

Agilent X-Series Signal Analyzer

This manual provides documentation for the following X-Series Analyzers:

**PXA Signal Analyzer N9030A
MXA Signal Analyzer N9020A
EXA Signal Analyzer N9010A
CXA Signal Analyzer N9000A**

N6158A & W6158A CMMB Measurement Application Measurement Guide



Agilent Technologies

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Manual Part Number

N6158-90002

Print Date

July 2010

Printed in USA

Agilent Technologies, Inc.
1400 Fountaingrove Parkway
Santa Rosa, CA 95403

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1

About the N6158A CMMB Measurement Application

This chapter provides the overall information on the N6158A CMMB measurement application. CMMB measurement application supports CMMB standard measurements.

CMMB (China Multimedia Mobile Broadcasting) is a mobile digital video standard developed in China, and was implemented on November 1, 2006.

What Does the CMMB Measurement Application Do?

The CMMB measurement application allows the signal analyzer to be used for testing a CMMB transmitter or exciter.

This application is manufactured according to the following documents:

- GY/T 220.1-2006 Mobile Multimedia Broadcasting Part 1: Framing Structure, Channel Coding and Modulation for Broadcasting Channel
- GD/J020-2008 Technical Specifications and Methods of Measurement for Mobile Multimedia Broadcasting Transmitters
- Technical Specifications and Methods of Measurement for Mobile Multimedia Broadcasting Exciters (draft)

These documents define complex, multi-part measurements to create an interference-free environment and to ensure high quality transmission. For example, the documents standardize the test methods for transmitting power, shoulder attenuation, ACP, spectrum emission mask, MER, and other critical measurements.

The analyzer automatically makes these measurements according to the methods defined in the documents. The detailed measurement results enable you to analyze the CMMB transmitter/exciter's performance. You can also alter the measurement parameters for specialized analysis.

The N6158A CMMB measurement application provides the following measurements of CMMB signals:

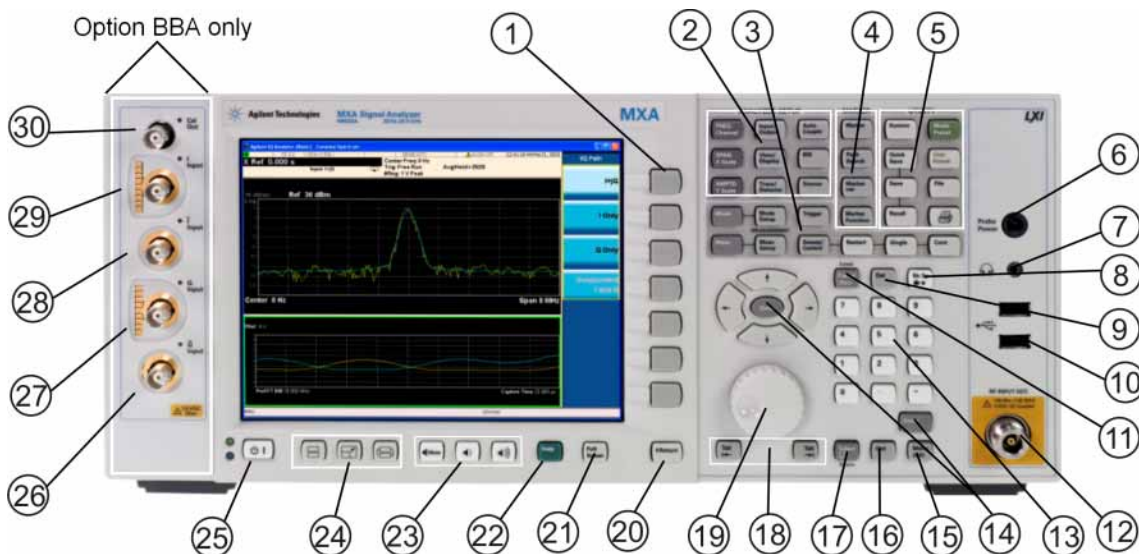
- Channel Power
- ACP
- Power Stat CCDF
- Spectrum Emission Mask
- Mod Accuracy
- Occupied BW
- Monitor Spectrum
- IQ Waveform

If the option BBA is installed, you can analyze analog baseband I/Q signal characteristics of CMMB signals. The analog baseband I/Q analysis is available in the following measurements:

- Power Stat CCDF
- Modulation Accuracy
- IQ Waveform

- “Front-Panel Features” on page 12
- “Display Annotations” on page 19
- “Rear-Panel Features” on page 21
- “Front and Rear Panel Symbols” on page 24

Front-Panel Features



Item		Description
#	Name	
1	Menu Keys	Key labels appear to the left of the menu keys to identify the current function of each key. The displayed functions are dependent on the currently selected Mode and Measurement, and are directly related to the most recent key press.
2	Analyzer Setup Keys	These keys set the parameters used for making measurements in the current Mode and Measurement.
3	Measurement Keys	These keys select the Mode, and the Measurement within the mode. They also control the initiation and rate of recurrence of measurements.
4	Marker Keys	Markers are often available for a measurement, to measure a very specific point/segment of data within the range of the current measurement data.
5	Utility Keys	These keys control system-wide functionality such as: <ul style="list-style-type: none"> instrument configuration information and I/O setup, printer setup and printing, file management, save and recall, instrument presets.
6	Probe Power	Supplies power for external high frequency probes and accessories.
7	Headphones Output	Headphones can be used to hear any available audio output.
8	Back Space Key	Press this key to delete the previous character when entering alphanumeric information. It also works as the Back key in Help and Explorer windows.

Item		Description
#	Name	
9	Delete Key	Press this key to delete files, or to perform other deletion tasks.
10	USB Connectors	Standard USB 2.0 ports, Type A. Connect to external peripherals such as a mouse, keyboard, DVD drive, or hard drive.
11	Local/Cancel/(Esc) Key	<p>If you are in remote operation, Local:</p> <ul style="list-style-type: none"> • returns instrument control from remote back to local (the front panel). • turns the display on (if it was turned off for remote operation). • can be used to clear errors. (Press the key once to return to local control, and a second time to clear error message line.) <p>If you have not already pressed the units or Enter key, Cancel exits the currently selected function without changing its value.</p> <p>Esc works the same as it does on a PC keyboard. It:</p> <ul style="list-style-type: none"> • exits Windows dialogs • clears errors • aborts printing • cancels operations.
12	RF Input	Connector for inputting an external signal. Make sure that the total power of all signals at the analyzer input does <i>not</i> exceed +30 dBm (1 watt).
13	Numeric Keypad	Enters a specific numeric value for the current function. Entries appear on the upper left of the display, in the measurement information area.
14	Enter and Arrow Keys	<p>The Enter key terminates data entry when either no unit of measure is needed, or you want to use the default unit.</p> <p>The arrow keys:</p> <ul style="list-style-type: none"> • Increment and decrement the value of the current measurement selection. • Navigate help topics. • Navigate, or make selections, within Windows dialogs. • Navigate within forms used for setting up measurements. • Navigate within tables. <p>NOTE The arrow keys cannot be used to move a mouse pointer around on the display.</p>
15	Menu/ (Alt) Key	Alt works the same as a PC keyboard. Use it to change control focus in Windows pull-down menus.
16	Ctrl Key	Ctrl works the same as a PC keyboard. Use it to navigate in Windows applications, or to select multiple items in lists.
17	Select / Space Key	Select is also the Space key and it has typical PC functionality. For example, in Windows dialogs, it selects files, checks and unchecks check boxes, and picks radio button choices. It opens a highlighted Help topic.
18	Tab Keys	Use these keys to move between fields in Windows dialogs.
19	Knob	Increments and decrements the value of the current active function.
20	Return Key	Exits the current menu and returns to the previous menu. Has typical PC functionality.

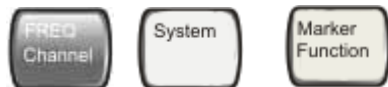
Front and Rear Panel Features
Front-Panel Features

Item		Description
#	Name	
21	Full Screen Key	Pressing this key turns off the softkeys to maximize the graticule display area. Press the key again to restore the normal display.
22	Help Key	Initiates a context-sensitive Help display for the current Mode. Once Help is accessed, pressing a front panel key brings up the help topic for that key function.
23	Speaker Control Keys	Enables you to increase or decrease the speaker volume, or mute it.
24	Window Control Keys	These keys select between single or multiple window displays. They zoom the current window to fill the data display, or change the currently selected window. They can be used to switch between the Help window navigation pane and the topic pane.
25	Power Standby/ On	Turns the analyzer on. A green light indicates power on. A yellow light indicates standby mode. <div style="background-color: #cccccc; padding: 2px; display: inline-block; margin-bottom: 5px;">NOTE</div> <p>The front-panel switch is a standby switch, <i>not</i> a LINE switch (disconnecting device). The analyzer continues to draw power even when the line switch is in standby.</p> <p>The main power cord can be used as the system disconnecting device. It disconnects the mains circuits from the mains supply.</p>
26	Q Input	Input port for the Q channel when in differential mode. ^a
27	Q Input	Input port for the Q channel for either single or differential mode. ^a
28	I Input	Input port for the I channel when in differential mode. ^a
29	I Input	Input port for the I channel for either single or differential mode. ^a
30	Cal Out	Output port for calibrating the I, I, Q and Q inputs and probes used with these inputs. ^a

a. Status of the LED indicates whether the current state of the port is active (green) or is not in use (dark).

Overview of key types

The keys labeled **FREQ Channel**, **System**, and **Marker Functions** are all examples of front-panel keys.

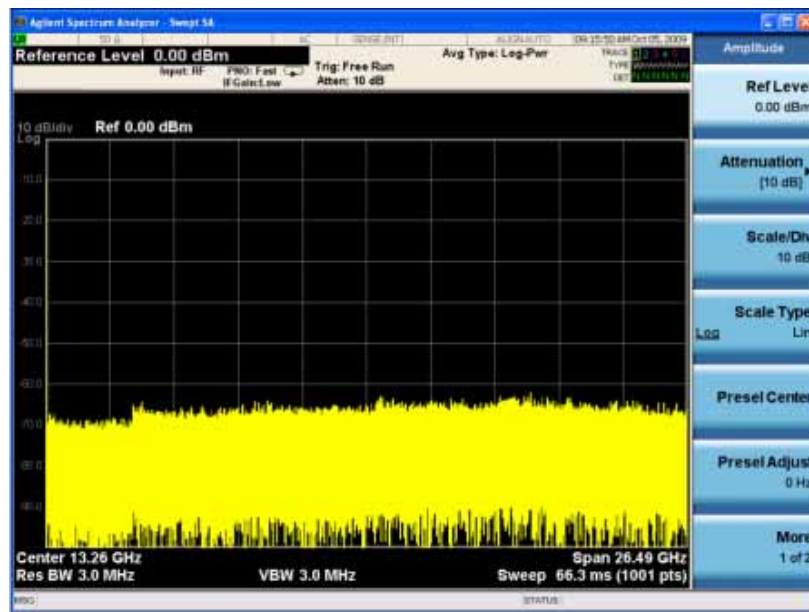


Most of the dark or light gray keys access menus of functions that are displayed along the right side of the display. These displayed key labels are next to a column of keys called menu keys.

Menu keys list functions based on which front-panel key was pressed last. These

functions are also dependant on the current selection of measurement application (**Mode**) and measurement (**Meas**).

If the numeric value of a menu key function can be changed, it is called an active function. The function label of the active function is highlighted after that key has been selected. For example, press **AMPTD Y Scale**. This calls up the menu of related amplitude functions. The function labeled **Ref Level** (the default selected key in the Amplitude menu) is highlighted. **Ref Level** also appears in the upper left of the display in the measurement information area. The displayed value indicates that the function is selected and its value can now be changed using any of the data entry controls.

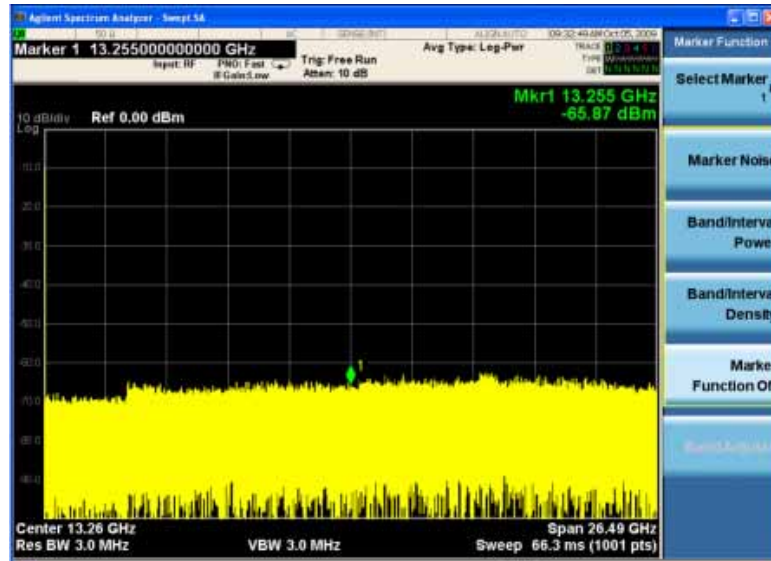


Some menu keys have multiple choices on their label, such as **On/Off**, **Auto/Man**, or **Log/Lin** (as shown above). The different choices are selected by pressing the key multiple times. For example, the Auto/Man type of key. To select the function, press the menu key and notice that Auto is underlined and the key becomes highlighted. To change the function to manual, press the key again so that Man is underlined. If there are more than two settings on the key, keep pressing it until the desired selection is underlined.

Front and Rear Panel Features

Front-Panel Features

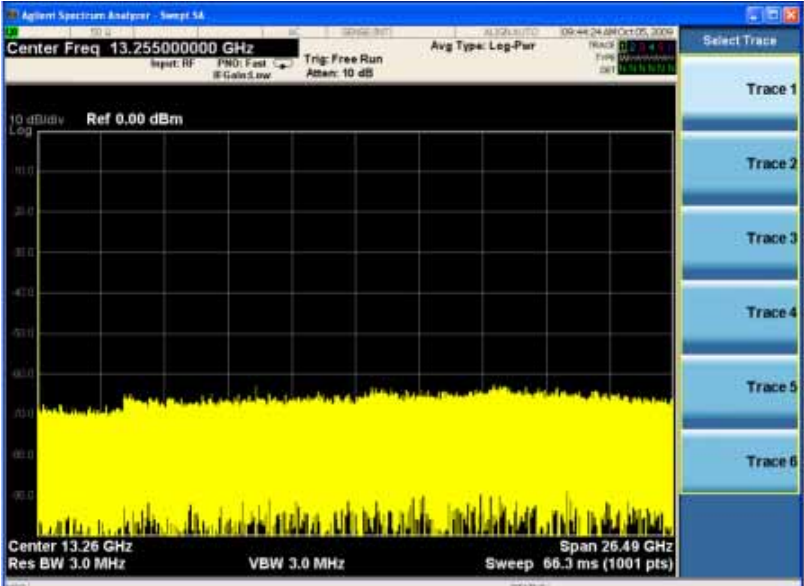
When a menu first appears, one key label is highlighted to show which key is the default selection. If you press **Marker Function**, the **Marker Function Off** key is the menu default key, and is highlighted.



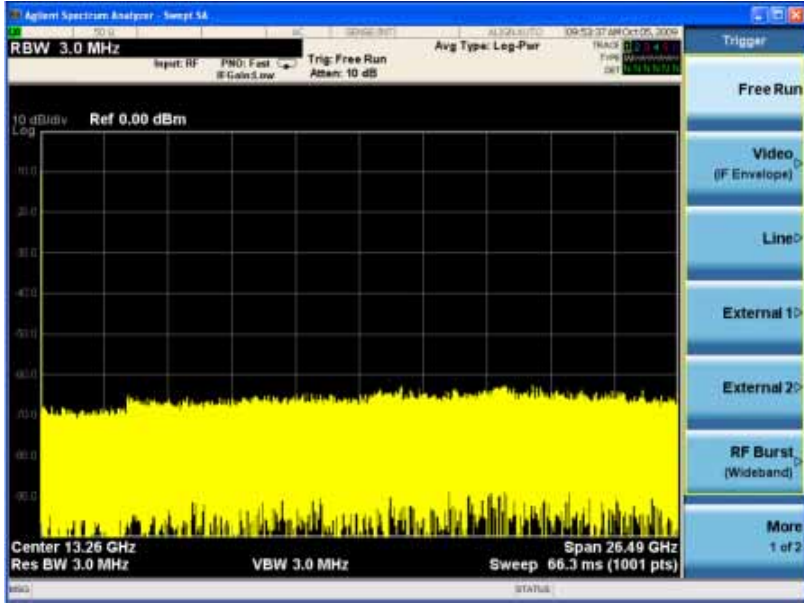
Some of the menu keys are grouped together by a yellow bar running behind the keys near the left side or by a yellow border around the group of keys. When you press a key within the yellow region, such as **Marker Noise**, the highlight moves to that key to show it has been selected. The keys that are linked are related functions, and only one of them can be selected at any one time. For example, a marker can only have one marker function active on it. So if you select a different function it turns off the previous selection. If the current menu is two pages long, the yellow bar or border could include keys on the second page of keys.

In some key menus, a key label is highlighted to show which key has been selected from multiple available choices. And the menu is immediately exited when you press one of the other keys. For example, when you press the **Select Trace** key (in the **Trace/Detector** menu), it brings up its own menu of keys. The **Trace 1** key is highlighted. When you press the **Trace 2** key, the highlight moves to that key and

the screen returns to the **Trace/Detector** menu.

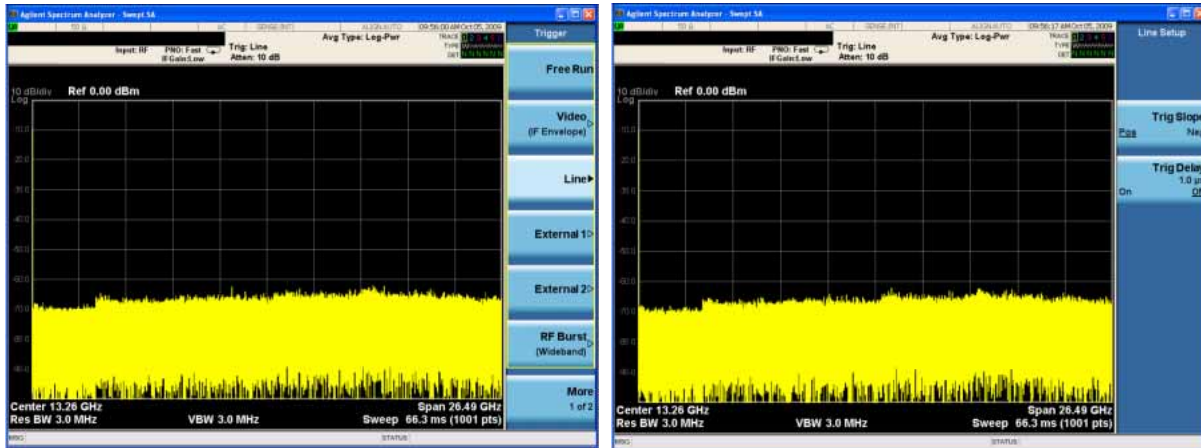


If a displayed key label shows a small solid-black arrow tip pointing to the right, it indicates that additional key menus are available. If the arrow tip is not filled in solid then pressing the key the first time selects that function. Now the arrow is solid and pressing it again brings up an additional menu of settings.



