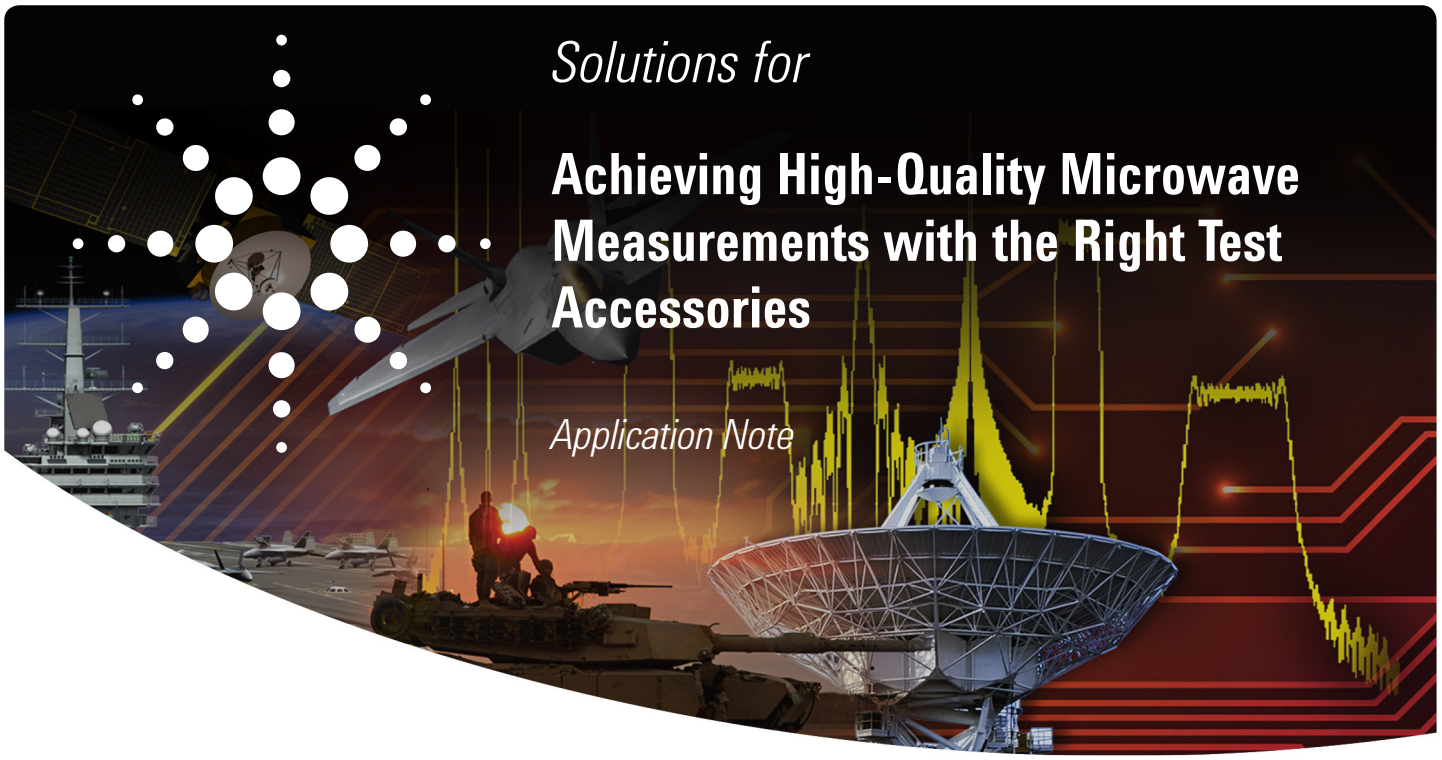

Solutions for

Achieving High-Quality Microwave Measurements with the Right Test Accessories

Application Note

Overview

RF and microwave test accessories—which can include everything from blocks, attenuators and couplers, to switches and system amplifiers—play an integral role in completing a test system. The accessories complement the system's instrumentation by helping to simplify test setups and maximizing the instrumentation's full potential. With high-performance instrumentation and accessories pushing the envelope of today's advanced high-frequency applications, it is now more crucial than ever for engineers to select the right test accessories for use in their test systems.

