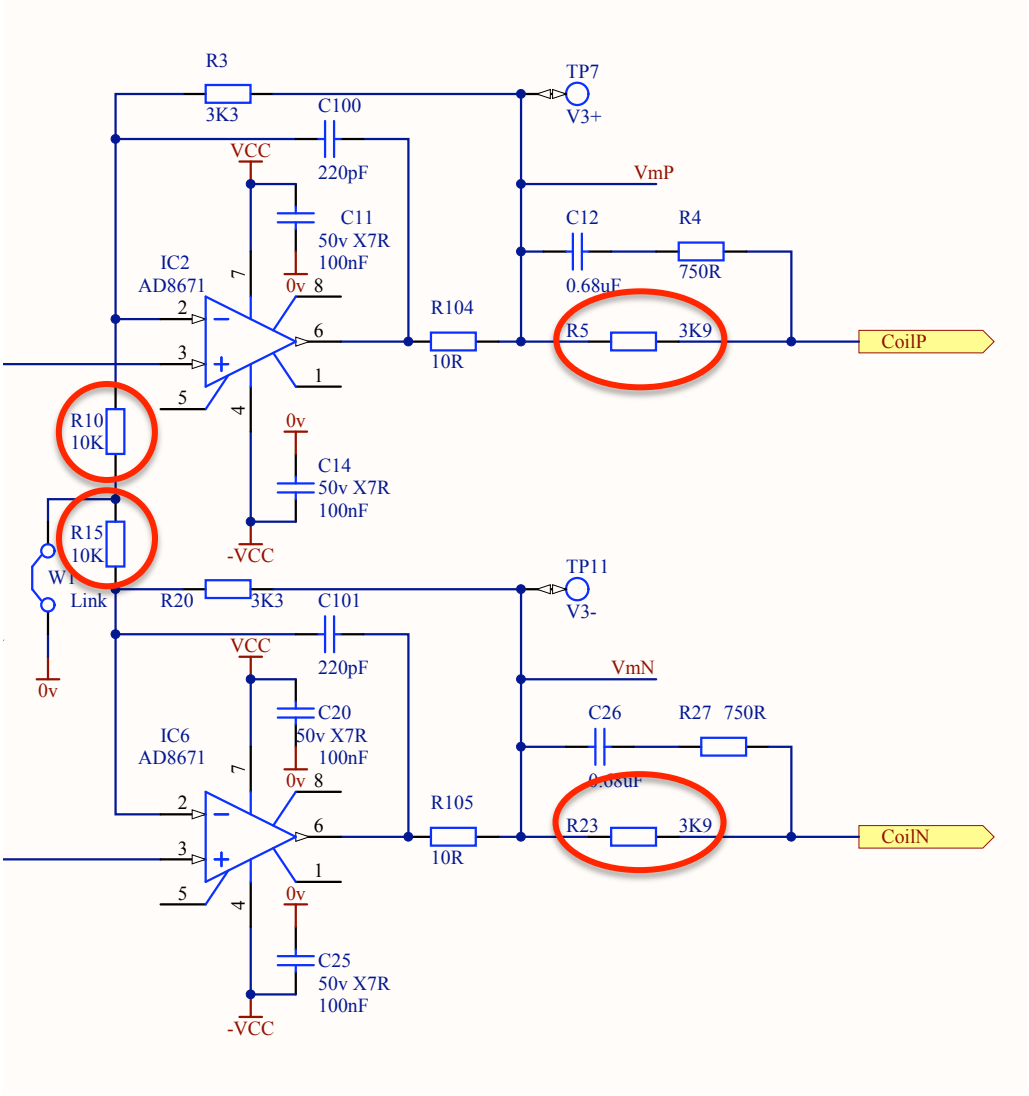


*Figure 1.* Differential output stages of the UIM coil driver, D070481-v4. The resistors to be changes are circled in red. R10 & R15: change to 2200 ohms; this will make the voltage gain of these stages 2.5. R5 & R23: change to 2000 ohms. Maximum coil current will then be approximately 6.25 ma. The output drive current capability of the AD8671 is +/-20ma.

## 3 Circuit simulation

The UIM coil driver circuit has been simulated using LISO (thanks to C Wipf); the transfer function and output current noise with the modifications are shown below.

