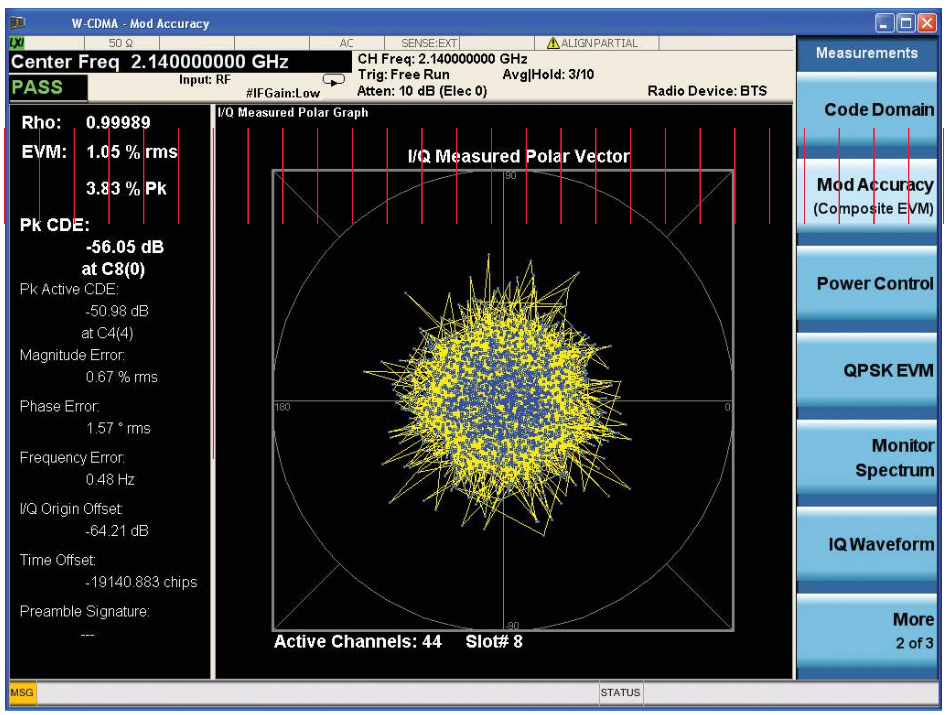
Keysight Technologies
N9073A W-CDMA/HSPA/HSPA+
W9073A W-CDMA/HSPA

X-Series Measurement Application

Demo Guide



KEYSIGHT
TECHNOLOGIES

Demonstration Preparation

All demonstrations utilize an X-Series signal analyzer and an N5182A MXG signal generator with N7600B Signal Studio software. Keystrokes surrounded by [ ] indicate front-panel keys, while softkeys located on the right edge of the display are indicated in bold type.

The W-CDMA/HSPA/HSPA+ measurement application transforms the X-Series signal analyzers into 3GPP standard-based transmitter tester. The application provides fast one-button RF conformance measurements to help you design, evaluate, and manufacture your W-CDMA/HSPA/HSPA+ base station and user equipment devices. The measurement application closely follows the 3GPP standard allowing you to stay on the leading edge of your design and manufacturing challenges.

Instruments	Model number	Required options
Keysight MXG vector signal generator	N5182A	503 or 506 – frequency range at 3 GHz or 6 GHz 651, 652 or 654 – internal baseband generator UNV – Enhanced dynamic range (required for better ACP performance)
Signal Studio software	N7600B	3GPP W-CDMA FDD 3FP to connect with MXG EFP Basic W-CDMA/HSPA (Release 7) FFP Basic W-CDMA/HSPA+ (Release 8) QFP Advanced W-CDMA/HSPA+ (Release 8)
X-Series signal analyzers	N9030A PXA N9020A MXA N9010A EXA N9000A CXA	503, 508 (507 for EXA and CXA), 513, or 526 – frequency range up to 26.5 GHz (7.5 GHz for CXA) EA3 – Electric attenuator, 3.6 GHz (recommended) P0x – Preampifier (recommended) For PXA, B25, B40, B1X – Analysis bandwidth 25 MHz, 40 MHz, 140 MHz (required for analysis over 10 MHz such as 4-carrier CCDF) For MXA/EXA, B25, B40 – Analysis bandwidth 25, 40 MHz (required for analysis over 10 MHz such as 4-carrier CCDF) For CXA, B25 – 25 MHz analysis bandwidth (required for analysis over 10 MHz such as 4-carrier CCDF) N9020A-BBA – MXA analog baseband IQ inputs (required for analog baseband analysis, not available on PXA, EXA and CXA)
X-Series measurement application	N9073A W9073A (Options 1FP and 2FP only)	1FP or 1TP W-CDMA measurement application 2FP or 2TP HSPA measurement application 3FP or 3TP HSPA+ measurement application XFP or XTP single acquisition combined W-CDMA measurement application for MXA and EXA (not compatible with B40, 40 MHz BW option)
Controller PC for Signal Studio		Install N7600B to generate and download the signal waveform into the Keysight MXG via GPIB or LAN (TCP/IP). Please refer the online documentation for installation and setup

Helpful tip:

Update your instrument firmware and software to the latest version, available at

www.keysight.com/find/mxg
www.keysight.com/find/signalstudio
www.keysight.com/find/xseries_software

Demonstration Setup

To configure these instruments, connect the Keysight MXG's 50 Ω RF output to X-Series analyzer's 50 Ω RF input with a 50 Ω RF cable. Turn on the power in both instruments.

Now, set up the Keysight MXG and Signal Studio software to generate a W-CDMA signal (test model 1).

Instructions	Software operations
On the Signal Studio software:	
Start the Signal Studio software.	**Start > Program > Keysight Signal Studio > 3GPP W-CDMA**
Configure the Keysight MXG as a hardware connected via GPIB or LAN (TCP/IP).	Follow the Signal Studio instructions to connect to the Keysight N5182A MXG.
Set the basic parameters of the signal at center frequency 2.14 GHz, amplitude –20 dBm and RF Output turned ON.	Click **Signal Generator** at the Hardware on the explorer menu at the left hand. Press [**Preset**] green button on the top. Frequency = 2.14 GHz, Amplitude = –20 dBm, RF Output = On, ALC = On
Select the predefined test model in waveform setup. Default setting must be W-CDMA FDD Downlink with Test Model 1 + 64 DPCH.	Click **Carrier** 1 under Waveform Setup on the explorer menu at the left hand. Channel Configuration = Test Model 1 + 64 DPCH. Pull down the Channel Configuration menu to see how many predefined configurations are available for W-CDMA FDD Downlink.
Confirm the test signal condition in detail channel setup.	Click **Channel Setup** to see each channel parameters, states and CDP/CCDF display.
Download the signal to the Keysight MXG.	Press **Generate and Download** button on the top tool bar. If you encounter any errors, please refer the online help of Signal Studio software.
Save the signal file for future reuse.	**File > Save As... > WCDMA_Demo1.scp**
Export the waveform file for future reuse.	**File > Export Waveform Data > Demo1.wfm** (Name it as you like).

Demonstration 1:

Channel power

The channel power measurement identifies the channel power within a specific bandwidth (default of 5 MHz, as per 3GPP W-CDMA technical specifications) and the power spectral density (PSD) in dBm/Hz.

Control the following channel power measurement parameters:

– Integration bandwidth (default to 5 MHz)
– Number of trace averages (default to 200)
– Data points displays, 101 to 20001 (default to 1001)
– Turn on RRC filter with flexible filter alpha value (default to Off)
– Trigger source: free run, video, line, external-½, RF burst, and periodic timer (default to free run)

Instructions	Keystrokes
On the X-Series analyzer W-CDMA mode:	
Select W-CDMA analysis. If N9073A-2FP installed, the key label will be **W-CDMA with HSPA.** If N9073A-3FP is installed, the key label will be **W-CDMA with HSPA+**	[Mode Preset] [Mode] W-CDMA with HSPA or W-CDMA with HSPA+
Choose transmitter radio device to base station (downlink).	[Mode Setup] Radio Device BTS MS
Set a center frequency at 2.14 GHz.	[FREQ] [2.14] GHz
Make channel power measurement.	[Meas] Channel Power

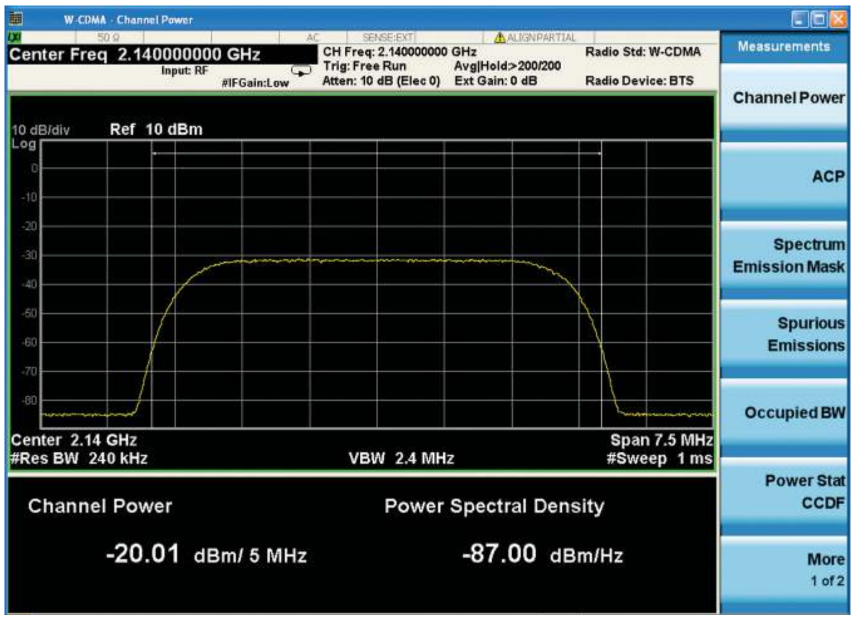


Figure 1. Channel power in W-CDMA mode

Demonstration 2:

Adjacent channel power (ACP)

Reducing transmitter channel leakage allows for more channels to be transmitted simultaneously, which, in turn, increases base station efficiency. The ACP, designated by the 3GPP W-CDMA specifications as the adjacent channel leakage power ratio (ACLR), is a measure of the power in adjacent channels relative to the transmitted power. The standard requires the power of both the transmitted and adjacent channels be measured through a root raised cosine (RRC) filter with a roll-off factor of 0.22.

