



Agilent X-Series Signal Analyzer

This manual provides documentation
for the following 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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1 About the CMMB Measurement Application

This chapter provides the overall information on the N6158A (for PXA, MXA, EXA) & W6158A (for CXA) CMMB measurement application, and describes CMMB measurements made by the analyzer.

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 & W6158A 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



2 Making CMMB Measurements

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 19
- “ACP Measurements” on page 21
- “Power Stat CCDF Measurements” on page 23
- “Spectrum Emission Mask Measurements” on page 25
- “Modulation Accuracy Measurements” on page 27
- “Occupied Bandwidth Measurements” on page 34
- “Monitor Spectrum Measurements” on page 35
- “IQ Waveform (Time Domain) Measurements” on page 37

Setting Up and Making a Measurement

Making Initial Connection and Configuring the Measurement System

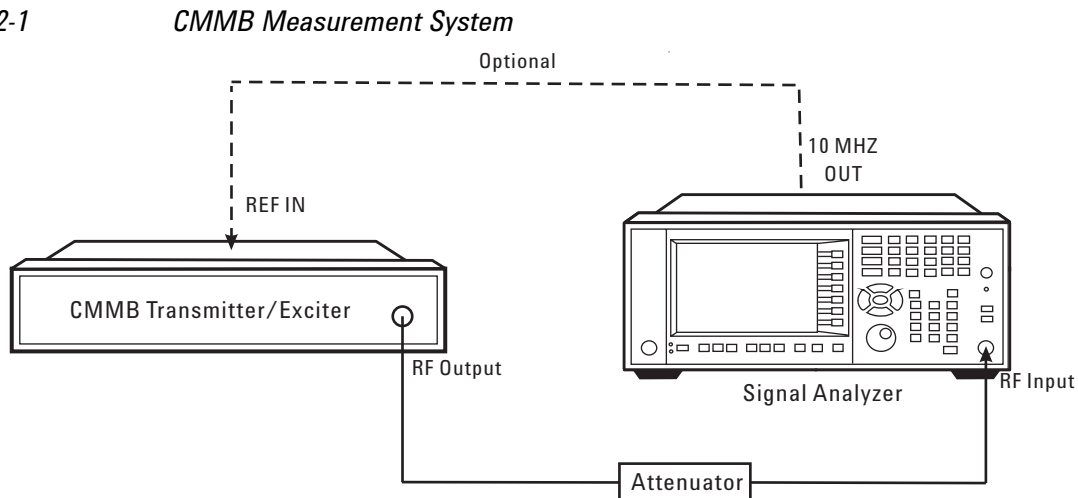
Set the CMMB transmitter/exciter under test to transmit RF power. This transmitting signal is connected to the RF input port of the instrument. Connect the equipments as shown in [Figure 2-1](#).

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.

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

Figure 2-1



After finishing the connection, see the Input/Output key menus for details on selecting input ports and AMPTD Y Scale menu for details on setting the internal attenuation to prevent overloading of the analyzer.

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 2-1](#).

Table 2-1 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 2-2](#). [Table 2-3](#) 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 19
- “ACP Measurements” on page 21
- “Power Stat CCDF Measurements” on page 23
- “Spectrum Emission Mask Measurements” on page 25
- “Modulation Accuracy Measurements” on page 27
- “Occupied Bandwidth Measurements” on page 34
- “Monitor Spectrum Measurements” on page 35
- “IQ Waveform (Time Domain) Measurements” on page 37



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 2-2 The 3 Steps to Set up and Make a Measurement

Step	Action	Notes
1 1. Select and Set Up the Mode	<ul style="list-style-type: none"> a. Press Mode. b. Press a mode key, like Spectrum Analyzer, IQ Analyzer (Basic), or CMMB. c. Press Mode Preset. d. Press Mode Setup. 	<p>All licensed, installed modes available are shown under the Mode key.</p> <p>Using Mode Setup, make any required adjustments to the mode settings. These settings apply to all measurements in the mode.</p>
2 2. Select and Set Up the Measurement	<ul style="list-style-type: none"> a. Press Meas. b. Select the specific measurement to be performed. c. Press Meas Setup. 	<p>The resulting data is shown on the display or is available for export.</p> <p>Use Meas Setup to make any required adjustment to the selected measurement settings. The settings only apply to this measurement.</p>

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

Step	Action	Notes
3 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 2-3 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.

Common Measurement Steps – Setting up the CMMB Mode

This section lists the steps common to all measurements in CMMB mode. Whatever measurements you are making, you need to begin with the following steps:

Step	Notes
1 Press Mode, CMMB .	
2 Press Mode Preset .	
3 Do one of the following to set center frequency: <ul style="list-style-type: none">• Press FREQ Channel, Center Freq, 634, MHz.• Press FREQ Channel, Chan Table, PAL-D/K, PAL-D/K DS, and then press FREQ Channel, Channel, 28.	<p>The first method is to enter the frequency directly.</p> <p>The second method is to set the frequency through channel table. Multiple channel tables are predefined in the instrument, including NTSC-M, NTSC-J, NTSC-Brazil, PAL-M, PAL-I, PAL-B/G, and PAL-D/K.</p> <p>You can change the definition of the channel table following the steps in “Customizing the Channel Table Definition” on page 16.</p>
4 Press Mode Setup, Device Type, Transmitter .	This selects transmitter as the device type.

Customizing the Channel Table Definition

Channel table function enables you to specify the center frequency by entering the channel number under a specific channel table. In a channel table, each channel number corresponds to a center frequency exactly. The predefined channel table complies with the industry standards.

A channel table file is used to export, edit, and then import the channel table settings so that you can customize the channel table to satisfy your measurement requirements.

The format of the channel table file is illustrated in [Figure 2-2](#). The channel table file includes channel definitions for all the channel plans, such as NTSC-B, NTSC-J, NTSC-M, PAL-M, PAL-I, PAL-B/G, and PAL-D/K. Each channel plan is separated with a blank line.

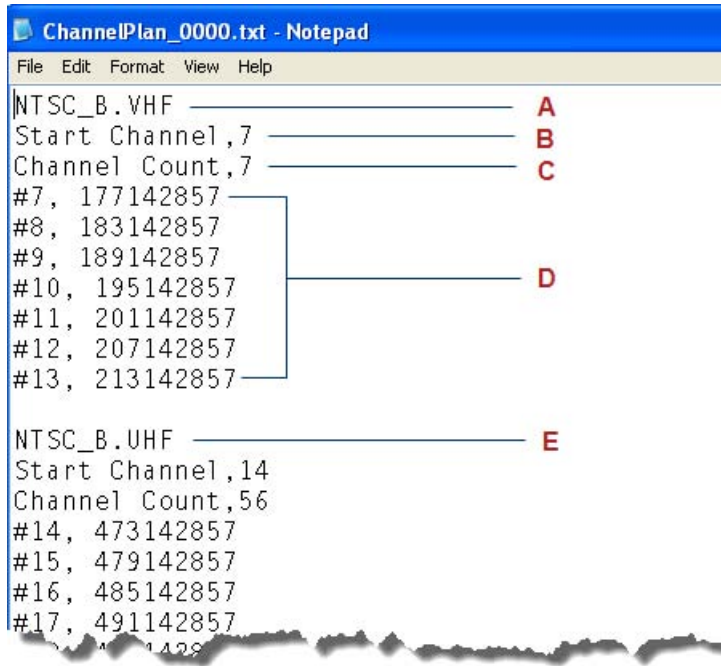
File default location: My Documents\Digital Video\data

File type: text file

File extension: .txt

Figure 2-2

Format of the Channel Table File



- A.** Channel plan name. This is the channel plan for NTSC-B VHF;
- B.** Start channel number. Here, the start channel number is 7;
- C.** Channel count in the current channel plan. There are 7 channels in the predefined NTSC-B VHF.
- D.** Channel number and corresponding center frequency, unit Hz. For example, #7, 177142857 means the center frequency for the channel 7 is 177142857 Hz.
- E.** The start of another channel plan NTSC-B UHF.