Problem

In the RF and microwave domain, high frequencies and stringent application specifications have become the norm, challenging engineers to be able to make precise measurements with accurate data and obtain repeatable results. Test accessories offer an ideal way for engineers to address these challenges. Using a wrong accessory will result in a weak link in the test system's measurement path, further complicating its setup and limiting its measurement ability. However, selection of the right test accessories, with the highest quality, will improve the test system's utility and automation, ensure an optimized, more reliable test setup, and allow engineers to achieve the highest quality microwave measurements.

Solution

The trick to selecting the right test accessory lies in knowing which accessory to use in a given application. Some of the more common test accessories and their key applications are as follows:

Test Accessory:
Electromechanical (EM) Switch

Application:
Increasing Efficiency

In signal routing schemes, EM switches enable multiple measurements with a single connection. The ability to test multiple devices-under-test (DUTs) with a single instrument or to make multiple types of measurements on a DUT maximizes the test system's throughput.

When selecting an EM switch, engineers must:

- Read the datasheet carefully. Watch for words like 'typical' or 'guaranteed' following a specification, which may indicate a need to investigate the specification further.
- Pick a switch with good reliability and a long operating life (specified by the number of cycles it can complete while still meeting performance/repeatability specifications).
- Determine the switch's true cost by breaking down its price into units based on its specified lifetime. Remember, having a test system go down to replace a switch can be a costly proposition. When working with non-latching switches, it may be worthwhile to break down the switch's cost based on power consumption.
- Select a switch with an effective solution to debris accumulation and therefore, better switch repeatability (Figure 1).

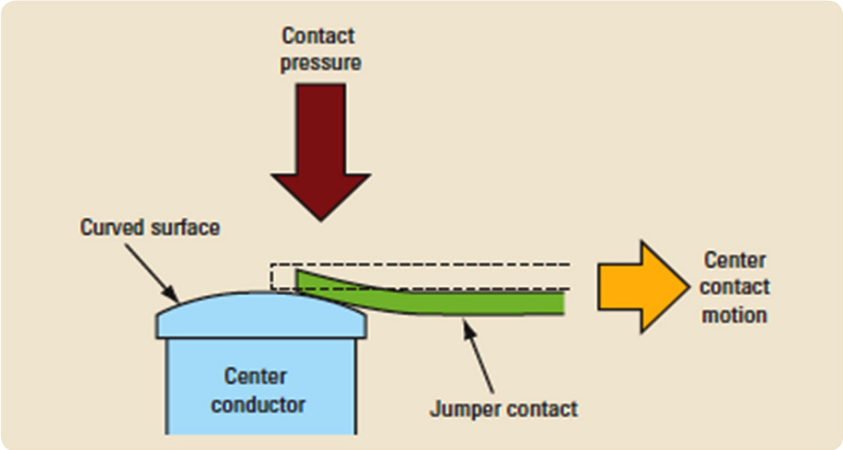

FIGURE 1: *Agilent switches employ a patented design with a curved top center conductor that produces friction between the jumper contact and center conductor during switch closure. The friction mimics a wiping action that removes contact point debris. Because of this wiping, Agilent is able to specify a switch repeatability of 0.03 dB (variation in insertion loss) over the guaranteed life of the switch.*

Test Accessory:
Step Attenuator

Application:
Enabling Reliable Signal Conditioning

A variable step attenuator ensures reliable signal conditioning by eliminating power nonlinearity and inaccuracies from the source. As an example, consider adding an external attenuator and directional coupler to a conventional test setup for a mobile receiver sensitivity test used to measure real-time power. Doing so enables easy one-time power calibration, allows the source to stay at a single power level, frees the user from power-level nonlinearity and accuracy issues from the source, and makes it easier to obtain accurate and calibrated low power levels.

