

2910

- Exceptional signal generation capability at an economical price
- Fast signal tuning for high speed test execution—1.3ms typical for most signals
- Continuous frequency range of 400MHz–2.5GHz spans key mobile wireless frequency bands
- Intuitive, easy-to-use graphical user interface
- 40MHz modulation bandwidth using internally generated modulation
- >200MHz modulation bandwidth using external I-Q inputs
- Built-in waveforms for digital (GSM/GPRS/EDGE, cdmaOne/cdma2000 1xRTT, and W-CDMA) and analog (CW, AM, FM, Φ M, noise, two-tone CW, and pulsed) signal formats
- GUI supports editing waveform files and creating new files for GSM, GPRS, EDGE, W-CDMA, cdmaOne, and cdma2000 downlink signals
- 256MB (64 mega-samples) built-in arbitrary waveform generator supports downloading waveforms generated externally
- Half-rack, 3U enclosure fits easily into both rack and benchtop system configurations
- Remote control via Ethernet, USB, and GPIB interfaces
- Readily updatable software-defined radio architecture

RF Vector Signal Generator



The Model 2910 RF Vector Signal Generator is the first in a series of Keithley RF instruments that sets a new price/performance standard. It's priced significantly less than instruments or systems with comparable levels of functions and performance and offers far more functionality and better performance than comparably priced equipment. While the Model 2910 offers capabilities and ranges that make it ideal for production testing of today's sophisticated mobile handsets, it also has features that make it useful for applications like testing mobile communications infrastructure, RFICs, and wireless connectivity devices. The Model 2910's exceptional testing capabilities and ease of use make it a good choice for use in mobile communications research and education settings.

When characterizing or verifying DUT performance, the speed of the RF signal generator can have a major impact on overall test throughput and, therefore, the cost of test. Higher speed also makes it possible for manufacturers to respond quickly to increased volume demands. The Model 2910 is designed to execute key tasks like frequency tuning, amplitude switching, and waveform changes significantly faster than other products available.

The Model 2910's continuous frequency range of 400MHz to 2.5GHz spans key mobile wireless bands. Digital waveforms for key tests in major cellular formats (GSM, GPRS, EDGE, W-CDMA, cdmaOne, cdma2000) for testing handsets are built in, as is support for analog modulation (continuous wave, two-tone continuous wave, amplitude modulation, frequency modulation, phase modulation, pulse modulation, and noise). The 64 mega-sample Arbitrary Waveform Generator (ARB) and 40MHz modulation bandwidth support downloading a wide range of externally generated signal waveforms. The 1kHz to 2MHz noise bandwidth supports "quick-check" noise immunity tests on a variety of devices.

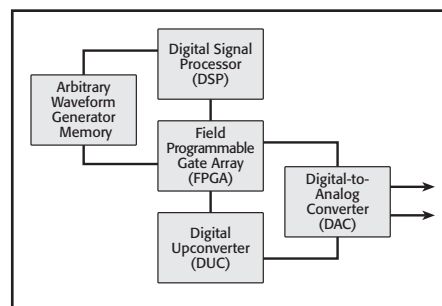


Figure 1. The Model 2910's software-defined radio architecture allows users to adapt it readily to changing test requirements.

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Ordering Information

- 2910-FRK RF Connector on Front, Configured for Rack Installation***
- 2910-RRK RF Connector on Rear, Configured for Rack Installation***
- 2910-F RF Connector on Front, Configured for Bench-top Use****
- 2910-R RF Connector on Rear, Configured for Bench-top Use****

* Versions configured for rack installation include rack mount kit and exclude bumpers and handle.

** Versions configured for bench-top use include bumpers and handle and exclude rack mount kit.

Options

- 2910-ARB 64 Mega-Sample Arbitrary Waveform Generator**
- 2910-GSM* GSM/EDGE Signal Generation Personality**
- 2910-CDMA2000* cdma2000 Signal Generation Personality**
- 2910-WCDMA* W-CDMA Signal Generation Personality**
- 2910-LPN Low Phase Noise**

*Requires 2910-ARB option

Accessories Supplied

AC power cable, printed Quick Start Guide, CD-ROM containing 2910 VSG System Help, utility programs, and PDF files (also available on-line at www.keithley.com).

