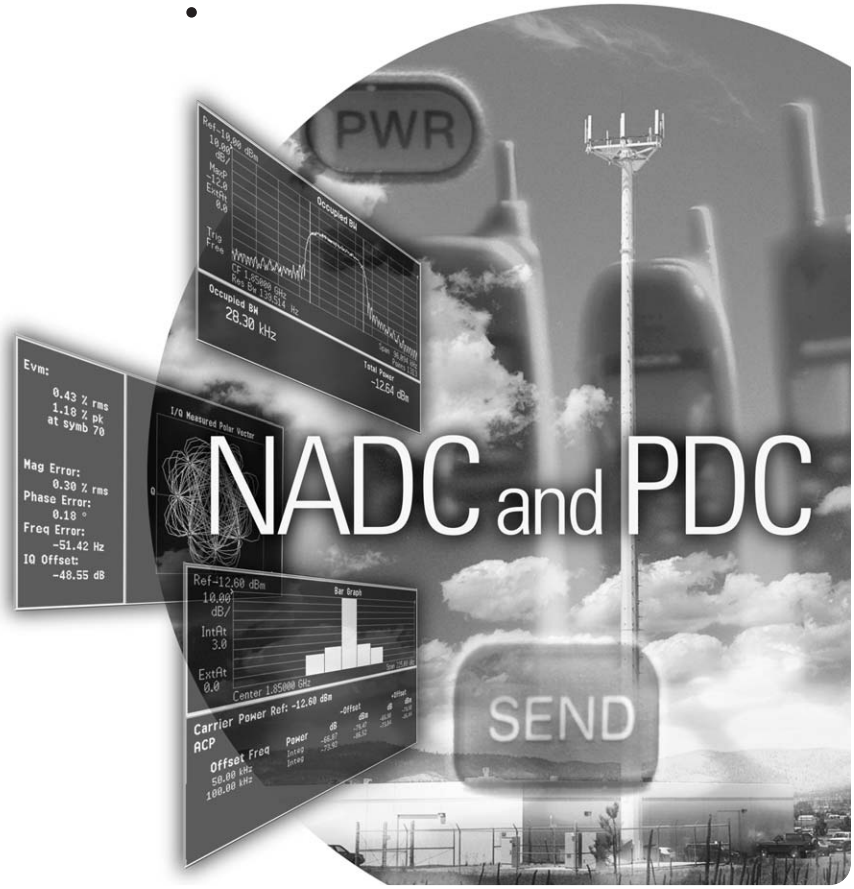
# Agilent
# PSA Series Spectrum Analyzers
# E4406A Vector Signal Analyzer
# NADC, PDC Measurement Personality

## 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.




Agilent Technologies

# 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.

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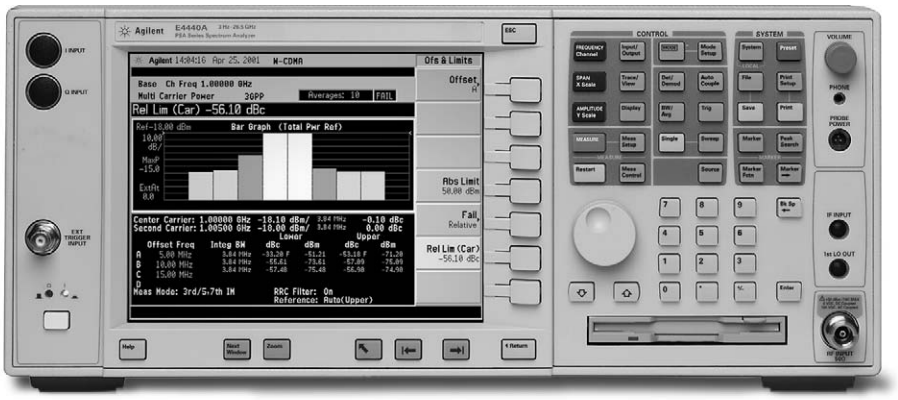
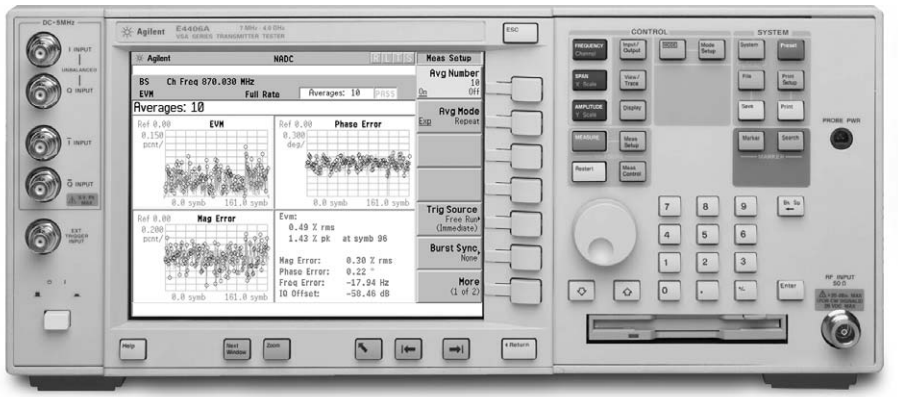
NADC measurements page 4

