NADC, PDC Measurement Guide

Agilent Technologies E4406A VSA Series Transmitter Tester

Agilent Technologies

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1 Understanding NADC

What is the NADC Communications System?

The North American Dual-Mode Cellular (NADC) is one of the cellular communications systems. NADC is also referred to as North American Digital Cellular, or American Digital Cellular (ADC). Occasionally it is also referred to as Digital Advanced Mobile Phone Service (D-AMPS) or NADC-TDMA.

The NADC communications system is defined in the Electronics Industry Alliance (EIA) and Telecommunication Industry Association (TIA) standard documents. The following is a list of all relevant and applicable standard documents:

- TIA/EIA IS-136.1

  TDMA Cellular/PCS - Radio Interface - Mobile Station - Base Station Compatibility - Digital Control Channel

- TIA/EIA IS-136.2

  TDMA Cellular/PCS - Radio Interface - Mobile Station - Base Station Compatibility - Traffic Channels and FSK Control Channel

- TIA/EIA IS-137

  TDMA Cellular/PCS - Radio Interface - Minimum Performance Standards for Mobile Stations

- TIA/EIA IS-138

  TDMA Cellular/PCS - Radio Interface - Minimum Performance Standards for Base Stations

- TIA/EIA-627

  800 MHz Cellular System, TDMA Radio Interface, Dual-Mode Mobile Station - Base Station Compatibility Standard (ANSI/TIA/EIA-627-96), which replaced IS-54-B

- TIA/EIA-628

  800 MHz Cellular System, TDMA Radio Interface, Minimum Performance Standards for Dual-Mode Mobile Stations (TIA/EIA-628-96), which replaced IS-55-A

- TIA/EIA-629

  800 MHz Cellular System, TDMA Radio Interface, Minimum Performance Standards for Base Stations Supporting Dual-Mode Mobile Stations (ANSI/TIA/EIA-629-96), which replaced IS-56-A

Each base station retains the analog control channels and analog traffic channels of the advanced mobile phone service (AMPS) system. In addition, a base station can have digital traffic channels. The mobile stations are dual mode and access the network via the analog control channel. They are capable of using either analog or digital traffic channel. Digital control channel and digital only mobile stations are also currently being produced.

The digital part of the NADC system employs a combination of FDMA and time division multiple access (TDMA). The NADC time division multiple access structure allows up to six users to share a single carrier frequency. The TDMA frame structure divides time on a carrier into a stream of frames. Each frame is 40 ms long consisting of 6 timeslots; thus, one timeslot is 6.667 ms long. A digital traffic channel is defined by a carrier frequency (or channel number) and a timeslot number. Each user must transmit data only on his carrier frequency, at a time defined by a timeslot number. Currently, 2 timeslots per frame are required for each user because more time is required to transmit voice using full-rate speech codecs presently available. This allows 3 users per frequency pair. When half-rate speech codecs are incorporated into the system, each traffic channel will require just one timeslot per frame allowing 6 users per frequency pair.

NADC digital mobile stations transmit a burst of data when their assigned timeslot occurs. This means a mobile station transmits a bursted amplitude modulation signal, ramping transmission power on and off. An NADC digital base station transmits continuously, switching digital modulation on at the appropriate timeslots.

The digital modulation format used in the NADC system is the $\pi/4$ differential quadrature phase shift keying ($\pi/4$ DQPSK). The $\pi/4$ DQPSK modulation causes both phase and amplitude variations on the RF signal. The quadrature nature of this modulation allows 2 bits to be transmitted at the same time on orthogonal carriers. These 2 bits make one NADC symbol. The digital modulation operates at 162 symbols, or 324 bits in each timeslot. The symbol period is 41.16 μs. Since there are 1944 bits in 6 timeslots and 25 frames in one second, the transmission bit rate is 48,600 bits per second, or 24,300 symbols per second.

The key objectives of the NADC system are to increase the subscriber capacity, provide more secure voice communications, and be backwards compatible with the existing AMPS analog cellular system.

Since the system transmits all information in a digital form, it will be much harder to listen to someone else’s cellular phone conversation. This is a key benefit for people using cellular phones that convey confidential information.

Following is a summary of the NADC air interface. Note that the frequency range is the same as the analog cellular. Since it is a dual-mode system, NADC will use the same frequency band currently assigned to the AMPS cellular. The available channels are divided into analog and digital channels. The channel spacing is 30 kHz each, and the RX/TX frequency difference is 45 MHz as in the AMPS cellular. NADC has a RX/TX time spacing of 1.85 ms.

Band	Uplink	Downlink	Channel Numbers
800 MHz	825.030 to 848.970 MHz	870.030 to 893.970 MHz	1 to 799
	824.040 to 825.000 MHz	869.040 to 870.000 MHz	991 to 1023
1900 MHz	1850.040 to 1909.920 MHz	1930.080 to 1989.990 MHz	2 to 1998

What does the Agilent Technologies E4406A do?

This instrument can help determine if an NADC transmitter operates correctly. When configured for NADC, the instrument can be used to test an NADC transmitter according to the TIA/EIA standards, 627, 628, 629, IS-136, IS-137, and IS-138. This document defines complex and multiple-part measurements used to maintain an interference-free environment. For example, the document includes the testing method of a carrier power. The E4406A Transmitter Tester automatically makes these measurements based on the TIA/EIA standards. The detailed measurement result displays allow you to analyze NADC system performance. You may alter the measuring parameters for your specific measurement and analysis.

Other Sources of Measurement Information

Additional measurement application information is available through your local Agilent Technologies sales and service office. The following application notes explain digital communications measurements in much greater detail than discussed in this guide.

- Application Note 1298

  Digital Modulation in Communications Systems - An Introduction
  part number 5965-7160E

- Application Note 1324

  Understanding PDC and NADC Transmitter Measurements for Base Transceiver Stations and Mobile Stations
  part number 5968-5537E

Instrument Updates at www.agilent .com/find/vsa

This web location can be used to access the latest information about the transmitter tester.

2 Setting Up the NADC Mode

NADC Mode

You may want to install a new personality, reinstall a personality that you have previously uninstalled, or uninstall a personality option. Instructions can be found in "Installing and Uninstalling Optional Measurement Personalities" on page 33.

At the initial power up, the transmitter tester will come up in the Basic mode, with the Spectrum (frequency domain) measurement selected and the **Measure** menu displayed.

To access the NADC measurement personality press the **Mode** key and select **NADC**.

If you want to set the NADC mode to a known, factory default state, press the **Preset** key. This will preset the mode setup and all of the NADC measurements to the factory default parameters.

NOTE Pressing the **Preset** key does not switch instrument modes.

How to Make a Measurement

Follow the three-step procedure shown in the table below:

Step	Primary Key	Setup Keys	Related Keys
1. Select & setup a mode.	**Mode**	**Mode Setup**, **Input**, **Frequency Channel**	**System**
2. Select & setup a measurement.	**Measure**	**Meas Setup**	**Meas Control**, **Restart**
3. Select & setup a view.	**View/Trace**	**Span X Scale**, **Amplitude Y Scale**, **Display**, **Next Window**, **Zoom**	**File**, **Save**, **Print**, **Print Setup**, **Marker**, **Search**

Step 1. Select & setup a mode, for example:

- Press the **Mode** key and select **NADC**.
- Press the **Frequency Channel** key and enter the channel frequency to be measured.
- Press the **Mode Setup** key to change any of the settings in the **Radio**, **Input**, **Trigger** and **Burst** menus from those default settings, if required.

Refer to "Changing the Mode Setup" on page 18 and "Changing the Frequency Channel" on page 23 for further explanation.

Refer to "Mode Setup / Frequency Channel Key Flow" on page 25 for the hierarchical details.

Step 2. Select & setup a measurement, for example:

- Press the **Measure** key and select either **ACP**, **EVM**, **Spectrum (Freq Domain)**, or **Waveform (Time Domain)** to make its measurement.
- Press the **Meas Setup** key to change any of the measurement parameters from the default settings, if required. These parameters such as Span, Resolution Bandwidth, Trigger Source, Average, Limit Test and Limits, are decided according to the measurement selected.

Refer to "ACP Measurement Key Flow" on page 26, and to "Waveform (Time Domain) Measurement Key Flow (1 of 2)" on page 31 for the hierarchical details.

Step 3. Select & setup a view, for example:

- Press the **View/Trace** key and select the desired view for the current measurement.
- Press the **Next Window** key and select a window, then press the **Zoom** key to expand the window to the full display area.
- Press the **Span X Scale**, **Amplitude Y Scale**, and/or **Marker** keys for your desired display. These keys are not always valid for each measurement being done. The **Display** key is only valid for **EVM** measurements.

Refer to "ACP Measurement Key Flow" on page 26, and to "Waveform (Time Domain) Measurement Key Flow (1 of 2)" on page 31 for the hierarchical details.

Changing the Mode Setup

Numerous settings can be changed at the mode level by pressing the **Mode Setup** key. This will access the selection menu listed below. These settings affect only the measurements in the NADC mode.

Radio

The **Radio** key accesses the menu as follows:

- **Traffic Rate** - Allows you to toggle the traffic rate between **Full** and **Half**.
- **Device** - Allows you to toggle the test device between **BS** (Base Station) and **MS** (Mobile Station).

When the NADC mode is selected, the instrument will default to the following settings.

Radio Default Settings	
Traffic Rate	Full
Device	BS

Input

The **Input** key accesses the menu as follows: (You can also access this menu from the **Input** front-panel key.)

- **RF Input Range** - Allows you to toggle the RF input range function between **Auto** and **Man** (manual). **Auto** is not used for Spectrum (freq domain) measurements. If **Auto** is chosen, the instrument automatically sets the input attenuator based on the carrier power level, where it is tuned. Once you change the **Max Total Pwr** or **Input Atten** value with the RPG knob, for example, the **RF Input Range** key is automatically set to **Man**. If there are multiple carriers present, the total power might overdrive the front end amplifiers. In this case you need to set **RF Input Range** to **Man** and enter the expected maximum total power by activating the **Max Total Pwr** key. **Man** is also useful to hold the input attenuation constant for the best relative power accuracy. For single carriers it is generally recommended to set this to **Auto**.
- **Max Total Pwr** - Allows you to set the maximum total power from the UUT (Unit Under Test). The range is –200.00 to +50.00 dBm with 0.01 dB resolution. This is the expected maximum value of the mean carrier power referenced to the output of the UUT; it may include multiple carriers. The **Max Total Pwr** setting is coupled together with the **Input Atten** and **Ext Atten** settings. Once you change the **Max Total Pwr** value with the RPG knob, for example, the **RF Input Range** key is automatically set to **Man**.

- **Input Atten** - Allows you to control the internal input attenuator setting. The range is 0 to 40 dB with 1 dB resolution. The **Input Atten** key reads out the actual hardware value that is used for the current measurement. If more than one input attenuator value is used in a single measurement, the value used at the carrier frequency will be displayed. The **Input Atten** setting is coupled together with the **Max Total Pwr** setting. Once you change the **Input Atten** value with the RPG knob, for example, the **RF Input Range** key is automatically set to **Man**.
- **Ext Atten** - Allows you to access the following menu to enter the external attenuation values. Either of the **Ext Atten** settings is coupled together with the **Max Total Pwr** setting, however, pressing **Ext Atten** does not switch the **RF Input Range** key to **Man**. This will allow the instrument to display the measurement results referenced to the output of the UUT.

  MS - Sets an external attenuation value ranging from –50.00 to +50.00 dB with 0.01 dB resolution for MS. The default setting is 0.00 dB.

  BS - Sets an external attenuation value ranging from –50.00 to +50.00 dB with 0.01 dB resolution for BS. The default setting is 0.00 dB.

NOTE The **Max Total Pwr** setting is coupled together with the **Input Atten** and **Ext Atten** settings. For a given measurement, changing the input **Max Total Pwr** setting by x dB changes the **Input Atten** setting by x dB, and vice-versa. However, changing the **Max Total Pwr** setting does not change the **Ext Atten** setting, even though changing the **Ext Atten** setting by x dB changes the **Max Total Pwr** setting by x dB. When you switch to a different measurement, the **Max Total Pwr** setting is kept constant, but the **Input Atten** setting may change if the two measurements have different mixer margins. Thus, you can directly set the transmitter tester input attenuator, or you can set it indirectly by specifying the expected maximum power from the UUT.

When the NADC mode is selected, the instrument will default to the following settings.

Input Default Settings	
RF Input Range	Auto[a]
Max Total Pwr	–15.00 dBm[b]
Input Atten	0.00 dB[b]
Ext Atten:	
MS	0.00 dB
BS	0.00 dB

a. Auto is not used for Spectrum (freq domain) measurements.
b. This may differ if the maximum input power is more than –15 dBm.

Trigger

The **Trigger** key allows you: (1) to access the trigger source selection menu to specify the triggering conditions for each trigger source, (2) to modify the default trigger holdoff time using the **Trig Holdoff** key, (3) to modify the auto trigger time and to activate or deactivate the auto trigger feature using the **Auto Trig** key, and (4) to modify the period of the frame timer using the **Frame Timer** key.

NOTE The actual trigger source is selected separately for each measurement under the **Meas Setup** key.

- **RF Burst**, **Video (IF Envlp)**, **Ext Front** and **Ext Rear** - Pressing one of these trigger keys will access each triggering condition setup menu. This menu is used to specify the **Delay**, **Level** and **Slope** settings for each trigger source as follows:

  Delay - Allows you to enter a numerical value to modify the trigger delay time. The range is –500.000 to +500.000 ms with the best resolution of 1 µs. For trigger delay use a positive value, and for pre-trigger use a negative value.

  Level - Allows you to enter a numerical value to adjust the trigger level depending on the trigger source selected.

  — For **RF Burst** selection, the RF level range is –200.00 to 0.00 dB with 0.01 dB resolution, relative to the peak RF signal level. The realistic range can be down to –20 dB.

  — For **Video (IF Envlp)** selection, the video level range is –200.00 to +50.00 dBm with 0.01 dB resolution at the RF input. The realistic range can be down to around –40 dBm, depending on the noise floor level of the input signal.

— For **Ext Front** or **Ext Rear** selection, the level range is –5.00 to +5.00 V with 1 or 10 mV resolution.

Slope - Allows you to toggle the trigger slope between **Pos** at the positive-going edge and **Neg** at the negative-going edge of the burst signal.

Other keys accessed under the **Trigger** key:

- **Trig Holdoff** - Allows you to set the period of time before the next trigger can occur. The range is 0.000 to 500.0 ms with the best resolution of 1 µs.
- **Auto Trig** - Allows you to specify a time for a trigger timeout. The range is 0.000 to 1000 sec with the best resolution of 1 µs. If no trigger occurs by the specified time, a trigger is automatically generated.
- **Frame Timer** - Allows you to access the menu to manually control the frame timer:

  Period - Allows you to set the period of the frame clock. The range is 1.000000 to 559.0000 ms with the best resolution of 1 ns.

When the NADC mode is selected, the instrument will default to the following settings.

Trigger Default Settings	
RF Burst:	
Delay	0.000 sec
Peak Level	–10.0 dB
Slope	Pos
Video (IF Envlp):	
Delay	0.000 sec
Level	–30.00 dBm
Slope	Pos
Ext Front & Ext Rear:	
Delay	0.000 sec
Level	2.00 V
Slope	Pos
Trig Holdoff	10.00 ms
Auto Trig	100.0 ms, On
Frame Timer:	
Period:	
(if set to full rate)	20.00000 ms
(if set to half rate)	40.00000 ms

Burst

The **Burst** key allows you to access the following menu to set the trigger condition for the ACP and EVM measurements when **Device** under **Radio** is set to **MS**. This is used in conjunction with **Frame Timer**.

- **Delay** - Allows you to set the delay time after searching a threshold level of NADC bursts. The range is –500.0 to +500.0 ms with the best resolution of 0.1 µs.
- **Search Threshold** - Allows you to set the threshold level used in search for NADC bursts after data is acquired. The range is –200.00 to –0.01 dB with 0.01 dB resolution. The realistic range can be down to the noise floor level of the input signal.

When the NADC mode is selected, the instrument will default to the following settings.

Burst Default Settings	
Delay	0.000 s
Search Threshold	–30.00 dB

Changing the Frequency Channel

After selecting the desired mode setup, you will need to select the desired center frequency, burst type and slot. The selections made here will apply to all measurements in the mode. Press the **Frequency Channel** key to access the following menu:

- **Center Freq** - Allows you to enter a frequency value that corresponds to the desired RF channel to be measured. This is the current instrument center frequency for any measurement function.
- **Burst Type -** Allows you to choose an NADC burst type from the following selections only when **Device** under **Radio** is previously set to **MS,** otherwise this key is unavailable. This is used only when making EVM measurements.

  Traffic (TCH) - Sets to the traffic channel burst signal of which burst length is 324 bits or 162 symbols.
  Control (CCH) - Sets to the control channel burst signal of which burst length is 280 bits or 140 symbols.

- **Slot (Std)** - Allows you to toggle the slot selection function between **Auto** and **Man** (manual), and also to specify the particular timeslot to be measured when **Man** is selected. This is used only when making EVM measurements.

  Auto - In auto, the measurement is made on the first timeslot found to have any one of the valid sync words, corresponding to slots 1 to 6. The measurement may be made on various timeslots if more than one timeslot has a valid sync word.

  Man - In manual, the measurement is made only on the specified timeslot that has a valid sync word. The timeslot range is 1 to 6.

When the NADC mode is selected, the instrument will default to the following settings.

Frequency Channel Default Settings	
Center Freq	1.00000 GHz
Burst Type[a]	Traffic (TCH)
Slot (Std)	1, Auto

a. This is used only when Device is MS.

NADC Measurement Key Flow

The key flow diagrams, shown in a hierarchical manner on the following pages, will help the user to grasp the overall functional relationships for the front-panel keys and the softkeys displayed at the extreme right side of the screen. The diagrams are:

"Mode Setup / Frequency Channel Key Flow" on page 25,

"ACP Measurement Key Flow" on page 26,

"EVM Measurement Key Flow" on page 27,

"Spectrum (Freq Domain) Measurement Key Flow (1 of 3)" on page 28,

"Waveform (Time Domain) Measurement Key Flow (1 of 2)" on page 31.

Use these flow diagrams as follows:

- There are some basic conventions:

(Meas Setup) An oval represents one of the front-panel keys.

[EVM] This box represents one of the softkeys displayed.

<for EVM> This represents an explanatory description on its specific key.

[Avg Number 10 On | Off] This box represents one of the default condition softkeys displayed. Default conditions are shown as much as possible with underlined parameters or values shown on those softkey labels.

- Start from the extreme upper left corner of each measurement diagram to the right direction, and go from the top to the bottom.
- When defining a key from auto with underline to manual, for example, just press that key one time.
- When entering a numeric value of **Frequency**, for example, use the numeric keypad by terminating with the appropriate unit selection from the softkeys displayed.
- When entering a numeric value of **Slot (Std)**, for example, use the numeric keypad by terminating with the **Enter** front-panel key.
- Instead of using the numeric keypad to enter a value, it may be easier to use the RPG knob or **Up/Down** keys depending on the input field of a parameter.

Figure 2-1 Mode Setup / Frequency Channel Key Flow

- Mode — NADC
- Mode Setup
  - Radio
    - Traffic Rate Full | Half
    - Device BS | MS
  - Input
    - RF Input Range Auto | Man <Auto not for Spectru
    - Max Total Pwr -15.00 dBm
    - Input Atten 0.00 dB
    - Ext Atten
      - MS 0.00 dB
      - BS 0.00 dB
  - Trigger
    - RF Burst
      - Delay 0.000 s
      - Peak Level -10.00 dB
      - Slope Pos | Neg
    - Video (IF Envlp)
      - Delay 0.000 s
      - Level -30.00 dBm
      - Slope Pos | Neg
    - Ext Front
      - Delay 0.000 s
      - Level 2.00 V
      - Slope Pos | Neg
    - Ext Rear
      - Delay 0.000 s
      - Level 2.00 V
      - Slope Pos | Neg
    - Trig Holdoff 10.00 ms
    - Auto Trig 100.0 ms On | Off
    - Frame Timer
      - Period 20.00000 ms
  - Burst
    - Delay 0.000 s
    - Search Threshold -30.00 dB
- Frequency Channel
  - Center Freq 1.00000 GHz
  - Burst Type Traffic (TCH) <for EVM when Device is MS>
    - Traffic (TCH)
    - Control (CCH)
  - Slot (Std) 1 Auto | Man <for EVM>

Figure 2-2 ACP Measurement Key Flow

- Measure — ACP
  - Meas Setup
    - Avg Number 10 On | Off
    - Avg Mode Exp | Repeat
    - Trig Source Free Run (Immediate)
      - Free Run (Immediate)
      - RF Burst (Wideband)
      - Ext Front
      - Ext Rear
      - Frame
    - Limit Test On | Off
    - Offs & Limits
      - Offset A — <A: default selection>
        - A
        - B
        - C
        - D
        - E
      - Offset Freq 30.000 kHz On | Off — <default settings> <A: 30.000 kHz On> <B: 60.000 kHz On> <C: 90.000 kHz On> <D: 120.000 kHz Off> <E: 0.00 Hz Off>
      - Offset Power Integ | Peak
      - Abs Limit 0.00 dBm — <default settings> <A, B, D, E: 0.00 dBm> <C: -13.00 dBm>
      - Fail Relative
        - AND — <default for D & E>
        - OR — <default for C>
        - Absolute
        - Relative — <default for A & B>
      - Rel Limit (Car) -26.00 dB — <default settings> <A: -26.00 dB> <B, C: -45 dB> <D, E: 0.00 dB>
    - Restore Meas Defaults
- Measure — ACP
  - View/Trace
    - Bar Graph
    - Spectrum
      - Amplitude Y Scale
        - Scale/Div 10.00 dB
        - Ref Value -30.00 dBm
        - Ref Position Top | Ctr | Bot
        - Scale Coupling On | Off

Figure 2-3 EVM Measurement Key Flow

- Measure → EVM
  - Meas Setup
    - Avg Number 10 On | Off
    - Avg Mode Exp | Repeat
    - Trig Source Free Run (Immediate)
      - Free Run (Immediate)
      - Video (IF Envlp)
      - RF Burst (Wideband)
      - Ext Front
      - Ext Rear
      - Frame
    - Burst Sync None
      - Sync Word
      - RF Amptd
      - None
    - Limit Test On | Off
    - Limits
      - RMS EVM 12.5 Pcnt
      - Peak EVM 40.0 Pcnt
      - First 10 EVM (MS only) 25.0 Pcnt
      - Origin Offset -20.00 dB
    - Restore Meas Defaults
- Measure → EVM
  - View/Trace
    - I/Q Measured Polar Vector
    - I/Q Measured Polar Constln
    - I/Q Error (Quad View)
      - Span X Scale
        - Scale/Div 16.10 Sym <for BS; 15.6 Sym for MS>
        - Ref Value 0.000 Sym
        - Ref Position Left | Ctr | Right
        - Scale Coupling On | Off
      - Amplitude Y Scale <for EVM>
        - Scale/Div 10.0 Pcnt
        - Ref Value 0.00 Pcnt
        - Ref Position Top | Ctr | Bot
        - Scale Coupling On | Off
      - Amplitude Y Scale <for Phase Error>
        - Scale/Div 2.00 Deg
        - Ref Value 0.00 Deg
        - Ref Position Top | Ctr | Bot
        - Scale Coupling On | Off
      - Amplitude Y Scale <for Mag Error>
        - Scale/Div 10.0 Pcnt
        - Ref Value 0.00 Pcnt
        - Ref Position Top | Ctr | Bot
        - Scale Coupling On | Off
- Measure → EVM
  - Display
    - Pts/Symb Displayed 1 | 5
    - Symbol Dots On | Off

Figure 2-4 Spectrum (Freq Domain) Measurement Key Flow (1 of 3)

- Measure
  - Spectrum (Freq Domain)
- Meas Setup
  - Span 1.00000 MHz
  - Res BW 20.0000 kHz Auto | Man
  - Avg Number 25 On | Off
  - Avg Mode Exp | Repeat
  - Avg Type Log-Pwr Avg (Video)
    - Pwr Avg (RMS)
    - Log-Pwr Avg (Video)
    - Voltage Avg
    - Maximum
    - Minimum
  - Trig Source Free Run (Immediate)
    - Free Run (Immediate)
    - Video (IF Envlp)
    - RF Burst (Wideband)
    - Ext Front
    - Ext Rear
    - Frame
    - Line
  - Restore Meas Defaults
  - Advanced
    - Pre-ADC BPF On | Off
    - Pre-FFT Fltr Gaussian | Flat
    - Pre-FFT BW 1.55000 MHz Auto | Man
    - FFT Window Flat Top (High Amptd Acc)
      - Flat Top (High Amptd Acc)
      - Uniform
      - Hanning
      - Hamming
      - Gaussian (Alpha 3.5)
      - Blackman
      - Blackman-Harris
      - K-B 70 dB (Kaiser-Bessel)
      - K-B 90 dB (Kaiser-Bessel)
      - K-B 110 dB (Kaiser-Bessel)
    - FFT Size
      - Length Ctr l Auto | Man
      - Min Pnts/RBW 1.300000
      - Window Length 706
      - FFT Length 4096
    - (a)

Figure 2-5 Spectrum (Freq Domain) Measurement Key Flow (2 of 3)