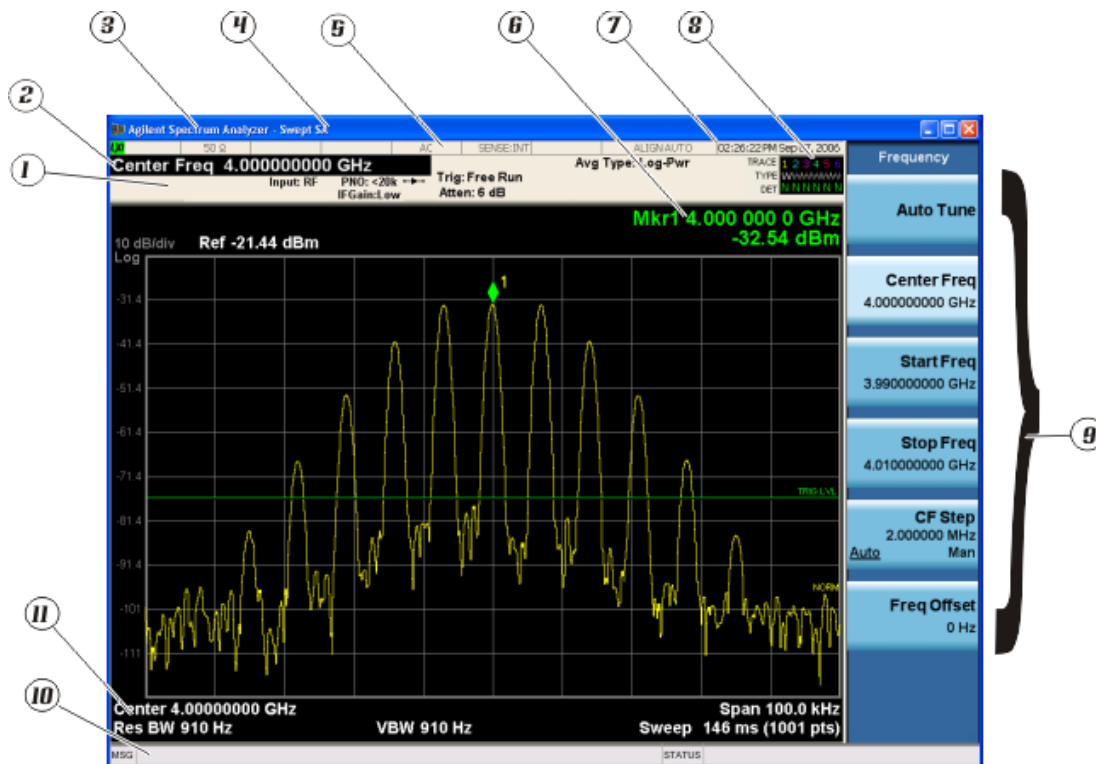
Front and Rear Panel Features



Front-Panel Features



Display Annotations

This section describes the display annotation as it is on the Spectrum Analyzer Measurement Application display. Other measurement application modes will have some annotation differences.



Item	Description	Function Keys
1	Measurement bar - Shows general measurement settings and information.   Indicates single/continuous measurement. Some measurements include limits that the data is tested against. A Pass/Fail indication may be shown in the lower left of the measurement bar.	All the keys in the Analyzer Setup part of the front panel.
2	Active Function (measurement bar) - when the current active function has a settable numeric value, it is shown here.	Currently selected front panel key.
3	Banner - shows the name of the selected measurement application and the measurement that is currently running.	Mode, Meas

Front and Rear Panel Features Display Annotations

Item	Description	Function Keys
4	Measurement title (banner) - shows title information for the current Measurement, or a title that you created for the measurement.	Meas View/Display, Display, Title
5	Settings panel - displays system information that is not specific to any one application. <ul style="list-style-type: none"> • Input/Output status - green LXI indicates the LAN is connected. RLTS indicate Remote, Listen, Talk, SRQ • Input impedance and coupling • Selection of external frequency reference • Setting of automatic internal alignment routine 	Local and System, I/O Config Input/Output, Amplitude, System and others.
6	Active marker frequency, amplitude or function value.	Marker
7	Settings panel - time and date display.	System, Control Panel
8	Trace and detector information.	Trace/Detector, Clear Write (W) Trace Average (A) Max Hold (M) Min Hold (m) Trace/Detector, More, Detector, Average (A) Normal (N) Peak (P) Sample (S) Negative Peak (p)
9	Key labels that change based on the most recent key press.	Softkeys
10	Displays information, warning and error messages. Message area - single events, Status area - conditions.	
11	Measurement settings for the data currently being displayed in the graticule area. In the example above: center frequency, resolution bandwidth, video bandwidth, frequency span, sweep time and number of sweep points.	Keys in the Analyzer Setup part of the front panel.

Rear-Panel Features

PXA, MXA and EXA with Option PC2

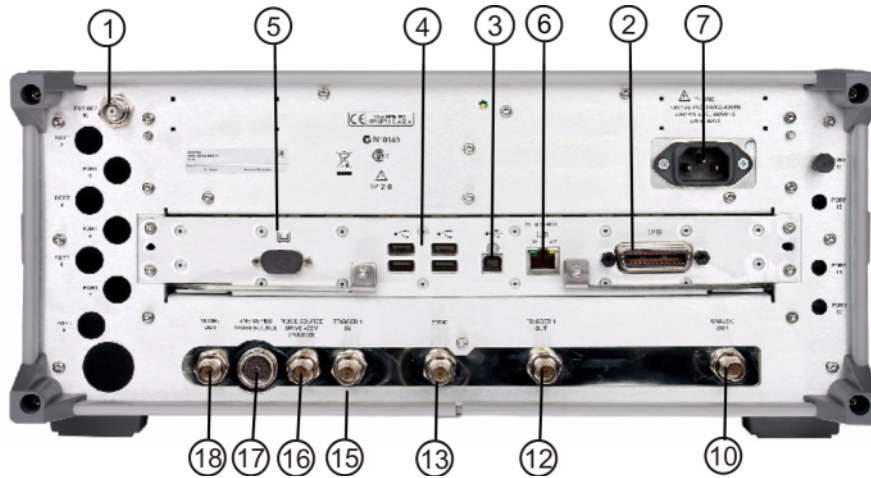


EXA



Front and Rear Panel Features
Rear-Panel Features

CXA



Item		Description
#	Name	
1	EXT REF IN	Input for an external frequency reference signal: For PXA – 1 to 50 MHz For MXA – 1 to 50 MHz For EXA – 10 MHz. For CXA – 10 MHz.
2	GPIB	A General Purpose Interface Bus (GPIB, IEEE 488.1) connection that can be used for remote analyzer operation.
3	USB Connector	USB 2.0 port, Type B. USB TMC (test and measurement class) connects to an external pc controller to control the instrument and for data transfers over a 480 Mbps link.
4	USB Connectors	Standard USB 2.0 ports, Type A. Connect to external peripherals such as a mouse, keyboard, printer, DVD drive, or hard drive.
5	MONITOR	Allows connection of an external VGA monitor.
6	LAN	A TCP/IP Interface that is used for remote analyzer operation.
7	Line power input	The AC power connection. See the product specifications for more details.
8	Removable Disk Drive	Standard on PXA and MXA. Optional on EXA.
9	Digital Bus	Reserved for future use.

Item		Description
#	Name	
10	Analog Out	For PXA option YAV: Screen Video Log Video Linear Video For PXA option EMC: Demod Audio
11	TRIGGER 2 OUT	A trigger output used to synchronize other test equipment with the analyzer. Configurable from the Input/Output keys.
12	TRIGGER 1 OUT	A trigger output used to synchronize other test equipment with the analyzer. Configurable from the Input/Output keys.
13	Sync	Reserved for future use.
14	TRIGGER 2 IN	Allows external triggering of measurements.
15	TRIGGER 1 IN	Allows external triggering of measurements.
16	Noise Source Drive +28 V (Pulsed)	For use with Agilent 346A, 346B, and 346C Noise Sources.
17	SNS Series Noise Source	For use with Agilent N4000A, N4001A, N4002A Smart Noise Sources (SNS).
18	10 MHz OUT	An output of the analyzer internal 10 MHz frequency reference signal. It is used to lock the frequency reference of other test equipment to the analyzer.
19	Preselector Tune Out	Reserved for future use.
20	Aux IF Out	For PXA options: CR3 Second IF Out CRP Arbitrary IF Out ALV Log Video

Front and Rear Panel Symbols



This symbol is used to indicate power ON (green LED).



This symbol is used to indicate power STANDBY mode (yellow LED).



This symbol indicates the input power required is AC.



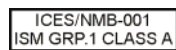
The instruction documentation symbol. The product is marked with this symbol when it is necessary for the user to refer to instructions in the documentation.



The CE mark is a registered trademark of the European Community.



The C-Tick mark is a registered trademark of the Australian Spectrum Management Agency.



This is a marking of a product in compliance with the Canadian Interference-Causing Equipment Standard (ICES-001).

This is also a symbol of an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 4).



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This symbol on all primary and secondary packaging indicates compliance to China standard GB 18455-2001.

To return unwanted products, contact your local Agilent office, or see <http://www.agilent.com/environment/product/> for more information.

This chapter first introduces the instructions common to all measurements, and then, discusses the instructions specific to individual measurements, as follows.

- “Channel Power Measurements” on page 31
- “ACP Measurements” on page 35
- “Power Stat CCDF Measurements” on page 39
- “Spectrum Emission Mask Measurements” on page 43
- “Modulation Accuracy Measurements” on page 49
- “Occupied Bandwidth Measurements” on page 59
- “Monitor Spectrum Measurements” on page 63
- “IQ Waveform (Time Domain) Measurements” on page 65

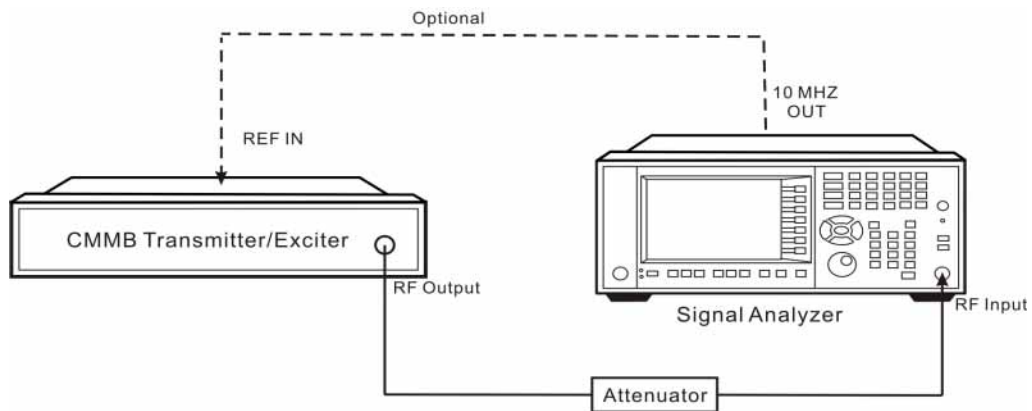
Setting Up and Making a Measurement

Making Initial Connection and Configuring the Measurement System

- Step 1.** Set the CMMB transmitter/exciter under test to transmit RF power. This transmitting signal is connected to the RF input port of the instrument. Connect the equipments as shown in [Figure 3-1](#).

CAUTION Before connecting a CMMB signal to the analyzer, make sure the analyzer can safely accept the signal level provided. The maximum signal level limits are marked next to the RF Input connectors on the front panel.

Figure 3-1 CMMB Measurement System



- Connect the output signal from the CMMB transmitter/exciter to the RF input port of the analyzer using appropriate cables, attenuators, and adapters.
- Optional: If there is a frequency reference port on the CMMB transmitter, connect it to the EXT REF IN port of the analyzer with a cable for frequency synchronization.

- Step 2.** Select the input port settings using the keys under **Input/Output** menu.

NOTE The parameters under **Input/Output** menu can't be reset by pressing **Mode Preset**. Then if you've made any changes to the Input/Output parameters which aren't required in another measurement, remember to restore these settings manually.

Setting the CMMB Transmitter (Example)

Set up the CMMB transmitter to transmit the RF power as follows (example):

Frequency: 634.000000 MHz

(Channel Num: 28, Channel Table: PAL-D/K)

Attenuator: 60 dB

Transmitted Power: 40 dBm (at RF output); -20 dBm (at the analyzer input)

An example of PLCH configuration is shown in [Table 3-1](#).

Table 3-1 Configuration of PLCHs

PLCH	Number of TS	Modulation Format	RS Rate	LDPC Rate	Interleave Mode	Scramble Initial Code
CLCH	1 (0)	BPSK	RS(240,240)	1/2	Mode1	Mode0
SLCH0	3 (1-3)	16QAM	RS(240,224)	3/4	Mode2	Mode0
SLCH1	5 (4-8)	QPSK	RS(240,240)	1/2	Mode1	Mode6
SLCH2	7 (9-15)	BPSK	RS(240,192)	3/4	Mode1	Mode2
SLCH3	4 (16-19)	BPSK	RS(240,176)	1/2	Mode1	Mode2
SLCH4	7 (20-26)	16QAM	RS(240,240)	1/2	Mode1	Mode2
SLCH5	1 (27)	QPSK	RS(240,240)	1/2	Mode1	Mode2
SLCH6	2 (28-29)	QPSK	RS(240,240)	1/2	Mode1	Mode4
SLCH7	1 (30)	QPSK	RS(240,224)	1/2	Mode2	Mode5
SLCH8	3 (31-33)	BPSK	RS(240,240)	1/2	Mode1	Mode7
SLCH9	1 (34)	QPSK	RS(240,192)	3/4	Mode1	Mode4
SLCH10	5 (35-39)	QPSK	RS(240,224)	1/2	Mode2	Mode4

Using Analyzer Mode and Measurement Presets

To set your current measurement mode to a known factory default state, press **Mode Preset**. This initializes the analyzer mode by returning the mode setup and all of the measurement setups in that mode to the factory default parameters.

To preset the parameters that are specific to an active, selected measurement, press **Meas Setup, Meas Preset**. This returns all the measurement setup parameters to the factory defaults, but only for the currently selected measurement.

The 3 Steps to Set Up and Make Measurements

Generally speaking, all measurements can be set up using the following three steps in [Table 3-2](#). [Table 3-3](#) shows the main keys and functions that may be used while following the steps. For the detailed procedures of a specific measurement, refer to:

- [“Channel Power Measurements” on page 31](#)
- [“ACP Measurements” on page 35](#)
- [“Power Stat CCDF Measurements” on page 39](#)

Making CMMB Measurements
Setting Up and Making a Measurement

- “Spectrum Emission Mask Measurements” on page 43
- “Modulation Accuracy Measurements” on page 49
- “Occupied Bandwidth Measurements” on page 59
- “Monitor Spectrum Measurements” on page 63
- “IQ Waveform (Time Domain) Measurements” on page 65

NOTE



Press  on the front panel to enter the help system and see detailed descriptions for the keys you are not familiar with. Press  on the front panel to exit the help system.

Table 3-2 The 3 Steps to Set Up and Make a Measurement

Step	Action	Notes
1. Select and Set Up the Mode	a. Press Mode . b. Press a mode key, like Spectrum Analyzer , IQ Analyzer (Basic) , or CMMB . c. Press Mode Preset . d. Press Mode Setup .	All licensed, installed modes available are shown under the Mode key. Using Mode Setup , make any required adjustments to the mode settings. These settings apply to all measurements in the mode.
2. Select and Set Up the Measurement	a. Press Meas . b. Select the specific measurement to be performed. c. Press Meas Setup .	The resulting data is shown on the display or is available for export. Use Meas Setup to make any required adjustment to the selected measurement settings. The settings only apply to this measurement.
3. Select and Set Up a View of the Results	Press View/Display . Set display format and select a view for the current measurement data.	Depending on the mode and measurement selected, the graphical and tabular data presentations are available. Use Span X Scale and AMPTD Y Scale to adjust the display of the measurement graphics.

NOTE

You can change the settings as needed, and the changes will be in effect on the next measurement cycle or view.

Table 3-3 Main Keys and Functions for Making Measurements

Step	Primary Key	Setup Keys	Related Keys
1. Select and set up a mode.	Mode	Mode Setup, FREQ Channel	System
2. Select and set up a measurement.	Meas	Meas Setup	BW, Sweep/Control, Restart, Single, Cont
3. Select and set up a view of the results.	View/Display	SPAN X Scale, AMPTD Y Scale	Peak Search, Quick Save, Save, Recall, File, Print

NOTE

If you encounter a problem, or get an error message, see the guide “*Instrument Messages*”, which is provided on the Documentation CD ROM, and in the instrument here:

C:\Program Files\Agilent\SignalAnalysis\Infrastructure\Help\bookfiles.

Making CMMB Measurements
Setting Up and Making a Measurement

Channel Power Measurements

This section explains how to make a Channel Power measurement on a CMMB transmitter/exciter. Channel Power measurements show the spectrum, the total RF power and the shoulder attenuation of the signal.

The Channel Power measurement procedure includes three parts:

- a. [“Selecting and Setting up the CMMB Mode” on page 31](#)
- b. [“Selecting and Setting up Channel Power Measurement” on page 31](#)
- c. [“Selecting and Viewing the Measurement Results” on page 32](#)

Selecting and Setting up the CMMB Mode

Step 1. Select CMMB mode.

Press **Mode, CMMB**.

Step 2. Preset the analyzer.

Press **Mode Preset**.

Step 3. Set the center frequency. There are two ways:

- Enter the center frequency directly.
Press **FREQ Channel, Center Freq, 634, MHz**.
- Select the channel number under a specific channel table.
 - a. Specify a channel table by selecting a video standard.
Press **FREQ Channel, Chan Table, PAL-D/K, PAL-D/K DS**.
 - b. Set the channel number.
Press **FREQ Channel, Channel, 28**.

Step 4. Set the Device Type to Transmitter.

Press **Mode Setup, Device Type, Transmitter**.

Selecting and Setting up Channel Power Measurement

Step 1. Initiate the Channel Power measurement.

Press **Meas, Channel Power**.

Step 2. Set up the Channel Power measurement and see the parameters available to change. The default settings are compliant with the specification in CMMB standards, so you can use the default settings for most cases.

Press **Meas Setup**.

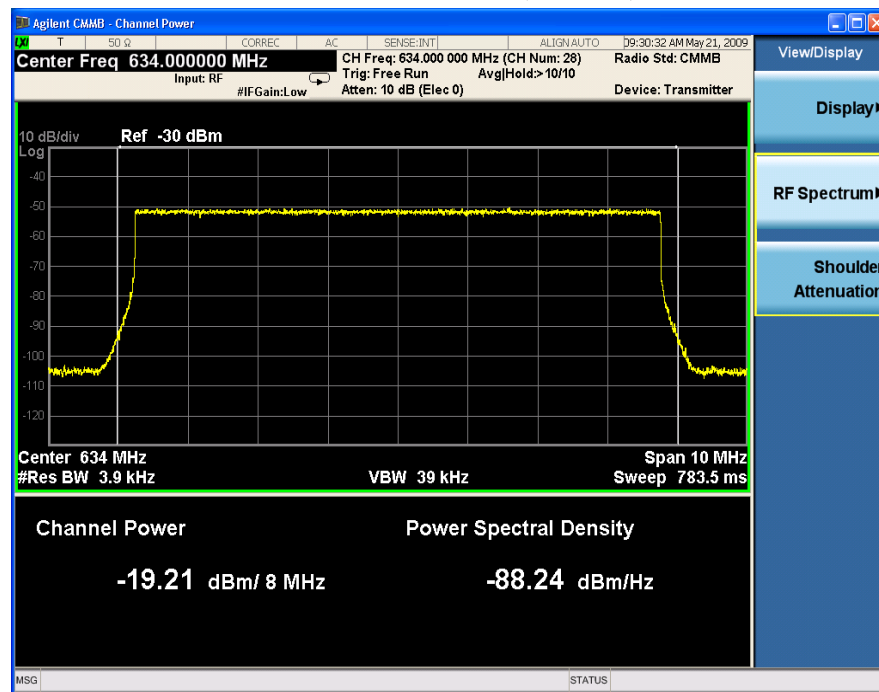
Selecting and Viewing the Measurement Results

Two views are available in the Channel Power measurement. Press **View/Display**, the name of the view to display them.

- **RF Spectrum** displays the RF spectrum and power in the channel. The RF Spectrum measurement results should look like [Figure 3-2](#). The text window shows the total channel power and its mean power spectral density values over 8 MHz.

Figure 3-2

Channel Power Measurement Result (Default)



NOTE To change the measurement bandwidth, press **Meas Setup, Integ BW**.