Perform the following steps to customize the channel table:

Step

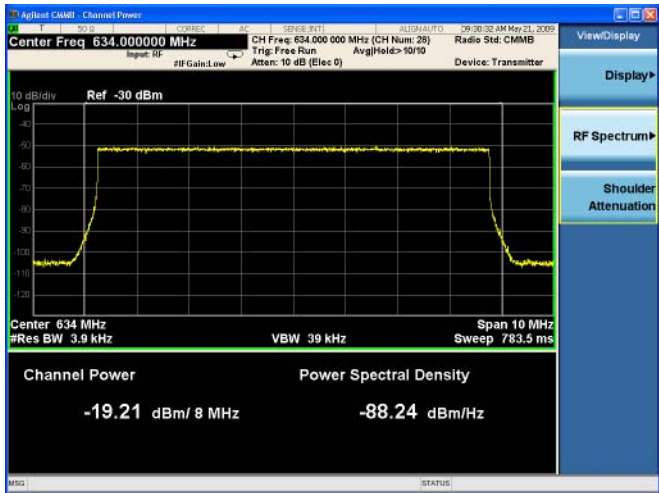
Notes

- | Step | Notes |
|--|--|
| 1 Press Save, Data, Channel Table , and then press Save As... , save the current channel table file as ChannelPlan_0000.txt (for example). | This saves the data of the current channel table into a file.
You can save the file into the default directory "My Documents\Digital Video\data" or any other locations you like. |

Step	Notes
<hr/> 2 Open the saved channel table file ChannelPlan_0000.txt, find the channel plan you are going to edit, and then make your desired changes.	<hr/> <p>You can add your own channel definitions to the channel table file, edit the center frequency value for the predefined channel, or remove the channel definitions unnecessary for your test.</p> <ul style="list-style-type: none">• Adding channel definitions First, choose and find the channel plan you're going to edit on, for example, NTSC_B.VHF. Then, add the channel definitions including channel number and corresponding center frequency following the format "# channel number, centerfrequency". After that, edit the Start Channel and Channel Count values according to your changes.• Editing the center frequency value for the channel Choose and find the channel plan you're going to edit, and then enter the center frequency value for the channel.• Removing unnecessary channel definitions Choose and find the channel plan you're going to edit, and then delete the unnecessary channel definition. After that edit the Start Channel and Channel Count values. <p>Note that the name of the channel plan couldn't be changed. If it is changed, the modifications under this channel plan will not work and the default channel settings of the channel plan will work instead.</p> <hr/>
3 Press Recall, Data, Channel Table , then press Open... , and open the channel table file you edited.	
4 Press FREQ Channel to specify the center frequency under the new channel table.	If the instrument is restarted, the channel table file needs to be recalled again.

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.

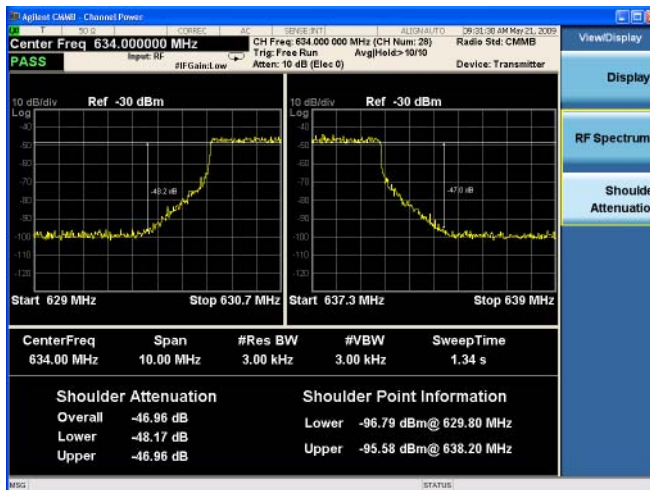
Step	Notes
1 Set up the CMMB mode parameters according to “ Common Measurement Steps – Setting up the CMMB Mode ” on page 16	If the CMMB mode is NOT set up properly, the measurement results will be incorrect.
2 Press Meas, Channel Power .	This selects the Channel Power measurement.
3 Press View/Display, RF Spectrum .	This selects the RF Spectrum view.
4 View the RF Spectrum results.	In the figure below, the graph window shows the spectrum trace and the text window shows the total power and PSD (power spectral density) level over 8 MHz bandwidth.
	
5 Press View/Display, Shoulder Attenuation ;	This selects the Shoulder Attenuation view.

Step

Notes

- 6 View the shoulder attenuation results.

In the figure below, the text window shows the shoulder attenuation value and shoulder points information.



To make the measurement on a specified frequency range, press **Meas Setup** and set the values for **Shoulder Offset Start** and **Shoulder Offset Stop** correspondingly.

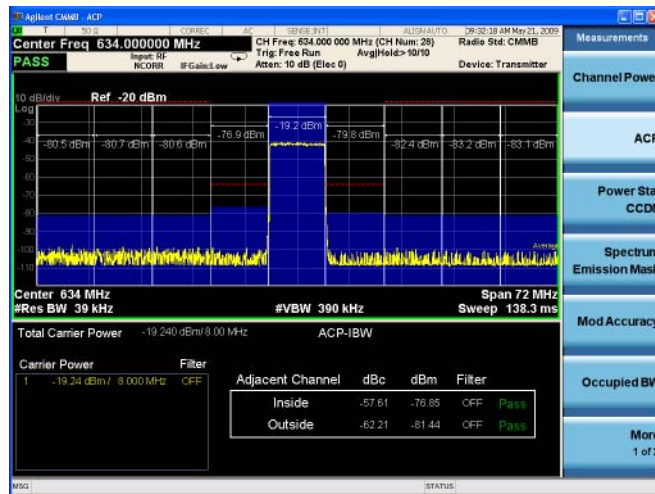
To learn more about the measurement method of shoulder attenuation, refer to [“Shoulder Attenuation”](#) on page 51.

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.

Step	Notes
1 Set up the CMMB mode parameters according to “ Common Measurement Steps – Setting up the CMMB Mode ” on page 16.	If the CMMB mode parameters are NOT set up properly, the measurement results will be incorrect.
2 Press Meas, ACP .	
3 Press Meas Setup, More 1 of 2, Noise Correction and toggle it to On .	This operation can reduce the noise levels and improve the ACP measurement results.
4 View the ACP measurement results.	See the figure below for the ACP result for CMMB transmitter. 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 3-2 on page 53](#).



You can define your own limit mask by configuring the related parameters such as settings under **Meas Setup, Carrier Setup** and **Offset/Limits**, and toggle **Limit Test** under **Meas Setup** to **On**.

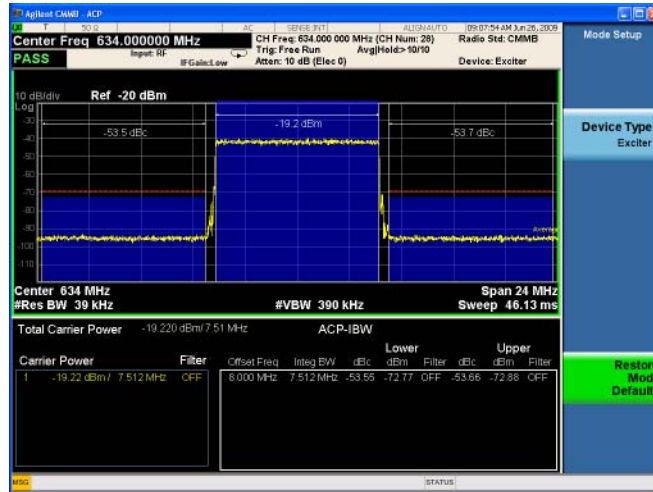
Making CMMB Measurements ACP Measurements

Step

- 5 If the device under test is an CMMB exciter, the ACP results are displayed differently.

Notes

See the figure below. 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.



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.

Power Statistics CCDF measurements can also 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 39.

Step	Notes
1 Set up the CMMB mode parameters according to “Common Measurement Steps – Setting up the CMMB Mode” on page 16.	If the CMMB mode is NOT set up properly, the measurement results will be incorrect.
2 Press Power Stat CCDF .	
3 View the Power Stat CCDF measurement results.	In the following figure, the statistic data of the peak to average ratio is listed in the text window. In the graph window, 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 .



Step

- 4 Press **Trace/Detector, Ref Trace (On)** to display the user-definable reference trace (violet line).

Notes

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.

Step	Notes
1 Set up the CMMB mode parameters according to “Common Measurement Steps – Setting up the CMMB Mode” on page 16.	If the CMMB mode parameters are NOT set up properly, the measurement results will be incorrect.
2 Press Spectrum Emission Mask .	This selects the Spectrum Emission Mask measurement.
3 Press Input/Output, External Gain, Ext Preamp, -60, dB .	This sets the value for the external attenuator to get the actual transmitting power of the transmitter under test.
4 Press Input/Output, More 1 of 2, Corrections , toggle the Correction key to On , and then do one of the following to specify correction data: <ul style="list-style-type: none"> <li data-bbox="204 1016 643 1079">• Press Edit and enter the frequency and amplitude data. <li data-bbox="204 1100 651 1199">• Press Recall, Data (Import) Amptd Cor1, Open to import the correction file. 	This applies amplitude correction. 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. For more detailed information regarding amplitude correction and the definition of correction data, refer to “Using Amplitude Correction in Spectrum Emission Mask Measurement” on page 57.

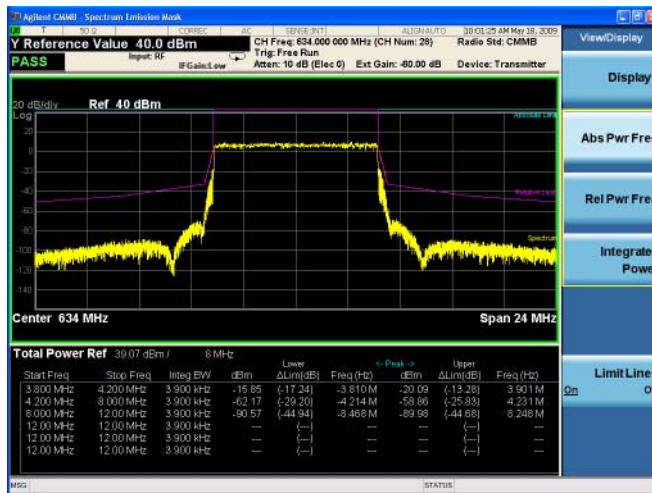
Step

- 5 View the Spectrum Emission Mask measurement results.

