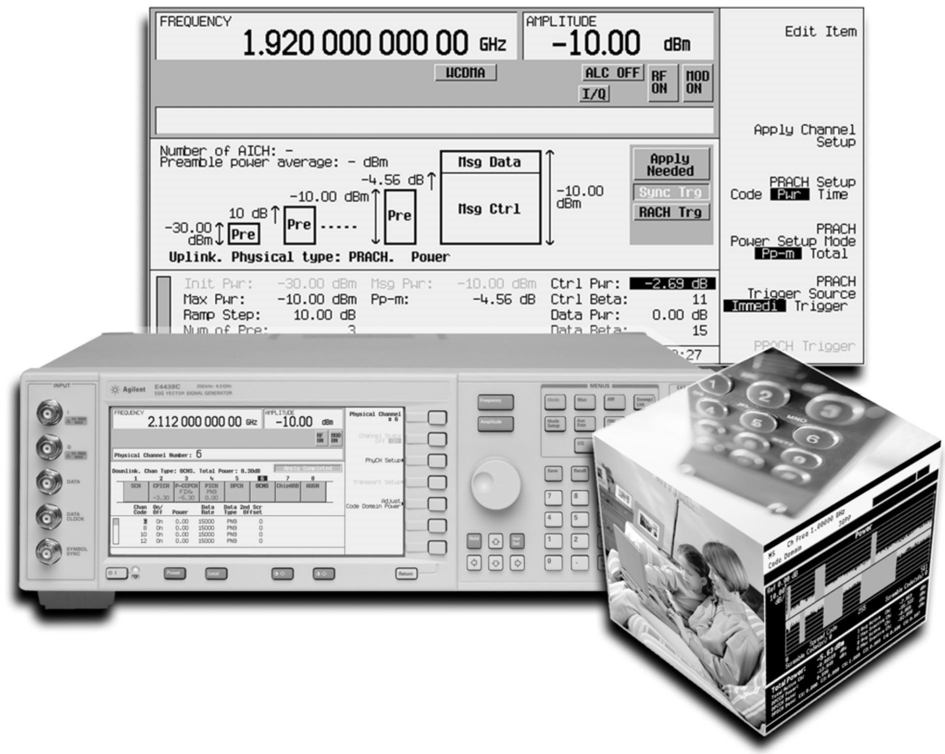
Agilent
3GPP W-CDMA Firmware
E4438C ESG Vector Signal Generator

Option 400
Technical Overview



The 3GPP W-CDMA firmware option for the Agilent E4438C ESG vector signal generator provides a broad collection of W-CDMA test signals. Combining the 3GPP W-CDMA waveform playback and real-time personalities into a single firmware option provides a viable test solution for evolving 3G mobile radio networks – from the component to the system level. This simplifies the ordering process and provides a flexible test solution for both development and manufacturing engineers.

Key Features

W-CDMA real-time signal generation

- transmit diversity
- fully-coded compressed mode
- multiple PRACH
- set AWGN using C/N, E_b/N_o, or E_c/N_o
- closed-loop power control
- 16 OCNS channels in the downlink
- adjust channel powers in real-time
- preconfigured 3GPP W-CDMA tests

W-CDMA waveform playback

- HSDPA channels
- fast waveform build times
- generate up to 16 carriers
- multicarrier timing and phase offsets
- multicarrier clipping

Agilent Technologies

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Introduction

The 3GPP W-CDMA firmware option for the E4438C ESG combines two flexible signal generation personalities to provide a powerful development and manufacturing test suite for evolving 3G mobile radios, base stations, and their components.

- 3GPP W-CDMA waveform playback
- 3GPP W-CDMA real-time signal generation

These personalities are designed to run on the powerful E4438C ESG baseband generator. They have been enhanced to take advantage of the baseband generator's 80 MHz I/Q bandwidth, 32 megasamples (Msa) waveform playback RAM, and optional 6 GB hard drive. The baseband generator can operate in one of two modes, waveform playback or real-time signal generation.

The waveform playback and real-time signal generation modes are not equivalent.
In fact, they are intended to serve completely different test needs. Combined, they provide a comprehensive set of standard-based test signals for both R&D and manufacturing. The key differences between the waveform playback and real-time signal generation capabilities are highlighted on the following page.

Introduction

Arbitrary waveform playback and real-time signal generation feature comparison

Feature	W-CDMA arbitrary waveform playback	W-CDMA real-time signal generation
Access method supported	Frequency Division Duplex [FDD] 3GPP W-CDMA	
Version of standard supported	September 2002 issue of the Release 5 3GPP specifications	
Primary application	Component testing Example, testing ACPR and EVM where spectrally correct signals are needed	Receiver testing & ASIC and baseband verification Example testing BER where frames with full channel coding are needed
Coding level	Partially coded Supports physical layer coding, i.e. spreading and scrambling only	Fully coded Supports transport & physical layer coding, i.e. CRC, convolutional/turbo coding, interleaving, rate matching, etc.
Waveform length	10 ms continuously repeated	Infinite
Filters	Standards-based and custom	Standards-based and custom
Baseband clipping	Yes	No
Differential outputs available	Yes	Yes
Number of DPCH channels	512	2
Number of OCNS	512	16
Data types	PN9, random, 8-bit pattern	PN9, PN15, User File, 4 bit pattern
Standards-based setups	Test models 1 through 5	Reference measurement channels Conformance tests
Number of carriers	16 carriers	1 carrier
Compressed mode	No	Yes
Set C/N, E_c/N_o or E_b/N_o	No	Yes
Waveform build times	Seconds	Milliseconds
Downlink channels	C-PICH, P-SCH, S-SCH, P-CCPCH, S-CCPCH, PICH, DPCH, OCNS, HS-SCCH, HS-PDSCH	C-PICH, P-SCH, S-SCH, P-CCPH, PICH, DPCH, OCNS
Uplink channels	DPCCH, DPDCH	DPCCH, DPDCH, PRACH

Arbitrary Waveform Playback Mode

Configure multicarrier uplink and downlink 3GPP W-CDMA test signals with the proper stress level to exercise components – including combiners, filters, and amplifiers. Signals generated in arbitrary waveform playback mode can be used for base station and mobile tests ranging from the component level to the system level; however, they are primarily intended for the component test industry.

