# MIMO

- Ideal for antenna research, 802.11n WLAN, 802.16e mobile WiMAX Wave 2, and LTE

**Excellent Performance**

- 40MHz bandwidth
- High performance platforms, 2820 SISO EVM -40dB (40MHz BW, 5.8GHz - characteristic)
- ±1ns signal sampler synchronization
- <±1ns Waveform ARB Alignment
- <1° peak-to-peak RF-carrier phase jitter

**Flexible**

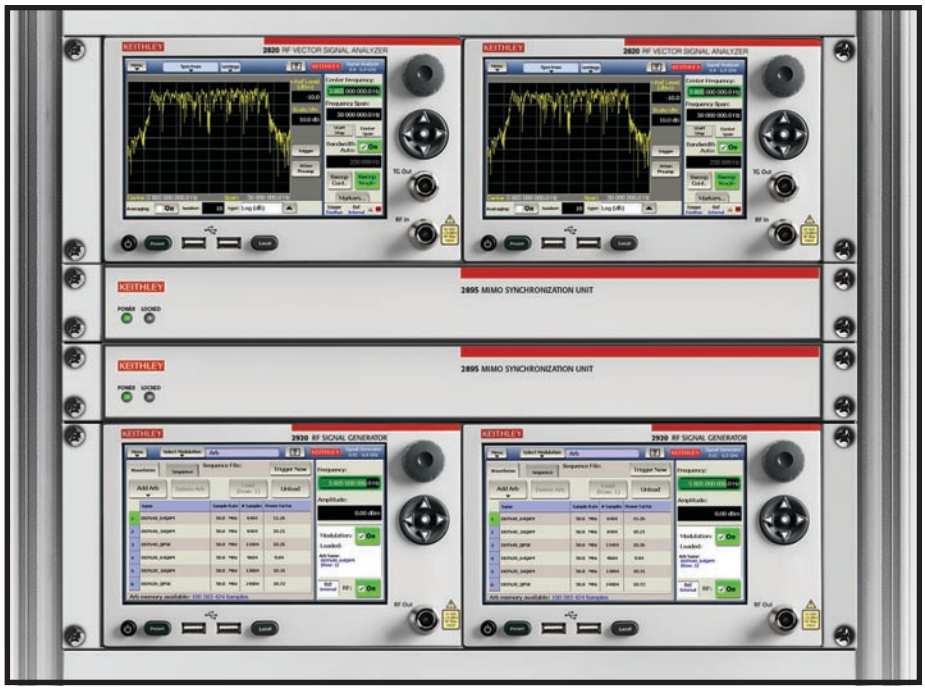
- Two-, three-, four-, or up to 8-channel configurations
- Standalone MIMO-ready Vector Signal Generators or Analyzers can be reconfigured to any MIMO configuration up to 8×8 using the Model 2895 MIMO synchronization unit
- MIMO signal generation and analysis with Model 290101 v3.0 SignalMeister
- Ideal for 802.11n WLAN and 802.16e mobile-WiMAX Wave 2

LXI

**APPLICATIONS**

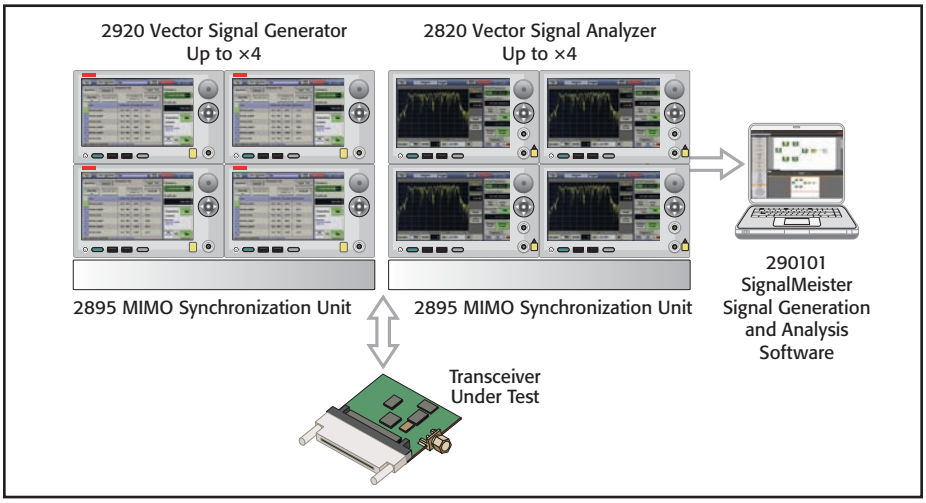
- Technology research
- Product development and production test of:
  - Wireless equipment
  - Modules and sub-assemblies
  - RFIC devices

