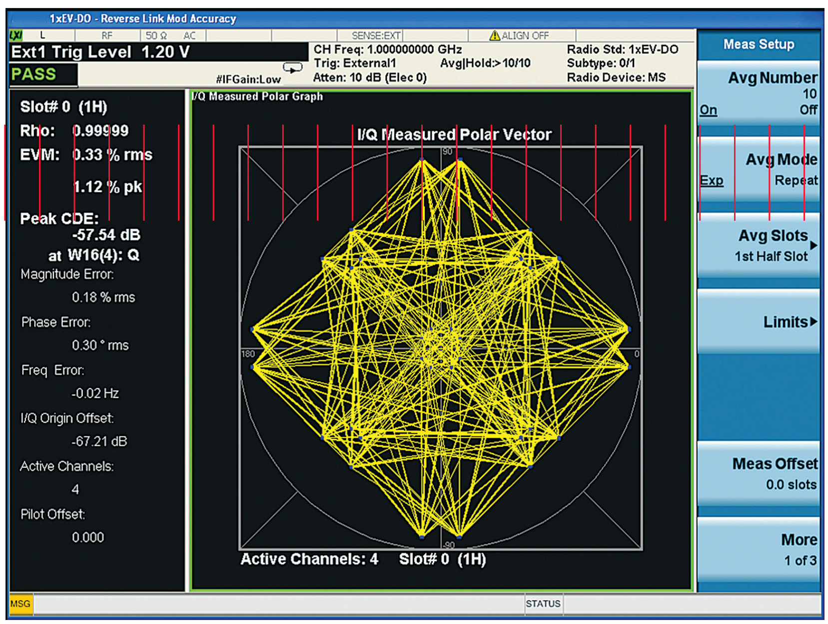
Keysight Technologies
N9076A & W9076A 1xEV-DO

X-Series Measurement Application

Self-Guided Demonstration



This demonstration guide provides step-by-step instructions to analyze power and modulation for forward link and modulation accuracy for reverse link. Each demonstration is given a brief description of its function and the corresponding measurement steps on the signal generator and/or signal analyzer.

Demonstration Preparation

The N/W9076A 1xEV-DO measurement application provides fast one-button RF conformance measurements to help you design, evaluate, and manufacture your cdma2000® 1xEV-DO base station (Access Network) and mobile station (Access Terminal) devices based on the 3GPP2 (Rel. 0, Rev. A and Rev. B) specifications.

All demonstrations use an X-Series signal analyzer with the N/W9076A 1xEV-DO measurement application, and an N5182A MXG vector signal generator with the N7601B 3GPP2 CDMA Signal Studio software.

This demonstration guide describes how to evaluate key product features through demonstration and is not intended to be a detailed user's guide. Prior knowledge of the Keysight Technologies, Inc. products are not required for this demonstrations and step-by-step instruction are provided.

The demonstrations found within this document assume basic knowledge of 1xEV-DO physical layer signal characteristics. For more in-depth CDMA and 1xEV-DO technical information, please visit

www.keysight.com/find/1xEV-DO

Product type	Model number	Required options
MXG vector signal generator ***Note:** ESG-C can also be used*	N5182A (or E4438C)	– 503 or 506 – frequency range at 3 GHz or 6 GHz – 651, 652 or 654 – Internal baseband generator (option 654 – 125 MSa clock rate required for MXG not for ESG-C) – UNV – Enhanced dynamic range (required for better ACP performance)
Signal Studio for 3GPP2 CDMA	N7601B- V1.5.0.0 or later	– 3FP – N5182A connectivity – FFP – Basic 1xEV-DO, fixed, perpetual license – RFP – Advanced 1xEV-DO, fixed, perpetual license
X-Series signal analyzer	N9030A PXA, N9020A MXA, N9010A EXA, or N9000A CXA ***Note:*** For PXA and CXA, *the firmware revision must be A.08.03 or later.*	Required: – 503, 508 (507 for EXA and CXA), 513, 526, 543, 544 or 550 – frequency range up to 50 GHz (7.5 GHz for CXA, 26.5 GHz for MXA and EXA) Recommended: – EA3 – Electronic attenuator, 3.6 GHz – P0x – Preamplifier – BBA – Analog baseband IQ inputs (required for analog baseband analysis, not available on EXA and CXA) – PFR – Precision frequency reference
X-Series 1xEV-DO measurement application	N9076A-1FP or 1TP	– 1xEV-DO Measurement application fixed perpetual or transportable license option (for PXA, MXA or EXA)
	W9076A-1FP	– 1xEV-DO Measurement application, fixed perpetual license (for CXA only)
Controller PC for Signal Studio		Install N7601B to generate and download the signal waveform into the Keysight MXG via GPIB or LAN (TCP/IP) – please refer to the online documentation for installation and setup

Keystrokes surrounded by [ ] indicate hard keys on X-Series analyzers, while key names surrounded by { } indicate soft keys located on the right edge of the X-Series display.

Helpful tip:

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

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

Demonstration Setup

Connect the PC, X-Series, and MXG

Connect a PC (loaded with N7601B Signal Studio for 1xEV-DO software and Keysight I/O libraries) to the N5182A MXG via GPIB or LAN. Follow the Signal Studio instructions to complete the connection, and then perform the following steps to interconnect the X-Series and MXG (see Figure 1 for a graphical overview):

A. Connect the MXG RF Output port to the X-Series RF Input port.
B. Connect the MXG 10 MHz Out to the X-Series Ext Ref In port (rear panel) for frequency accuracy.
C. Connect the MXG Event1 port to the X-Series Trigger 1 In port (rear panel).

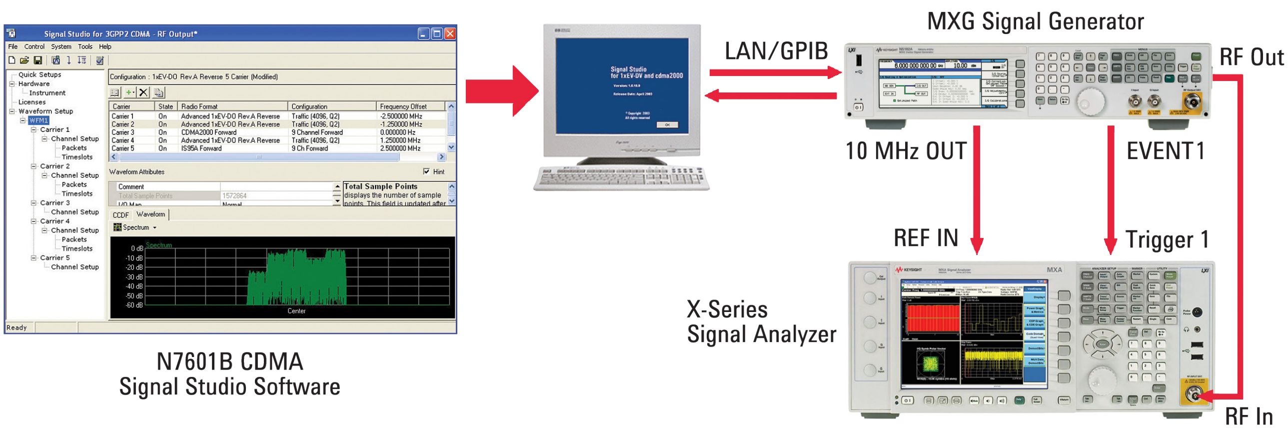
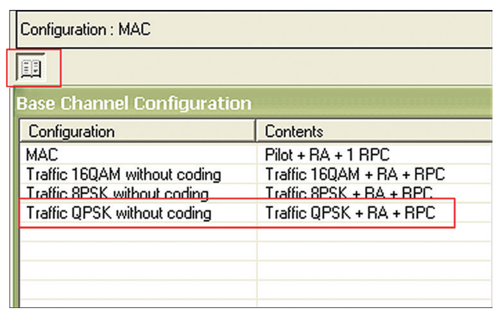


Figure 1. Demonstration setup

Generate 1xEV-DO waveform with Signal Studio on N5182A MXG

The N7601B Signal Studio for CDMA is a Windows-based utility that simplifies the creation of standards-based waveforms for CDMA including 1xEV-DO.

