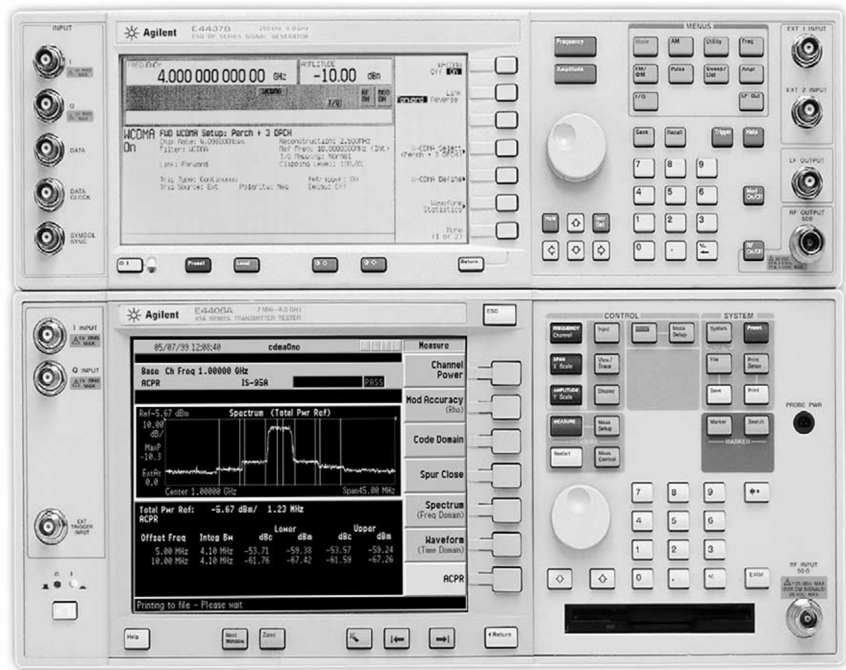
Agilent E4406A Vector Signal Analyzer

Self-Guided Demo

Product Note



This demo is a tool to gain familiarity with the basic functions and features of the Agilent E4406A VSA. All exercises utilize the Agilent E4433B or E4437B ESG series RF signal generator. Keystrokes surrounded by [ ] indicated hard keys located on the front panel, while keystrokes surrounded by { } indicate soft keys located on the display.

Note: You may notice slight differences in the soft key menu on your display and those shown in this document's figures. This is due to differences in firmware. Please consult the technical support area of the Agilent web site, www.agilent.com/find/vsa, for the latest firmware upgrades.

Agilent Technologies
Innovating the HP Way

Table of contents

Part 1.
The basics: mode, measure, and view

The measurement model for the E4406A VSA is:

1. **Mode** (select and setup the measurement mode you want to use)
2. **Measure** (select and setup the measurement you wish to see)
3. **View** (display the measurement)

Once the user selects and sets up the mode, the instrument configures itself to measure the signal according to the industry standards for that mode.

Part 2.
Demo preparation

The following options are required for the ESG series signal generator and the E4406A VSA signal analyzer:

Product type	Model number	Required options
ESG-D/DP series[1]	E4433B/E4437B	UND, UN8, UN5, 100, 201, and 202
VSA	E4406A	202, BAF, B78, BAC, BAE, BAH

Using an RF cable with an impedance of 50Ω, connect the RF output 50Ω port on the ESG-D/DP series RF signal generator to the RF input 50Ω port on the E4406A VSA as shown in Figure 1.

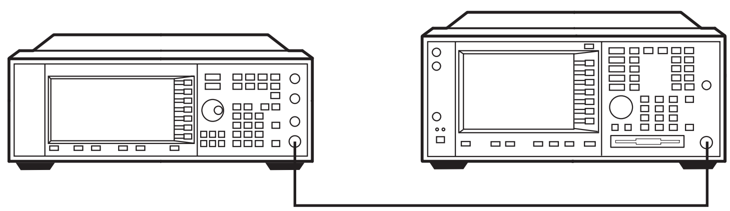


Figure 1. ESG-D/DP series signal generator and an E4406A VSA

This self-guided demo is based on using the E4406A VSA with an ESG-D/DP series signal generator. Agilent continues to enhance the VSA and ESG-D/DP series.

1. The ESG-D or DP series can be used for this demo.

Part 3. W-CDMA measurements

The third generation partnership project (3GPP) is standardizing the types of measurements, test methods, and acceptable limits for W-CDMA. In Japan, DoCoMo intends to implement service in Spring of 2001 and manufacturers are already developing/evaluating baseband units, RF sub-modules, and power amplifiers based on 3GPP documents. Test instruments that are able to accurately make the conformance tests defined by 3GPP are needed.

In this section, configure the ESG-D/DP series signal generator to generate a W-CDMA signal. Then, use the E4406A to perform conformance tests with the touch of a button.

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Preset the instrument	[Preset]
Set the center frequency to 2 GHz	[Frequency] [2] {GHz}
Set the amplitude to –5 dBm	[Amplitude] [+/-] [10] {dBm}
Go to W-CDMA under the built-in Arb Waveform Generator menu	[Mode] {Arb Waveform Generator} {CDMA Formats} {W-CDMA (3GPP 3.2 03-00)}
Generate a W-CDMA TEST Model 1 with 16 DPCH	{W-CDMA Select} {Test Models} { TEST Model 1 w/ 16 DPCH}
Activate the format	{W-CDMA: Off/On} [RF On/Off]

Measurement 1. Adjacent channel power ratio with root raised cosine filter

The adjacent channel power ratio (ACPR) measurement is a critical measurement for transmitters and their components. It describes the amount of distortion generated due to non-linear factors in the RF components being tested.

For W-CDMA, ACPR is referred to as adjacent channel power leakage ratio (ACLR).

This measurement must be performed using a root raised cosine (RRC) filter with roll-off factor 0.22. The E4406A VSA is equipped with a RRC filter that defaults to "On" during the ACPR measurement. Optionally you can switch the RRC filter to "Off". The actual measurement difference caused by turning the RRC filter on and off is about 0.1 dB for an ESG input signal.

As standards change, the definition of the ACPR measurement often changes. This includes the defined bandwidths and offsets used to make the ACPR measurement. The VSA enables you to quickly customize these offsets.

In this section, measure the W-CDMA ACPR and then customize these offsets.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Preset the instrument	[Preset]
Set the VSA to the W-CDMA 3GPP	[MODE] {W-CDMA (3GPP)}
Set the center frequency to 2 GHz	[FREQUENCY] [2] {GHz}
Make the adjacent channel power measurement (Figure 1)	[MEASURE] {ACPR}
Select Offset C	[Meas Setup]{Ofs & Limits} {Offset} {C}
Change the desired bandwidth	{Ref BW} [5] {MHz}
Change the frequency offset	{Offset Freq} [10] [MHz] {Offset Freq On/Off}

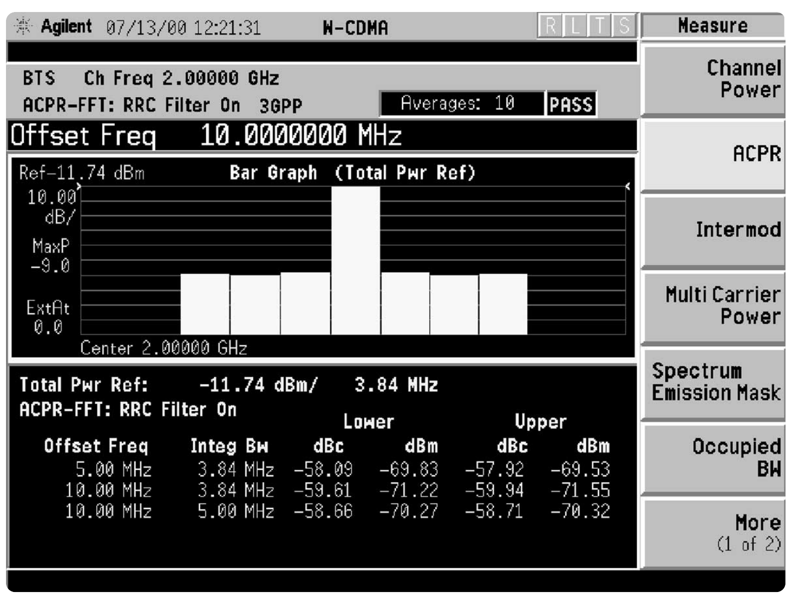


Figure 1. W-CDMA adjacent channel power ratio

Measurement 2. Occupied bandwidth

The occupied bandwidth (OBW) measurement finds the frequency bandwidth corresponding to 99 percent of the total power. For 3GPP, OBW is required to be less than 5 MHz.

The VSA measures the total power within the frequency span. Then, it measures inward from both edges of the span until 0.5 percent of the total power is accounted for in the upper and lower frequency band, respectively. The difference between these two is the OBW. On the display, two white vertical lines represent the bandwidth. To simplify the setup, the VSA sets the PASS/FAIL limit value to 5 MHz by default.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure OBW (Figure 2)	[MEASURE] {OBW}

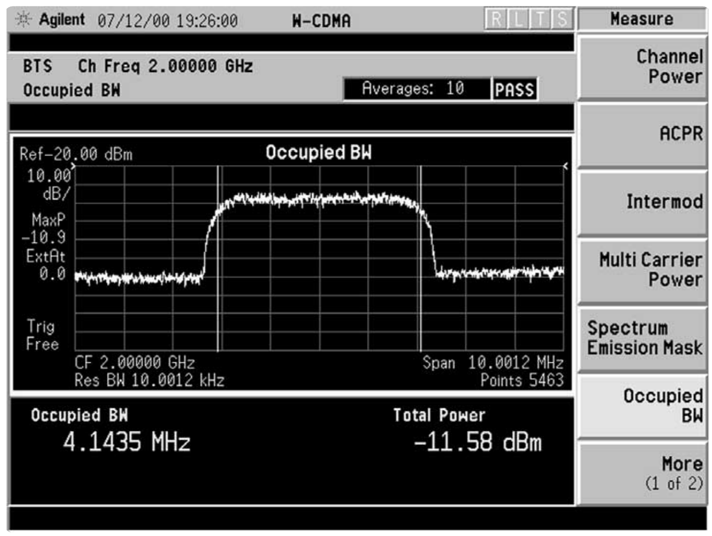


Figure 2. Occupied bandwidth

Measurement 3. Spectrum emission mask

In the spectrum emission mask measurement for 3GPP, several different resolution bandwidths and frequency offsets are required. Figure 3 and Table 1 are excerpted from 3GPP document TS25.141(v3.0.0). Notice that in the offset range 2.7 to 3.5 MHz, the limit value varies linearly with the offset frequency.

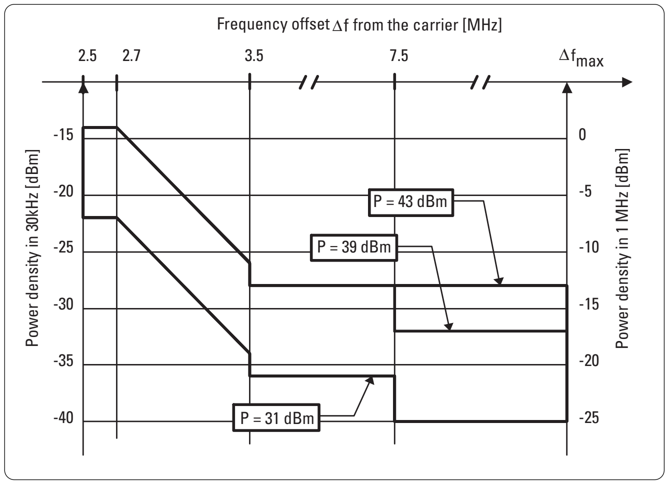


Figure 3. Power density verses frequency offset from carrier

Table 1. Spectrum emission mask values, BS maximum output power P≥43 dBm

Frequency offset Δf	Maximum level	Measurement bandwidth
2.5 ≤ Δf ≤ 2.7MHz	-14dBm	30kHz[1]
2.7 ≤ Δf ≤ 3.5MHz	-14-15*(Δf –2.7)dB	30kHz [1]
3.5 ≤ Δf ≤ Δf_{max} MHz	-13dBm	1MHz[2]

The use of a traditional spectrum analyzer for this measurement requires a list of complex settings, but the VSA is able to execute this measurement with just one soft key.

Instructions: E4406A VSA	**Keystrokes: E4406A VSA**
Measure spectrum emission mask (Figure 4)	[MEASURE] {Spectrum Emission Mask}

1. The first and last measurement positions with a 30kHz filter are 2.515MHz and 3.485MHz.
2. The first and last measurement positions with a 1MHz filter are 4MHz and (Δf max –500kHz).

