Vector signal analyzer with powerful spectrum analysis capabilities; ideal test companion to the Model 2910

RF/MICROWAVE

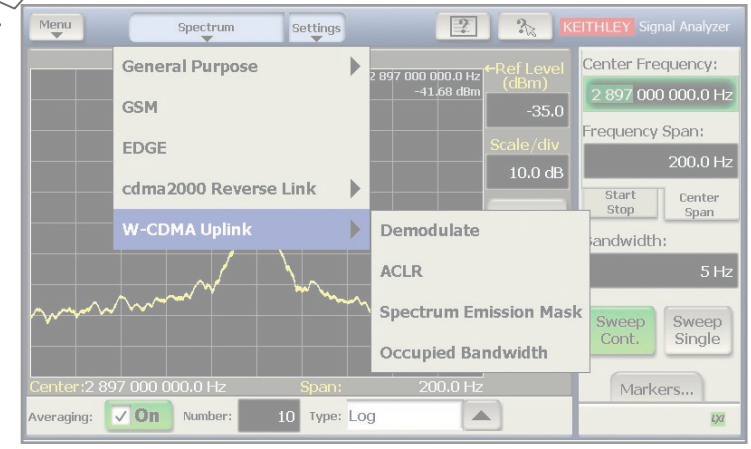
2810

RF Vector Signal Analyzer

400MHz to 2.5GHz

- **Continuous frequency range of 400MHz–2.5GHz spans key mobile wireless frequency bands**
- **Intuitive, easy-to-use graphical user interface**
- **40MHz modulation measurement bandwidth for capturing signals based on the latest high bandwidth wireless standards**
- **Signal analysis options for all worldwide mobile phone standards: GSM/GPRS/EDGE, cdma2000 1xRTT, and WCDMA**
- **Built-in spectrum analyzer mode**
- **High speed DSP delivers low noise floor for measuring signals thousands of times faster than competitive solutions**
- **Fast sweep times: A fifteen-second sweep can display 200MHz of a signal's spectrum with a 100Hz resolution bandwidth**
- **Built-in, fixed-output variable frequency generator**
- **Remotely controllable via Ethernet, USB, and GPIB interfaces**
- **LXI Class C compliant**
- **Readily updatable software-defined radio architecture**

The Model 2810 RF Vector Signal Analyzer combines complex signal analysis and spectrum analysis capabilities with high performance and unprecedented ease of use. It's designed to address a wide range of measurement needs for wireless devices, wireless transceiver modules, and RF components. In production testing applications, the Model 2810's fast frequency tuning, rapid attenuator switching, and high speed digital signal processing reduce test time significantly, which helps to minimize overall testing costs. High speed digital architecture and the use of Fast Fourier Transform (FFT) technology allow the Model 2810 to measure signals near the noise floor thousands of times faster than competitive solutions, such as sweep-type spectrum analyzers. That means manufacturers can test prototype circuits more thoroughly than previously possible, speeding time to market and identifying costly design flaws sooner. Research and development engineers will appreciate how the Model 2810's fast sweep times with narrow resolution bandwidths over wide frequency spans allow them to obtain the maximum information from a spectrum for characterization and analysis. A highly intuitive graphical user interface and simple operation allow even occasional users to make measurements with confidence.



Easily navigable menus provide quick access to all measurements and set-up parameters. The Model 2810's menus can be controlled from the front panel using either the touch screen or the USB mouse.

APPLICATIONS

- Mobile handset production test
- Handset R&D and design verification
- Testing mobile communications infrastructure
- RFIC testing
- Wireless connectivity testing (802.11b/g WLAN, Bluetooth)
- Research and education in mobile communications

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Ordering Information

2810 RF Vector Signal Analyzer

Configuration Choices (Specify one from each group in the format 2810-xx-yy-zzz)

Example: 2810-FP-BT-002

RF Connector Location (-xx):
- **-FP Front-panel RF input**
- **-RP Rear-panel RF input**

Use Configuration (-yy)
- **-BT Bench-top**
- **-RK Rack-mount**

Frequency Range (-zzz):
- **-002 2.5GHz**

Options

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

2800-80216-E 802.16e WiMAX and WiBRO SISI Signal Analysis License

2800-CDMA-R CDMA2000 and IS-95A Reverse Link Signal Analysis License

2800-DIG Flexible Digital Modulation Signal Analysis License

2800-EDGE2 Edge Evolution Signal Analysis License

2800-GSM GSM/GPRS/EDGE Signal Analysis Personality

2800-HSDPA-D W-CDMA HSDPA Downlink Signal Analysis License

2800-WCDMA-D W-CDMA FDD Downlink Signal Analysis License

2800-WCDMA-U W-CDMA FDD Uplink Signal Analysis License

2810-SPI Single-port Interface

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

Accessories Supplied

AC power cable

Printed Quick Start Guide

CD-ROM containing 2810 system help, utility programs, and PDF files (also available on-line at www.keithley.com)

ACCESSORIES AVAILABLE

2890-BT	Bench Top Kit
2890-RK	Rack Mount Kit
2910-ADAPTER-KIT	Cable and Adapter Accessory Kit

CABLES/ADAPTERS

7007-1	Shielded IEEE-488 Cable, 1m (3.3 ft)
7007-2	Shielded IEEE-488 Cable, 2m (6.6 ft)

OTHER

KPCI-488LPA	IEEE-488 Interface/Controller for the PCI Bus
KPXI-488	IEEE-488 Interface Board for the PXI Bus
KUSB-488A	IEEE-488 USB-to-GPIB Interface Adapter

SERVICES AVAILABLE

2810-3Y-EW	1-year factory warranty extended to 3 years from date of shipment
C/2810-3Y-DATA	3 (Z540-1 compliant) calibrations within 3 years of purchase*

*Not available in all countries

The Model 2810's 400MHz—2.5GHz frequency range covers the mobile wireless frequency bands where extensive product innovation is continually occurring. Optional signal analysis formats support power calibration and modulation quality analysis for the major worldwide mobile phone standards. The Model 2810 can test and analyze signals from GSM, GPRS, EDGE, cdma2000, and WCDMA mobile phones.

With greater than 30MHz of signal acquisition bandwidth, the Model 2810 can acquire any of the current wireless signals in one sweep, as well as signals from the wireless standards now being developed. Its large built-in memory is capable of storing up to 50 mega-samples of down-converted I and Q pairs for either internal or customized external modulation analysis.

The instrument's flexible, software-defined radio architecture and ongoing firmware updates make it easy and economical to incorporate new modulation analysis schemes and new measurement algorithms into the Model 2810 as needed.

