

Keysight X-Series Signal Analyzers

This manual provides documentation for the following Analyzers:

PXA Signal Analyzer N9030A
EXA Signal Analyzer N9010A

MXA Signal Analyzer N9020A
CXA Signal Analyzer N9000A

Notice: This document contains references to Agilent. Please note that Agilent's Test and Measurement business has become Keysight Technologies. For more information, go to www.keysight.com.

N9071A &
W9071A
GSM/EDGE
Measurement
Application
Measurement
Guide

Notices

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1 Introduction to GSM and EDGE

This chapter provides overall information on the Keysight N9071A & W9071A GSM/EDGE Measurement Application, and describes GSM and EDGE measurements made by the application.

What does the Keysight N9071A GSM/EDGE Measurement Application do?

This application makes measurements that conform to the ETSI EN 300 910 (GSM 05.05), ETSI EN 300 607.1, (GSM 11.10-1), ETSI EN 301 087 (GSM 11.21), and ANSI J-STD-007 specifications. It also complies with the 3GPP TS 51.021 Base Station System (BSS) equipment specification; Radio Aspects (Release-5) V.5.3.0 (2003-06), and the 3GPP TS 51.010-1 Mobile Station (MS) Conformance specification; Part 1: Conformance specification (Release-5) V.5.4.0 (2003-06).

These documents define complex, multi-part measurements used to maintain an interference-free environment. For example, the documents include measuring the power of a carrier. The application automatically makes these measurements using the measurement methods and limits defined in the standards. The detailed results displayed by the measurements allow you to analyze GSM and EDGE system performance. You may alter the measurement parameters for specialized analysis.

This application was primarily developed for making measurements on digital transmission carriers. These measurements can help determine if a GSM transmitter is working correctly. The application is capable of measuring the continuous carrier of a base station transmitter.

For infrastructure test, the application can test base station transmitters in a non-interfering manner through use of a coupler or power splitter.

This application makes the following measurements:

- Transmit Power Measurement - see [page 19](#)
- GMSK Power vs. Time Measurement - see [page 23](#)
- GMSK Phase and Frequency Error Measurement - see [page 29](#)
- GMSK Output RF Spectrum (ORFS) Measurement - see [page 35](#)
- GMSK Tx Band Spur Measurement - see [page 45](#)
- EDGE Power vs. Time Measurement - see [page 49](#)
- EDGE Error Vector Magnitude (EVM) Measurement - see [page 55](#)
- EDGE Output RF Spectrum (ORFS) Measurement - see [page 63](#)
- EDGE Tx Band Spur Measurement - see [page 75](#)
- Monitor Spectrum (Frequency Domain) Measurement - see [page 79](#)
- IQ Waveform (Time Domain) Measurement - see [page 81](#)

For conceptual information about these measurements see [Chapter 3, "Concepts", on page 89](#).

2 Making Measurements

This chapter describes procedures used for making measurements of GSM and EDGE BTS or MS. Instructions to help you set up and perform the measurements are provided, and examples of GSM and EDGE measurement results are shown.

GSM and EDGE Measurements

The following measurements for the GSM 450, GSM 480, GSM 700, GSM 850, GSM 900, DCS 1800, and PCS 1900 bands are available in the GSM/EDGE Measurement Application (except for the Tx Band Spurs measurement, which supports P-GSM, E-GSM, R-GSM, DCS 1800, and PCS 1900 only):

When you press the key to select a measurement, it becomes the active measurement, using settings and a display unique to that measurement. Data acquisitions automatically begin, provided trigger requirements, if any, are met.

Transmit Power – This test verifies in-channel power for GSM and EDGE systems. Good measurement results ensure that dynamic power control is optimized, overall system interference is minimized, and mobile station battery life is maximized. See [“Transmit Power Measurements” on page 19](#)

Power vs. Time – Verifies that the transmitter output power has the correct amplitude, shape, and timing for the GSM or EDGE format. GMSK and EDGE versions of this measurement are available. See [“GMSK Power vs. Time \(PVT\) Measurements” on page 23](#) and [“EDGE Power vs. Time \(PVT\) Measurements” on page 49](#).

