Sinc Filters Overview

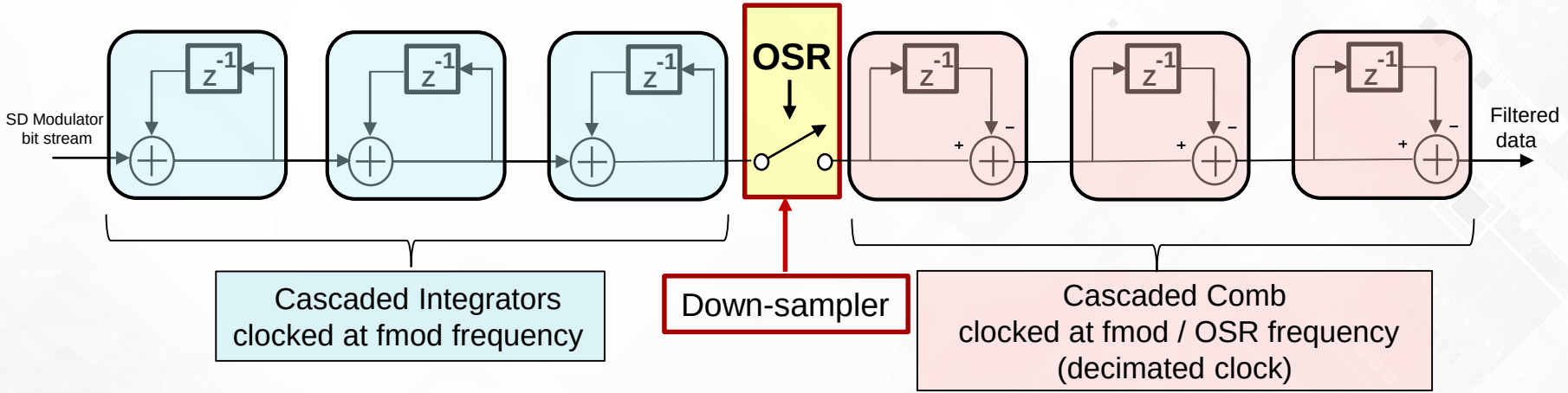
C2000 Sigma Delta Filter Module (SDFM) Series

Sinc filters

- Cascaded Integrator-Comb (CIC) filters
- Configurable Low pass filter

Z-Transform of Sinc filter of order N

$$H(Z) = \left[\frac{1 - Z^{-OSR}}{1 - Z^{-1}} \right]^{N}$$



Data rate and Latency

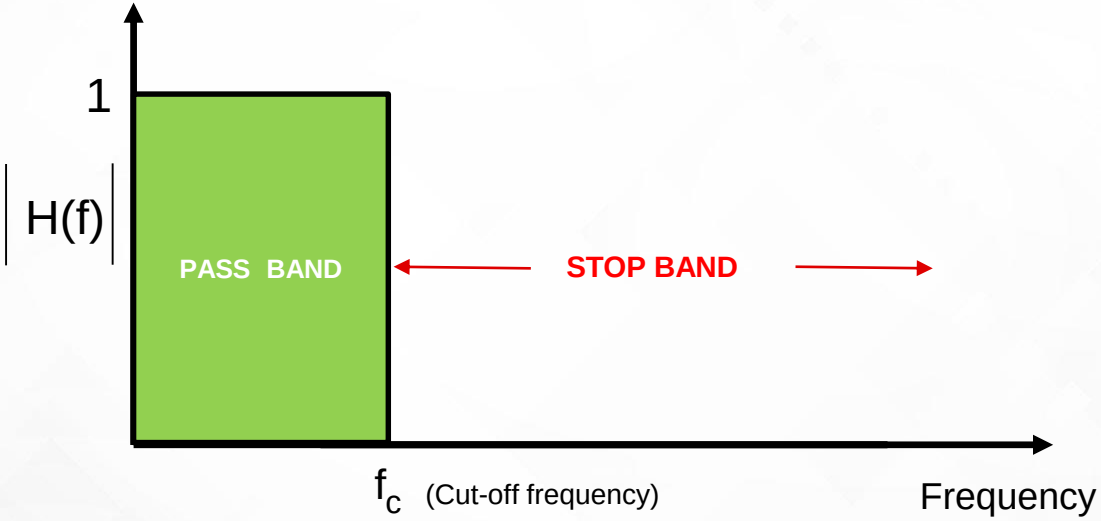
$$\text{Data rate of Sinc filter} = \frac{\text{Modulator data rate}}{\text{OSR}}$$

$$\text{Latency of Sinc filter} = \frac{\text{Order of Sinc filter}}{\text{Data rate of Sinc filter}}$$

Step Response of Sinc Filters with same OSR

Ideal Low Pass Filter

Ideal Low pass filter passes all signals below cut-off frequency (fc) without any distortion and completely attenuates all signals above the cut-off frequency