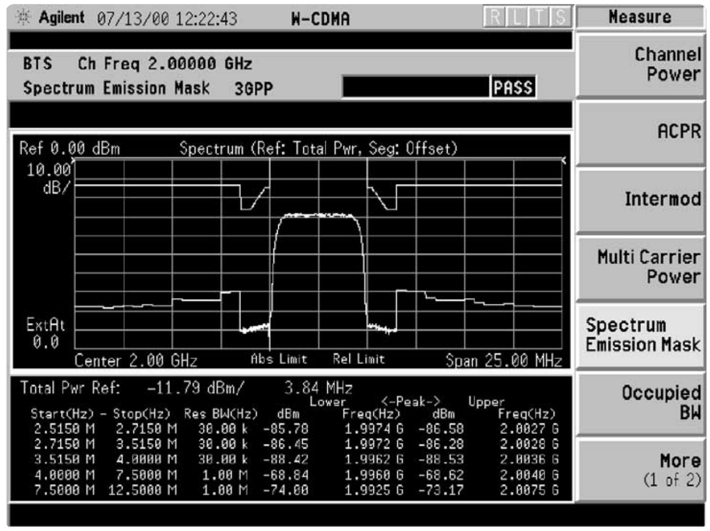


Figure 4. Spectrum emission mask

In the spectrum emission mask measurement, the measured signal trace and mask are displayed in the upper window, while the power (indB/dBc) is shown in the lower window for each specified bandwidth. A sloped limit mask can be configured. Both RMS and Peak detection modes are selectable. Also, the measurement interval is variable up to 10 ms. The frequency range is limited from 329 MHz to 3.678 GHz.

Because the VSA is a fast Fourier transform (FFT) based analyzer, the local oscillator is not designed to “sweep” like a spectrum analyzer. Instead, the LO repeatedly steps in discrete frequency increment. (The step size is defined under [Meas Setup]{Offset/Limits} {Step Freq}.) A measurement is made at each frequency point; offset segments group the points. For each segment, you can independently specify the resolution bandwidth. {Step Freq} and {Res BW} default to coupled mode. If you choose to set these parameters in the manual mode, make sure that the resolution bandwidth is larger than the LO step size. Otherwise, some components of the signal will be missed because they fall between successive peaks of the resolution bandwidth filter. In fact, it is good practice to make the {Res BW} twice as wide as the step size since the filter is Gaussian. This ensures successive filter bandwidths will overlap.

Measurement 4. Intermodulation distortion

Note: To perform measurements 4 and 5, a second ESG is required. If not available, proceed to measurement 6.

Intermodulation distortion manifests itself as harmonic mixing products resulting from non-linear elements within power amplifiers. This measurement requires an interfering signal in addition to the desired signal.

Before beginning this measurement, set up another ESG. Connect the device under test (DUT) to the probe power outlet on the front of the VSA.

<ESG Number 1>

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Generate continuous wave (CW) signal	[Mod On/Off] [RF On/Off]

<ESG Number 2>

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Preset the instrument	[Preset]
Set the center frequency to 2.005 GHz	[Frequency] [2.005] {GHz}
Set the amplitude to –5 dBm	[Amplitude] [+/-] [10] {dBm}
Generate CW signal	[Mod On/Off] [RF On/Off]
After ESGs are set up, combine their outputs, and input the composite signal into the DUT	Be sure to identify which is the input and which is the output of the DUT

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure Intermodulation (Figure 5)	[Measure] {Intermod}

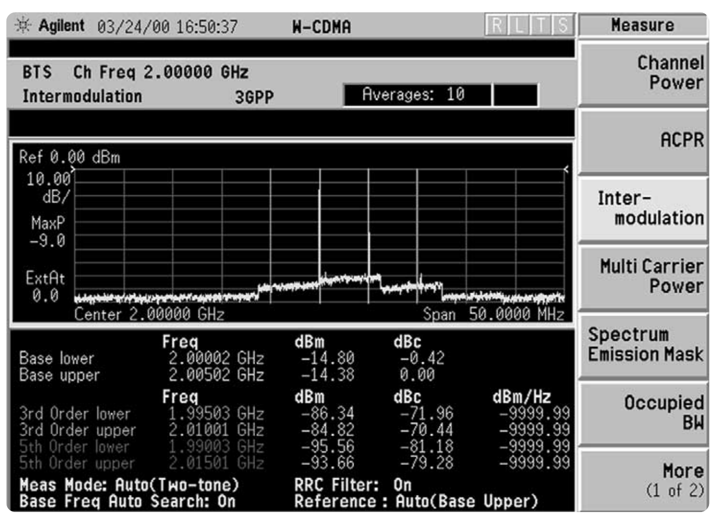


Figure 5. Intermodulation distortion*

*The DUT intermodulation results shown above will vary from your specific DUT measurements.

The 3rd order mixing products are denoted by blue lines and the 5th order products are denoted with violet lines. The 3rd order and 5th order frequencies are automatically derived from the fundamental (carrier) frequencies. The result is expressed in both dBm and dBc. The reference used to calculate the relative power is the lower frequency signal as {Reference} set to {Auto}. You can use either the lower or upper signal as a reference, as shown below.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Change the reference to upper signal	[Meas Setup] {Reference} {Base upper}

The most commonly used signal condition for intermodulation testing is CW + CW. However, it is becoming increasingly common for a CW + Modulated signal to be used, especially for power amplifiers used in CDMA. The VSA is also capable of making this measurement, as shown below.

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Generate a W-CDMA TEST Model I with DPCH	[Mod On/Off]

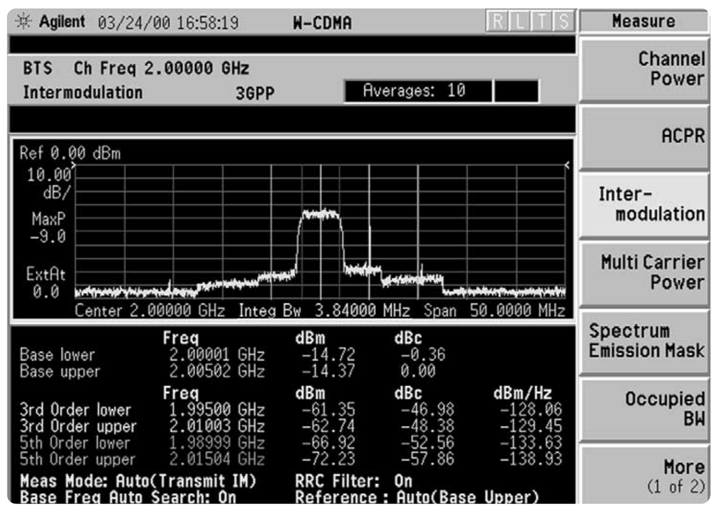


Figure 6. W-CDMA signal (CW + modulation)

The VSA automatically recognizes that one input signal has changed to a modulated signal. The measurement result indicates this by showing the spectrum of the carrier and the integration bandwidth, denoted by red lines on the display. The integration bandwidth is required for this measurement because the distortion is now broadband in nature, rather than single tones.

Measurement 5. Multi-carrier power

Multi-carrier amplifier manufacturers require additional information to 3rd order intermodulation products; they also desire to know channel power at 5 MHz, 10 MHz, and 15 MHz offsets. In some cases, they wish to know the interference power between carriers. The multi-carrier power measurement capability of the VSA makes this possible.

<ESG Number 1>

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Generate continuous wave (CW) signal	[Mod On/Off] [RF On/Off]

<ESG Number 2>

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Set the center frequency to 2.015 GHz	[Frequency] [2.015] {GHz}
Go to W-CDMA under the built-in Arb Waveform Generator menu	[Mode] {Arb Waveform Generator} {CDMA Formats} {W-CDMA (3GPP 3.2 03-00)}
Generate a W-CDMA TEST Model 1 with 16 DPCH	{W-CDMA Select} {Test models} { TEST Model 1 1 w/ 16 DPCH} {W-CDMA: Off/On} [RF On/Off] [Mod On/Off]

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Set the VSA to measure multicarrier power	[Measure] {Multicarrier Power}
Specify the frequency of No.2 ESG signal by selecting the frequency value relative to the center frequency	[Meas Setup] {2nd Carrier Offset} {+15 MHz}
Set a reference signal to make the relative power readings in dBc	[Meas Setup] {Ref Chan} {Lower}
Restart Multi-Carrier Power (Figure 7)	[Restart]

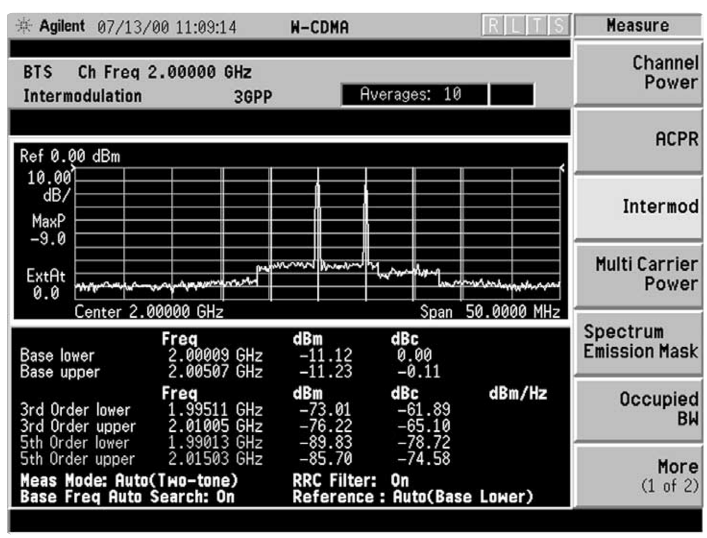


Figure 7. Multi-carrier power

The result is shown as a bar graph. The lower offset frequencies are measured relative to the lower carrier, while the upper offset frequencies are measured relative to the upper carrier. All power levels are referenced to the lower carrier unless you change the reference. Note that the power between carriers is also shown, even though IMD products are not normally significant in this case. The automatic range control maximizes the dynamic range, eliminating the detailed setting by users. It is possible to make extremely fast measurements by using the “3rd IM Only” function. This feature can be very helpful to customers tuning power amplifiers by observing the 3rd order intermodulation products.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure 3rd order intermodulation (Figure 8)	{Meas Setup} {Meas Mode} {3rd IM Only}

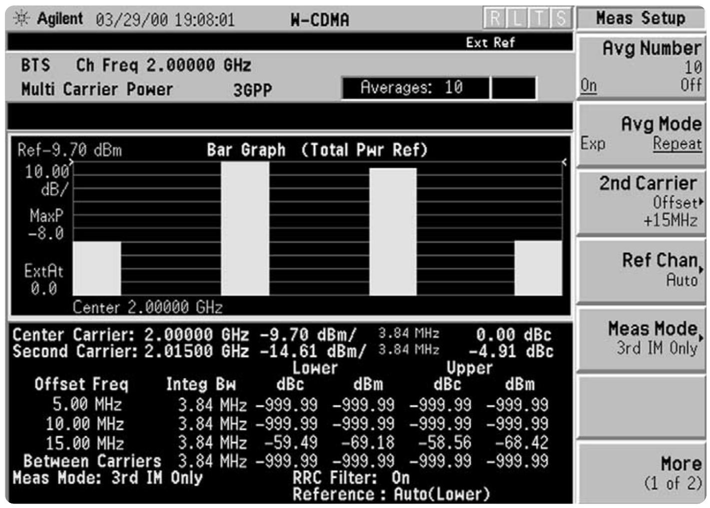


Figure 8. 3rd order intermodulation

Measurment 6. Code domain power

If applicable, disconnect ESG No. 2 and reconnect ESG No. 1 to the VSA. *Caution: For this part of the demo to work properly, be sure that the scramble code for all code channels in the ESG are set to 1. Instructions for this are at the beginning of "Part 3. W-CDMA Measurements" .*

In this section, measure the code domain power (CDP) of a W-CDMA signal.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Verify that the center frequency is correct	[Frequency] [2] {GHz}
Measure CDP (Figure 9)	[Measure] {More}{Code Domain}

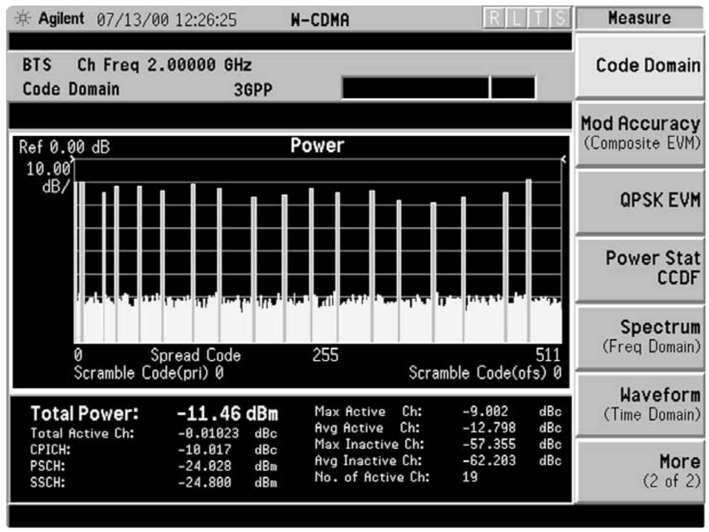


Figure 9. Code domain power

The data capture in this example is limited to two frames; however up to 16 frames are possible. Two frames are equivalent to 30 time slots. Any number of slots (up to 30) can be displayed, and any offset from the beginning of the first frame can be selected. {Meas Offset} is used to set the offset for the starting slot to be viewed, and {Meas Interval} sets the number of slots to be viewed. {Meas Offset} and {Meas Interval} are found under [Meas Setup].