- Measure up to 12 carriers for multi-carrier ACP (Figure 3 shows 4-carrier W-CDMA ACP measurement)
- Adjust integration bandwidth
- Select up to six channel offsets
- Choose channel offset frequency
- Adjust and display both absolute and relative power
- View bar graph over spectrum trace
- Use built-in averaging detector (RMS) for speed and accuracy
- Turn on RRC filter with flexible filter alpha value
- Noise correction On/Off (default is Off)

Instructions	Keystrokes
On the X-Series analyzer W-CDMA mode:	
Measure ACP with Test Model 1 + 64 DPCH at 2.14 GHz.	**[Meas] ACP**
Adjust the power level by changing attenuation.	**[AMPTD] Attenuation > [up] [down]** arrow keys (to add or reduce attenuations)
Adjust the limit for one offset pair. Notice as green PASS indicator in the upper left corner changes to a red FAIL when the signal does not meet limit requirements.	**[Meas Setup] Offset/Limits > Offset A > More > Rel Lim (Car) > [–90] dB**
Compare the measured result with noise correction turned On. A better ACP result is achieved with noise correction (Figure 2).	[Meas Setup] More > Noise Correction On Off

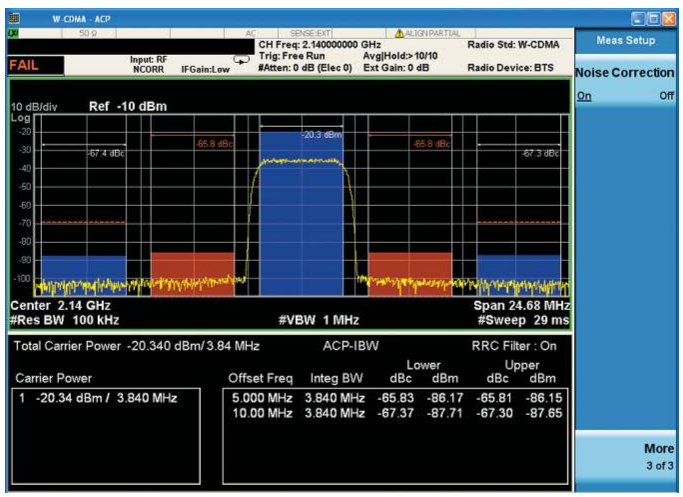


Figure 2. ACP with fail indicator on limit test and noise correction

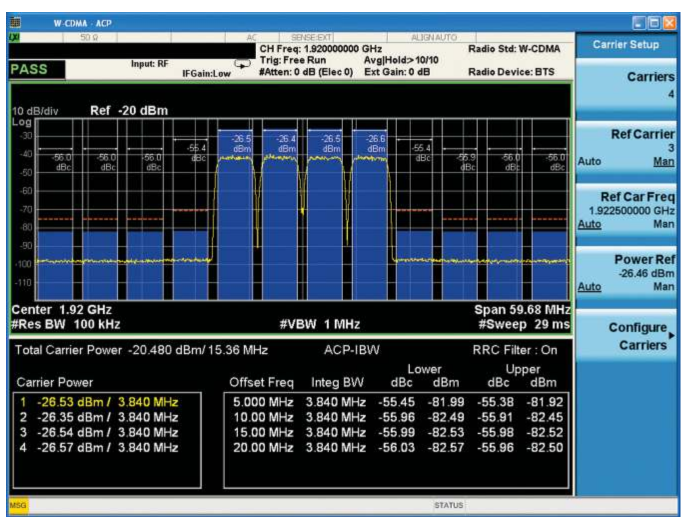


Figure 3. ACP with four-carrier W-CDMA (sample screen)

Demonstration 3:

Spectrum emission mask (SEM)

The spectrum emission mask measurement required by 3GPP specifications encompasses different power limits and different measurement bandwidths (resolution bandwidths) at various frequency offsets. Figure 4 is a diagram of the specification requirements for power density versus frequency offset from carrier (excerpt from the 3GPP TS25.104 v.8.6.0). Completing the many measurements required to comply with this standard is made quick and easy with an X-Series signal analyzer.

Note: The default settings in SEM take account the test tolerances defined in TS25.141.

Instructions	Keystrokes
On the X-Series analyzer W-CDMA mode:	
Make spectrum emission mask measurement.	[Meas] Spectrum Emission Mask
Set the reference level at 0 dBm.	[AMPTD] Ref Value [0] dBm
Choose the type of values to display.	**[View/Display] Abs Pwr Freq** or **Rel Pwr Freq** or **Integrated Power**
Observe the measurement values change in the lower window to reflect the selected value type (Figure 5).	
View customizable offsets and limits. Measurement parameters as well as limit values may be customized for any of the six offset pairs A through F or for any individual offset.	[Meas Setup] Offset/Limits > More > Limits

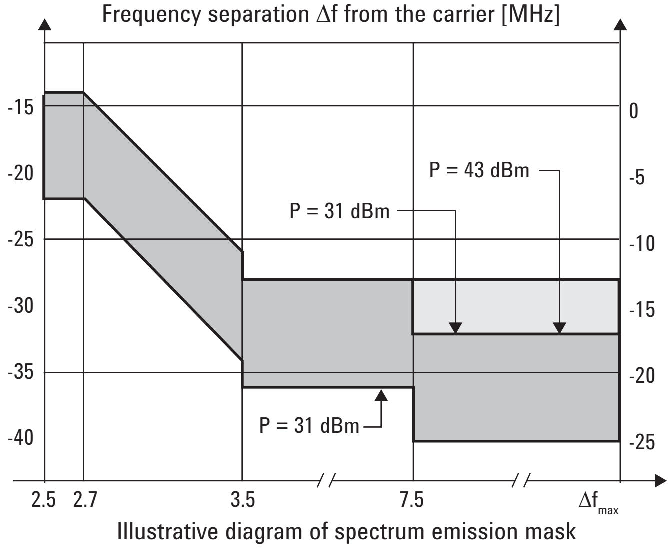
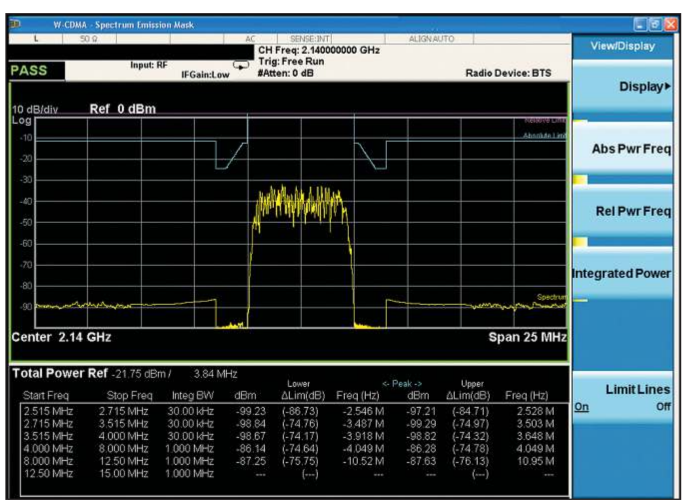


Figure 4. W-CDMA specifications for SEM (from TS 25.104 v.8.6.0)



Start Freq	Stop Freq	Integ BW	Lower dBm	Lower ΔLim(dB)	Lower Freq (Hz)	Upper dBm	Upper ΔLim(dB)	Upper Freq (Hz)
2.515 MHz	2.715 MHz	30.00 kHz	-99.23	(-86.73)	-2.546 M	-97.21	(-84.71)	2.528 M
2.715 MHz	3.515 MHz	30.00 kHz	-98.84	(-74.76)	-3.487 M	-99.29	(-74.97)	3.503 M
3.515 MHz	4.000 MHz	30.00 kHz	-98.67	(-74.17)	-3.918 M	-98.82	(-74.32)	3.648 M
4.000 MHz	8.000 MHz	1.000 MHz	-86.14	(-74.64)	-4.049 M	-86.28	(-74.78)	4.049 M
8.000 MHz	12.50 MHz	1.000 MHz	-87.25	(-75.75)	-10.52 M	-87.63	(-76.13)	10.95 M
12.50 MHz	15.00 MHz	1.000 MHz	---	(---)	---	---	(---)	---

Figure 5. Spectrum emission mask

Demonstration 4:

Spurious emissions

The spurious emissions measurement identifies and determines the power level of spurious emissions in 3GPP defined frequency bands. The measurement allows the user to set pass/fail limits and a reported spur threshold value. The results are conveniently displayed in a result table that can show up to 200 values.