Notes

In the figure below, the top window shows the measured trace together with the limit mask and the bottom window lists the related parameters.

To make the spectrum emission mask measurement with your own limit mask, press **Meas Setup** and then set the parameters under **Ref Channel** and **Offset/Limit** panel.



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.

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.

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.

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 39.

Step	Notes
1 Set up the CMMB mode parameters according to “Common Measurement Steps – Setting up the CMMB Mode” on page 16.	If the CMMB mode parameters are NOT set up properly, the measurement results will be incorrect.
2 Press Meas, Mod Accuracy .	This selects the modulation accuracy measurement.
3 Do as follows to set up the trigger: <ol style="list-style-type: none"> <li data-bbox="245 947 634 1010">a. Press Trigger, More 1 of 2, Periodic Timer (default setting). <li data-bbox="245 1035 618 1098">b. Press Meas Setup, Advanced, Sync Frame Now. <li data-bbox="245 1123 618 1182">c. Press Meas Setup, Advanced, toggle Frame Tracking to On. 	<p>This sets the instrument to generate a periodic trigger inside (default setting) and synchronize the internal periodic trigger to the start of the CMMB frame. For more details, refer to “Using Triggers in CMMB Mod Accuracy Measurement” on page 63.</p> <p>Setting Frame Tracking to On makes the instrument track and compensate the difference between the periodic timer and the start of the CMMB frame.</p> <p>NOTE If only one modulation format is used in CMMB signals, setting up triggers is not necessary. In this case, set up the measurement as follows:</p> <ol style="list-style-type: none"> <li data-bbox="833 1291 1414 1354">a. Press Trigger, Free Run to set the trigger to free run. <li data-bbox="833 1379 1414 1442">b. Press Meas Setup, Timeslot Settings, QPSK (for example) to set the modulation format. <p>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 64.</p> <p>If the input signal is BBIQ signal, an external trigger is required, as there are no periodic tiggers in BBIQ input.</p>

Making CMMB Measurements Modulation Accuracy Measurements

Step

Notes

4 Set the data to be measured. It can be set to a specified PLCH, timeslot, or the whole frame. Here, take PLCH for example.

Do as follows to measure SLCH0 (example).

- Press **Meas Setup, Meas Type, PLCH**.
- Press **PLCH Settings**.
- Toggle **PLCH Type** to **SLCH**.
- Press **SLCH Index, 0**.

If measurement type is PLCH and the PLCH type is set to CLCH, the SLCH Index key will be grayed out.

You can also set the data to a specified timeslot or to the whole frame. Do as follows to measure timeslot 1-3 (example).

- Press **Meas Setup, Meas Type, Timeslot**.
- Press **Timeslot Settings**.
- Press **Start Timeslot, 1**.
- Press **Meas Interval, 3, slots**.
- Press **Modulation Format, 16QAM**.

If the measurement type is Timeslot, you need to set the modulation format of the timeslots and make sure the timeslots to be measured use the same modulation format.

To measure the whole frame, press **Meas Setup, Meas Type, Frame**. The instrument will demodulate the signal according to the control information in CLCH. You may have to wait for a while before the analysis on the data of one frame finishes.

5 Press **View/Display, I/Q Measured Polar Graph**.

This selects the I/Q measured polar graph view, which is the default view.

6 View the I/Q measured polar graph results.

The constellation graph is shown in the graphic window, and the results, such as EVM, MER, and so on, are shown in the text window. The white points in the constellation window stand for scattered pilot and green points stand for continual pilot.



To view the constellation graph for specified carrier ranges in specified timeslot, press **I/Q Measure Polar Graph** again, set values for the **Start Carrier**, **Stop Carrier**, and **Timeslot Index**. Ensure that the corresponding timeslot is inside the data under measurement, which is set in Step 4.

Step

Notes

7 Press **View/Display, I/Q Error**.

This selects the I/Q error view.

8 View the I/Q error results.

Four windows are displayed in the I/Q Error results as below.

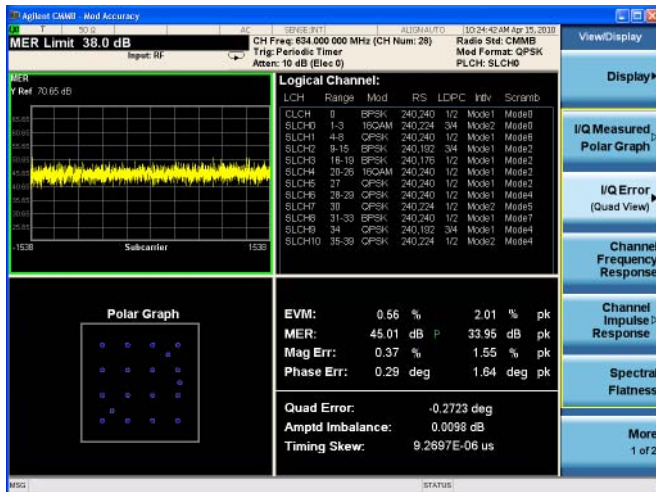
- MER\EVM vs. Subcarrier\Frequency window (left top): MER or EVM on each subcarrier or frequency.

You can change the scale type for the vertical axis and the horizontal axis by setting the Scale Type key under AMPTD Y Scale and Span X Scale menus.

- 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.

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.

- Polar Graph window (left bottom): the constellation of the measured signal.
- Result window (right bottom).



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.

9 Press **View/Display, Channel Frequency Response**.

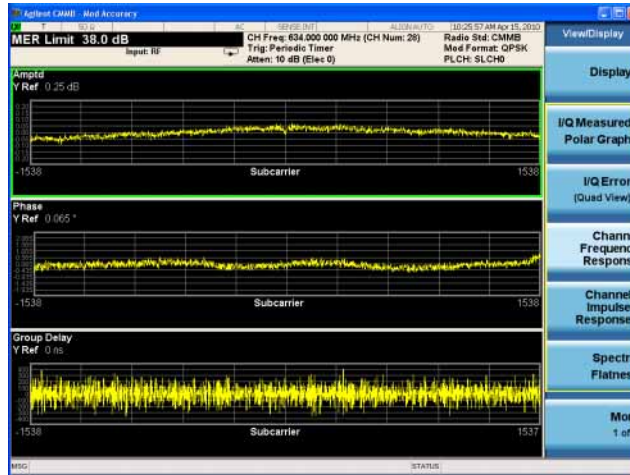
This selects the channel frequency response view.

Step

Notes

10 View the channel frequency response results.

The figure below displays the amplitude, phase, and group delay results on every subcarrier.

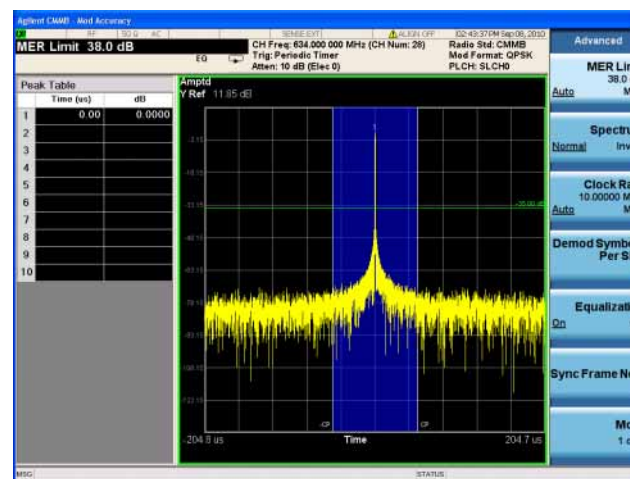


11 Press **View/Display, Channel Impulse Response**, and then press **Meas Setup, Advanced**, toggle **Equalization to On**.

This selects the channel impulse response view, and turns on the equalizer. Turning the equalizer on can gain better channel impulse response results.

12 View the channel impulse response results.

The graphic window shows the channel impulse response trace, and the peak table window shows the delay and amplitude of the top 10 peaks on the trace at most. The blue bar indicates the -CP (Cyclic Prefix) to CP range. The green line with -35 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 then enter your desired peak limit value.



Peak table window is very useful when there are more than one path in the channel. For more information, refer to [“Multi-path Channel Impulse Response”](#) on page 62.

