ECE615 Mixed-Signal IC Design

Lecture 17 Slides

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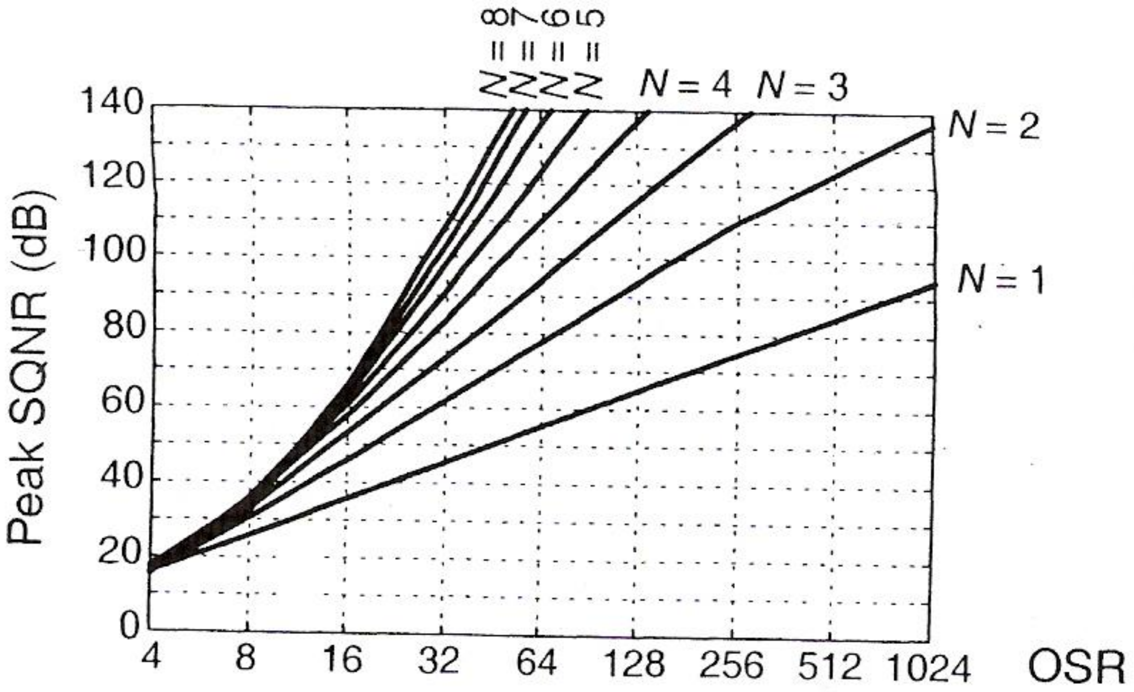
SQNR Limit for DSMs with 1-bit Quantizers



4.14: Empirical SQNR limit for 1-bit modulators of order *N*.

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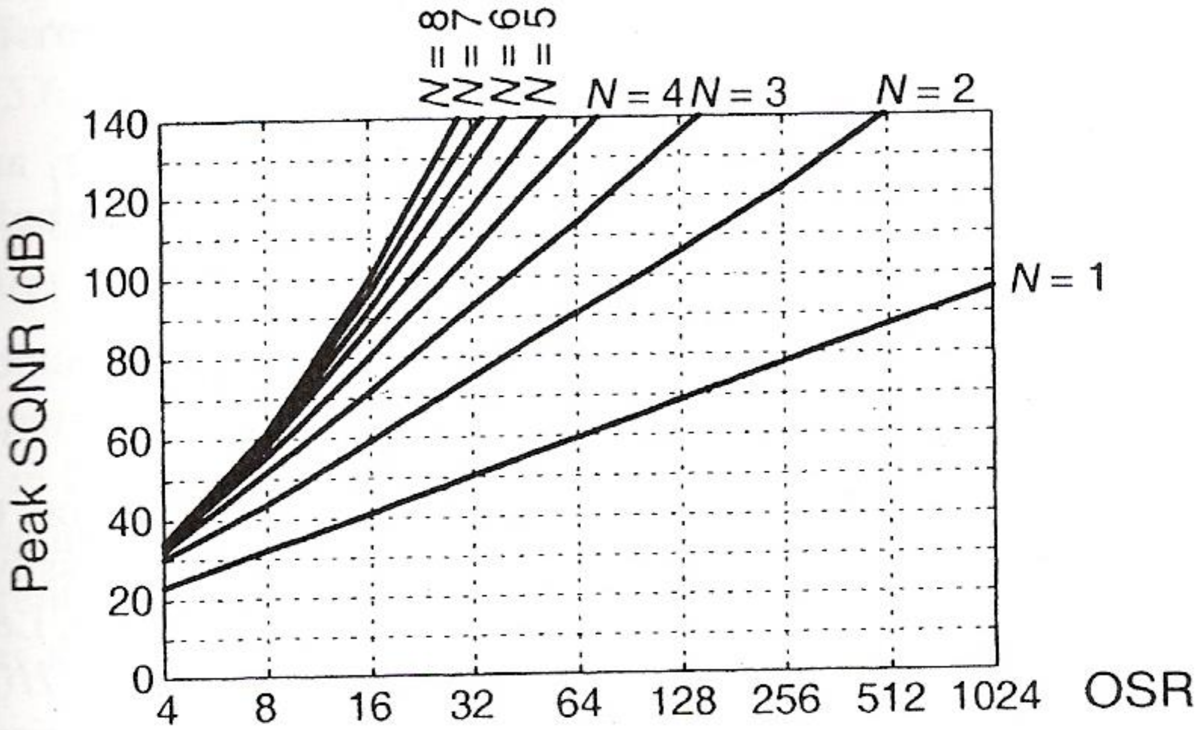
SQNR Limit for DSMs with 2-bit Quantizers



