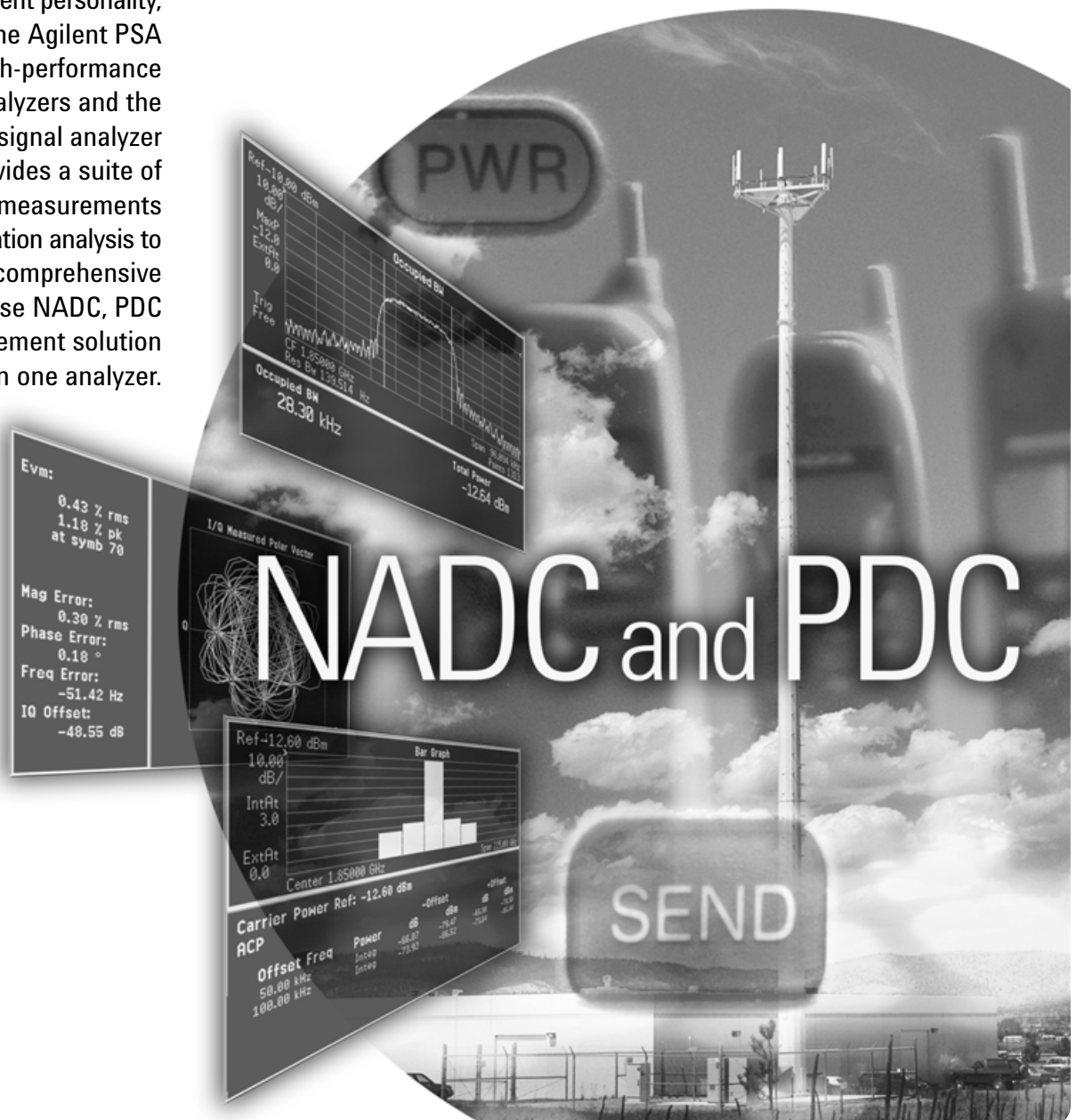


Agilent PSA Series Spectrum Analyzers E4406A Vector Signal Analyzer NADC, PDC Measurement Personality

Technical Overview with Self-Guided Demonstration
Option BAE

The NADC, PDC measurement personality, available on the Agilent PSA Series high-performance spectrum analyzers and the E4406A vector signal analyzer (VSA), provides a suite of standard-based measurements with digital modulation analysis to provide the most comprehensive and easy-to-use NADC, PDC measurement solution in one analyzer.