ACCESSORIES AVAILABLE

2910-RMK	Rack Mount Kit
2910-BENCH-KIT	Bench-Top Kit: Bumpers and Handle
2910-DCBLOCK	External DC Block
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-488LP	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

RF Vector Signal Generator

The instrument's software-defined radio architecture provides the testing flexibility needed to keep pace with changing wireless technologies, as well as fast frequency tuning and amplitude settling. New signal structures and instrument features can be incorporated easily and economically with ongoing firmware updates.

Higher Speed for Lower Cost of Test

A state-of-the-art digital signal processor (DSP) and high speed RF architecture provide the Model 2910's speed and help reduce cost of test:

- **Faster tuning.** The Model 2910 can switch frequencies in about one millisecond for most frequency steps, which is significantly faster than many higher-priced competitive instruments.
- **Faster amplitude settling.** When changing signal amplitude levels, the Model 2910's unique RF output structure typically settles to specified level accuracy in less than three milliseconds, which is significantly faster than most competitive instruments.
- **Highly responsive controls.** The Model 2910's high speed response to user inputs from the front panel or to programmed commands ensure fast waveform downloads and fast switching from one waveform to another, eliminating waiting times.
- **Large Arbitrary Waveform Generator.** A built-in Arbitrary Waveform Generator (AWG) with 256MB (64 mega-samples) of waveform memory allows users to have many waveforms resident in memory simultaneously. The large memory supports downloading ARB files created with external software packages like MATLAB®, Mathcad®, or other tools capable of generating I-Q waveforms. A choice of hardware triggering (for maximum speed) and software triggering (for simplified command programming) makes it easy to switch quickly between waveforms—typically in less than three milliseconds.

Powerful Built-in Tools and Capabilities

The most important digital signal structures needed to produce forward link (downlink) signals for all the major cellular formats (GSM, GPRS, EDGE, W-CDMA, cdmaOne, cdma2000) are already built into the Model 2910. The intuitive graphical user interface (GUI) greatly simplifies generation of non-standard signals or modification of existing waveforms for GSM, GPRS, EDGE, W-CDMA, cdmaOne, and cdma2000 forward link (downlink) signals. The large arbitrary waveform generator memory and 40MHz modulation bandwidth extend the signal generation capability to virtually any signal with up to 40MHz of bandwidth. For applications that require even more modulation bandwidth, the Model 2910 gives users the external I-Q modulation inputs (with >200MHz of modulation bandwidth).

The Model 2910's continuous tuning capability from 400MHz–2.5GHz covers all the key mobile communications bands, yet expands its applications far beyond the production test floor. The user-friendly GUI, easy-to-use front panel controls, and range of analog modulation capabilities make it an excellent choice for R&D applications.

Superior Signal Generation Accuracy

Digital baseband processing and optimal real-time digital reconstruction filtering allow the Model 2910 to deliver an extremely clean signal to a high performance I-Q modulator. As a result, the modulator produces signals with outstanding modulation quality. For example, the error vector magnitude (EVM) for EDGE signals is extremely low (<0.3% typical). This ensures precise, repeatable signals that help minimize measurement errors.

Outstanding amplitude accuracy (<0.5dB) and linearity (<0.05dB) minimize signal level uncertainty, which minimizes measurement guard-bands, simplifies the testing process, and allows for tighter specifications for devices under test.

