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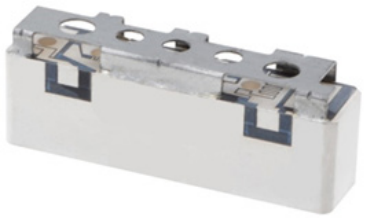
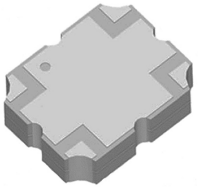
Integrating Low Pass Filters with Band Pass Filters for improved out of band rejection.

RF Filters





Whitepaper

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Integrating Low Pass Filters with Band Pass Filters for improved out of band rejection.

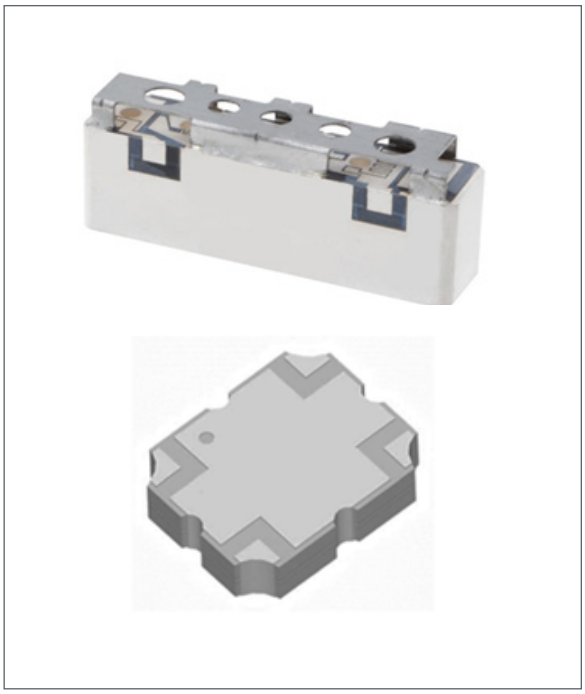
Ceramic Monoblock RF filters provide an excellent combination of power handling, size, and cost in a surface mount package that provides low insertion loss and stability over a wide temperature range.

A characteristic of RF filters is that at various harmonics, the attenuation level is significantly reduced allowing unwanted signal to be transmitted or received into the circuitry. This may cause interference with devices operating on near band spectrum or degrade the signal processing of the receive circuitry for the filtered device. Monoblock ceramic RF filters can incorporate a shield that provides harmonic suppresion, but some applications may find that insufficient.

An effective way to improve harmonic suppression is to incorporate a low pass filter. Low pass filters provide additional noise rejection beyond a specific "cut-off" frequency. It is important to select a low pass filter that is a small size, low loss, and with a cut-off frequency greater than the passband, so as to not dramatically increase the system size and to maintain good signal to loss ratio.

In a test to evaluate the signal performance improvement from combining a ceramic bandpass filter and a low pass filter, CTS assembled two test boards to compare harmonic suppression performance: one board included the only a monoblock ceramic RF bandpass filter with integrated shield, and a second board that combines the low pass filter and bandpass filter, to compare the performance of both options.

In this test, we plan to demonstrate that combining a low pass filter with a bandpass filter can maintain high rejection values in the harmonic frequency range while maintaining good insertion loss within the passband.



