Keysight X-Series Signal Analyzers

This manual provides documentation for the following Analyzers:

PXA Signal Analyzer N9030A

MXA Signal Analyzer N9020A

EXA Signal Analyzer N9010A

CXA Signal Analyzer N9000A

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N9079A & W9079A TD-SCDMA with HSPA/8PSK Measurement Application Measurement Guide

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Table of Contents

1 Making TD-SCDMA with HSPA/8PSK Measurements

Setting Up and Making a Measurement 12
Making the Initial Signal Connection 12
Using Analyzer Mode and Measurement Presets 12
The 3 Steps to Set Up and Make Measurements 12
Transmit Power Measurements 14
Configuring the Measurement System 14
Setting the BTS (Example) 15
Measurement Procedure 15
Measurement Results 16
Troubleshooting Hints 19
ACP Measurements 20
Configuring the Measurement System 20
Setting the BTS (Example) 21
Measurement Procedure 21
Measurement Results 22
Power vs. Time Measurements 25
Configuring the Measurement System 25
Setting the BTS (Example) 26
Measurement Procedure 26
Measurement Results 28
Troubleshooting Hints 29
Spectrum Emission Mask Measurements 30
Configuring the Measurement System 30
Setting the BTS (Example) 31
Measurement Procedure 31
Measurement Results 32
Troubleshooting Hints 34

Spurious Emissions Measurement 35
Configuring the Measurement System 35
Setting the BTS (Example) 36
Measurement Procedure 36
Measurement Results 37
Troubleshooting Hints 38
Occupied Bandwidth Measurements 39
Configuring the Measurement System 39
Setting the BTS (Example) 39
Measurement Procedure 40
Measurement Results 41
Troubleshooting Hints 42
Power Statistics CCDF Measurements 43
Configuring the Measurement System 43
Setting the BTS (Example) 44
Measurement Procedure 45
Measurement Results 45
Troubleshooting Hints 46
Modulation Accuracy (Composite EVM) Measurements 47
Configuring the Measurement System 47
Setting the BTS (Example) 48
Measurement Procedure 49
Measurement Results 49
Troubleshooting Hints 51
Code Domain Measurements 53
Configuring the Measurement System 53
Setting the BTS (Example) 54
Measurement Procedure 55
Results 56
Troubleshooting Hints 60
IQ Waveform (Time Domain) Measurements 61
Configuring the Measurement System 61

Setting the BTS (Example) 62
Measurement Procedure 63
Measurement Results 64
Monitor Spectrum Measurements 65
Configuring the Measurement System 65
Setting the BTS (Example) 66
Measurement Procedure 66
Measurement Results 67

2 Using Option BBA Baseband I/Q Inputs

Baseband I/Q Measurements Available for X-Series Signal Analyzers 70
Baseband I/Q Measurement Overview 72

3 Concepts

TD-SCDMA Concepts 76
What is TD-SCDMA? 76
TD-SCDMA Slots, Frames, and Power Control 76
HSDPA Concepts 80
What is HSDPA? 80
Modulation Scheme Detection 80
Why Test HSPDPA User Equipment? 80
Transmit Power Measurement Concepts 82
Purpose 82
Measurement Method 82
Power vs. Time Measurement Concepts 85
Purpose 85
Measurement Method 85
Adjacent Channel Power (ACP) Measurement Concepts 88
Purpose 88
Measurement Method 88
Multi-carrier Power Measurement 88
Spectrum Emissions Mask (SEM) Measurement Concepts 91

Purpose 91
Measurement Method 91
Spurious Emissions Measurement Concepts 92
Purpose 92
Measurement Method 92
Occupied Bandwidth (OBW) Measurement Concepts 94
Purpose 94
Making the Measurement 94
Modulation Quality Measurements 95
Error Vector Magnitude (EVM) 95
Phase and Frequency Errors 95
Rho 96
Impairments 96
Code Domain Measurement Concepts 101
What is the Code Domain? 101
Purpose 101
Measurement Method 104
Modulation Accuracy (Composite EVM) 105
Purpose 105
Measurement Method 107
Spectrum (Frequency Domain) Measurement Concepts 110
Purpose 110
Measurement Method 110
Troubleshooting Hints 110
Waveform (Time Domain) Measurement Concepts 111
Purpose 111
Measurement Method 111
Baseband I/Q Inputs (Option BBA) Measurement Concepts 113
What are Baseband I/Q Inputs? 113
What are Baseband I/Q Signals? 114
Why Make Measurements at Baseband? 114
Selecting Input Probes for Baseband Measurements 115

Baseband I/Q Measurement Views 116

Contents

1 Making TD-SCDMA with HSPA/8PSK Measurements

This chapter begins with instructions common to all measurements, then details all the measurements available by pressing the **Meas** key when the **TD-SCDMA with HSPA/8PSK** mode is selected.

NOTE

If you only install Option N9079-1FP, press **TD-SCDMA** to select the TD-SCDMA mode.

If you install both Option N9079-1FP and Option N9079-2FP, press **TD-SCDMA with HSPA/8PSK** to select the TD-SCDMA mode.

For information specific to individual measurements, see the sections at the page numbers below.

- "Transmit Power Measurements" on page 14
- "ACP Measurements" on page 20
- "Power vs. Time Measurements" on page 25
- "Spectrum Emission Mask Measurements" on page 30
- "Spurious Emissions Measurement" on page 35
- "Occupied Bandwidth Measurements" on page 39
- "Power Statistics CCDF Measurements" on page 43
- "Modulation Accuracy (Composite EVM) Measurements" on page 47
- "Code Domain Measurements" on page 53
- "IQ Waveform (Time Domain) Measurements" on page 61
- "Monitor Spectrum Measurements" on page 65

Setting Up and Making a Measurement

Making the Initial Signal Connection

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

See the Input Key menu for details on selecting input ports and the AMPTD Y Scale menu for details on setting internal attenuation to prevent overloading the analyzer.

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 by returning the mode setup and all of the measurement setups in the 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

All measurements can be set up using the following three steps. The sequence starts at the Mode level, is followed by the Measurement level, then finally, the result displays may be adjusted.

Table 1-1 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, W-CDMA with HSDPA/HSUPA**, or **GSM/EDGE**. 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 will apply to all measurements in the mode.

Table 1-1 The 3 Steps to Set Up and Make a Measurement

Step	Action	Notes
2 Select and Set Up the Measurement	a. Press **Meas.** b. Select the specific measurement to be performed. c. Press **Meas Setup**	The measurement begins as soon as any required trigger conditions are met. 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**. Select a display format for the current measurement data.	Depending on the mode and measurement selected, other graphical and tabular data presentations may be available. **X-Scale** and **Y-Scale** adjustments may also be made now.

NOTE A setting may be reset at any time, and will be in effect on the next measurement cycle or view.

Table 1-2 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**	**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**

Transmit Power Measurements

This section explains how to make a Transmit Power measurement on a TD-SCDMA base transceiver station (BTS), a mobile station (MS), a repeater or a power amplifier (PA). This test measures the average RF power present in the channel.

There are three methods to determine the power level:

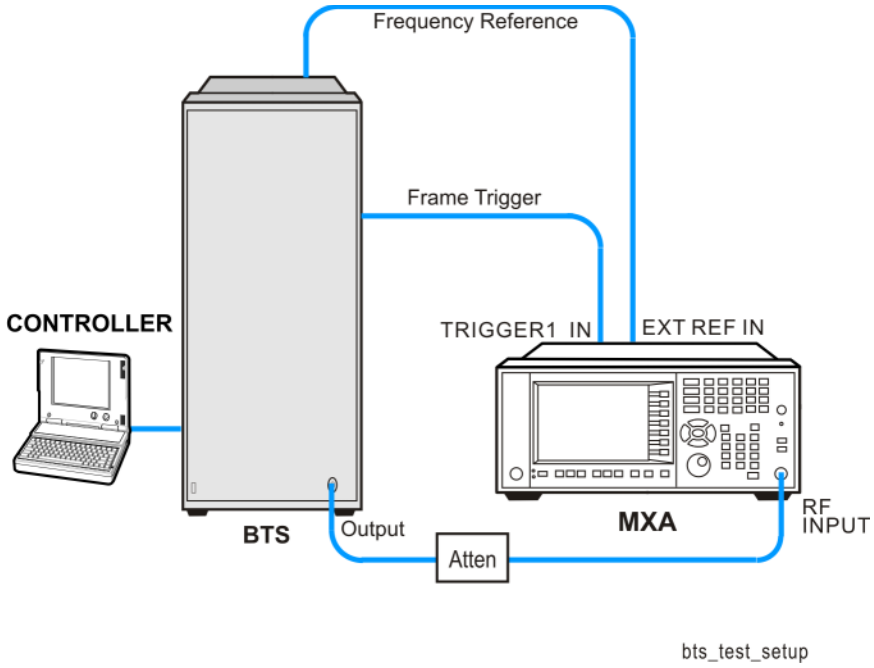
- At or above a specified threshold value;
- Within the detected burst width;
- Captured in single timeslot.

The results are shown in a graph window and in a text window.

Configuring the Measurement System

The BTS under test have to be set to transmit the RF power remotely through the system controller. This transmitting signal is connected to the analyzer RF input port. Connect the equipment as shown.

Figure 1-1 *Transmit Power Measurement System*



1. Using the appropriate cables, attenuator and adapters, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect a BNC cable between the frequency reference port of the BTS and the EXT REF IN port of the analyzer.
3. Connect the Trigger Out from the BTS to the TRIGGER1 IN port of the analyzer.

4. Connect the system controller to the BTS through the serial bus cable to control the BTS operation.

Setting the BTS (Example)

From the BTS and the system controller, set up a call using loopback mode for the BTS to transmit the RF power as follows:

Frequency: 2.0 GHz

Output Power: –20 dBm

Carrier Number: 1

Switching Point: 3

Scramble Code: 0

Table 1-3 Timeslot Setup

Timeslot	State
0	On
1	On
2	On
3	On
4	Off
5	Off
6	Off
DwPTS	On
UpPTS	Off

Measurement Procedure

Step 1. Press **Mode**, **TD-SCDMA with HSPA/8PSK** to enable the TD-SCDMA mode measurements.

Step 2. Press **Mode Preset** to preset the analyzer.

Step 3. Press **Input/Output**, **External Gain**, **BTS** and enter the number and **–dB** according to the external attenuator connected to the analyzer.

Step 4. Press **Mode Setup, Radio, Device to toggle the device to BTS**.

Step 5. Press **Mode Setup, Analysis TimeSlot, TS0 to select the timeslot to be analyzed**.

Step 6. Press **Meas**, **Transmit Power** to initiate the Transmit Power measurement.

Step 7. Press **FREQ Channel**, **2**, **GHz** to set the center frequency to 2 GHz.

Step 8. Press **Trigger** and select the appropriate trigger source according to the external trigger connection **External 1**.

If no measurement is performed and only a symbol of yellow '*' displays on the top right of the screen, you need to check the trigger settings. You need the correct trigger signal to make the Transmit Power measurement.

Step 9. Press **Meas Setup** to check the keys available to change the measurement parameters from the default condition.

To change the algorithm to measure the power, press **Meas Method** and select the desired method from the listed three method: **Above Threshold Lvl**, **Measured Burst Width**, or **Single Time Slot**.

NOTE When you select **Above Threshold Lvl**, the **Burst Width** key will be grayed out.

When you select **Single Time Slot**, the **Threshold Lvl** key and the **Burst Width** key will be grayed out.

You can adjust the parameters for the selected method as follows:

- To set a relative threshold level for the measurement, press **Threshold Lvl** to toggle the state to **Rel** and enter the desired value.
- To set a burst width for the measurement, press **Burst Width** to toggle the state to **Man** and enter the desired value.

  When you press **Mode Setup**, **Radio** and toggle the **Device** key to **MS**, the Meas Method will automatically switch to **Burst Width**.
- To capture multiple bursts, press **More** and **Meas Interval** and enter the desired value to extend the measurement period (default setting is 1 slot).

NOTE When the analyzer can not find a valid burst width, it's recommended to extend the **Meas Interval** and increase the **Threshold Lvl** until a valid result is displayed.

For more details about changing measurement parameters, see *N9079A TD-SCDMA with HSPA/8PSK User's and Programmer's Reference*.

If you have a problem, and get an error message, see the "*Instrument Messages Guide*".

Measurement Results

Figure 1-2 shows the Transmit Power in single timeslot.

The Output Power is displayed on the left of the text window and on the right under the heading Current Data Output Pwr. If averaging is turned off, the two values will be the same. When you turn averaging on, the left Output Power is an averaged value of “n” times measurements, while the current data Output Pwr indicates the result of the last measurement.

Figure 1-2 *Transmit Power - Single Timeslot*

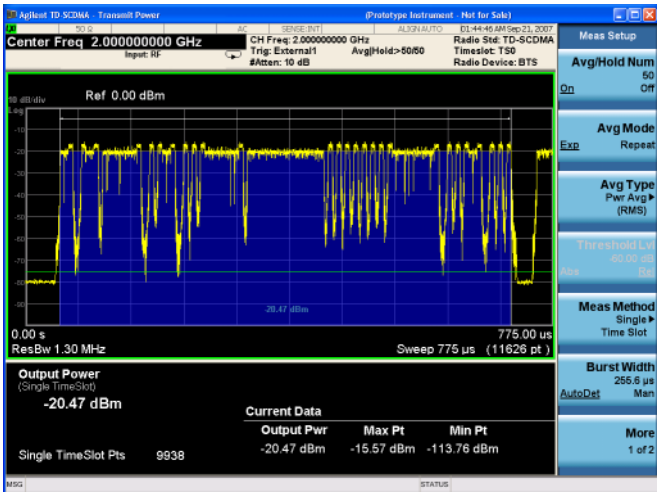


Figure 1-3 shows the Transmit Power measured by burst width.

Full Burst Width and Measured Width (Burst Width) are displayed in the text window, as well as the Threshold levels used to calculate the burst center. When the default Burst Width is inappropriate to perform a measurement, it's recommended to increase the Meas Interval and Threshold Lvl or to manually enter the desired Burst Width value.

Figure 1-3 *Transmit Power - Measured Burst Width*

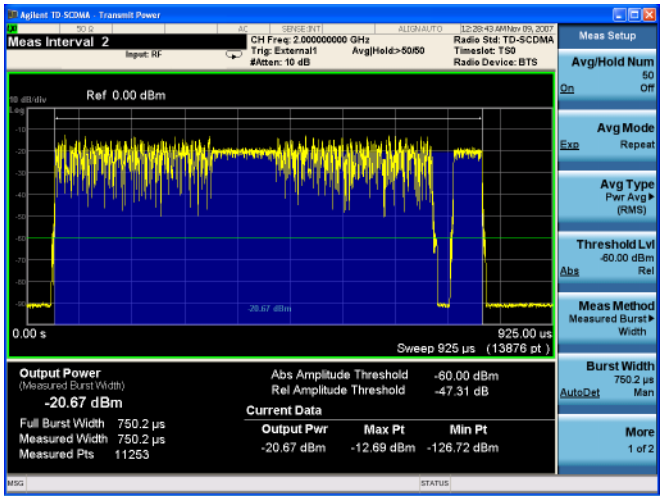
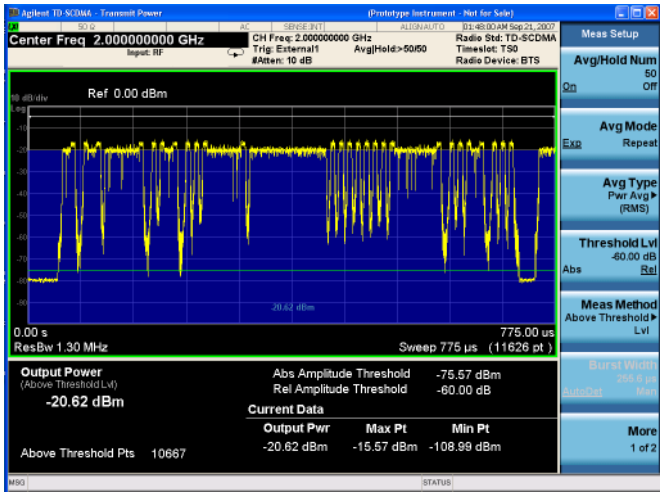


Figure 1-4 shows the Transmit Power above threshold level.

Absolute Amplitude Threshold and Relative Amplitude Threshold are displayed. The relative threshold is defined as relative to the peak power.

Figure 1-4 *Transmit Power - Above Threshold Lvl*



Troubleshooting Hints

Low output power can lead to poor coverage and intermittent service for phone users. Out of specification power measurements indicate a fault usually in the power amplifier circuitry. They can also provide early indication of a fault with the power supply, for example the battery in the case of mobile stations.

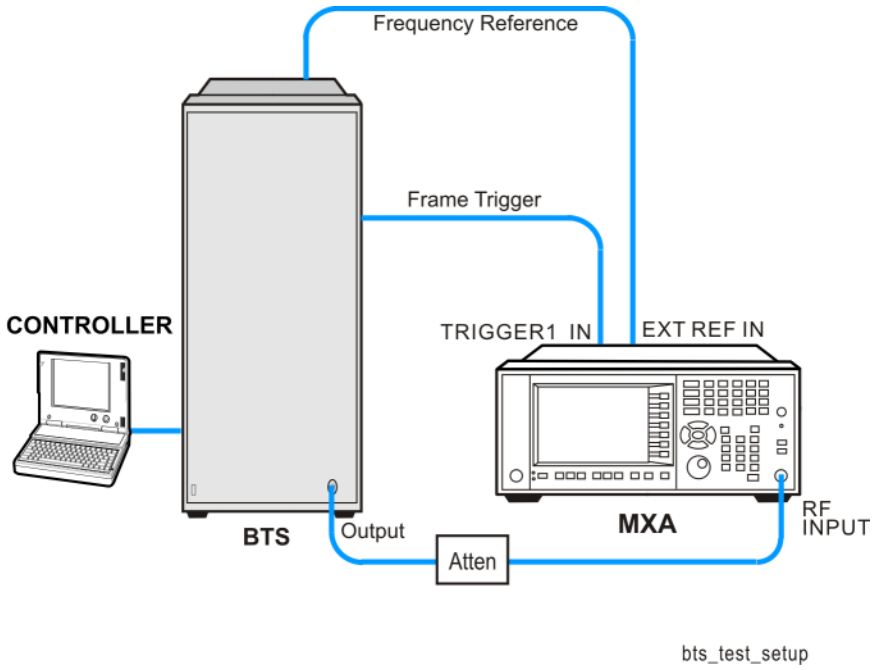
ACP Measurements

This chapter explains how to make the Adjacent Channel Power (ACP) measurement on a TD-SCDMA base transceiver station (BTS), a mobile station (MS), a TD-SCDMA repeater or a power amplifier (PA). ACP is a measurement of the amount of interference, or power, in an adjacent frequency channel. The results are shown as a bar graph or as spectrum data, with measurement data at specified offsets. A Pass or Fail indication is shown in the Measurement Bar.

Configuring the Measurement System

The BTS under test must be set to transmit the RF power remotely through the system controller. This transmitting signal is connected to the RF input port of the analyzer. Connect the equipment as shown.

Figure 1-5 Adjacent Channel Power Measurement System



1. Using the appropriate cables, attenuator and adapters, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect a BNC cable between the frequency reference port of the BTS and the EXT REF IN port of the analyzer.
3. Using a BNC cable, connect the trigger signal from the BTS to the TRIGGER1 IN port of the analyzer.
4. Connect the system controller to the BTS through the serial bus cable to control the BTS operation.

Setting the BTS (Example)

From the BTS and the system controller, set up a call using loopback mode for the BTS to transmit the RF power as follows:

Frequency: 2.0 GHz

Output Power: –20 dBm

Carrier Number: 1

Switching Point: 3

Scramble Code: 0

Table 1-4 Timeslot Setup

Timeslot	State
0	On
1	On
2	On
3	On
4	Off
5	Off
6	Off
DwPTS	On
UpPTS	Off

Measurement Procedure

Step 1. Press **Mode**, **TD-SCDMA with HSPA/8PSK** to enable the TD-SCDMA mode measurements.

Step 2. Press **Mode Preset** to preset the analyzer.

Step 3. Press **Input/Output**, **External Gain**, **BTS** and enter the number and **–dB** according to the external attenuator connected to the analyzer.

Step 4. Press **Mode Setup, Radio, Device to toggle the device to BTS**.

Step 5. Press **Meas**, **ACP** to initiate the Adjacent Channel Power measurement.

Step 6. Press **Sweep/Control**, **Gate** and toggle the **Gate** to **On**. Press **More**, **Gate Source** and select the desired gate source **External 1**.

If no measurement is performed and only a symbol of yellow '*' displays on the top right of the screen, you need to check the gate settings. You need the correct gate signal to make the ACP measurement.

Step 7. Press **FREQ Channel**, **2**, **GHz** to set the center frequency to 2 GHz.

Or, you can also manually set the reference frequency by pressing **Meas Setup**, **Carrier Setup**, **Ref Carrier** and enter the carrier number to be referenced, and pressing **Ref Car Freq** and enter the carrier frequency.

NOTE When the number of carriers (**Carriers**) is set to 1, the **Ref Carrier** is automatically grayed out and set to 1.

Step 8. Press **Meas Setup** to check the keys available to change the measurement parameters from the default condition.

- Press **Carrier Setup**, **Carriers** and enter the number of carriers.
- Press **Config Carriers** to adjust the parameter settings for each carrier, or to couple other carriers to Carrier 1 when **Carriers** is set to greater than 1.

NOTE If Option N9060A-5FP is installed, the max number of carriers is set to 18. Otherwise, the max number of carriers is set to 12.

Step 9. Press **Meas Setup**, **Carrier Result** and enter the carrier number to display and highlight the desired carrier power result in the text window.

NOTE When Carriers is set to 1, the **Carrier Result** is grayed out.

Step 10. Press **Offset/Limits** to adjust the adjacent channel offset and test limits parameters.

