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Modular VSA Pushes to 50 GHz

1. The M9393A modular vector signal analyzer consists of four separate PXIe modules—the M9214A digitizer, M9308A frequency synthesizer, M9365A downconverter, and M9300A frequency reference.

A 50-GHz PXIe vector signal analyzer is just one of the latest additions to a growing lineup of modular test instruments for RF/microwave signal generation and analysis.

MODULAR RF/MICROWAVE TEST instruments are quickly becoming popular among engineers due to their flexibility and substantial measurement capability in small packages. For the M9393A modular PXIe vector signal analyzer (VSA) from Keysight Technologies, the small size also applies to its wavelengths—its new, extended frequency range to 50 GHz (and continuous frequency sweeps from 3.6 to 50.0 GHz) can handle Ka-band commercial and satellite communications (satcom) testing.

The model M9393A PXIe VSA *(Fig. 1)* actually comprises four separate PXIe modules: an M9214A intermediate-frequency (IF) digitizer, M9308A frequency synthesizer, M9300A frequency reference, and M9365A frequency downconverter. Together, they fit with room to spare within a PXI/PXIe chassis. When using instrument modules (e.g., AXIe or PXIe modules), performance can be modified by adding, say, an M9169E switchable attenuator to increase the M9393A's measurement dynamic range.

The VSA's frequency reference is based on an internal 10-MHz oven-controlled crystal oscillator (OCXO) and 100-MHz phase-locked loop (PLL). It provides stable outputs at 10 and 100 MHz, including directly from the OCXO (and typically at levels of +9.5 dBm or higher).

The frequency-reference module also accepts clock signals from an external frequency reference, from 1 to 110 MHz at levels of 0 to +10 dBm with a nominal lock range of ±1 ppm. The 100-MHz output from the frequency reference feeds the M9308A frequency synthesizer, which employs a PLL to generate RF/microwave signals from 2.85 to 9.00 GHz along with a series of dividers and multipliers to broaden the frequency range for input to the M9365A frequency downconverter.

The M9214A IF digitizer accepts IF signals from the M9365A. The digitizer is stabilized by 100-MHz signals from the frequency reference. It includes a high-performance, high-resolution analog-to-digital converter (ADC) supported by an FPGA and custom ASIC for advanced signal processing. The M9214A includes lots of dedicated random-access memory (RAM) for storing waveform data.

RANGE OF RANGES

Thanks to its modular configuration, the M9393A VSA is available in a number of different versions, including five frequency ranges, to meet the spectral needs of users across the board: 9 kHz to 8.4 GHz, 9 kHz to 14 GHz, 9 kHz to 18 GHz, 9 kHz to 27 GHz, and 3.6 to 50.0 GHz. All feature impressive 0.01-Hz frequency tuning resolution. These compact analyzers can also be specified with different maximum analysis bandwidths and final IF bandwidths available for studying different types of modulated signals. For example, analyzers with maximum available analysis bandwidths of 40 MHz have final IF bandwidth of 240 MHz. For 100-MHz max bandwidth, final IF bandwidth is 300 MHz, and 160-MHz final bandwith has final IF bandwidth of 326 MHz.

The VSAs also come with a bypass option (WB1), which provides a wide 800-MHz nominal IF output bandwidth to be digitized by an external wideband digitizer. It analyzes signals (and interference) occupying extremely wide portions of spectrum. All instruments have 1-Hz minimum resolution bandwidth.

2. The model M8196A arbitrary waveform generator extends to 92 Gsamples/s and produces signal 3-dB bandwidths to 32 GHz in a single AXIe module.

DIGGING INTO THE SPECS

The VSAs handle RF input signals at levels to +30 dBm, with an input signal dynamic range of –170 to +30 dBm without an additional preamplifier. They offer 0.01-db amplitude resolution with ±0.03-dB amplitude repeatability without a preamplifier. The amplitude of IF outputs is well controlled with typical IF flatness of ±0.16 dB across a 40-MHz IF bandwidth; ±0.21 dB across a 100-MHz IF bandwidth; and ±0.34 dB across a 160-MHz IF bandwidth for signals from 9 kHz to 13.6 GHz. Above that frequency, typical IF flatness is ±0.17 dB across a 40-MHz IF bandwidth; ±0.31 dB across a 100-MHz IF bandwidth; and ±0.47 dB across a 160-MHz IF bandwidth.

