ECE 697 Delta-Sigma Converters Design

Lecture#11 Slides

Vishal Saxena
(vishalsaxena@u.boisetstate.edu)

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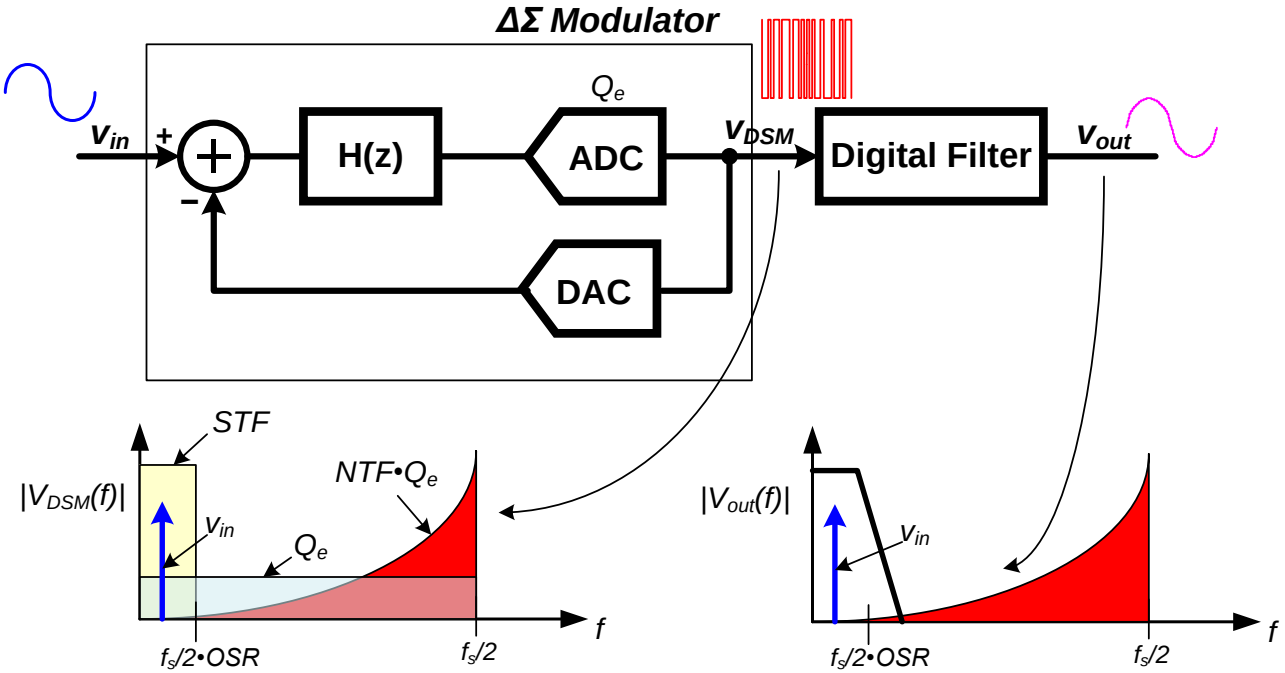
Delta-Sigma (ΔΣ or DS) Modulation



- Use oversampling ($f_s = 2 \cdot OSR \cdot BW$) to shape the quantization noise out of the signal band.
- Use low-resolution ADC and DAC to higher much higher resolution
  - ✓ In MATLAB, Quantizer = ADC + DAC
- Digitally filter away the out-of band shaped (modulated) noise.
- Trades-off SNR with oversampling ratio.