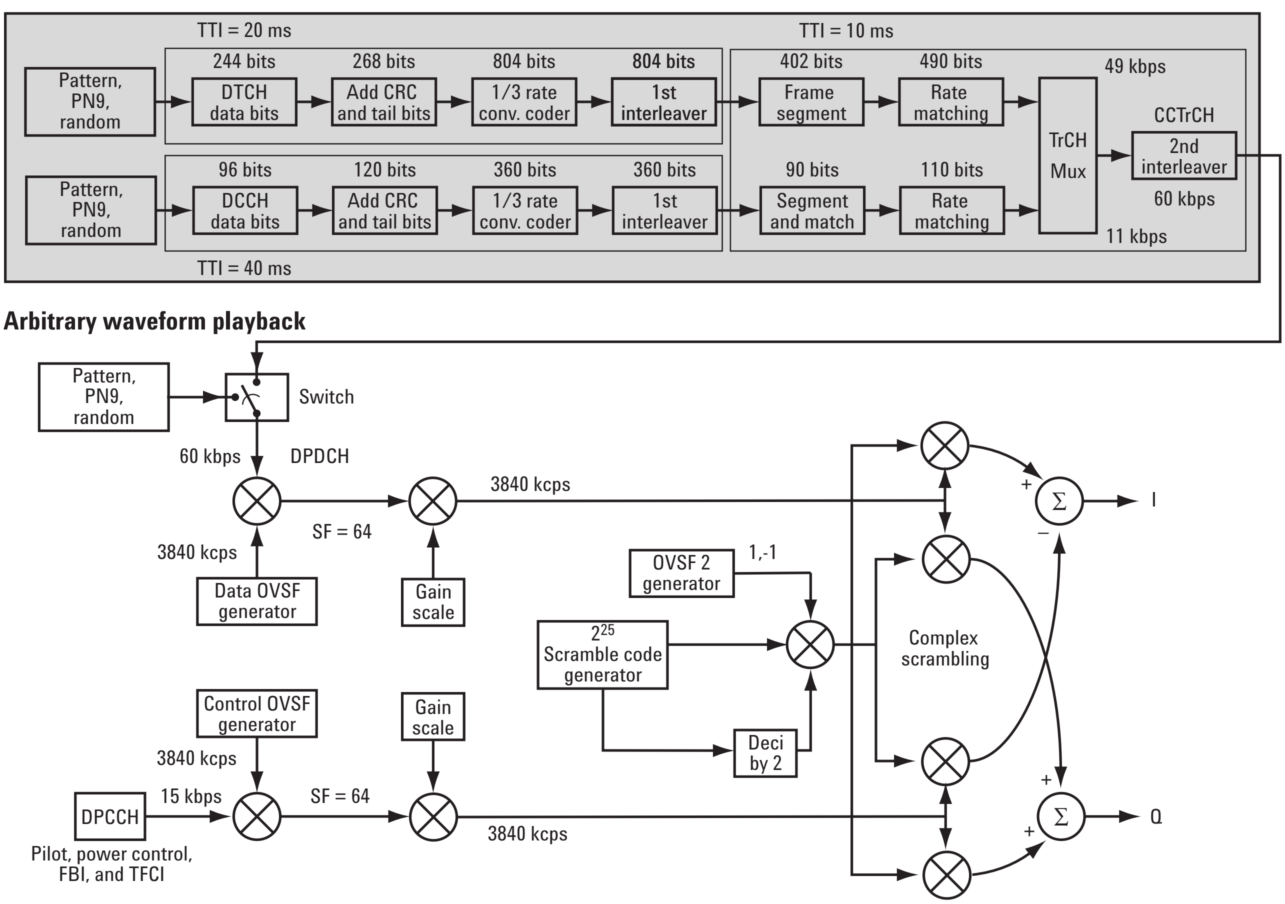
In the arbitrary waveform playback mode, the E4438C ESG baseband generator operates like a traditional arbitrary waveform generator. After the signal parameters have been configured, a sampled version of the baseband signal is stored in waveform RAM. These samples are then played back through a reconstruction filter and fed to the I/Q modulator.

Because these signals are primarily intended for component test, full channel coding is not implemented. Instead, partially coded signals that are statistically equivalent to fully coded signals are generated in waveform playback mode. This means the signal will stress amplifiers and other components exactly as a fully coded signal would.

Block diagram

The following uplink 3GPP W-CDMA block diagram illustrates the difference between the waveform playback and real-time signal generation modes.

Real-time fully coded transport layer (two of six available transport channels shown)



Uplink 3GPP W-CDMA block diagram outlining the difference between the arbitrary waveform playback and real-time W-CDMA personalities. The real-time personality encompasses the entire block diagram. The arbitrary waveform playback personality provides only the lower, unshaded portion of the block diagram. Both are included in Option 400.

Arbitrary Waveform Playback Mode

Feature summary

Multicarrier capability
Stress active components by generating up to 16 W-CDMA carriers. Each carrier can be defined to have a unique channel configuration, frequency offset, and power offset. Also, the relative timing between each carrier, starting phase, scramble code and clipping level can be set for each carrier for generating uncorrelated signals; important for creating realistic crest factors. This ensures the device under test experiences actual operating conditions.

Table editor features
Easily modify channel configurations.
- Modify the W-CDMA downlink by choosing: data rate, data pattern, orthogonal variable spreading factor [OVSF] code, power, τDPCH offset, TFCI bits, TFCI power, TPC bits, TPC power, pilot bits, pilot power, scramble code, scramble type, and scramble offset.
- Modify the W-CDMA uplink by choosing: data rate, data pattern, OVSF code, power, TFCI bits, TPC bits, and FBI bits.

Pre-configured channel setups
Quickly generate 3GPP standard signals. Test models 1 through 5 are predefined for testing transmitter components.
- test model 1 – ACLR, spurious emissions and intermodulation
- test model 2 – Output power dynamics
- test model 3 – Peak code domain power
- test model 4 – EVM measurements
- test model 5 – EVM measurements for base stations supporting HS-PDSCH

Also, access other predefined configurations or save and recall your own custom channel configurations.

Powerful filtering options
Choose or create unique filters. Choose from the standard W-CDMA filter, or root Nyquist, Nyquist, Gaussian filters, or rectangular filters. Define your own 256 tap FIR filter to meet specific [non-standard] test requirements. Time domain windows can be applied to the filter characteristic to improve ACLR performance.

Flexible baseband clipping
Reduce signal stress on power amplifiers. Clip the peak-to-average power of signals before or after baseband FIR filtering. Clipping the signal before filtering smooths any discontinuities in the resulting signal that can generate distortion. Optionally, the signal can be clipped after FIR filtering to simulate base stations that operate in this mode. Clipping may be applied individually to I and Q or to the composite I/Q vector.

Arbitrary Waveform Playback Mode

Code domain power and CCDF curve display
Quickly check signal statistics. Visually check the channel configuration and the peak-to-average ratio of the configured signal. View the relative channel power or the power statistics of the waveform as compared to additive white Gaussian noise [AWGN].

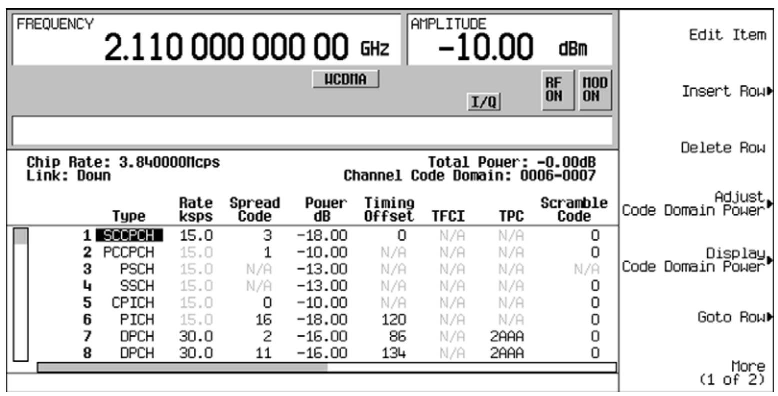
6 GB hard drive for signal storage
Store a vast array of test scenarios. Store all of your multi-format waveforms for W-CDMA, cdma2000, GSM, EDGE and more. The size of a typical W-CDMA waveform is about 1 MB.

Waveform sequencing
Eliminate waveform build times. Build a play list from waveforms stored in the arbitrary waveform baseband generator. Over 100 W-CDMA waveforms can be stored in the 32 Msa baseband generator. These waveforms can quickly be stored or recalled from the optional 6 GB hard drive.

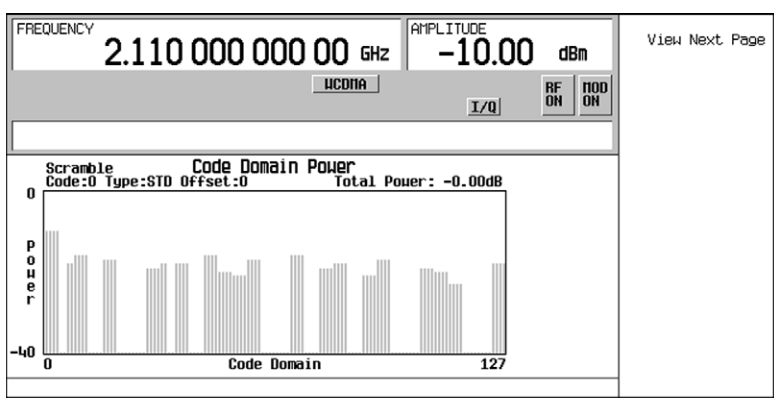
Hardware resampling technology
Eliminate reconstruction filter problems. The personality automatically resamples the signal in hardware resulting in

- No need to quadruple your samples resulting in more effective memory usage.
- Sampling images are automatically filtered out.