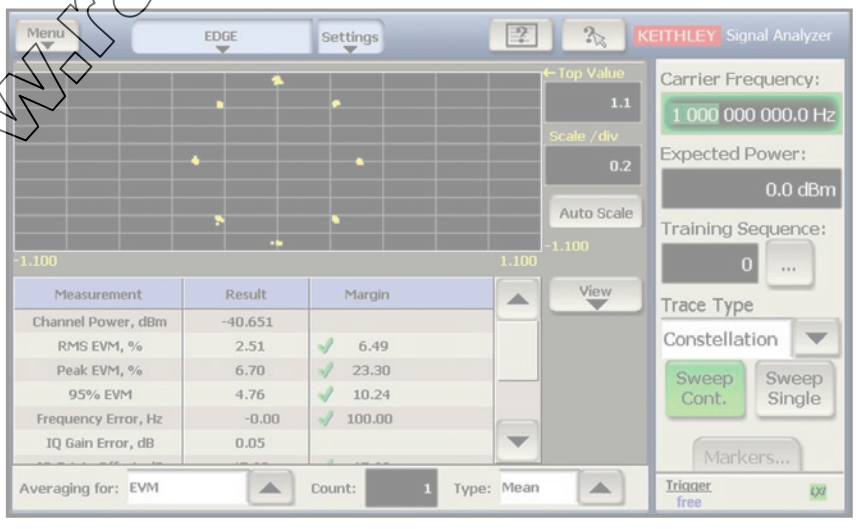
Multiple Personalities

Multiple user-installable analysis options are available for testing mobile phone handsets based on a variety of technologies. These analysis "personalities" are provided as firmware modules that can quickly and cost-effectively tailor and/or update the Model 2810's operation. Examples include the following:

The *Model 2800-GSM* is a GSM/GPRS/EDGE Signal Analysis Personality that measures all the key modulation quality parameters needed to assess the performance of a GSM/GPRS/EDGE transmitter: channel power, frequency error, phase error, time mask conformance, the Output RF Spectrum due to Modulation, and the Output RF Spectrum due to Switching. For testing EDGE transmitters, the Model 2810-GSM option also measures Error Vector Magnitude (EVM) and related parameters.

The *Model 2800-cdma2000* is a cdma2000 Reverse Link Signal Analysis Personality that analyzes 1.23MHz spread spectrum CDMA reverse link signals with measurements of channel power, frequency error, rho (ρ), adjacent channel power, code domain power, occupied bandwidth, and spurious emissions conformance.

The *Model 2800-WCDMA* is a WCDMA Uplink Signal Analysis Personality that tests WCDMA transmitters with measurements similar to the cdma2000 modulation quality measurements. Rather than ρ and code domain power, the Model 2810-WCDMA option measures EVM and peak code domain error on a 3.84MHz WCDMA transmitter signal.



The Model 2810-GSM, which is the GSM/GPRS/EDGE Signal Analysis Option, demodulates GSM and EDGE transmitter signals and provides both displays and computations of a number of modulation quality parameters. This constellation diagram of an 8PSK EDGE transmission also includes measurements of EVM, frequency error, and I-Q gain error.

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RF/MICROWAVE

RF Vector Signal Analyzer
400MHz to 2.5GHz

To minimize test time and maximize throughput in production testing, the analysis options compute multiple measurements with only a single acquisition of data. Furthermore, these signal analysis options are portable, so the license for any option can be transferred from one Model 2810 to another. This licensing flexibility helps reduce capital costs because it's no longer necessary for manufacturers to order all their instruments "fully loaded" with options in order to be prepared for every testing possibility. Options can be transferred from Model 2810s on one production line to instruments on another production line, so manufacturers can quickly respond to changes in capacity requirements and device type. Options can be transferred between instruments over a LAN network in minutes, so it's easy to modify the test capabilities of production lines quickly.

Optimized for High Speed Testing

For making high speed measurements, the Model 2810 has a powerful digital processing engine, which substantially reduces test times and the cost of test. Conventional spectrum analyzers aren't able to match its ability to acquire wide segments of a signal's spectrum with high resolution. For example, while a Model 2810 can sweep a frequency band that's 200MHz wide using a 100Hz resolution bandwidth in just fifteen seconds, conventional sweeping spectrum analyzers can take a thousand times longer to perform the same task. Solid-state variable attenuators allow the Model 2810 to change reference levels quickly. It can also tune to any frequency in less than 3ms. These speeds make it possible to perform a set of GSM or EDGE measurements in approximately 27 milliseconds.

High Speed RF Component Testing

When used in combination with the Model 2910 RF Vector Signal Generator, the Model 2810 can reduce both test times and capital equipment costs for testing active and passive RF components. Unlike time-consuming instruments that require issuing a separate command for each instruction, both the Models 2810 and 2910 are supported by powerful bus commands that allow generating multiple signals at different frequencies and taking multiple measurements at different frequencies. The Model 2810 can de-compose a modulated signal into the I and Q samples that created the signal, while the Model 2910 can generate modulated waveforms. This economical, two-instrument configuration can analyze the magnitude of modulation distortion created by a component, making it possible to estimate or model the performance of the component in a modulating circuit.

A TTL signal output provided by the Model 2910 indicates when the generator's output has settled, eliminating the need to program time-consuming delay states into the Model 2810 to ensure the source signal has settled sufficiently before analysis begins. Both instruments have TTL trigger inputs and synchronization outputs to communicate with each other directly and control the test protocol. This direct communication bypasses the much slower control process of using individual PC commands to control every aspect of the test.

Compact System for Transceiver Testing

Combine the Model 2810 and the Model 2910 Vector Signal Generator with an RF-coupled, single-connection interface (Model 2910-SPI) to a transceiver to perform high speed transmitter and receiver calibration and testing. With fast frequency tuning and fast amplitude switching times, the transmitter and receiver circuits can be quickly calibrated over multiple operating bands—the response of the device under test becomes the limiting factor in test time reduction. For testing mobile phone handsets with multiple operating modes, such as GSM and WCDMA, the Models 2810 and 2910 switch quickly between the different mobile phone operating standards to eliminate delays due to instrument state changes. A test system configured with the Models 2810, 2910, and a 1U-high RF single-connection interface minimizes both equipment costs and rack space, requiring just 4U of rack height.

Easy to Configure, Easy to Use

A variety of features simplify configuring and operating Model 2810-based RF test systems:

- **Intuitive GUI.** The Model 2810's simple, touch-screen graphical user interface (GUI) makes it ideal for use by both experienced RF test engineers and novices, including students.
- **Compact size.** At just 3U (5.25 inches) high and half the width of a 19-inch rack, the Model 2810 fits equally well in a test rack or on a benchtop. Its compact enclosure makes it easy to pair with other half-rack RF instruments, such as the Model 2910, for maximum testing capability in minimal space.
- **Choice of remote programming interfaces.** The Model 2810's built-in 100Base-T Ethernet and USB interfaces allow direct, high speed programming and command transfer to the system controller. A GPIB interface makes it adaptable for use in legacy environments.
- **Built-in generator.** A variable frequency, RF source output is built into the Model 2810 for use as a system self-test signal, as a test stimulus signal, or as a local oscillator drive for an external mixer.
- **Flexible software tools.** The collection of software tools included was selected to help speed and simplify development of remote control software applications. Programmers have the flexibility to develop applications directly in SCPI, employ IVI-COM drivers, or use a LabVIEW® driver.
- **LXI Class C Compliance.** The Model 2810 supports the physical, programmable, LAN, and Web portions of the emerging LAN eXtensions for Instrumentation (LXI) standard. The instrument can be monitored and controlled from any location on the LAN network via its LXI Web page.
- **Graphical Help system.** The Model 2810's Help system provides comprehensive and easy-to-use documentation that's accessible via the GUI and also remotely, so users can refer to it while working directly with the instrument or while working at their desks on their PCs.

