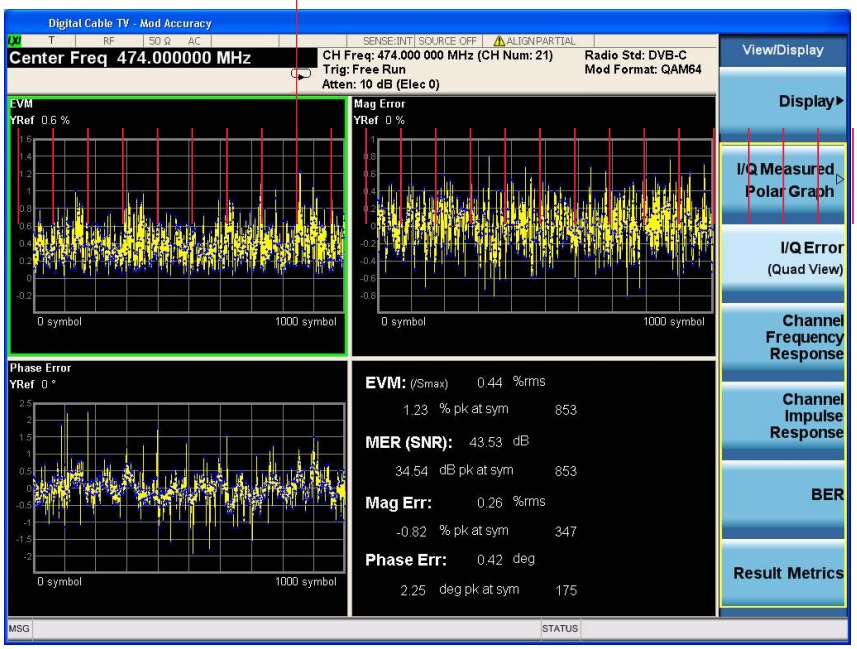
Keysight Technologies
N6152A & W6152A Digital Cable TV

X-Series Measurement Application

Demo Guide



KEYSIGHT TECHNOLOGIES

Introduction

This demonstration guide follows the list from page 2, which shows the demonstrations included in this document. Each demonstration is given a brief description of its function and the corresponding measurement steps on the signal generator and/or signal analyzer.

Digital Cable TV Measurement Application

Measurement Details

All of the RF transmitter measurements as defined by the Digital Cable TV standards, as well as a wide range of additional measurements and analysis tools, are available with a press of a button. These measurements are fully remote controllable via the IEC/IEEE bus or LAN, using SCPI commands. Analog baseband measurements are available on the MXA signal analyzer equipped with BBIQ hardware. Supported baseband measurements include all of the modulation quality plus I/Q waveform and CCDF measurements.

Technology	Digital Cable TV standards (DVB-C (J.83/A), J.83/B, J.83/C)
Measurement application	N6152A, W6152A
X-Series signal analyzer	PXA, MXA, EXA, CXA
Measurements	Channel power
	ACP (Adjacent channel power)
	Power stat CCDF
	Spectrum emission mask
	Modulation accuracy Constellation graph RMS EVM (%) Peak EVM (%) Position of peak EVM RMS MER (SNR) (dB) Peak MER (SNR) (dB) Position of peak MER (SNR) RMS mag error (%) Peak mag error (%) Position of peak mag error RMS phase error (deg) Peak phase error (deg) Position of peak phase error Frequency error (Hz) IQ Offset (dB) Quadrature error (deg) Gain imbalance (dB) Tx power (dBm) MER/EVM vs. symbol Mag error vs. symbol (%) Phase error vs. symbol (deg) Amplitude vs. frequency (dB) Phase vs. frequency (deg) Group delay vs. frequency (ns) Channel impulse response (dB) BER before RS BER after RS Packet error ratio
	Monitor spectrum
	IQ waveform

Demonstration Preparation

All demonstrations use an X-Series signal analyzer with the Digital Cable TV measurement application and the N5182A MXG vector signal generator. Keystrokes surrounded by [ ] indicate front-panel keys; keystrokes surrounded by { } indicate softkeys located on the display.

Helpful tips!

Update your instrument firmware and software to the latest version, at www.keysight.com/find/xseries_software www.keysight.com/find/signalstudio

