ECE478 Lab 7 Report

The Sampling Theorem

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ABSTRACT:

The following lab explores the sampling theorem in communication theory. This is done via TIMS Hardware and MATLAB

Experiment

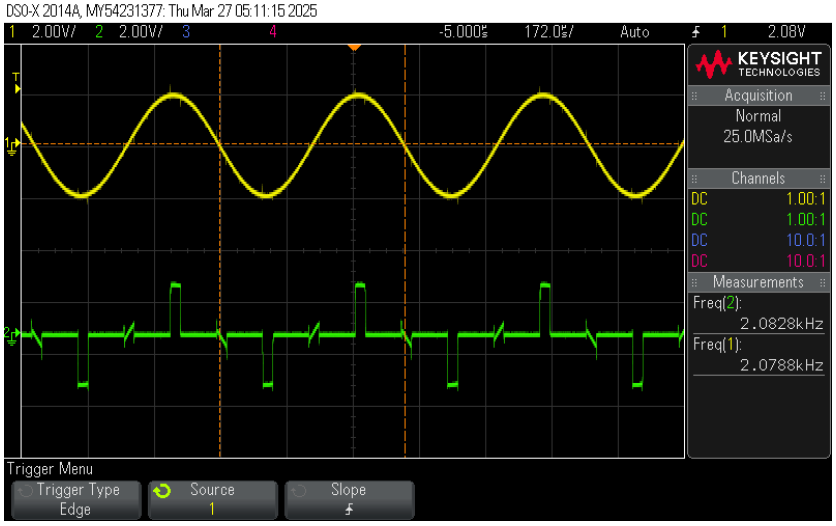

Figure 1: Message and sampled message.

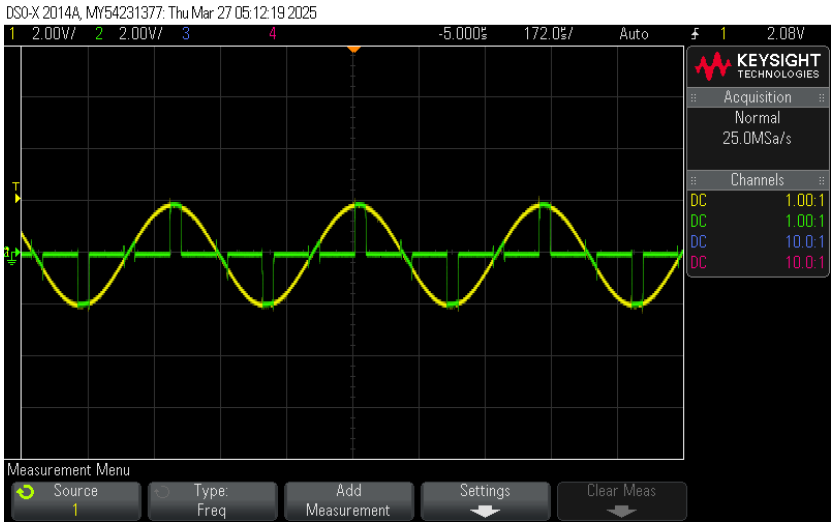

Figure 2: Sampled message at reconstructable sample rate

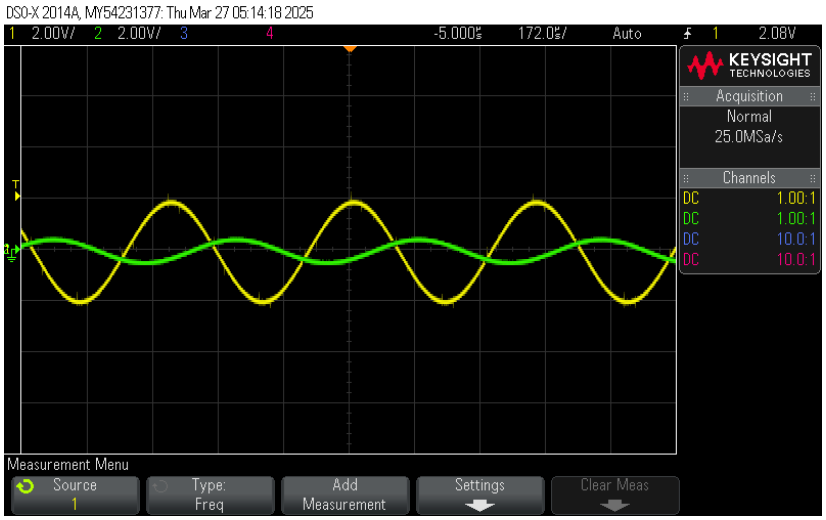

Figure 3: Message and reconstructed message post LPF

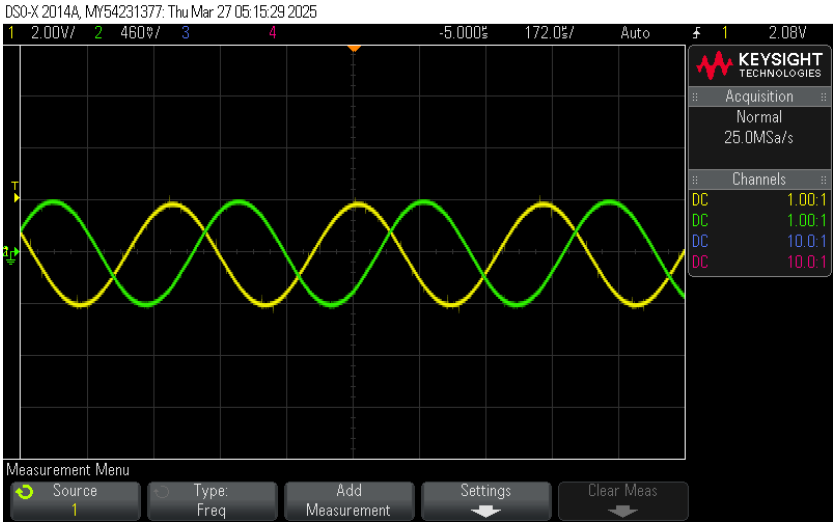

Figure 4: Same as Figure 3, with readjusted amplitude (shows attenuation)

