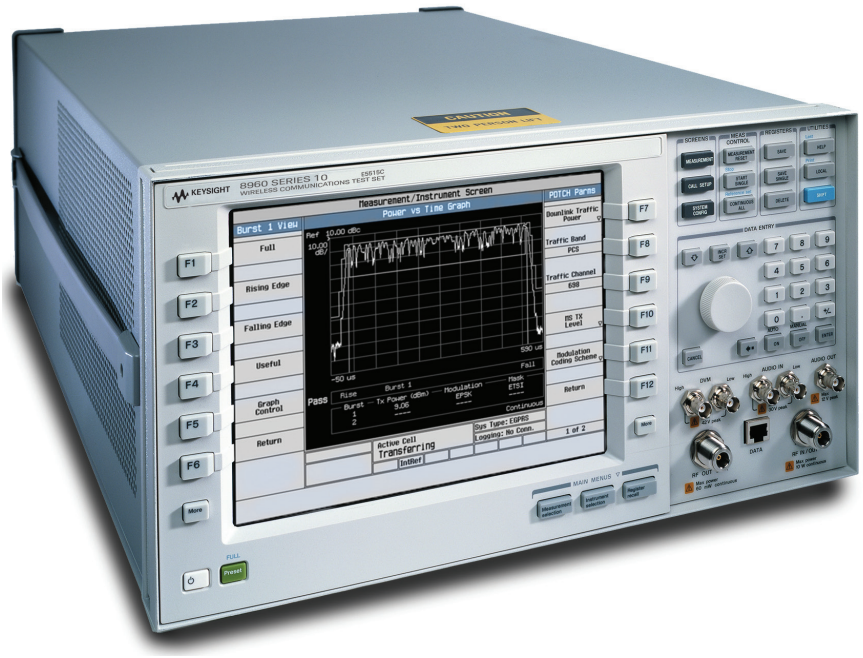
Keysight E1968A

GSM/GPRS/EGPRS Test Application

For the E5515C/E wireless communications test set and the E1987A fast switching test application

Technical Overview



KEYSIGHT TECHNOLOGIES

Accelerate production of high volume quality phones at the lowest possible cost

Flexible

- The E1968A includes all essential connection types and signaling options necessary for a complete GSM/GPRS/ EGPRS/E-EDGE manufacturing test solution
- Some licensed feature options can also be used in R&D and reduce your R&D cycle

Fast

- Digital ORFS – up to 20x faster
- Dynamic power – fast automatic signaling and non-signaling method for Tx output power calibration
- Phase and amplitude versus time (PAvT) – measurement for calibration of polar modulated devices
- Fast device tune (FDT) – faster simultaneous mobile phone Rx and Tx calibration (based on typical test plan)
- Discontinuous timeslot TXP – supports simultaneous power measurement for up to 7 timeslots, reduces phone calibration time

Key features

- PAvT and IQ capture functionality
- Enhanced fast device calibration across level and frequency simultaneously
- E-EDGE2-A signaling and measurement
- VAMOS type I and type II solutions for mobile R&D and manufacturing
- Test mode BER reduces your BER measurement time in production without setting up a call connection; MS calculated BER separates the Rx from Tx test and reduces Rx test time through multi-phone test scenario
- Class 45 feature enables simultaneous Tx and Rx measurement of all bursts up to 6 uplink timeslots
- Real-time audio codec and DAI interface
- Free text-type SMS functionality and licensed full functionality SMS
- Single channel GPS source
- FM radio source allows easy FM radio phone calibration in production
- 2-box voice handover between GSM and W-CDMA

GSM/GPRS/EGPRS/E-EDGE Signaling and Base Station Emulation

The E1968A GSM/GPRS/EGPRS/E-EDGE mobile test application gives you the test solution designed especially for your GSM/GPRS/EGPRS test requirements of transceivers and wireless terminals by delivering speed and flexibility needed for high-volume, automated production-test environments. Since this solution is based on the high-performance E5515C/E (8960) wireless communications test set, you get speed and concurrent measurement capabilities, providing immediate benefits that translate into a competitive advantage for mobile phone manufacturers. This significantly cuts test times, helping reduce the manufacturing cost per phone.

Audio functionality

- Choice of speech encoded on downlink TCH: none, echo, 300 Hz sine, 1 kHz sine, 3 kHz sine, or PRBS-9, PRBS-15, multi-tone, or custom
- GSM analog audio measurement (audio level, distortion, frequency, SINAD)
- Uplink and downlink audio measurement with real-time audio codec and DAI
- PESQ measurement

Receiver measurements

- GSM fast BER via loopback type C
- GSM BER via loopback type A and B
- GPRS/EGPRS multislot BER
- GPRS/EGPRS multislot block error ratio (BLER)
- MS calculated BER
- Test mode BER
- EGPRS2-A 16QAM/32QAM BEP report

Transmitter measurements

- GPRS/EGPRS multislot transmit power
- EGPRS multislot-tolerant transmit power
- 8PSK multislot-tolerant modulation accuracy (peak, rms, 95th percentile and sample EVM; frequency, magnitude and phase errors; origin offset suppression; IQ imbalance)
- GMSK multislot-tolerant frequency error
- GMSK multislot-tolerant phase error (peak and rms with confidence limits)
- Multislot power versus time (burst mask comparison with settable masks)
- Burst timing error with signaling
- Burst timing error under test mode
- Multislot-tolerant output RF spectrum due to modulation and switching
- ORFS measurement in time domain
- IQ tuning
- GSM decoded audio level
- Dynamic power
- Phase and amplitude versus time (PAvT)
- IQ capture
- Fast device tune (FDT)
- AM-PM timing offset
- Discontinuous timeslot TXP measurement
- 8PSK/16QAM measurement

Instruments

- Audio generator
- General-purpose spectrum monitor
- GSM multi-tone audio

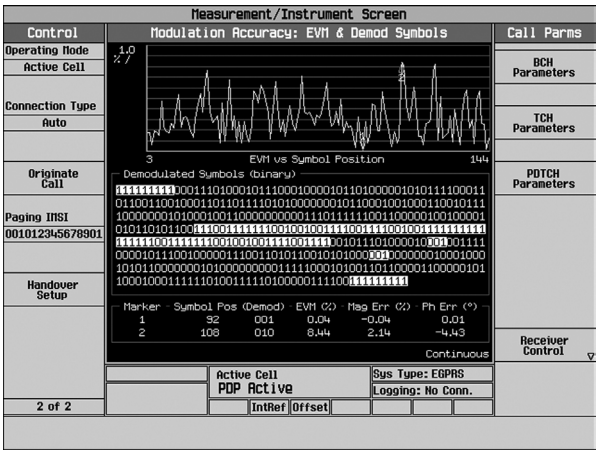


Figure 1. Use graphical measurement results to troubleshoot your EGPRS wireless device.

Integrated GSM, GPRS, and EGPRS Functionality

- Switch between GSM, GPRS, and EGPRS serving cells
- Switch between data and voice connections without losing camp or attach
- Establish a voice or data connection after initial GPRS attach
- Supports Evolved EDGE functionality
- Supports EGPRS2-A signaling and test mode measurement

GSM functionality

Mobile station power output level control	Meets GSM phase one and phase two power control levels
Traffic channels	TCH/FS – FR, EFR, and HR speech modes
Broadcast channel configuration	BCCH + CCCH + SDCCH/4
Signaling protocol setup	FACCH audio speech echo delay is settable from 1 to 4 seconds
Real-time audio codec	Audio encoder and decoder support FR, HR, EFR, AMR, and WB-AMR codec

GPRS functionality

Multislot classes supported	1 through 12
	30 through 45
Control channels	BCH on timeslot 0 on any ARFCN in any band
Broadcast channel configuration	FCCH + SCH + BCCH + CCCH + SDCCH/4 (0-3) + SACCH/C4 (0-3)
Downlink PDTCH	One, two, three, or four on the same PDTCH ARFCN with one or two PDTCH amplitudes settable between 0 and 55 dB below BCH amplitude; amplitudes in adjacent timeslots selectable as off, PRL (power reduction level) one, or PRL two

EGPRS functionality

Multislot classes supported	1 through 12
	30 through 45
Control channels	BCH on timeslot 0 on any ARFCN in any band
Broadcast channel configuration	FCCH + SCH + BCCH + CCCH + SDCCH/4 (0-3) + SACCH/C4 (0-3)
Downlink PDTCH	One, two, three, four, or five on the same PDTCH ARFCN with one or two PDTCH amplitudes settable between 0 and 55 dB below BCH amplitude; amplitudes in adjacent timeslots selectable as off, PRL one, or PRL two

Evolved EDGE Functionality

Downlink PDTCH

- Downlink dual carrier (DLDC) setup
- Supports RTTI mode
- Fast Ack/Non-Ack setup
- 16QAM/32QAM downlink setup
- 16QAM uplink setup