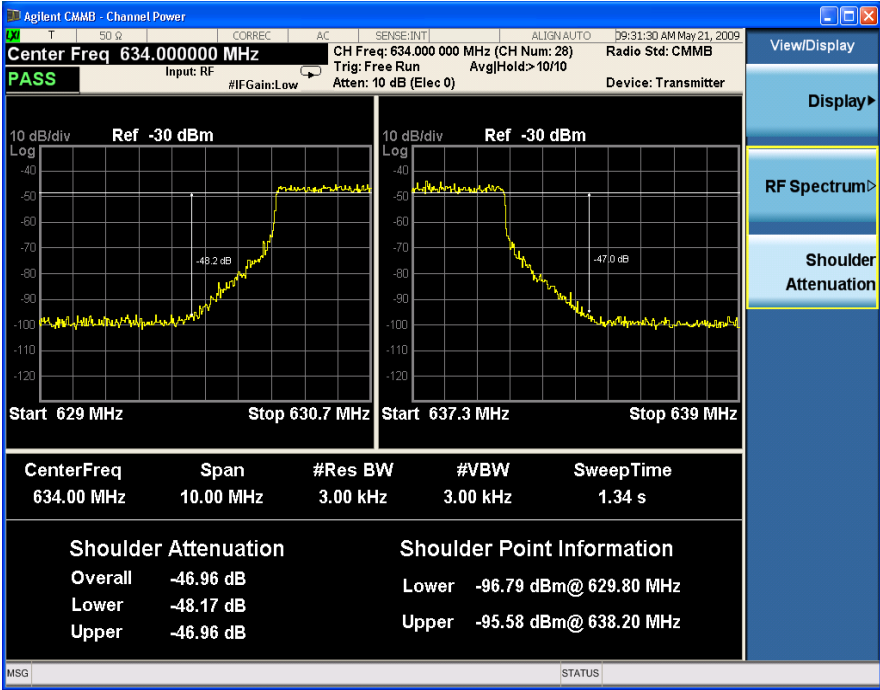
- **Shoulder Attenuation** displays the CMMB standard defined shoulder attenuation. The shoulder attenuation measurement should look like [Figure 3-3](#). The text window shows the value of shoulder attenuation and shoulder point information.

NOTE For the measurement method of shoulder attenuation, refer to “[Shoulder Attenuation](#)” on page 80.

If you need to make the measurement on specified shoulder offset, press **Meas Setup** and set the value for **Shoulder Offset**.

Figure 3-3

Channel Power Measurement Result - Shoulder Attenuation View



Making CMMB Measurements
Channel Power Measurements

ACP Measurements

This section describes the Adjacent Channel Leakage Power Ratio (ACLR or ACPR) measurement on a CMMB transmitter/exciter. ACPR is the measurement of the amount of interference, or power, in adjacent frequency channels. The results are displayed as a bar graph or as spectrum data, with measurement data at specified offsets.

The ACP measurement procedure includes three parts:

- a. “[Selecting and Setting up the CMMB Mode](#)” on page 35
- b. “[Selecting and Setting up ACP Measurement](#)” on page 35
- c. “[Viewing ACP Measurement Results](#)” on page 36

Selecting and Setting up the CMMB Mode

Step 1. Select CMMB mode.

Press **Mode, CMMB**.

Step 2. Preset the analyzer.

Press **Mode Preset**.

Step 3. Set the center frequency. There are two methods:

- Enter the center frequency directly.
Press **FREQ Channel, Center Freq, 634, MHz**.
- Select the channel number under a specific channel table.
 - a. Specify a channel table by selecting a video standard.
Press **FREQ Channel, Chan Table, PAL-D/K, PAL-D/K DS**.
 - b. Set the channel number.
Press **FREQ Channel, Channel, 28**.

Step 4. Set the Device Type as Transmitter.

Press **Mode Setup, Device Type, Transmitter**.

Selecting and Setting up ACP Measurement

Step 1. Initiate the adjacent channel power measurement.

Press **Meas, ACP**.

Step 2. Set up the ACP measurement and see the parameters available to change. The default settings are compliant with the specification in CMMB standards, so you can use the default settings for most cases.

Making CMMB Measurements ACP Measurements

Press **Meas Setup**.

TIP To achieve better ACP results, press **Meas Setup, More 1 of 2**, and toggle the **Noise Correction** key to **On**.

Viewing ACP Measurement Results

The ACP result should look like [Figure 3-4](#). The graph window shows the bar graph with the spectrum trace overlay. The text window shows the absolute total power reference, while the power inside adjacent channel and outside adjacent channel are displayed in both absolute and relative readings. The measurement method and PASS/FAIL limit are described in [Table 4-2 on page 82](#).

- Toggle **View/Display, Bar Graph** to **Off** to turn off the bar graph.


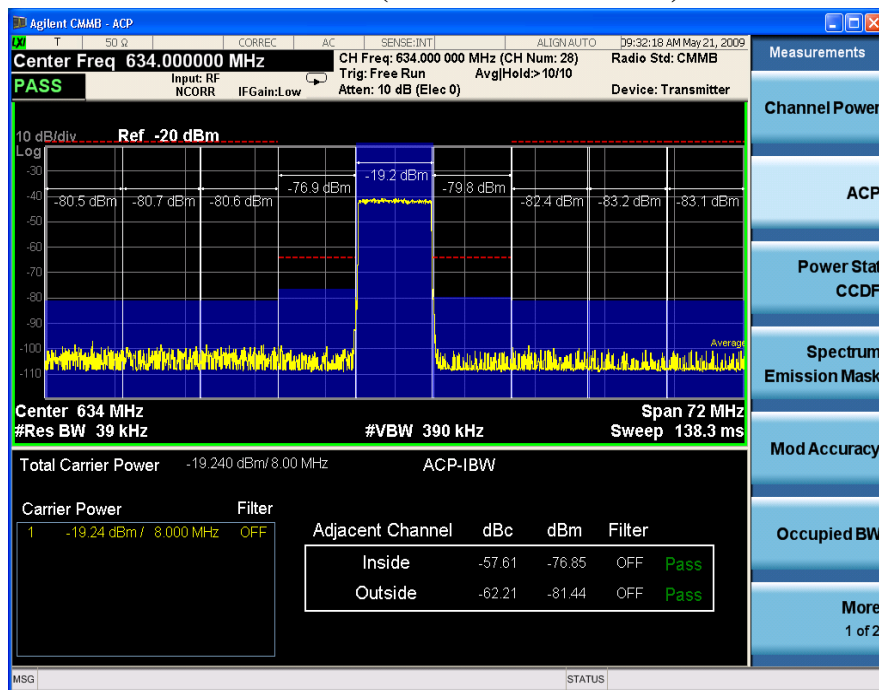
NOTE You can zoom on either the graphic window or the text window by pressing the Window Control keys  at the left bottom of the front panel.

Figure 3-4

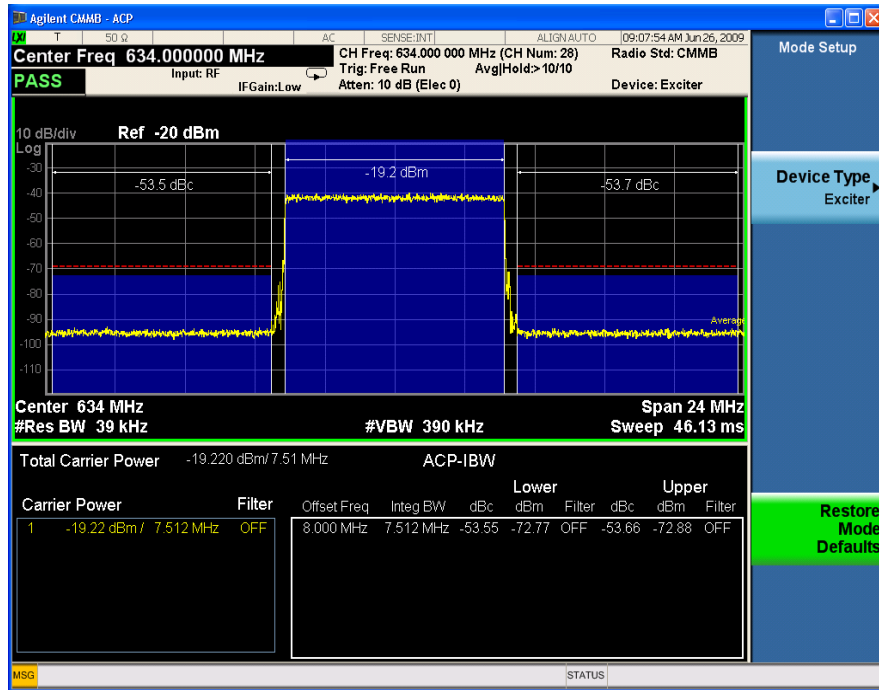
ACP Measurement Result (Noise Correction On)



NOTE If the device under test is Exciter, the display of the ACP measurement results is different as shown in [Figure 3-5](#). The graph window shows the bar graph with the spectrum trace overlay. The text window shows the total power in reference channel, absolute and relative power in offset channels.

Figure 3-5

ACP Measurement Result for Exciter



Making CMMB Measurements
ACP Measurements

Power Stat CCDF Measurements

This section outlines how to make the Power Statistics Complementary Cumulative Distribution Function (Power Stat CCDF) measurement on a CMMB transmitter/exciter. Power Stat CCDF measurements characterize the higher level power statistics of a digitally modulated signal.

The Power Stat CCDF measurement procedure includes three parts:

- a. [“Selecting and Setting up the CMMB Mode” on page 39](#)
- b. [“Selecting and Setting up Power Stat CCDF Measurement” on page 39](#)
- c. [“Viewing the Measurement Results” on page 40](#)

Selecting and Setting up the CMMB Mode

Step 1. Select CMMB mode.

Press **Mode, CMMB**.

Step 2. Preset the analyzer.

Press **Mode Preset**.

Step 3. Set the center frequency. There are two methods:

- Enter the center frequency directly.
Press **FREQ Channel, Center Freq, 634, MHz**.
- Select the channel number under a specific channel table.
 - a. Specify a channel table by selecting a video standard.
Press **FREQ Channel, Chan Table, PAL-D/K, PAL-D/K DS**.
 - b. Set the channel number.
Press **FREQ Channel, Channel, 28**.

Step 4. Set the Device Type as Transmitter.

Press **Mode Setup, Device Type, Transmitter**.

NOTE

Power Stat CCDF measurements can be used to measure the BBIQ (Baseband I/Q) signals. For the detailed measurement procedure, refer to [“Using Option BBA Baseband I/Q Inputs” on page 69](#).

Selecting and Setting up Power Stat CCDF Measurement

Step 1. Initiate the Power Stat CCDF measurement.

Press **Meas, Power Stat CCDF**.

Making CMMB Measurements Power Stat CCDF Measurements

Step 2. Set up the Power Stat CCDF measurement and see the parameters available to change. You can use the default settings for most cases.

Press **Meas Setup**.

TIP

Three key parameters under **Meas Setup** menu are available to set up the Power Stat CCDF measurements.

- **Counts** sets the accumulated number of sampling points for data acquisition.
- **Meas Cycles** sets the number of measurement cycles.
- **Meas Interval** sets the measurement time for one cycle.

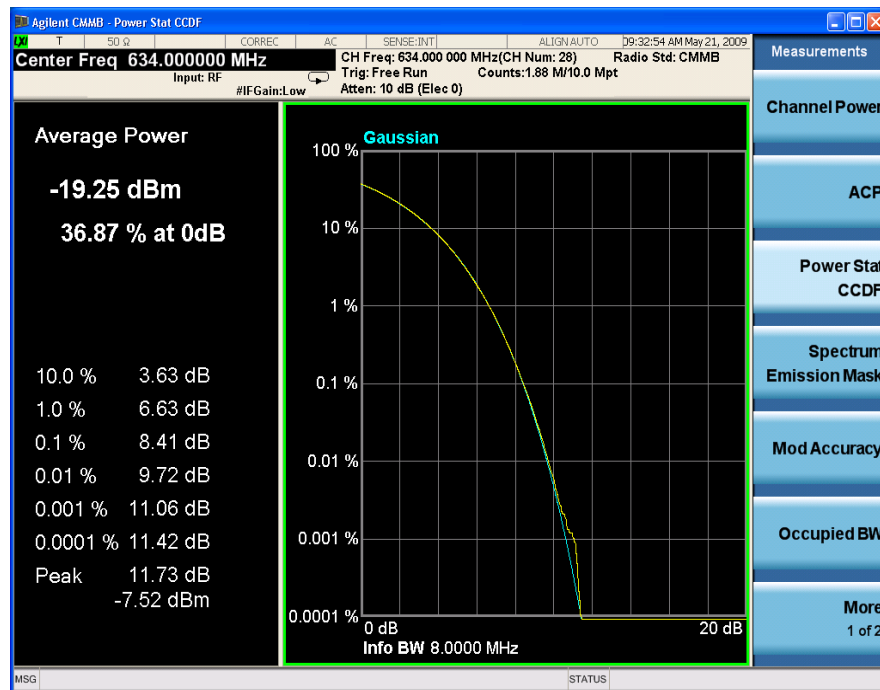
Viewing the Measurement Results

The Power Stat CCDF measurement result should look like [Figure 3-6](#).

- Press **Trace/Detector, Ref Trace (On)** to display the user-definable reference trace (violet line). The Power Stat CCDF measurement with the reference trace should look like [Figure 3-7](#).

Figure 3-6

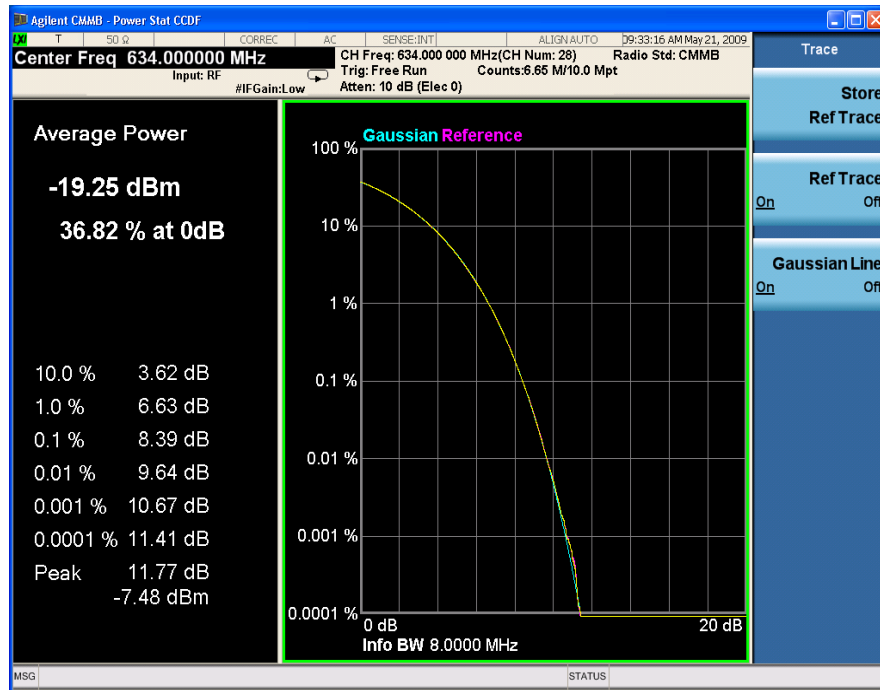
Measurement Results-Power Statistics CCDF Result



The blue line is the Gaussian trace and the yellow line is the measurement result. The Info BW is the channel bandwidth that will be used for data acquisition. The default value is 8 MHz. You can manually change the Info BW by pressing **BW**, **Info BW**.

Figure 3-7

Power Statistics CCDF Result



The reference trace is a measurement trace stored as a reference trace to be compared to a later measurement. You can use the **Store Ref Trace** key to save the currently measured trace as the reference trace. This reference trace will be lost if you switch between modes or measurements.

Troubleshooting Hints

The Power Stat CCDF measurement is useful in defining the signal power specifications for design criteria for systems, amplifiers, and other components. When the signal power is larger than the limit of the mixer or ADC, the CCDF result trace will deviate from the Gaussian trace.

Spectrum Emission Mask Measurements

This section describes how to make Spectrum Emission Mask (SEM) measurements on a CMMB transmitter/exciter. SEM measurements compare the power levels within given offset channels on both sides of the carrier frequency, to the power levels allowed by the standard when there are digital TV signals or other services in adjacent channels. Results of each offset segment measurement can be viewed separately.

The SEM measurement procedure includes four parts:

- a. “[Selecting and Setting up the CMMB Mode](#)” on page 43
- b. “[Setting up the Input Ports](#)” on page 43
- c. “[Selecting and Setting up Spectrum Emission Mask Measurement](#)” on page 44
- d. “[Viewing the Measurement Results](#)” on page 44

Selecting and Setting up the CMMB Mode

Step 1. Select CMMB mode.

Press **Mode, CMMB**.

Step 2. Preset the analyzer.

Press **Mode Preset**.

Step 3. Set the center frequency. There are two methods:

- Enter the center frequency directly.
Press **FREQ Channel, Center Freq, 634, MHz**.
- Select the channel number under a specific channel table.
 - a. Specify a channel table by selecting a video standard.
Press **FREQ Channel, Chan Table, PAL-D/K, PAL-D/K DS**.
 - b. Set the channel number.
Press **FREQ Channel, Channel, 28**.

Step 4. Set the Device Type as Transmitter.

Press **Mode Setup, Device Type, Transmitter**.

Setting up the Input Ports

Step 1. Input the value of the external attenuator.

Press **Input/Output, External Gain, Ext Preamp, -60, dB**.

Step 2. Apply amplitude corrections.

Press **Input/Output, More 1 of 2, Corrections**. Then,

a. Specify the correction data using:

- Onscreen editor. Press **Edit**.
- SCPI, or
- A file. Press **Recall, Data (Import) Amptd Cor1, Open**.

TIP

To get the format of the file to be recalled, first edit several points using onscreen editor, then press **Save, Data (Export) Correction 1, Save As...** to save the correction data to a file. Open the file, and view the format.

It is recommended to edit and save the correction data to a file when the correction data has a lot of points.

b. Toggle the **Correction** key to **On** to apply the corrections.

For the information of using amplitude correction and defining correction data, refer to [“Using Amplitude Correction in Spectrum Emission Mask Measurement” on page 86](#).

Selecting and Setting up Spectrum Emission Mask Measurement

Step 1. Initiate the Spectrum Emission Mask measurement.

Press **Meas, Spectrum Emission Mask**.


Step 2. Set up the Spectrum Emission Mask measurement and see the parameters available to change. The default settings are compliant with the specification in CMMB standards, so you can use the default settings for most cases.

Press **Meas Setup**.

Viewing the Measurement Results

Three views are available in the Spectrum Emission Mask measurement. Press **View/Display, the name of the view** to display them. In Spectrum Emission Mask measurement on CMMB signal, use the first two views: Abs Pwr Freq view and Rel Pwr Freq view.

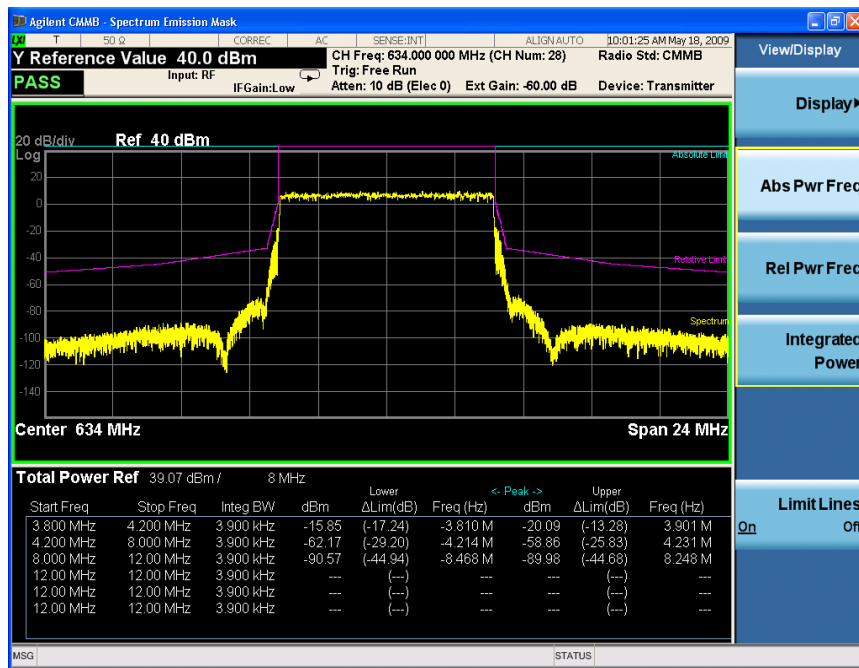
NOTE

You can zoom on either the graphic window or the text window by pressing the Window Control keys  at the left bottom of the frontpanel.