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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Easy to Configure, Easy to Use

A variety of features combine to simplify configuring and operating Model 2900-based RF test systems:

- **Intuitive GUI.** The simplicity of the Model 2910's touch-screen or mouse-driven Windows®-based graphical user interface makes it ideal for both experienced RF test engineers and novices such as students.
- **Compact size.** At just 3U (5.25 inches, 133mm) high and half the width of a 19-inch rack, the Model 2910 is equally well-suited for test rack installation and benchtop use. Its compact enclosure makes it easy to pair with complementary half-rack RF instruments for a lot of testing capability in little space.
- **Choice of remote programming interfaces.** The Model 2910 offers wide connection flexibility when linking it to a system controller. Its built-in 100Base-T Ethernet and USB interfaces allow direct, high speed programming and command transfer. A GPIB interface is also included for use in legacy environments.
- **Flexible remote software tools.** A collection of tools are included with the Model 2910 to provide flexibility and simplicity to developers of remote control software applications. Programmers can develop applications directly in SCPI or make use of IVI-COM and IVI-C drivers, or a suite of LabVIEW™ building blocks.
- **LXI Class C Compliance.** The Model 2910 supports the physical, programmatic, LAN, and web portions of the emerging LAN eXtensions for Instrumentation (LXI) standard.
- **Graphical Help system.** The comprehensive and easy-to-use documentation in the instrument's Help system is accessible both through the GUI and off-line, so users can refer to it while working directly with the Model 2910 or while working at their desks on their PCs.

Keithley's Growing RF Line

The Model 2910 is part of our expanding RF/wireless test offering. In fact, Keithley serves many stages within the wireless industry, starting with our automated DC/RF parametric test systems for wafer-level testing. Component manufacturers often choose Series 2400 and 2600 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 handset testing and our THD Multimeters and Audio Analyzing DMMs are popular choices for audio test systems. We also have a broad array of RF/microwave signal routing solutions, in both standard and custom configurations, ranging from stand-alone switches and simple plug-in modules for multimeters to fully integrated turnkey solutions designed for production test applications.

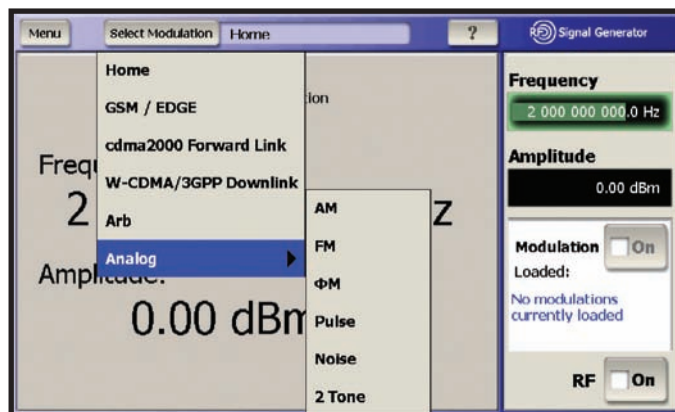


Figure 2. The Model 2910 features an intuitive GUI that simplifies selecting, creating, or editing a variety of waveforms.

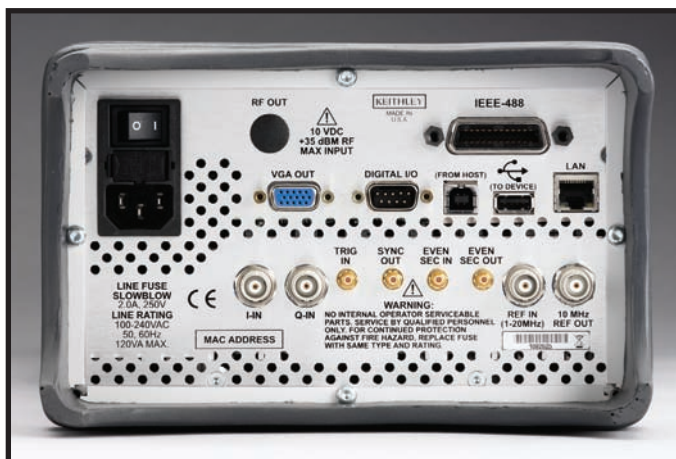


Figure 3. The Model 2910 rear panel.

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BASIC MODES OF OPERATION

CW SIGNAL GENERATOR MODE: CW signal generator. Default mode.