re 4.15: **Empirical SQNR limit for modulators with 2-bit quantizers.**

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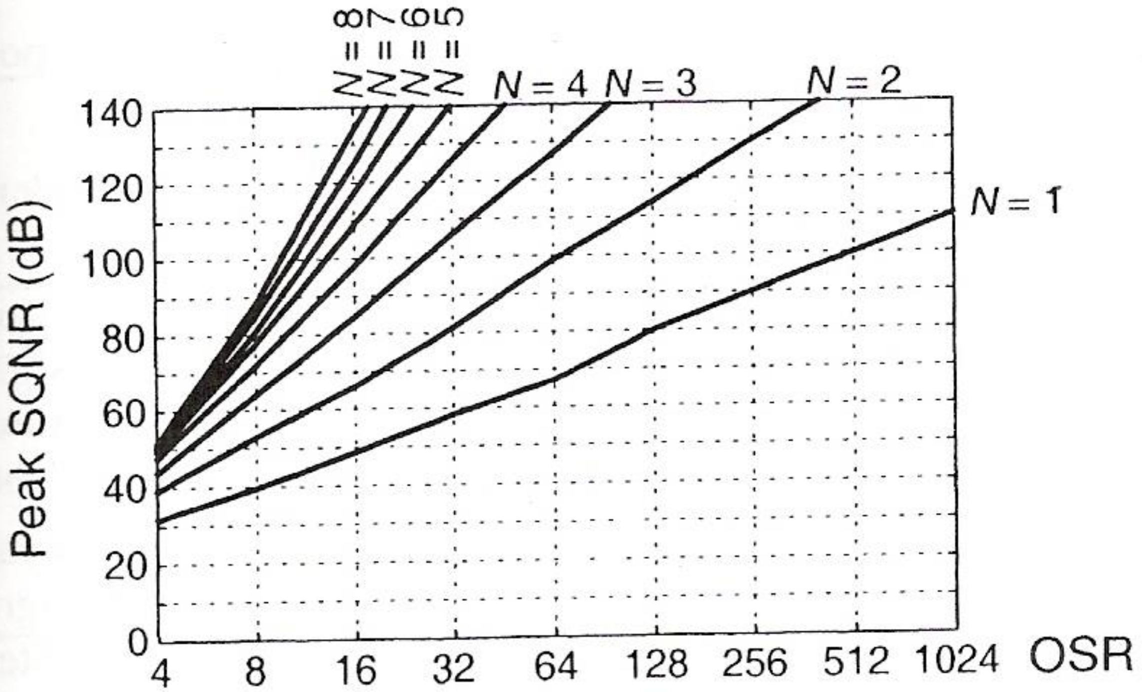
SQNR Limit for DSMs with 3-bit Quantizers



e 4.16: **Empirical SQNR limit for modulators with 3-bit quantization.**

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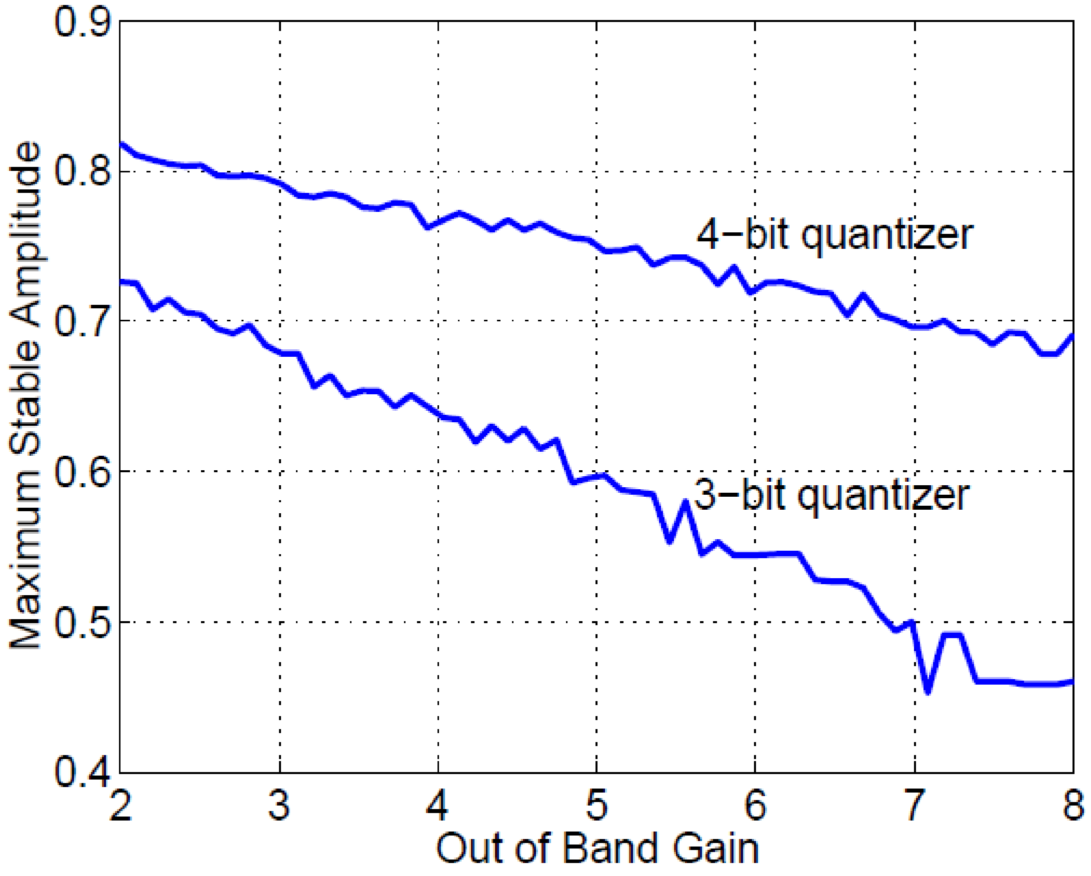
MSA vs OBG for a Third-Order NTF



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Estimating MSA (Maximum Stable Amplitude)

- MSA is found through extensive simulation.
- Simulate for input sinusoids of varying amplitudes for all possible signal frequencies in the signal band.
  - For every input amplitude compute in-band SNR.
  - Beyond the MSA, the NTF poles move out of the unit circle.
  - Noise shaping is disrupted and the in-band SNR drops.
  - At this point the quantizer input (y[n]) blows up.
- simulateSNR function in the toolbox does exactly the same.
- Time consuming and often impractical for iterative design.

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Estimating MSA using Risbo's Method

- Lars Risbo suggested a method for estimating MSA without sinewave inputs.
- Use a slow ramp input from 0 to FS value.
  - Plot $\log_{10}|y[n]|$. Observe where this plot blows up.
  - Take 90% of the input amplitude where $\log_{10}|y[n]|$ blows up as a conservative estimate for MSA.
  - Estimated MSA is close to that predicted by the sinewave input method.
- Much quicker than the sinewave technique (simulateSNR function).
- Write your own toolbox function generalizing this method !