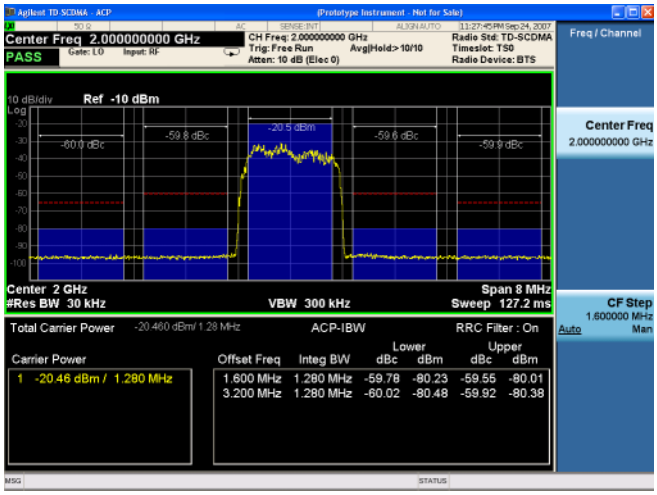
For more information about changing measurement parameters, see *N9079A TD-SCDMA with HSPA/8PSK User's and Programmer's Reference*.

If you have a problem, and get an error message, see the "*Instrument Messages Guide*".

Measurement Results

Press **View/Display**, and toggle the **Bar Graph** key to **On** to see the bar graph with the spectrum trace graph overlay. The text window shows the absolute total power reference, while the lower and upper offset channel power levels are displayed in both absolute and relative readings. See Figure 1-6.

Figure 1-6 *ACP - Bar Graph View (Default)*



Press **View/Display**, and toggle the **Bar Graph** key to **Off** to see the spectrum trace graph. The spectrum graph measurement result should look similar to Figure 1-7. The graph (referenced to the total power) and a text window are displayed. The corresponding measured data is also shown in the text window.

Figure 1-7 *ACP - Bar Graph Off*

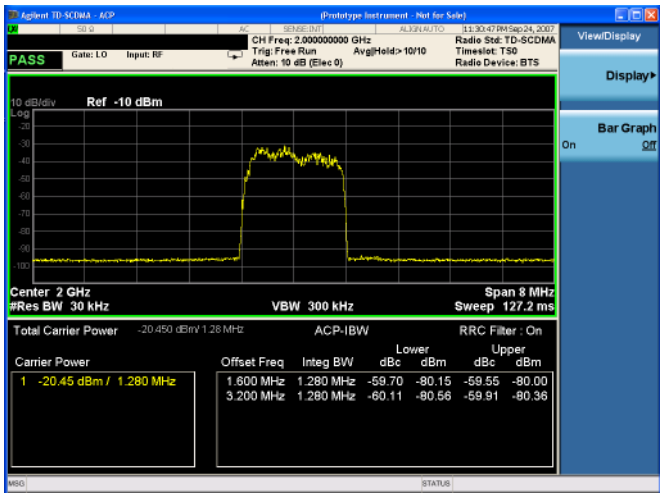
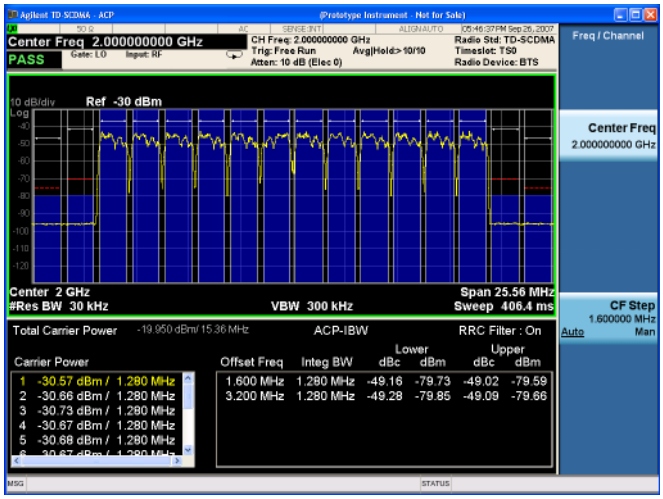


Figure 1-8 shows a ACP measurement example with 12 carriers.

Figure 1-8 ACP - Multiple Carriers



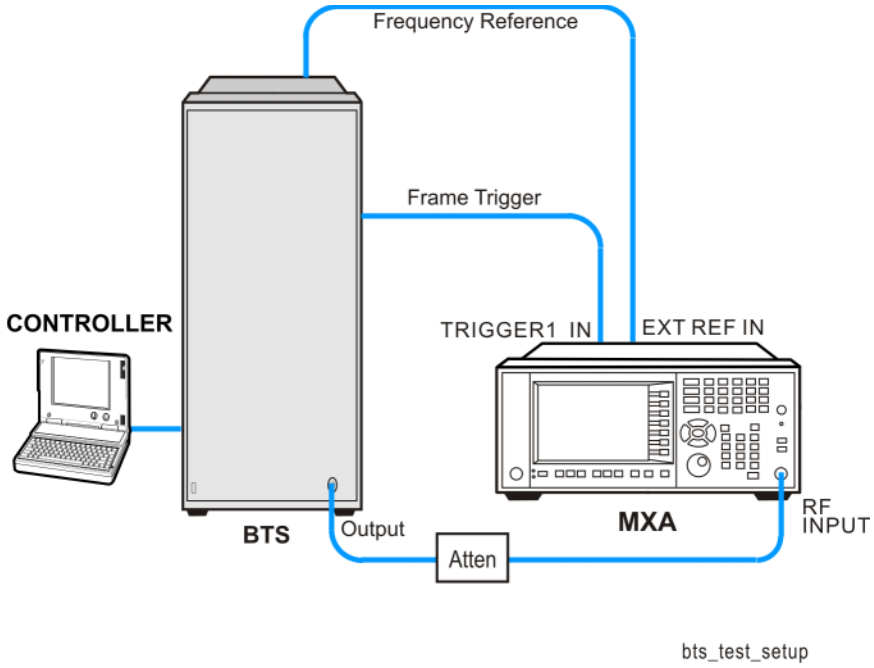
Power vs. Time Measurements

This section explains how to make a TD-SCDMA Power vs Time (PvT) measurement on a TD-SCDMA base transceiver station (BTS), a TD-SCDMA repeater or a power amplifier (PA). Good PvT measurement results verify that the transmitter output power has the correct amplitude, shape, and timing for the TD-SCDMA format. A Pass or Fail indication is shown in the Measurement Bar.

Configuring the Measurement System

This example shows a BTS under test set up to transmit RF power, and being controlled remotely by a system controller. The transmitting signal is connected to the analyzer RF input port. Connect the equipment as shown.

Figure 1-9 *Pwr vs Time Measurement System*



1. Using the appropriate cables, adapters, and attenuator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect a BNC cable between the frequency reference port of the BTS and the EXT REF IN port of the analyzer.
3. Using a BNC cable, connect the trigger signal from the BTS to the TRIGGER1 IN port of the analyzer.
4. Connect the system controller to the BTS through the serial bus cable to control the BTS operation.

Setting the BTS (Example)

From the base transmission station simulator and the system controller, set up a call using loopback mode for the BTS to transmit the RF power as follows:

Frequency: 2.0 GHz

Output Power: –20 dBm

Carrier Number: 1

Switching Point: 3

Scramble Code: 0

Table 1-5 Timeslot Setup

Timeslot	State
0	On
1	On
2	On
3	On
4	Off
5	Off
6	Off
DwPTS	On
UpPTS	Off

Measurement Procedure

Step 1. Press **Mode**, **TD-SCDMA with HSPA/8PSK** to enable the TD-SCDMA with HSPA/8PSK mode measurements.

Step 2. Press **Mode Preset** to preset the analyzer.

Step 3. Press **Input/Output**, **External Gain**, **BTS** and enter the number and **–dB** according to the external attenuator connected to the analyzer.

Step 4. Press **Mode Setup**, **Radio**, **Device** to toggle the device to **BTS**.

Step 5. Press **Trigger** to select the appropriate trigger source **External 1**.

If no measurement is performed and only a symbol of yellow '*' displays on the top right of the screen, you need to check the trigger settings. You need the correct trigger signal to make the Power vs Time measurement.

Step 6. Press **FREQ Channel**, **2**, **GHz** to set the center frequency to 2 GHz.

Step 7. Press **Meas**, **Power vs Time** to initiate the Power vs Time measurement.

Step 8. Press **Restart** or **Single** to perform the measurement once.

NOTE Power vs Time measurement is set in the Single sweep mode. Because of the switching of the Preamp state from On to Off, performing Power vs Time measurements in the Continuous sweep mode is not recommended.

After you change the parameters, press **Restart** or **Single** to perform the measurement again.

Step 9. Press **Meas Setup** to check the keys available to change the measurement parameters from the default condition.

- To extend the number of timeslots to be measured, press **Meas Interval** and enter the number of timeslots. DwPTS or UpPTS will be counted as a separate timeslot. The start timeslots is determined by **Analysis Timeslot**.
- To make an averaged measurement, press **Avg/Hold Num** to toggle the state to **On** and enter the number of averages. Each single measurement will perform the averages twice.
- To select the averaging algorithm, toggle the **Avg Mode** key between **Exp** and **Repeat**. A Repeat averaged measurement is faster than an Exponential averaged measurement.
- Press **IF Gain**, **Low Gain** to measure large signals. Option **High Gain** allows better noise level measurements.

  You can also set the IF Gain to **Auto** which selects **High Gain** under any of the following Auto Rules:

  — The input attenuator is set to 0 dB.

  — The Preamp is turned on.

  — The Max Mixer Level is 20 dBm or lower.

Step 10. To better investigate the measurement display, set **Meas Interval** to **9** and zoom the window by pressing **SPAN X Scale**, **Ref Value**, **100**, **ms**, **Scale/Div**, **5**, **ms** and press **Restart** or **Single** to perform the measurement once.

Pressing **View/Display**, you can turn on any of the following lines: **Trigger Line** (white), **Burst Line** (red), **Ramp Line** (blue), and **Limit Mask** (green).

NOTE Set **Meas Interval** to a number big enough to display a complete burst. Otherwise the Burst Line can not be displayed.

For more details about changing measurement parameters, see *N9079A TD-SCDMA with HSPA/8PSK User's and Programmer's Reference*.

If you have a problem, and get an error message, see the "**Error Messages Guide**".

Measurement Results

Figure 1-10 shows the Power vs Time in single timeslot.

The Mean Power is displayed on the left of the text window. If Meas Interval is set to 2 or above, Burst Width will be displayed on the right and the Avg Pwr and Slot Width of the each active timeslot are shown in the box below. See Figure 1-11.

Figure 1-10 *Power vs Time - Single-Slot View (Default)*

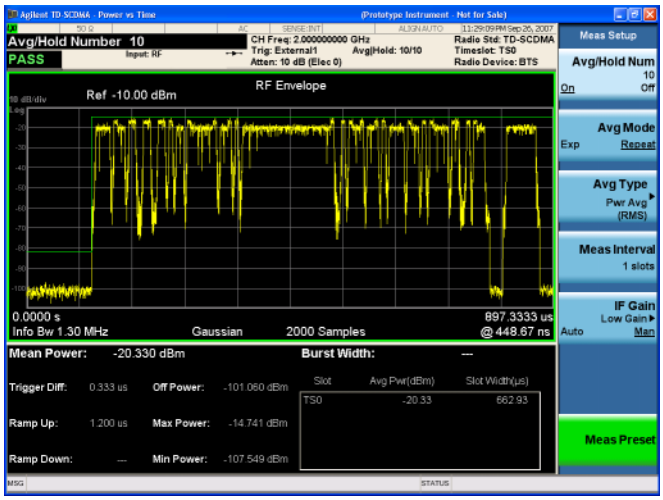


Figure 1-11 *Power vs Time - Multi-Slot View (Meas Interval = 9)*

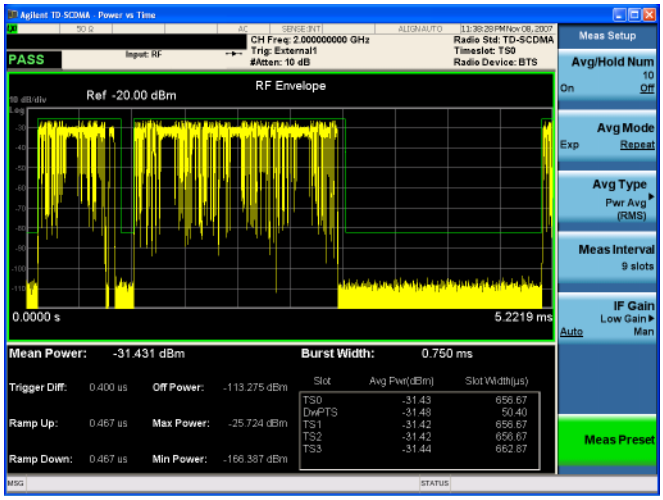
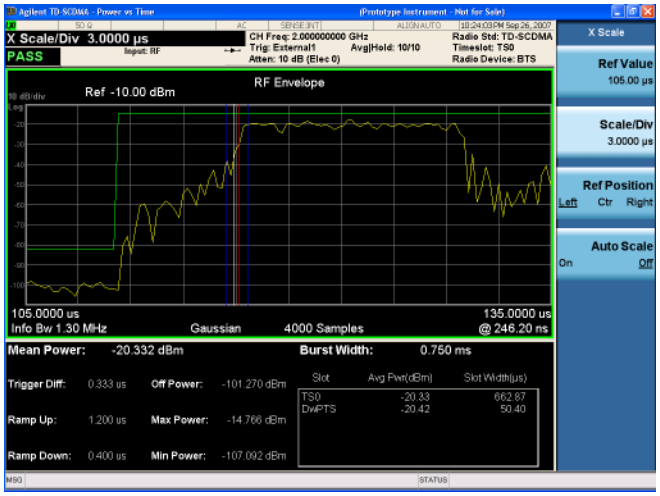


Figure 1-10 shows the Power vs Time zoomed in window.

Figure 1-12 Power vs. Time - Zoom in (Ref Value = 105µs, Scale/Div = 3µs)



Troubleshooting Hints

If a transmitter fails the Power vs. Time measurement this usually indicates a problem with the units output amplifier or leveling loop.

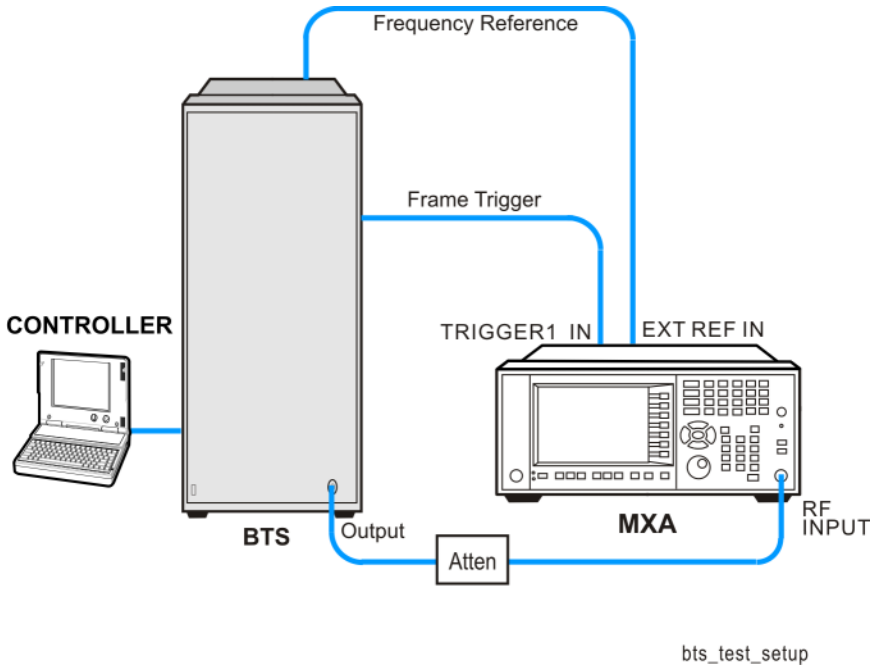
Spectrum Emission Mask Measurements

This chapter explains how to make the spectrum emission mask (SEM) measurement on a TD-SCDMA base transceiver station (BTS), a TD-SCDMA repeater or a power amplifier (PA). SEM compares the total power level within the defined carrier bandwidth and the given offset channels on both sides of the carrier frequency, to levels allowed by the standard. Results of the measurement of each offset segment can be viewed separately. A Pass or Fail indication is shown in the Measurement Bar.

Configuring the Measurement System

The BTS under test must be set to transmit the RF power remotely through the system controller. This transmitting signal is connected to the RF input port of the instrument. Connect the equipment as shown.

Figure 1-13 Spectrum Emission Mask Measurement System



1. Using the appropriate cables, adapters, and attenuator, connect the output signal from the BTS to the RF input port of the analyzer.
2. Connect a BNC cable between the frequency reference port of the BTS and the EXT REF IN port of the analyzer.
3. Using a BNC cable, connect the trigger signal from the BTS to the TRIGGER1 IN port of the analyzer.
4. Connect the system controller to the MS through the serial bus cable to control the BTS operation.

Setting the BTS (Example)

From the base transmission station simulator and the system controller, set up a call using loopback mode for the BTS to transmit the RF power as follows:

Frequency: 2.0 GHz

Output Power: –20 dBm

Carrier Number: 1

Switching Point: 3

Scramble Code: 0

Table 1-6 Timeslot Setup

Timeslot	State
0	On
1	On
2	On
3	On
4	Off
5	Off
6	Off
DwPTS	On
UpPTS	Off

Measurement Procedure

Step 1. Press **Mode**, **TD-SCDMA with HSPA/8PSK** to enable the TD-SCDMA with HSPA/8PSK mode measurements.

Step 2. Press **Mode Preset** to preset the analyzer.

Step 3. Press **Input/Output**, **External Gain**, **BTS** and enter the number and **–dB** according to the external attenuator connected to the analyzer.

Step 4. Press **Mode Setup**, **Radio**, **Device** to toggle the device to **BTS**.

Step 5. Press **Mode Setup**, **Analysis Timeslot** to select the timeslot to be measured.

Step 6. Press **Sweep/Control**, **Gate** and toggle the **Gate** to **On**. Press **More**, **Gate Source** and select the desired gate source **External 1**.

If no measurement is performed and only a symbol of yellow '*' displays on the top right of the screen, you need to check the gate settings. You need the correct gate signal to make the SEM measurement.

Step 7. Press **FREQ Channel**, **2**, **GHz** to set the center frequency to 2 GHz.

Step 8. Press **Meas**, **Spectrum Emission Mask** to initiate the Spectrum Emission Mask measurement.

Step 9. Press **Meas Setup** to check the keys available to change the measurement parameters from the default condition.

To make an averaged measurement, press **Avg/Hold Num** to toggle the state to **On** and enter the number of averages.

To select the power reference, press **Meas Type** key to select from **Total Power Ref, PSD Ref** and **Spectrum Pk Ref**.

To adjust the offset parameters, toggle the **Limit State** key to **Manual** and press **Offset/Limits** to change the offset parameters and limit lines.

Step 10. Press **View/Display** and select the desired view from **Abs Pwr Freq**, **Rel Pwr Freq** and **Integrated Power**. You can also turn on or turn off the limit lines by toggle the **LimitLines** between **On** and **Off**.

For more details about changing measurement parameters, see *N9079A TD-SCDMA with HSPA/8PSK User's and Programmer's Reference*.

If you have a problem, and get an error message, see the "*Instrument Messages Guide*".

Measurement Results

The Spectrum Emission Mask measurement result should look similar to Figure 1-14. The text window shows the reference total power and the absolute peak power levels and margins from limit lines which correspond to the frequency bands on both sides of the reference channel.

Figure 1-14 *SEM - Total Power Ref, Abs Pwr Freq view*

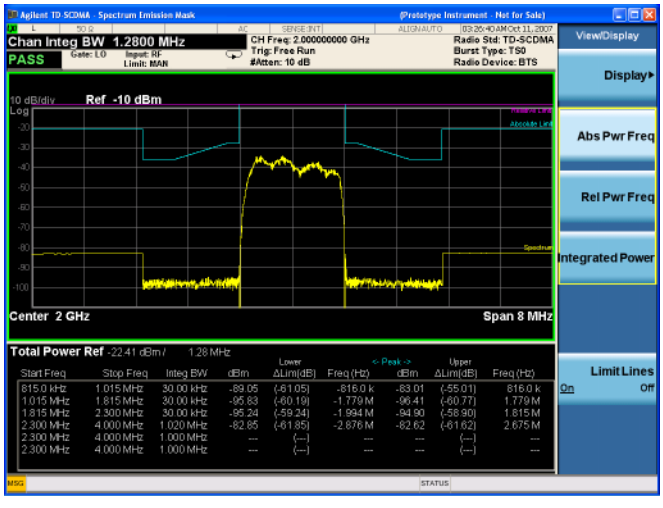


Figure 1-15 shows the Spectrum Peak reference and the relative peak power levels and margins from limit lines which correspond to the frequency bands on both sides of the reference channel

Figure 1-15 *SEM - Spec Peak Ref, Rel Pwr Freq view*

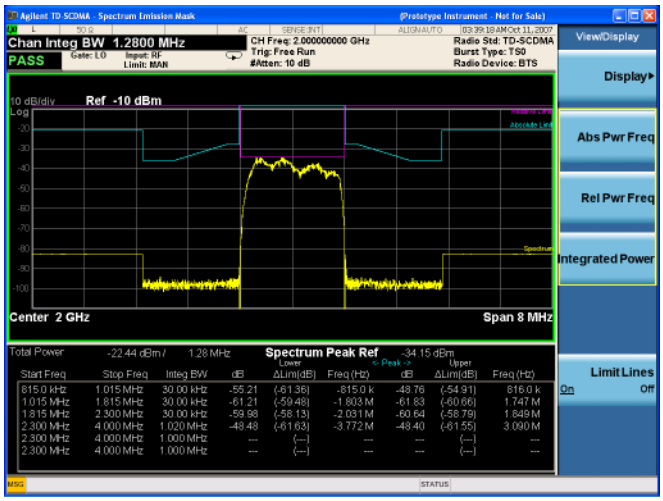
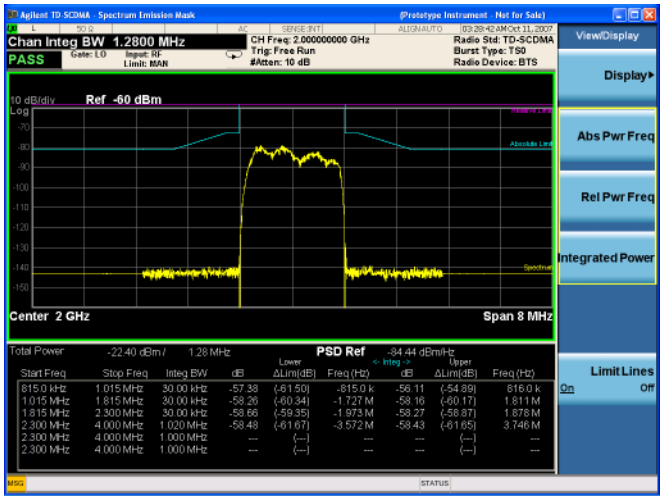


Figure 1-16 shows the reference PSD and the integrated power levels and margins from limit lines which correspond to the frequency bands on both sides of the reference channel

Figure 1-16 *SEM - PSD Ref, Integrated Power view*



Troubleshooting Hints

This spectrum emission mask measurement can reveal degraded or defective parts in the transmitter section of the unit under test. The following examples are those areas to be checked further.