# MIMO RF Signal Analysis and Generation Test Systems and Software




The System 2800-MIMO RF Signal Analyzer and System 2900-MIMO RF Signal Generator are high performance MIMO test systems designed to meet the requirements of 802.11n WiFi and 802.16e mobile-WiMAX Wave 2 multi-input, multi-output communications standards. Each system can be configured into two, three, four, or up to eight channels with 40MHz signal bandwidth using the Model 2820 RF Vector Signal Analyzer or Model 2920 RF Vector Signal Generator instruments. These instruments are MIMO-ready with the hardware connections and firmware built into every instrument.

The MIMO systems can be initially configured as a 2×2 system then upgraded at a later date to three four, or up to eight channels by adding standard Model 2820 or Model 2920 instruments. Moreover, the instruments need not be dedicated to a MIMO system. They can be configured for use either in a




**The System 2800-MIMO and System 2900-MIMO can be configured into high-performance two-, three-, four-, or up to eight-channel systems to test WiFi, WiMAX, and other MIMO devices and equipment.**

Signal analysis and generation for RF communications testing

RF/MICROWAVE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# MIMO

## Ordering Information

**System 2800-MIMO:**

**2820** RF Vector Signal Analyzer (2, 3, 4, or 8 units)

**2895** MIMO Synchronization Unit

**System 2900-MIMO:**

**2920** RF Vector Signal Generator (2, 3, 4, or 8 units)

**2900-ARB-40** Arbitrary Waveform Generator, 40MHz bandwidth

**2900-ARB-80** Arbitrary Waveform Generator, 80MHz bandwidth

**2895** MIMO Synchronization Unit

## Optional Software and Licenses

**2800-80211**
WLAN 802.11a-b-g-j-n SISO Signal Analysis Personality

**2900-80211-PC**
SignalMeister™ License for 802.11a-b-g-j WLAN

**2900-80211-N-PC**
SignalMeister License for 802.11n SISO & MIMO WLAN

**2900-80216-E-PC**
SignalMeister License for 802.16e-2005 mobile-WiMAX

**290101**
SignalMeister RF Communications Test Toolkit

Contact your local Keithley sales representative for the latest information on new personalities and software.

## Accessories Supplied

AC power cable; RF, clock, and synchronization cables to connect up to four Model 2820 or 2920 units; and Quick Start Guide.

# MIMO RF Signal Analysis and Generation Test Systems and Software

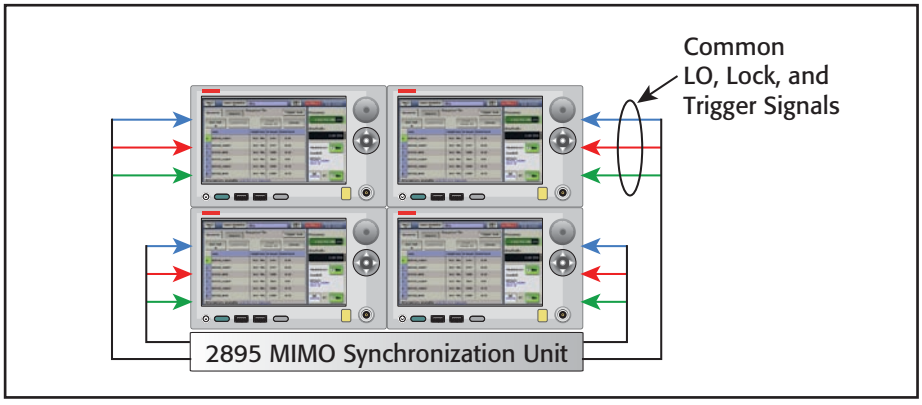
MIMO system or as stand-alone SISO (single-input, single-output) instruments by selecting the configuration in firmware and changing a few rear-panel cables.