Call Processing Functionality

- GSM MS and BS origination
- GSM MS and BS release
- GPRS mobile-initiated attach and detach
- GPRS and EGPRS packet data transfers on uplink and downlink
- E-EDGE and EGPRS2-A call setup
- Intra-cell channel assignments
- Inter-cell handovers between all bands
- Handover from W-CDMA to GSM (with E1987A test application)
- 2-box handover from W-CDMA to GSM or GSM to GSM
- BA table with 16 settable neighbor cells
- External triggers provide a signal output each frame with settable timeslot, bit, and option to include or exclude the idle frame

BCH setup and parameters

- Settable downlink power, band, and channel number
- Settable maximum control channel power used by the MS for access bursts of 0 to 31
- Settable maximum control channel power offset value for DCS 1800 MHz band of 0 to 3
- Band indication of DCS or PCS

GSM TCH parameters

- Settable downlink in TCH power including power in unused bursts, uplink band, channel number, and power level
- Channel modes of FR, EFR, and HR, plus HR subchannel of 0 or 1
- Settable uplink timeslot of 1 to 7
- Settable timing advance of 0 to 63
- Mobile loopback of off, type A, type B, or type C as defined in ETSI 04.14 or 3GPP 44.014
- Downlink TCH speech types of none, echo, 300 Hz sine, 1 kHz sine, 3 kHz sine, or PRBS-9, PRBS-15, multi-tone, custom or real-time vocoder

GPRS and EGPRS PDTCH parameters

- Settable downlink PDTCH power including power in unused bursts, uplink band, channel number, and power level
- GPRS coding schemes of CS-1, CS-2, CS-3, or CS-4
- EGPRS uplink modulation coding schemes of MCS-1, MCS-2, MCS-3, MCS-4, MCS-5, MCS-6, MCS-7, MCS-8, or MCS-9
- EGPRS downlink modulation coding schemes: Same as uplink, MCS-1, MCS-2, MCS-3, MCS-4, MCS-5, MCS-6, MCS-7, MCS-8, or MCS-9
- EGPRS2-A downlink modulation coding schemes: MCS1 to MCS9, DAS5 to DAS12
- EGPRS2-A uplink modulation coding schemes: MCS1 to MCS6, UAS7 to UAS11
- EGPRS modulation coding scheme of 8PSK clear coded in EGPRS BCH+PDTCH operating mode
- (E)GPRS multislot configurations of 1x1, 1x2, 1x3, 1x4, 1x5, 1x6, 2x1, 2x2, 2x3, 2x4, 3x1, 3x2, 3x3, 4x1, 4x2, 5x1, 6x1 (downlink x uplink)
- Selection of which contiguous down- link bursts to loop back on the uplink with connection type ETSI type B or SRB loopback
- Selection of which uplink burst to use for multislot-tolerant RF measurements

Cell parameters

- Three-digit MNC off or on in PCS 1900 MHz and GSM 850 MHz bands
- Settable MCC, MND, LAC, RAC, NCC, and BCC
- Option to get IMEI at call setup
- Mobile DTX on or off
- Paging mode reorganized or normal
- Settable paging multiframes of 2 to 9
- Repeat paging on or off
- Tx level FACCH signaling on or off
- Symmetric or asymmetric uplink frame segmentation
- Settable random frequency offset for BCH and PDTCH

Handover setup

- GSM traffic band, traffic channel, timeslot, channel mode, half-rate speech subchannel, MS Tx level
- GPRS traffic band, traffic channel, coding scheme, multislot configuration, P0, MS Tx level burst 1 to 6
- EGPRS traffic band, traffic channel, downlink modulation coding scheme, uplink modulation coding scheme, multislot configuration, P0, MS Tx level burst 1 to 6

Protocol control

- RLC/MAC header off or on in GPRS BCH+PDTCH operating mode
- RLC/MAC header selectable as uplink or downlink in EGPRS BCH+PDTCH operating mode
- RLC/MAC packet timeslot reconfigure off or on
- RLC/MAC packet power timing advance on or off
- Settable RLC/MAC block poll rate of 1 to 256
- RLC/MAC frame start position of relative, absolute, or immediate
- LLC BLER FCS of valid or corrupt

Protocol control (continued)

- Settable LLC payload patterns for connection types ETSI type B or for BLER with corrupt FCS of all zeros, all ones, alternate bits, alternate pairs, alternate quads, PRBS-9, PRBS-15, fixed 2B (hex), custom, GMM information for BLER

Receiver control

- Expected power control auto or manual
- Manual power bursts 1 to 6 settable in dBm
- Measurement frequency auto or settable in MHz
- Modulation formal control auto or manual
- Manual modulation of bursts 1 to 6 selectable as GMSK or 8PSK

DUT information

- International mobile subscriber identity (IMSI)
- International mobile equipment identity (IMEI) (if selected)
- GPRS multislot class
- EGPRS multislot class
- GMSK power class
- 8PSK power class

Counters reported

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

Errors reported

- Burst timing error
- BLER (block error rate)

Last location information reported

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

SACCH reports (on a GSM voice call)

- Timing advance
- Tx level
- Rx level
- Rx qual

Neighbor cell reports

- Channel number
- Base station color code (BCC)
- Rx level
- Network color code (NCC)

Operating Modes

Active cell GSM, GPRS, or EGPRS

A BCH is generated on the downlink. Attach and detach procedures, voice and packet data transfers on the uplink(s), and downlink(s) can be executed. TCH and PDTCH band and channel, GSM timeslot, GSM channel mode, GPRS and EGPRS multislot configurations, GPRS coding scheme, EGPRS uplink and downlink modulation coding schemes, and downlink and uplink power level(s) can be changed. All transmitter measurements can be made. GSM, GPRS, or EGPRS is used as the serving cell.

Six connection types are available in the active cell operating modes as follows:

(E)GPRS connection type ETSI type A	Test mode A as defined in ETSI 04.14 or 3GPP 44.014; the downlink is terminated once the uplink has been established
(E)GPRS connection type ETSI type B (unack)	Test mode B as defined in ETSI 04.14 or 3GPP 44.014 with MS in RLC acknowledged mode; downlink PDTCH(s) data is generated and the mobile loops back the downlink data on the uplink(s); BER and BLER measurements can be made
(E)GPRS connection type ETSI type B (ack)	Test mode B as defined in ETSI 04.14 or 3GPP 44.014 with MS in RCL acknowledged mode; downlink PDTCH(s) data is generated and the mobile loops back the downlink data on the uplink(s); BER and BLER measurements can be made
(E)GPRS connection type BLER	Keysight-proprietary data connection with the primary purpose of calculating BLER
Connection type auto	A GSM voice call or GPRS or EGPRS data connection can be initiated by the mobile; the test set can initiate a GSM voice call; if a voice call is in progress, data transfer requests are ignored; network-initiated GSM voice call while a GPRS or EGPRS data transfer is in progress causes the data connection to be terminated
EGPRS connection type SRB loopback	An EGPRS Layer 1 loopback mode for testing BER as defined in ETSI 04.14 or 3GPP 44.014

Cell off

All signaling and RF power output is discontinued; this mode is used mainly for adjusting cell parameters that cannot be changed when a live cell is operating.

The following six operating modes use limited signaling for call setup. Protocol is used only to maintain a link established by the mobile station. Over-the-air signaling and capability to demodulate and decode uplink random access channel (RACH) bursts are not available.

GSM BCH	A broadcast channel (BCH) without a traffic channel (TCH) is generated on the downlink and mobile station level information is carried on the broadcast control channel (BCCH)
GSM BCH+TCH	A BCH and TCH are generated on the downlink; mobile station level information is carried on the BCCH and the downlink slow associated control channel (SACCH); 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 absolute radio frequency channel number (ARFCN) 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
GPRS BCH	A BCH is generated on the downlink, but no uplink demodulation occurs
GPRS BCH + PDTCH(s)	A BCH and PDTCH(s) are generated on the down link and the downlink multislot configuration can be changed; a forced call can be established if the mobile is manually synchronized to the test set's downlink and the mobile's uplink PDTCH(s) uses the same ARFCN and timeslot(s) as the downlink; when a forced call is established, BER and BLER measurements can be made and demodulation and channel decoding of the uplink are available, although no messages are decoded
EGPRS BCH	A BCH is generated on the downlink, but no uplink demodulation occurs
EGPRS BCH+PDTCH(s)	A BCH and PDTCH(s) are generated on the down link and the downlink multislot configuration can be changed; a forced call can be established if the mobile is manually synchronized to the test set's downlink and the mobile's uplink PDTCH(s) uses the same ARFCN and timeslot(s) as the downlink; when a forced call is established, BER and BLER measurements can be made and demodulation and channel decoding of the uplink are available, although no messages are decoded
CW	Under CW mode, an unmodulated continuous wave (CW) or a FM signal can be generated on the downlink; the level and frequency of the CW signal can be changed; for FM signal, besides the level, frequency, some other FM related parameters such as FM deviation and modulation frequency are also settable; no uplink demodulation or channel decoding is available with CW mode; in the latest firmware, reduced single channel GPS source signal can be generated under CW mode. The power level, satellite ID and data patterns can be changed
Fast device tune	With this special operating mode, a downlink GSM/GPRS signal sequence based on GSM/GPRS burst and frame structure can be generated for mobile phone Rx calibration; simultaneously, a measurement uplink test sequence also can be configured for mobile phone Tx calibration. Thus, the phone calibration time will be reduced significantly

Technical Specifications

These specifications apply to an E5515C mainframe with Option 002, or E5515E when used with the E1968A test application of firmware revision A.09 or higher, or the E1987A test application of firmware revision A.08 or higher. Depending on the exact configuration, earlier E5515C and E5515B instruments may require hardware upgrades to obtain certain features and capability. Features which may require hardware upgrades include: EGPRS (all capability), higher EGPRS multislot classes, spectrum monitor, RF out only port, phase and amplitude versus time (PAvT), fast device tune, and ORFS digital filter option.