Phase and Frequency – Verifies modulation quality of the 0.3 GMSK signal for GSM systems. The modulation quality indicates the carrier to noise performance of the system, which is critical for mobiles with low signal levels, at the edge of a cell, or under difficult fading or Doppler conditions. See [“GMSK Phase and Frequency Error Measurements” on page 29](#).

Output RF Spectrum (ORFS) – Verifies that the modulation, wideband noise, and power level switching spectra are within limits and do not produce significant interference in the adjacent base transceiver station (BTS) channels. GMSK and EDGE versions of this measurement are available. See [“GMSK Output RF Spectrum \(ORFS\) Measurements” on page 35](#) and [“EDGE Output RF Spectrum \(ORFS\) Measurements” on page 63](#).

Tx Band Spur – Verifies that a BTS transmitter does not transmit undesirable energy into the transmit band. This energy may cause interference for other users of the GSM system. GMSK and EDGE versions of this measurement are available. See [“GMSK Transmitter Band Spurious Signal \(Tx Band Spur\) Measurements” on page 45](#) and [“EDGE Transmitter Band Spur Measurements” on page 75](#).

Error Vector Magnitude (EVM) – Provides a measure of modulation accuracy. The EDGE 8 PSK modulation pattern uses a rotation of $3\pi/8$ radians to avoid zero crossing, thus providing a margin of linearity relief for amplifier performance. This is an EDGE-only measurement. See [“EDGE Error Vector Magnitude \(EVM\) Measurements” on page 55](#).

Monitor Spectrum – Provides spectrum analysis capability similar to a swept tuned analyzer. See [“Monitor Spectrum Measurements” on page 79](#).

IQ Waveform – Enables you to view waveforms in the time domain. 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. See [“IQ Waveform \(Time Domain\) Measurements” on page 81](#).

Baseband IQ – Available with option BBA. Provides a the ability to mix baseband I and Q channels and perform measurements on the resulting signal. See [“Using Option BBA Baseband I/Q Inputs” on page 85](#)

Making Measurements
GSM and EDGE Measurements

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.

Step	Action	Notes
1 Select and Set Up the Mode	a. Press Mode b. Press a mode key, such as Spectrum Analyzer, W-CDMA with HSDPA/HSUPA, or GSM/EDGE/EDGE Evo. 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.

Setting Up and Making 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 2-1 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

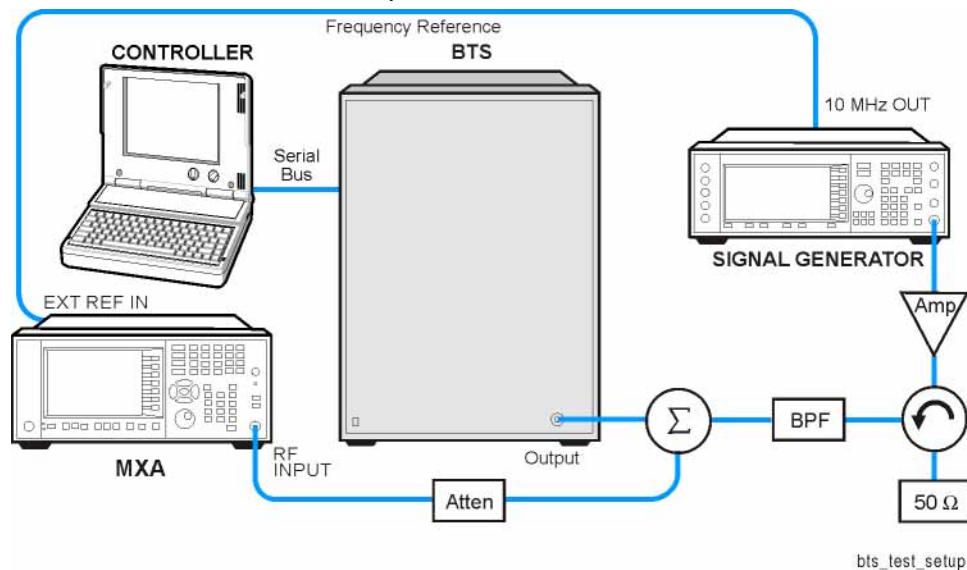
This section explains how to make a Transmit Power measurement on a GSM or EDGE base station. This test verifies in-channel power for GSM and EDGE systems. Good measurement results ensure that dynamic power control is optimized, over all system interference is minimized, and mobile station battery life is maximized.

