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New RCG Decimation Filter for 16 kHz models

LIGO-T1600066-v1

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The real-time code generator (RCG) uses IIR low-pass filters for data decimation to go from the sample rate of the input-output processor (iop) to the sample rate used by an individual RCG model. These filters are described in LIGO-T1500075. The purpose of this note is to define a new decimation filter for the RCG model rate of 16384 /sec. The new filter has smaller ripple and less phase shift in the pass-band, at the expense of less attenuation just above the cut-off frequency. The filter is 6th order, the same as before.

Filter coefficients

The filter coefficients are given below: the first is a gain factor, followed by one row for each of the SOS.

```
gain = 0.054285975  
{a11, a21, b11, b21} = {-1.38902210, 0.56547295, -1.43079926, 1.02500927}  
{a21, a22, b21, b22} = {-1.52191125, 0.90075507, -3.83663314e-6, 1.07232307}
```

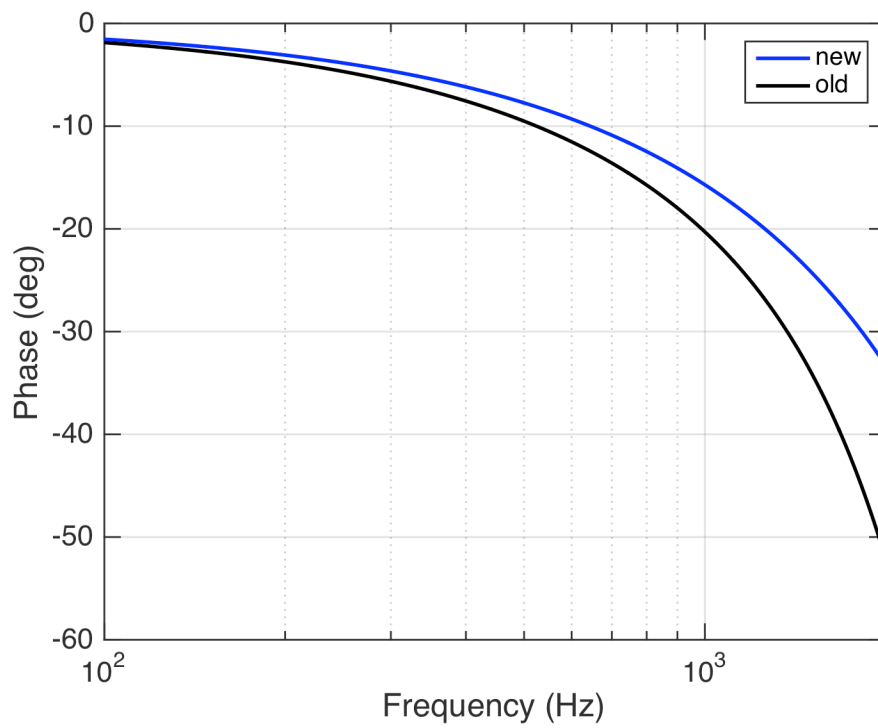
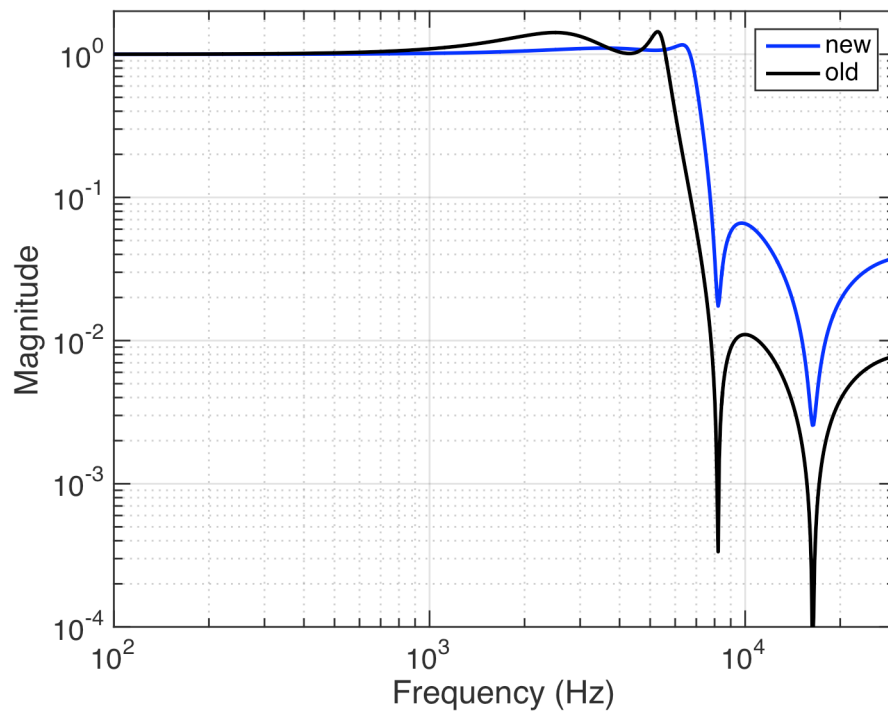
The zero-pole definition of the filter is:

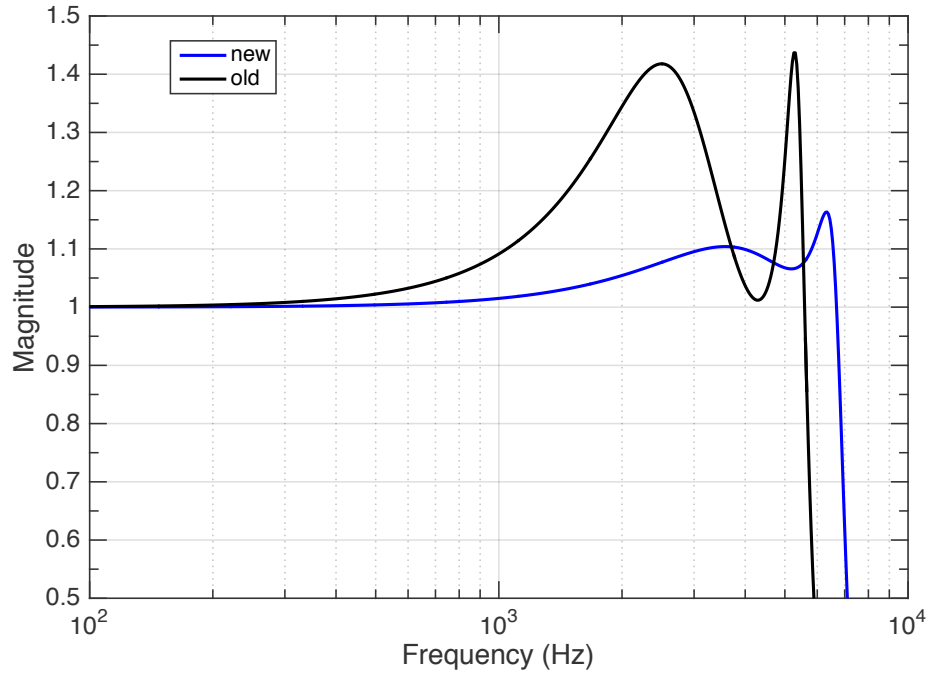
```
complex pole pair at: f = 5000 Hz, phase = +/- 127 deg  
complex pole pair at: f = 6700 Hz, phase = +/- 95 deg
```

```
complex zero pair at: f = 8200 Hz, phase = +/- 89 deg  
complex zero pair at: f = 16384 Hz, phase = +/- 87 deg
```

Transfer functions

The transfer functions for the new and old filters are shown below.





Anti-aliasing.

The following plot shows the low-pass filtering provided by the combination of the hardware AA filter (3rd order Butterworth at 10 kHz) and the new RCG decimation filter.