Minimum equipment configuration requirements

Product type/instrument	Model number	Required options
MXG (or ESG) vector signal generator	N5182A (or E4438C) firmware revision of MXG A.01.44 or later	– 503 – frequency range at 3 GHz – 651, 652, or 654 – internal baseband generator – 019 – Upgrade baseband generator memory to 64 Msa (recommended)
Signal Studio for Digital Video, Digital Cable TV options	N7623B Signal Studio for Digital Video Please check the N7623B Signal Studio webpage for the latest version www.keysight.com/find/N7623B	– 3FP – N5182A connectivity – QFP – Advanced DVB-T/H/C/J.83 Annex A/C – XFP – Advanced J.83 Annex B
X-Series signal analyzer	*N9030A PXA, N9020A MXA, N9010A EXA, or N9000A CXA* Firmware revision A.07.xx or later	– 503, 507 (for EXA and CXA), 508, 513 or 526 (513 and 526 not available for CXA) *Recommended:* – EA3 – electronic attenuator, 3.6 GHz – P0x – preamplifier – B25 , B40 or B1X – analysis bandwidth up to 25 MHz, 40 MHz or 140 MHz – BBA – analog baseband IQ inputs (only for MXA)
Digital cable TV measurement application	N6152A (PXA, MXA, EXA) W6152A (CXA)	– 2FP: DVB-C (J.83 Annex A/C) measurement application, fixed perpetual license – 3FP: J.83 Annex B measurement application, fixed perpetual license Or – 2TP: DVB-C (J.83 Annex A/C) measurement application, transportable license (only for PXA/MXA/EXA) – 3TP: J.83 Annex B measurement application, transportable license (only for PXA/MXA/EXA)
Controller PC for Signal Studio		– Install N7623B 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

Demonstration Setup:

Connect the PC, X-Series Signal Analyzer and MXG

Connect a PC (loaded with N7623B Signal Studio for Digital Video software and Keysight I/O libraries) to the N5182A MXG via GPIB or LAN. Follow the Signal Studio instructions to complete the connection, then perform the following steps to interconnect the X-Series signal analyzer and MXG (see Figure 1 for a graphical overview):

a. Connect the MXG RF output port to the X-Series signal analyzer RF input port
b. Connect the MXG 10 MHz out to the X-Series signal analyzer Ext Ref in port (rear panel)

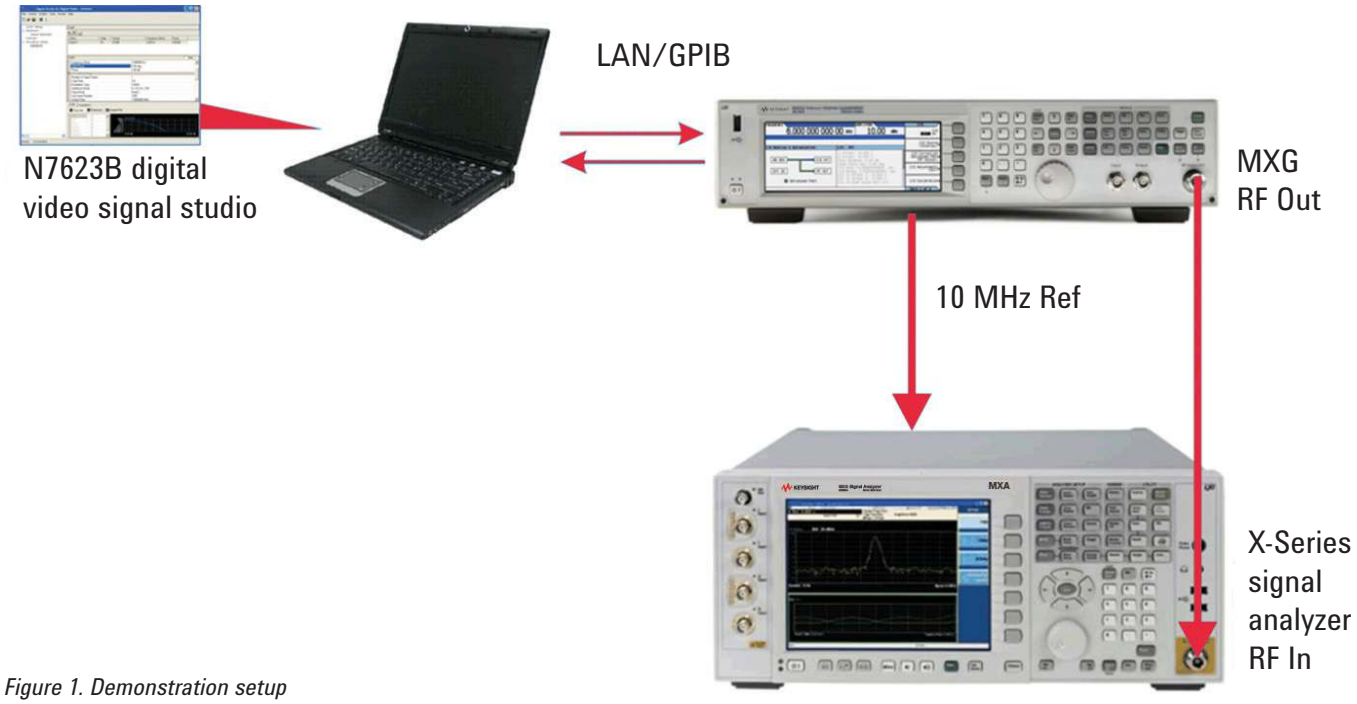


Figure 1. Demonstration setup

Demonstration 1:

Set up Signal Studio for digital video on the MXG

The N7623B Signal Studio for Digital Video is a Windows-based utility that simplifies the creation of standards-based or customized digital cable TV signals, including DVB-C (J.83/A), J.83/B, and J.83/C, and then the parameters are downloaded into the MXG vector signal generator, which creates the desired waveform. In this demonstration guide, DVB-C (J.83/A) signals are used as an example.