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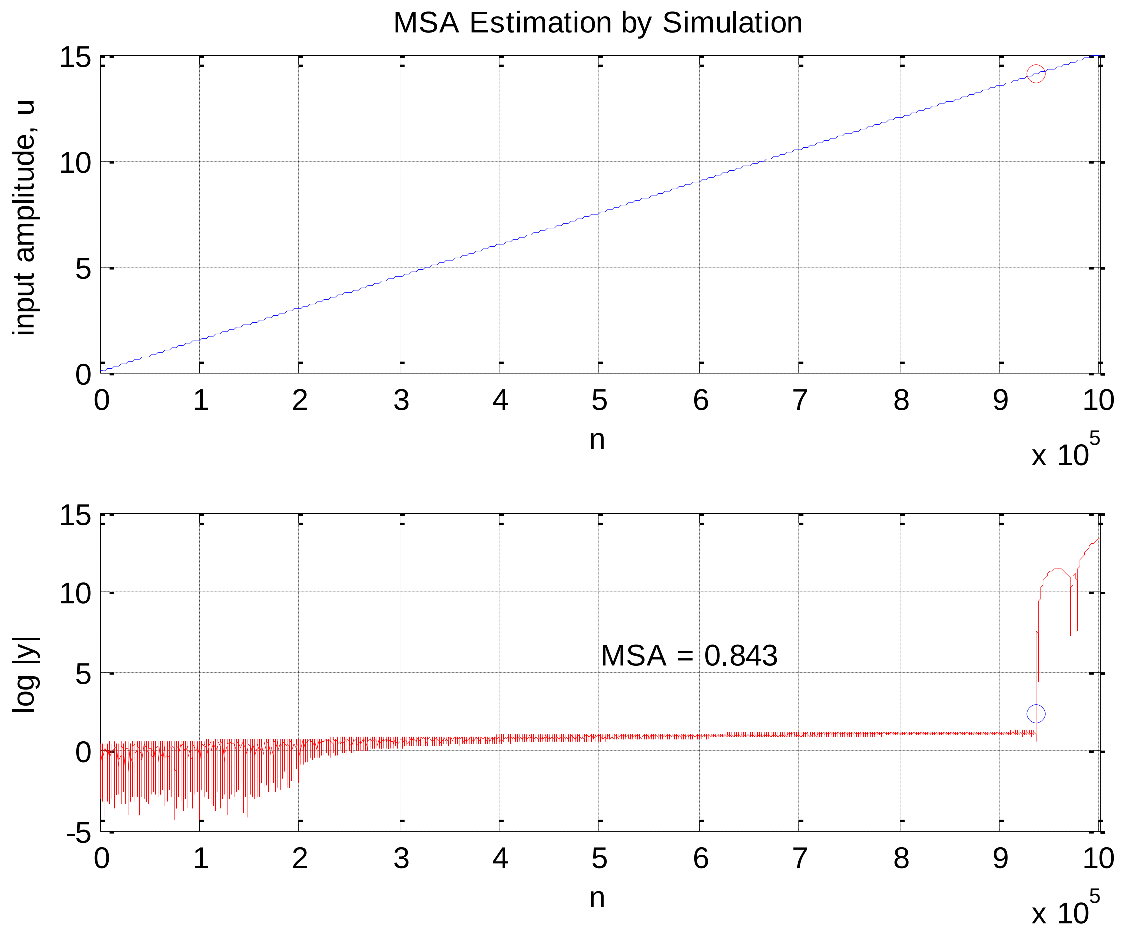
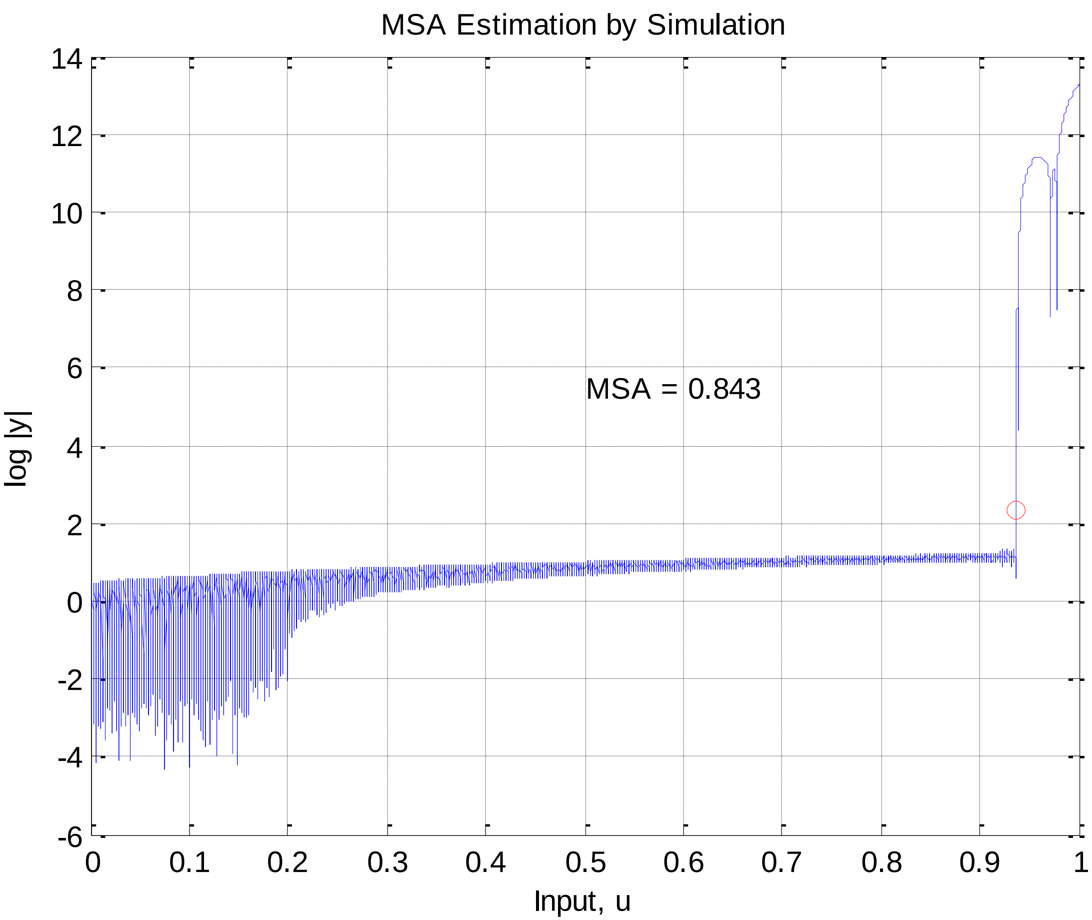
Estimating MSA using Risbo’s Method contd.



