FLAT TOP SAMPLING AND DISCRETE-TIME MODELING

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PART A: SETTING UP THE VIRTUAL CONTINUOUS TIME MODE

Step 1: Generate a chirp signal. The minimum frequency is 10 hz and maximum frequency is 500 hz for a duration of T = 0.2 seconds. The signal model in Figure A-1 is over-sampled with a total of 6401 samples and at $f_{s1} = 64\ \ f_{max} = 1/T_{s1}$. Time is varied from 0 to T in steps of T_{s1}. A chirp signal is $s(t) = \cos(2\pi (a t^2 + b t))$.

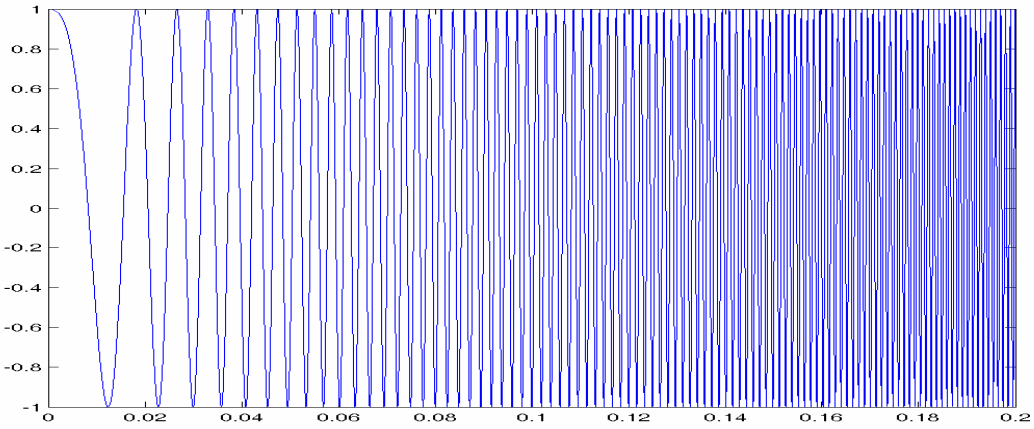

Figure A-1: Chirp signal.

Step 2: Generate the spectra of the chirp signal using a DFT as shown in Fig. A-2. Note that the frequency equivalent access, in hz, is $f = k f_{s1}/N$ where $N = 1 + T/T_{s1}$. Find the equivalent maximum frequency of the chirp signal. This maximum value is due to the modulation of the chirp.

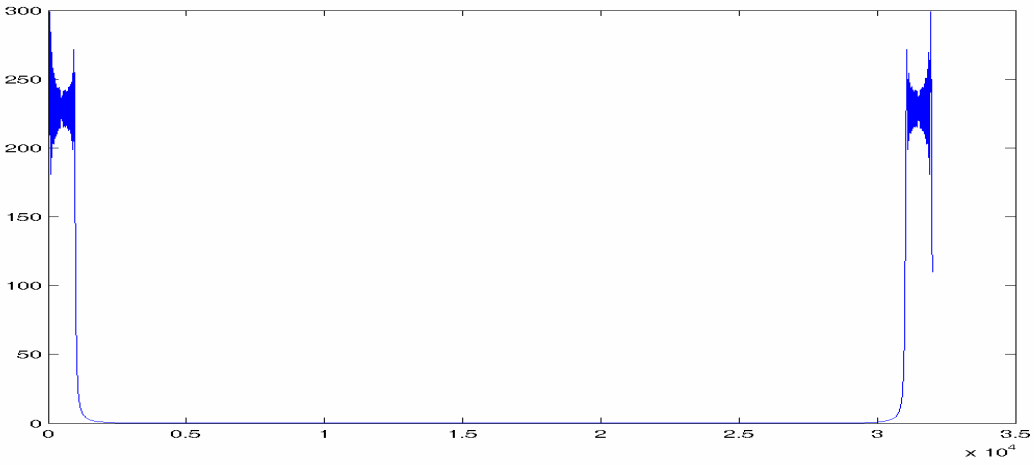

Figure A-2: DFT of chirp signal shown in Fig. A-1. Horizontal axis is in hertz.

PART B: MODEL THE FLAT TOP SAMPLING PROCESS

Step 1: Flat top sample the signal in Fig. A-1. The result should be the same length even though the sampling rate, f_{s2}, is only twice Nyquist which is about 8 f_{max}. Explain why the Nyquist rate is 4 f_{max} instead of 2 f_{max}, by referring to Fig. A-2. Example is shown in Fig. B-1.