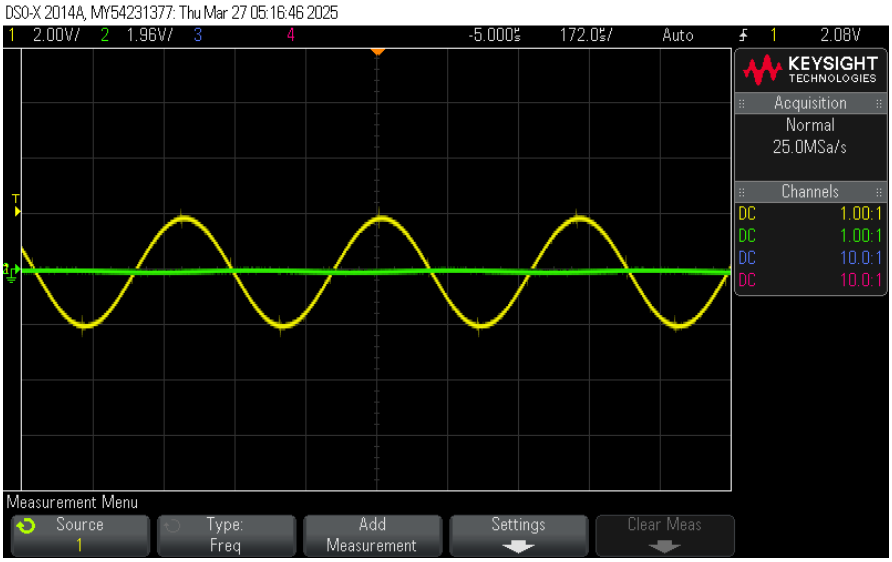

Figure 5: Smallest sample width reconstruction

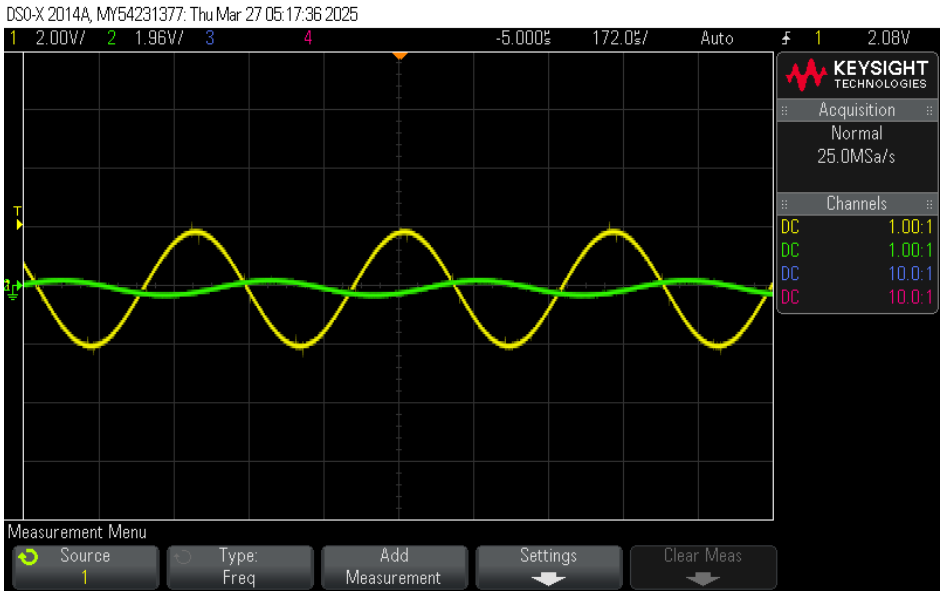

Figure 6: Moderate sample width reconstruction

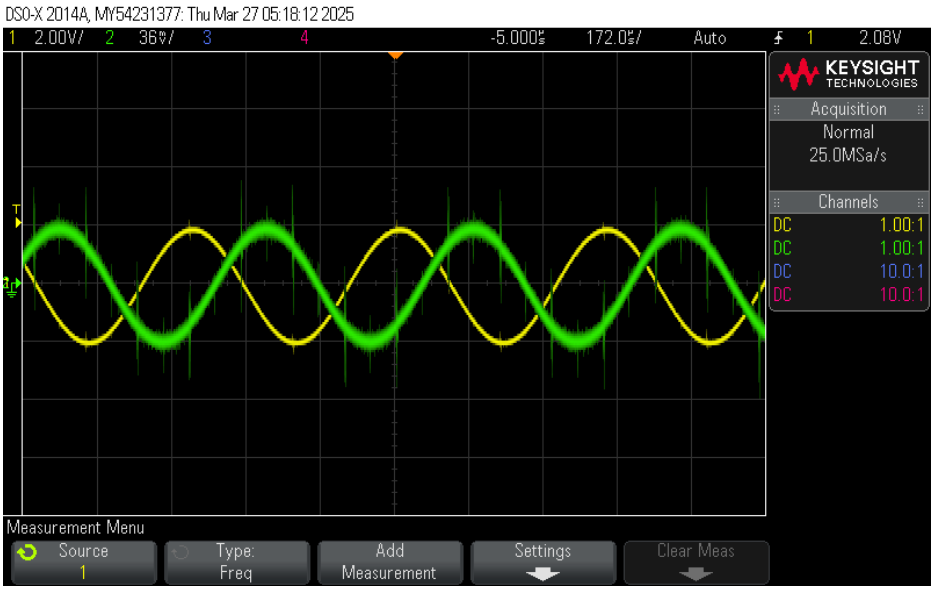

Figure 7: Largest sample width reconstruction

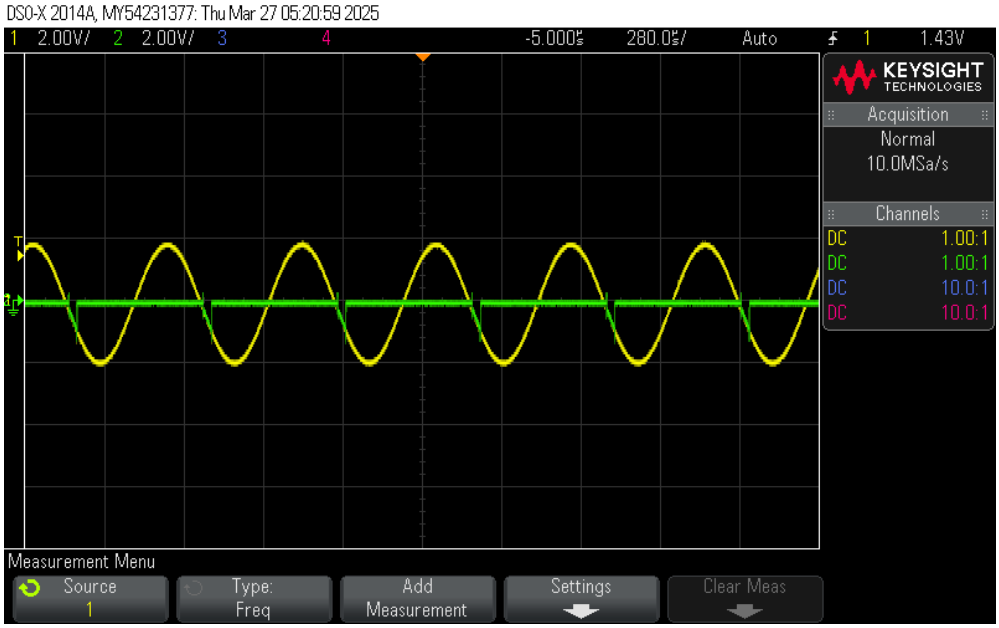

Figure 8: Synchronous

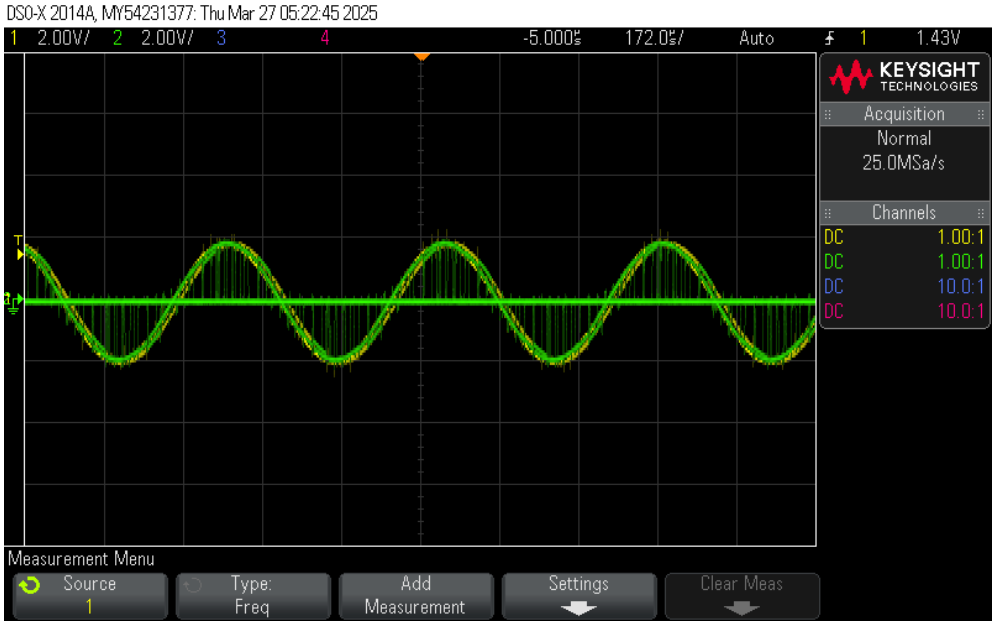