Test Accessory:
Power Limiter

Application:
Protecting Investments

Power limiters with ESD provide engineers with an inexpensive way to protect their measurement system investments against high repair costs or significant test system downtime caused by damaged or mishandled instruments or components (Figure 2).

FIGURE 2: *Shown here is a typical application using a power limiter to protect an RF instrument. In this case, the input of a spectrum analyzer is protected from an inadvertent overload due to high-level signals from an antenna.*

Test Accessory:
RF Active Probe

Application:
Optimizing RF Circuit Design

An active RF differential probe provides an effective way for designers to optimize and troubleshoot their circuit designs. It can be used to measure a design's harmonics, power levels and frequency, as well as its modulation, to identify faulty or problem areas (Figure 3). When used with a high dynamic range signal/spectrum analyzer, the probe's high sensitivity and low distortion levels enable even the smallest signals to be detected. It can also be used with a signal source analyzer to measure the phase noise and jitter of a clock in a high-speed digital board design.

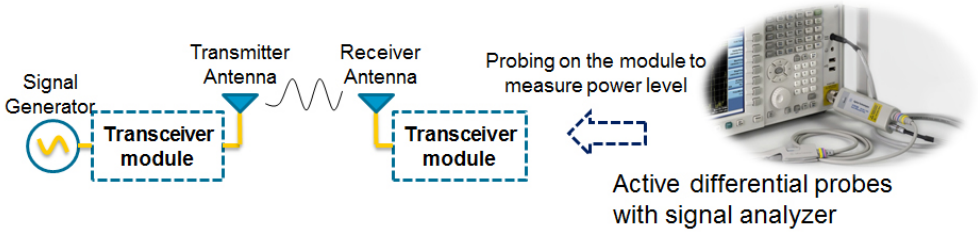

FIGURE 3: *An active RF differential probe can be used to perform general RF and microwave troubleshooting work, as shown in this example. With this solution, accurate troubleshooting in a greater dynamic range of the instrument is possible.*

Test Accessory:
RF Detector

Application:
Measuring Power

An RF detector is ideal for measuring power. As an example, consider the power measurement diagram in Figure 4. Here, the absolute power is measured by characterizing the detector with a power sensor and meter using a reliable source. The detector is connected to a source, which is swept across the frequency or power level of interest. The output voltage measured from the detector is then collected and plotted. Using the slope of the resulting graph, the power detected is calculated based on the measured voltage.

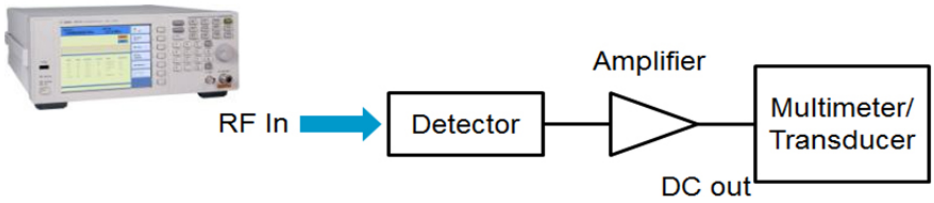

FIGURE 4: *Shown here is a simple block diagram of a power measurement. The method for calculating power, highlighted here, can also be used beyond the square-law region, where variations are repeatable and predictable for each diode family. Computer-controlled compensation compensates for any nonlinearity.*

Summary of Results

While use of low-quality RF and microwave test accessories can result in inefficient, unreliable test systems, use of the right accessories can ensure test system optimization and minimize measurement uncertainty. Moreover, use of high-quality test accessories helps engineers protect their investment in expensive instrumentation. The best way to achieve these goals is by purchasing accessories from a premium vendor with unmatched reliability and repeatability. The accessories should have a proven long operating life and require minimal maintenance throughout their lifetime. Additionally, the right accessory must be used for the right application in question. By following these tips, today's engineers can simplify their test setups and maximize their equipment's full potential to ensure the best possible measurement results.

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