Measurement 7. Complementary cumulative distribution function

CDMA signals have a very high and variable ratio of average power to peak power, known as the crest factor. The crest factor can exceed 12 dB, which means that a transmitter with an average power of 8 watts must be capable of handling peak values of 126 watts without clipping or distortion. The complementary cumulative distribution function (CCDF) measurement plots the probability (% on vertical axis) that the signal power peaks will exceed a certain power level above the average power (dB on the horizontal axis).

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure CCDF	[Measure] {More}{Power Stat CCDF}

The measurement shows two curves: The blue line is a reference trace describing the power statistics of white Gaussian noise. The yellow line is the input signal – the power statistics of our Test Model signal. The instrument is measuring the peak-to-average power levels of the signal versus time. Now we will examine how the signal coding can significantly affect RF performance.

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Turn off all but one channel	{WCDMA Select} {1DPCH}

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Restart the CCDF measurement (Figure 10)	[Restart]

Notice the peak excursions are now significantly lower due to the absence of code channels. When the CCDF curve in the figure below shifts left, this indicates that the device under test (DUT) is operating under optimum power conditions. This characterization can be very important to power amplifier designers where conservation of battery life is key for mobile applications.

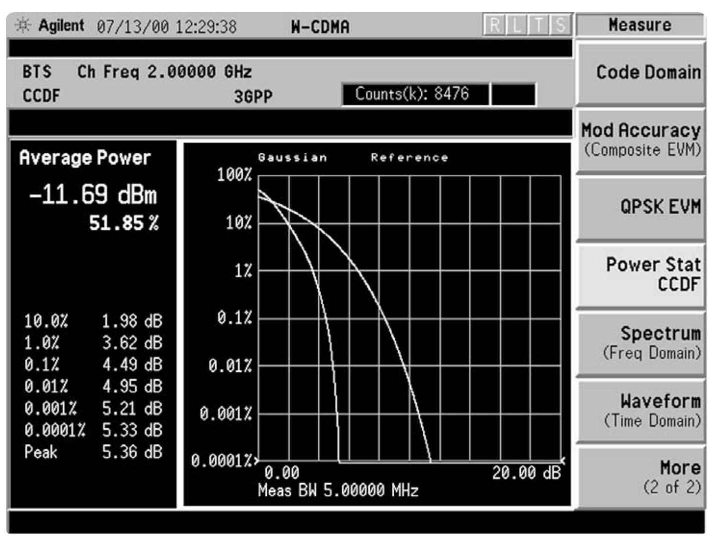


Figure 10. Complimentary cumulative distribution function

Part 4. Cdma2000 measurements

Cdma2000 is one of the proposals for the IMT-2000 requirements for a third generation (3G) global wireless communications system. Cdma2000 offers backwards compatibility with cdmaOne systems and a smooth migration from second generation (2G) cdmaOne systems to 3G.

In this section, you will configure the ESG-D/DP to generate a cdma2000 signal. Then, use the E4406A to perform one-button standards compliant measurements.

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Preset the instrument	[Preset]
Set the center frequency to 1 GHz	[Frequency] [1] {GHz}
Set the amplitude to –10 dBm	[Amplitude] [+/-] [10] {dBm}
Go to cdma2000 under the built-in Arb Waveform Generator menu	[Mode] {Arb Waveform Generator} {CDMA Formats} {cdma2000 (Rev. 8)}
Generate a cdma2000 Spread Rate 1 signal	{Spread Rate} {Spread Rate 1}
Select the channel structure	{CDMA2000 Select} {9 Channel}
Change the data rate and Walsh code of a supplemental1 traffic channel	{More (1 of 2)} {CDMA2000 Define} {Edit Channel Setup}. Tab to Row 5 under "Walsh". {Edit Item} [5] {Enter}. Tab to Row 5 under "Rate bps". {Edit Item} {More (1 of 2)} {76800 Bps} [Return] [Return] {More (2 of 2)}
Activate the format	{CDMA2000: Off On} [RF On/Off]

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Set the center frequency to 1 GHz	[Frequency] [1] {GHz}
Activate the cdma2000 measurement personality	[Mode] {More} {cdma2000}
Set the span to 5 MHz	[Span] [5] {MHz}
View the "Measure" function capabilities (Note: This is the main key that allows access to the capabilities of the VSA. The View/Trace, Display, and Meas Setup keys access submenus of the current measurement mode, to allow different views and different setup parameters)	[Measure]

Measurement 1. Code domain power (forward link)

The code domain power (CDP) measurement verifies that the base station is transmitting the correct power in each channel. Errors in the code domain usually arise from the channel elements that construct the individual channels or from incorrect network software settings. The Pilot and Sync channels in cdma2000 SR1 systems have the same structure as in cdmaOne. Cdma2000 defines different physical channel configurations called radio configurations (RCs). Radio configuration defines the physical channel configuration based upon a specific channel data rate. Each RC specifies the spreading rate, data rates and physical coding.

Now, generate the cdma2000 CDP measurement.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Activate the CDP measurement (Figure 11)	[Measure] {More 1 of 2}{Code Domain}

Compare the channel configuration in the signal generator to the CDP display in the E4406A VSA. The Pilot, Sync and Paging channel power levels are displayed at the bottom of the screen.

Unlike cdmaOne, cdma2000 uses Walsh codes of different lengths. Channels with shorter code lengths (higher data rates) occupy more code space. For example, 8-bit Walsh codes occupy eight times more code space than 64-bit Walsh codes. This can be seen in the E4406A VSA display of the CDP.

The example below illustrates how the E4406A can easily display the CDP using Hadamard Walsh codes.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Set the marker to Walsh code 5	[Marker] [5] [Enter]
Verify that the consolidated marker feature is turned on	[Display] {Consolidated marker On Off}

The dark blue channel bar indicates the selected Walsh code.

When the “Consolidated Marker” feature is turned on (default condition), the dark and light blue bars on the display are the composite representation of the traffic channel. In this example, the traffic channel is supplemental 1 and the channel power corresponds to that of all eight highlighted channels.

When the “Consolidated Marker” feature is turned off, the channel power corresponds to the selected Walsh code only.

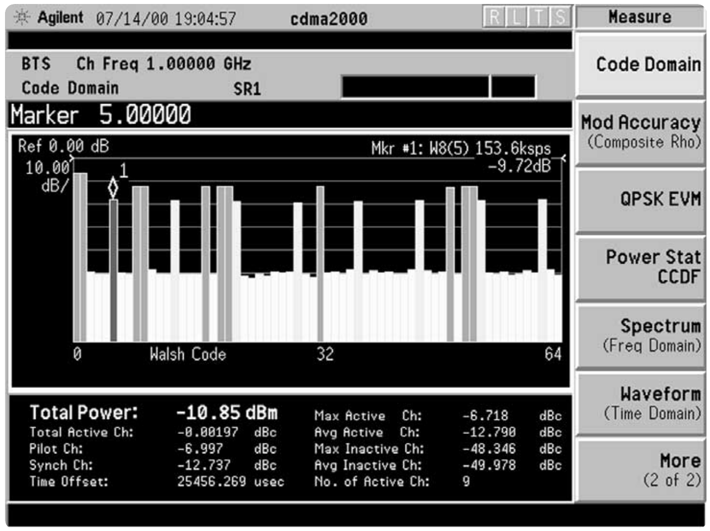


Figure 11. Code domain power

Now change the code display from Hadamard to bit reverse. This is a different method of assigning the code domain channels. It is similar to Walsh coding, except the codes from a given spread level are contiguous instead of uniformly distributed.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Change the Walsh code algorithm to bit reverse (Figure 12)	[Code Order Bit Reverse]

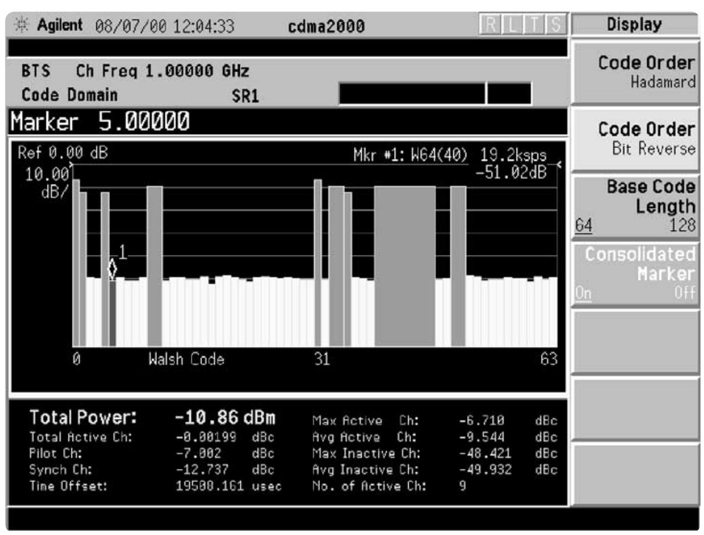


Figure 12. Bit reverse code remain power

Notice how the high data rate channel has been consolidated from multiple bars into a single, wide bar. And, note that the power level is represented in a composite fashion.

Next, we will look at the cdma2000 signal using the quad view of the CDP measurement.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Change the Walsh code algorithm to Hadamard	[Code Order Hadamard]
Select the quad view (Figure 13)	[View/Trace] {Code Domain (Quad View)}

Now, we will focus on the selected Walsh code. You will select the code channel identified by the marker for display in the other three windows.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Select Walsh code 5 for the quad view	[Marker] [5] [Enter]
Activate the quad view for channel 5	{More} {Marker ->Despread}

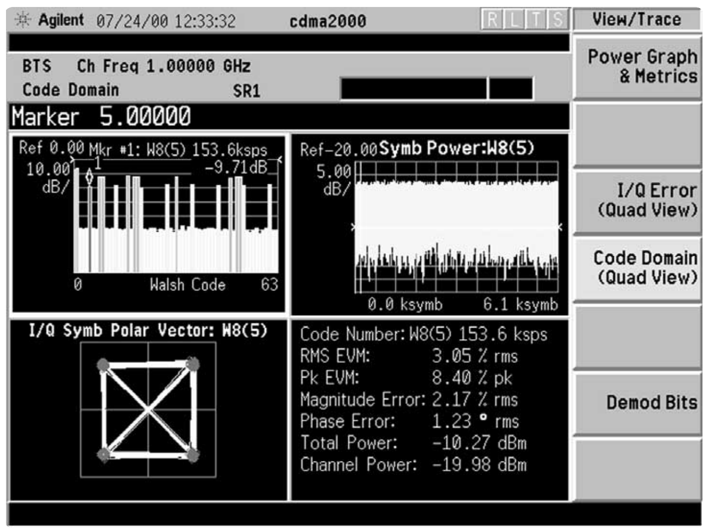


Figure 13. cdma2000 (quad view)

The quad view is arranged as follows (clockwise, starting with the top left):

1. code domain power measurement
2. symbol power (yellow) together with the chip power (blue)
3. vector diagram of the designated code channel
4. modulation quality information, such as symbol RMS and peak error vector magnitude (EVM)

Note: The display may not look exactly like the one above due to firmware enhancements.

In addition to the code domain power and the symbol power, we can see the demodulated data from the selected channel.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
View the demodulated data from Walsh code 5	[View / Trace] {Demod Bits}

To view additional demodulated data on this channel,

Instructions: E4406A VSA	Keystrokes: E4406A VSA
View the demodulated data from Walsh code 5 for a measurement interval of four power control groups (Figure 14)	[Meas Setup] {Meas Interval} {4} [Enter]

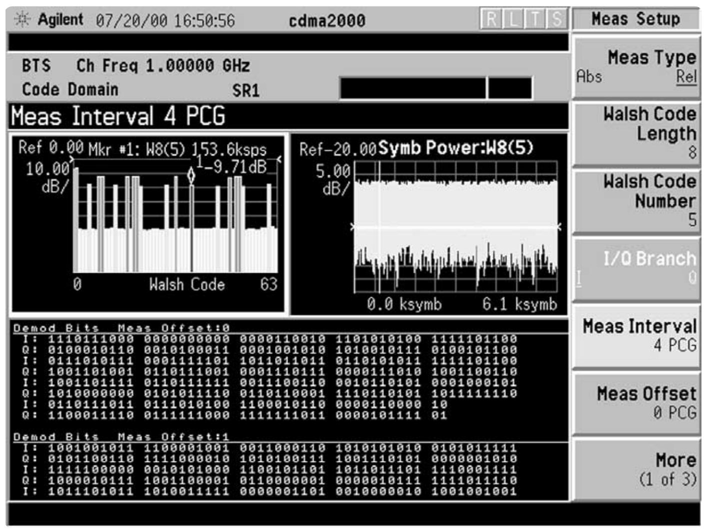


Figure 14. cdma2000 demodulated data (Walsh code 5) with four power control groups

Code domain power (reverse link)

The measurements thus far have been focused on analysis of the forward link (i.e. base station signals). This is the default device setting for “BTS”. Next, we will examine the capability of the device for analyzing signals in the reverse link i.e. mobile devices.