Configuring the Measurement System

The base station (BTS) under test has 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 2-1

Transmit Power Measurement System



1. Using the appropriate cables, adapters, and circulator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect the base transmission station simulator or signal generator to the BTS through a circulator to initiate a link constructed with sync and pilot channels, if required.
3. Connect a BNC cable between the 10 MHz OUT port of the signal generator and the EXT REF 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:

BTS: Symbol Rate: 270.833 kbps

Transmit Power Measurements

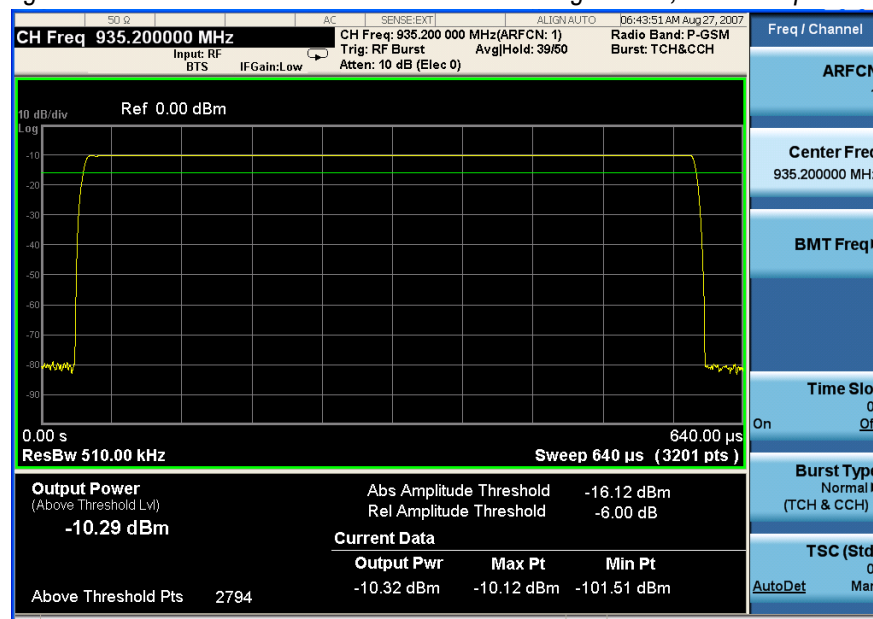
Frequency: 935.2000 MHz (ARFCN number 1)

Output Power: -3 dBW (0.5 W)

Measurement Procedure

Step	Notes
1 Select GSM/EDGE Mode.	Press Mode , GSM/EDGE/EDGE Evo .
2 Preset the analyzer.	Press Mode Preset .
3 Select a trigger source.	Press Trigger .
4 Select the desired center frequency or ARFCN.	Press FREQ Channel .
5 Initiate the measurement.	Press Meas, Transmit Pwr .

Figure 2-2 Transmit Power Result - Single Burst, RF Envelope



The Transmit Power measurement result display should look similar to the example above, with a time domain display of the burst waveform plotted in dB, and the power measurement values displayed below.

Both the averaged and instantaneous results for Mean Transmit Power are displayed on the screen of the analyzer. The Averaged Mean Transmit Power Above Threshold is displayed on the left of the display, while the value of the Mean Transmit Power Above Threshold for the current acquisition is displayed on the right of the screen under the heading Current Data Output Pwr. If averaging is turned off, the two values can be the same. When you turn averaging on the Mean Transmit Power Above Threshold is an averaged value.

Step	Notes
6 Examine keys available to change the measurement parameters from the default condition.	Press Meas Setup .

For More Information

For more details about changing measurement parameters, see [“Transmit Power \(Burst Power\) Measurement Concepts”](#) on page 94.