Keithley's Growing RF Line

The Model 2810 is the latest addition to our expanding RF/wireless test offering, which provides a complete line of RF sourcing, measurement, and signal routing capabilities. In addition, Keithley serves many phases within the wireless industry, starting with our automated DC/RF parametric test systems for wafer-level testing. Component manufacturers often choose Series 2400 and 2600A SourceMeter® instruments for high speed DC testing of packaged parts like RFICs. Keithley's high speed power supplies and battery/charger simulators are widely used in board-level, wireless handset testing, and our THD Multimeters and Audio Analyzing DMMs are popular choices for audio test systems. We also offer an array of RF/microwave signal routing solutions, ranging from stand-alone switches and simple plug-in modules for multimeters to large, high density solutions designed for production test applications.

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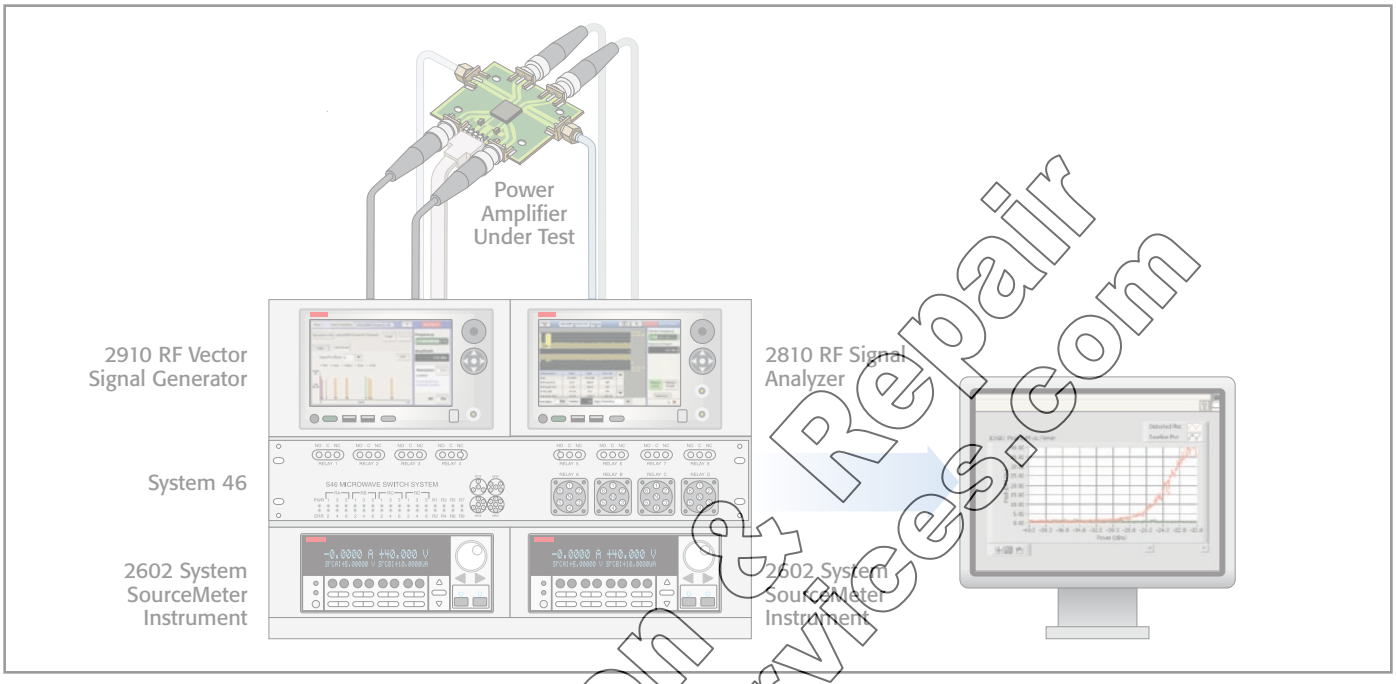
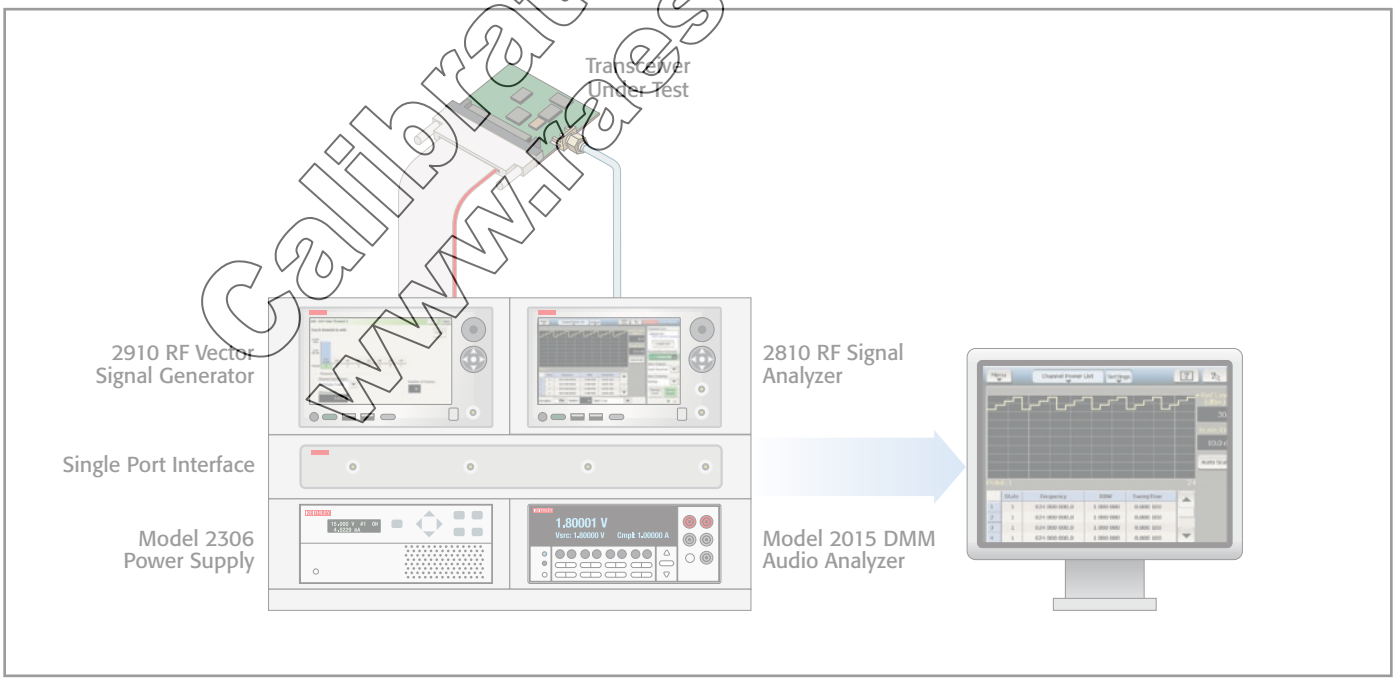


The combination of the Model 2810 Vector Signal Analyzer and the Model 2910 Vector Signal Generator with the triggering and test script control of the Model 2602A System SourceMeter® instruments allows for simultaneous measurements of RF power and DC load currents. In addition, the Model 2810 and the Model 2910 can perform high speed measurements of modulation performance on the device under test.



In just 4U of rack space, this configuration supports calibrating and testing the modulation and demodulation performance of transceivers, all with far faster test times and lower costs than dedicated communication testers allow.