CAUTION: Loading an application onto your E5515C/E test set that is not compatible with your E5515C/E's hardware revision can cause your E5515C/E to lock-up. For information on application/E5515C/E compatibility go to **www.keysight.com/find/E5515C** and select the relevant link to E5515C/E Release Notes. Always refer to this information before loading an application.

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 generator level accuracy is derived from 95th percentile observations with 95 percent confidence (corresponds to an expanded uncertainty with a 95 percent confidence (k=2)) at ambient conditions, then qualified to include the environmental effects of temperature and humidity.

RF (downlink) generator specifications

RF generator specifications apply to both RF IN/OUT and the RF OUT ONLY port on the 8960 (E5515C/E).

RF frequency	
Frequency ranges	450 to 496 MHz, 700 to 800 MHz, 810 to 960 MHz, 1.7 to 1.9 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
Operating frequency range	292 to 2700 MHz
Setting resolution	1 Hz
RF amplitude	
Output level range at RF IN/OUT	–110 to –13 dBm
Output level range at RF OUT ONLY	–110 to –5 dBm
Absolute output level accuracy	< ± 1.0 dB
VSWR at RF IN/OUT	< 1.14 : 1 for 450 to 496 MHz and 810 to 960 MHz, < 1.2 : 1 for 1.7 to 1.99 GHz
Reverse power at RF IN/OUT	< 2.5 W continuous, < 5 W peak bursted power
Reverse power at RF OUT ONLY	< 500 mW continuous
Supplemental characteristics	
Typical output level accuracy	< ± 0.5 dB
Typical output level repeatability at RF IN/OUT (returning to the same frequency and level)	< ± 0.1 dB
Typical VSWR at RF OUT ONLY	< 1.4 : 1 for 450 to 496 MHz and 810 to 960 MHz, < 1.45 : 1 for 1.7 to 1.99 GHz
Typical isolation from RF OUT ONLY port to RF IN/OUT port (when the RF generator is routed to the RF OUT ONLY port)	> 60 dB for 450 to 496 MHz and 810 to 960 MHz, > 40 dB for 1.7 to 1.99 GHz
Operating level range at RF IN/OUT	–127 to –10 dBm
Operating level range at RF OUT ONLY	–119 to –2 dBm
FM signal generation	
These specifications apply to an E5515C/E test set when used with an E5520A FM adapter. Output signal amplitude and distortion specifications for FM testing with the E5515C/E and E5520A are supplemental.	
Amplitude	
Conversion gain through E5520A	–20.00 dB
Output level range	–20 to –140 dBm
Output level accuracy	± 1 dB at 76 to 108 MHz and –30 to –110 dBm
Frequency modulation	
Rate range	50 Hz to 20 kHz
Deviation range	0 to 75 kHz
Deviation accuracy	± 5% + residual FM at 1 kHz rate
Residual FM	< 30 Hz at 50 Hz to 20 kHz

Single channel GPS source	
A reduced single channel GPS signal can be generated for GPS receiver C/N0 test. The signal can be output from either RF IN/OUT or RF OUTPUT ONLY.	
Signal frequency	1575.42 MHz
Signal level range	–70 to –125 dBm
Satellite ID	1 to 37
Chip rate	1.023 Mcps
Code support	C/A code
Signal level accuracy	< ± 1.0 dB for signal level from – 70 to –116 dBm
	< ± 1.5 dB for signal level from –116 to –25 dBm

GMSK signal generation	
Absolute output level accuracy with GMSK modulation on:	
Specification	Ranges
< ± 1.10 dB	Single slot from –110 to –13 dBm
< ± 1.10 dB	1 multislot level between –110 and –13 dBm
< ± 1.50 dB	2 multislot levels ≤ 20 dB apart between –110 and –70 dBm
Peak phase error	< ± 4 degrees
rms phase error	< 1 degree
Frequency error	< ± 0.01 ppm plus timebase reference
Amplitude flatness	< ± 0.3 dB for single-slot GMSK signals
	< ± 1.0 dB for multislot GMSK signals
Supplemental characteristics	
Typical absolute output level accuracy with GMSK modulation on:	
Specification	Ranges
< ± 0.55 dB	Single slot from –110 to –13 dBm
< ± 0.55 dB	1 multislot level between –110 and –13 dBm
< ± 0.85 dB	2 multislot levels ≤ 20 dB apart between –110 and –70 dBm
Typical burst modulation on/off ratio (referenced to lowest signal level)	> 50 dB

8PSK signal generation	
Absolute output level accuracy with 8PSK modulation on:	
Specification	Ranges
< ± 1.10 dB	Single slot from –110 to –13 dBm
< ± 1.10 dB	1 multislot level between –110 and –13 dBm
< ± 1.50 dB	2 multislot levels ≤ 20 dB apart between –110 and –70 dBm
rms EVM	< 4%
Origin offset suppression	> 35 dB
Frequency error	< ± 0.02 ppm plus timebase reference
Supplemental characteristics	
Typical absolute output level accuracy with 8PSK modulation on:	
Specification	Ranges
< ± 0.57 dB	Single slot from –110 to –13 dBm
< ± 0.57 dB	1 multislot level between –110 and –13 dBm
< ± 0.85 dB	2 multislot levels ≤ 20 dB apart between –110 and –70 dBm

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 to < 100 kHz offsets
	< –53 dBc for line-related non-harmonics
Typical spurious due to receiver LO leakage	< –50 dBm for spurious at 105 ± 2.5 MHz below expected transmitter frequency and its second harmonic

RF analyzer functionality

RF frequency	
Ranges applied to demodulation and transmitter specifications	450 to 496 MHz, 700 to 800 MHz, 810 to 960 MHz, and 1.7 to 1.99 GHz
Supplemental characteristics	
Operating range	292.5 to 2700 MHz

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 results.

EGPRS 8PSK measurements are GSMSK-tolerant. Any GMSK bursts are detected and discarded. Measurements continue when the next 8PSK burst is detected. EGPRS GMSK measurements are also 8PSK-tolerant.

Frequency coverage and amplitude range

Unless otherwise noted, all specifications apply to frequencies of 450 to 496 MHz, 700 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 +37 dBm, and temperatures of 0 to +55 °C. Input signal transmit 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 ± 100 kHz of test set's expected frequency for warranted performance
Single-slot demodulation sensitivity	≥ –30 dBm for BER and BLER measurements
Multislot demodulation sensitivity	All uplink timeslots ≥ –30 dBm for maintaining a data link when
	– Adjacent GMSK timeslots from GPRS signals are ≤ 25 dB different in level
	– Adjacent GMSK timeslots from EGPRS signals are ≤ 20 dB different in level, or
	– Adjacent 8PSK timeslots are ≤ 10 dB different in level
Supplemental characteristics	
Typical demodulation sensitivity	≥ –40 dBm for maintaining a link

GSM BER measurement

Types of signals measured	Compares 260 bits of speech data using mobile phone loopback with or without signaling of erased speech frames
Minimum input level	Uplink signals at test set's RF IN/OUT must have transmit power ≥ –30 dBm for warranted performance
Residual BER	< 10^{-6}
Mobile loopback	In active cell operating modes as type A or type B must be selected
Measurement type	Selected as residual type Ia, residual type Ib, residual type II, type Ia, type Ib, or type II
Signaling loopback control	Selectable as on or off
Data patterns	Selectable in GSM+TCH operating mode as all zeros, all ones, alternate bits, alternate pairs, alternate quads, PRBS-9, PRBS-15, fixed 2B (hex), multi-tone, or custom
Closed-loop signaling delay:	Settable between 0 and 5 s
Speech frames delay	Settable between 1 and 15 frames or automatically determined
Measurement unit	Selectable as percent or count
Numerical results	BER, number of bits tested, number of bad bits, frame erasure (FER) for residual measurement types, cyclic redundancy check (CRC) for non-residual measurement types, speech frame delay, Rx level, Rx quality
Multi-measurement capabilities	1 to 999,000 bits
Concurrency capabilities	GSM BER measurements cannot be made concurrently with GSM FBER measurements, GSM decoded audio level measurements, or while speech is provided on the downlink TCH; GSM BER measurements can be made concurrently with all other measurements
Supplemental characteristics	
Measurement resolution	0.01 percent