- 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.
- Some degradation in the gain and output power level of the amplifier due to the degraded gain control or increased distortion, or both.
- Some degradation of the amplifier linearity or other performance characteristics.

Power amplifiers are one of the final stage elements of a base or mobile 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 wide band signal, it is a key measurement linking amplifier linearity and other performance characteristics to the stringent system specifications.

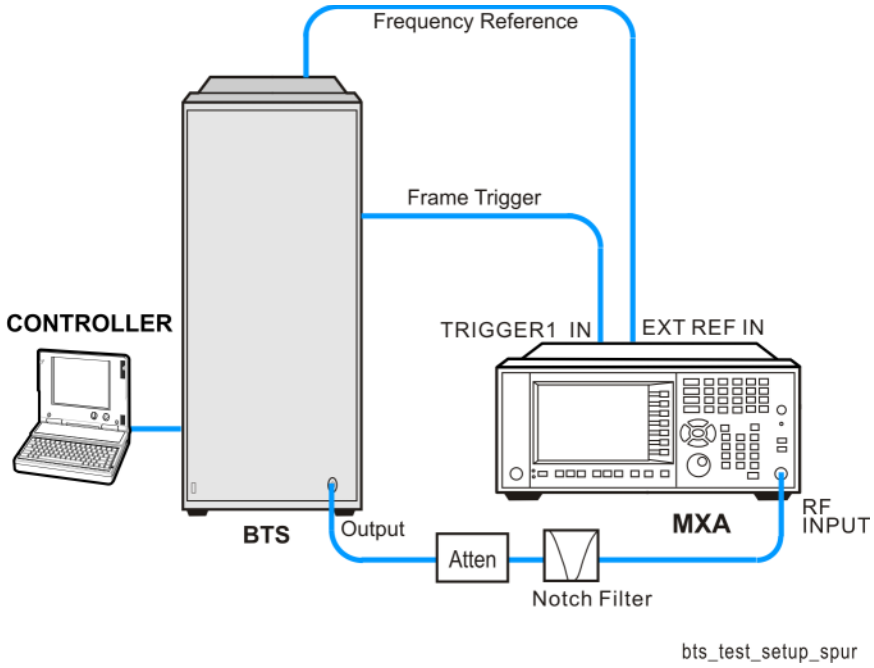
Spurious Emissions Measurement

This section explains how to make the spurious emission measurement on a TD-SCDMA base transceiver station (BTS), a TD-SCDMA repeater or a power amplifier (PA). This measurement identifies and determines the power level of spurious emissions in certain frequency bands. A Pass or Fail indication is shown in the Measurement Bar.

Configuring the Measurement System

The BTS under test must be set to transmit the RF power remotely through the system controller. This transmitting signal is connected to the RF input port of the instrument. Connect the equipment as shown.

Figure 1-17 *Spurious Emission Measurement System*



1. Using the appropriate cables, adapters, notch filter and attenuator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect a BNC cable between the frequency reference port of the BTS and the EXT REF IN port of the analyzer.
3. Using a BNC cable, connect the trigger signal from the BTS to the TRIGGER1 IN port of the analyzer.
4. Connect the system controller to the BTS through the serial bus cable to control the BTS operation.

Setting the BTS (Example)

From the base transmission station simulator and the system controller, set up a call using loopback mode for the BTS to transmit the RF power as follows:

Frequency: 2.0 GHz

Output Power: –20 dBm

Carrier Number: 1

Switching Point: 3

Scramble Code: 0

Table 1-7 Timeslot Setup

Timeslot	State
0	On
1	On
2	On
3	On
4	Off
5	Off
6	Off
DwPTS	On
UpPTS	Off

Measurement Procedure

Step 1. Press **Mode**, **TD-SCDMA with HSPA/8PSK** to enable the TD-SCDMA with HSPA/8PSK mode measurements.

Step 2. Press **Mode Preset** to preset the analyzer.

Step 3. Press **Input/Output**, **External Gain**, **BTS** and enter the number and **–dB** according to the external attenuator connected to the analyzer.

Step 4. Press **Input/Output**, **RF Input**, **RF Coupling** to toggle the RF Coupling to **DC**.

Step 5. Press **Mode Setup**, **Radio**, **Device** to toggle the device to **BTS**.

Step 6. Press **Meas**, **Spurious Emission** to initiate the spurious emission measurement.

Step 7. Press **Meas Setup**, **More**, **Range Preset**, **Freq Setup** and enter the appropriate carrier parameters for your testing

Step 8. Press **Return** to back to Range Preset menu and select **Category A** or **Category B** for your testing. Range Table parameters and limit lines will be set automatically according to your selection.

Category A or Category B define the Base Station mandatory spurious emissions limits with the specified frequency ranges. For more information, see *N9079A TD-SCDMA with HSPA/8PSK User's and Programmer's Reference*.

The **Mobile** key is grayed out when you are in BTS test mode. It is available only when you select **MS** by pressing **Mode Setup**, **Radio**, **Device**.

Step 9. Check the spurs reported in the text window and press **Meas Setup**, **Spur** and enter the spur number to highlight the data you are interested in. The marker in the graph window will move synchronously.

Toggle the **Meas Type** key between **Examine** and **Full**. The **Examine** type sets the average mode to **Exp** and the **Full** type sets the average mode to **Repeat**.

Step 10. Press **More**, **Spur Report** and toggle the mode from **All** to **LimitTest**. Only spurs above the limit line are displayed.

Step 11. If you want to change the measurement parameters from their default condition for a customized measurement, press **Meas Setup**, **Range Table** to adjust the parameters for your testing.

For more information about changing measurement parameters, see *N9079A TD-SCDMA with HSPA/8PSK User's and Programmer's Reference*.

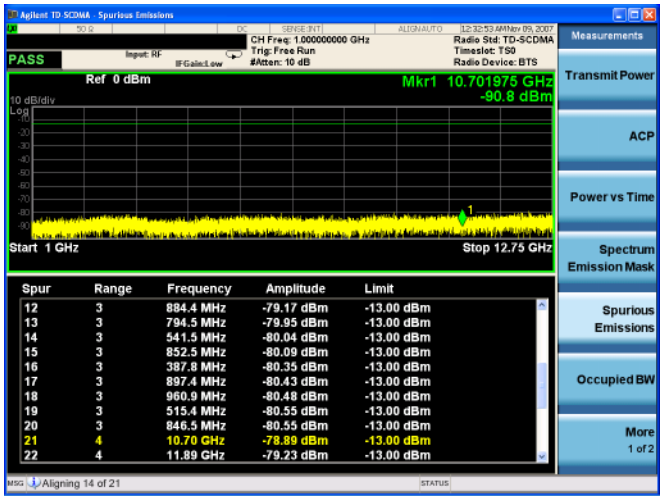
Measurement Results

The Spurious Emissions measurement results should look similar to Figure 1-18. The spectrum window and the text window show the spurs that are within the current value of the Marker Peak Excursion setting of the absolute limit. Any spur that has failed the absolute limit will have an 'F' beside it.

The analyzer scans the band using the specified Range Table settings. As each band is swept, any signal above the Peak Threshold and has a peak excursion of greater than the Peak Excursion will be added to the list of spurs in the text window. A total of 200 spurs can be recorded for one measurement, with a limit of 10 spurs for each frequency range.

If no spurs are reported, but the measured trace exceeds the limit line for any range, a red `FAIL` indicator will be displayed.

Figure 1-18 Spurious Emissions Measurement



If you have a problem, and get an error message, see the "*Instrument Messages Guide*".

Troubleshooting Hints

If there is a frequency channel dependency in the operating characteristics of a multi-carrier power amplifier, it might have channel balance problems due to spurious response, distortion, and/or inter-modulation products.

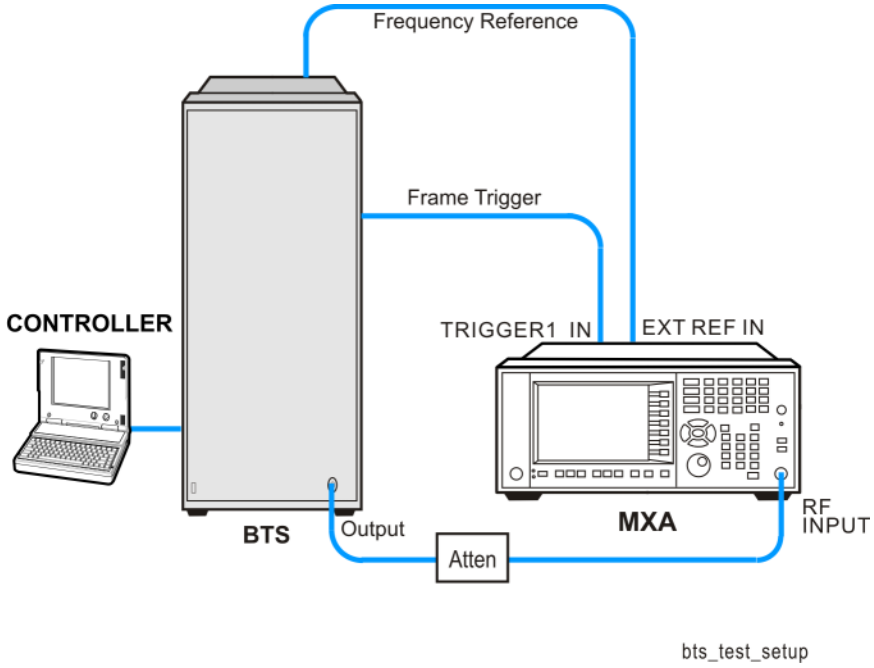
Occupied Bandwidth Measurements

This chapter explains how to make the occupied bandwidth measurement on a TD-SCDMA base transceiver station (BTS), a TD-SCDMA repeater or a power amplifier (PA). The instrument measures power across the band, and then calculates its 99.0% power bandwidth.

Configuring the Measurement System

The BTS under test must be set to transmit the RF power remotely through the system controller. This transmitting signal is connected to the RF input port of the instrument. Connect the equipment as shown.

Figure 1-19 Occupied Bandwidth Measurement System



1. Using the appropriate cables, adapters, and attenuator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect a BNC cable between the frequency reference port of the BTS and the EXT REF IN port of the analyzer.
3. Using a BNC cable, connect the trigger signal from the BTS to the TRIGGER1 IN port of the analyzer.
4. Connect the system controller to the BTS through the serial bus cable to control the BTS operation.

Setting the BTS (Example)

From the base transmission station simulator and the system controller, set up a call using loopback mode for the BTS to transmit the RF power as follows:

Frequency: 2.0 GHz

Output Power: –20 dBm

Carrier Number: 1

Switching Point: 3

Scramble Code: 0

Table 1-8 *Timeslot Setup*

Timeslot	State
0	On
1	On
2	On
3	On
4	Off
5	Off
6	Off
DwPTS	On
UpPTS	Off

Measurement Procedure

Step 1. Press **Mode**, **TD-SCDMA with HSPA/8PSK** to enable the TD-SCDMA with HSPA/8PSK mode measurements.

Step 2. Press **Mode Preset** to preset the analyzer.

Step 3. Press **Input/Output**, **External Gain**, **BTS** and enter the number and **–dB** according to the external attenuator connected to the analyzer.

Step 4. Press **Mode Setup**, **Radio**, **Device** to toggle the device to **BTS**.

Step 5. Press **Meas**, **Occupied BW** to initiate the occupied bandwidth measurement.

Step 6. Press **Sweep/Control**, **Gate** and toggle the **Gate** to **On**. Press **More**, **Gate Source** and select the desired gate source **External 1**.

If no measurement is performed and only a symbol of yellow '*' displays on the top right of the screen, you need to check the gate settings. You need the correct gate signal to make the OBW measurement.

Step 7. Press **FREQ Channel**, **2**, **GHz** to set the center frequency to 2 GHz.

Step 8. Press **Meas Setup** to check the keys available to change the measurement parameters from the default condition.

To make an averaged measurement, press **Avg/Hold Num** to toggle the state to **On** and enter the number of averages.

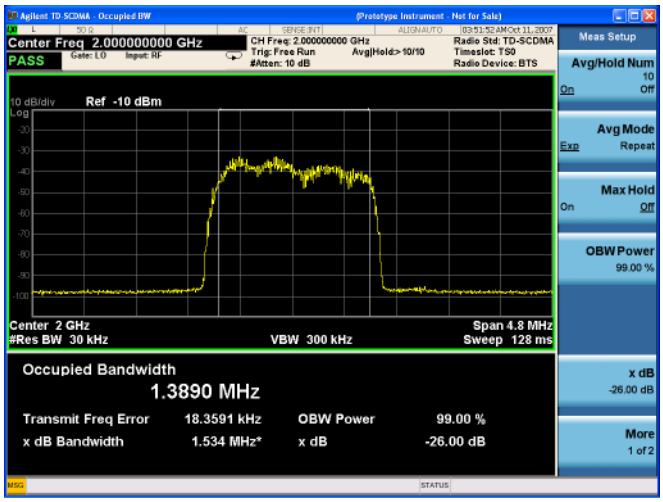
For more information about changing measurement parameters, see *N9079A TD-SCDMA with HSPA/8PSK User's and Programmer's Reference*.

If you have a problem, and get an error message, see the "*Instrument Messages Guide*".

Measurement Results

The Occupied BW measurement result should look similar to the Figure 1-20. A pair of white vertical lines represent the standard carrier bandwidth 1.6 MHz.

Figure 1-20 *Occupied Bandwidth Measurement*



Information shown in the text window of the displays include:

- Occupied Bandwidth - The result indicates the bandwidth containing 99% of the total transmitted power. The power of the transmitted signal is measured with an approximately Gaussian filter with 30 kHz bandwidth and the Measure span is 4.8 MHz, which is centered on channel center frequency and compliant with 3GPP standard.
- **Transmit Freq Error.** - The result is the transmit frequency error from the specified center frequency.
- **OBW Power** - Specifies the percentage of the total power. The bandwidth which contains the specified power will be measured. The default setting is 99%. You can adjust the parameter for your testing.
- **x dB Bandwidth** - The result is the frequency bandwidth when the power drops to the specified x dB relative to the peak level, which is centered on channel center frequency.
- **x dB** - Defines the dB number relative to peak level. The default setting is -26 dB. You can adjust the parameter for your testing.

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.

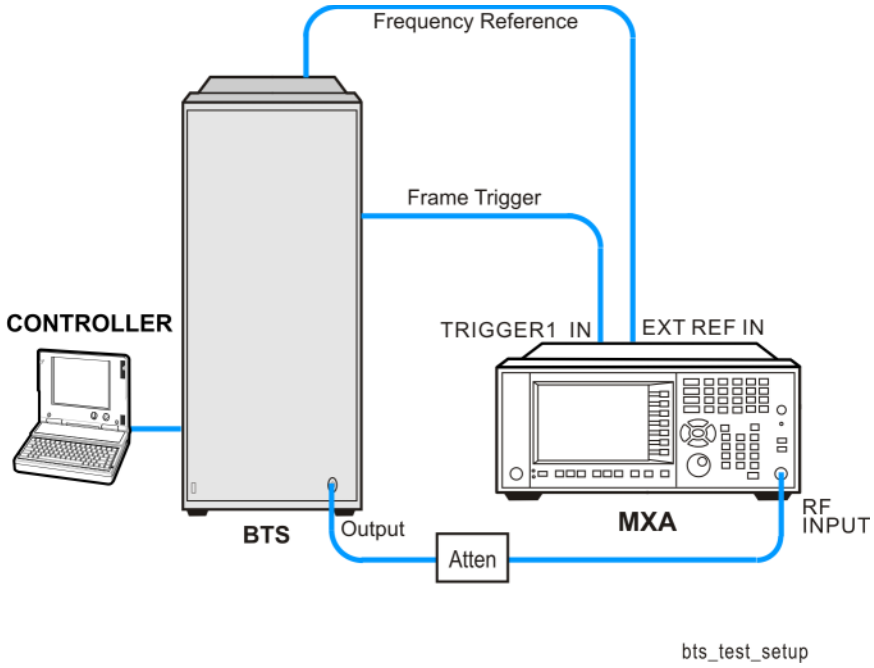
Power Statistics CCDF Measurements

This section explains how to make the Power Statistics Complementary Cumulative Distribution Function (Power Stat CCDF) measurement on a TD-SCDMA base transceiver station (BTS), a TD-SCDMA repeater or a power amplifier (PA). Power Stat CCDF curves characterize the higher level power statistics of a digitally modulated signal.

Configuring the Measurement System

The BTS under test must be set to transmit the RF power remotely through the system controller. This transmitting signal is connected to the RF input port of the instrument. Connect the equipment as shown.

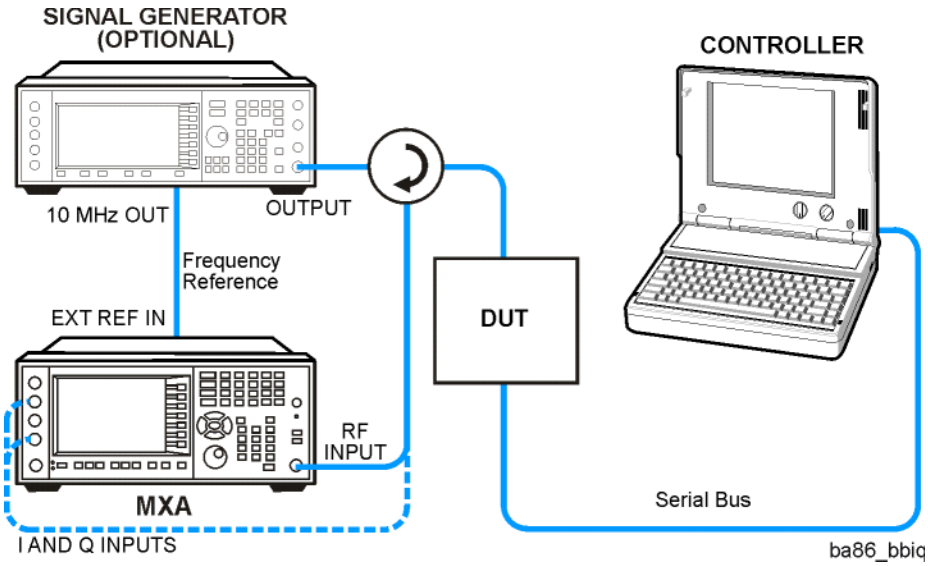
Figure 1-21 Power Statistics (CCDF) Measurement System



1. Using the appropriate cables, adapters, and attenuator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect a BNC cable between the frequency reference port of the BTS and the EXT REF IN port of the analyzer.
3. Using a BNC cable, connect the trigger signal from the BTS to the TRIGGER1 IN port of the analyzer.
4. Connect the system controller to the BTS through the serial bus cable to control the BTS operation.

Units with option BBA can also make Baseband I+jQ measurements. Connect the equipment as shown in the following illustration.

Figure 1-22 *Code Domain Power Measurement System—Baseband*



Setting the BTS (Example)

From the base transmission station simulator and the system controller, set up a call using loopback mode for the BTS to transmit the RF power as follows:

Frequency: 2.0 GHz

Output Power: –20 dBm

Carrier Number: 1

Switching Point: 3

Scramble Code: 0

Table 1-9 *Timeslot Setup*

Timeslot	State
0	On
1	On
2	On
3	On
4	Off
5	Off
6	Off
DwPTS	On
UpPTS	Off

Measurement Procedure

Step 1. Press **Mode**, **TD-SCDMA with HSPA/8PSK** to enable the TD-SCDMA with HSPA/8PSK mode measurements.

Step 2. Press **Mode Preset** to preset the analyzer.

Step 3. Select the signal inputs for the measurement.

For BBIQ measurements this will be the I or I input and the Q or Q input. Use the procedure in Chapter 2, “Using Option BBA Baseband I/Q Inputs”, on page 69.

Step 4. Press **Input/Output**, **External Gain**, **BTS** and enter the number and **–dB** according to the external attenuator connected to the analyzer.

Step 5. Press **Mode Setup, Radio, Device to toggle the device to BTS**.

Step 6. Press **Meas**, **Power Stat CCDF** to initiate the power statistics CCDF measurement.