Instructions	Keystrokes
On the MXG	
Preset the MXG. Check the IP address.	**[Preset]** **[Utility] {I/O Config} {GPIB/LAN Setup}**
On the Signal Studio software	
Run the Signal Studio for 1x EV-DO.	Double-click on the 3GPP2 CDMA shortcut on the desktop or access the program via the Windows start menu.
Verify the software is communicating with the instrument via the GPIB or LAN (TCP/IP) link.	To establish a new connection, click on the **{System}** pull-down menu at the top of the Signal Studio program window. Next, select **{Run System Configuration Wizard}**
Set MXG at center frequency 1 GHz, amplitude -10 dBm, and RF Output turned ON.	Click Signal Generator at the Hardware on the explorer menu on the left. Press green Preset button on the top. Then use the default setting Frequency = **1 GHz** Amplitude = **-10 dBm** RF Output = **On**
Select Basic 1xEV-DO Rev. 0 Forward Link carrier in waveform setup.	Click Carrier 1 under Waveform Setup on the explorer menu at the left hand. Click button on the top tool bar to delete the default IS-95 carrier. Click to add **Basic 1xEV-DO Rev.0 Forward** link carrier in the Channel Configuration menu. Click Channel Setup on the explorer menu, and click Predefined Configuration button on the top to select "Traffic QPSK without Coding". 
Download the signal to Keysight MXG.	Click Generate and Download button on the top tool bar. If you encounter any errors, please refer to the online help of Signal Studio software.
Save the signal file for future use.	File > Save Setting File > 1xEV-DO_Demo.scp (name it as you like.)

Demonstrations

Demonstration 1:

Channel power

The channel power measurement determines the total rms power in a user-specified bandwidth (default of 1.23 MHz, as per 3GPP2 1xEV-DO technical specifications). The power spectral density (PSD) is also displayed in dBm/Hz.

The following channel power measurement parameters can be edited:

- Integration bandwidth (defaults to 1.23 MHz)
- Channel power span (defaults to 2 MHz)
- Number of trace averages (defaults to 20)
- Data points displayed (101 to 20001, defaults to 1001)

Signal Studio instructions	Keystrokes
Modify the waveform setup. Change the signal from Active slot to idle slot (Pilot+MAC, burst signal).	Click Carrier 1 on the explorer menu, and click Channel Configuration to select "MAC" (the Traffic channel automatically turn to OFF)
Download the waveform to MXG.	Click Generate and Download button on the top tool bar.

X-Series instructions	Keystrokes
Select 1xEV-DO mode.	**[Mode Preset]** **[Mode]>{1xEV-DO}**
Change the center frequency if it is not at the default 1 GHz.	**{Center Freq}>[1] {GHz}**
Choose transmitter device. The X-Series can make measurements on both the forward and reverse links.	**[Mode Setup]>{Radio}>** **{Device BTS(Fwd)}**
Activate channel power measurement. Observe the white bars indicating the spectrum channel width and the quantitative values given beneath.	**[Meas]>{Channel Power}**
Active channel power measurement.	**[Meas] {Channel Power}**
Turn on Gating and Gate View.	**[Sweep/Control]>{Gate}>{Gate On Off}>** **{Gate View On Off}**
Adjust the gate delay and gate length to ensure the measurement is at a specific time slot.	**{Gate Delay}>[3] [5] [0] {µs}** **{Gate Length} [1] [0] [0] {µs}** **See Figure 2**

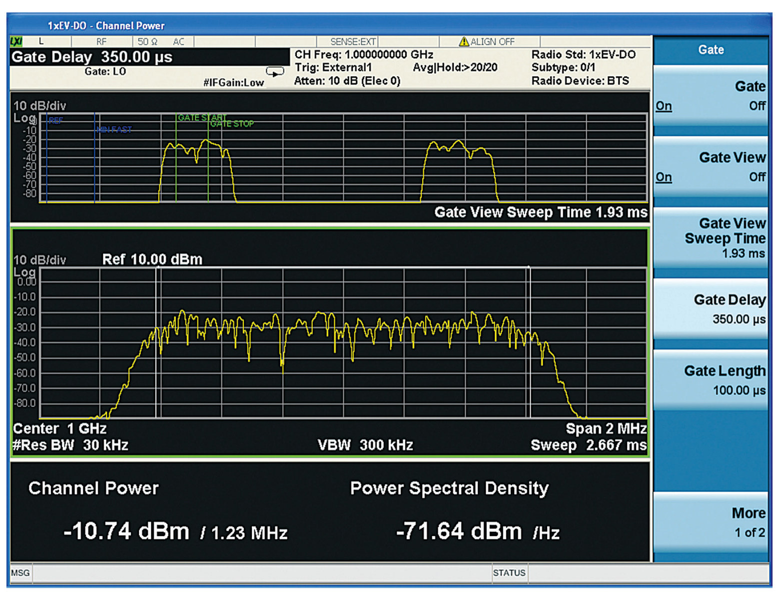


Figure 2. Channel power—Gate view On

Demonstration 2:

ACP

This demonstration shows how to make the adjacent channel leakage power ratio (ACLR or ACP) measurement on a 1xEV-DO base station (BS). ACP is a measurement of the amount of interference, or power, in an adjacent frequency channel relative to the transmitted power. The results are shown as a bar graph or as spectrum data, with measurement data at specified offsets. A Pass or Fail indication is shown in the Measurement Bar.

X-Series instructions	Keystrokes
Choose ACP measurement.	**[Meas]>{ACP}**
Adjust the power level by changing Ref Value.	**[AMPTD]>{Ref Value} [0] {dBm}**
Turn on Noise Correction.	**[Meas Setup]>{More 1 of 2}> {Noise Correction On Off}**

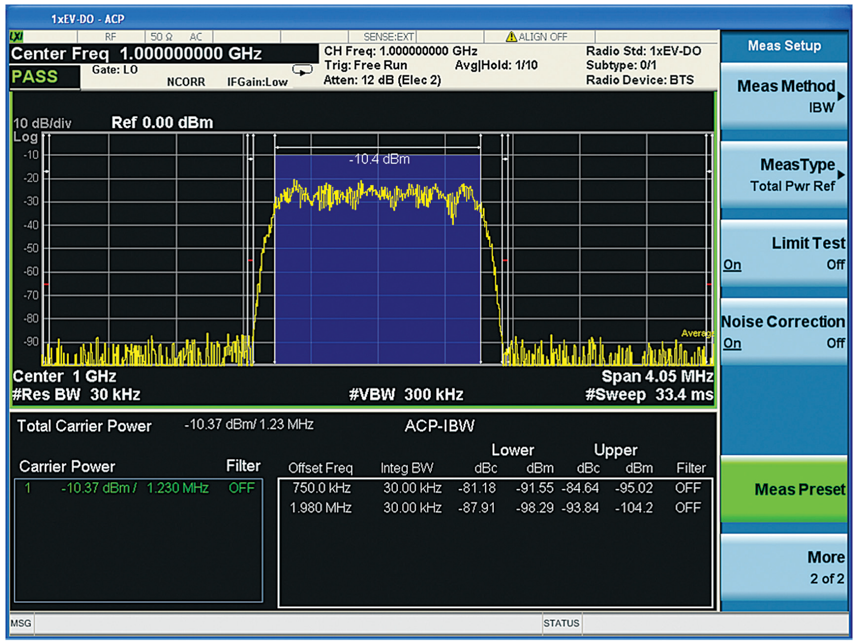


Figure 3. ACP with noise correction

Demonstration 3:

Occupied BW

The 3GPP2 standards require the occupied bandwidth (OBW) of a transmitted 1xEV-DO signal to be less than 1.48 MHz, where occupied bandwidth (OBW) is defined as the bandwidth containing 99% of the total channel power.