Figure 9: 2kHz message sampled with 8.333kHz TTL

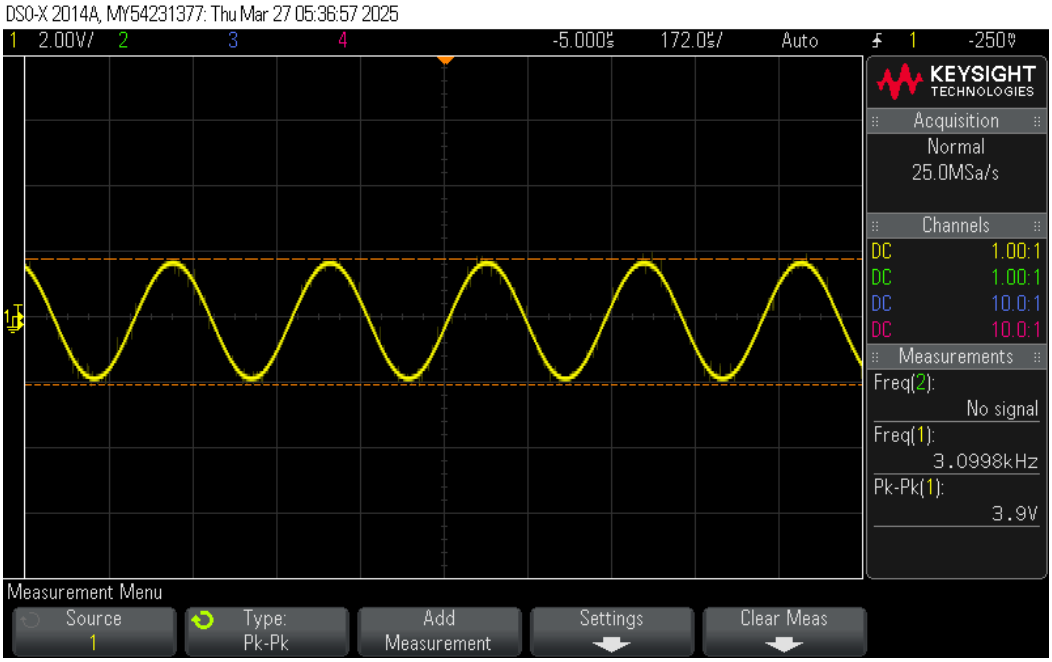

Figure 10: 4V peak to peak adder output

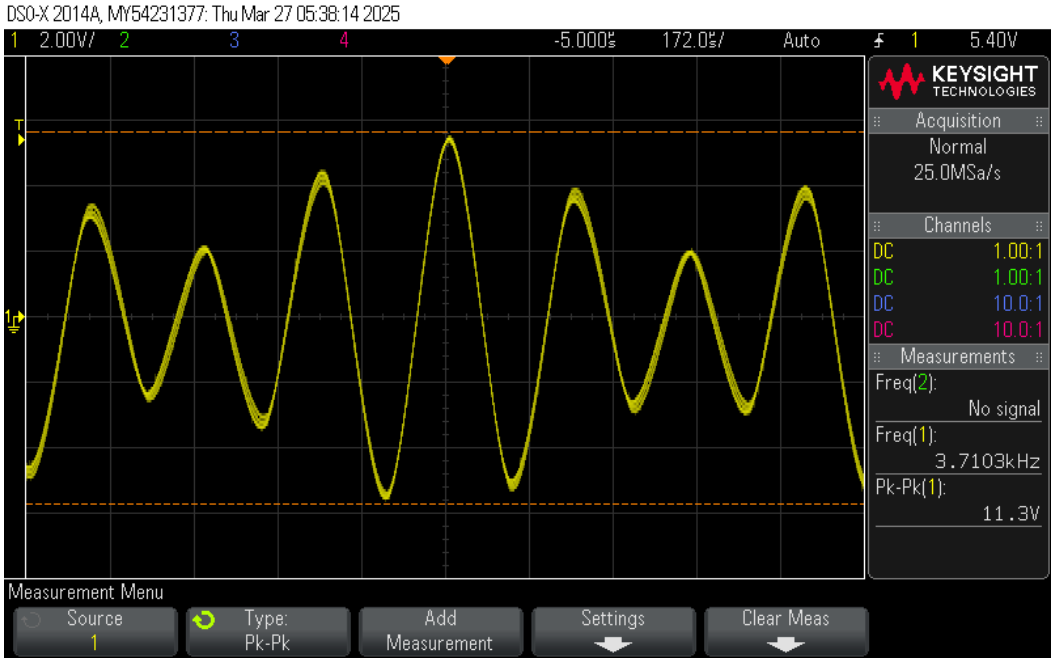

Figure 11: Adder output with maximum noise

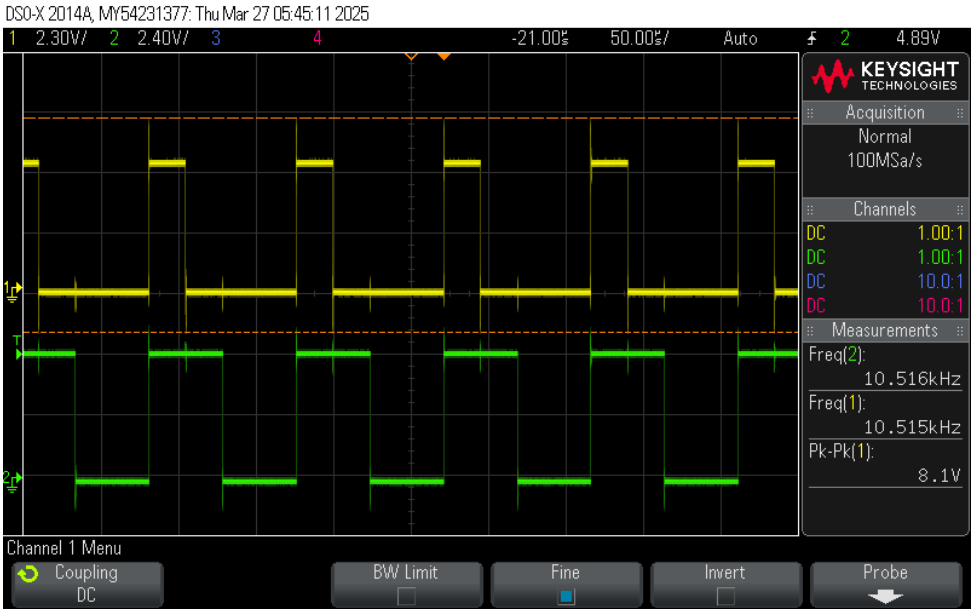

Figure 12: Synchronized, sample width 20% of sample period

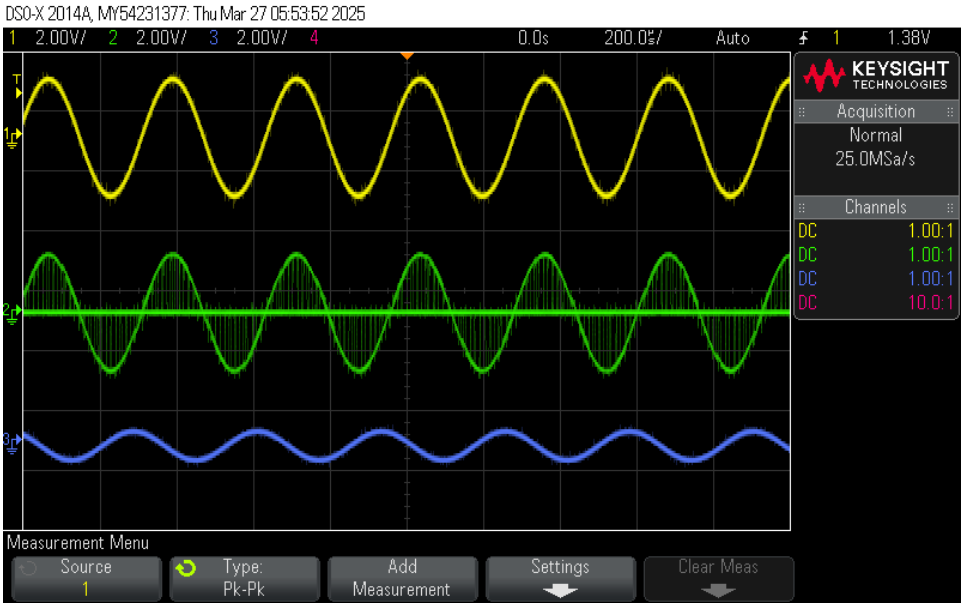