- **Abs Pwr Freq** displays the absolute power levels in dBm and the corresponding frequencies in the text window, as shown in Figure 3-8.

Figure 3-8

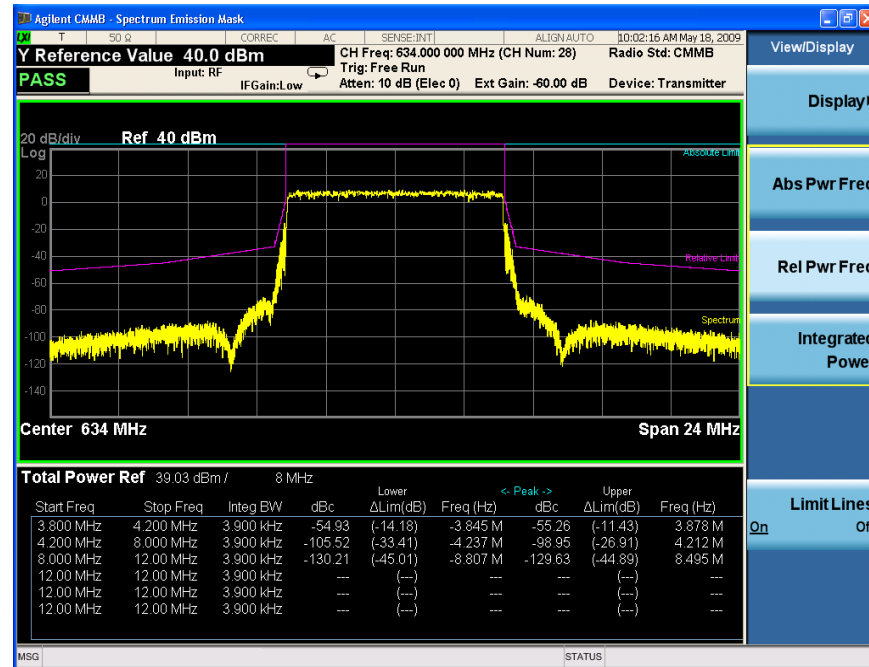
Spectrum Emission Mask Measurement Result - Abs Pwr Freq (Default)View



- **Rel Pwr Freq** displays the relative power levels in dBc and the corresponding frequencies in the text window, as shown in Figure 3-9.

Figure 3-9

Spectrum Emission Mask Measurement Result - Rel Pwr Freq View

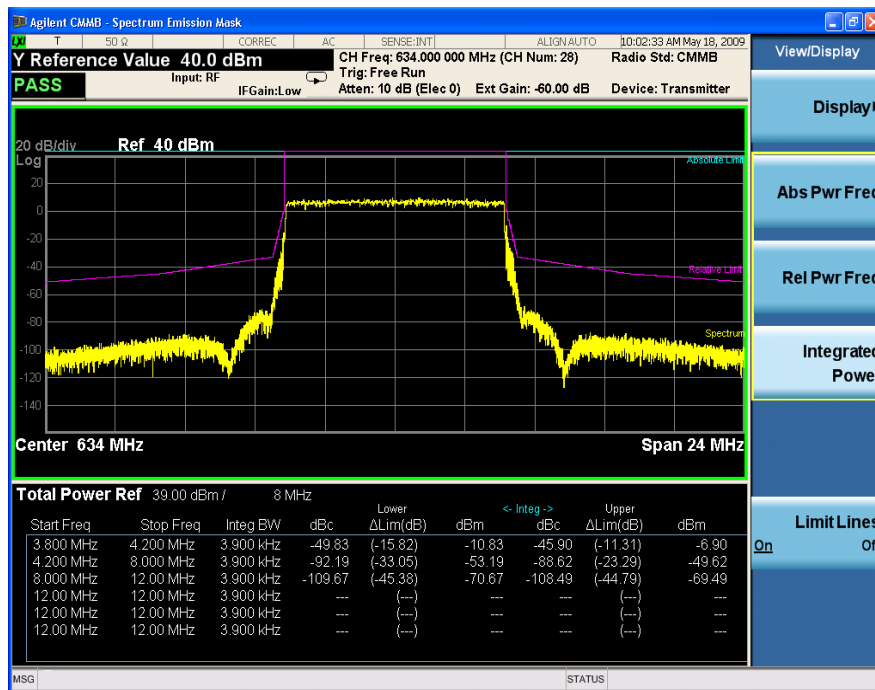


Making CMMB Measurements
Spectrum Emission Mask Measurements

- **Integrated Power** displays the absolute and relative power levels integrated throughout the bandwidths between the start and stop frequencies in the text window, as shown in Figure 3-10.

Figure 3-10

Spectrum Emission Mask Measurement Result - Integrated Power View



Troubleshooting Hints

This Spectrum Emission Mask measurements can reveal degraded or defective parts in the transmitter section of the unit under test (UUT). The following are examples of typical causes for poor performance:

- Faulty DC power supply control of the transmitter power amplifier.
- RF power controller of the pre-power amplifier stage.
- I/Q control of the baseband stage.
- Degradation in the gain and output power level of the amplifier may be due to degraded gain control or increased distortion, or both.
- Degradation of the amplifier linearity or other performance characteristics.

Power amplifiers are one of the final stage elements of a CMMB transmitter and are a critical part of meeting the important power and spectral efficiency specifications. Since spectrum emission mask measures the spectral response of the amplifier to a complex wideband signal, SEM is a key measurement linking amplifier linearity and other performance characteristics to the stringent system specifications.

Making CMMB Measurements
Spectrum Emission Mask Measurements

Modulation Accuracy Measurements

This section describes how to make a Modulation Accuracy measurement on a CMMB transmitter/exciter. Modulation Accuracy measurements provide methods for measuring the I/Q errors in CMMB transmitter/exciter. The results comprise EVM, MER, Magnitude Error, Phase Error, Frequency Error, Quad Error, Amplitude Imbalance, etc.

The Mod Accuracy measurement procedure includes three parts:

- a. [“Selecting and Setting up the CMMB Mode” on page 49](#)
- b. [“Selecting and Setting up Mod Accuracy Measurement” on page 50](#)
- c. [“Selecting and Viewing the Measurement Results” on page 51](#)

Selecting and Setting up the CMMB Mode

Step 1. Select CMMB mode.

Press **Mode, CMMB**.

Step 2. Preset the analyzer.

Press **Mode Preset**.

Step 3. Set the center frequency. There are two methods:

- Enter the center frequency directly.
Press **FREQ Channel, Center Freq, 634, MHz**.
- Select the channel number under a specific channel table.
 - a. Specify a channel table by selecting a video standard.
Press **FREQ Channel, Chan Table, PAL-D/K, PAL-D/K DS**.
 - b. Set the channel number.
Press **FREQ Channel, Channel, 28**.

Step 4. Set the Device Type as Transmitter.

Press **Mode Setup, Device Type, Transmitter**.

NOTE

Mod Accuracy measurements can be used to measure BBIQ (Baseband I/Q) signals. For the detailed measurement procedure, refer to [“Using Option BBA Baseband I/Q Inputs” on page 69](#).

Selecting and Setting up Mod Accuracy Measurement

Step 1. Initiate the Modulation Accuracy measurement.

Press **Meas, Mod Accuracy**.

Step 2. Set up the trigger. For more details about using trigger in CMMB measurement, refer to “[Using Triggers in CMMB Mod Accuracy Measurement](#)” on page 91.

a. Set the instrument to generate a periodic trigger inside (default setting).

Press **Trigger, More 1 of 2, Periodic Timer**.

b. Synchronize the generated trigger with the beginning of the CMMB frame.

Press **Meas Setup, Advanced, Sync Frame Now**.

NOTE

When only one modulation format is used in the CMMB signals, setting up triggers is not a must. In this case, set up the measurement as follows.

a. Set the trigger mode to free run.

Press **Trigger, Free Run**.

b. Set the modulation format.

Press **Meas Setup, Timeslot Settings, QPSK** (for example).

As an alternative, external trigger can also be used for synchronization, while both the configuration and setting up steps are different and more complicated. For more details, refer to “[Using External Trigger in CMMB Modulation Accuracy Measurement](#)” on page 92.

Step 3. Set up the Mod Accuracy measurement and see the parameters available to change to customize your measurement.

Press **Meas Setup**.

You need to set the data to be measured as shown in [Table 3-4](#). The settings made under the Meas Setup menu will affect the results of all the views in the current measurement.

Table 3-4 Meas Type settings

Meas Type	Actions (Example)	Note
PLCH	Set the measurement to measure SLCH 0. a. Press Meas Setup, Meas Type, PLCH . b. Press PLCH Settings . c. Toggle PLCH Type to SLCH . d. Press SLCH Index, 0 .	If you toggle the Meas Type to CLCH , the SLCH Index key will be grayed out.

Table 3-4 Meas Type settings

Meas Type	Actions (Example)	Note
Timeslot	Set the measurement to measure Timeslot 1. a. Press Meas Setup, Meas Type, Timeslot. b. Press Timeslot Settings. c. Press Start Timeslot, 1. d. Press Meas Interval, 1, slots. e. Press Modulation Format, 16QAM.	When setting the Meas Type to Timeslot, you need to know the modulation format of the timeslots. Make sure the modulation format is the same in the timeslots to be measured.
Frame	Set the measurement to measure the Frame. Press Meas Setup, Meas Type, Frame.	When setting the Meas Type to Frame, you don't need to set up other parameter. The instrument will demodulate the signal according to the control information in CLCH. You may have to wait momentarily before the analysis on data of one frame finishes.

Selecting and Viewing the Measurement Results

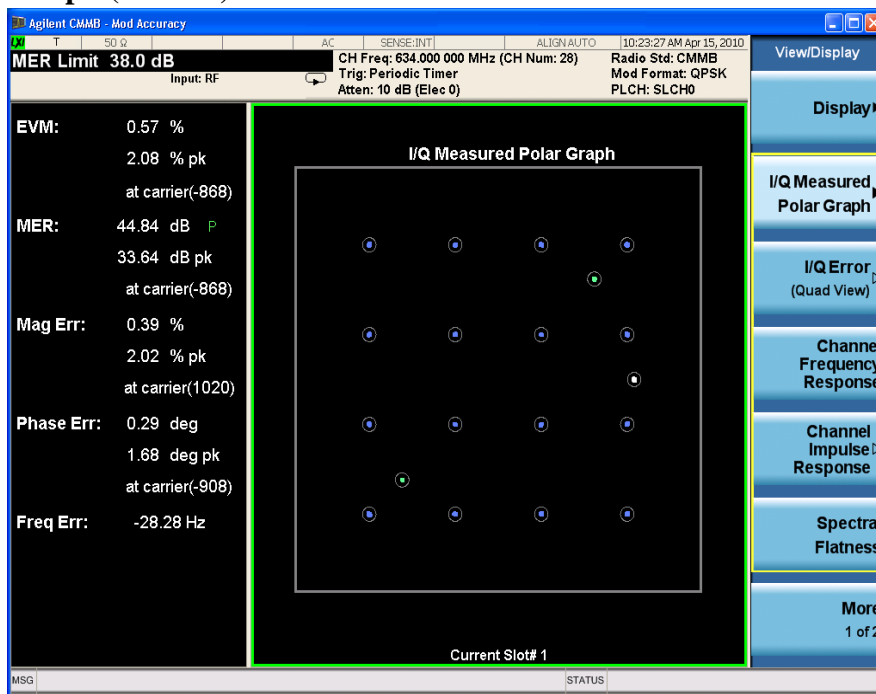
Seven views are available in the Mod Accuracy measurement. Press **View/Display, the name of the view** to display them.

NOTE

You can zoom on either the graphic window or the text window in each view by pressing the Window Control keys  at the left bottom of the frontpanel.

- **I/Q Measured Polar Graph** displays a combination view of I/Q measured polar graph and metric windows as shown in [Figure 3-11](#). The modulation constellation is shown, along with EVM, MER, magnitude and phase errors, and frequency error. The white points in the constellation window stand for scattered pilot and green points stand for continual pilot.

Figure 3-11 Modulation Accuracy Measurement Result - I/Q Measured Polar Graph (Default) View



NOTE View the I/Q Measured Polar Graph results for specified carriers by setting the **Start Carrier** value and **Stop Carrier** value under the **I/Q Measured Polar Graph** key.

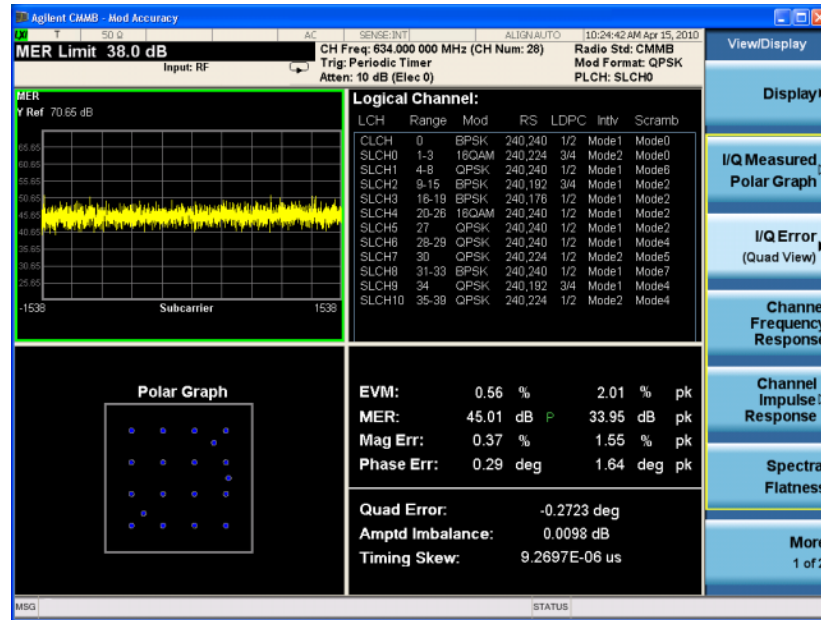
- **I/Q Error (Quad View)** displays a combination view of the MER/EVM, logical channel, I/Q polar graph and result. Four windows are presented:
 - MER\EVM vs. Subcarrier\Frequency window (left top): MER or EVM on each subcarrier or frequency.
 - Logical Channel window (right top): The physical layer parameters on each logical channel and timeslot. This information is decoded (after the LDPC decoding) from the CLCH of the received CMMB signal.
 - Polar Graph window (left bottom): the constellation of the measured signal.
 - Result window (right bottom).

NOTE Note that, you can set the scale type of the vertical axis to **MER** or **EVM** and that of the horizontal axis to **Carrier** or **Freq** in the top left window of I/Q Error view. To view the MER vs. Subcarrier results, do as follows:

- Press **AMPTD Y Scale, More 1 of 2** and toggle the **Scale Type** key to **MER**.
- Press **Span X Scale** and toggle the **Scale Type** key to **Carrier**.

The measurement result should look like [Figure 3-12](#).

Figure 3-12 Modulation Accuracy Measurement Result - I/Q Error View

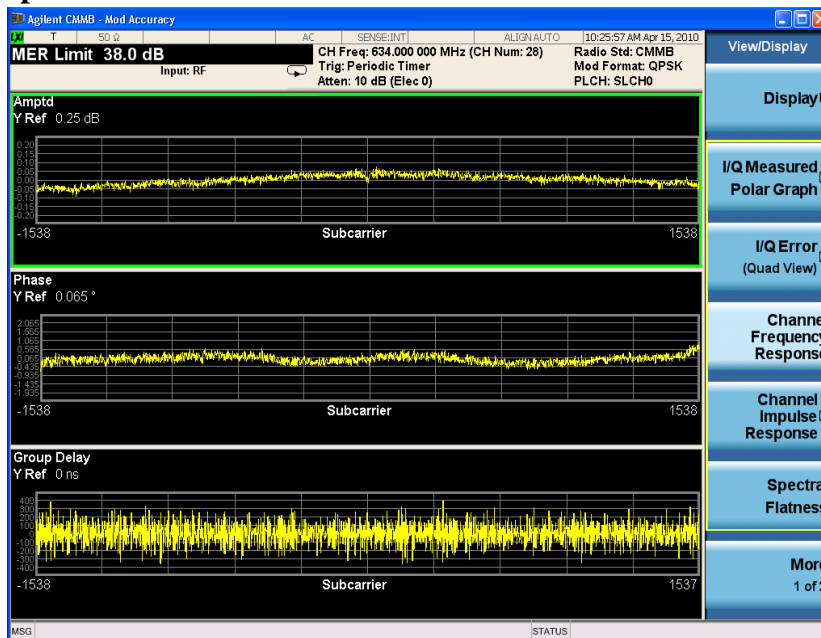


NOTE

In the Logical Channel window, if the results are listed on more than one page, use either a mouse connected to the instrument or the Scroll keys such as **Prev Page**, **Next Page**, **Scroll Up**, **Scroll Down**, **First Page**, **Last Page** under **I/Q Error** menu to view the complete results.

- **Channel Frequency Response** displays the amplitude, phase and group delay of the channel frequency response on every subcarrier as shown in Figure 3-13.

Figure 3-13 Modulation Accuracy Measurement Result - Channel Frequency Response

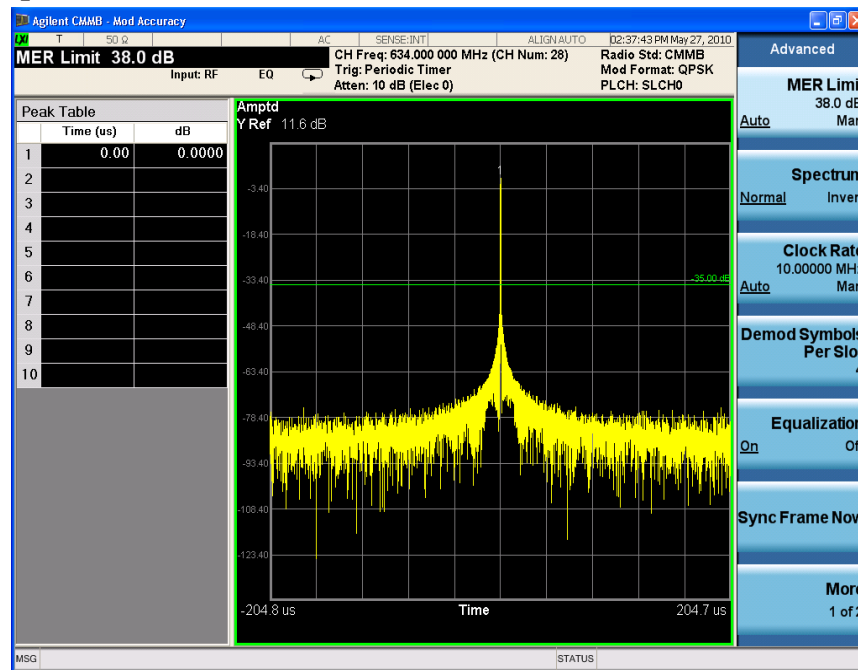


Making CMMB Measurements Modulation Accuracy Measurements

- **Channel Impulse Response** displays the state and the delay profile of channel. This view has two windows, the graphic window showing the channel impulse response trace and the peak table window showing the delay and amplitude of the top 10 peaks on the trace.

In this view, equalization need to be turned on to get better result. Press **Meas Setup, Advanced, Equalization**, and toggle Equalization to **On**. The measurement results should look like [Figure 3-14](#). In the graphic, the green line with the -35.00 dB above its right side is the peak limit line, which means only peaks above this line can be displayed in the peak table. To adjust the peak limit line, press **Peak Search, More 1 of 2, Peak table**, and enter your desired peak limit value.