NADC and PDC

Use the NADC, PDC Personality to Evaluate TDMA Signals Throughout the Design and Manufacturing Process

The Agilent PSA Series offers high-performance spectrum analysis up to 50 GHz with powerful one-button measurements, a versatile feature set, and a leading-edge combination of flexibility, speed, accuracy, and dynamic range. Expand the PSA to include NADC and PDC digital signal analysis capability with the NADC, PDC measurement personality (option BAE).

For many manufacturing needs, the E4406A VSA, a vector signal analyzer, is an affordable platform that also offers the NADC, PDC personality.

The NADC, PDC measurement personality provides key transmitter measurement for analyzing systems based on the following standards:

- NADC (North American dual-mode cellular):
ANS TIA/EIA IS-136 (Oct '96)
ANS TIA/EIA IS-137/138 (Jul '96)
ANS TIA/EIA-627/628/629 (Jun '96)
- PDC (personal digital cellular):
ARIB RCR STD-27E (Sep '96)

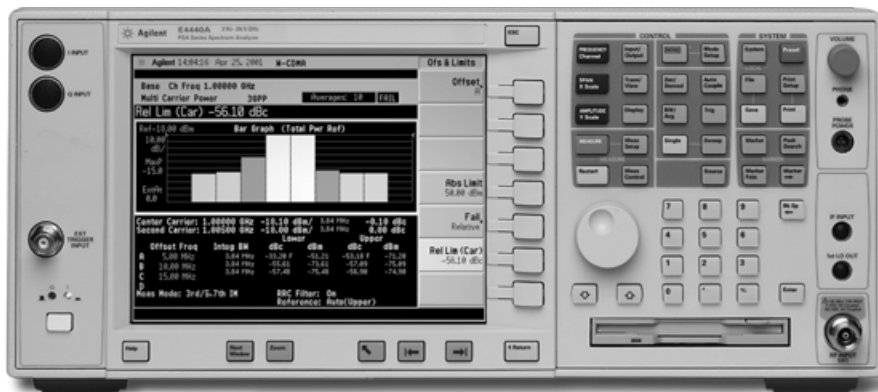
Measurement may be performed on the forward and reverse link signals.

This technical overview includes

- measurement details
- demonstrations
- PSA Series key specifications for NADC and PDC measurements
- ordering information
- related literature

All demonstrations utilize the PSA Series and the E4438C ESG vector signal generator; however, they can also be performed with the E4406A VSA. Keystrokes surrounded by [] indicate hard keys located on the front panel, while key names surrounded by { } indicate soft keys located on the right edge of the display.

Demonstration preparation page 4



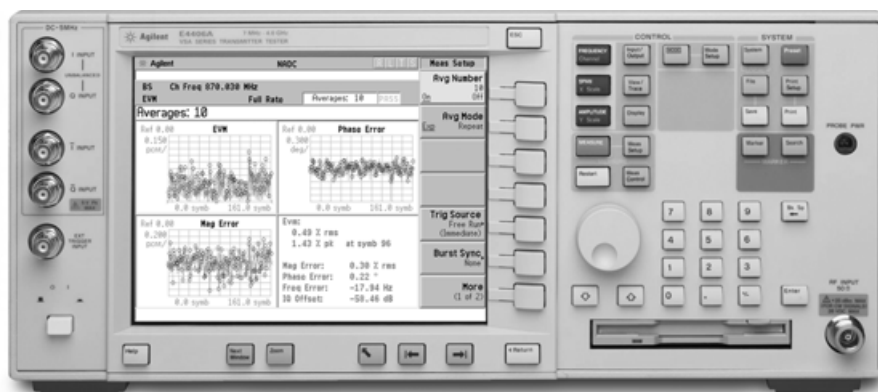
Error vector magnitude (EVM) page 5

NADC measurements page 4

PSA Series spectrum analyzer

PDC measurements page 7

Adjacent channel power (ACP) page 5



Occupied bandwidth page 8

E4406A vector signal analyzer

Demonstration preparation

To perform the demonstrations, the ESG and the PSA Series require the following options.

Product type	Model number	Required options
ESG vector signal generator	E4438C	001 or 002 – baseband generator 402 – TDMA personalities
PSA Series spectrum analyzer	E4440A/E4443A/E4445A/ E4446A/E4448A	B7J – Digital demodulation hardware BAE – NADC, PDC measurement personality

To configure the instruments, connect the ESG's 50 Ω RF output to the PSA's 50 Ω RF input with a 50 Ω RF cable. Turn on the power in both instruments.