If you have a problem, and get an error message, refer to the *Instrument Messages* manual.

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.

GMSK Power vs. Time (PvT) Measurements

This section explains how to make a GMSK Power versus Time (PvT) measurement on a GSM base station (BTS). Good PvT measurement results verify that the transmitter output power has the correct amplitude, shape, and timing for the GSM format.

NOTE

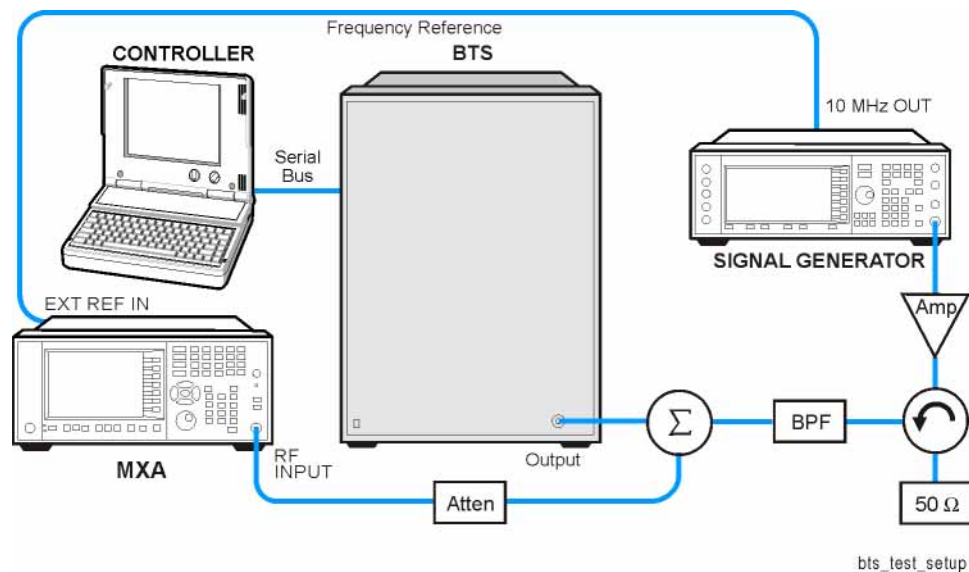
This measurement is designed for GSM. For the EDGE PvT measurement see [“EDGE Power vs. Time \(PVT\) Measurements”](#) on page 49.

Configuring the Measurement System

This example shows a base station (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 2-3

GMSK Pwr vs. Time Measurement System



1. Using the appropriate cables, adapters, and circulator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect the base transmission station simulator or signal generator to the BTS through a circulator to initiate a link constructed with sync and pilot channels, if required.
3. Connect a BNC cable between the 10 MHz OUT port of the signal generator and the EXT REF 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:

BTS: Symbol Rate: 270.833 kbps
 Frequency: 935.2000 MHz (ARFCN number 1)
 Output Power: -3 dBW (0.5 W)

Measurement Procedure

Step	Notes
1 Select GSM/EDGE Mode.	Press Mode , GSM/EDGE/EDGE Evo .
2 Preset the analyzer.	Press Mode Preset .
3 Select a trigger source.	Press Trigger .
4 Select the desired band.	Press Mode Setup, Radio , Band . This determines the frequency and band-related presets. Our example uses the default setting, P-GSM .
5 Select the desired center frequency or ARFCN.	Press FREQ Channel .
6 Select the desired burst type.	Press Burst Type .
7 If your signal of interest contains more than 1 Training Sequence, select a standard Training Sequence.	Press TSC to select a standard Training Sequence (numbered 0-7) to which the measurement will synchronize. The default setting for TSC is Auto Det , which automatically correlates to any one of the standard Training Sequences numbered 0-7.
8 Initiate the measurement.	Press Meas , GMSK Power vs Time .
9 Select the desired power control level.	Press Mode Setup , Radio , Pwr Ctrl Lvl (PCL) . Our example uses the default setting of 1.

Results

The views available under the **View/Display** menu are **Burst**, **Rise & Fall**, and **Multi-Slot**.