Figure 3-14 Modulation Accuracy Measurement Result - Channel Impulse Response



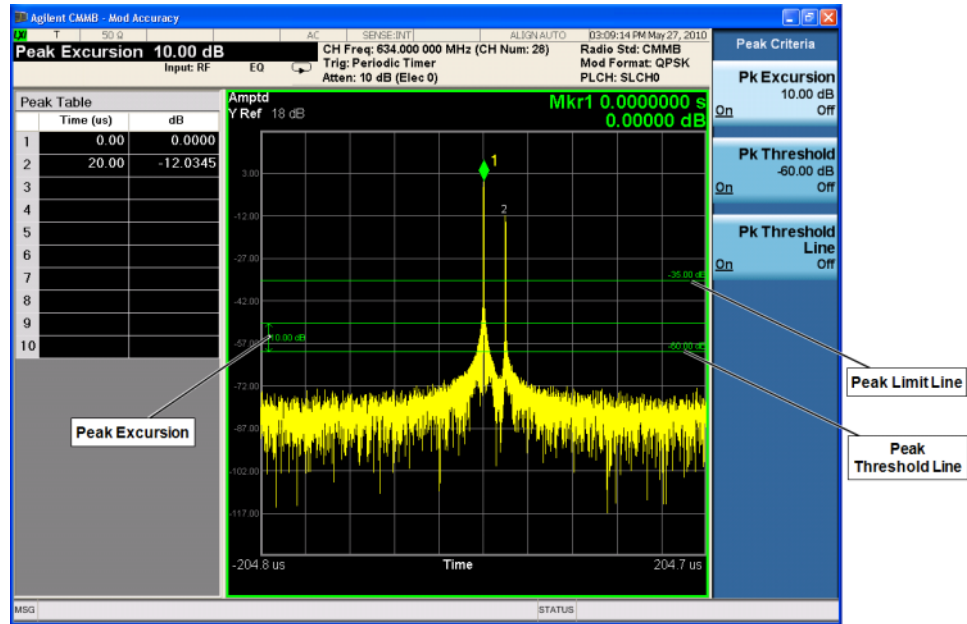
Peak table window is very useful when there are more than one path in the signal channel. Here is an example of channel impulse response of a two-path channel with 0 and 20 us delay respectively. You can customize your peak table measurement using the following settings:

- Press **Peak Search, More 1 of 2, Peak Table, Peak Sort** and toggle **Peak Sort** to **Amptd** to set the sorting rule.
- Press **Peak Search, More 1 of 2, Peak Criteria, Pk Excursion, 10, dB, Pk Threshold, -60, dB** and then toggle **PK Threshold Line** to **On** to set the criteria for peak. To see how the Pk Excursion and Pk Threshold affect the peak criteria, refer to [“Peak Criteria” on page 91](#).

The multi-path measurement result should look like [Figure 3-15](#), including peak threshold line, peak excursion, and peak limit line.

Figure 3-15

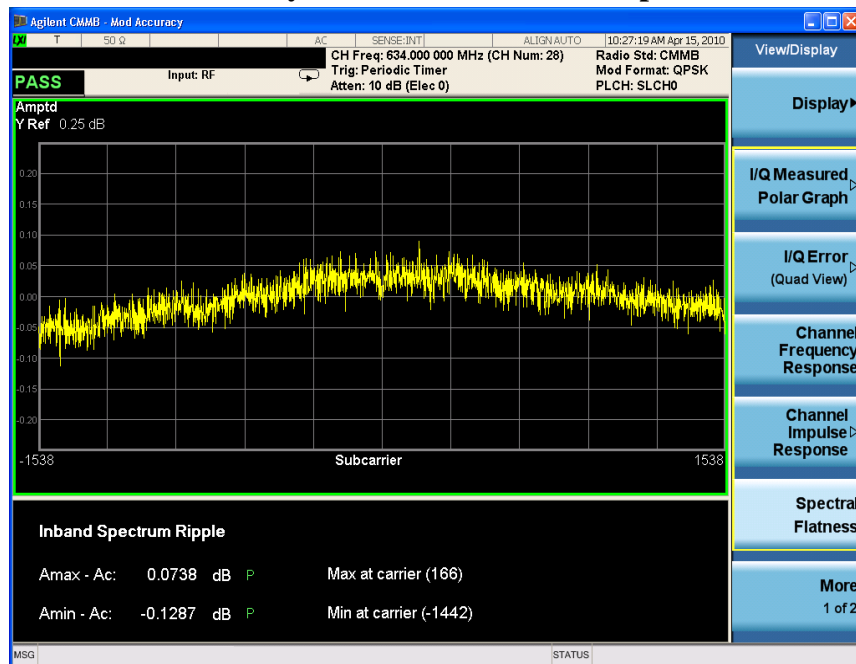
Channel Impulse Response with Two Paths



- **Spectral Flatness** displays the inband spectrum ripple as shown in Figure 3-16. According to the specifications, the ripple inband should be less than ± 0.5 dB.

Figure 3-16

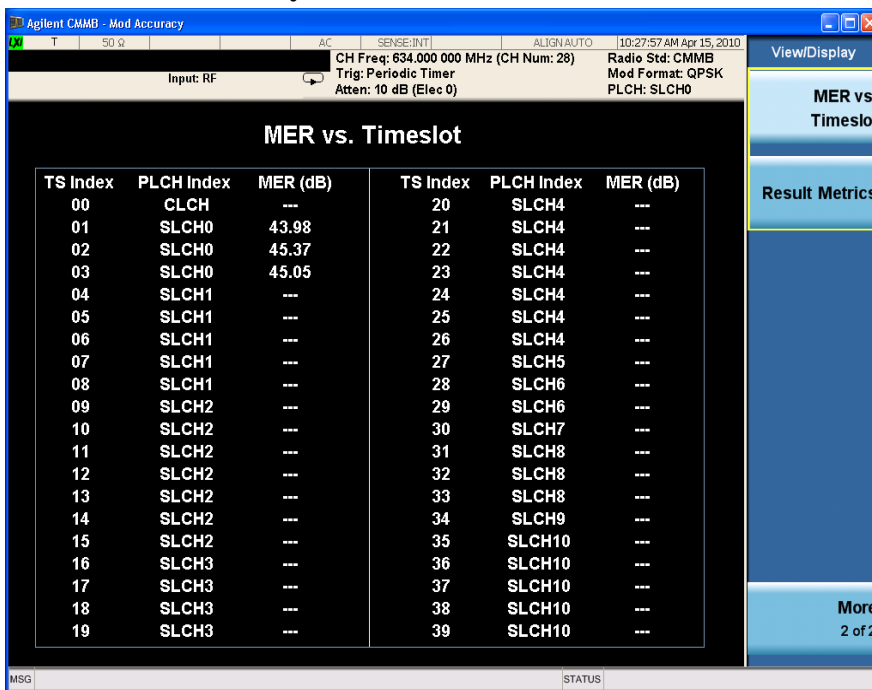
Modulation Accuracy Measurement Result - Spectral Flatness



- **MER vs. Timeslot** displays the MER on each timeslot under measurement. The measurement result should look like Figure 3-17. As the data under measurement is SLCH0 which is set under Meas Setup, there are only MER results on TS1, TS2, and TS3.

Figure 3-17

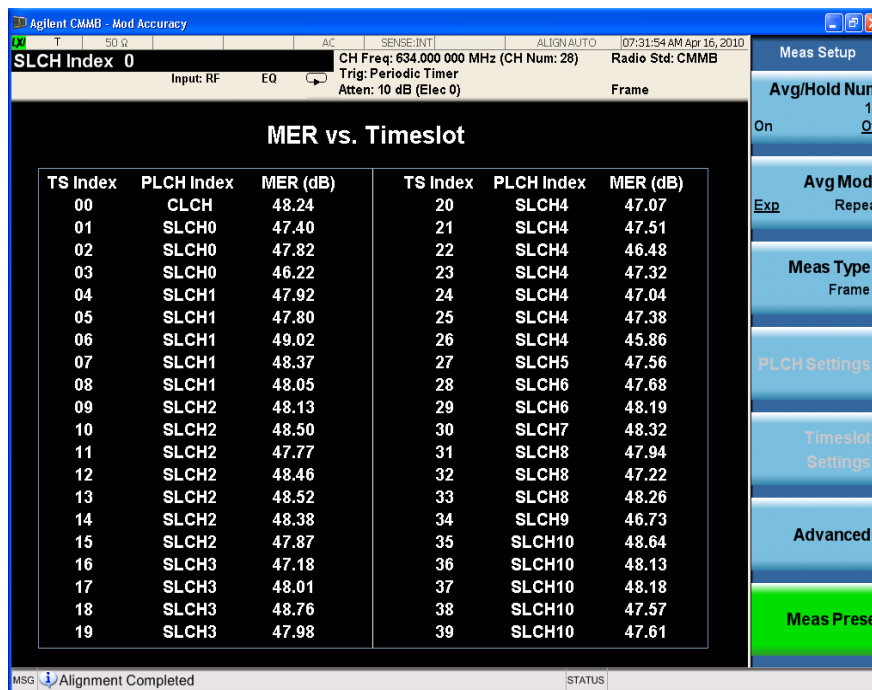
Modulation Accuracy Measurement Result - MER vs. Timeslot



To see the MER on the whole frame, press **Meas Setup**, **Meas Type**, **Frame**. You may need to wait for a while as the calculation of results on a whole frame takes more time. The measurement results should look like Figure 3-18.

Figure 3-18

MER vs. Timeslot of the Whole Frame



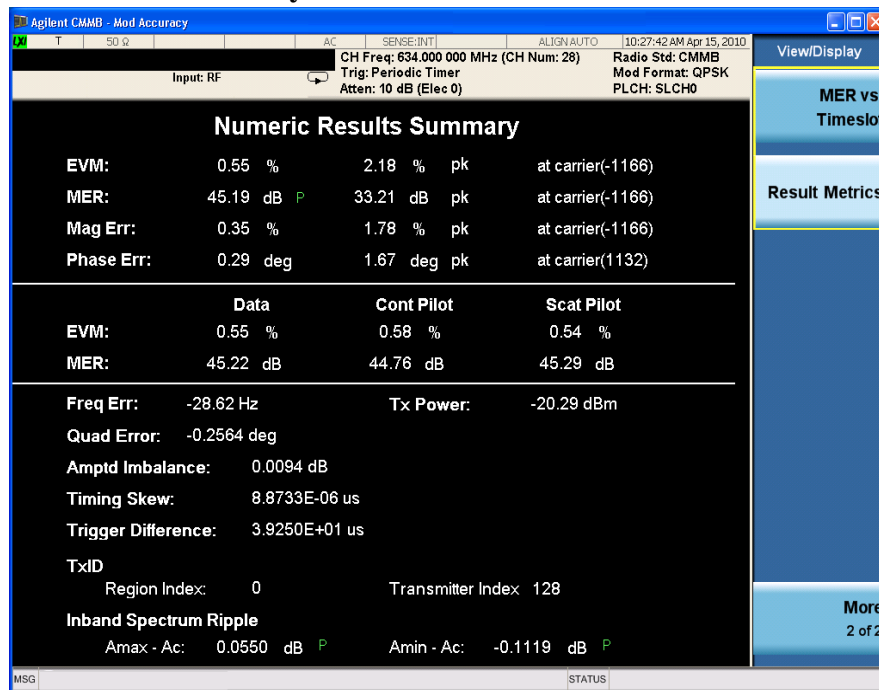
- **Result Metrics** displays a summary of the measurement results as shown in [Figure 3-19](#).

Trigger Difference shows the difference between the internal/external trigger and the beginning of TS0.

In TxID results, the value of “Region Index” or “Transmitter Index” may be displayed as “---” when there is only one timeslot measured, because “Transmitter Index” and “Region Index” are carried in odd timeslots and even timeslots separately.

Figure 3-19

Modulation Accuracy Measurement Result - Result Metrics



NOTE

To place a Marker on the different traces of the various views, press **Marker, Properties, Marker Trace**, then select the trace you want to put the marker on. There are 6 traces to select from: Polar Trace, MER vs.Carr, Amptd vs.Carr, Phase vs.Carr, GD vs.Carr, and Amptd vs.Time.

Making CMMB Measurements
Modulation Accuracy Measurements

Occupied Bandwidth Measurements

This section explains how to make an Occupied Bandwidth measurement on a CMMB transmitter/exciter. The instrument measures the power across the band, and then calculates its power bandwidth at a certain percentage.

The Occupied Bandwidth measurement procedure includes three parts:

- a. “Selecting and Setting up the CMMB Mode” on page 59
- b. “Selecting and Setting up the Occupied BW Measurement” on page 59
- c. “Viewing the Measurement Results” on page 60

Selecting and Setting up the CMMB Mode

Step 1. Select CMMB mode.

Press **Mode, CMMB**.

Step 2. Preset the analyzer.

Press **Mode Preset**.

Step 3. Set the center frequency. There are two methods:

- Enter the center frequency directly.
Press **FREQ Channel, Center Freq, 634, MHz**.
- Select the channel number under a specific channel table.
 - a. Specify a channel table by selecting a video standard.
Press **FREQ Channel, Chan Table, PAL-D/K, PAL-D/K DS**.
 - b. Set the channel number.
Press **FREQ Channel, Channel, 28**.

Step 4. Set the Device Type as Transmitter.

Press **Mode Setup, Device Type, Transmitter**.

Selecting and Setting up the Occupied BW Measurement

Step 1. Initiate the Occupied BW measurement.

Press **Meas, Occupied BW**.

Step 2. Set up the Occupied BW measurement and see the parameters available to change. The key parameters are shown in [Table 3-5](#).

Making CMMB Measurements
 Occupied Bandwidth Measurements

Press **Meas Setup**.

Table 3-5 Key Parameters in Occupied Bandwidth measurement

Name	Actions (e.g.)	Function
OBW Power	Press Meas Setup, OBW Power, 99 .	Set the percentage of the total power that is measured within the occupied bandwidth.
X dB	Press Meas Setup, x dB, -26 .	Set the x dB value for the 'x dB bandwidth' result.
Limit	<ul style="list-style-type: none"> Press Meas Setup, More 1 of 2, Limit, 7.512, MHz. Toggle the Limit to On. 	Turn on the limit checking for the specified frequency.

Viewing the Measurement Results

The Occupied BW measurement results should look like [Figure 3-20](#). The occupied bandwidth of the specified percentage and the x dB bandwidth of the specified x dB are shown in the text window.

Figure 3-20

Occupied Bandwidth Measurement Result



Troubleshooting Hints

Any distortion such as harmonics or intermodulation, for example, produces undesirable power outside the specified bandwidth.

Shoulders on either side of the spectrum shape indicate spectral regrowth and intermodulation. Rounding or sloping of the top shape can indicate filter shape problems.

Making CMMB Measurements
Occupied Bandwidth Measurements

Monitor Spectrum Measurements

This section explains how to make a Monitor Spectrum measurement on a CMMB transmitter/exciter. Monitor Spectrum measurements show a spectrum domain display of the CMMB signal.

The Monitor Spectrum measurement procedure includes three parts:

- a. [“Selecting and Setting up the CMMB Mode” on page 63](#)
- b. [“Selecting and Setting up Monitor Spectrum Measurement” on page 63](#)
- c. [“Viewing the Measurement Results” on page 64](#)

Selecting and Setting up the CMMB Mode

Step 1. Select CMMB mode.

Press **Mode, CMMB**.

Step 2. Preset the analyzer.

Press **Mode Preset**.

Step 3. Set the center frequency. There are two methods:

- Enter the center frequency directly.
Press **FREQ Channel, Center Freq, 634.000000, MHz**.
- Select the channel number under a specific channel table.
 - a. Specify a channel table by selecting a video standard.
Press **FREQ Channel, Chan Table, PAL-D/K, PAL-D/K DS**.
 - b. Set the channel number.
Press **FREQ Channel, Channel, 28**.

Step 4. Set the Device Type as Transmitter.

Press **Mode Setup, Device Type, Transmitter**.

Selecting and Setting up Monitor Spectrum Measurement

Step 1. Initiate the Monitor Spectrum measurement.

Press **Meas, Monitor Spectrum**.

Step 2. Set up the Monitor Spectrum measurement and see the parameters available to change. You can use the default settings for most cases.

Press **Meas Setup**.

Viewing the Measurement Results

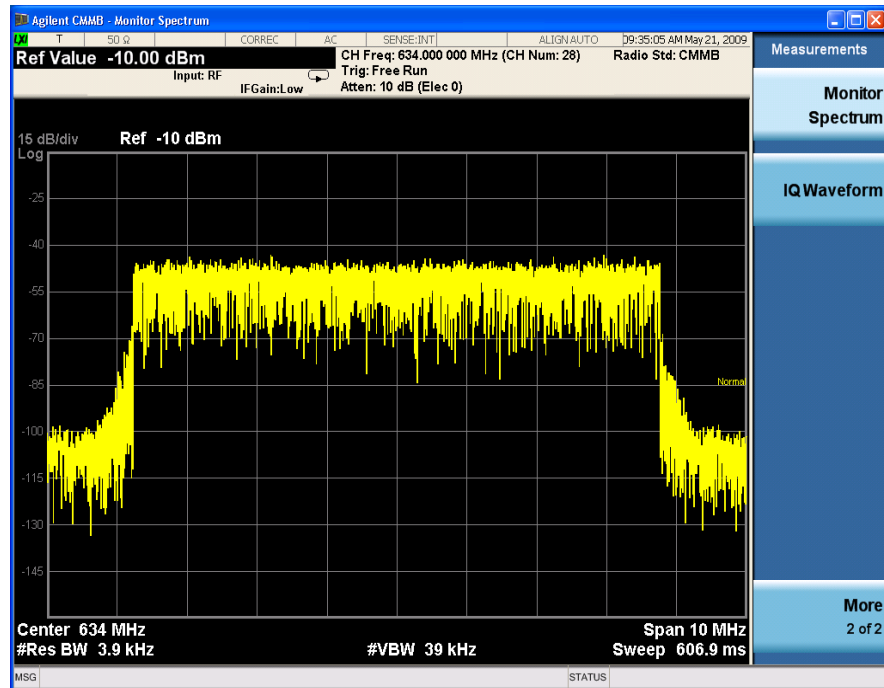
The Monitor Spectrum measurement result should look like [Figure 3-21](#).

The default display shows the **Current** (yellow trace) data. To make viewing the display easier, you can view either the **Current** trace or **Average** separately.

- Press **Trace/Detector**, **Select Trace** and select the trace(s) desired for display, then toggle **Display** to **Show**. Then press Update to **On** to see the updated trace.

Figure 3-21

Monitor Spectrum Measurement - Spectrum View



IQ Waveform (Time Domain) Measurements

This section explains how to make a Waveform (time domain) measurement on a CMMB transmitter/exciter. The measurement of I and Q modulated waveforms in the time domain discloses the voltages which comprise the complex modulated waveform of a digital signal.

The IQ Waveform measurement procedure includes three parts:

- a. [“Selecting and Setting up the CMMB Mode” on page 65](#)
- b. [“Selecting and Setting up IQ Waveform Measurements” on page 65](#)
- c. [“Selecting and Viewing the Measurement Results” on page 66](#)

Selecting and Setting up the CMMB Mode

Step 1. Select CMMB mode.

Press **Mode, CMMB**.

Step 2. Preset the analyzer.

Press **Mode Preset**.

Step 3. Set the center frequency. There are two methods:

- Enter the center frequency directly.
Press **FREQ Channel, Center Freq, 634.000000, MHz**.
- Select the channel number under a specific channel table.
 - a. Specify a channel table by selecting a video standard.
Press **FREQ Channel, Chan Table, PAL-D/K, PAL-D/K DS**.
 - b. Set the channel number.
Press **FREQ Channel, Channel, 28**.

Step 4. Set the Device Type as Transmitter.

Press **Mode Setup, Device Type, Transmitter**.

NOTE

IQ Waveform measurements can be used to measure the BBIQ (Baseband I/Q) signals. For the detailed measurement procedure, refer to [“Using Option BBA Baseband I/Q Inputs” on page 69](#).