Instructions	Keystrokes
On the ESG:	
Set the center frequency to 870.03 MHz and the amplitude to -10 dBm.	[Preset] [Frequency] [870.03] {MHz} [Amplitude] [-10] {dBm}
Set the ESG to generate a NADC signal.	[Mode] {Real Time TDMA} {NADC} {NADC <u>On</u> } [RF <u>On</u>]

NADC measurements

NADC uses time division multiple access (TDMA) with $\pi/4$ -DQPSK modulation. Adjacent channel power (ACP) and error vector magnitude (EVM) are two essential measurements for NADC transmission characterization. In this section, you will explore these measurements on the PSA Series.

On the PSA:	
Perform factory preset.	[System] {Power <u>On</u> /Preset} {Preset Type} {Factory}
Enter the NADC mode. If {NADC} does not appear in the Mode menu, try the {More} key.	[Preset] [Mode] {NADC}
Verify mode setup for full traffic base station test.	[Mode Setup] {Radio} {Traffic Rate <u>Full</u> } {Device <u>BS</u> }
Set the center frequency to 870.03 MHz (this is channel #1 for NADC 800 MHz system).	[FREQUENCY] [870.03] {MHz}

Adjacent channel power (ACP) – NADC or PDC

This measurement quickly calculates the ACP for an NADC or PDC signal. It incorporates a standard-based setup, and gives results in tabular and graphical formats.

The following ACP measurement parameters can be configured:

- number of averages and type of average
- trigger mode – free run, RF burst, external, or frame
- offsets to measure
- offset frequencies
- control of each offset's limits

The PSA Series defaults to frequency offsets of 30, 60, and 90 kHz, but they can be easily customized.

Instructions

On the PSA:

Activate the ACP measurement.

Keystrokes

[MEASURE] {ACP}

Set the first offset to fail at -40 dB below the carrier (Figure 1).

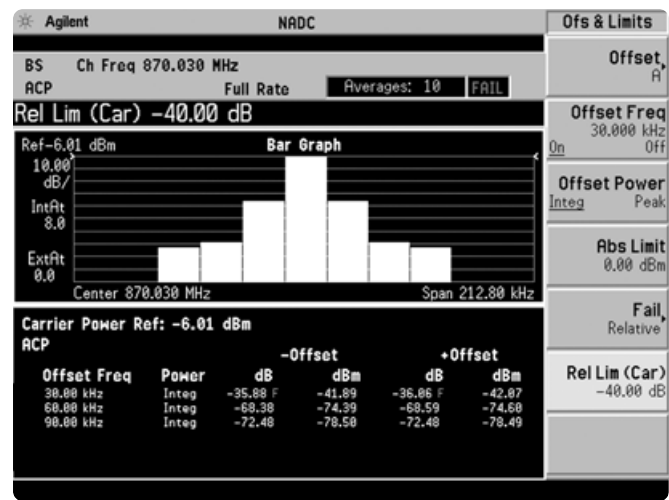
[Meas Setup] {More} {Ofs & Limits}
 {Rel Lim (Car)} [-40] {dB}

Observe the PASS indicator change to FAIL in the upper right corner and notice the fail indicators appear in the table.

View the results in spectrum format.