Figure 13: Message, sampled message, and reconstructed message

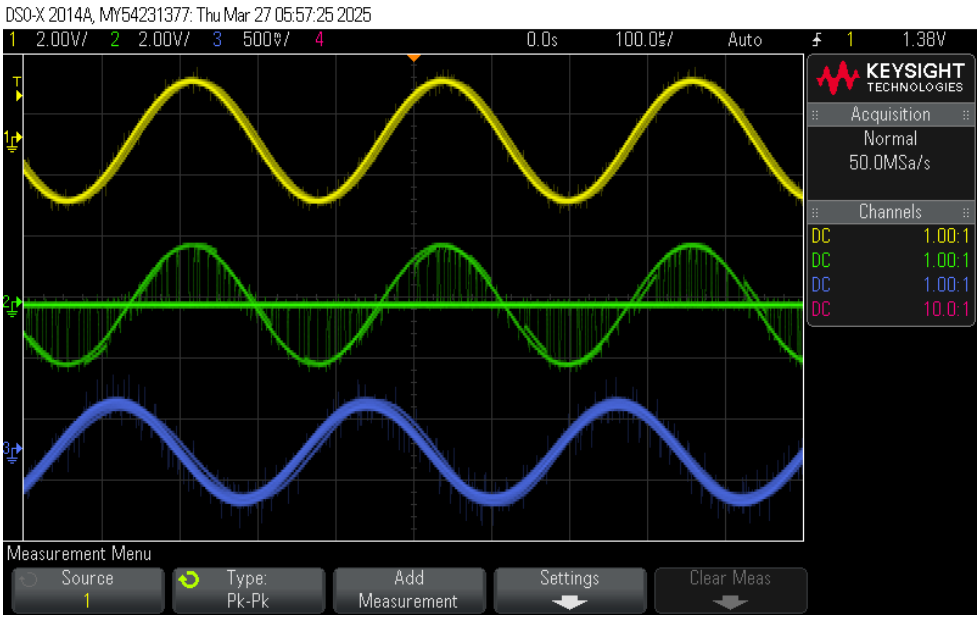

Figure 14: Reconstruction with f_s=7.087kHz, the minimum rate

The required sampling of the filter turns out to be slightly more than double the bandwidth of the signal, where we need 7.087kHz, while minimum by the sampling theorem for a 2kHz sinusoid would be 4kHz.