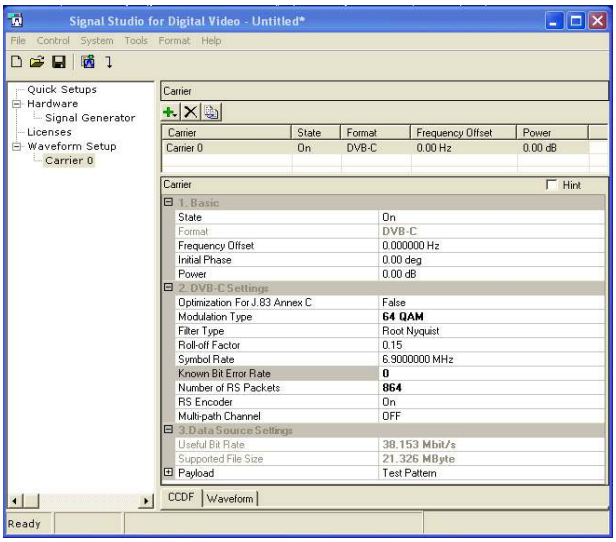


Figure 2. Digital Cable TV signals setup in the Signal Studio for Digital Video software

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 Digital Video	Double-click on the Digital Video 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}.**
Select the DVB-C, J.83 Annex A/C format	Click on the **{Format}** pull down menu at the top of the signal studio program window, Next, select **{DVB-C, J.83 Annex A/C}.**
Set the basic parameters of the signal at center frequency 474 MHz, amplitude –20 dBm, and RF output turned ON	Click **Signal Generator** at the hardware on the explorer menu on the left. Instrument Model Number: N5162A/N5182A Press **[Preset]** green button on the top. Frequency = 474 MHz, amplitude = –20 dBm, RF Output = On , ALC = On
Confirm the waveform setup from upper level	Click **Waveform Setup** to see the fundamental waveform signal setups, set DVB-C common parameters as follows: Oversampling Ratio = 2, Mirror Spectrum = Off, Quadrature Angle Adjustment = 0 deg, I/Q Gain Balance = 0 dB
Set a test signal for demonstrations. The settings of the signal are as follows: Standard: DVB-C (J.83/A) Symbol rate: 6.9 MHz Modulation type: 64QAM Filter type: Root Nyquist Roll-off factor: 0.15	Click **Carrier0 (Basic)** under **Waveform Setup** on the explorer menu on the left. Set the parameters of the signal to be transmitted on the right side of the menu accordingly. Figure 2 is a graphic showing the signals setting once the setup done.
Download the signal to the 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 > DVB_C.scp (name it as you like.)
Export the waveform file for future use	File > Export Waveform Data > DVB_C.wfm (name it as you like).

Demonstration 2:

Channel power

The channel power measurement measures and reports the integrated power in the digital cable TV defined bandwidth and power spectral density (PSD) displayed in dBm/Hz or dBm/MHz.

Instructions	Keystrokes
On the X-Series in Digital Cable TV mode:	
Select Digital Cable TV mode	**[Mode Preset] [Mode] {Digital Cable TV}**
Set the center frequency at 474 MHz	**[FREQ Channel] {Center Freq} {474} {MHz}**
Select the DVB-C (J.83/A) standard	**[Mode Setup] {Radio Std} {DVB-C (J.83/A)}**
Set the modulation format and symbols rate	**[Mode Setup] {Modulation Format} {64QAM}** **[Mode Setup] {Symbol Rate Auto}**
Activate the channel power measurement	**[Meas] {Channel Power}**

Figure 3. Channel power measurement

Demonstration 3:

Adjacent channel power (ACP)

Adjacent channel power can measure and report the power in one or more transmit channels. The text window shows the total power within the defined carrier bandwidth and at given frequency offsets on both sides of the carrier frequency. The ACP measurement results should look similar to Figure 4.