Variable chip rates
Integrate and research. Vary the 3.84 Mcps chip rate ±10% when integrating system components in R&D or simulate clock drift between systems.



Use the flexible table editor to fully configure a W-CDMA signal waveform



Verify the distribution of power in the code domain before producing the signal

Arbitrary Waveform Playback Mode

Downlink and uplink features

Coding level	Supports physical layer coding
Chip rate variation	3.456 Mcps to 4.224 Mcps
Frame duration	10 ms
Filters	
W-CDMA	α = 0.22
Nyquist, root Nyquist	α = 0 to 1
Gaussian	B_bT = 0 to 1
Rectangle	
Custom FIR	Up to 256 coefficients, 16 bit resolution
I/Q mapping	Normal, invert
Clipping[1]	
Clip location	Pre- or post-FIR filter
Clipping type	|I+jQ|, |I| and |Q|
Clipping range	10% to 100% [Clip the modulation level to a percentage of full scale. A level of 100% equates to no clipping.]

Downlink features

Modulation	QPSK and 16QAM[2]
Total number of channels	Up to 512 with any combination of supported channel types
Pre-defined channel configurations	test model 1 with 16, 32, or 64 DPCH test model 2 test model 3 with 16 or 32 DPCH test model 4 test model 5 with 2, 4, or 8 HS-PDSCH 1 DPCH 3 DPCH PCCPCH + SCH PCCPCH + SCH + 1 DPCH PCCPCH + SCH + 3 DPCH
Common Pilot Channel [CPICH]	
Power	-40 dB to 0 dB
Spreading code	0 to 255
Symbol rate	Fixed to 15 ksps
Scramble code	0 to 511
Scramble type	Standard, left alternate, and right alternate
Scramble offset	0 to 15
Primary Synchronization Channel [PSCH]	
Power	-40 dB to 0 dB
Symbol rate	Fixed to 15 ksps
Secondary Synchronization Channel [SSCH]	
Power	-40 dB to 0 dB
Symbol rate	Fixed to 15 ksps
Scramble code	0 to 511
Scramble type	Standard, left alternate, and right alternate
Scramble offset	0 to 15

1. Multicarrier note: Each carrier can be clipped individually or the composite waveform can be clipped.
2. 16QAM is supported for the HS-PDSCH.

Arbitrary Waveform Playback Mode

Primary Common Control Physical Channel [P-CCPCH]

Power	-40 dB to 0 dB
Spreading code	0 to 255
Symbol rate	Fixed to 15 ksps
Data pattern	PN9, random, fixed 8-bit pattern
Scramble code	0 to 511
Scramble type	Standard, left alternate, and right alternate
Scramble offset	0 to 15

Secondary Common Control Physical Channel [S-CCPCH]

Power	-40 dB to 0 dB
Spreading code	15, 30, 60, 120, 240, 480, 960 ksps
Symbol rate	0 to 255
τDPCH offset	0 to 149 [in increments of 256 chips]
TFCI	0 to 1023, or disable TFCI bits in DPCCH
Number of pilot bits	0 or 8
Data pattern	PN9, random, fixed 8-bit pattern
Scramble code	0 to 511
Scramble type	Standard, left alternate, and right alternate
Scramble offset	0 to 15

Page Indication Channel [PICH]

Power	-40 dB to 0 dB
Spreading code	0 to 255
Symbol rate	Fixed to 15 ksps
τDPCH offset	0 to 149 [increments of 256 chips]
Data pattern	18 bit paging pattern, PN9, random, fixed 8-bit pattern
Scramble code	0 to 511
Scramble type	Standard, left alternate, and right alternate
Scramble offset	0 to 15

Dedicated Physical Channel [DPCH]

Power	-40 dB to 0 dB
Spreading code	0 to 511
Symbol rate	7.5, 15, 30, 60, 120, 240, 480, 960 ksps
τDPCH offset	0 to 149 [increments of 256 chips]
TFCI	0 to 1023, or disable TFCI bits in DPCCH
TFCI power	-20 to 20 dB relative to channel
TPC	0 to 7FFF hex
TPC power	-20 to 20 dB relative to channel
Number of pilot bits	4 or 8
Pilot power	-20 dB to 20 dB
Data pattern	PN9, random, fixed 8-bit pattern
Scramble code	0 to 511
Scramble type	Standard, left alternate, and right alternate
Scramble offset	0 to 15

Orthogonal Channel Noise Simulator [OCNS]

Power	-40 dB to 0 dB
Spreading code	0 to 511
Symbol rate	7.5, 15, 30, 60, 120, 240, 480, 960 ksps
Data pattern	PN9, random, fixed 8-bit pattern
Scramble code	0 to 511
Scramble type	Standard, left alternate, and right alternate
Scramble offset	0 to 15

Arbitrary Waveform Playback Mode

High Speed Shared Control Channel [HS-SCCH]	
Power	-40 dB to 0 dB
Spreading code	0 to 127
Symbol rate	Fixed to 30 ksps
τDPCH offset	0 to 149 [increments of 256 chips]
Data pattern	PN9, random, fixed 8-bit pattern
Scramble code	0 to 511
Scramble type	Standard, left alternate, and right alternate
Scramble offset	0 to 15
High Speed Physical Downlink Shared Channel [HS-PDSCH]	
Power	-40 dB to 0 dB
Spreading code	0 to 15
Symbol rate	Fixed to 240 ksps
τDPCH offset	0 to 149 [increments of 256 chips]
Data pattern	PN9, random, fixed 8-bit pattern
Scramble code	0 to 511
Scramble type	Standard, left alternate, and right alternate
Scramble offset	0 to 15
Downlink multicarrier	
Number of carriers	Up to 16 [user defined, individually configurable]
Frequency offset [per carrier]	Up to ± 37.5 MHz
Offset resolution	1 Hz
Carrier power [per carrier]	0 dB to -40 dB
Clipping	Clip each carrier before or after FIR filtering along with clipping the composite waveform
Primary scramble code	0 to 511 [applied to each channel in the carrier]
Timing offset	0 to 149 in increments of 512 chips [applied to each channel in the carrier]
Initial phase	0 to 359 in degrees [sets the phase for each carrier]
Auto increment scramble code	The scramble code of each additional carrier will be incremented by 1
Auto increment timing offset	The relative timing for each additional carrier will be incremented by 1/5 of a timeslot [512 chips]
Inputs and outputs	
Inputs	10 MHz local oscillator reference Baseband generator clock reference [250 kHz to 100 MHz] Waveform start trigger
Outputs	4 user definable markers