The Model 2895 MIMO Synchronization Unit provides synchronized signals to the system instruments. This gives the system a highly precise and stable alignment between up to eight signal analyzers or signal generators.

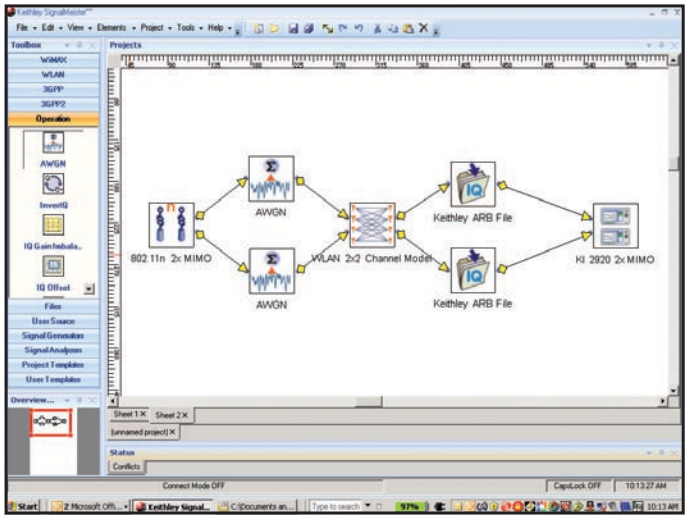
### Precise and Stable Synchronization

The MIMO systems are designed to have a stable RF carrier and a precise signal sampler alignment between all instruments in the system. The Model 2895 MIMO Synchronization Unit distributes a common LO (local oscillator), common clock, and precise trigger to all the signal analyzers or generators connected in the system. This high alignment enables the system to make accurate and repeatable measurements of OFDM (orthogonal frequency-division multiplexing) MIMO signals.

The RF carrier's phase of all instruments in each system is synchronized with one another without the limitations of using a phase-locked loop. The RF carrier phases have less than one degree peak-to-peak phase jitter between any two instruments. Additionally, the signal samplers of the MIMO system instruments are precisely aligned. The system has a maximum sample time difference of 1ns and peak-to-peak sampler jitter of less than 1ns between any two instruments.




**Precise and stable synchronization is achieved by providing common LO, common clock, and precise trigger signals to all of the signal analyzer or signal generator instruments.**




**MIMO signals are easy to create, utilizing ready-made signal libraries with signal impairment elements to create a variety of distortions including channel distortion.**

# MIMO RF Signal Analysis and Generation Test Systems and Software

## RF Communications Test Toolkit

The Model 290101 v3.0 SignalMeister RF Communications Test Toolkit can be used for single- or multi-channel signal creation and analysis in WiMAX 802.16e Wave 2 and WLAN 802.11n MIMO communications systems. It can also create channel conditions such as the 802.11a, b, g, j, and n channel models, create impairments to model non-ideal transmitter conditions, and perform simulation studies without the use of the actual hardware. The GUI interface allows users to quickly and easily configure systems with drag-and-drop block diagrams. Through the LXI-LAN interface, it can control up to eight Model 2820 VSAs and Model 2920 VSGs. For more information, see the data sheet for the Model 290101 v3.0 SignalMeister RF Communications Test Toolkit.

## Production Test Systems

Production testing of MIMO devices usually calibrates and tests the characteristics of each individual radio using a SISO test system. This reduces test system cost, though can increase total test time. Each radio is tested sequentially with the other radios in an inactive state.

The Model 2820 RF Vector Signal Analyzer and Model 2920 RF Vector Signal Generator are used with a multiplexer switch to connect to each of the DUT radio transceivers. The multiplexer may have the capability to connect and test more than one DUT in the test fixture, provide signal conditioning elements, or both.