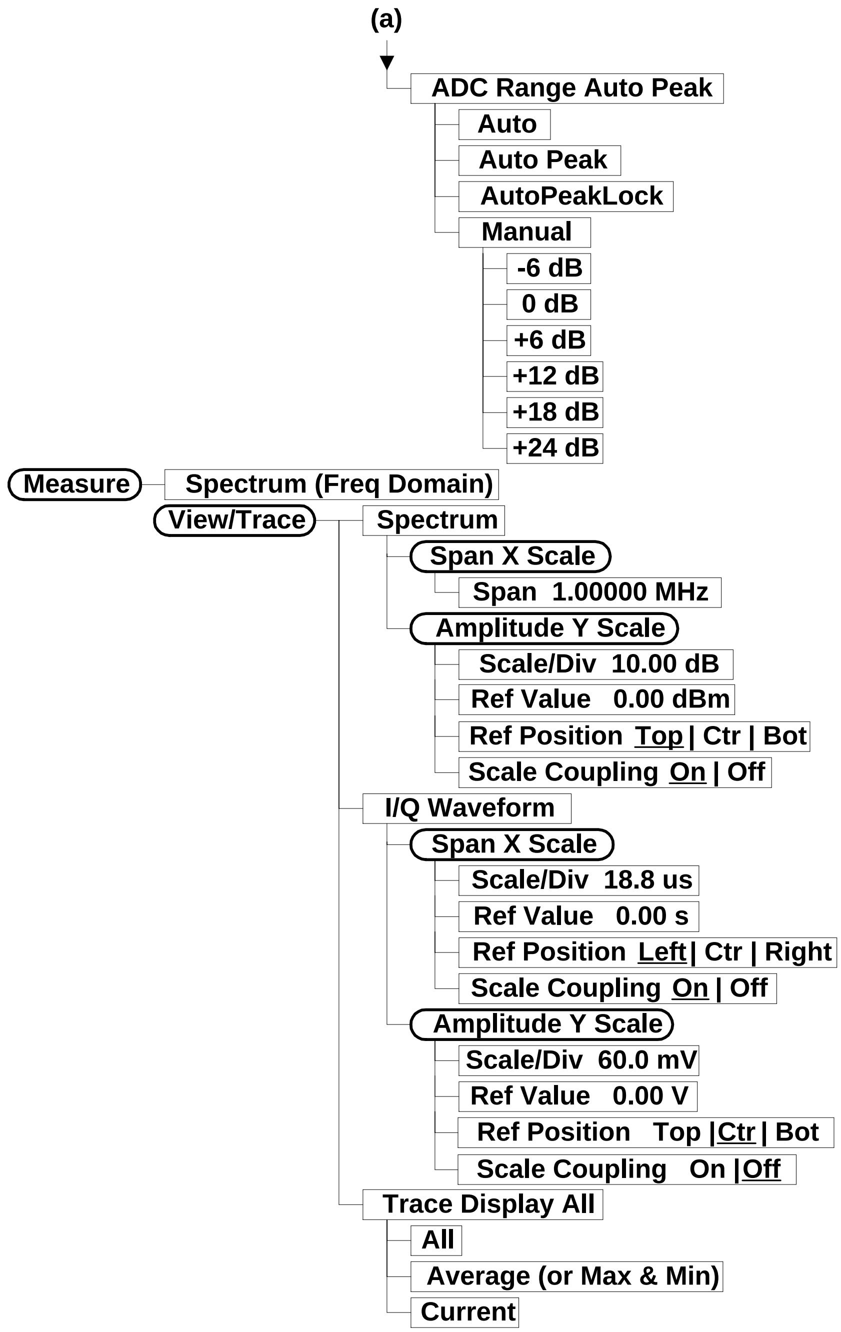


Figure 2-6 Spectrum (Freq Domain) Measurement Key Flow (3 of 3)

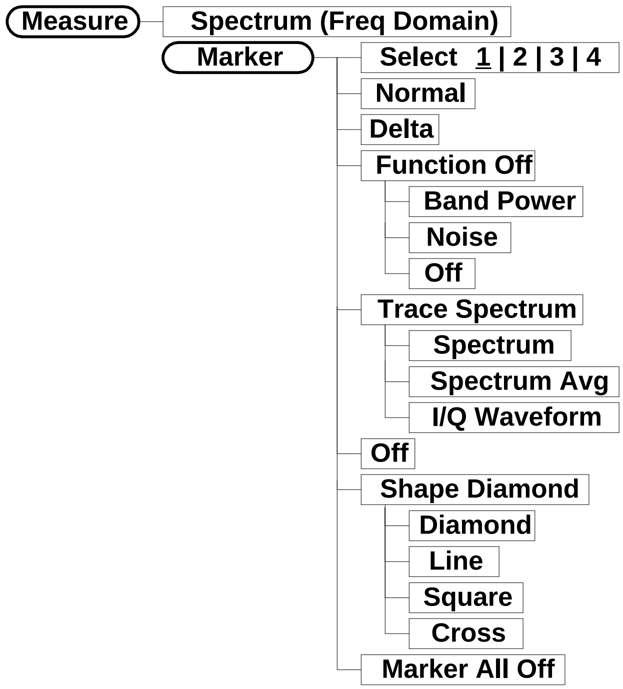


Figure 2-7 Waveform (Time Domain) Measurement Key Flow (1 of 2)

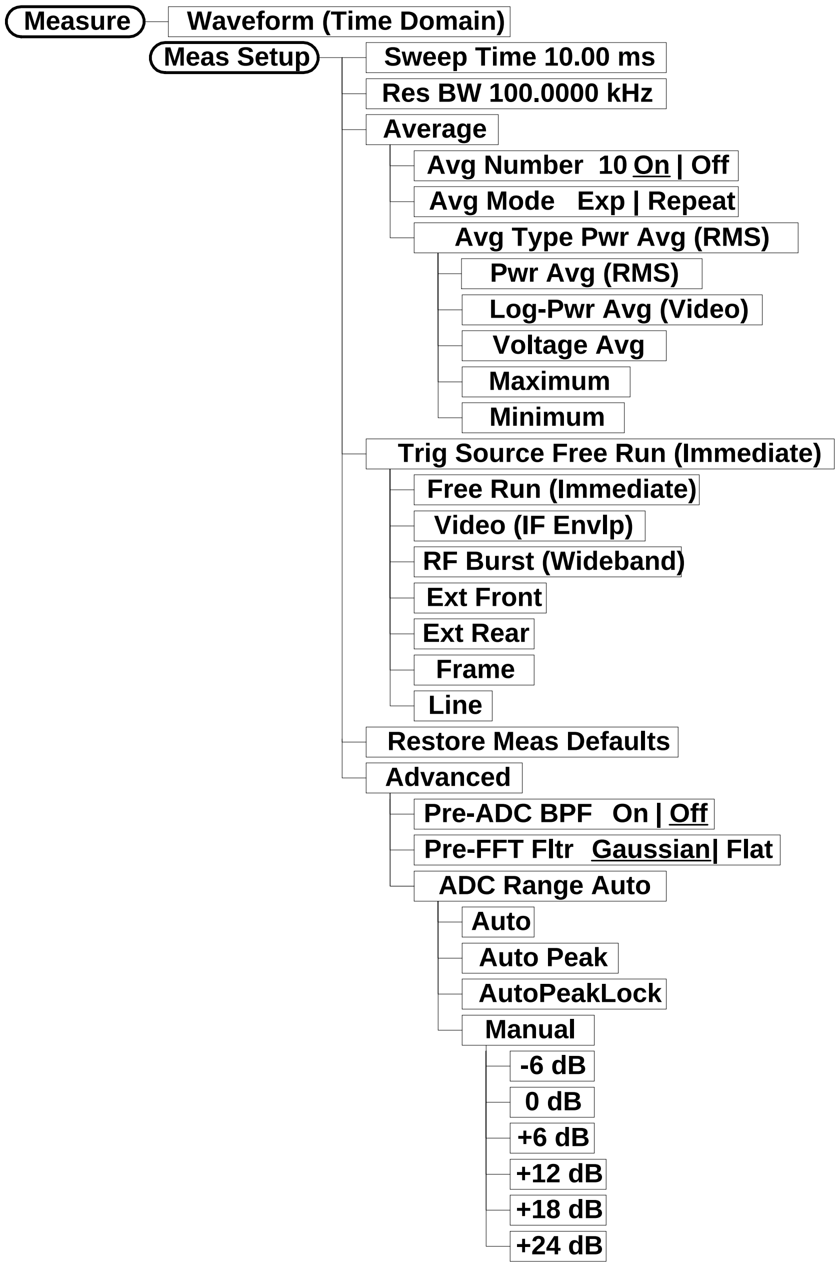
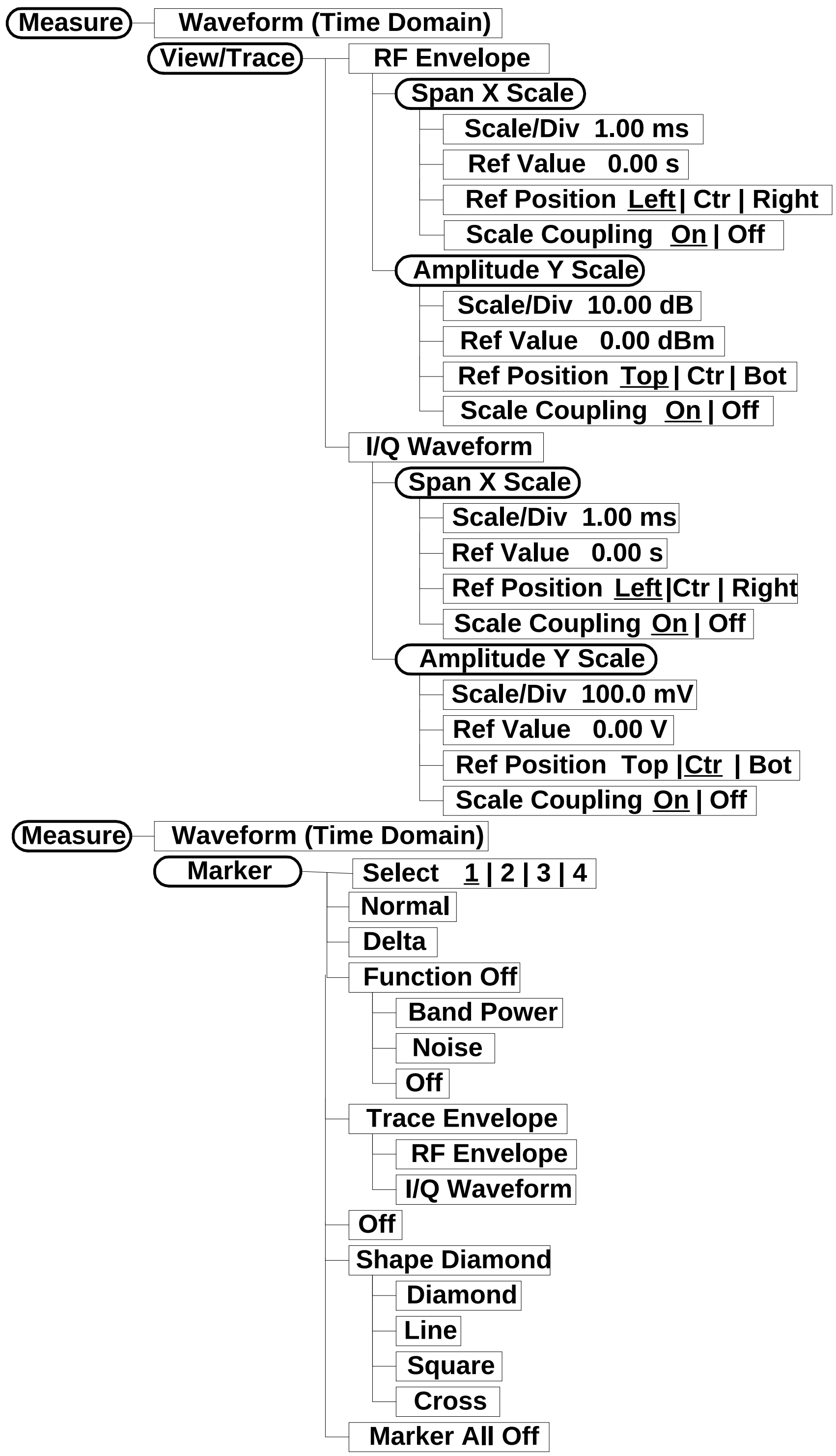


Figure 2-8 Waveform (Time Domain) Measurement Key Flow (2 of 2)



Installing and Uninstalling Optional Measurement Personalities

Active License Key

The measurement personality option you have purchased with your instrument has been installed and enabled at the factory. With the purchase of the measurement personality, and with any future purchase of a new personality, you will receive a unique license key number. The license key enables you to install, or reinstall, any personality you have purchased. Follow these steps to locate the unique license key number for the measurement personality that has come installed in your instrument:

1. Press **System**, **More (1 of 3)**, **More (2 of 3)**, **Install**, **License Key**. **Your unique license key number will now appear in the active function area of the display.**
2. If you are going to install a new personality option purchased later on, you will receive a certificate which displays the unique license key number that you will use to install that option. Refer to "Installing Personality Options" on page 34 to install it using the front panel keys.
3. If you need to uninstall one of the current personality options in order to secure memory space for another option for example, refer to "Uninstalling Personality Options" on page 35 to uninstall it from the instrument using the front panel keys.

You will want to keep a copy of your license key number in a secure location. Please enter your license key numbers in the box provided below for future reference. If you should lose your license key number, call your nearest Agilent Technologies sales and service office for assistance.

Active License Key Numbers for Instrument with Serial # ________
For Option______________ the license number is ________________________
For Option______________ the license number is ________________________
For Option______________ the license number is ________________________

NOTE You will only need to use a license key number if, (1) you purchase an additional measurement personality, (2) you want to uninstall a selected personality option, or (3) you want to reinstall a measurement personality that has been uninstalled.

Installing Personality Options

The option designation consists of three upper-case letters, as shown in the **Option** column of the table below.

Available Personalities	Option
GSM measurement personality	**BAH**
cdmaOne measurement personality	**BAC**
NADC, PDC measurement personality	**BAE**

To install the selected option use the following steps:

1. Press **System**, **More(1 of 3)**, **More(2 of 3)**, **Install**, and **Choose Option**. Pressing the **Choose Option** key will activate the alpha editor menu. Use the alpha editor to enter the three-letter option designation in upper-case, then press the **Done** key. As you enter the option number you will see your entry in the active function area of the display.
2. The **License Key** number will require entry of both letters and numbers. Use the alpha editor to enter letters. Use the front-panel numeric keyboard to enter numerical values. You will see your entry in the active function area. When you have completed entering the license key number, press the **Done** key.
3. Press the **Install Now** key after you have entered the active license key number and the personality option. When pressed, the **Yes** and **No** keys will appear in the **Install Now** menu, and an instruction message, “`Insert disk and power cycle the instrument`”, will appear in the active function area of the display. Press the **No** key only if you wish to cancel the installation process. If you want to proceed with the installation, press the **Yes** key and cycle the instrument off and then on. When the instrument is powered on, the data from the disk will be read and automatically loaded into your instrument.

NOTE Not all personality installations require an installation disk. If the personality upgrade kit does not include a disk, disregard the `Insert disk` portion of the message that appears in the active function area when the **Install Now** key is pressed.

4. The **Exit Main Firmware** key is only for use when you want to update firmware using a LAN connection. The **Exit Main Firmware** key halts the operation of the resident firmware code so you can install an updated version of firmware using a LAN connection. Instructions for loading future firmware updates will be available at the following URL: **www.agilent.com/find/vsa**.

Uninstalling Personality Options

The possibility exists that there may be more personalities available than can fit into the instrument's memory at the same time. You may need to uninstall a selected personality in order to free up memory space to install other personalities.

NOTE The following procedure removes an option from the instrument memory by deleting the option firmware and license key files for the selected option. Write down the 12 digit license key number for the option you are uninstalling before uninstalling it. If that measurement personality is to be reinstalled later, you will need the license key number to reinstall the personality firmware.

1. Press **System**, **More(1 of 3)**, **More(2 of 3)**, **Uninstall**, and **Choose Option**. Pressing the **Choose Option** key will activate the alpha editor menu. Use the alpha editor to enter the three-letter option designation in upper-case, then press the **Done** key. As you enter the option number you will see your entry in the active function area of the display.
2. Press the **Uninstall Now** key after you have entered the personality option. When pressed, the **Yes** and **No** keys will appear, and you will see a message, "`Uninstall Now`", appear in the active function area of the display. Press the **No** key only if you wish to cancel the installation process. Press the **Yes** key if you want to uninstall the selected option.
3. Cycle the instrument power off and on to complete the uninstall process.

3 Making NADC Measurements

NADC Measurements

Once in the NADC mode the following measurements for the NADC band are available by pressing the **Measure** key.

Adjacent Channel Power on page 45

- Error Vector Magnitude on page 52
- Spectrum (Frequency Domain) on page 61
- Waveform (Time Domain) on page 71

These are referred to as one-button measurements. When you press the key to select a measurement, it will become the active measurement, using settings and a display unique to that measurement. Data acquisitions will automatically begin when trigger requirements, if any, are met.

Preparing for Measurements

If you want to set the NADC mode to a known, factory default state, press **Preset**. This will preset the mode setup and all of the measurements to the factory default parameters. You should often be able to make a measurement using these defaults.

NOTE Pressing the **Preset** key does not switch instrument modes.

To preset only the settings that are specific to the selected measurement, press **Meas Setup**, **More (1 of 2)**, **Restore Meas Defaults**. This will reset the measure setup parameters, for the currently selected measurement only, to the factory defaults.

Initial Setup

Before making a measurement, make sure the mode setup and frequency channel parameters are set to the desired settings. Refer to the sections "Changing the Mode Setup" on page 18 and "Changing the Frequency Channel" on page 23.

Measurement Selection

The **Measure** front-panel key accesses the menu to select one of the following measurements:

- **ACP** - Press this key to make adjacent channel power (ACP) measurements. The following menu is activated by the **View/Trace** front-panel key:

  Bar Graph - Displays the ACP bar graph at ±30, ±60 and ±90 kHz offsets from the center frequency of the carrier signal. The summary data is also available in the text window. This is the default selection for ACP measurements.

  Spectrum - Displays the ACP spectrum graph (with 24.3 kHz bandwidth marker lines) at ±30, ±60 and ±90 kHz offsets from the center frequency of the carrier signal. The summary data is also available in the text window.

- **EVM** - Press this key to make error vector magnitude (EVM) measurements. The following menu is activated by the **View/Trace** front-panel key:

  I/Q Measured Polar Vector - Displays the EVM polar vector graph of the I/Q demodulated signal. The summary data is also available in the text window. This is the default selection for EVM measurements.

I/Q Measured Polar Constln - Displays the EVM polar constellation graph of the I/Q demodulated signal. The summary data is also available in the text window.

I/Q Error (Quad-View) - Displays four windows for the **EVM**, **Mag Error**, **Phase Error** graphs and the **EVM** summary data. By selecting one of the windows with the **Next Window** front-panel key, you can enlarge it to the full display area by pressing the **Zoom** key.

- **Spectrum (Freq Domain)** - Press this key to make spectrum measurements with the spectrum and I/Q waveform display windows. The following menu is activated by the **View/Trace** front-panel key:

  Spectrum - Switches from the **I/Q Waveform** window to **Spectrum** window. This is equivalent to the **Next Window** front-panel key. This is the default selection for spectrum (frequency domain) measurements.

  I/Q Waveform - Switches from the **Spectrum** window to **I/Q Waveform** window. This is equivalent to the **Next Window** front-panel key.

  Trace Display - Allows you to control the traces displayed for the current measurement data and/or the averaged data as follows:

    All - Displays both current and average traces if the **Average** function is already activated. This is the default selection for spectrum (frequency domain) measurements.

    Average (or Max & Min) - Displays only the average trace if it is already activated.

    Current - Displays only the current data trace.

- **Waveform (Time Domain)** - Press this key to make time-domain waveform measurements with either display of the **RF Envelope** graph and summary data windows or the **I/Q Waveform** window. The following menu is activated by the **View/Trace** front-panel key:

  RF Envelope - Changes to display the RF envelope graph window and the summary data window. This is the default selection for waveform (time domain) measurements.

  I/Q Waveform - Changes to display the I/Q waveform graph window.

Measurement Control

The **Meas Control** front-panel key accesses the menu to control processes that affect running the current measurement.

- **Restart -** Press this key to repeat the current measurement from the beginning, while retaining the current measurement settings. This is equivalent to the **Restart** front-panel key.
- **Measure -** Press this key (not to be confused with the **Measure** front-panel key which has a different function) to toggle the measurement state between **Single** and **Cont** (continuous). When set to single, the measurement will continue until it has reached the specified number of averages set by the average counter. When set to continuous, the measurement will run continuously and execute averaging according to the current average mode, either repeat or exponential. The default setting is **Cont**.
- **Pause** - Press this key to pause the current measurement until you reactivate the measurement. Once toggled, the label of the **Pause** key changes to read **Resume**. The **Resume** key, once pressed, continues the active measurement from the point at which it was paused.

Measurement Setup

The **Meas Setup** key accesses the features that enable you to adjust parameters of the current measurement, such as resolution bandwidth. You will also use the **Meas Setup** menu to access the **Avg Number**, **Avg Mode** and **Trig Source** keys.

The following measure setup feature can be used with many or all measurements.

- **Restore Meas Defaults** - Allows you to preset only the settings that are specific to the selected measurement by pressing **Meas Setup**, **More (1 of 2)**, **Restore Meas Defaults**. This will set the measure setup parameters, for the currently selected measurement only, to the factory defaults.

Averaging

Selecting one of the averaging keys in the **Meas Setup** menu will allow you to modify the average number and averaging mode you use for the currently selected measurement. For spectrum (frequency domain) and waveform (time domain) measurements, the **Average** key activates the following menu:

- **Avg Number** - Allows you to change the number of N averages to be made.

- **Avg Mode** - Allows you to toggle the averaging mode between **Exp** (exponential) and **Repeat**. This selection only effects the averaging result after the number of N averages is reached. The N is set using the **Avg Number** key.

  Normal averaging: Normal (linear) averaging is always used until the specified number of N averages is reached. When the **Measure** key under **Meas Control** is set to **Single**, data acquisition is stopped when the number of N averages is reached, thus **Avg Mode** has no effect in the **Single** measurement mode.

  Exponential averaging: When **Measure** is set to **Cont**, data acquisition will continue indefinitely. Exponential averaging is used with a weighting factor of N (the displayed count of averages stops at N). Exponential averaging weights new data more heavily than old data, which allows tracking of slow-changing signals. The weighting factor N is set using the **Avg Number** key.

  Repeat averaging: When **Measure** is set to **Cont**, data acquisition will continue indefinitely. After the number of N averages is reached, all previous result data is cleared and the displayed count of averages is set back to 1. This is equivalent to being in **Measure Single** and pressing the **Restart** key each time the single measurement finishes.

- **Avg Type** - Allows you to access the following menu only for making spectrum (frequency domain) and waveform (time domain) measurements:

  Pwr Avg (RMS) - Executes the true power averaging which is equivalent to taking the rms of the voltage. This is the most accurate type.

  Log-Pwr Avg (Video) - Simulates the traditional spectrum analyzer type of averaging by calculating an average of the log power.

  Voltage Avg - Executes the voltage averaging.

  Maximum - Executes the maximum voltage averaging by capturing peak data.

  Minimum - Executes the minimum voltage averaging.

Trigger Source

Changing the selection in the **Trig Source** menu alters the trigger source for the selected measurement only. Not all of the selections are available for all measurements. Choose one of the following trigger sources:

NOTE The **RF Burst**, **Video (IF Envlp)**, **Ext Front** and **Ext Rear** keys found under the **Trigger** menu enable you to change the default settings of the delay, level and slope for each of these trigger sources.

- **Free Run (Immediate)** - A trigger occurs at the time the data is requested, completely asynchronous with the RF or IF signal.
- **Video (IF Envlp)** - An internal IF envelope trigger that occurs at the absolute threshold level of the IF signal level. This trigger source is not available for ACP measurements.
- **RF Burst (Wideband)** - An internal wideband RF burst trigger that has the automatic level control for burst signals. It triggers at the level that is set relative to the peak RF signal (12 MHz bandwidth) input level.
- **Ext Front** - Activates the front-panel external trigger input (**EXT TRIGGER INPUT**) port. The external signal must be between –5.00 and +5.00 V with 1 or 10 mV resolution.
- **Ext Rear** - Activates the rear panel external trigger input (**TRIGGER IN**) port. The external signal must be between –5.00 and +5.00 V with 1 or 10 mV resolution.
- **Frame** - Uses the internal frame clock to generate a trigger signal. The clock parameters are controlled under the **Mode Setup** key or the measurement firmware, but not both. See the specific measurement for details.
- **Line** - Sets the trigger to the internal line mode. Sweep triggers occur at intervals synchronous to the line frequency. This trigger source is available for spectrum (frequency domain) and waveform (time domain) measurements.

The rear panel **TRIGGER 1 OUT** and **TRIGGER 2 OUT** connectors are coupled to the selected trigger source. These trigger outputs are always on at the rising edge with a pulse width of at least 1 μs.

Burst Sync

This menu is only used for EVM measurements. Pressing the **Burst Sync** key allows you to choose the source used to synchronize the measurement to the "point 0" of the NADC burst. The "point 0" is defined as the start of symbol 1 in timeslot 1. Pressing the **Burst Sync** key accesses the menu with the following choices:

- **Sync Word** - Synchronizes the measurement to the sync word which is one of the six possible 28-bit NADC timeslot synchronization words contained in the signal. This is the default selection when **Device** is set to **MS**.
- **RF Amptd** - Synchronizes the measurement to the rising edge of the bursted RF carrier. The **Search Threshold** setting in the **Burst** menu under **Mode Setup** applies to **RF Amptd**.
- **None** - Measurements are made without synchronizing with the NADC burst. This is the default selection when **Device** is set to **BS**.

Making the Adjacent Channel Power Measurement

Purpose

To maintain a quality call by avoiding channel interference, it is quite important to measure and reduce an adjacent channel power (ACP) transmitted from an NADC mobile phone. The characteristics of adjacent channel power are mainly determined by the transmitter design, including a digital filter called a root Nyquist filter.

Adjacent channel power is defined by the NADC standard as the total power within the defined bandwidth, centered at Δf kHz offset from the carrier frequency. The carrier is modulated by the standard coding test signal which has the same coding speed as the NADC modulation signal. The following specifications from the TIA/EIA IS-136, IS-137 and IS-138 standards apply to both base stations and mobile stations:

(1) At ±30 kHz offsets: Less than –26 dBc

(2) At ±60 kHz offsets: Less than –45 dBc

(3) At ±90 kHz offsets: Less than –45 dBc or –13 dBm, whichever is the lowest power

For Tx power >50 W: –60 dBc

Measurement Method

This measurement analyzes the total power levels within the defined bandwidth at given offset frequencies on both sides of the carrier frequency using Fast Fourier Transform (FFT). If **Offset Power** is set to **Integ** (integration), the total power within the 32.8 kHz bandwidth, using the root-raised cosine weighting filter, is measured at each offset frequency. The equivalent 3-dB bandwidth is 24.3 kHz. If **Offset Power** is set to **Peak**, the total peak power is measured with 1 kHz resolution bandwidth through the entire NADC bandwidth of 30 kHz.