Instructions	Keystrokes
On the X-Series Digital Cable TV mode:	
Active adjacent channel power measurement	**[Meas] {ACP}**
Compare the measurement results with noise correction turned on. Better ACP results are achieved with noise correction on (Figure 4).	**[Meas Setup] {More 1 of 2} {Noise Correction On}**

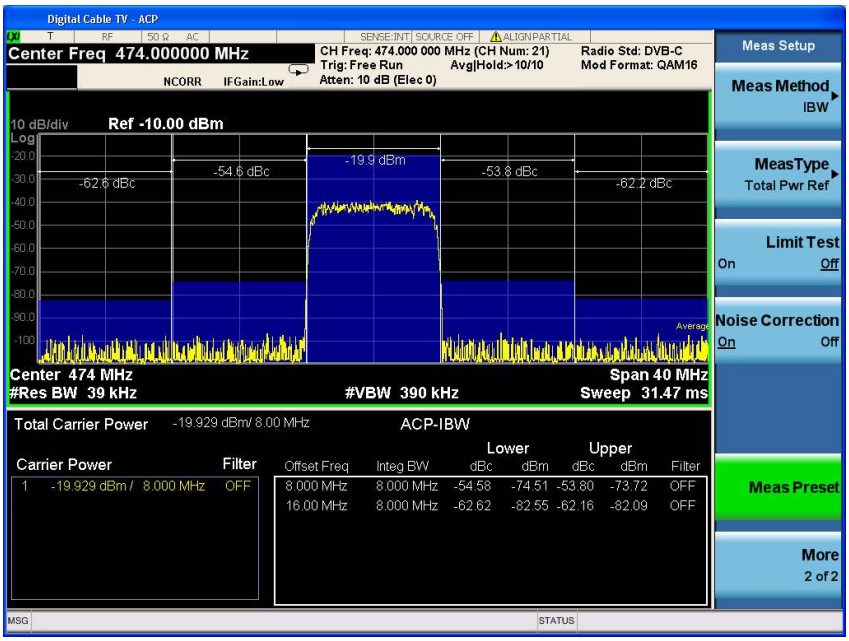


Figure 4.
ACP measurement with noise correction on

Demonstration 4:

Power stat CCDF

The power stat complementary cumulative distribution function (CCDF) is a statistical method used to interpret the peak-to-average ratio of digitally modulated noise-like signals. It is a key tool for power amplifier design for digital cable TV transmitters, which is particularly challenging because the amplifier must be capable of handling the high peak-to-average ratio while maintaining good adjacent channel leakage performance.

Instructions	Keystrokes
On the X-Series Digital Cable TV mode:	
Active the power stat CCDF measurement	**[Meas] {Power Stat CCDF}**
Store a reference trace	**[Trace/Detector] {Store Ref Trace}**
Turn on reference trace	**[Trace/Detector] {Ref Trace On}**

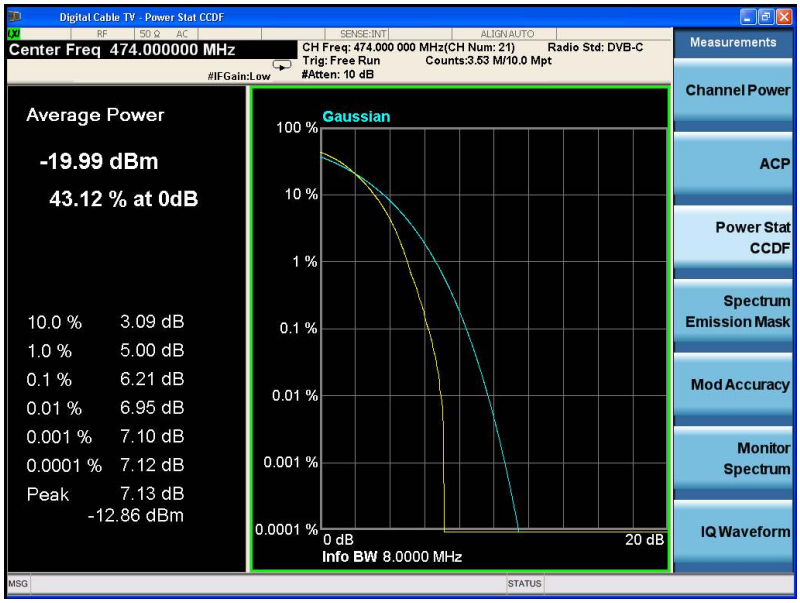


Figure 5. Power stat CCDF measurement

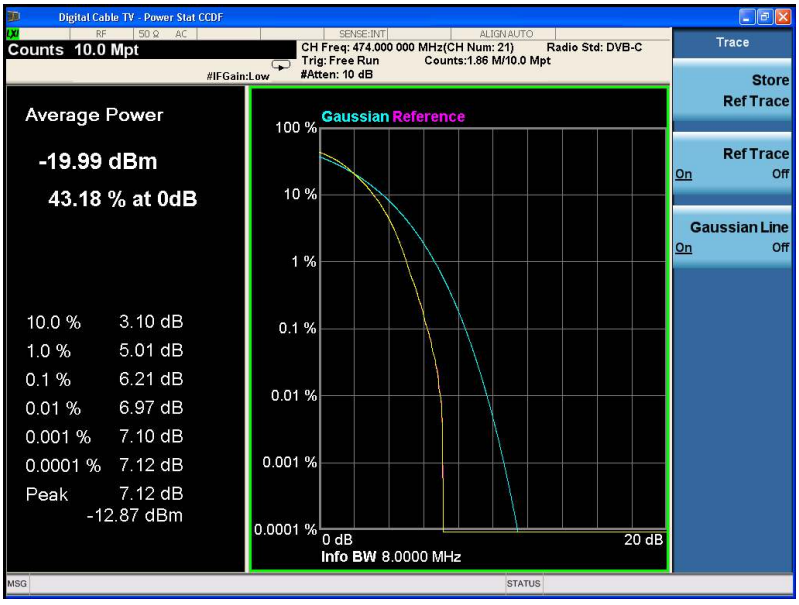


Figure 6. Power stat CCDF measurement with reference trace

Demonstration 5:

Spectrum emission mask

The spectrum emission mask (SEM) measurement compares the total power level within the defined carrier bandwidth and the given offset channel on both sides of the carrier frequency to levels allowed by the standard or manually set by the user. This measurement refers to the design of the power amplifier in the transmitter, and it is a key measurement linking amplifier linearity and other performance characteristics to the stringent system specifications.

Instructions	Keystrokes
On the X-Series Digital Cable TV mode:	
Active the spectrum emission mask measurement	**[Meas] {Spectrum Emission Mask}**
Set the limit mask as needed	**[Meas Setup] {Ref Channel}** **[Meas Setup] {Offset Limit}**

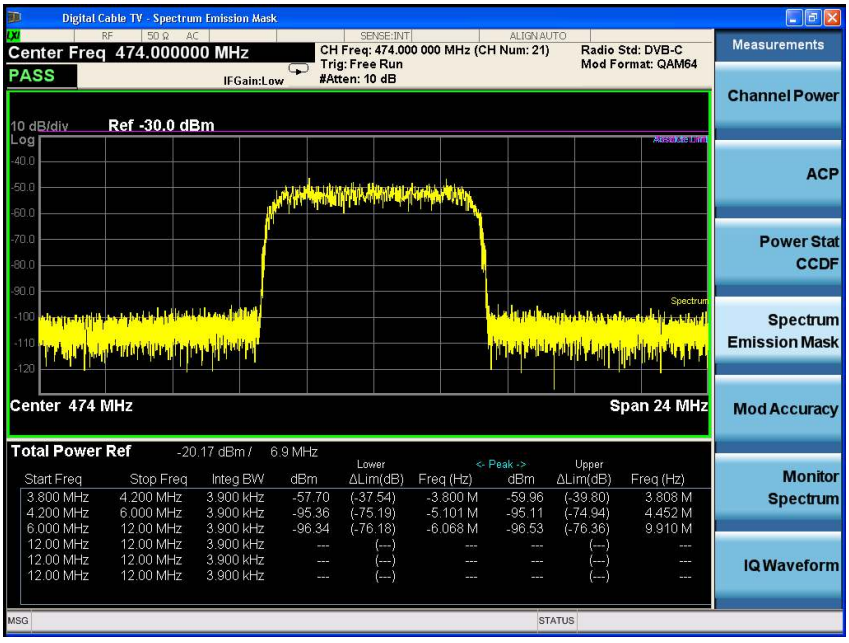


Figure 7. Spectrum emission mask measurement

Demonstration 6:

Modulation accuracy

Measurement of modulation accuracy and quality are necessary to meet test requirements defined in ETSI TR 101 290 and ensure proper operations of the transmitters. Error vector magnitude (EVM) and modulation error ratio (MER) present the total signal degradation including noise, interferences, or distortions at the input of a commercial receiver's decision circuits to give an indication of the ability of that receiver to correctly decode the signal.

The modulation accuracy measurement provides many methods for measuring the errors in a digital cable TV transmitter. In the measurements, you can measure the EVM, MER, magnitude error, phase error and more.

Instructions	Keystrokes
On the X-Series Digital Cable TV mode:	
Active the modulation accuracy measurement	**[Meas] {Mod Accuracy}**
View the IQ measured polar graph results (Figure 8)	**[View/Display] {I/Q Measured Polar Graph}**
View the IQ error results (Figure 9)	**[View/Display] {IQ Error}** To view the MER vs. symbol results in the top left window, press **[AMPTD Y Scale], {More 1 of 2}** and toggle the **{Scale Type}** to **MER.**
Turn the equalizer on to view the channel frequency response and channel impulse response results	**[Meas Setup] {Adaptive Equalizer} {Filter On}**
View the channel frequency response results (Figure 10)	**[View/Display] {Channel Frequency Response}**
View the channel impulse response results (Figure 11)	**[View/Display] {Channel Impulse Response}**
View the BER results (Figure 12)	**[View/Display] {BER}** If the signal under test are Null TS packet, press **[Meas Setup], {Decode}** and toggle the **{Payload}** to **NullPacket.**
View the result metrics (Figure 13)	**[View/Display] {Result Metrics}**

Available views and traces in modulation accuracy:

- I/Q measured polar graph view (Figure 8):
  - Results metrics (left)
  - I/Q measured polar graph (right)
- I/Q error view (Figure 9): A view of computed error vector between corresponding symbol points in the I/Q measured and I/Q reference signals
  - EVM/MER vs. symbol (top left)
  - Mag error vs. symbol (top right)
  - Phase error vs. symbol (bottom left)
  - Results metrics (bottom right)
- Channel frequency response view (Figure 10):
  - Amplitude vs. sub-carrier (top)
  - Phase vs. sub-carrier (middle)
  - Group delay vs. sub-carrier (bottom)
- Channel impulse response view (Figure 11): a view of the state of the channel
- BER view (Figure 12): summary of non real-time BER results
- Result metrics view (Figure 13): summary of all the result metrics

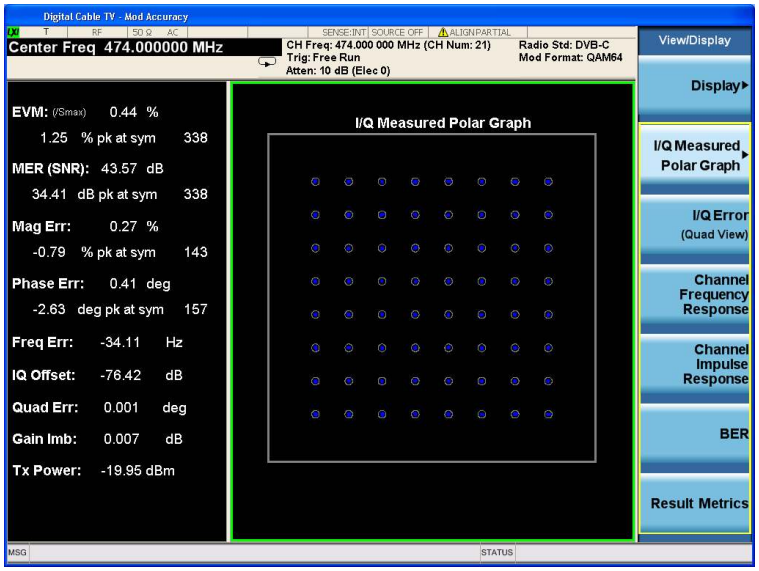


Figure 8.