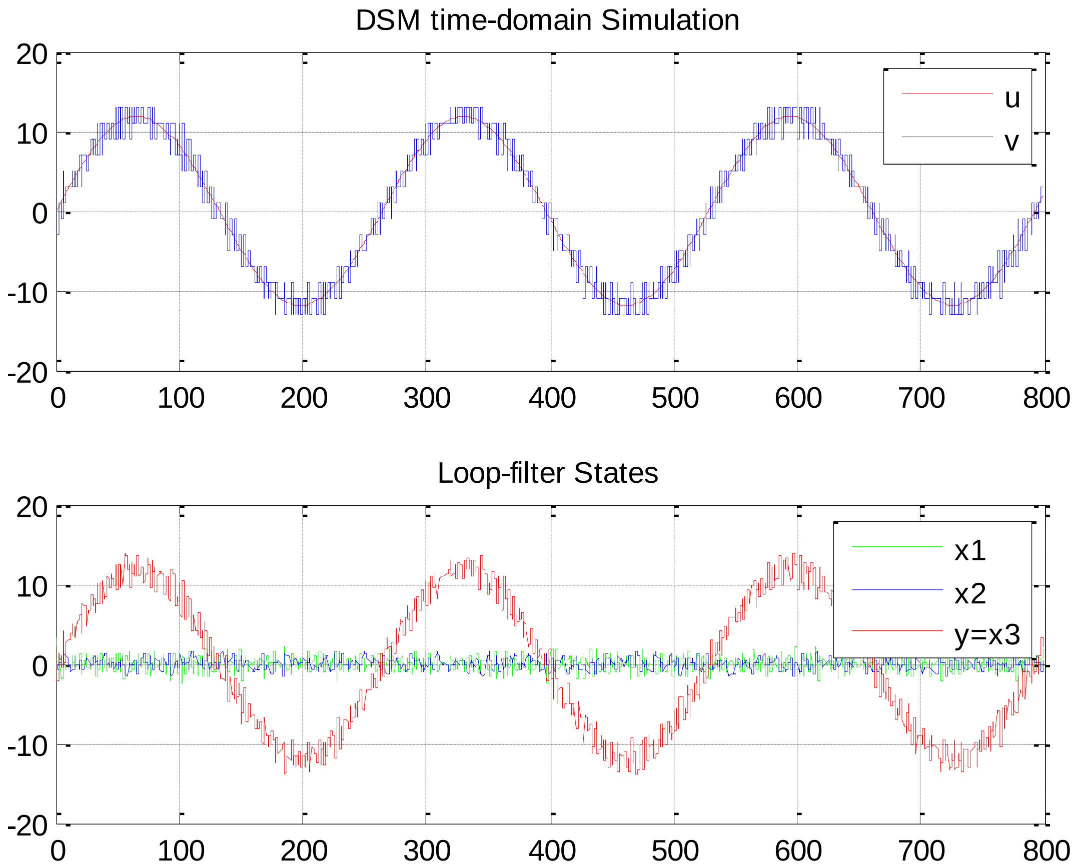
File: MSA_Risbo_Method.m

Estimating MSA using Risbo's Method contd.