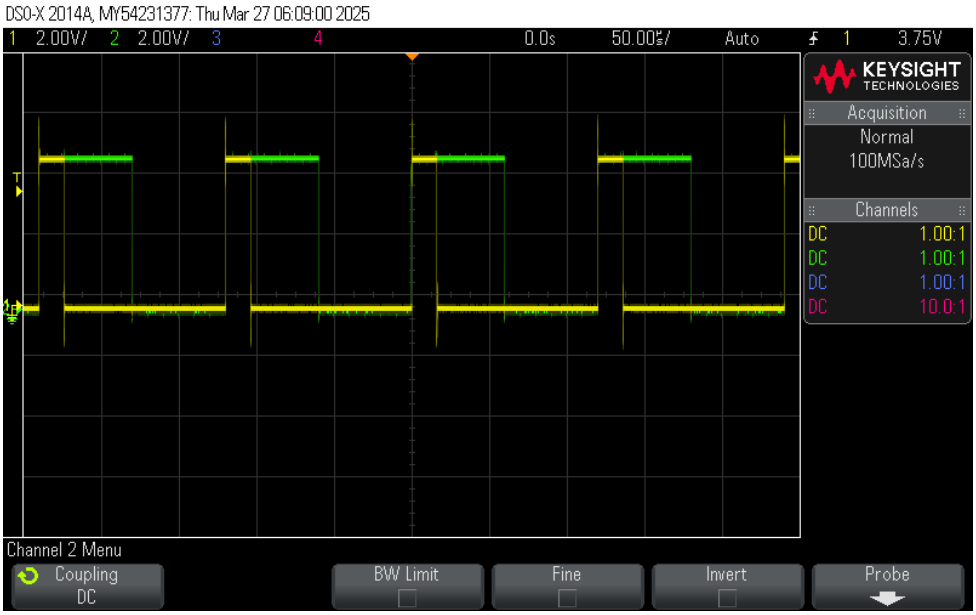

Figure 15: Sample duration 1/10 of clock period

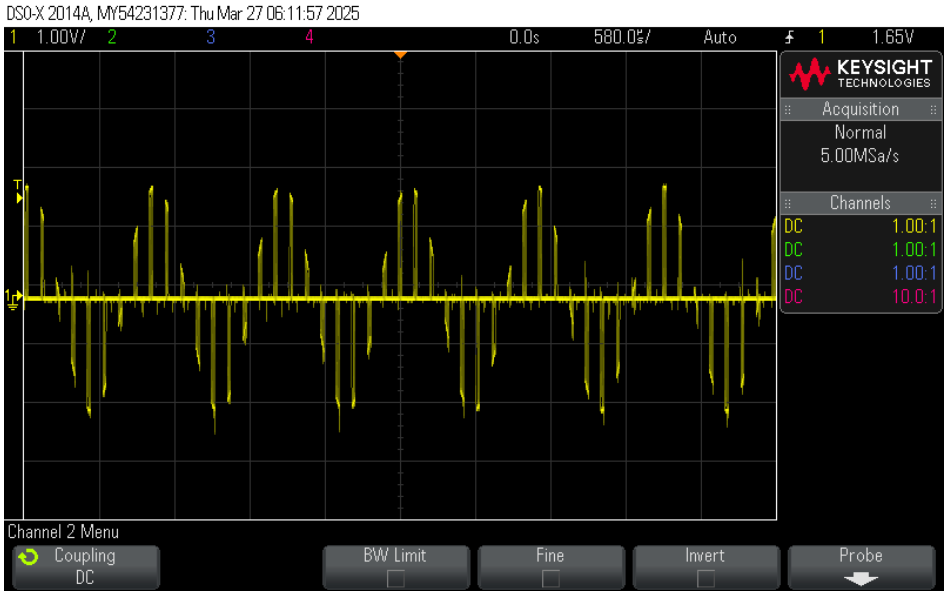

Figure 16: Sampled message

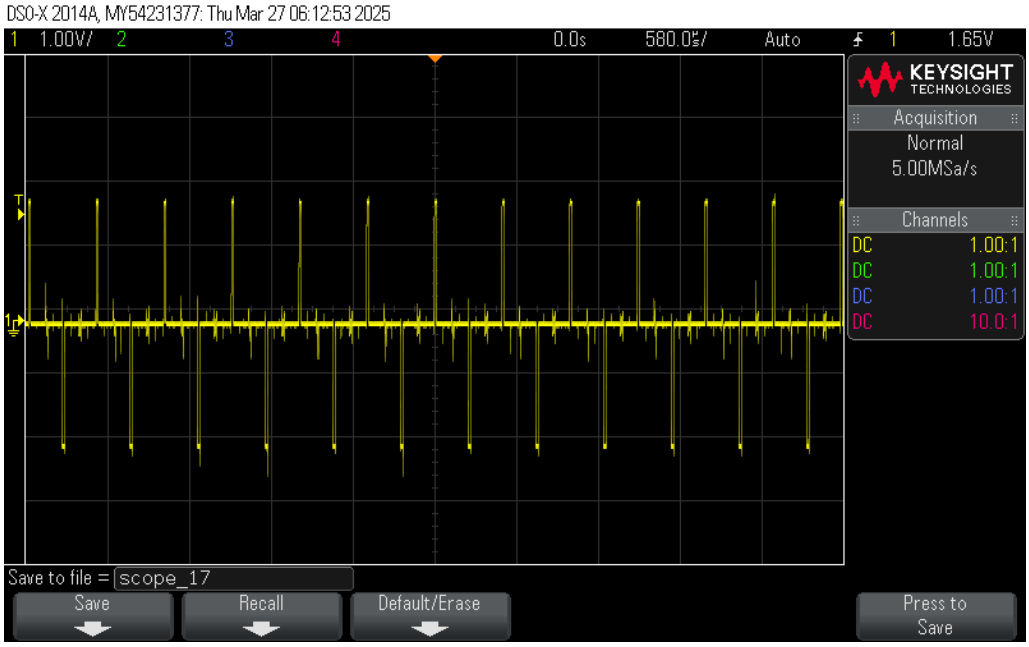

Figure 17: Message sampled with aliasing

