

E6416A Multi Transceiver RF Test Set

Phase and Time Coherent RF Test Platform for Quick and Easy RF MIMO and Massive MIMO Beamforming Measurements

E6416A Multi Transceiver RF Test Set (MTRX) is a scalable RF test platform hardware that provides 4 or up to 16 ports for Vector Signal Analysis (VSA) and 4 or up to 16 ports for Vector Signal Generation (VSG) in one instrument. It features advanced digital MIMO and massive MIMO signal weighting matrix and pass-through connectivity options for end-to-end beamforming test of network and device(s).

VSA measurements are available for analysis through Keysight's PathWave Vector Signal Analysis (89600 VSA), Keysight Wireless Analyzer WaveJudge software, or leveraging an open IQ file format. VSG waveforms are configured with Keysight PathWave Signal Generation software.



5G MIMO and beamforming RF measurements in the FR1 frequency range

- Create and analyze:
 - Downlink RF/L1 beams and signals
 - Uplink RF/L1 beams and signals
- Measure all beams and signals instantly in uplink and downlink
- Pinpoint beamforming problems
- Uplink SRS scheduling tests
- Perform single- and multi-user beamforming test
- Scale up your MIMO tests with flexible product configurations

The E6416A provides a platform for all RF MIMO and beamforming measurements, enabling both RF conducted test bench and RF Over-the-Air testing in anechoic rooms.

The MTRX platform addresses testing needs in MIMO and massive MIMO radio unit and base station design workflows from antenna array calibration, RF/L1, and L1/L2 to full-stack testing of beamforming performance with a live network base station and user devices.

Keysight delivers MTRX based massive MIMO RF beamforming solutions for both Open RAN Radio Units (O-RU) and complete base station tests.

Definitions and Conditions

Specifications

Specifications represent warranted performance of a calibrated instrument that has been stored for a minimum of 6 hours within the operating temperature of 18 to 28 °C, unless otherwise stated, and after a 60-minute warm-up period. The specifications include measurement uncertainty. Data represented in this document are specifications unless otherwise noted.

Typical

Typical describes additional product performance information that is not covered by product warranty. It is performance beyond specifications that 80 percent of the units exhibit with a 90 percent confidence level at room temperature (approximately 23 °C). Typical performance does not include measurement uncertainty.

Nominal

Nominal values indicate expected performance or describe product performance that is useful in the application of the product but are not guaranteed as per our specifications.

Measured

Measured (meas.) describes an attribute measured during the design phase for purposes of communicating expected performance, such as amplitude drift vs. time. This data is not warranted and is measured at room temperature (approximately 23 °C).

All the above apply when using the instrument in its default settings and without other applications or 3rd party software running simultaneously with the equipment control software on the equipment integrated PC windows operating system.

Vector Signal Analyzer in MTRX E6416A

Frequency	Performance	Conditions
Frequency range	Opt-R60 450 – 6000 MHz Opt-R72 450 – 7250 MHz Opt-R04 30 – 450 MHz (requires -R60 or -R72)	Operation below 30 MHz or above 7250 MHz not specified. Options R60, R74 and R04 are factory installation only
Frequency reference	10MHz, nominal. Maximum frequency drift ± 0.1 ppm over 2 years	Warm-up time 30min
Maximum Instant Analysis Signal bandwidth	100 MHz BW	30 – 7250 MHz (operation below 30 MHz not specified). Opt-010, Opt-020.
	200 MHz BW	30 – 7250 MHz (operation below 30 MHz not specified). Opt-020.
Amplitude	Performance	Conditions
CW Input reference level range	+25 dBm ... -20 dBm	100 MHz – 7250 MHz
	+7 dBm ... -20 dBm	30 - 100 MHz
Absolute maximum rating	+27 dBm RMS / 36 dBm peak, DC 10 V	100 MHz – 7250 MHz
(Exceeding the absolute maximum ratings may cause permanent damage for the unit)	+7dBm RMS / 16 dBm peak, DC 10 V	30 - 100 MHz
CW input power accuracy	± 0.5 dB, typical at port center frequency (*)	At input reference level range
Input reference level setting resolution	0.1 dB	
Displayed Average Noise Floor (DANL)	-163 dBm/Hz (measured)	RF input range setting -20dBm
VSWR	< 1.8 nominal	30 to 1000 MHz
	< 1.3 nominal	1000 to 3000 MHz
	< 1.5 nominal	3000 to 7500 MHz
Port-to-port isolation, VSA to VSA	> 100 dB, typical	Full-Duplex TRX port to Full-Duplex TRX port.
Port-to-port isolation, VSG to VSA	> 100 dB, typical	Half duplex TX port to Half duplex RX port.
Spectral	Performance	Conditions
Amplitude spectral flatness	± 0.5 dB, typical	100 MHz bandwidth
	± 1.5 dB	200 MHz bandwidth
	± 0.7 dB, typical	
Sample rate	250 MHz	Signal BW up to 200 MHz
Multi-port VSA	Performance	Conditions
Number of VSAs	Available configurations from factory 4, 8, 12 or 16	Each TRX module has 1 VSA.

