Appendix A:

While conducting an experiment, WallE Gator expected the input signal to be a sine wave of frequency 1KHz sampled at 25KHz. However, the observed input was a square wave with ringing (shown in blue in Figure A-2). WallE mathematically interpolated the input to the square wave (shown in green in Figure A-2). Realizing that the signal was corrupted by higher order harmonics, Wally designed a FIR filter to clean up the signal. The magnitude and impulse response of the filter are shown in Figure A-1. The expected output is a near-sine wave (shown in red in Figure A-2) delayed by the group delay of the filter which is 3.5 samples. The FFT of the input (blue) and the filtered output (red) are shown in Figure A-3.

Filter coefficients:

For this lab, the following filter coefficients for a 8-tap filter (in decimal) are used:

[0.068556404040904, 0.111805808555109, 0.149037722285938, 0.170581276322676, 0.170581276322676, 0.149037722285938, 0.111805808555109, 0.068556404040904]

- You need to convert them into the IEEE single-precision floating point (32 bit) format (e.g., use converter at: http://babbage.cs.qc.cuny.edu/IEEE-754/)

sign bit exponent fractional
[31] [30..23] [22..0]

Decimal value = $(-1)^s * 2^{e-127} * 1 + f$

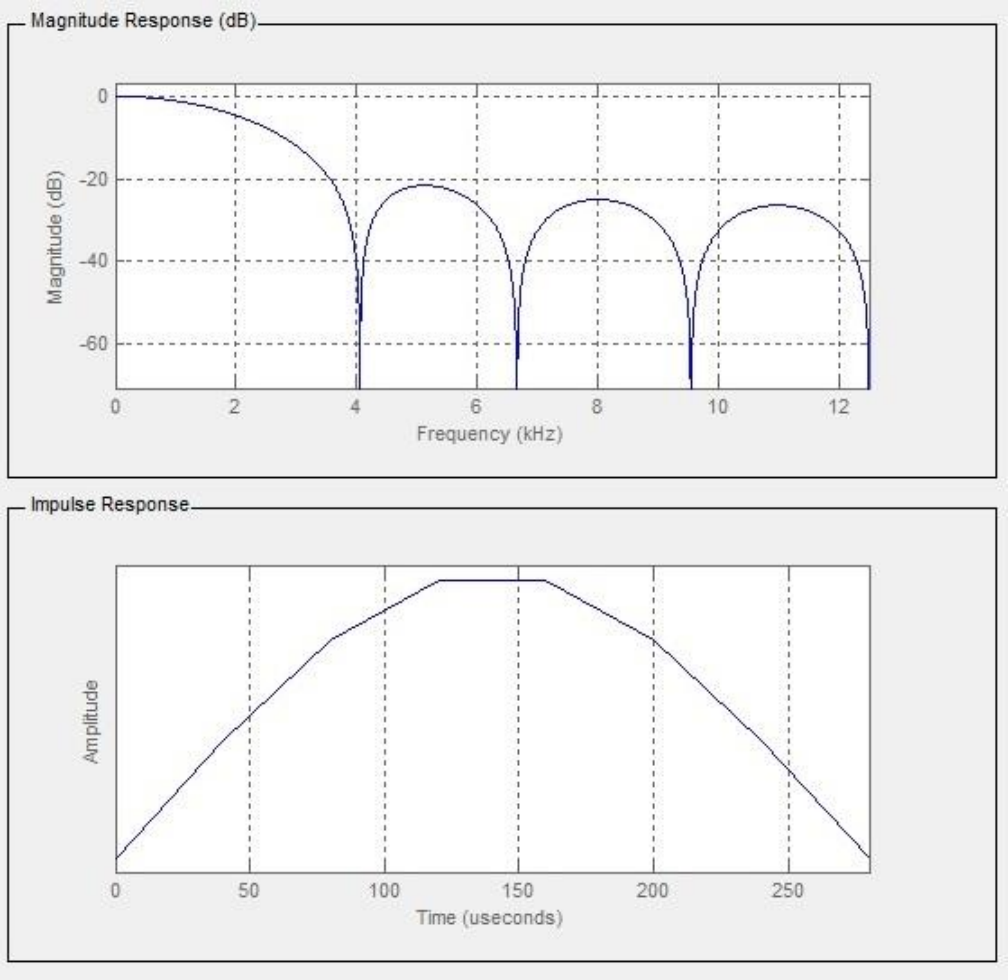

Figure A-1. Corresponding Filter Magnitude and Impulse Response

For this lab, the input vector (already converted to single-precision floating point) is given in FIR_INPUT.mif.

