# LT1012 is the best op-amp for the GS13 preamp

Brian Lantz, Sept 16, 2007

The best opamp to use with the GS13 is the LT1012. To calculate the noise performance, I use a file called GS13_noise_calc_2007.m. This takes the factory numbers for a GS13, puts a resistor across the output to give it a Q of 5, and puts a non-inverted op-amp with reasonable gain as the preamp. The noise from the system is the combination of: op-amp voltage noise; op-amp current noise * the back impedance of the unlocked GS-13, which is very large on resonance; and the Johnson noise, which is the real part of the coil impedance, and has some additional noise on the 1 Hz resonance.

I use a m-file called opampnoise.m to look up the noise of the op amps. This is based on the manufacture's spec sheets, and assumes that the voltage and current ASD of the devices each scale as f^(-1/2) at low frequency.

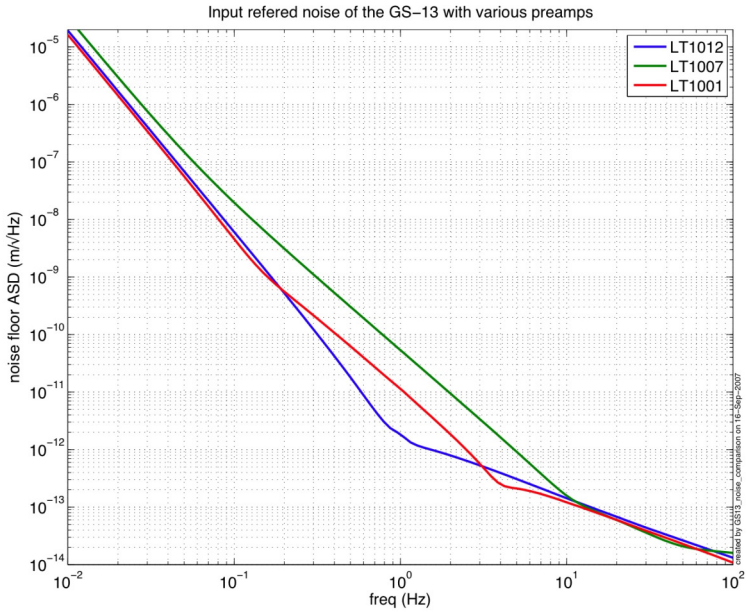


Figure 1. Noise performance of various preamps with the GS13. The best overall performance comes from the LT1012.

The LT1012 works well because it has the best mix of current and voltage noise to match the very high impedance of the 1 Hz resonance. The effective impedance of the GS-13 is shown below in figure 2. The impedance on resonance is limited by the 845 kohm damping resistor which is shorted across the coil to reduce the Q to 5.

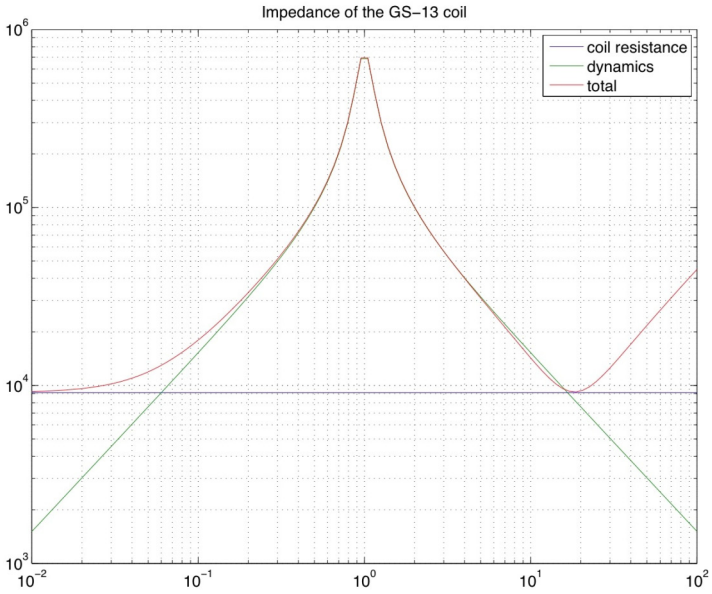


Figure 2. Impedance of the coil with a 845 kohm load resistor across the coil to reduce the Q to 5. We assume a R/L corner of 20 Hz, but have not measured it.