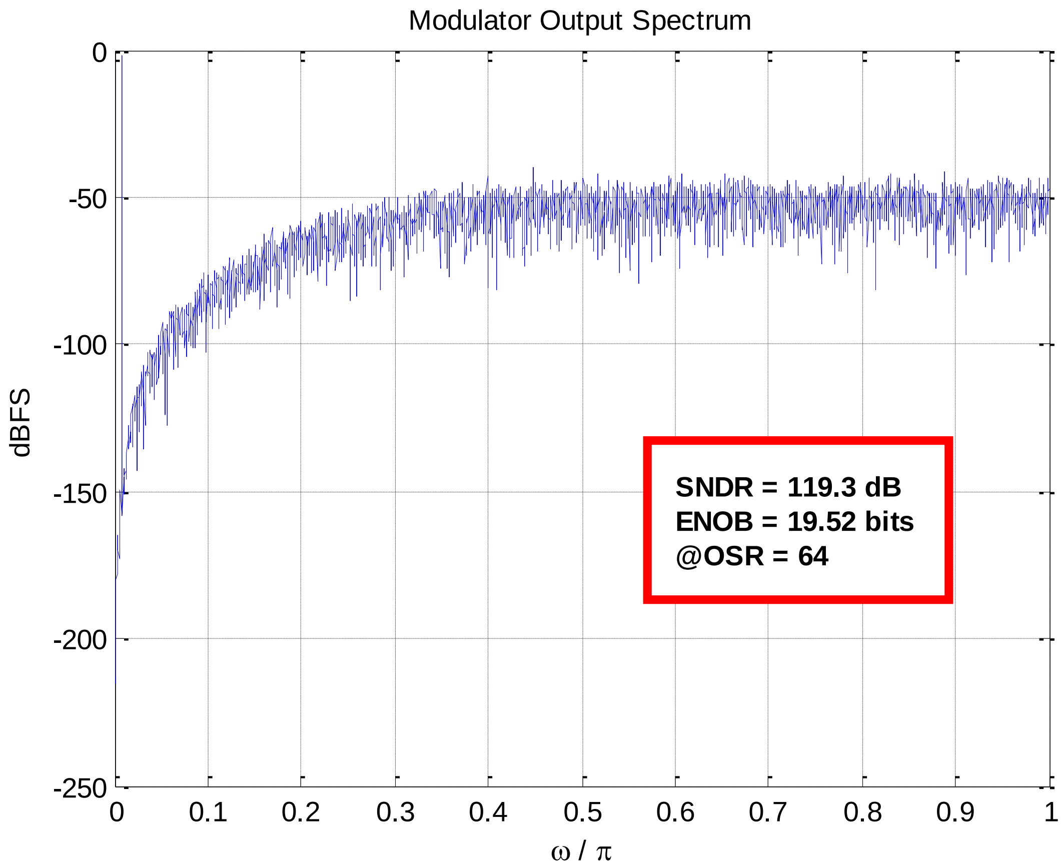
File: MSA_Risbo_Method.m

Simulation with input with MSA



File: MSA_Risbo_Method.m

Simulated SNR with input with MSA



File: MSA_Risbo_Method.m

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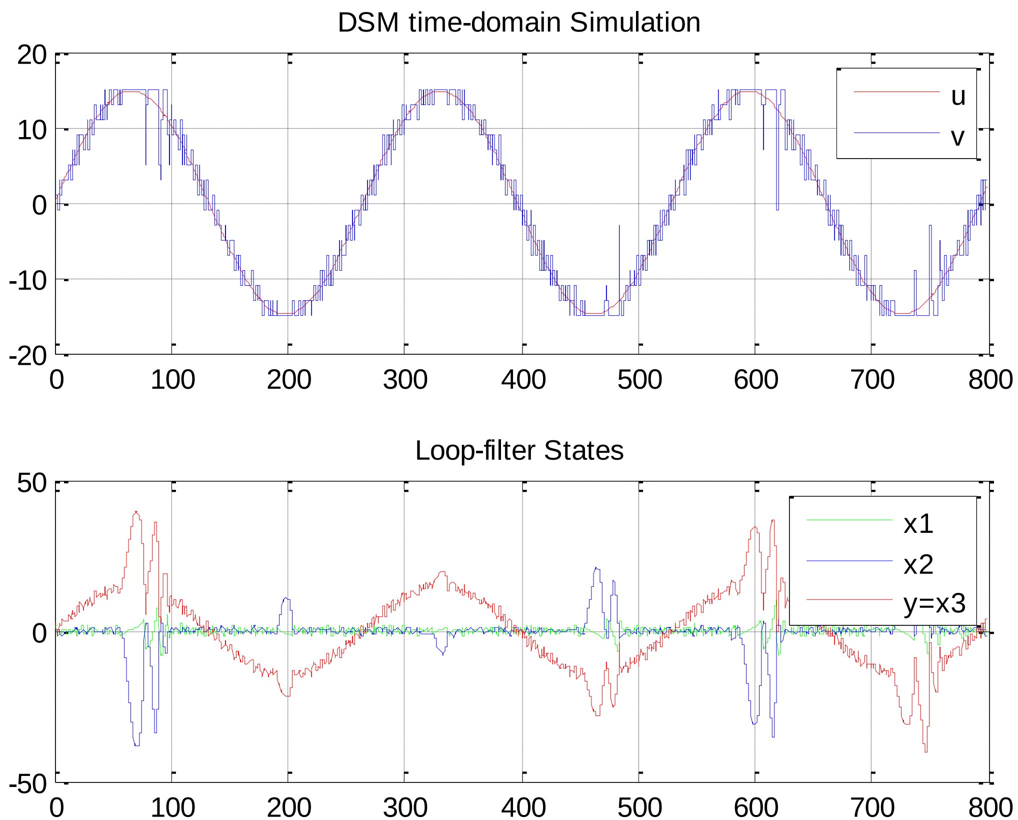
Simulation with input with 1.2*MSA



File: MSA_Risbo_Method.m

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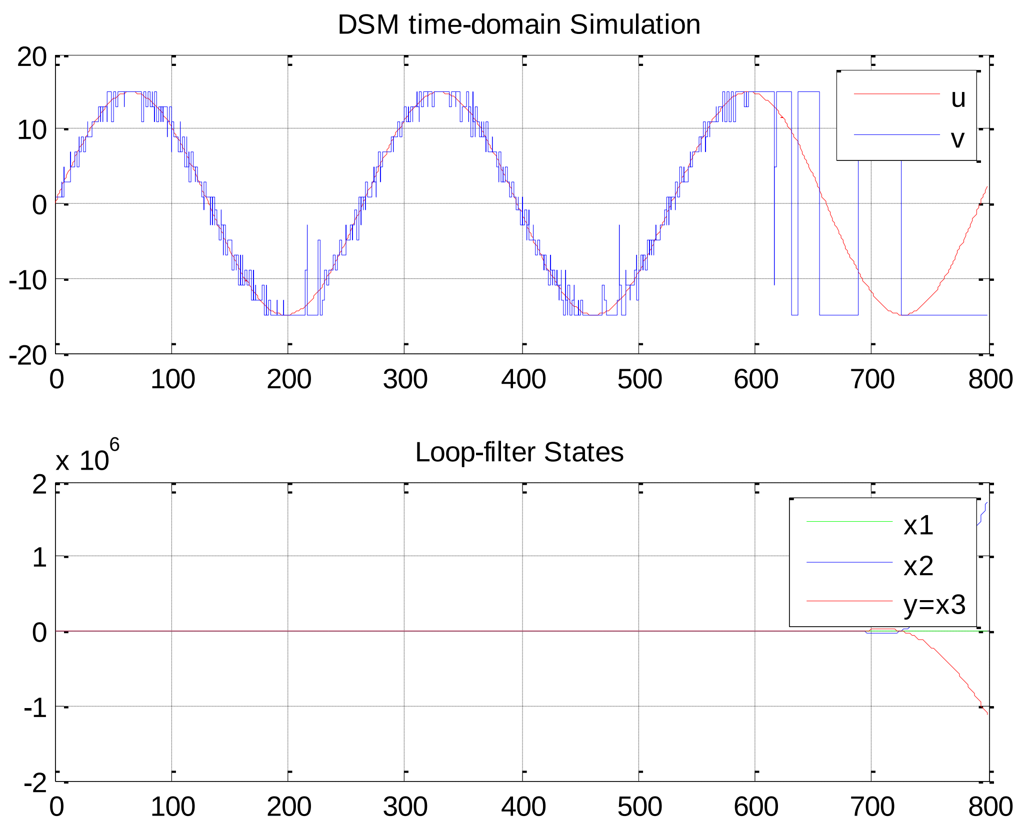
Simulation with input with 1.2*MSA



