SPECIFYING FILTERS:
GET IT RIGHT THE FIRST TIME!

RF & microwave filters have long been a comparatively simple solution for eliminating interference. However, specifying filters effectively requires some basic knowledge about key performance parameters, and how they can conflict or will cause the cost, size, or other important factor to become unacceptable.

For example, when specifying a bandpass filter, combining low insertion loss with very high rejection and a narrow passband bandwidth increases the complexity, size, and cost of the filter. A VSWR of 1.5:1 is typically acceptable for most applications. Lower values are achievable, but if they are not necessary, why incur the expense that achieving higher performance in this area will entail? The information in this document is designed to help solve problems like this early in the specification process.

However, when in doubt, contact Anatech first. It could save you hours of valuable time, call us at (973) 772-4242, or send us an e-mail at sales@anatechelectronics.com.

GOOD RULES TO KNOW

Don't make the filter an afterthought: After the system has been deployed is obviously not the time to discover that a filter is needed. At this stage, the cost to remedy the problem almost invariably far exceeds the cost of adding a filter to the design in the first place. At the beginning of the design cycle, look at the frequencies around the target band and ask what conflicting signals are likely to appear. This does not mean that a spurious signal might not pop up at some time, but nearby services and low harmonics of known emitters are suspects.

Use a filter with sharp cut-off and high isolation: A filter attenuating a signal just 3 MHz away must be able to reject signal strength by more than 40 dB outside its passband. Filters today exhibit sharp cut-off characteristics and this requirement becomes very important when services operate very close to each other. Duplexers, for example, which are necessary for any simultaneous send-receive communication and are essentially two bandpass filters hooked together, must have especially sharp cutoff characteristics, high isolation, and as little insertion loss as possible so that neither the send or receive frequencies will interfere with each other.

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Don't test the product in too "friendly" an environment: In the eagerness to rush a product to market, environmental testing can take place under artificial conditions that don’t reflect what the product will experience in service. Just because a product breezes through EMF testing within a lab doesn't mean it won't cause interference on a corner in midtown Manhattan.

Subject a subsystem or system to “real-world” signals that can be created by most modern signal generators and perform electromagnetic compatibility (EMC) testing. The latter is not inexpensive, but it’s lot less than recalling hundreds or thousands of products from the field.

Consider packaging and mounting up front: Packaging considerations can impact cost and size impacts cost the most. The tighter the size requirement, the higher the cost of the filter. That is, if a filter is desired with low insertion loss and very high rejection at frequencies very close to the cutoff frequency of the passband, it requires more than 11 sections to be realized. This increases its size and thus the cost of the filter.

High-power filters require a larger package so that the components are placed to achieve optimum current distribution. A surface-mount filter will be the lowest in cost of all filter styles as are filters that can be supplied on tape and reel carriers for automated “pick-and-place” assembly. A connectorized filter will normally cost more but will cost the user less to incorporate into the subsystem when compared with a through-hole type of mounting.

Don’t forget power handling: Every filter has practical limits in terms of the RF power levels it can withstand. Make sure to match the application’s power levels to the type of filters being considered.

Remember to include all specs: Filter manufacturers must have a complete list of requested specifications to work with before quoting a particular filter. These specifications as well as those for other types of products manufactured by Anatech are available on the Anatech Electronics Web site.

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Choose a filter manufacturer carefully: Even the best designs are occasionally comprised by a frequency conflict that could not have been foreseen. In such instances, it pays to work with a filter manufacturer that can (or will) modify its products to suit specific requirements. For example, a manufacturer may need to change the center frequency of a filter to improve its performance within a particular band

A way to do this without scrapping the design is to work with a filter manufacturer that can adapt a standard product. For example, a system might require a standard 915 MHz bandpass filter but once field tested might actually require a filter with a center frequency of 920 MHz.

Filter manufacturers like Anatech Electronics can accommodate this because they have in-house design and manufacturing capability. It's difficult to obtain that kind of response from a distributor that gets its parts from offshore sources. The same applies to changes in connector type or gender and even mounting configurations.

TRADE-OFFS FOR SPECIFIC FILTER TYPES

Highpass filters: An important parameter when specifying this type of filter is how far from the center frequency the specified flatness must extend, and how wide the passband must be. Specifying flatness to twice the center frequency is realistic and achievable from design and manufacturing cost perspectives – but “frequency response to infinity” is not.

Placing the rejection specification too close to the passband is also undesirable. For example, a highpass filter with a 1-dB point of 120 MHz and rejection greater than 90 dB at 90 MHz will require about 9 to 11 sections. This increases the filter’s size and cost, so understanding which parameter is more critical for a given application is essential.

Lowpass filters: The tradeoffs for lowpass filters are similar to those for highpass filters. If rejection is specified lower than really necessary, the design will become more complex. In addition, how far beyond the cutoff frequency the rejection must extend, and how far out the stopband must span are important as well. A value of twice the cutoff frequency is realistic and achievable and results in a lower-cost design.

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Bandpass and bandstop filters: Insertion loss in the passband and rejection in the stopband are critical parameters in bandpass and bandstop filters. Low insertion loss together with a large amount of rejection within a narrow passband results in a greater number of sections, which increases filter size and cost. Harmonic rejection is also important as the filter will have its first harmonic at twice the center frequency. In order to achieve attenuation to beyond the passband, additional manufacturing steps are required.

Duplexers and diplexers: In addition to the considerations for the filter structures noted above, isolation between output sections is important when specifying diplexer and duplexer filters. Very high isolation and a narrow guard band will result in more sections, as both the filters that comprise the device must have very sharp attenuation characteristics. This increases the size of the filter. A stringent specification in a small package is very difficult to realize. Be sure to provide requirements for phase and group delay, input power, size, environmental exposures, and mechanical requirements, when specifying these devices.

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