Specifications

HEWLETT PACKARD

HP | 8960 Series 10 | E5515A Wireless Communications Test Set

With HP E1960A GSM Mobile Test Application

Transmitter Measurements

- Frequency error
- Output power
- Phase error (peak and rms)
- Power versus time (burst mask comparison)
- Burst timing
- Output RF spectrum due to switching
- Output RF spectrum due to modulation

Audio Functionality

- Speech echo back to mobile station
- Audio generator encoded on downlink TCH
- Uplink speech level measurement
- Audio generator
- Audio level measurement

Receiver Measurement

- Burst-by-burst bit error ratio (fast BER)
- Normal bit error ratio (BER)

GSM Functionality

Mobile Station Power Output Level Control: Meets GSM phase one and phase two power control levels

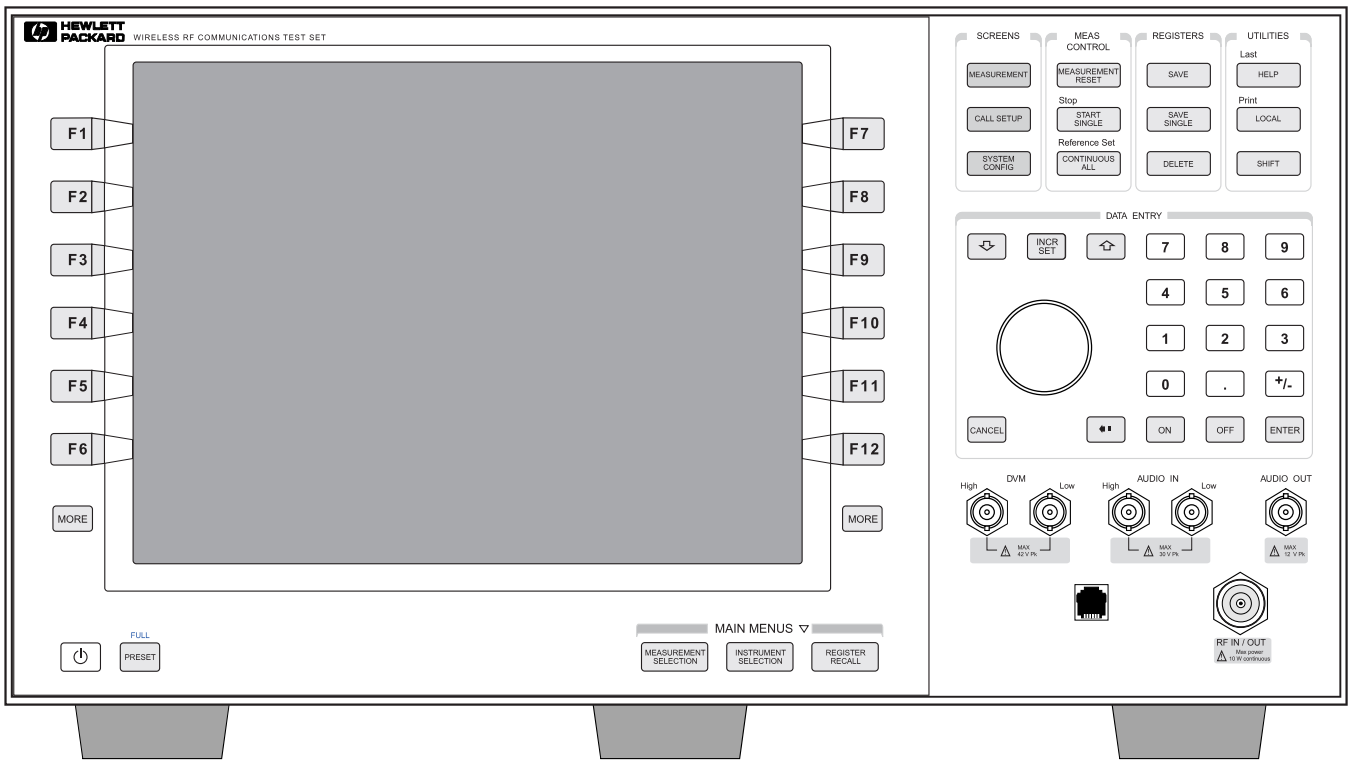
Traffic Channels: TCH/FS—full rate speech