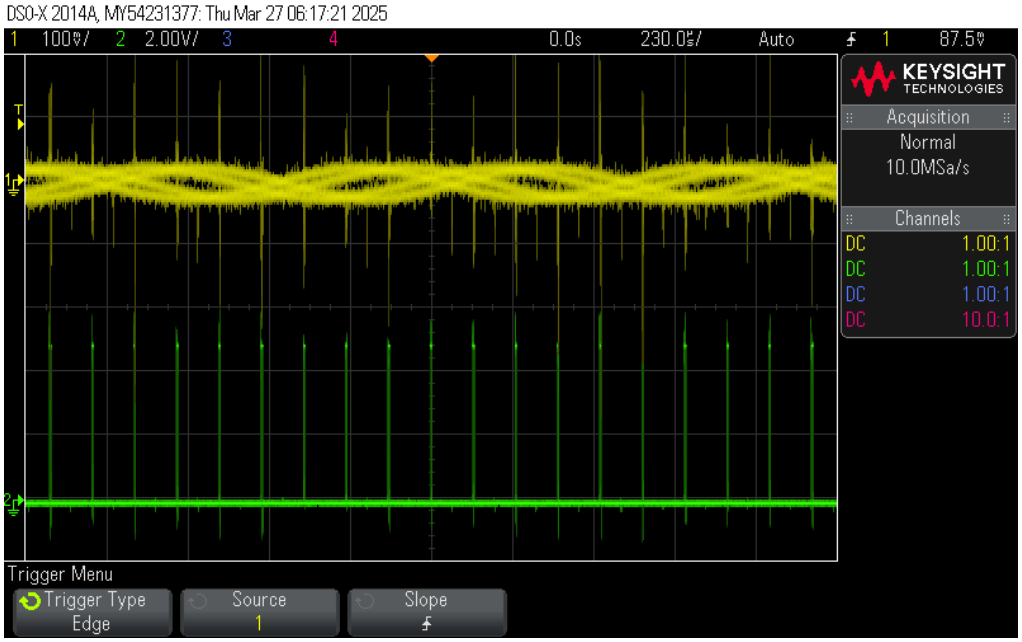

Figure 18: Reconstruction with closed LPF

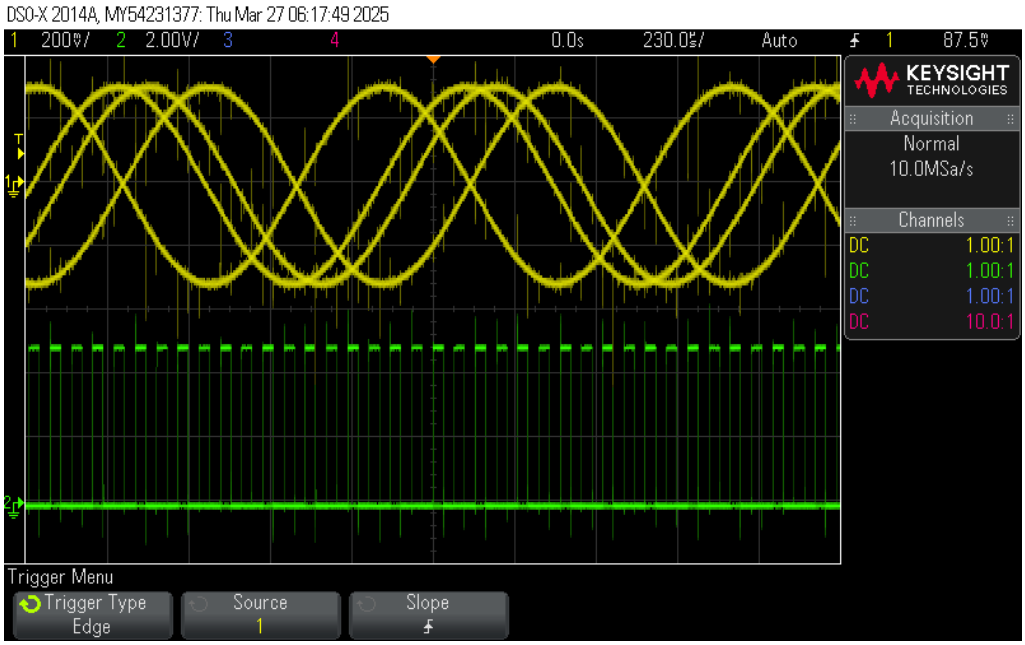

Figure 19: Reconstruction with moderately-open LPF

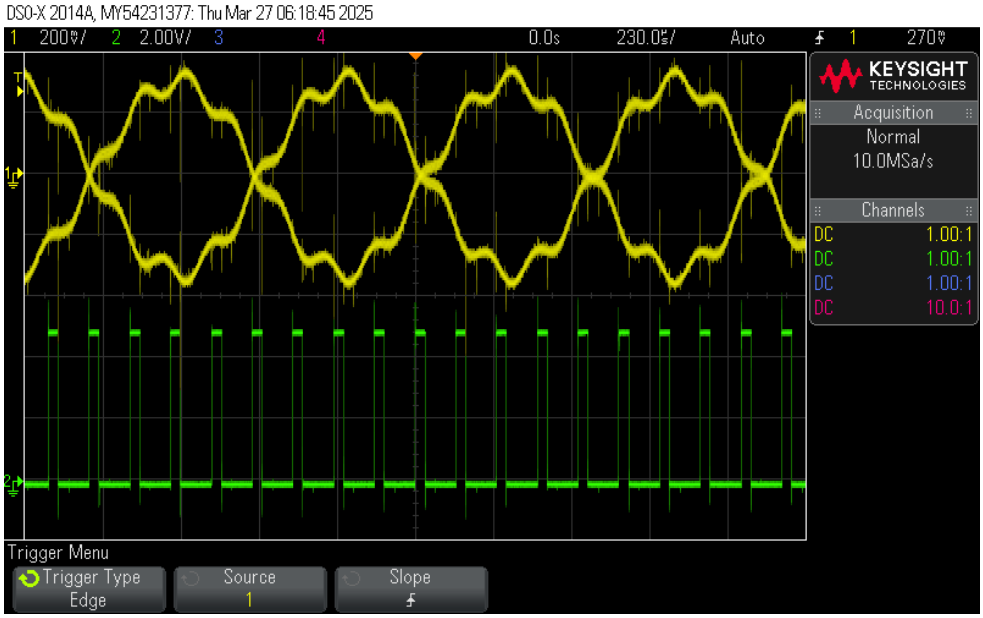