Arbitrary Waveform Playback Mode

Uplink features

Modulation	OCQPSK [HPSK]
Pre-defined channel configurations	1 DPCCH 15 ksps, spread code 0 DPCCH + 1 DPDCH 960 ksps, spread code 1 DPCCH + 2 DPDCH 960 ksps, spread code 1 DPCCH + 3 DPDCH 960 ksps, spread code 2 DPCCH + 4 DPDCH 960 ksps, spread code 2 DPCCH + 5 DPDCH 960 ksps, spread code 3
Number of channels	1 DPCCH and up to 6 DPDCH
Adjustable channel parameters	
Scramble code	0 to FFFFFF hex, common for all channels
Dedicated Physical Control Channel [DPCCH]	
Power	-60 dB to 0 dB
Spreading code	0 to 255
TFCI	0 to 1023, or disable TFCI bits
TPC	0 to 7FFF hex
Number of FBI bits	0, 1, or 2
Dedicated Physical Data Channel [DPDCH]	
Power	-60 dB to 0 dB
Spreading code	0 to 255
Symbol rate	15, 30, 60, 120, 240, 480, 960 ksps
Data pattern	Random and fixed 8-bit pattern
Additional DPDCH orientation	I or Q
Inputs and outputs	
Inputs	10 MHz local oscillator reference Baseband generator clock reference [250 kHz to 100 MHz] Waveform start trigger
Outputs	4 user definable markers

Arbitrary Waveform Playback Mode

Specifications[2]

Error vector magnitude[1]
[1.8 GHz < f_c < 2.2 GHz, default W-CDMA filters, 2.1 MHz baseband filter, 3.84 Mcps chip rate, ≤ 4 dBm, ≤ 7 dBm with Option UNB]

1 DPCH	≤ 2.3%, (< 1.3%)

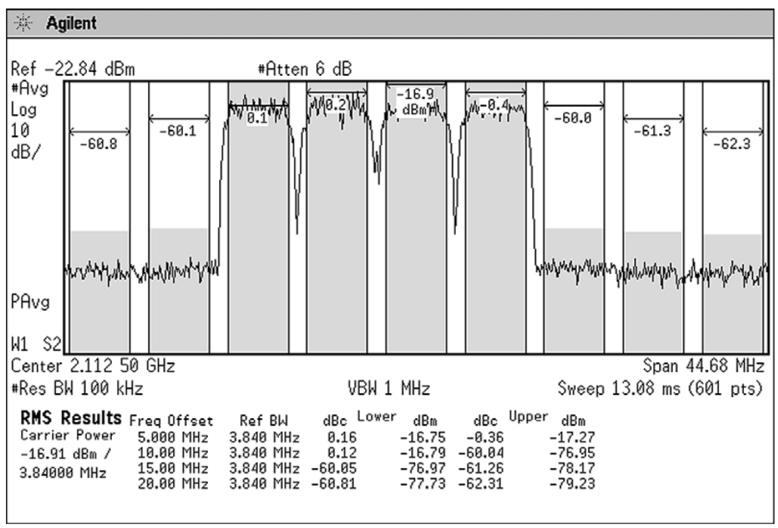
Level accuracy [relative to CW at 800, 900, 1800, 1900, 2200 MHz][1]
[≤ 2.5 dBm standard, 7.5 dBm for Option UNB, and 4.5 dBm for Option 506]
±0.7 dB (±0.35 dB)

Adjacent channel power[1]
[1.8 GHz < f_c < 2.2 GHz, default W-CDMA filters, 3.84 Mcps chip rate, ≤ 0 dBm Option UNB, ≤ –3dBm Option 506, ≤ –5 dBm standard in Optimize ADJ mode]

1 DPCH	–65 dBc (–67 dBc)
Test Model 1 + 64 DPCH	–63 dBc (–65 dBc)

Alternate channel power[1]
[1.8 GHz < f_c < 2.2 GHz, default W-CDMA filters, 3.84 Mcps chip rate, ≤ 2.5 dBm standard, ≤ 4.5 dBm Option 506, ≤ 7.5 dBm Option UNB, in Optimize ALT mode]

1 DPCH	–70 dBc (–73 dBc)
Test Model 1 + 64 DPCH	–68 dBc (–70 dBc)



The signal is composed of four 3GPP W-CDMA carriers using Test Model 1 with 64 DPCH.

1. Parentheses denote typical performance.
2. Valid for 23° ±5°C.

Real-Time Signal Generation Mode

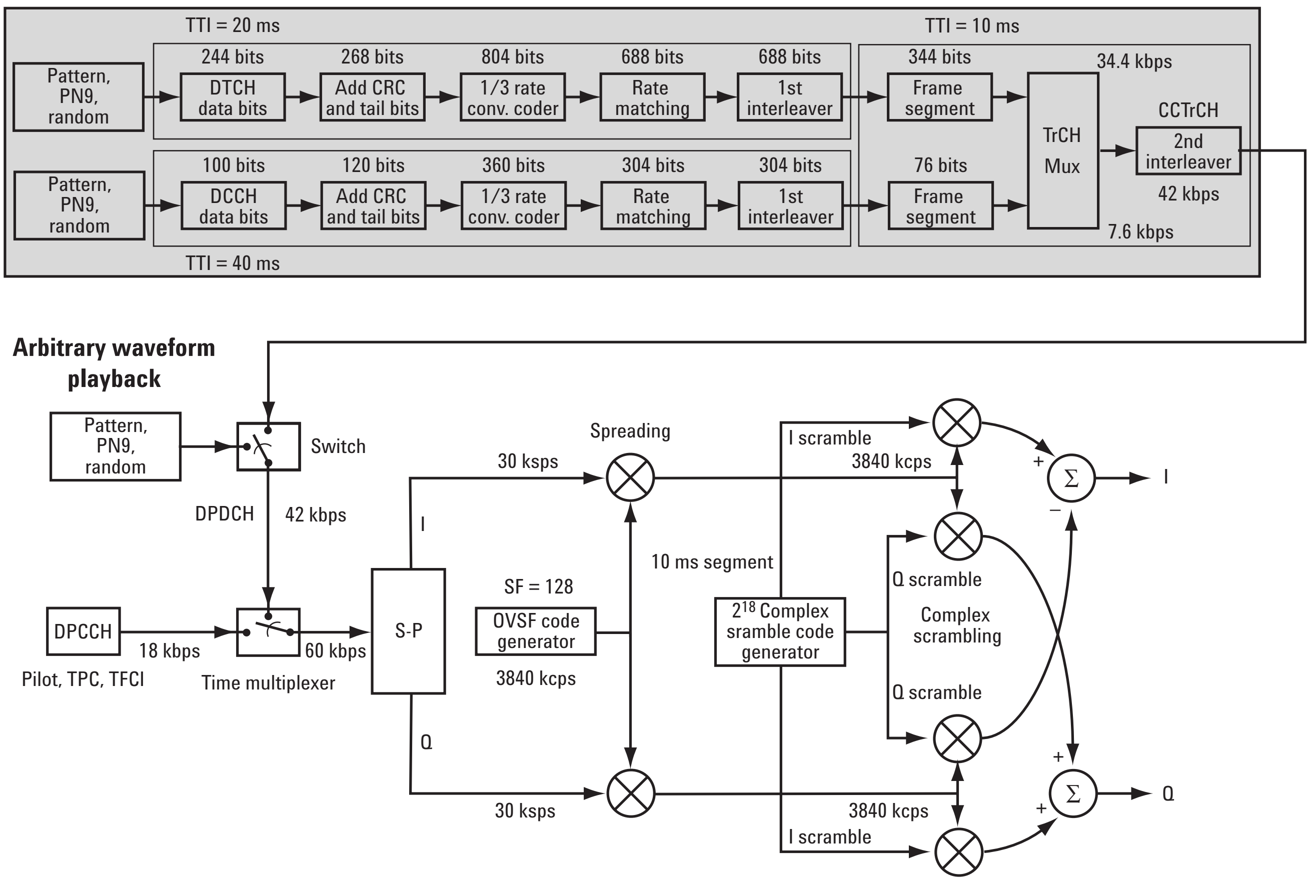
In real-time signal generation mode, the E4438C ESG baseband generator produces test signals continuously, rather than playing a stored waveform repeatedly. Once configured, the 3GPP W-CDMA personality generates a stream of fully-coded downlink or uplink 3GPP W-CDMA frames.