GSM 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	Uplink signal at test set's RF IN/OUT must have transmit power ≥ –30 dBm for warranted performance
Residual BER	< 10^{-6}
Measurement data pattern	PRBS-9, PRBS-15
Mobile loopback	In active cell operating mode type C must be selected
TDMA frame delay	Settable between 0 and 26 frames or automatically determined
Signaling loopback control	On or off
Closed-loop signaling delay	Settable between 0 and 5 s
Measurement unit	Selectable as percent or count
Numerical results	Number of bits tested, FBER, number of bad bits, TDMA frame delay, Rx level, Rx quality
Multi-measurement capabilities	1 to 999,000 bits
Concurrency capabilities	GSM FBER measurements cannot be made concurrently with GSM BER measurement, GSM decoded audio level measurements, or while speech is provided on the downlink TCH; GSM FBER measurements can be made concurrently with all other measurements
Supplemental characteristics	
Measurement resolution	0.01 percent

(E)GPRS multislot BER measurement

Types of signals measured	PRBS-15 data sent on GMSK or 8PSK downlink PDTCH(s) and looped back by the mobile
Minimum input level	For warranted performance, uplink signals at test set's RF IN/OUT must have transmit power ≥ –30 dBm and – ≤ 25 dB difference in power between levels of adjacent GMSK timeslots sent on GPRS signals – ≤ 20 dB difference in power between levels of adjacent GMSK timeslots sent on EGPRS signals, or – ≤ 10 dB difference in power between levels of adjacent 8PSK timeslots
Residual BER	< 10^{-6}
Connection types	ETSI type B in active cell GPRS or EGPRS operating mode or SRB loopback in active cell EGPRS operating mode
Measurement data patterns	With data connection type ETSI B (unack) and data looped back by the mobile, selectable as all zeros, all ones, alternate bits, alternate pairs, alternate quads, PRBS-9, PRBS-15, fixed 2B (hex), or custom
GPRS block delay	Settable from 1 to 12 blocks or automatically determined
EGPRS close loop signaling delay	Settable from 0 to 5 s
EGPRS loopback delay	From 0 to 20
GPRS zero bad blocks	Settable as off or on; when on, all bits within a bad block are set to zero
Numerical results	Number of bits tested, BER, bit error count, GPRS block delay, EGPRS loopback delay
Multi-measurement capabilities	1 to 999,000 bits
Concurrency capabilities	(E)GPRS BER measurements cannot be made concurrently with (E)GPRS BLER measurements, but can be made concurrently with all other measurements
Supplemental characteristics	
Measurement resolution	0.01 percent

(E)GPRS multislot BLER measurement

Types of signals measured	GMSK data looped back by the mobile using connection type ETSI type B (unack), 8PSK data looped back by the mobile using connection type SRB loopback, or information reported by the mobile in Packet_Uplink_Ack_Nack messages using connection type ETSI type B (ack) or BLER
Minimum input level	For warranted performance, uplink signals at test set's RF IN/OUT must have transmit power ≥ –30 dBm and
For warranted performance, uplink signals at test set's RF IN/OUT must have transmit power ≥ –30 dBm and	≤ 25 dB difference in power between levels of adjacent GMSK timeslots sent on GPRS signals ≤ 20 dB difference in power between levels of adjacent GMSK timeslots sent on EGPRS signals, or ≤ 10 dB difference in power between levels of adjacent 8PSK timeslots
Connection types	Settable as ETSI type B (unack), ETSI type B (ack), BLER (for GPRS), or SRB loopback (for EGPRS)
Measurement data patterns	With data connection type ETSI B (unack) and data looped back by the mobile, selectable as all zeros, all ones, all alternate bits, alternate pairs, alternate quads, PRBS-9, PRBS-15, or fixed 2B (hex), or custom
Block delay	Settable between 1 and 6 blocks or automatically determined
Numerical results	Number of blocks tested, BLER, block error count, BLER of each burst (for connection type ETSI type B (ack), or BLER), level of each downlink burst, block delay
Multi-measurement capabilities	1 to 99,000 blocks
Concurrency capabilities	GPRS/EGPRS BLER measurements cannot be made concurrently with GPRS/EGPRS BER measurements, but can be made concurrently with all other measurements
Supplemental characteristics	
Measurement resolution	0.01 percent

Transmitter measurement specifications

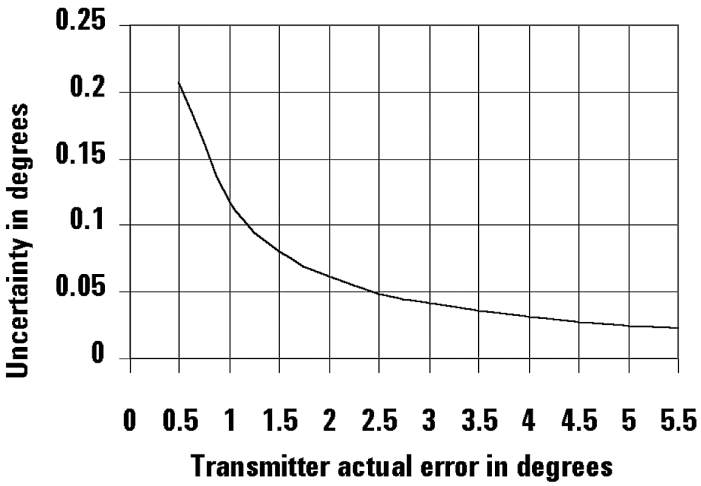
Unless otherwise specified, transmitter measurements can be performed in active cell (GSM), active cell (GPRS), and active cell (EGPRS) operating modes.

GMSK multislot-tolerant phase and frequency error measurement

Types of signals measured	Normal GSMK bursts from GPRS or EGPRS signals, RACH bursts for a single uplink timeslot only
Multislot input signal conditions	≤ 30 dB difference in power level between adjacent timeslots
Multislot signal measurement capability	Measurement of one user-specified timeslot transmitted as a single timeslot or four adjacent timeslots
GPRS frequency capture range	Signal must be within ± 100 kHz of test set's expected frequency for warranted performance
EGPRS frequency capture range	Signal must be within ± 1 kHz of test set's expected frequency for warranted performance
Minimum input level	Signal at test set's RF IN/OUT must have transmit 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
Trigger sources	RF rise, protocol, immediate, auto, external
Trigger delay	Settable between ± 2.31 ms
Trigger qualification	On or off
Burst synchronization	Midamble, RF amplitude, none for a single uplink timeslot; midamble for two uplink timeslots and all EGPRS signals

GMSK multislot-tolerant phase and frequency error measurement (continued)

Confidence level	Settable from 80 to 99.99 percent
Peak phase error pass/fail maximum limit	Settable between 0 and 20 degrees
rms phase error pass/fail maximum limit	Settable between 0 and 5 degrees
Frequency error pass/fail maximum limit	Settable between 0 and 0.1 ppm
Numerical results	rms and peak phase error, frequency error, pass/fail for each result
Displayed graphical results	Peak phase error in degrees versus bits and demodulated bits with settable marker and pass/fail limits, variable bit and amplitude axes
Multi-measurement capabilities	1 to 999 bursts; maximum, minimum, and average phase and frequency error, and worst-case frequency error results
Concurrency capabilities	GMSK multislot-tolerant phase and frequency error measurements can be made concurrently with all other measurements
Supplemental characteristics	
Frequency error measurement resolution	0.01 Hz
Phase error measurement resolution	0.01 degree
Typical rms phase error uncertainty versus transmitter actual error	



8PSK/16QAM multislot-tolerant modulation accuracy measurement

All specifications for the 8PSK/16QAM multislot-tolerant modulation accuracy measurement are valid for the frequency ranges 700 to 800 MHz, 810 to 960 MHz, and 1.7 to 1.99 GHz.