CTS Band Pass Filter and XLF Low Pass Filter

Variety of CTS Band Pass Filters

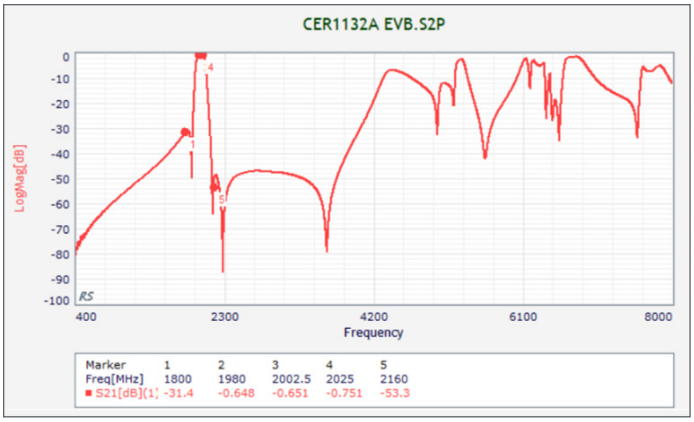


Figure 1- CER1132A Frequency Response

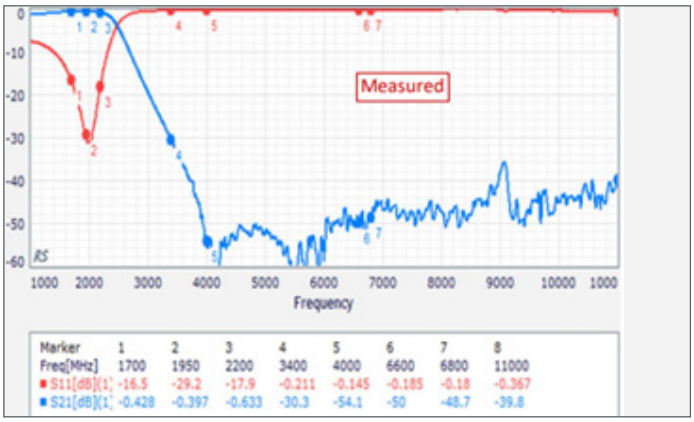


Figure 2 - XLF220A Frequency Response

CER1132A Bandpass Filter

The CER1132A ceramic monoblock RF bandpass filter from CTS has a passband of 1980 to 2025 MHz with out of band rejections greater than 40 dB on both the near low and high side rejection bands. Once the frequency reaches the 2nd harmonic and beyond, the rejections degrade to 10 dB and below. Filter performance as a standalone component can be seen in Figure 1.

XLF0220A Lowpass Filter

The XLF filter line is a series Low Pass Filters which provide additional harmonic and ripple suppression while maintaining low insertion loss. XLF low pass filters have a Passband Insertion loss of less than 0.65 dB and rejections in the Primary Stopband greater than 40 dB. Filter performance as a standalone component can be seen in Figure 2.

CER1132A + XLF0220A Test Board

The test board was fabricated from 20 mil RO4350B material with a dimension of 29 x 27.8 mm and a thickness of approximately 0.63 mm. Two edge mount SMA connectors were used for the test connections. The bandpass filter side was used as the input although the S12 and S21 were similar in both directions. The return loss did differ when measured from the low pass filter side. The test board is shown in Figure 3.

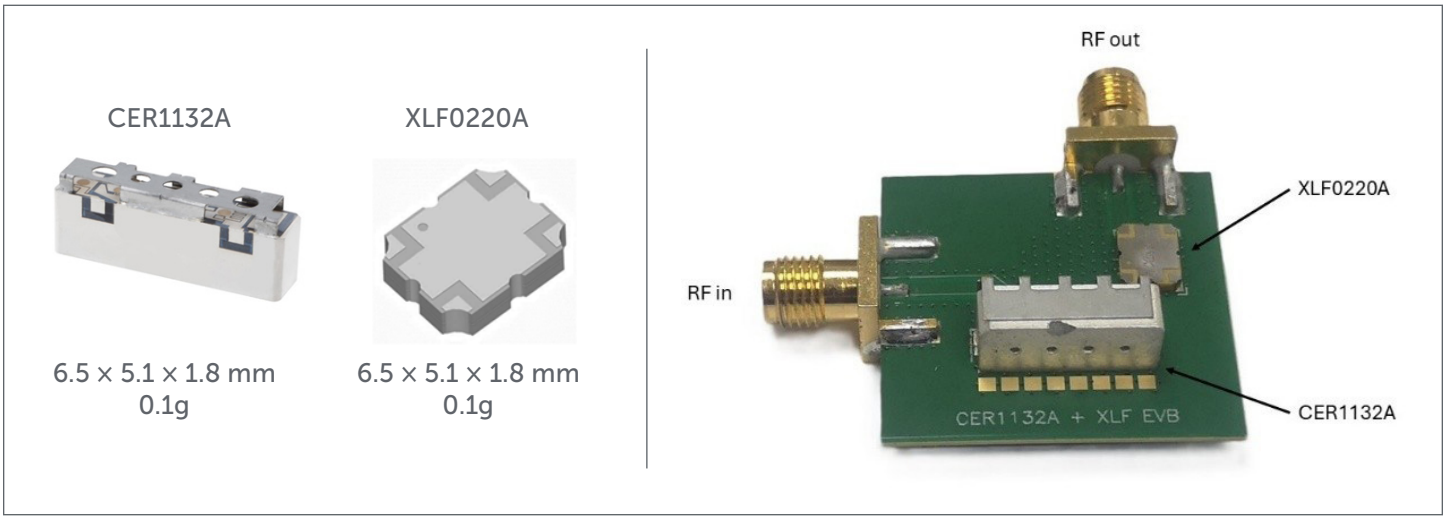


Figure 3 - Test Board

Test Results

As shown in Figures 4 and 5, the addition of the Low Pass Filter to the circuit added 35 -45 dB of addition rejection at the upper harmonics. This allowed a minimum rejection of 30 dB past 14 GHz. Within the passband, the Low Pass Filter added less than 0.5 dB of insertion loss to the circuit and maintained a flat response through the band.

In conclusion, the addition of an XLF Low Pass Filter can allow ceramic monoblock filters to be used in wideband applications with a minimal penalty to the circuit's insertion loss in the passband.

