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PIM Reading Requires Care

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Wireless operators have invested a lot of money into 3G networks and will continue to do so for the next generation of technologies, whether it's HSPA+, LTE, or others. These investments are often overlaid on the existing network, utilizing existing tower equipment such as feeder coaxial cable lines and base station antennas. Operators are increasingly taking steps to avoid potential signal degradation that can result from overlays, especially when adding new frequency bands. One such concern is passive intermodulation (PIM) distortion, and it's enough of an issue that many operators are deploying PIM testing equipment to the field. But using PIM equipment correctly requires greater care than standard voltage standing wave ratio (VSWR) site sweeps or distance-to-fault transmission line testing.

Two or more signals need to be present for PIM to be created. PIM usually results from transmit signals mixing in the presence of an imperfect (or imperfectly installed) piece of hardware, causing interference signals in the receive band. PIM is a major problem when the base receiver is at the same frequency as the PIM distortion, and the PIM is of sufficient level to degrade the desired signal. The probability of PIM distortion being an issue is higher with next generation network broadband signals such as LTE and when new frequency bands have been added. Everything from a guy wire in the antenna's field or poorly torqued RF path connectors to poor quality components, rusting metal in fences or tower parts, or wear-and-tear can increase PIM to troublesome levels. All sources of PIM in the entire cell site combine to yield the total PIM distortion for the system.

The problem with taking PIM measurements is that the readings are especially sensitive to test equipment and surroundings that can increase PIM, resulting in false failures. Antennas are typically specified to have -150 dBc (-107 dBm) third order intermodulation levels although that can vary from model to model and from supplier to supplier. This level is specified when measured as a standalone unit in a factory or lab setting, when using two 20 Watt test signals and in a special chamber that uses absorptive material. The same measurement is very difficult to replicate in the field due to the need for a pristine RF environment.

At one recent field test, PIM of a BSA was recorded to be -123 dBm when pointed at a clear sky with no metal objects in the field of the antenna, and then dropped as low as -84 dBm when different objects were moved near the testing equipment. Forklifts, people with cell phones and metal objects, fences, site equipment, and even the weather can impact PIM readings. That is a good example of why understanding potentially contributing PIM sources, proper connectorization techniques, and how to conduct PIM testing most effectively is so important.

The ideal measurement is done on a clear day, away from other equipment, and with jumper cables and antennas known to be good (and not causing PIM themselves). Since connections are potential trouble points, minimizing the number of adapters is recommended, as is using cable with the same connector style as the equipment to be tested (7/16 DIN are preferred) to avoid the use of adapters. Unlike with VSWR sweeps, connectors must be properly torqued—not just hand-tightened—to take accurate measurements. We also recommend a total frequency system sweep and not just in fixed frequencies,



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which can cause fortuitous though misleading cancellation of PIM distortion. With non-swept frequency test equipment, you should repeat measurements at two or three frequencies. It is also important to avoid resistive load elements, braided cables, or worn-out adapters in testing equipment, which themselves can cause PIM.

Gaining experience and taking care with PIM testing techniques is important, just as is learning the proper installation techniques for avoiding excess PIM in the first place. One of the biggest contributors to disruptive PIM is poor connections due to improper cable preparation, incorrect tools, or inexperience. The best way to avoid PIM field failures is by limiting PIM disruption from the start.

In keeping with the Primus commitment to our customers of supplying only the highest quality products available, we are proud to present the information contained in this article as it reflects Andrew's ongoing commitment to providing the finest products applying their unparalleled engineering expertise. PIM is and will remain an important topic for Primus.

Primus President Michael Johnson wishes to thank the Andrew Corporation for its outstanding dedication to addressing numerous important industry issues such as PIM. Johnson adds that it is truly an honor to represent a company such as Andrew that serves the industry with the highest level of emphasis on quality products, systems performance, installation integrity and industry professionalism.