Step 7. Press **Trigger** to select the appropriate trigger source **External 1**.

If no measurement is performed and only a symbol of yellow ‘*’ displays on the top right of the screen, you need to check the trigger settings. You need the correct trigger signal to make the CCDF measurement.

Step 8. Press **FREQ Channel**, **2**, **GHz** to set the center frequency to 2 GHz.

Step 9. Press **Meas Setup** to check the keys available to change the measurement parameters from the default condition.

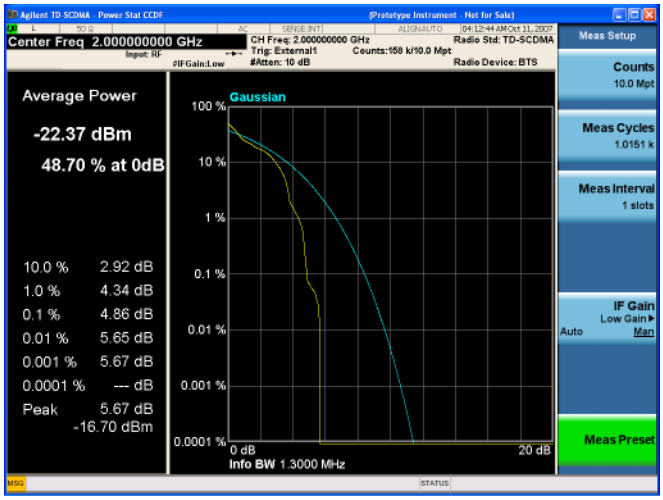
For more information about changing measurement parameters, see *N9079A TD-SCDMA with HSPA/8PSK User’s and Programmer’s Reference*.

If you have a problem, and get an error message, see the “*Instrument Messages Guide*”.

Measurement Results

The CCDF measurement result looks similar to Figure 1-23.

Figure 1-23 Power Statistics CCDF Measurement



Troubleshooting Hints

The power statistics CCDF measurement can contribute in setting the signal power specifications for design criteria for systems, amplifiers, and other components. For example, it can help determine the optimum operating point to adjust each code timing for appropriate peak or average power ratio, or both, throughout the wide channel bandwidth of the transmitter for a TD-CDMA system.

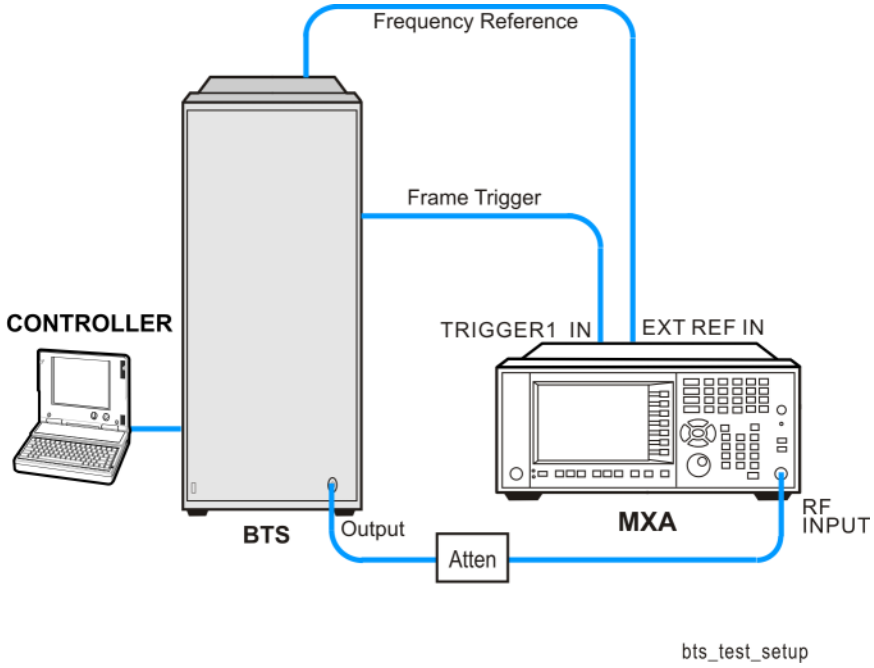
Modulation Accuracy (Composite EVM) Measurements

This section explains how to make the modulation accuracy (composite EVM) measurement on a TD-SCDMA base transceiver station (BTS), a TD-SCDMA repeater or a power amplifier (PA). Modulation accuracy is the ratio of the correlated power in a multi-coded channel to the total signal power.

Configuring the Measurement System

The BTS under test must be set to transmit the RF power remotely through the system controller. This transmitting signal is connected to the RF input port of the instrument. Connect the equipment as shown.

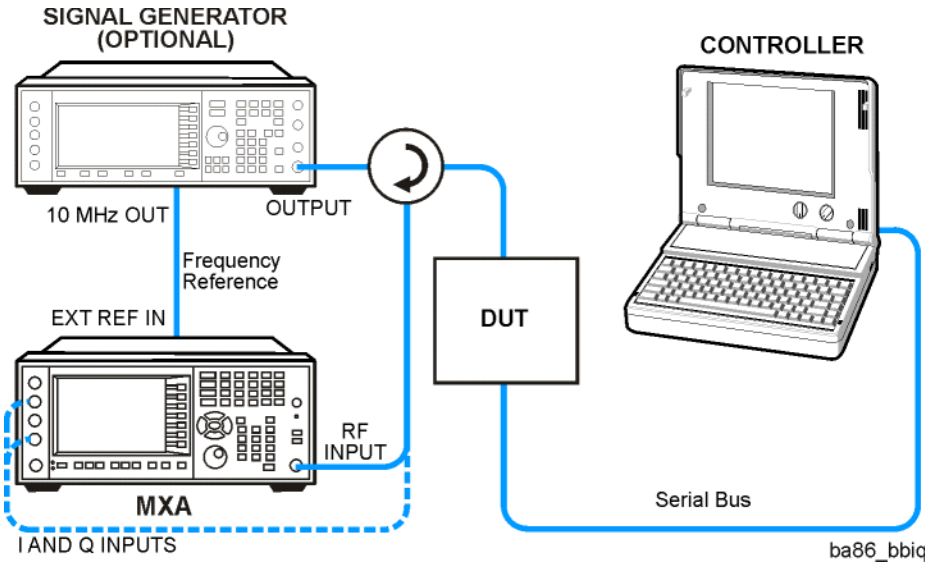
Figure 1-24 Modulation Accuracy Measurement System



1. Using the appropriate cables, adapters, and attenuator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect a BNC cable between the frequency reference port of the BTS and the EXT REF IN port of the analyzer.
3. Using a BNC cable, connect the trigger signal from the BTS to the TRIGGER1 IN port of the analyzer.
4. Connect the system controller to the BTS through the serial bus cable to control the BTS or MS operation.

Units with option BBA can also make Baseband I+jQ measurements. Connect the equipment as shown.

Figure 1-25 *Code Domain Power Measurement System—Baseband*



Setting the BTS (Example)

From the base transmission station simulator and the system controller, set up a call using loopback mode for the BTS to transmit the RF power as follows:

Frequency: 2.0 GHz

Output Power: –20 dBm

Carrier Number: 1

Switching Point: 3

Scramble Code: 0

Table 1-10 *Timeslot Setup*

Timeslot	State
0	On
1	On
2	On
3	On
4	Off
5	Off
6	Off
DwPTS	On
UpPTS	Off

Measurement Procedure

Step 1. Press **Mode**, **TD-SCDMA with HSPA/8PSK** to enable the TD-SCDMA with HSPA/8PSK mode measurements.

Step 2. Press **Mode Preset** to preset the analyzer.

Step 3. Select the signal inputs for the measurement.

For BBIQ measurements this will be the I or I input and the Q or Q input. Use the procedure in Chapter 2, “Using Option BBA Baseband I/Q Inputs”, on page 69.

Step 4. Press **Input/Output**, **External Gain**, **BTS** and enter the number and **–dB** according to the external attenuator connected to the analyzer.

Step 5. Press **Mode Setup**, **Radio**, **Device** to toggle the device to **BTS**.

Step 6. Press **Mode Setup**, **Analysis Timeslot** to select the timeslot to be measured.

Step 7. Press **Meas**, **Mod Accuracy (Composite EVM)** to initiate the modulation accuracy (composite EVM) measurement.

Step 8. Press **FREQ Channel**, **2**, **GHz** to set the center frequency to 2 GHz.

Step 9. Press **Meas Setup** to check the keys available to change the measurement parameters from the default condition.

When you need to estimate the S1/S2 phase on DwPTS, press **Result Length** and enter the desired value. **Result Length** should be set to a number no less than 4.

To specify which sub-frame is used for analysis within the acquired Result Length, press **Analysis Subframe** and enter the desired value.

To adjust the limit parameters, press **Limits** to change the limit lines.

Step 10. Press **View/Display** to select from the following views:

- I/Q Measured Polar Graph
- I/Q Error (Quad view).
- Code Domain Power
- Capture Time Summary
- Numeric Results.

For more information about changing measurement parameters, see *N9079A TD-SCDMA with HSPA/8PSK User’s and Programmer’s Reference*.

If you have a problem, and get an error message, see the “*Instrument Messages Guide*”.

Measurement Results

The Mod Accuracy I/Q Polar Vector Constellation measurement result should look similar to Figure 1-26.

The modulation constellation is shown, along with summary data for Rho, EVM, Peak Code Domain Error, and phase and magnitude errors.

Figure 1-26 *Modulation Accuracy - I/Q Measured Polar Graph View (Default)*

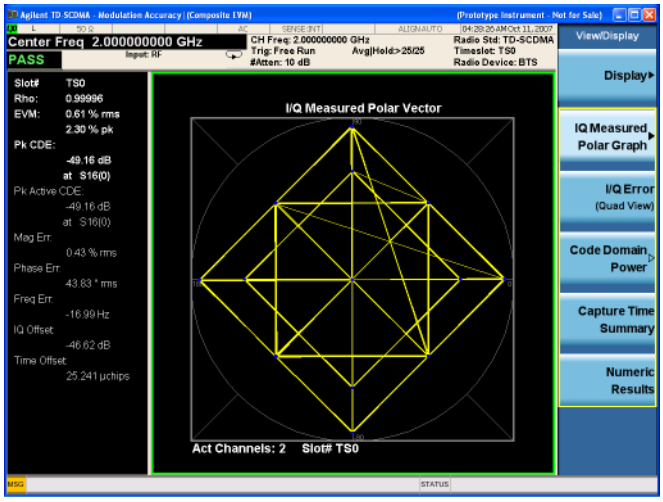


Figure 1-26 shows a combination view of the code domain power graph and metrics windows.

Figure 1-27 *Modulation Accuracy - Code Domain Power View*

Figure 1-28 shows a combination view of the magnitude error, phase error, and EVM graph windows.

Figure 1-28 *Modulation Accuracy Measurement - I/Q Error View*

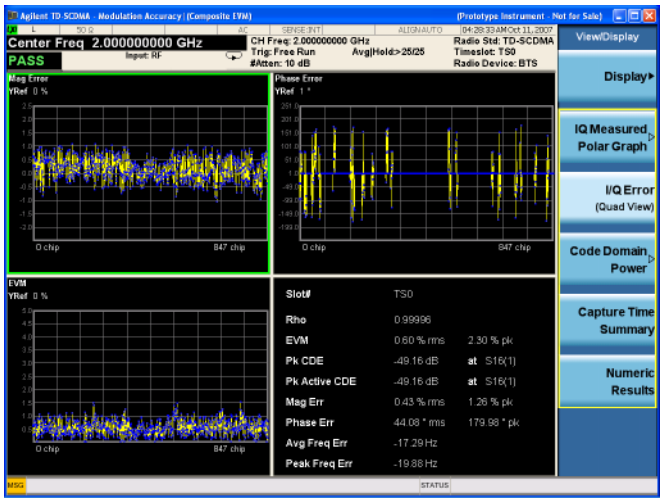
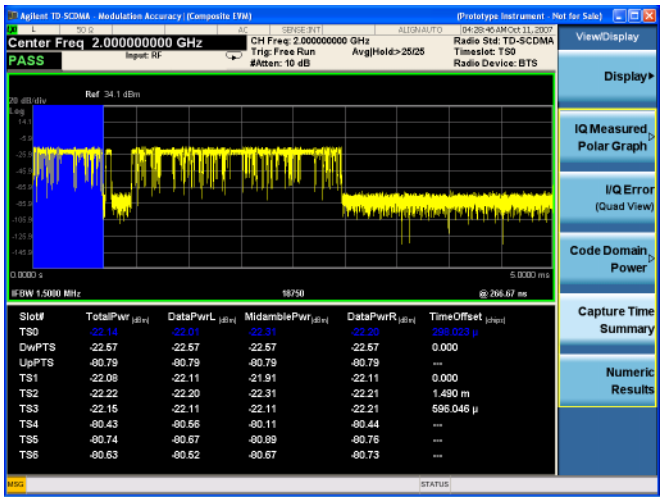


Figure 1-29 shows a combination view of the captured data trace and metrics windows.

Figure 1-29 *Modulation Accuracy Measurement Result - Capture Time Summary*



Troubleshooting Hints

Poor phase error often indicates a problem with the I/Q baseband generator, filters, or modulator, or all three, in the transmitter circuitry of the unit under test (UUT). The output amplifier in the transmitter can also create distortion that causes unacceptably high phase error. In a real system, a poor phase error will reduce the ability of a receiver to correctly demodulate the received signal, especially in marginal signal conditions.

If the error "`Can not correlate to input signal`" is shown, it means that your measurement has failed to find any active channels due to the lack of correlation with the input signal. The input signal level or scramble code, or both, may need to be adjusted to obtain correlation.

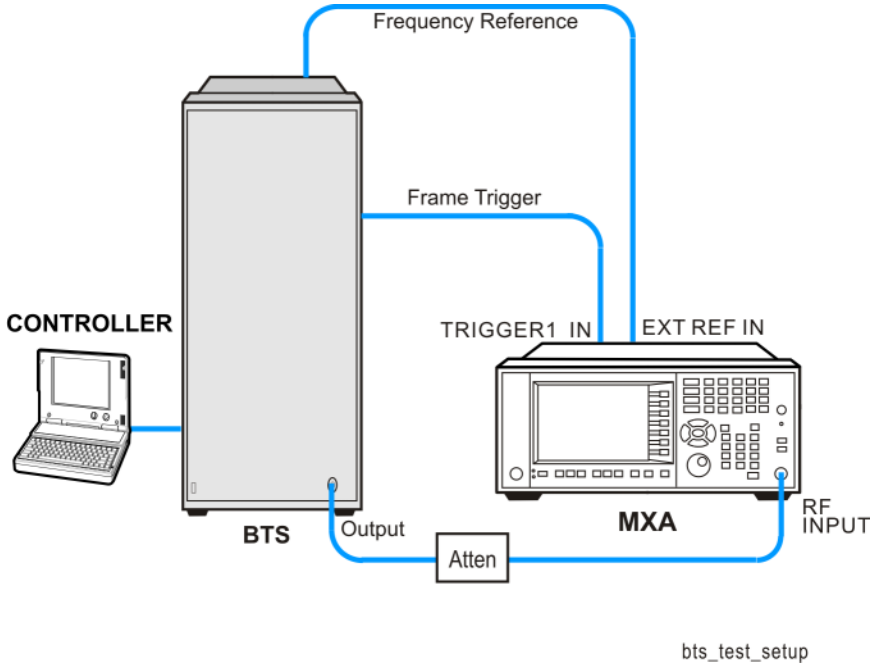
Code Domain Measurements

This chapter explains how to make a code domain measurement on a TD-SCDMA base transceiver station (BTS), a TD-SCDMA repeater or a power amplifier (PA). Code Domain measurements provide the power data and error data for an individual code channel and layer for a specified timeslot and sub-frame.

Configuring the Measurement System

For RF measurements, the BTS under test must be set to transmit the RF power remotely through the system controller. This transmitting signal is connected to the RF input port of the instrument. Connect the equipment as shown.

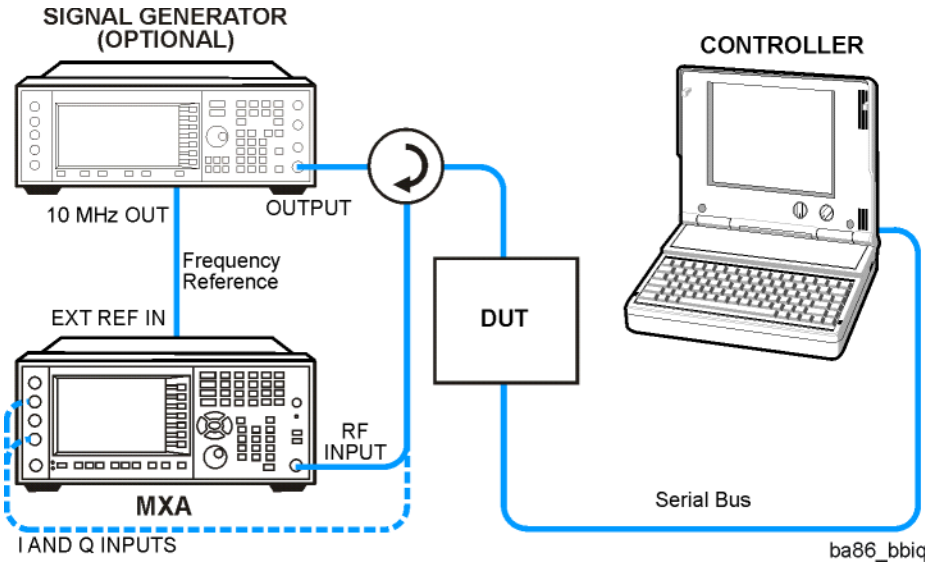
Figure 1-30 Code Domain Power Measurement System—RF



1. Using the appropriate cables, adapters, and attenuator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect a BNC cable between the frequency reference port of the BTS and the EXT REF IN port of the analyzer.
3. Using a BNC cable, connect the trigger signal from the BTS to the TRIGGER1 IN port of the analyzer.
4. Connect the system controller to the BTS through the serial bus cable to control the BTS or MS operation.

Units with option BBA can also make Baseband I+jQ measurements. Connect the equipment as shown.

Figure 1-31 *Code Domain Power Measurement System—Baseband*



Setting the BTS (Example)

From the base transmission station simulator and the system controller, set up a call using loopback mode for the BTS to transmit the RF power as follows:

Frequency: 2.0 GHz

Output Power: –20 dBm

Carrier Number: 1

Switching Point: 3

Scramble Code: 0

Table 1-11 *Timeslot Setup*

Timeslot	State
0	On
1	On
2	On
3	On
4	Off
5	Off
6	Off
DwPTS	On
UpPTS	Off

Measurement Procedure

Step 1. Press **Mode**, **TD-SCDMA with HSPA/8PSK** to enable the TD-SCDMA mode measurements.

Step 2. Press **Mode Preset** to preset the analyzer.

Step 3. Select the signal inputs for the measurement.

For BBIQ measurements this will be the I or I input and the Q or Q input. Use the procedure in Chapter 2, “Using Option BBA Baseband I/Q Inputs”, on page 69.

Step 4. Press **Input/Output**, **External Gain**, **BTS** and enter the number and **–dB** according to the external attenuator connected to the analyzer.

Step 5. Press **Mode Setup**, **Analysis Timeslot** to select the timeslot to be measured.

Step 6. Press **Radio, Device to toggle the device to BTS**.

Step 7. Press **Mode Setup** and turn on **HSPA/8PSK Enable** to enable HSPA/8PSK function.

NOTE If you don’t install Option N9079A-2FP, **HSPA/8PSK Enable** is grayed out.

Step 8. Press **Mode Setup**, **Demod** to change the demodulation parameters.

In order to analyze the signal correctly, you need to set the parameters same as those of the input signal, like **Scramble Code**, **Uplink Pilot** (SYNC-UL), **Uplink Switch Point** and so on.

To specify the modulation format, press **More**, toggle **Mod Scheme** to **Man** and press **Channel Configuration** to select **Mod Format** from **Auto**, **QPSK**, **8PSK**, **16QAM** or **64QAM**.

Toggle **Code Channel Detection** to **Man** and press **Channel Configuration** to check the keys available to change the parameters for a specific code channel, like **Midamble Shift** and **Phase Shift**.

NOTE If you don’t enable HSPA/8PSK function, **Mod Scheme** is grayed out.

To analyze 64QAM signals, you need to install Option N9079A-2FP, turn on **HSPA/8PSK Enable** and manually set **Mod Format** to **64QAM**.

Step 9. Press **Meas**, **Code Domain** to initiate the code domain measurement.

Step 10. Press **FREQ Channel**, **2**, **GHz** to set the center frequency to 2 GHz.

Step 11. Press **View/Display** to select from the following views:

- CDP Graph & Metrics – provides a combination view of the code domain power graph and the summary data.
- CDE Graph & Metrics – provides a combination view of the code domain power graph and the code domain error.
- I/Q Error – provides a combination view of magnitude error, phase error, symbol EVM and the summary data.
- Code Domain – provides a combination view of the code domain power, symbol power, I/Q symbol polar vector and the summary data.
- Demod Bits – provides a combination view of the graphs for the code domain power and symbol power, and the I/Q demodulated bit stream data for the symbol power slots selected by the measurement interval and measurement offset.
- Result Metrics – provides a view of the measurement summary data.

Step 12. Press **Marker**, **Properties**, **Marker Trace** to select a desired trace and press **Marker**, **Peak Search** to put on a marker. You can check the measurement results with the marker.

For more information about changing measurement parameters, see *N9079A TD-SCDMA with HSPA/8PSK User's and Programmer's Reference*.

If you have a problem, and get an error message, see the "*Instrument Messages Guide*".

Results

The measurement result should look similar to Figure 1-32. The graph window is displayed with a text window below it. The text window shows the total power level along with the relative power levels of the various channels.