Adjacent channel power (ACP) page 5




**PSA Series spectrum analyzer**




**E4406A vector signal analyzer**

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## 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<br>402 – TDMA personalities |
| PSA Series spectrum analyzer | E4440A/E4443A/E4445A/ E4446A/E4448A | B7J – Digital demodulation hardware<br>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}<br>[Amplitude] [–10] {dBm} |
| Set the ESG to generate a NADC signal. | [Mode] {Real Time TDMA}<br>{NADC} {NADC On} [RF On] |

## NADC measurements

NADC uses time division multiple access (TDMA) with π/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 On/Preset} {Preset Type}<br>{Factory} |
| Enter the NADC mode.<br>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 Full}<br>{Device BS} |
| 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.

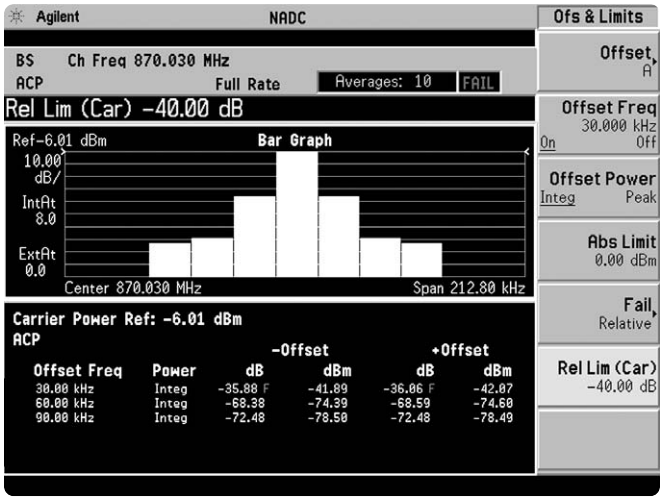
The following ACP measurement parameters can be configured:

- 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 | Keystrokes |
|---|---|
| **On the PSA:** | |
| Activate the ACP measurement. | [MEASURE] {ACP} |
| Set the first offset to fail at –40 dB below the carrier (Figure 1).<br>Observe the PASS indicator change to FAIL in the upper right corner and notice the fail indicators appear in the table. | [Meas Setup] {More} {Ofs & Limits} {Rel Lim (Car)} [–40] {dB} |
| View the results in spectrum format. | [Trace/View] {Spectrum} |