Selecting and Setting up IQ Waveform Measurements

Step 1. Initiate the IQ Waveform measurement.

Press **Meas, IQ Waveform**.

Making CMMB Measurements
IQ Waveform (Time Domain) Measurements

Step 2. Set up the IQ Waveform measurement and see the parameters available to change. You can use the default settings for most cases.

Press **Meas Setup**.

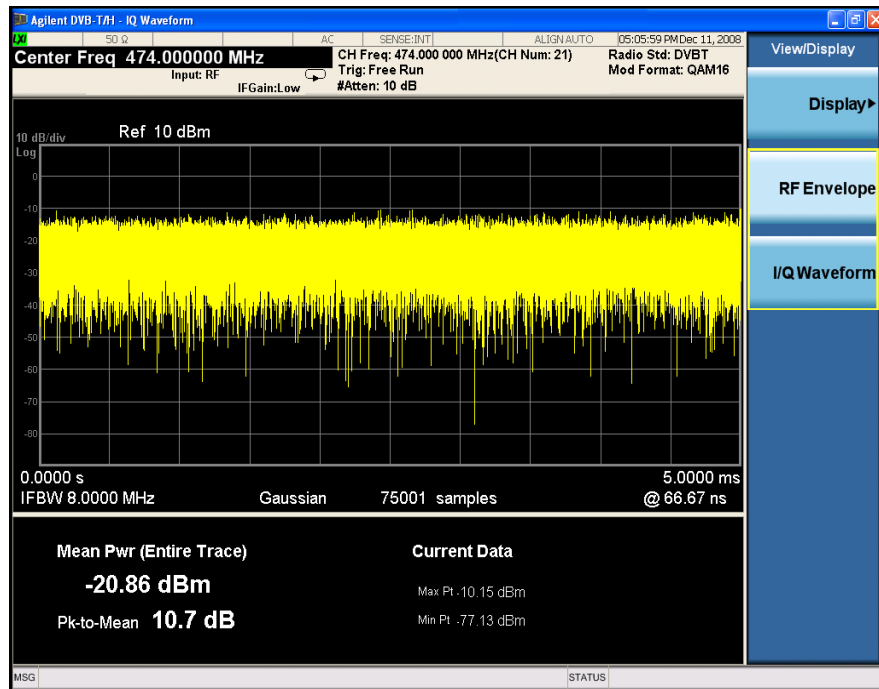
Selecting and Viewing the Measurement Results

Two views are available in the IQ Waveform measurement. Press **View/Display**, the name of the view to display them.

- **RF Envelope** displays the RF envelope with the current data as shown in [Figure 3-22](#). The measured values for the mean power and peak-to-mean power are shown in the text window.

Figure 3-22

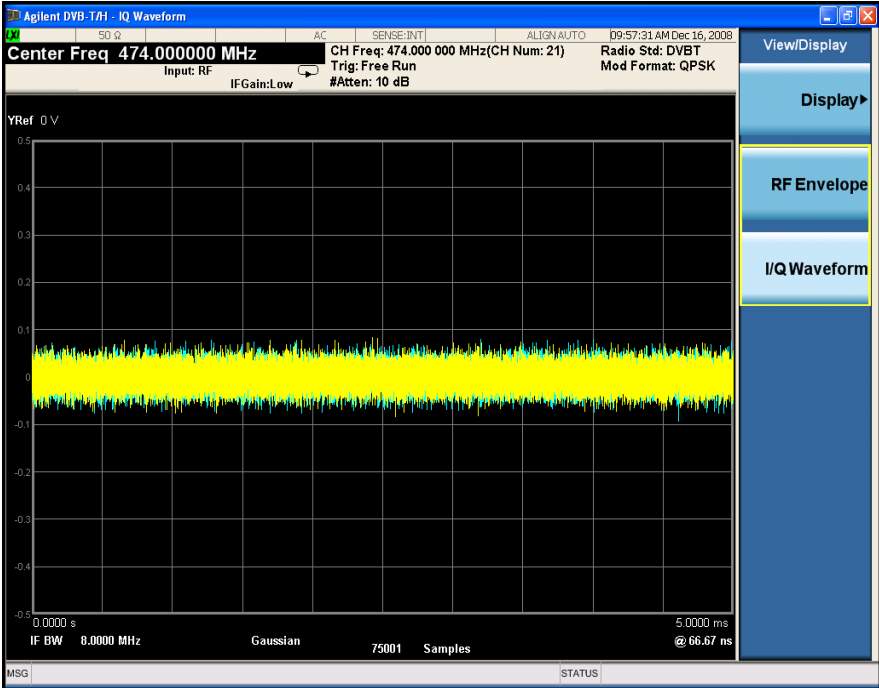
Waveform Measurement - RF Envelope (Default View)



- **IQ Waveform** displays a view of the I (yellow trace) and Q (blue trace) waveforms on the same graph in terms of voltage versus time in linear scale as shown in [Figure 3-23](#).

Figure 3-23

Waveform Measurement - I/Q Waveform View



Making CMMB Measurements
IQ Waveform (Time Domain) Measurements

Using Option BBA Baseband I/Q Inputs

Baseband I/Q Measurements Available for X-Series Signal Analyzers

The following table shows the measurements that can be made using Baseband I/Q inputs:

Table 3-6 BBIQ Supported Measurements vs. Mode

Mode	Measurements
GSM	IQ Waveform GMSK Phase & Freq EDGE EVM
802.16 OFDMA	IQ Waveform Power Stat CCDF Modulation Analysis
TD-SCDMA	IQ Waveform Power Stat CCDF Code Domain Mod Accuracy
cdma2000	IQ Waveform Power Stat CCDF Code Domain Mod Accuracy QPSK EVM
DTMB (CTTB)	IQ Waveform Power Stat CCDF Mod Accuracy
DVB-T/H	IQ Waveform Power Stat CCDF Mod Accuracy
ISDB-T	IQ Waveform Power Stat CCDF Mod Accuracy
CMMB	IQ Waveform Power Stat CCDF Mod Accuracy
IQ Analyzer (Basic)	IQ Waveform Complex Spectrum

Baseband I/Q Measurement Overview

The Baseband I/Q functionality is a hardware option, Option BBA. If the option is not installed in the instrument, the I/Q functionality cannot be enabled.

The Baseband I/Q option provides four input ports and one Calibration Output port. The input ports are I, I-bar, Q, and Q-bar. The I and I-bar together compose the I channel and the Q and Q-bar together compose the Q channel. Each channel has two modes of operation:

Single Ended
(unbalanced)

In this mode, only the main port (I or Q) is used and the complementary ports (I-bar or Q-bar) are ignored. The I and Q ports are in single-ended mode when Differential “Off” is selected.

Differential
(balanced)

In this mode, both main and complementary ports are used. To activate this mode, select Differential “On” from the I and Q Setup softkey menus.

The system supports a variety of input passive probes as well as the Agilent 1153A active differential probe using the Infinimax probe interface.

NOTE

To avoid duplication, this section describes only the details unique to using the baseband I/Q inputs. For generic measurement details, refer to the previous ““[Making CMMB Measurements](#)” on page 25” sections.

To make measurements using baseband I/Q Inputs, make the following selections:

- Step 1.** Select a measurement that supports baseband I/Q inputs.
- Step 2.** Select the I/Q Path.
Press **Input/Output, I/Q, I/Q Path**. Select from the choices present on the screen. The path selected is shown at the top of the measurement screen.
- Step 3.** Select the appropriate circuit location and probe(s) for measurements. For details see “[Selecting Input Probes for Baseband Measurements](#)” on page 99 in the Concepts chapter.
- Step 4.** Select baseband I/Q input connectors.
- Step 5.** If you have set the I/Q Path to **I+jQ** or to **I Only**, press **I Setup**.
 - A. Select whether **Differential (Balanced)** input is **On** or **Off**.
 - B. Select the input impedance, **Input Z**.
 - C. Input a **Skew** value in seconds.
 - D. Set up the I Probe by pressing **I Probe**.
 - a. Select probe **Attenuation**.
 - b. Calibrate the probe. Press **Calibrate...** to start the calibration procedure.

Follow the calibration procedure, clicking **Next** at the end of each step.

- Step 6.** If you have set the I/Q Path to **I+jQ** or to **Q Only**, press **Q Setup**.
- A. Select whether **Differential (Balanced)** input is **On** or **Off**.
 - B. Select the input impedance, **Input Z**.
 - C. Input a **Skew** value in seconds.
 - D. Set up the I Probe by pressing **I Probe**.
 - a. Select probe **Attenuation**.
 - b. Calibrate the probe. Press **Calibrate...** to start the calibration procedure. Follow the calibration procedure, clicking **Next** at the end of each step.
- Step 7.** Select the reference impedance by pressing **Reference Z**, and inputting a value from one ohm to one megohm. The impedance selected is shown at the top of the measurement screen.
- Step 8.** If you are using cables that were not calibrated in the probe calibration step, press **I/Q Cable Calibrate...** Follow the calibration procedure, clicking **Next** at the end of each step.
- Step 9.** After completing the baseband IQ setup procedures, make your desired measurement.

Making CMMB Measurements
Using Option BBA Baseband I/Q Inputs

This chapter provides details about the CMMB broadcast systems, and explains how the various measurements are performed by the instrument. Suggestions for optimizing and troubleshooting your setup are provided, along with a list of related documents that are referenced for further information.

CMMB Broadcast System Overview

CMMB (China Multimedia Mobile Broadcasting) is a mobile digital video standard developed in China by SARFT (State Administration of Radio, Film, and Television). Announced in 2006, CMMB network has been deployed in more than a hundred cities in China.

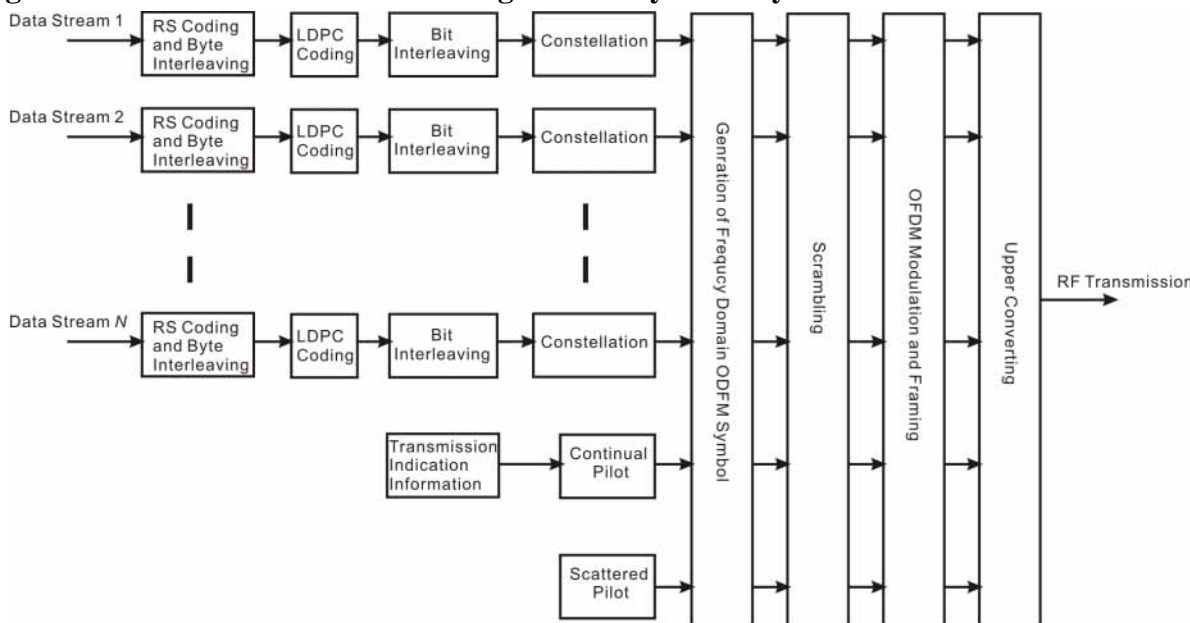
The core part of CMMB is STiMi (satellite and terrestrial interactive multiservice infrastructure). It uses both satellite and terrestrial signals to obtain effective coverage both in densely populated cities and in sparsely populated rural areas. The system supports single-frequency network (SFN) and multiple-frequency network (MFN).

CMMB standard supports broadcasting channel of 8 MHz and 2 MHz bandwidth. Because 2 MHz bandwidth is not widely used, the N6158A CMMB application only supports measurement of 8 MHz bandwidth CMMB signals.

Physical Layer Structure of CMMB Standard

The overall function block diagram for the physical layer of CMMB system is shown in Figure 4-1. The input data stream from the up-layer services is first processed by RS coding, byte interleaving, LDPC coding, bit interleaving, and constellation in sequence. Then, the data is multiplexed with continual pilot and scattered pilot to form frequency domain OFDM symbol. Afterwards, the frequency domain OFDM symbols are scrambled and mapped to time domain OFDM symbol through IFFT, and then are inserted in the frame header to form the frame. Finally, the data is upconverted to RF frequency band and transmitted. [1]

Figure 4-1 Function Block Diagram of Physical Layer

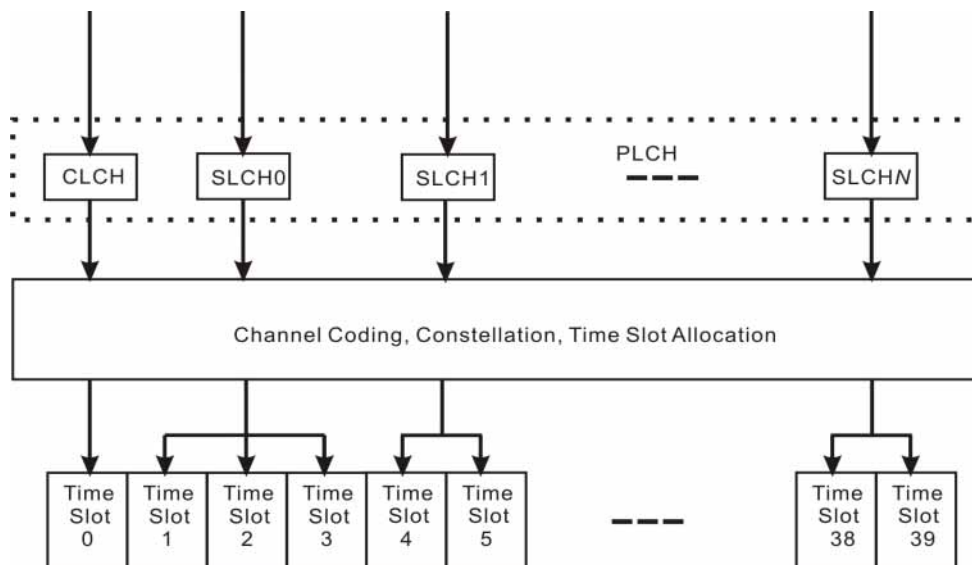


PLCH

The physical layer of CMMB transmission system uses PLCH (Physical Logical Channels) to transmit the upper-layer services. Each PLCH can be configured to channel coding, constellation and timeslots allocation. The allocation of PLCHs is shown in [Figure 4-2](#).

The PLCHs on the physical layer include one CLCH (Control Logical Channel) and 1~39 SLCH (Service Logical Channels). The CLCH contains CMMB broadcast system control information and occupies only time slot 0. The SLCH can be configured to contain one or more time slots to transmit broadcasting services.

Figure 4-2 CMMB Broadcast Channel PLCH



The channel coding and modulation scheme for CLCH is fixed as below:

RS Coding: RS(240, 240)

LDPC Coding Rate: 1/2

Modulation Format: BPSK

Scrambler: initial value is Option 0

The configurable parameters for SLCHs are shown in [Table 4-1](#). For more details about the SLCH configurations, refer to [\[1\]](#).

Table 4-1 Configurable Parameters for SLCHs (8 MHz Bandwidth)

Parameters	Options	Note
Time Slot	1~39	The sum of the time slot numbers of all the SLCHs should be 39.

Table 4-1 Configurable Parameters for SLCHs (8 MHz Bandwidth)

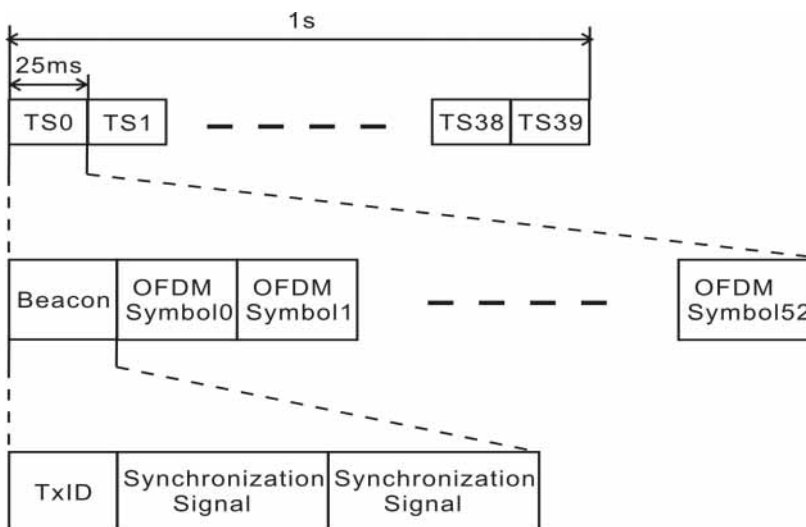
RS Coding	RS(240, 240)			
	RS(240,224)			
	RS(240,192)			
	RS(240,176)			
LDPC Coding Rate	1/2			For different LDPC coding rates, the bit interleaving depths are different.
	3/4			
Bit Interleaving Mode	Mode	1/2 LDPC	3/4 LDPC	M_I is the interleaving depth.
	Mode1	$M_I = 72$	$M_I = 108$	
	Mode2	$M_I = 144$	$M_I = 216$	
	Mode3	$M_I = 288$	$M_I = 432$	
Modulation Format	BPSK			Bit interleaving mode 1 is used when BPSK.
	QPSK			Bit interleaving mode 2 is used when QPSK.
	16QAM			Bit interleaving mode 3 is used when 16QAM.

Frame Structure

The frame structure is shown in Figure 4-3. The duration of a physical layer frame is 1s, which consists of 40 time slots numbered from 0 to 39. Each time slot includes a beacon and 53 OFDM symbols. The duration of a time slot is 25 ms.

The beacon consists of one TxID (transmitter ID) and two synchronization signals.

Figure 4-3 Frame structure based on Time Slots



OFDM

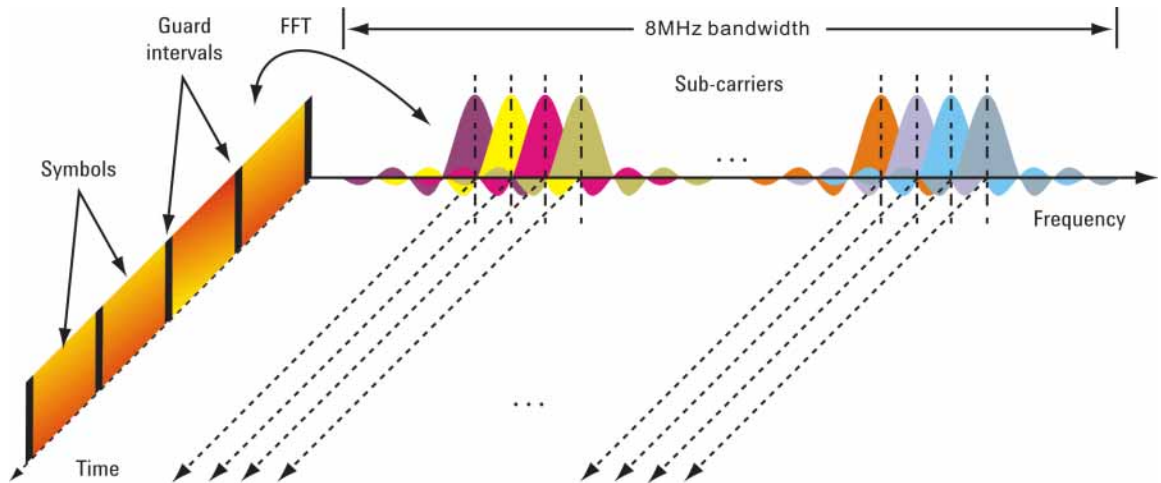
CMMB uses Orthogonal Frequency Division Multiplexing (OFDM) for modulation. Rather than transmitting a high-rate stream of data with a single carrier, OFDM makes use of a large number of closely spaced orthogonal subcarriers that are transmitted in parallel.