The measurement functions, such as averaging, trigger source, limit test, offsets and limits, need to be set up to make a measurement and pass/fail test based on the NADC channel width and weighting prescribed in the NADC standard. The test result is displayed in either bar graph window or spectrum window. Both the absolute power levels and the power levels relative to the center power band are displayed in the text window. When **Spectrum View** is selected, the vertical scale can be varied for your optimum observation by pressing the **Amplitude Y Scale** front-panel key.

Making the Measurement

NOTE The factory default parameters provided for this measurement will give you an NADC compliant measurement for the instrument setup. You should be able to make a measurement often using these defaults.

Select the desired center frequency as described in “Changing the Frequency Channel” on page 23.

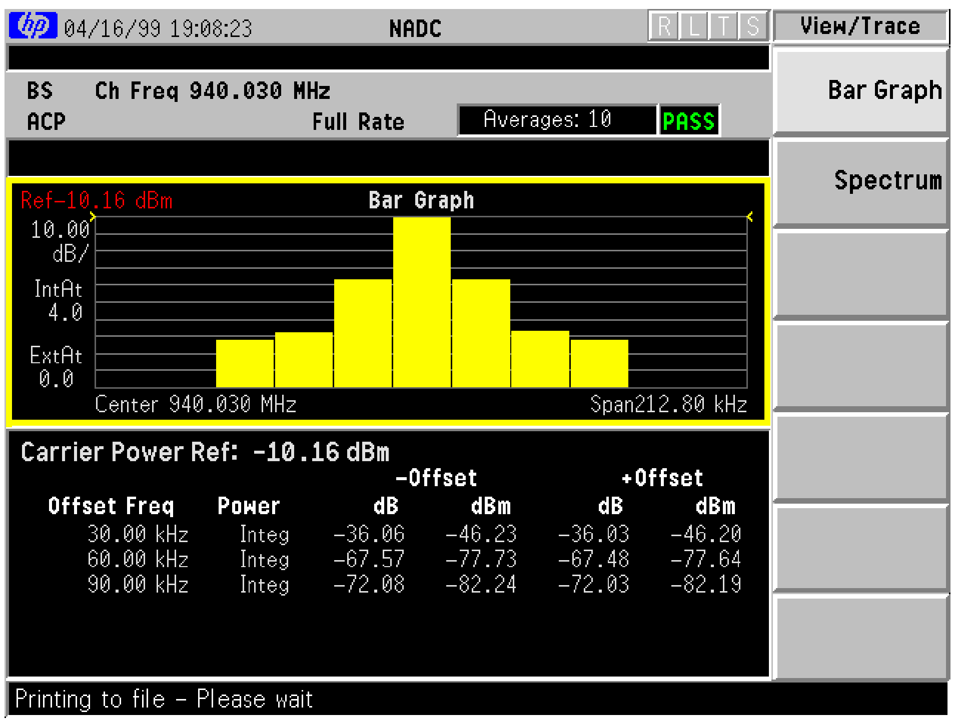
Press **Measure**, **ACP** to immediately make an adjacent channel power measurement.

To change any of the measurement parameters from the factory default values, refer to “Changing the Measurement Setup” on page 47 for this measurement.

Results

The next figure shows an example result of adjacent channel power measurements in the bar graph window. The power levels on both sides of the carrier frequency are displayed in the graph window and text window.

Figure 3-1 Adjacent Channel Power Measurement - Bar Graph View



Changing the Measurement Setup

The next table shows the factory default settings for adjacent channel power measurements.

Table 3-1 Adjacent Channel Power Measurement Defaults

Measurement Parameter	Factory Default Condition
View/Trace	Bar Graph
Meas Setup:	
Avg Number	10, On
Avg Mode	Exp
Trig Source:	
(when Device is MS)	Free Run (Immediate)
(when Device is BS)	RF Burst (Wideband)
Limit Test	On
Ofs & Limits:	
Offset	A
Offset Freq:	
A	30.000 kHz, On
B	60.000 kHz, On
C	90.000 kHz, On
D	120.000 kHz, Off
E	0.0 Hz, Off
Offset Power	Integ
Abs Limit:	
A, B, D, E	0.00 dBm
C	–13.00 dBm
Fail:	
A, B	Relative
C	OR
D, E	AND
Rel Lim (Car):	
A	–26.00 dB
B, C	–45.00 dB
D, E	0.00 dB

Make sure the **ACP** measurement is selected under the **Measure** menu. The **Meas Setup** key accesses the menu which allows you to modify the average number, average mode and trigger source for this measurement as described in "Measurement Setup" on page 41. However, the trigger source does not include **Video** and **Line**. In addition, the following parameters for adjacent channel power measurements can be modified:

- **Limit Test** - Allows you to toggle the limit test function between **On** and **Off**. If set to **On**, **Abs Limit** and/or **Rel Lim (Car)** need to be specified to execute pass/fail tests with the logical judgement under the **Fail** key. Pass/fail results are shown in the active display window with the number of averages. In the text window, a red character F is shown on the right side of each measurement result, either relative or absolute, if it exceeds the limits with its logical judgement.
- **Ofs & Limits** - Allows you to access the menu to change the following parameters for pass/fail tests:

  Offset - Allows you to access the memory selection menu to store 5 offset frequency values in **A** through **E**. Only one selection at a time (A, B, C, D, or E) is shown on this key label. The default selection is A.

  Offset Freq - Allows you to enter an offset frequency value and toggle the offset frequency function between **On** and **Off**, according to each offset key selected. The allowable range is 0 Hz to 200.000 kHz. While this key is activated, enter an offset value from the numeric keypad by terminating with one of the frequency unit keys shown. For NADC measurements offsets A, B and C are defaulted to 30.000 kHz On, 60.000 kHz On, and 90.000 kHz On, respectively. Offset D is temporarily defaulted to 120.000 kHz Off while offset E is defaulted to 0.00 Hz Off. One offset frequency value selected from the **Offset** menu is shown on this key label. The default state shows 30.000 kHz On.

  Offset Power - Allows you to select either one of the following power measurement methods:

    Integ (integration) - Measures the total power within the NADC bandwidth of 32.8 kHz with the root-raised cosine weighting filter.

    Peak - In a 1 kHz resolution bandwidth, the peak frequency amplitude across the 30 kHz channel is reported. When averaging is on, an rms average is computed prior to the peak selection. This creates a banded limit line measurement, similar to other standards which call for a close-in spurious response measurement. Limits can be relative or absolute. When the limits are relative, the average power in the reference channel, normalized to a 1 kHz bandwidth, is used to compute the ratio.

Abs Limit - Allows you to enter an absolute limit value ranging from –200.00 to +50.00 dBm with the best resolution of 0.01 dB. The default settings for offsets A, B, D and E are 0.00 dBm, while offset C is defaulted to –13.00 dBm to make the OR logical judgement with its relative limit of –45.00 dB.

Fail - Allows you to access the following menu to select one of the logic keys for fail conditions between the measurement results and the test limits:

AND - Fail is shown if one of the relative ACP measurement results is larger than **Rel Lim (Car)** AND one of the absolute ACP measurement results is larger than **Abs Limit**. This is the default setting for offsets D and E.

OR - Fail is shown if one of the relative ACP measurement results is larger than **Rel Lim (Car)** OR one of the absolute ACP measurement results is larger than **Abs Limit**. This is the default setting for offset C.

Absolute - Fail is shown if one of the absolute ACP measurement results is larger than **Abs Limit**.

Relative - Fail is shown if one of the relative ACP measurement results is larger than **Rel Lim (Car)**. This is the default setting for offsets A and B.

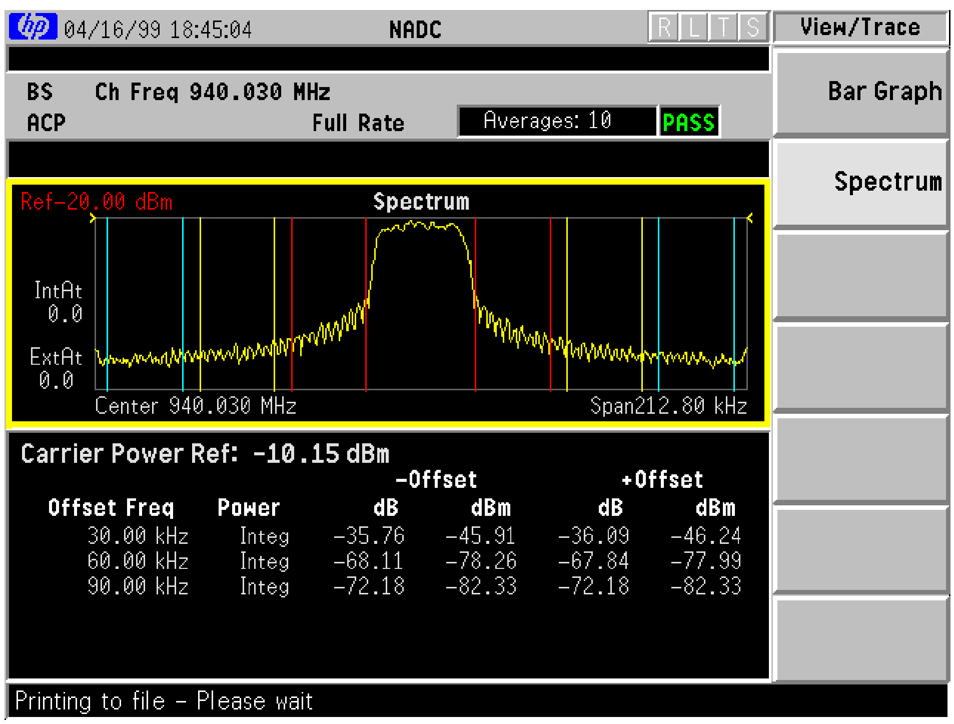
Rel Lim (Car)- Allows you to enter a relative limit value ranging from –200.00 to +50.00 dB with the best resolution of 0.01 dB. The default settings for offsets A, B and C are –26.00, –45.00 and –45.00 dB, respectively, while offsets D and E are defaulted to 0.00 dB.

Changing the View

The **View/Trace** key accesses the menu which allows you to select the desired measurement view from the following selections:

- **Bar Graph** - In the factory default condition, 7 of the total integration power levels, centered at the carrier frequency and ±30 kHz, ±60 kHz and ±90 kHz offset frequencies, are shown in the bar graph window. The corresponding measured data is shown in the text window as shown in Figure 3-1 on page 46.
- **Spectrum** - Once this view is selected, Figure 3-1 on page 46 changes as shown below. In the factory default condition, the swept frequency spectrum is displayed with the bandwidth marker lines in the spectrum graph window. The corresponding measured data in the text window is the total integration power within the defined bandwidth. While in this view, you can change the vertical scale by pressing the **Amplitude Y Scale** key.

Figure 3-2 Adjacent Channel Power Measurement - Spectrum View



Troubleshooting Hints

The adjacent channel power measurements suggest us numerous faults in the transmitter section of the UUT, as follows:

(1) Faults caused by a malfunction of the baseband circuitry consisting of a code generator, a digital filter, digital-to-analog converters, 90-degree phase shifter, and I/Q modulators.

(2) Faults due to high phase noise levels from the local oscillators.

(3) Faults due to excessive noise floor levels from the up-converter, output amplifier, and/or analog filters.

Making the Error Vector Magnitude Measurement

Purpose

Phase and frequency errors are the measures of modulation quality for the NADC system. This modulation quality is obtained through Error Vector Magnitude (EVM) measurements. Since the NADC system uses the $\pi/4$ DQPSK modulation technique, the phase and frequency accuracies of the NADC transmitter are critical to the communications system performance and ultimately affect range.

NADC receivers rely on the phase and frequency quality of the $\pi/4$ DQPSK modulation signal in order to achieve the expected carrier to noise ratio. A transmitter with high phase and frequency errors will often still be able to support phone calls during a functional test. However, it will tend to provide difficulty for mobiles trying to maintain service at the edge of the cell with low signal levels or under difficult fading and Doppler conditions.

Measurement Method

The phase error of the unit under test is measured by computing the difference between the phase of the transmitted signal and the phase of a theoretically perfect signal.

The instrument samples the transmitter output in order to capture the actual phase trajectory. This is then demodulated and the ideal phase trajectory is mathematically derived using detected bits and raised-cosine channel filtering. Subtracting one from the other results in a phase error signal.

For base stations, the NADC standard specifies that the phase error should not exceed 5 degrees rms or 20 degrees peak, and that the mean frequency error across the burst must not exceed 0.05 ppm. These specifications hold true for normal and extreme temperature conditions, and with exposure to vibration.

This measurement allows you to display these errors numerically and graphically on the instrument display. There are graphs for `EVM`, `Phase Error` and `Mag Error` in the graph windows. In the text window, there are `Evm:` in % rms, in % peak at the highest symbol number, in % rms on the first 10 symbols (only when Device is MS), `Mag Error:` in % rms, `Phase Error:` in degrees, `Freq Error:` in Hz, and `IQ Offset:` in dB.

Making the Measurement

NOTE The factory default parameters provided for this measurement will give you an NADC compliant measurement for the instrument setup. You should be able to make a measurement often using these defaults.

Select the desired center frequency, burst type, and slot as described in "Changing the Frequency Channel" on page 23.

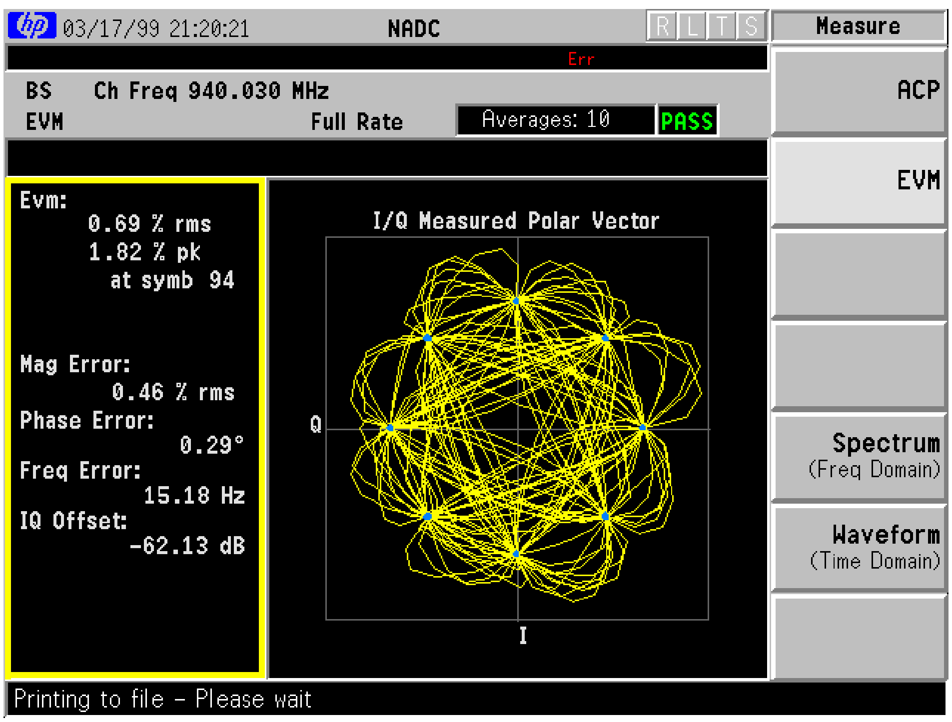
Press **Measure**, **EVM** to immediately make an error vector magnitude measurement.

To change any of the measurement parameters from the factory default values, refer to "Changing the Measurement Setup" on page 63 for this measurement.

Results

The next figure shows an example of measurement result with the graph and text windows. The measured summary data is shown in the left window and the dynamic vector trajectory of the I/Q demodulated signal is shown as a polar vector display in the right window. When **Device** is set to **MS**, the **First 10 EVM** result is also shown in the left window.

Figure 3-3 Error Vector Magnitude Measurement - Polar Vector View



Changing the Measurement Setup

The next table shows the factory default settings for error vector magnitude measurements.

Table 3-2 Error Vector Magnitude Measurement Defaults

Measurement Parameter	Factory Default Condition
View/Trace	I/Q Measured Polar Vector
Meas Setup:	
Avg Number	10, On
Avg Mode	Exp
Trig Source: (when Device is BS) (when Device is MS)	 Free Run (Immediate) RF Burst (Wideband)
Burst Sync: (when Device is BS) (when Device is MS)	 None Sync Word
Limit Test	On
Limits: RMS EVM Peak EVM First 10 EVM (MS only) Origin Offset	 12.5 Pcnt 40.0 Pcnt 25.0 Pcnt –20.00 dB

Make sure the **EVM** measurement is selected under the **Measure** menu. The **Meas Setup** key accesses the menu which allows you to modify the averaging, trigger source and burst sync for this measurement as described in "Measurement Setup" on page 41. However, the trigger source does not include **Line**. In addition, the following error vector magnitude measurement parameters can be modified:

- **Limit Test** - Allows you to toggle the limit test function between **On** and **Off**. If set to **On**, the **Limits** key needs to be pressed to specify the limit values for rms EVM, peak EVM, first 10 symbols EVM (when Device is set to MS) and origin offset. Pass/fail results are shown in the active display window with the number of averages.
- **Limits** - Allows you to access the menu to change the following parameters for pass/fail tests:

  RMS EVM - Allows you to enter a limit value ranging from 0.0 to 50.0% with 0.1% resolution for the pass/fail test of the rms error vector magnitude measured on all of the symbols. The default setting is 12.5%.

Peak EVM - Allows you to enter a limit value ranging from 0.0 to 50.0% with 0.1% resolution for the pass/fail test of the peak error vector magnitude measured on all of the symbols. The default setting is 40.0%.

First 10 EVM (MS only) - Allows you to enter a limit value ranging from 0.0 to 50.0% with 0.1% resolution for the pass/fail test of the error vector magnitude measured on the first 10 symbols. The default setting is 25.0%. This is valid when **Device** is set to **MS**.

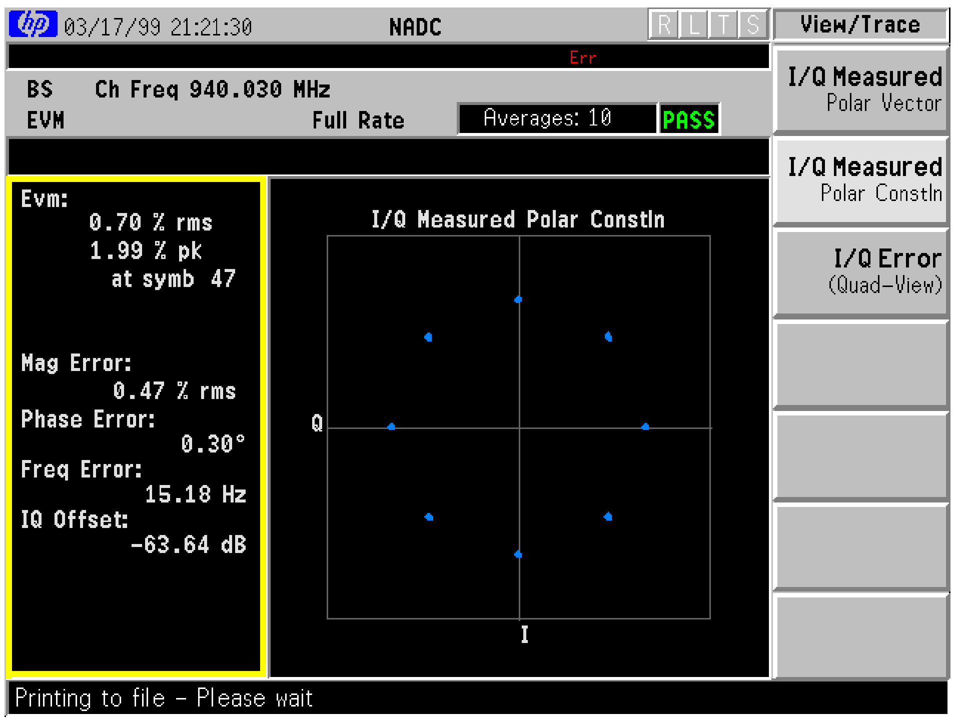
Origin Offset - Allows you to enter a limit value ranging from –100.00 to 0.00 dB with 0.01 dB resolution for the pass/fail test of the origin offset. The default setting is –20.00 dB.

Changing the View

The **View/Trace** key accesses the menu which allows you to select the desired measurement view from the following selections:

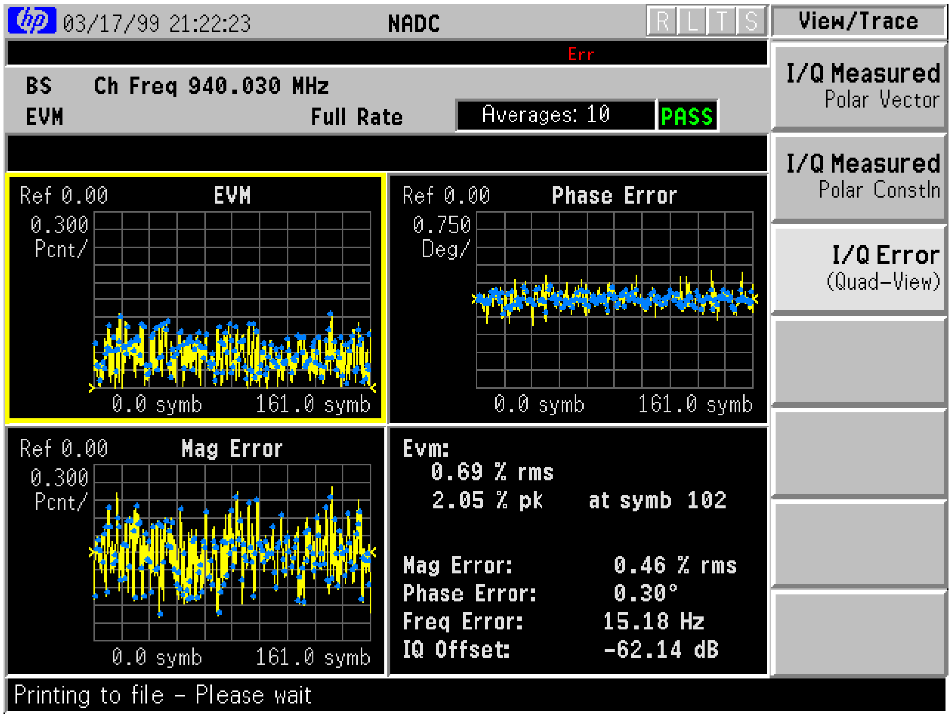
- **I/Q Measured Polar Vector** - The measured summary data is shown in the left window and the dynamic vector trajectory of the I/Q demodulated signal is shown as a polar vector display in the right window as shown in Figure 3-3 on page 53.
- **I/Q Measured Polar Constln** - The measured summary data is shown in the left window and the dynamic polar constellation of the I/Q demodulated signal is shown as a polar constellation display in the right window as shown below.

Figure 3-4 Error Vector Magnitude Measurement - Polar Constln View



- **I/Q Error (Quad-View)** - Four display windows show EVM, `Mag Error` and `Phase Error` graphs, and the EVM summary data text as shown below.

Figure 3-5 Error Vector Magnitude Measurement - Quad View



Changing the Display

The **Display** key accesses the menu to allow the following selections for changing the graph displays of I/Q Measured Polar Vector and I/Q Error (Quad-View):

- **Pts/Symb Displayed** - Allows you to specify the number of displayed points per symbol, either **1** or **5**. The default setting is **5**.
- **Symbol Dots** - Allows you to toggle the symbol dot display function between **On** and **Off**. The default setting is **On**.

When either EVM, `Phase Error` or `Mag Error` window is active in the I/Q Error (Quad-View) display, the **Span X Scale** key accesses the menu to allow the following selections:

- **Scale/Div** - Allows you to define the horizontal scale by changing the symbol value per division. The range is 1.000 to 100.0 symbols per division with the best resolution of 0.001 symbol. The default setting is 16.10 (for BS) or 15.60 (for MS) symbols per division. However, since the **Scale Coupling** default is set to **On**, this value is automatically determined by the measurement result.
- **Ref Value** - Allows you to set the symbol reference value ranging from 0 to 1000 symbols. The default setting is 0.000 symbol. This value is automatically determined by the magnitude of the measurement results because **Scale Coupling** is defaulted to **On**.
- **Ref Position** - Allows you to set the reference position to either **Left**, **Ctr** (center) or **Right**. The default setting is **Left**.
- **Scale Coupling** - Allows you to toggle the scale coupling function between **On** and **Off**. The default setting is **On.** This function automatically determines the scale per division and reference value by the magnitude of the measurement results.

When either EVM or `Mag Error` window is active in the I/Q Error (Quad-View) display, the **Amplitude Y Scale** key accesses the menu to allow the following selections:

- **Scale/Div** - Allows you to define the vertical scale by changing the value per division. The range is 0.100 to 50.0% per division. The default setting is 20.0%. However, since the **Scale Coupling** default is set to **On**, this value is automatically determined by the measurement result.
- **Ref Value** - Allows you to set the reference value ranging from 0.00 to 500.0%. The default setting is 0.00%. This value is automatically determined by the magnitude of the measurement results because **Scale Coupling** is defaulted to **On**.
- **Ref Position** - Allows you to set the reference position to either **Top**, **Ctr** (center) or **Bot** (bottom). For the EVM graph, the default setting is **Bot**. For the `Mag Error` graph, the default setting is **Ctr**.

- **Scale Coupling -** Allows you to toggle the scale coupling function between **On** and **Off**. The default setting is **On**. This function automatically determines the scale per division and reference value by the magnitude of the measurement results.