(*) Read out accuracy from VSA software installed on MTRX instrument.

Vector Signal Generator in MTRX E6416A

Frequency	Performance	Conditions
Frequency range	Opt-R60 450 – 6000 MHz Opt-R72 450 – 7250 MHz Opt-R04 30 – 450 MHz (requires -R60 or -R72)	Operation below 30 MHz or above 7250 MHz not specified. Options R60, R74 and R04 are factory installation only.
Frequency reference	10 MHz, nominal. Maximum frequency drift ± 0.1 ppm over 2 years	Warm-up time 30 min
Maximum Instant Playback Waveform Signal bandwidth	100MHz BW	30 – 7250 MHz (operation below 30 MHz not specified). Opt-010, Opt-020.
	200MHz BW	30 – 7250 MHz (operation below 30 MHz not specified). Opt-020.
Amplitude	Performance	Conditions
CW output level range Full Duplex port (TRX port)	TRX port 0 dBm ... -100 dBm	
CW output power accuracy Full Duplex port (TRX port)	$< \pm 1.5$ dB down to -100dBm $< \pm 0.3$ dB, typical when RF output level > -40 dBm	At center frequency +1MHz
Absolute maximum rating Full Duplex port (TRX port)	+27 dBm RMS / +36 dBm peak (reverse) DC 10 V	100 MHz – 7250 MHz
	+7 dBm RMS / +16 dBm peak (reverse) DC 10 V	30 – 100 MHz
CW output level range Half Duplex port (TX port)	TX port +10 dBm ... -100 dBm	
CW output power accuracy Half Duplex port (TX port)	$< \pm 1.5$ dB down to -80dBm $< \pm 0.3$ dB, typical when RF output level > -30 dBm	At center frequency +1MHz
Absolute maximum rating Half Duplex port (TX port)	+16 dBm peak (reverse) DC 10 V	100 MHz – 7250MHz
	+10 dBm peak (reverse) DC 10 V	30 - 100 MHz
Output level setting resolution Full Duplex/Half Duplex port	0.1 dB	
VSWR	< 1.8 nominal	30 to 1000 MHz
	< 1.3 nominal	1000 to 3000 MHz
	< 1.5 nominal	3000 to 7500 MHz
Port-to-port isolation, VSG to VSG	> 100 dB, typical	Full-Duplex TRX port to Full-Duplex TRX port.
Port-to-port isolation, VSG to VSA	> 100 dB, typical	Half duplex TX port to Half duplex RX port.
Spectral	Performance	Conditions
CW in-channel spurious	> 50 dB, typical	30 MHz – 1 GHz
	> 60 dB, typical	1 GHz – 7250 GHz
Amplitude Spectral flatness	± 0.5 dB, typical	100 MHz bandwidth
	± 1.5 dB ± 0.7 dB, typical	200 MHz bandwidth
Output noise floor	< -170 dBm/Hz, typical	output level ≤ -40 dBm
	< -160 dBm/Hz, typical	below 30 MHz, output level ≤ -40 dBm
Sample rate	250 MHz	Signal BW up to 200 MHz
Multi-port VSG	Performance	Conditions
Number of VSGs	Available configurations from factory 4, 8, 12 or 16	Each TRX module has 1 VSG waveform source.

(*) Exceeding the absolute maximum ratings may cause permanent damage for the unit.

Instrument Features

Note some instrument features may require specific hardware configuration, options or software application.