These fully-coded test signals are primarily intended for mobile and base station receiver tests in the R&D environment. The high level of channel coding enables thorough evaluation of receiver demodulation capabilities at various design stages. Standards-based measurements, including sensitivity, dynamic range, adjacent channel selectivity, blocking characteristics, and BER tests can be performed using these test signals. In addition, the baseband generator single-ended and differential I/Q outputs facilitate baseband verification and component tests.

Block diagram

The following 3GPP W-CDMA downlink block diagram illustrates the difference between the arbitrary waveform and real-time signal generation modes.

Real-time fully coded transport layer (two of six transport channels shown)



Downlink 3GPP W-CDMA block diagram outlining the difference between the arbitrary waveform playback and real-time W-CDMA personalities. The real-time personality encompasses the entire block diagram. The arbitrary waveform playback personality provides only the lower, unshaded portion of the block diagram. Both capabilities are included with Option 400.

Real-Time Signal Generation Mode

Feature summary

Full transport channel coding

Enables BER/FER testing and baseband ASIC verification. Transport layer coding along with physical layer coding generates signals ready for BER and FER testing. Full control over transport layer coding, such as block size, coding type, TTI, data, rate matching attribute, CRC size, and transport channel position enable ASIC and RF chipset demodulation capabilities to be verified. Each DPCH/DPDCH [uplink/downlink] channel supports up to six transport channels.

16 OCNS channels with DPCH

Create realistic test signals. Generate up to 16 OCNS channels along with the DPCH and common channels to simulate the noise-like signal a mobile receiver would experience in the real world.

Table editor

Easily modify channel configurations. The table editor quickly enables the user to create new custom waveforms with slot structures defined by the 3GPP standard or modify predefined configurations. Add/delete channels, change OVSF codes, scramble codes, data rates, TPC patterns, τDPCH offset, TFCI, FBI, pilot bits, power levels and more.

Infinite frame generation

Create signals for BER and BLER testing. The real-time generation capability of the personality generates continuous channel coded W-CDMA frames. The infinite continuous W-CDMA frames eliminate the need to worry about truncated data sequences.

Set E_b/N_o , E_c/N_o, and C/N

Emulate in-channel noise. The optional AWGN personality adds noise to the W-CDMA signal in a bandwidth twice the chip rate. The noise level is set by adjusting the energy per chip to noise power density ratio [E_c/N_o] [downlink only] or energy per bit to noise power density ratio [E_b/N_o] [uplink only] or the carrier to noise density ratio [C/N]. This enables sensitivity testing of receivers to be made along with 3GPP functional tests.

The total RF output power remains constant as the noise ratio is changed. This ensures the receiver remains at the same gain level, important for reducing the number of factors contributing to the overall BER/BLER.

Closed loop power control

Perform closed loop power control by varying the downlink TPC bits or the DPCCH/DPDCH power level in real-time.

Control the power of the mobile in real-time. The ESG accepts an external signal that controls the downlink TPC bits being transmitted on a slot-by-slot basis. This enables
- changing the power level of the mobile quickly for BER or conformance testing
- calibrating the mobile RF transmit power without using an external connector

Control the RF power of the uplink signal in real-time. The ESG accepts an external signal that controls the RF level of the transmitted DPCCH/DPDCH on a slot-by-slot basis. This enables
- testing the ability of the BTS to control its power through the TPC bits
- testing the BTS BER/BLER with a continuously varying power level

Real-time OCNS power balancing

Continuously modify the DPCH power level without rebuilding the waveform. The DPCH power level can be modified in real-time while the power level of the OCNS channels adjust to keep the sum of all the channels at 0 dB. This is essential for debugging designs and performing BER tests. Note, any of the channel powers can be modified in real-time without rebuilding the waveform, but the DPCH is the only channel that supports automatically balancing the power with the OCNS.

Real-Time Signal Generation Mode

Transmit diversity

Evaluate receiver performance with open loop transmit diversity. Transmit diversity is a technique used to counter the effects of fading by transmitting an altered version of the W-CDMA signal through a second antenna. A single ESG can generate a transport layer coded signal simulating antenna 1 or antenna 2. Two ESGs can be synchronized together to simultaneously generate the antenna 1 and antenna 2 signals. The primary and secondary synchronization channels employ transmit switched time diversity (TSTD) while all other channels use space time transmit diversity (STTD). The TSTD encoding can be turned off to facilitate signal acquisition when only one ESG is used.

Compressed mode

Test BER/BLER of a compressed frame signal. Compressed mode operation inserts discontinuous transmission (DTX) slots into the frame in preparation for a handover. The receiver must be able to recognize these DTX gaps and continue to demodulate and decode the data correctly. Both the uplink and the downlink generate transport layer coded compressed frames according to the 3GPP standard. A comprehensive feature set enables thorough receiver evaluation. Features include

- single frame or double frame method
- configure two patterns
- configure two gaps per pattern
- specify the stop connection frame number
- trigger the compressed frame sequence via external trigger or softkey
- power offsets compensate for reduced spreading gain
- optimize the frame structure for gap length or power control in the downlink
- up to 6 compressed mode pattern sequences can be defined in the uplink

Independent transport layer definitions

Save time by performing multiple receiver tests with one setup. Each downlink DPCH channel supports unique transport layer coding configurations. This enables testing of different reference measurement channels concurrently by demodulating and decoding a different OVSF code in the receiver. This eliminates reconfiguring the signal generator and then having the mobile resynchronize back to the ESG.

Predefined Reference Measurement Channel [RMC]

Quickly generate 3GPP standard signals. The uplink and downlink 3GPP W-CDMA reference measurement channels can be setup with the touch of a button.

Predefined 3GPP W-CDMA conformance tests[1]

Quickly generate signals for conformance testing. The following downlink conformance tests can be configured with the touch of a button per the 3G TS 25.141 and 3G TS 34.121 specifications:

- reference sensitivity level
- maximum input level
- adjacent channel selectivity
- blocking characteristics
- spurious response
- intermodulation characteristics
- performance tests [with external fader]

Incrementing system frame number

Demodulate and decode transport channels with different transmission time intervals [TTI]. The P-CCPCH channel contains the incrementing system frame number [SFN], which is necessary to decode the base station signal. The SFN enables the mobile to determine frame boundaries for a particular TTI. The SFN repeats every 4096 frames as defined by the standard.

Powerful filtering options

Choose or create unique filters. Choose from the standard W-CDMA filter, or root Nyquist, Nyquist, Gaussian filters, or rectangular filters. Define your own 256 tap FIR filter to meet specific [non-standard] test requirements. Time domain windows can be applied to the filter characteristic to improve ACLR performance in custom configurations.

1. The ESG can generate the appropriate 3GPP W-CDMA modulated signal. Interferers must be provided separately.

Real-Time Signal Generation Mode

Variable chip rates

Integrate and research. Vary the nominal 3.84 Mcps chip rate from 1 ksps to 4.25 Mcps when integrating system components in R&D or to simulate clock drift between systems.

BER testing

Perform BER tests in the ESG. The ESG can perform BER testing on PN9, PN11, PN15, PN20, and PN23 with clock rates up to 60 MHz using Option UN7. [Requires a demodulated and decoded CMOS or TTL level return signal.]

Flexible synchronization

Easily interface to mobile handsets and base stations.

- external baseband reference clock – 250 kHz to 100 MHz
- external 10 MHz frequency reference
- synchronize to base stations using SFN reset or frame trigger from the base station

PRACH

Test the base station's ability to respond the physical random access channel. The fully-coded message payload enables BER/BLER testing to be performed. Also, multiple PRACH signals can be generated for overload testing of base stations.

