Cavity Filters, Duplexers Meet Demands of 700 MHz 4G Networks

by Anatech Electronics

Having been bombarded with advertising about "4G", whether in the form of LTE at 700 MHz, WiMAX at 2500 MHz, or HSPA+, the fact remains that deploying these networks is posing major challenges for carriers. One problem (among many) is that channel spacing especially at 700 MHz is extremely narrow, and higher-order modulation techniques will not tolerate spurious signals from a transmit band appearing in the receive band. This becomes even more vexing at collocated sites where several carriers' networks are in operation and the equipment has been modified over the years for various reasons, producing a rat's nest of transmission cables, couplers, and filters.

Last but not least is the problem of passive intermodulation (PIM) distortion, typically caused by passive components that because of their materials, poor connections, and general abuse generate signals can degrade receiver performance. To address the challenges posed by these installations, Anatech Electronics has introduced a line of standard LTE cavity filters, cavity band combiners, and duplexers whose characteristics and performance are tailored to meet these stringent requirements. These standard models are available at the company's Web store, amcrf.com and custom models are available by calling the company's engineering department.

Figure 1: The Model AB734B944 cavity bandpass filter has a center frequency of 733 MHz, a 12-MHz bandwidth of 728 to 740 MHz, rejection of at least 40 dB at 700 kHz from the passband edges, and PIM of -150 dBc.

Covering the 700 MHz Waterfront

In order to accommodate the needs of LTE system builders, the 700-MHz band combiners, bandpass filters, and duplexers are available in models that cover the frequency bands of interest. Examples of the bandpass filters are shown in Table 1, and the Model AB734B944 is shown in Figure 1. They conservatively handle at least 50 W, which makes them well suited for the installation on single channels. They have low insertion loss, return loss of at least 14 dB, and their characteristics are extremely well controlled. Rejection of the Model AB734B944 is shown in Figure 2.

All standard bandpass filters, band combiners, and duplexers for the 700 MHz LTE employ Type-N connectors, although 7/16-DIN connectors, which provide a greater measure of ruggedness in the face of rough handling, can be specified as well. While all models are rugged and able to withstand the rigors of the base station environment with an operating temperature range of -40 to +85° C, they can also be specified with features that allow them to be employed outdoors.

Facing Down PIM

PIM has been a problem for communications system designers and technicians who must "go to the mountain" to service public service, broadcast, wireless, and other communications systems for decades. It is a particularly nasty problem for satellite communications designers as conditions in space can cause PIM-producing conditions, which are obviously not easily rectified. PIM has also plagued military ships, as it can arise from corroded or rusty bolts and other metals that when subject to high ambient levels of electromagnetic energy act as diodes and generate spurious signals that

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Table 1: Cavity Bandpass Filter Specifications, Typical Models[1]

Model	Band	Center frequency (MHz)	Bandwidth (MHz)	Passband (MHz)
AB704B942	A	703	11	698 to 709
AB710B943	B	710	12	704 to 716
AB7134944	E	733	12	728 to 739
AB740B945	D	740	12	734 to 746
AB701B946	A	700	5	698 to 703
AB707B947	A	706	5	704 to 709
AB713B948	B	713	6	710 to 716
AB731B949	A	731	5	728 to 733
AB737B950	B	737	6	734 to 740
AB743B951	C	741	6	740 to 746

1. All models: Rejection: at least 40 dB at 700 kHz from passband edges, power handling: 50 W (higher power levels available), PIM -150 dBc, insertion loss 2 dB, operating temperature -40º to +75º C, Type-N connectors.

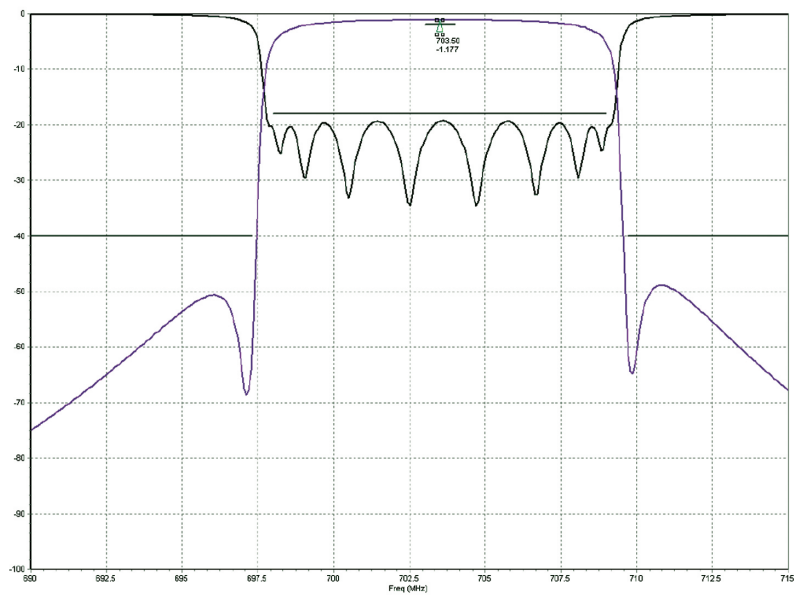

Figure 2: Rejection characteristics of the Model AB734B944.