When the `Phase Error` window is active in the I/Q Error display, the **Amplitude Y Scale** key accesses the menu to allow the following selections:

- **Scale/Div -** Allows you to define the vertical scale by changing the value per division. The range is 0.01 to 3600 degrees. The default setting is 20.0 degrees per division. However, since the **Scale Coupling** default is set to **On**, this value is automatically determined by the magnitude of measurement results.
- **Ref Value -** Allows you to set the reference value ranging from –36000 to 36000 degrees. The default setting is 0.00 degrees. This value is automatically determined by the magnitude of the measurement results because **Scale Coupling** is defaulted to **On**.
- **Ref Position -** Allows you to set the reference position to either **Top**, **Ctr** (center) or **Bot** (bottom). The default setting is **Ctr**.
- **Scale Coupling -** Allows you to toggle the scale coupling function between **On** and **Off**. The default setting is **On**. This function automatically determines the scale per division and reference value by the magnitude of the measurement results.

Troubleshooting Hints

A poor phase error indicates a problem at the I/Q baseband generator, filters, and/or modulator in the transmitter circuitry of the UUT. The output amplifier in the transmitter can also create distortion that causes unacceptably high phase error. In a real system, a poor phase error will reduce the ability of a receiver to correctly demodulate the received signal, especially in marginal signal conditions.

Making the Spectrum (Frequency Domain) Measurement

Purpose

Excessive amount of spectrum energy spilling into an adjacent frequency channel could interfere with signals being transmitted to other mobile stations or base stations. The measurements are made for both spectrums due to π/4 DQPSK modulation and due to switching transients (burst ramping).

The spectrum measurement is a generic measurement for viewing spectrums in the frequency domain. The instrument uses Fast Fourier Transform (FFT) to provide the spectrum measurement. The measurement control is designed to be familiar to those who are accustomed to using general swept frequency spectrum analyzers.

The FFT-specific parameters are located in the **Advanced** menu on page 64. Also available is an I/Q waveform window, which shows the I and Q signals in parameters of voltage and time. The advantage of having an I/Q waveform view available in spectrum measurements is that it allows you to view complex components of the same signal without changing any settings or measurements.

Measurement Method

The transmitter tester uses digital signal processing (DSP) to sample the input signal and convert it to the frequency domain. With the instrument tuned to a fixed center frequency, samples are digitized at a high rate, converted to I and Q components with DSP hardware, and then converted to the frequency domain with FFT software.

Making the Measurement

NOTE The factory default parameters provided for this measurement will give you an NADC compliant measurement for the instrument setup. You should be able to make a measurement often using these defaults. Press **Meas Setup**, **More (1 of 2)**, **Restore Meas Defaults** at any time to return all parameters for the current measurement to their default settings.

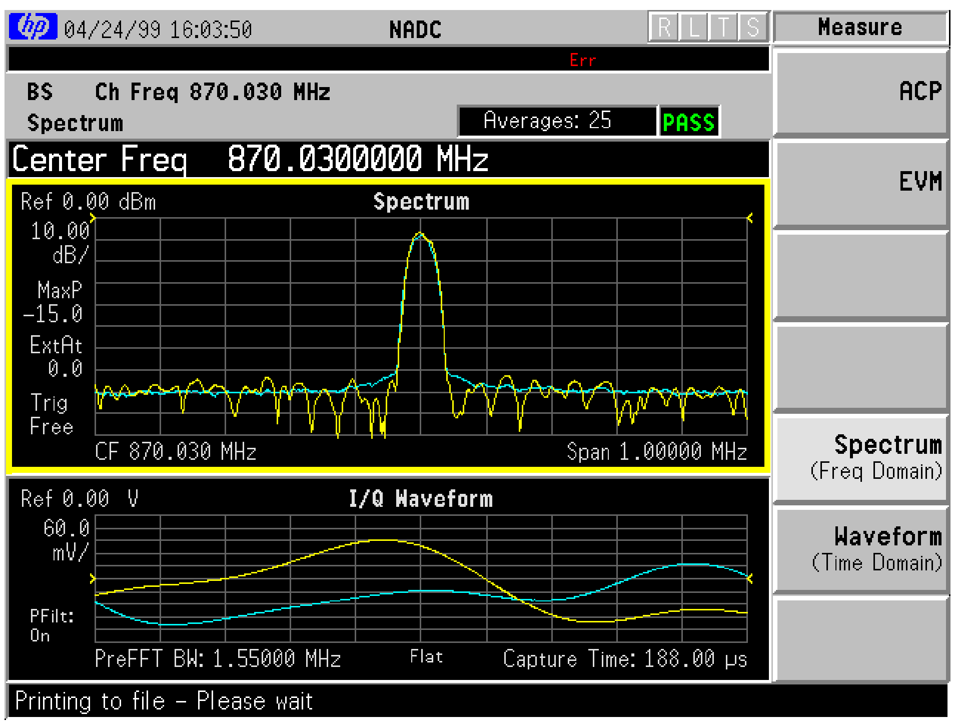
Press **Measure**, **Spectrum (Freq Domain)** to immediately make a spectrum (frequency domain) measurement.

To change any of the measurement parameters from the default values, refer to "Changing the Measurement Setup" on page 63 for this measurement.

Results

A display with both a `Spectrum` window and an `I/Q Waveform` window will appear when you activate a spectrum measurement. Use the **Next Window** key to select a window, and the **Zoom** key to enlarge it. Figure 3-6 shows an example of the spectrum measurement.

Figure 3-6 Spectrum Measurement - Spectrum and I/Q Waveform View



Changing the Measurement Setup

The next table shows the factory default settings for spectrum (frequency domain) measurements.

Table 3-3 Spectrum (Frequency Domain) Measurement Defaults

Measurement Parameter	Factory Default Condition
Meas Setup:	
Res BW	20.0000 kHz, Auto
Trig Source	Free Run (Immediate)
Average:	
Avg Number	25, On
Avg Mode	Exp
Avg Type	Log-Pwr Avg (Video)
Spectrum Window	
Meas Setup: Span	1.00000 MHz
Amplitude Y Scale: Scale/Div	10.00 dB
I/Q Waveform Window (major items)	
Meas Setup: Capture Time	188.00 µs
Amplitude Y Scale: Scale/Div	60.0 mV
Advanced	
Pre-ADC BPF	On
Pre-FFT Fltr	Flat
Pre-FFT BW	1.55000 MHz, Auto
FFT Window	Flat Top (High Amptd Acc)
FFT Size:	
Length Ctrl	Auto
Min Pnts/RBW	1.300000
Window Length	706 when Length Ctrl is Man
FFT Length	4096 when Length Ctrl is Man
ADC Range	Auto Peak
Data Packing	Auto
ADC Dither	Auto
Decimation	0, Auto
IF Flatness	On

NOTE Parameters under the **Advanced** key seldom need to be changed. Any changes from the default advanced values may result in invalid measurement data.

Make sure the **Spectrum (Freq Domain)** measurement is selected under the **Measure** menu. Press the **Meas Setup** key to access a menu which allows you to modify the averaging function and trigger source for this measurement as described in "Measurement Setup" on page 41. In addition, the following parameters can be modified:

- **Span** - Allows you to modify the frequency span in which the FFT measurement is made. The default setting is 1.00000 MHz. Changing the span causes the bandwidth to change automatically, and will affect data acquisition time.
- **Res BW** - Allows you to toggle the resolution bandwidth control between **Auto** and **Man**, and to specify the bandwidth value if set to **Man**. The default settings are **Auto** and 20.0000 kHz. A narrower bandwidth will result in a longer data acquisition time but you will be able to examine the signal more closely. In auto, the resolution bandwidth is set to **Span**/50 (2% of the span).
- **Advanced** - Allows you to access the following selection menu. The FFT advanced features should be used only if you are familiar with their operation. Changes from the default settings may result in invalid data.

  Pre-ADC BPF - Allows you to toggle the pre-ADC bandpass filter between **On** and **Off**. The default setting is **On**. The pre-ADC bandpass filter is useful for rejecting nearby signals, so that sensitivity within the span range can be improved by increasing the ADC range gain.

  Pre-FFT Fltr - Allows you to toggle the pre-FFT filter type between **Flat** (flat top) and **Gaussian**. The default setting is **Flat** which is suitable for FFT analysis. The Gaussian filter has better pulse response.

  Pre-FFT BW - Allows you to toggle the pre-FFT bandwidth control between **Auto** and **Man**. The default setting is **Auto**. In auto, this bandwidth is nominally 50% wider than the span. In manual, the bandwidth ranges from 1 Hz to 10 MHz. This bandwidth determines the ADC sampling rate.

FFT Window - Allows you to access the following selection menu. The default setting is **Flat Top (High Amptd Acc)**. If you are familiar with FFT windows, you can use other digital filters but the use of the flat top filter is recommended.

Flat Top (High Amptd Acc) - Select this filter for best amplitude accuracy by reducing scalloping error.
Uniform - Select this filter to have no active window.
Hanning - Press this key to activate the Hanning filter.
Hamming - Press this key to activate the Hamming filter.
Gaussian (Alpha 3.5) - Press this key to activate the Gaussian filter with an alpha of 3.5.
Blackman - Press this key to activate the Blackman filter.
Blackman-Harris - Press this key to activate the Blackman-Harris filter.
K-B 70dB/90dB/110dB (Kaiser-Bessel) - Allows you to select one of the Kaiser-Bessel filters with sidelobes at –70, –90, or –110 dB.

FFT Size - Allows you to access the following selection menu to define the FFT size:

Length Ctrl - Allows you to toggle the FFT and window length controls between **Auto** and **Man**.

Min Pnts/RBW - Allows you to set the minimum number of data points that will be used inside the resolution bandwidth. The range is 0.10 to 100.00 points with 0.01 or 0.1 resolution. The default setting is 1.300000 points. This key is valid if **Length Ctrl** is set to **Auto**.

Window Length - Allows you to enter the FFT window length in the number of captured samples ranging from 8 to 1048576. The default setting is 706. This length represents the actual quantity of I/Q samples that are captured for the FFT processing. This key is valid if **Length Ctrl** is set to **Man**.

FFT Length - Allows you to enter the FFT length in the number of captured samples ranging from 8 to 1048576. The default setting is 4096. The FFT length setting is automatically limited to equal to or greater than the FFT window length setting. Any amount greater than the window length is implemented by zero-padding. This key is valid if **Length Ctrl** is set to **Man**.

ADC Range - Allows you to access the following selection menu to define one of the ADC ranging functions. The default setting is **Auto Peak**.

Auto - Select this to set the ADC range automatically. For most FFT spectrum measurements, the auto feature should not be selected. An exception is when measuring a “bursty” signal, in which case auto can maximize the time domain dynamic range, if FFT results are less important to you than time domain results.

Auto Peak - Select this to set the ADC range automatically to the highest peak signal level. Auto peak is a compromise that works well for both CW and bursted signals.

Auto Peak Lock - Select this to adjust and hold the ADC range automatically at the peak signal level, even when that peak signal is no longer present. Auto peak lock is more stable than auto peak for CW signals, but should not be used for “bursty” signals.

Manual - Allows you to access the selection menu: –**6 dB**, **0 dB**, **+6 dB**, **+12 dB**, **+18 dB**, **+24 dB**, to set the ADC range level. Also note that manual ranging is best for CW signals.

Data Packing - Allows you to access the following selection menu to define one of the data packing methods. The default setting is **Auto**.

Auto - Data is automatically packed. This is the default setting and most recommended.

Short (16 bit) - Data is packed by every 16 bits.

Medium (24 bit) - Data is packed by every 24 bits.

Long (32 bit) - Data is packed by every 32 bits.

ADC Dither - Allows you to set the ADC dither function to **Auto**, **On**, or **Off**. The default setting is **Auto**. When set to auto, ADC dither will be activated when a narrow bandwidth is being measured, and deactivated when a wide bandwidth is being measured. “ADC dither” refers to the introduction of noise to the digitized steps of the analog-to-digital converter; the result is an improvement in amplitude accuracy. Use of ADC dither, however, reduces the dynamic range by approximately 3 dB.

Decimation - Allows you to toggle the decimation function between **Auto** and **Man**, and to enter a decimation value ranging from 0 to 1000 if set to **Man**. The default setting is 0 and **Auto** which is the preferred setting, and the only setting that guarantees aliasing-free FFT spectrum measurements. If you are familiar with the decimation feature, you can change the decimation value by setting to **Man**, but be aware that aliasing can result in higher values.

IF Flatness - Allows you to toggle the IF flatness feature between **On** and **Off**. The default setting is **On**. When toggled to **On**, the IF flatness feature causes background amplitude corrections to be performed on the FFT spectrum. The **Off** setting is used for adjustment and troubleshooting the transmitter tester.

Changing the View

The **View/Trace** key is used to activate a measurement view with preset X and Y scale parameters, called a “window”. Using the **Span X Scale** and **Amplitude Y Scale** keys you can then modify these settings. You can also activate one specific trace using the **Trace Display** key.

Windows Available for Spectrum Measurements

The spectrum and I/Q waveform windows can be viewed at the same time or individually. You can use the **Next Window** and **Zoom** keys to move between these views.

- **Spectrum** - Select this window if you want to analyze frequency and power. Changes to frequency span or power will sometimes affect data acquisition.
- **I/Q Waveform** - Select this window to view the I and Q signal characteristics of the current measurement in parameters of voltage and time.

NOTE For the widest spans, such as 4.5 MHz and greater, the I/Q waveform window becomes just “ADC time domain samples”, because the I/Q down-conversion is no longer in effect.

Using the Markers

The **Marker** front-panel key accesses the menu to configure the markers. If you want to use the marker function in the I/Q waveform window, press **View/Trace**, **I/Q Waveform**, **Marker**, **Trace**, **IQ Waveform**.

- **Select** - Allows you to activate up to four markers with the corresponding numbers, respectively. The selected number is underlined and its function is defined by pressing the **Function** key. The default setting is 1.
- **Normal** - Allows you to activate the selected marker to read the frequency and amplitude of the marker position on the spectrum trace, for example, which is controlled by the RPG knob.
- **Delta** - Allows you to read the differences in frequencies and amplitudes between the selected marker and the next.
- **Function** - Allows you to define the selected marker function to be **Band Power**, **Noise**, or **Off**. The default setting is **Off**. If set to **Band Power**, you need to select **Delta**. If set to **Noise**, you need to select **Normal**.
- **Trace** - Allows you to place the selected marker on the **Spectrum**, **Spectrum Avg**, or **I/Q Waveform** trace. The default setting is **Spectrum**.
- **Off** - Allows you to turn off the selected marker.
- **Shape** - Allows you to access the menu to define the selected marker shape to **Diamond**, **Line**, **Square**, or **Cross**. The default setting is **Diamond**.
- **Marker All Off** - Allows you to turn off all of the markers.

Example: Band Power Measurement

A band power measurement using the markers calculates the average power between two adjustable markers. To make a band power measurement:

Step 1. Press the **Marker** key.

Step 2. Press **Trace**, **Spectrum** to activate a marker on the instantaneous spectrum trace.

Step 3. Press **Function** and select **Band Power**.

Step 4. Two marker lines are activated at the extreme left side of the horizontal scale. Press **Normal** and move marker 1 to the desired place by rotating the RPG knob.

Step 5. Press **Delta** to bring marker 2 to the same place as marker 1.

Step 6. Move marker 1 to the other desired position by rotating the RPG knob. Example: “`Pwr Mkrs: 1, 2: 74.305 kHz –30.60 dBm`” displayed in the upper right corner of the spectrum window.

For a full description of the marker features see the user’s guide for your instrument.

Troubleshooting Hints

The spectrum measurement, along with the error vector magnitude measurements, can reveal several faults in the transmitter section, such as the I/Q baseband generator, filters, modulators and power amplifier, of the UUT.

Making the Waveform (Time Domain) Measurement

Purpose

The waveform measurement is a generic measurement for viewing waveforms in the time domain. This measurement is how the instrument performs the zero span functionality found in traditional spectrum analyzers. Also available under the basic waveform measurement is an I/Q waveform window that shows the I and Q signals with voltage and time parameters. The advantage of having an I/Q view available during waveform measurements is that it allows you to view complex components of the same signal without changing settings or measurements.

The waveform measurement can be used to perform general purpose power measurements to a high degree of accuracy.

Measurement Method

The transmitter tester makes repeated power measurements at a set frequency, similar to the way a swept-tuned spectrum analyzer makes zero span measurements. The analog input signal is converted to a digital signal, which then is processed into a representation of a waveform measurement using FFT. The transmitter tester relies on a high rate sampling process to create an accurate representation of a time domain signal.

Making the Measurement

NOTE The factory default parameters provided for this measurement will give you an NADC compliant measurement for the instrument setup. You should be able to make a measurement often using these defaults.

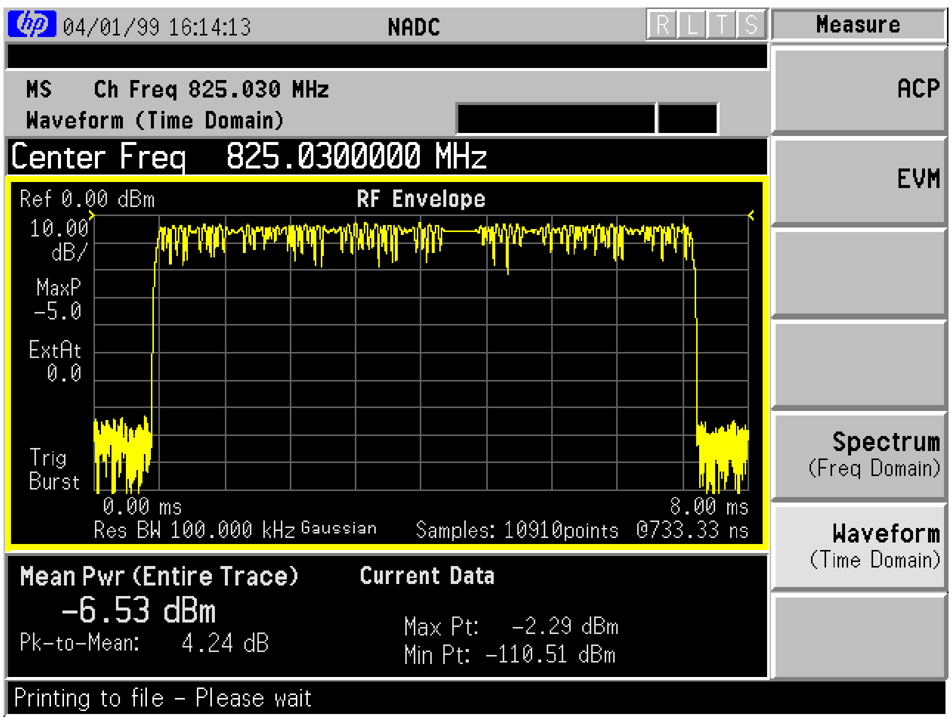
Press **Measure**, **Waveform (Time Domain)** to immediately make a waveform (time domain) measurement.

To change any of the measurement parameters from the factory default values, refer to "Changing the Measurement Setup" on page 73 for this measurement.

Results

A display with the RF envelope window and measured data window will appear when you activate a waveform (time domain) measurement. Figure 3-7 shows an example of the waveform (time domain) measurement.

Figure 3-7 Waveform (Time Domain) Measurement - RF Envelope View



Changing the Measurement Setup

The next table shows the factory default settings for waveform (time domain) measurements.

Table 3-4 Waveform (Time Domain) Measurement Defaults

Measurement Parameter	Factory Default Condition
View/Trace	RF Envelope
Meas Setup:	
Sweep Time	10.00 ms
Res BW	100.000 kHz
Average:	
Avg Number	10, Off
Avg Mode	Exp
Avg Type	Pwr Avg (RMS)
Trig Source	Free Run (Immediate)
RF Envelope	
Amplitude Y Scale:	
Scale/Div	10.00 dB
Ref Position	Top
I/Q Waveform	
Amplitude Y Scale:	
Scale/Div	100.0 mV
Ref Position	Ctr
Advanced	
Pre-ADC BPF	Off
RBW Filter	Gaussian
ADC Range	Auto
Data Packing	Auto
ADC Dither	Off
Decimation	Off

Make sure the **Waveform (Time Domain)** measurement is selected under the **Measure** menu. Press the **Meas Setup** key to access the menu which allows you to modify the averaging and trigger source for this measurement as described in “Measurement Setup” on page 41. In addition, the following waveform parameters can be modified:

- **Sweep Time** - Allows you to select the measurement acquisition time. The allowable range is 1.0 μs to 100.0 s, depending upon the resolution bandwidth setting. The default setting is 10.00 ms. It is used to specify the length of the time capture record.
- **Res BW**- Allows you to set the measurement resolution bandwidth. The allowable range is 10.0 Hz to 7.5 MHz with the best resolution of 1 Hz. The default setting is 100.000 kHz. A higher resolution bandwidth results in a larger number of acquisition points and reduces the maximum sweep time allowed.

NOTE Parameters under the **Advanced** key seldom need to be changed. Any changes from the default values may result in invalid measurement data.

- **Advanced** - Allows you to access the following selection menu. The FFT advanced features should be used only if you are familiar with their operation. Changes from the default settings may result in invalid data.

  Pre-ADC BPF - Allows you to toggle the pre-ADC bandpass filter between **On** and **Off**. The default setting is **Off**. The pre-ADC bandpass filter is useful for rejecting nearby signals, so that sensitivity within the span range can be improved by increasing the ADC range gain.

  RBW Filter - Allows you to toggle the resolution bandwidth filter type between **Flat** (flat top) and **Gaussian**. The default setting is **Gaussian**. The Gaussian filter provides more even time domain response, particularly for bursts. The flat top filter provides a flatter bandwidth but is less accurate for pulse responses. The flat top filter also requires less memory and allows longer data acquisition times. For most waveform applications, the Gaussian filter is recommended.

ADC Range - Allows you to access the following selection menu to define one of the ADC ranging functions. The default setting is **Auto**.

Auto - Select this to adjust the ADC range automatically for optimum results. As this is the time domain measurement of the bursted signal, auto can maximize the time domain dynamic range.

Auto Peak - Select this to adjust the ADC range continuously to the highest peak signal level identified. Auto peak is a compromise that works well for both CW and bursted signals.

Auto Peak Lock - Select this to adjust and hold the ADC range automatically at the highest peak signal level, even when that peak signal is no longer present. Auto peak lock is more stable than auto peak for CW signals, but should not be used for "bursty" signals.

Manual - Allows you to access the selection menu: –**6 dB**, **0 dB**, **+6 dB**, **+12 dB**, **+18 dB**, **+24 dB**, to set the ADC range level. Also note that manual ranging is best for CW signals.

Changing the View

The **View/Trace** key is used to activate a measurement view with preset X and Y scale parameters, called a "window". Using the **Span X Scale** and **Amplitude Y Scale** keys you can then modify these settings. You can also activate one specific trace using the **Trace Display** key.

Windows Available for Waveform Measurements

- **RF Envelope** - Select this window if you want to view power (in dBm) vs. time. Remember that data acquisition will be affected when you change the sweep time. An illustration of an RF envelope window is found in Figure 3-7 on page 72.
- **I/Q Waveform** - Select this window to view the I and Q signal characteristics of the current measurement in parameters of voltage and time.

Using the Markers

The **Marker** front-panel key accesses the menu to configure the markers. If you want to use the marker function in the I/Q waveform window, press **View/Trace**, **I/Q Waveform**, **Marker**, **Trace**, **IQ Waveform**.

- **Select** - Allows you to activate up to four markers with the corresponding numbers, respectively. The selected number is underlined and its function is defined by pressing the **Function** key. The default setting is 1.
- **Normal** - Allows you to activate the selected marker to read the time and amplitude of the marker position on the waveform trace, for example, which is controlled by the RPG knob.
- **Delta** - Allows you to read the differences in times and amplitudes between the selected marker and the next.
- **Function** - Allows you to define the selected marker function to **Band Power**, **Noise**, or **Off**. The default setting is **Off**. Press **Band Power**, **Delta** to read the time and absolute power differences between the selected marker and the next. Press **Off**, **Delta** to read the time and relative power differences between the markers. Pressing **Noise** is invalid and displays the message: "`Time Domain Noise Mkr not available`".
- **Trace** - Allows you to place the selected marker on the **RF Envelope** or the **I/Q Waveform** trace. The default setting is **RF Envelope**.
- **Off** - Allows you to turn off the selected marker.
- **Shape** - Allows you to access the menu to define the selected marker shape to **Diamond**, **Line**, **Square**, or **Cross**. The default setting is **Diamond**.
- **Marker All Off** - Allows you to turn off all of the markers.

For a full description of the marker features see the user's guide for your instrument.

Troubleshooting Hints

This waveform measurement, very often along with the adjacent carrier power measurement and/or spectrum measurement, can reveal some defective parts in the transmitter section of the UUT as follows:

(1) Some faults in the DC power supply control of the transmitter power amplifier, RF power controller of the pre-power amplifier stage, and/or I/Q control of the baseband stage, if the specified dynamic range is less than 80 dB.

(2) Some timing error from the faulty DC power on/off control circuit and other linear RF level control circuit.

4 Understanding PDC

What is the PDC Communications System?

Personal Digital Cellular (PDC) is one of the cellular communications systems in Japan. The PDC communications system is defined in the Association of Radio Industries and Business (ARIB) document, RCR STD-27, Personal Digital Cellular Telecommunication System Standard.

The PDC system is a digital communications system that employs a combination of a frequency division multiple access (FDMA) and a time division multiple access (TDMA). A pair of frequencies (130 or 50 MHz apart in the 800 MHz bands and 48 MHz apart in the 1500 MHz band) is used to provide the full duplex operation with RF channels spacing 50 kHz each with interleaving by 25 kHz.

Band	Uplink	Downlink
800 MHz	940 to 958 MHz	810 to 828 MHz
	887 to 889 MHz	832 to 834 MHz
	898 to 901 MHz	843 to 846 MHz
	915 to 940 MHz	860 to 885 MHz
1500 MHz	1429 to 1453 MHz	1477 to 1501 MHz

One TDMA frame is structured with 6 timeslots, so each channel frequency can support up to 6 timeslots. There are two types of speech codecs. One is the full-rate speech codec with 11.2 kbps coding speed in which two timeslots of each frame are used for one traffic channel. Another is the half-rate speech codec with 5.6 kbps coding speed in which each traffic channel requires just one timeslot per frame. For example, there is a transmission service among others that allows the network transmission function to switch between 5.6 kbps voice and 11.2 kbps data.

One frame is 40 ms long and each timeslot is 6.667 ms long. Thus, the mobile stations have burst carriers that are turned on for two timeslots (full-rate codec) or one timeslot (half-rate codec). When an RF channel is in use by a digital base station, the base station carrier will be turned on for one entire frame. This is true even if only one traffic channel is in use on that RF channel. However, the carrier power can be different at each timeslot.