Transfer function of ideal low pass filter

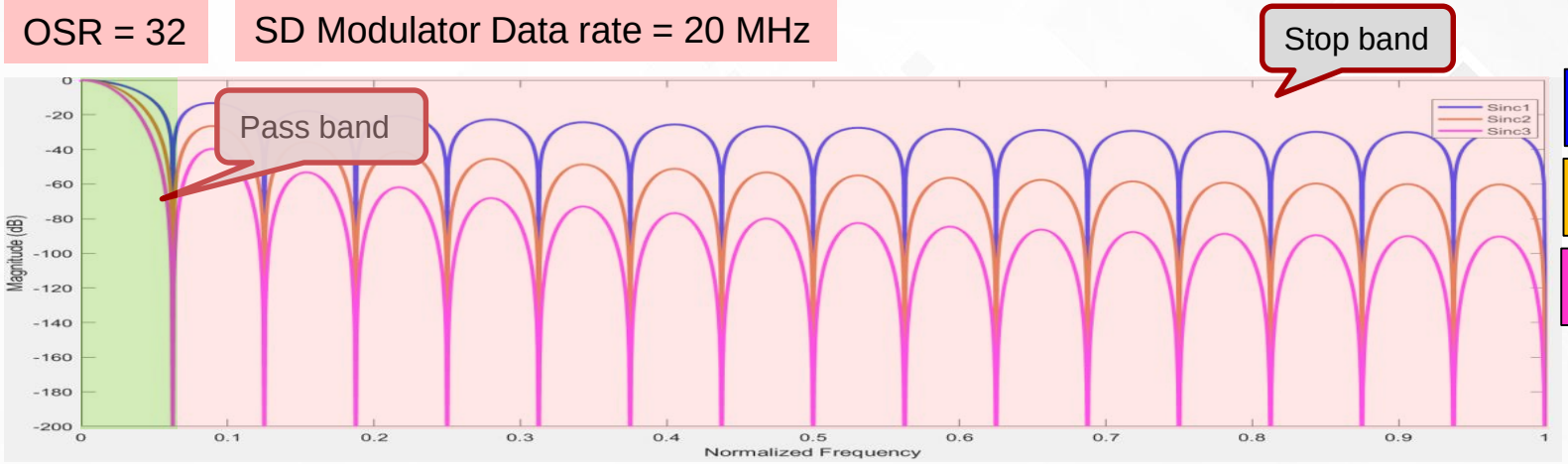
$$|H(f)| = \begin{cases} 1 & \text{for } f <= f_c \\ 0 & \text{for } f > f_c \end{cases}$$

Understanding Sinc Filter Frequency Response

For same OSR settings, higher order Sinc filters provides better noise attenuation for the same data rate and higher latency

OSR = 32

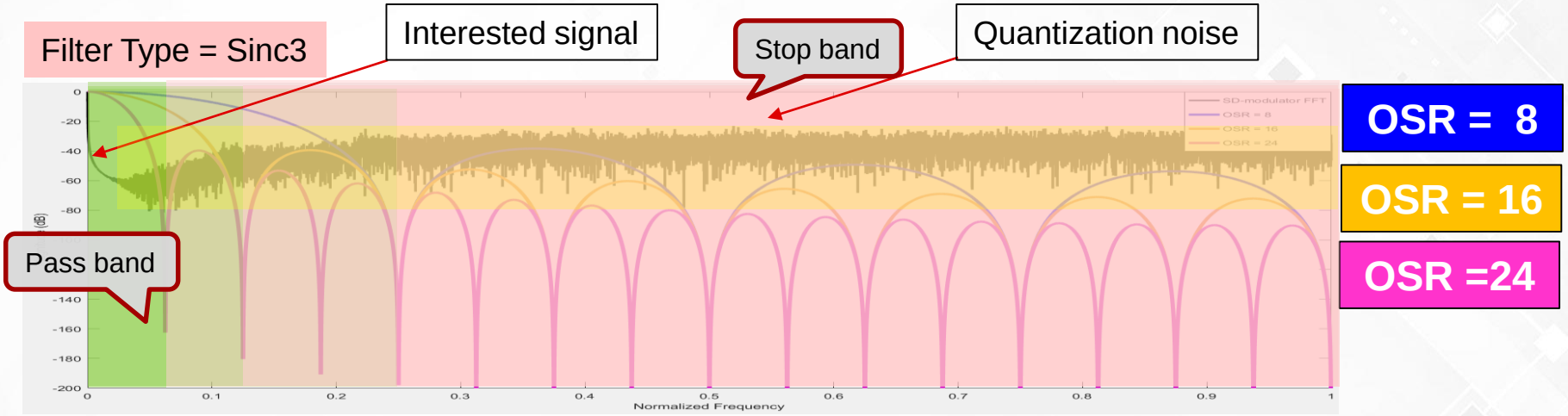
SD Modulator Data rate = 20 MHz



Filter	OSR	Order	Weighted average	# SD data samples	Data rate	Latency
Sinc1	32	1	32 SD-modulated bitstreams	32 bitstreams (1 x OSR)	1.6 us	1.6 us
Sinc2	32	2	32 Sinc1 filter data	64 bitstreams (2 x OSR)	1.6 us	3.2 us
Sinc3	32	3	32 Sinc2 filter data	96 bitstreams (3 x OSR)	1.6 us	4.8 us