The VSAs also offer tightly controlled phase characteristics, with excellent IF phase linearity, for evaluating signals with phase-based modulation. For 9-kHz to 13.6-GHz signals, typical IF phase linearity is ±0.81 deg. across a 40-MHz IF bandwidth; ±1.34 deg. across a 100-MHz IF bandwidth; and ±1.56 deg. across a 160-MHz IF bandwidth. For signals above 13.6 GHz, typical IF phase linearity is ±1.69 deg. across a 40-MHz IF bandwidth; ±2.56 deg. across a 100-MHz IF bandwidth; and ±3.59 deg. across a 160-MHz IF bandwidth.

3. The model M9420A vector transceiver (VXT) generates and analyzes I/Q signals with coverage as wide as 60 MHz to 6 GHz in a single three-slot-wide PXIe module.

The displayed average noise level (DANL) remains low, even when not using the available noise correction. Without noise correction or additional preamplification, the M9393A achieves typical DANL of –129 dBm/Hz from 9 to 300 kHz; –145 dBm/Hz or better from 300 kHz to 13.6 GHz; and –122 dBm/Hz or better from 13.6 to 27.0 GHz. When using the noise correction (and no preamplification), the DANL typically drops to –135 dBm/Hz from 9 to 300 kHz; –156 dBm/Hz or better from 300 kHz to 13.6 GHz; and –133 dBm/Hz or better from 13.6 to 27.0 GHz. For higher-frequency operation through 50 GHz, achieved with the model M9169E frequency extension module (option FRX), the typical DANL is –153 dBm/Hz from 13.6 to 34.0 GHz; –151 dBm/Hz from greater than 34.0 GHz to 45 GHz; and –147 dBm/Hz from greater than 45 GHz to 50 GHz.

Thanks to the PXIe format's flexibility, dynamic measurement range can be increased at any time when adding an optional preamplifier or electronic attenuator. One such example is the M9169E electronic step attenuator, which provides 0 to 42 dB attenuation in 0.25-dB steps from 9 kHz to 27 GHz (higher-frequency versions will be available). It features typical amplitude accuracy of ±0.71 dB from 100 kHz to 1 MHz; ±0.49 dB from 1 to 20 MHz; and ±0.40 dB or better across the remainder of the frequency range to 27 GHz.

The M9393A VSAs boast fast frequency-switching speeds that work with the high-speed PCIe control interface of the PXIe format to achieve fast, large-volume production testing. Its nominal frequency-switching speed is 5 ms, resulting in fast frequency sweeps for high-speed production testing. In addition, option UNZ is available for switching speeds faster than 175 µs for arbitrary changes in frequency. But such switching speed does not compromise spectral purity, with the VNAs exhibiting typical phase noise of –105 dBc/Hz offset 1 kHz from a 1-GHz carrier; –110 dBc/Hz offset 10 kHz from the same carrier; and –134 dBc/Hz offset 1 MHz also from the same 1-GHz carrier.

Other high-frequency test instruments recently developed by Keysight in the AXIe or PXIe modular formats include the versatile M8196A arbitrary waveform generator (AWG) and the more recent M9420A PXIe vector transceiver. Both complement the M9393A with added signal-generation and analysis capabilities. The M8196A is housed in a one-slot-high *(Fig. 2)* AXIe module with 512 ksamples of waveform memory per channel. Capable of 83 to 92 Gsamples/s, the source can generate analog signals across a typical 32-GHz, 3-dB bandwidth. The waveform generator has 8-b vertical resolution and built-in frequency and phase response calibration for well-controlled output signals.

Versions of the AWG come with one, two, and four channels, with single-ended or differential outputs (single- and dual-channel models can be upgraded to four channels via software licenses). The AXIe format supports tight synchronization of multiple output signals, with ±7-ps typical skew between any pair of output signals. For pulsed waveforms, the generator delivers typical rise/fall time of 9 ps. The spectral purity is quite good, with typical phase noise of –110 dBc/Hz offset 1 kHz from a 1-GHz sine wave; –118 dBc/Hz offset 100 kHz from a 1-GHz sine wave; and –138 dBc/Hz offset 1 MHz from a 1-GHz sine wave.

In terms of modular instrumentation innovation, the model M9420A vector transceiver (VXT) fits within a single three-slot-wide PXIe module *(Fig. 3)*. With versions for frequency coverage as wide as 60 MHz to 6 GHz, it provides a maximum 160-MHz in-phase/quadrature (I/Q) bandwidth for both vector signal generation and analysis. As many as four VXT modules can fit in a single 18-slot PXI chassis, providing densely packed measurement capability for multichannel systems and components. mw

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