The digital modulation format used in the PDC system is the $\pi/4$ differential quadrature phase shift keying ($\pi/4$ DQPSK). The $\pi/4$ DQPSK modulation causes both phase and amplitude variations on the RF signal. The quadrature nature of this modulation allows 2 bits to be transmitted at the same time on orthogonal carriers. These 2 bits make one PDC symbol. The digital modulation operates at 140 symbols, or

280 bits in each timeslot. The symbol period is 47.63 μs. Since there are 1,680 bits in 6 timeslots and 25 frames in one second, the transmission bit rate is 42,000 bits per second.

What does the Agilent Technologies E4406A do?

This instrument can help determine if a PDC transmitter operates correctly. When configured for PDC, the instrument can be used to test a PDC transmitter according to the Research and Development Center for Radio Systems (RCR) standards, RCR STD-27. This document defines complex and multiple-part measurements used to maintain an interference-free environment. For example, the document includes the testing method of a carrier power. The E4406A Transmitter Tester automatically makes these measurements based on the RCR standards. The detailed measurement result displays allow you to analyze PDC system performance. You may alter the measuring parameters for your specific measurement and analysis.

Other Sources of Measurement Information

Additional measurement application information is available through your local Agilent Technologies sales and service office. The following application notes explain digital communications measurements in much greater detail than discussed in this guide.

- Application Note 1298

  Digital Modulation in Communications Systems - An Introduction
  part number 5965-7160E

- Application Note 1324

  Understanding PDC and NADC Transmitter Measurements for Base Transceiver Stations and Mobile Stations
  part number 5968-5537E

Instrument Updates at www.agilent.com/find/vsa

This web location can be used to access the latest information about the transmitter tester.

5 Setting Up the PDC Mode

PDC Mode

You may want to install a new personality, reinstall a personality that you have previously uninstalled, or uninstall a personality option. Instructions can be found in "Installing and Uninstalling Optional Measurement Personalities" on page 104.

At the initial power up, the transmitter tester will come up in the Basic mode, with the Spectrum (frequency domain) measurement selected and the **Measure** menu displayed.

To access the PDC measurement personality press the **Mode** key and select **PDC**.

If you want to set the PDC mode to a known, factory default state, press the **Preset** key. This will preset the mode setup and all of the PDC measurements to the factory default parameters.

NOTE Pressing the **Preset** key does not switch instrument modes.

How to Make a Measurement

Follow the three-step procedure shown in the table below:

Step	Primary Key	Setup Keys	Related Keys
1. Select & setup a mode.	**Mode**	**Mode Setup**, **Input**, **Frequency Channel**	**System**
2. Select & setup a measurement.	**Measure**	**Meas Setup**	**Meas Control**, **Restart**
3. Select & setup a view.	**View/Trace**	**Span X Scale**, **Amplitude Y Scale**, **Display**, **Next Window**, **Zoom**	**File**, **Save**, **Print**, **Print Setup**, **Marker**, **Search**

Step 1. Select & setup a mode, for example:

- Press the **Mode** key and select **PDC**.
- Press the **Frequency Channel** key and enter the channel frequency to be measured.
- Press the **Mode Setup** key to change any of the settings in the **Radio**, **Input**, **Trigger** and **Burst** menus from those default settings, if required.

Refer to "Changing the Mode Setup" on page 88 and "Changing the Frequency Channel" on page 93 for further explanation.

Refer to "Mode Setup / Frequency Channel Key Flow" on page 95 for the hierarchical details.

Step 2. Select & setup a measurement, for example:

- Press the **Measure** key and select either **ACP**, **EVM**, **Occupied BW**, **Spectrum (Freq Domain)**, or **Waveform (Time Domain)** key to make its measurement.
- Press the **Meas Setup** key to change any of the measurement parameters from the default settings, if required. These parameters such as Span, Resolution Bandwidth, Trigger Source, Average, Limit Test and Limits, are decided according to the measurement selected.

Refer to "ACP Measurement Key Flow" on page 96, and to "Waveform (Time Domain) Measurement Key Flow (1 of 2)" on page 102 for the hierarchical details.

Step 3. Select & setup a view, for example:

- Press the **View/Trace** key and select the desired view for the current measurement.
- Press the **Next Window** key and select a window, then press the **Zoom** key to expand the window to the full display area.
- Press the **Span X Scale**, **Amplitude Y Scale**, and/or **Marker** keys for your desired display. These keys are not always valid for each measurement being done. The **Display** key is only valid for **EVM** measurements.

Refer to "ACP Measurement Key Flow" on page 96, and to "Waveform (Time Domain) Measurement Key Flow (1 of 2)" on page 102 for the hierarchical details.

Changing the Mode Setup

Numerous settings can be changed at the mode level by pressing the **Mode Setup** key. This will access the selection menu listed below. These settings affect only the measurements in the PDC mode.

Radio

The **Radio** key accesses the menu as follows:

- **Traffic Rate** - Allows you to toggle the traffic rate between **Full** and **Half**.
- **Device** - Allows you to toggle the test device between **BS** (Base Station) and **MS** (Mobile Station).

When the PDC mode is selected, the instrument will default to the following settings.

Radio Default Settings	
Traffic Rate	Full
Device	BS

Input

The **Input** key accesses the menu as follows: (You can also access this menu from the **Input** front-panel key.)

- **RF Input Range** - Allows you to toggle the RF input range function between **Auto** and **Man** (manual). **Auto** is not used for Spectrum (freq domain) measurements. If **Auto** is chosen, the instrument automatically sets the input attenuator based on the carrier power level, where it is tuned. Once you change the **Max Total Pwr** or **Input Atten** value with the RPG knob, for example, the **RF Input Range** key is automatically set to **Man**. If there are multiple carriers present, the total power might overdrive the front end amplifiers. In this case you need to set **RF Input Range** to **Man** and enter the expected maximum total power by activating the **Max Total Pwr** key. **Man** is also useful to hold the input attenuation constant for the best relative power accuracy. For single carriers it is generally recommended to set this to **Auto**.
- **Max Total Pwr** - Allows you to set the maximum total power from the UUT (Unit Under Test). The range is –200.00 to +50.00 dBm with 0.01 dB resolution. This is the expected maximum value of the mean carrier power referenced to the output of the UUT; it may include multiple carriers. The **Max Total Pwr** setting is coupled together with the **Input Atten** and **Ext Atten** settings. Once you change the **Max Total Pwr** value with the RPG knob, for example, the **RF Input Range** key is automatically set to **Man**.

- **Input Atten** - Allows you to control the internal input attenuator setting. The range is 0 to 40 dB with 1 dB resolution. The **Input Atten** key reads out the actual hardware value that is used for the current measurement. If more than one input attenuator value is used in a single measurement, the value used at the carrier frequency will be displayed. The **Input Atten** setting is coupled together with the **Max Total Pwr** setting. Once you change the **Input Atten** value with the RPG knob, for example, the **RF Input Range** key is automatically set to **Man**.
- **Ext Atten** - Allows you to access the following menu to enter the external attenuation values. Either of the **Ext Atten** settings is coupled together with the **Max Total Pwr** setting, however, pressing **Ext Atten** does not switch the **RF Input Range** key to **Man**. This will allow the instrument to display the measurement results referenced to the output of the UUT.

  MS - Sets an external attenuator value ranging from –50.00 to +50.00 dB with 0.01 dB resolution for MS. The default setting is 0.00 dB.

  BS - Sets an external attenuator value ranging from –50.00 to +50.00 dB with 0.01 dB resolution for BS. The default setting is 0.00 dB.

NOTE The **Max Total Pwr** setting is coupled together with the **Input Atten** and **Ext Atten** settings. For a given measurement, changing the input **Max Total Pwr** setting by x dB changes the **Input Atten** setting by x dB, and vice-versa. However, changing the **Max Total Pwr** setting does not change the **Ext Atten** setting, even though changing the **Ext Atten** setting by x dB changes the **Max Total Pwr** setting by x dB. When you switch to a different measurement, the **Max Total Pwr** setting is kept constant, but the **Input Atten** setting may change if the two measurements have different mixer margins. Thus, you can directly set the transmitter tester input attenuator, or you can set it indirectly by specifying the expected maximum power from the UUT.

When the PDC mode is selected, the instrument will default to the following settings.

Input Default Settings	
RF Input Range	Auto[a]
Max Total Pwr	–15.00 dBm[b]
Input Atten	0.00 dB[b]
Ext Atten:	
MS	0.00 dB
BS	0.00 dB

a. Auto is not used for Spectrum (freq domain) measurements.
b. This may differ if the maximum input power is more than –15 dBm.

Trigger

The **Trigger** key allows you: (1) to access the trigger source selection menu to specify the triggering conditions for each trigger source, (2) to modify the default trigger holdoff time using the **Trig Holdoff** key, (3) to modify the auto trigger time and to activate or deactivate the auto trigger feature using the **Auto Trig** key, and (4) to modify the period of the frame timer using the **Frame Timer** key.

NOTE The actual trigger source is selected separately for each measurement under the **Meas Setup** key.

- **RF Burst**, **Video (IF Envlp)**, **Ext Front** and **Ext Rear** - Pressing one of these trigger keys will access each triggering condition setup menu. This menu is used to specify the **Delay**, **Level** and **Slope** settings for each trigger source as follows:

  Delay - Allows you to enter a numerical value to modify the trigger delay time. The range is –500.000 to +500.000 ms with the best resolution of 1 µs. For trigger delay use a positive value, and for pre-trigger use a negative value.

  Level - Allows you to enter a numerical value to adjust the trigger level depending on the trigger source selected.

  — For **RF Burst** selection, the RF level range is –200.00 to 0.00 dB with 0.01 dB resolution, relative to the peak RF signal level. The realistic range can be down to –20 dB.

  — For **Video (IF Envlp)** selection, the video level range is –200.00 to +50.00 dBm with 0.01 dB resolution at the RF input. The realistic range can be down to around –40 dBm, depending on the noise floor level of the input signal.

  — For **Ext Front** or **Ext Rear** selection, the level range is –5.00 to +5.00 V with 1 or 10 mV resolution.

  Slope - Allows you to toggle the trigger slope between **Pos** at the positive-going edge and **Neg** at the negative-going edge of the burst signal.

Other keys accessed under the **Trigger** key:

- **Trig Holdoff** - Allows you to set the period of time before the next trigger can occur. The range is 0.000 to 500.0 ms with the best resolution of 1 µs.

- **Auto Trig** - Allows you to specify a time for a trigger timeout. The range is 0.000 to 1000 sec with the best resolution of 1 µs. If no trigger occurs by the specified time, a trigger is automatically generated.
- **Frame Timer** - Allows you to access the menu to manually control the frame timer:

  Period - Allows you to set the period of the frame clock. The range is 1.000000 to 559.0000 ms with the best resolution of 1 ns.

When the PDC mode is selected, the instrument will default to the following settings.

Trigger Default Settings	
RF Burst:	
Delay	0.000 sec
Peak Level	–10.0 dB
Slope	Pos
Video (IF Envlp):	
Delay	0.000 sec
Level	–30.00 dBm
Slope	Pos
Ext Front & Ext Rear:	
Delay	0.000 sec
Level	2.00 V
Slope	Pos
Trig Holdoff	10.00 ms
Auto Trig	100.0 ms, On
Frame Timer:	
Period:	
(if set to full rate)	20.00000 ms
(if set to half rate)	40.00000 ms

Burst

The **Burst** key allows you to access the following menu to set the trigger condition for the ACP and EVM measurements when **Device** under **Radio** is set to **MS**. This is used in conjunction with **Frame Timer**.

- **Delay** - Allows you to set the delay time after searching a threshold level of PDC bursts. The range is –500.0 to +500.0 ms with the best resolution of 0.1 µs.
- **Search Threshold** - Allows you to set the threshold level used in search for PDC bursts after data is acquired. The range is –200.00 to –0.01 dB with 0.01 dB resolution. The realistic range can be down to the noise floor level of the input signal.

When the PDC mode is selected, the instrument will default to the following settings.

Burst Default Settings	
Delay	0.000 s
Search Threshold	–30.00 dB

Changing the Frequency Channel

After selecting the desired mode setup, you will need to select the desired center frequency, burst type and slot. The selections made here will apply to all measurements in the mode. Press the **Frequency Channel** key to access the following menu:

- **Center Freq -** Allows you to enter a frequency value that corresponds to the desired RF channel to be measured. This is the current instrument center frequency for any measurement function.
- **Burst Type -** Allows you to choose a PDC burst type from the following selections only when **Device** under **Radio** is previously set to **MS,** otherwise this key is unavailable. This is used only when making EVM measurements.

    Traffic (TCH) - Sets to the traffic channel burst signal of which burst length is 270 bits or 135 symbols.
    Control (CCH) - Sets to the control channel burst signal of which burst length is 258 bits or 129 symbols.

- **Slot (Std)** - Allows you to toggle the slot selection function between **Auto** and **Man** (manual), and also to specify the particular timeslot to be measured when **Man** is selected. This is used only when making EVM measurements.

    Auto - In auto, the measurement is made on the first timeslot found to have any one of the valid sync words, corresponding to slots 0 to 5. The measurement may be made on various timeslots if more than one timeslot has a valid sync word.

    Man - In manual, the measurement is made only on the specified timeslot that has a valid sync word. The timeslot range is 0 to 5.

When the PDC mode is selected, the instrument will default to the following settings.

Frequency Channel Default Settings	
Center Freq	1.00000 GHz
Burst Type[a]	Traffic (TCH)
Slot (Std)	0, Auto

a. This is used only when Device is MS.

PDC Measurement Key Flow

The key flow diagrams, shown in a hierarchical manner on the following pages, will help the user to grasp the overall functional relationships for the front-panel keys and the softkeys displayed at the extreme right side of the screen. The diagrams are:

"Mode Setup / Frequency Channel Key Flow" on page 95,

"ACP Measurement Key Flow" on page 96,

"EVM Measurement Key Flow" on page 97,

"Occupied Bandwidth Measurement Key Flow" on page 98,

"Spectrum (Freq Domain) Measurement Key Flow (1 of 3)" on page 99,

"Waveform (Time Domain) Measurement Key Flow (1 of 2)" on page 102.

Use these flow diagrams as follows:

- There are some basic conventions:

(Meas Setup) An oval represents one of the front-panel keys.

[EVM] This box represents one of the softkeys displayed.

<for EVM> This represents an explanatory description on its specific key.

[Avg Number 10 On | Off] This box represents one of the default condition softkeys displayed. Default conditions are shown as much as possible with underlined parameters or values displayed on those softkey labels.

- Start from the extreme upper left corner of each measurement diagram to the right direction, and go from the top to the bottom.
- When defining a key from auto with underline to manual, for example, just press that key one time.
- When entering a numeric value of **Frequency**, for example, use the numeric keypad by terminating with the appropriate unit selection from the softkeys displayed.
- When entering a numeric value of **Slot (Std)**, for example, use the numeric keypad by terminating with the **Enter** front-panel key.
- Instead of using the numeric keypad to enter a value, it may be easier to use the RPG knob or **Up/Down** keys depending on the input field of a parameter.

Figure 5-1 Mode Setup / Frequency Channel Key Flow

- Mode — PDC
- Mode Setup
  - Radio
    - Traffic Rate Full | Half
    - Device BS | MS
  - Input
    - RF Input Range Auto | Man <Auto not for Spectrum>
    - Max Total Pwr -15.00 dBm
    - Input Atten 0.00 dB
    - Ext Atten
      - MS 0.00 dB
      - BS 0.00 dB
  - Trigger
    - RF Burst
      - Delay 0.000 s
      - Peak Level -10.00 dB
      - Slope Pos | Neg
    - Video (IF Envlp)
      - Delay 0.000 s
      - Level -30.00 dBm
      - Slope Pos | Neg
    - Ext Front
      - Delay 0.000 s
      - Level 2.00 V
      - Slope Pos | Neg
    - Ext Rear
      - Delay 0.000 s
      - Level 2.00 V
      - Slope Pos | Neg
    - Trig Holdoff 10.00 ms
    - Auto Trig 100.0 ms On | Off
    - Frame Timer
      - Period 20.00000 ms
  - Burst
    - Delay 0.000 s
    - Search Threshold -30.00 dB
- Frequency Channel
  - Center Freq 1.00000 GHz
  - Burst Type Traffic (TCH) <for EVM when Device is MS>
    - Traffic (TCH)
    - Control (CCH)
  - Slot (Std) 0 Auto | Man <for EVM>

Figure 5-2 ACP Measurement Key Flow

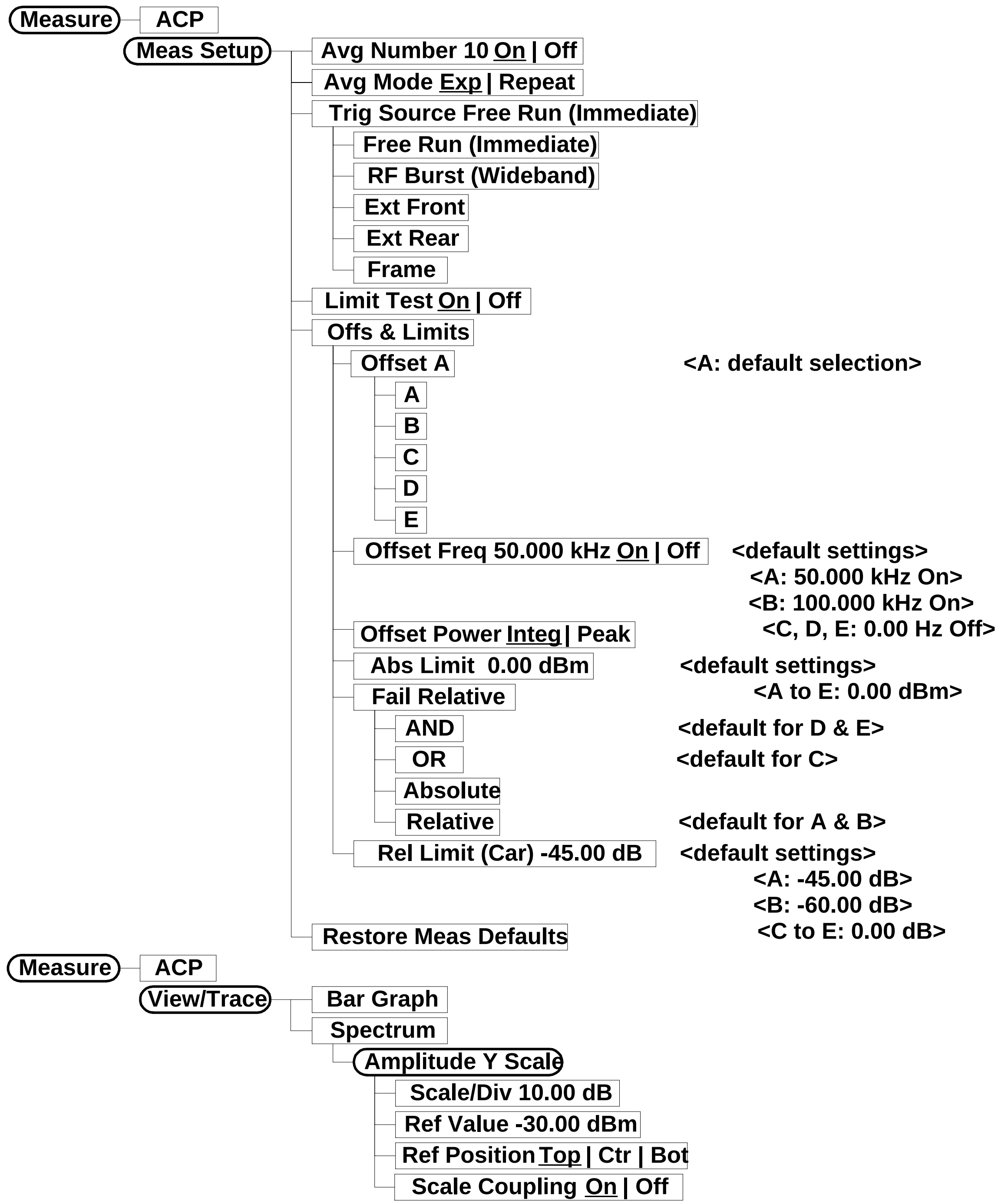


Figure 5-3 EVM Measurement Key Flow

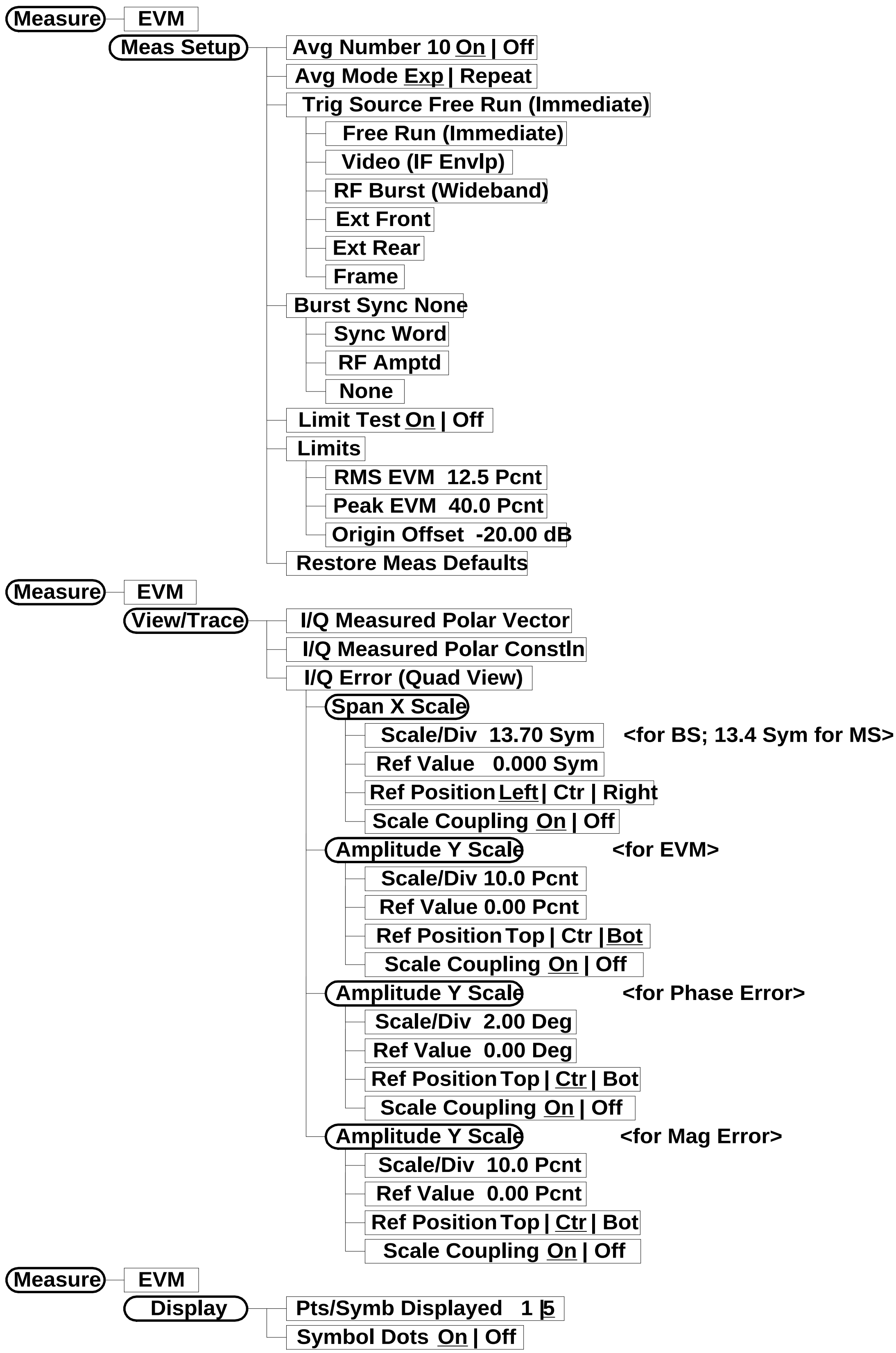


Figure 5-4 Occupied Bandwidth Measurement Key Flow

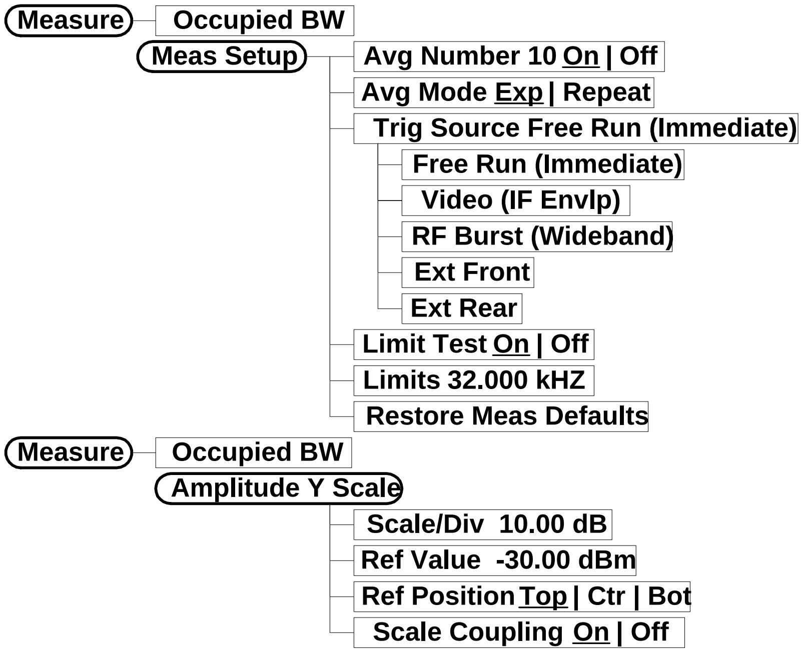


Figure 5-5 Spectrum (Freq Domain) Measurement Key Flow (1 of 3)