Figure 1-32 Code Domain Measurement - CDP Graph & Metrics View

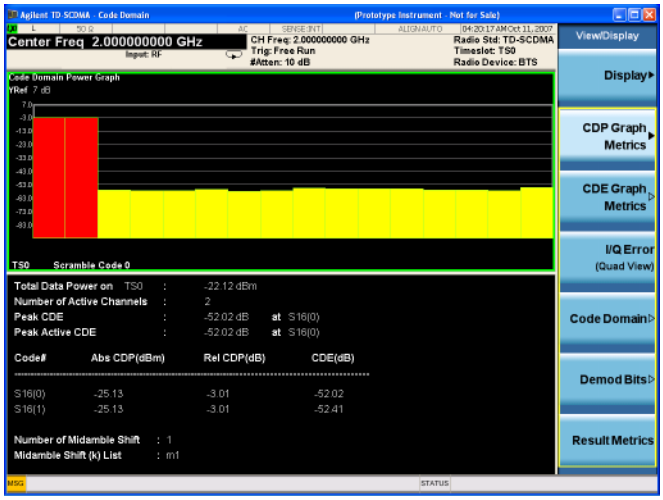


Figure 1-33 shows a combination view of code domain error graph window and a text window.

Figure 1-33 Code Domain Measurement - CDE Graph & Metrics View

Figure 1-34 shows a combination view of the code domain power, symbol power, and I/Q symbol polar vector graph windows, with a summary results window.

The summary data at the lower right indicates peak and RMS EVM, magnitude and phase errors, powers of the signal and the channel.

Figure 1-34 Code Domain Measurement Result - Code Domain Quad View

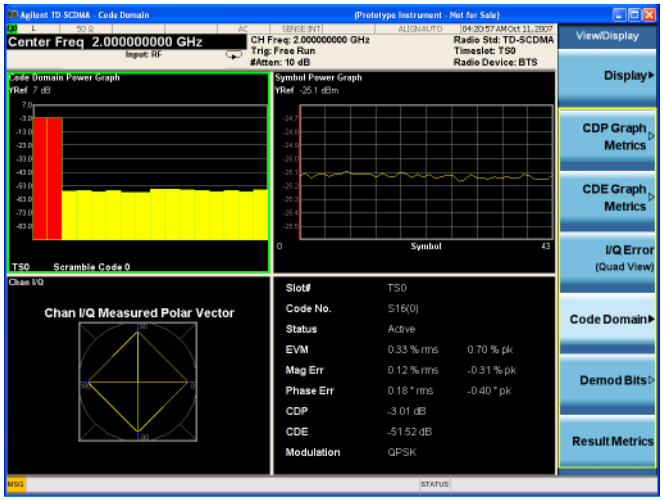


Figure 1-35 shows a combination view of the magnitude error vs. symbol, phase error vs. symbol, and EVM vs. symbol graph windows, with the modulation summary results window.

The results screen shows the data for the same code domain channel that was selected for despreading by the marker in the Code Domain Quad View.

Figure 1-35 Code Domain Measurement Result - I/Q Error Quad View

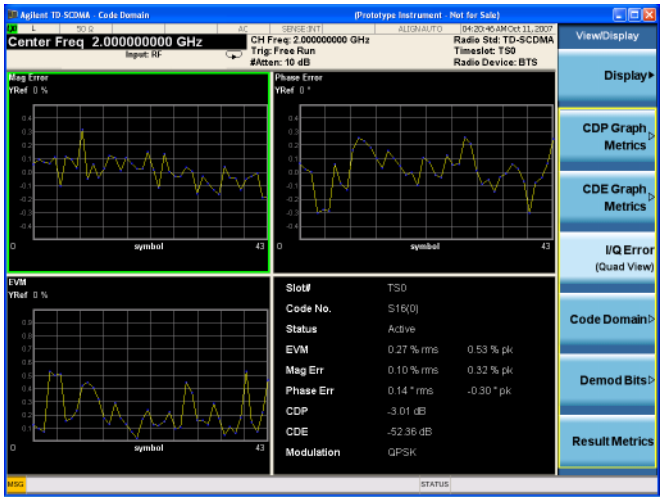


Figure 1-36 shows a combination view of the code domain power, symbol power graph windows, and the I/Q demodulated bit stream data for the symbol power slots selected by the measurement interval and measurement offset parameters.

The Demod Bits View displays the same Code Domain Power and Symbol Power windows as the Code Domain (Quad View) shown in Figure 1-35.

The demodulated bit stream displayed is the data contained in the Meas Interval 1. In the Symbol Power graph, this is the data shown as the red vertical bars.

Figure 1-36 *Code Domain Measurement Result - Demod Bits View*

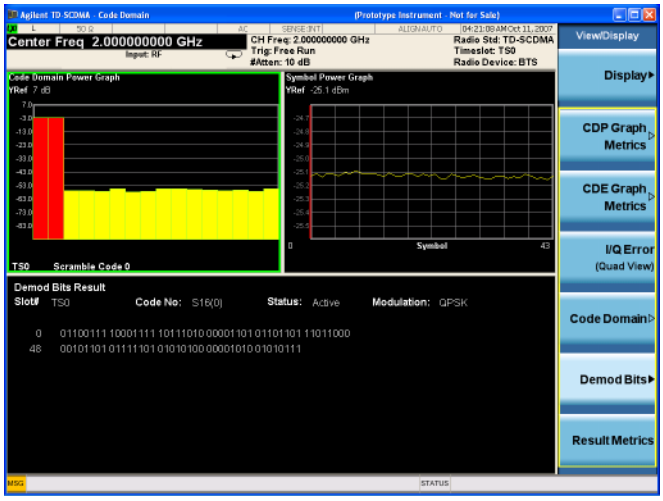


Figure 1-37 shows a result summary window.

Figure 1-37 *Code Domain Measurement - Result Metrics View*

Troubleshooting Hints

Uncorrelated interference may cause CW interference like local oscillator feed through or spurs. Another cause of uncorrelated noise can be I/Q modulation impairments. Correlated impairments can be due to the phase noise on the local oscillator in the upconverter or I/Q modulator of the unit under test (UUT). These will be analyzed by the code domain measurements along with the QPSK EVM measurements and others.

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

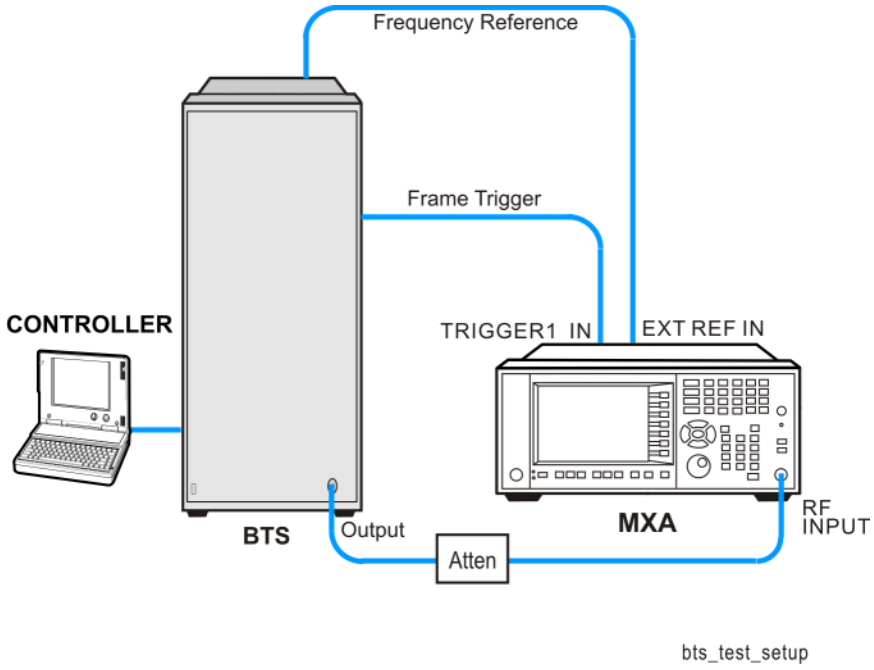
IQ Waveform (Time Domain) Measurements

This chapter explains how to make a waveform (time domain) measurement. The measurement of I and Q modulated waveforms in the time domain enables you to see the voltages which comprise the complex modulated waveform of a digital signal.

Configuring the Measurement System

The base station (BTS) under test have to be set to transmit the RF power remotely through the system controller. This transmitting signal is connected to the analyzer RF input port. Connect the equipment as shown.

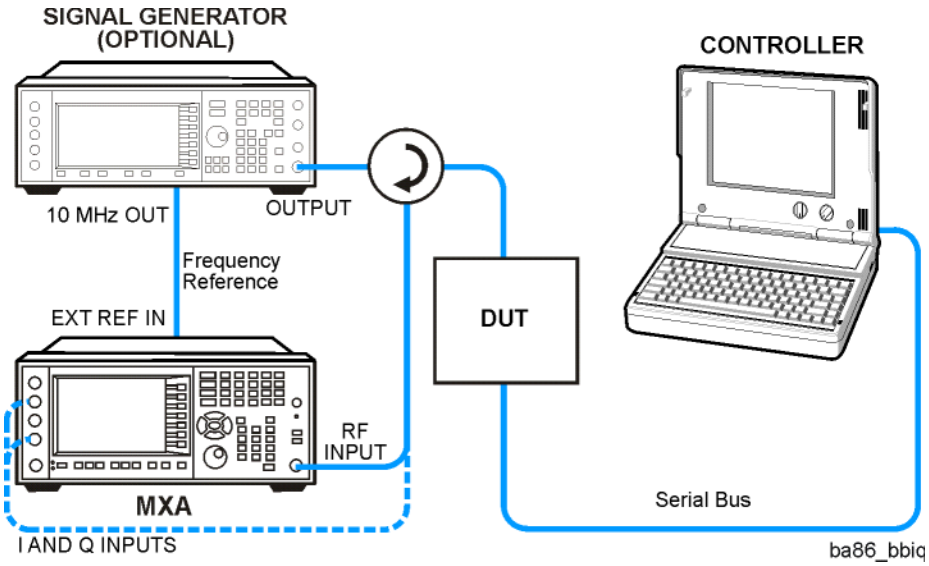
Figure 1-38 Transmit Power Measurement System



1. Using the appropriate cables, adapters, and attenuator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect a BNC cable between the frequency reference port of the BTS and the EXT REF IN port of the analyzer.
3. Using a BNC cable, connect the trigger signal from the BTS to the TRIGGER1 IN port of the analyzer.
4. Connect the system controller to the BTS through the serial bus cable to control the BTS operation.

Units with option BBA can also make Baseband I+jQ measurements. Connect the equipment as shown.

Figure 1-39 *Code Domain Power Measurement System—Baseband*



Setting the BTS (Example)

From the base transmission station simulator and the system controller, set up a call using loopback mode for the BTS to transmit the RF power as follows:

Frequency: 2.0 GHz

Output Power: –20 dBm

Carrier Number: 1

Switching Point: 3

Scramble Code: 0

Table 1-12 *Timeslot Setup*

Timeslot	State
0	On
1	On
2	On
3	On
4	Off
5	Off
6	Off
DwPTS	On
UpPTS	Off

Measurement Procedure

Step 1. Press **Mode**, **TD-SCDMA with HSPA/8PSK** to enable the TD-SCDMA with HSPA/8PSK mode measurements.

Step 2. Press **Mode Preset** to preset the analyzer.

Step 3. Select the signal inputs for the measurement.

For BBIQ measurements this will be the I or I input and the Q or Q input. Use the procedure in Chapter 2, “Using Option BBA Baseband I/Q Inputs”, on page 69.

Step 4. Press **Input/Output**, **External Gain**, **BTS** and enter the number and **–dB** according to the external attenuator connected to the analyzer.

Step 5. Press **Mode Setup**, **Radio**, **Device** to toggle the device to **BTS**.

Step 6. Press **Meas**, **IQ Waveform** to initiate the IQ Waveform measurement.

Step 7. Press **Trigger** to select the appropriate trigger source.

If no measurement is performed and only a symbol of yellow ‘*’ displays on the top right of the screen, you need to check the trigger settings. You need the correct trigger signal to make the IQ Waveform measurement.

Step 8. Press **FREQ Channel**, **2**, **GHz** to set the center frequency to 2 GHz.

Step 9. Press **View/Display** to select the desired view from the following views.

- RF Envelope
- I/Q Waveform

Step 10. Press **SPAN X Scale** to set the span so that the waveform is shown at a convenient time scale for viewing.

Step 11. Press the **AMPTD Y Scale**, and down arrow keys until the waveforms are shown at a convenient voltage scale for viewing.

Step 12. Press the **Marker**, **Select Marker**, keys to activate a marker. Rotate the RPG knob until the marker is shown at a desired time in the waveform for viewing the trace values at the time position of the marker.

Step 13. To make a measurement repeatedly, press **Cont**.

Step 14. Press the **Meas Setup** key to see the keys available to change the measurement parameters from the default condition.

For more details about changing measurement parameters, see *N9079A TD-SCDMA with HSPA/8PSK User’s and Programmer’s Reference*.

If you have a problem, and get an error message, see the “*Instrument Messages Guide*”.

Measurement Results

Figure 1-2 shows the IQ Waveform measurement result in RF Envelope view and Figure 1-41 shows IQ Waveform view.

Figure 1-40 Monitor Spectrum Measurement - RF Envelope view (Default)

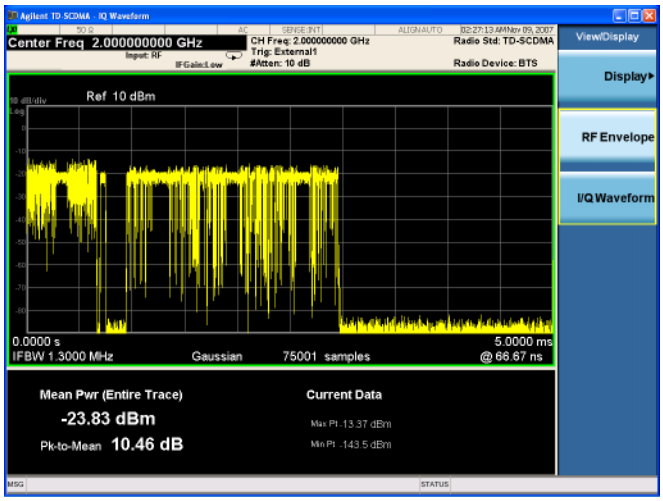
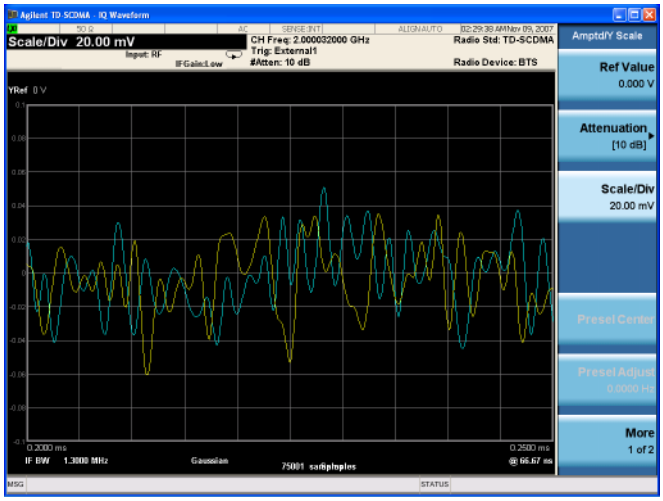


Figure 1-41 Monitor Spectrum Measurement - I/Q Waveform view



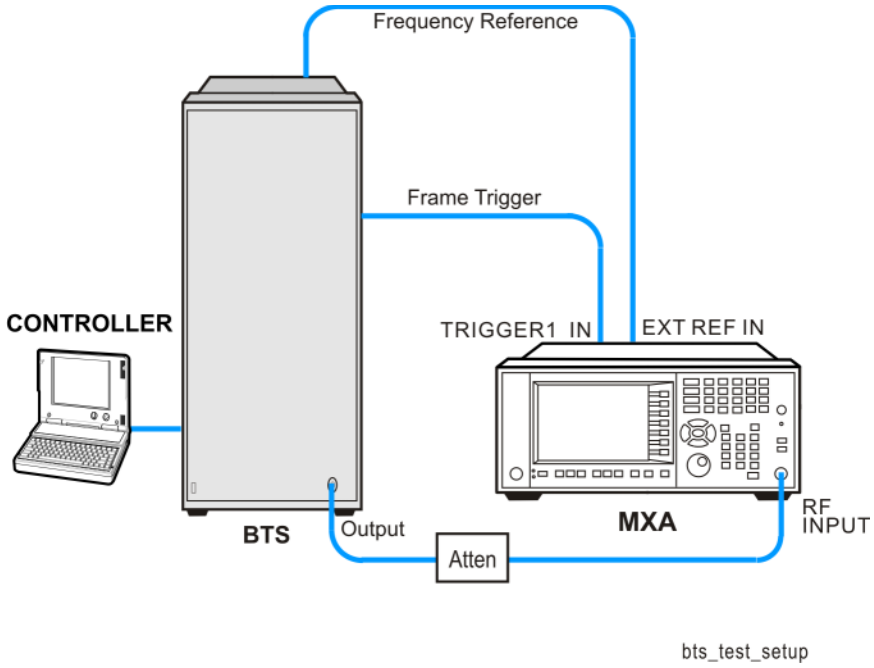
Monitor Spectrum Measurements

This section explains how to make a Monitor Spectrum measurement on a TD-SCDMA base transceiver station (BTS), a TD-SCDMA repeater or a power amplifier (PA). This measurement shows a spectrum domain of the signal, providing you a quick and convenient means of looking at the entire spectrum, which is similar to the Spectrum Analyzer mode. The results are shown in a graph window.

Configuring the Measurement System

The base station (BTS) under test have to be set to transmit the RF power remotely through the system controller. This transmitting signal is connected to the analyzer RF input port. Connect the equipment as shown.

Figure 1-42 *Transmit Power Measurement System*



1. Using the appropriate cables, adapters, and attenuator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect a BNC cable between the frequency reference port of the BTS and the EXT REF IN port of the analyzer.
3. Using a BNC cable, connect the trigger signal from the BTS to the TRIGGER1 IN port of the analyzer.
4. Connect the system controller to the BTS through the serial bus cable to control the BTS operation.

Setting the BTS (Example)

From the base transmission station simulator and the system controller, set up a call using loopback mode for the BTS to transmit the RF power as follows:

Frequency: 2.0 GHz

Output Power: –20 dBm

Carrier Number: 1

Switching Point: 3

Scramble Code: 0

Table 1-13 Timeslot Setup

Timeslot	State
0	On
1	On
2	On
3	On
4	Off
5	Off
6	Off
DwPTS	On
UpPTS	Off

Measurement Procedure

Step 1. Press **Mode**, **TD-SCDMA with HSPA/8PSK** to enable the TD-SCDMA mode measurements.

Step 2. Press **Mode Preset** to preset the analyzer.

Step 3. Press **Input/Output**, **External Gain**, **BTS** and enter the number and **–dB** according to the external attenuator connected to the analyzer.

Step 4. Press **Mode Setup, Radio, Device to toggle the device to BTS**.

Step 5. Press **Meas**, **Monitor Spectrum** to initiate the Monitor Spectrum measurement.

Step 6. Press **Sweep/Control**, **Gate** and toggle the **Gate** to **On**. Press **More**, **Gate Source** and select the desired gate source **External 1**.

If no measurement is performed and only a symbol of yellow '*' displays on the top right of the screen, you need to check the gate settings. You need the correct gate signal to make the Monitor Spectrum measurement.

Step 7. Press **FREQ Channel**, **2**, **GHz** to set the center frequency to 2 GHz.

Step 8. Press **SPAN X Scale**, enter a numerical span using the front-panel keypad, and select a units key, such as **MHz**.

NOTE A display with a Spectrum window appears when you activate a Spectrum measurement. Changes to the **FREQ**, **Span**, or **AMPTD** settings will affect only the active window.

Step 9. Press **Meas Setup** to check the keys available to change the measurement parameters from the default condition.

Step 10. Press **Trace/Detector, Select Trace** and select the trace(s) desired for display, then toggle **Display** to **Show**.

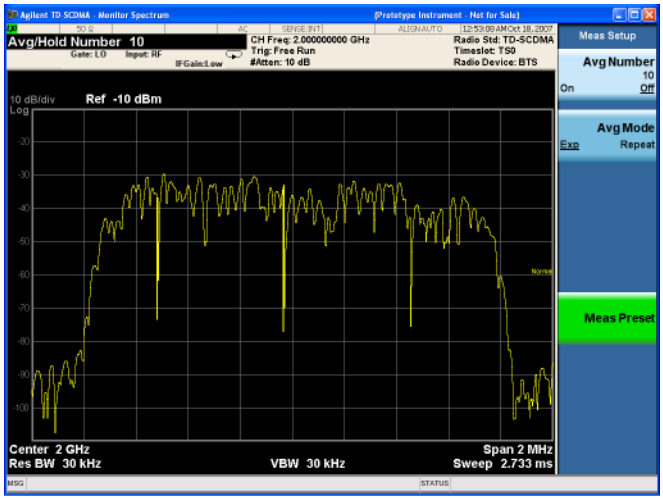
For more details about changing measurement parameters, see *N9079A TD-SCDMA with HSPA/8PSK User's and Programmer's Reference*.

If you have a problem, and get an error message, see the "*Instrument Messages Guide*".

Measurement Results

Figure 1-2 shows the Monitor Spectrum measurement result.

Figure 1-43 *Monitor Spectrum Measurement*



2 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 2-1 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
W-CDMA	IQ Waveform Power Stat CCDF Code Domain Mod Accuracy QPSK EVM
1xEV-DO	IQ Waveform Power Stat CCDF Forward Link Code Domain Reverse Link Code Domain Forward Link Mod Accuracy Reverse Link Mod Accuracy QPSK EVM
LTE	IQ Waveform Power Stat CCDF
LTE TDD	IQ Waveform Power Stat CCDF
DTMB	IQ Waveform Power Stat CCDF Mod Accuracy

Table 2-1 BBIQ Supported Measurements vs. Mode

Mode	Measurements
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) is 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 Keysight 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 Measurements” 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 115” 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)** inputs 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)** inputs 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**

i. Select probe **Attenuation**

ii. 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 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.