Types of signals measured	Normal 8PSK/16QAM bursts
Multislot input signal conditions	≤ 30 dB difference in power level between adjacent timeslots
Multislot signal measurement capability	Measurement of one user-specified timeslot transmitted as a single timeslot or four adjacent timeslots
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 8PSK/16QAM burst power ≥ –15 dBm for warranted performance
Residual rms EVM	< 1 percent for 8PSK
	< 1 percent for 8PSK difference ≤ 30 dB
rms EVM measurement accuracy	< 0.5 or > –1.0 for 8PSK
	< 1.5 or > 2.0 for 16QAM for measured average rms EVM between 1 and 10 percent
Sample EVM measurement accuracy	< ± 4 percent
Frequency error measurement accuracy	< ± 10 Hz plus timebase accuracy
Origin offset suppression measurement accuracy for 8PSK	< ± 1.5 dB for measured origin offset suppression between 25 and 40 dB
Trigger sources	RF rise, protocol, immediate, auto, external
Trigger delay	Settable between ± 2.31 ms
Burst synchronization	Midamble
Displayed graphical results	EVM versus symbol, demodulated symbols in octal and binary, magnitude error versus symbol, phase error versus symbol, sample EVM histogram with plots of measured sample EVM PDF, expected sample EVM PDF, 95th percentile EVM, and probability with settable markers and variable axes
Multi-measurement capabilities	1 to 999 bursts; maximum, minimum, and average results
Concurrency capabilities	8PSK multislot-tolerant modulation accuracy measurements can be made concurrently with all other measurements
Supplemental characteristics	
Measurement resolution	0.01 percent
Frequency error measurement resolution	0.01 Hz
Origin offset suppression measurement resolution	0.01 dB
Amplitude droop measurement resolution	0.01 dB
Magnitude error measurement resolution	0.01 percent
Phase error measurement resolution	0.01 degree
IQ imbalance measurement resolution	0.01 dB
Probability measurement resolution	0.01 percent

GSM/GPRS/EGPRS multislot transmit power measurement

The following specifications are valid when the burst capture range is set to Single:

Types of signals measured	Normal GMSK bursts sent as GSM or GPRS signals, CW, RACH bursts for a single uplink timeslot only
Multislot input signal conditions	≤ 30 dB difference in power level between adjacent timeslots
Multislot signal measurement capability	Measurement of one user-specified timeslot transmitted as a single timeslot or two adjacent timeslots
Frequency capture range	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 transmit power ≥ –25 dBm for warranted performance
	Measurement accuracy at RF IN/OUT port between +20 and +55 °C

Accuracy (dBm)	Frequency (MHz)	Timeslot
< ± 0.27 < ± 0.29	810 to 960 450 to 496 700 to 800 1700 to 1990	Single slot and multislot at the same level
< ± 0.52 < ± 0.54	810 to 960 450 to 496 700 to 800 1700 to 1990	Multislot at different levels

Measurement accuracy when RF OUT ONLY port is selected for signal generation (in addition to measurement accuracy at RF IN/OUT port):

Accuracy (dBm)	Frequency (MHz)
< ± 0.27 < ± 0.29	450 to 496 700 to 800 810 to 960
< ± 0.52 < ± 0.54	1700 to 1990

VSWR at RF IN/OUT	< 1.14 : 1 for 450 to 496 MHz and 700 to 960 MHz, < 1.2 : 1 for 1.7 to 1.99 GHz
Trigger sources	RF rise, protocol, immediate, auto, external
Trigger delay	Settable between ± 2.31 ms

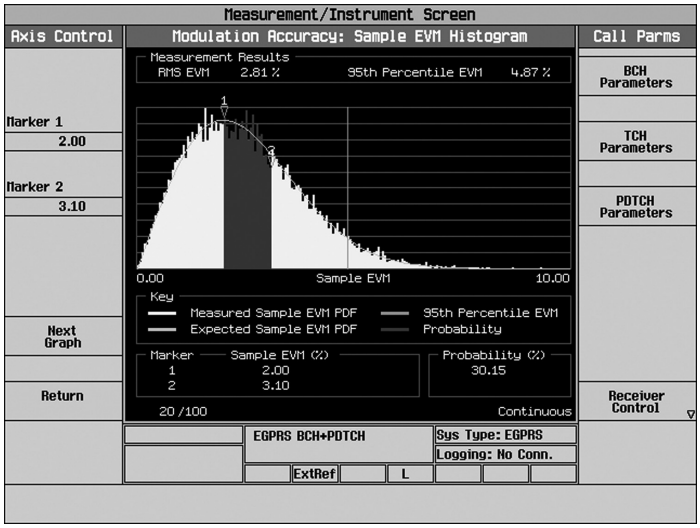


Figure 2. EGPRS modulation accuracy measurement includes a graphical sample EVM histogram to observe your device's statistical EGPRS performance.

GSM/GPRS/EGPRS multislot transmit power measurement (continued)

Burst synchronization	RF amplitude (GSM/GPRS midamble-synchronized transmit power result is available as part of the multislot power versus time measurement)
Numerical result	GMSK transmit power
Multi-measurement capabilities	1 to 999 bursts; minimum, maximum, average, and standard deviation results
Concurrency capabilities	GSM/GPRS/EGPRS multislot-tolerant transmit power measurements can be made concurrently with all other measurements
Supplemental characteristics	
Extended amplitude range	Results are provided for signals at the test set's RF IN/OUT port for transmit power within –10 and +5 dB of expected power

Typical measurement accuracy at RF IN/OUT port:

Accuracy (dBm)	Frequency (MHz)	Timeslot
< ± 0.10	450 to 496	Single slot and multislot at the same level
< ± 0.13	700 to 800 810 to 960	
< ± 0.14	1700 to 1990	
< ± 0.32	450 to 496	Multislot at different levels
< ± 0.36	700 to 800 810 to 960	
< ± 0.38	1700 to 1990	

Typical measurement accuracy when RF OUT ONLY port is selected for signal generation (in addition to typical measurement accuracy at RF IN/OUT port):

Accuracy (dBm)	Frequency (MHz)
< ± 0.01	450 to 496 700 to 800 810 to 960
< ± 0.04	1700 to 1990

Typical measurement repeatability	< ± 0.05 dB
Measurement resolution	0.01 dB
The following specifications are valid when the burst capture range is set to All:	
Types of signals measured	Normal GMSK bursts sent as GSM or GPRS signals, normal GMSK and 8PSK bursts sent as EGPRS signals, CW, RACH bursts for a single uplink timeslot only
Multislot input signal conditions	< 30 dB difference in power level between adjacent timeslots. When autoranging is off, input signal transmit power must be within ± 3 dB for highest burst and +3 dB/–30 dB for other bursts relative to expected power of highest burst; when autoranging is on, input signal transmit power must be within ± 3 dB/–30 dB for all bursts
Multislot signal measurement capability	Simultaneous measurement of all bursts up to 6 uplink timeslots in the multislot Class 45 configuration
Frequency capture range	Signal must be within ± 100 kHz of the test set's expected frequency for warranted performance
Minimum input level	For warranted performance, signal at test set's RF IN/OUT must have transmit power > –25 dBm for GMSK transmit power or 8PSK burst power, and > –20 dBm for 8PSK estimated carrier power

Measurement accuracy for GMSK transmit power at RF IN/OUT port between +20 and +55 °C

Accuracy (dBm)	Frequency (MHz)	Timeslot
< ± 0.27	700 to 800 810 to 960	Single slot
< ± 0.29	450 to 496 1700 to 1990	

Measurement accuracy for GMSK transmit power at RF IN/OUT port between +20 and +55 °C (continued)

Accuracy (dBm)	Frequency (MHz)	Timeslot
< ± 0.32	700 to 800 810 to 960	Multislot at the same level
< ± 0.34	450 to 496 1700 to 1990	
< ± 0.70	700 to 800 810 to 960	Multislot at different levels
< ± 0.72	450 to 496 1700 to 1990	

Measurement accuracy for 8PSK burst power at RF IN/OUT port between +20 and +55 °C

Accuracy (dBm)	Frequency (MHz)	Timeslot
< ± 0.32	700 to 800 810 to 960	Single slot
< ± 0.33	450 to 496 1700 to 1990	
< ± 0.36	700 to 800 810 to 960	Multislot at the same level
< ± 0.37	450 to 496 1700 to 1990	
< ± 0.75	700 to 800 810 to 960	Multislot at different levels
< ± 0.76	450 to 496 1700 to 1990	

Measurement accuracy for 8PSK/16QAM estimated carrier power at RF IN/OUT port between +20 and +55 °C

Accuracy (dBm)	Frequency (MHz)	Timeslot
< ± 0.42	700 to 800 810 to 960	Single slot
< ± 0.43	450 to 496 1700 to 1990	
< ± 0.46	700 to 800 810 to 960	Multislot at the same level
< ± 0.47	450 to 496 1700 to 1990	
< ± 0.85	700 to 800 810 to 960	Multislot at different levels
< ± 0.86	450 to 496 1700 to 1990	

Note: 8PSK estimated carrier power specifications above can be met when signal quality is not degraded.