Note: When an RMS detector is used in an X-Series analyzer, VBW is automatically set to RBW:VBW as 10:1.

This demo procedure shows how to edit the range table and how to look up the detected spurious signals. The range table refers to 3GPP TS25.141 v.8.6.0 Section 6.5.3.7.2 (Band I, Category B).

Instructions	Keystrokes
On the X-Series analyzer W-CDMA mode:	
Make spurious emissions measurement.	[Meas] Spurious emissions
Edit the range table as shown in the table below. This is modified for the carrier at 2.14 GHz.	**[Meas Setup] Range Table**

Range	Start	Stop	RBW	Filter	Abs Start Limit
1	9 kHz	150 kHz	1 kHz	Gaussian	–36 dBm
2	150 kHz	30 MHz	10 kHz	Gaussian	–36 dBm
3	30 MHz	1 GHz	100 kHz	Gaussian	–36 dBm
4	1 GHz	2.1 GHz	1 MHz	Gaussian	–30 dBm
5	2.1 GHz	2.1 GHz	1 MHz	Gaussian	–25 dBm
6	2.1 GHz	2.1275 GHz	1 MHz	Gaussian	–15 dBm
7	2.1525 GHz	2.18 GHz	1 MHz	Gaussian	–15 dBm
8	2.18 GHz	2.18 GHz	1 MHz	Gaussian	–25 dBm
9	2.18 GHz	12.75 GHz	1 MHz	Gaussian	–30 dBm

Run a single spurious measurement.	[Single]
Search a spurious detected as fifth (Figure 6).	[Meas Setup] Spur > 5 [Enter]

Note: The instrument shows a warning status at the bottom line as "AC coupled: Accy unspec'd < 10 MHz." This comes out when the measured frequency set to below 10 MHz. Please refer to the instrument User's Guide for more details.

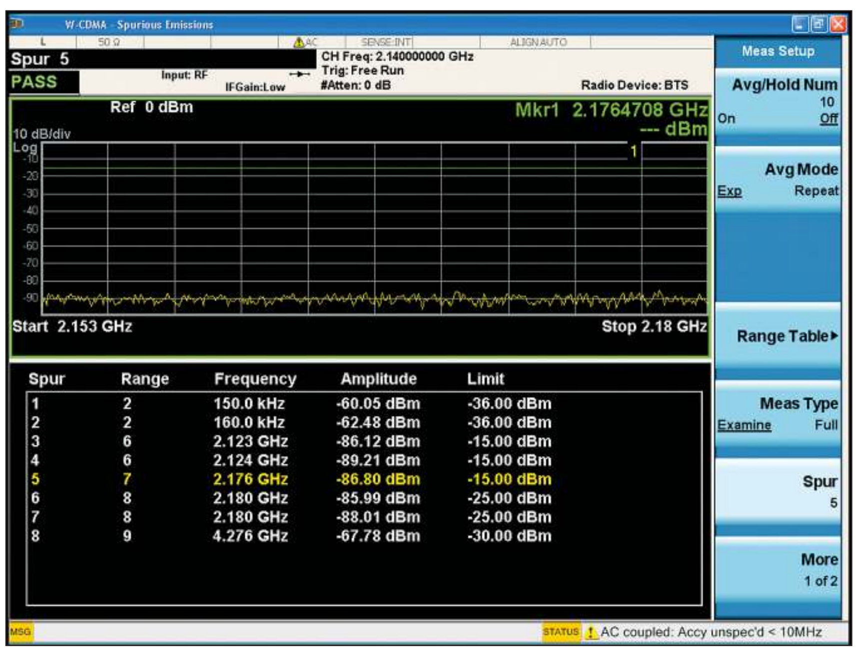


Figure 6. Spurious emissions

Demonstration 5:

Occupied bandwidth

The 3GPP specifications require the occupied bandwidth (OBW) of a transmitted W-CDMA signal to be less than 5 MHz, where occupied bandwidth is defined as the bandwidth containing 99% of the total channel power.

– Changeable occupied bandwidth % power
– Measure 99% occupied bandwidth and the x dB bandwidth

In this measurement, the total power of the displayed span is measured. Then the power is measured inward from the right and left extremes until 0.5% of the power accounted for in each of the upper and lower part of the span. The calculated difference is the occupied bandwidth. In accordance with the 3GPP specification, the W-CDMA mode defaults to a 5 MHz PASS/FAIL limit values.

Instructions	Keystrokes
On the X-Series analyzer W-CDMA mode:	
Measure the occupied bandwidth (Figure 7).	**[Meas] Occupied Bandwidth** **[Meas Setup]**

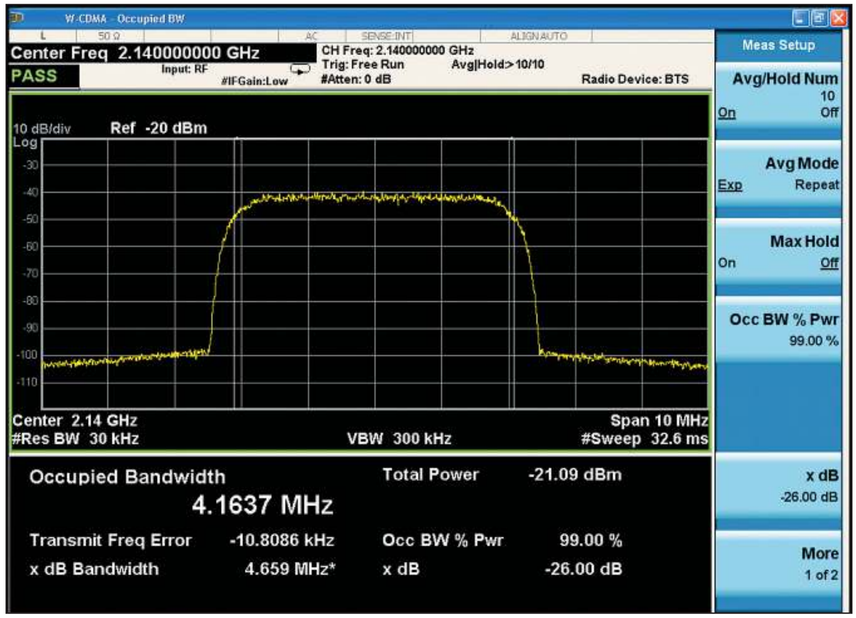


Figure 7. Occupied bandwidth

Demonstration 6:

Power statistics CCDF

The complementary cumulative distribution function (CCDF) is a plot of peak-to-average power ratio (PAR) versus probability and fully characterizes the power statistics of a signal. It is a key measurement for base station amplifier design, which is particularly challenging because the amplifier must be capable of handling the high PAR which the signal exhibits while maintaining good adjacent channel leakage performance. Designing multi-carrier power amplifiers pushes complexity yet another step further.

– Set a reference trace, compare to Gaussian noise trace
– Select measurement bandwidth and measurement interval
– Choose trigger source: video, line, replace with: external 1, external 2, RF burst, and periodic timer

This exercise illustrates the simplicity of measuring CCDF for W-CDMA.

If W-CDMA multi-carrier power amplifier (MCPA) needs to be measured in CCDF, N9030A-B25 (or B40 or B1X), N9020A-B25 (or B40), N9010A-B25 (or B40) or N9000A-B25 is required for analysis wider than 10 MH.

Instructions	Keystrokes
On the X-Series analyzer W-CDMA mode:	
Measure the CCDF (Figure 8).	**[Meas] Power Stat CCDF**

Figure 8. CCDF of single carrier signal

Figure 9. CCDF of four-carrier W-CDMA signal (sample with MXA plus B25, 25 MHz analysis bandwidth)

Demonstration 7:

Code domain

The code domain analysis measurement provides a variety of different results and traces.

First, code domain power analysis measures the distribution of signal power across the set of code channels, normalized to the total signal power. This measurement helps to verify that each code channel is operating at its proper level and helps to identify problems throughout the transmitter design from coding to the RF section. System imperfections, such as amplifier non-linearity, will present themselves as an undesired distribution of power in the code domain.

Now analyze the W-CDMA signal in code domain measurement.