In contrast to the forward link, the reverse link has a hybrid phase shift key (HPSK) modulation scheme. The mobile unit can transmit more than one code channel to accommodate the high data rates. The minimum configuration consists of a reverse pilot and fundamental for voice. Additional channels can be used to send data or signaling information.

The E4406A’s ability to perform code domain power in the reverse link is a powerful feature greatly simplifying complex mobile test requirements.

In the following example, the ESG will serve as the base station signal source and the E4406A will represent the signal received by the mobile.

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Preset the instrument	[Preset]
Set the center frequency to 1 GHz	[Frequency] [1] {GHz}
Set the amplitude to –10 dBm	[Amplitude] [+/-] [10] {dBm}
Go to cdma2000 under the built-in Arb Waveform Generator menu	[Mode] {Arb Waveform Generator} {CDMA Formats} {cdma2000 (Rev. 8)}
Select a cdma2000 reverse link signal	{Link: Forward / Reverse}
Generate a cdma2000 Spread Rate 1 signal	{Spread Rate} {Spread Rate 1}
Select the channel structure	{CDMA2000 Select} {5 Channel}
Edit the channel structure	{More 1 of 2} {CDMA2000 Define} {Edit Channel Setup}
Delete row 5	[Move cursor to row 5] Then press {Delete Row}
Change supplemental channel data rate to 76,800 bps	Tab to “Rate bps” in row 4. {Edit Item} {More 1 of 2} {76,8000}
Activate the format	[Return] [Return] {More 2 of 2} {CDMA2000: Off On} [RF On/Off]

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Preset the instrument	[Preset]
Select the mobile device setting	[Mode Setup] {Radio} {Device: BTS MS}
Measure the reverse link code domain power (Figure 15)	[Measure] {More 1 of 2} {Code Domain}

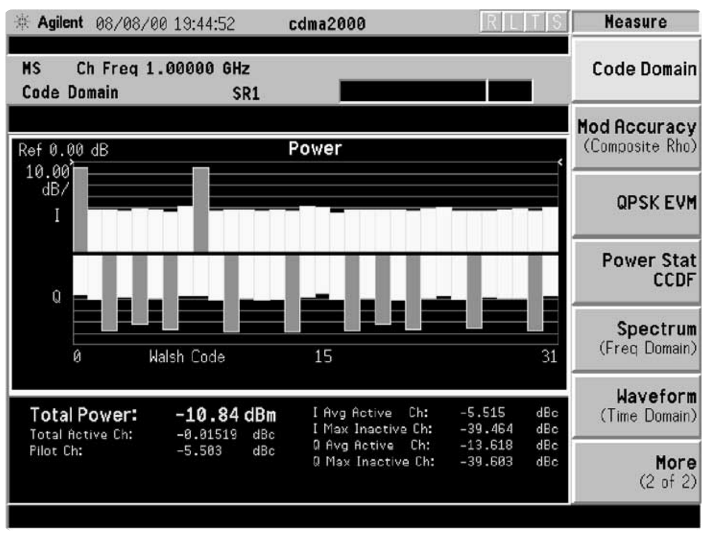


Figure 15. Reverse link code domain power (pilot/traffic/dedicated control/supplemental)

Measurement 2. Composite error vector magnitude (reverse link)

The specified measurement for modulation accuracy is rho. Rho is the ratio of the correlated power to the total power. In cdmaOne, rho measurements are performed on the reverse link signal.

Composite rho, also known as composite error vector magnitude (EVM), allows you to verify the overall modulation accuracy of a transmitter. This is independent of the channel configuration as long as the R-Pilot is present.

Like QPSK EVM, composite EVM calculates the error vector difference between the measured and the ideal signal. Essentially, it descrambles and despreads the measured signal to calculate the ideal (reference) signal.

The E4406A' s ability to perform composite EVM is a powerful feature greatly reducing the complexity of mobile (reverse link) and base station (forward link) measurements.

Next, we will setup the ESG to make this measurement.

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Preset the instrument	[Preset]
Set the center frequency to 1 GHz	[Frequency] [1] {GHz}
Set the amplitude to –10 dBm	[Amplitude] [+/-] [10] {dBm}
Go to cdma2000 under the built-in Arb	[Mode] {Arb Waveform Generator}
Waveform Generator menu	{CDMA Formats} {cdma2000 (Rev. 8)}
Select a cdma2000 reverse link signal	{Link: Forward / Reverse}
Generate a cdma2000 Spread Rate 1 signal	{Spread Rate} {Spread Rate 1}
Select the channel structure	{CDMA2000 Select} {Pilot}
Edit the channel structure by adding a dedicated control, traffic, and supplemental channel	{More 1 of 2} {cdma2000 Define} {Edit Channel Setup} {Insert Row} {Dedicated Control} {Traffic} {Done} {Supplemental1 Traffic} {Data Rate (307200)} {9600 bps} {Done}
Apply filtering	[Return] [Return] {Filter} {Select (IS-95/2000)} {IS-95 and IS-2000 (IS-95 mod)} {IS-95} [Return]{Reconstruction Filter} {Through}
Apply the channel structure	{Apply Channel Setup}
Activate the format	[Return] {More 2 of 2} {CDMA2000: Off On} [RF On/Off]

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Select the mobile device setting	[Mode Setup] {Radio} {Device: BTS MS}
Measure the reverse link composite EVM (Figure 16)	[Measure] {More 1 of 2} {Mod Accuracy (Composite rho)}

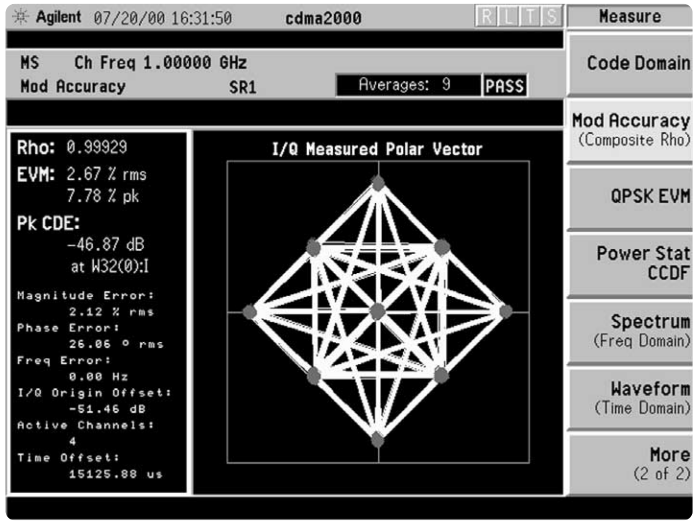


Figure 16. Reverse link modulation accuracy (composite EVM)

Part 5. CdmaOne measurements

The E4406A VSA offers cdmaOne measurements at the touch of a button. The instrument optimizes each measurement for the best possible speed and dynamic range.

In this section, configure the ESG-D/DP series RF signal generator to generate a pilot signal at 1.93125 GHz. (This configuration will be used for some the of measurements in Part 5.)

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Preset the instrument	[Preset]
Set the ESG-D/DP center frequency to 1.93125 GHz *This is channel #25 for ANSI J-STD-008.*	[Frequency] [1.93125] {GHz}
Set the ESG-D/DP amplitude to –10 dBm	[Amplitude] [+/–] [10] {dBm}
Set the ESG-D/DP to generate a cdmaOne pilot signal	[MODE] {Arb Waveform Generator} {CDMA}{Setup Select} {Pilot} {CDMA: On}; [RF: On]

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Preset instrument	[Preset]
Enable cdmaOne measurements *Return to this menu at any time by pressing [Mode].*	[MODE] {cdmaOne}
Setup the mode based on ANSI J-STD-008 standards	[Mode Setup] {Radio} {Band} {J-STD-008}
Set center frequency to 1.93125 GHz	[Frequency] [1.93125] {GHz}
Verify frequency reference is set to internal	[System] {Reference} {Freq Ref: Int}
Save the instrument state. If necessary, recall this state anytime during the cdmaOne demo.	[Save] [3] [Enter]

Measurement 1. Channel power

The limiting factor for cdmaOne system capacity is signal interference, so controlling the power in the system is essential to achieve maximum capacity. Agilent's E4406A VSA uses digital filtering techniques to automatically band-limit the power to 1.23 MHz. It also sets the analyzer to root-mean-square (rms) averaging with an appropriate flat-top window for maximum amplitude accuracy. With the unprecedented linearity over its dynamic range, the E4406A VSA can measure signals to –80 dBm with a measurement accuracy of ±1 dB.

In this section, measure channel power and vary the number of measurement averages.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure Channel Power (Figure 17)	[Measure] {Channel Power}
Adjust averaging	
1. Turn off the averaging (Figure 18)	[Meas Setup] {Avg Number} {Avg Number: Off}
2. Change the number of averages to 35 (Figure 19)	[35] [Enter]
Note: that we are in exponential averaging mode.	

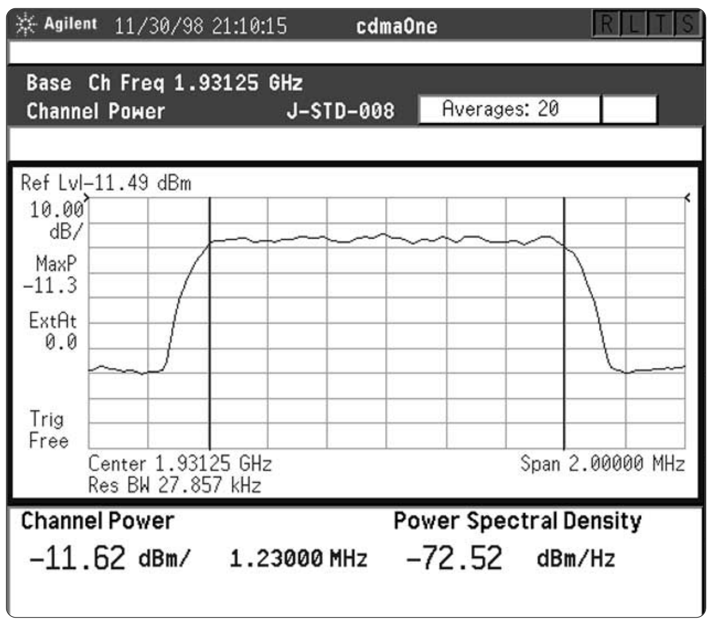


Figure 17. Channel power

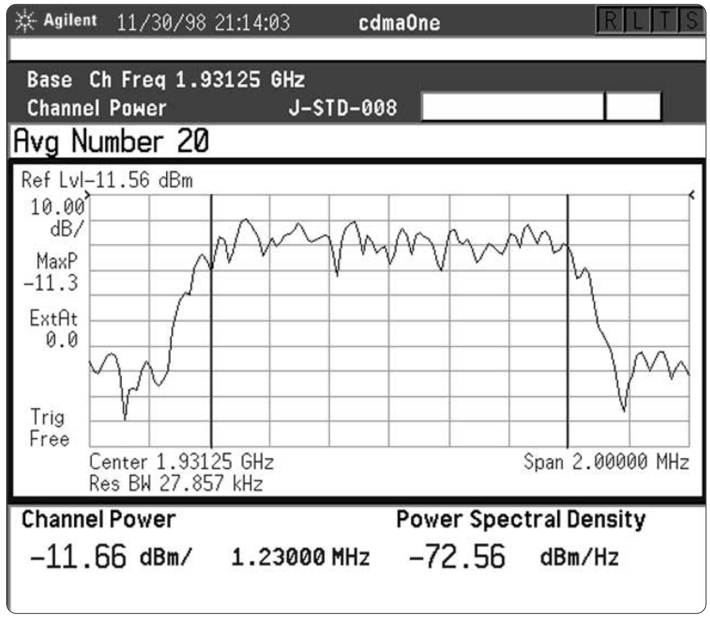


Figure 18. No averaging

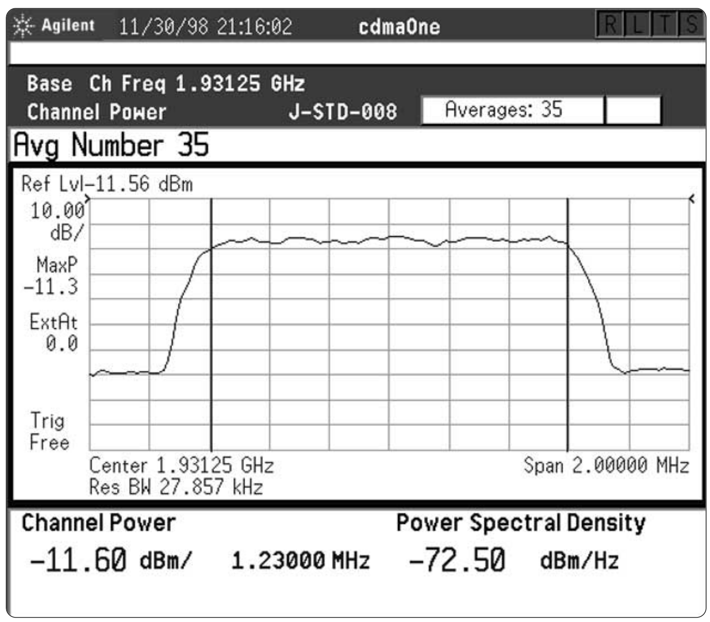


Figure 19. 35 averages

Measurement 2. Modulation accuracy (rho)