– Specify the resolution bandwidth (defaults to 30 kHz) and the span (defaults to 3.75 MHz)

– Customize a simple PASS/FAIL limit test (defaults to 1.48 MHz)

– 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 is accounted for in each of the upper and lower portions of the span. The calculated difference is the occupied bandwidth. In accordance with the 3GPP2 specification, the 1xEV-DO mode defaults to a 1.48 MHz PASS/FAIL limit values.

X-Series instructions	Keystrokes
Choose OBW measurement.	**[Meas]>{Occupied BW}**

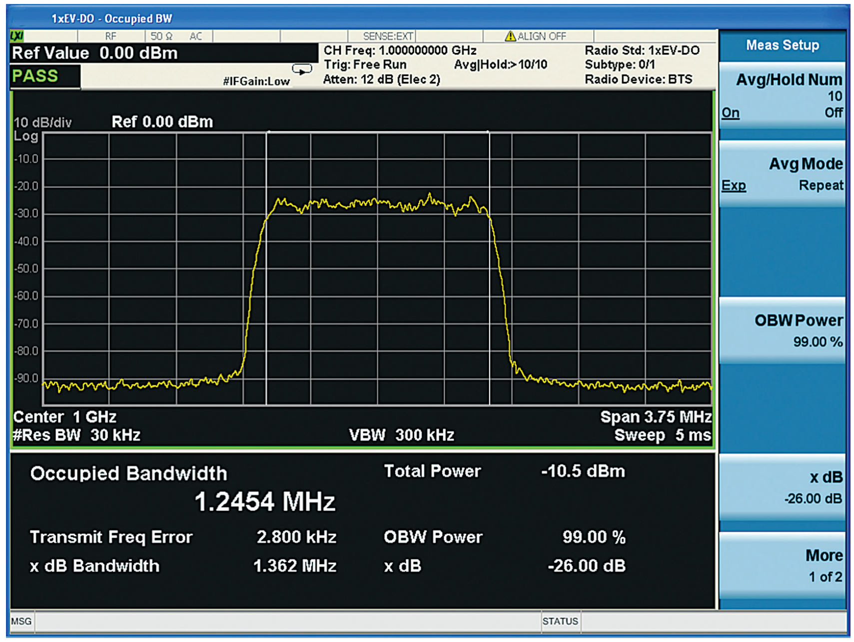


Figure 4. Occupied bandwidth

Demonstration 4:

Power versus Time

Power versus time (PvT) is a key measurement for 1xEV-DO signals. Measurement of the burst signal is necessary in the transmitter test based on "Pilot/MAC channel power" requirements. Good PvT results verify that the transmitter output power has the correct amplitude, shape, and timing for the 1xEV-DO format. Active slot also can be measured in PvT to support the "Total power" test item.

Change the carrier to basic forward link carrier that contains MAC and Pilot only in the Signal Studio.

As seen in Figure 5, the burst power, region masks and limit lines are displayed in the upper graph window. The average power levels, maximum and minimum peak levels, and delta values to the limit, along with the power reference, the burst length and the first error point are shown in the lower text window.

Figure 6 is another view of PvT measurement with the burst signal rise and fall trace details.

Signal Studio instructions	Keystrokes
Modify the waveform setup. Change the signal from Active slot to idle slot (Pilot+MAC, burst signal).	Click Carrier 1 on the explorer menu, and click Channel Configuration to select "MAC". (the Traffic channel automatically turn to OFF)
Download the waveform to MXG.	Click ⤓ Generate and Download button on the top tool bar.

X-Series instructions	Keystrokes
Choose Power vs Time measurement.	**[Meas]>{Power vs Time}**
View "Rise and Fall".	**[View/Display]>{Rise & Fall}**

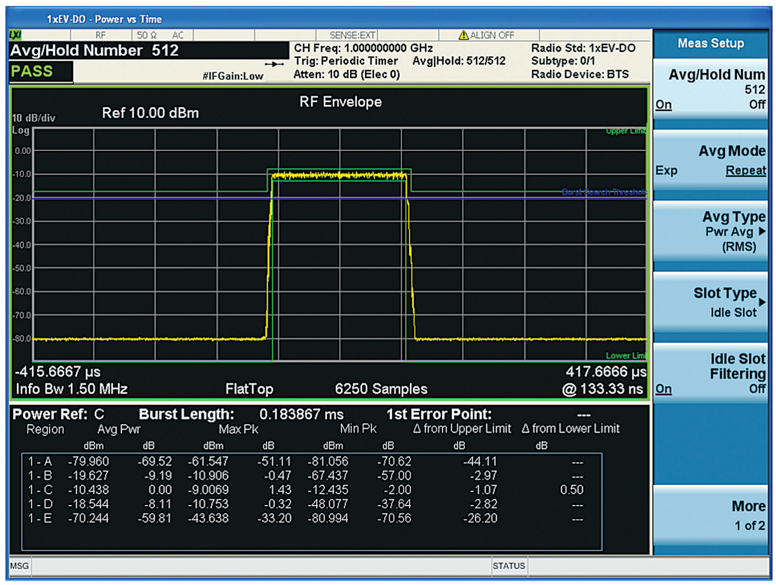


Figure 5. Power vs. Time—Burst View

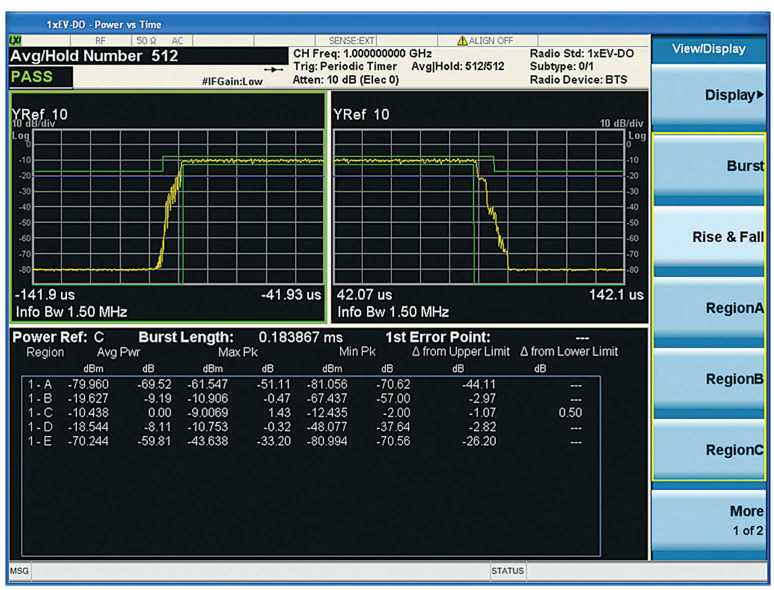


Figure 6. Power vs. Time—Rise and Fall View

Demonstration 5:

Spectrum Emission Mask

The Spectrum Emission Mask (SEM) measurement for 1xEV-DO is based on "Conducted Spurious Emissions" defined by 3GPP2 standards. SEM measurements encompass different power limits and different measurement bandwidths (resolution bandwidths) at various frequency offsets. When choosing an SEM measurement, the offset frequency, RBW, and limit lines are automatically adjusted according to 3GPP2 standards.