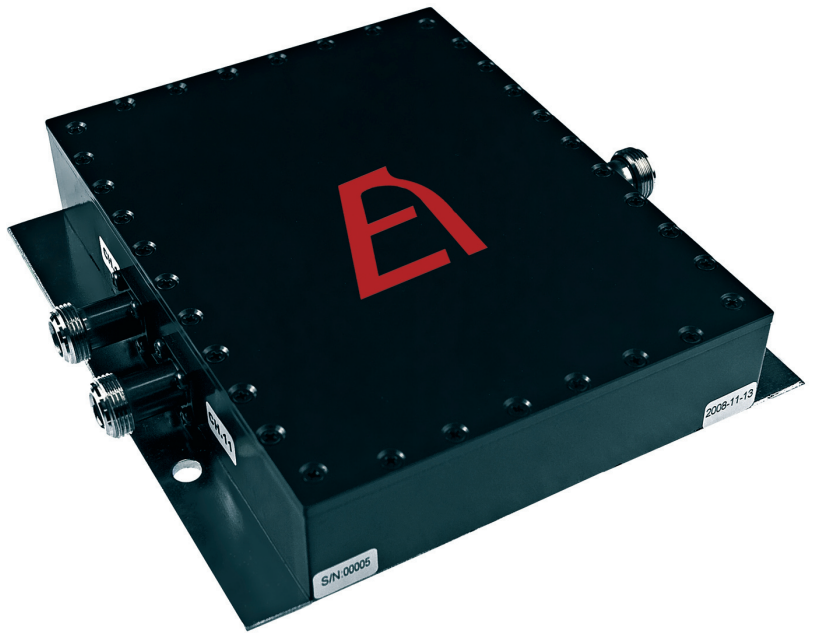

Figure 3: The 700-MHz cavity duplexer line is designed specifically to meet the requirements of LTE networks

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appear in the receive bands of shipboard communications, radar, EW, ECM, and fire control systems. This "rusty bolt effect" is part of the lore of naval history.

Intermodulation distortion (IMD), of which PIM is one form, occurs when two or more signals combine to form other unwanted frequencies. It can occur in transmitters and in the RF front end and mixing stages of receivers. However, unlike other forms of IMD, PIM can arise from bizarre situations such as the aforementioned "rusty bolt" effect as well as connection of dissimilar metals, connectors that are improperly tightened or damaged and can occur with all types of passive components – including cavity bandpass filters, combiners, and duplexers.

PIM has always been lurking in the performance metrics of every base station, but with today's dense channel spacing and digital modulation techniques it is essential to reduce it to levels that will not interfere with the receive band of the host system – or in other systems collocated at a site. Recognizing this requirement, many of Anatech's cavity filters, combiners, and duplexers have been designed using metals that do not generate PIM, connectors that have proven low-PIM performance, and other techniques that reduce PIM to levels of -150 dBc or more. Requests for these models, which are available as custom parts, can be quickly accommodated along with measured PIM performance plots. In addition to filters, combiners, and duplexers, the company offers directional couplers, power dividers, and other components designed for service at 700 MHz, as well as for all current wireless bands from 450 MHz through 3 GHz.

Models with two to eight resonators and bandwidths from 0.3% to 4% are available along with moderate-bandwidth types with bandwidths from 3% to 30%. The wideband cavity bandpass filters are interdigital types with 4 to 13 resonators and bandwidths from 10% to 100%. Standard designs have a 0.05-dB Chebyshev response and other types include Butterworth and elliptic. All types range in size from 1 in. to more than 10 in., depending on the number of sections, insertion loss, power handling, and center frequency.

The company's duplexer line includes models with 2 to 18 resonators and bandwidths ranging from 3% to 100%. The resonator and the cavity are silver plated for lower insertion loss and better selectivity. Standard cavity duplexers can handle power up to 500 W (although much higher powers can be specified) and can withstand adverse conditions. For more information, visit www.amcrf.com and www.anatechelectronics.com.

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Table 2: Band Combiner Specifications, Typical Models[1]

Model	Assigned band (up and down-link paths)	Passband 1 (MHz)	Passband 2 (MHz)	Ins. loss @ center frequency (dB)	Ins. loss (dB) @ band edges	Return loss (dB)	PIM (dBc)
AD701-731C111	A	698 to 703	728 to 733	1	2	14	-150
AD707-737C112	B	704 to 709	734 to 739	1	2	15	-150
AD713-743C113	C	710 to 716	740 to 746	1	2	14	-150

1. All models: Rejection: at least 40 dB at 700 kHz from passband edges, power handling: 50 W (higher power levels available), insertion loss 2 dB, operating temperature -40º to +75º C, Type-N connectors.