Instructions	Keystrokes
On the X-Series analyzer W-CDMA mode:	
Make code domain measurement.	**[Meas] Code Domain**
Specify the synchronization start slot number.	**[Meas Setup] Sync Start Slot 0 On/Off**
Change to Single measurement.	**[Single]**
Look at the power and symbol rate of a specific channel with a marker. It's PICH (paging indicator channel) at C8(16).	**[Marker] [32] [Enter]**
Examine characteristics of the code channel with the active marker at C8(16) (Figure 10).	**[Marker->] Mkr ->Despread**
Show I and Q symbol bits.	**[View/Display] Demod Bits**
Shift the selected slot to the symbol power off gap.	**[Meas Setup] Meas Offset** or rotate knob or use **[up] [down]** arrow keys
Change bit format from binary (0,1) to tri-state (0, 1, X) to make burst off period more visible in demodulated bits (Figure 11).	**[Meas Setup] Symbol Analysis > DTX/ Burst Detect On/Off**

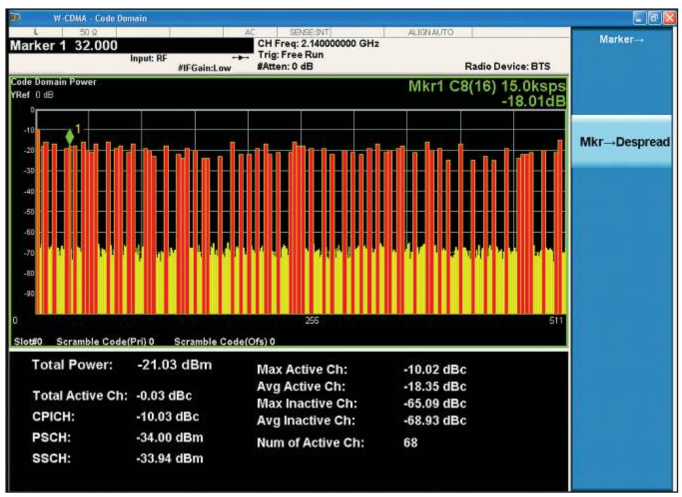


Figure 10. Code domain power graph with a marker at PICH, C8(16)

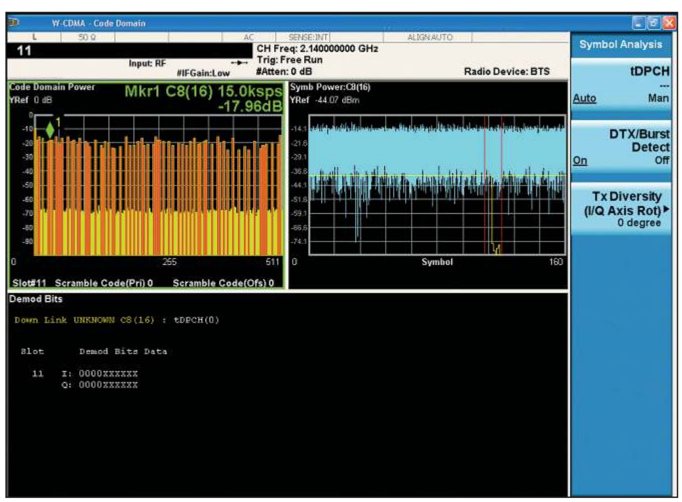


Figure 11. Code domain symbol power and demodulated bits (power off period shown as XXXX)

Code domain, continued

HSDPA in 3GPP release 5 of 3GPP specifications add high speed downlink packed access (HSDPA) in an effort to make the system more efficient for packet data applications to increasing peak data rates and reducing packet latency. Theoretical peak data rate is approximately 14 Mbps in maximum. To improve W-CDMA system performance, HSDPA makes a number of changes to the radio interface, that mainly affect the physical layer:

Now change the signal from W-CDMA test mode 1 to HSDPA test model 5 + 8 HS-PDSCH.

Instructions	Software operations
On the Signal Studio software:	
Modify the waveform setup from W-CDMA FDD downlink with Test Model 1 + 64 DPCH to Test Model 5 + 8 HS-PDSCH.	Click **Carrier 1** under Waveform Setup on the explorer menu at the left hand. Channel Configuration = Test Model 5 + 8 HS-PDSCH
Confirm the test signal condition in detail channel setup.	Click **Channel Setup** to see each channel parameters, states and CDP/CCDF display
Download the signal to the Keysight MXG.	Press **Generate and Download** on the top tool bar

Code domain in W-CDMA mode has flexibility to customize measurements for your particular needs. Setting the capture interval determines the measurement length—short for fast measurements or long for in-depth analysis to monitor any variance in time domain. Test models in downlink are pre-programmed to allow you for enforced active channel identification.

Now examine the HSDPA test model 5 in code domain analysis.

Instructions	Keystrokes
On the X-Series analyzer W-CDMA mode:	
Return to the power graph.	**[View/Display] Power Graph & Metrics**
Use predefined test model for active channel identification.	**[Meas Setup] Symbol Boundary > Predefined Test Models > Test Model 5 w/8 HSPDSCH**
Change measurement from continuous to single.	**[Single]**
Look at the power and symbol rate of a selected HS-PDSCH.	**[Marker] [140] [Enter]**
Despread the marked code channel, HS-PDSCH at C4(4).	**[Marker->] Mkr -> Despread**
Switch the view to observe the selected HS-PDSCH (Figure 12).	**[View/Display] Code Domain (Quad View)**
Change the view for demodulated bits, move the selected window to the bottom, and switch bit format from binary to hexadecimal (Figure 13).	**[View/Display] Demod Bits** **[Next Window]**  **[View/Display] Demod Bits > Demod Bit Format Binary | Hex**

Code domain, continued

Code domain quad view
Upper left: Code domain power graph
Upper right: Symbol power trace in yellow, chip power trace in aqua blue.
Lower left: I/Q symbol constellation of the selected code channel. Lower right: Symbol analysis results of the selected code channel.

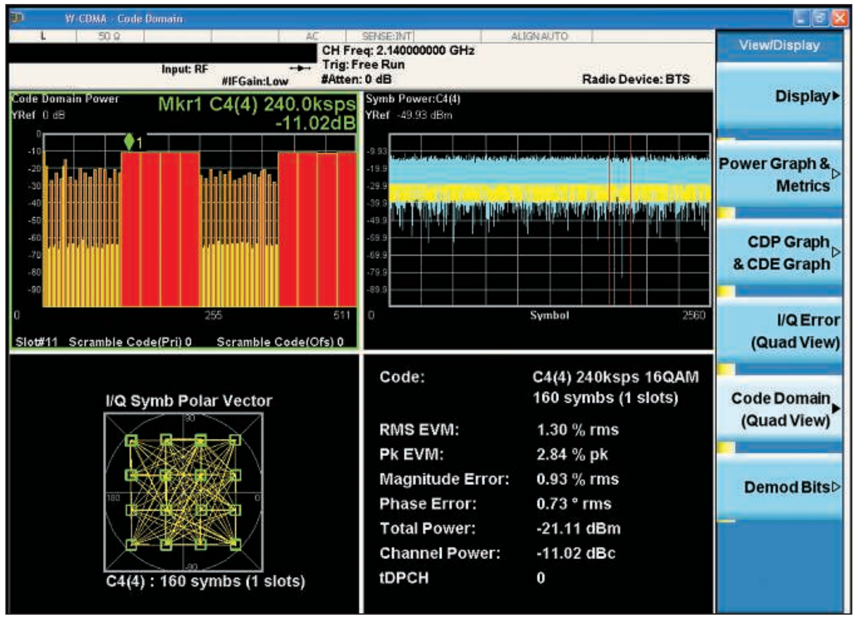


Figure 12. Code domain quad view with HS-PDSCH in 16QAM symbol analysis

Demodulated bits
Lower window contains demodulated bits of the selected code channel in measured interval

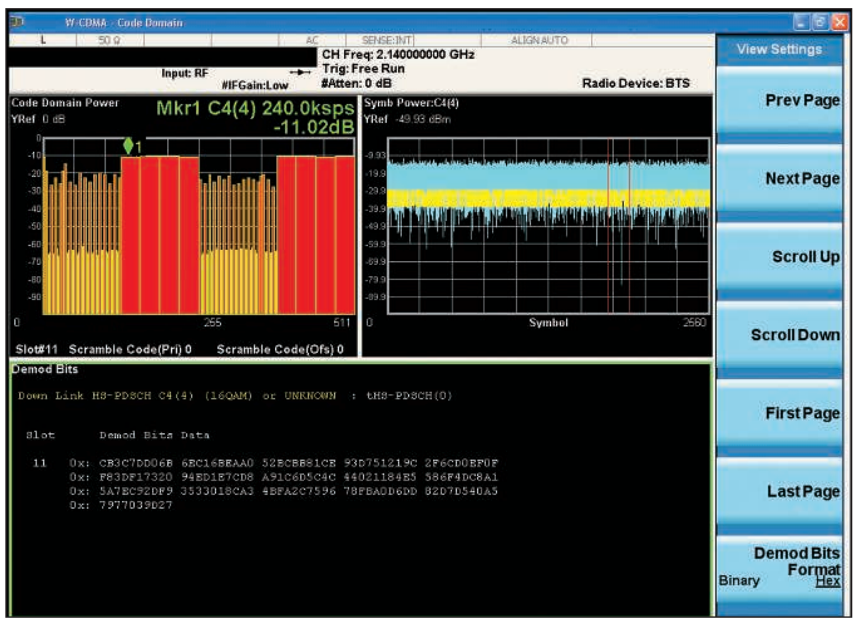


Figure 13. Code domain demodulated bits in hexadecimal format

Code domain, continued

HSUPA in 3GPP Release 6
High-speed uplink packed access (HSUPA) is a new technology over W-CDMA and HSDPA defined in 3GPP release 6 to improve the uplink data rate. It is also described as E-DCH (enhanced dedicated channel) in 3GPP standards. Theoretically, it may improve the uplink data rate to 5.76 Mbps with new uplink physical channels of E-DPCCH (E-DCH dedicated physical control channel) and E-DPDCH (E-DCH dedicated physical data channel). In downlink, there are three physical channels for HSUPA as E-AGCH (E-DCH absolute grant channel), E-RGCH (E-DCH relative grant channel) and E-HICH (E-DCH HARQ indicator channel).