Conducted spurious emissions must be measured under two test conditions: continuous data mode (no idle slots) and idle mode (all idle slots, except the control channel). When making continuous data mode measurements, the forward-traffic channel data rate should be set to 2,457.6 kbps. The MAC channel should be configured with 14 active MAC indices—the RA channel and 13 RPC channels. When making idle mode measurements, the transmitter should emit a stream of idle slots. The control channel can be optionally transmitted or inhibited. The MAC channel should be configured with 14 active MAC indices—the RA channel and 13 RPC channels. In this section, the idle mode will be demonstrated.

Signal Studio instructions	Keystrokes
Modify the waveform setup. Turn off all the traffic channels.	Click Timeslots on the explorer menu, and click Channel Configuration button to select TrCh State "All Off".
Download the waveform to MXG.	Click Generate and Download button on the top tool bar.

X-Series instructions	Keystrokes
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}**
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}**

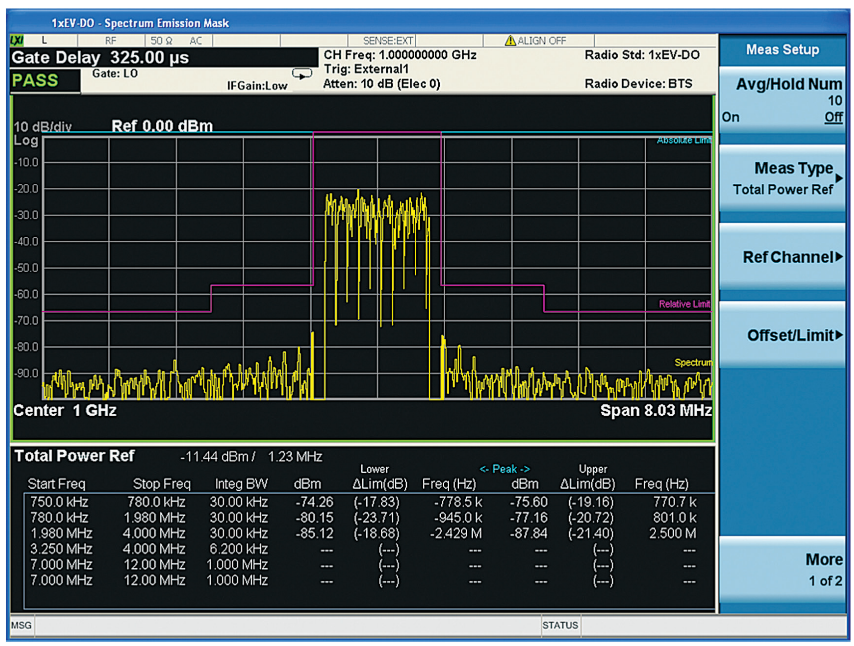


Figure 7. Spectrum Emission Mask

Demonstration 6:

Spurious emissions

The spurious emissions measurement identifies and determines the power level of spurious emissions in 3GPP2 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. When an RMS detector is used in an X-Series analyzer, VBW is automatically set to RBW:VBW as 10:1.

The spurious emissions measurement results should look similar to Figure 8. The spectrum window and the text window show the spurs that are within the current value of the Marker Peak Excursion setting of the absolute limit. Any spur that has failed the absolute limit will have an 'F' beside it.

X-Series instructions	Keystrokes
Set RF coupling to DC.	**[Input/Output]>{RF Input}> {RF Couping AC DC}***
Make spurious emissions measurement.	**[Meas]>{Spurious Emissions}**
Adjust the parameters for range table and limits.	**[Meas Setup]>{Range Table**

* *In AC coupling mode, you can view signals less than 10 MHz but the amplitude accuracy is not specified. To accurately see a signal of less than 10 MHz, you must switch to DC coupling. When operating in DC coupled mode, ensure protection of the external mixer by limiting the DC part of the input level to within 200 mV.*

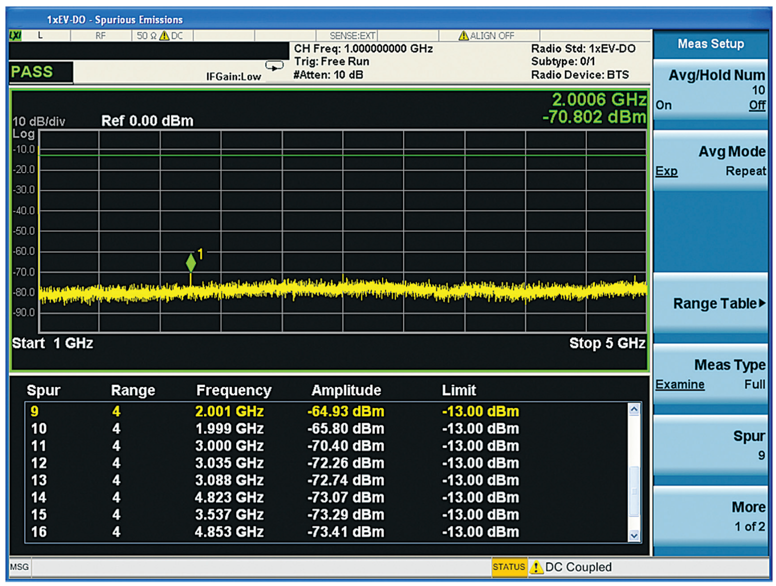


Figure 8. Spurious emissions result

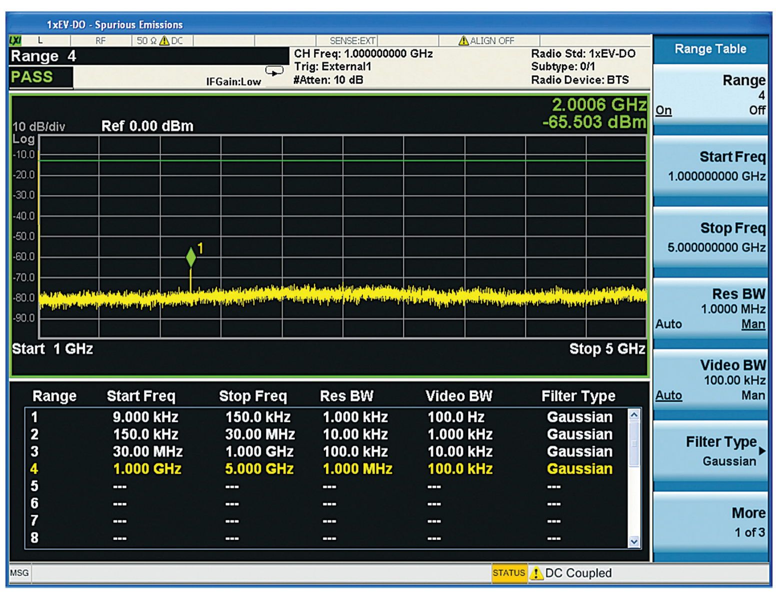


Figure 9. Spurious emissions—range table settings

Demonstration 7:

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 that the signal exhibits while maintaining good adjacent channel leakage performance.

