November 2009
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focus
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What's New?

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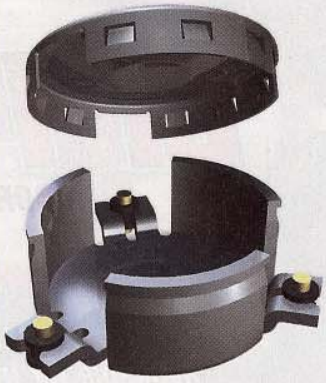
PASSIVE COMPONENTS

Surface-Mount Isolators/Circulators SHAVE SIZE and Insertion Loss

Low-cost surface-mount isolators and circulators now offer compatibility with automated manufacturing processes while delivering superior performance at higher frequencies and power levels.

ASHOK BINDRA/Technology Writer

Isolators and circulators are vital to modern communication systems. They play an important role in guiding signals from port to port as well as providing isolation between them. Consequently, makers like Anaren Microwave, Anatech Electronics, DiTOM Microwave, RF Micro Devices, M/A-COM Technology Solutions, MESL Microwave, Renaissance Electronics, Raditek, Response Microwave, Temex, and TRAK Microwave work continuously to enhance the performance of their ferrite-based components to satisfy myriad RF/microwave communication applications. They are employing better ferrite materials and clever circuit techniques combined with simulation and modeling to achieve improvements. In doing so, they are cutting intermodulation distortion (IMD) while providing better isolation and lower insertion loss at higher frequencies.



Because it is compatible with automated SMT assembly techniques, this robust lead surface-mount circulator eliminates all manual processes.

For example, Renaissance Electronics (www.rec-usa.com) has developed a ferrite-based, coplanar surface-mount circulator for avionics covering 4.2 to 4.4 GHz. Designated the 3SMH6NA, this patented coplanar circulator is designed to meet aircraft shock and vibration specifications with low EMI/EMC characteristics (MIL-STD-883 and MIL-STD-202). It promises to provide comparable electrical performance with existing drop-in models. "To match the solder reflow profile, we had to incorporate a better temperature compensator," notes Anuj Srivastava, the firm's Vice President of Engineering. Measuring only 0.63 x 0.63 x 0.19 in., the 3SMH6NA offers 19 dB isolation with a voltage standing wave ratio (VSWR) of 1.25:1. It exhibits 0.5 dB insertion loss from −40° to +85°C.

Higher-frequency models reaching 6 GHz also are available in this package style. Those models come with 700-MHz

bandwidth without compromising electrical and mechanical performance, says Srivastava. Meanwhile, efforts are in progress to reach frequencies to 10 GHz with as much as 1-GHz bandwidth.

For FM digital-radio applications, Renaissance has developed compact coaxial circulators to replace expensive ferrite devices. Tailored for a frequency range of 88 to 108 MHz, the model 3A1NBV offers more than 22 dB isolation over a 4-MHz bandwidth. The circulator can handle more than 1500 W CW power without forced cooling and suffers only 0.1 dB insertion loss. Occupying 5.2 x 6.62 x 1.59 in., the model 3A1NBV is one-half the size of a traditional circulator design. While traditional designs typically offer 10-percent bandwidth, however, the 3A1NBV provides only 3-percent bandwidth.

To further boost the ruggedness of surface-mountable ferrite circulators and isolators for wireless infrastructure and radar systems, M/A-COM Technology Solutions (www.macomtech.com) has designed a line of circulators using its patented robust lead housing technology. The resulting high-performance circulator comes in a low-cost, surface-mount package. "This new patented package uses a unique vertical lead to make the connection between the center conductor of the circulator and the customer's PC board (PCB). Firmly captivated inside a high-temperature plastic, this robust lead ensures excellent unit coplanarity," asserts Brian Hartnett, Director of Engineering at M/A-COM.

Traditional "drop-in" designs require manual placement, screw installation, and manual soldering of the circulator leads to the PCB. In contrast, the robust lead circulator is shipped in tape and reel to allow the use of automated SMT reflow assembly techniques, thereby eliminating all manual processes (*Fig. 1*). The three gold-plated leads boast superior solderability while allowing for easy inspection of the solder joint, notes Hartnett. To ensure good RF grounding and thermal dissipation, he points out that the base of the robust lead circulator is soldered directly to the PCB.

The model MAFR-000483-000001, for example, is designed for WCDMA applications from 2110 to 2170 MHz. Measuring 20 mm in diameter with a height of 6.5 mm, it exhibits insertion loss of 0.20 dB. The component offers isolation and return loss greater than 20 dB. Another part in the robust lead circulator line is the MAFR-000517-000001, which operates from 925 to 960 MHz. Because it operates at lower frequencies, its housing measures 25 mm in diameter and 8 mm high. The unit's third-order IMD is less than –70 dBc guaranteed over the temperature range of –40° to +85°C. It exhibits insertion loss of 0.25 dB.

For next-generation power amplifiers in software-defined radios (SDRs), M/A-COM has developed a broadband circulator with insertion loss of 0.4 dB from 790 to 960 MHz. It offers 17 dB isolation. Labeled MAFR-000490-000001, the circulator provides –60 dB IMD with two 30-W CW tones set 5 MHz apart. According to the firm, this broadband performance was achieved using a sophisticated magnet circuit model to determine the optimum ferrite/circuit design. Recently, the company launched drop-in isolators and circulators for Long-Term Evolution (LTE) and TD-SCDMA base stations as well as L- and S-band radar and avionics applications.