Measurement accuracy when RF OUT ONLY port is selected for signal generation (in addition to measurement accuracy at RF IN/OUT port)

Accuracy (dBm)	Frequency (MHz)
< ± 0.01	450 to 496 700 to 800 810 to 960
< ± 0.04	1700 to 1990

VSWR at RF IN/OUT	< 1.14 : 1 for 450 to 496 MHz and 700 to 960 MHz, < 1.2 : 1 for 1.7 to 1.99 GHz
Trigger sources	RF rise, protocol, immediate, auto, external
Trigger delay	Settable between ± 2.31 ms
Burst synchronization	Midamble
Numerical result	GMSK transmit power, 8PSK burst power, 8PSK estimated carrier power, 16QAM burst power, 16QAM estimated carrier power
Multi-measurement capabilities	1 to 999 bursts; minimum, maximum, average, and standard deviation results
Concurrency capabilities	GSM/GPRS/EGPRS multislot transmit power measurements can be made concurrently with all other measurements

Supplemental characteristics

Supplemental characteristics	Results are provided for signals at the test set's RF IN/OUT port for transmit power within –10 and +5 dB of expected power

Typical measurement accuracy for GMSK transmit power at RF IN/OUT port:

Accuracy (dBm)	Frequency (MHz)	Timeslot
< ± 0.10	700 to 800 810 to 960	Single slot
< ± 0.11	450 to 496 1700 to 1990	
< ± 0.14	700 to 800 810 to 960	Multislot at the same level
< ± 0.15	450 to 496 1700 to 1990	
< ± 0.29	700 to 800 810 to 960	Multislot at different levels
< ± 0.30	450 to 496 1700 to 1990	

Typical measurement accuracy for 8PSK/16QAM burst power at RF IN/OUT port:

Accuracy (dBm)	Frequency (MHz)	Timeslot
< ± 0.14	700 to 800 810 to 960	Single slot
< ± 0.15	450 to 496 1700 to 1990	
< ± 0.17	700 to 800 810 to 960	Multislot at the same level
< ± 0.17	450 to 496 1700 to 1990	
< ± 0.33	700 to 800 810 to 960	Multislot at different levels
< ± 0.34	450 to 496 1700 to 1990	

Typical measurement accuracy when RF OUT ONLY port is selected for signal generation (in addition to typical measurement accuracy at RF IN/OUT port):

Accuracy (dBm)	Frequency (MHz)
< ± 0.01	450 to 496 700 to 800 810 to 960
< ± 0.04	1700 to 1990

Typical measurement repeatability	< ±0.05 dB
Measurement resolution	0.01 dB

EGPRS multislot-tolerant transmit power measurement

Types of signals measured	Normal GMSK and 8PSK/16QAM bursts sent as EGPRS signals
Multislot input signal conditions	≤ 30 dB difference in power level between adjacent timeslots
Multislot signal measurement capability	Measurement of one user-specified timeslot transmitted as a single timeslot or two adjacent timeslots
Frequency capture range	Signal must be within ± 1 kHz of test set's expected frequency for warranted performance
Minimum input level	For warranted performance, signal at test set's RF IN/OUT must have transmit power
	≥ –25 dBm for GMSK transmit power or 8PSK burst power, and
	≥ –20 dBm for 8PSK/16QAM estimated carrier power

Measurement accuracy for GMSK transmit power or 8PSK/16QAM burst power at RF IN/OUT port between +20 and +55 °C:

Accuracy (dBm)	Frequency (MHz)	Timeslot
< ± 0.32	700 to 800 810 to 960	Single slot and multi-slot at the same level
< ± 0.34	450 to 496 1700 to 1990	
< ± 0.57	700 to 800 810 to 960	Multislot at different levels
< ± 0.59	450 to 496 1700 to 1990	

Measurement accuracy for 8PSK/16QAM estimated carrier power at RF IN/OUT port between + 20 and +55 °C:

Accuracy (dBm)	Frequency (MHz)	Timeslot
< ± 0.40	700 to 800 810 to 960	Single slot and multi-slot at the same level
< ± 0.42	450 to 496 1700 to 1990	
< ± 0.65	700 to 800 810 to 960	Multislot at different levels
< ± 0.67	450 to 496 1700 to 1990	

Note: 8PSK estimated carrier power accuracy specifications above can be met when signal quality is not degraded.

Measurement accuracy when RF OUT ONLY port is selected for signal generation (in addition to measurement accuracy at RF IN/OUT port):

Accuracy (dBm)	Frequency (MHz)
< ± 0.01	450 to 496 700 to 800 810 to 960
< ± 0.04	1700 to 1990

VSWR at RF IN/OUT	< 1.14 : 1 for 450 to 496 MHz and 700 to 960 MHz, < 1.2 : 1 for 1.7 to 1.99 GHz
Trigger sources	RF rise, protocol, immediate, auto, external
Trigger delay	Settable between ± 2.31 ms
Burst synchronization	Midamble
Numerical result	GMSK transmit power, 8PSK burst power, 8PSK estimated carrier power, 16QAM burst power, 16QAM estimated carrier power
Multi-measurement capabilities	1 to 999 bursts; minimum, maximum, average, and standard deviation results
Concurrency capabilities	EGPRS multislot-tolerant transmit power measurements can be made concurrently with all other measurements
Supplemental characteristics	
Extended amplitude range	Results are provided for signals at the test set's RF IN/OUT port for transmit power within –10 and +5 dB of expected power

Typical measurement accuracy for GMSK transmit power or 8PSK burst power at RF IN/OUT port:

Accuracy (dBm)	Frequency (MHz)	Timeslot
< ± 0.15	700 to 800 810 to 960	Single slot and multi-slot at the same level
< ± 0.16	450 to 496 1700 to 1990	
< ± 0.35	700 to 800 810 to 960	Multislot at different levels
< ± 0.36	450 to 496 1700 to 1990	

Typical measurement repeatability	< ±0.05 dB
Measurement resolution	0.01 dB

Multislot power versus time measurement

All specifications for the multislot power versus time measurement are valid between +20 and +55 °C and using high linearity ranging mode. GSM/GPRS/EGPRS multislot transmit power measurement or EGPRS multislot-tolerant transmit power measurement accuracy specifications apply to output power results.

Types of signals measured	Normal GMSK and 8PSK bursts, RACH bursts for a single uplink timeslot only
Multislot input signal conditions	≤ 30 dB difference in power level between adjacent timeslots. For warranted performance at Capture All Mode, the maximum difference between all slots should be ≤ 20 dB
Multislot signal measurement capability	Measurement of a single GMSK or 8PSK uplink timeslot or five adjacent GMSK and/or 8PSK uplink timeslots with capture all mode
Frequency capture ranges	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 transmit power ≥ –15 dBm for warranted performance
Mask placement timing accuracy	< ± 0.1 symbols with midamble synchronization

Accuracy (dBm)	Frequency (MHz)
< ± 0.5 dB	–7 to +1 dB for GMSK bursts
< ± 1.0 dB	–7 to +4 dB for 8PSK bursts
< ± 2.0 dB	–20 to < –7 dB
	–32 to < –20 dB
< ± 2.7 dB	–50 to < –32 dB, ≥ –46 dBm [1]
< ± 3.0 dB	–60 to < –50 dB, ≥ –46 dBm [1]

1. For measurements on any burst in a multislot configuration where the burst is not the highest, the minimum power is the higher of the following three cases:
   - –60 dB below reference
   - For capture all mode –60 dB and for capture single mode, –70 dB below reference plus the offset between this burst power levels and the highest burst power level
   - –46 dBm

Trigger sources	RF rise, protocol, immediate, auto, external
Trigger delay	Settable between ± 2.31 ms
Burst synchronization	Midamble, RF amplitude, none for a single GSM or GPRS uplink timeslot; midamble for two GSM or GPRS uplink timeslots or any EGPRS uplink timeslots
Tx power method	Estimated carrier power or average burst power
Ranging mode	High linearity or high dynamic range
Marker measurement points	12 time points within each burst are definable
PCS ETSI limit	Selection of narrow or relaxed mask in PCS 1900 MHz band
Mask types	Selectable as ETSI, custom 1, custom 2, or no mask for each burst and ETSI, custom, or no mask for guard period between bursts
Numerical results	– For entire single or multislot signal: pass/fail for rising edge, active part(s), falling edge, and guard period – For each burst: GMSK transmit power or 8PSK burst power, worst case upper mask limit margin and time, worst case lower mask limit margin and time, amplitude at marker measurement points
Displayed graphical results	– For single-slot signals: fixed dBc versus µs views of full, rising edge, falling edge, and useful part of burst – For multislot signals: fixed dBc versus µs views of both bursts, guard period, burst 1, and burst 2 – For all signals: ETSI-defined mask, pass/fail indicators, settable marker, and variable time and amplitude axes
Multi-measurement capabilities	1 to 999 bursts; minimum, maximum, average, and standard deviation results
Concurrency capabilities	Multislot power versus time measurements can be made concurrently with all other measurements
Supplemental characteristics	
Typical relative measurement accuracy	< ± 0.25 dB over –7 to +1 dB for GMSK bursts < ± 0.25 dB over –4 to +4 dB for 8PSK bursts
Typical dynamic range and typical noise floor	For measurement of the second burst in a multislot configuration with the first burst > 10 dB higher than the second burst – Typical dynamic range: > lesser of 74 or 84 dB minus power offset between bursts, or – Typical noise floor: < –62 dBm, whichever dominates
For all other single and multislot signals	
– 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 GMSK or 8PSK bursts, RACH bursts for a single uplink timeslot only
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 transmit power ≥ –30 dBm and ≤ 20 dB difference in levels of adjacent timeslots
Numerical 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 PDTCH(s) are not active
Supplemental characteristics	
Typical measurement repeatability	< ± 0.25 T (0.923 µs)
Measurement resolution	0.25 T (0.923 µs)

Multislot-tolerant output RF spectrum (ORFS) measurement

All specifications for the multislot-tolerant ORFS measurement are valid between +20 and +55 °C. GSM/GPRS/EGPRS multislot transmit power measurement or EGPRS multislot-tolerant transmit power measurement accuracy specifications apply to output power result. These specifications apply to E5515C mainframes with Option 002 supplied after serial number GB46040001 January 2006, or E5515E.