Step

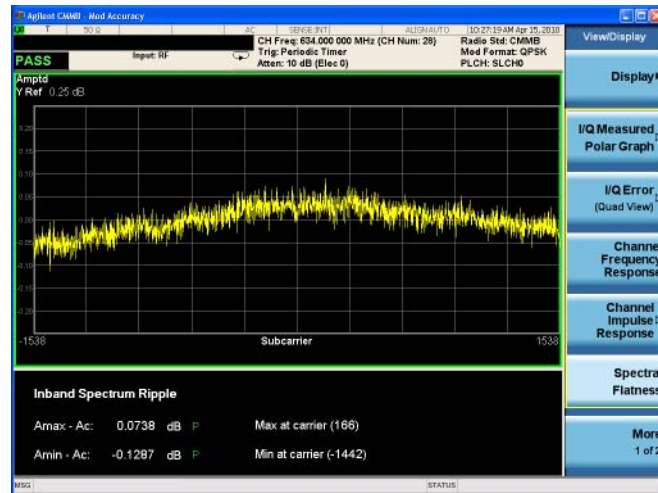
Notes

13 Press **View/Display, Spectral Flatness**.

This selects the spectral flatness view.

14 View the spectral flatness results.

The figure below displays the inband spectrum ripple. According to the specifications, the ripple inband should be less than ± 0.5 dB.



15 Press **View/Display, More 1 of 2, MER vs. Timeslot**.

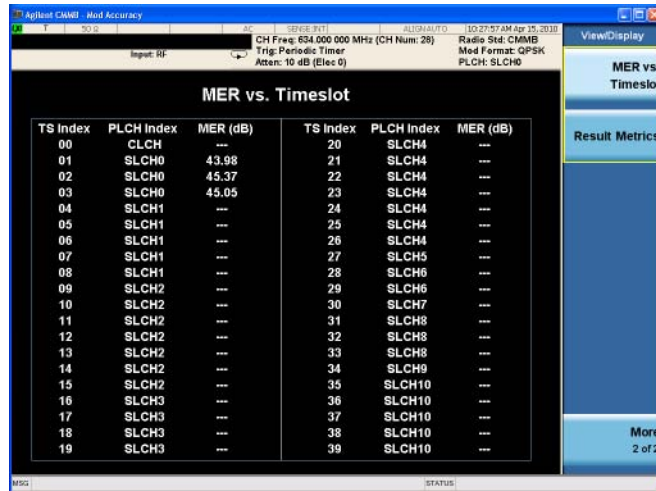
This selects the MER vs. Timeslot view.

Step

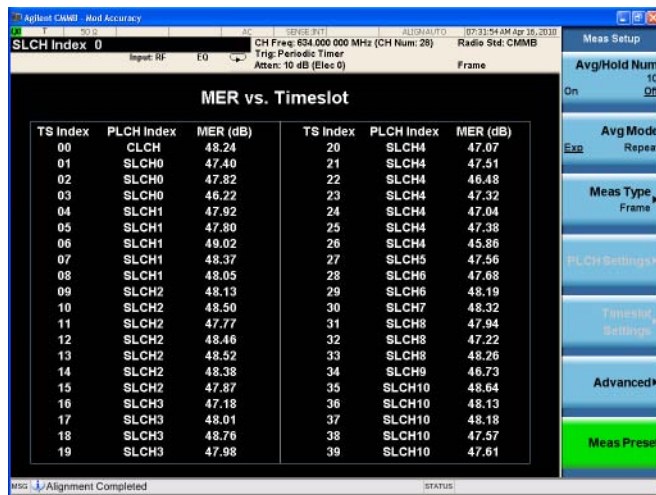
Notes

16 View the MER vs. timeslot results.

This view displays the MER on each timeslot under measurement. In the figure below, as the data under measurement is SLCH0 which is set under **Meas Setup**, there are only MER results on TS1, TS2, and TS3.



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 results are as below.



17 Press **View/Display, Result Metrics**.

This selects the result metrics view.

Step

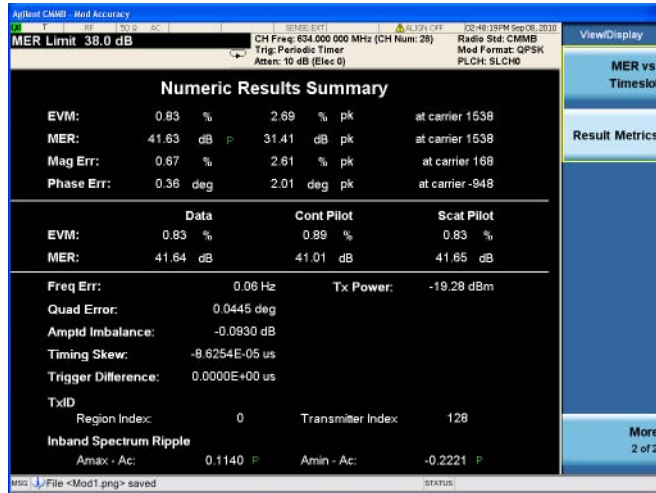
Notes

18 View the summary of the results.

This view is a summary of the modulation accuracy measurement results.

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

For 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.



NOTE

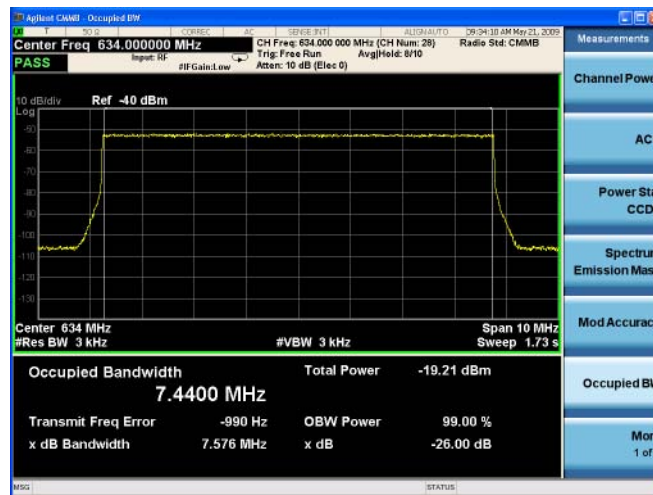
To place a Marker on the different traces of the various views, press **Marker, Properties, Marker Trace**, then select the trace you want to put the marker on. There are six traces to select from: Polar Trace, MER vs.Carr, Amptd vs.Carr, Phase vs.Carr, GD vs.Carr, and Amptd vs.Time.

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.

Step	Notes
1 Set up the CMMB mode parameters according to “ Common Measurement Steps – Setting up the CMMB Mode ” on page 16.	If the CMMB mode parameters are NOT set up properly, the measurement results will be incorrect.
2 Press Meas, Occupied BW .	This selects the occupied BW measurement.
3 View the occupied BW measurement results.	In the figure below, the graphic window shows the spectrum for the current signal, and the text window shows the occupied bandwidth of the specified percentage and the x dB bandwidth of the specified x dB.

The predefined settings are compliant with the specs. You can customize the occupied BW measurement by setting the parameters, such as OBW power, x dB, and limit under Meas Setup menu.



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.

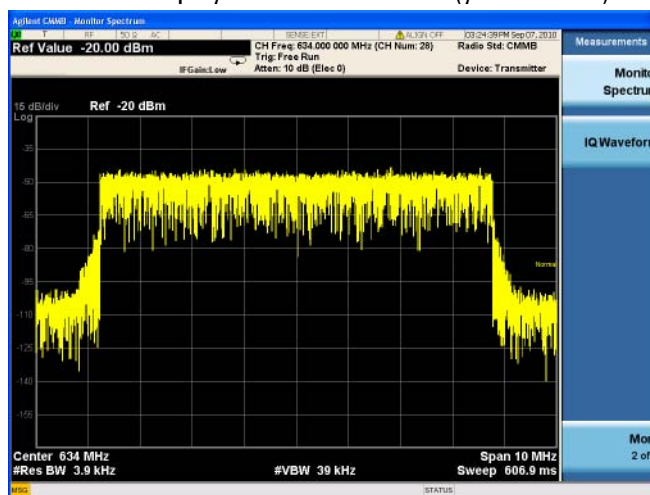
Monitor Spectrum Measurements

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.

Step

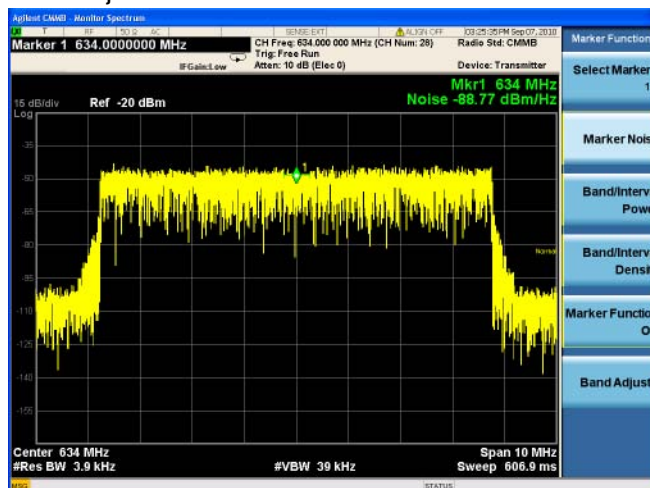
Notes

- 1 Set up the CMMB mode parameters according to “Common Measurement Steps – Setting up the CMMB Mode” on page 16.
- 2 Press **Meas, Monitor Spectrum**. This selects monitor spectrum view.
- 3 View the monitor spectrum results. The default display shows the **Current** (yellow trace) data.