3 Concepts

TD-SCDMA Concepts

What is TD-SCDMA?

TD-SCDMA (Time Division-Synchronous Code Division Multiple Access) is a mobile radio format developed by the China Academy of Telecommunication and Technology (CATT). TD-SCDMA is a multiple access technology, which is a combination of time division multiple access (TDMA) and code division multiple access (CDMA) to provide an efficient use of resources and dynamically adapt to both symmetric and asymmetric traffic loads.

TD-SCDMA benefits from several key technological features that enable its efficiency in handling symmetric and asymmetric traffic loads and optimize system performance and capacity. These include the following:

Smart antennas permit cell sectorization through the use of multiple, dynamic, focused base station antenna beam patterns. These multiple-element antenna arrays receive and transmit signals to specific areas within a cell, in order to target specific mobile users individually and simultaneously. They also enable the base station to track the user as it moves within a cell. Additionally, smart antennas help minimize multiple access interference, and increase the capacity of the TD-SCDMA network.

Joint detection is used to combat multiple access interference and increase system capacity. Efficient implementation of joint detection is made possible through the limited use of CDMA codes per timeslot (a maximum of 16), thus avoiding the high computational complexity of joint detection as implemented in other systems. The capacity improvement through the use of joint detection is enhanced by the synchronization of nodes in the network.

Synchronization also reduces the search time for handover searching and reduces the time for position location calculations. It enables the use of hard handoffs instead of soft handoffs, thus reducing system overhead.

Optimal utilization of spectrum is achieved through the use of unpaired frequency bands. Assigning separate frequency bands for uplink and downlink signals is inefficient for use with applications that have asymmetric traffic loads. Applications that have a heavy downlink requirement do not efficiently use frequency bands allocated to uplink signals. TD-SCDMA uses the same frequency band for both uplink and downlink, and can dynamically allocate resources for either uplink or downlink as needed.

TD-SCDMA Slots, Frames, and Power Control

TD-SCDMA combines a TDMA component with a CDMA component to provide an efficient use of resources and dynamically adapt to both symmetric and asymmetric traffic loads.

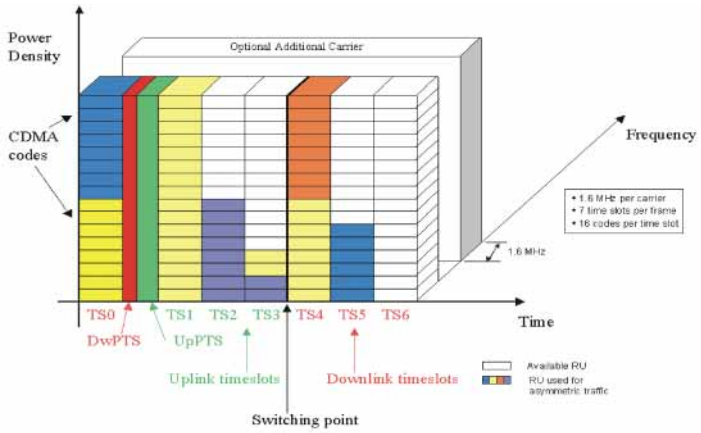
TDD (Time Division Duplexing) is used in TD-SCDMA to separate the uplink and downlink. The frame length (or the TDD interval) of TD-SCDMA is 5 ms and the whole frame is divided into downlink and uplink the two switching points. Both the

uplink and downlink periods are divided into timeslots. The total number of timeslots is (numbered 0 through 6). The ratio for uplink/downlink can be reconfigured to provide symmetric or asymmetric data services.

Within each time slot, the CDMA is implemented with the maximum spreading factor of 16. In other word, there are up to 16 code channels that are available to allocate to a single user or to distribute among multiple users.

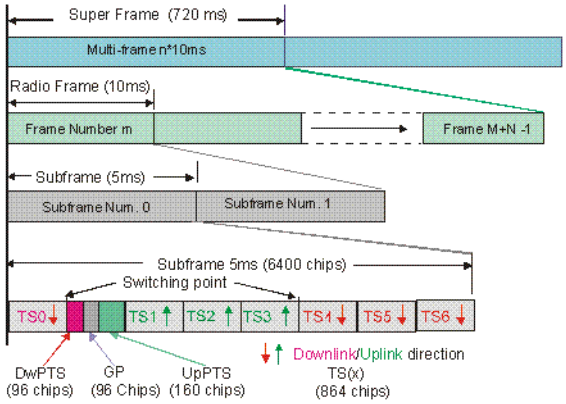
Therefore, a Resource Unit (RU) is defined by a frequency, time slot, and code channel with spreading factor. The basic resource unit uses a spreading factor of 16. Halving the Spreading Factor doubles the number of RU's.

Figure 3-1 *TD-SCDMA Resource Unit Structure*



In TD-SCDMA, the CDMA chip rate is 1.28 Mcps and each carrier signal occupies 1.6 MHz bandwidth. All physical channels utilize a three-layer structure: Super frame, Radio frame, and Sub-frame. A physical channel is defined by frequency, timeslot, channelization code, burst type, and radio frame allocation. The physical channels can either be of infinite duration or finite duration, defined for the given allocation.

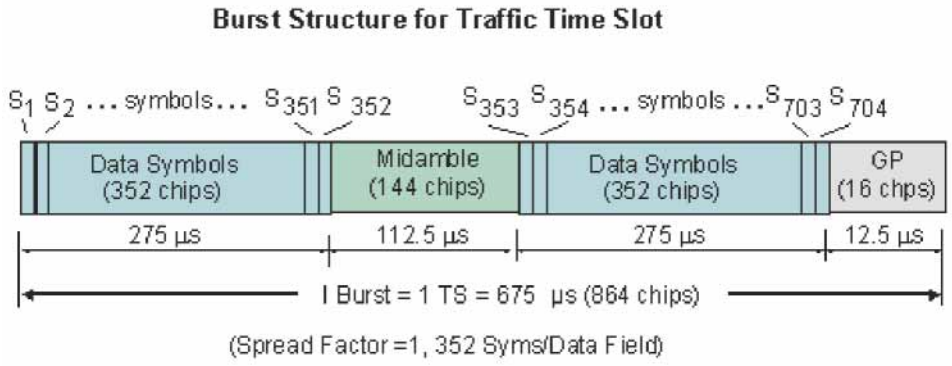
Figure 3-2 *Frame Structure*



The first time slot in a frame, time slot 0, is always allocated to downlink traffic. Also included in each 5 ms frame are two additional time slots, the downlink pilot timeslot (DwPTS) and the uplink pilot timeslot (UpPTS), which are separated by a 75 µs guard period. The DwPTS and UpPTS are separated from the traffic time-slot 0 by a switching point. The next time slots, beginning with time slot 1, are allocated to uplink traffic, until the second switching point in the frame occurs, at which point traffic time slots switch from uplink to downlink traffic slots. TD-SCDMA adapts to symmetric and asymmetric traffic loads by adjusting the number of downlink and uplink time slots per frame.

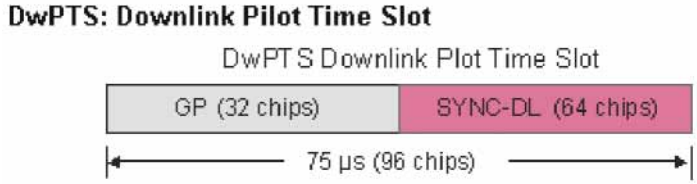
In TD-SCDMA, a traffic time slot burst consists of two data symbol fields, a midamble field, and a guard period. Each traffic burst is 675 µs in length, including the 12.5 µs long guard period at the end of the burst, which is used to avoid time slot multi-path interference. The midamble is used as a training sequence for channel estimation, power measurements, and synchronization.

Figure 3-3 *Burst Structure for Traffic Time Slot*



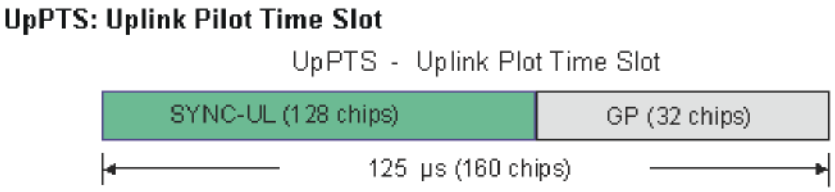
The downlink pilot time slot is used for downlink synchronization and cell initial search. There are 32 different downlink synchronization codes used to distinguish base stations. The DwPTS is 75 µs long.

Figure 3-4 *Downlink Pilot Time Slot*



The uplink pilot timeslot is used for initial synchronization, random access, and adjacent cell handoff measurements. There are 256 synchronization codes, which can be divided into 32 groups of 8 codes. The base station receives initial beam forming parameters from this signal. This time slot is 125 µs long.

Figure 3-5 Uplink Pilot Time Slot



HSDPA Concepts

What is HSDPA?

High Speed Downlink Packet Access (HSDPA) is a digital packet communications format that supports high speed data transmission. HSDPA operates inside a TD-SCDMA downlink with data transmission up to 8-10 Mbps (and 20 Mbps for MIMO systems) over a 1.6 MHz bandwidth. Appropriate uses for HSDPA are DL data bit streams like those employed for Internet browsing, video, or GPS mapping data.

HSDPA physical layer code channels are defined in 3GPP TS 25.211-214 v.5. HSDPA implementations as defined by 3GPP include Adaptive Modulation and Coding (AMC), Hybrid Automatic reQuest (HARQ), and fast cell search.

3GPP specifications include three new code channels: HS-DSCH, HS-SCCH, HS-SICH.

Modulation Scheme Detection

The DL HS-PDSCH may be modulated using either QPSK or 16QAM. MS (UE) gets the modulation scheme in advance of the actual modulated signal from information encoded into the HS-SCCH. The modulation scheme can change dynamically as often as every subframe, or every 3 slots.

For Code Domain and Modulation Accuracy (Composite EVM) measurements the user can select the method by which the modulation scheme is detected, or the modulation scheme can be predetermined. For details see “Code Domain Measurement Concepts” on page 101, or “Modulation Accuracy (Composite EVM)” on page 105.

Why Test HSPDPA User Equipment?

Although HSDPA is primarily a baseband or signaling extension to TD-SCDMA, many aspects of the new service require specialized testing.

The main aspects of HSDPA technology that have implications for physical layer testing of the UE are the following:

- The new uplink high speed dedicated physical control channel (HS-SICH) increases the peak-to-average power ratio (PAR).
- The uplink HS-SICH is not usually transmitted continuously and can be offset in time from the dedicated physical control channel (DSCH).
- The new 16QAM format in the downlink high speed physical data shared channel (HS-DSCH) has less margin for UE receiver impairments than does QPSK.
- Decoding the downlink high speed data shared channel (HS-DSCH) involves complex new functionality.
- Accurate channel quality reporting is crucial to overall system performance.

- Without correct detection of the high speed shared control channel (HS-SCCH) downlink control information, HSDPA communication is not possible.

Each of these areas of change and the implications for testing are next discussed briefly.

Transmit Power Measurement Concepts

Purpose

Transmit Power is the measure of in-channel power for TD-SCDMA systems. Mobile stations (MS) and base transceiver stations (BTS) must transmit enough power, with sufficient modulation accuracy, to maintain a call of acceptable quality without leaking into frequency channels or timeslots allocated for others. TD-SCDMA systems use dynamic power control to ensure that each link is maintained with minimum power. This gives two fundamental benefits: overall system interference is kept to a minimum and, in the case of mobile stations, battery life is maximized.

The Transmit Power measurement determines the average power for an RF signal burst at or above a specified threshold value. The threshold value may be absolute, or relative to the peak value of the signal.

At the BTS, the purpose of the Transmit Power measurement is to determine the power delivered to the antenna system on the radio-frequency channel under test. The Transmit Power measurement verifies the accuracy of the mean transmitted RF carrier power. This can be done across the frequency range and at each power step.

Measurement Method

The analyzer acquires a TD-SCDMA signal in the time domain with IQ data capture method. The average power level above the threshold or measured burst width is then computed and displayed.

This measurement uses three calculation method as follows:

Above Threshold method instead of the “useful part of the burst” method defined in the GSM standards. The measured Transmit Carrier Power will be very nearly the same for these two methods. The power-above-threshold method has the advantages of being faster and allows power measurements to be made at somewhat lower power levels. It also has the advantage of not requiring the carrier to have a valid Training Sequence Code (TSC).

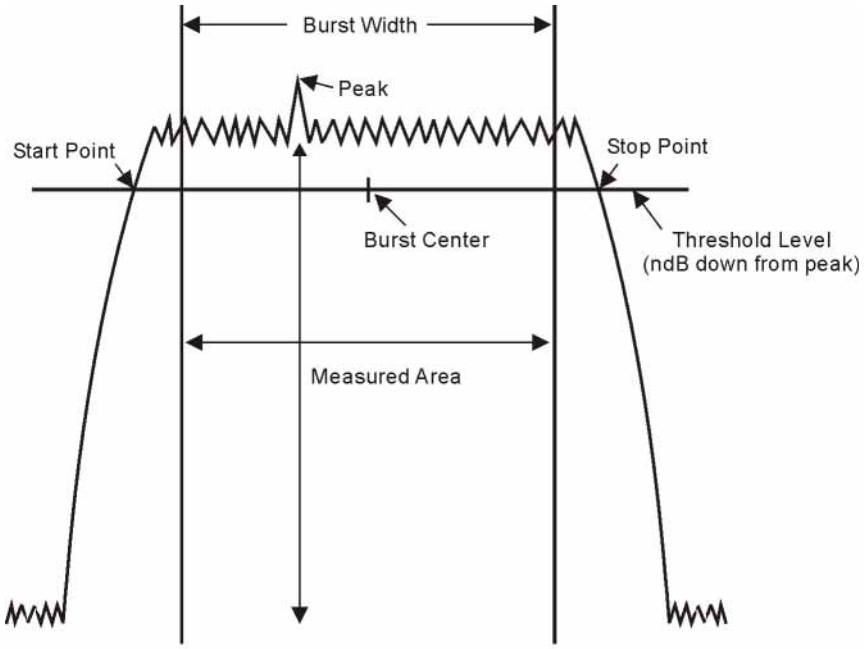
Note that this measurement does not provide a way to specify which timeslot is to be measured. Therefore if multiple timeslots are on, they should all be set at the same power level, or the levels of those timeslots to be excluded need to be kept below the threshold level. If you want to measure Transmit Carrier Power using the GSM specified useful part of the burst method, use the Power vs. Time measurement, which also measures the power ramping of the burst.

The analyzer captures a time record and averages only those points in the time record that exceed the user-specified threshold level. The analyzer does not attempt to position the burst, or to calculate or display the burst width. This algorithm can be used to measure continuous signals, or burst signals where the Measured Burst Width algorithm is too restrictive.

Measured Burst Width method uses the threshold level to calculate the burst center and average those points that fall within a user-specified burst width that is centered upon the burst. The burst width parameter can be changed when Burst Width mode is set to manual.

Single Time Slot method, a TD-SCDMA specific algorithm, captures a single time slot record and calculates the start and stop position of the time slot in terms of the trigger position theoretically. The analyzer does not attempt to position the burst, or to calculate or display the burst width. This method is recommended to measure the mean transmit power in a single slot when trigger source is External while the Measured Burst Width algorithm is too restrictive.

The transmit power measurement is an accurate method of determining the average power for the specified burst.



The transmit power measurement acquires data from the “Measured Area” above when a radio standard is chosen and when **Measured Burst Width** method is selected. When **Above Threshold Lvl** method is selected, the “Measured Area” extends the burst width delimiter lines to the start and stop points. When Single Time Slot method is selected, the “Measured Area” is considered to be the theoretical width of the time slot.

The mean carrier power is calculated by:

1. converting each trace point amplitude from dBm into linear power
2. Adding the above amplitudes together and dividing by the number of points included in the average.
3. This value is then displayed in logarithmic form (dBm).

$$(P_{avg}) = \mathbf{10log10}\left\{\frac{\left(\sum_{n}^{m}\left(\mathbf{10}^{\frac{p}{\mathbf{10}}}\right)\right)}{m-n}\right\}$$

where P_{avg} = average power, n is the start trace point, m = the stop trace point, and p = the trace point amplitude power in dBm.

NOTE The analyzer sweep time can be changed by pressing **Meas Setup**, **Meas Interval**.

Power vs. Time Measurement Concepts

Purpose

The Power vs. Time (PvT) measurement analyzes the amplitude profile and timing of the burst signal and provides a time mask for the signal. It measures the mean transmit power during the “useful part” of TD-SCDMA bursts and verifies that the power ramp fits within the defined mask.

TD-SCDMA is a Time Division Multiple Access (TDMA) scheme with seven time slots, or bursts, per RF channel. If the burst does not occur at exactly the right time, or if the burst is irregular, then other adjacent timeslots can experience interference. Because of this, the industry standards specify a tight mask for the fit of the TD-SCDMA burst. The measurement allows adjustment of Meas Interval to capture from 1 to 9 timeslots (up to one complete subframe).

This measurement supports the three types of TD-SCDMA timeslots Traffic, Uplink Pilot, and Downlink Pilot.

The Power vs. Time measurement provides masks for both BTS (Base Transceiver Station) and MS (mobile station).

Measurement Method

The analyzer acquires a TD-SCDMA signal by capturing two time records for each Power vs Time measurement using a 1.3 MHz IF BW (Gaussian, with 0.658 dB compensation), instead of using a Root-Raised Cosine filter (RRC, with a roll off α=0.22 and a bandwidth equal to the chip rate).

The first time record capture is made using the settings which minimize the instrument internal noise floor, with the internal preamp enabled and with the minimal internal attenuation to support the required Base Station transmit off level of –82 dBm.

The second time capture is made using the settings of internal preamp and internal attenuation defined by the Auto RF Range algorithm to ensure accurate measurement of the burst transmit on power level.

The data from the two sweeps will be combined to create one trace. This combined trace is displayed (with the limit mask, if it has not been turned off) and is used to calculate results data.

CAUTION It is imperative that there be no more than +30 dBm present at the analyzer input, in order to prevent damage to the internal attenuator.

This two sweep method allows the measurement to reach the high dynamic range requirement of greater than 112 dB for the Transmit ON/OFF Time Mask defined by the TD-SCDMA Specs for Base Station when measuring a maximum input signal power of +30 dBm.

NOTE

- PvT requires a Preamplifier Option. The measurement will still work without this option present, but you will not be able to reach the dynamic range required by the TD-SCDMA specifications.
- PvT is set in the single sweep mode. Because of the switching of the Preamp state from on to off, making PvT measurements in the continuous sweep mode is not recommended.

The default limit masks used in the Power vs Time measurement are defined in the China Wireless Telecommunication Standard documents CWTS TSM 05.05 V.3.1.0 and CWTS TSM 11.21 V.3.1.0. The measurement meets the requirements of the standards documents listed below. Limit Pass or Fail results are displayed upon the completion of the measurement.

Table 3-1 Power vs Time Measurement Reference Standards

Document	Section	Test Name
3GPP TS 34.122 V4.2.0 (2001–12)	5.4.4	Transmit On/Off Time Mask
CWTS TSM 05.05 V.3.1.0 (2002–12)	4.1.1.5 4.1.2.4	Transmit On/Off Power
3GPP TS 34.122 V4.2.0 (2001–12)	5.4.3	Transmit Off Power
CWTS TSM 05.05 V.3.1.0 (2002–12)	4.1.1.5.1 4.1.2.6.1	Transmit Off Power
3GPP TS 34.122 V4.2.0 (2001–12)	5.4.2	Minimum Output Power
CWTS TSM 05.05 V.3.1.0 (2002–12)	4.1.1.3 4.1.2.3	Minimum Output Power
CWTS TSM 11.21 V.3.1.0 (2002–12)	6.5	Transmit ON/OFF Power

Figure 3-6 *Power vs Time Measurement BTS Mask*

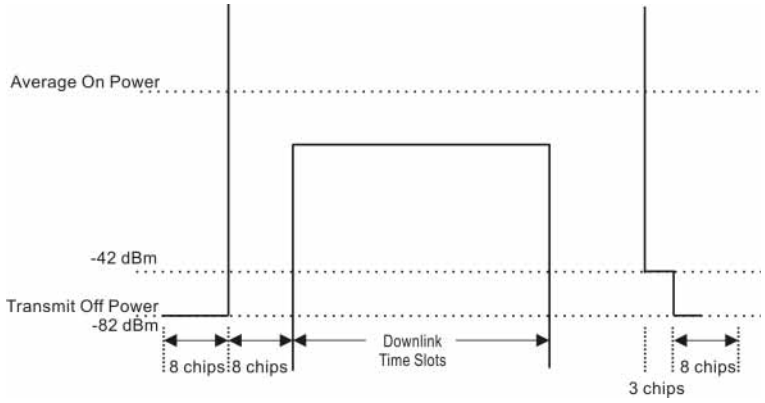
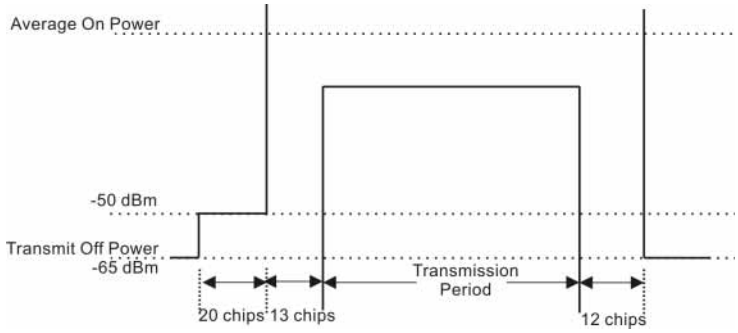


Figure 3-7 *Power vs Time Measurement MS Mask*



Adjacent Channel Power (ACP) Measurement Concepts

Purpose

Adjacent Channel Power (ACP) 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 composite 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 call by avoiding channel interference, it is important to measure and reduce any adjacent channel leakage power transmitted from a mobile phone. The characteristics of adjacent channel leakage power are mainly determined by the transmitter design, particularly the low-pass filter.