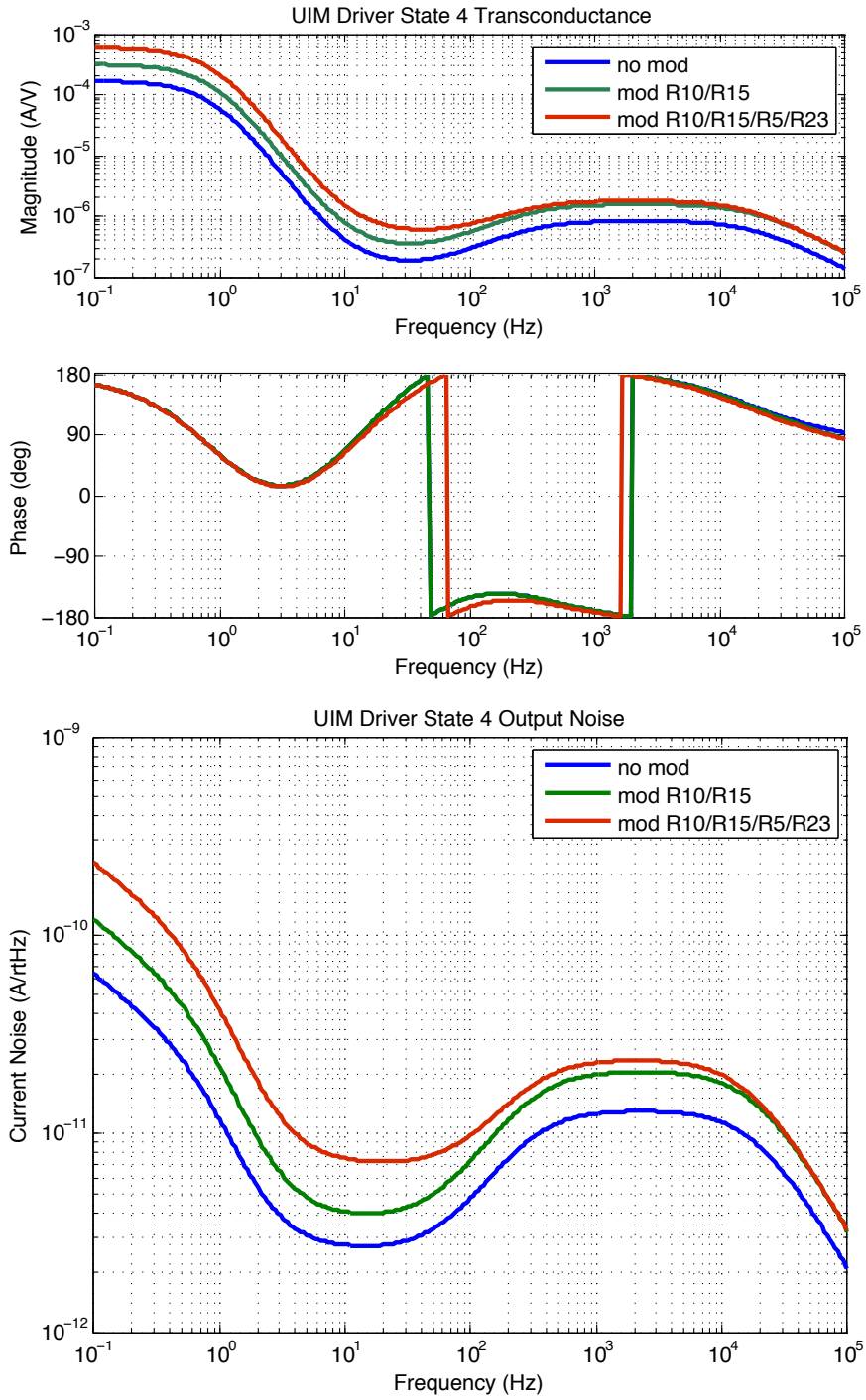


*Figure 2.* UIM coil driver response and output noise (input shorted). Red curves are for the modifications given in Figure 1.

The output impedance network produces a zero/pole response that will change with the output resistor change. The zero moves from 50 Hz to 85 Hz. The pole stays at 312 Hz.
The total output current noise (not shown, but used in the next section) also includes DAC voltage noise at the driver input. However, with the typical DAC noise level of 150 nV/Hz$^{1/2}$, the DAC noise contribution is small (below 1 pA/Hz$^{1/2}$ at 10 Hz).