[Trace/View] {Spectrum}

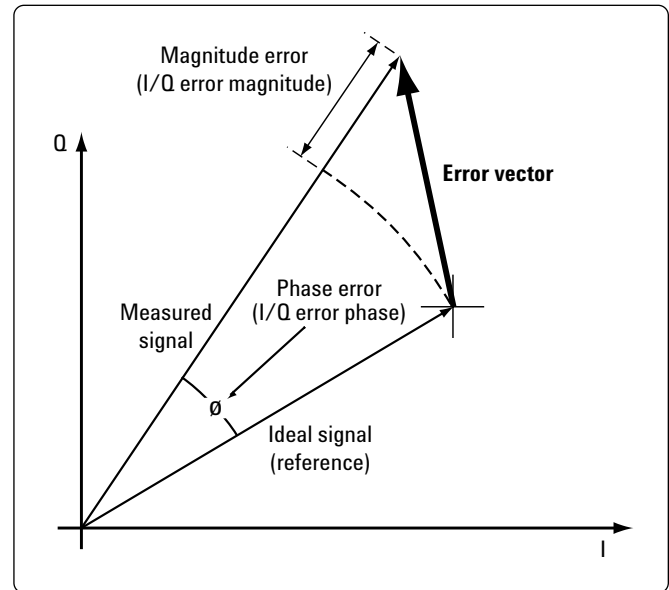
Figure 1.
ACP measurement



Error vector magnitude (EVM) – NADC or PDC

Figure 2 defines the error vector, a measure of the amplitude and phase differences between the ideal modulated signal and the actual modulated signal. The root mean square (rms) of the error vector is computed and expressed as a percentage of the square root of the mean power of the ideal signal. This is the error vector magnitude. EVM is a common modulation quality metric widely used in digital communications.

Figure 2.
The error vector



EVM can help diagnose problems in modulators, amplifiers and other radio subsystems. Visual constellation displays help guide you to where the errors are occurring and tabular data gives precise measurements of peak and rms EVM. Custom limit settings speed your production rate and help you identify problematic parts.

Set up the EVM measurement via the following parameters:

- number and type of averages
- trigger mode - free run, RF burst, external, or frame
- burst synchronization – none, RF amplitude, or synchronization word
- custom limit levels for rms EVM percentage, peak EVM percentage, and origin offset (dB)
- custom limit for first 10 symbol EVM in mobile station testing

The PSA Series' EVM measurement for NADC also provides a constellation diagram and plots for magnitude and phase errors.

Instructions

Keystrokes

On the PSA:

Make the EVM measurement.	[MEASURE] {EVM}
View the limits menu (Figure 3).	[Meas Setup] {More} {Limits}
Examine the error plots.	[Trace/View] {I/Q Error}
Run a single measurement and use the marker to find the highest phase error value in this data capture.	[Single] {Marker} {Trace} {Phase Error} {Peak Search}
Zoom in on the phase error plot (Figure 4).	[Next Window] until phase error plot is highlighted in green [Zoom]

Figure 3.
Constellation diagram and EVM data

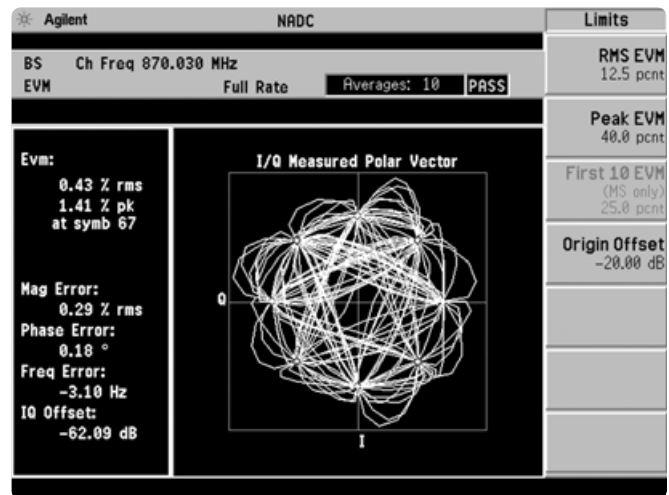
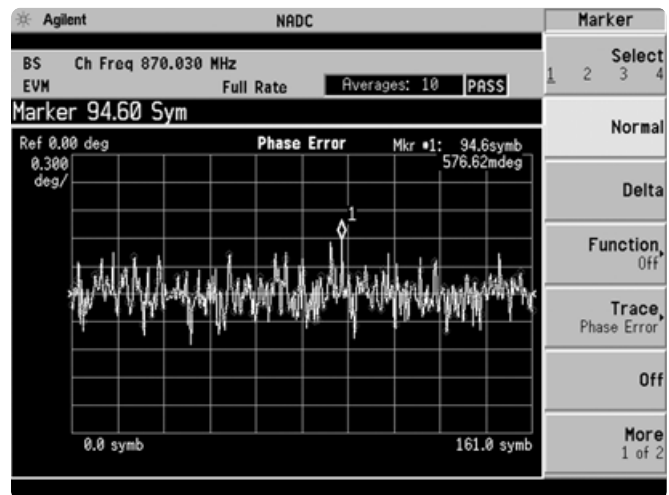


Figure 4.
Phase error plot with marker



PDC measurements

PDC is very similar to NADC in that it uses TDMA with $\pi/4$ -DQPSK modulation. However, there are some differences, which are listed in Table 1.