Measurement Method

This ACP measurement analyzes the total power levels within the defined carrier bandwidth and at given frequency offsets on both sides of the carrier frequency.This measurement requires the user to specify measurement bandwidths of the carrier channel and each of the offset frequency pairs up to 6. Each pair may be defined with unique measurement bandwidths.

It uses an integration bandwidth (IBW) method that performs a swept trace data acquisition in the frequency domain. In this process, the channel integration bandwidth is analyzed using the automatically defined resolution bandwidth (RBW), which is much narrower than the channel bandwidth. The measurement computes an average power of the carrier channel and each of the offset channels, automatically compensating for resolution bandwidth and noise bandwidth.

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.

Multi-carrier Power Measurement

Multi-carrier Power is a measure of the power in two or more transmit channels and of the power that leaks into their adjacent transmit channels. The results reported are identical to the adjacent channel power measurement, but the setup is different to allow for two or more carriers present.

When you choose the ACP measurement from the Measurement menu, the center frequency of the analyzer is maintained. If you have set Ref Freq Mode to auto, the slot with the highest power will be used as the reference. However, you also may

enter a value for Ref Freq, and this will set the Ref Freq Mode to man. To ensure that the carriers are always centered on the screen, the following algorithm is used to calculate the Ref Freq:

CtrFreq = Ref Freq + (((0.5*Carriers) – Ref Carrier Pos + 0.5) * Carrier Span)

This algorithm is identical to the algorithm used for the ACP measurement, except the appropriate number of carriers will be included in the sequence of bursts measured before the spectrum view is constructed.

If the RRC filter is turned on, this will be noted in the results area. All carriers and offsets will have the filter mathematically applied before the power results are reported. The value (rolloff) for the filter will be set to the value of the Filter Alpha parameter and T will be 1/Integ BW (where the default Integration BW parameters are set to 1.28 MHz, equal to the chip rate).

There is no change in algorithm when the view is changed to either Spectrum or Combined.

Results

The results shown in the results view are described below.

Result	Units	Min	Max
Total Carrier Power	dBm	-200	200
Ref Carrier Power	dBm	-200	200
Carrier Power (Carrier Pwr Present set to Yes | No)	dBm | dB	-200	200
Offset Relative Power	dB	-200	200
Offset Absolute Power	dBm	-200	200

Total Carrier Power result gives the total power in all the carriers with carrier power present set to yes. The power is calculated by integrating across the bandwidth declared by the Carrier Integ BW parameter for each carrier then totaling. The total integration bandwidth is shown as part of the result. This will be the total of the Carrier Integ BW parameters of the carriers used in calculating the total carrier power.

Ref Carrier Power result gives the power in the reference carrier. The power is calculated by integrating across the multi-carrier power bandwidth declared by the Carrier Integ BW parameter for that carrier. The integration bandwidth is shown as part of the result.

On the graph display the carrier representing the reference carrier will be identified using white. In Spectrum view the vertical lines used to identify the carrier will be white and in combined view the width arrow will be white.

Carrier Power result is the power in all the currently defined carriers. If the carrier has carrier power present the power will be absolute. If it is defined as not having power present the power will be relative to the reference carrier. The power is calculated by integrating across the bandwidth declared by the Carrier Integ BW parameter. The integration bandwidth is shown as part of the result. As there may be more results than can be easily viewed on the display a scrollable list is used to display the results. The currently selected Carrier Result will be displayed on the last line of the carrier power result list unless:

- the selected Carrier Result is 4 or less in normal multi-carrier power results view. In this case the first 4 carrier power results will be displayed.
- the selected Carrier Result is 9 or greater in normal multi-carrier power results view. In this case the last 4 carrier power results will be displayed.
- the zoom mode is selected. In this case all carrier power ranges can be displayed.

On the graph display, the carrier(s) representing the carriers with power present (with the exception of the reference carrier) are identified using red. The carrier(s) representing carriers with no power present are identified using pale blue. In the Spectrum view, the vertical lines used to identify the carrier(s) with power present are red and the vertical lines used to identify the carrier(s) with no power present are pale blue. In combined view, the width arrow for carrier(s) with power present are red and the width arrow for carrier(s) with no power present are pale blue.

Offset Relative Power result gives the power in the offsets relative to the reference carrier. The power is calculated by integrating across the bandwidth declared by the Offset Integ BW parameter. The offset integration bandwidth is shown as part of the result.

On the graph display, the offsets A, B and C are identified using yellow, blue and purple respectively. In the Spectrum view, the appropriate color is applied to the vertical lines to identify the offset.

Offset Absolute Power result gives the absolute power in the offsets. The power is calculated by integrating across the bandwidth declared by the Offset Integ BW parameter. The offset integration bandwidth is shown as part of the result. On the graph display, the offset A, B and C are identified using yellow, blue and purple respectively. In the Spectrum view, the appropriate color is applied to the vertical lines to identify the offset.

Spectrum Emissions Mask (SEM) Measurement Concepts

Purpose

The Spectrum Emission Mask measurement includes the in-band and out-of-band spurious emissions. As it applies to TD-SCDMA, this 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.

This spectrum emission mask measurement is a composite measurement of out-of-channel emissions, combining both in-band and out-of-band specifications. It provides useful figures-of-merit for the 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 five 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 and offset/region powers. Spectrum emission mask measurements are made, relative to the carrier channel frequency bandwidth.

This integration bandwidth method is used to perform a data acquisition. In this process, the reference channel integration bandwidth (Meas BW) is analyzed using the automatically defined resolution bandwidth (Res BW), 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 you to specify the measurement bandwidths of carrier channel and each of the offset/region frequency pairs up to 5. You may define each pair with unique measurement bandwidths. The results are displayed either as relative power (to the measured output power of the signal) in dBc, or as absolute power in dBm. In addition to the reference power a “Total Pwr” result is displayed at the top of the trace window. This value is a duplicate of the top left hand value in the results window. This allows you to zoom into this trace window and have all the relevant results, while adjusting your DUT power parameters.

Spurious Emissions Measurement Concepts

Purpose

This measurement identifies and determines the (absolute) power level of spurious emissions in certain frequency bands. This energy may cause interference for other users of the TD-SCDMA system. You may use the range table to specify the parameters of the ranges to be swept.

Measurement Method

NOTE The factory default settings provide a measurement that complies with pre-established standards for TD-SCDMA. For special requirements, you may need to change some of the settings. To return all parameters for the current measurement to their default settings press **Meas Setup**, **More**, **Meas Preset** at any time.

The Spurious Emissions measurement begins executing when the **Spurious Emissions** menu key in the Measure menu is pressed. The measurement sets up the analyzer using the data from the first active range. If no ranges are active, the star symbol * is displayed on the top right screen and the measurement is put in the idle state.

For each range that you specify and activate, the analyzer scans the band using the specified Range Table settings, for example, Res BW, Video BW, Start and Stop Freq and Sweep Time settings. As each band is swept, any signal which is above the Peak Threshold value and has a peak excursion of greater than the Peak Excursion value will be added to a list of spurs displayed in the lower (data) results window. A total of 200 spurs can be recorded for one measurement, with a limit of 10 spurs per frequency range.

Those spurs in the list with a peak amplitude greater than the Absolute Limit for that range will be logged as a measurement failure and indicated by a red ‘F’ in the ‘Amplitude’ column of the table.

The China Wireless Telecommunication Standard document CWTS TSM 05.05 V3.1 requires different default measurement ranges for mobile devices (UE or MS) and base stations (BTS). The spurious emissions measurement takes these differences into account, according to the Device parameter value you enter under the **Mode Setup**, **Radio**, **Device** menu.

When the radio device is set to MS, the measurement will not report any spurs that are within 4 MHz of the expected MS carrier frequency that you enter as the Mobile Carrier value on the Frequency Setup menu. When the radio device is set to BTS, the measurement will not report any spurs for the spectrum 4 MHz below the beginning of the transmission band nor the spectrum 4 MHz above the end of the transmission band. The beginning and ending of the transmission band are set by you using the Tx

Band Start and Tx Band Stop menu keys (or SCPI commands). Any spectrum falling within either “skipped' spectrum will indeed not be swept so that an optimal reference level can be used.

Occupied Bandwidth (OBW) Measurement Concepts

Purpose

This measurement measures 'Occupied Bandwidth' primarily, as well as 'x dB Bandwidth' and two other incidental parameters. The 'Occupied Bandwidth' measured parameter is the bandwidth that contains some fraction (default is 99%) of the power within the displayed span. The 'x dB Bandwidth' measured parameter is the bandwidth outside of which all the spectrum is more than x dB (default for x is 26 dB) below the peak of the spectrum.

The measurement also reports “transmitter frequency error” and “total power”.

Making the Measurement

The Occupied Bandwidth measurement begins executing when the **Occupied Bandwidth** menu key in the Measure menu is pressed. The measurement measures the bandwidth containing 99% of the total transmitted power and is centered on the channel center frequency. The power of the transmitted signal is measured with an approximately Gaussian filter with 30 kHz bandwidth. The measure span is 4.8 MHz, which is centered on channel center frequency and compliant with 3GPP standard.

Modulation Quality Measurements

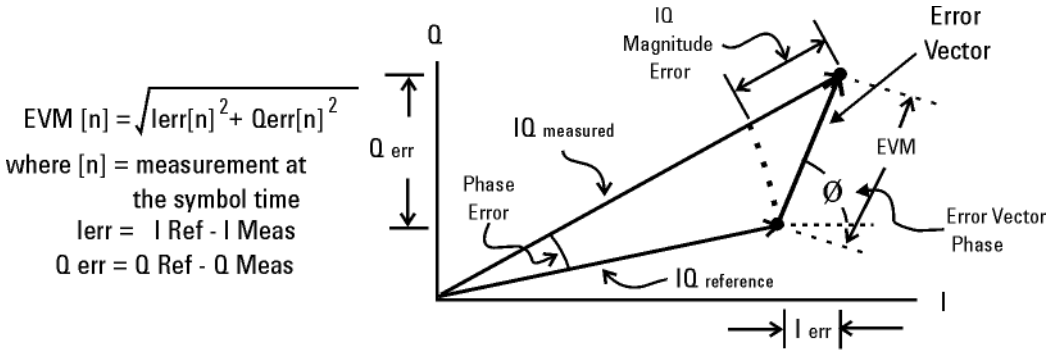
There are a number of different ways to measure the quality of a digitally modulated signal. These usually involve precision demodulation of the transmitted signal and comparison of this transmitted signal with a mathematically generated ideal or reference signal, as we saw earlier. The definition of the actual measurement depends mainly on the modulation scheme and standard followed.

Error Vector Magnitude (EVM)

The most widely used modulation quality metric in digital communications systems is error vector magnitude (EVM). The error vector is the vector difference at a given time between the ideal reference signal and the measured signal (Figure 3-8). The error vector is a complex quantity that contains a magnitude and phase component. It is important not to confuse the magnitude of the error vector with the magnitude error, or the phase of the error vector with the phase error.

Expressed another way, the EVM is the residual noise and distortion remaining after an ideal version of the signal has been stripped away.

Figure 3-8



Error Vector Magnitude (EVM) is the difference between the actual measured signal and an ideal reference signal.

EVM is defined as the root mean square (RMS) of the error vector over time at the instants of the symbol clock transitions. By convention, EVM is usually normalized to either the amplitude of the outermost symbol or the square root of the average symbol power. The EVM measurement and the various related data results are sensitive to any signal impairment that affects the magnitude and phase trajectory of a signal for any digital modulation format. This makes it an ideal measurement tool for troubleshooting communications system problems at baseband, IF, or RF sections of the radio transmitter.

Phase and Frequency Errors

For constant-amplitude modulation formats, such as GMSK used in GSM systems, the I/Q phase and frequency errors are more representative measures of the quality of the signal than EVM. As with EVM, the analyzer samples the transmitter output in order to capture the actual phase trajectory. This is then demodulated, and the ideal

(or reference) phase trajectory is mathematically derived. Comparing the actual and reference signals determine the phase error. The mean gradient of the phase error signal is the frequency error.

Significant phase errors can indicate problems in the baseband section of the transmitter. The output amplifier in the transmitter can also create distortion that causes unacceptably high phase error for multi carrier signals. Significant phase error at the beginning of a burst can indicate that a synthesizer is failing to settle quickly enough. In a real system, poor phase error reduces the ability of a receiver to correctly demodulate, especially with marginal signal conditions. This ultimately degrades sensitivity.

Frequency error is the difference between the specified carrier frequency and the actual carrier frequency. A stable frequency error simply indicates that a slightly wrong carrier frequency is being used. Unstable frequency errors can indicate short-term instability in the LO, improper filtering, AM-PM conversion in the amplifier, or wrong modulation index if the transmitter is implemented using an analog frequency modulator.

Rho

CDMA systems use ρ (rho) as one of the modulation quality metrics. Rho is measured on signals with a single code channel. It is the ratio of correlated power to total power transmitted. The correlated power is computed by removing frequency, phase and time offsets, and performing a cross correlation between the corrected measured signal and the ideal reference. If some of the transmitted energy does not correlate, this excess power appears as added noise that may interfere with other users on the system.

The rho measurement indicates the overall modulation performance level of a CDMA transmitter when transmitting a single channel. Since un-correlated power appears as interference, poor rho performance affects the capacity of the cell.

Impairments

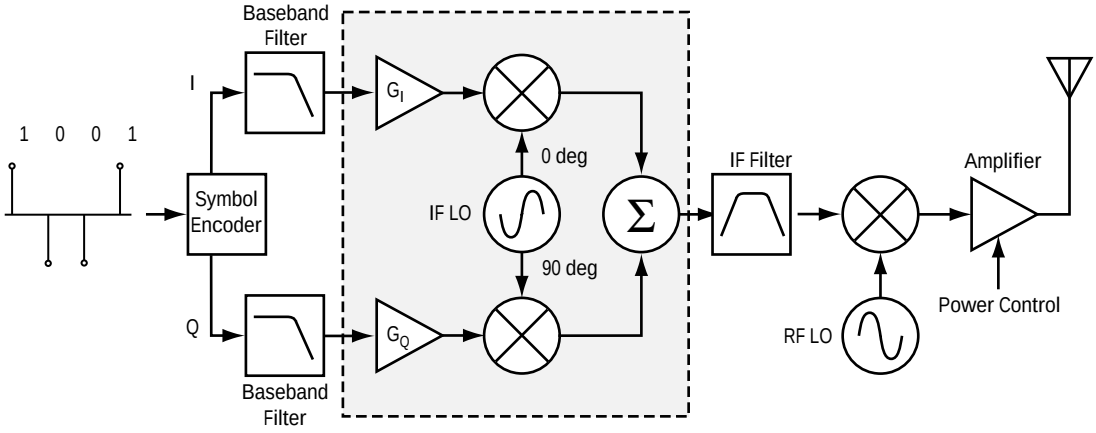
How can you verify the different I/Q impairments? The best way to verify most I/Q impairments is to look at the constellation and EVM metrics.

Matching problems due to component differences between the I side and Q side of a network can cause I/Q impairments. The I/Q modulator in the transmitter is a significant source of I/Q impairments. A diagram of it is shown in Figure 3-9.

For any of these errors, magnifying the scale of the constellation can help detect subtle imbalances visually. Since the constellation is affected, these errors deteriorate EVM.

The most common I/Q impairments are listed below:

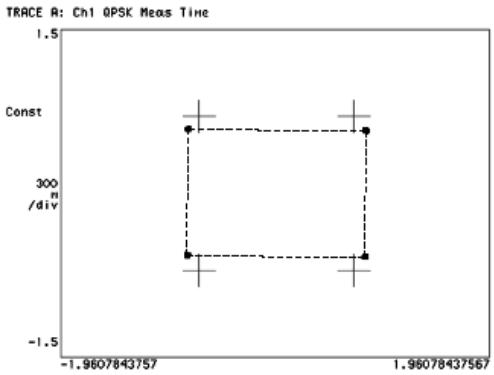
Figure 3-9 *I/Q Modulator a source of Impairments*



I/Q Gain Imbalance

Since I and Q are two separate signals, each one is created and amplified independently. Inequality of this gain between the I and Q paths results in incorrect positioning of each symbol in the constellation, causing errors in recovering the data. I/Q gain imbalance results in an asymmetric constellation, as seen in Figure 3-10. This problem is rare in systems where the IF is implemented digitally.

Figure 3-10 *I/Q Gain Imbalance*

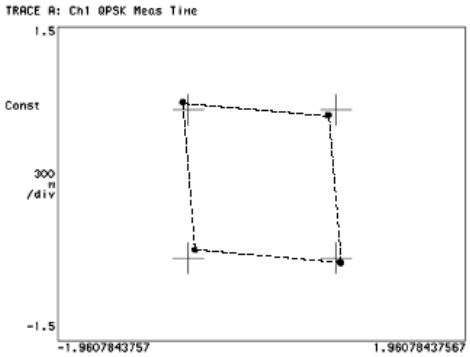


Quadrature errors

Quadrature errors. If the phase shift between the IF (or RF) LO signals that mix with the I and Q baseband signal at the modulator is not 90 degrees, a quadrature error occurs. The constellation of the signal is distorted (see Figure 3-11 on page 98), which may cause error in the interpretation of the recovered symbols.

Quadrature errors result in a “tipped” or skewed constellation, as seen in Figure 3-11

Figure 3-11 *I/Q Quadrature Errors*

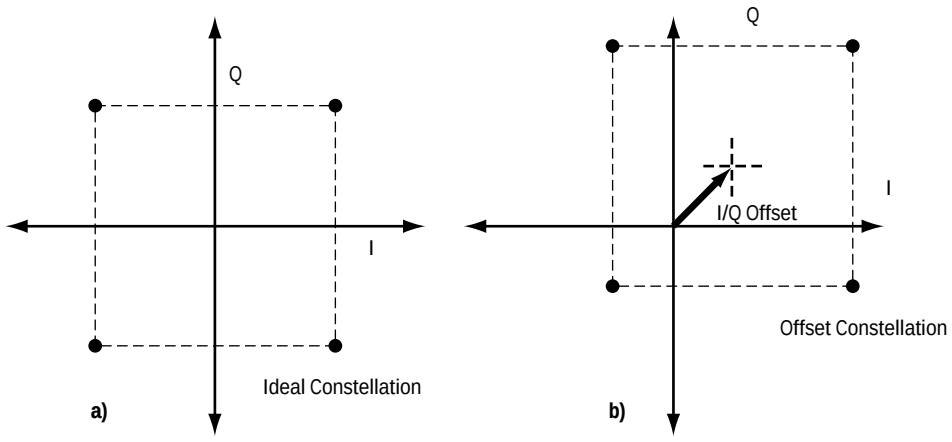


I/Q Offsets

DC offsets may be introduced in the I and Q paths. They may be added in by the amplifiers in the I and Q paths, see Figure 3-12.

For digital IF implementations, offsets may also occur from rounding errors in the DSP. I/Q offsets result in carrier feed through. Some instruments compensate for this error before displaying the constellation or polar diagram and measuring EVM. In that case, I/Q offset is given as a separate error metric.

Figure 3-12 *Ideal Versus I/Q Offset Constellation*



Delays in I/Q paths

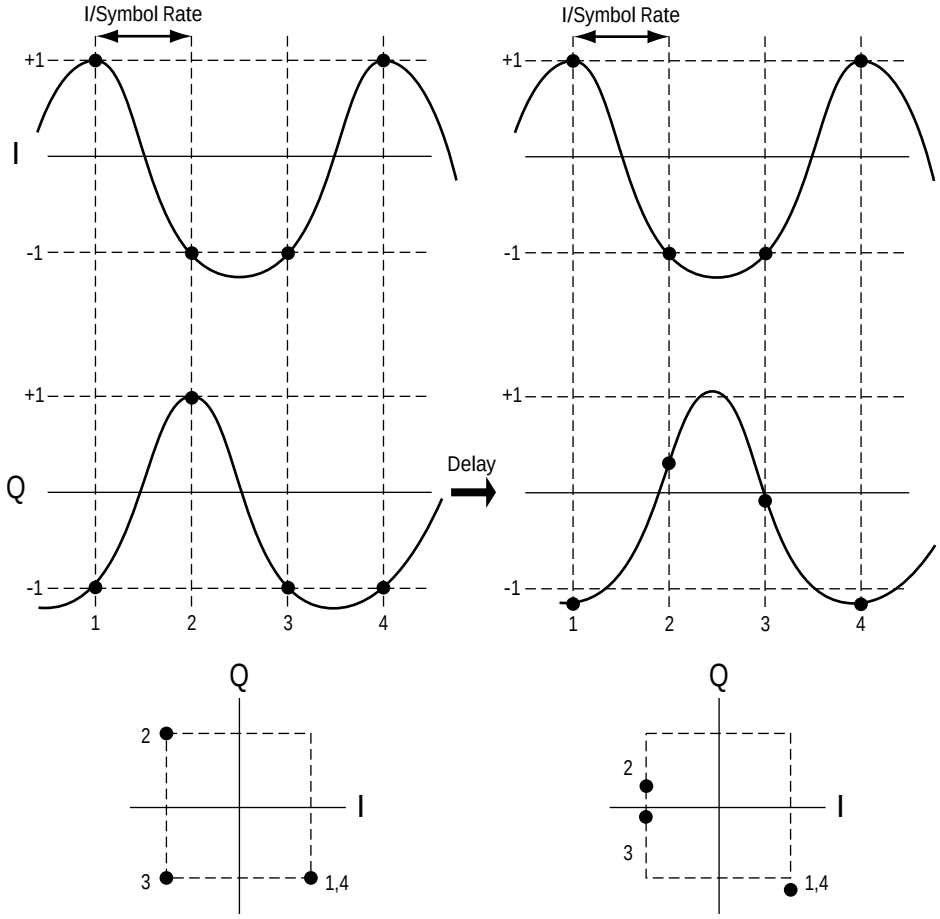
Delays in the I or Q paths also distort the measured constellation.