Broadcast Channel Configuration: BCCH + CCCH + SDCCH/4

Signaling Protocol Setup: FACCH

Audio Speech Echo: One-second fixed delay

Measurement Coordination: Flexible control of burst type, ARFCN and timeslot



Call Processing Functionality

- MS origination
- MS release
- BS origination
- BS release
- Intra-cell channel assignments
- Inter-cell handovers

SACCH reporting of servicing cell:

- RX quality
- RX level
- TX level
- Timing advance

SACCH reporting of first neighbour cell:

- Channel number
- Base station colour code (BCC)
- RX level
- Network colour code (NCC)

Counters reported:

- RACH count
- Corrupt burst count
- Page count
- Decode error count
- Missing burst count

Last location information reported:

- Location area code (LAC)
- Mobile country code (MCC)
- Mobile network code (MNC)

Mobile-reported information:

- International mobile subscriber identity (IMSI)
- International mobile equipment identity (IMEI)
- Revision level
- Power class
- Supported band
- Called number

Signaling Modes

Full Signaling Call Setup (active cell mode): Protocol used to establish, maintain, change channels and power levels, and terminate the link.

Limited Signaling Call Setup (test mode): Protocol used only to maintain a link established by the mobile station, over-the-air signaling and capability to demodulate and decode uplink RACH (random access channel) bursts is not available. Three options exist as follows.

BCH only: A BCH (broadcast channel) without a TCH (traffic channel) is generated on the downlink and mobile station level information is carried on the BCCH (broadcast control channel).

BCH+TCH: BCH and TCH are generated on the downlink, mobile station level information is carried on the BCCH and the downlink SACCH (slow associated control channel), timing advance changes are sent on the downlink SACCH. A call can be established by manually synchronizing the mobile station with the TCH and turning on the mobile station's TCH at the same ARFCN (absolute radio frequency channel number) and timeslot as the test set's TCH. During a call, demodulation and channel decoding of the uplink are available, although no messages are decoded.

CW: An unmodulated CW signal is generated on the downlink. The level and frequency of the CW signal can be changed. No uplink demodulation or channel decoding is available.

Technical Specifications

Specifications describe the test set's warranted performance and are valid over the entire operation and environmental ranges unless otherwise noted. All specifications are valid after a 30-minute warm-up period of continuous operation, and within the frequency ranges of 810 to 960 MHz and 1.7 to 1.99 GHz.

Supplemental characteristics are intended to provide additional information useful in applying the instrument by giving typical, but non-warranted performance parameters. These characteristics are shown in Italics and labeled as "typical," or "supplemental", and apply at 25 °C.

RF (Downlink) Generator Specifications

RF generator specifications apply to both RF generators in the HP 8960

RF Frequency

Frequency Range: 810 to 960 MHz, 1.7 to 1.99 GHz

Accuracy and Stability: Same as timebase reference

Supplemental Characteristics

Typical CW Frequency Switching Speed: *<10 ms to be within <0.1 ppm of final frequency*

Setting Resolution: *1 Hz*

RF Amplitude

Output Level Range: –110 to –13 dBm

Absolute Output Level Accuracy: <±1.0 dB

Reverse Power: <10 W continuous, <20 W at 50% duty cycle

Supplemental Characteristics

Typical Output Level Accuracy: *<±0.5 dB*

Typical Output Level Repeatability *(returning to the same frequency and level): <±0.1 dB*

Typical Relative Output Level Accuracy *(during channel assignments between bands): <±0.5 dB*

Output Level Setting Resolution: *0.1 dB*

Typical Output Level Switching Time: *<50 ms to be within 0.05 dB of final level (non-bursted)*

Typical VSWR* at *RF IN/OUT: *<1.2:1 for 810 to 960 MHz, <1.25:1 for 1.7 to 1.99 GHz*

GSM Signal Generation

Peak Phase Error: <±4 degrees

rms Phase Error: <1 degree

Frequency Error: <±0.02 ppm plus timebase reference

Amplitude Flatness: <±0.3 dB across useful part of burst

Supplemental Characteristics

Typical Frequency Error: *<±0.01 ppm plus timebase reference*

Typical Burst Modulation On/Off Ratio: *>50 dB*

Spectral Purity

Harmonics: ≤–25 dBc for levels ≤–17 dBm

Subharmonics: ≤–40 dBc

Non-Harmonics:
<–55 dBc for 100 to ≤1500 kHz offsets from carrier
<–68 dBc for >1500 kHz offsets from carrier