The PSA offers the ACP and EVM measurements for PDC and includes the occupied bandwidth measurement. Since the ACP and EVM measurements are very similar to those for NADC, they will not be explored in this exercise. However, the occupied bandwidth measurement will be performed.

Table 1. Overview of NADC and PDC systems

	NADC	PDC
Access scheme	TDMA	TDMA
Modulation	$\pi/4$ -DQPSK	$\pi/4$ -DQPSK
Channel spacing	30 kHz	50 kHz (25 kHz interleaving)
Channels/carrier	3 (full rate), 6 (half rate)	3 (full rate), 6 (half rate)
Modulation data rate	48.6 kbps (2 bits/symbol)	42 kbps (2 bits/symbol)
Data rate	13 kbps (full), 6.5 kbps (half)	11.2 kbps (full), 5.6 kbps (half)
Filter	SQRT raised cosine ($\alpha = 0.35$)	SQRT raised cosine ($\alpha = 0.35$)

Instructions	Keystrokes
On the ESG:	
Set the center frequency to 810 MHz and the amplitude to -10 dBm.	[Preset] [Frequency] [810] {MHz} [Amplitude] [-10] {dBm}
Set the ESG to generate a PDC signal.	[Mode] {Real Time TDMA} {PDC} {PDC On} [RF On]
On the PSA:	
Enter the PDC mode. If {PDC} does not appear under the Mode menu, try the {More} key.	[Preset] [Mode] {PDC}
Verify mode setup for full traffic base station test.	[Mode Setup] {Radio} {Traffic Rate Full} {Device BS}
Set the center frequency to 810 MHz (this is code #0 for PDC 800 MHz system).	[FREQUENCY] [810] {MHz}

Occupied bandwidth (OBW) – PDC only

Occupied bandwidth measurements show the width of the transmitted signal. This measurement verifies that the transmitter is well-controlled and not spilling excess energy into adjacent channels, as well as verifying good spectral control over varying power levels.

Set up OBW measurement via the following parameters:

- number and type of averages
- trigger mode - free run, RF burst, external, or frame
- custom limit setting for BW

In this exercise, you will make the occupied bandwidth measurement and change the limit to make the signal fail.

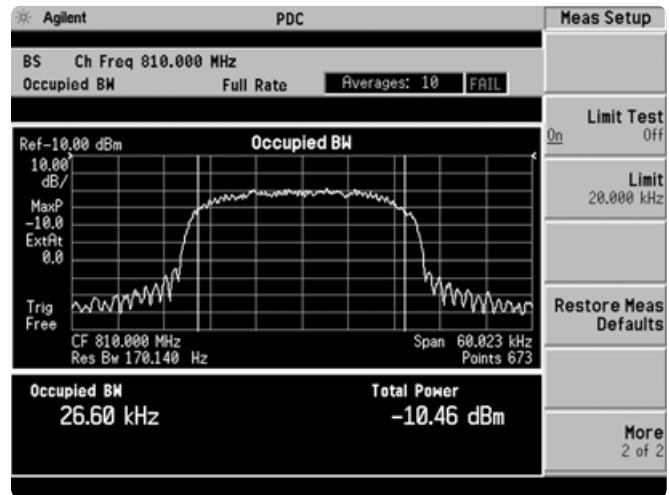
Instructions

Keystrokes

On the PSA:

Activate the occupied bandwidth measurement.	[MEASURE] {Occupied BW}
Change the limit to 20 kHz (Figure 5). Notice the PASS indicator change to FAIL.	[Meas Setup] {More} {Limit} [20] {kHz}

Figure 5.
PDC occupied bandwidth measurement



PSA Series Key Specifications¹

NADC, PDC measurement personality

The following specifications apply to models E4440A/43A/45A only.
Models E4446A and E4448A similar but not warranted performance.