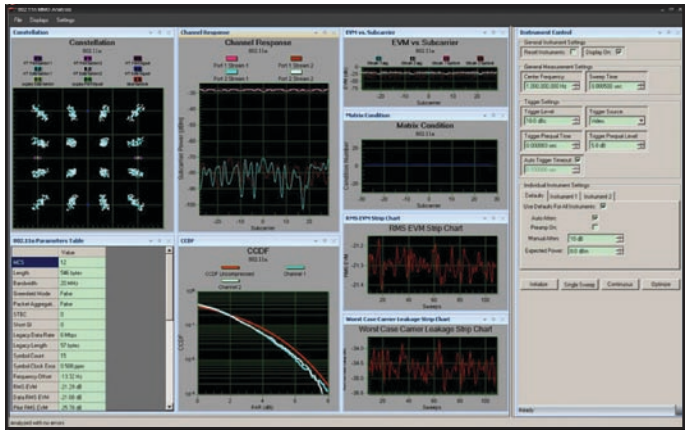
MIMO measurements are not commonly made on every device produced. An example is crosstalk between radios, which requires testing with all the radios in an active state. These characteristics are assumed to be set by design. MIMO measurements are made on production samples to ensure production process constancy.

## Test Instrumentation

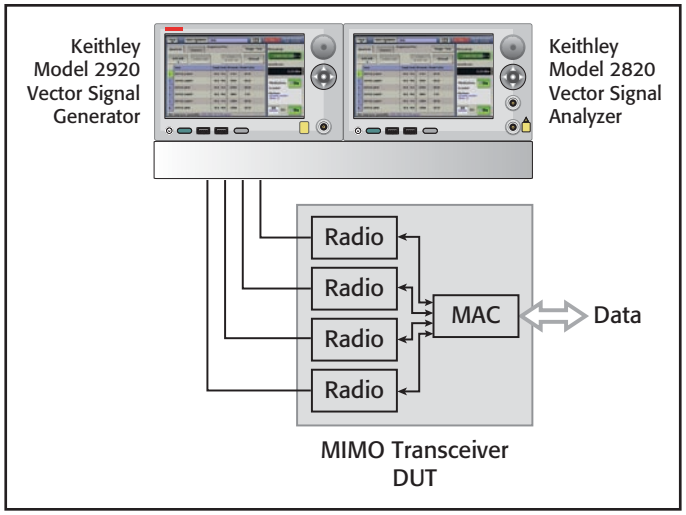
The Model 2820 RF Vector Signal Analyzer and Model 2920 RF Vector Signal Generator are mid-performance test instruments designed for R&D and production testing of modern RF communications equipment and devices. They are built on a next-generation instrument platform that uses state-of-the-art RF and DSP (digital signal processing) technology. This gives them the capability to measure and generate RF signals rapidly without compromising accuracy and repeatability.

The DSP-based Software-Defined Radio architecture is both fast and flexible. Measurement of multiple signal types with up to 40MHz bandwidth is possible with one instrument pair that share a common architecture platform. These innovative technologies allow instruments to fit into a small package and have a price point that makes them the logical choice for many test applications.

The Models 2820 and 2920 are MIMO-ready and have the hardware and software required to configure them into a MIMO test system. They can be easily reconfigured as stand-alone test instruments or into a MIMO system. This flexibility is useful for those who do not want to dedicate a large investment to a MIMO system, yet want the capability to do so when necessary.



**The Model 290101 SignalMeister RF Communications Test Toolkit is a fast and powerful PC-based tool with an extensive measurement suite used to characterize WLAN, WiMAX, and MIMO communications systems using SISO and MIMO technologies.**




**The Models 2820 and 2920 are used in a SISO configuration with a switch multiplexer to test the individual transceiver radios of MIMO devices in production applications.**