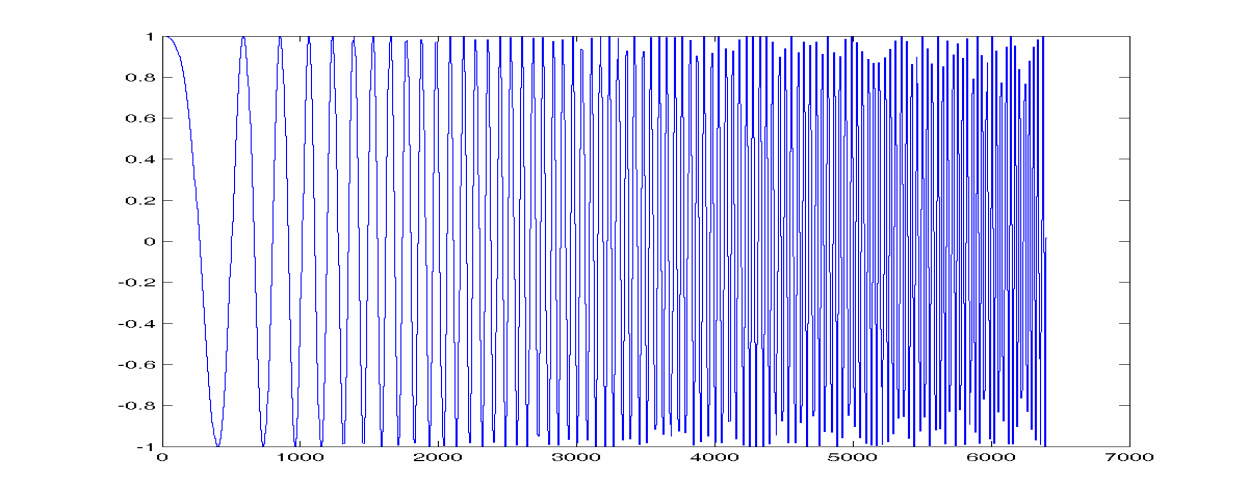

Figure B-1: Flat top sampled chirp signal.

Step 2: Construct a reconstruction filter that has a bandwith of $f_{s2}/2$.

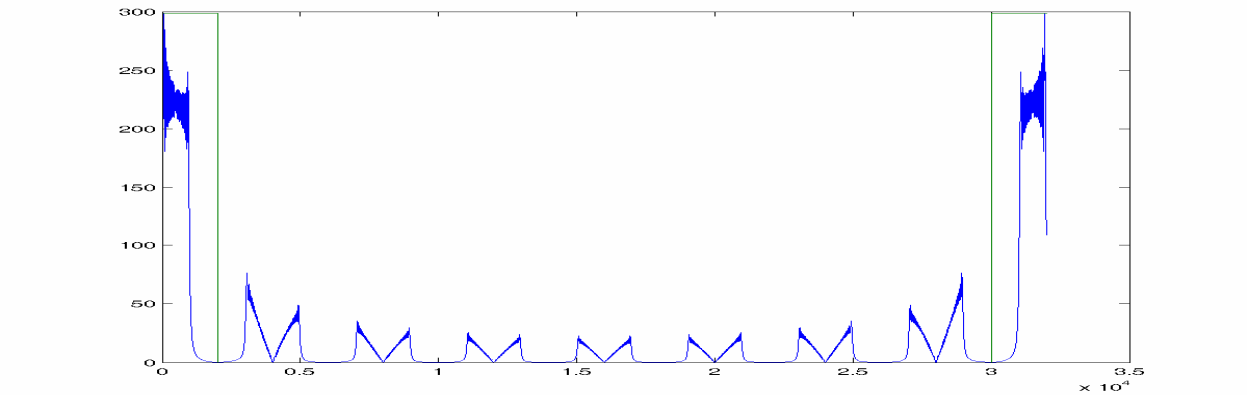

Figure B-2: Spectrum of flat top sampled chirp with reconstruction filter spectrum superimposed in green.

Step 3: Reconstruct the chirp signal from the flat top sampled one. Show results similar to Fig. B-3.