File: MSA_Risbo_Method.m

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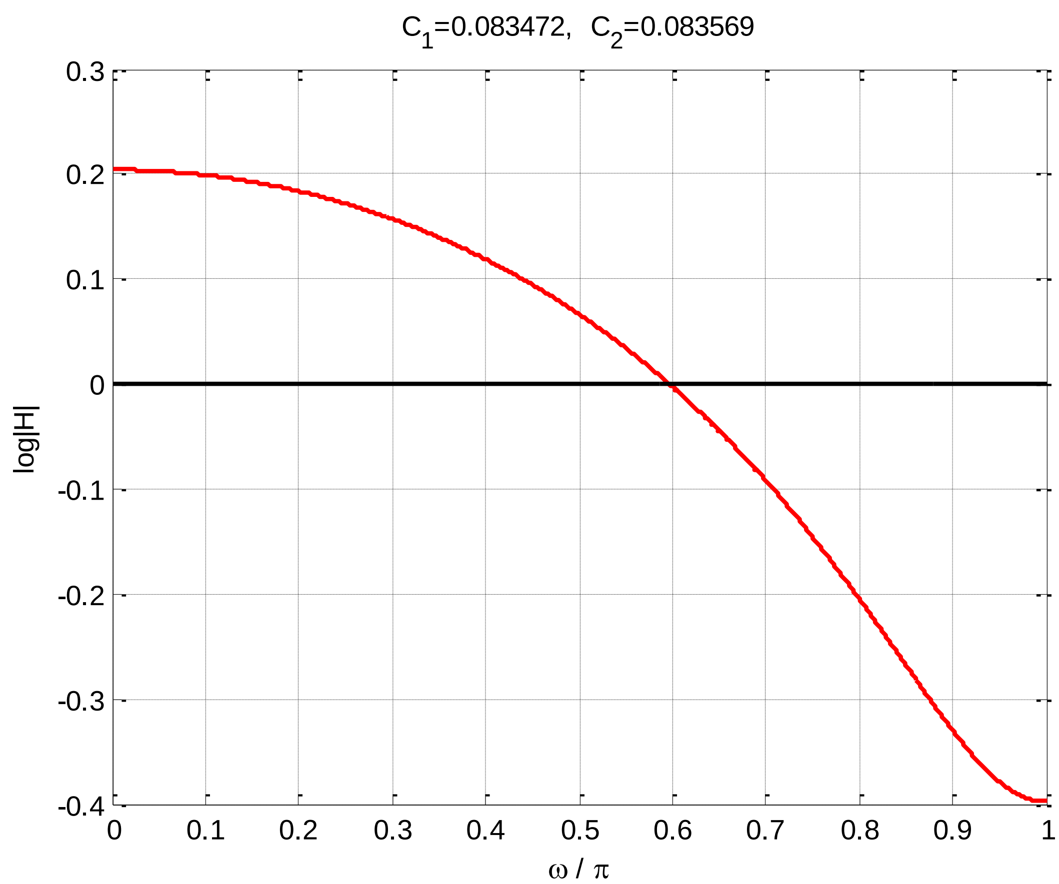
Bode Sensitivity Integral

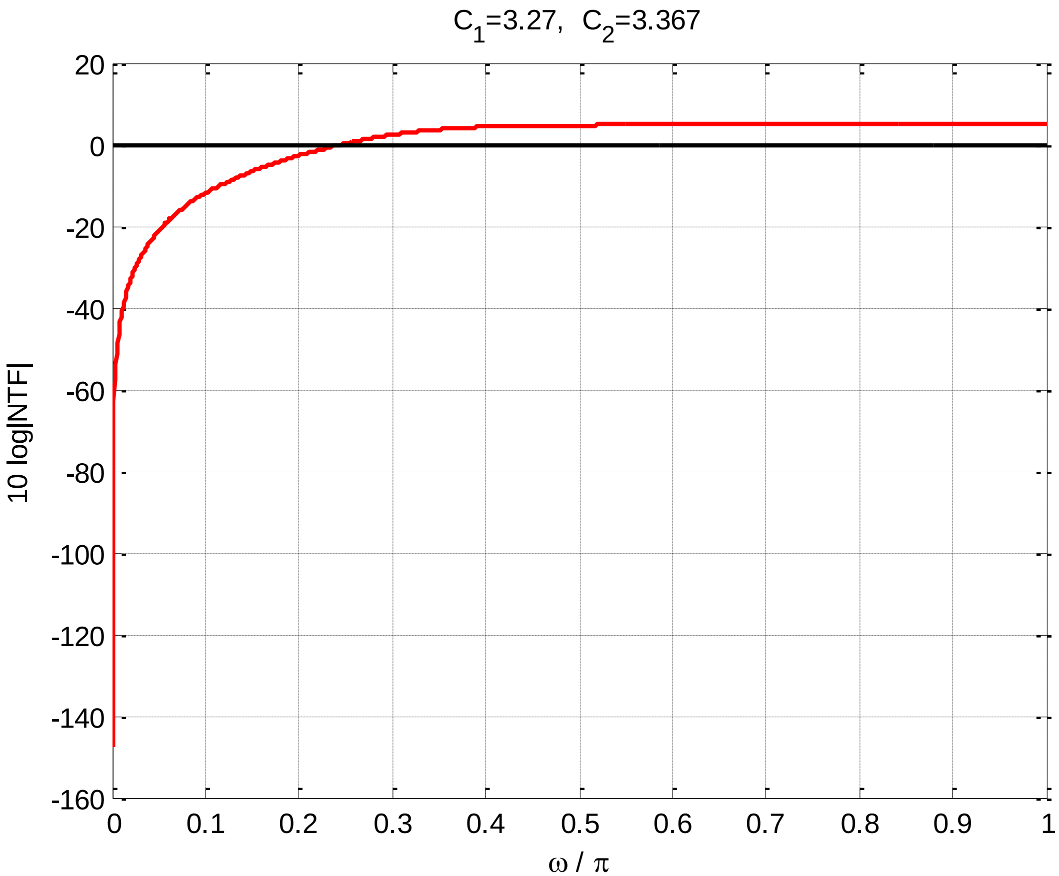


Single pole/zero transfer function with pole/zero inside the unit circle.

Area above and below the 0-dB axis are equal.

File: BodeSensitivity1.m

Bode Sensitivity Integral



Butterworth NTF.