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2810 RF Vector Signal Analyzer
400MHz to 2.5GHz

Basic Modes of Operation

STANDARD SPECTRUM ANALYSIS MODES

- Spectrum Analyzer (power envelope amplitude vs. frequency spectrum)
- Zero Span (power envelope amplitude vs. time)
- ACPR (adjacent channel power ratio bar chart)
- Channel power list
- Spectrum Emissions Mask (SEM)

OPTIONAL VECTOR SIGNAL ANALYSIS MODES

- GSM-GPRS-EDGE
- EDGE Evolution
- cdmaOne-cdma2000
- W-CDMA FDD uplink (mobile phone transmitter signals)
- W-CDMA FDD downlink (base station transmitter signals)
- 802.11a, b, g, j, and n WLAN (SISO signals)
- 802.16e-2005 WiMAX (SISO signals)
- Generic FSK and PSK signals

Note: All items are specifications unless otherwise noted.

Frequency

FREQUENCY RANGE[1]: 400MHz to 2.5GHz.

FREQUENCY SETTLING RESOLUTION: 0.1Hz.

FREQUENCY ACCURACY: Same as frequency reference + synthesizer resolution term[2].

INTERNAL FREQUENCY REFERENCE

AGING RATE: ≤1ppm/year.

TEMPERATURE STABILITY: ≤0.2ppm[3].

FREQUENCY REFERENCE OUTPUT

IMPEDANCE: 50Ω (characteristic), AC coupled.

REF. OUTPUT SIGNAL: 10MHz, +7dBm ±3dB (characteristic).

EXTERNAL FREQUENCY REFERENCE INPUT

FREQUENCY: 1 to 20MHz[4].

AMPLITUDE: Lock Range: 0 to +15dBm[5].

IMPEDANCE: 50Ω (characteristic).

Spectrum Analysis Controls and Parameters

FREQUENCY SPAN: 200Hz to 2.1GHz[6]. Zero Span mode available.

SWEEP TIME SETTINGS IN ZERO SPAN MODE: 1μs to 30s[7].

SWEEP MODES: Continuous, Single.

IF BANDWIDTH:
Relative Flatness over 20MHz: ±1.0dB (typical).
Relative Flatness over 4MHz: ±0.3dB (typical).
3dB BW: >30MHz.

RESOLUTION BANDWIDTHS: 2Hz to 3MHz (ENBW) with 1Hz resolution for spans >0Hz[8].

RESOLUTION BANDWIDTH FILTERS (1Hz resolution)[9]:
Brickwall: 10Hz to 35MHz, flat BW[10].
Root Raised Cosine: α = 0.22: 10Hz to 28MHz, 3dB BW.
Gaussian: 10Hz to 7MHz, 3dB BW.
5 pole Synchronously Tuned: 10Hz to 2.3MHz, 3dB BW.
4 pole Synchronously Tuned: 10Hz to 1.75MHz, 3dB BW.

AMPLITUDE:
Reference Level Range Setting: +40dBm to –170dBm.
Scale Settings: Manual: 0.1dB/division to 20dB/division.

PRE-AMPLIFIER (15dB gain characteristic): On, off.

DISPLAY:
Detection modes: Normal, Maximum, Minimum, Sample, Power Average, Power Average + Noise Correction.
Trace Hold Displays: Normal, Max Hold, Min Hold, Min/Max Hold.
Averaging: 1–1,000 traces[11]. **Modes:** Log, Power, Log Group, Power Group, Max Group, Min Group, Min/Max Group.

MARKERS: Four independent markers, each with a delta marker, Normal and Peak modes.
Marker Amplitude Resolution: 0.01dB from front panel; 0.001dB via remote interface.

CHANNEL POWER LIST: Single command to execute up to 501 power measurements.

SPECTRUM ANALYSIS AMPLITUDE[12]

MAXIMUM SAFE INPUT POWER: +35dBm.

MAXIMUM SAFE DC VOLTAGE: ±50VDC.

ABSOLUTE ACCURACY[13]:

	Specified	Typical
400MHz ≤ Freq ≤ 2,000MHz	±0.6dB	±0.3dB
2,000MHz < Freq ≤ 2,500MHz	±0.7dB	±0.4dB

REF LEVEL ACCURACY (referenced to 0dBm):

Reference Level Setting	Accuracy
+10 to –70dBm	±0.2dB
–70 to –90dBm	±0.4dB
–90 to –100dBm	±1.0dB

DISPLAY SCALE FIDELITY[14]: ±0.16dB.

RESOLUTION BANDWIDTH SWITCHING ERROR[15]: ±0.01dB.

ATTENUATOR ACCURACY[16]:
±0.10dB for 0 through 15dB attenuator settings.
±0.15dB for 20 and 25dB attenuator settings.
±0.25dB for 30dB attenuator setting.

AMPLITUDE REPEATABILITY[17]: ±0.20dB, ±0.14dB (typical).

AMPLITUDE CHANGE DUE TO PREAMP ON: ±0.3dB, ±0.18dB (typical).

DISPLAYED AVERAGE NOISE LEVEL[18]:
≤–141dBm/Hz, pre-amp off. ≤–148dBm/Hz, pre-amp on.

VSWR: ≤1.4:1

SPURIOUS AND RESIDUAL RESPONSES:
TOI (referred to the 2810 input, two 0dBm input signals and reference level = 0dBm): +30dBm (typical).
SOI (referred to the 2810 input, 0dBm input signals and reference level = 0dBm): +50dBm (typical).
Residuals (reference level setting ≤–40dBm): ≤–90dBm.
LO Spurs: ≤–55dBc.
Phase Noise (1GHz carrier frequency and 20kHz offset frequency): ≤–115dBc/Hz.

Generator Output

FREQUENCY RANGE: 400MHz to 2.5GHz[19].

SWEEP SPAN: 0Hz to 2.1GHz[20].

SWEEP POINTS: 1 to 501.

DWELL SETTING: 1ms to 1s in 1ms increments.

AMPLITUDE: Fixed: –10dBm ±3.5dB (typical: ±3dB).

Measurement Speed Characteristics

GENERAL PURPOSE MODE

SPECTRUM OR ZERO SPAN[21]: 16.0ms.

ACPR/ACLR[22]

CENTER, UPPER & LOWER ADJ, UPPER AND LOWER ALT: 8.0ms.

CENTER CHANNEL ONLY (measurement of Adj and Alt Off): 4.5ms.

CHANNEL POWER LIST MODE[23]

SINGLE FREQUENCY: 0.9ms per point.

FREQUENCY STEP SIZE ≤1MHz: 1.6ms per point.

MAXIMUM READING RATE (minimum step width)[24]: 100μs per point.

GSM MODE[25]

PHASE ERROR, CHANNEL POWER AND TIME MASK: 21.8ms.

PHASE ERROR AND CHANNEL POWER FREE RUN TRIGGER: 15.3ms (6.33ms/burst[26]).

PHASE ERROR AND CHANNEL POWER VIDEO TRIGGER: 13.8ms (4.72ms/burst[26]).

ORFS DUE TO MODULATION OR SWITCHING: 17.3ms.

EDGE MODE[27]

EVM, CHANNEL POWER AND TIME MASK: 22.1ms.