Supplemental Characteristics

Typical Non-Harmonic Performance:
<–55 dBc for 3 kHz to <100 kHz offsets
<–53 dBc for line-related non-harmonics

Typical Receiver LO Spurious: *Receiver LO spurious at 105±2.5 MHz below expected transmitter frequency and its second harmonic are typically <–50 dBm*

CW RF Generator Functionality

When using the CW RF generator to generate an unmodulated CW signal on the downlink in test mode, the following ranges are available. The CW RF generator meets the RF frequency, RF amplitude and spectral purity specifications as listed for the RF generator within the frequency ranges of 810 to 960 MHz and 1.7 to 1.99 GHz, and within the amplitude range of –110 to –13 dBm. The rest of the total available range is over-range functionality that is not currently specified.

CW RF Generator Functionality:

Functionality	Total Available Range (using test mode with CW)	Range Applicable to RF Generator Specifications
RF Frequency	45 to 2700 MHz	810 to 960 MHz and 1.7 to 1.99 GHz
Output Level	–127 to –10 dBm	–110 to –13 dBm

RF Analyzer Functionality

When manually controlling the RF analyzer (receiver) in the HP 8960 Series 10, the following ranges are available. The RF analyzer meets the demodulation and transmitter measurement specifications as listed within the frequency ranges of 810 to 960 MHz and 1.7 to 1.99 GHz, and within the amplitude ranges specified for the demodulator and for each transmitter measurement. The rest of the total available range is over-range functionality that is not currently specified.

Functionality	Total Available Range	Range Applicable to Demod. and Transmitter Specifications
RF Frequency	293 to 2700 MHz	810 to 960 MHz and 1.7 to 1.99 GHz

Transmitter and Receiver Measurement Specifications

The time until a measurement times-out and returns control to the user can be set independently for each measurement. All measurements return a measurement integrity result indicating the accuracy and usefulness of each measurement's numerical results.

Frequency Coverage and Amplitude Range

Unless otherwise noted, all specifications apply to frequencies of 810 to 960 MHz and 1.7 to 1.99 GHz, signals with peak input power at the test set's RF IN/OUT not higher than +43 dBm and temperatures of 0 to 55 °C. Input signal TX output power (defined as the average power over the useful part of the burst) at the test set's RF IN/OUT must be within ±3 dB of the test set's expected power for warranted performance.

Receiver Measurement Specifications

Simultaneous Demodulation and Measurements

The test set's RF analyzer provides dedicated signal paths for demodulation (maintaining the link) and measurements to be performed simultaneously.

Demodulation Frequency Capture Range: Signal must be within ±200 Hz of test set's expected frequency

Demodulation Sensitivity: ≥–20 dBm for BER measurements

Supplemental Characteristics

Typical Demodulation Sensitivity: *≥–30 dBm for maintaining a link*

Bit Error Ratio (BER) Measurement

Types of Signals Measured: Type Ia, Type Ib, or Type II bits by comparing 260 bits of speech data using mobile phone loopback with or without signalling of erased speech frames

Minimum Input Level: Signal at test set RF IN/OUT must have TX output power ≥–20 dBm for warranted performance

Measurement Data Pattern: PRBS-15

Speech Frame Delay: User-settable between 1 and 15

Measurement Results: Number of bits tested, BER, number of bad bits, CRC ratio (without frame erasure), number of bad CRCs (without frame erasure), frame erasure ratio (FER) (with frame erasure), number of frames erased (with frame erasure), speech frame delay

Multi-Measurement Capabilities: 1 to 999,000 bits

Concurrency Capabilities: BER measurements cannot be made concurrently with FBER measurements, uplink speech level measurements, or while speech is provided on the downlink TCH. BER measurements can be made concurrently with all transmitter measurements, and with audio level measurements.

Supplemental Characteristics

Measurement Resolution: *0.01%*

Fast Bit Error Ratio (FBER) Measurement

Types of Signals Measured: Comparison of 114 bits of interleaved data with mobile phone in burst-by-burst loopback

Minimum Input Level: Signal at test set RF IN/OUT must have TX output power ≥–20 dBm for warranted performance

Measurement Data Pattern: PRBS-15

TDMA Frame Delay: User-settable between 0 and 26

Measurement Results: Number of bits tested, FBER, number of bad bits, TDMA frame delay

Multi-Measurement Capabilities: 1 to 999,000 bits

Concurrency Capabilities: FBER measurements cannot be made concurrently with BER measurements, uplink speech level measurements or while speech is provided on the downlink TCH. FBER measurements can be made concurrently with all transmitter measurements, and with audio level measurements.