- (Measure) — Spectrum (Freq Domain)
- (Meas Setup)
  - Span 1.00000 MHz
  - Res BW 20.0000 kHz Auto| Man
  - Avg Number 25 On | Off
  - Avg Mode Exp | Repeat
  - Avg Type Log-Pwr Avg (Video)
    - Pwr Avg (RMS)
    - Log-Pwr Avg (Video)
    - Voltage Avg
    - Maximum
    - Minimum
  - Trig Source Free Run (Immediate)
    - Free Run (Immediate)
    - Video (IF Envlp)
    - RF Burst (Wideband)
    - Ext Front
    - Ext Rear
    - Frame
    - Line
  - Restore Meas Defaults
  - Advanced
    - Pre-ADC BPF On | Off
    - Pre-FFT Fltr Gaussian Flat
    - Pre-FFT BW 1.55000 MHz Auto| Man
    - FFT Window Flat Top (High Amptd Acc)
      - Flat Top (High Amptd Acc)
      - Uniform
      - Hanning
      - Hamming
      - Gaussian (Alpha 3.5)
      - Blackman
      - Blackman-Harris
      - K-B 70 dB (Kaiser-Bessel)
      - K-B 90 dB (Kaiser-Bessel)
      - K-B 110 dB (Kaiser-Bessel)
    - FFT Size
      - Length Ctrl Auto| Man
      - Min Pnts/RBW 1.300000
      - Window Length 706
      - FFT Length 4096
    - (a)

Figure 5-6 Spectrum (Freq Domain) Measurement Key Flow (2 of 3)

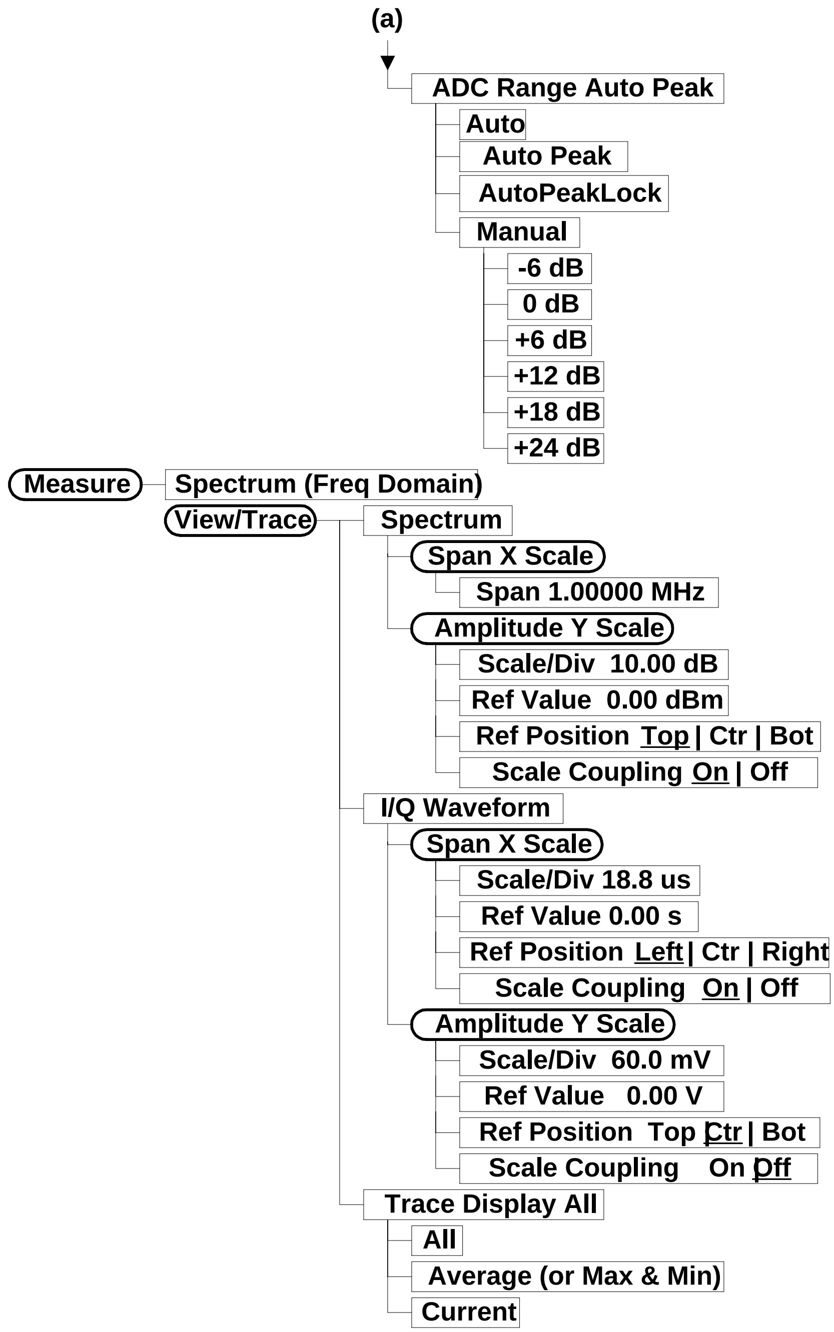


Figure 5-7 Spectrum (Freq Domain) Measurement Key Flow (3 of 3)

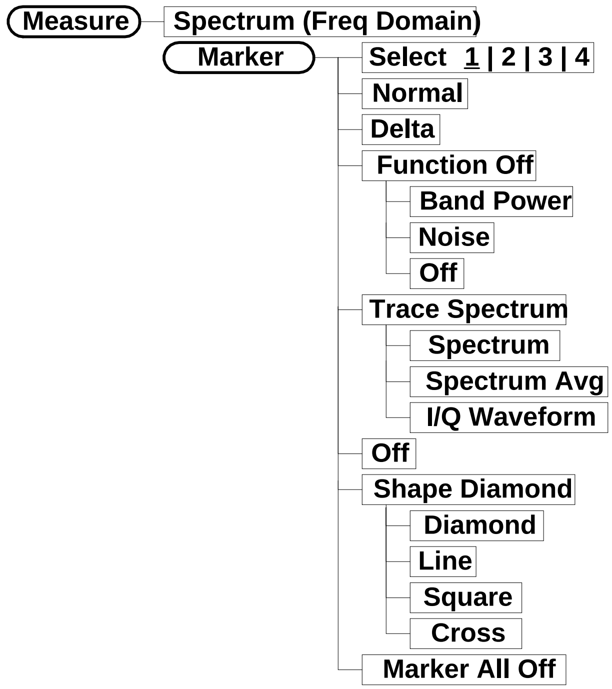


Figure 5-8 Waveform (Time Domain) Measurement Key Flow (1 of 2)

- (Measure) — Waveform (Time Domain)
  - (Meas Setup)
    - Sweep Time 10.00 ms
    - Res BW 100.0000 kHz
    - Average
      - Avg Number 10 On | Off
      - Avg Mode Exp | Repeat
      - Avg Type Pwr Avg (RMS)
        - Pwr Avg (RMS)
        - Log-Pwr Avg (Video)
        - Voltage Avg
        - Maximum
        - Minimum
    - Trig Source Free Run (Immediate)
      - Free Run (Immediate)
      - Video (IF Envlp)
      - RF Burst (Wideband)
      - Ext Front
      - Ext Rear
      - Frame
      - Line
    - Restore Meas Defaults
    - Advanced
      - Pre-ADC BPF On | Off
      - Pre-FFT Fltr Gaussian| Flat
      - ADC Range Auto
        - Auto
        - Auto Peak
        - AutoPeakLock
        - Manual
          - -6 dB
          - 0 dB
          - +6 dB
          - +12 dB
          - +18 dB
          - +24 dB

Figure 5-9 Waveform (Time Domain) Measurement Key Flow (2 of 2)

- (Measure) — Waveform (Time Domain)
  - (View/Trace)
    - RF Envelope
      - (Span X Scale)
        - Scale/Div 1.00 ms
        - Ref Value 0.00 s
        - Ref Position Left | Ctr | Right
        - Scale Coupling On | Off
      - (Amplitude Y Scale)
        - Scale/Div 10.00 dB
        - Ref Value 0.00 dBm
        - Ref Position Top | Ctr | Bot
        - Scale Coupling On | Off
    - I/Q Waveform
      - (Span X Scale)
        - Scale/Div 1.00 ms
        - Ref Value 0.00 s
        - Ref Position Left | Ctr | Right
        - Scale Coupling On | Off
      - (Amplitude Y Scale)
        - Scale/Div 100.0 mV
        - Ref Value 0.00 V
        - Ref Position Top Ctr | Bot
        - Scale Coupling On | Off
- (Measure) — Waveform (Time Domain)
  - (Marker)
    - Select 1 | 2 | 3 | 4
    - Normal
    - Delta
    - Function Off
      - Band Power
      - Noise
      - Off
    - Trace Envelope
      - RF Envelope
      - I/Q Waveform
    - Off
    - Shape Diamond
      - Diamond
      - Line
      - Square
      - Cross
    - Marker All Off

Installing and Uninstalling Optional Measurement Personalities

Active License Key

The measurement personality option you have purchased with your instrument has been installed and enabled at the factory. With the purchase of the measurement personality, and with any future purchase of a new personality, you will receive a unique license key number. This license key enables you to install, or reinstall, any personality you have purchased. Follow these steps to locate the unique license key number for the measurement personality that has come installed in your instrument:

1. Press **System**, **More (1 of 3)**, **More (2 of 3)**, **Install**, **License Key**. **Your unique license key number will now appear in the active function area of the display.**
2. If you are going to install a new personality option purchased later on, you will receive a certificate which displays the unique license key number that you will use to install that option. Refer to "Installing Personality Options" on page 105 to install it using the front-panel keys.
3. If you need to uninstall one of the current personality options in order to secure memory space for another option for example, refer to "Uninstalling Personality Options" on page 106 to uninstall it from the instrument using the front panel keys.

You will want to keep a copy of your license key number in a secure location. Please enter your license key numbers in the box provided below for future reference. If you should lose your license key number, call your nearest Agilent Technologies sales and service office for assistance.

Active License Key Numbers for Instrument with Serial # ________
For Option______________ the license number is ________________________
For Option______________ the license number is ________________________
For Option______________ the license number is ________________________

NOTE You will only need to use a license key number if, (1) you purchase an additional measurement personality, (2) you want to uninstall a selected personality option, or (3) you want to reinstall a measurement personality that has been uninstalled.

Installing Personality Options

The option designation consists of three upper-case letters, as shown in the **Option** column of the table below.

Available Personalities	Option
GSM measurement personality	BAH
cdmaOne measurement personality	BAC
NADC, PDC measurement personality	BAE

To install the selected option use the following steps:

1. Press **System**, **More(1 of 3)**, **More(2 of 3)**, **Install**, and **Choose Option**. Pressing the **Choose Option** key will activate the alpha editor menu. Use the alpha editor to enter the three-letter option designation in upper-case, then press the **Done** key. As you enter the option number you will see your entry in the active function area of the display.

2. The **License Key** number will require entry of both letters and numbers. Use the alpha editor to enter letters. Use the front-panel numeric keyboard to enter numerical values. You will see your entry in the active function area. When you have completed entering the license key number, press the **Done** key.

3. Press the **Install Now** key after you have entered the active license key number and the personality option. When pressed, the **Yes** and **No** keys will appear in the **Install Now** menu, and an instruction message, “`Insert disk and power cycle the instrument.`”, will appear in the active function area of the display. Press the **No** key only if you wish to cancel the installation process. If you want to proceed with the installation, press the **Yes** key and cycle the instrument off and then on. When the instrument is powered on, the data from the disk will be read and automatically loaded into your instrument.

NOTE Not all personality installations require an installation disk. If the personality upgrade kit does not include a disk, disregard the `Insert disk` portion of the message that appears in the active function area when the **Install Now** key is pressed.

4. The **Exit Main Firmware** key is only for use when you want to update firmware using a LAN connection. The **Exit Main Firmware** key halts the operation of the resident firmware code so you can install an updated version of firmware using a LAN connection. Instructions for loading future firmware updates will be available at the following URL: **www.agilent.com/find/vsa**.

Uninstalling Personality Options

The possibility exists that there may be more personalities available than can fit into the instrument's memory at the same time. You may need to uninstall a selected personality in order to free up memory space to install other personalities.

NOTE The following procedure removes an option from the instrument memory by deleting the option firmware and license key files for the selected option. Write down the 12 digit license key number for the option you are uninstalling before uninstalling it. If that measurement personality is to be reinstalled later, you will need the license key number to reinstall the personality firmware.

1. Press **System**, **More(1 of 3)**, **More(2 of 3)**, **Uninstall**, and **Choose Option**. Pressing the **Choose Option** key will activate the alpha editor menu. Use the alpha editor to enter the three-letter option designation in upper-case, then press the **Done** key. As you enter the option number you will see your entry in the active function area of the display.
2. Press the **Uninstall Now** key after you have entered the personality option. When pressed, the **Yes** and **No** keys will appear, and you will see a message "`Uninstall Now`" appear in the active function area of the display. Press the **No** key only if you wish to cancel the installation process. Press the **Yes** key if you want to uninstall the selected option.
3. Cycle the instrument power off and on to complete the uninstall process.

6 Making PDC Measurements

PDC Measurements

Once in the PDC mode the following measurements for the PDC band are available by pressing the **Measure** key.

- Adjacent Channel Power on page 115
- Error Vector Magnitude on page 122
- Occupied Bandwidth on page 131
- Spectrum (Frequency Domain) on page 135
- Waveform (Time Domain) on page 145

These are referred to as one-button measurements. When you press the key to select a measurement, it will become the active measurement, using settings and a display unique to that measurement. Data acquisitions will automatically begin when trigger requirements, if any, are met.

Preparing for Measurements

If you want to set the PDC mode to a known, factory default state, press **Preset**. This will preset the mode setup and all of the measurements to the factory default parameters. You should often be able to make a measurement using these defaults.

NOTE Pressing the **Preset** key does not switch instrument modes.

To preset only the settings that are specific to the selected measurement, press **Meas Setup**, **More (1 of 2)**, **Restore Meas Defaults**. This will reset the measure setup parameters, for the currently selected measurement only, to the factory defaults.

Initial Setup

Before making a measurement, make sure the mode setup and frequency channel parameters are set to the desired settings. Refer to the sections "Changing the Mode Setup" on page 88 and "Changing the Frequency Channel" on page 93.

Measurement Selection

The **Measure** front-panel key accesses the menu to select one of the following measurements:

- **ACP** - Press this key to make adjacent channel power (ACP) measurements. The following menu is activated by the **View/Trace** front-panel key:

  Bar Graph - Displays the ACP bar graph with 21.0 kHz power bandwidths centered at ±50 and ±100 kHz offsets from the center frequency of the carrier signal. The summary data is also available in the text window. This is the default selection for ACP measurements.

  Spectrum - Displays the ACP spectrum graph (with 21.0 kHz bandwidth marker lines) at ±50 and ±100 kHz offsets from the center frequency of the carrier signal. The summary data is also available in the text window.

- **EVM** - Press this key to make error vector magnitude (EVM) measurements. The following menu is activated by the **View/Trace** front-panel key:

  I/Q Measured Polar Vector - Displays the EVM polar vector graph of the I/Q demodulated signal. The summary data is also available in the text window. This is the default selection for EVM measurements.

I/Q Measured Polar Constln - Displays the EVM polar constellation graph of the I/Q demodulated signal. The summary data is also available in the text window.

I/Q Error (Quad-View) - Displays four windows for the **EVM**, **Mag Error**, **Phase Error** graphs and the **EVM** summary data. By selecting one of the windows with the **Next Window** front-panel key you can enlarge it to the full display area by pressing the **Zoom** key.

- **Occupied BW** - Press this key to make occupied bandwidth measurements with the occupied bandwidth graph window and summary data window. Two vertical lines mark the ±0.5% power points on the display. The **View/Trace**, **Span X Scale**, and **Marker** menus are not available for this measurement, but the **Amplitude Y Scale** menu is available.

- **Spectrum (Freq Domain)** - Press this key to make spectrum measurements with the spectrum and I/Q waveform display windows. The following menu is activated by the **View/Trace** front-panel key:

  Spectrum - Switches from the **I/Q Waveform** window to **Spectrum** window. This is equivalent to the **Next Window** front-panel key. This is the default selection for spectrum (frequency domain) measurements.

  I/Q Waveform - Switches from the **Spectrum** window to **I/Q Waveform** window. This is equivalent to the **Next Window** front-panel key.

  Trace Display - Allows you to control the traces displayed for the current measurement data and/or the averaged data as follows:

    All - Displays both current and average traces if the **Average** function is already activated. This is the default selection for spectrum (frequency domain) measurements.

    Average (or Max & Min) - Displays only the average trace if it is already activated.

    Current - Displays only the current data trace.

- **Waveform (Time Domain)** - Press this key to make time-domain waveform measurements with either display of the **RF Envelope** graph and summary data windows or the **I/Q Waveform** window. The following menu is activated by the **View/Trace** front-panel key:

  RF Envelope - Changes to display the RF envelope graph window and the summary data window. This is the default selection for waveform (time domain) measurements.

  I/Q Waveform - Changes to display the I/Q waveform graph window.

Measurement Control

The **Meas Control** front-panel key accesses the menu to control processes that affect running the current measurement.

- **Restart -** Press this key to repeat the current measurement from the beginning, while retaining the current measurement settings. This is equivalent to the **Restart** front-panel key.
- **Measure -** Press this key (not to be confused with the **Measure** front-panel key which has a different function) to toggle the measurement state between **Single** and **Cont** (continuous). When set to single, the measurement will continue until it has reached the specified number of averages set by the average counter. When set to continuous, the measurement will run continuously and execute averaging according to the current average mode, either repeat or exponential. The default setting is **Cont**.
- **Pause** - Press this key to pause the current measurement until you reactivate the measurement. Once toggled, the label of the **Pause** key changes to read **Resume**. The **Resume** key, once pressed, continues the active measurement from the point at which it was paused.

Measurement Setup

The **Meas Setup** key accesses the features that enable you to adjust parameters of the current measurement, such as resolution bandwidth. You will also use the **Meas Setup** menu to access the **Avg Number**, **Avg Mode**, and **Trig Source** keys.

The following measure setup feature can be used with many or all measurements.

- **Restore Meas Defaults** - Allows you to preset only the settings that are specific to the selected measurement by pressing **Meas Setup**, **More (1 of 2)**, **Restore Meas Defaults**. This will set the measure setup parameters, for the currently selected measurement only, to the factory defaults.

Averaging

Selecting one of the averaging keys in the **Meas Setup** menu will allow you to modify the average number and averaging mode you use for the currently selected measurement. For spectrum (frequency domain) and waveform (time domain) measurements, the **Average** key activates the following menu:

- **Avg Number** - Allows you to change the number of N averages to be made.

- **Avg Mode** - Allows you to toggle the averaging mode between **Exp** (exponential) and **Repeat**. This selection only effects the averaging result after the number of N averages is reached. The N is set using the **Avg Number** key.

  Normal averaging: Normal (linear) averaging is always used until the specified number of N averages is reached. When the **Measure** key under **Meas Control** is set to **Single**, data acquisition is stopped when the number of N averages is reached, thus **Avg Mode** has no effect in the **Single** measurement mode.

  Exponential averaging: When **Measure** is set to **Cont**, data acquisition will continue indefinitely. Exponential averaging is used with a weighting factor of N (the displayed count of averages stops at N). Exponential averaging weights new data more heavily than old data, which allows tracking of slow-changing signals. The weighting factor N is set using the **Avg Number** key.

  Repeat averaging: When **Measure** is set to **Cont**, data acquisition will continue indefinitely. After the number of N averages is reached, all previous result data is cleared and the displayed count of averages is set back to 1. This is equivalent to being in **Measure Single** and pressing the **Restart** key each time the single measurement finishes.

- **Avg Type** - Allows you to access the following menu only for making spectrum (frequency domain) and waveform (time domain) measurements:

  Pwr Avg (RMS) - Executes the true power averaging which is equivalent to taking the rms of the voltage. This is the most accurate type.

  Log-Pwr Avg (Video) - Simulates the traditional spectrum analyzer type of averaging by calculating an average of the log power.

  Voltage Avg - Executes the voltage averaging.

  Maximum - Executes the maximum voltage averaging by capturing peak data.

  Minimum - Executes the minimum voltage averaging.

Trigger Source

Changing the selection in the **Trig Source** menu alters the trigger source for the selected measurement only. Not all of the selections are available for all measurements. Choose one of the following trigger sources:

NOTE The **RF Burst**, **Video (IF Envlp)**, **Ext Front** and **Ext Rear** keys found under the **Trigger** menu enable you to change the default settings of the delay, level and slope for each of these trigger sources.

- **Free Run (Immediate)** - A trigger occurs at the time the data is requested, completely asynchronous with the RF or IF signal.
- **Video (IF Envlp)** - An internal IF envelope trigger that occurs at the absolute threshold level of the IF signal level. This trigger source is not available for ACP measurements.
- **RF Burst (Wideband)** - An internal wideband RF burst trigger that has the automatic level control for burst signals. It triggers at the level that is set relative to the peak RF signal (12 MHz bandwidth) input level.
- **Ext Front** - Activates the front-panel external trigger input (**EXT TRIGGER INPUT**) port. The external signal must be between –5.00 and +5.00 V with 1 or 10 mV resolution.
- **Ext Rear** - Activates the rear panel external trigger input (**TRIGGER IN**) port. The external signal must be between –5.00 and +5.00 V with 1 or 10 mV resolution.
- **Frame** - Uses the internal frame clock to generate a trigger signal. The clock parameters are controlled under the **Mode Setup** key or the measurement firmware, but not both. See the specific measurement for details. This trigger source is not available for occupied bandwidth measurements.
- **Line** - Sets the trigger to the internal line mode. Sweep triggers occur at intervals synchronous to the line frequency. This trigger source is available for spectrum (frequency domain) and waveform (time domain) measurements.

The rear-panel **TRIGGER 1 OUT** and **TRIGGER 2 OUT** connectors are coupled to the selected trigger source. These trigger outputs are always on at the rising edge with a pulse width of at least 1 μs.

Burst Sync

This menu is only used for EVM measurements. Pressing the **Burst Sync** key allows you to choose the source used to synchronize the measurement to the "point 0" of the PDC burst. The "point 0" is defined as the start of symbol 0 in timeslot 0. Pressing the **Burst Sync** key accesses the menu with the following choices:

- **Sync Word** - Synchronizes the measurement to the sync word which is one of the six possible 20-bit PDC timeslot synchronization words contained in the signal. This is the default selection when **Device** is set to **MS**.
- **RF Amptd** - Synchronizes the measurement to the rising edge of the bursted RF carrier. The **Search Threshold** setting in the **Burst** menu under **Mode Setup** applies to **RF Amptd**.
- **None** - Measurements are made without synchronizing with the PDC burst. This is the default selection when **Device** is set to **BS**.

Making the Adjacent Channel Power Measurement

Purpose

To maintain a quality call by avoiding channel interference, it is quite important to measure and reduce an adjacent channel power (ACP) transmitted from a PDC mobile phone. The characteristics of adjacent channel power are mainly determined by the transmitter design, including a digital filter called a root Nyquist filter.

Adjacent channel power is defined by the PDC standard as the total power within the defined bandwidth, centered at Δf kHz offset from the carrier frequency. The carrier is modulated by the standard coding test signal which has the same coding speed as the PDC modulation signal. The following specifications from the RCR STD-27 standards apply to both base stations and mobile stations:

(1) At ±50 kHz offset: Less than –45 dB

(2) At ±100 kHz offset: Less than –60 dB

Measurement Method

This measurement analyzes the total power levels within the defined bandwidth of 21.0 kHz at given offset frequencies on both sides of the carrier frequency using Fast Fourier Transform (FFT).

The measurement functions, such as averaging, trigger source, limit test, offsets and limits, need to be setup for a measurement and pass/fail test. The test result is displayed in either bar graph window or spectrum window. Both the absolute power levels and the power levels relative to the center power band are displayed in the text window. When **Spectrum View** is selected, the vertical scale can be varied for your optimum observation by pressing the **Amplitude Y Scale** front-panel key.

Making the Measurement

NOTE The factory default parameters provided for this measurement will give you a PDC compliant measurement for the instrument setup. You should be able to make a measurement often using these defaults.

Select the desired center frequency as described in "Changing the Frequency Channel" on page 93.

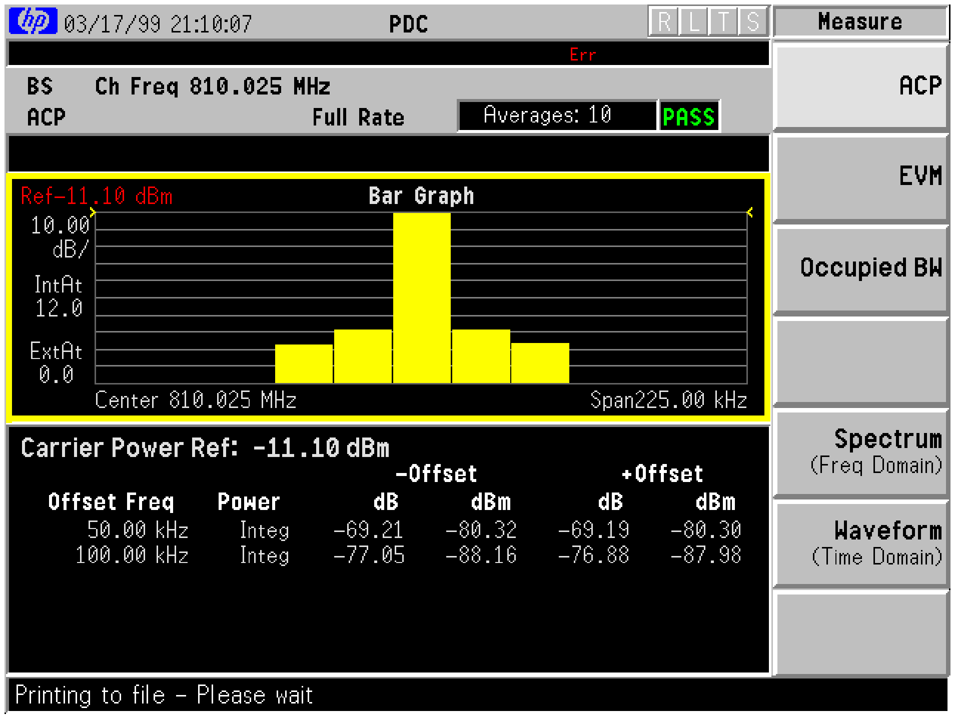
Press **Measure**, **ACP** to immediately make an adjacent channel power measurement.