EVM AND CHANNEL POWER: 23.0ms (6.46ms/burst[28]).

ORFS DUE TO MODULATION OR SWITCHING: 20.1ms.

EDGE 2.0

EVM, CHANNEL POWER AND TIME MASK: 23.1ms.

EVM AND CHANNEL POWER: 24.5ms (5.03ms/burst[28]).

ORFS DUE TO MODULATION OR SWITCHING: 17.7ms.

CDMA2000 MODE

DEMODULATION MEASUREMENT[29]: 46.2ms.

ACPR: 26.3ms[30] (227ms[31]).

SPECTRUM EMISSIONS MASK: 125.4ms.

OCCUPIED BANDWIDTH: 51.0ms.

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WCDMA DL MODE
DEMODULATION MEASUREMENT [29]: 117.2ms.
ACLR: 8.3ms [33] (208.5ms [31]).
SPECTRUM EMISSIONS MASK: 131.6ms.
OCCUPIED BANDWIDTH: 44.4ms.

WCDMA UL MODE
DEMODULATION MEASUREMENT [32]: 57.3ms.
ACLR: 8.0ms [33] (208.5ms [28]).
SPECTRUM EMISSIONS MASK: 130.4ms.
OCCUPIED BANDWIDTH: 44.3ms.

HSDPA
DEMODULATION MEASUREMENT [29]: 130.5ms.
ACLR: 8.0ms [33] (208.5ms).
SPECTRUM EMISSIONS MASK: 131.7ms.
OCCUPIED BANDWIDTH: 44.7ms.

WLAN MODE [34]
802.11a: 18ms.
802.11b: 38ms.
802.11j: 18ms.
802.11n 20MHz SIGNAL BANDWIDTH: 18ms.
802.11n 40MHz SIGNAL BANDWIDTH: 18ms.

WIMAX MODE [35]
802.16e 10MHz SIGNAL BANDWIDTH: 164.8ms.
802.16e 20MHz SIGNAL BANDWIDTH: 148.0ms.

MAXIMUM DISPLAY REFRESH RATE FOR A COMPLETE UPDATE OF A 640×480 PIXEL VGA SCREEN: Internal Display: 30 sweeps/s (33ms/sweep).
DATA TRANSFER OVER LAN/TCP/IP: Up to 0.4MByte/s.
REMOTE TRACE DATA TRANSFER [36]:
- **LAN:** 5.7ms.
- **USB:** 12.7ms.
- **GPIB:** 20ms.

TIME TO SWITCH BETWEEN MEASUREMENTS [37]:
- **Within General Purpose Mode:** 10ms.
- **From Digital to General Purpose Mode:** 10ms.
- **From General Purpose to Digital Mode:** 10ms.
- **Within GSM or EDGE Mode:** 10ms.
- **From CDMA2000 or WCDMA Non-demodulate to Demodulate:** 11ms.
- **From CDMA2000 or WCDMA Demodulate to Non-demodulate:** 11ms.

2810-SPI
Single Port Interface Personality

All specifications remain the same with this option except the following:

DISPLAYED AVERAGE NOISE LEVEL: ≤–140dBm/Hz, pre-amp off. ≤–147dBm/Hz, pre-amp on.
REAR PANEL RF INPUT TO FRONT PANEL RF INPUT LOSS: 20dB ±2dB (characteristic).

2800-GSM
GSM/GPRS/EDGE Signal Analysis Personality

GSM/GPRS POWER AND MODULATION QUALITY
CHANNEL POWER:
- **Measurement Range:** +33dBm to –30dBm (typical).
- **Accuracy:** ±0.6dB (typical).

PHASE AND FREQUENCY ERROR:
- **Frequency Error Measurement Range:** ±50kHz (typical).
- **Frequency Error Accuracy:** ±10Hz (typical).
- **RMS Phase Error Measurement Range:** 0° – 10° (typical).
- **RMS Phase Error Accuracy:** <±1°.
- **Peak Phase Error Measurement Range [38]:** 0° – 25° (typical).
- **Peak Phase Error Accuracy [39]:** ±2°.
- **Phase Error Floor:** RMS: 0.35°, Peak: 1.0°.

TIME MASK CONFORMANCE:
- **Sampling Resolution:** 0.615µs (1/6 bit).
- **Accuracy Along Burst Peak:** ±0.25dB.
- **Outputs:** Pass/Fail, complete burst with upper and lower mask limit lines.

OUTPUT RF SPECTRUM [40]:
- **ORFS Due to Modulation:**

	Dynamic Range (dBc)	
Offset Frequency (kHz)	Carrier Frequency (F_C) (typical in parentheses)	
	400MHz ≤ F_C ≤ 1GHz	1GHz < F_C < 2GHz
200	34 (35)	34 (35)
250	39 (40)	39 (40)
400	66 (67)	62 (64)
600	71 (74)	67 (70)
1200	74 (79)	74 (76)
1800 [41]	70 (76)	70 (74)

Relative Accuracy: ±0.5dB.

ORFS Due to Switching:

	Dynamic Range	
Offset Frequency (kHz)	Carrier Frequency (F_C) (typical)	
	400MHz ≤ F_C ≤ 1GHz	1GHz < F_C < 2GHz
400	(65)	(62)
600	(71)	(67)
1200	(76)	(74)
1800	(78)	(77)

Relative Accuracy: ±0.5dB.

Displays: Power vs. Time with Time Mask, ORFS due to Modulation, ORFS due to Switching, Phase Error vs. Time, Symbols vs. Time.

EDGE POWER AND MODULATION QUALITY
CHANNEL POWER:
- **Measurement Range:** +33dBm to –30dBm (typical).
- **Accuracy:** ±0.6dB (typical).

FREQUENCY ERROR:
- **Frequency Error Measurement Offset:** ±50kHz (typical).
- **Frequency Error Accuracy:** ±10Hz (typical).

EVM:
- **RMS Measurement Range:** 0 – 15% (typical).
- **RMS Floor:** ≤0.5%.
- **Origin Offset Range:** –20dBc maximum (typical).
- **RMS Accuracy:** ±0.5%.

TIME MASK CONFORMANCE:
- **Sampling Resolution:** 0.615µs (1/6 bit) (typical).
- **Accuracy Along Burst Peak:** ±0.25dB (typical).
- **Outputs:** Pass/Fail, complete burst with upper and lower mask limit lines.

OUTPUT RF SPECTRUM [42]:
- **ORFS Due to Modulation:**

	Dynamic Range (dB)	
Offset Frequency (kHz)	Carrier Frequency (F_C) (typical in parentheses)	
	400MHz ≤ F_C ≤ 1GHz	1GHz < F_C ≤ 2GHz
200	36 (37)	36 (37)
250	39 (41)	39 (41)
400	65 (67)	60 (63)
600	70 (71)	64 (68)
1200	73 (75)	71 (73)
1800 [43]	68 (72)	67 (70)

Relative Accuracy: ±0.5dB.

ORFS Due to Switching:

	Dynamic Range (dB)	
Offset Frequency (kHz)	Carrier Frequency (F_C) (typical)	
	400MHz ≤ F_C ≤ 1GHz	1GHz < F_C ≤ 2GHz
400	(62)	(60)
600	(68)	(65)
1200	(72)	(70)
1800	(74)	(73)

Relative Accuracy: ±0.5dB (typical).