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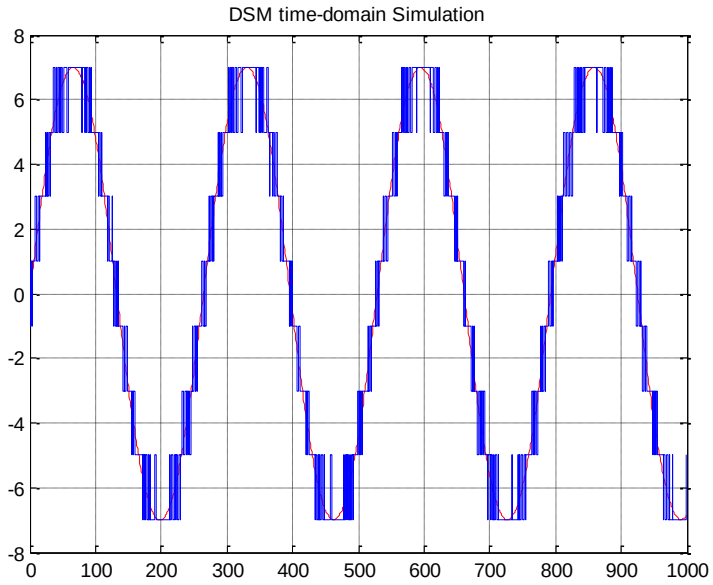
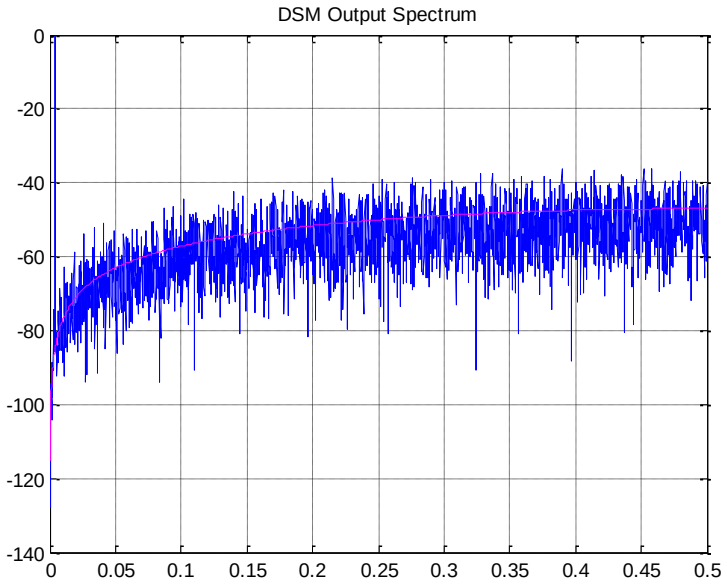
First-order Noise Shaping





File: First_Order_DSM.m

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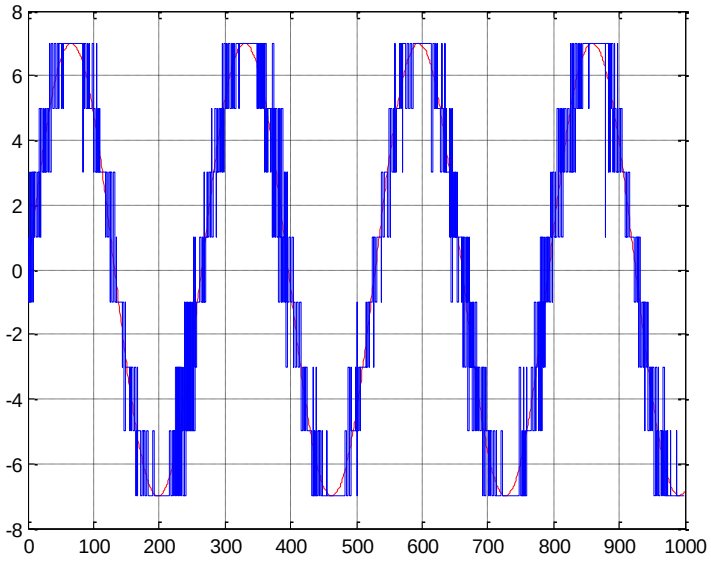
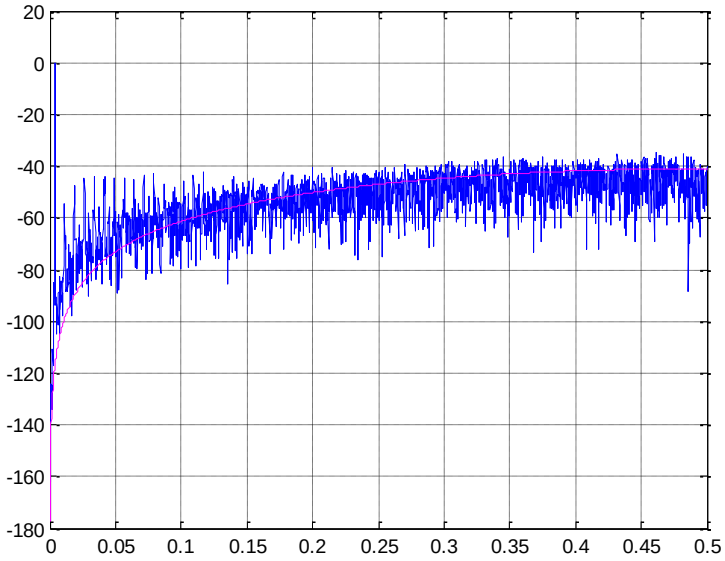
Second-order Noise Shaping