Now change the signal from HSDPA downlink test model 5 to HSUPA uplink signal.

Instructions	Software operations
On the Signal Studio software:	
Delete carrier 1 W-CDMA FDD downlink signal.	Click **Carrier 1** under Waveform Setup on the explorer menu at the left hand. Press [**X**] on the tool bar or use [**Delete**] on your PC keyboard
Put a carrier of W-CDMA FDD uplink for new configuration.	Press [+] on the tool bar, and select **W-CDMA FDD Uplink** from the drop-down menu
Set a center frequency at 1.95 GHz for uplink.	Press [**Preset**] green button on the top Frequency = 1.95 GHz, Amplitude = –20 dBm, RF Output = On, ALC = On
Change the channel configuration from default DPCCH to DPCCH + E-DPCCH + 4 E-DPDCH.	Channel Configuration = DPCCH + E-DPCCH + 4 E-DPDCH
Confirm the test signal condition in detail channel setup.	Click **Channel Setup** to see each channel parameters, states and CDP/CCDF display
Download the signal to the Keysight MXG.	Press **Generate and Download** on the top tool bar

The following features are available for HSUPA with N/W9073A-2FP:

– Auto-detection of E-DPDCH in spreading factor 2 and 4
– E-DPCCH power beta calculation based on 3GPP standard configuration
– Adaptive modulation analysis capability

Now examine the HSUPA signal with E-DPDCH in SF 2 and SF 4.

Instructions	Keystrokes
On the X-Series analyzer W-CDMA mode:	
Change the radio device to uplink code domain analysis.	**[Mode Setup] Radio Device BTS MS [FREQ] [1.95] GHz**
Return to the power graph.	**[View/Display] Power Graph & Metrics**
Look at the power and symbol rate of a selected E-DPDCH.	**[Marker] [130] [Enter]**
Change configuration for correct beta calculations and run a single measurement (Figure 14).	**[Meas Setup] {DPCH/E-DPCH Config} -> 3 (no DPDCH) [Single] [Restart]**
Despread the marked code channel, E-DPDCH.	**[Marker->] Mkr -> Despread**
Check the symbol analysis results in code domain quad view (Figure 15).	**[View/Display] Code Domain (Quad View)**

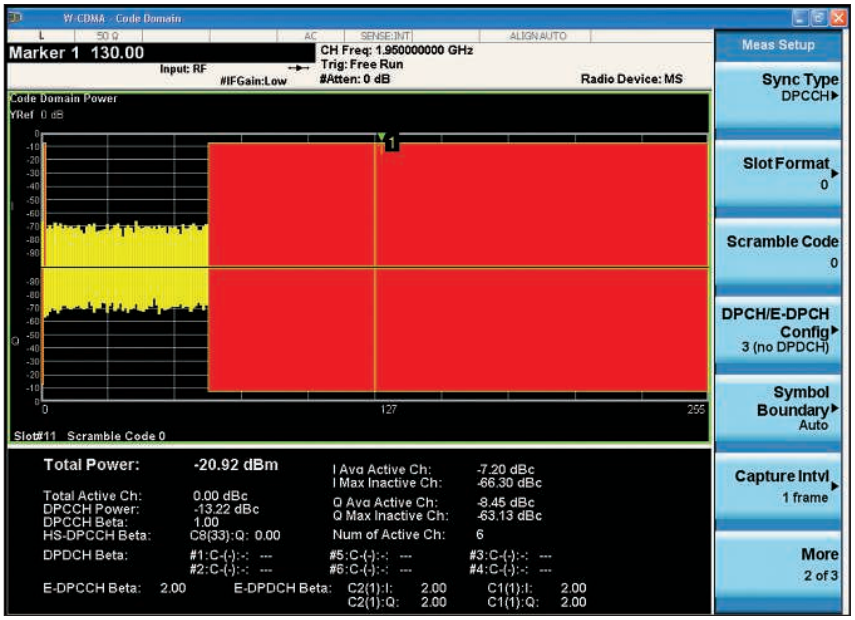


Figure 14. Code domain power graph with HSUPA signal

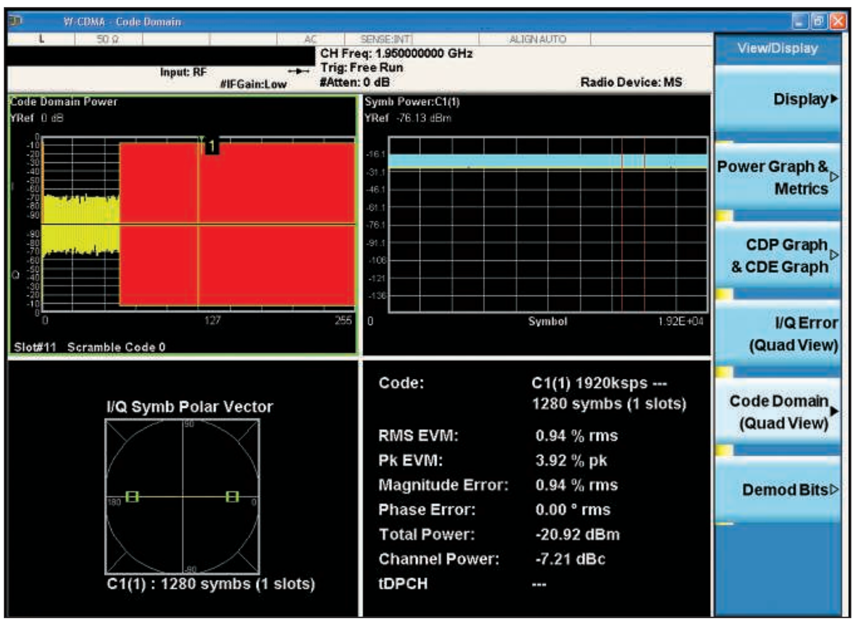


Figure 15. Code domain quad view with E-DPDCH in SF2 symbol analysis

Code domain, continued

HSPA+ in 3GPP Release 7 and beyond
To increase the data rate over existing HSPA (HSDPA/HSUPA), HSPA+ (or HSPA Evolution, Evolved HSPA, eHSPA) was introduced in release 7 and 8 of 3GPP standard. Theoretical peak data rate can be extended from 14 Mbps to 28 Mbps, then up to 42 Mbps with 2x2 MIMO in downlink. Uplink data rate can be increased from HSUPA 5.76 Mbps in maximum to 11 Mbps in HSPA+.

Create and generate HSPA+ downlink test model 6.

Instructions	Software operations
On the Signal Studio software:	
Delete carrier 1 W-CDMA FDD uplink signal.	Click **Carrier 1** under Waveform Setup on the explorer menu at the left hand. Press [**X**] on the tool bar or use [**Delete**] on your PC keyboard
Put a carrier of W-CDMA FDD downlink release 8 for new configuration.	Press **[+]** on the tool bar, and select **W-CDMA FDD Downlink (Rel 8 Sep 07)** from the drop-down menu
Set a center frequency at 2.14 GHz for downlink with instrument menu in explorer menu.	Press **[Preset]** green button on the top Frequency = 2.14 GHz, Amplitude = –20 dBm, RF Output = On
Change the channel configuration from default 1 DPCH to test model 6.	Click **Carrier** 1 and set channel configuration as test model 6 + 8 HS-PDSCH (64QAM)
Confirm the test signal condition in detail channel setup.	Click **Channel Setup** to see each channel parameters, states and CDP/CCDF display
Download the signal to the Keysight MXG.	Press **Generate and Download** on the top tool bar

Run a measurement with HSPA+ DL test model in code domain.