Operating modes

- send the preamble only
- send variable number of preambles and then the message payload data
- send the preamble until the AICH trigger is received from the base station and then send the message payload data
- send up to 16 fully-coded PRACH signals by cascading two ESGs
  The PRACH supports incrementing power of the preamble, selectable signature, control over power levels, and configurable timing relationships.

Out of synchronization testing

Test the mobile's ability to correctly monitor the DPCCH. The mobile must terminate its output transmission when the downlink DPCCH can no longer be received reliably. The DPCH channel can be turned on and off in real-time via an external trigger to perform the out of synchronization handling of output power test.

Trigger signals

Choose the trigger signals for your specific test needs. Over 50 output trigger and clock signals can be mapped to the physical connectors on the ESG. Signals can be reassigned to different output connectors without causing any discontinuities in the RF output signal. Signals can also be assigned to multiple connectors. The table-based editor allows changes to be made easily and can also be used to view the input trigger signal mapping.

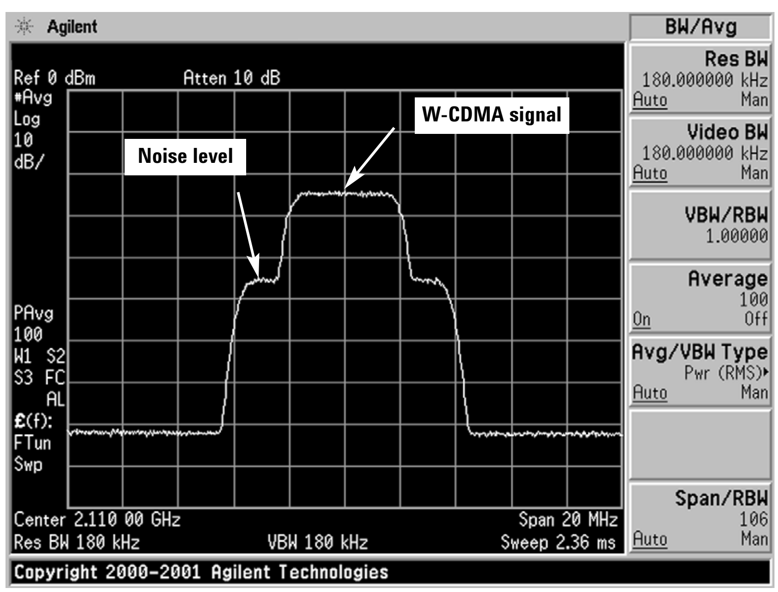
Real-Time Signal Generation Mode

Downlink and uplink features

Coding Level	Transport and physical layer coding
Chip rate variation	1 ksps – 4.25 Mcps
Frame duration	10 ms
Filters	
W-CDMA	a = 0.22
Nyquist, root Nyquist	a = 0 to 1
Gaussian	B_bT = 0 to 1
Rectangle	
Custom FIR	Up to 256 coefficients, 16 bit resolution

Downlink features

Modulation	QPSK
Primary scramble code	0 to 511
Transmit diversity	
Type	Open loop with STTD and TSTD coding
Antenna selection	Off, antenna 1, antenna 2
ESG synchronization	Synchronize two ESGs to simulate both antennas
Primary Synchronization Channel [PSCH]	
Power	-40 dB to 0 dB
Symbol rate	Fixed to 30 ksps
Secondary Synchronization Channel [SSCH]	
Power	-40 dB to 0 dB
Symbol rate	Fixed to 30 ksps
Scramble code group	0 to 63 [coupled to primary scramble code]
Primary Common Control Physical Channel [P-CCPCH]	
Power	-40 dB to 0 dB
Spreading code	0 to 255
Symbol rate	Fixed to 30 ksps
Transport channel	BCH coding
Data field	PN9, PN15, 4-bit repeating pattern, user file



Add calibrated AWGN to the W-CDMA signal by setting C/N, E_b/N_o, or E_c/N

Real-Time Signal Generation Mode

Common Pilot Channel [CPICH]	
Power	-40 dB to 0 dB
Spreading code	Fixed at 0
Symbol rate	Fixed to 30 ksps
Dedicated Physical Channel [DPCH]	
Number of channels	2
Pre-configured reference measurement channels	12.2, 64, 144, 384 kbps RMC AMR 12.2 kbps 64 kbps UDI ISDN
Predefined conformance tests	Reference sensitivity level, maximum input level, adjacent channel selectivity, blocking characteristics, spurious response, intermodulation characteristics, performance test
Transport layer	
Number of DCH	Up to 6 for each DPCH
Block set size	0 to 5000
Block size	0 or same as block set size
Number of blocks	1 to 8
Coding	1/2 convolutional, 1/3 convolutional, turbo, or none
TTI	10, 20, 40, or 80 ms
Data pattern	PN9, fixed 4-bit pattern, user file
Rate matching attribute	1 to 256
CRC size	0, 8, 12, 16, or 24 bits
Transport position	Fixed or flexible
Display parameters	bits/frame, puncturing percentage, bit rate
Physical layer	
Power	-40 dB to 0 dB
Spreading code	0 to 511 [dependent on channel symbol rate]
Symbol rate	7.5, 15, 30, 60, 120, 240, 480, 960 ksps
Slot format	0 to 16 [dependent on channel symbol rate]
TFCI pattern	10-bit user defined input pattern [converted to 30-bit code word with Reed-Mueller coding]
TPC pattern	Ramp up/down N number of times [N = 1 to 80], all up, all down, user file, and real-time control based on an external signal]
τDPCH offset	0 to 149 [increments of 256 chips]
Secondary scramble code offset	0 to 15
Data pattern	PN9, PN15, user file, 4-bit repeating pattern, or a continuous data stream from the transport layer
Compressed mode	
CM method	SF/2 or puncturing
Frame structure	A or B
Power offset	0 to 6 dB
Stop CFN	0 to 255
TGPS	Active or inactive
TGPRC	Infinity or 1 to 511
TGPL1	1 to 144
TGPL2	1 to 144, or omitted
TGSN	0 to 14
TGL1	3, 4, 5, 7, 10, 14
TGL2	3, 4, 5, 7, 10, 14, or omitted
TDG	15 to 269, or 0
TGPS	Fixed to 1
Predefined setups	Reference types from 3GPP TS 25.101 and TS 34.121

Real-Time Signal Generation Mode

Page Indication Channel [PICH]

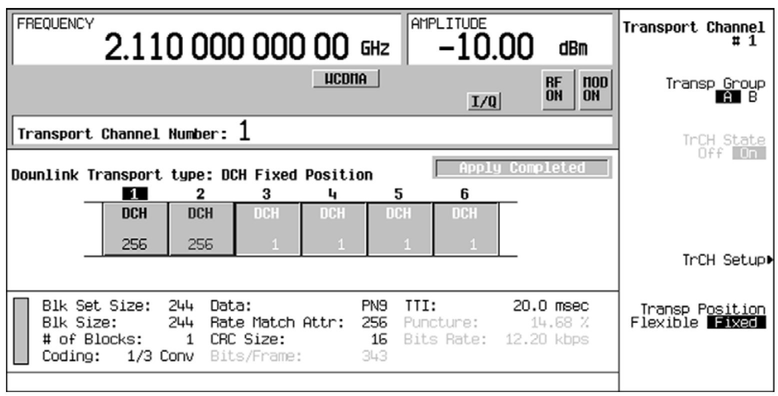
Power	-40 dB to 0 dB
Spreading code	0 to 511 [dependent on channel symbol rate]
Symbol rate	7.5, 15, 30, 60, 120, 240, 480, 960 ksps
Data pattern	PN9, PN15, user file, 4-bit repeating pattern
Number of PI bits	288
Number of paging indication bits	144

Orthogonal Channel Noise Simulator [OCNS]

