

Multilayer Magic Yields Shrinking Circuits

Multi-Mix PICO reduces the size of components, such as quadrature hybrids and directional couplers, by 84 percent when compared to any conventional competitive product.

multi-Mix multilayer technology burst on the market in 1998, with components comparable in size to the smallest of those then available, and performance competitive with any other technology. Now, three years later, Merrimac Industries (West Caldwell, NJ) has introduced the next generation of Multi-Mix, known as Multi-Mix PICO, along with a family of quadrature hybrids and directional couplers (the

simplifies the design process and allows the company to offer them as off-the-shelf

components with delivery from stock.

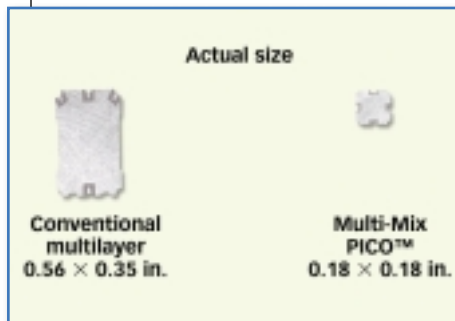
Multi-Mix is a unique circuit-design and fabrication process that allows microwave circuits to be constructed in three dimensions (3D) rather than in the conventional two-dimensional (2D) planar format. It provides tremendous advantages in size, weight, shielding effectiveness, and electrical per-

Z series) that is up to 87 percent smaller than its predecessors, while still handling 100-W continuous-wave (CW) power with appropriate heat sinking.

The small footprint realized by the Multi-Mix PICO components is dramatic when they are compared to the footprint of their predecessors (Fig. 1). The size reduction should be well-received by

designers of two-and-a-half-generation (2.5G) and third-generation (3G) wireless base stations, picocells, multicarrier amplifiers, and other wireless systems, where space is increasingly at a premium. All of the components have a standard footprint and are based on a library of Multi-Mix configurations, which

JACK BROWNE
Publisher/Editor



1. The Multi-Mix PICO footprint is compared to its predecessor, which was formerly the smallest footprint available.

Table 1: Multi-Mix PICO quad hybrids

| Parameter | QHD-2Z-1.9G | QHD-2Z-2.1G |
|---------------------|------------------------|----------------|
| Frequency range | 1.7 to 2.0 GHz | 2.0 to 2.3 GHz |
| Insertion loss | 0.35 dB (max) | 0.35 dB (max) |
| Isolation | | |
| Paths 1 to 3 | 20 dB (min) | 20 dB (min) |
| Paths 2 to 4 | 15 dB (min) | 15 dB (min) |
| VSWR | | |
| Ports 2 and 4 | 1.30:1 (max) | 1.40:1 (max) |
| Ports 1 and 3 | 1.50:1 (max) | 1.60:1 (max) |
| Amplitude imbalance | ±0.4 dB (max) | ±0.3 dB (max) |
| Phase imbalance | ±3 deg. (max) | ±4 deg. (max) |
| Maximum input power | 100 W CW (max) | 100 W CW (max) |
| Size | 0.18 × 0.18 × 0.09 in. | |
| Weight | 0.003 oz. | |

formance compared to conventional stripline approaches. The Multi-Mix circuit consists of various circuit and isolation layers. The layers are fusion-bonded together, with multiple layers aligned through indexing holes. Plated-through holes are used to provide electrical and ground connections between layers. The fusion-bonding process delivers a multilayered, homogeneous monolithic structure that is extremely compact, and supports integration of active and passive components. The company has manufactured a considerable number of Multi-Mix multifunction modules, including filter banks. Multi-Mix PICO will allow these same modules to be manufactured with significantly smaller dimensions.

The Multi-Mix PICO components include the Z series of quad hybrids and directional couplers. The quad hybrids include the 1.7-to-2.0-GHz model QHD-2Z-1.9G and the 2.0-to-2.3-GHz model QHD-2Z-2.1G. The tiny stripline components feature outstanding phase and amplitude balance with 0.35 dB or less insertion loss (Table 1), and measure only 0.18 × 0.18 × 0.09 in. (0.46 × 0.46 × 0.23 cm) while weighing only 0.003 oz. The hybrids are fabricated on stable ceramic-filled polytetrafluoroethylene (PTFE) dielectrics