IQ measured polar graph view

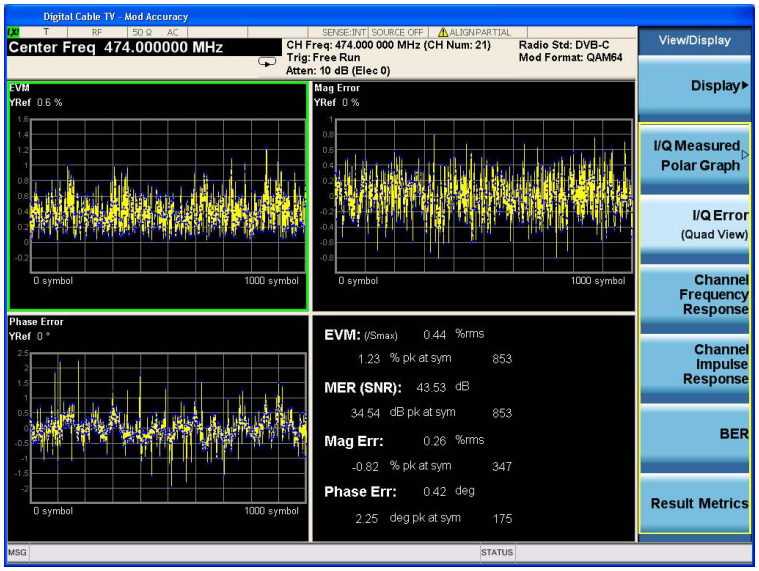


Figure 9.
IQ error view

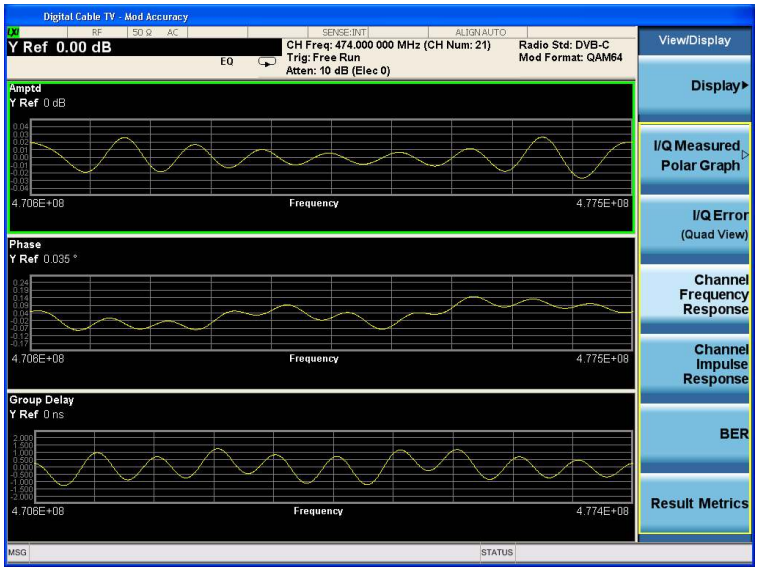


Figure 10.
Channel frequency response view

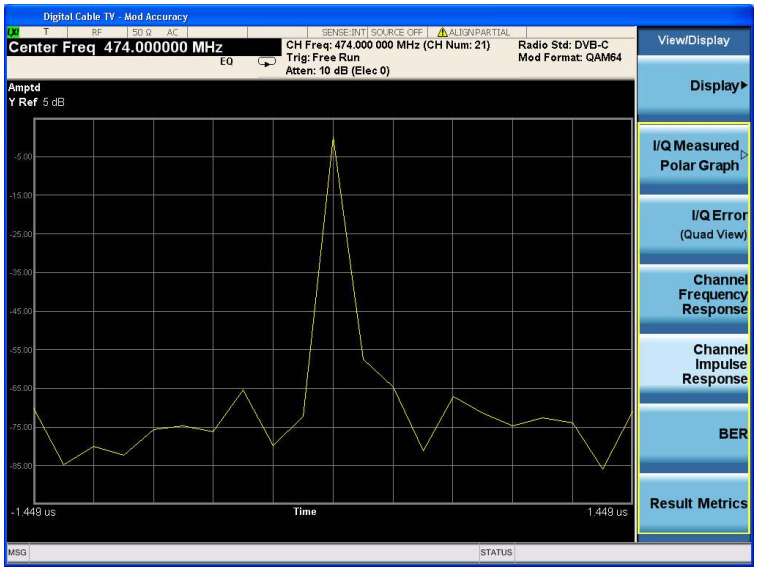


Figure 11. Channel impulse response view

Figure 12. BER view

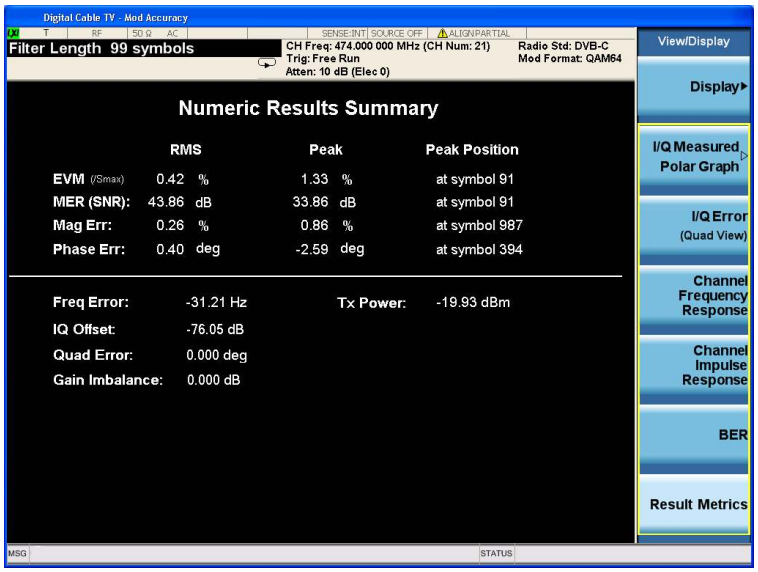


Figure 13. Result metrics view

Demonstration 7:

Monitor spectrum

The monitor spectrum measurement is used as a quick, convenient means of looking at the entire spectrum. While the look and feel is similar to the spectrum analyzer mode, the functionality is greatly reduced for easy operation. The main purpose of the measurement is to show the spectrum.

Instructions	Keystrokes
On the X-Series Digital Cable TV mode:	
Active the monitor spectrum measurement	**[Meas] {Monitor Spectrum}**