VECTOR SIGNAL GENERATOR PERSONALITIES: Modulation quality source for GSM, GPRS, EDGE, cdma2000, and W-CDMA mobile phone RF transmitter signals.

FREQUENCY

FREQUENCY RANGE:¹ 400MHz to 2.5GHz.

FREQUENCY SETTING RESOLUTION: 0.1Hz.

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

FREQUENCY SWITCHING TIME:³ $\leq 1.6\text{ms}$ (modulation off), $\leq 1.8\text{ms}$ (modulation on).
 $\leq 3.0\text{ms}$ (characteristic).⁴

INTERNAL FREQUENCY REFERENCE

AGING RATE: $\leq 1\text{ppm/year}$.

TEMPERATURE STABILITY: $\leq \pm 0.2\text{ppm}^5$.

FREQUENCY REFERENCE OUTPUT

IMPEDANCE: 50Ω (characteristic), AC coupled.

REF OUTPUT SIGNAL: 10MHz, +7dBm $\pm 3\text{dB}$ (characteristic).

EXTERNAL FREQUENCY REFERENCE INPUT

FREQUENCY: 1 to 20MHz.⁶

AMPLITUDE: Lock Range: 0 to +15dBm.⁷

IMPEDANCE: 50Ω (characteristic).

SPECTRAL PURITY

SSB PHASE NOISE (dBc/Hz; 20kHz offset):

Carrier Frequency 1.0GHz: ≤ -117 (< -124 characteristic).

HARMONICS:⁸ Fundamental Frequency, $F < 550\text{MHz}$: $\leq -30\text{dBc}$.

Fundamental Frequency, $F \geq 550\text{MHz}$: $\leq -40\text{dBc}$.

NON-HARMONIC SPURIOUS:⁹

Fundamental Frequency, F : $400\text{MHz} \leq F \leq 2.5\text{GHz}$: $< -55\text{dBc}$ ($< -60\text{dBc}$ characteristic).

2910-LPN LOW PHASE NOISE OPTION

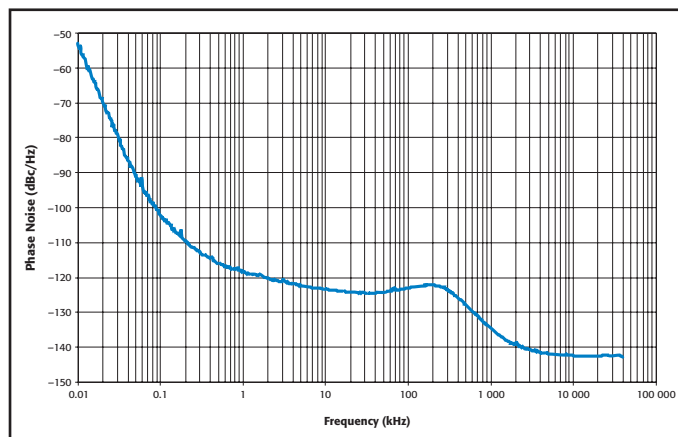
SSB PHASE NOISE (dBc/Hz; 20kHz offset):

Carrier Frequency 1.0GHz: ≤ -120 (< -124 characteristic).

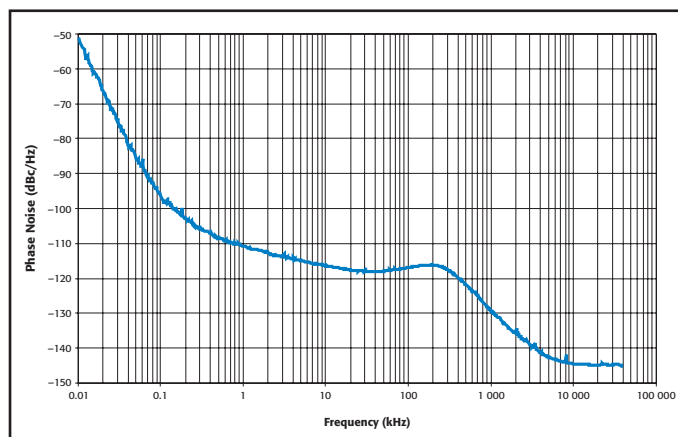
Carrier Frequency 2.0GHz: ≤ -113 (< -117 characteristic).