Information shown in the settings panel at the top of the displays include:

- **Atten** - This value reflects the **Internal RF Atten** setting.
- **Sync** - The **Burst Sync** setting used in the current measurement
- **Trig** - The **Trigger Source** setting used in the current measurement

The Mean Transmit Power is displayed at the bottom left of the Burst and Rise & Fall views:

- **Mean Transmit Power** - This is the RMS average power across the “useful” part of the burst, or the 147 bits centered on the transition from bit 13 to bit 14 (the “T0” time point) of the 26 bit training sequence. An RMS calculation is performed and displayed regardless of the averaging mode selected for the trace data.

If Averaging is set to On, the result displayed is the RMS average power of all bursts measured. If Averaging is set to Off, the result is the RMS average power of the single burst measured. This is a different measurement result from Mean Transmit Power, below.

The **Current Data** displayed at the bottom of the Burst and Rise & Fall views include:

- **Mean Transmit Power** - This result appears only if Averaging is set to On. It is the RMS average of power across the “useful” part of the burst, for the current burst only. If a single measurement of “n” averages has been completed, the result indicates the Mean Transmit Power of the last burst. The RMS calculation is performed and displayed regardless of the averaging mode selected for the trace data. This is a different measurement result from Mean Transmit Power, above.
- **Max Pt.** - Maximum signal power point of the most recently acquired data, in dBm
- **Min Pt.** - Minimum signal power point of the most recently acquired data, in dBm
- **Burst Width** - Time duration of burst at -3 dB below the mean power in the useful part of the burst
- **1st Error Pt** - (Error Point) The time (displayed in ms or μ s) indicates the point on the X Scale where the first failure of a signal was detected. Use a marker to locate this point in order to examine the nature of the failure. The 1st Error Pt. date is displayed only when there is an limit failure.