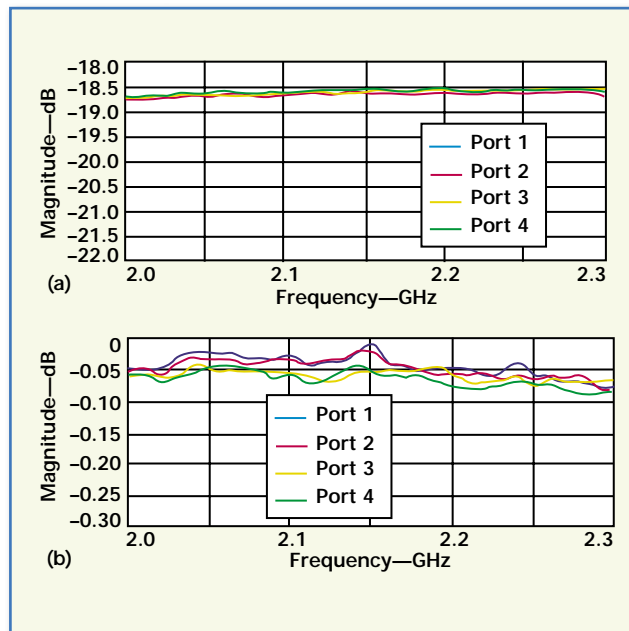
| Parameter | CSD-10Z-1.9G | CSD-20Z-1.9G | CSD-10Z-2.1G | CSD-20G-2.0G |
|-----------------------|----------------|----------------|----------------|----------------|
| Frequency range | 1.7 to 2.0 GHz | 1.7 to 2.0 GHz | 2.0 to 2.3 GHz | 2.0 to 2.3 GHz |
| Coupling | 10.5 dB | 19.5 dB | 10.5 dB | 20.0 dB |
| Coupling flatness | ±1.0 dB | ±1.0 dB | ±1.0 dB | ±1.0 dB |
| Insertion loss | 0.2 dB (max) | 0.2 dB (max) | 0.2 dB (max) | 0.2 dB (max) |
| VSWR | 1.30:1 (max) | 1.30:1 (max) | 1.30:1 (max) | 1.30:1 (max) |
| Frequency sensitivity | ±0.5 dB | ±0.3 dB | ±0.3 dB | ±0.2 dB |
| Directivity | 15 dB (min) | 13 dB (min) | 15 dB (min) | 15 dB (min) |
| Input power (max) | 100 W CW | 100 W CW | 100 W CW | 100 W CW |

that are compatible with a wide range of substrates, including FR-4, polyamide, and G-10 materials. A wraparound ground plane provides a high level of electromagnetic-interference (EMI) shielding.

The Z series of Multi-Mix PICO directional couplers includes the 10-dB models CSD-10Z-1.9G and CSD-10Z-2.1G, as well as the 20-dB CSD-20Z-2.0, all with an operating frequency range of 1.7 to 2.3 GHz. As with their quad hybrid counterparts, the directional couplers measure only 0.18 × 0.18 × 0.09 in. (0.46 × 0.46 × 0.23 cm) while weighing only 0.003 oz. The couplers have insertion loss of 2 dB, with accuracy within ±1 dB. Directivity is 13 dB or better for all models (Table 2) while the worst-case frequency sensitivity is ±0.3 dB. Measured data (Fig. 2) show the rated specifications to be somewhat conservative in terms of coupling

flatness and insertion loss.

The Multi-Mix PICO directional couplers and quad hybrids are rated for operating temperatures from -55 to +85°C. The components are supplied on tape and reel for automatic assembly or can be integrated with other components as part of a Multi-Mix multifunction module. The Multi-Mix product families have passed many environmental screening tests, including thermal and mechanical shock, burn-in, acceleration, vibration, moisture resistance, solder heat resistance, and thermal cycling of more than 1000 cycles. P&A: \$0.95 for standard models (250,000 qty. or less); stock. **Merrimac Industries, Inc., 41 Fairfield Pl., West Caldwell, NJ 07006; (888) 434-MMFM, FAX: (973) 882-5990, e-mail: MMFM@merrimacind.com, Internet: www.multi-mix.com. MRF**
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2. Measurements performed on a model CSD-20Z-2.0G directional coupler show the coupling to be flat and uniform at all ports (top), with insertion loss that is considerably less than the rated 0.2-dB specification (bottom).