Modulation measurement implementation	Performed using a five-pole, synchronously-tuned 30 kHz RBW filter averaged over 40 bits
Switching measurement implementation	Performed using a five-pole, synchronously-tuned 30 kHz RBW filter with peak hold during the whole burst
Types of signals measured	GMSK or 8PSK normal bursts
Multislot input signal conditions	≤ 30 dB difference in power level between adjacent timeslots
Multislot signal measurement capability	Measurement of one user-specified timeslot transmitted as a single timeslot or four adjacent timeslots
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 transmit power ≥ –10 dBm for warranted performance
Filter options	Digital, analog, and auto
Trigger sources	RF rise, protocol, immediate, auto, external
Trigger delay	Settable between ± 2.31 ms
Burst synchronization	RF amplitude for GSM or GPRS signals, midamble for EGPRS signals
Measurement offsets	22 modulation and 8 switching offsets from carrier are definable
Pass/fail limits	ETSI or user-defined
Numerical results	Modulation and switching results at each selected offset, output power, transmit power in 30 kHz bandwidth, modulation and switching pass/fail indicators, modulation type
Displayed graphical results	Fixed dB versus frequency views of modulation, switching, or both modulation and switching, settable marker and pass/fail limits, modulation and switching pass/fail indicators, variable frequency and amplitude axes
Multi-measurement capabilities	1 to 999 measurements; average modulation result, maximum switching result
Concurrency capabilities	Multislot-tolerant ORFS measurements can be made concurrently with all other measurements
Supplemental characteristics	
Modulation dynamic range	– –74 dBr digital filter-type for full spectrum, power 0 dBm or greater – –74 dBr analog filter-type for full spectrum, power +10 dBm or greater
Typical switching dynamic range	–70 dBc/–60 dBm (whichever is greater) at 600, 1200, and 1800 kHz offsets, power +10 dBm or greater

Phase and amplitude versus time (PAvT) measurement

Optional PAvT measurement, requires separate license, orderable as part number E1968A-410.

All specifications for the PAvT measurement are valid between +20 and +55 °C.

Types of signals measured	CW only – discrete amplitude step waveform or continuous ramp waveform
Waveform type	Discrete or continuous
Trigger sources	RF rise, immediate, external
Trigger delay	Settable between 0 to 10 ms
Trigger threshold	Settable between 0 to 30 dB
Measurement timeout	Settable between 0.1 to 999.9 s
Continuous measurement count	Settable between 1 to 5000
Continuous measurement delay	Settable between 0 to 500 ms
Discrete step width	Settable between 0.1 to 400 ms
Discrete step count	Settable between 1 to 512
Discrete step center	Settable between 0.05 to 399.95 ms
Concurrency capabilities	PAvT measurements cannot be made concurrently with any other measurements

Fast device tune (FDT) measurement

Optional FDT measurement requires separate license, orderable as part number E1999A-202.

All specifications for the FDT measurement are valid for the frequency ranges 450 to 496 MHz, 740 to 960 MHz, and 1700 to 1990 MHz.

FDT (downlink) generator specifications

FDT absolute output level accuracy with GMSK modulation on:

Specification	Ranges
< ± 2.10 dB	Single slot from –110 to –13 dBm
< ± 2.10 dB	1 multislot level between –110 and –13 dBm
< ± 2.50 dB	2 multislot levels ≤ 20 dB apart

Peak phase error	< ± 5 degrees
Frequency error	< ± 0.02 ppm plus timebase reference

Supplemental characteristics

Typical FDT absolute output level accuracy with GMSK modulation on:

Specification	Ranges
< ± 1.40 dB	Single slot from –110 to –13 dBm
< ± 1.40 dB	1 multislot level between –110 and –13 dBm
< ± 1.70 dB	2 multislot levels ≤ 20 dB apart

Typical burst modulation on/off ratio (referenced to lowest signal level)	> 50 dB
Typical RMS phase error	< 0.9 degree

FDT transmit power measurement specifications

Input signal conditions	First slot has to be the highest burst, and power level of first timeslot has to be within ± 3 dB of expected power
Multislot signal measurement capability	Measurement of up to seven timeslots
Minimum input level	For warranted performance, the signal at the test set's RF IN/OUT must have transmit power > –14 dBm for first timeslot, and ≥ –25 dBm for second to seventh timeslot

Measurement accuracy for FDT GMSK transmit power at RF IN/OUT port between +20 and +55 °C

Accuracy (dBm)	Ranges
< ± 0.85	700 to 800 810 to 960
< ± 0.87	450 to 496 1700 to 1990

Frequency capture range	Signal must be within ± 70 kHz of test set's expected frequency for warranted performance
VSWR at RF IN/OUT	< 1.14 : 1 for 450 to 496 MHz and 700 to 960 MHz, < 1.2 : 1 for 1.7 to 1.99 GHz
Trigger sources	Fixed as protocol trigger (RF rising trigger for the first step)
Trigger delay	± 2.31 ms
Concurrency capabilities	Fast device tune measurements cannot be made concurrently with other measurements

Supplemental characteristics

Typical measurement accuracy for FDT GMSK transmit power at RF IN/OUT port between +20 and +55 °C:

Accuracy (dBm)	Frequency (MHz)
< ± 1.40	700 to 800 810 to 960
< ± 0.41	450 to 496 1700 to 1990

Typical measurement repeatability	< ± 0.05 dB
Measurement resolution	0.01 dB

General-purpose spectrum monitor

Operating modes	Active cell and test mode
Measurement modes	Swept mode or zero span
Frequency ranges	Although the spectrum monitor is available at any frequency supported by the test set, specifications apply only inside of the calibrated bands: 450 to 496 MHz, 700 to 800 MHz, 810 to 960 MHz, and 1.7 to 1.99 GHz
Frequency spans, resolution bandwidth, displayed dynamic ranges	Coupled, with the following combinations available

Span	RBW	Displayed dynamic range
100 MHz	5 MHz	50 dB
80 MHz	1 MHz	55 dB
40 MHz	300 kHz	60 dB
20 MHz	100 kHz	65 dB
12 MHz	100 kHz	65 dB
10 MHz	100 kHz	65 dB
5 MHz	30 kHz	70 dB
4 MHz	30 kHz	70 dB
2.5 MHz	10 kHz	75 dB
1.25 MHz	3 kHz	80 dB
500 kHz	1 kHz	80 dB
125 kHz	300 Hz	80 dB
0	1 MHz	55 dB
0	300 kHz	60 dB
0	100 kHz	65 dB

RBW filter types	Flattop in swept mode, Gaussian in zero span
Zero span sweep time	Settable from 50 µs to 70 ms
Zero span offset time	Settable from 0 to 10 s
Reference level range	Settable from –50 to +37 dBm, or automatically determined
Amplitude scaling	Settable from 0.1 to 20 dB/division in 0.1 dB steps
Trigger source	Immediate, protocol, RF rise, external, auto
Trigger delay	Settable between ± 50 ms
Peak threshold	Settable from –120 to +37 dBm
Peak excursion	Settable between 1.2 to 100 dB
Trace functions	Clear write, max hold, min hold
Detector type	Peak or sample
Averaging capabilities	Settable between 1 and 999, or off
Marker functions	Three independent markers with modes of normal, data, and off; operations are peak search, marker to expected power, and marker to expected frequency
Concurrency capabilities	Spectrum monitor analysis can be performed concurrently with all measurements

Supplemental characteristics

Typical level accuracy:

- < ± 2 dB for signals within 50 dB of a reference level ≥ –10 dBm and RBW < 5 MHz
- < ± 2 dB for signals within 30 dB of a reference level < –10 dBm and RBW = 5 MHz using 5 averages
- < ± 3.5 dB for signals > –70 dBm and within 50 dB of a reference level < –10 dBm with RBW < 5 MHz

Displayed average noise level	< –90 dBm for reference level of –40 dBm and 30 kHz bandwidth
Typical residual responses	< –70 dB with input terminated, reference level of –10 dBm and RF generator power < –80 dBm
Typical spurious responses	< –50 dBc with expected frequency tuned to carrier, carrier > 420 MHz, signal and reference level at –10 dBm and all spectral components within 100 MHz of carrier
Frequency resolution	1 Hz
Marker amplitude resolution	0.01 dB

GSM decoded audio level measurement

The MS needs to be stimulated with a pulsed audio signal at a 10 Hz rate with 50 percent duty cycle for the decoded audio level measurement to provide accurate results.