To verify the correctness of your output, the first 4 elements of input vector = [0x00000000, 0x3F96FE83, 0x3F66C78A, 0x3F88BC21 …]
which is equivalent to decimal [0, 1.179642127146860, 0.901482240402704, 1.068241253763636 …]

The initial outputs from MATLAB (convolution of the filter coefficients with the input vector) are: (0.0, 0.0, 0.0, … , 0.0, 0.080872022292352, 0.193693222540071, 0.349836905534984, 0.519945872966512, 0.691668332609275, 0.835610111214736,) 0.944075796021697, 1.005825233266888, 0.997671734634238, 1.000970868755058, 1.000128130759343, 0.993578584887082, 0.859460044230899, 0.636072206561142, 0.339308741242015, …

The first set of outputs is still "junk" (i.e., the shift register is not filled with valid input data yet, etc.). The first correct output (to be put into output RAM address 0 is 0.944075796021697.

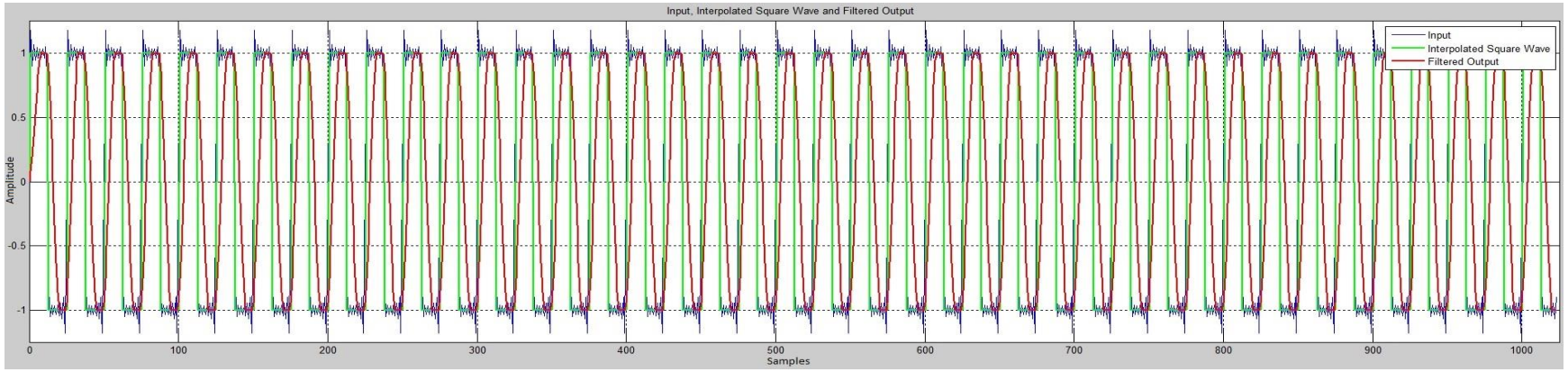

Figure A-2. Input, Interpolated Square Wave and Filtered Output

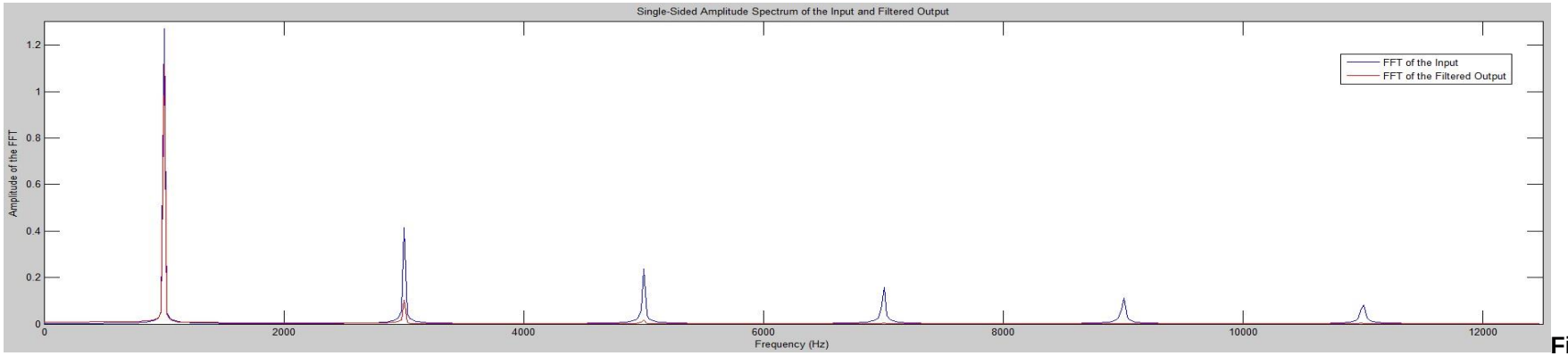

Figure A-3. FFT of the Input and Filtered Output