Modulation quality for cdmaOne is measured by rho. Rho is defined as the ratio of correlated power versus total power. If some of the transmitted energy does not correlate, this excess power will appear as added noise that may interfere with other users. Poor rho performance will affect each cell's capacity. Uncorrelated power appears as interference to the mobiles, causing the signal on the traffic channels to be raised to overcome the interference. At some point, the site will have to shed calls in order to supply the remaining calls with an adequate signal-to-interference ratio. The E4406A VSA measures rho according to IS-95 specifications, assuring standards compliance for manufacturers. The user can see vector, EVM, and constellation views of the rho measurement.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure modulation accuracy (Rho) (Figure 20)	[Measure] {Mod Accuracy (Rho)}
View (Figure 21) I/Q Error	[View/Trace] {I/Q Error (Quad-View)}
View Complementary Constellation (Figure 22)	{IQ Measured} {Compl Constln}

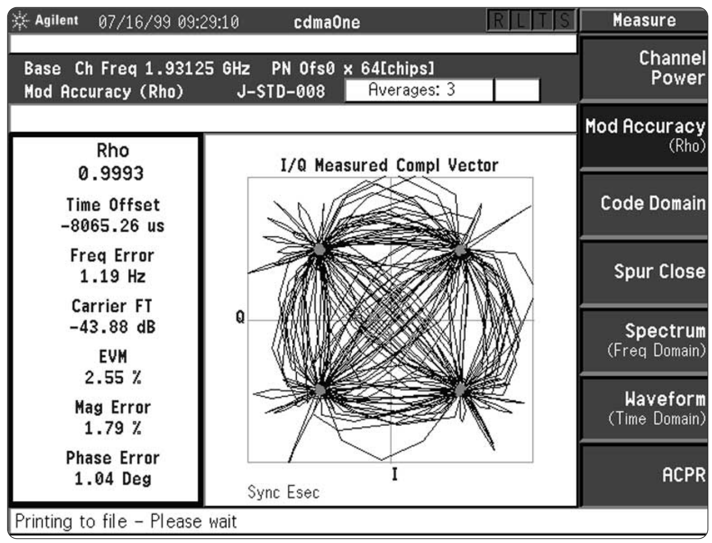


Figure 20. Modulation accuracy

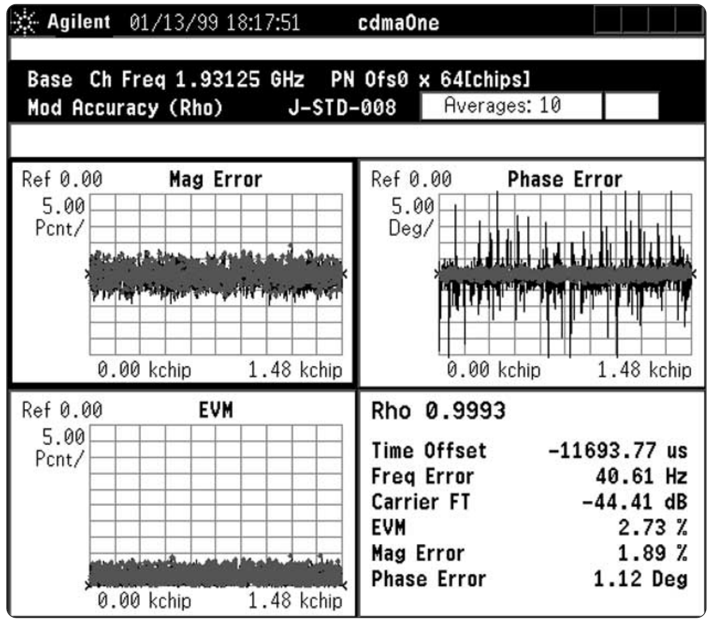


Figure 21. I/Q error (Quad-view)

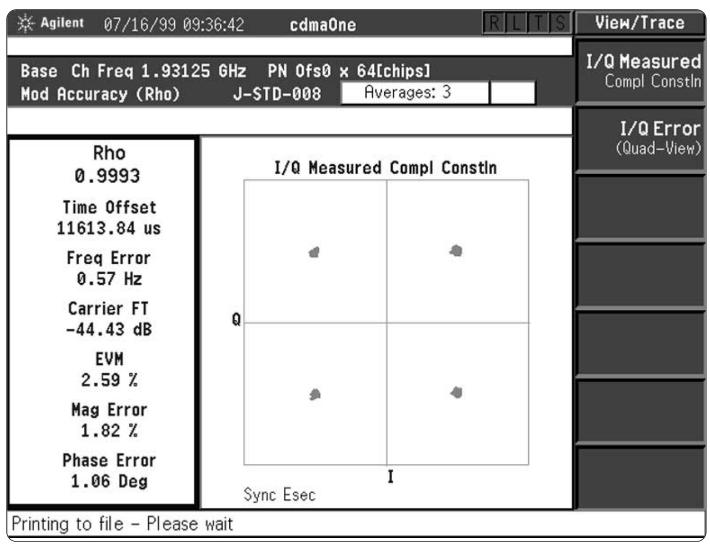


Figure 22. Complimentary constellation

Measurement 3. Code domain power

Walsh codes are the fundamental channelization mechanism for cdmaOne. Code domain power (CDP) measures the fraction of total power transmitted in each Walsh-coded channel. The contribution of each Walsh-coded channel is measured and displayed as a bar.

In this section, set the ESG-D/DP series RF signal generator to generate a 32-channel signal. Then, on the E4406A VSA, view the power, the phase error, and the timing error in each Walsh channel.

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Set the ESG-D/DP to generate a thirty-two channel	{Setup Select} {32 Ch Fwd}

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure CDP (Figure 23)	[Measure] {Code Domain}
View timing and phase errors for each Walsh code (Figure 24)	[Meas Setup] {Meas Method} {Timing Phase} {View/Trace} {Power Timing & Phase}
Zoom in on timing error, then phase error, then zoom Out	[Next Window] [Zoom] [Next Window] [Zoom]

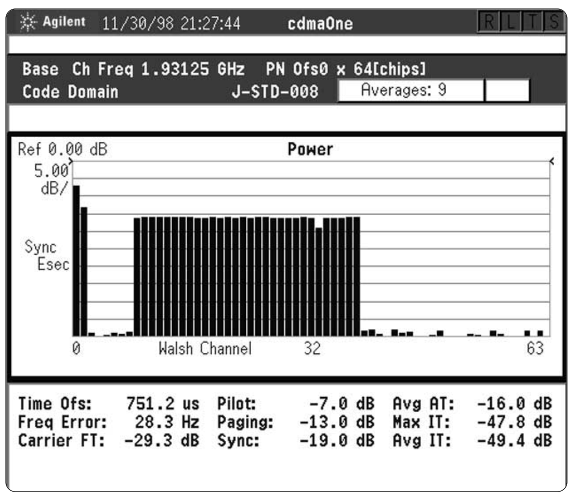


Figure 23. Code domain power

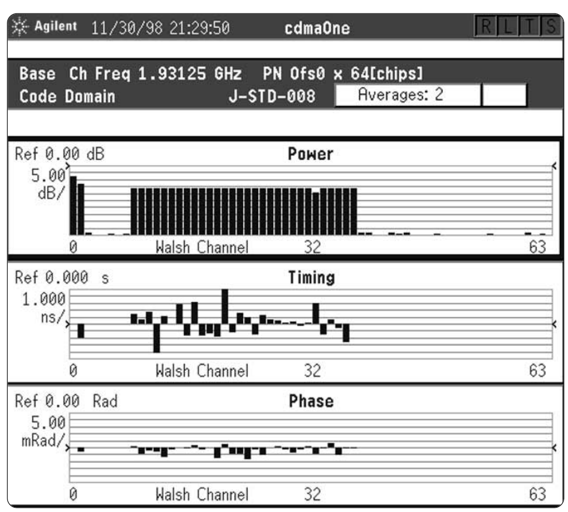


Figure 24. Timing and phase errors

Measurement 4. Adjacent channel power ratio

The adjacent channel power ratio (ACPR) is a speedy spot-check of the spurious close specification. ACPR is the ratio of adjacent channel power to the average in channel power. The measurement is performed at several frequency offsets. The E4406A VSA's default is based on industry standards, but the user can easily modify the setup.

In this section, measure ACPR and see both a spectrum view and a bar graph view of the measurement.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure ACPR (Figure 25)	[Measure] {ACPR}
View spectrum (Figure 26)	[View/Trace] {Spectrum Total Pwr Ref}

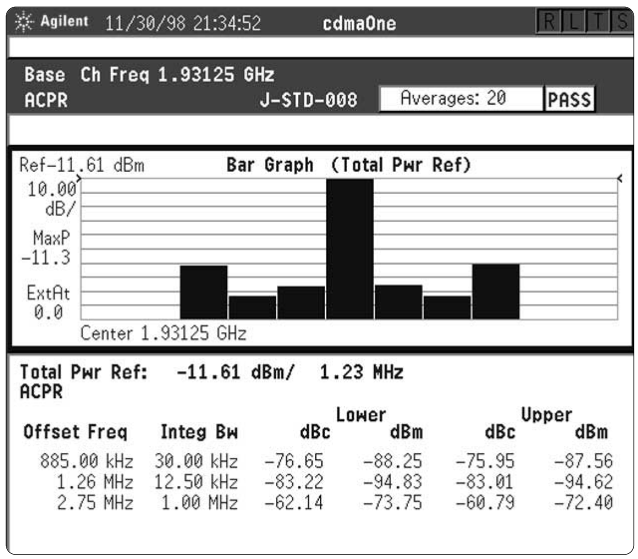


Figure 25. Adjacent channel power

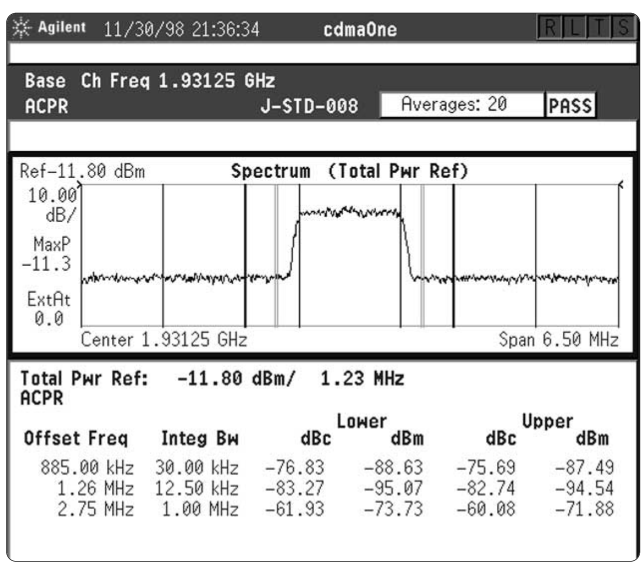


Figure 26. Spectrum view

Part 6. EDGE measurements

EDGE (Enhanced Data rates for GSM Evolution) is a new physical layer that enables higher bandwidth services than exist with GSM. GSM-based services like general packet radio service (GPRS) and high speed circuit switched data (HSCSD) will evolve into EPRS and ECSD, respectively, which are EDGE-enabled versions of their GSM predecessors. Most EDGE devices will also transmit and receive GSM signals. In general, most EDGE traffic will be in the downlink (base station to mobile) since most data will flow in that direction. Mobile units will likely transmit GSM on the uplink, and receive GSM for low data rate services (e.g. voice) or in poor signal environments.

In terms of symbol rate, data framing, and burst shape, EDGE is very similar to GSM, making it compatible with much of the RF hardware that exists today in GSM infrastructure. However, there are some differences, summarized below:

	GSM	EDGE
Symbol Rate	270.833 KHz	270.833 KHz
Bits per Symbol	1	3
Modulation Format	Minimum shift keying (MSK)	$3\pi/8$-rotating 8 phase shift keying (PSK)
Baseband Filter	Gaussian (BT = 0.3)	"linearized" Gaussian
Envelope	Constant Amplitude	Non-Constant Amplitude (Peak-to-average power ratio = 3.2 dB)

The new EDGE measurements are error vector magnitude (EVM), power versus time (PvT), and output RF spectrum (ORFS). The EDGE PvT and ORFS measurements are very similar to the GSM counterparts. However, EDGE EVM is a brand new measurement that was pioneered by Agilent Technologies. The E4406A utilizes an EDGE industry standard filter that provides highly accurate EVM measurements.

In this section, configure the Agilent ESG-D/DP for generating and making measurements of a framed EDGE signal at absolute radio frequency channel number (ARFCN) 1 for the uplink (890.2 MHz). Then, use the E4406A VSA to make key industry measurements with the touch of a button.