## 4 Impact on DARM noise

The interferometer displacement noise (DARM) due to the modified UIM drivers is calculated assuming the two ETM drivers are modified. Each UIM has 4 coil-magnet actuators, and the force coefficient of each actuator is 1.7 N/A. The resulting DARM noise is shown in the figure below, along with the technical noise limit.

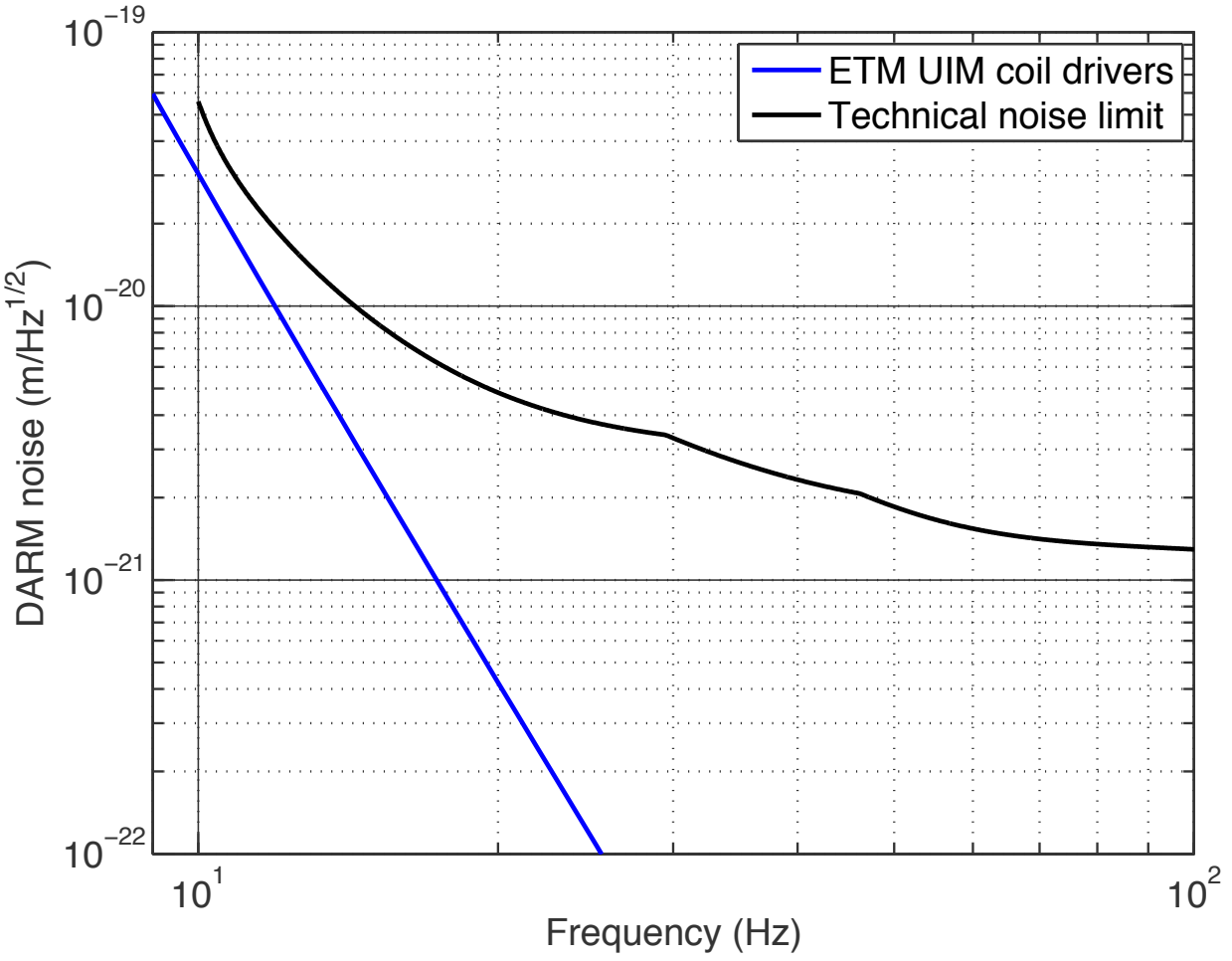


*Figure 3.* DARM displacement noise due to the ETM UIM coil drivers, as modified for greater range (blue curve). The black curve is the DARM displacement noise limit for technical noise sources, as given in the Systems Design, T010075.