Supplemental Characteristics

Measurement Resolution: *0.01%*

Transmitter Measurement Specifications

Phase and Frequency Error Measurement

Types of Signals Measured: Normal and RACH bursts

Frequency Capture Range (for any mobile burst): Signal must be within ±100 kHz of test set's expected frequency for warranted performance

Minimum Input Level: Signal at test set's RF IN/OUT must have TX output power ≥–15 dBm for warranted performance

Frequency Error Measurement Accuracy:

<±12 Hz plus timebase accuracy for normal bursts

<±18 Hz plus timebase accuracy for RACH bursts

When using the RF generator as the RF reference frequency for the mobile, the RF generator frequency error relative to the timebase reference must be added.

rms Phase Error Measurement Accuracy: <1 degree

Peak Phase Error Measurement Accuracy: <4 degrees

Measurement Trigger Sources: RF rise, protocol, immediate, auto

Measurement Trigger Delay: User-settable between ±2.31 ms

Measurement Synchronization: Midamble, RF amplitude, none

Available Results: rms and peak phase error, frequency error

Multi-Measurement Capabilities: 1 to 999 bursts, maximum, minimum and average phase and frequency error, and worst case frequency error results

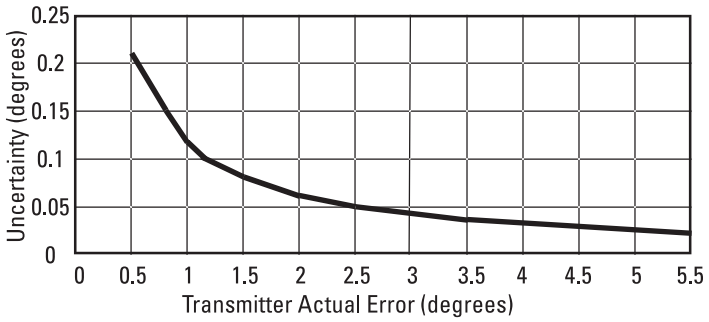
Concurrency Capabilities: Phase and frequency error measurements can be made concurrently with all other measurements

Supplemental Characteristics

Frequency Measurement Resolution: *0.01 Hz*

Phase Measurement Resolution: *0.01 degrees*

Typical rms Phase Error Uncertainty versus Transmitter Actual Error:



Transmitter Output Power Measurement

Types of Signals Measured: Normal and RACH bursts, CW

Frequency Capture Range: Signal must be within ±100 kHz of test set's expected frequency for warranted performance

Extended Amplitude Range: Results are provided for signals at test set's RF IN/OUT with TX output power within +5 and –10 dB of expected power, but performance is not warranted

Minimum Input Level: Signal at test set's RF IN/OUT must have TX output power ≥–20 dBm for warranted performance

Measurement Accuracy between 20 and 55°C:

Frequency Range	Amplitude Range	Measurement Accuracy
810 to 960 MHz	≥+4 to +43 dBm	<±0.36 dB
810 to 960 MHz	–20 to <+4 dBm	<±0.44 dB
1.7 to 1.99 GHz	–20 to +43 dBm	<±0.48 dB

Measurement Trigger Sources: RF rise, protocol, immediate, auto

Measurement Trigger Delay: User-settable between ±2.31 ms

Measurement Synchronization: RF amplitude (Midamble-synchronized output power result is available as part of the power versus time measurement)

Available Result: Output power

Multi-Measurement Capabilities: 1 to 999 bursts, minimum, maximum, average and standard deviation results

Supplemental Characteristics

Typical Measurement Accuracy:

Frequency Range	*Amplitude Range*	*Measurement Accuracy*
810 to 960 MHz	*≥+4 to +43 dBm*	*<±0.20 dB*
810 to 960 MHz	*–20 to <+4 dBm*	*<±0.25 dB*
1.7 to 1.99 GHz	*–20 to +43 dBm*	*<±0.28 dB*

Typical Measurement Repeatability: *<±0.1 dB*

Typical VSWR at RF IN/OUT: *<1.2:1 for 810 to 960 MHz, <1.25:1 for 1.7 to 1.99 GHz*

Measurement Resolution: *0.01 dB*

Power versus Time Measurement

All specifications for the power versus time measurement are valid between 20 and 55 °C.