The CCDF measurement result should look like Figure 10. The blue line is the Gaussian trace and the yellow line is the measurement result. The Info BW is the channel bandwidth that will be used for data acquisition. The default value is 1.3 MHz. You can manually change the Info BW under the BW menu.

X-Series instructions	Keystrokes
Select External 1 as trigger source.	**[Trigger]>{External 1}**
Measure the CCDF.	**[Meas]>{Power stat CCDF}**

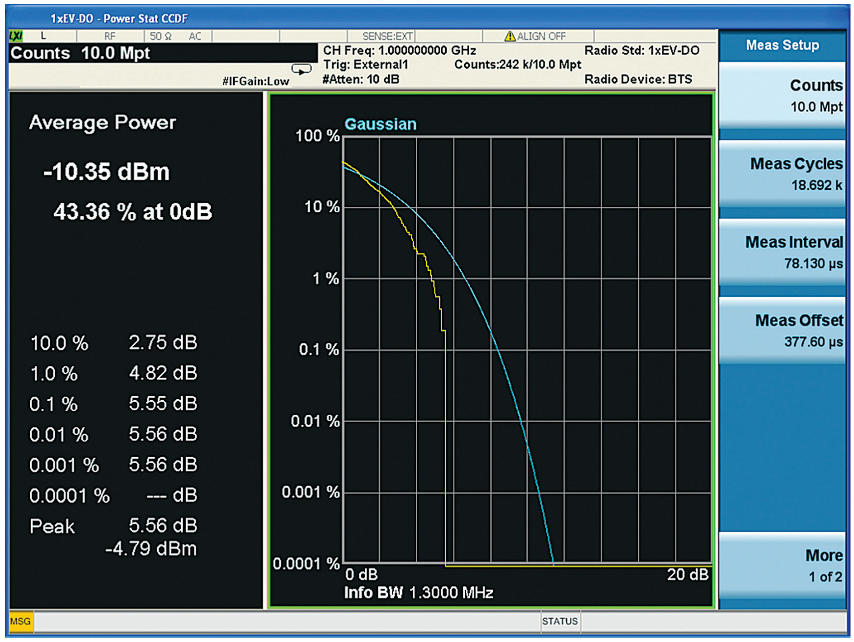


Figure 10. Power statistics CCDF

Demonstration 8:

Forward link code domain

The code domain analysis measurement provides a variety of results. 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.

For the traffic channel code domain analysis, the analyzer will de-spread any single code channel in chip power versus time trace, symbol IQ polar vector, slot power versus time, and demodulated bits. Multiplexed demodulated bits information is also available by switching View/Display menu.

X-Series instructions	Keystrokes
Switch the physical layer type.	**[Mode Setup]>{Demod}> {Physical Layer Subtype 0/1 2 3}**
Activate the code domain measurement.	**[Meas]>{More}> {Forward Link Code Domain}**
Change the channel type from Pilot to MAC.	**[Meas Setup]>{Channel Type}>{MAC}**

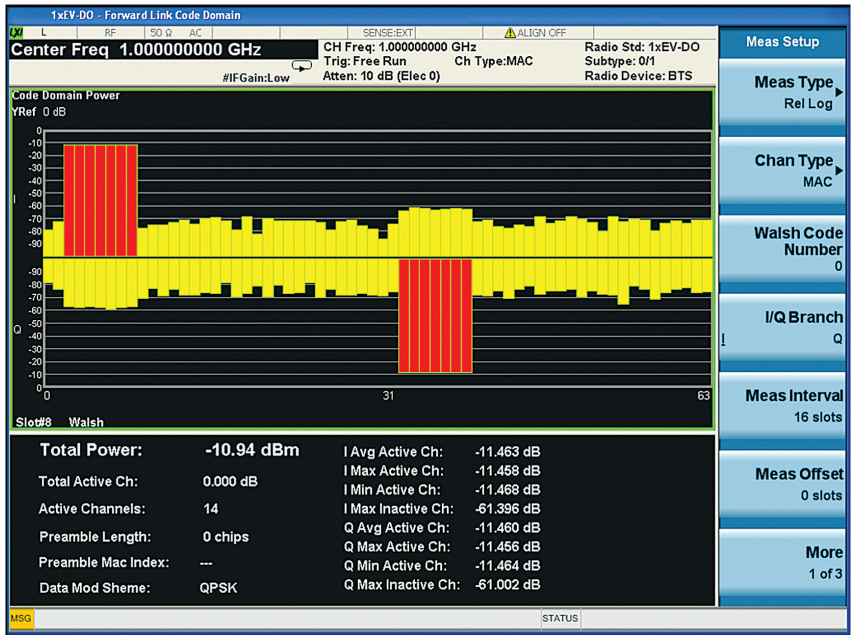


Figure 11. Code domain for MAC channel with subtype 0/1

X-Series instructions	Keystrokes
Change the channel type from Pilot to Data.	**[Meas Setup]>{Channel Type}>{Data}**
Switch the view to observe the Demod Bits. See Figure 12.	**[View/Display]>{Demod Bits}**
Place a marker on the specific code channel and de-spread.	**[Marker] [Marker→] {Marker→Despread}**
Switch the view to observe the MUX Data Demod Bits. See Figure 13.	**[View/Display] {MUX Data Demod Bits}**