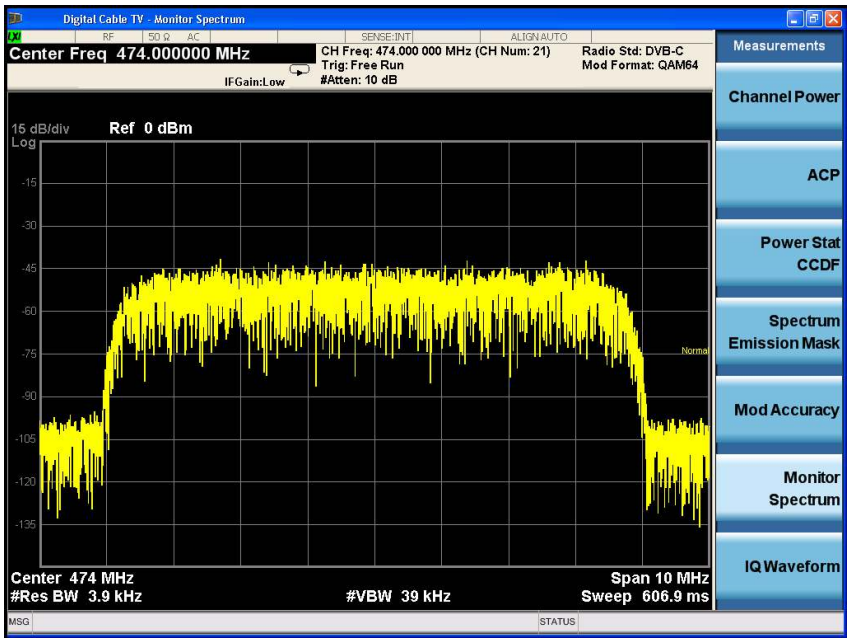


Figure 14. Monitor spectrum measurement

Demonstration 8:

IQ waveform

Waveform measurement is a generic measurement for viewing the input signal waveforms in the time domain. Under this measurement there is also an I/Q waveform window that shows I and Q signal waveforms in parameters of voltage versus time to disclose the voltages, which comprise the complex modulated waveform of a digital signal. The waveform measurement can also be used to perform general-purpose power measurements with a high degree of accuracy.

Instructions	Keystrokes
On the X-Series Digital Cable TV mode:	
Active the IQ waveform measurement (RF envelope view default) (Figure 15)	**[Meas] {IQ Waveform}**
View the IQ waveform (Figure 16)	**[View/Display] {I/Q Waveform}**

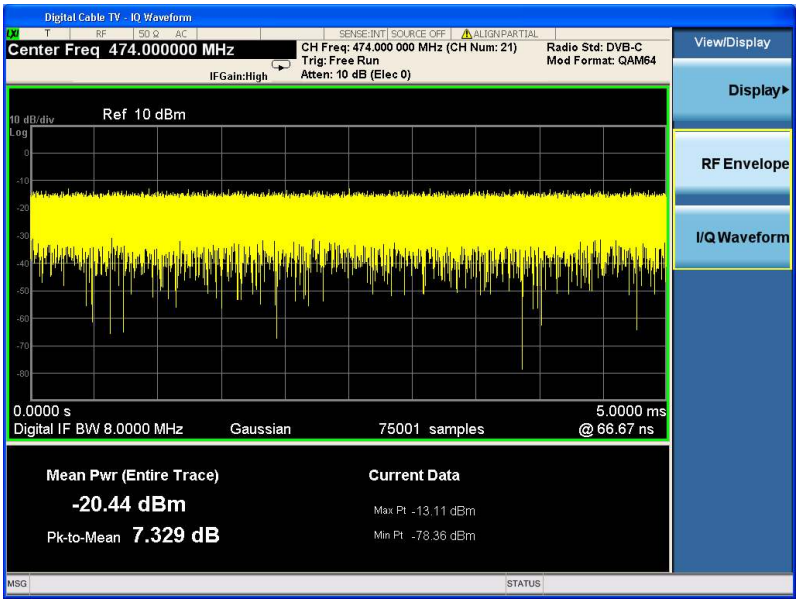


Figure 15.
RF envelope view

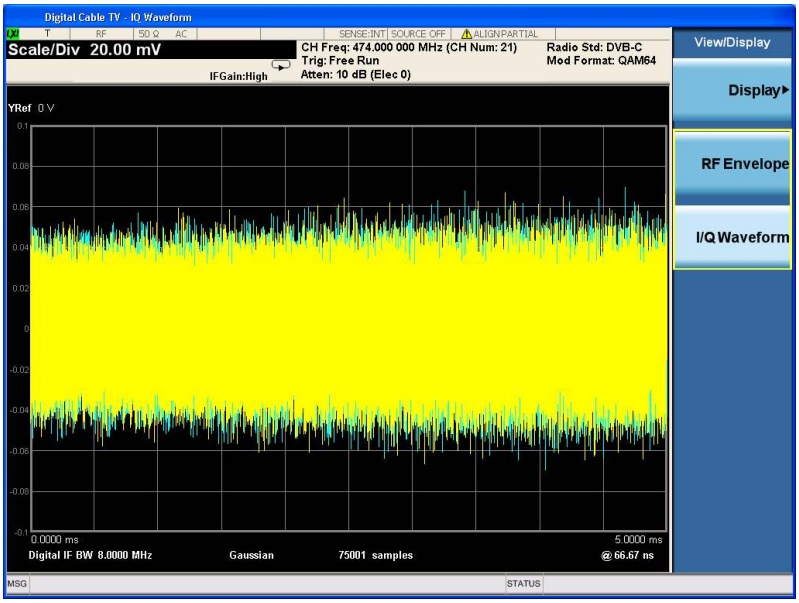


Figure 16.
I/Q waveform view

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