Types of Signals Measured: Normal and RACH bursts, CW

Frequency Capture Range: Signal must be within ±10 kHz of test set's expected frequency for warranted performance

Minimum Input Level: Signal at test set's RF IN/OUT must have TX output power ≥–15 dBm for warranted performance

Mask Placement Timing Accuracy: <±0.1 bits (0.3692 µs) with midamble synchronization

Relative Measurement Accuracy (referenced to average output power during useful part of burst):
<±0.5 dB for –7 to +1 dB
<±1.0 dB for –20 to <–7 dB
<±2.0 dB for –32 to <–20 dB
<±2.5 dB for –45 to <–32 dB
<±2.7 dB for –50 to <–45 dB, and ≥–46 dBm
<±3.0 dB for –60 to <–50 dB, and ≥–46 dBm

Measurement Trigger Sources: RF rise, protocol, immediate, auto

Measurement Trigger Delay: User-settable between ±2.31 ms

Measurement Synchronization: Midamble, RF amplitude, none

Marker Measurement Points: 12 time points within a burst are user-definable

Available Results: Pass/Fail, output power, worst case upper mask limit margin and time, worst case lower mask limit margin and time, amplitude at marker measurement points

Multi-Measurement Capabilities: 1 to 999 bursts, minimum, maximum, average and standard deviation results

Supplemental Characteristics

Typical Dynamic Range: *>74 dB, or* ***Typical Noise Floor:*** *<–62 dBm, whichever dominates*

Measurement Resolution: *0.01 dB*

Burst Timing Error Measurement

Burst timing error measurement result is available on Call Setup screen.

Types of Signals Measured: Normal and RACH bursts

Measurement Capture Range: Signal must be within ±3 T (bit periods) of test set's expected position

Minimum Input Level: Signal at test set's RF IN/OUT must have TX output power ≥–20 dBm

Available Result: Burst timing error

Concurrency Capabilities: Burst timing error measurements can be made concurrently with all other measurements, but burst timing result is not available when test mode with CW is selected

Supplemental Characteristics

Typical Measurement Repeatability: *<±0.25 T (0.923 µs)*

Measurement Resolution: *0.25 T (0.923 µs)*

Output RF Spectrum (ORFS) Due to Modulation Measurement

All specifications for the ORFS due to modulation measurement are valid between 20 and 55 °C.

Measurement Implementation
The ORFS due to modulation measurement is performed using a five-pole, synchronously tuned 30 kHz RBW filter averaged over 40 bits, with a video bandwidth of 30 kHz.

Types of Signals Measured: Normal bursts

Frequency Capture Range: Signal must be within ±200 Hz of test set's expected frequency for warranted performance

Minimum Input Level: Signal at test set's RF IN/OUT must have TX output power ≥–10 dBm for warranted performance

Measurement Accuracy (referenced to output power in a 30 kHz bandwidth and averaged over 100 measurements):

kHz Offset from Carrier	Power Below Reference (Whichever is Highest)	Measurement Accuracy
±100	–10 dB or –46 dBm	<±1.5 dB
±200	–40 dB or –46 dBm	<±1.5 dB
±250	–43 dB or –46 dBm	<±1.5 dB
±400 to ±1800	–62 dB or –66 dBm	<±1.5 dB[1]

[1] Signal power at test set's RF IN/OUT should be ≥expected power and ≥+16 dBm for specified accuracy. Otherwise, accuracy is <±2.0 dB.

Measurement Trigger Sources: RF rise, protocol, immediate, auto

Measurement Trigger Delay: User-settable between ±2.31 ms

Measurement Synchronization: RF amplitude

Measurement Offsets: 22 offsets from carrier are user-definable

Available Results: Modulation result at each selected offset, output power, output power in 30 kHz bandwidth

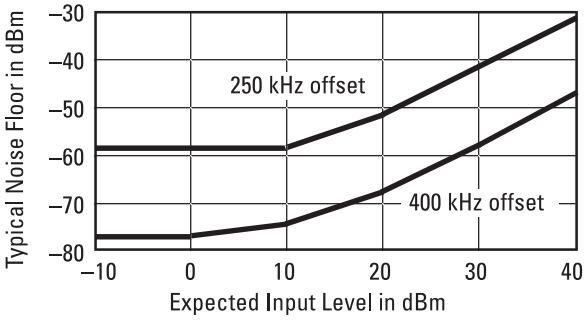
Multi-Measurement Capabilities: 1 to 999 measurements, average result