# MIMO RF Signal Analysis and Generation Test Systems and Software

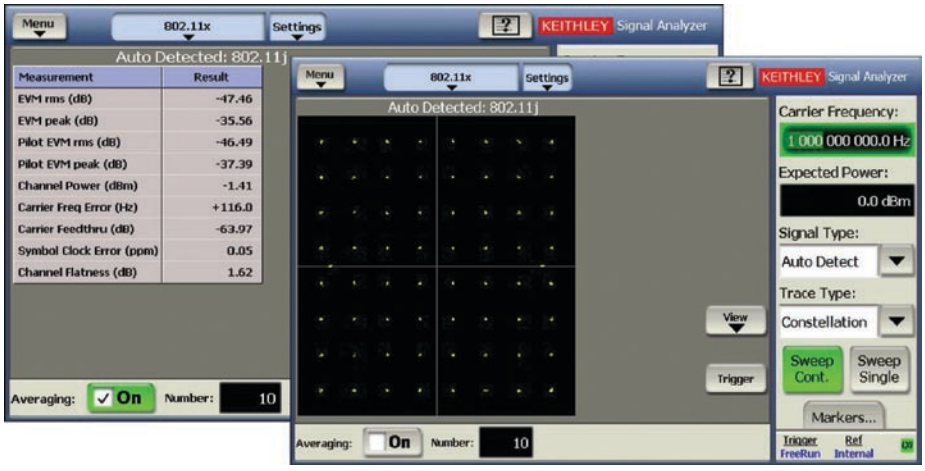


**The Models 2820 and 2920 feature DSP-based software-defined radio architecture to make accurate, high speed measurements for R&D and production test applications.**

The Model 2820 RF Vector Signal Analyzer with the optional Model 2820-80211 WLAN 802.11 Signal Analysis Personality can make measurements on all 802.11a, b, g, j, or n SISO signals. The personality can automatically detect the modulation type. It has several measurement displays, including constellation, EVM per channel, EVM per symbol, CCDF, and more. A full set of signal measurements are made in 17 to 50ms, depending on the signal type. The optional Model 2800-80216-E WiMAX Signal Analysis Personality also provides an extensive set of capabilities.

The Model 2920 has arbitrary waveform generator (ARB) options with 100 Mega-samples of waveform memory and up to 80MHz bandwidth to generate WLAN, WiMAX, and virtually any other test signal required. Many different signal waveforms can be simultaneously resident in the Model 2920's ARB memory. Switching between any two waveforms takes less than 3ms using a SCPI command and is nearly instantaneous using the ARB Sequence mode. Frequency switching time is 1.3ms when using the List mode or ARB Sequence mode and 3ms using a SCPI command. This results in ultra-fast test times of RF devices requiring multiple test frequencies, multiple test signals, or both.

Refer to the Model 2820 and 2920 datasheets for more detailed product information.

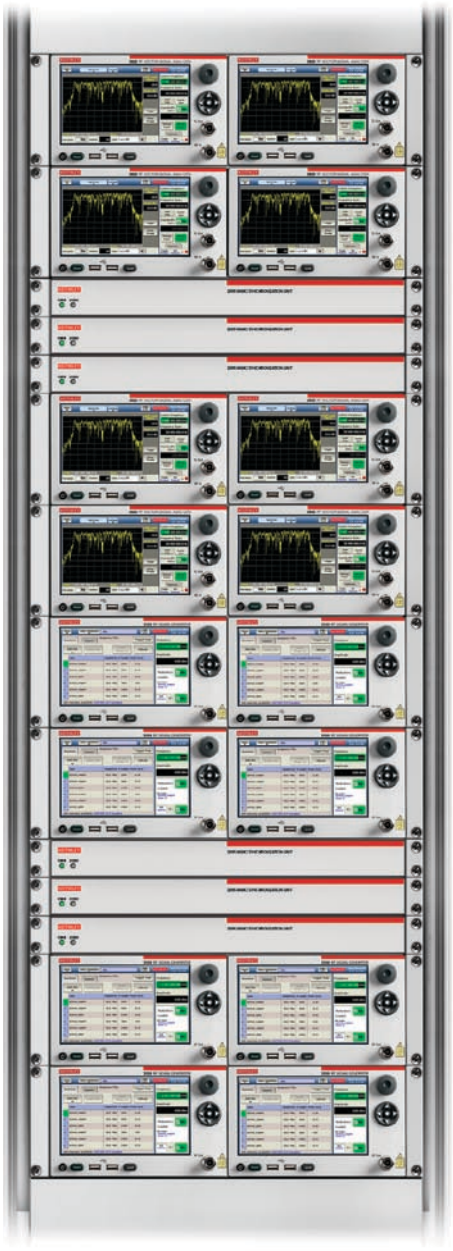



**The Model 2820-80211 WLAN Signal Analysis Personality option has a full set of measurement capabilities for high speed testing of wireless devices using 802.11a, b, g, j, and n signals. The same extensive capability is available for WiMAX signals with the Model 2800-80216-E WiMAX signal analysis personality.**