Area above and below the 0-dB axis are equal.

File: BodeSensitivity2.m

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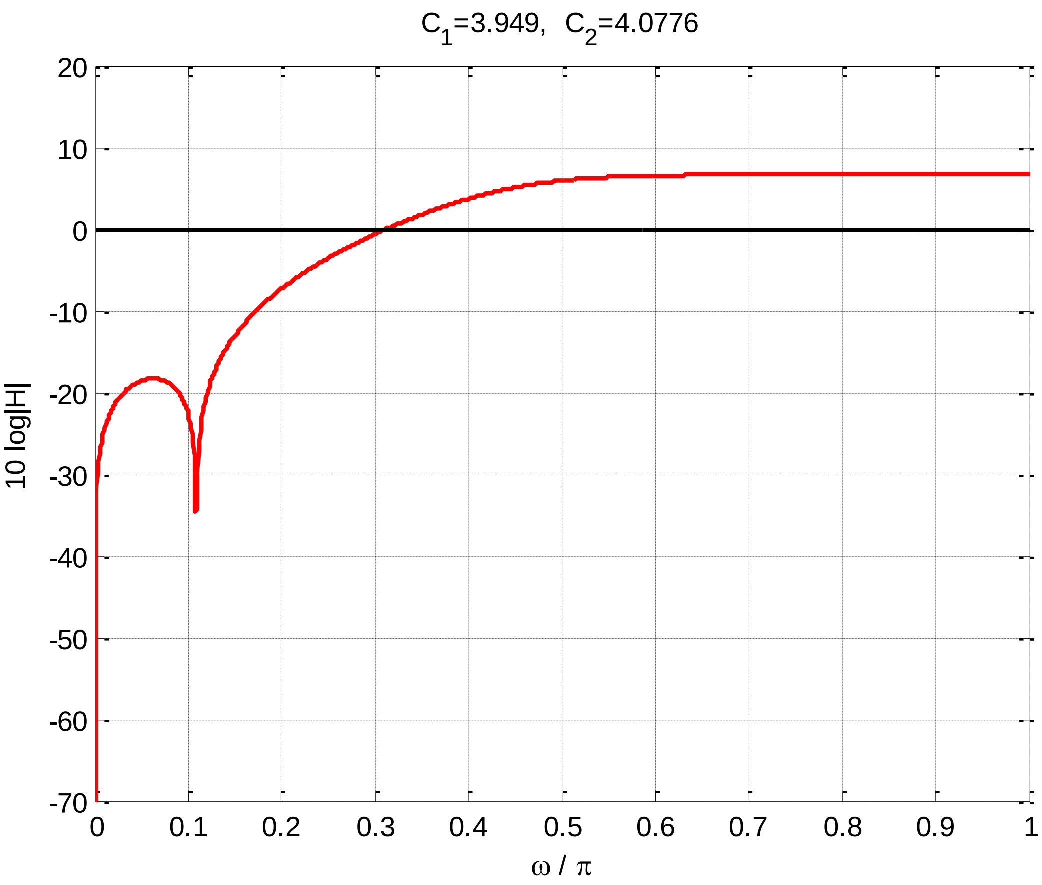
Bode Sensitivity Integral



Inverse Chebyshev NTF.

Area above and below the 0-dB axis are equal.

File: BodeSensitivity3.m

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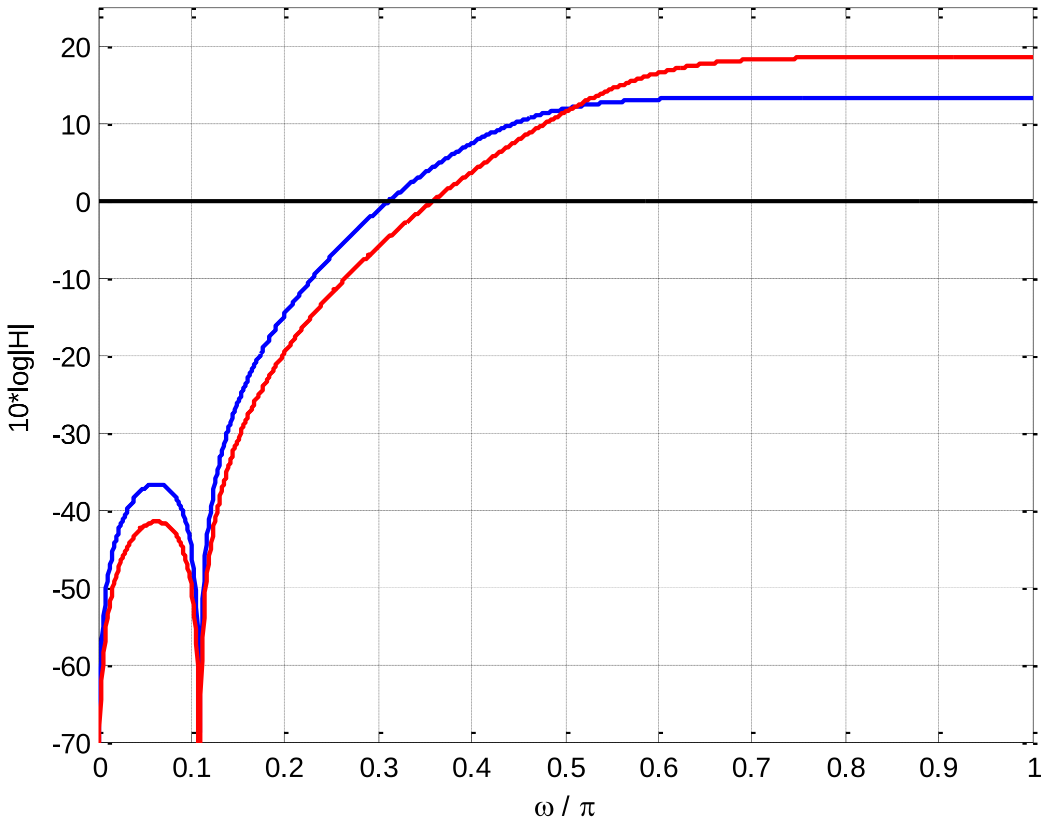
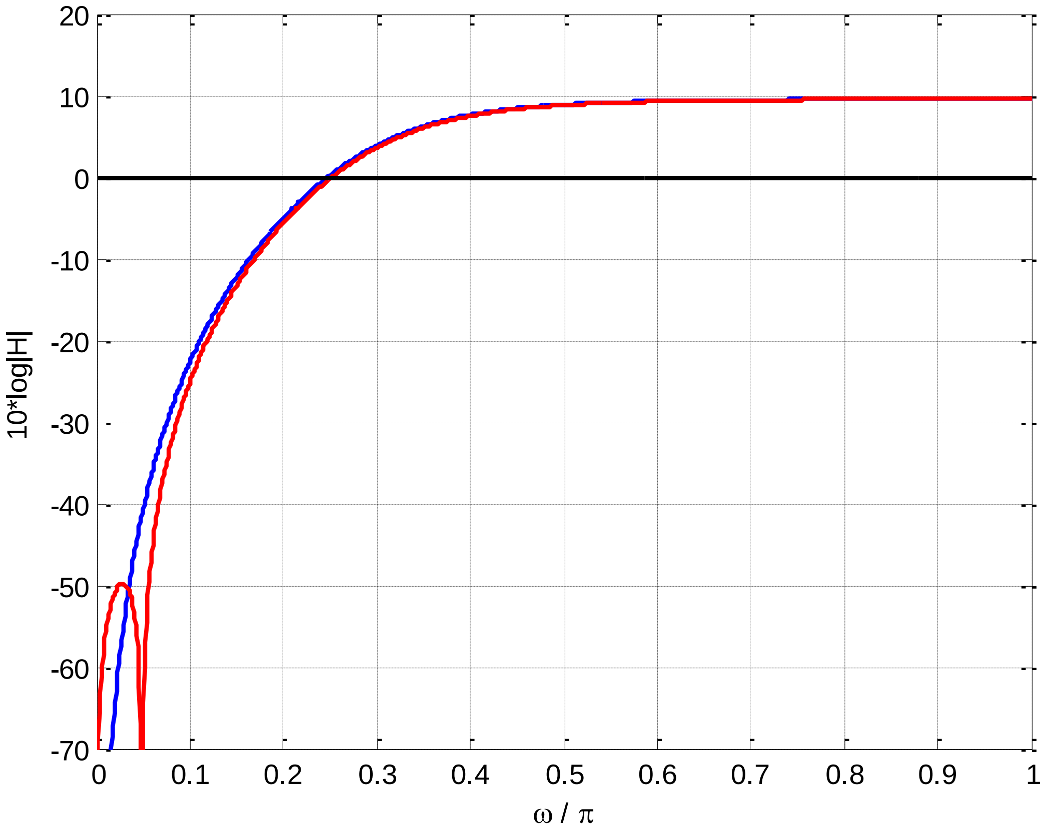
Bode Sensitivity Integral