Each subcarrier is modulated with a conventional modulation scheme (such as BPSK, QPSK, or 16QAM) at a low symbol rate. The combination of hundreds or thousands of subcarriers enables data rates similar to conventional single-carrier modulation schemes in the same bandwidth.

The diagram in [Figure 4-4](#) illustrates the key features of an OFDM signal in frequency and time. In the frequency domain, multiple adjacent tones or subcarriers are each independently modulated with data. Then in the time domain, guard intervals are inserted between each of the symbols to prevent inter-symbol interference at the receiver caused by multi-path delay spread in the radio channel.

Figure 4-4

OFDM Signal In Frequency and Time

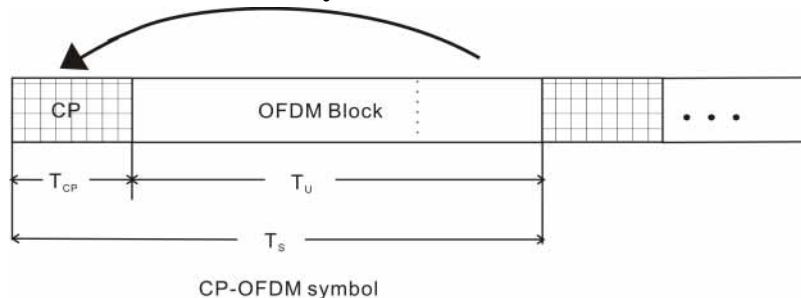


OFDM Symbol

An OFDM symbol of CMMB signal consists of CP (cyclic prefix) and OFDM block as shown in [Figure 4-5](#). The length of the OFDM block (T_u) is $409.6 \mu s$, the length of CP (T_{cp}) is $51.2 \mu s$, and the length of the OFDM symbol (T_s) is $460.8 \mu s$.

Figure 4-5

Structure for OFDM Symbols



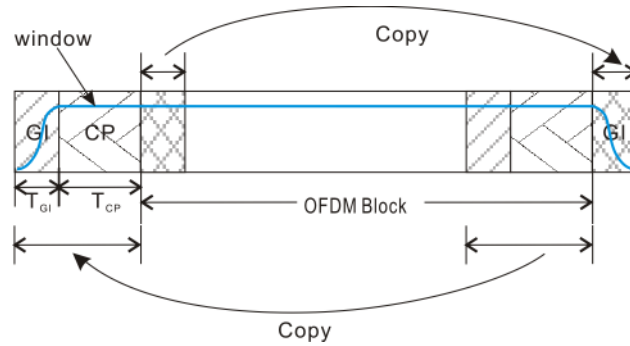
Guard Interval

An overlapped guard interval is inserted between the TxID, synchronization signal and consecutive OFDM symbols. Here take the OFDM symbols for example.

The generation method of the guard interval is shown in Figure 4-6. The length of the overlapped GI is $2.4 \mu\text{s}$. Before overlapping, each symbol is weighted with a time window.

Figure 4-6

Generation Method of Guard Interval



Capturing Signals for Measurement

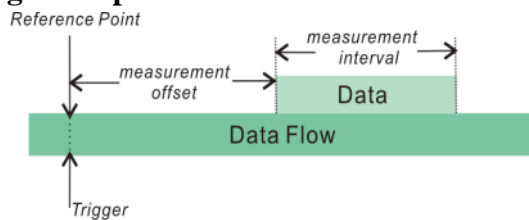
An analyzer performing vector signal analysis is not a real-time receiver but rather is a block-mode receiver. It captures a time record, and processes and displays the result before capturing the next block of data. Typically the processing and analysis time is longer than the capture time so there may be a gap between the end of one time record and the beginning of the next. Those gaps in time imply that the analyzer is not a real-time processor. This also applies to an analyzer that is configured to trigger on an event such as the change in the amplitude at the beginning of a burst. It may take the analyzer longer to process the current record than the time it takes for the next trigger event to occur.

Here again, the analyzer is not operating in real-time. Fortunately, vector signal analyzers provide a way to get real-time measurements for a limited length of time by using a time capture or recording of the input waveform. Time capturing allows the storage of complete time records with no time gaps produced in the record. The time capture is performed prior to data processing and once the waveform is captured, the signal is played back for analysis.

The signal analyzer captures the time record directly from the measurement hardware and stores the record in memory for immediate analysis or future use. Capturing the time record has the added benefit that the same signal can be analyzed over many different combinations of instrument settings including all the time and frequency measurements discussed in this section.

Figure 4-7

Signal Capture and Measurement Interval Diagram



The parameters used in signal capture is shown in [Figure 4-7](#), including:

- **Reference Point:** This specifies the reference point for measurement offset. Here, the reference point is the time trigger occurs.
- **Measurement Offset:** Determines the start position of the Measurement Interval.
- **Measurement Interval:** Determines the length of data that is used for computing and displaying the trace data results.

Channel Power Measurement Concepts

Purpose

The Channel Power measurement is an important test in the digital video industry to measure the channel power characteristics of the CMMB radio signal. First of all, it measures the integrated power and power spectral density (PSD) in CMMB defined bandwidth. Secondly, it measures and reports the shoulder attenuation.

Measurement Method

Channel Power measurement has two views. The measurement methods for each view are described as follows:

RF Spectrum

The RF Spectrum measurement reports the total transmitted power within the channel bandwidth (8 MHz for the CMMB mode). The integration bandwidth (IBW) method is used to determine channel power.

Channel Power is a swept-frequency measurement allowing you to change the RBW and VBW settings manually. To improve repeatability, you can increase the number of averages. The channel power graph is shown in the graph window, while the absolute channel power in dBm and the mean power spectral density in dBm/Hz are shown in the text window.

Shoulder Attenuation

For shoulder attenuation measurements, the instrument first measures the power value at the center frequency f_c and $f_c \pm 4.2$ MHz, then calculates the power difference between f_c and $f_c \pm 4.2$ MHz. The smaller value is defined as shoulder attenuation. The PASS/FAIL limit for shoulder attenuation is -35 dB when the device is a transmitter and -50 dB when the device is an exciter. [2] [3]

Adjacent Channel Power (ACP) Measurement Concepts

Purpose

Adjacent Channel Power (ACP), as it applies to CMMB, is the power contained in a specified frequency channel bandwidth relative to the total carrier power. It may also be expressed as a ratio of power spectral densities between the carrier and the specified offset frequency band.

As a measurement of out-of-channel emissions, ACP combines both in-band and out-of-band specifications to provide useful figures-of-merit for spectral regrowth and emissions produced by components and circuit blocks without the rigor of performing a full spectrum emissions mask measurement.

To maintain a quality transmission by avoiding channel interference, it is important to measure and reduce any adjacent channel leakage power transmitted from a CMMB transmitter. The characteristics of adjacent channel leakage power are mainly determined by the transmitter design, particularly the low-pass filter.

Measurement Method

The ACP measurement measures the power inside and outside the adjacent channel.

The measurement method and PASS/FAIL limit for the different device types (Transmitter/Exciter) are described in [Table 4-2](#).

In this measurement, three methods can be used to calculate power.

- **IBW (Integration BW):** The channel integration bandwidth is analyzed using the user defined resolution bandwidth (RBW), which is much narrower than the channel bandwidth.
- **Filter IBW:** This method is useful for improving dynamic range on the signal because a sharp cutoff band pass filter is used.
- **RBW:** This method uses zero-span and an appropriate RBW setting to capture the total power in the carrier channel and the offsets.

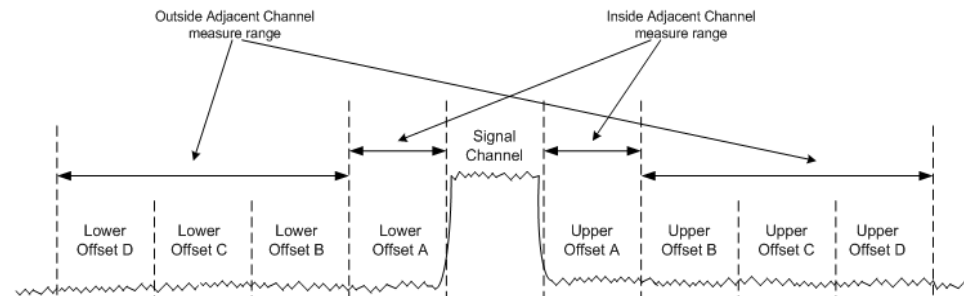
The default setting is IBW.

If **Total Pwr Ref** is selected as the measurement type, the results are displayed as relative power in dBc and as absolute power in dBm. If **PSD Ref** (Power Spectral Density Reference) is selected, the results are displayed as relative power in dB, and as absolute power in dBm/Hz.

Table 4-2 Device and Measurement Method in ACP Measurement

Measurement	Device	Measurement Method	PASS/FAIL Limit
ACP	Transmitter	<p>There are two measurement ranges: Inside Adjacent Channel and Outside Adjacent Channel.</p> <p>1. Inside Adjacent Channel: (1) Offset Frequency: ± 8 MHz (2) Offset Integ BW: 7.512 MHz (3) Result: the MAX value of the Lower and Upper Offset Abs/Rel Power</p> <p>2. Outside Adjacent Channel: (1) Offset Frequency: ± 16 MHz, ± 24 MHz, ± 32 MHz (2) Offset Integ BW: 7.512 MHz (3) Result: the RMS value of the six Lower and Upper Offset Abs/Rel Power</p>	<p>Inside Adjacent Channel: Abs Limit ≤ 13 mW and Rel Limit ≤ -45 dB</p> <p>Outside Adjacent Channel: Abs Limit ≤ 13 mW or Rel Limit ≤ -60 dB</p>
	Exciter	<p>There is only one measurement range: Inside Adjacent Channel.</p> <p>Inside Adjacent Channel: (1) Offset Frequency: ± 8 MHz (2) Offset Integ BW: 7.512 MHz (3) Result: the MAX value of the Lower and Upper Offset Abs/Rel Power</p>	<p>Inside Adjacent Channel: Rel Limit < -50 dB</p>

Figure 4-8 Channel classification in ACP measurement



Power Stat CCDF Measurement Concepts

Purpose

Many digitally modulated signals appear noise-like in the time and frequency domain. This means that statistical measurements of the signals can be a useful characterization. Power Complementary Cumulative Distribution Function (CCDF) curves characterize the higher-level power statistics of a digitally-modulated signal. The curves can be useful in determining design parameters for digital broadcast systems.

Peak-to-average power ratio is the ratio of the peak envelope power to the average envelope power of a signal. If the peak-to-average power ratio is small, the headroom required in the amplifier to prevent compression of the signal and interference with the adjacent frequency channels is small. Thus, the amplifier can operate more efficiently.

CCDF curves can help you in several situations:

- To determine the headroom required when designing a component.
- To confirm the power statistics of a given signal or stimulus. CCDF curves allow you to verify if the stimulus signal provided by another design team is adequate. For example, RF designers can use CCDF curves to verify that the signal provided by the digital signal processing (DSP) section is realistic.
- To confirm that a component design is adequate or to troubleshoot your subsystem or system design, you can make CCDF measurements at several points of a system.

Measurement Method

The power measured in power statistics CCDF curves is actually instantaneous envelope power defined by the equation:

$$P = (I^2 + Q^2)/Z_0$$

(where I and Q are the quadrature voltage components of the waveform and Z_0 is the characteristic impedance).

Then, to obtain the distribution, make a frequency distribution table in the power calculated above. In this measurement, there are 30001 points ranging from -200 dBm to 100 dBm by 0.01dB. For example, sampled power = 10 dBm, this means the 21000th index point of this table, so increase the variable that is indexed by this power.

After that, the CCDF trace vector can be made. The CCDF means a probability distribution more than any power and the trace starts from average power. The trace is obtained by converting the frequency distribution table to more than average power.

Concepts

Power Stat CCDF Measurement Concepts

To make the power statistics CCDF measurement, the instrument uses digital signal processing (DSP) to sample the input signal in the channel bandwidth.

The Gaussian distribution line as the band-limited gaussian noise CCDF reference line, the user-definable reference trace, and the currently measured trace can be displayed on a semi-log graph. If the currently measured trace is above the user reference trace, it means that the higher peak power levels against the average power are included in the input signal.

Spectrum Emission Mask Measurement Concepts

Purpose

Spectrum Emission Mask measurements include the in-band and out-of-band spurious emissions. As it applies to CMMB, it is the power contained in a specified frequency bandwidth at certain offsets relative to the total carrier power. It may also be expressed as a ratio of power spectral densities between the carrier and the specified offset frequency band.

As a measurement of out-of-channel emissions, the Spectrum Emission Mask measurement combines both in-band and out-of-band specifications to provide useful figures-of-merit for spectral regrowth and emissions produced by components and circuit blocks without the rigor of performing a full spectrum emissions mask measurement.

Measurement Method

The Spectrum Emission Mask measurement measures spurious signal levels in up to six pairs of offset/region frequencies and relates them to the carrier power. The reference channel integration bandwidth method is used to measure the carrier channel power.

The channel integration bandwidth is analyzed using the user defined resolution bandwidth (RBW), which is much narrower than the channel bandwidth. The measurement computes an average power of the channel or offset/region over a specified number of data acquisitions, automatically compensating for resolution bandwidth and noise bandwidth.

This measurement requires the user to specify measurement bandwidths of the carrier channel and each of the offset/region frequency pairs up to 6. Each pair may be defined with unique measurement bandwidths. The results are displayed both as relative power in dBc, and as absolute power in dBm.

Spectrum Emission Limits Defined by Standard

The spectrum emissions shall not exceed the limits specified in [Table 4-3](#). [1]

Table 4-3 **Spectrum Emission Limits for CMMB**

Frequency difference from the center frequency (MHz)	Relative level (dBc)
±12	-90
±8	-84
±4.2	-72
±3.8	-37

Spectrum emission limits are given as mean power level measured in a 4 kHz bandwidth, where 0 dB corresponds to the mean output power.

Using Amplitude Correction in Spectrum Emission Mask Measurement

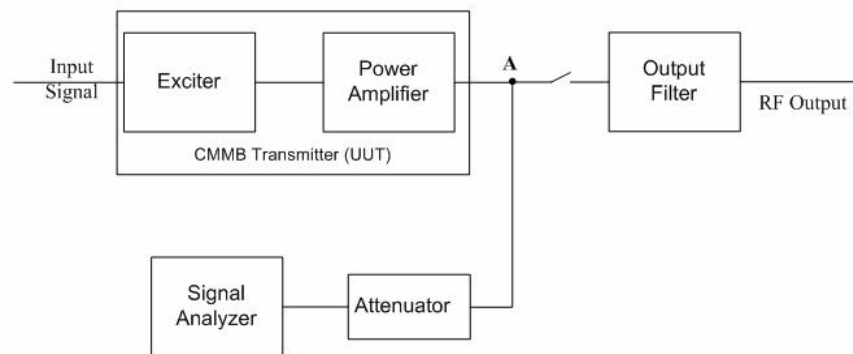
The dynamic range of the RF output of a real CMMB transmitter typically exceeds that of the analyzer, therefore, the direct measurement result is always “FAIL”, which does not reflect the real RF output.

To measure the Spectrum Emission Mask of the transmitter’s RF output, there are two methods.

- If the CMMB transmitter has an output filter, the diagram for Spectrum Emission Mask measurement is shown in [Figure 4-9](#).

Figure 4-9

Diagram for the Spectrum Emission Mask Measurement on CMMB transmitter



The steps for measuring the Spectrum Emission Mask are as follows:

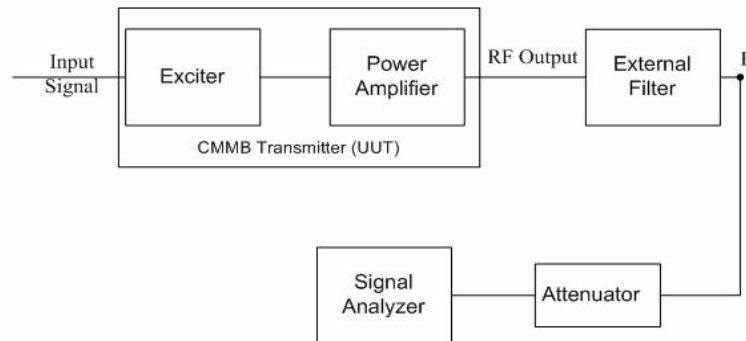
- Measure the frequency response of the output filter using a network analyzer or a combination of signal source and signal analyzer.
- Measure the signal transmitted at point A as shown in [Figure 4-9](#).
- Apply amplitude correction on spectrum value measured in step b using the filter’s response from step a.

The correction data is typically a table of the filter’s frequency response, in dB, at a number of frequency points across the band.

- If the transmitter doesn’t have the output filter, an external filter with a band-block filter frequency response should be added after the transmitter for measurement arrangement as shown in [Figure 4-10](#).

Figure 4-10

Diagram for Spectrum Emission Mask Measurement on CMMB Transmitter without Output Filter



The steps for measuring the Spectrum Emission Mask is as follows:

- a. Measure the frequency response of the external filter using a network analyzer or a combination of signal source and signal analyzer.
- b. Measure the signal transmitted at point B as shown in [Figure 4-10](#).
- c. Apply amplitude correction on spectrum value measured in step b using the filter's response from step a.

The correction data is typically a table of the negative of filter's frequency response, in dB, at a number of frequency points across the band.

Modulation Accuracy Measurement Concepts

Purpose

Measurement of modulation accuracy and quality is necessary to meet CMMB defined tests and to ensure proper operation of the transmitters. This measurement takes into account all possible error mechanisms in the entire transmission chain including baseband filtering, I/Q modulation anomalies, filter amplitude and phase non-linearities, and power amplifier distortion. This measurement provides an overall indication of the performance level of the transmitter of the UUT.

Measurement Method

Modulation Accuracy measurement measures the performance of the transmitter or exciter's modulation circuitry.

In a digitally modulated signal, it is possible to predict what the ideal magnitude and phase of the carrier should be at any time, based on the transmitted data sequence. The transmitter's modulated signal is compared to an ideal signal vector. The difference between these two vectors is sampled and processed using DSP.

In the modulation accuracy measurement, the following data is provided:

- EVM - peak and rms error vector magnitude
- MER - power ratio of the sum of squares of the ideal symbol vectors' magnitude to the sum of squares of the symbol error vectors' magnitude
- Magnitude Error - difference in amplitude between I/Q measured signal and I/Q reference signal
- Phase Error - difference in phase between the I/Q measured signal and I/Q reference signal
- Freq Error - the frequency difference between the transmitter's actual center frequency and the analyzer's center frequency
- Quad Error - the orthogonal error between I and Q signals
- Amplitude Imbalance - a form of IQ gain imbalance
- Timing Skew - the skew changes between the I and Q signals
- Trigger Difference - the time difference between the trigger and TS0 (Time slot 0)

The detailed description of the parameters above is as follows:

EVM

EVM (Error Vector Magnitude) is a modulation quality metric widely used in digital Broadcast systems. It is defined as:

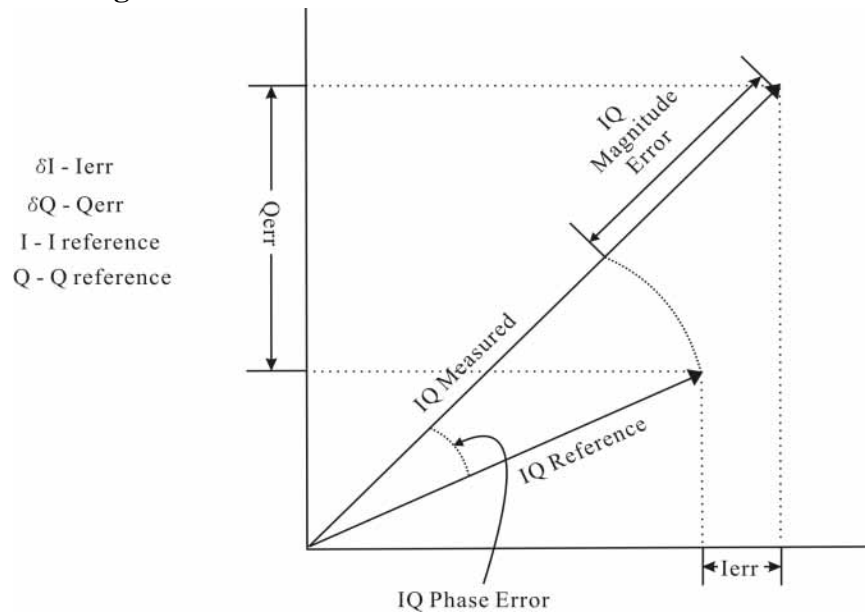
$$EVM = \frac{\sqrt{\frac{1}{N} \sum_{j=1}^N (\delta I_j^2 + \delta Q_j^2)}}{S_{rms}} \times 100\%$$

Where N is the number of data points in the measurement samples. S_{rms} is

calculated in the following way: $S_{rms} = \sqrt{\frac{1}{N} \sum_{j=1}^N (I_j^2 + Q_j^2)}$

The representation of other definitions are expressed in [Figure 4-11](#).