Instructions	Software operations
On the X-Series analyzer W-CDMA mode:	
Change the radio device for downlink code domain analysis.	**[Mode Setup] Radio Device BTS MS [FREQ] [2.14] GHz**
Return to the code domain quad view.	**[View/Display] Code Domain (Quad View)**
Place a marker on HS-PDSCH detected as C4(7).	**[Marker] [250] [Enter]**
Select test model 6 from pre-defined test models (Figure 16).	**[Meas Setup] Symbol Boundary -> Test Model 6 -> Test Model 6 w/8 HS-PDSCH w/30 DPCH**
Change to demod bits view.	**[View/Display] Demod Bits**
To see entire demod bits data, of C4(7) HS-PDSCH in 64QAM, select window to zoom in (Figure 17).	**[Next Window]** to move selected window to demod bits. **[Zoom]** (These window control keys are available on the bottom of display)

Code domain, continued

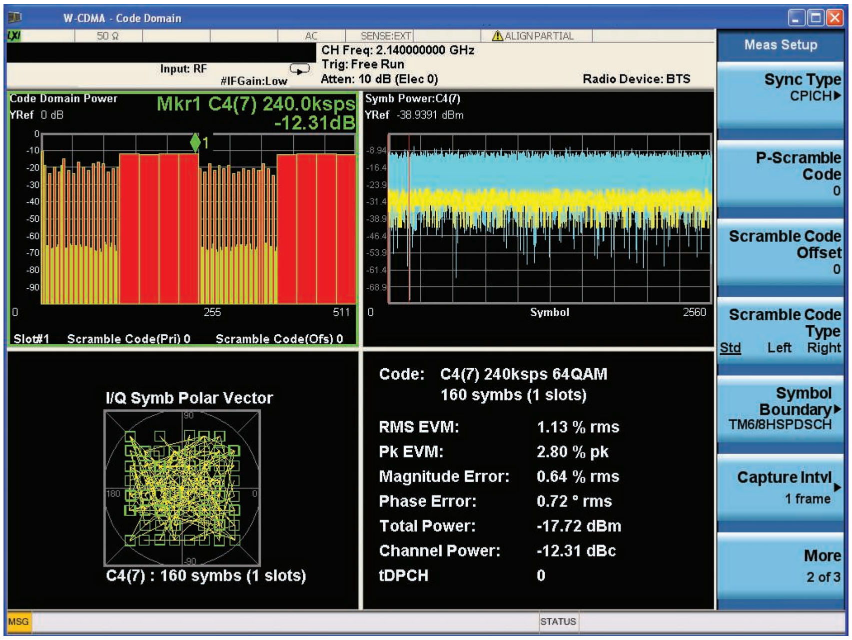


Figure 16. Code domain quad view with HSPA+ downlink test model 6

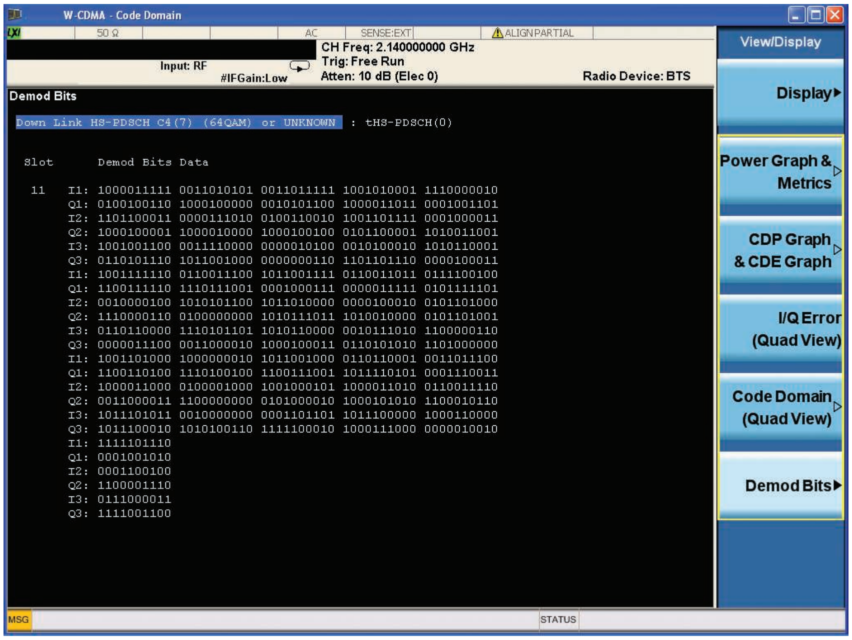


Figure 17. Demod bits view of HS-PDSCH in 64QAM

Demonstration 8:

Modulation accuracy (composite EVM)

Modulation accuracy (composite EVM) Error vector magnitude (EVM) is defined in 3GPP conformance tests for both downlink and uplink. EVM is a common modulation quality metric widely used in digital communications. Mod accuracy (composite EVM) measures the EVM of the multi-code channel signal. It is valuable for evaluating the quality of the transmitter for a multi-channel signal, detecting spreading or scrambling errors, identifying certain problems between baseband and RF sections, and analyzing errors that cause high-interference in the signal.

Instructions	Keystrokes
On the X-Series analyzer W-CDMA mode:	
Go to modulation accuracy measurement in a single measurement control (Figure 18). Observe the I/Q measured polar vector display on the right and the quantitative data provided on the left.	**[Meas] Mod Accuracy (Composite EVM) [Single]**
View magnitude error, phase error, and EVM plots over 15 slots (1 frame) (Figure 19).	**[View/Display] I/Q Error**

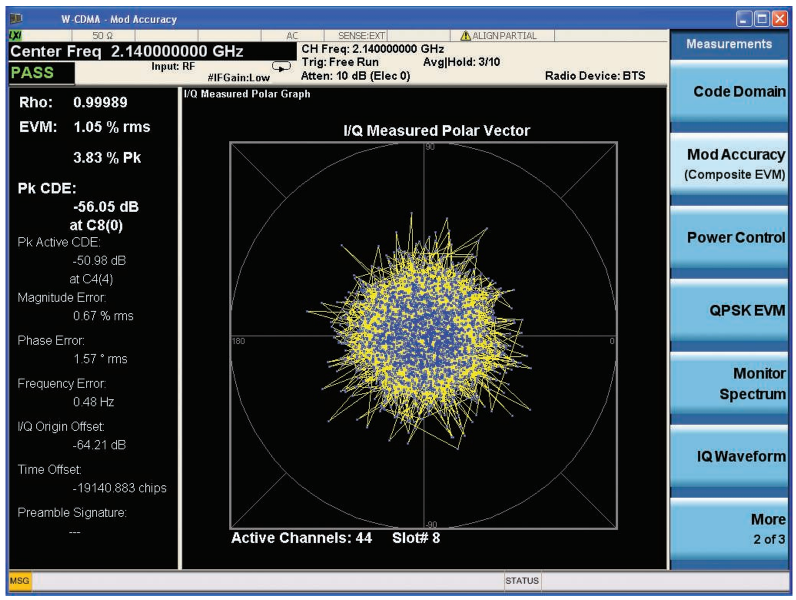


Figure 18. Modulation accuracy with HSPA+ test model 6

Figure 19. Error plots over 15 slots

Modulation accuracy (composite EVM), continued

HSPA+ uplink modulation analysis
As mentioned earlier, 4PAM-I/Q (4-state pulse amplitude modulation) modulation is added for uplink E-DPDCH. 4-PAM in I and Q can be seen as 16QAM in I/Q combined domain.

Relative code domain error (RCDE) is added in code domain power and peak/avg metrics views for 3GPP UE conformance tests defined in TS34.121, 5.13.2A and 2B.

Create and generate HSPA+ uplink signal containing 4PAM-I/Q.

Instructions	Software operations
On the Signal Studio software:	
Delete carrier 1 W-CDMA FDD downlink signal.	Click **Carrier 1** under Waveform Setup on the explorer menu at the left hand. Press **[X]** on the tool bar or use **[Delete]** on your PC keyboard
Put a carrier of W-CDMA FDD uplink release 8 for new configuration.	Press **[+]** on the tool bar, and select **W-CDMA FDD Uplink (Rel 8 Sep 07)** from the drop-down menu
Set a center frequency at 1.95 GHz For downlink with Instrument menu in explorer menu.	Press **[Preset]** green button on the top. Then set Frequency = 1.95 GHz, Amplitude = –20 dBm, RF Output = On
Change the channel configuration from default DPCCH to DPCCH + E-DPCCH + 4 E-DPDCH.	Click **Carrier 1** and set Channel Configuration as DPCCH + E-DPCCH + 4 E-DPDCH
Change the modulation from BPSK to 4PAM with E-DPDCH of channel 5 and 6 at 1920 ksps.	Click **Channel Setup** and select Ch5: E-DPDCH on I 4PAM. Repeat it for Ch6: E-DPDCH
Confirm the test signal condition in detail channel setup.	Click **Channel Setup** to see each channel parameters, status, and CDP/CCDF display
Download the signal to the Keysight MXG.	Press **Generate and Download** on the top tool bar

Run a measurement with HSPA+ UL with 4PAM-I/Q in modulation accuracy.

Instructions	Software operations
On the X-Series analyzer W-CDMA mode:	
Change the radio device for uplink modulation accuracy.	**[Mode Setup] Radio Device BTS MS [FREQ] [1.95] GHz**
Return to the code domain power view (Figure 20).	**[View/Display] Code Domain Power**
Change to peak/average metrics view to monitor the worst value over the averaging period (Figure 21).	**[View/Display] Peak/Avg Metrics**

Modulation accuracy (composite EVM), continued

Relative Code Domain Error (RCDE) is reported in modulation accuracy. Code domain power view provides RCDE for each code channel. And peak/average metrics shows the statistic result in measured length as of 1 frame (15 slots) by default.