To change any of the measurement parameters from the factory default values, refer to "Changing the Measurement Setup" on page 117 for this measurement.

Results

The next figure shows an example result of adjacent channel power measurements in the bar graph window. The power levels on both sides of the carrier frequency are displayed in the graph window and text window.

Figure 6-1 Adjacent Channel Power Measurement - Bar Graph View



Changing the Measurement Setup

The next table shows the factory default settings for adjacent channel power measurements.

Table 6-1 Adjacent Channel Power Measurement Defaults

Measurement Parameter	Factory Default Condition
View/Trace	Bar Graph
Meas Setup:	
Avg Number	10, On
Avg Mode	Exp
Trig Source: (when Device is MS) (when Device is BS)	 RF Burst (Immediate) Free Run (Wideband)
Limit Test	On
Offs & Limits:	
Offset	A
Offset Freq: A B C, D, E	 50.000 kHz, On 100.000 kHz, On 0.0 Hz, Off
Abs Limit: A, B, C, D, E	 0.00 dBm
Fail: A, B C D, E	 Relative OR AND
Rel Limit (Car): A B C, D, E	 –45.00 dB –60.00 dB 0.00 dB

Make sure the **ACP** measurement is selected under the **Measure** menu. The **Meas Setup** key accesses the menu which allows you to modify the average number, average mode and trigger source for this measurement as described in "Measurement Setup" on page 111. However, the trigger source does not include **Video** and **Line**. In addition, the following parameters for adjacent channel power measurements can be modified:

- **Limit Test** - Allows you to toggle the limit test function between **On** and **Off**. If set to **On**, **Abs Limit** and/or **Rel Lim (Car)** need to be specified to execute pass/fail tests with the logical judgement under the **Fail** key. Pass/fail results are shown in the active display window with the number of averages. In the text window, a red character F is shown on the right side of each measurement result, either relative or absolute, if it exceeds the limits with its logical judgement.
- **Ofs & Limits** - Allows you to access the menu to change the following parameters for pass/fail tests:

  Offset - Allows you to access the memory selection menu to store 5 offset frequency values in **A** through **E**. Only one selection at a time (A, B, C, D, or E) is shown on this key label. The default selection is A.

  Offset Freq - Allows you to enter an offset frequency value and toggle the offset frequency function between **On** and **Off**, according to each offset key selected. The allowable range is 0 Hz to 200.000 kHz. While this key is activated, enter an offset value from the numeric keypad by terminating with one of the frequency unit keys shown. For PDC measurements offsets A and B are defaulted to 50.000 kHz On and 100.000 kHz On, respectively, while offsets C, D and E are defaulted to 0.0 Hz Off. One offset frequency value selected from the **Offset** menu is shown on this key label. The default state shows 50.000 kHz On.

  Abs Limit - Allows you to enter an absolute limit value ranging from –200.00 to +50.00 dBm with the best resolution of 0.01 dB. The default settings for all offsets are 0.00 dBm.

  Fail - Allows you to access the following menu to select one of the logic keys for fail conditions between the measurement results and the test limits:

    AND - Fail is shown if one of the relative ACP measurement results is larger than **Rel Lim (Car)** AND one of the absolute ACP measurement results is larger than **Abs Limit**. This is the default setting for offsets D and E.

    OR - Fail is shown if one of the relative ACP measurement results is larger than **Rel Lim (Car)** OR one of the absolute ACP measurement results is larger than **Abs Limit**. This is the default setting for offset C.

Absolute - Fail is shown if one of the absolute ACP measurement results is larger than **Abs Limit**.

Relative - Fail is shown if one of the relative ACP measurement results is larger than **Rel Lim (Car)**. This is the default setting for offsets A and B.

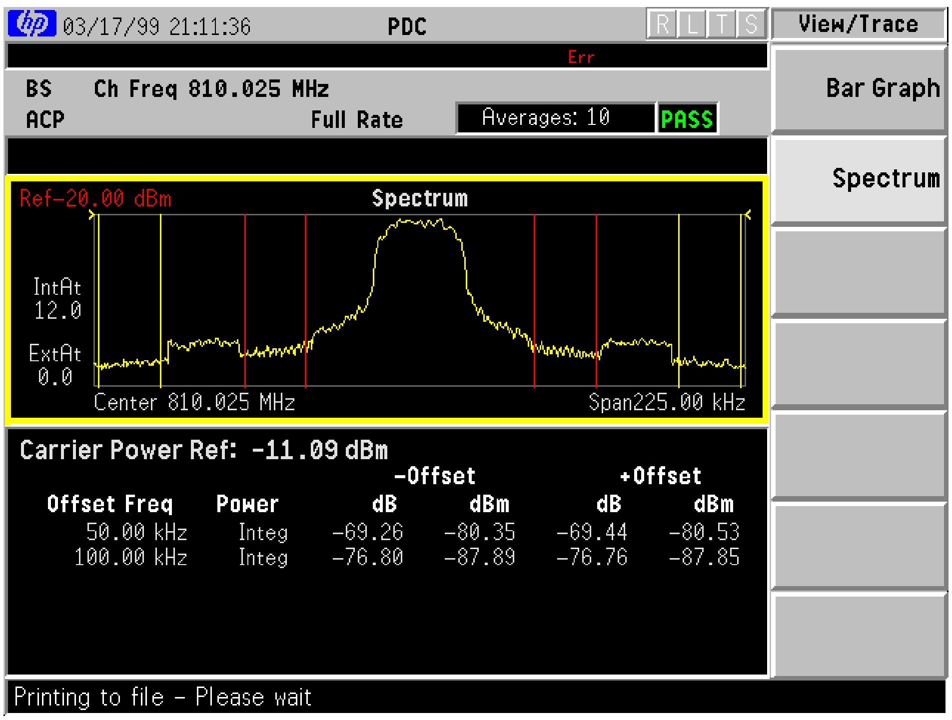
Rel Lim (Car) - Allows you to enter a relative limit value ranging from –200.00 to +50.00 dB with the best resolution of 0.01 dB. The default settings for offsets A and B are –45.00 and –60.00 dB, respectively, while offsets C, D and E are defaulted to 0.00 dB.

Changing the View

The **View/Trace** key accesses the menu which allows you to select the desired measurement view from the following selections:

- **Bar Graph** - In the factory default condition, 5 of the total integration power levels within 21.0 kHz bandwidth, centered at the carrier frequency and ±50 kHz and ±100 kHz offset frequencies, are shown in the bar graph window. The corresponding measured data is shown in the text window as shown in Figure 6-1 on page 116.
- **Spectrum** - Once this view is selected, Figure 6-1 on page 116 changes as shown below. In the factory default condition, the swept frequency spectrum is displayed with the bandwidth marker lines in the spectrum graph window. The corresponding measured data in the text window is the total integration power within the defined bandwidth of 21.0 kHz. While in this view, you can change the vertical scale by pressing the **Amplitude Y Scale** key.

Figure 6-2 Adjacent Channel Power Measurement - Spectrum View



Troubleshooting Hints

The adjacent channel power measurements suggest us numerous faults in the transmitter section of the UUT, as follows:

(1) Faults caused by a malfunction of the baseband circuitry consisting of a code generator, a digital filter, digital-to-analog converters, 90-degree phase shifter, and I/Q modulators.

(2) Faults due to high phase noise levels from the local oscillators.

(3) Faults due to excessive noise floor levels from the up-converter, output amplifier, and/or analog filters.

Making the Error Vector Magnitude Measurement

Purpose

Phase and frequency errors are the measures of modulation quality for the PDC system. This modulation quality is obtained through Error Vector Magnitude (EVM) measurements. Since the PDC system uses the π/4 DQPSK modulation technique, the phase and frequency accuracies of the PDC transmitter are critical to the communications system performance and ultimately affect range.

PDC receivers rely on the phase and frequency quality of the π/4 DQPSK modulation signal in order to achieve the expected carrier to noise ratio. A transmitter with high phase and frequency errors will often still be able to support phone calls during a functional test. However, it will tend to provide difficulty for mobiles trying to maintain service at the edge of the cell with low signal levels or under difficult fading and Doppler conditions.

Measurement Method

The phase error of the unit under test is measured by computing the difference between the phase of the transmitted signal and the phase of a theoretically perfect signal.

The instrument samples the transmitter output in order to capture the actual phase trajectory. This is then demodulated and the ideal phase trajectory is mathematically derived using detected bits and raised-cosine channel filtering. Subtracting one from the other results in a phase error signal.

For base stations, the PDC standard specifies that the phase error should not exceed 5 degrees rms or 20 degrees peak, and that the mean frequency error across the burst must not exceed 0.05 ppm. These specifications hold true for normal and extreme temperature conditions, and with exposure to vibration.

This measurement allows you to display these errors numerically and graphically on the instrument display. There are graphs for `EVM`, `Phase Error` and `Mag Error` in the graph windows. In the text window, there are `Evm:` in % rms, in % peak at the highest symbol number, `Mag Error:` in % rms, `Phase Error:` in degrees, `Freq Error:` in Hz, and `IQ Offset:` in dB.

Making the Measurement

NOTE The factory default parameters provided for this measurement will give you a PDC compliant measurement for the instrument setup. You should be able to make a measurement often using these defaults.

Select the desired center frequency, burst type, and slot as described in "Changing the Frequency Channel" on page 93.

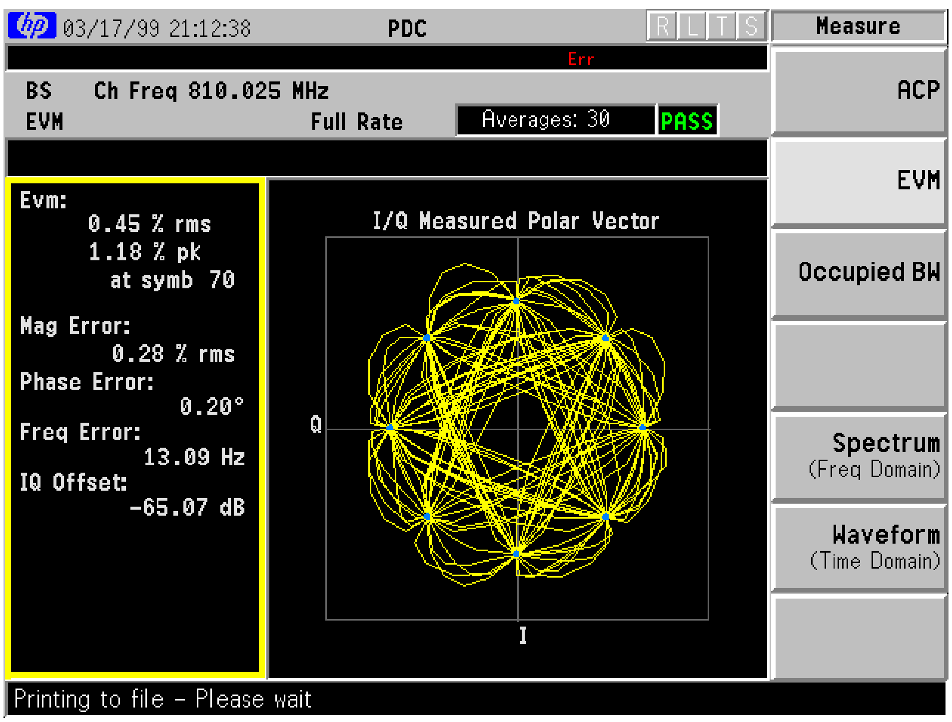
Press **Measure**, **EVM** to immediately make an error vector magnitude measurement.

To change any of the measurement parameters from the factory default values, refer to "Changing the Measurement Setup" on page 117 for this measurement.

Results

The next figure shows an example of measurement result with the graph and text windows. The measured summary data is shown in the left window and the dynamic vector trajectory of the I/Q demodulated signal is shown as a polar vector display in the right window.

Figure 6-3 Error Vector Magnitude Measurement - Polar Vector View



Changing the Measurement Setup

The next table shows the factory default settings for error vector magnitude measurements.

Table 6-2 Error Vector Magnitude Measurement Defaults

Measurement Parameter	Factory Default Condition
View/Trace	I/Q Measured Polar Vector
Meas Setup:	
Avg Number	10, On
Avg Mode	Exp
Trig Source:	
(when Device is BS)	Free Run (Immediate)
(when Device is MS)	RF Burst (Wideband)
Burst Sync:	
(when Device is BS)	None
(when Device is MS)	Sync Word
Limit Test	On
Limits:	
RMS EVM	12.5 Pcnt
Peak EVM	40.0 Pcnt
Origin Offset	–20.00 dB

Make sure the **EVM** measurement is selected under the **Measure** menu. The **Meas Setup** key accesses the menu which allows you to modify the averaging, trigger source and burst sync for this measurement as described in “Measurement Setup” on page 111. However, the trigger source does not include **Line**. In addition, the following error vector magnitude measurement parameters can be modified:

- **Limit Test** - Allows you to toggle the limit test function between **On** and **Off**. If set to **On**, the **Limits** key needs to be pressed to specify the limit values for rms EVM, peak EVM and origin offset. Pass/fail results are shown in the active display window with the number of averages.
- **Limits** - Allows you to access the menu to change the following parameters for pass/fail tests:

  RMS EVM - Allows you to enter a limit value ranging from 0.0 to 50.0% with 0.1% resolution for the pass/fail test of the rms error vector magnitude measured on all of the symbols. The default setting is 12.5%.

Peak EVM - Allows you to enter a limit value ranging from 0.0 to 50.0% with 0.1% resolution for the pass/fail test of the peak error vector magnitude measured on all of the symbols. The default setting is 40.0%.

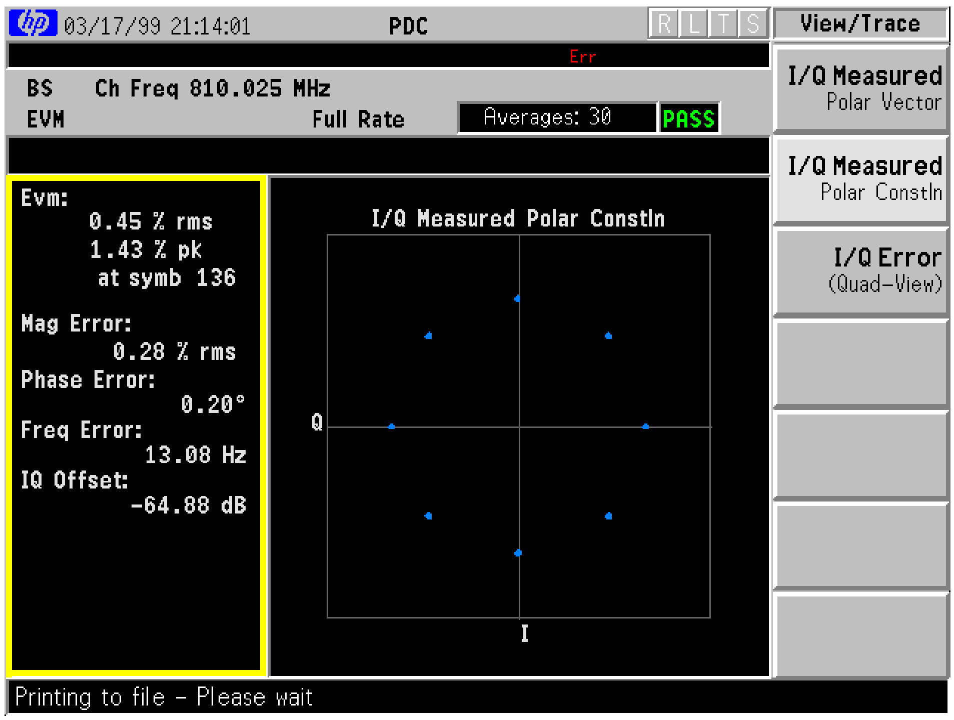
Origin Offset - Allows you to enter a limit value ranging from –100.00 to 0.00 dB with 0.01 dB resolution for the pass/fail test of the origin offset. The default setting is –20.00 dB.

Changing the View

The **View/Trace** key accesses the menu which allows you to select the desired measurement view from the following selections:

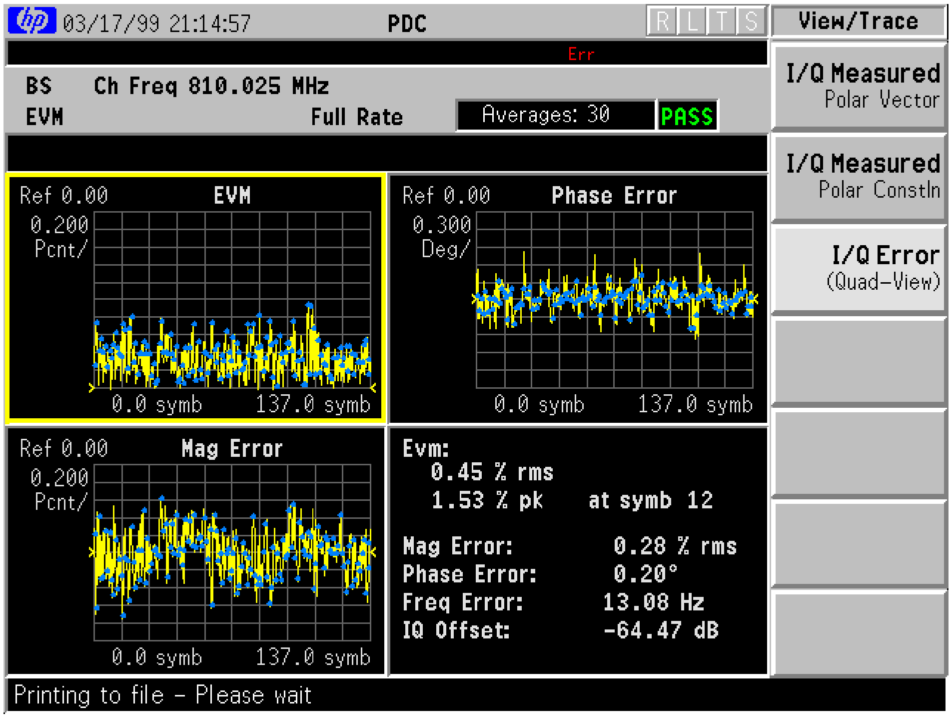
- **I/Q Measured Polar Vector** - The measured summary data is shown in the left window and the dynamic vector trajectory of the I/Q demodulated signal is shown as a polar vector display in the right window as shown in Figure 6-3 on page 123.
- **I/Q Measured Polar Constln** - The measured summary data is shown in the left window and the dynamic polar constellation of the I/Q demodulated signal is shown as a polar constellation display in the right window as shown below.

Figure 6-4 Error Vector Magnitude Measurement - Polar Constln View



- **I/Q Error (Quad-View)** - Four display windows show EVM, Mag Error and Phase Error graphs, and the EVM summary data text as shown below.

Figure 6-5 Error Vector Magnitude Measurement - Quad View



Changing the Display

The **Display** key accesses the menu to allow the following selections for changing the graph displays of I/Q Measured Polar Vector and I/Q Error (Quad-View):

- **Pts/Symb Displayed** - Allows you to specify the number of displayed points per symbol, either **1** or **5**. The default setting is **5**.
- **Symbol Dots** - Allows you to toggle the symbol dot display function between **On** and **Off**. The default setting is **On**.

When either `EVM`, `Phase Error` or `Mag Error` window is active in the I/Q Error (Quad-View) display, the **Span X Scale** key accesses the menu to allow the following selections:

- **Scale/Div** - Allows you to define the horizontal scale by changing a symbol value per division. The range is 1.000 to 100.0 symbols per division with the best resolution of 0.001 symbol. The default setting is 13.70 (for BS) or 13.40 (for MS) symbols per division. However, since the **Scale Coupling** default is set to **On**, this value is automatically determined by the measurement result.
- **Ref Value** - Allows you to set the symbol reference value ranging from 0 to 1000 symbols. The default setting is 0.000 symbol. This value is automatically determined by the magnitude of the measurement results because **Scale Coupling** is defaulted to **On**.
- **Ref Position** - Allows you to set the reference position to either **Left**, **Ctr** (center) or **Right**. The default setting is **Left**.
- **Scale Coupling** - Allows you to toggle the scale coupling function between **On** and **Off**. The default setting is **On**. This function automatically determines the scale per division and reference value by the magnitude of the measurement results.

When either `EVM` or `Mag Error` window is active in the I/Q Error (Quad-View) display, the **Amplitude Y Scale** key accesses the menu to allow the following selections:

- **Scale/Div** - Allows you to define the vertical scale by changing the value per division. The range is 0.100 to 50.0% per division. The default setting is 20.0%. However, since the **Scale Coupling** default is set to **On**, this value is automatically determined by the measurement result.
- **Ref Value** - Allows you to set the reference value ranging from 0.00 to 500.0%. The default setting is 0.00%. This value is automatically determined by the magnitude of the measurement results because **Scale Coupling** is defaulted to **On**.
- **Ref Position** - Allows you to set the reference position to either **Top**, **Ctr** (center) or **Bot** (bottom). For the `EVM` graph, the default setting is **Bot**. For the `Mag Error` graph, the default setting is **Ctr**.

- **Scale Coupling -** Allows you to toggle the scale coupling function between **On** and **Off**. The default setting is **On**. This function automatically determines the scale per division and reference value by the magnitude of the measurement results.

When the `Phase Error` window is active in the I/Q Error display, the **Amplitude Y Scale** key accesses the menu to allow the following selections:

- **Scale/Div -** Allows you to define the vertical scale by changing the value per division. The range is 0.01 to 3600 degrees. The default setting is 20.0 degrees per division. However, since the **Scale Coupling** default is set to **On**, this value is automatically determined by the magnitude of measurement result.
- **Ref Value -** Allows you to set the reference value ranging from –36000 to 36000 degrees. The default setting is 0.00 degrees. This value is automatically determined by the magnitude of the measurement results because **Scale Coupling** is defaulted to **On**.
- **Ref Position -** Allows you to set the reference position to either **Top**, **Ctr** (center) or **Bot** (bottom). The default setting is **Ctr**.
- **Scale Coupling -** Allows you to toggle the scale coupling function between **On** and **Off**. The default setting is **On**. This function automatically determines the scale per division and reference value by the magnitude of the measurement results.

Troubleshooting Hints

A poor phase error indicates a problem at the I/Q baseband generator, filters, and/or modulator in the transmitter circuitry of the UUT. The output amplifier in the transmitter can also create distortion that causes unacceptably high phase error. In a real system, a poor phase error will reduce the ability of a receiver to correctly demodulate the received signal, especially in marginal signal conditions.

Making the Occupied Bandwidth Measurement

Purpose

To utilize the limited resource of radio frequency bands to provide as many communication channels as possible, it is critical to measure and control the occupied bandwidth transmitted from a mobile phone. This occupied bandwidth is defined as the frequency bandwidth in which 99% of the total power is measured.

The occupied bandwidth of a mobile phone tends to be improved if its adjacent channel power is reduced. To provide as many channels as possible to meet the increasing number of subscribers, both of these characteristics of a mobile phone need to be measured and analyzed for further performance improvement.

Measurement Method

This measurement is made to analyze the frequency bandwidth in which 99% of the total power is measured, based on Fast Fourier Transform (FFT).

In the actual measuring process, first the total channel power is measured using a sampling method. Then each power sample is integrated up to 0.5% of the total power from the lowest and highest frequency sides to determine the low and high limit frequencies. The difference derived from these frequencies is the occupied bandwidth.

The measurement functions, such as averaging, trigger source, limit test and limit, need to be setup to make a measurement and pass/fail test. The test results are displayed in the graph window and in the text window.

Making the Measurement

NOTE The factory default parameters provided for this measurement will give you a PDC compliant measurement for the instrument setup. You should be able to make a measurement often using these defaults.

Select the desired center frequency as described in "Changing the Frequency Channel" on page 93.

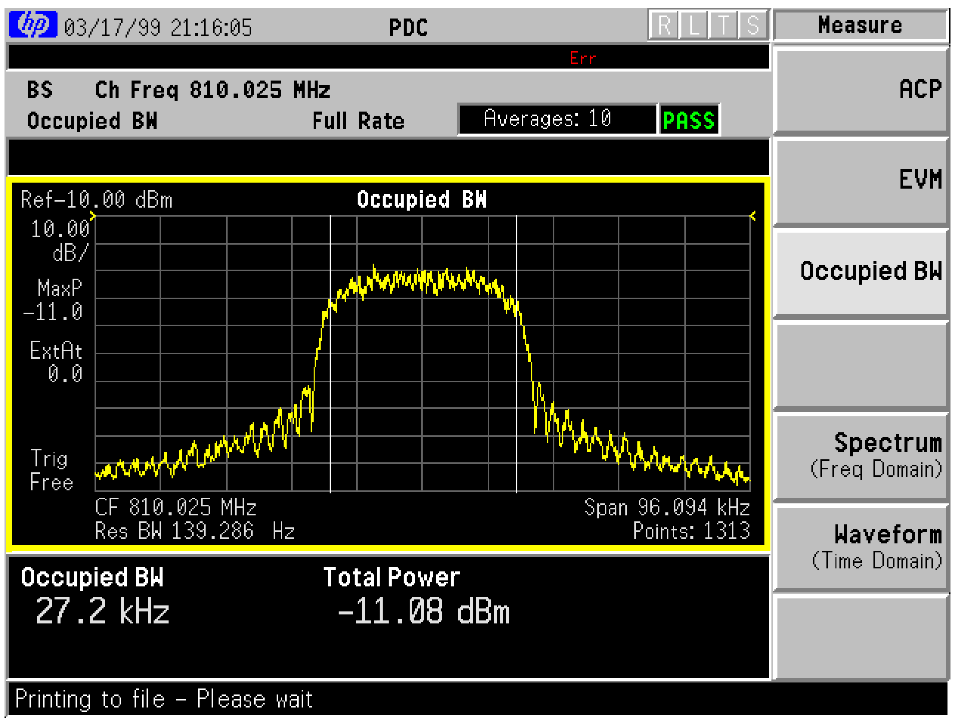
Press **Measure**, **Occupied BW** to immediately make an occupied bandwidth measurement.

To change any of the measurement parameters from the factory default values, refer to "Changing the Measurement Setup" on page 117 for this measurement.