Figure 4-11 **Digital Demodulation Error**



MER

MER (Modulation Error Ratio) is a power ratio expressed in dB of the sum of squares of the magnitude of the ideal symbol vectors to the sum of the squares of the magnitudes of the symbol error vectors.

The MER is calculated as below:

$$MER = 10 \log_{10} \left[\frac{\sum_{j=1}^N (I_j^2 + Q_j^2)}{\sum_{j=1}^N (\delta I_j^2 + \delta Q_j^2)} \right] dB$$

N is the number of data points in the measurement samples.

The representations of other definitions are expressed in [Figure 4-11](#).

Magnitude Error

Magnitude Error is the difference in amplitude between the I/Q measured signal and the I/Q reference signal which is shown in [Figure 4-11](#).

Phase Error

Phase error is the difference in phase between the I/Q reference signal and the I/Q measured signal for composite signal. Phase Error is shown in [Figure 4-11](#).

Frequency Error

Frequency Error shows the signal carrier frequency-error relative to analyzer's center frequency. This parameter is displayed in Hz and is the amount of frequency shift, from the analyzer's center frequency, that the analyzer must perform to achieve carrier lock.

Errors in RF frequency, LO frequency, or digitizer clock rate could all appear as carrier frequency error.

Quad Error

Quad Error (Quadrature Skew Error) indicates the orthogonal error between the I and Q signals.

Ideally, I and Q should be orthogonal (90 degrees apart). A quadrature skew error of 3 degrees means I and Q are 93 degrees apart. A quadrature skew error of -3 degrees means I and Q are 87 degrees apart.

Amplitude Imbalance

Amplitude Imbalance is another form of IQ Gain imbalance. It is calculated from the formula below:

$$AI = 20 \log_{10} \frac{V_I}{V_Q} \text{ dB}$$

Where v_I and v_Q represent I and Q gain respectively.

Timing Skew

Timing Skew indicates the skew changes between the I and Q signals in microsecond. A positive value means that the I signal delays relative to the Q signal and a negative value means that the Q signal delays relative to the I signal.

Trigger Difference

Trigger Difference is the time difference between external or internal periodic trigger and TS0. A positive value means that the trigger is anterior of TS0 and a negative value means that trigger is posterior of TS0.

Peak Criteria

How can a signal be considered as a peak? This section describes the criteria for peak, which involves mainly two parameters: Peak Excursion and Peak Threshold.

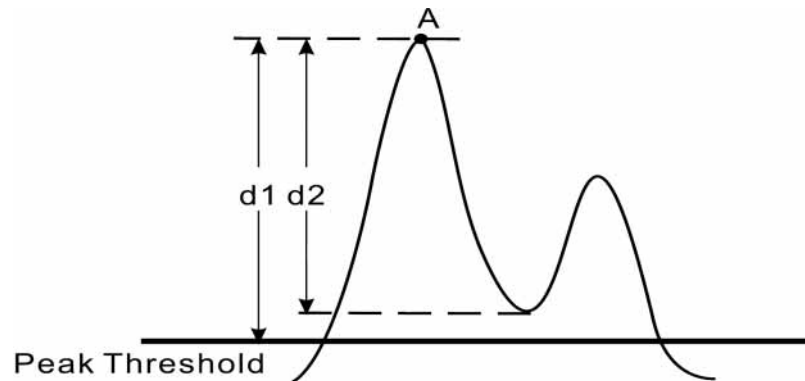
Peak (Pk) Excursion: This value determines the minimum amplitude variation (rise and fall) required for a signal to be identified as a peak.

Peak (Pk) Threshold: This value defines the minimum signal level that the peak identification algorithm uses to recognize a peak.

If both Pk excursion and Pk Threshold are on, a signal must rise above the Pk threshold value by at least the Peak Excursion value and then fall back from its local maximum by at least Peak Excursion value to be considered as a peak. As shown in [Figure 4-12](#), only when both d1 and d2 are more than or equal to the value of peak excursion, point A can be identified as a peak.

Figure 4-12

Peak Criteria



Using Triggers in CMMB Mod Accuracy Measurement

When making CMMB Mod Accuracy measurement, you need to set up triggers as introduced in [“Selecting and Setting up Mod Accuracy Measurement” on page 50](#). This section focuses on the reason for using trigger in CMMB Mod Accuracy measurement.

Different kinds of modulation schemes may coexist in a CMMB signal. To demod the signal, you need to:

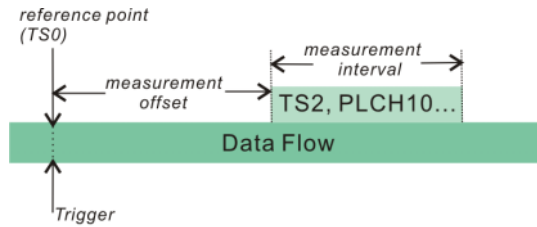
- Capture the desired signal, e.g., TS10, PLCH2.
- Identify the modulation type.

Capturing the desired signal is the first step of the demodulation. As mentioned in [“Capturing Signals for Measurement” on page 79](#), the signal analyzer is not a real-time processor. The data between the end of the one time record and the beginning of the next is not processed. The capture length of one time record is not long enough to include one CMMB frame, so the desired signal may not be included. To make sure the desired signal can be captured every time, a trigger is needed to provide a reference point in the whole CMMB data flow, as shown in [Figure 4-13](#). Once the trigger occurs, the analysis starts. By adjusting the

measurement offset, it is convenience to find and capture the desired signal.

Figure 4-13

Function of Trigger



The trigger used in CMMB demodulation procedure is a periodic trigger with the period of 1s, the length of a CMMB frame. The trigger is set to occur at the start time of TS0 so that the measurement offset can be adjusted to capture any signal in a frame. And by decoding the control informations included in TS0, the analyzer can identify the modulation type of the signal automatically.

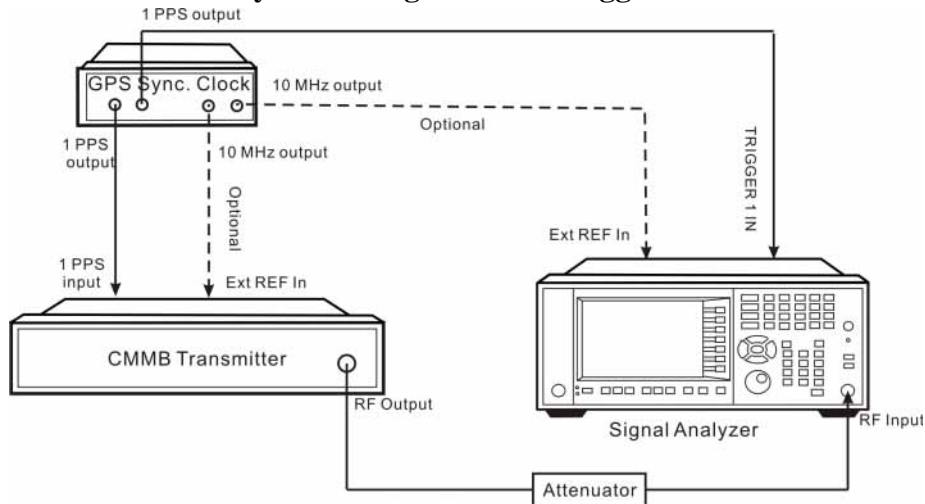
Using External Trigger in CMMB Modulation Accuracy Measurement

External trigger can also be used for synchronization. The configuration of the measurement system should look like [Figure 4-14](#).

In this system, a GPS synchronized clock providing both the 1 pps output and 10 MHz output is needed to act as the external trigger. Such a GPS clock can be easily found in a SFN network, in which several transmitters send the same signal in the same frequency band at the same time.

Figure 4-14

Measurement System Using External Trigger



- a. Connect the output signal of the CMMB transmitter/exciter to the RF input port of the analyzer using appropriate cables, attenuators, and adapters.
- b. Connect the 1 PPS output of the GPS clock to the TRIGGER 1 IN port on the rear of the spectrum analyzer and the 1 PPS input of the CMMB transmitter.

- c. Optional: Connect the 10 MHz output of the GPS clock to the external reference in port of the CMMB transmitter and signal analyzer respectively.

After connecting the measurement system, set the trigger to external 1 in Modulation Accuracy measurement. Press **Trigger, External 1**.

Occupied Bandwidth Measurement Concepts

Purpose

Occupied Bandwidth measurements express the percentage of the transmitted power within a specified bandwidth. This percentage is typically 99%.

The spectrum shape of a CMMB signal can give useful qualitative insight into transmitter operation. Any distortion to the spectrum shape can indicate problems in transmitter performance.

Measurement Method

The instrument uses sweep mode to capture the data and the total power within the measurement frequency span is integrated for its 100% of power. The frequencies of 1% of the total power are then calculated to get 99.0% bandwidth.

Monitor Spectrum Measurement Concepts

Purpose

The monitor spectrum measurement provides spectrum analysis capability for the instrument. It is used as a quick, convenient means of looking at the entire spectrum. While the look and feel are similar to the Spectrum Analyzer mode, the functionality is greatly reduced for easy operation. The main purpose of the measurement is to show the spectrum. The default span should cover an appropriate frequency range of the application.

Measurement Method

The measurement takes the sweep and acquires the data between the start frequency and stop frequency, then trace is displayed in the measurement window.

Troubleshooting Hints

Changes made by the user to advanced spectrum settings, particularly to ADC range settings, can inadvertently result in spectrum measurements that are invalid and cause error messages to appear. Care needs to be taken when using advanced features.

IQ Waveform Measurement Concepts

Purpose

The waveform measurement is a generic measurement for viewing the input signal waveforms in the time domain. This measurement is how the instrument performs the zero span functionality found in traditional spectrum analyzers.

Basic mode waveform measurement data may be displayed using either a Signal Envelope window, or an I/Q window which shows the I and Q signal waveforms in parameters of voltage versus time. The advantage of having an I/Q view available while making a waveform measurement 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 in the time domain with excellent accuracy.

Measurement Method

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

Baseband I/Q Inputs (Option BBA) Measurement Concepts

The N9020A Option BBA Baseband I/Q Inputs provides the ability to analyze baseband I/Q signal characteristics of mobile and base station transmitters. This option may be used only in conjunction with the following modes:

- IQ Analyzer (Basic)
- 802.16 OFDMA (WiMAX/WiBro)
- cdma2000
- GSM/EDGE
- TD-SCDMA
- DTMB (CTTB)
- DVB-T/H
- CMMB
- ISDB-T

What are Baseband I/Q Inputs?

Option BBA consists of a Baseband Input module, four input connectors, and a calibration output connector. The connectors are at the left side of the front panel. The two ports labeled “I” and “Q” are the “unbalanced” inputs.

An unbalanced or “single-ended” baseband measurement of an I or Q signal is made using a probe connected to the I or Q connector. A simultaneous I/Q unbalanced single-ended measurement may be made using two probes connected to the I and Q input connectors.

If “balanced” signals are available, they may be used to make a more accurate measurement. Balanced signals are signals present in two separate conductors, are symmetrical about ground, and are opposite in polarity, or out of phase by 180 degrees.

Measurements using balanced signals can have a higher signal to noise ratio resulting in improved accuracy. Noise coupled into each conductor equally in a “common mode” to both signals may be separated from the signal. The measure of this separation is “common-mode rejection”.

To make a balanced measurement, the two connectors labeled “I” and “Q” are used in conjunction with the I and Q inputs. The terms “I-bar” and “Q-bar” may be applied to the signals, as well as the inputs themselves. Probes (customer provided) must be used to input balanced baseband I/Q signals. This may be referred to as a balanced measurement.

Balanced baseband measurements are made using the I and connectors for I only

signal measurements, while the Q and connectors are used for a Q only signal measurement. Balanced measurements of I/Q require differential probe connections to all four input connectors. For details of probe selection and use, refer to “[Selecting Input Probes for Baseband Measurements](#)” on page 99.

What are Baseband I/Q Signals?

In transmitters, the term baseband I/Q refers to signals that are the fundamental products of individual I/Q modulators, before the I and Q component signals are combined, and before upconversion to IF or RF frequencies.

In receivers, baseband I/Q analysis may be used to test the I and Q products of I/Q demodulators, after a RF signal has been downconverted and demodulated.

Why Make Measurements at Baseband?

Baseband I/Q measurements are a valuable means of making qualitative analyses of the following operating characteristics:

- I/Q signal layer access for performing format-specific demodulation measurements (for example, CMMB, ISDB-T, W-CDMA).
- Modulation accuracy – that is, I/Q plane metrics:
 - error vector magnitude; rms, peak
 - frequency error
 - magnitude and phase errors
- CCDF of $I^2 + Q^2$
- Basic analysis of I and Q signals in isolation including: DC content, rms and peak to peak levels, CCDF of each channel

Comparisons of measurements made at baseband and RF frequencies produced by the same device are especially revealing. Once signal integrity is verified at baseband, impairments can be traced to specific stages of upconversion, amplification, or filtering by RF analysis. In addition, impairments to signal quality that are apparent at RF frequencies may be traceable to baseband using baseband analysis.

Selecting Input Probes for Baseband Measurements

The selection of baseband measurement probe(s) and measurement method is primarily dependent on the location of the measurement point in the circuit. The probe must sample voltages without imposing an inappropriate load on the circuit.

The system supports a variety of 1 M Ω impedance input passive probes as well as the Agilent 1153A active differential probe using the InfiniMax probe interface.

The Agilent 1153A active probe can be used for both single-ended and differential measurements. In either case a single connection is made for each channel (on either the I or Q input). The input is automatically configured to 50 Ω single-ended type measurement and the probe power is supplied through the InfiniMax interface. The probe can be configured for a variety of input coupling and low frequency rejection modes. In addition, a wide range of offset voltages and probe attenuation accessories are supported at the probe interface. The active probe has the advantage that it does not significantly load the circuit under test, even with unity gain probing.

With passive 1 M Ω probes, the probe will introduce a capacitive load on the circuit, unless a higher attenuation is used at the probe interface. Higher attenuation helps isolate the probe, however, it reduces the signal level and degrades the signal-to-noise-ratio of the measurement. Passive probes are available with a variety of attenuation values for a moderate cost. Many Agilent passive probes can be automatically identified by the system, setting the input impedance required as well as the nominal attenuation. For single-ended measurements a single probe is used for each channel. Other passive probes can be used, after manually setting the attenuation and probe impedance configurations.

For full differential measurements, the system supports probes on each of the four inputs. The attenuation for each of the probes should be the same for good common mode rejection and channel match.

Supported Probes

The following table lists the probes currently supported by Option BBA:

Probe Type	Model Number	Description
Active	1130A	1.5 GHz differential probe amp (No probe head)
	1131A ^a	InfiniMax 3.5 GHz probe
	1132A ^a	InfiniMax 5 GHz probe
	1133A ^a	InfiniMax 7 GHz probe
Passive	1161A	Miniature passive probe, 10:1, 10 M Ω , 1.5 m

- a. Probe heads are necessary to attach to your device properly. Probe connectivity kits such as the E2668A, E2669A or E2675A are needed. For more details, refer to the Agilent probe configuration guide, 5968-7141EN and 5989-6162EN.

Probes without Stored Calibration

The following 115xA active probes may be used with the MXA's baseband IQ inputs and may use the same probe calibration utility software. However, the probe calibration data is not stored in the MXA and will be lost if power is cycled. Use of the E2655B de-skew and calibration kit, including the calibration fixture, is required because of the different physical configuration of the probes. (The physical connections are different mechanically, not electrically.)

Probe Type	Model Number	Description
Active	1153A	200MHz differential probe
	1156A	Active probe, 1.5 GHz
	1157A	Active probe, 2.5 GHz
	1158A	Active probe, 4 GHz

Refer to the current Agilent probe data sheet for specific information regarding frequency of operation and power supply requirements.

Baseband I/Q Measurement Views

Measurement result views made in the IQ Analyzer (Basic) mode are available for baseband signals if they relate to the nature of the signal itself. Many measurements which relate to the characteristics that baseband I and Q signals have when mixed and upconverted to signals in the RF spectrum can be made as well. However, measurements which relate to the characteristics of an upconverted signal that lie beyond the bandwidth available to the Baseband I/Q Input circuits can not be measured (the limits are dependent on the installed options: Standard – 10 Hz to 20 MHz, Option B25 – 10 Hz to 50 MHz, and Option S40 – 10 Hz to 80 MHz).

At RF frequencies, power measurements are conventionally displayed on a logarithmic vertical scale in dBm units, whereas measurements of baseband signals using Baseband I/Q inputs may be conveniently displayed as voltage using a linear vertical scale as well as a log scale.

Spectrum Views and 0 Hz Center Frequency

To view the Spectrum display of I only or Q only signals, use the Complex Spectrum measurement capability in IQ Analyzer (Basic) Mode.

I only and Q only Spectrum views are conventional, displayed with 0 Hz at the left side of the horizontal axis. When upconverted or multiplied, an I only or Q only signal could ultimately lie above or below the carrier center frequency, but in

either case it will only occupy half the bandwidth.

Waveform Signal Envelope Views of I only or Q only

To view the Signal Envelope display of I only or Q only signals, use the Waveform measurement capability in IQ Analyzer (Basic) Mode.

The I and Q Waveform of an I/Q signal is very different from the complex signal displayed in the RF Envelope view. That is because the RF Envelope is a product of both the I and Q modulation waveforms.

However, an I and Q Waveform measurement of an I only or Q only signal is exactly the same signal displayed in the RF Envelope view. That is because an I only or Q only waveform determines the I only or Q only signal envelope. Thus, the RF Envelope view can be used to measure an I only or Q only waveform directly.

Other Sources of Measurement Information

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

- Application Note
Spectrum Analysis Basics
Agilent part number 5952-0292E
- Application Note 1298
Digital Modulation in Communications Systems - An Introduction
Agilent part number 5965-7160E
- Application Note
Characterizing Digitally Modulated Signals with CCDF Curves
Agilent part number 5968-5858E

Go to http://www.agilent.com/find/digital_video to find more products and literatures on digital video transmitter and receiver measurements.

Instrument Updates at www.agilent.com

These web locations can be used to access the latest information about the instrument, including the latest firmware version.

<http://www.agilent.com/find/cxa>

<http://www.agilent.com/find/exa>

<http://www.agilent.com/find/mxa>

<http://www.agilent.com/find/pxa>

References

- [1] GY/T 220.1-2006 Mobile Multimedia Broadcasting Part 1: Framing Structure, Channel Coding and Modulation for Broadcasting Channel
- [2] GD/J020-2008 Technical Specifications and Methods of Measurement for Mobile Multimedia Broadcasting Transmitters
- [3] Technical Specifications and Methods of Measurement for Mobile Multimedia Broadcasting Exciters (draft)

Concepts
References