Number of TRX modules	Factory configurations 4, 8, 12 or 16 TRX modules.
RF ports per TRX	1 Full-Duplex/Half-Duplex TRX/RX port (SMA female, 50 ohm nominal) 1 Half-Duplex TX RF port (SMA female, 50 ohm nominal)
RF local oscillators in E6416A	2, 4 or 8 independent RFLO's.
Signal routing and weighting matrix	Waveform source to TRX/TX port. TRX port to TRX/TX port (pass through): - SISO signal routing and weight (i;j) - MIMO signal routing and weight matrix (i;j)
VSA signal capture length	Up to 1000 ms per each TRX module (250MSa).
VSG waveform length	Up to 1000 ms per each TRX module (250MSa).
Phase and Amplitude calibration	Integrated phase and amplitude calibration.
Remote control	ATE SCPI commands via Ethernet connection
Time base	Standard frequency reference 10MHz, nominal. Maximum frequency drift $\pm 0.1\text{ppm}/2$ years. Warm-up time 30 min
VSA, VSG triggering	Hardware trigger C3/C4 (LVTTTL). RF input power burst
	VSA trigger offset range -400 ms to 500 ms.
	Waveform playback trigger delay set range from 5 us ... 1000 ms
10 MHz reference	10 MHz reference IN, BNC female 50 ohm. 10 MHz reference OUT, BNC female 50 ohm.
Integrated PC	Windows OS. Hard Disk mass storage memory 1TB (removable SSD)

Instrument Interfaces

Interface	Connector type, signal type	Absolute maximum ratings (*)
TRX (in/out) RF ports, Full Duplex 2, 4 ... 16 (even port ID)	Connector type: SMA female Nominal impedance: 50 ohm	100 – 7250MHz : +27 dBm RMS, +36dBm peak 30 - 100 MHz : +7 dBm RMS, +16 dBm peak.
TX (out) RF ports, Half Duplex 1, 3 ... 15 (odd port ID)	Connector type: SMA female Nominal impedance: 50 ohm	100 – 7250MHz : +16 dBm peak (reverse) 30 - 100 MHz : +10 dBm peak (reverse).
Sync in C1, multi MTRX operation	Connector type: BNC female LVTTTL : 0 ... +3.3 VDC, nominal	0 / +3.8 VDC
Sync out C2, multi MTRX operation	Connector type: BNC female LVTTTL : 0 ... +3.3 VDC, nominal	0 / +3.8 VDC (reverse)
VSA, VSG trigger port C4	Connector type: BNC female LVTTTL : 0 ... +3.3 VDC, nominal	0 / +3.8 VDC
Control IO ports C3, C5...C7 Reserved for future use.	Connector type: BNC female LVTTTL : 0 ... +3.3 VDC, nominal	0 / +3.8 VDC
System reference (internal only)	Connector type: BNC female LVTTTL : 0 ... +3.3 VDC, nominal	0 / +3.8 VDC
10 MHz Ref IN	Connector type: BNC female Nominal impedance: 50 ohm	+15dBm
10 MHz Ref OUT	Connector type: BNC female Nominal impedance: 50 ohm	+15dBm (reverse)
SFP+	Digital interface 1 (for future use)	
IOIOI	Digital interface 2 (for future use)	
LAN	Gigabit LAN, 10/100/1000 Base-T connector for LAN connectivity	
USB	USB connectors (6) for external keyboard, mouse, and memory	
DisplayPort	DisplayPort connectors (2) for external displays	
AC input (power plug)	1 x 110 or 1 x 230 VAC, 50/60 Hz, nominal Range 100 – 240 VAC	264 VAC 50/60 Hz

(*) Exceeding Absolute maximum ratings may cause permanent damage for the instrument. Absolute maximum values are not operating values.

Dimensions, Power Supply and Environmental Conditions

Feature	Specification	Conditions
Dimensions	Height 293 (mm) x Width 435 (mm) x Depth 610 (mm).	
Power supply ratings	Voltage 1 x 110/230 VAC, 50/60 Hz, nominal. Range 100 – 240 VAC Current consumption 100VAC 1 x 15 A max, 200VAC 1x 10A max.	
Power consumption	1500 W max	16 TRX modules
Operating temperature	+18 to +28 °C	Rate of change of temperature <0.5 °C/min 5% to 80% non-condensing relative humidity
Storage temperature	25 ... +70°C, unventilated enclosures	After transportation or storage, the temperature of the device must be stabilized at least 6 hours before switching the power on to prevent condensation.

5G NR Performance Characteristics

Feature	Specification	Conditions
Measurement (VSA)		
VSA residual EVM 256QAM	< 0.35% (measured)	-10 dBm input, 100 MHz bandwidth, RF bands 410 MHz – 7125 MHz
Source (VSG)		
VSG residual EVM 256QAM	<0.35% (measured)	-10 dBm output, 100 MHz bandwidth, RF bands 410 MHz – 7125 MHz

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