FREQUENCY NOTES

1. Over-range operation is provided: 325MHz to 2.7GHz. Performance below 400MHz and above 2.5GHz is not specified.
2. Synthesizer resolution term: $\leq 5\mu\text{Hz}$.
3. To within 0.1ppm of final value. List Mode or Sweep mode. Free Run or external hardware trigger. ALC Off. Modulation On or Off.
4. To within 0.1ppm of final value. Via remote command after receipt of end-of-operation indicator (EOI). ALC off. Modulation on or off.
5. Total variation relative to 0° to 50°C ambient temperature range.
6. On 10Hz boundaries: $\text{Freq} = 1\text{MHz} + n * 10\text{Hz}$. Reference accuracy $\leq \pm 1\text{ppm}$. Sine or square wave inputs acceptable.
7. For optimum phase noise, $0\text{dBm} \leq P_{in} \leq +10\text{dBm}$.
8. $P_{out} \leq +4\text{dBm}$
9. Offset from carrier $> 10\text{kHz}$, $P_{out} = 0\text{dBm}$ and Modulation off.



2910-LPN Option: Characteristic Single Side Band Phase Noise, Carrier Frequency = 1GHz



2910-LPN Option: Characteristic Single Side Band Phase Noise, Carrier Frequency = 2GHz

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AMPLITUDE ¹

AMPLITUDE LEVEL RANGE (CW): -125 to +13dBm.

AMPLITUDE LEVEL RANGE (GSM): -125 to +6dBm.

AMPLITUDE LEVEL RANGE (EDGE): -125 to +6dBm.

AMPLITUDE LEVEL RANGE (cdma2000)²: -125 to +3dBm.

AMPLITUDE LEVEL RANGE (W-CDMA)³: -125 to +4dBm.

AMPLITUDE SETTING RESOLUTION: 0.01dB.

ABSOLUTE AMPLITUDE LEVEL ACCURACY (CW), dB:

+13 to -75dBm: $\leq \pm 0.5$ dB ($\leq \pm 0.3$ dB typical).

-75 to -110dBm: $\leq \pm 0.6$ dB ($\leq \pm 0.3$ dB typical).

-110 to -120dBm: $\leq \pm 1.0$ dB ($\leq \pm 0.6$ dB typical).

-120 to -125dBm: $\leq \pm 1.0$ dB (characteristic).

POWER CHANGE OVER TEMPERATURE 0°C TO 50°C (characteristic): 0.015 dB/°C.

RELATIVE AMPLITUDE ACCURACY (linearity)⁴: $\leq \pm 0.05$ dB.

AMPLITUDE REPEATABILITY⁵: $\leq \pm 0.05$ dB.

AMPLITUDE SWITCHING TIME:⁶

List or Sweep Mode⁷: ≤ 1.6 ms (Modulation Off), ≤ 1.8 ms (Modulation On).

Via Remote Command (after receipt of end-of-operation indicator, EOI)⁸:
 ≤ 3.0 ms (characteristic).

ALC On⁹: < 2.6 ms (Modulation Off) characteristic, < 4.1 ms (Modulation On) characteristic.

VSWR, RF OUT PORT: $< 1.35:1$ ($< 1.25:1$ typical).

REVERSE POWER PROTECTION¹⁰: +35dBm or 10VDC.