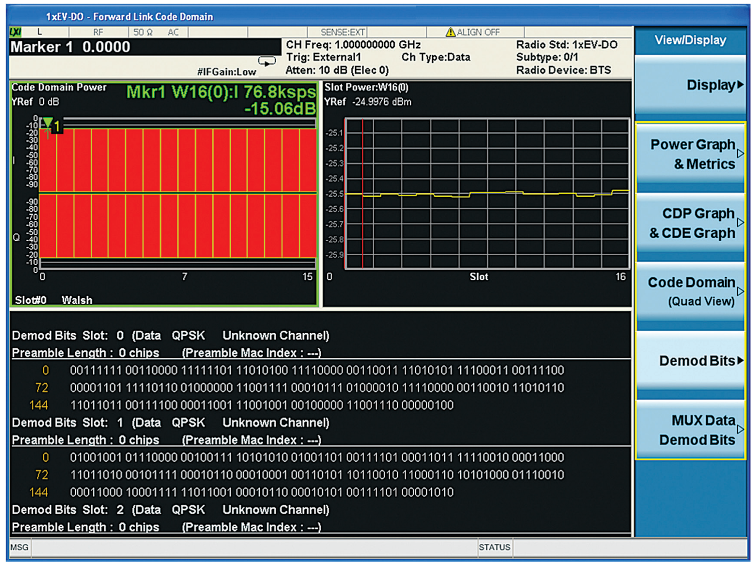


Figure 12. Code Domain for Data Channel—Demod Bits view

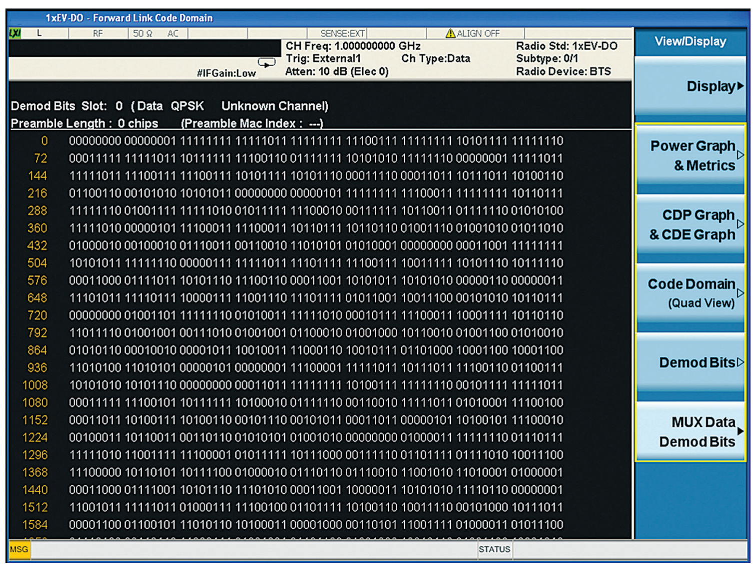


Figure 13. Code Domain for Data Channel—MUX Data Demod Bits view

1xEV-DO Rev. B is a multi-carrier evolution of the Rev. A. It delivers dramatically improved data rates by aggregation of multiple carriers and high order modulation (64QAM). N9076A/W9076A provides industry leading capabilities to support 1xEV-DO Rev. B demodulation and analysis.

X-Series instructions	Keystrokes
Switch the physical layer type.	**[Mode Setup]>{Demod}> {Physical Layer Subtype 0/1 2 3}**
Activate the code domain measurement.	**[Meas]>{More}>{Forward Link Code Domain}**
Change the channel type from Pilot to Data.	**[Meas Setup] {Channel Type} {Data}**
Switch the view to Quad View.	**[View/Display] {Code Domain (Quad View)}**
Zoom in I/Q symbol Polar Vector trace. See Figure 14.	Press Next Window button on the front panel to select I/Q symbol Polar Vector trace, then press Zoom button

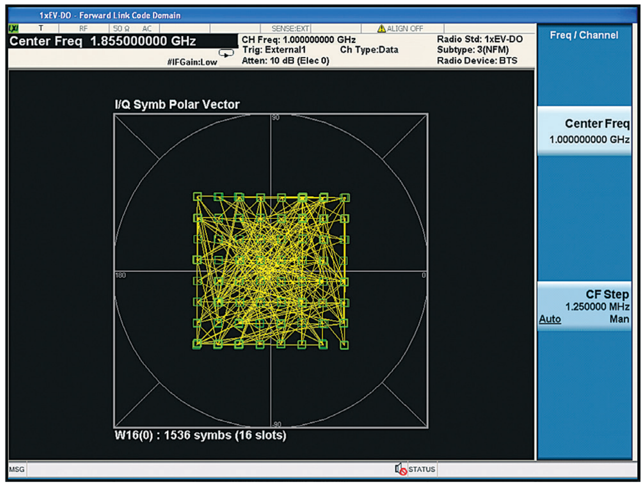


Figure 14. Code Domain for Data Channel with subtype 3 (1xEV-DO Rev. B)

Demonstration 9:

Forward link mod accuracy

An important measure of modulation accuracy for 1xEV-DO signals is rho. Rho is the ratio of the correlated power to the total power. The correlated power is computed by removing frequency, phase, and time offset and performing a cross correlation between the correlated signal and an ideal reference. Rho is important because power appears as interference to a receiver. However, a rho measurement can also be performed on signals with multiple code channels. This measurement is known as composite rho. It allows you to verify the overall modulation accuracy for a transmitter, regardless of the channel configuration, as long as a pilot channel is present. A composite rho measurement accounts for all spreading and scrambling problems in the active channels and for all baseband IF and RF impairment in the transmitter chain.

X-Series instructions	Keystrokes
Switch the physical layer type.	**[Mode Setup]>{Demod}>{Physical Layer Subtype 0/1 2 3}**
Activate the Mod Accuracy measurement. See Figure 15.	**[Meas]>{More}>{Forward Link Mod Accuracy}**
Change trigger source to External 1.	**[Trigger]>{External 1}***
Change the channel type from Pilot to Data. See Figure 16.	**[View/Display]>{Display Channel Type}>{Data}**
Switch the view to one-slot Result Metrics. See Figure 17.	**[View/Display]>{Result Metrics (one-slot)}**
Switch the view to I/Q Error quad view. See Figure 18.	**[View/Display]>{I/Q Error (quad View)}**

* *In order to determine which slot is to be measured, an external trigger is recommended for modulation analysis. The external trigger is also intended to measure the pilot offset per timing based.*