- 4 (Optional) Press **Marker Function, Marker Noise**.

This turns on the Marker Function. The figure below is an example for marker noise. You can also select Band/Interval Power and Band/Interval Density to see the power or power density in a specified band, which is set using the keys under the Band Adjust menu.



Making CMMB Measurements

Monitor Spectrum Measurements

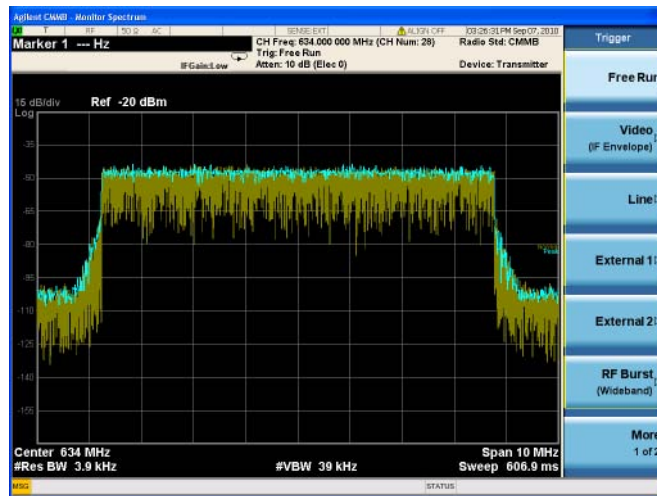
Step

5 (Optional) To compare the current trace with the average/max hold/min hold trace, perform the following steps:

- Press **Trace/Detector**, **Select Trace**, **Trace 1**, and then toggle **Update** to **Off**.
- Press **Select Trace**, **Trace 2**, press **Max Hold**, and then toggle **Update** to **On**, **Display** to **Show**.

Notes

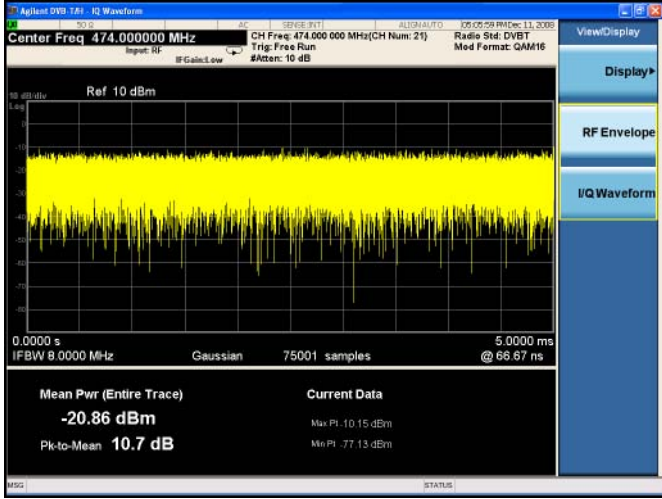
The dark yellow trace is the clear write trace, and the blue trace is the max hold trace. You can also add other traces using the same procedure.



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.

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 39.

Step	Notes
1 Set up the DVB-T/H with T2 mode parameters according to “Common Measurement Steps – Setting up the CMMB Mode” on page 16.	If the DVB-T/H with T2 mode is NOT set up properly, the measurement results will be incorrect.
2 Press Meas, IQ Waveform .	This selects the IQ waveform measurements.
3 Press View/Display,	
4 View the RF envelope (default view) results.	The following picture shows the RF envelope results in the graphic windows, and shows the mean power and peak-to-mean power results in the text window.
	
5 Press View/Display, I/Q Waveform .	This selects the I/Q waveform view.

Making CMMB Measurements

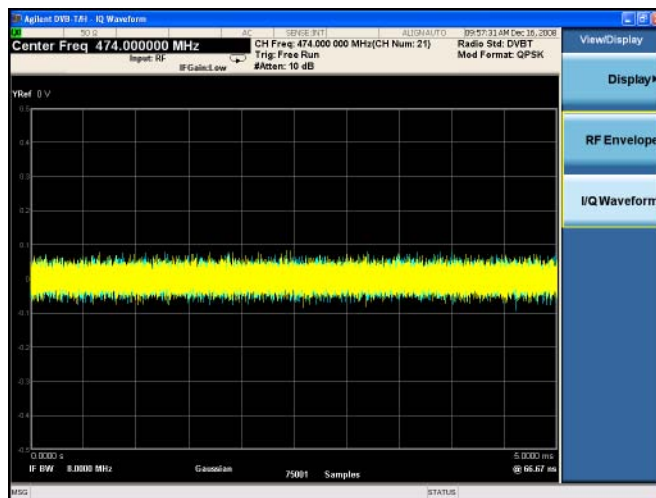
IQ Waveform (Time Domain) Measurements

Step

Notes

6 View the I/Q waveform results.

The I/Q waveform view displays the I (yellow trace) and Q (blue trace) waveforms on the same graph in terms of voltage versus time in linear scale.



7 (Optional) Press **AMPTD Y Scale**, and configure the settings for the Y axis to a convenient scale for viewing.

8 (Optional) Press **Span X Scale**, and configure the settings for the X axis to a convenient time scale for viewing.

9 (Optional) Press **Marker Function** and select **Marker Noise**, **Band/Interval Power**, or **Band/Interval Density**.

You can use band adjust to set frequency span for those marker functions.

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 2-4

BBIQ Supported Measurements vs. Mode

Mode	Measurements
GSM	IQ Waveform GMSK Phase & Freq EDGE EVM
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 with T2	IQ Waveform Power Stat CCDF DVB-T/H Mod Accuracy DVB-T2 Mod Accuracy
ISDB-T	IQ Waveform Power Stat CCDF Mod Accuracy
CMMB	IQ Waveform Power Stat CCDF Mod Accuracy
Digital Cable TV	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 11" sections.

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

Step	Notes
1 Select a measurement that supports baseband I/Q inputs by pressing Meas .	Table 2-4 on page 39 lists the measurements that support baseband I/Q inputs in each mode. If the selected measurement is Mod Accuracy, an external trigger is needed. Set up the measurement system and trigger according to the section " Using External Trigger in CMMB Modulation Accuracy Measurement " on page 64.
2 Select the I/Q Path. Press Input/Output, I/Q, I/Q Path , and then select from the choices present on the screen.	The path selected in this step is shown at the top of the measurement screen.
3 Select the appropriate circuit location and probe(s) for measurements.	For details see " Selecting Input Probes for Baseband Measurements " on page 70 in the Concepts chapter.
4 Select baseband I/Q input connectors and connect the I/Q signals to the corresponding I/Q ports on the instrument..	

Step	Notes
<p>5 If you have set the I/Q Path to I+jQ or to I Only, press I Setup.</p> <p>A. Select whether Differential (Balanced) input is On or Off.</p> <p>B. Select the input impedance, Input Z.</p> <p>C. Input a Skew value in seconds.</p> <p>D. Set up the I Probe by pressing I Probe.</p> <p>a. Select probe Attenuation.</p> <p>b. Calibrate the probe. Press Calibrate... to start the calibration procedure. Follow the calibration procedure, clicking Next at the end of each step.</p>	
<p>6 If you have set the I/Q Path to I+jQ or to Q Only, press Q Setup.</p> <p>A. Select whether Differential (Balanced) input is On or Off.</p> <p>B. Select the input impedance, Input Z.</p> <p>C. Input a Skew value in seconds.</p> <p>D. Set up the I Probe by pressing I Probe.</p> <p>a. Select probe Attenuation.</p> <p>b. Calibrate the probe. Press Calibrate... to start the calibration procedure. Follow the calibration procedure, clicking Next at the end of each step.</p>	
<p>7 Select the reference impedance by pressing Reference Z and inputting a value from one ohm to one megohm.</p>	The impedance selected is shown at the top of the measurement screen.
<p>8 If you are using cables that were not calibrated in the probe calibration step, press I/Q Cable Calibrate..., follow the calibration procedure, and click Next at the end of each step.</p>	
<p>9 After completing the baseband IQ setup procedures, make your desired measurement.</p>	

Making CMMB Measurements
Using Option BBA Baseband I/Q Inputs



3 Concepts

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.

