

# Quantization Noise Analysis in Advanced LIGO Digital Control Systems

**Abstract:** Advanced LIGO implements hundreds of control loops using digital signal processing techniques. These controllers are known to inject noise due to round-off error as signals are IIR filtered, and converted to and from the digital domain. In this project, the origins of this quantization noise, and its analysis have been investigated for the digital controller implemented at the Advanced LIGO sites. The quantization noise analysis is done for all its sources viz. the digital filters, Analog to Digital Converters(ADCs) and Digital to Analog Converters (DACs). The quantization noise in the filters depend on their structure which has been thoroughly analyzed in this study. The report would also summarize the results of quantization noise analysis in the DAC code and noise shaping implementation so that the quantization noise level is mitigated in the frequency band of interest to gravitational wave detection.