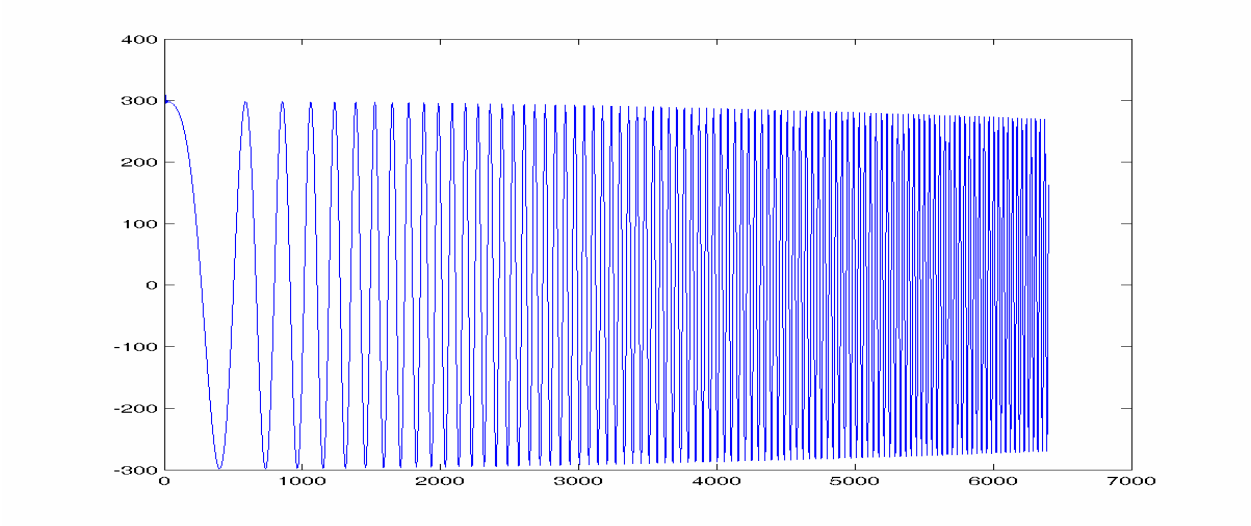

Figure B-3: Reconstructed Chirp signal.

PART C: UNDERSAMPLED FLAT TOP SAMPLING

Repeat part B, but at a sampling rate that is half of Nyquist.

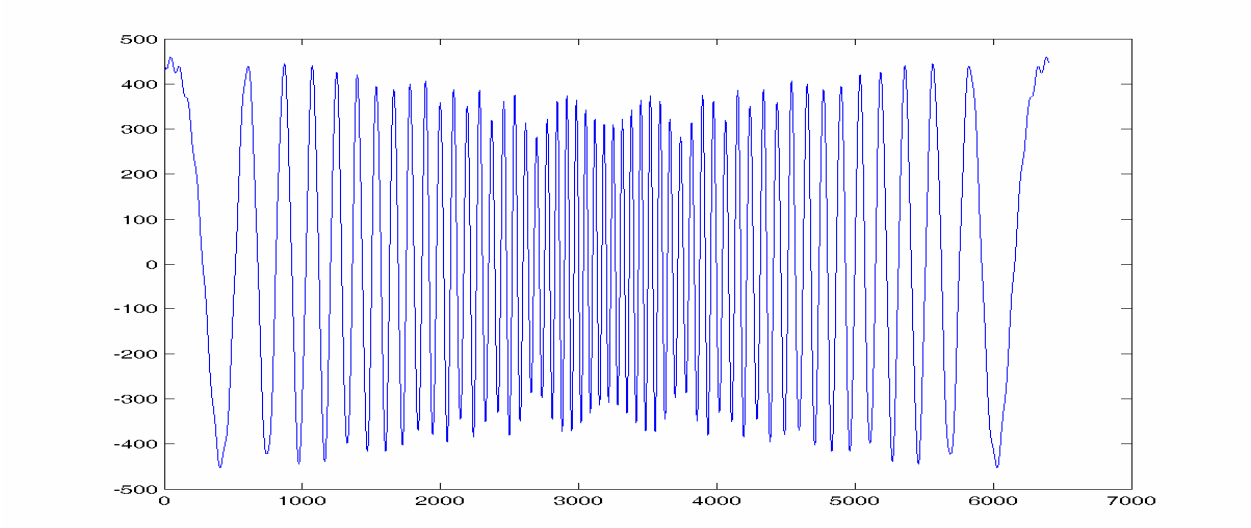

Figure C-1: Reconstructed chirp signal when under-sampled.