File: Second_Order_DSM.m

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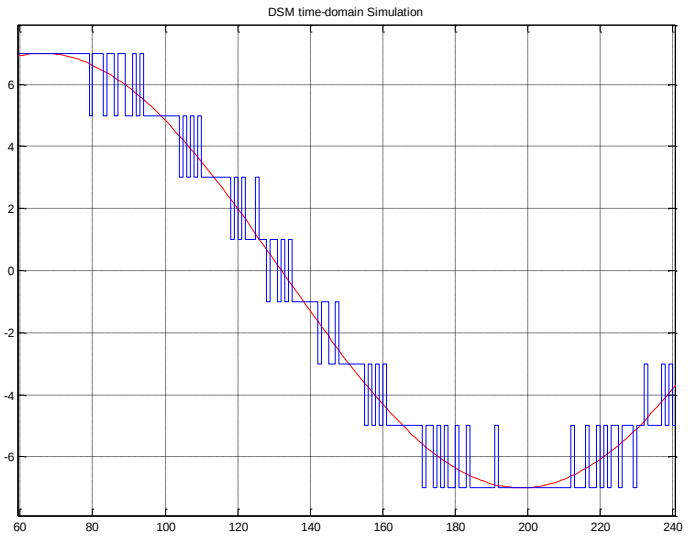
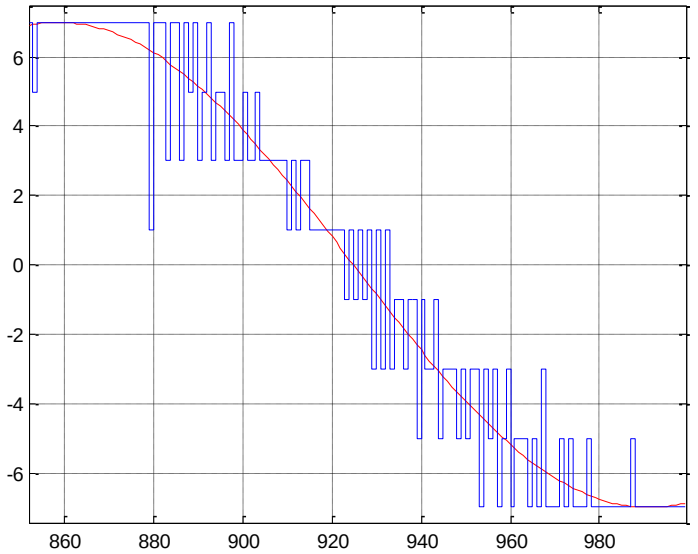
Comparison: 1st and 2nd order modulator waveforms





- $NTF(z) = (1-z^{-1})$
- OBG = 2
- Max LSB jump = 1

- $NTF(z) = (1-z^{-1})^2$
- OBG = 4
- Max LSB jump = 3

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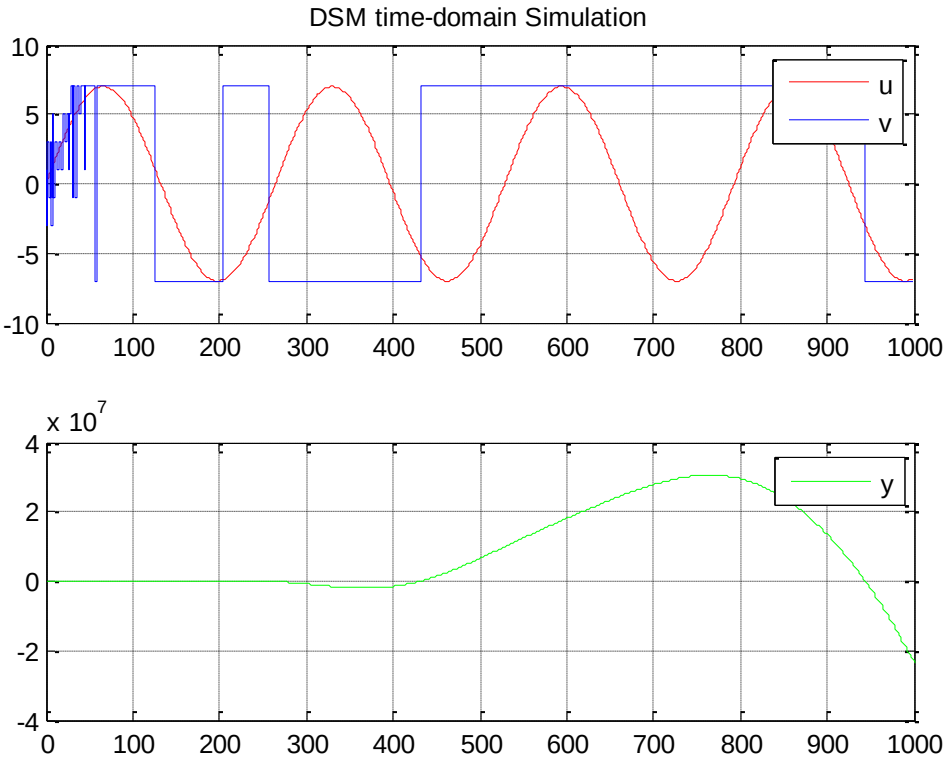
Third-order Noise Shaping (trivial design)