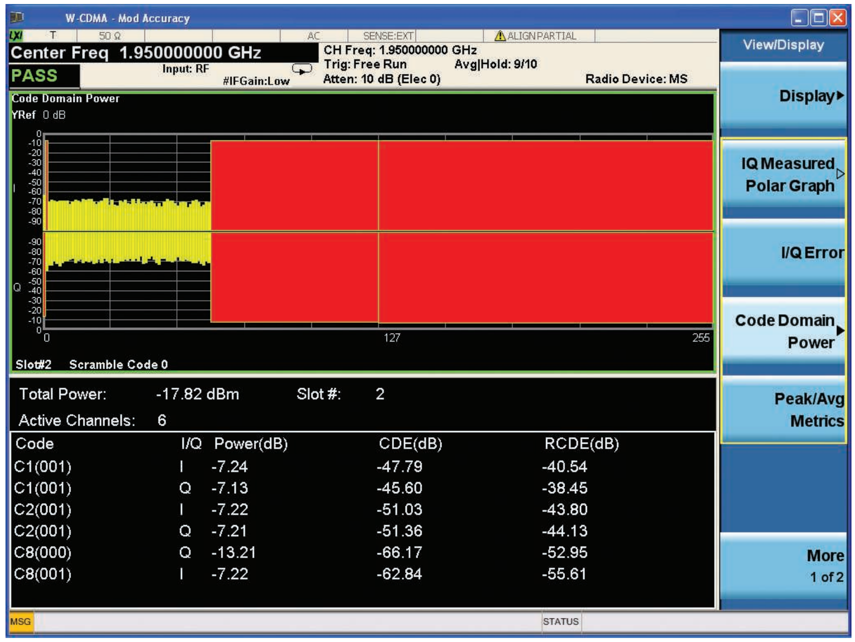


Figure 20. Code domain power view with HSPA+ uplink in modulation accuracy

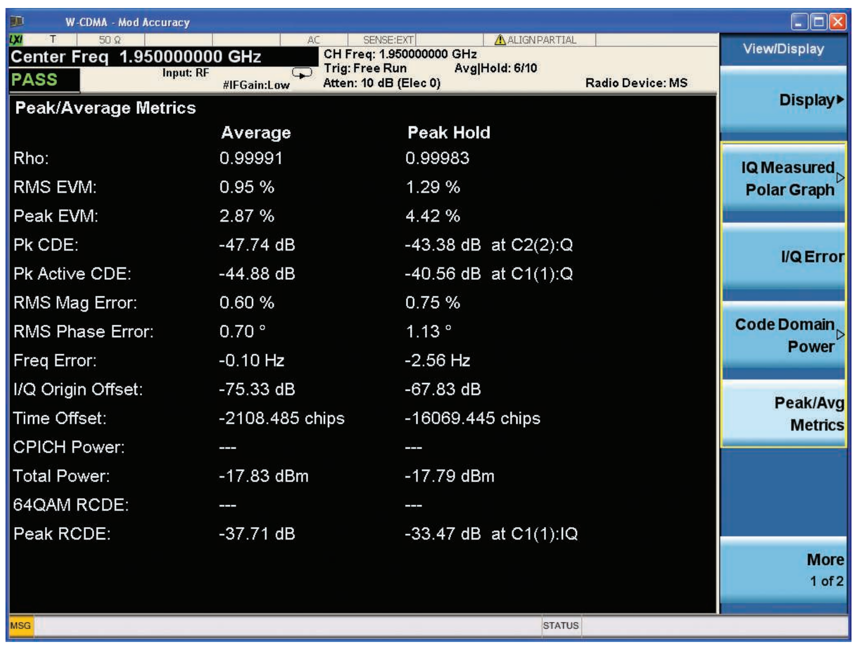


Figure 21. Peak/Avg metrics view for statistic report in modulation accuracy

Modulation accuracy (composite EVM), continued

Instructions	Keystrokes
On the X-Series analyzer W-CDMA mode:	
View the result summary table over the captured 15 slots. Find the average over the captured period on the bottom (Figure 22).	**[View/Display] Capture Time Summary**
View the EVM, peak CDE, and frequency error results in the slot-based trace.	**[View/Display] Slot CDE/EVM**

Figure 22. Capture time summary

Demonstration 9:

Power control

The power control measurement capability is one of the major functions of a W-CDMA (3GPP) digital radio system. This power control measurement provides a solution for users to make 3GPP uplink conformance tests, and can be used to accurately design, characterize, evaluate, and verify 3GPP transmitters, components, and devices for mobile stations.

The power control measurement includes three types of measurements:

- Slot power measures uplink slot power level.
- PRACH power measures uplink PRACH preamble power level and message power level.
- Slot phase measures phase error, frequency error and EVM of uplink slots in addition to their slot power. It is designed for 3GPP UE phase discontinuity.

The slot power measurement measures uplink slot power level.

The PRACH power measurement measures uplink PRACH preamble power level and message power level.

The slot phase measurement measures phase error, frequency error, and EVM of uplink slots in addition to their slot power.

The slot power and PRACH power measurement can be done using two methods:

- Waveform method is asynchronous. It provides results using a specified information bandwidth and a specified filter type for the number of frames, 1 through 8, specified by the capture interval. It is faster than the chip power method because there is no synchronization with DPCCH.
- Chip power method is synchronized to chip timing. It re-samples the power measurement results based on the chip clock timing of the radio system. Because of the synchronization to accurate chip timing, it is slower than the waveform method.

The slot phase measurement is always made based on synchronized chip timing.

Note: When BTS is selected in Radio Device, power control measurement is enabled, but this measurement is designed for uplink power control analysis. As for downlink power control, it can be measured in code domain measurement to see the symbol power trace for the selected code channel.

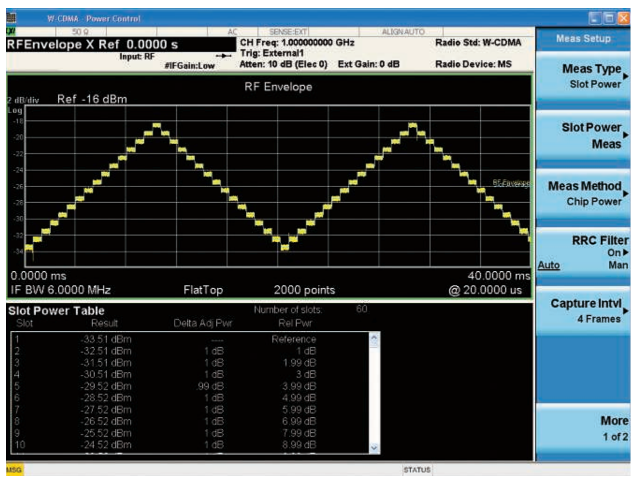


Figure 23. Power control for slot power (sample screen)

Figure 24. Power control for PRACH power (sample screen)

Figure 25. Power control for UE phase discontinuity (sample screen)

Demonstration 10:

QPSK EVM

The quadrature phase shift keying (QPSK) error vector magnitude (EVM) measurement is a measure of phase and amplitude modulation quality that relates the performance of the actual signal compared to an ideal signal as a percentage, as calculated over the course of the ideal constellation. These phase and frequency errors are measures of modulation quality for the W-CDMA (3GPP) system, and can be quantified through QPSK EVM measurements. This is just for a single channel signal in QPSK modulation. It is useful in troubleshooting when the W-CDMA signal fails the synchronization. Any single code channel in QPSK can be measured EVM without de-scrambling. It can be used for PRACH preamble EVM by using longer measure interval up to 4096 chip. For multiple code channels signal, modulation accuracy (composite EVM) measurement is available in W-CDMA mode.

Instructions	Software operations
On the Signal Studio software:	
Change the channel configuration from HSUPA configuration to DPCCH only.	Channel Configuration = DPCCH
Confirm the test signal condition in detail channel setup.	Click **Channel Setup** to see each channel parameters, states and CDP/CCDF display
Download the signal to the Keysight MXG.	Press **Generate and Download** button on the top tool bar

Instructions	Keystrokes
On the X-Series analyzer W-CDMA mode:	
Measure QPSK EVM (Figure 26).	**[MEAS] QPSK EVM**
Switch the view to I/Q error quad view (Figure 27).	**[View/Display] I/Q Error**