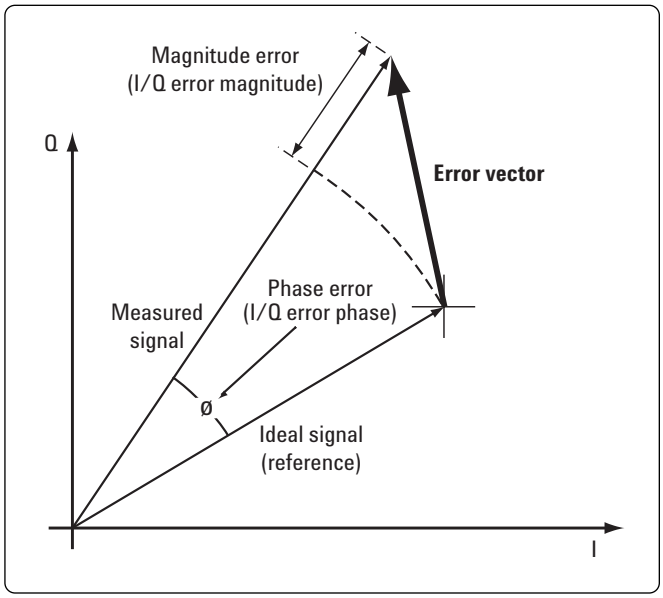
**Figure 1.**
**ACP measurement**




## 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**

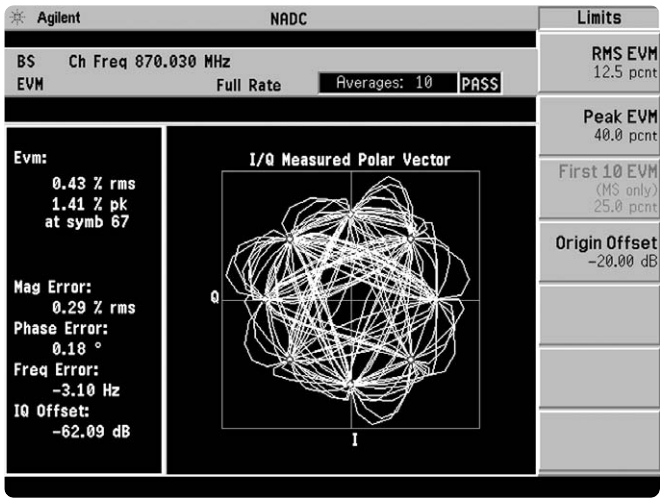
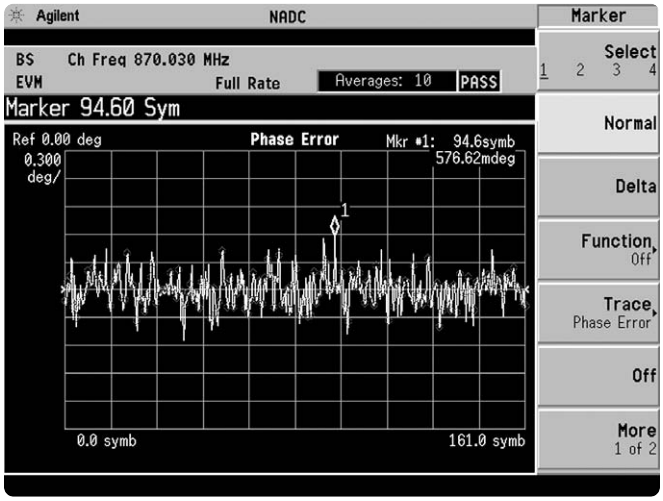



**Figure 4. Phase error plot with marker**



## PDC measurements

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

**Table 1. Overview of NADC and PDC systems**

| | NADC | PDC |
|---|---|---|
| Access scheme | TDMA | TDMA |
| Modulation | π/4-DQPSK | π/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) |

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.

| 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.<br>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.

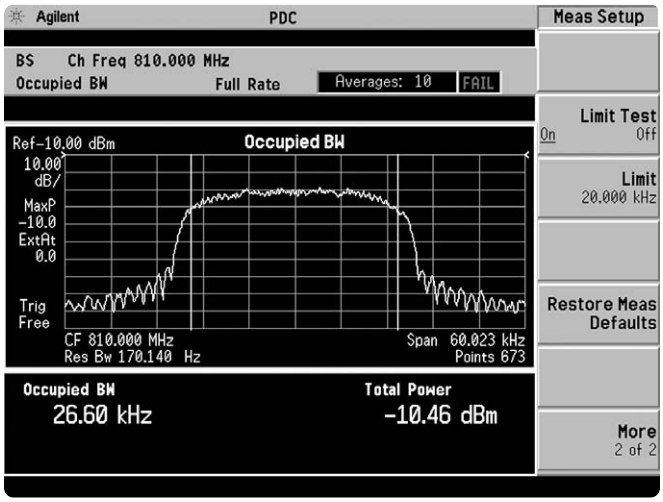
Set up OBW measurement via the following parameters:

- 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).<br>Notice the PASS indicator change to FAIL. | [Meas Setup] {More} {Limit} [20] {kHz} |

**Figure 5. PDC occupied bandwidth measurement**



# PSA Series Key Specifications[1]

## 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)<br>–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)<br>–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) |

### 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 |

### Inputs and outputs

| | |
|---|---|
| E4440A-BAB | Replaces type-N input connector with APC 3.5 connector |

### Connectivity software

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

### Warranty and service

Standard warranty is 36 months.

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

### Calibration[1]

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

| | |
|---|---|
| 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 |

### Connectivity software

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

### Warranty and service

Standard warranty is 36 months.

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

### Calibration[1]

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

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

1. Options not available in all countries.

# 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**

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