AMPLITUDE NOTES

- Specifications apply when in auto-coupled mode unless otherwise stated.
- +3dBm max. for Pilot only; +0.5dBm max. for Forward 9 channel.
- +4dBm max. for CPICH only; -1.0dBm max. for Test Model 1 with 16 DPCH.
- 110dBm $< P_{out} < +2$ dBm. Modulation Off.
- 110dBm $< P_{out} < +2$ dBm, ALC mode = fast. Modulation Off.
- To within ± 0.05 dB of final value (to within ± 0.15 dB for power changes that cross $P_{max} - 11$ dB). For P_{max} see amplitude level range values for each modulation.
- Free Run or ALC trigger, ALC off.
- ALC Off, Modulation On or Off.
- ALC mode = Auto (Sample and Hold mode for Modulation On. Fast mode, Modulation Off).
- Up to 50VDC with optional external DC block (Keithley part no. 2910-DCBLOCK).

SWEEP AND LIST MODES

FREQUENCY SWEEP: Start Freq., Stop Freq., Number of Steps, Dwell Time.

AMPLITUDE SWEEP: Start Power, Stop Power, Number of Steps, Dwell Time.

DWELL TIME RANGE.: 0 to 1 second.

DWELL TIME RESOLUTION: 0.1ms.

ARBITRARY LIST: List of Frequency, Amplitude, and Dwell Time sets. Maximum number of sets = 1000.

ANALOG MODULATION

AMPLITUDE MODULATION:

Modulation Frequency Range: 1Hz to 100kHz.

Modulation Frequency Resolution, internal sine wave only: 1Hz.

Modulation Depth Range: 0 to 100%.

AM Distortion: $< 1.0\%$ (characteristic).

FREQUENCY MODULATION:

Modulation Frequency Range: 1Hz to 100kHz.

Modulation Frequency Resolution: 1Hz.

Modulation Deviation Range, internal sine wave only: 0Hz to 1MHz.

FM Distortion: $< 1.5\%$ (characteristic).

PHASE MODULATION:

Modulation Frequency Range: 1Hz to 100kHz.

Modulation Frequency Resolution, internal sine wave only: 1Hz.

Modulation Deviation Range: 0 to 100 radians.

Φ M Distortion: $< 1.5\%$ (characteristic).

PULSE MODULATION:

Pulse Repetition Rate Range: 1Hz to 100kHz.

Pulse Repetition Rate Resolution: 1Hz.

Minimum Pulse Width: 1.2 μ s.

On-Off Ratio¹: Pulse Width $< 50\mu$ s: > 50 dB. Pulse Width $\geq 50\mu$ s: > 100 dB.

Rise/Fall Time (10% to 90%): Pulse Width $< 50\mu$ s: < 600 ns. Pulse Width $\geq 50\mu$ s: $< 2\mu$ s.

TWO-TONE

Two-Tone CW Frequency Separation Range: 2Hz to 2MHz.

Two-Tone CW 3rd Order Intermodulation²: -54dBc (characteristic).

Two-Tone CW Carrier Feedthrough: -65dBc (characteristic).

NOISE MODULATION:

Noise Bandwidth Range³: 1kHz to 2MHz.

EXTERNAL MODULATION:

Maximum Modulation Bandwidth, external I-Q inputs⁴: ≥ 200 MHz (characteristic)

ANALOG MODULATION NOTES

- Valid when Pulse Modulation is the only active modulation type.
- Relative to power of fundamental tones at $P_{out} = 0$ dBm.
- 6dB double-sided.
- 3dB bandwidth. Inputs applied directly to I-Q modulator. Optimal drive voltage ± 0.8 V I-Q AC and DC amplitude, phase skew and offsets to be provided by user.

2910-ARB: ARBITRARY WAVEFORM GENERATOR

WAVEFORM MEMORY: 64 megasamples in 256MB of memory.

MAXIMUM MODULATION BANDWIDTH (internal modulation generation, < 1 dB flatness):
40MHz (characteristic).

MINIMUM SEGMENT LENGTH: 100 samples.¹

MAXIMUM SEGMENT LENGTH: 64 megasamples.

MAXIMUM NUMBER OF SEGMENTS: 1,000.

- For sampling rates (F_s) < 10 MS/s, 1000 samples minimum for $F_s > 10$ MS/s.