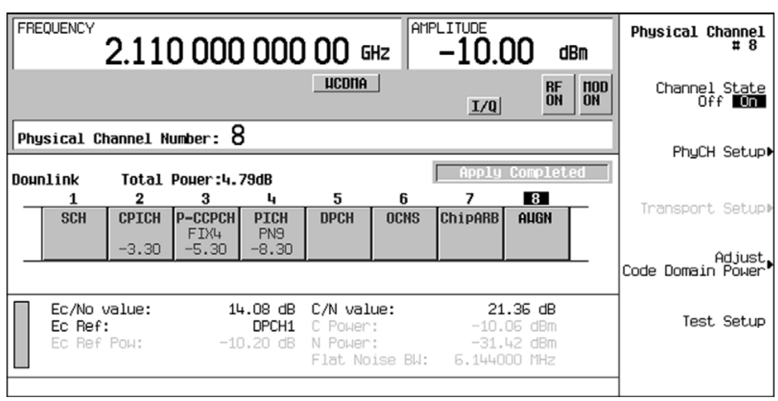
Number of channels	16
Power	-40 dB to 0 dB
Spreading code	0 to 155 [Dependent on channel symbol rate]
Symbol rate	7.5, 15, 30, 60, 120, 240, 480, 960 ksps
Data pattern	PN9, PN15
Secondary scramble code offset	0 to 15
τOCNS offset	0 to 149 [increments of 256 chips]

Additive White Gaussian Noise [AWGN]

E_c/N_o	Range depends on parameters of E_c reference channel
C/N	-30 dB to 30 dB
E_c Ref	P-CCPCH, DPCH 1, DPCH 2, CPICH, PICH

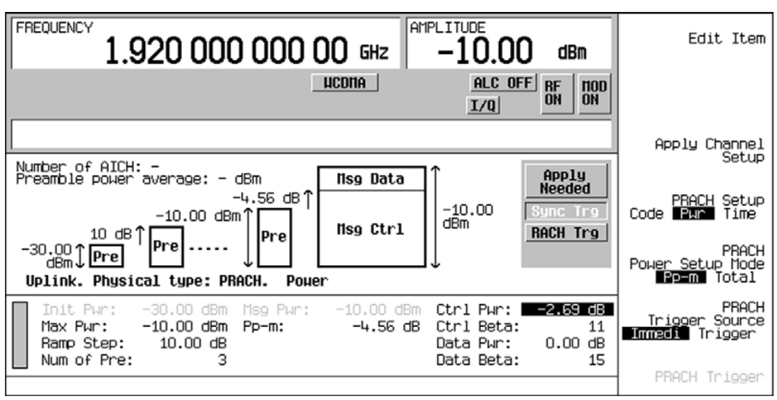


Choose up to six independent transport channels for each DPCH



Adjust AWGN as E_c/N_o, E_b/N_o or C/N in real-time

Input/output		
Inputs		TPC bit input for DPCH System frame number [SFN] reset Chip clock Compressed mode start trigger Compressed mode stop trigger DPCH DTX gate for out-of-synch-test Multi-ESG synchronization trigger Baseband generator frequency reference [250 to 100 MHz] 10 MHz local oscillator reference
Outputs		Chip clock System frame number [SFN] reset SFN synch pulse SCH slot pulse 10 ms frame pulse 80 ms frame pulse DPDCH data clock with DTX DPDCH data clock without DTX DPCCH TPC data clock DPCCH TFCI data clock DPCCH pilot data clock DPCH TPC bit output DPCH data stream DPCH data clock DPCH timeslot pulse DPCH 10 ms frame pulse DPCH compressed frame indicator DPCH gap indicator PICH data PICH data clock PICH timeslot pulse PICH 10 ms frame pulse P-CCPCH data P-CCPCH data clock DPCH chip ARB frame pulse Multi-ESG synchronization trigger 10 MHz local oscillator reference

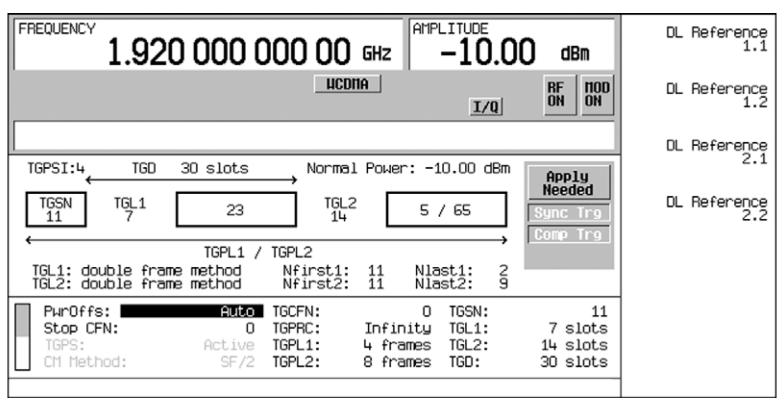


Configure a fully-coded transport layer PRACH signal for BER testing

Real-Time Signal Generation Mode

Uplink features

Modulation	OCQPSK [HPSK]
Scrambling code	0 to 16,777,215
Synchronization setup	
Timing offset range	Timing offset -512 to 2560 chips; Timeslot offset 0 to 119 slots
Synchronization signal	SFN reset or frame clock
Frame clock interval	10, 20, 40, 80, or 2560 ms
Frame clock polarity	Positive, negative
SFN RST polarity	Positive, negative
Sync trigger mode	Single, continuous
Baseband generator chip clock	Internal, external
External clock rate	x1 [3.84 MHz], x2 [7.68 MHz], x4 [15.36 MHz]
External clock polarity	Positive, negative
Real-Time Power Control	
Channels	DPCCH/DPDCH
Power step size	0.5, 1, 2, or 3 dB
Initial power	-40 to 0 dB
Power control range	40 dB
Control mechanism	External trigger signal sampled each timeslot
Dedicated Physical Control Channel [DPCCH]	
Power	-40 dB to 0 dB
Beta	0 to 15 [coupled to power]
Slot format	0 to 5
Symbol rate	Fixed to 15 ksps
Spreading code	0 to 255
TFCI pattern	PN9, PN15, 0 to 03FF hex, user file
TFCI state	[Depends on slot format]
FBI pattern	PN9, PN15, 0 to 3FFFFFFF
FBI state	[Depends on slot format]
Interleaver	On [non adjustable]
TPC pattern	PN9, PN15, 4-bit repeating pattern, user file, up/down, down/up, all up, all down
TPC pattern steps	1 to 80



Configure compressed mode frames in uplink [compressed mode for down-link is also available]

