MAREK ANTKOWIAK | President

PIM-Free Attenuator Aids Amplifier Testing

By substituting directional couplers for attenuators, this attenuation subsystem improves the accuracy of PIM measurements on high-power amplifiers for 4G cellular base stations.

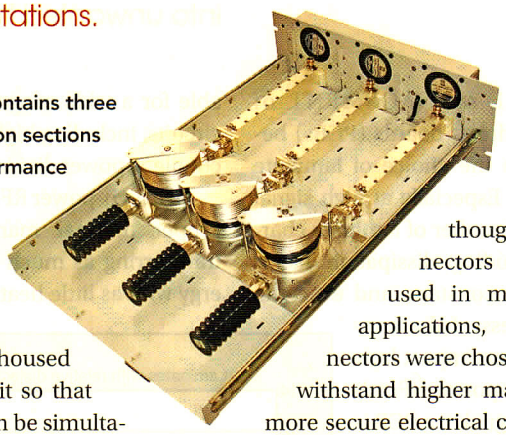
TESTING AMPLIFIERS for fourth-generation (4G) wireless networks such as LTE and WiMAX can be troublesome because of the passive intermodulation (PIM) distortion generated by passive test components—especially high-power attenuators.

These devices are required to reduce the output of high-power amplifiers to levels acceptable for power meters and other test gear. Attenuation must be accomplished with precision over frequency and power level, and connectors must be able to withstand many connections and disconnections without damage.

To solve this problem, R&D Microwaves (www.rdmicrowaves.com) has developed their model AT-A09 attenuation subsystem for wireless bands from 400 to 2900 MHz; it virtually eliminates PIM in the attenuation path of a test system, with a measured level of -170 dBc or better over those wireless frequency bands.

Model AT-A09 (**Fig. 1**) also eliminates attenuators from the "attenuated" test channel, implementing the same functionality with three basic components arrayed in order of their distance from the signal source: a 30-dB airline directional coupler, a tightly-wound long spool of flexible microwave cable, and a resistive load. The coupled port is fed to the instrument (attenuated by 30 dB) while the remaining signal power passes through the coupler's main line path through the cable spool (with its inherent attenuation).

The termination produces a DC ground path for the signal after the cable. Three of these configurations, each with identical performance, are housed together in the unit so that three amplifiers can be simultaneously evaluated.



1. Model AT-A09 contains three complete attenuation sections with identical performance that allow multiple amplifiers to be tested simultaneously.

This approach has been used in test and measurement and other applications over the years, but the requirements for low PIM, good attenuation stability with temperature and frequency, and high return loss posed challenges. The directional coupler design itself was created (and patented) by company President Marek Antkowiak and employs five quarter-wave sections and other techniques that result in broad bandwidth (such as 400 to 2900 MHz), return loss of 28 dB (a VSWR of 1.08:1), and typical PIM of -174 dBc.

The coupler's flatness with frequency is better than ±0.05 dB over any 20 MHz bandwidth from 400 to 2900 MHz to enable output power with frequency to be accurately measured. The cable load that terminates the coupler, which has return loss of 28 dB, has little if any effect on the coupling or "attenuation" value.

All components of the subsystem were chosen for their PIM characteristics. The flexible cable is hot-tin-dipped for negligible PIM. Since the signal level exiting the cable is low, only a standard termination is required to dissipate the remaining power, and PIM levels at this point are minimal. Although Type-N connectors are commonly used in most high-power applications, 7/16-DIN connectors were chosen because they withstand higher mating torque for more secure electrical connections with lower PIM, and are far more robust.

The latter attribute makes them better suited for measurement as well as field environments, as discontinuities of any type will invariably raise PIM. Only the coupled port employs a Type-N connector that is compatible with the input of the measurement equipment.

A benchtop PIM analyzer from Summitek Instruments (www.summitekinstruments.com) measured the model AT-A09's third-order PIM at levels of -178 to -180 dBc from 1870 to 1900 MHz (Fig. 2). Return loss is better than 25 dB from 400 to 2900 MHz, with similar results at other frequency ranges. Although rated for input power levels to 150 W CW, the unit was subjected to power levels as high as 180 W CW without degradation.

Attenuation accuracy is ±0.05 dB over any 20-MHz segment and ±0.7 dB from 400 to 2900 MHz. Model AT-A09 occupies four spaces (4U) in a 19-in. rack and operates from -20 to +50°C.

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