Results

In the upper window, the spectrum is displayed with the vertical lines marking the 0.5% power points. The actual measured data of the occupied bandwidth and the total channel power are shown in the lower window.

Figure 6-6 Occupied Bandwidth Measurement View



Changing the Measurement Setup

The next table shows the factory default settings for occupied bandwidth measurements.

Table 6-3 Occupied Bandwidth Measurement Defaults

Measurement Parameter	Factory Default Condition
Meas Setup:	
Avg Number	10, On
Avg Mode	Exp
Trig Source	Free Run (Immediate)
Limit Test	On
Limit	32.000 kHz
Amplitude Y Scale: Scale/Div	10.00 dB

Make sure the **Occupied BW** measurement is selected under the **Measure** menu. The **Meas Setup** key accesses the menu which allows you to modify the averaging and trigger source for this measurement as described in “Measurement Setup” on page 111. However, the trigger source does not include **Frame** and **Line**. In addition, the following occupied bandwidth measurement parameters can be modified:

- **Limit Test** - Allows you to toggle the limit test function between **On** and **Off**. The default setting is **On**. If set to **On**, the **Limit** key needs to be pressed to change the default limit value of 32.000 kHz. Pass/fail results are shown in the active display window with the number of averages.
- **Limit** - Allows you to specify the frequency limit value ranging from 10.000 to 60.000 kHz with 0.1 kHz resolution. The default setting is 32.000 kHz.

Changing the Display

The **Amplitude Y Scale** key accesses the menu to allow the following selections:

- **Scale/Div -** Allows you to define the vertical scale by changing a value per division. The range is 0.10 to 20.00 dB per division with the best resolution of 0.01 dB. The default setting is 10.00 dB. However, since the **Scale Coupling** default is set to **On**, this value is automatically determined by the measurement result.
- **Ref Value -** Allows you to set the reference value ranging from –250.00 to +250.00 dBm with 0.01 dB resolution. This value is automatically determined in 10 dB steps by the magnitude of the measurement results because **Scale Coupling** is defaulted to **On**.
- **Ref Position -** Allows you to set the reference position to either **Top**, **Ctr** (center) or **Bot** (bottom). The default setting is **Top**.
- **Scale Coupling -** Allows you to toggle the scale coupling function between **On** and **Off**. The default setting is **On**. If set to On, the scale per division and reference value are automatically determined by the magnitude of the measurement results.

Troubleshooting Hints

The occupied bandwidth measurements can suggest some defective parts in the I/Q modulator section of the UUT.

Making the Spectrum (Frequency Domain) Measurement

Purpose

Excessive amount of spectrum energy spilling into an adjacent frequency channel could interfere with signals being transmitted to other mobile stations or base stations. The measurements are made for both spectrums due to $\pi/4$ DQPSK modulation and due to switching transients (burst ramping).

The spectrum measurement is a generic measurement for viewing spectrums in the frequency domain. The instrument uses Fast Fourier Transform (FFT) to provide the spectrum measurement. The measurement control is designed to be familiar to those who are accustomed to using general swept frequency spectrum analyzers.

The FFT-specific parameters are located in the **Advanced** menu on page 138. Also available is an I/Q waveform window, which shows the I and Q signals in parameters of voltage and time. The advantage of having an I/Q waveform view available in spectrum measurements is that it allows you to view complex components of the same signal without any changing settings or measurements.

Measurement Method

The transmitter tester uses digital signal processing (DSP) to sample the input signal and convert it to the frequency domain. With the instrument tuned to a fixed center frequency, samples are digitized at a high rate, converted to I and Q components with DSP hardware, and then converted to the frequency domain with FFT software.

Making the Measurement

NOTE

The factory default parameters provided for this measurement will give you an PDC compliant measurement for the instrument setup. You should be able to make a measurement often using these defaults. Press **Meas Setup**, **More (1 of 2)**, **Restore Meas Defaults** at any time to return all parameters for the current measurement to their default settings.

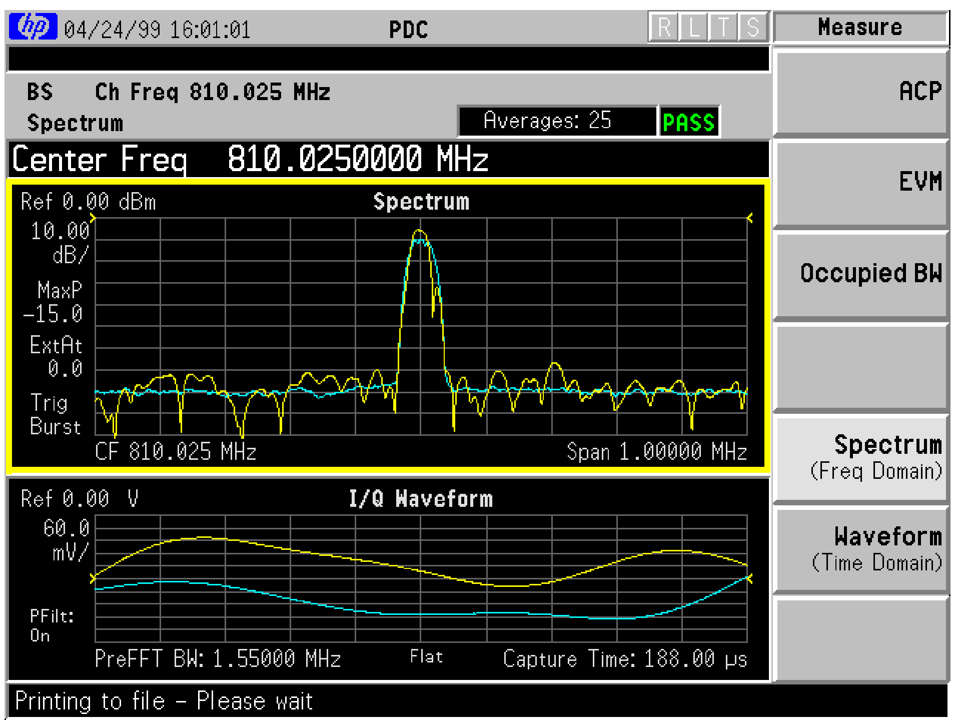
Press **Measure**, **Spectrum (Freq Domain)** to immediately make a spectrum (frequency domain) measurement.

To change any of the measurement parameters from the default values, refer to "Changing the Measurement Setup" on page 137 for this measurement.

Results

A display with both a `Spectrum` window and an `I/Q Waveform` window will appear when you activate a spectrum measurement. Use the **Next Window** key to select a window, and the **Zoom** key to enlarge it. Figure 6-7 shows an example of the spectrum measurement.

Figure 6-7 Spectrum Measurement - Spectrum and I/Q Waveform View



Changing the Measurement Setup

The next table shows the factory default settings for spectrum (frequency domain) measurements.

Table 6-4 Spectrum (Frequency Domain) Measurement Defaults

Measurement Parameter	Factory Default Condition
Meas Setup:	
Res BW	20.0000 kHz, Auto
Trig Source	Free Run (Immediate)
Average:	
Avg Number	25, On
Avg Mode	Exp
Avg Type	Log-Pwr Avg (Video)
Spectrum Window	
Meas Setup: Span	1.00000 MHz
Amplitude Y Scale: Scale/Div	10.00 dB
I/Q Waveform Window (major items)	
Meas Setup: Capture Time	188.00 µs
Amplitude Y Scale: Scale/Div	60.0 mV
Advanced	
Pre-ADC BPF	On
Pre-FFT Fltr	Flat
Pre-FFT BW	1.55000 MHz, Auto
FFT Window	Flat Top (High Amptd Acc)
FFT Size:	
Length Ctrl	Auto
Min Pnts/RBW	1.300000
Window Length	706 when Length Ctrl is Man
FFT Length	4096 when Length Ctrl is Man
ADC Range	Auto Peak
Data Packing	Auto
ADC Dither	Auto
Decimation	0, Auto
IF Flatness	On

NOTE Parameters under the **Advanced** key seldom need to be changed. Any changes from the default advanced values may result in invalid measurement data.

Make sure the **Spectrum (Freq Domain)** measurement is selected under the **Measure** menu. Press the **Meas Setup** key to access a menu which allows you to modify the averaging function and trigger source for this measurement as described in "Measurement Setup" on page 111. In addition, the following parameters can be modified:

- **Span** - Allows you to modify the frequency span in which the FFT measurement is made. The default setting is 1.00000 MHz. Changing the span causes the bandwidth to change automatically, and will affect data acquisition time.
- **Res BW** - Allows you to toggle the resolution bandwidth control between **Auto** and **Man**, and to specify the bandwidth value if set to **Man**. The default settings are **Auto** and 20.0000 kHz. A narrower bandwidth will result in a longer data acquisition time but you will be able to examine the signal more closely. In auto, the resolution bandwidth is set to **Span**/50 (2% of the span).
- **Advanced** - Allows you to access the following selection menu. The FFT advanced features should be used only if you are familiar with their operation. Changes from the default settings may result in invalid data.

  Pre-ADC BPF - Allows you to toggle the pre-ADC bandpass filter between **On** and **Off**. The default setting is **On**. The pre-ADC bandpass filter is useful for rejecting nearby signals, so that sensitivity within the span range can be improved by increasing the ADC range gain.

  Pre-FFT Fltr - Allows you to toggle the pre-FFT filter type between **Flat** (flat top) and **Gaussian**. The default setting is **Flat** which is suitable for FFT analysis. The Gaussian filter has better pulse response.

  Pre-FFT BW - Allows you to toggle the pre-FFT bandwidth control between **Auto** and **Man**. The default setting is **Auto**. In auto, this bandwidth is nominally 50% wider than the span. In manual, the bandwidth ranges from 1 Hz to 10 MHz. This bandwidth determines the ADC sampling rate.

FFT Window - Allows you to access the following selection menu. The default setting is **Flat Top (High Amptd Acc)**. If you are familiar with FFT windows, you can use other digital filters but the use of the flat top filter is recommended.

Flat Top (High Amptd Acc) - Select this filter for best amplitude accuracy by reducing scalloping error.
Uniform - Select this filter to have no active window.
Hanning - Press this key to activate the Hanning filter.
Hamming - Press this key to activate the Hamming filter.
Gaussian (Alpha 3.5) - Press this key to activate the Gaussian filter with an alpha of 3.5.
Blackman - Press this key to activate the Blackman filter.
Blackman-Harris - Press this key to activate the Blackman-Harris filter.
K-B 70dB/90dB/110dB (Kaiser-Bessel) - Allows you to select one of the Kaiser-Bessel filters with sidelobes at –70, –90, or –110 dB.

FFT Size - Allows you to access the following selection menu to define the FFT size:

Length Ctrl - Allows you to toggle the FFT and window length controls between **Auto** and **Man**.

Min Pnts/RBW - Allows you to set the minimum number of data points that will be used inside the resolution bandwidth. The range is 0.10 to 100.00 points with 0.01 or 0.1 resolution. The default setting is 1.300000 points. This key is valid if **Length Ctrl** is set to **Auto**.

Window Length - Allows you to enter the FFT window length in the number of captured samples ranging from 8 to 1048576. The default setting is 706. This length represents the actual quantity of I/Q samples that are captured for the FFT processing. This key is valid if **Length Ctrl** is set to **Man**.

FFT Length - Allows you to enter the FFT length in the number of captured samples ranging from 8 to 1048576. The default setting is 4096. The FFT length setting is automatically limited to equal to or greater than the FFT window length setting. Any amount greater than the window length is implemented by zero-padding. This key is valid if **Length Ctrl** is set to **Man**.

ADC Range - Allows you to access the following selection menu to define one of the ADC ranging functions. The default setting is **Auto Peak**.

Auto - Select this to set the ADC range automatically. For most FFT spectrum measurements, the auto feature should not be selected. An exception is when measuring a “bursty” signal, in which case auto can maximize the time domain dynamic range, if FFT results are less important to you than time domain results.

Auto Peak - Select this to set the ADC range automatically to the highest peak signal level. Auto peak is a compromise that works well for both CW and bursted signals.

Auto Peak Lock - Select this to adjust and hold the ADC range automatically at the peak signal level, even when that peak signal is no longer present. Auto peak lock is more stable than auto peak for CW signals, but should not be used for “bursty” signals.

Manual - Allows you to access the selection menu: –**6 dB**, **0 dB**, **+6 dB**, **+12 dB**, **+18 dB**, **+24 dB**, to set the ADC range level. Also note that manual ranging is best for CW signals.

Data Packing - Allows you to access the following selection menu to define one of the data packing methods. The default setting is **Auto**.

Auto - Data is automatically packed. This is the default setting and most recommended.

Short (16 bit) - Data is packed by every 16 bits.

Medium (24 bit) - Data is packed by every 24 bits.

Long (32 bit) - Data is packed by every 32 bits.

ADC Dither - Allows you to set the ADC dither function to **Auto**, **On**, or **Off**. The default setting is **Auto**. When set to auto, ADC dither will be activated when a narrow bandwidth is being measured, and deactivated when a wide bandwidth is being measured. “ADC dither” refers to the introduction of noise to the digitized steps of the analog-to-digital converter; the result is an improvement in amplitude accuracy. Use of ADC dither, however, reduces the dynamic range by approximately 3 dB.

Decimation - Allows you to toggle the decimation function between **Auto** and **Man**, and to enter a decimation value ranging from 0 to 1000 if set to **Man**. The default setting is 0 and **Auto** which is the preferred setting, and the only setting that guarantees aliasing-free FFT spectrum measurements. If you are familiar with the decimation feature you can change the decimation value by setting to **Man**, but be aware that aliasing can result in higher values.

IF Flatness - Allows you to toggle the IF flatness feature between **On** and **Off**. The default setting is **On**. When toggled to **On**, the IF flatness feature causes background amplitude corrections to be performed on the FFT spectrum. The **Off** setting is used for adjustment and troubleshooting the transmitter tester.

Changing the View

The **View/Trace** key is used to activate a measurement view with preset X and Y scale parameters, called a “window”. Using the **Span X Scale** and **Amplitude Y Scale** keys you can then modify these settings. You can also activate one specific trace using the **Trace Display** key.

Windows Available for Spectrum Measurements

The spectrum and I/Q waveform windows can be viewed at the same time or individually. You can use the **Next Window** and **Zoom** keys to move between these views.

- **Spectrum** - Select this window if you want to analyze frequency and power. Changes to frequency span or power will sometimes affect data acquisition.
- **I/Q Waveform** - Select this window to view the I and Q signal characteristics of the current measurement in parameters of voltage and time.

NOTE For the widest spans, such as 4.5 MHz and greater, the I/Q waveform window becomes just “ADC time domain samples”, because the I/Q down-conversion is no longer in effect.

Using the Markers

The **Marker** front-panel key accesses the menu to configure the markers. If you want to use the marker function in the I/Q waveform window, press **View/Trace**, **I/Q Waveform**, **Marker**, **Trace**, **IQ Waveform**.

- **Select** - Allows you to activate up to four markers with the corresponding numbers, respectively. The selected number is underlined and its function is defined by pressing the **Function** key. The default setting is 1.
- **Normal** - Allows you to activate the selected marker to read the frequency and amplitude of the marker position on the spectrum trace, for example, which is controlled by the RPG knob.
- **Delta** - Allows you to read the differences in frequencies and amplitudes between the selected marker and the next.
- **Function** - Allows you to define the selected marker function to be **Band Power**, **Noise**, or **Off**. The default setting is **Off**. If set to **Band Power**, you need to select **Delta**. If set to **Noise**, you need to select **Normal**.
- **Trace** - Allows you to place the selected marker on the **Spectrum**, **Spectrum Avg**, or **I/Q Waveform** trace. The default setting is **Spectrum**.
- **Off** - Allows you to turn off the selected marker.
- **Shape** - Allows you to access the menu to define the selected marker shape to **Diamond**, **Line**, **Square**, or **Cross**. The default setting is **Diamond**.
- **Marker All Off** - Allows you to turn off all of the markers.

Example: Band Power Measurement

A band power measurement using the markers calculates the average power between two adjustable markers. To make a band power measurement:

Step 1. Press the **Marker** key.

Step 2. Press **Trace**, **Spectrum** to activate a marker on the instantaneous spectrum trace.

Step 3. Press **Function** and select **Band Power**.

Step 4. Two marker lines are activated at the extreme left side of the horizontal scale. Press **Normal** and move marker 1 to the desired place by rotating the RPG knob.

Step 5. Press **Delta** to bring marker 2 to the same place as marker 1.

Step 6. Move marker 1 to the other desired position by rotating the RPG knob. Example: “`Pwr Mkrs: 1, 2: 74.306 kHz –30.61 dBm`” displayed in the upper right corner of the spectrum window.

For a full description of the marker features see the user's guide for your instrument.

Troubleshooting Hints

The spectrum measurement, along with the error vector magnitude measurements, can reveal several faults in the transmitter section, such as the I/Q baseband generator, filters, modulators and power amplifier, of the UUT.

Making the Waveform (Time Domain) Measurement

Purpose

The waveform measurement is a generic measurement for viewing waveforms in the time domain. This measurement is how the instrument performs the zero span functionality found in traditional spectrum analyzers. Also available under the basic waveform measurement is an I/Q waveform window that shows the I and Q signals with voltage and time parameters. The advantage of having an I/Q view available during waveform measurements is that it allows you to view complex components of the same signal without changing settings or measurements.

The waveform measurement can be also used to perform general purpose power measurements to a high degree of accuracy.

Measurement Method

The transmitter tester makes repeated power measurements at a set frequency, similar to the way a swept-tuned spectrum analyzer makes zero span measurements. The analog input signal is converted to a digital signal, which then is processed into a representation of a waveform measurement using FFT. The transmitter tester relies on a high rate sampling process to create an accurate representation of a time domain signal.

Making the Measurement

NOTE The factory default parameters provided for this measurement will give you a PDC compliant measurement for the instrument setup. You should be able to make a measurement often using these defaults.

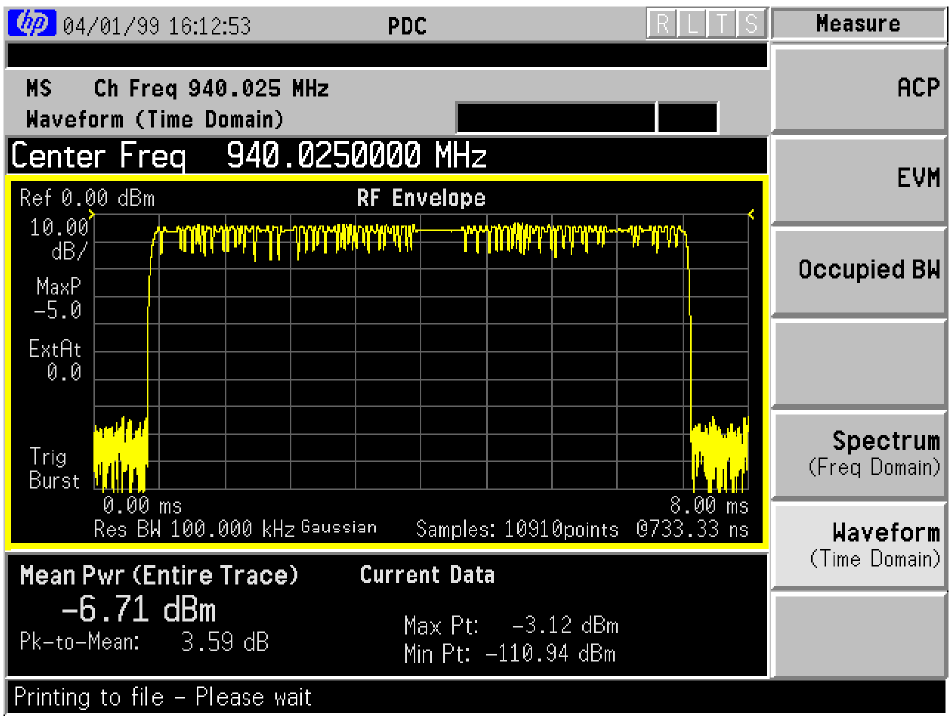
Press **Measure**, **Waveform (Time Domain)** to immediately make a waveform (time domain) measurement.

To change any of the measurement parameters from the factory default values, refer to "Changing the Measurement Setup" on page 147 for this measurement.

Results

A display with the RF envelope window and measured data window will appear when you activate a waveform (time domain) measurement. Figure 6-8 shows an example of the waveform (time domain) measurement.

Figure 6-8 Waveform (Time Domain) Measurement - RF Envelope View



Changing the Measurement Setup

The next table shows the factory default settings for waveform (time domain) measurements.

Table 6-5 Waveform (Time Domain) Measurement Defaults

Measurement Parameter	Factory Default Condition
View/Trace	RF Envelope
Meas Setup:	
Sweep Time	10.00 ms
Res BW	100.000 kHz
Average:	
Avg Number	10, Off
Avg Mode	Exp
Avg Type	Pwr Avg (RMS)
Trig Source	Free Run (Immediate)
RF Envelope	
Amplitude Y Scale:	
Scale/Div	10.00 dB
Ref Position	Top
I/Q Waveform	
Amplitude Y Scale:	
Scale/Div	100.0 mV
Ref Position	Ctr
Advanced	
Pre-ADC BPF	Off
RBW Filter	Gaussian
ADC Range	Auto
Data Packing	Auto
ADC Dither	Off
Decimation	Off

Make sure the **Waveform (Time Domain)** measurement is selected under the **Measure** menu. Press the **Meas Setup** key to access the menu which allows you to modify the averaging and trigger source for this measurement as described in "Measurement Setup" on page 111. In addition, the following waveform parameters can be modified:

- **Sweep Time** - Allows you to select the measurement acquisition time. The allowable range is 1.0 μs to 100.0 s, depending upon the resolution bandwidth setting. The default setting is 10.00 ms. It is used to specify the length of the time capture record.
- **Res BW**- Allows you to set the measurement resolution bandwidth. The allowable range is 10.0 Hz to 7.5 MHz with the best resolution of 1 Hz. The default setting is 100.000 kHz. A higher resolution bandwidth results in a larger number of acquisition points, and reduces the maximum sweep time allowed.

NOTE Parameters under the **Advanced** key seldom need to be changed. Any changes from the default values may result in invalid measurement data.

- **Advanced** - Allows you to access the following selection menu. The FFT advanced features should be used only if you are familiar with their operation. Changes from the default settings may result in invalid data.

  Pre-ADC BPF - Allows you to toggle the pre-ADC bandpass filter between On and Off. The default setting is Off. The pre-ADC bandpass filter is useful for rejecting nearby signals, so that sensitivity within the span range can be improved by increasing the ADC range gain.

  RBW Filter - Allows you to toggle the resolution bandwidth filter type between **Flat** (flat top) and **Gaussian**. The default setting is **Gaussian**. The Gaussian filter provides more even time domain response, particularly for bursts. The flat top filter provides a flatter bandwidth but is less accurate for pulse responses. The flat top filter also requires less memory and allows longer data acquisition times. For most waveform applications, the Gaussian filter is recommended.

ADC Range - Allows you to access the following selection menu to define one of the ADC ranging functions: The default setting is Auto.

Auto - Select this to adjust the ADC range automatically for optimum results. As this is the time domain measurement of the bursted signal, auto can maximize the time domain dynamic range.

Auto Peak - Select this to adjust the ADC range continuously to the highest peak signal level identified. Auto peak is a compromise that works well for both CW and bursted signals.

Auto Peak Lock - Select this to adjust and hold the ADC range automatically at the highest peak signal level, even when that peak signal is no longer present. Auto peak lock is more stable than auto peak for CW signals, but should not be used for "bursty" signals.

Manual - Allows you to access the selection menu: –**6 dB**, **0 dB**, **+6 dB**, **+12 dB**, **+18 dB**, **+24 dB**, to set the ADC range level. Also note that manual ranging is best for CW signals.

Changing the View

The **View/Trace** key is used to activate a measurement view with preset X and Y scale parameters, called a "window". Using the **Span X Scale** and **Amplitude Y Scale** keys you can then modify these settings. You can also activate one specific trace using the **Trace Display** key.

Windows Available for Waveform Measurements

- **RF Envelope -** Select this window if you want to view power (in dBm) vs. time. Remember that data acquisition will be affected when you change the sweep time. An illustration of an RF envelope window is found in Figure 6-8 on page 146.
- **I/Q Waveform -** Select this window to view the I and Q signal characteristics of the current measurement in parameters of voltage and time.

Using the Markers

The **Marker** front-panel key accesses the menu to configure the markers. If you want to use the marker function in the I/Q waveform window, press **View/Trace**, **I/Q Waveform**, **Marker**, **Trace**, **IQ Waveform**.

- **Select** - Allows you to activate up to four markers with the corresponding numbers, respectively. The selected number is underlined and its function is defined by pressing the **Function** key. The default setting is 1.
- **Normal** - Allows you to activate the selected marker to read the time and amplitude of the marker position on the waveform trace, for example, which is controlled by the RPG knob.
- **Delta** - Allows you to read the differences in times and amplitudes between the selected marker and the next.
- **Function** - Allows you to define the selected marker function to **Band Power**, **Noise**, or **Off**. The default setting is **Off**. Press **Band Power**, **Delta** to read the time and absolute power differences between the selected marker and the next. Press **Off**, **Delta** to read the time and relative power differences between the markers. Pressing **Noise** is invalid and displays the message: “`Time Domain Noise Mkr not available.`”
- **Trace** - Allows you to place the selected marker on the **RF Envelope** or the **I/Q Waveform** trace. The default setting is **RF Envelope**.
- **Off** - Allows you to turn off the selected marker.
- **Shape** - Allows you to access the menu to define the selected marker shape to **Diamond**, **Line**, **Square**, or **Cross**. The default setting is **Diamond**.
- **Marker All Off** - Allows you to turn off all of the markers.

For a full description of the marker features see the user’s guide for your instrument.

Troubleshooting Hints

This waveform measurement, very often along with the adjacent carrier power measurement and/or spectrum measurement, can reveal some defective parts in the transmitter section of the UUT as follows:

(1) Some faults in the DC power supply control of the transmitter power amplifier, RF power controller of the pre-power amplifier stage, and/or I/Q control of the baseband stage, if the specified dynamic range is less than 80 dB.

(2) Some timing error from the faulty DC power on/off control circuit and other linear RF level control circuit.