Displays: Power vs. Time with Time Mask, ORFS due to Modulation, ORFS due to Switching, EVM vs. Time, Symbols vs. Time, Constellation.

RF Vector Signal Analyzer
400MHz to 2.5GHz

2800-EDGE2 Edge Evolution Signal Analysis

EDGE EVOLUTION POWER AND MODULATION QUALITY (Carrier ≤2.4GHz)

CHANNEL POWER:
Measurement Range: +33dBm to –30 dBm (typical).
Accuracy: ±0.6dB (typical).

FREQUENCY ERROR:
Frequency Error Measurement Offset: ±50kHz (typical).
Frequency Error Accuracy: ±10Hz (typical).

EVM:
RMS Measurement Range: 0–15% (typical).
RMS Floor: ≤0.5%.
Origin Offset Range: –20dBc maximum (typical).
RMS Accuracy: ±0.5%.

TIME MASK CONFORMANCE:
Sampling Resolution: 0.615µs (1/6 bit) (typical).
Accuracy Along Burst Peak: ±0.25dB (typical).
Outputs: Pass/Fail, complete burst with upper and lower mask limit lines.

OUTPUT RF SPECTRUM [44]:
ORFS Due to Modulation:

Dynamic Range (dB)

Offset Frequency (kHz)	Carrier Frequency (F_C) (typical in parentheses) 400MHz ≤ F_C ≤ 1GHz	1GHz < F_C ≤ 2GHz
200	36 (37)	36 (37)
250	39 (40)	39 (40)
400	66 (68)	63 (64)
600	72 (73)	68 (70)
1200	77 (79)	75 (77)
1800 [45]	73 (75)	73 (75)

Relative Accuracy: ±0.7dB (typical).

ORFS Due to Switching:

Dynamic Range (dB)

Offset Frequency (kHz)	Carrier Frequency (F_C) (typical) 400MHz ≤ F_C ≤ 1GHz	1GHz < F_C ≤ 2GHz
400	65 (67)	62 (64)
600	72 (74)	67 (69)
1200	76 (80)	75 (77)
1800	79 (82)	78 (80)

Relative Accuracy: ±0.7dB (typical).

Displays: Power vs. Time with Time Mask, ORFS due to Modulation, ORFS due to Switching, EVM vs. Time, Symbols vs. Time, Constellation.

2800-CDMA-R cdma2000 Reverse Link Signal Analysis Personality

CDMA2000 POWER AND MODULATION QUALITY (Carrier ≤2.5GHz)

CHANNEL POWER:
Measurement Range: +33dBm to –70dBm (typical).
Accuracy (1.2288MHz BW): ±0.6dB (typical).

FREQUENCY ERROR:
Frequency Error Measurement Range: ±3kHz (typical).
Frequency Error Accuracy: ±10Hz (typical).

RHO (ρ):
Range: 0.7–1.0 (typical).
Ceiling: 0.999.
Accuracy: ±0.005 (for ρ values >0.9).

CODE DOMAIN POWER:
Relative Accuracy, for Code Channels ≥ –20dB of Total Power: ±0.3dB (typical).

ADJACENT CHANNEL POWER [46]:
Dynamic Range: 65dBc @ 885kHz offset (typical).
80dBc @1980kHz offset (typical).
Relative Accuracy: ±0.5dB.

OCCUPIED BANDWIDTH:
Frequency Accuracy: ±5kHz (typical).

SPECTRUM EMISSIONS MASK [47]:
Accuracy relative to carrier power: <0.5dB.

DISPLAYS: Code Domain Power, Adjacent Channel Power with limits, Occupied Bandwidth with limit lines, Conducted Spurious Emissions with limits.

2800-WCDMA-U WCDMA Uplink Signal Analysis Personality

WCDMA POWER AND MODULATION QUALITY (Carrier Frequency = 1800MHz–2200MHz)

CHANNEL POWER:
Measurement Range: +33dBm to –60dBm (typical).
Accuracy (3.84MHz BW): ±0.6dB (typical).

FREQUENCY ERROR:
Frequency Error Measurement Range: ±3kHz (typical).
Frequency Error Accuracy: ±10Hz (typical).

RMS EVM:
Range: 0%–25% (typical).
Floor: 1.75% (typical).
Accuracy: ±2%.

CODE DOMAIN POWER:
Relative Accuracy, for Code Channels ≥ –20dB of Total Power: ±0.3dB.

ADJACENT CHANNEL POWER [48]:
Dynamic Range: 64dBc @ 5MHz offset (typical).
69dBc @10MHz offset (typical).
Relative Accuracy: ±0.5dB.

OCCUPIED BANDWIDTH:
Frequency Accuracy: ±20kHz (characteristic).

SPECTRUM EMISSIONS MASK [49]:
Accuracy Relative to Carrier Power: <1.5dB (characteristic).

DISPLAYS: Code Domain Power, Adjacent Channel Power with limits, Occupied Bandwidth with limit lines, Spectrum Emissions with limits.

2800-WCDMA-D WCDMA Downlink Signal Analysis Personality

WCDMA POWER AND MODULATION QUALITY (Carrier Frequency = 1800MHz–2200MHz)

CHANNEL POWER:
Measurement Range: +33dBm to –60dBm (typical).
Accuracy (3.84MHz BW): ±0.6dB (typical).

FREQUENCY ERROR:
Frequency Error Measurement Range: ±3kHz (typical).
Frequency Error Accuracy: ±10Hz (typical).

RMS EVM:
Range: 0%–25% (typical).
Floor: 1.9% (typical).
Accuracy: ±2%.
Symbol EVM [50]: 0.25%.

CODE DOMAIN POWER:
Relative Accuracy, for Code Channels ≥ –20dB of Total Power: ±0.3dB.

ADJACENT CHANNEL POWER [51]:
Dynamic Range: 63dBc @ 5MHz offset (typical).
69dBc @10MHz offset (typical).
Relative Accuracy: ±0.5dB (typical).

OCCUPIED BANDWIDTH:
Frequency Accuracy: ±20kHz (characteristic).

SPECTRUM EMISSIONS MASK [52]:
Accuracy Relative to Carrier Power: <1.5dB (characteristic).

DISPLAYS: Code Domain Power, Adjacent Channel Power with limits, Occupied Bandwidth with limit lines, Spectrum Emissions with limits.

2800-HSDPA-D Downlink Signal Analysis Personality

HSDPA POWER AND MODULATION QUALITY (Carrier Frequency = 1800MHz–2200MHz)

CHANNEL POWER:
Measurement Range: +33dBm to –60dBm (typical).
Accuracy (3.84MHz BW): ±0.6dB (typical).

FREQUENCY ERROR:
Frequency Error Measurement Range: ±3kHz (typical).
Frequency Error Accuracy: ±10Hz (typical).

RMS EVM:
Range: 0%–25% (typical).
Floor: 2.25% (typical).
Accuracy: ±2%.
Symbol EVM [53]: 0.5%.

CODE DOMAIN POWER:
Relative Accuracy, for Code Channels ≥ –20dB of Total Power: ±0.3dB.

ADJACENT CHANNEL POWER [54]:
Dynamic Range: –60dBc @ 5MHz offset (typical).
–66dBc @10MHz offset (typical).
Relative Accuracy: ±0.5dB (typical).