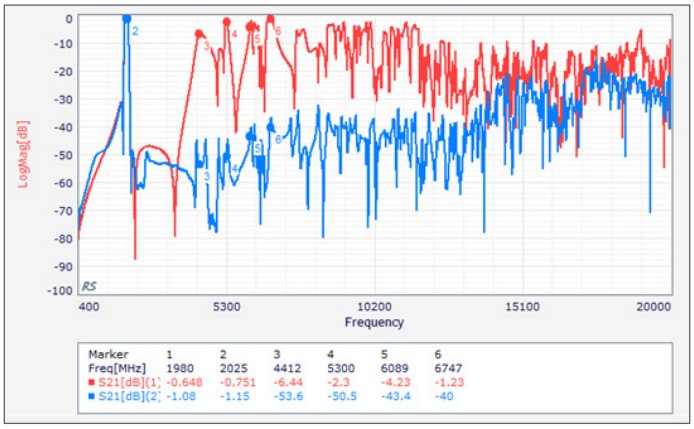


Figure 4 - CER1132A (RED) vs. CER1132A + XLF220A (Blue) Passband

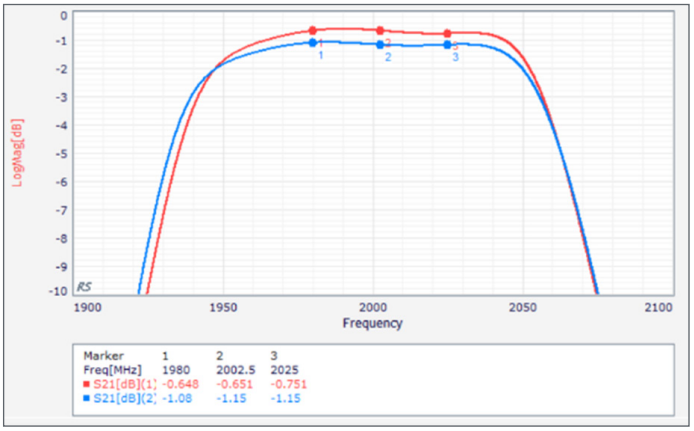


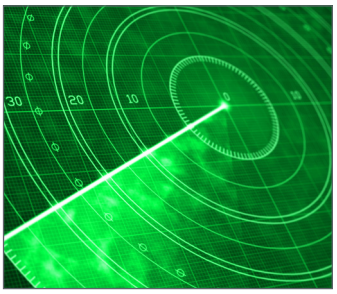
Figure 5 - CER1132A (RED) vs. CER1132A + XLF220A (Blue) Passband

XLF Filter Family

Model	Features	Passband Freq range (MHz)	Max IL (DB)	Input Power (w)		Primary Stopband Freq (MHz)	Primary Stopband Atten	Secondary Stopband Freq (MHz)	Secondary Stopband Atten (dB)
				avg	peak				
XLF0220A	Smaller LPF passing <2.2GHz with 2nd-5th harmonic supression	1700-2200	0.65	6.0	60	4000-6600	40	up to 11000	15
XLF0250A	Smaller LPF passing <2.5GHz with 2nd-5th harmonic supression	2200-2500	0.65	6.0	60	4600-7500	40	up to 12500	15
XLF0270A	Smaller LPF passing <2.7GHz with 2nd-5th harmonic supression	2400-2700	0.65	6.0	60	5000-8100	40	up to 13500	15
XLF0380A	Smaller LPF passing <3.8GHz with 2nd-5th harmonic supression	3300-3800	0.65	6.0	60	6900-11400	40	up to 19000	15
XLF0400A	Smaller LPF passing <4.0GHz with 2nd-5th harmonic supression	3300-4000	0.65	6.0	60	7200-12000	40	up to 20000	15
XLF0420A	Smaller LPF passing <5.0GHz with 2nd-5th harmonic supression	3300-4200	0.65	6.0	60	7600-12600	40	up to 21000	15
XLF0500A	Smaller LPF passing <2.5GHz with 2nd-5th harmonic supression	4400-5000	0.65	6.0	60	9000-15000	40	up to 25000	15

Applications

4G/5G Wireless Infrastructure



Avionics and Radar

Satellite Navigation

Communications

Land Mobile Communications

Satcom

4G/5G Wireless Infrastructure

Tactical Communications

Our Expertise

CTS Corporation is the global leader in ceramic filters. As the inventor of the ceramic monoblock (1982), CTS has a unique intellectual property position which enables us to deliver the best ceramic RF filters: lowest Insertion Loss (IL), highest attenuation / rejection / isolation, highest Q-Factor, smallest size for specified performance, highest power handling (average and peak), and sharpest transition slope.

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