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Preset instrument	[Preset]
Set amplitude to -10 dBm	[Amplitude] [±] [10] {dBm}
Generate a framed EDGE signal and turn the RF carrier on	[MODE] {Real Time I/Q Baseband} {TDMA} {EDGE} {EDGE Off/On} {Data Format: Pattern/Framed} [RF On/Off]
Set the carrier frequency to ARFCN 1 for the uplink	{More (1 of 2)} {Freq Channels} {Freq Channels: Off/On} {Channel Number} [1] {Enter} {Channel Band} {More (1 of 2)} {P-GSM Mobile}

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Preset Instrument	[Preset]
Enable EDGE measurements	[MODE] {EDGE w/ GSM}
Set the VSA to the primary GSM (P-GSM) mode	[Mode Setup] {Radio} {Band} {P-GSM} {Device: BTS/MS}
Set the channel to ARFCN 1	[FREQUENCY] {ARFCN} [1] [Enter] [ESC]
Average 50 Readings	[Meas Setup] {Average} {Avg Number: On/Off} [50] [Enter]
Display averaged trace	[View/Trace] {Trace Display} {Average (or Max & Min)}
Fill display area with spectrum graph	[Zoom]
Restart and view the EDGE spectrum (Figure 27)	[Restart]

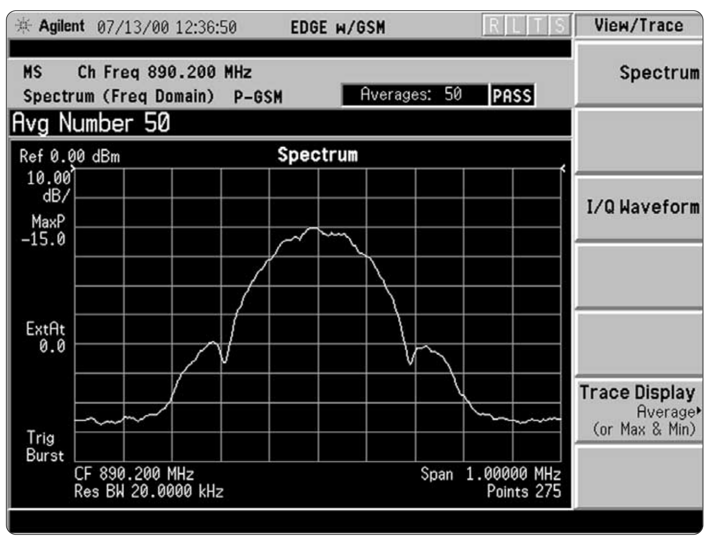


Figure 27. EDGE spectrum (ARFCN 1 uplink)

The EDGE spectrum is similar to the GSM spectrum. However, the nulls at the edges of the main lobe are deeper.

Measurement 1. Error vector magnitude

The EDGE EVM measurement measures the modulation quality or accuracy of an EDGE modulated signal. This measurement provides an I/Q constellation diagram with EVM in rms and peak. In addition, with EVM provides magnitude error versus chip, phase error versus chip, and EVM versus chip in a quad view display. The E4406A VSA uses an industry standard EDGE filter to provide highly accurate EVM measurements.

For GSM signals, the amplitude is constant; therefore, the phase error serves as a good measure of modulation accuracy. However, EDGE signals do not have constant amplitude, making EVM the only way to adequately quantify modulation accuracy.

Measure the EVM of an EDGE signal.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Zoom out the display to see all available measurement windows	[Zoom]
Measure EVM Look at the EDGE constellation diagram (Figure 28)	[Measure] {More 1 of 2} {EDGE EVM}
View the EVM verses chip in the quad view display	[View / Trace] {I/Q Error (Quad-View)}

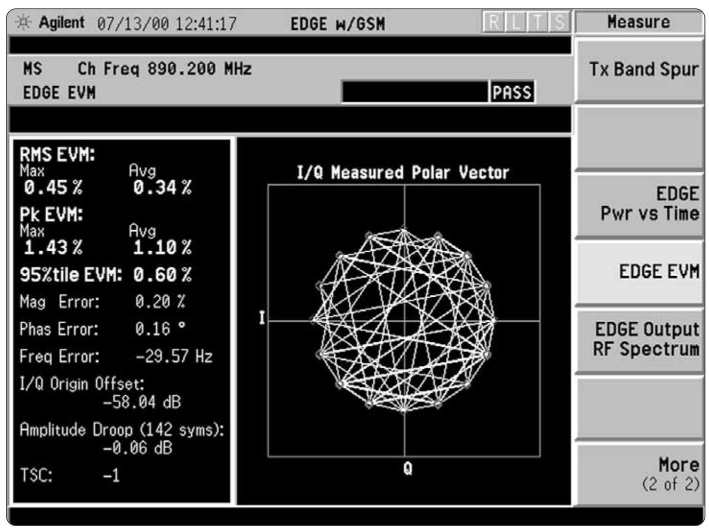


Figure 28. EDGE spectrum (ARFCN 1 uplink)

Measurement 2: Power versus time

EDGE is a time division multiple access (TDMA) multiplexing scheme with eight timeslots per frequency channel. An EDGE transmitter must burst power on and off during the span of a timeslot. If the burst does not occur at exactly the right time, or if the burst is irregular, then interference can occur in adjacent channels. Because of this, the industry standards specify a tight mask for the fit of the EDGE burst. Notice that the mask for an EDGE signal is wider than that for a GSM signal. This allows for amplitude variations of the 3π/8-rotating 8-PSK modulation.

Measure the power versus time (PvT) or power ramp of the EDGE signal.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure PvT (Figure 29)	[Measure] {More (1 of 2)} {EDGE PvT}

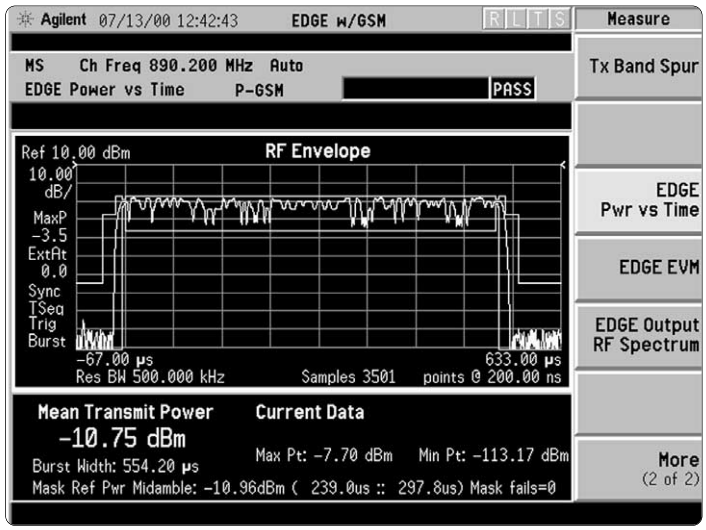


Figure 29. Power versus time

The mid-amble has a lower peak-to-average ratio than the data portions of the burst. This occurs because the mid-amble symbols were chosen to produce a phase trajectory similar to that of an MSK signal. The reasoning behind this is that an MSK receiver can decode the mid-amble of an 8-PSK EDGE burst.

Measurement 3. Output RF spectrum measurements

Output RF spectrum (ORFS) measurements involve testing for adjacent frequency channel interference from two effects: modulation within the burst and switching transients. The Agilent E4406A VSA uses a default table of test offsets to quickly make ORFS measurements. However, a single offset can be examined with a corresponding trace. Or, up to 15 offsets can be measured with a tabular data display.

Measure the ORFS due to modulation. Notice how quickly you can make the output RF spectrum measurement due to modulation.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure the ORFS due to modulation (Figure 30)	[Measure] {More 1 of 2} {ORFS}

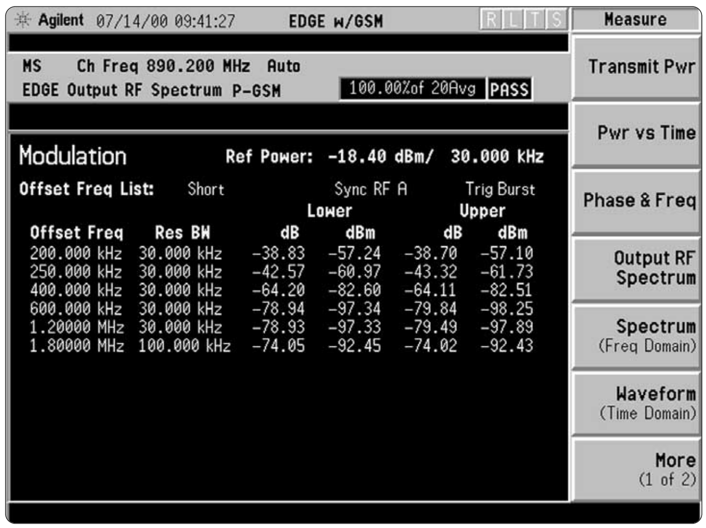


Figure 30. Output RF spectrum (modulation only)

Now, try measuring the ORFS due to modulation and switching the transients in the burst. Notice that the measurement for modulation and switching transients together requires much more time.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure the Output RF spectrum due to modulation and switching trancients in the burst	[Meas Setup] {Meas Type} {Mod & Switch}

Part 7. GSM measurements

The E4406A VSA GSM measurement personality lets you quickly and efficiently perform GSM measurements.

In this section, configure the ESG-D/DP series RF signal generator to generate a GSM900 signal at 935.2 MHz. (This configuration will be used for all of the measurements in Part 7.) Then make several key industry measurements, with one-button tests, on the E4406A VSA.

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Preset the instrument	[Preset]
Set the ESG-D/DP center frequency to 935.2 MHz This is channel #1 for GSM900	[Frequency] [935.2] {MHz}
Set the ESG-D/DP amplitude to 0 dBm	[Amplitude] [0] {dBm}
Set the ESG-D/DP to generate a framed GSM signal	[MODE] {Real-Time I/Q Baseband} {TDMA} {GSM} {GSM: On} {Data Format: Framed} [RF: On]

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Preset instrument	[Preset]
Enable GSM measurements *Return to this menu at any time by pressing [Mode].*	[MODE] {GSM}
Verify instrument setup for GSM 900 band	[Mode Setup] {Radio} {Band} {P-GSM}
Set center frequency to 935.2 MHz	[Frequency] {ARFCN} [1] [ENTER]
Verify frequency reference is set to internal	[System] {Reference} {Freq Ref: Int}
Save the instrument state. If necessary, recall this state anytime during the GSM demo.	[Save] [2] [Enter]

Measurement 1. Mean transmitter carrier power

Carrier power is the measure of in-channel power for GSM systems. Mobiles and base stations must transmit enough power, with sufficient modulation accuracy, to maintain a call of acceptable quality without the power leaking into other frequency channels or timeslots. GSM systems use dynamic power control to ensure that each link is maintained with minimum power. This gives two fundamental benefits: overall system interference is kept to a minimum and, in the case of mobile stations, battery life is maximized.

In this section, measure the mean transmitter carrier power and view the signal with the high dynamic range of the E4406A VSA.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure Transmitter Power (Figure 31)	[Measure] {Transmit Pwr}
Move the Threshold level to –40 dB *Notice the Threshold level drop relative to signal (Figure 32).*	[Meas Setup] {Threshold Lvl} [+/–] [40] {dB}

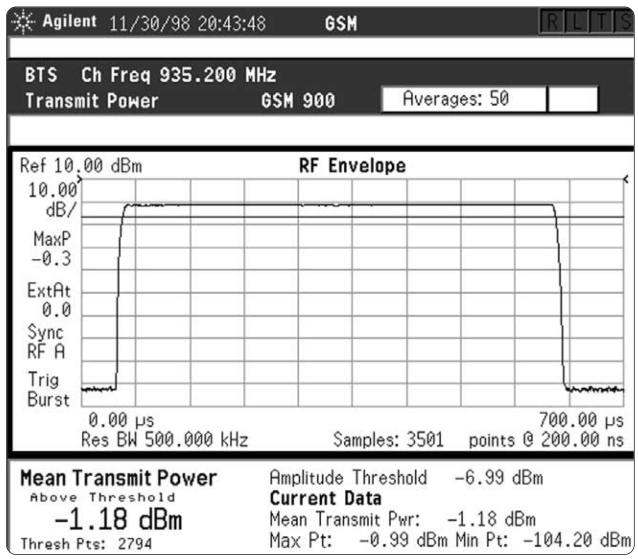


Figure 31. Transmitter power

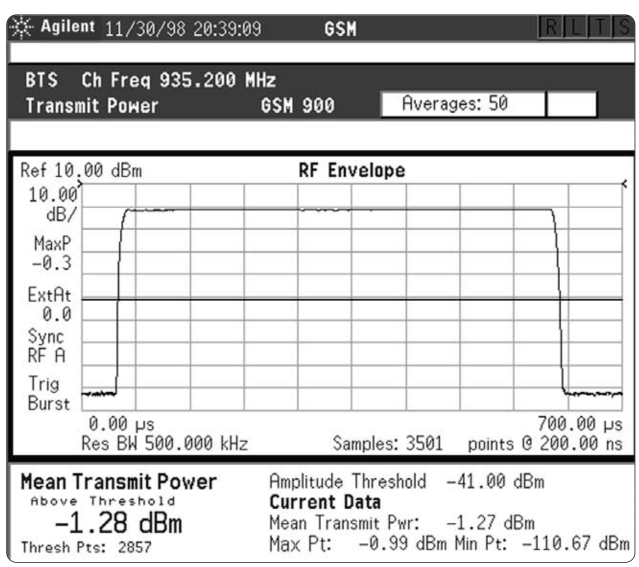


Figure 32. The threshold level drops

Measurement 2. Power versus time

GSM is a time division multiple access (TDMA) multiplexing scheme with eight time slots, or bursts, per frequency channel. If the burst does not occur at exactly the right time, or if the burst is irregular, then adjacent channels can experience interference. Because of this, the industry standards specify a tight mask for the fit of the TDMA burst. For easy pass/fail testing the E4406A VSA displays the burst for a given time slot on the screen under the mask specified by GSM 05.05 standards.