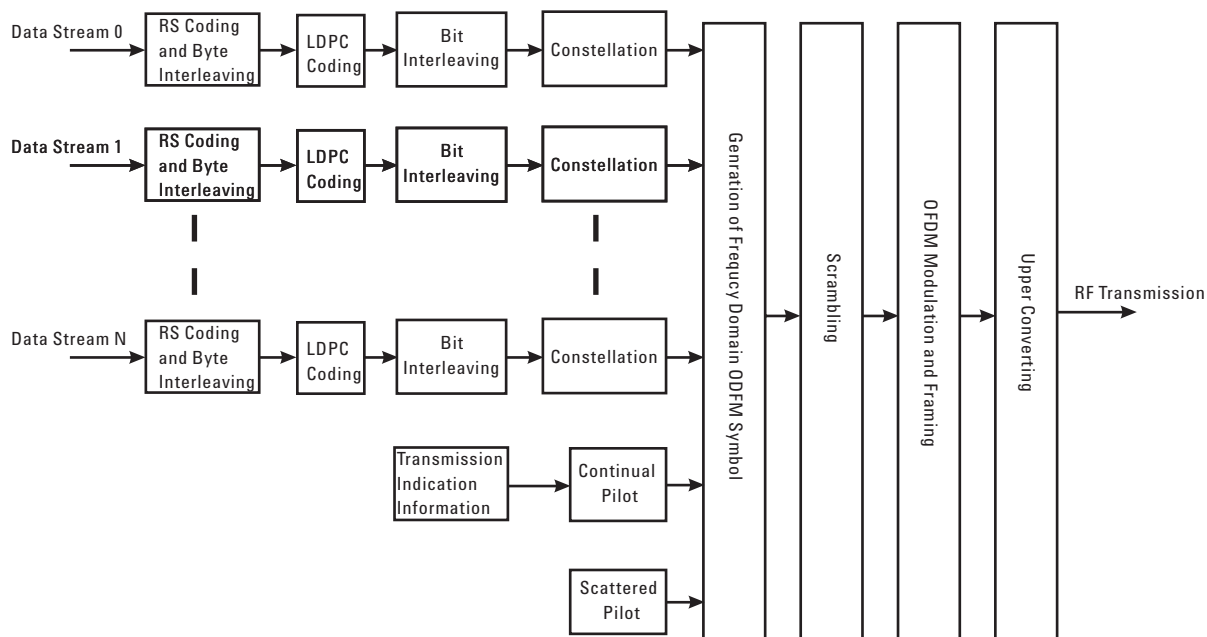
The core part of CMMB is STiMi (satellite and terrestrial interactive multiservice infrastructure). It uses both satellite and terrestrial signals to obtain effective coverage both in densely populated cities and in sparsely populated rural areas. The system supports single-frequency network (SFN) and 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 3-1](#). 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 3-1 Function Block Diagram of Physical Layer



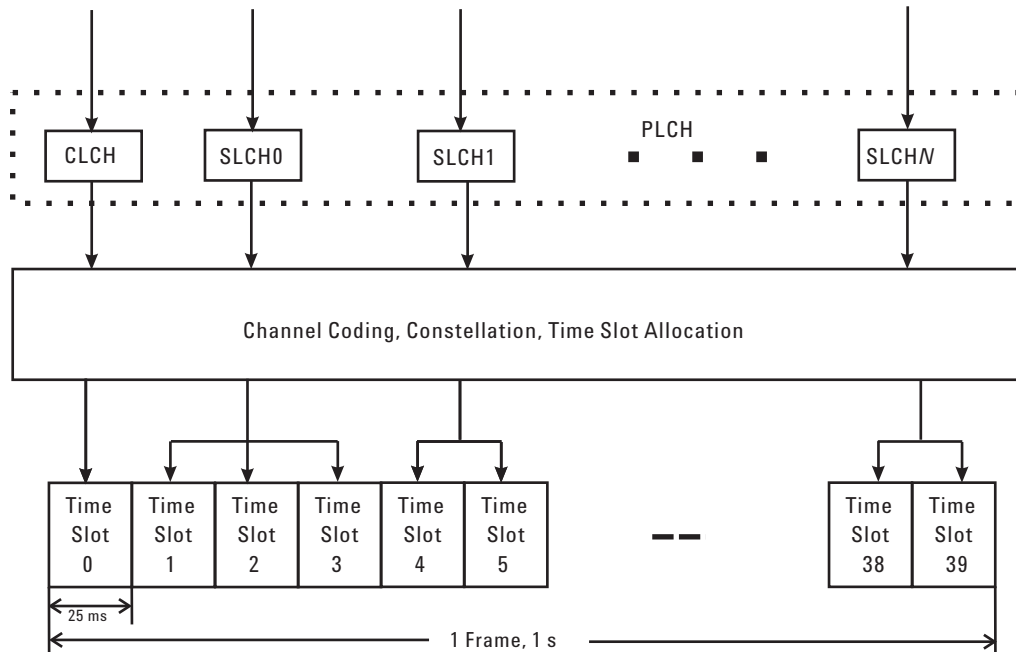
PLCH

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 3-2](#).

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 3-2

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 3-1](#). For more details about the SLCH configurations, refer to [\[1\]](#).

Table 3-1

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 3-1 Configurable Parameters for SLCHs (8 MHz Bandwidth)

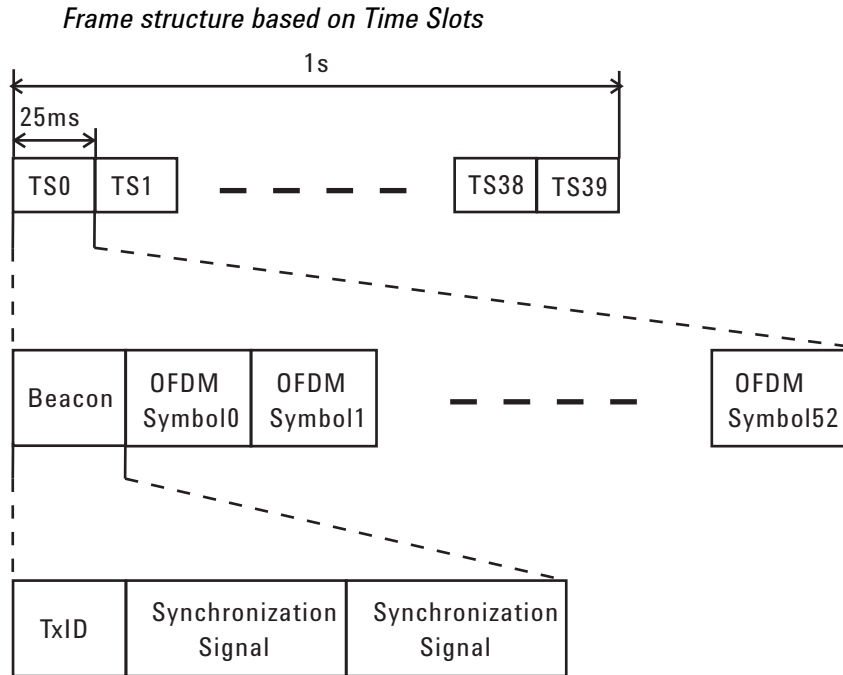
Parameters	Options			Note
RS Coding	RS(240, 240)			
	RS(240,224)			
	RS(240,192)			
	RS(240,176)			
LDPC Coding Rate	1/2			For different LDPC coding rates, the bit interleaving depths are different.
	3/4			
Bit Interleaving Mode	Mode	1/2 LDPC	3/4 LDPC	MI is the interleaving depth.
	Mode 1	MI = 72	MI = 108	
	Mode 2	MI = 144	MI = 216	
	Mode 3	MI = 288	MI = 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 3-3](#). 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 3-3



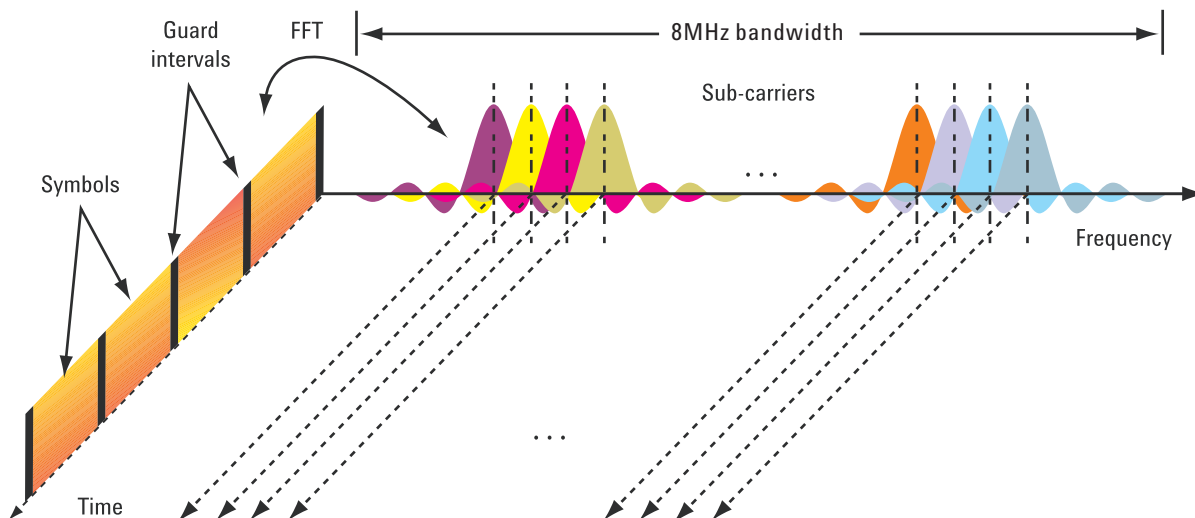
OFDM

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 3-4](#) 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.