- NTF(z) = $(1-z^{-1})^3$
- OBG = 8, Full-scale input.
- Unstable after few samples (look at y[n] blowing up).
  - ✓ Worst for a single-bit quantizer.

File: Third_Order_DSM.m

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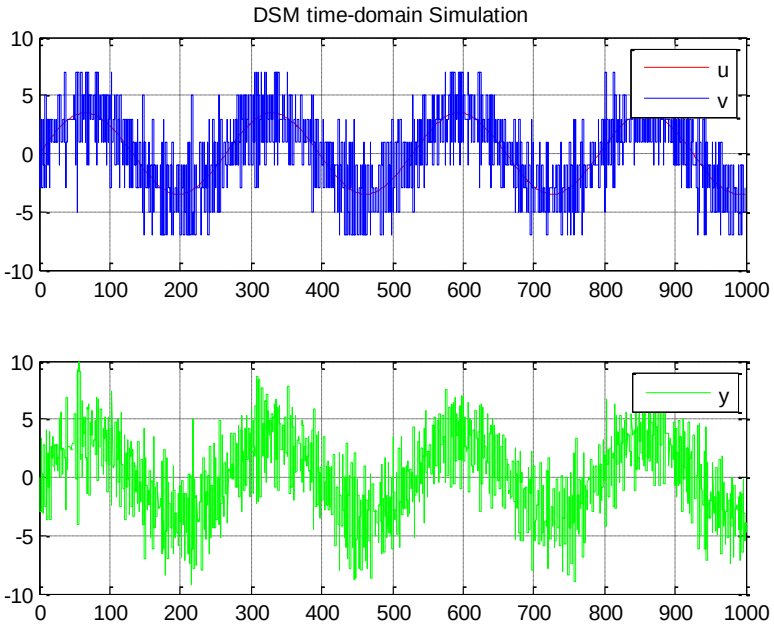
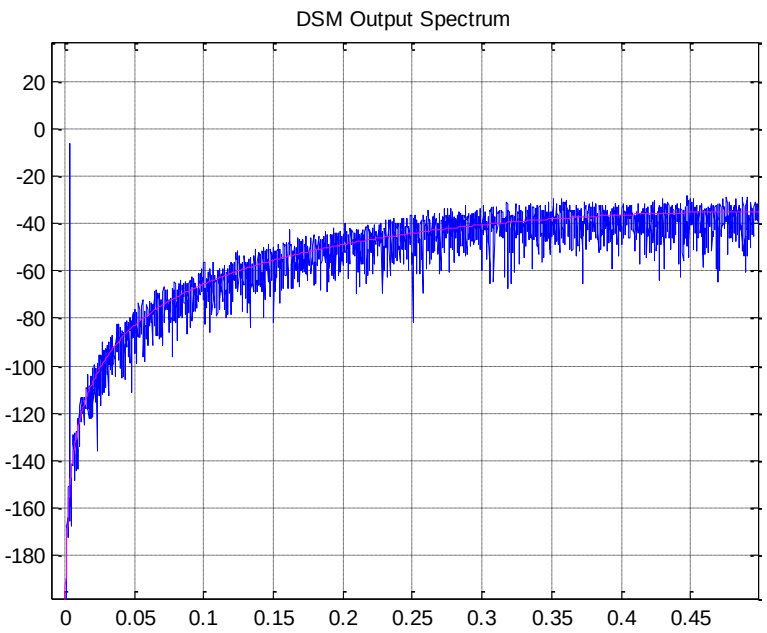
Third-order Noise Shaping contd.





- Input amplitude = 0.5·FS
- Signal dependent stability.
  - Need to develop intuition for modulator stability.
  - Reference: Stability theory from the Yellow book of delta-sigma.

File: Third_Order_DSM.m

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