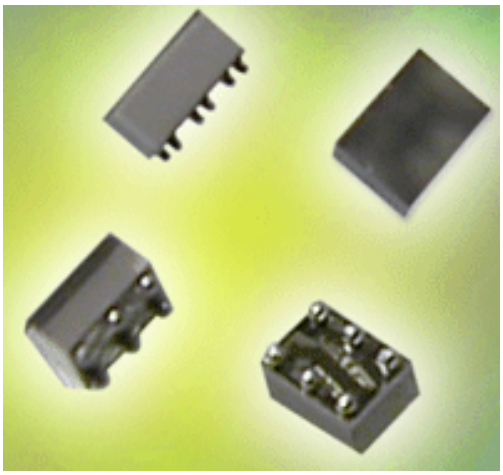
Selecting the Right Filter for Your Wireless Design

Understanding the key parameters and technologies when selecting a proper radio frequency (RF) filters.

By Scott S. Klettke, Murata Electronics North America

Filters are prevalent in our daily lives. They range from coffee filters that keep the grounds out of our lattes to air filters that keep dust and dirt from our lungs. Filters in



communications work under the same principle in that what is desirable is allowed to pass and the unwanted portion is blocked. The goal is to pass the wanted portion without anything being left behind, and the unwanted items to never gain entrance. With all the wireless systems in the world today, there are many unwanted signals flying around when we are typically interested in just a small subset. The antenna is the first chance to accept wanted signals and reject others. After the antenna, there are many options for the type of filter and the technology in which it is implemented.

Key Parameters for Filter Selection

1.Type of filter: There are low pass filters (LPF), high pass filters (HPF), band pass filters (BPF), and band stop or band elimination filters (BEF) or notch filters. Low pass filters allow lower frequencies to pass while rejecting higher frequencies. They are often characterized by a cutoff frequency that represents the frequency that starts the transition from passing to rejecting. Low pass filters are commonly used to attenuate harmonics. Conversely, a high pass filter will pass higher frequencies while rejecting those lower than the cutoff frequency. A band pass filter will pass a certain frequency range while rejecting all others outside that range. Finally, a band elimination filter will reject a very specific frequency. There are cases where a combination of band pass and band elimination filters are used to meet more

stringent requirements of filtering, such as when there is a certain unwanted frequency within a range of useable frequencies.

2.Center Frequency (MHz): The mid point of the range of frequencies you would like to pass. It can also be expressed in Hertz, Kilohertz, Gigahertz, etc. and can be noted as fcor fo.

3.Bandwidth (MHz): The range of the frequencies that are passed by the filter. In the case of low pass or high pass, this parameter is usually not used in favor of a cutoff frequency as explained earlier. The bandwidth may be expressed as a start and stop frequency or as a value relative to the center frequency, such as 2450 &#177 50 MHz, where &#177 50 MHz would be the bandwidth signifying 100 MHz.

4.Insertion Loss (dB): The amount of power of the wanted signal that is lost in the passband. I, but there is some threshold or maximum value that can be found when considering the entire receive or transmit paths in a communication system.

Figure 2. Hybrid Filter Surface Acoustic Wave Filter used in wireless/cyclic entry applications.

5.Attenuation point or stop band (dB): The measure of the level of rejection of unwanted frequencies. Attenuation is usually associated with a certain frequency or range of frequencies. Rejecting frequencies by greater decibels or frequencies that are closer to the wanted frequencies, such as the pass band requires a high order filter. There is a trade-off for insertion loss when increasing the order of the filter. As attenuation increases, so does the insertion loss. A high attenuation filter that can reduce frequencies very close to the pass band is often referred to as a filter with high selectivity.

6.Ripple (dB): This is the amount of variation or flatness in the passband.

7.Package Size: There are various package sizes that are dependent on the technology used to make the filter. Different filter technologies have different trade-offs for performance, size and cost. Some typical filter technologies used in wireless communications are dielectric ceramic, low temperature co-fired ceramic or lumped element, surface acoustic wave, bulk acoustic wave and integrated passive.

8.Power Handling (W): Power handling is usually a function of the technology used to realize the filter. Higher power generates heat, which can change performance characteristics or permanently damage a filter. It is a good practice to consider the temperature range that a filter is specified to operate in, as well as the amount of

power that it can handle without performance change or damage.

When requesting a filter, most designers fail to mention all the selection criteria. At a minimum, knowing the insertion loss across the passband, the attenuation points, the maximum size and target cost allows filter suppliers to suggest the best filter for your design. It is also worth mentioning again that insertion loss, attenuation and size are trade-offs. It is not uncommon to develop a filter around a set of specifications only to find the size is huge and the cost much higher than expected. Specifications can mysteriously be relaxed to get a new proposal that will meet the additional size and cost targets. Everyone can work more efficiently when all the basic parameters are known up front.

Conclusion

Figure 3. Miniature style dielectric filter used in a wireless radio and GPS application.

So what is the future of filtering? There is always pressure to reduce the complexity and cost of radio systems. The move from superheterodyne radio systems to direct conversion or zero IF, eliminated the need for external IF filters. More and more filtering requirements are being realized digitally or in the silicon of the semiconductor. Filters with integrated baluns are being requested to eliminate some interstage filters, as well. A performance sacrifice is the usual result. Murata Electronics continues to reduce the size and cost of filters and works to develop innovative technologies to help maintain a high level of system performance while keeping cost and complexity low.

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