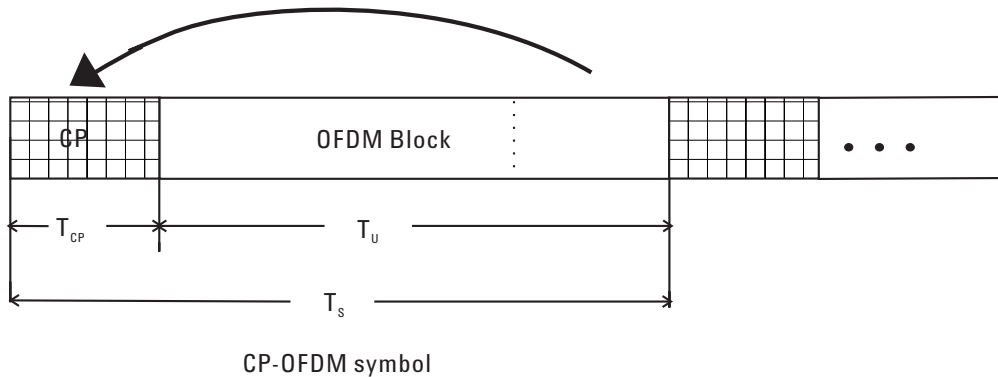
Figure 3-4 OFDM Signal In Frequency and Time



OFDM Symbol

An OFDM symbol of CMMB signal consists of CP (cyclic prefix) and OFDM block as shown in Figure 3-5. 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 3-5 Structure for OFDM Symbols



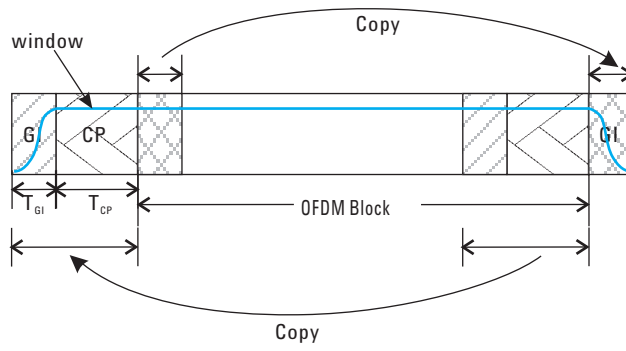
Guard Interval

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 3-6. The length of the overlapped GI is $2.4 \mu s$. Before overlapping, each symbol is weighted with a time window.

Figure 3-6

Generation Method of Guard Interval



Capturing Signals for Measurement

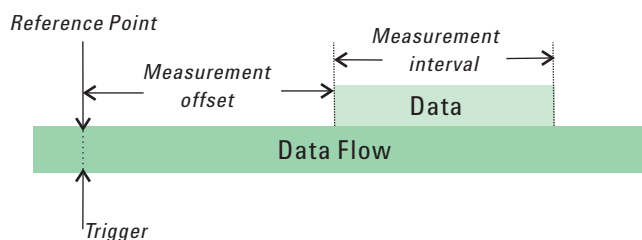
An analyzer performing vector signal analysis is not a real-time receiver but rather is a block-mode receiver. It captures a time record, and processes and displays the result before capturing the next block of data. Typically the processing and analysis time is longer than the capture time so there 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 3-7

Signal Capture and Measurement Interval Diagram



The parameters used in signal capture is shown in [Figure 3-7](#), 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 3-2](#).

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.

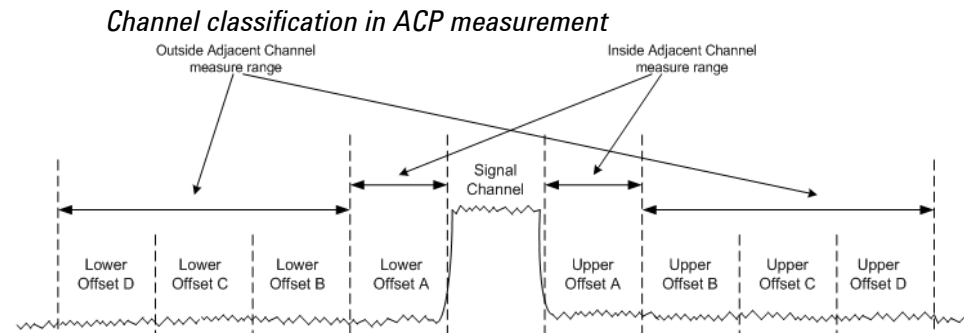
The default setting is IBW.

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

Figure 3-8



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.

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 3-3](#). [1]

Table 3-3 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.

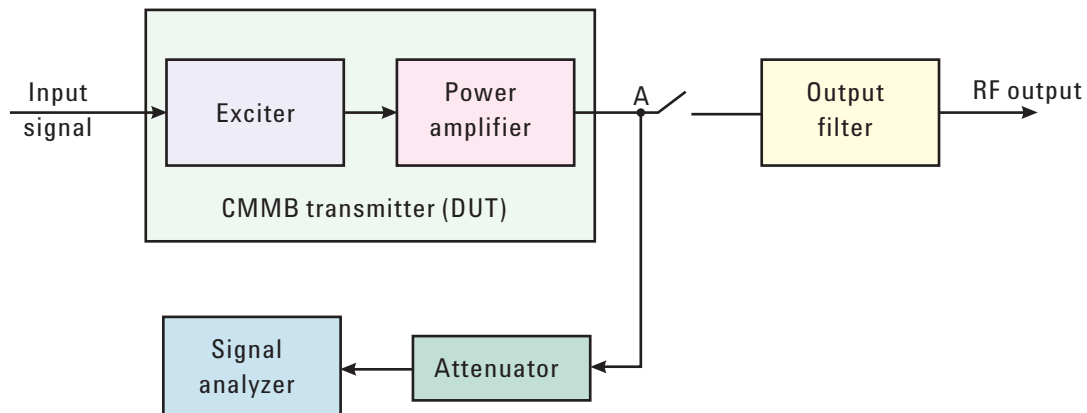
Using Amplitude Correction in Spectrum Emission Mask Measurement

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 3-9](#).

Figure 3-9 Diagram for the Spectrum Emission Mask Measurement on CMMB transmitter



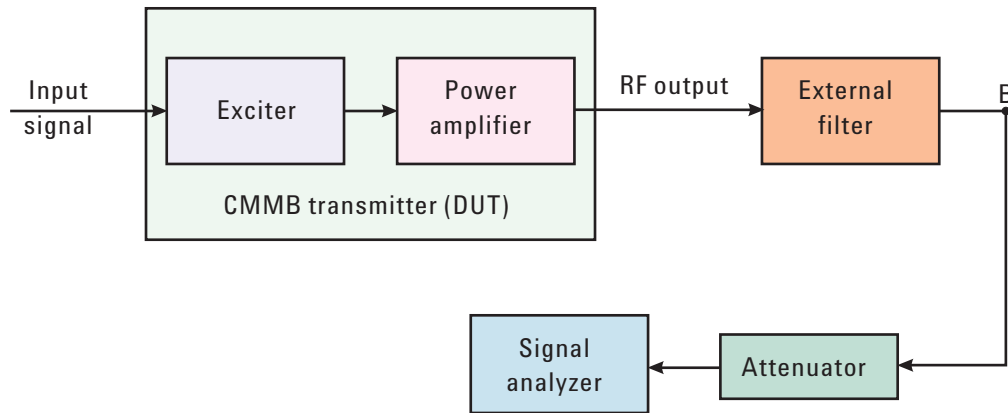
The steps for measuring the Spectrum Emission Mask are as follows:

- 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 3-9](#).
- 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 3-10](#).

Figure 3-10 *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 3-10](#).
- 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:

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

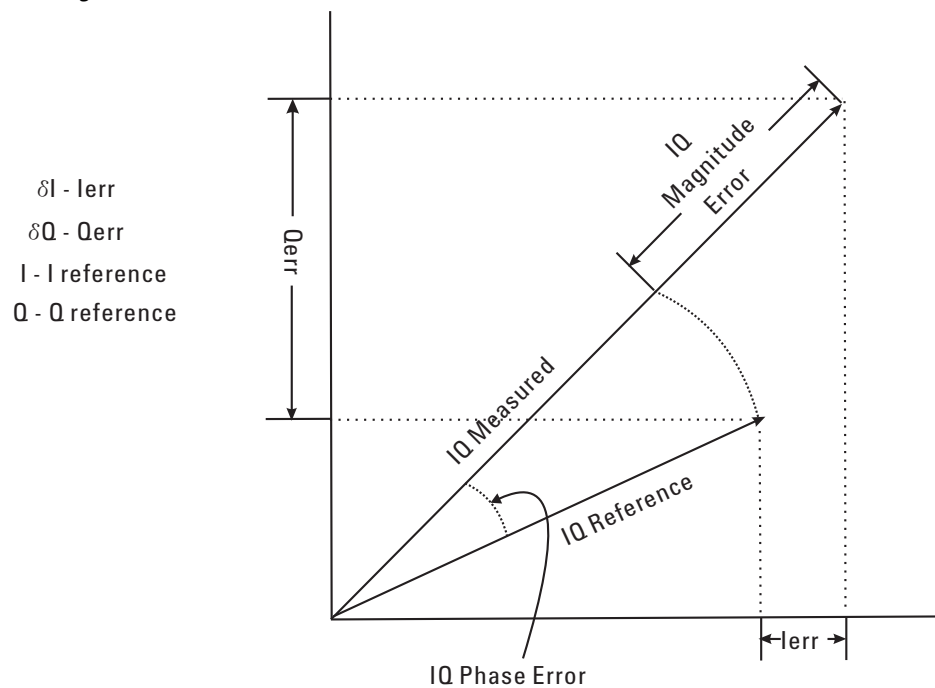
Where N is the number of data points in the measurement samples. S_{rms} is calculated

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 3-11](#).