GMSK Power vs. Time (PvT) Measurements

Figure 2-4

GMSK Power vs. Time Result - Burst View

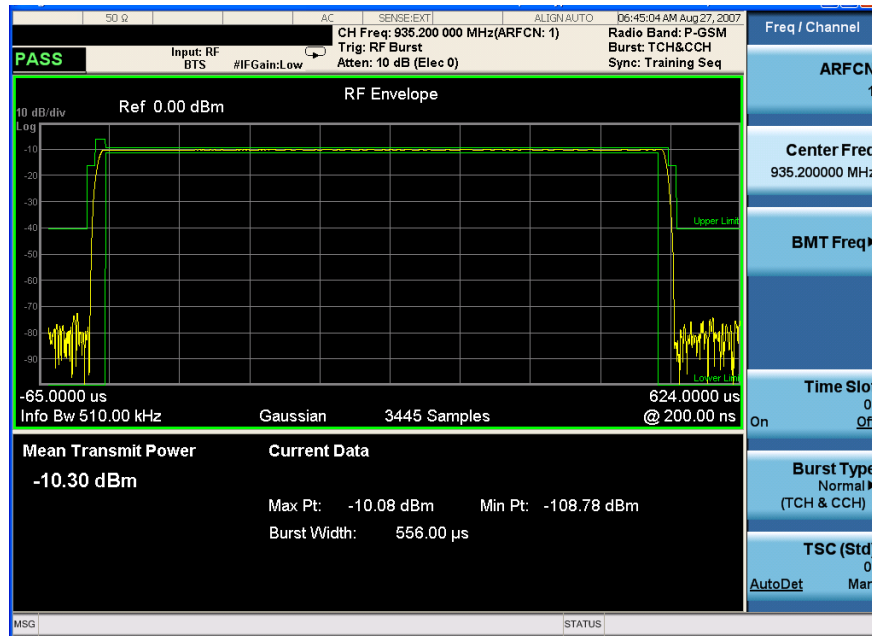


Figure 2-5

GMSK Power vs. Time Result - Rise & Fall View

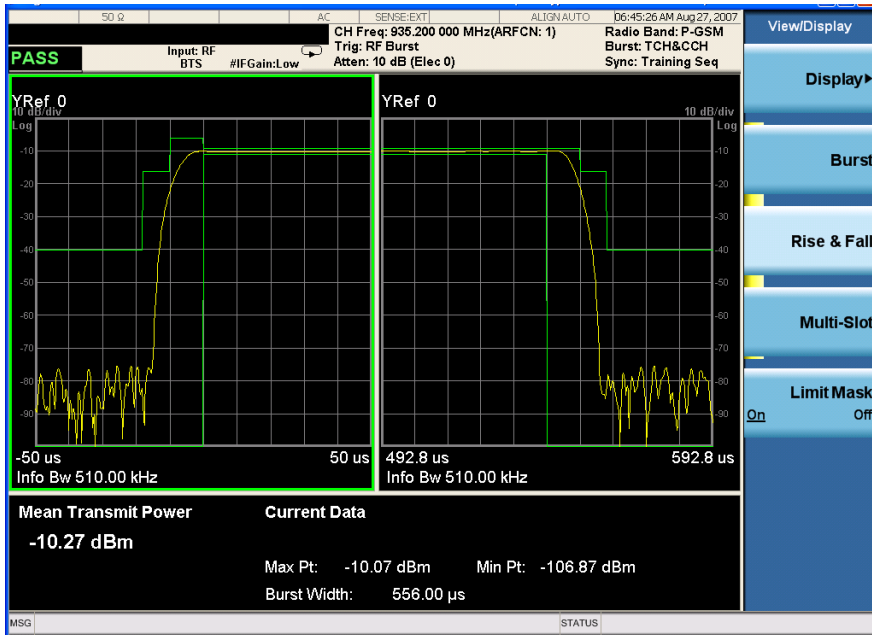
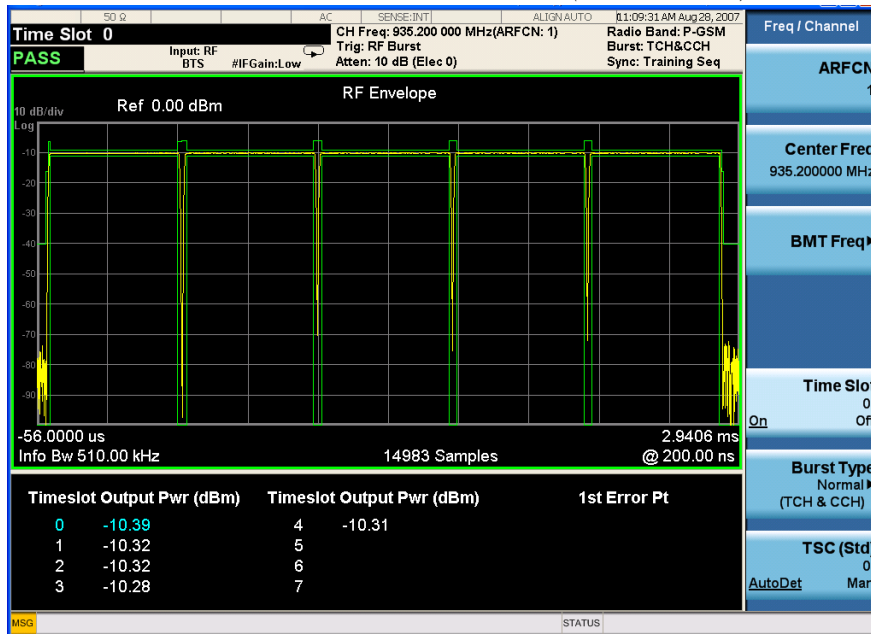


Figure 2-6

GMSK Power vs. Time Result - Multi-Slot View (5 slots shown)



The table in the lower portion of the multi-slot view shows the output power in dBm for each timeslot, as determined by the integer (1 to 8) entered in the **Meas Setup**, **Meas Time** setting. Output power levels are presented for the active slots. A dashed line appears for any slot that is inactive. The timeslot that contains the burst of interest is highlighted in blue.

For more information on making measurements of two consecutive bursts, including the SCPI commands used to make the measurement, refer to the section in the *User's and Programmer's Reference* manual.