Real-Time Signal Generation Mode

Dedicated Physical Data Channel [DPDCH]	
Pre-configured reference measurement channels	12.2 kbps, 64 kbps, 144 kbps, 384 kbps RMC, AMR 12.2 kbps, 64 kbps UDI
Transport Layer	
Number of DCH	Up to 6
Block size	0 to 5000
Number of blocks	0 to 4095
Coding	1/2 convolutional, 1/3 convolutional, turbo, none
TTI	10, 20, 40, 80 ms
Data pattern	PN9, 4-bit repeating pattern, user file
Rate matching attribute	1 to 256
CRC size	0, 8, 12, 16 or 24 bits
Error insertion	BLER or BER, or none
BLER [block error rate]	0 to 1 [resolution 0.001]
BER [bit error rate]	0 to 1 [resolution 0.0001]
Displayed parameters	bits/frame, puncturing percentage, bit rate
Physical layer	
Power	Off, -40 dB to 0 dB
Beta	0 to15 [coupled to power]
Slot format	0 to 6
Symbol rate	15, 30, 60, 120, 240, 480, 960 ksps [depends on slot format]
Spreading code	0 to 255 [maximum value depends on symbol rate and slot format]
Data pattern	PN9, PN15, 4-bit repeating pattern or a continuous data stream from the transport layer
Error insertion	BER
BER [bit error rate]	Errors inserted after 2nd interleaver as ratio of error bits to total bits
Compressed mode	
CM method	SF/2 or higher layer scheduling
Power offset	0 dB to 6 dB, or auto
TGPS	Active or inactive
TGPRC	Infinity or 1 to 511
TGPL1	1 to 144
TGPL2	1 to 144, or omitted
TGSN	0 to 14
TGL1	3, 4, 5, 7, 10, 14
TGL2	3, 4, 5, 7, 10, 14, or omitted
TDG	15 to 269, or undefined
TGPS	Up to 6
Predefined setups	Reference types from 3GPP TS 25.101 and TS 34.121
Additive white Gaussian noise [AWGN]	
E_b/N_o	Range depends on parameters from E_b reference channel
C/N	- 30 dB to 30 dB
E_b reference	DPCCH, DPDCH, or transport DCH 1 to 6
Single Physical Random Access Channel [PRACH]	
Preamble signature	0 to 15
Message control	
TFCI	0 to 3FF, PN9, PN15, or user file
Data pattern	PN9, PN15, 4-bit repeating pattern, user file, 3GPP
Slot format	0 to 3
Spreading code	0 to 255
Message data	
Data pattern	PN9, PN15, 4-bit repeating pattern, user file, or a continuous data stream from the transport layer
Symbol rate	15, 30, 60, 120 ksps
Spreading code	0 to 255

Single Physical Random Access Channel [PRACH] *(continued)*

Transport channel coding	
Block size	0 to 5000
Number of blocks	0 to 4095
TTI	10 to 20 msec
Data pattern	PN9, 4-bit repeating pattern, or user file
CRC size	0, 8, 12, 16, or 24
Error insertion	BLER, BER, or NONE
BLER	0 to 1 [resolution 0.001]
BER	0 to 1 [resolution 0.0001]
Displayed parameters	Coding type, rate matching attribute, bits/frame, puncturing percentage, bit rate
Additive white Gaussian noise [AWGN]	
E_b/N_o value	Depends on parameters of E_b reference channel
C/N value	-30 dB to 30 dB
E_b reference	Preamble, message control, message data, RACH TrCH
Power menu setup	
Ramp step	0 dB to 10 dB
Number of preambles	1 to 30 [when no. steps x no. preambles ≤ 30 dB Infinite when step size = 0 dB]
Message power	-136 dB to 20 dB
Power delta between preamble and message control	-20 dB to 10 dB
Control power	-40 dB to 0 dB
Control beta	0 to 15
Data power	-40 dB to 0 dB
Data beta	0 to 15
Time menu setup	
Number of PRACH cycles	1 to 2,147,483,647, or infinite
Number of preambles	1 to 30 [when no. steps x no. preambles ≤ 30 dB Infinite when step size = 0 dB]
Start sub channel number	0 to 11
Message part	On, off, or wait for AICH trigger
Time between preambles	1 to 60 access slots
Time between preamble and message payload	1 to 15 access slots
TTI	10 msec or 20 msec

Multiple PRACH mode

Configure up to 8 PRACH per ESG.
Two ESGs can be cascaded together to obtain a 16 PRACH signal.
Each PRACH can have a unique signature, however, all of the PRACHs share the same transport layer coding and timing relationships between the preamble and message payload.
Each PRACH can be defined to start anywhere within an 80 ms period.
This PRACH pattern can be repeated 1 to 2, 147, 447, 836 times or repeated infinitely.

All other parameters for the multiple PRACH are the same except for the following:

The OVSF code for the message control and message data are coupled to the signature for a particular preamble.
Preambles do not increment in power.
AICH trigger can not be received.
Number of preambles is fixed to 1.
All of the PRACHs are configured the same.

Real-Time Signal Generation Mode

Inputs and outputs

Dedicated Physical Channel [DPCH]		
	Inputs	Frame sych trigger Compressed mode start trigger Compressed mode stop trigger TPC user file trigger Chip clock Baseband generator frequency reference [250 kHz to 100 MHz]
	Outputs	Chip clock DPDCH data clock DPDCH data DPCCH data clock DPCCH data 10 ms fame pulse Trigger synch reply Compressed frame indicator TTI frame clock CFN #0 frame pulse
Physical Random Access Channel [PRACH]		
	Inputs	Frame synch trigger AICH trigger PRACH start trigger Chip clock Baseband generator frequency reference [250 kHz to 100 MHz]
	Outputs	Chip clock Message data clock Message data Message control data clock Message control data Message pulse Preamble data clock Preamble data Preamble pulse PRACH pulse PRACH processing Sub channel timing Trigger synch 10 ms frame pulse 80 ms frame pulse ESG sync trigger Echo back start trigger for multi-PRACH

Connectivity Information

The E4438C ESG vector signal generator offers a wide array of I/O capabilities to simplify measurement setups.

Perform firmware upgrades, download waveforms to the instrument, or remotely control the instrument with SCPI commands using either 10BaseT LAN or IEEE-488 GPIB. LAN control requires the use of the L version of Agilent I/O libraries, downloadable from the Agilent web site: **www.agilent.com**

Recommended Configuration[1]

E4438C ESG vector signal generator

Frequency option	
503	250 kHz to 3 GHz frequency range
Hardware options	
1E5	High-stability time base
002	Internal baseband generator with 32 Msample memory
005	6 GB hard drive [Option 001or 002 required]
Firmware option	
400	3GPP W-CDMA personality
403	Calibrated noise personality

Other configurations are available. For details regarding the E4438C ESG option structure, refer to the *Configuration Guide* in the *Related Agilent literature* section.

1. All options should be ordered using E4438C-xxx, where the xxx represents the option number.

Ordering Information[1]

The 3GPP W-CDMA firmware may be purchased as Option 400 with a new Agilent E4438C ESG vector signal generator. If you need assistance, your Agilent field sales engineer can help configure your instrument properly. Contact information can be found at: **www.agilent.com/find/assist**

Upgrade kits

If you currently own an E4438C ESG with the optional baseband generator and are interested in obtaining an upgrade kit only [license key], order: E4438CK Option 400.

This kit is not compatible with earlier models of the ESG.

Firmware Updates

Firmware updates can be downloaded from **www.agilent.com/find/esg**

1. All options should be ordered using E4438C-xxx, where the xxx represents the option number.

Related Agilent Literature

Brochures

Agilent E4438C ESG Vector Signal Generator
Publication number 5988-3935EN
2G & 3G Solutions - Accelerating Progress
Publication number 5968-5860E

Data sheets

Agilent E4438C ESG Vector Signal Generator
Publication number 5988-4039EN

Configuration guides

E4438C ESG Vector Signal Generator
Publication number 5988-4085EN

Application Notes

Digital Modulation in Communication Systems-An Introduction
Publication number 5965-7160E
Testing and Troubleshooting Digital RF Communications Transmitter Designs - Application note 1313
Publication number 5968-3578E
Testing and Troubleshooting Digital RF Communications Receiver Designs
Publication number 5968-3579E
Designing and Testing W-CDMA User Equipment – Application Note 1356
Publication number 5980-1238E
Designing and Testing W-CDMA Base Stations – Application Note 1355
Publication number 5980-1239E
Characterizing Digitally Modulated Signals with CCDF Curves
Publication number 5968-6875E

Other products

Wireless Communications Products
Publication number 5968-6174E
Agilent E4406A Vector Signal Analyzer
Publication number 5968-7618E
Agilent PSA Series Spectrum Analyzers
Publication number 5980-1284E
See **www.agilent.com** for more information

For more information please visit the ESG Web site at **www.agilent.com/find/ESG**

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