OCCUPIED BANDWIDTH:
Frequency Accuracy: ±20kHz (characteristic).

SPECTRUM EMISSIONS MASK [55]:
Accuracy Relative to Carrier Power: <1.5dB (characteristic).

DISPLAYS: Code Domain Power, Adjacent Channel Power with limits, Occupied Bandwidth with limit lines, Spectrum Emissions with limits.

RF Vector Signal Analyzer
400MHz to 2.5GHz

2800-80211 Wireless LAN Signal Analysis Personality

WLAN POWER AND MODULATION QUALITY

CHANNEL POWER:
- **Measurement Range, Carrier Frequency 2.4GHz:** +33dBm to –60dBm (typical).
- **Accuracy:**
  - **OFDM 20MHz Signal Bandwidth:** ±0.85dB (typical).
  - **OFDM 40MHz Signal Bandwidth:** ±0.85dB (typical).
  - **DSSS/CCK:** ±0.85dB (typical).

FREQUENCY ERROR:
- **Measurement Range: OFDM:** ±312kHz.
  DSSS/CCK: ±100kHz.
- **Accuracy:** ±10Hz (typical).

RMS EVM FLOOR, Typical (Characteristic) [56]:
- **802.11b:** –44dB @ 2.4GHz.
- **802.11g:** –41dB (–44.8dB) @ 2.4GHz.
- **802.11n 20MHz Signal Bandwidth [57]:** –40dB (–44.1dB) @ 2.4GHz.

CHANNEL FLATNESS MASK MARGIN:
- **OFDM 20MHz Signal Bandwidth:** 1.4dB (typical) at 2.4GHz.

2800-80216-E WiMAX Signal Analysis Personality

WIMAX POWER AND MODULATION QUALITY

CHANNEL POWER:
- **Measurement Range, Carrier Frequency ≤2.4GHz:** +33dBm to –60dBm (typical).
- **Accuracy:**
  - **10MHz Signal Bandwidth:** ±0.85dB (typical).
  - **20MHz Signal Bandwidth:** ±0.85dB (typical).

FREQUENCY ERROR:
- **Measurement Range:**
  - **10MHz Signal Bandwidth [58]:** ±60kHz.
  - **20MHz Signal Bandwidth [59]:** ±120kHz.
- **Accuracy:** ±10Hz (characteristic).

RCE FLOOR [60], Typical (Characteristic):
- **10MHz Signal Bandwidth [61]:** –40dB (–47dB) @ 700MHz.
  –44dB (–45dB) @ 2.5GHz.
- **20MHz Signal Bandwidth [62]:** –44dB (–45dB) @ 700MHz.
  –43dB (–44dB) @ 2.5GHz.

CHANNEL FLATNESS MASK MARGIN:
- **10MHz Signal Bandwidth:** 1.6dB (characteristic).
- **20MHz Signal Bandwidth:** 1.7dB (characteristic).

SPECTRUM EMISSIONS MASK [63]:
- **Accuracy Relative to Carrier Power:** <2.0dB swept mode, <1.0dB step mode.

2800-DIG Flexible Digital Modulation Analysis Personality

FSK PARAMETERS

MODULATION TYPE: FSK2.

FILTERS:
- **Filter Types:** Rectangular, RC, RRC, Gaussian, NRZ Gauss.

FILTER FACTOR:
- **RC, RRC:** 0.2 to 1.0.
- **Gaussian, NRZ Gauss:** 0.2 to 3.0.

SYMBOL RATE:
- **Symbol Rate Resolution:** 1 Symbols/s.
- **Minimum Symbol Rate:** 10K Symbols/s.
- **Maximum Symbol Rate:**
  - **Gaussian, NRZ Gauss:** 3.125MSps (Factor < 0.5)
    2.5MSps (0.5 ≤ Factor < 1.0)
    1.25MSps (Factor ≥ 1.0).
  - **RC, RRC, Rectangular:** 1.25MSps

FREQUENCY SEPARATION:
- **Range:**
  - **Gaussian, NRZ Gauss, Rectangular:** 2 × Symbol Rate.
  - **RC, RRC:** 1 × Symbol Rate.

PSK PARAMETERS

MODULATION TYPES: BPSK, QPSK, pi/4 QPSK, 3pi/4 QPSK, 8PSK.

FILTERS: Filter Types: NRZ, RC, RRC, Gaussian, NRZ Gauss, Wideband.

FILTER FACTOR:
- **RC, RRC:** 0.2 to 1.0.
- **Gaussian, NRZ Gauss:** 0.3 to 3.0.

SYMBOL RATE:
- **Symbol Rate Resolution:** 1 Symbols/s.
- **Minimum Symbol Rate:** 10K Symbols/s.
- **Maximum Symbol Rate:**
  - **Gaussian, NRZ Gauss:** 3.125MSps (Factor < 0.5)
    2.5MSps (0.5 ≤ Factor < 1.0)
    1.25MSps (Factor ≥ 1.0).
  - **NRZ, Wideband:** 1.25MSps
  - **RC, RRC:** 6.25MSps

EVM CHARACTERISTICS

MODULATION	FILTER TYPE	RMS EVM, %
All PSK	NRZ, Wideband	<0.25%
FSK	NRZ	<0.3%

Trigger and Synchronization Inputs and Outputs

TRIGGER SOURCES [64]:
- Free run
- External
- Video
- Bus
- External arm using video trigger
- Bus arm using external or video trigger

TRIGGER DELAY RANGE: –0.5 to +0.5s.

TRIGGER MODES: On measurement
On acquire

EXTERNAL TRIGGER:
- Rising edge of external input
- Falling edge of external input
- Input level TTL
- Minimum input pulse width required 50ns (characteristic)

VIDEO TRIGGER MODES:
- Rising signal edge
- Falling signal edge
- Video level
- Pre-qualification mode level and time settings

SYNC OUTPUT MODES:
- **Generate a sync pulse:**
  - Off
  - Begin measurement
  - Start tune
  - Ready acquire
  - Start acquire
  - End acquire
  - End measurement

SYNC OUTPUT POLARITY SELECT:
- Sync out is on the rising edge
- Sync out is on the falling edge

SYNC OUTPUT: TTL level. Minimum pulse width 200ns (characteristic).

EVEN SECOND CLOCK INPUT: External even second clock (TTL).

EVEN SECOND CLOCK OUTPUT: External even second clock (TTL).

2810

RF Vector Signal Analyzer

400MHz to 2.5GHz

GENERAL SPECIFICATIONS

POWER: 100VAC to 240VAC; 50/60Hz (automatically detected); 120VA 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: 1 year.

ENVIRONMENT (FOR INDOOR USE ONLY): 18°–28°C specified operating, unless otherwise noted.

0°–50°C operating survival, non-specified operation.

–25° to 65°C non-operating (AC power off) storage.

Altitude: 2000 meters above sea level maximum specified operating.

Cooling: Forced air top, bottom, and side intakes and rear exhaust. For proper cooling in a rack, use Keithley Instruments 2890-RK Rack Mount Kit.

DIGITAL INPUTS/OUTPUTS: 4 bits, TTL-compatible.

INTERFACES: IEEE-488.1 compliant. Supports IEEE-488.2 common commands and status model topology.

LAN: 10/100Base-T Ethernet, RJ45, LXI Class C, no auto MDIX.