Types of signals measured	Encoded audio present on uplink TCH
Measurement range	200 Hz to 3.6 kHz
Measurement accuracy	Observed inaccuracies are due to MS encoder errors since the algorithm in the test set contributes no bit errors
Band pass filter capabilities	100 Hz bandwidth, tunable from 200 Hz to 3.6 kHz, selectable as on or off
Measurement trigger source	Immediate
Measurement synchronization	None required
Numerical result	rms audio level
Multi-measurement capabilities	1 to 999 measurements; average, minimum, maximum, and standard deviation results
Concurrency capabilities	GSM decoded audio level measurements cannot be made concurrently with GSM BER or GSM FBER measurements; GSM decoded audio level measurements can be made concurrently with all other measurements
Supplemental characteristics	
Measurement resolution	0.01 percent

Audio generator specifications

Frequency	
Operating range	100 Hz to 20 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 OUT connector

Ranges	0 to 1 V peak, 1 to 9 V peak (into ≥ 600 Ω)
Accuracy	< ± (1.5% of setting + resolution) when output is DC coupled
Distortion	< 0.1 percent for 0.2 to 9 V peak into ≥ 600 Ω
Pulse mode	Pulsed audio signal at a 10 Hz rate with 50 percent duty cycle, selectable as on or off (for use with the GSM decoded audio level measurement)
Coupling mode	Selectable as DC or AC (5 µF in series with output)
Supplemental characteristics	
Typical maximum output current	100 mA peak into 8 Ω
Typical output impedance	< 1.5 Ω at 1 kHz when output is DC coupled
Typical DC offset (when output is DC coupled)	< 1 mV for 0 to 1 V peak output, < 10 mV peak for 1 to 9 V peak output
Output level resolution	< 0.5 mV for 0 to 1 V peak output
	< 5.0 mV for 1 to 9 V peak output

GSM analog audio measurement specifications

All analog audio measurement specifications apply to signals present at test set's AUDIO IN ports.	
De-emphasis	750 µs de-emphasis selectable as off or on
Expandor	Selectable as off or on with reference level setting of 10 mV to 10 V
Filters	None, C-message, 50 Hz to 15 kHz band pass, 300 Hz to 15 kHz band pass, or 100 Hz bandwidth tunable band pass, tunable over 300 Hz to 15 kHz

GSM analog audio level measurement

Types of signals measured	Sinusoidal audio signals
Measurement frequency range	100 Hz to 15 kHz
AUDIO IN level range	7.1 mV to 20 V peak (5 mV to 14.1 V rms)
Measurement accuracy	< ± (2 percent of reading + resolution) for 100 Hz to ≤ 8 kHz
	< ± (3 percent of reading + resolution) for > 8 to 20 kHz
Measurement THD plus noise	< 200 µV rms
Measurement detectors	rms or peak
Measurement trigger source	Immediate
Measurement synchronization	None required
Numerical result	Audio level
Multi-measurement capabilities	1 to 999 measurements; average, minimum, maximum, and standard deviation results
Concurrency capabilities	GSM analog audio level measurements cannot be made concurrently with GSM multi-tone audio, but can be made concurrently with all other measurements
Supplemental characteristics	
Typical measurement accuracy	< ± 1.2 percent of reading for 100 Hz to ≤ 8 kHz and 20 mV to 20 V peak
Typical external input impedance	100 k Ω in parallel with 105 pF
Measurement resolution	0.3 percent of expected level setting or 0.2 mV, whichever is greater

GSM analog audio distortion measurement

Types of signals measured	Sinusoidal audio signals
Measurement frequency range	100 Hz to 10 kHz
AUDIO IN level range	42.4 mV to 20 V peak (30 mV to 14.1 V rms)
Measurement accuracy	< ± 12 percent of reading (± 1.0 dB) for distortion > 0.67 percent
Residual THD plus noise	< –60 dB or 200 µV rms, whichever is greater
Measurement trigger source	Immediate
Measurement synchronization	None required
Numerical result	Audio distortion
Multi-measurement capabilities	1 to 999 measurements; average, minimum, maximum, and standard deviation results
Concurrency capabilities	GSM analog audio distortion measurements cannot be made concurrently with GSM multi-tone audio, but can be made concurrently with all other measurements
Supplemental characteristics	
Measurement resolution	0.1 percent

GSM analog audio frequency measurement

Types of signals measured	Sinusoidal audio signals
Measurement frequency range	100 Hz to 15 kHz
AUDIO IN level range	7.1 mV to 20 V peak (5 mV to 14.1 V rms)
AUDIO IN signal conditions	Signal at test set's AUDIO IN must have signal-to-noise ratio > 30 dB for warranted performance
Measurement accuracy	< 0.1 Hz averaged over 10 measurements,
	< 1.0 Hz for a single measurement
Measurement THD plus noise	< 200 µV rms
Measurement trigger source	Immediate
Measurement synchronization	None required
Numerical result	Audio frequency
Multi-measurement capabilities	1 to 999 measurements; average, minimum, maximum, and standard deviation results
Concurrency capabilities	GSM analog audio frequency measurements cannot be made concurrently with GSM multi-tone audio, but can be made concurrently with all other measurements
Supplemental characteristics	
Measurement resolution	0.1 Hz

GSM analog audio SINAD measurement

Types of signals measured	Sinusoidal audio signals
Measurement frequency range	100 Hz to 10 kHz
AUDIO IN level range	42.4 mV to 20 V peak (30 mV to 14.1 V rms)
Measurement accuracy	< ± 1.0 dB for SINAD < 43.5 dB
Residual THD plus noise	< –60 dB or 200 µV rms, whichever is greater
Measurement trigger source	Immediate
Measurement synchronization	None required
Numerical result	SINAD ratio
Multi-measurement capabilities	1 to 999 measurements; average, minimum, maximum, and standard deviation results
Concurrency capabilities	GSM analog audio SINAD measurements cannot be made concurrently with GSM multi-tone audio, but can be made concurrently with all other measurements
Supplemental characteristics	
Measurement resolution	0.1 dB

GSM multi-tone audio

Downlink audio measurement mode

Test set generates a multi-tone audio signal and encodes it into speech frames sent on the downlink traffic channel; the MS decodes the received speech frames and provides and audio output via a speaker connected to the test set's AUDIO IN port.

Applicable specifications	GSM analog audio measurement specifications apply to measured results
Analyzer downlink reference level	Settable between 100 mV and 5 V
Multi-tone audio generator downlink levels	Total level settable between 0 and 70 percent of 0 dB reference or 1 to 20 levels are settable between 0 and 70 percent of 0 dB reference, where the total level of all tones must be < 70 percent of 0 dB reference
Expected AUDIO IN peak voltage	Settable between 1 mV and 20 V peak

Uplink audio measurement mode

Test set generates a multi-tone audio signal out of the AUDIO OUT port connected to the MS's microphone; the MS encodes the tones into speech frames on the uplink traffic channel and the test set decodes the received speech frames.

Applicable specifications	Audio generator specifications apply to multi-tone audio signal at the AUDIO OUT port, GSM decoded audio level measurement specifications apply to measured results
Analyzer uplink reference level	Settable between 1 and 100 percent of 0 dB reference
Multi-tone audio generator uplink levels	Total level settable between 0 and 4.5 V rms, or 1 to 20 levels are settable between 0 and 4.5 V rms, where the total level of all tones must be < 4.5 V rms

Both measurement modes

Analyzer 0 dB reference mode	Absolute or relative
Analyzer reference tone	Settable between 1 and 20 Hz
Device settling time	Settable between 20 ms and 1 s
SINAD/distortion (on audio tone 1) state	On or off
Multi-tone audio generator frequencies	1 to 20 frequencies are settable between 10 Hz and 4 kHz or off, 7 preset states are selectable as multi-tone 140, multi-tone 100, single tone 300 Hz, single tone 1 kHz, single tone 3 kHz, all tones off, and none
Multi-tone audio analyzer frequencies	Use multi-tone audio generator frequencies or 1 to 20 frequencies are settable between 10 Hz and 4 kHz
Multi-tone audio level limits	Upper and lower limits are settable between ± 100 dB for 1 to 20 audio tones
Numerical results	Audio level, frequency, SINAD, distortion, total generator audio level, total measurement audio level, measurement mode, 0 dB reference
Graphical results	Level and frequency of each audio tone with limits, settable marker and axes

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) x (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

GPIB	IEEE standard 488.2
Remote front panel lockout	Allows remote user to disable the front panel display to improve GPIB measurement speed
Functions implemented	T6, TE0, L4, LE0, SH1, AH1, RL1, SR1, PP0, DC1, DT0, C0, E2

Test Subscriber Identification Module (SIM) Cards

Test SIM cards are available for purchase from Keysight Technologies, Inc. Two types are available as follows

- Programmed GSM SIM card micro-size:
  Fits most current wireless devices (about 15 x 25 mm), part number 08922-61887
- Programmed UMTS SIM card micro-size:
  Fits most current wireless devices (about 15 x 25 mm), part number E5515-61286

Ordering Information

For current ordering information, please refer to the configuration guide, literature number 5968-7873E, on the Web at **www.keysight.com/find/8960**

For more information on ordering test SIM cards, visit the Keysight site at **www.parts.keysight.com**

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