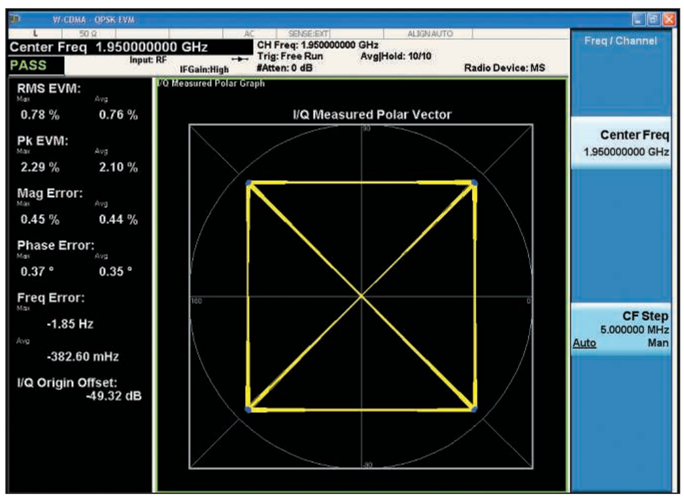


Figure 26. QPSK EVM in polar graph

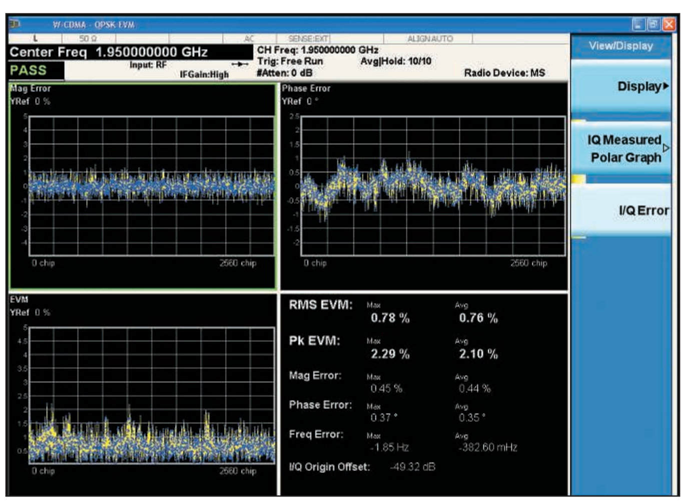


Figure 27. QPSK EVM in I/Q error quad view

Single Acquisition Combined W-CDMA Measurement Application (for MXA and EXA only)

Introduction

The complexity of today's mobile devices-driven by the need for multiple frequency/band coverage, format support (2G/3G and emerging communication technologies), and applications (phone, multimedia, and PDA)—combined with increasing pressure to lower expenses and speed production, are driving manufacturers to look for ways to reduce test times and costs. By using general-purpose RF test equipment without any call-processing for production testing, it is possible to apply new measurement techniques to drastically reduce test time and save money.

In order to perform the single acquisition combined measurements, the N9073A-XFP measurement application requires the N9073A-1FP W-CDMA measurement application to be installed.

Single acquisition: Contains one continuous block of captured data collected, using predefined capture settings. The capture period can be defined by test engineers to suit the requirements for specific device tests.

Combined measurements: Implies that the measurement sequence performed by the analyzer can accommodate any mix of transmitter power measurements and modulation quality measurements performed on the data collected within the capture period.

Measurement overview

Single acquisition combined measurements are performed using the following sequence for production tests:

Step 1 List power step measurement for power level calibration

Step 2 Transmitter performance verification with combined W-CDMA measurements

Fast measurement settling time:
The Keysight X-Series signal analyzers have an extremely short local oscillator (LO) settling time of less than 500 microsecond. Coupled with a fast LO re-tune speed, the analyzers are capable of rapid frequency stepping for full transmitter power calibration in fractions of a second.

Step 1: List power step measurement for rapid power calibration "Fast Device Tune"
The list power step measurement allows fast frequency versus power calibration for RF transmitters. This offers an alternative approach to a power-meter-based test to determine the calibration matrix for a transmitter eliminating the need for active signaling during the test. The user can specify a range of frequency and power levels, and the instrument will make all of these measurements sequentially upon receipt of the trigger to begin the test.

As more manufacturers move to non-signaling mode measurements on the production line, the N9073A-XFP measurement application list power step measurement provides a new approach for performing "Fast Device Tune" (FDT) measurements using a general-purpose signal analyzer.

Step 2: Transmitter performance verification with combined W-CDMA measurements
The N9073A-XFP measurement application option can make any combination of ACP, QPSK EVM, and modulation accuracy (Rho) measurements after the individual measurement item is enabled using the associated remote SCPI command. The data capture will be done once. The acquired data is a sequence of captures and all of the results will be calculated after the capture is completed. If there is more than one band/frequency to be measured, the user can specify multiple frequencies in a capture list using SCPI commands, along with an allowable time period for the "Step Capture Interval" at each frequency in the sequence.

The combined W-CDMA measurement also performs I/Q data acquisition. The supported measurement items are shown in Table 1.

Table 1. Description of I/Q acquisition used in combined WCDMA measurement application

Acquisition types	Support measurements	Associated enable/disable SCPI commands
I/Q data acquisition	ACP measurement	ACP Enable [:SENSe]:CWCDma:ACPower[:ENABle] ON|OFF
	Rho measurement[1]	Rho Enable [:SENSe]:CWCDma:RHO[:ENABle] ON|OFF
	QPSK EVM measurement[1]	QPSK EVM Enable [:SENSe]:CWCDma:EVMQpsk[:ENABle] ON|OFF

1. The Rho and QPSK EVM are exclusive at the same time

Advantages of signal acquisition combined W-CDMA application measurements

Accelerated test speed with fewer acquisitions and no required measurement switching
Compared with traditional one-button measurements, which limit the speed of tests because of measurement switching time (such as from ACP to Rho), the combined W-CDMA measurement application uses SCPI-based programming to configure the X-Series signal analyzer to conduct the specified measurements ahead of time, without measurement switching, and with fewer acquisitions that normally would require processing of the data after each capture is completed.

Simplified user interface for reduced overhead processing and increased efficiency
The user interface of the N9073A-XFP measurement application option is designed for production users.

Figure 28 shows a "measurement list" view, which provides the current status of all enabled measurements and result items. The user can customize the measurement list according to specific production test requirements, disabled measurements are grayed out.

Figure 29 shows a "parameter list" view. This screen lists all names, remote SCPI commands, and parameter values of measurement commands. The value can be verified or modified by using the menu and front panel keys, or by using a mouse and keyboard. "Parameter list" view is more convenient than accessing the SCPI programming interface for minor changes.

Figure 30 shows a tabular "result metrics" view that contains information in the same order as the remote SCPI command measurement results by index (n = 1).

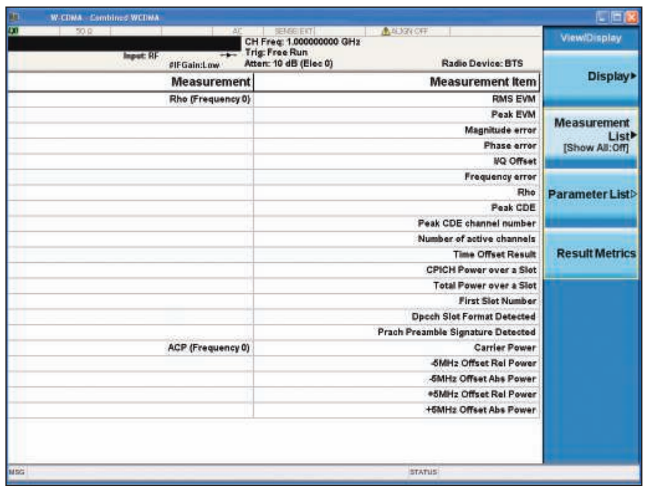


Figure 28. Measurement list view

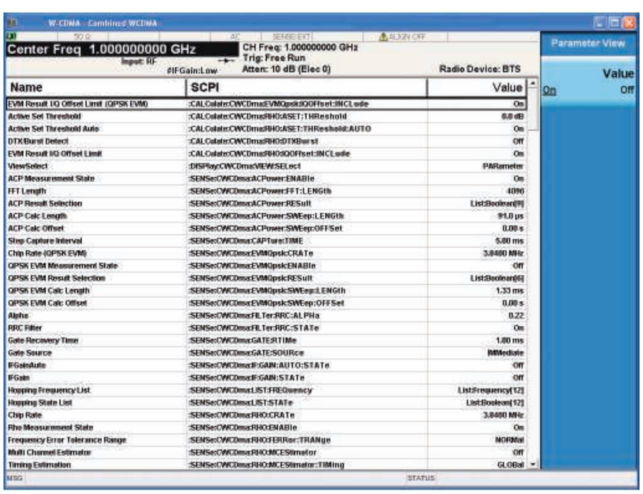


Figure 29. Parameter list view

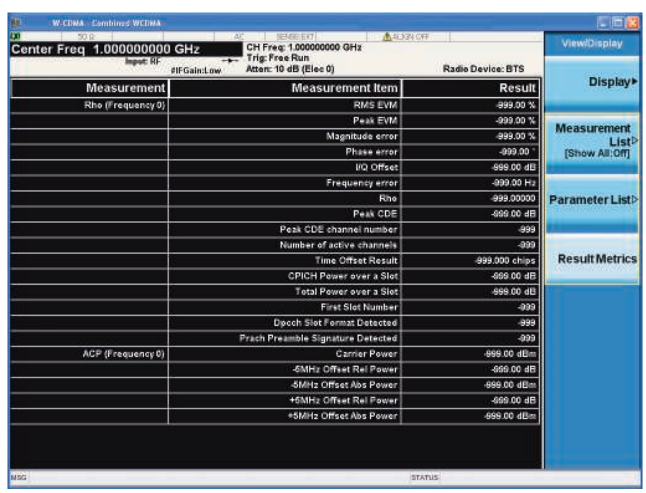


Figure 30. Result metrics view

Product Web sites

Product pages:
www.keysight.com/find/N9073A and
www.keysight.com/find/W9073A

X-Series signal analyzers:
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Published in USA, July 31, 2014
5990-5926EN
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