When the serial bit stream is encoded into symbols and the bits are split into parallel paths for creation of the I and Q signals, it is important that these signals are properly aligned. Problems in this process can cause unwanted delays between the I and Q signals. Delays can be caused by the modulator or by the previous components in the I or Q paths (for example, the baseband filter or the DAC). For instance, if the baseband filters are analog, variations in group delay between the filters cause

different delays in the I and Q paths. Different electrical lengths in the I and Q paths may also cause significant delay differences between the two paths, especially for signals with wide bandwidths (high symbol rates). See Figure 3-13.

However, if the delay is an integer number of samples, the final encoded symbols transmitted appear positioned correctly but are incorrect. The error cannot be detected unless a known sequence is measured. Mathematical functions in the measuring instrument can help compensate for delays between I and Q, by allowing you to introduce delays in the I or Q paths. In this way, you can confirm and measure the delay.

Figure 3-13 *Delays in I/Q paths*

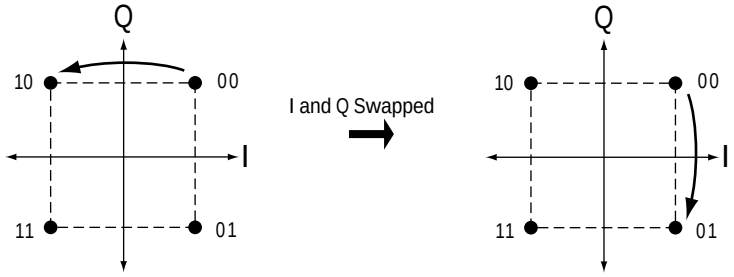


I/Q Signals “Swapped”

“Swapping”, or accidentally exchanging, the I and Q signals reverses the phase trajectory and inverts the spectrum around the carrier. Therefore, swapping the I and Q or changing the sign of the shift (+90 or –90 degrees) makes a difference in the signal transmitted:
cos(ω LO t)–jsin(ω LO t) versus cos(ω LO t)+jsin(ω LO t).

The mapping of the IF I and Q signals is reversed, which causes symbol errors, as seen in Figure 3-14

Figure 3-14 *I/Q Signals “Swapped”*



The condition I/Q swapped, results in an inverted spectrum. However, because of the noise-like shape of digitally modulated signals, the inversion is usually undetectable in the frequency domain.

Code Domain Measurement Concepts

What is the Code Domain?

Code domain power is an analysis of the distribution of signal power across the set of code channels, normalized to the total signal power. To analyze the composite waveform, each channel is decoded using a code-correlation algorithm. This algorithm determines the correlation coefficient factor for each code. Once the channels are decoded, the power in each code channel is determined.

The code domain power composite view provides information about the in-channel characteristics of the TD-SCDMA (3GPP) signal. It directly informs the user of the active channels with their individual channel powers. The composite view also shows which data rates are active and the corresponding amount of code space used.

When the level of the code domain noise floor is too high, relative to a reference or an expected level, one of the possible causes might be due to CW interference, like local oscillator feedthrough or spurs. I/Q modulation impairments can be another source of this uncorrelated noise. The I/Q demodulation measurements can reveal errors such as I/Q gain imbalance or I/Q quadrature error.

Purpose

The code domain power measurement helps you not only verify that each channel is operating at its proper amplitude, but also identify problems throughout the transmitter design from the coding to the RF section. In particular, the levels of the inactive channels can provide useful information about specific impairments. Ideally, the levels for the inactive channels would be zero. In reality, signal and system imperfections compromise the code orthogonality and result in a certain amount of signal power projecting onto inactive codes. A real signal will also have a certain noise level, which being random, will project more or less evenly onto all codes.

The projection of the error is interesting because it enables you to see how the error power is distributed in the code domain. You want the error power to be evenly distributed throughout the code domain, rather than concentrated in a few codes, to avoid code-dependent channel quality variations.

One possible cause of uneven distribution of error power is LO instability. In essence, energy is lost from the active channels and appears in those channels with codes that are closely related to the active channel codes. In the case of OVSF codes, this results in higher code domain noise for channels with code assignments consecutive to the active channel code, whether they are at the same or at a different I/Q path.

Peak Code Domain Error

To address the possibility of uneven error power distribution, the composite EVM measurement has been supplemented by another test called peak code domain error that specifies a limit for the error power in any one code.

The result of the measurement coincides with the peak active code domain error, which calculates the error only in the active code channels.

Symbol EVM

Apart from looking at the code domain power and peak code domain error, it is useful to analyze a specific code channel. The following sections describe some analysis tools and how they can be applied.

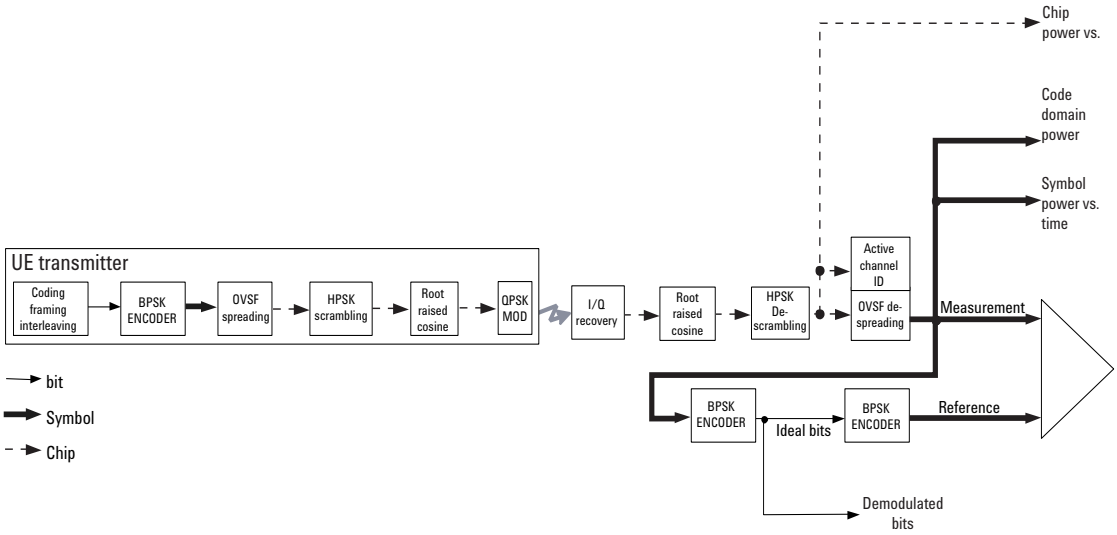
By descrambling and despreading the signal you can analyze the constellation and EVM for a specific code channel at the symbol level, even in the presence of multiple codes.

An impairment that affects symbol EVM will also affect the composite EVM. For example, an amplifier compression problem will appear both in the composite EVM and in the symbol EVM measurement. However, because of the spreading gain symbol EVM will mute the impairment. So why use symbol EVM?

Symbol EVM provides the bridge between RF and demodulated bits. Since it includes the spreading gain, it provides a measure of modulation quality closer to real-life performance. In this sense, you can think of symbol EVM as the actual quality the user in that channel will experience (similar to the reciprocal of the bit error rate).

The relationship between symbol EVM and chip EVM depends on the SF. At low SFs (high data rates) chip modulation errors have a significant effect on symbol EVM. But at high SFs, chip modulation errors have little effect on symbol EVM. In this sense, it is particularly useful to baseband digital signal processing (DSP) engineers to evaluate symbol quality and analyze how specific impairments affect the quality of channels at different data rates.

Figure 3-15 *Process to Calculate Code Domain Power, Symbol EVM, Symbol Power vs. Time, Chip Power vs. Time, and Demodulated Bits*
US (UL) above, BS (DL) below



Symbol Power versus Time (PvT)

Analyzing the symbol power for a specific code channel versus time can be particularly useful to monitor the power and response of the UE power control system for different code channels.

Chip power represents the total power of the signal at the chip rate. Analyzing the symbol power for a channel in combination with the total chip power versus time is particularly useful for system integrators to analyze the power amplifier response (ripple) to a power control command.

To view this combination display, you must select **Display**, **Composite Chip Power**, **ON**.

Demodulated Bits

By obtaining the demodulated bits after descrambling and despreading for each code channel, the correct bit patterns can be verified. You can verify if the bits for the different fields (Pilot, TPC, etc.) are correct by using the demodulated bits measurement.

Analyzing demodulated bits enables baseband engineers to identify coding and interleaving errors. In many cases, it can help you clarify situations where the BTS and UE are having problems communicating with each other. Analyzing the demodulated bits may verify whether the error is coming from the UE coding and interleaving, or the BTS de-interleaving and decoding process.

Modulation Scheme Selection

Modulation scheme selections are available to allow you to determine how the instrument demodulates detected TD-SCDMA active channels. There are three choices available under the **Meas Setup**, **Mod Scheme** menu:

- **Auto** - Use this setting to specify detected active channels will be automatically examined to determine modulation scheme based on the assumption the modulation scheme for ALL channels remains constant throughout the entire **Capture Intvl** (Interval) setting. When this criteria is met, this setting offers the most stable detection results.
- **QPSK** - The code channels specified by the **Symbol Rate** and **Code Number** settings are known to be QPSK modulated.
- **8QPSK** - The code channels specified by the **Symbol Rate** and **Code Number** settings are known to be 8QPSK modulated.
- **16QAM** - The code channels specified by the **Symbol Rate** and **Code Number** settings are known to be 16QAM modulated.

You should use the **Auto** setting when measuring HSDPA signals that employ Adaptive Modulation and Coding (AMC). With AMC, the modulation scheme changes dynamically between QPSK and 16QAM, so the **AUTO** detection algorithm cannot correctly calculate the difference, or EVM, between the reference and vector symbols. With **Auto** you can select the symbol boundary that defines

which slots may be detected as containing active channels. Use the **Symbol Rate** and **Code Number** settings to define these channels so only one modulation scheme is present in a measurement interval.

Measurement Method

This procedure measures the power levels of the spread channels in composite RF channels. For BTS tests, the symbol based sync type is available for defining any channel code to synchronize with. If **Device** is set to **MS**, the demodulated I and Q signals are individually shown in the code domain power graph window. Unlike most of the other measurements, the default setting for **Measure** in the **Meas Control** menu is **Single** for this measurement.

The code domain measurement displays the power for each of the spread channels. This power is relative to the total power within the 1.60 MHz channel bandwidth and centered around the center frequency. Each spread channel level is displayed as an individual vertical bar with a different width determined by a spread rate. Because this is a relative measurement, the default unit of measure is dBc.

Modulation Accuracy (Composite EVM)

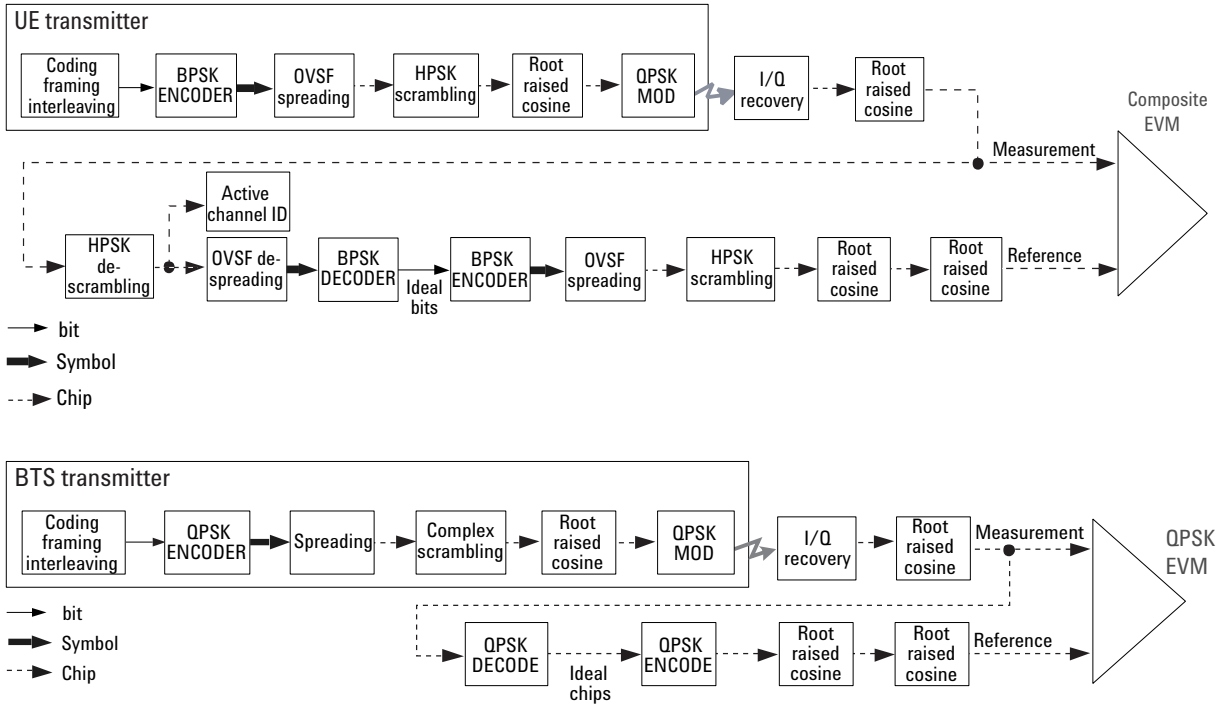
Purpose

The Modulation Accuracy (Composite EVM) measurement is made to qualify a transmitter. The Symbol EVM is for measuring a single coded channel. The composite EVM measurement is the modulation accuracy against the multi coded reference chip power through the spreading and scrambling circuits. For more basic information on Error Vector Magnitude measurements see "Error Vector Magnitude (EVM)" on page 95.

Rho is one of the key modulation quality metrics, along with EVM and code domain power. Rho is the ratio of the correlated power in a multi coded channel to the total signal power. 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 distortions. This provides an overall indication of the performance level of the transmitter of the unit under test (UUT). It corresponds to the modulation accuracy conformance test specified in the 3GPP specifications [9].

To evaluate the modulation accuracy of a TD-SCDMA multi-channel signal, we again need to synthesize a reference signal. The signal under test is downconverted (the baseband I and Q signals are recovered) and passed through a root raised cosine receiver filter. Active channels are descrambled, despread, and QPSK decoded to bits for UL signals and DL signals (see Figure 3-16 on page 106).

Figure 3-16 Process to Calculate Composite EVM for TD-SCDMA Signal



The despread bits are “perfectly” remodulated to produce the required reference signal at the chip level. The reference signal is then subtracted from the measured signal to produce a time record of error phasors. The square root of the ratio of the mean power of the error signal to the mean power of the reference signal is computed and expressed as a percentage EVM.

The composite EVM measurement accounts for all spreading and scrambling problems in the active channels and for all baseband, IF, and RF impairments in the transmitter chain.

There are several situations were you will want to use the Composite EVM measurement (and its related vector diagram, phase error and magnitude error metrics, etc.):

1. To evaluate the quality of the transmitter for a multi-channel signal. This is particularly important for RF designers, who need to test the RF section (or components) of the transmitter using realistic signals with correct statistics. In general, the peak-to-average power ratio of the signal increases as the number of channels increases. By measuring modulation quality on a multichannel signal you can analyze the performance of the RF design for TD-SCDMA UL signals with different levels of stress (different CCDFs). Evaluating the modulation quality of multi-channel signals is also important for the baseband designers to analyze the performance of multi-board baseband designs. For example, a small timing error in the clock synchronization between channels on different boards can be detected as a decrease in modulation quality.

2. Use the composite EVM measurement to detect spreading or scrambling errors. Depending on the degree of the error, the analyzer may show an intermittent unlock condition or may not be able to lock at all when trying to perform a composite EVM measurement. This is mainly useful to system integrators to determine errors in the spreading and scrambling. If this problem occurs, you can use the symbol EVM measurement to confirm that the rest of the transmitter is working as expected. If the scrambling or spreading error does not cause an unlock measurement condition, you can use the error vector versus time display to find the problematic chip.
3. Use the composite EVM measurement to detect certain problems between the baseband and RF sections. This is mainly useful for system integrators. For example, LO instability caused by interference from digital signals can be detected with symbol EVM. However, the symbol EVM measurement will not detect problems that require the measurement to synchronize with a bit sequence. For example, I/Q swapped (reversed I and Q) errors will look perfectly normal if a symbol EVM measurement is used. On the other hand, it will cause an unlock condition when performing a composite EVM measurement.

Measurement Method

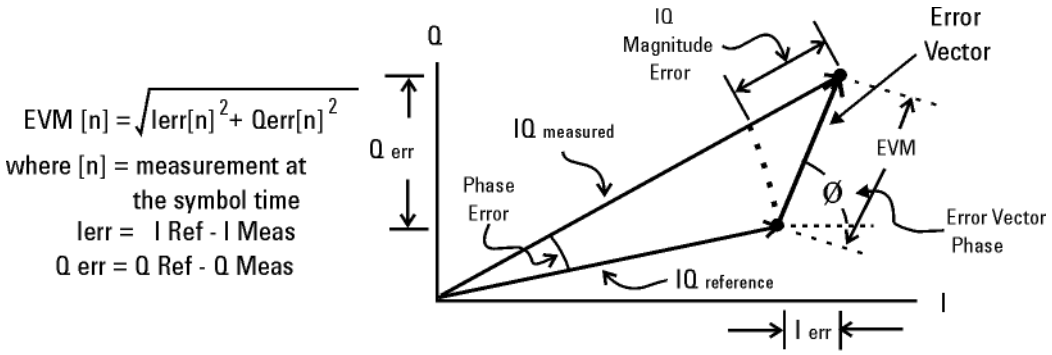
The modulation accuracy measurement is made to get results for a composite error vector magnitude, rho, and code domain error from this difference. The code domain error is computed by projecting the error vector power onto the code domain at the maximum spreading factor. The error vector for each power code is defined as the ratio to the mean power of the reference waveform expressed in dB. Rho values are in the range of 0 to 1. A value of 1 indicates perfect correlation to the reference (high modulation quality).

When a modulation accuracy measurement is performed, the following data is provided (See Figure 3-17 on page 108):

- Rho - modulation quality representing the ratio of the correlated power in a multi coded channel to the total signal power
- EVM - peak and rms error vector magnitude
- Peak CDE - peak code domain error at the code number, with respect to the ideal total power
- Peak Active CDE - peak active code domain error with a code number
- Magnitude Error - peak and rms magnitude error
- Phase Error - peak and rms phase error
- Freq Error - the frequency difference between the transmitter’s actual center frequency and the frequency (or channel) that you entered
- I/Q Offset - the origin offset for I/Q signals,
- Time Offset - the time offset between the measured and ideal start times for the indicated timeslot relative to the specified time reference.

- IQ Imbalance - the gain imbalance in the selected timeslot and sub-frame, defined as Igain/Qgain
- Quad Error- 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.

Figure 3-17 Error Vector Magnitude and Related Parameters



Error Vector Magnitude (EVM) is the difference between the actual measured signal and an ideal reference signal.

To perform the Modulation Accuracy measurements, you can also get following trace results, either on the screen display or via SCPI commands:

- Capture Time Data Trace
- Filtered Analysis Subframe Data Trace
- I/Q Measured Polar Data Trace (Unnormalized and Normalized)
- Magnitude Error vs. Chips Trace
- Phase Error vs. Chip Trace
- EVM vs. Chip Trace
- Code Length Trace
- Active Flag of Code Channels Trace
- Code Domain Power vs. Code Channels Trace (Unnormalized and Normalized)
- Code Domain Error vs. Code Channels Trace (Normalized)
- Power vs. Timeslots Trace
  - — Total power vs. timeslots trace
  - — Midamble power vs. timeslots trace
  - — Before Midamble power vs. timeslots trace
  - — After Midamble power vs. timeslots trace
- Time Offset vs. Timeslot Trace

- Limit PASS/FAIL Trace
- Active Flag of Timeslot Trace

Spectrum (Frequency Domain) Measurement Concepts

Purpose

The spectrum measurement provides spectrum analysis capability for the instrument. The control of the measurement was designed to be familiar to those who are accustomed to using swept spectrum analyzers.

This measurement is FFT (Fast Fourier Transform) based. The FFT-specific parameters are located in the **Meas Setup, Advanced** menu. Also available under basic mode spectrum measurements is an I/Q waveform 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 in the spectrum measurement is that it allows you to view complex components of the same signal without changing settings or measurements.

Measurement Method

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

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.

Waveform (Time Domain) 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 RF Envelope window, or an I/Q Waveform 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
- W-CDMA
- 1xEV-DO
- LTE
- LTE TDD
- DTMB
- DVB-T/H
- ISDB-T
- CMMB

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 115.

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 an 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, CDMA, GSM, W-CDMA).
- Modulation accuracy – that is,. I/Q plane metrics:
  - — rho
  - — error vector magnitude; rms, peak, or 95%
  - — carrier feed-through
  - — frequency error
  - — magnitude and phase errors
- Code-domain analysis (including code-specific metrics)
- CCDF of $I^2 + Q^2$
- Single sideband (SSB) metrics for assessing output quality
- 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 MΩ impedance input passive probes as well as the Keysight 1153A active differential probe using the InfiniMax probe interface.

The Keysight 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 MΩ 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 Keysight 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:

Table 3-2

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 MΩ, 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 Keysight 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.)

Table 3-3

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 Keysight 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 limit 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 Views for Baseband I/Q Inputs

For Waveform measurements, two displays are available for baseband I/Q input signals; the I and Q Waveform view, which separates the individual I and Q traces, and the RF Envelope view.

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.