Figure 20: Reconstruction with fully-open LPF

MATLAB

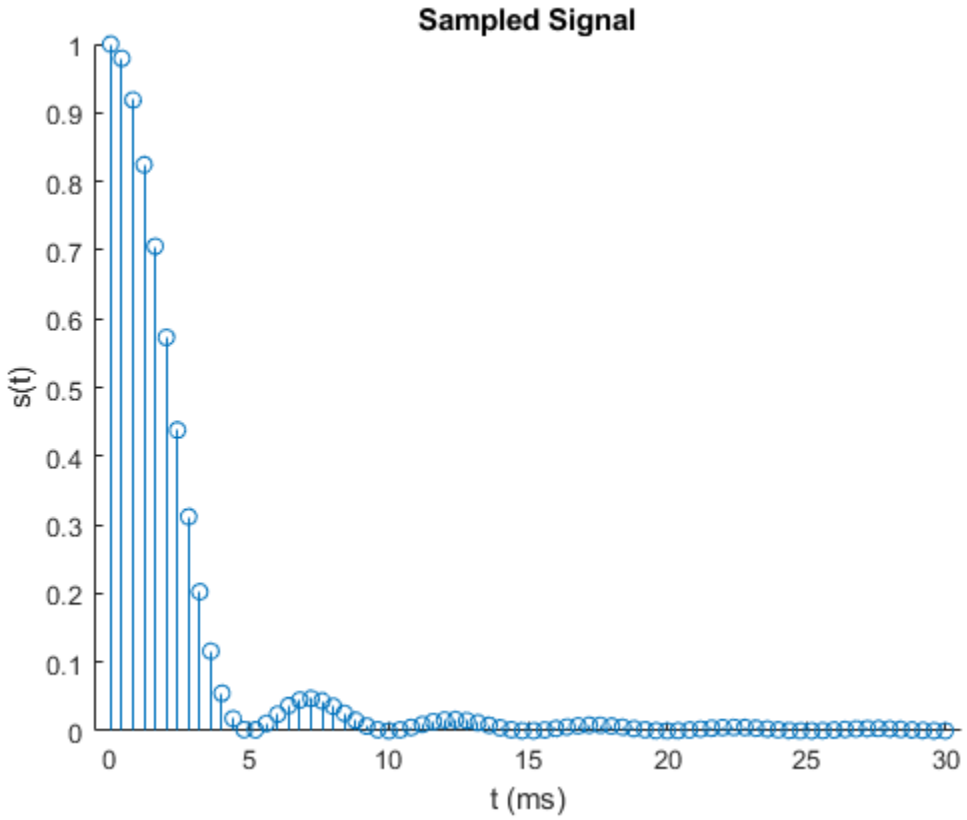

Figure 21: MATLAB sampled square sinc pulse

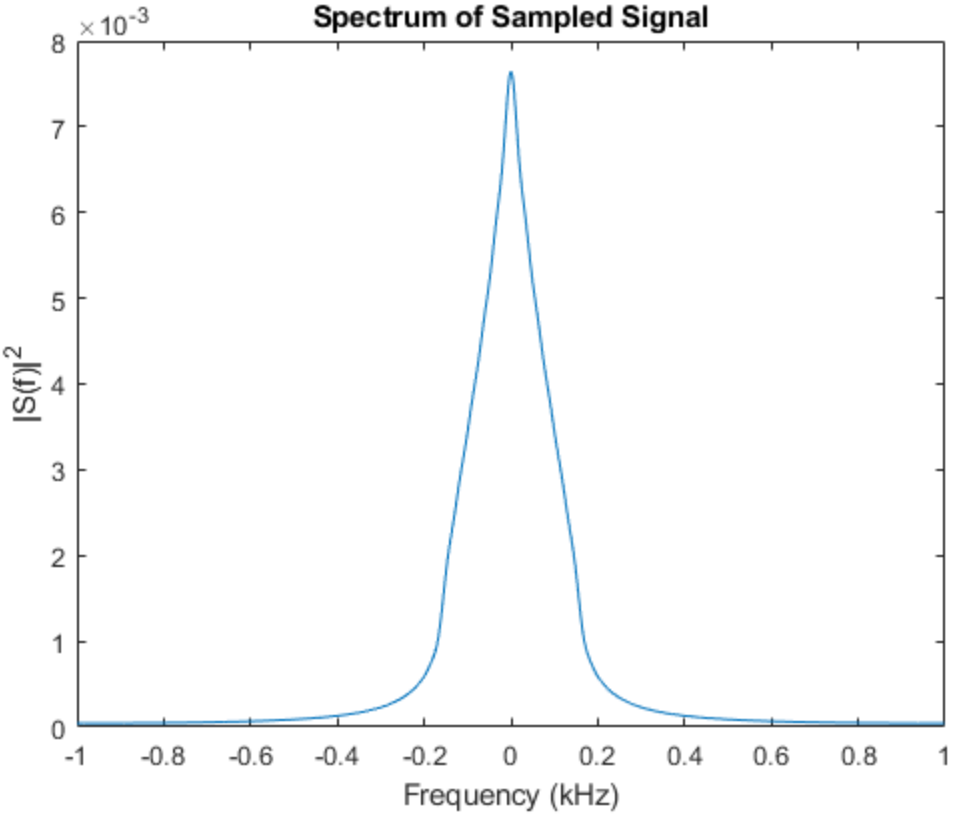

Figure 22: FFT of sampled square sinc pulse

