

Use the XL anti-alias calculator provided on the website for the following problems.

1. GRAPH LIMITS		BUTTERWORTH ANTI-ALIASING LOW-PASS FILTER			SAMPLING SPEC'S			ADC SPEC'S		
Fmin	Fmax	Fc	ORDER	GAIN (V/V)	SAMPLING FREQUENCY	SAMPLE HOLD	NATURAL SAMPLING	NOISE LEVEL	ADC # BITS	APERTURE JITTER
100	70000	5000	8	1	Fs	YES/NO	PW	dBrel (FS)	N	rms
					20000	no	1.25E-05	-200	16	1.00E-10

Use the above settings and observe what happens to the frequency spectrum when the order of the filter is changed to 4. Also play with the sampling frequency and vary it from 10k to 20k and 30 kHz. What happens to the ENOB_{eff}? When is it better? Explain why.

2. GRAPH LIMITS		BUTTERWORTH ANTI-ALIASING LOW-PASS FILTER			SAMPLING SPEC'S			ADC SPEC'S		
Fmin	Fmax	Fc	ORDER	GAIN (V/V)	SAMPLING FREQUENCY	SAMPLE HOLD	NATURAL SAMPLING	NOISE LEVEL	ADC # BITS	APERTURE JITTER
100	70000	5000	8	1	Fs	YES/NO	PW	dBrel (FS)	N	rms
					20000	YES	1.25E-05	-200	16	1.00E-10

- A) Use the above settings and observe what happens to the frequency spectrum when sample/hold is used instead of natural sampling. Describe what happens.
- B) Now zoom in on the baseband by changing F_{max} to 7000 Hz. Read the the first alias level and the ENOB_{eff} at 1000 Hz, 3000 Hz and 5000 Hz. Explain.
- C) Increase F_s to 30 kHz and repeat step B – you may have to change the vertical scale to see the first alias, double click the scale an lower minimum value.
- D) Repeat step B with -80 dB_{FS} of noise with settings as shown below.

GRAPH LIMITS		BUTTERWORTH ANTI-ALIASING LOW-PASS FILTER			SAMPLING SPEC'S			ADC SPEC'S		
Fmin	Fmax	Fc	ORDER	GAIN (V/V)	SAMPLING FREQUENCY	SAMPLE HOLD	NATURAL SAMPLING	NOISE LEVEL	ADC # BITS	APERTURE JITTER
100	7000	5000	8	1	Fs	YES/NO	PW	dBrel (FS)	N	rms
					30000	YES	1.25E-05	-80	16	1.00E-10

3. GRAPH LIMITS		BUTTERWORTH ANTI-ALIASING LOW-PASS FILTER			SAMPLING SPEC'S			ADC SPEC'S		
Fmin	Fmax	Fc	ORDER	GAIN (V/V)	SAMPLING FREQUENCY	SAMPLE HOLD	NATURAL SAMPLING	NOISE LEVEL	ADC # BITS	APERTURE JITTER
					Fs	YES/NO	PW	dBrel (FS)	N	rms
100	2.00E+06	1.00E+06	6	1	1.00E+07	YES	1.25E-05	-100	16	1.00E-11

A 0 to 1 MHz signal is sampled at 10 Msa/s and has a noise level of $-100 \text{ dB}_{\text{FS}}$. Determine the maximum aperture jitter required to maintain a ENOB_{eff} of at least 13 Over the bandwidth of the signal (0 to 1 MHz) with a 6th order filter that has a cutoff frequency of 1 MHz. Repeat for a noise level of $-90 \text{ dB}_{\text{F}}$. Explain the results.