Keysight Technologies
Achieve measurement accuracy and flexibility in your microwave test system – a modular approach

Application Note
A signal conditioning solution for design and verification of wideband MIMO signals

Increase measurement accuracy and flexibility in microwave test architecture with superior signal conditioning modules, particularly in wireless transceiver systems.

Abstract

The explosive growth of Wireless LAN is driving new IEEE WLAN standards that require very high throughput. In today’s WLAN, higher order modulation and an increased number of channels (MIMO) are common challenges faced by RF designers and engineers in maintaining measurement accuracy.

This application note describes how to enhance the measurement accuracy and flexibility in signal analysis by using the M9168C PXI programmable step attenuator module.

The M9168C provides precise attenuation as required with a known set of uncertainty. This ensures optimum signal quality delivery in various signal conditioning scenarios such as; overloading, gain compression, and distortion.

Introduction

Today’s wireless LAN readily enables distribution of high definition content in the home that must support high-speed and high-data rate streaming, and must also be able to mirror high definition video from PC tablets to smart TVs. These requirements bring forth the need to extend RF bandwidth (up to 160 MHz), more MIMO spatial streams (up to 8), multi-user MIMO, and high-density modulation (up to 256 QAM).

With this increased complexity in the corresponding test and measurement system, PXI has been one of the most rapidly adopted platforms, particularly in market segments that demand efficient but low cost-of-test solutions.

Application Overview

A step attenuator is a common approach to, or is generally used to, extend the attenuation range of test and measurement instruments. A common application would be to extend the output amplitude range of a microwave vector signal analyzer for wireless device signal analysis. Digital-modulation analysis is another application of the M9168C. The RF modulated carrier signal needs to be demodulated into its complex components for further vector-modulation analysis, where the digital data bits will be detected and recovered. Digital demodulation provides modulation quality measurements. Ideally, the measurement system will expose very subtle signal variations to translate signal quality information. Without the right combination of test instruments and accessories, the process of achieving accurate and precise measurements will become more elaborate and tedious, which inevitably leads to higher cost-of-test.

Solution

Keysight Technologies, Inc. is committed to providing best-in-class test solutions in a compact form factor that enables test system developers to achieve excellent levels of speed, performance, and flexibility via the PXI platform.

The M9168C is a programmable step attenuator module based on the PXI hybrid platform, operating from DC to 26.5 GHz with a guaranteed 0.03 dB insertion loss repeatability for each section throughout the 5 million cycles operating life. This signal conditioning module provides excellent attenuation accuracy across a wide operating temperature range to ensure precise measurements.

Generally, an electromechanical (EM) step attenuator is a preferred solution to increase the bandwidth of a signal analyzer than a solid-state step attenuator. An EM step attenuator ensures the lowest insertion loss at 0 dB state, lower standing wave ratio, and better linearity, and stability across a wider temperature range.
Solution details

The M9168C is specifically designed for fast data interfaces and it can be integrated with other test and automation modules into PXI, Compact PCI, and Hybrid chassis. Figure 2 shows the simplified block diagram of a wideband MIMO PXI vector signal analyzer. This solution consists of Keysight’s M9362A-D01 4-channel downconverter, M9202A 12-bit digitizer, M9302A LO, M9352A IF amplifier/attenuator, and M9168C RF attenuator modules for 1-4 measurement channels. When more channels are required, additional M9168C step attenuators and digitizer modules can be conveniently added to further expand the system capability, without the need to duplicate another full rack of instruments.

The RF attenuator is used to avoid overdriving the downconverter. With the limited dynamic range of hardware, every dB of attenuation counts. The built-in attenuators in the M9168C cover the attenuation range of 0 to 101 dB, at 1 dB step resolution. The 1 dB step size is crucial for signal demodulation, particularly for the 802.11ac standard testing which is heavily sensitive to SNR (signal-to-noise ratio).

With the increasing demand for high crest factors and even higher bandwidth within the wireless communication eco-systems, accurate power measurement systems may lead to steep increments in cost-of-test. By utilizing the M9168C attenuator module, the receiver system can be calibrated with a single accurate power measurement at higher power levels. The subsequent desired (lower) power levels can be sequentially controlled at a minimum of 1 dB step resolution, with calibration values provided at each attenuation value.

A minimum of 0.4 dB of characterized data accuracy is provided across the frequency range of DC to 26.5 GHz.

The M9168C is also bundled with a value-add feature which enables the user to track the cycle count (lifetime) of each of the attenuator sections. This information is crucial for engineers and technicians to plan out their test system preventive maintenance and downtime. Last but not least, with guaranteed 0.03 dB insertion loss repeatability throughout the operating life of up to 5 million cycles per section, precise measurement can be achieved, while reducing recalibration downtime substantially.

In summary, it is imperative that careful attention be placed when selecting the signal conditioning portion of the wireless transceiver system, as it will ultimately impact its overall accuracy, reliability, and cost-of-test.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Model</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>1-4</td>
<td>M9202A</td>
<td>PXI Express 12-bit wideband IF digitizer</td>
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<tr>
<td></td>
<td>M9362A-D01</td>
<td>PXIe microwave quad downconverter</td>
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<tr>
<td></td>
<td>M9352A</td>
<td>PXI hybrid amplifier/attenuator</td>
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<tr>
<td>1-4</td>
<td>M9168C</td>
<td>PXI programmable step attenuator module</td>
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<tr>
<td>1</td>
<td>M9302A</td>
<td>PXI local oscillator</td>
</tr>
</tbody>
</table>

Want to know more?

www.keysight.com/find/PXIattenuator

M9168C PXI programmable step attenuator, Data Sheet 5990-8586EN.

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Published in USA, August 2, 2014
5991-101BEN
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