Supplemental Characteristics

Typical Measurement Accuracy: *<±0.7 dB for 400 kHz offset from carrier*

Measurement Resolution: *0.01 dB*

Typical ORFS Due to Modulation Measurement Noise Floor versus Expected Input Level at 900 MHz:



Output RF Spectrum (ORFS) Due to Switching Measurement

All specifications for the ORFS due to switching measurement are valid between 20 and 55 °C.

Measurement Implementation
The ORFS due to switching measurement is performed using a five-pole, synchronously tuned 30 kHz RBW filter with peak hold during the whole burst, and a video bandwidth of 100 kHz.

Types of Signals Measured: Normal bursts

Frequency Capture Range: Signal must be within ±200 Hz of test set's expected frequency

Minimum Input Level: Signal at test set's RF IN/OUT must have TX output power ≥–10 dBm

Measurement Trigger Sources: RF rise, protocol, immediate, auto

Measurement Trigger Delay: User-settable between ±2.31 ms

Measurement Synchronization: RF amplitude

Measurement Offsets: 8 offsets from carrier are user-definable

Available Results: Switching result at each selected offset, output power

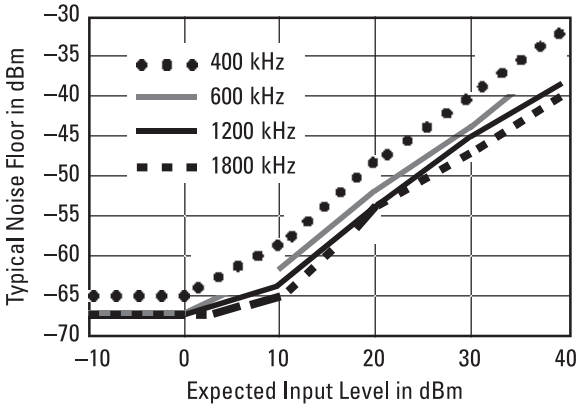
Multi-Measurement Capabilities: 1 to 999 bursts, maximum, average and standard deviation results

Supplemental Characteristics

Typical Absolute Measurement Accuracy (peak hold over 10 measurements): *<±1.0 dB for all offsets up to ±1.8 MHz*

Measurement Resolution: *0.01 dB*

Typical ORFS Due to Switching Measurement Noise Floor versus Expected Input Level at 900 MHz:



Audio Generator Specifications

Frequency

Operating Range: 100 Hz to 5 kHz

Accuracy: Same as timebase reference

Supplemental Characteristics

Typical Operating Range: *1 Hz to 20 kHz*

Frequency Resolution: *0.1 Hz*

Output Level from AUDIO OUTPUT Connector

Ranges: 0 to 1 V peak, 1 to 9 V peak (into ≥600 Ω)

Accuracy: <±1.5% of setting ± resolution

Distortion: <0.1% for 0.2 to 9 V peak into ≥600 Ω

Supplemental Characteristics

Typical Maximum Output Current: *100 mA peak into 8 Ω*

Typical Output Impedance: *<1 Ω*

Typical DC Offset: *<1% of range*

Output Level Resolution: *<0.5 mV for 0 to 1 V peak output, <5.0 mV for 1 to 9 V peak output*

Audio Measurement Specifications

Audio Level Measurement

All specifications for the audio level measurement apply to signals present at test set's AUDIO IN ports.

Types of Signals Measured: Sinusoidal audio signals

Measurement Range: 200 Hz to 8 kHz

External Input Range: 10 mV to 20 V peak

Measurement Accuracy: ±2% of reading ± resolution

Band Pass Filter Capabilities: 100 Hz bandwidth, tunable from 200 Hz to 8 kHz, selectable as on or off

Available Result: rms audio level

Multi-Measurement Capabilities: 1 to 999 measurements, average, minimum, maximum and standard deviation results

Concurrency Capabilities: Audio level measurements can be made concurrently with all other measurements

Supplemental Characteristics

Typical External Input Impedance: *100 kΩ in parallel with 105 pF*

Measurement Resolution: *0.3% of expected level setting or 0.2 mV, whichever is higher*