**Model 2895 rear panel. The unit comes with all connectors and cables to configure up to eight Model 2820 RF Vector Signal Analyzers or Model 2920 RF Vector Signal Generators.**

# MIMO

# MIMO RF Signal Analysis and Generation Test Systems and Software



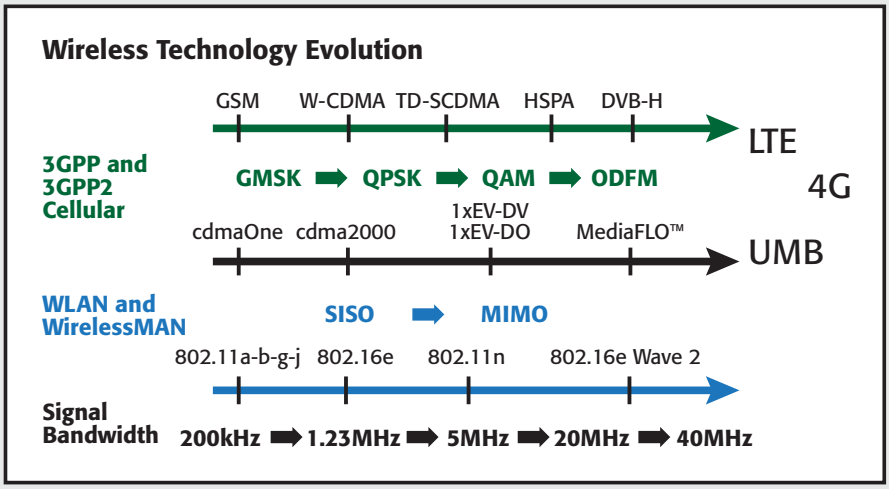
**Keithley's 8×8 MIMO solution uses the Model 2895 synchronization unit for a smooth upgrade path from existing MIMO systems to 8×8. Whatever size MIMO system you need, you can easily grow your system as needed up to 8×8, using existing instruments and synchronization units and adding more as needed.**

## Wireless Technology Evolution

The demand for wireless communications continues to increase. Mobility and cost are the main reasons. Wireless is the lowest-cost access for many services, including voice in third-world and developing countries. The number of new users and new services continues to increase. Wireless communication traffic is migrating from mostly voice to mostly data, and many new services require faster data rates.

With limited frequency spectrum, digital wireless technology has progressed rapidly over the past two decades to address these market demands. More spectrally-efficient modulation types and digital coding schemes are being used. These have increased signal bandwidths from 200kHz in the early 1990s to 40MHz today. New transmission methods are being deployed to further increase data rates, such as MIMO.

Keithley has the next-generation RF test instruments designed to meet the challenges faced by designers and manufacturers of today's wireless technologies and business conditions. They have the bandwidth to test today's wireless devices and are suitable for most future technologies. They have the flexibility to test multiple signals and can be used in test configurations for both SISO and MIMO testing. Additionally, they address the business requirements with the measurement accuracy needed to ensure high product quality and production yields as well as high test speed and low equipment cost needed to reduce test cost.




**The Models 2820 and 2920 have been designed to test wireless devices today and in the future that use OFDM, MIMO, and other technologies with signals up to 40MHz bandwidth.**

Signal analysis and generation for RF communications testing

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# MIMO

# MIMO RF Signal Analysis and Generation Test Systems and Software

## Modes of Operation

**SYSTEM 2800:** Multi-input system with up to four Model 2820 RF Vector Signal Analyzers.

**SYSTEM 2900:** Multi-output system with up to four Model 2920 RF Vector Signal Generators.

Note: All items are charateristics unless otherwise noted.