Understanding Sinc Filter Frequency Response

For same Filter Type, increasing the OSR settings provides better noise attenuation at slower data rate and higher latency



Filter	OSR	Order	Weighted average	# SD data samples	Data rate	Latency
Sinc3	8	1	8 Sinc2 filter data	24 SDCLKs	1.6 us	1.6 us
Sinc3	16	2	16 Sinc2 filter data	48 SDCLKs	1.6 us	3.2 us
Sinc3	24	3	24 Sinc2 filter data	92 SDCLKs	1.6 us	4.8 us

Performance metrics

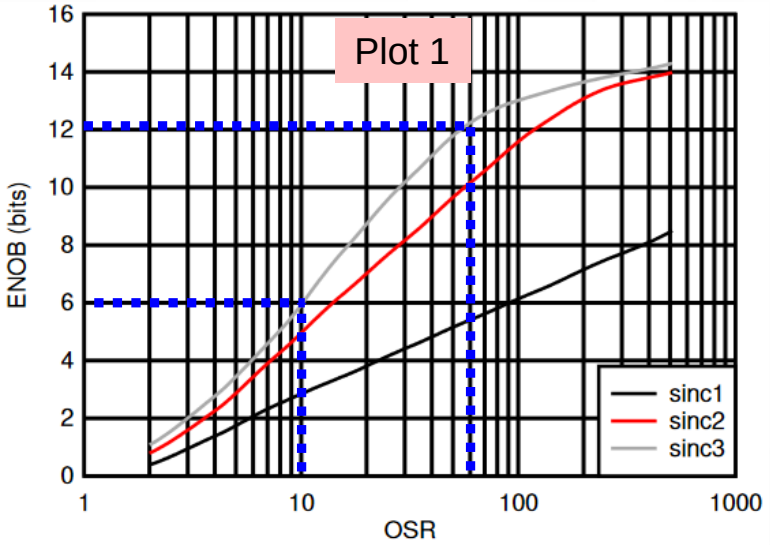
Short circuit detection requirement: 6 ENOB under 2us

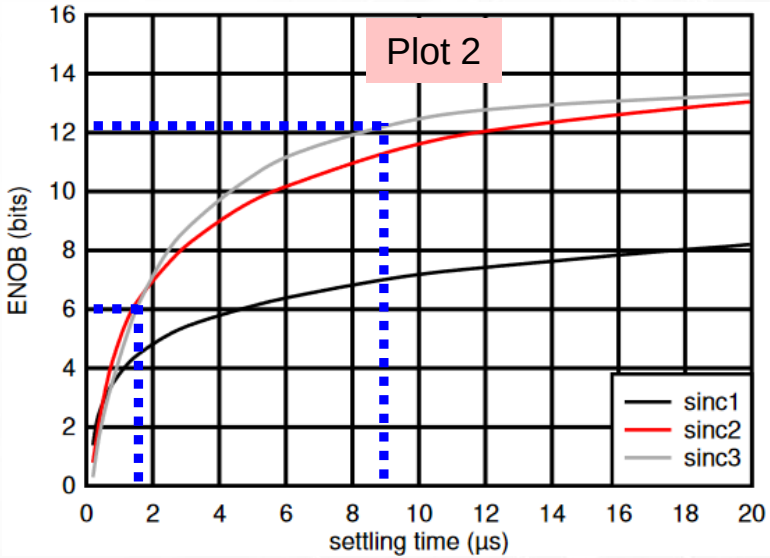
Sinc3, OSR = 10 with settling time of 1.5 us

High Resolution data: 12 ENOB

Sinc3, OSR = 60 with settling time of 9 us

Courtesy: AMC1304 datasheet





Additional SDFM Resources

Foundational Materials

- How delta-sigma ADCs work, Part 1
- How delta-sigma ADCs work, Part 2
- Nuts and Bolts of the Delta-Sigma Converter (video)
- C2000 Academy with Hands-on Labs

Expert Materials

- Achieving Better Signal Integrity With Isolated Delta-Sigma Modulators in Motor Drives
- C2000 DesignDRIVE Development Kit for Industrial Motor Control
- Isolated Current Shunt and Voltage Measurement Kit
- Three Phase Power Factor Correction Reference Design Using C2000 MCU

Check Video Description for Additional Resources