Figure 3-11

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 3-11](#).

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 3-11](#).

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 3-11](#).

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.

Multi-path Channel Impulse Response

Peak table window is very helpful in identifying the amplitude and delay of each path when there is 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.

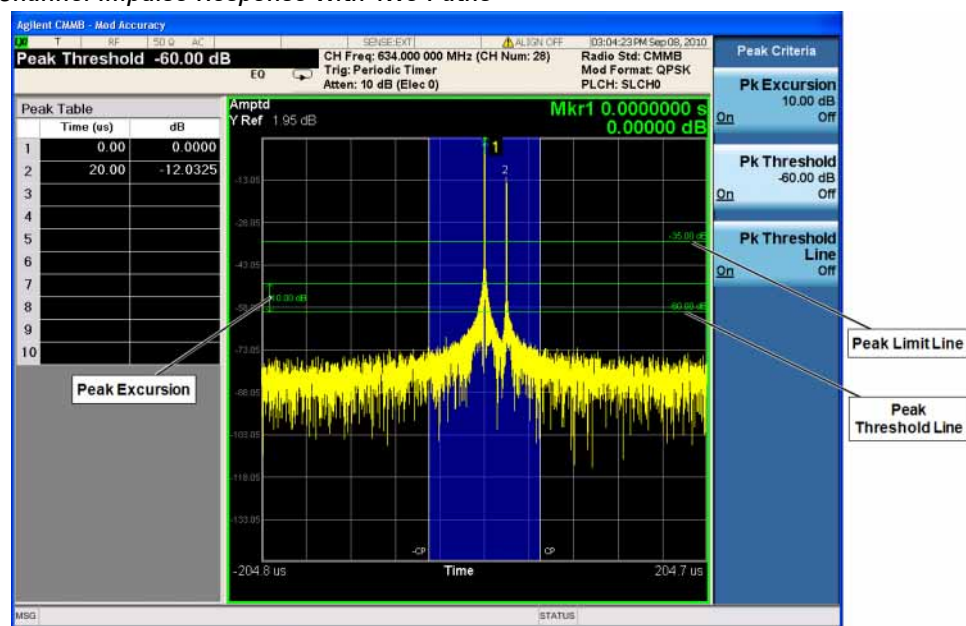
You can customize your peak table measurement using the following settings:

- Press **Peak Search, More 1 of 2, Peak 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 62.

The multi-path measurement results should look like [Figure 3-12](#), including peak threshold line, peak excursion, and peak limit line.

Figure 3-12

Channel Impulse Response with Two Paths



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.

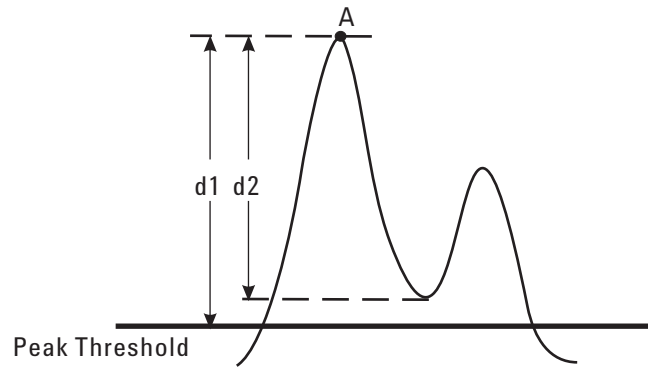
Peak (Pk) Excursion: This value determines the minimum amplitude variation (rise and fall) required for a signal to be identified as a peak.

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 3-13](#), 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 3-13

Peak Criteria



Using Triggers in CMMB Mod Accuracy Measurement

When making CMMB Mod Accuracy measurement, you need to set up triggers as introduced in “[Modulation Accuracy Measurements](#)” on page 27. This section focuses on the reason for using trigger in CMMB Mod Accuracy measurement.

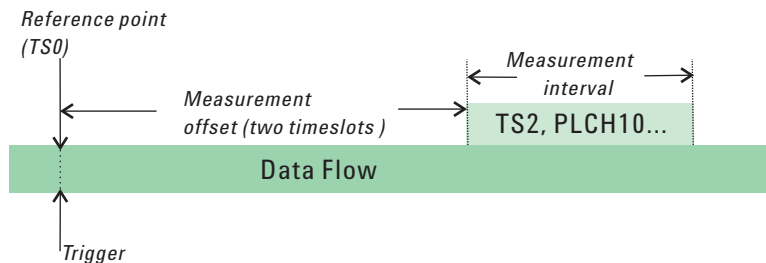
Different kinds of modulation schemes may coexist in a CMMB signal. To demod the signal, you need to:

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

Capturing the desired signal is the first step of the demodulation. As mentioned in “[Capturing Signals for Measurement](#)” on page 50, 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 3-14](#). Once the trigger occurs, the analysis starts. By adjusting the measurement offset, it is convenience to find and capture the desired signal.

Figure 3-14

Function of Trigger



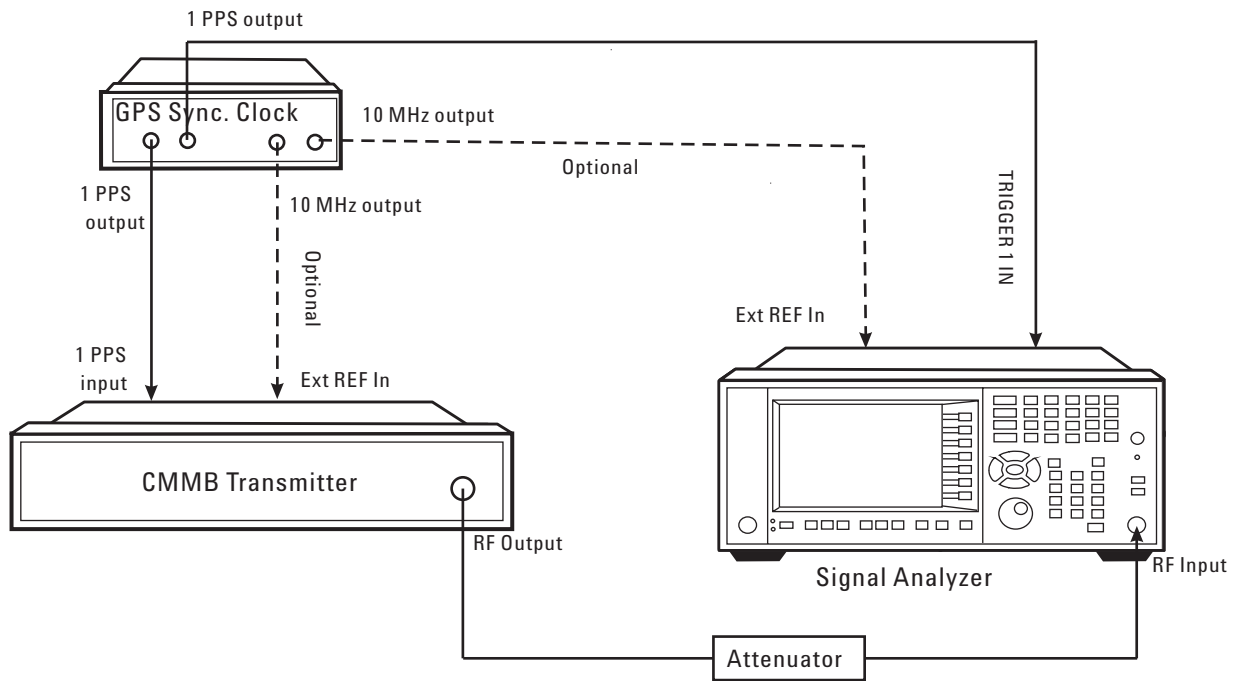
The trigger used in CMMB demodulation procedure is a periodic trigger with the period of 1s, the length of a CMMB frame. The trigger is set to occur at the start time of TS0 so that the measurement offset can be adjusted to capture any signal in a frame. And by decoding the control informations included 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 3-15](#).

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 3-15 Measurement System Using External Trigger



- Connect the output signal of the CMMB transmitter/exciter to the RF input port of the analyzer using appropriate cables, attenuators, and adapters.
- 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.
- (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 with T2
- CMMB
- ISDB-T
- Digital Cable TV

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 70.

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>

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