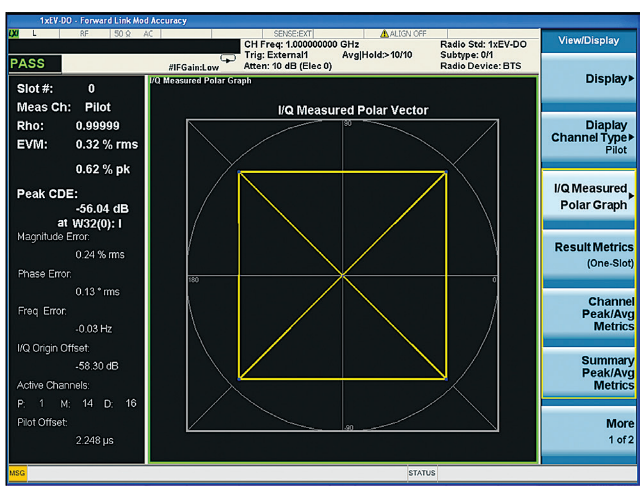


Figure 15. Mod accuracy—I/Q measured polar graph (Pilot) view

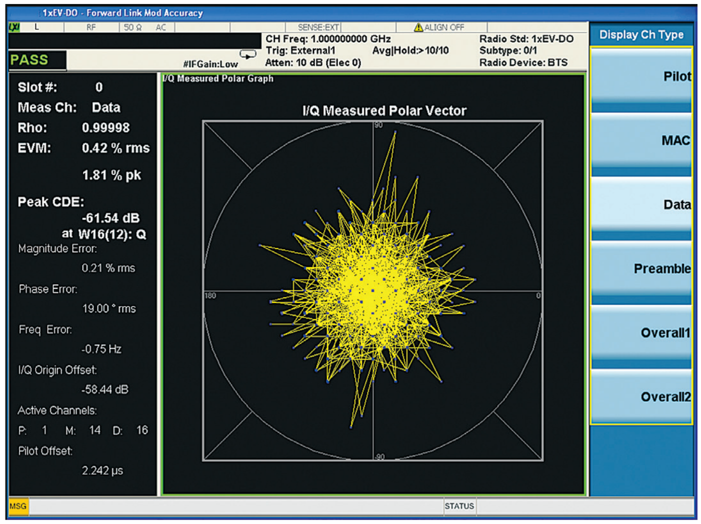


Figure 16. Mod accuracy—I/Q measured polar graph (Data) view

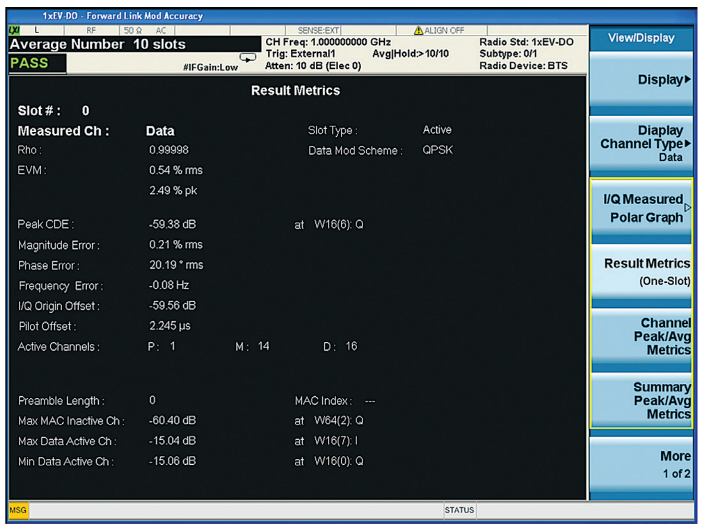


Figure 17. Mod accuracy—Result metrics (One-slot) view

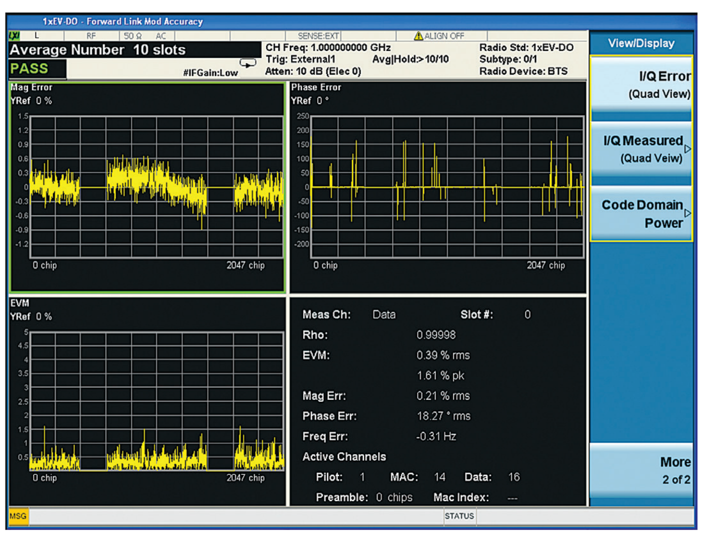


Figure 18. Mod accuracy—I/Q Error (Quad) view

Demonstration 10:

QPSK EVM

QPSK EVM is a measure of the 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. It can detect baseband filtering, modulation, and RF impairments, but does not detect spreading or scrambling errors.

In the default setting, the Meas Offset and Interval are set as: 464 chips and 96 chips, respectively. QPSK modulation can be found not only in the pilot channel, but also in the MAC and traffic (data) channels if selected. Using the modulation accuracy (composite rho) measurement, you can check the EVM results for each channel with QPSK modulation.

The QPSK EVM I/Q Measured Polar Vector measurement result should look like Figure 19. The measurement values for modulation accuracy are shown in the summary result window, and the PASS/FAIL in the top left corner indicates the limit test result.

I/Q Error is a combination view of the magnitude error, phase error, EVM graph windows, and the modulation summary result window.

X-Series instructions	Keystrokes
Activate the QPSK EVM measurement.	**[Meas]>{More}>{QPSK EVM}**
Change trigger source to External 1.	**[Trigger]>{External 1}**
Switch the Pre-Defined Interval/Offset to Pilot #1.	**[Mode Setup]>{Radio}>{Pre-Defined Interval/Offset }>{Pilot #1}**
Switch the view to I/Q Error.	**[View/Display]>{I/Q Error}**

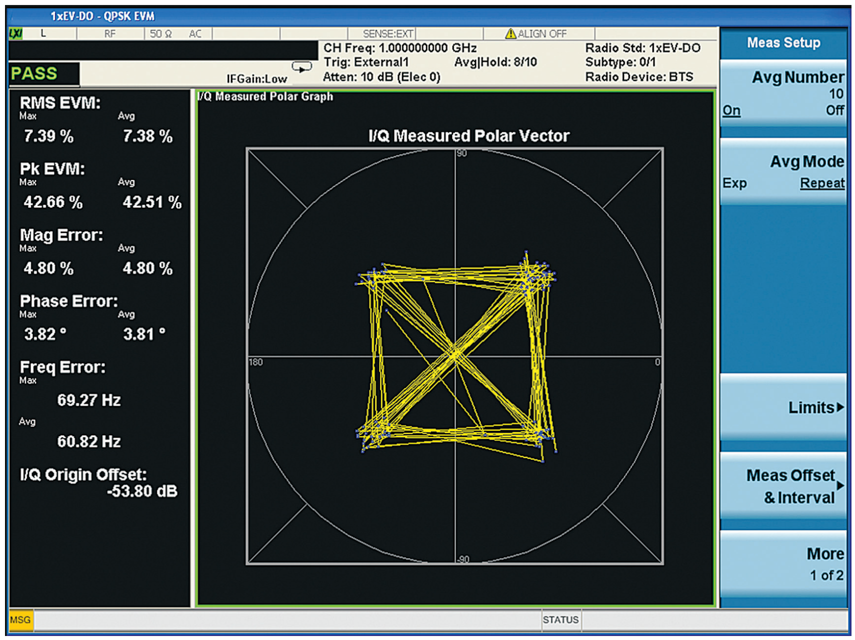


Figure 19. QPSK EVM result—Polar vector/constellation view

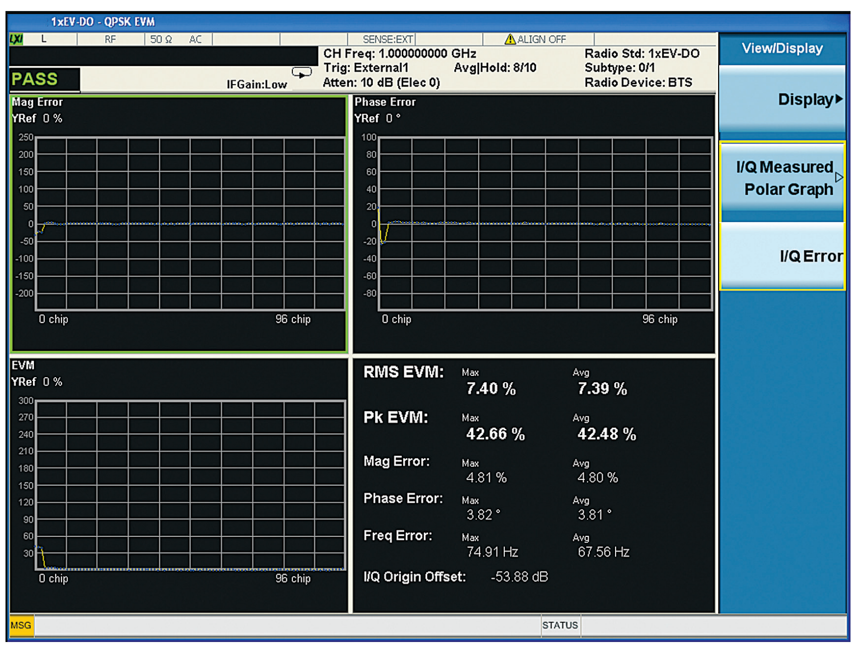


Figure 20. QPSK EVM result—I/Q error view

Demonstration 11:

Reverse link mod accuracy

This section explains how to make the modulation accuracy (composite EVM) measurement on a 1xEV-DO mobile station (MS). Modulation accuracy is the ratio of the correlated power in a multi-coded channel to the total signal power.

In Mod Accuracy I/Q Polar Vector Constellation view, the modulation constellation is shown, along with summary data for rho, EVM, Peak Code Domain Error, and phase and magnitude errors. The number of Active Channels and the Slot Number are shown at the bottom of the Polar Vector window.