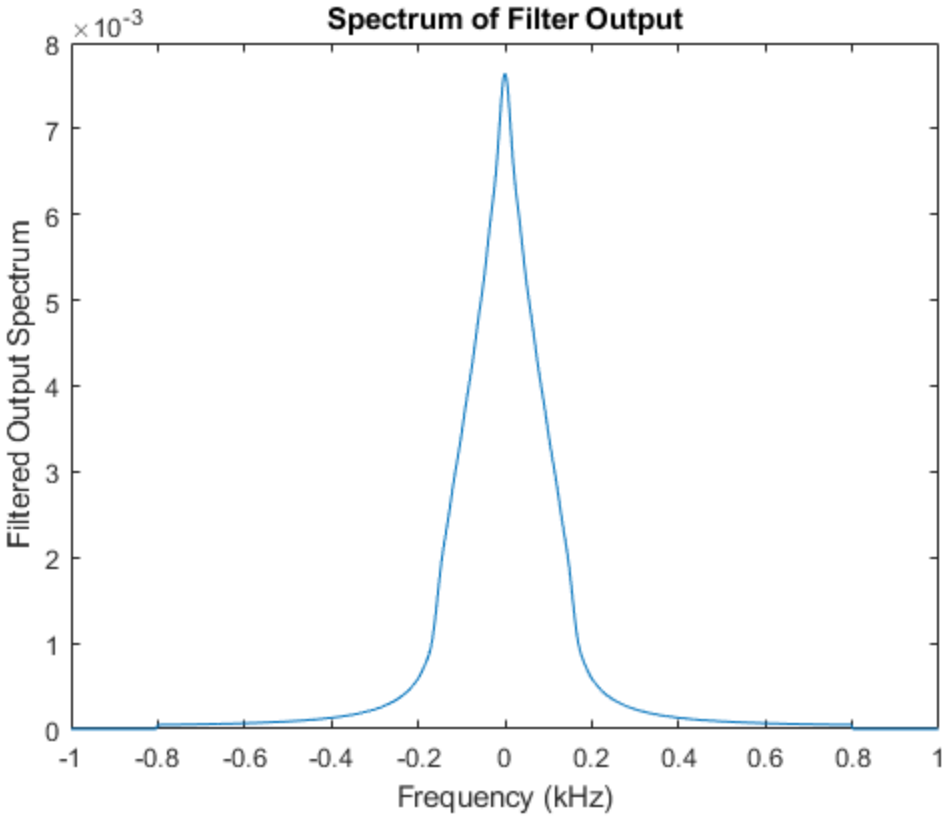

Figure 23: Output FFT of filtered sampled signal

Where we get the expected triangular frequency spectrum of a square sinc pulse as the LPF can pick out the original content of the sampled square sinc pulse.