ACPR measurement

Minimum power at RF input	-50 dBm (NADC) -36 dBm (PDC)	
Dynamic range		
Offset frequency	Integrated bandwidth	Dynamic range
30 kHz (NADC)	32.8 kHz	35 dB (typical)
60 kHz (NADC)	32.8 kHz	74 dB
90 kHz (NADC)	32.8 kHz	77 dB
50 kHz (PDC)	21.0 kHz	74 dB
100 kHz (PDC)	21.0 kHz	78 dB
Relative accuracy	±0.08 dB	

EVM measurement

Minimum power at RF input	-45 dBm (NADC) -50 dBm (PDC)
EVM Accuracy	±0.6 % (nominal)
Carrier frequency error accuracy	±2.0 Hz + (transmitter frequency x frequency reference accuracy)

OBW measurement (PDC only)

Minimum power at RF input	-60 dBm (nominal)
Frequency	
Resolution	100 Hz
Accuracy	-50 to -150 Hz (nominal)

1. For specifications on the E4406A VSA, please refer to the E4406A VSA data sheet, literature number 5968-3030E.

Ordering Information

PSA Series spectrum analyzers

E4443A	3 Hz to 6.7 GHz
E4445A	3 Hz to 13.2 GHz
E4440A	3 Hz to 26.5 GHz
E4446A	3 Hz to 44 GHz
E4448A	3 Hz to 50 GHz

Options

To add options to a product, use the following ordering scheme:

Model	E444xA (x = 0, 3, 5, 6 or 8)
Example options	E4440A-B7J E4448A-1DS

Digital demodulation hardware

E444xA-B7J	Digital demodulation hardware (required for digital demodulation measurement personalities)
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Digital demodulation measurements

E444xA-BAF	W-CDMA measurement personality
E444xA-202	GSM w/ EDGE measurement personality
E444xA-B78	cdma2000 measurement personality
E444xA-204	1xEV-DO measurement personality
E444xA-BAC	cdmaOne measurement personality
E444xA-BAE	NADC, PCD measurement personality

General purpose measurements

E444xA-226	Phase noise measurement personality
E444xA-219	Noise figure measurement personality

Amplifiers

E444xA-1DS	100 kHz to 3 GHz built-in preamplifier
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Inputs and outputs

E4440A-BAB	Replaces type-N input connector with APC 3.5 connector
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Connectivity software

E444xA-230	BenchLink Web Remote Control Software
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Warranty and service

For warranty and service of 5 years, please order 60 months of R-51B (quantity = 60). Standard warranty is 36 months.

R-51B	Return-to-Agilent warranty and service plan
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Calibration¹

For 3 years, order 36 months of the appropriate calibration plan shown below. For 5 years, specify 60 months.

R-50C-001	Standard calibration
R-50C-002	Standards compliant calibration

E4406A vector signal analyzer

E4406A 7 MHz to 4 GHz

Options

To add options to a product, use the following ordering scheme:

Model	E4406A
Example options	E4406A-BAH

Digital demodulation measurements

E4406A-BAF	W-CDMA measurement personality
E4406A-B78	cdma2000 measurement personality
E4406A-202	EDGE with GSM measurement personality
E4406A-204	1xEV-DO measurement personality
E4406A-BAH	GSM measurement personality
E4406A-BAC	cdmaOne measurement personality
E4406A-BAE	NADC, PDC measurement personality
E4406A-HN1	IDEN measurement personality

Inputs and outputs

E4406A-B7C	I/Q inputs
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Connectivity software

E444xA-230	BenchLink Web Remote Control Software
------------	---------------------------------------

Warranty and service

For warranty and service of 5 years, please order 60 months of R-51B (quantity = 60). Standard warranty is 36 months.

R-51B	Return-to-Agilent warranty and service plan
-------	---

Calibration¹

For 3 years, order 36 months of the appropriate calibration plan shown below. For 5 years, specify 60 months.

R-50C-001	Standard calibration
R-50C-002	Standards compliant calibration

Product Literature

Selecting the Right Signal Analyzer for Your Needs, selection guide, literature number 5968-3413E

PSA Series literature

PSA Series, brochure, literature number 5980-1283E

PSA Series, data sheet, literature number 5980-1284E

E4406A VSA literature

E4406A VSA, brochure, literature number 5968-7618E

E4406A VSA, data sheet, literature number 5968-3030E

Application literature

Testing and Troubleshooting Digital RF Communications Transmitter Designs, application note, literature number 5968-3578E

Understanding PDC and NADC Transmitter Measurement for Base Transceiver Stations and Mobile Stations, application note, literature number 5968-5537E

Testing and Troubleshooting Digital RF Communications Receiver Designs, application note, literature number 5968-3579E

For more information on the E4406A VSA or the PSA Series, please visit:

www.agilent.com/find/vsa

www.agilent.com/find/psa

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Printed in U.S.A., January 22, 2003
5988-3697EN



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