## System 2800 Multi-Input System Specifications

**TIME RECORD JITTER:** ≤250ps.

**RELATIVE PHASE JITTER OF SLAVE RELATIVE TO MASTER:** <±1 degree.

## System 2900 Multi-Output System Specifications

**WAVEFORM ARB ALIGNMENT:** <±1ns.

**WAVEFORM ARB JITTER:** ≤1ns.

**RELATIVE PHASE JITTER OF SLAVE RELATIVE TO MASTER [1]:** <±0.1 degree RMS.

**OFF POWER BETWEEN BURSTS: >0dBm:** <–90dBc. **<0dBm:** <90dBm.

**BURST RISE OR FALL TIMES (10–90%):** <200ns.

## 2895 Inputs and Outputs

### EXTERNAL FREQUENCY REFERENCE INPUT

**FREQUENCY LOCK RANGE:** 10MHz ±10Hz (1ppm).

**AMPLITUDE LOCK RANGE:** Input power range: 0 to +15dBm [2].

**IMPEDANCE:** 50Ω (characteristic), BNC connector.

### MIMO SYSTEM INTERCONNECTIONS

**LO IN:** Connects to the Master 2820 or 2920 LO output, SMA.

**LO OUT 1 THROUGH 4:** Provides distributed LO power to the Slave 2820s or 2920s and back to the Master 2820 or 2920, SMA.

**100Mz OUT 1 THROUGH 4:** Provides 100MHz Clock outputs to the Master and Slave 2820/2920s, SMB (m).

**SYNC IN 1 THROUGH 4:** Inputs from 2820 or 2920 SYNC Outputs. **Input Level:** 3.3V CMOS, SMB (m).

**SYNC OUT 1 THROUGH 4:** Provides SYNC signals to 2820 or 2920. **Output Level:** 3.3V CMOS, SMB (m).

### NOTES

1. Calculated from phase noise measurements.
2. For optimum phase noise performance, 0dBm ≤ Pin ≤ +10dBm.

## GENERAL SPECIFICATIONS

**POWER:** 100VAC to 240VAC, 50–60Hz (automatically detected), 40VA max.

**CE EMC COMPLIANCE:** EU Directive 89/336/EEC; EN 61326-1.

**CE SAFETY COMPLIANCE:** CE; EU Directive 73/23/EEC, EN 61010-1.

**CALIBRATION:** 2 years.

**ENVIRONMENT (for indoor use only):**
18°C to 28°C specified operating, unless otherwise noted.
0°C to 50°C operating survival, non-specified operation.
–25°C to 65°C non-operating (AC power off) storage.
**Altitude:** 2000 meters above sea level maximum specified operating.
**Cooling:** Convection, side intake, and exhaust.

**MECHANICAL VIBRATION AND SHOCK:** MIL-PRF-2880 CL3 random vibration, 3 axes.
Sine-Sweep test for resonances, 3 axes.
MIL-STD-810F 516.5 paragraph 4.5.7 procedure VI bench drop.

**GENERAL MECHANICAL CHARACTERISTICS:**
**Height:** 44mm (1.75 in.), 1U.
**Width:** 425mm (16.73 in.), half-rack.
**Depth:** 559mm (22.0 in.).
**Weight:** 4.5kg (10.0 lbs.).

### SPECIFICATION NOTES

Specifications describe the configuration or instrument's warranted performance. Typical and characteristic values are not warranted but provide additional information regarding performance of the Model 2895 and are provided to assist in a MIMO system configuration with Model 2820 RF Vector Signal Analyzers or Model 2920 RF Vector Signal Generators.

**SPECIFICATIONS (warranted performance)**

Specification values are performance that is warranted. All units are warranted to meet these performance specifications under the following conditions.

- Ambient operating temperature of 18°C to 28°C, unless otherwise noted.
- After a warm-up time of 30 minutes and self calibration at ambient temperature.

**TYPICAL (mean + 3 standard deviations)**

Typical values are performance that units will meet under the following conditions.

- Ambient operating temperature of 23°C, unless otherwise noted.
- After a warm-up time of 30 minutes and self calibration at ambient temperature.

This performance is not warranted.

**CHARACTERISTIC (mean or expected value)**

Characteristic values are nominal performance that units are expected to have under the following conditions.

- Ambient operating temperature of 23°C, unless otherwise noted.
- After a warm-up time of 30 minutes and self calibration at ambient temperature.

This performance is not warranted.