Better in-band performance results in worse out-of-band performance.

File: BodeSensitivity4.m

Bode Sensitivity Integral



Complex NTF zeros result in better in-band performance for the same OBG.

File: BodeSensitivity5.m

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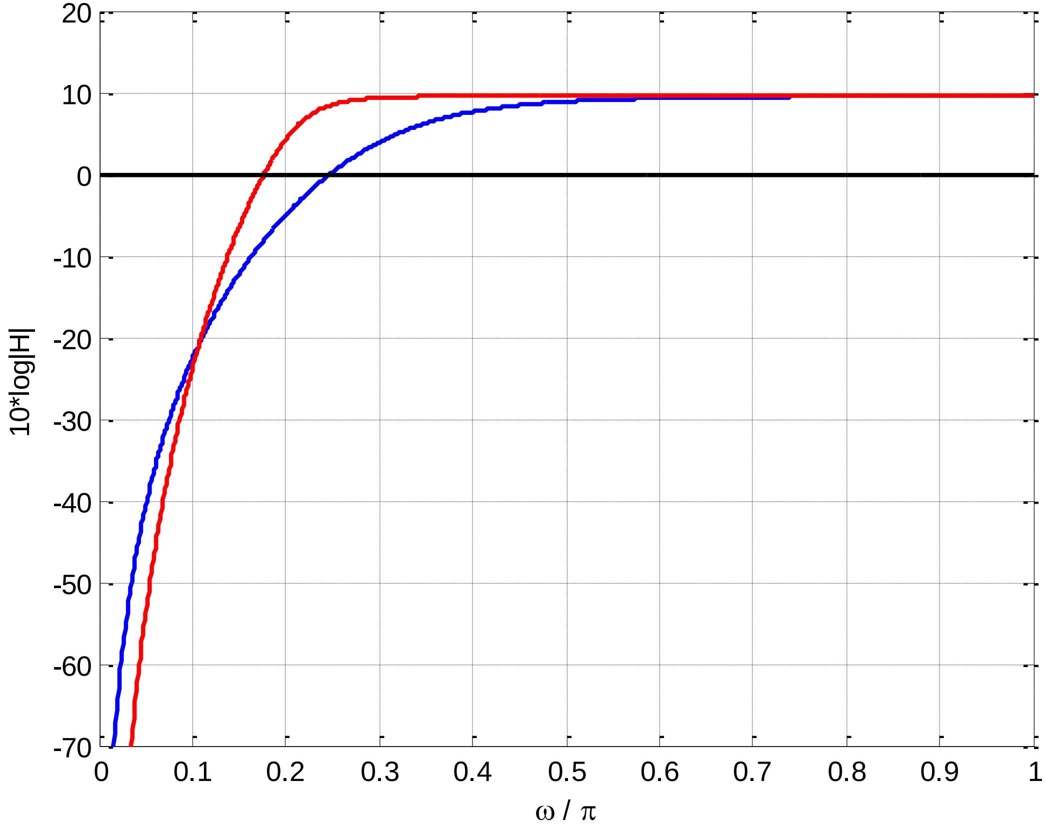
Bode Sensitivity Integral



Higher-order NTF results in better in-band performance for the same OBG.

File: BodeSensitivity6.m

References

[1] R. Schreier, Understanding Delta-Sigma Data Converters, Wiley, 2005.

[2] S. Pavan, N. Krishnapura, “Tutorial: Oversampling Analog to Digital Converters,” *21st International Conference on VLSI Design*, Jan. 4, 2008. [Online]:http://www.ee.iitm.ac.in/~nagendra/presentations/20080104vlsiconf/20080104vlsiconf.pdf