Uplink Speech Level Measurement

Types of Signals Measured: Speech present on uplink TCH pulsed with 50% duty cycle at a 10 Hz rate

Measurement Range: 200 Hz to 3.6 kHz

Measurement Accuracy: Observed inaccuracies are due to mobile phone encoder errors since the algorithm in the HP 8960 contributes no bit errors

Band Pass Filter Capabilities: 100 Hz bandwidth, tunable from 200 Hz to 3.6 kHz, selectable as on or off

Available Result: % full scale uplink speech level

Multi-Measurement Capabilities: 1 to 999 measurements, average, minimum, maximum and standard deviation results

Concurrency Capabilities: Uplink speech level measurements cannot be made concurrently with BER or FBER measurements. Uplink speech level measurements can be made concurrently with all transmitter measurements and with audio level measurements.

Supplemental Characteristics

Measurement Resolution: *0.01% of full scale*

Timebase Specifications

Internal High Stability 10 MHz Oven-Controlled Crystal Oscillator (OCXO)

Aging Rates: <±0.1 ppm per year, <±0.005 ppm peak-to-peak per day during any 24-hour period starting 24 hours or more after a cold start

Temperature Stability: <±0.01 ppm frequency variation from 25 °C over the temperature range 0 to 55 °C

Warm-Up Times: 5 minutes to be within ±0.1 ppm of frequency at one hour, 15 minutes to be within ±0.01 ppm of frequency at one hour

Supplemental Characteristics

Typical accuracy after a 30 minute warm-up period of continuous operation is derived from: *±[(time since last calibration) × (aging rate) + (temperature stability) + (accuracy of calibration)]*

Typical Initial Adjustment: *±0.03 ppm*

External Reference Input

Input Frequency: 10 MHz

Supplemental Characteristics

Input Frequency Range: *<±5 ppm of nominal reference frequency*

Input Level Range: *0 to +13 dBm*

Input Impedance: *50 Ω nominal*

External Reference Output

Output Frequency: Same as timebase (Internal 10 MHz OCXO or External Reference Input)

Supplemental Characteristics

Typical Output Level: *≥0.5 V rms*

Output Impedance: *50 Ω nominal*

Remote Programming

GP-IB: Hewlett-Packard's implementation of IEEE Standard 488.2

Remote Front Panel Lockout: Allows remote user to disable the front panel display to improve HP-IB measurement speed

Functions Implemented: T6, TE0, L4, LE0, SH1, AH1, RL1, SR1, PP0, DC1, DT0, C0, E2

LAN (Local area network) Port: RJ-45 connector, 10 Base T Ethernet with TCP/IP support

General Specifications

Dimensions (H × W × D): 8.75 × 16.75 × 24.63 inches (222 × 426 × 625 mm)

Weight: 66 lbs (30 kg)

Display: 10.5 inches (26.7 cm), active matrix, color, liquid crystal

Operating Temperature: 0 to +55 °C

Storage Temperature: –20 to +70 °C

Power: 100 to 240 Vac, 50 to 60 Hz, 550 VA maximum

Calibration Interval: 2 years

EMI: Conducted and radiated interference meets CISPR-11. Susceptibility meets IEC 1000-4-2, 1000-4-3 and 1000-4-4.

Supplemental Characteristics

Typical Power Consumption: *400 to 450 W continuous*

Typical Leakage Due to RF Generator: *<5 µV induced in a resonant dipole antenna one inch from any surface except the rear panel at set RF generator output frequency and output level of –40 dBm*

Typical Measurement Speed: *Measured using a 150 MHz Pentium processor in a laptop computer. Measurement speeds may vary depending on controller HP-IB environment and processor speed.*

Measurement Name	*One Measurement*	*Five Measurements*
Phase and Frequency Error	*35 ms*	*110 ms*
Transmitter Output Power	*11 ms*	*30 ms*
Power versus Time (8 time offsets)	*50 ms*	*175 ms*
Output RF Spectrum (2 modulation offsets and 4 switching offsets)	*215 ms*	*320 ms*
Audio Level	*30 ms*	*110 ms*

For more information about the HP 8960 Series 10 E5515A Wireless Communications Test Set visit our web site at:

http://www.hp.com/hp8960support

Available literature includes: brochures, product notes, a configuration guide, and case study.

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