The noise contributions for the various op-amps are shown below in figures 3a-c.

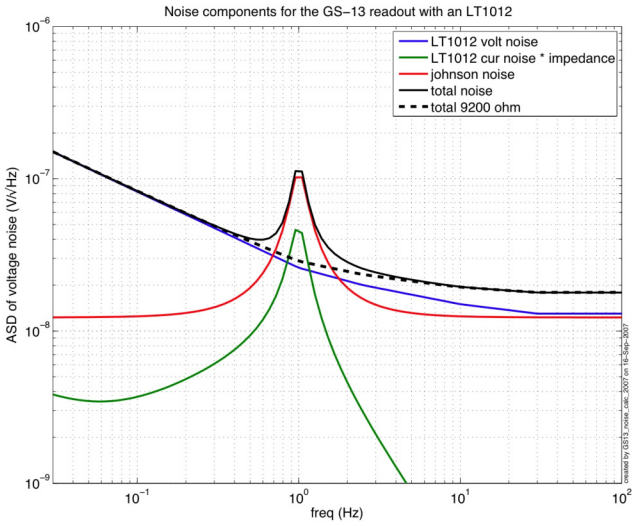


Figure 3a. Noise components of the LT1012. This is dominated either by voltage noise or the Johnson noise.

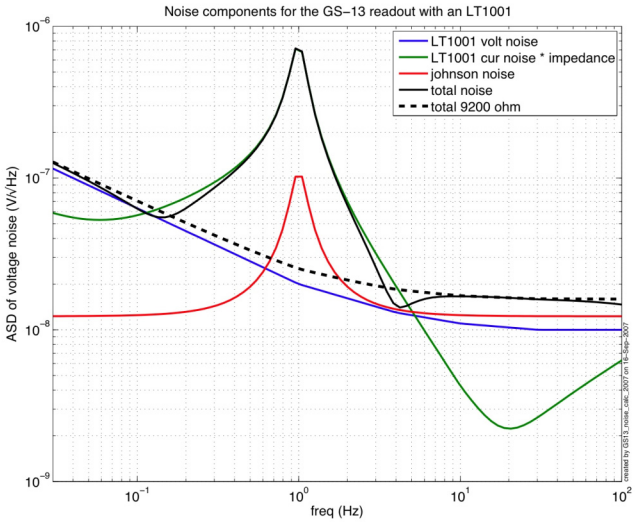


Figure 3b. Noise components for the LT1001. The current noise dominates on resonance, the voltage noise dominates off resonance.

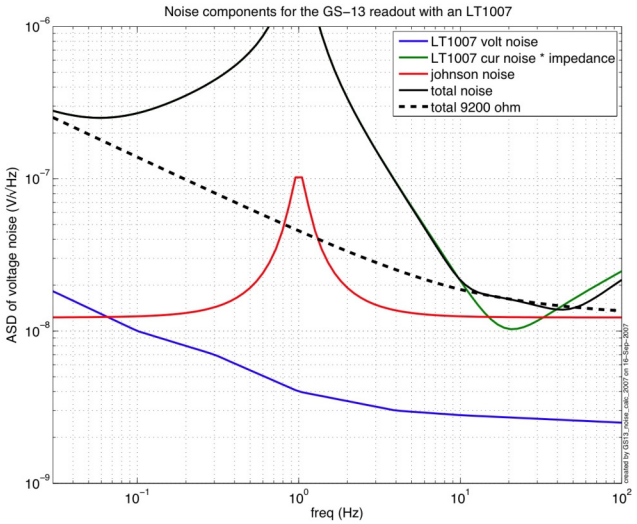


Figure 3c. The current noise of the LT1007 is too large for this application.