In this section, measure the power versus time for the GSM signal, then view only the rising and falling portions of the burst.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure power versus time (Figure 33)	[Measure] {Pwr vs Time}
View the rising and falling portions of the burst (Figure 34)	[View/Trace] {Rise & Fall}
Zoom in rising edge	[Zoom]
Zoom in falling edge	[Next Window]
Return to full screen	[Zoom]

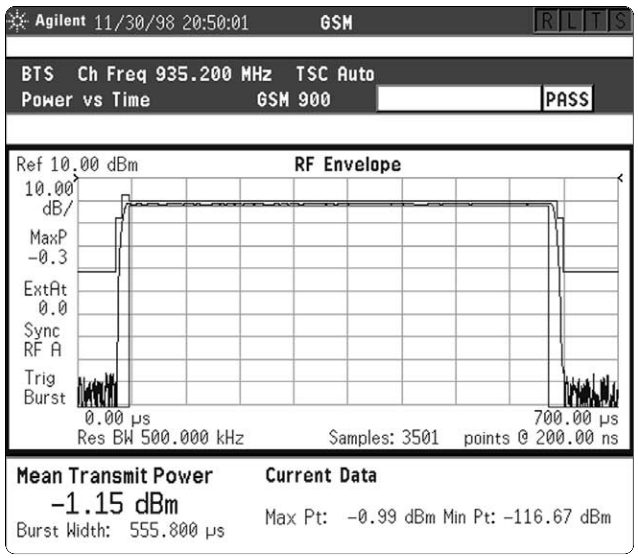


Figure 33. Power versus time

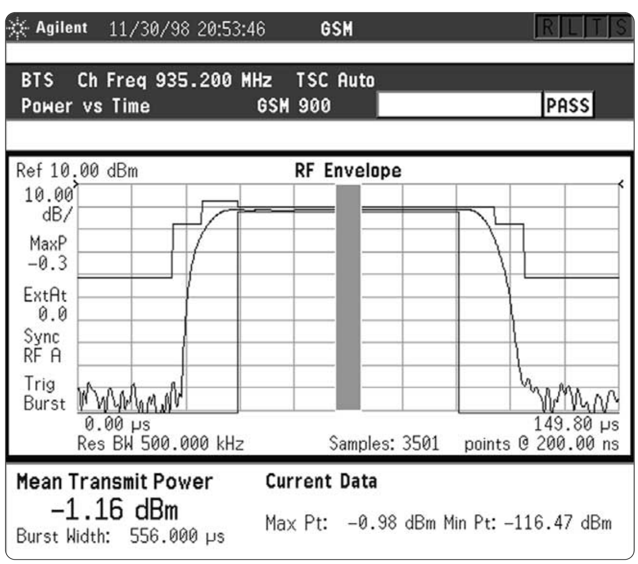


Figure 34. Rising and falling portions

Measurement 3. Phase and frequency error

Phase and frequency error are the measures of modulation quality for GSM systems. Since GSM systems use relative phase to transmit information, phase and frequency accuracy is critical to the system's performance and ultimately affects range. Demodulation and signal analysis required by industry standards is complicated by the challenges of triggering and synchronizing to the actual GSM signal. The Agilent E4406A VSA has multiple triggers and synchronization options.

In this section, a one-button measurement captures the phase and frequency error information.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure phase and frequency (Figure 35)	[Measure] {Phase & Freq}
View the polar vector (Figure 36)	[View/Trace] {IQ Measured Polar Vector}
View data bits (Figure 37) Notice training sequence bits.	{Data Bits}

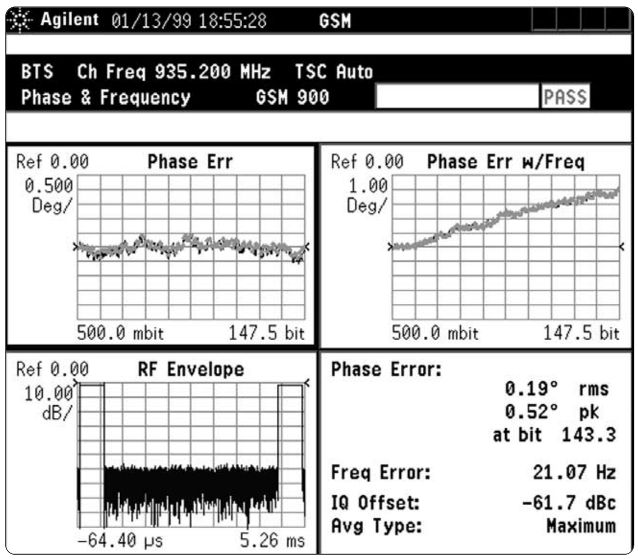


Figure 35. Phase and frequency

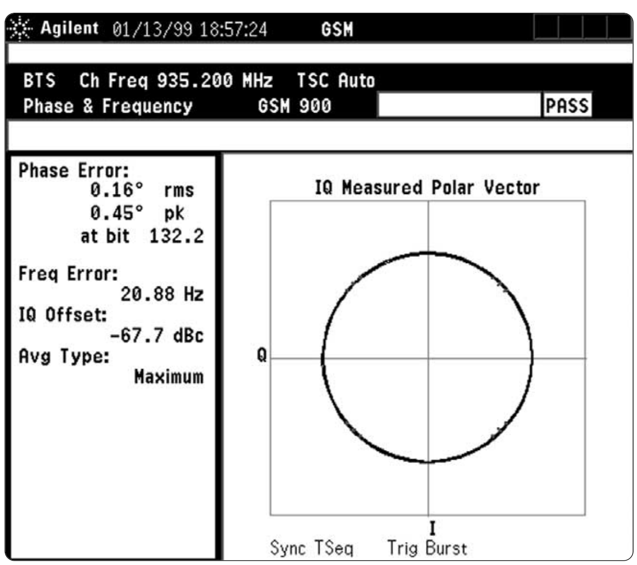


Figure 36. Polar vector

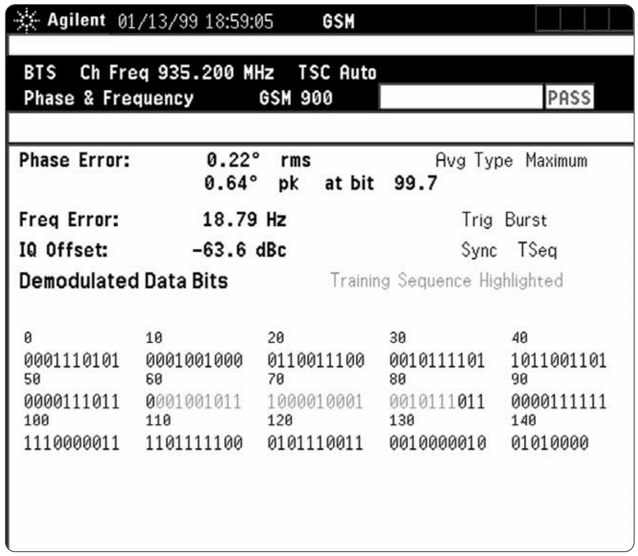


Figure 37. Data bits

Measurement 4. Output RF spectrum

Output RF spectrum (ORFS) requires over 80 dBc of dynamic range for offsets of 6 MHz or higher, this is not a challenge for the E4406A VSA. ORFS results from two effects: modulation, and switching transients.

In this section, measure the ORFS due to modulation and transients, then further increase the speed of the measurement by measuring modulation alone.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure ORFS	[Measure] {Output RF Spectrum}
Enable measurement for both modulation and modulation due to switching simultaneously (Figure 38)	[Meas Setup] {Meas Type} {Mod & Switch}
View modulation due to switching without remeasuring	[Meas Control] {Pause} [View/Trace] {Switching Numeric}

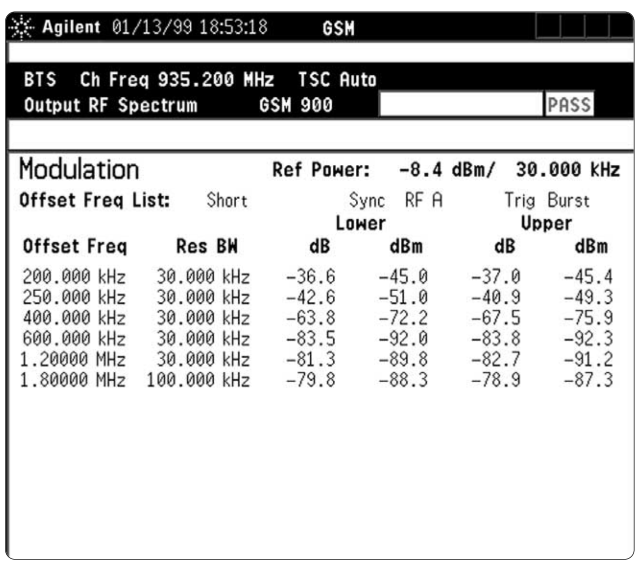


Figure 38. Output RF spectrum

Part 8. NADC measurements

The E4406A VSA's North American Digital Cellular (NADC) measurement personality allows the user to quickly verify adjacent channel power and error vector magnitude to the TDMA IS-136 standard.

First we will configure the ESG-D/DP series RF signal generator and the E4406A VSA for NADC. This configuration will be used for all of the measurements in Part 8.

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Preset the instrument	[Preset]
Set the ESG-D/DP center frequency to 870.030 MHz	[Frequency] [870.03] {MHz}
Set the ESG-D/DP amplitude to 0 dBm	[Amplitude] [0] {dBm}
Set the ESG-D/DP to generate a NADC signal	[MODE] {Real-Time I/Q Baseband} {TDMA} {NADC} {NADC: On} [RF: On]

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Preset instrument	[Preset]
Enable NADC measurements	[MODE] {NADC}
Verify mode setup for full traffic basestation test	[Mode Setup] {Radio} {Traffic Rate} {Full} {Device} {BS}
Set center frequency to 870.030 MHz *This is channel #1 for NADC 800 MHz system*	[FREQUENCY] [870.03] {MHz}

Measurement 1. Adjacent channel power

Adjacent channel power (ACP) is the ratio of in-channel power to out-of-channel power. The IS-136 standard specifies frequency offsets of 30, 60, and 90 kHz. The E4406A VSA defaults to these frequency offsets, but can be easily configured to test other frequency offsets. As dictated by the standard, the measurement is made with a root raised cosine filter applied.