2910-WCDMA: W-CDMA MODULATION PERSONALITY

EVM: $< 1.2\%$ rms (typical), 1.0% rms (characteristic).

ACP¹: < -62 dBc adjacent, < -68 dBc alternate (typical).

< -64 dBc adjacent, < -69 dBc alternate (characteristic).

- CPICH only, adjacent spacing 5MHz offset, alternate spacing 10MHz offset.

2910-CDMA2000: cdma2000 MODULATION PERSONALITY

RHO¹: > 0.9995 (typical), > 0.9998 (characteristic).

ACP²: < -66 dBc adjacent, < -80 dBc alternate (typical).

< -67 dBc adjacent, < -86 dBc alternate (characteristic).

- Pilot only.
- Pilot only, adjacent spacing 750kHz offset, alternate spacing 1.98MHz offset.

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2910-GSM: GSM/EDGE MODULATION PERSONALITY

PHASE ERROR FOR GSM: <0.20° rms (typical), <0.15° rms (characteristic).

EVM FOR EDGE: <0.50% rms (typical), <0.30% rms (characteristic).

ORFS FOR GSM (characteristic):

Frequency Offset, kHz	Carrier Frequency, F_c	
	1 GHz $P_{out} = 0$ dBm	400 MHz to 2.5 GHz -10 dBm $\leq P_{out} \leq +6$ dBm
200	< -36 dBc	< -35 dBc
400	< -69 dBc	< -65 dBc
600	< -76 dBc	< -69 dBc

ORFS FOR EDGE (characteristic):

Frequency Offset, kHz	Carrier Frequency, F_c	
	1 GHz $P_{out} = 0$ dBm	400 MHz to 2.5 GHz -10 dBm $\leq P_{out} \leq +6$ dBm
200	< -36 dBc	< -37 dBc
400	< -69 dBc	< -63 dBc
600	< -76 dBc	< -69 dBc

TRIGGER AND SYNCHRONIZATION INPUTS AND OUTPUTS

TRIGGER MODES:	Free Run
	Trigger steps in Sweep or List mode
	Trigger a sweep or list
	Trigger start of ARB waveform
TRIGGER DELAY:	0 to 1 second
TRIGGER SOURCE:	SCPI or front panel trigger
	Rising edge of external TTL input
	Falling edge of external TTL input
	50ns minimum input pulse width required (characteristic)
SYNC OUTPUT MODES:	Generate a sync pulse:
	Off (never)
	On ARB waveform wrap
	At end of each sweep in List or Sweep mode
	At beginning of each sweep or list
SYNC OUTPUT:	At end of each sweep or list
	TTL
	200ns minimum pulse width (characteristic)
SYNC OUTPUT POLARITY SELECT:	Rising edge
	Falling edge
EVEN SECOND CLOCK INPUT: External even second clock (TTL).	
EVEN SECOND CLOCK OUTPUT: External even second clock (TTL).	

GENERAL

POWER: 100VAC to 240VAC, 50–60Hz (automatically detected), 120VA max.

EMC: Conforms to European Union Directive 89/336/EEC, EN 61326-1.

SAFETY: CE; conforms to European Union Directive 73/23/EEC, EN 61010-1.

CALIBRATION: 1 year.

ENVIRONMENT: For indoor use only.

18°C to 28°C specified operating, unless otherwise noted.

0° to 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 Model 2910-RMK 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: 10/100BT Ethernet, RJ45, LXI Class C, no auto MDIX.

IVI-COM.

USB: USB full speed.

RF 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: 133mm (5.25"), 3U.

Width: 213mm (8.4"), half-rack.

Depth: 464mm (18.25").

Weight: 7.82kg (17.25 lb.).

WARRANTY: 3 years.

Specifications describe the instrument's warranted performance. Typical and characteristic values are not warranted, but provide additional information regarding performance of the Model 2910 and are provided to assist in application of the Model 2910.

Specification (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° 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 specified 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 specified warm-up time of 30 minutes and self calibration at ambient temperature.

This performance is not warranted.