By extending its proprietary multilayer-stripline Xinger technology to C- and X-band ferrite-based circulators, Anaren Microwave, Inc. (www.anaren.com) is developing a series of low-cost surface-mount circulators. These circulators promise to deliver superior electrical and mechanical performance at high frequencies. "By eliminating traditional metal housings and leads and by leveraging our long experience with manufacturing Xinger components, the new line of circulators will offer better physical stability, structural integrity, and lower weight," states Kurt Richardson, Product Line Manager for Ferrite Products. He adds, "Anaren's solution will especially help mitigate issues where aqueous washes and solvents are used to clean finished PCBs of soldering flux." To speed production, the new circulators will be compatible with standard, high-volume, automated pick-and-place equipment.

Similarly, Scotland's MESL Microwave (www.meslmcrowave.com) is focused on improving SMT packages that are suitable for automated placement and reflow temperatures without degradation. For point-to-point radio applications, the firm has readied a range of SMT-package drop-in

Sampling of recently released isolators and circulators

Supplier	Model number	Type	Frequency range (GHz)	Minimum isolation (dB)	Maximum insertion loss (dB)	Maximum VSWR	Forward power (W)
Anatech Electronics	STMC1350-80	Surface-mount circulator	1.250 - 2.750	20	0.35	1.20:1	50
DiTom Microwave	D3I0780S	Coaxial isolator	0.7 - 0.8	20	0.4	1.25:1	300
	D3C0780N	Coaxial circulator	0.7 - 0.8	20	0.4	1.25:1	300
M/A-COM Technology Solutions	MAFR-000483-000001	Surface-mount circulator	2.110 - 2.170	20	0.25	1.22:1	200
	MAFR-000490-000001	Circulator	0.790 - 0.960	17	0.4	1.33:1	200
MESL Microwave	CZF9906	Drop-in isolator	5.7 - 8.5	20	0.4	1.22:1	10
	XZM10128	Coaxial circulator	10.750 - 12.800	21	0.35	1.22:1	1
Renaissance Electronics	3SMH6NA	Surface-mount circulator	4.2 - 4.4	19	0.5	1.25:1	50
	3A1NBV	Coaxial circulator	0.088 - 0.108	22	0.1	1.15:1	1500
Raditek	RI-TT-de-LP	Stripline isolator	0.700 - 1.990	20	0.3	1.20:1	250
	RADI-29-31-MS-0.5WR	Microstrip isolator	29 - 31	20	1.0	1.35:1	2.0

isolators. It also has been striving to reduce loss and achieve low IMD performance. By strategically working with ferrite suppliers, the company has developed materials that exhibit low loss and IMD down to −85 dBc. Recently, it extended this capability to space applications with the release of microstrip drop-in and coaxial parts. The coaxial version with an MIC interface offers 0.25 dB in loss at ambient temperature and 0.35 dB over the temperature range, says Product Line Manager Keith Burns.

For defense applications, MESL debuted a range of multi-octave devices covering 2 to 6 and 6 to 18 GHz. Available as a package drop-in, the 6-to-18-GHz circulator exhibits insertion loss to 1.5 dB with 12.5 dB minimum isolation. It is rated to 50 W of average forward power.

Due to high volume, microstripline isolators are 25 to 33 percent lower in cost compared to traditional designs.

Multi-octave design is also a specialty of Raditek, Inc. (www.raditek.com). Combining the proprietary composition of ferrite material with engineering skills and experience, the company has created a multi-octave peripheral-mode isolator with more than three-octave coverage. This 2-to-18-GHz peripheral-mode unit targets test equipment and electronic-warfare (EW) applications. To expand its application base, it also has been revamping its microstrip, stripline, and coaxial isolators and circulators. The firm's microstrip parts, for example, now cover 2 to 98 GHz (*Fig. 2*). According to COO Peter Corbett, high-volume manufacturing has enabled the company to cut cost by 25 to 33 percent.

For third-generation/fourth-generation (3G/4G) cellular and PCS base-station applications, Raditek has developed stripline isolators with IMD performance that is better than −100 dBc. The developer attributes this capability to special ferrite material and the minimization of nonlinearity. Corbett notes that these isolators are highly optimized to perform over the temperature range.

Ultra-low IMD with high isolation from a miniature package is also a goal of Anatech Electronics (www.anatechelectronics.com). There, designers are developing a drop-in circulator that flaunts −110 dBc IMD performance for cellular applications. According to Anatech's President and Founder, Sam Benzacar, "There are several factors involved in achieving ultra-low IMD performance. Besides size and orientation of the ferrite, the physical design contributes to obtaining ultra-low IMD performance." To handle high power, the supplier also is working on trimming insertion loss and shrinking size. "The way you cut the ferrite impacts the size of the circulator," notes Benzacar. In the meantime, Anatech has developed a family of custom circulators for operation from 1250 to 2750 MHz with 80-MHz bandwidth. These circulators exhibit 0.35 dB insertion loss and a VSWR of 1.20:1. They provide at least 20 dB isolation and handle 30 W forward power.

For next-generation wireless-infrastructure applications, RF Micro Devices, Inc. (www.rfmd.com) has released nine single- and dual-junction isolators in rugged packaging. Constructed with samarium-cobalt (SmCo) magnets packaged in aluminum housings, the PIxxxxAG-21H and the PDxxxxAQ-21H isolator lines target the high-power, linear amplifiers used in cellular base stations. While the single-junction PIxxxxAG-21H offers 30 W reverse-power capability, the dual-version PDxxxxAQ-21H is rated for 100 W reverse power. The isolators were developed to meet the more demanding operational requirements of the new highly integrated, dual- and quad-density platforms utilized in next-generation cellular base stations.

Likewise, MECA Electronics (www.e-meca.com) has expanded its connectorized isolators and circulators to X and Ku bands. Featuring SMA-female connectors with average power rating of 2 W, these high-frequency components exhibit 0.4 dB insertion loss and VSWR of 1.30:1. They provide 18 dB isolation.