In this section, measure ACP using the bar graph and spectrum views of the measurement.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure ACP (Figure 39)	[MEASURE] {ACP}
View spectrum (Figure 40)	[View/Trace] {Spectrum}
Add additional frequency offset (Figure 41)	[Meas Setup] {More 1 of 2} {Ofs & Limits} {Offset} {D} {Offset Freq 120 kHz} {On}

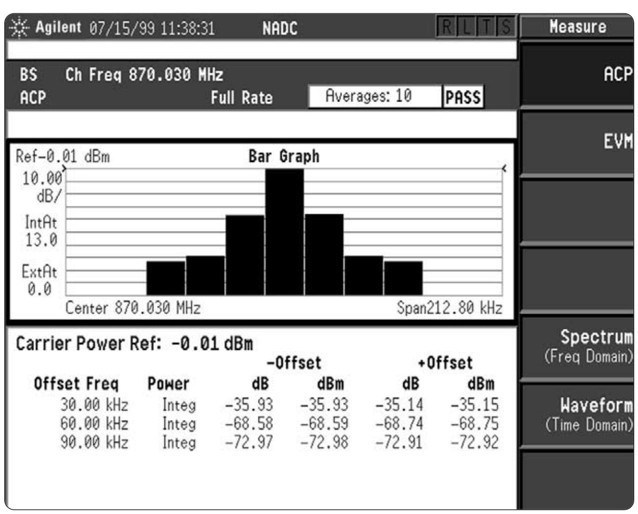


Figure 39. Adjacent channel power (bar graph)

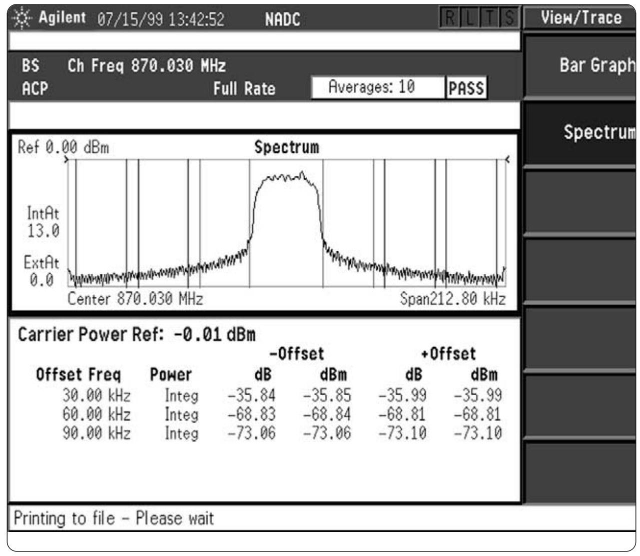


Figure 40. Adjacent channel power (spectrum view)

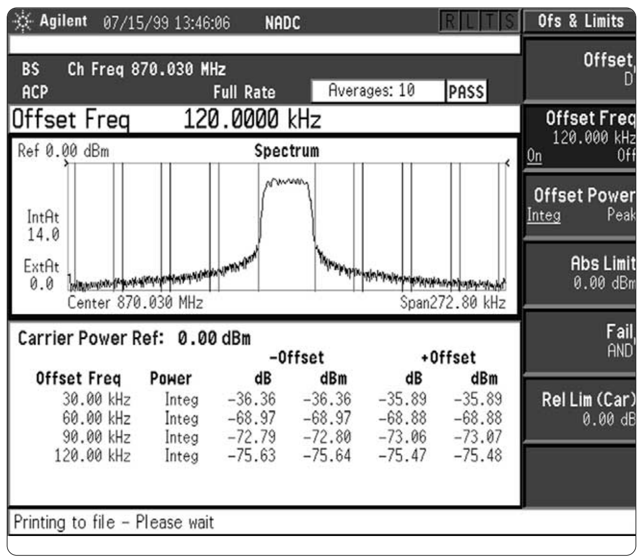


Figure 41. Additional frequency offset added

Measurement 2. Error vector magnitude

Error vector magnitude (EVM) is the measure of modulation quality for The main difference is the π/4 DQPSK data pattern transmitted is referenced to the previous phase state, so no phase reference is required. In a phase modulation system the phase and frequency accuracy of the transmitter is critical to the system's performance.

In this section, a one-button measurement captures EVM, phase error, magnitude error, and I/Q views.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure polar vector (Figure 42)	[MEASURE] {EVM}
View the polar constellation (Figure 43)	[View/Trace] {Polar Constellation}
View the EVM, phase error and mag error (Figure 44)	{I/Q Error}

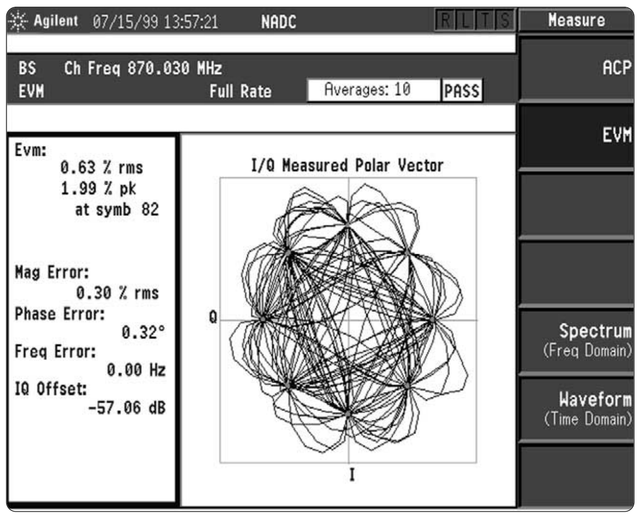


Figure 42. Polar vector

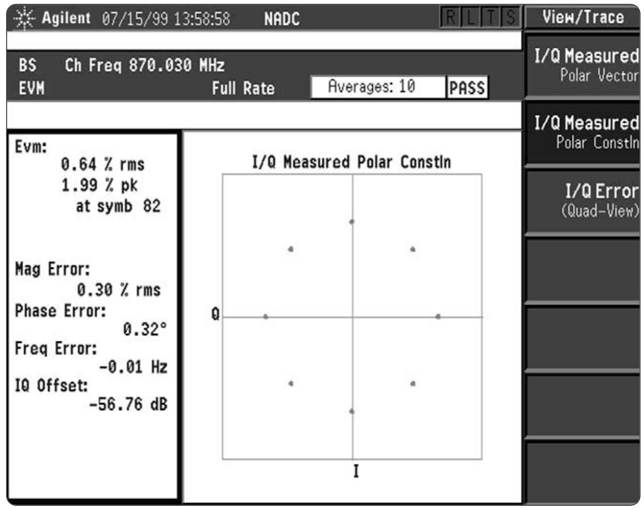


Figure 43 . Polar constellation

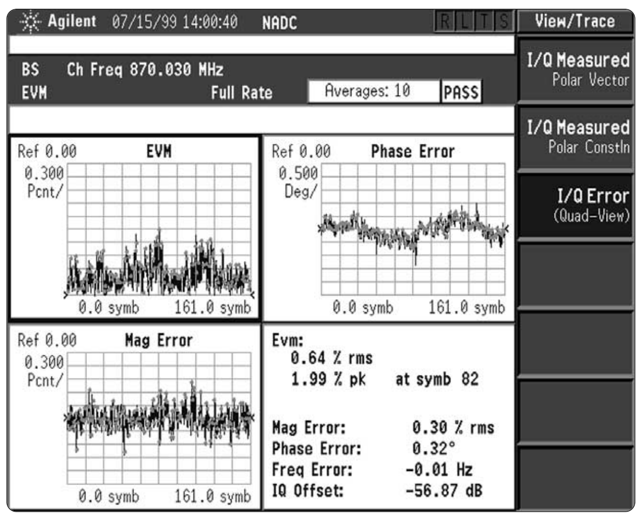


Figure 44 . EVM, phase error and mag error

Part 9. PDC measurements

The Agilent E4406A VSA's Personal Digital Cellular (PDC) measurement personality allows the user to quickly verify adjacent channel power, error vector magnitude, and occupied bandwidth.

First we will configure the ESG-D/DP series RF signal generator and the E4406A VSA for PDC. This configuration will be used for all of the measurements in Part 9.

Instructions: ESG-D/DP series signal generator	Keystrokes: ESG-D/DP series signal generator
Preset the instrument	[Preset]
Set the ESG-D/DP center frequency to 810 MHz	[Frequency] [810] {MHz}
Set the ESG-D/DP amplitude to 0 dBm	[Amplitude] [0] {dBm}
Set the ESG-D/DP to generate a PDC signal	[MODE] {Real-Time I/Q Baseband} {TDMA} {PDC} {PDC: On} [RF: On]

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Preset instrument	[Preset]
Enable PDC measurements	[MODE] {PDC}
Verify mode setup for full traffic basestation measurement	[Mode Setup] {Radio} {Traffic Rate} {Full} {Device} {BS}
Set center frequency to 810 MHz *This is frequency code #0 for PDC 800 MHz system*	[FREQUENCY] [810] {MHz}

Measurement 1. Adjacent channel power

Adjacent channel power (ACP) is the ratio of in-channel power to out-of-channel power. The PDC standard dictates that ACP is measured at 50 and 100 kHz offsets. The E4406A VSA defaults to these frequency offsets but can be easily configured to test additional frequencies.

In this section, measure ACP using bar graph and spectrum views.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure ACP (Figure 45)	[Measure] {ACP}
View spectrum (Figure 46) Notice the instrument is optimized for dynamic range in the specific channel under test	[View/Trace] {Spectrum}

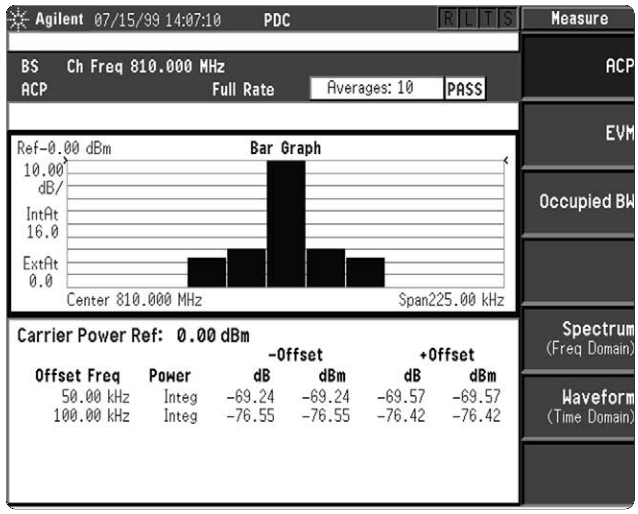


Figure 45 . Adjacent channel power (bar graph)

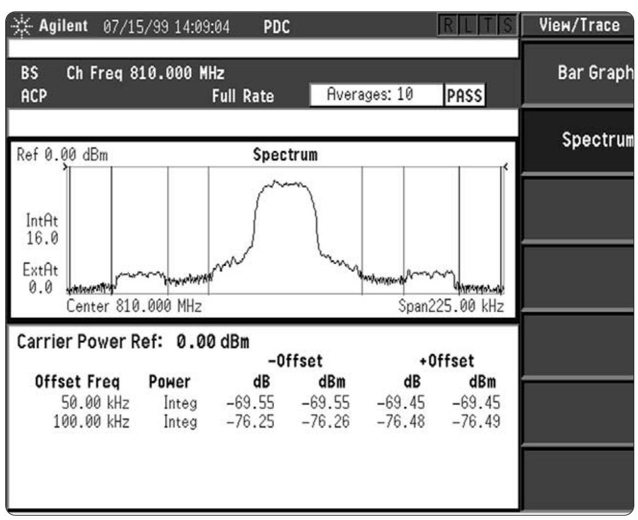


Figure 46. Adjacent channel power (spectrum view)

Measurement 2. Error vector magnitude

The error vector magnitude (EVM) measurement for PDC is similar to the EVM measurement for NADC. Both systems use π/4 DQPSK modulation. The E4406A VSA offers one-button measurements of EVM, phase error, magnitude error, and I/Q feed through. See the NADC section of this self-guided demo for details.

Measurement 3. Occupied bandwidth

Occupied bandwidth (OBW) is the bandwidth that contains 99 percent of the total carrier power. In Figure 47, you'll see two vertical line markers. Of the total power, 0.5 percent is below the lower frequency limit and 0.5 percent is above the upper frequency limit. The PDC standard limits the occupied bandwidth to 32 kHz. The user can modify this limit.

In this section, measure occupied bandwidth and adjust the measurement limits.

Instructions: E4406A VSA	Keystrokes: E4406A VSA
Measure occupied bandwidth (Figure 47)	[Measure] {Occupied BW}
Modify occupied bandwidth limit	[Meas Setup] {More 1 of 2}{Limit} [20] {kHz}

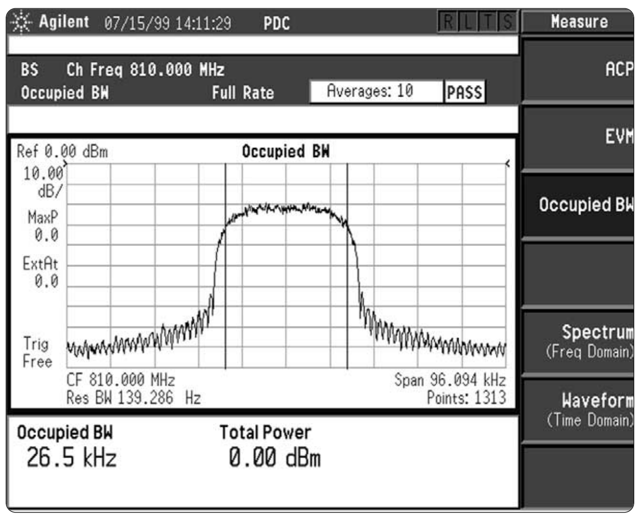


Figure 47. Occupied bandwidth

Agilent Technologies' Test and Measurement Support, Services, and Assistance
Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlay Agilent's overall support policy: "Our Promise" and "Your Advantage."

Our Promise
Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

Your Advantage
Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contacting us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

For more assistance with your test and measurement needs go to

www.agilent.com/find/assist

Or contact the test and measurement experts at Agilent Technologies
(During normal business hours)

United States:
(tel) 1 800 452 4844

Canada:
(tel) 1 877 894 4414
(fax) (905) 206 4120

Europe:
(tel) (31 20) 547 2000

Japan:
(tel) (81) 426 56 7832
(fax) (81) 426 56 7840

Latin America:
(tel) (305) 267 4245
(fax) (305) 267 4286

Australia:
(tel) 1 800 629 485
(fax) (61 3) 9272 0749

New Zealand:
(tel) 0 800 738 378
(fax) 64 4 495 8950

Asia Pacific:
(tel) (852) 3197 7777
(fax) (852) 2506 9284

Product specifications and descriptions in this document subject to change without notice.

Printed in USA 08/2000
5968-7617E

Agilent Technologies
Innovating the HP Way