Signal Studio instructions	Keystrokes
Select Basic 1xEV-DO Rev. 0 Reverse Link carrier in waveform setup.	Click Carrier 1 under Waveform Setup on the explorer menu at the left hand. Click button on the top tool bar to delete the default carrier. Click to add Basic 1xEV-DO Rev.0 Reverse carrier in the Channel Configuration menu.
Change the filter to IS95 standard.	Click Filter and select IS95 STD in drop list.
Set DRC, ACK and Data Channel Relative Gain.	Click Channel Setup and set DRC Relative Gain=3 dB, ACK Relative Gain=3 dB and Data Channel Relative Gain=3.75 dB.
Download the signal to the MXG.	Press Generate and Download button on the top tool bar.

X-Series instructions	Keystrokes
Choose transmitter device.	**[Mode Setup]>{Radio} {Device MS(Rev)}**
Switch the physical layer type.	**[Mode Setup]>{Demod}> {Physical Layer Subtype 0/1 2 3}**
Change trigger source to External 1.	**[Trigger]>{External 1}**
Activate the Mod Accuracy measurement.	**[Meas]>{More} {Reverse Link Mod Accuracy}**
Switch the view to Channel Peak/Avg Metrics View.	**[View/Display]>{Channel Peak/Avg Metrics}**
Switch the view to Code Domain Power view.	**[View/Display]>{Code Domain Power}**

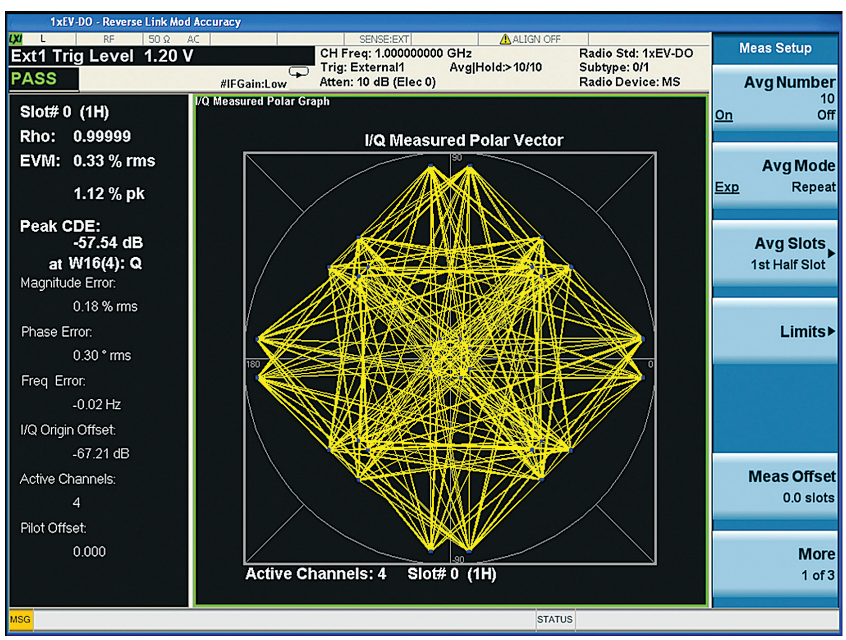


Figure 21. Reverse link mod accuracy —I/Q measured polar graph view

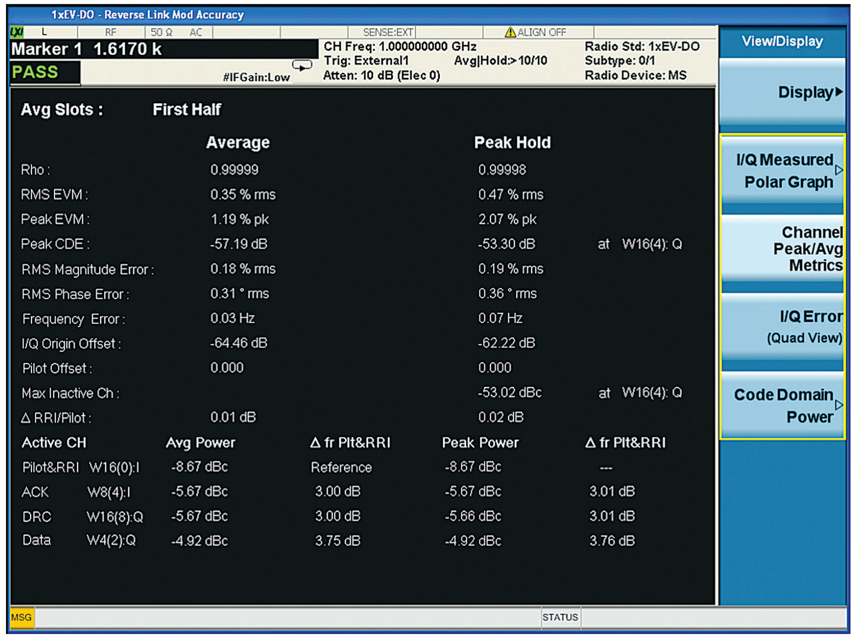


Figure 22. Reverse link mod accuracy—Channel peak/avg metrics view

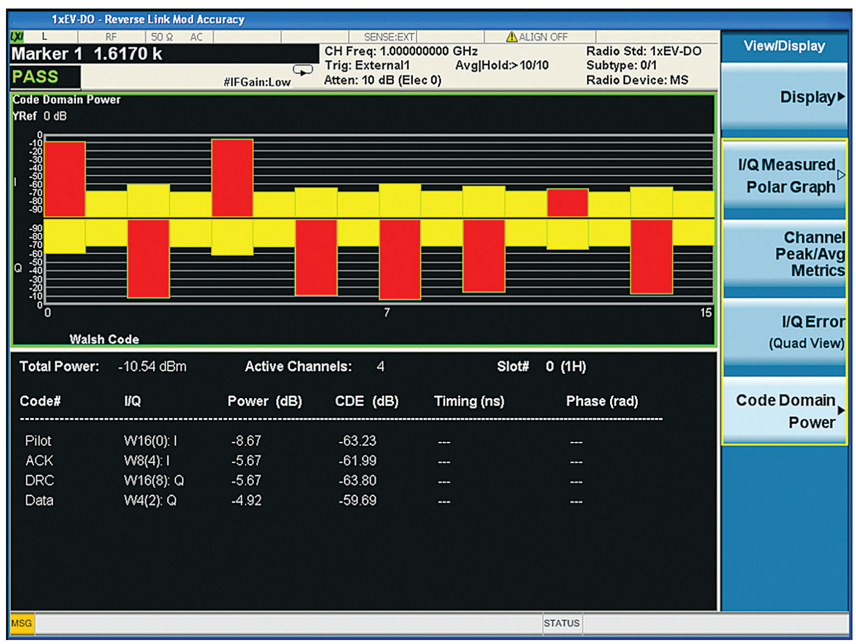


Figure 23. Reverse link mod accuracy—Code domain power view

Related Literature

N9076A & W9076A 1xEV-DO X-Series Measurement Application Technical Overview, Literature Number 5990-8012EN.

Keysight Forward Link Measurements for 1xEV-DO Access Networks, Literature Number 5988-6125EN.

PSA Spectrum Analyzer 1xEV-DO Measurement Personality Technical Overview, Literature Number 5988-4828EN

Product Web Sites

N/W9076A 1xEV-DO measurement application:
www.keysight.com/find/n9076a and
www.keysight.com/find/w9076a

X-Series signal analyzers:
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