IVI-COM.

USB: USB full speed.

RF In/TG Out: Type N connector.

MECHANICAL VIBRATION AND SHOCK:

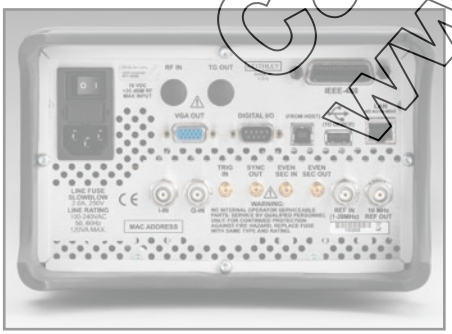
MIL-PRF-2880 CL3 random vibration, 3 axes.

Sine-Sweep test for resonances, 3 axes.

MIL-STD-810F 516.5 paragraph, 4.5.7 procedure VI bench drop.

GENERAL MECHANICAL CHARACTERISTICS:

Height: 3U (133mm) (5.25 in.).
Width: Half-rack (213mm) (8.4 in.).
Depth: 464mm (18.25 in.).
Weight: 7.5kg (16.5 lb.).



Model 2810 rear panel

NOTES:

1. Over range operation provided: 325MHz to 2.975GHz. Performance below 400MHz and above 2.5GHz is not specified.
2. Synthesizer resolution term: ≤5μHz.
3. Total variation relative to 0° to 50°C ambient temperature range.
4. On 10Hz boundaries Freq = 1MHz + n · 10Hz. Reference accuracy ≤ ±1ppm. Sine or square wave inputs acceptable.
5. For optimum phase noise, 0 to +10dBm.
6. Over range operation provided: 325MHz to 2.975GHz. Maximum span is 2.425GHz. Performance below 400MHz and above 2.5GHz is not specified.
7. Maximum sweep time is limited to 32MS data points.
8. RBW accuracy <1% characteristic.
9. Filter types are settable in Zero Span, Channel Power List, and ACPR modes.
10. ENBW is ≈ 1.10 * RBW setting. 6dB BW is ≈ 1.09 * RBW setting.
11. CDMA and WCDMA measurement personalities limit number of trace averages to 100.
12. Specifications apply when in Autocoupled mode unless otherwise stated.
13. Input power at 0dBm, span = 1MHz and RBW = 100Hz.
14. Signal level within 50dB of top of screen, reference level 0dBm, no change in instrument state.
15. RBW switching error specified for 10000 ≤ Span/RBW setting ratio ≤15000 and frequency spans ≤25MHz.
16. Applies only if input attenuator is changed from auto-coupled setting.
17. For repetitive CW power readings with CW signal removed then reapplied for signals: >40dB above noise floor within 5 minutes.
18. DANL specified performance with option 2810-SPI is listed in 2810-SPI section.
19. Over range operation provided: 325MHz to 2.7GHz. Performance below 400MHz and above 2.5GHz is not specified.
20. Over range operation provided: Maximum span: 2.375GHz. Performance below 400MHz and above 2.5GHz is not specified.
21. Instrument preset, all settings auto coupled. 400Hz ≤ span ≤ 300MHz. In zero span, sweep time ≤5ms and 1MHz BW. Time is trigger to data available.
22. 100μs sweep time, 3.84MHz BW, RRC filter.
23. 101 point list, 400μs acquisition time, ≥1MHz BW, brickwall.
24. ≤50μs acquisition time, ≥1MHz BW, brickwall.
25. Single burst, no averaging.
26. 100 averages.
27. Single burst, no averaging.
28. 100 averages.
29. Parameters measured: Rho, code domain power, RMS EVM, peak EVM, peak code domain error, frequency error, IQ offset, and total channel power.
30. 500μs sweep.
31. To preset condition accuracy, display off.
32. Parameters measured: code domain power, RMS EVM, peak EVM, peak code domain error, frequency error, IQ offset, and total channel power.
33. 100μs sweep.
34. Display off, plots turned off, mean of 100 iterations, no frequency change, time includes GPIB transfer time (802.11b waveform with 504 chips).
35. FFT Size: 1024. Channel equalization: Chan Est Seq + Pilots.
36. Zero span, sweep time 100μs, binary data transfer, 501 data points.
37. Display off, MEAS1;INIT;IMM;*WAI;;MEAS2;INIT;IMM;*OPC.
38. Average of peak from each burst.
39. Average of peak from each burst.
40. Nominal carrier power at RF input ≥ –10dBm. Does not include level uncertainty due to inherent noise.
41. 1800kHz offset measured using 100kHz RBW. All other offsets measured using 30kHz RBW.
42. Nominal carrier power at RF input ≥ –10dBm. Does not include level uncertainty due to inherent noise.
43. 1800kHz offset measured using 100kHz RBW. All other offsets measured using 30kHz RBW.
44. Nominal carrier power at RF input ≥–10 dBm. QAM32 R325 Normal. Does not include level uncertainty due to inherent noise.
45. 1800kHz offset measured using 100kHz RBW. All other offsets measured using 30kHz RBW.
46. Carrier power at RF input ≥–10dBm. Does not include level uncertainty due to inherent noise.
47. Carrier power at RF input ≥–10dBm. Does not include level uncertainty due to inherent noise.
48. Carrier power at RF input ≥–10dBm. Does not include level uncertainty due to inherent noise.
49. Carrier power at RF input ≥–10dBm. Does not include level uncertainty due to inherent noise.
50. Valid for CPICH only signal
51. Carrier power at RF input ≥–10dBm. Does not include level uncertainty due to inherent noise.
52. Carrier power at RF input ≥–10dBm. Does not include level uncertainty due to inherent noise.
53. Valid for CPICH only signal
54. Carrier power at RF input ≥–10dBm. Does not include level uncertainty due to inherent noise.
55. Carrier power at RF input ≥–10dBm. Does not include level uncertainty due to inherent noise.
56. Applies when input signal is above –20dBm, with Expected Channel Power set equal to input power.
57. Measuring 802.11n MIMO signals can degrade the EVM floor by as much as 3dB.
58. FFT Size: 1024. Channel equalization: Chan Est Seq + Pilots.
59. FFT Size: 1024. Channel equalization: Chan Est Seq + Pilots.
60. Applies when input signal is above –20dBm, with Expected Channel Power set equal to input power.
61. FFT Size: 1024. Channel equalization: Chan Est Seq + Pilots.
62. FFT Size: 1024. Channel equalization: Chan Est Seq + Pilots.
63. Carrier power at RF input ≥–20dBm. Does not include level uncertainty due to inherent noise.
64. Bus Trigger and Bus Arm available only in Channel Power List mode.

SPECIFICATION NOTES:

Specifications describe the instrument's warranted performance. Typical and characteristic values are not warranted, but provide additional information regarding performance that you should expect from the Model 2810 and are provided to assist in application of the Model 2810.

SPECIFICATIONS: (warranted performance):

Specifications indicate performance that is warranted. All units are warranted to meet these performance specifications under the following conditions:

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

TYPICAL (mean + 3 standard deviations):

Typical indicates performance that units will meet under the following conditions:

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

This performance is not warranted.

CHARACTERISTIC (mean or expected value):

Characteristic indicates performance that a unit would be expected to exhibit under the following conditions:

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

This performance is not warranted.