For More Information

For more details about changing measurement parameters, see [“EDGE Power vs. Time Measurement Concepts” on page 112](#).

If you have a problem, and get an error message, refer to the *Instrument Messages* manual.

Troubleshooting Hints

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

GMSK Power vs. Time (PvT) Measurements

GMSK Phase and Frequency Error Measurements

This section explains how to make a GMSK Phase and Frequency Error measurement on a GSM base station (BTS). Good measurement results verify modulation quality of the 0.3 GMSK signal for GSM systems. The modulation quality indicates the carrier to noise performance of the system, which is critical for mobiles with low signal levels, at the edge of a cell, or under difficult fading or Doppler conditions.

NOTE

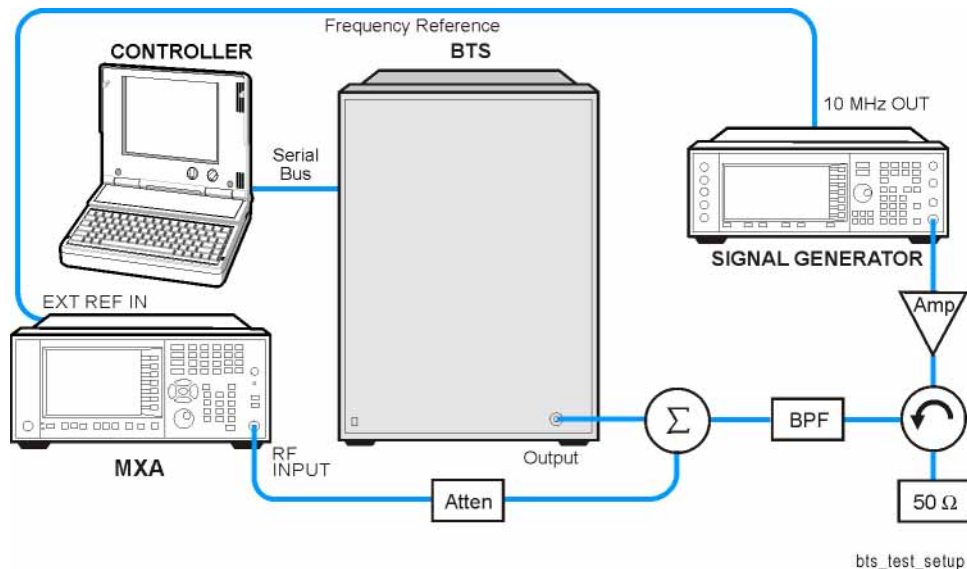
This measurement is designed for GSM only.

Configuring the Measurement System

This example shows a base station (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 2-7

GMSK Phase and Frequency Measurement System



1. Using the appropriate cables, adapters, and circulator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect the base transmission station simulator or signal generator to the BTS through a circulator to initiate a link constructed with sync and pilot channels, if required.
3. Connect a BNC cable between the 10 MHz OUT port of the signal generator and the EXT REF 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)

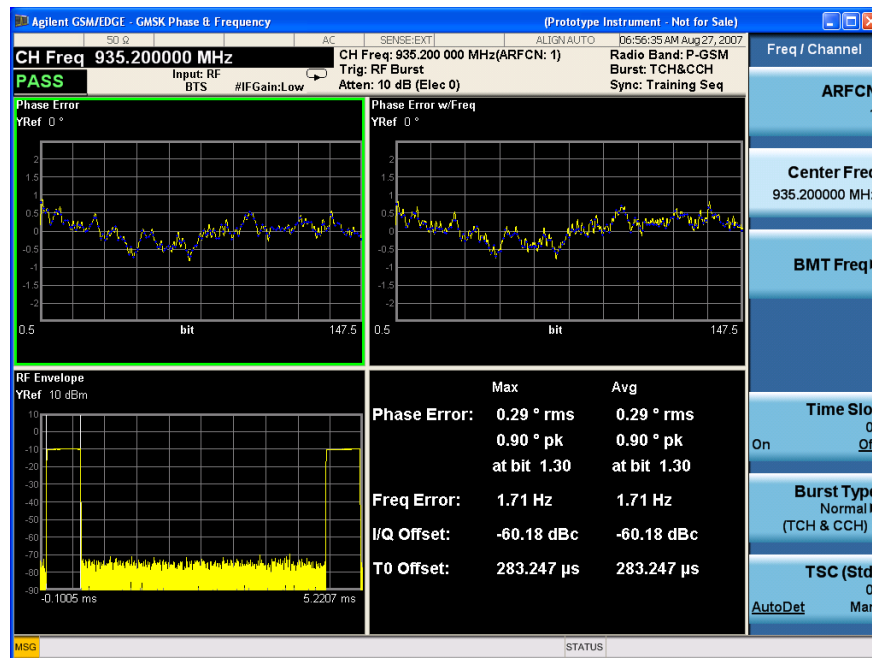
From the base transmission station simulator and the system controller, set up a call using loopback mode for the BTS to transmit the RF power as follows:

BTS: Symbol Rate: 270.833 kbps
Frequency: 935.2000 MHz (ARFCN number 1)
Output Power: -3 dBW (0.5 W)

Measurement Procedure

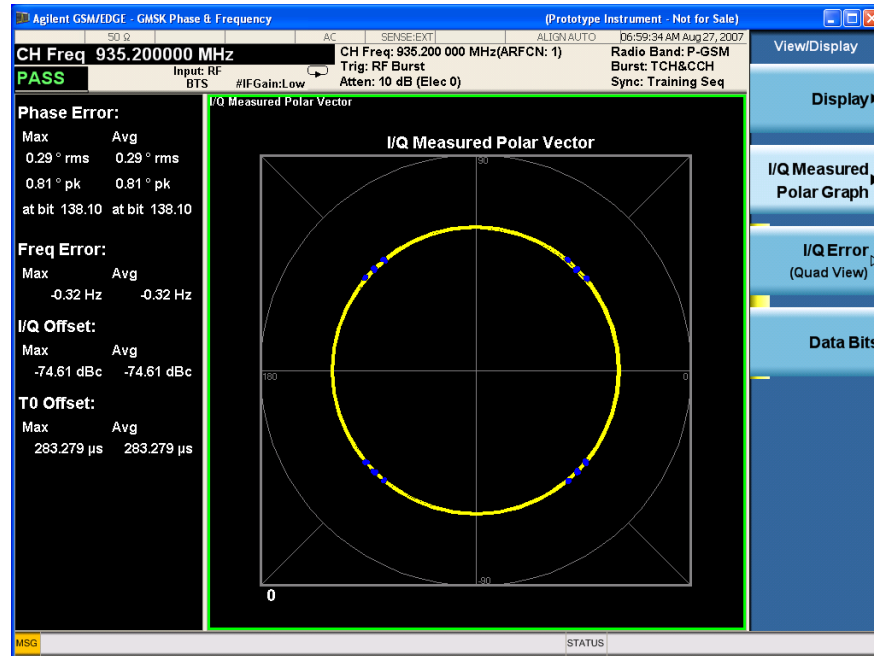
Step	Notes
1 Select GSM/EDGE Mode.	Press Mode , GSM/EDGE/EDGE Evo .
2 Preset the analyzer.	Press Mode Preset .
3 Select a trigger source.	Press Trigger .
4 Select the desired center frequency or ARFCN.	Press FREQ Channel .
5 Select the desired burst type.	Press Burst Type .
6 If your signal of interest contains more than 1 Training Sequence, select a standard Training Sequence.	Press TSC to select a standard Training Sequence (numbered 0-7), to which the measurement will synchronize. The default setting for TSC is Auto , which automatically correlates to any one of the standard Training Sequences numbered 0-7.
7 Initiate the measurement.	Press Meas , GMSK Phase & Freq .

Figure 2-8 GMSK Phase and Frequency Error Result - Quad View (Default)



Step	Notes
8	Expand each of the quadrants for closer inspection. Press Zoom and then Next Window .
9	View the Polar plot of vector data and the Phase and Frequency Error summaries. Press View/Display, I/Q Measured Polar Graph .

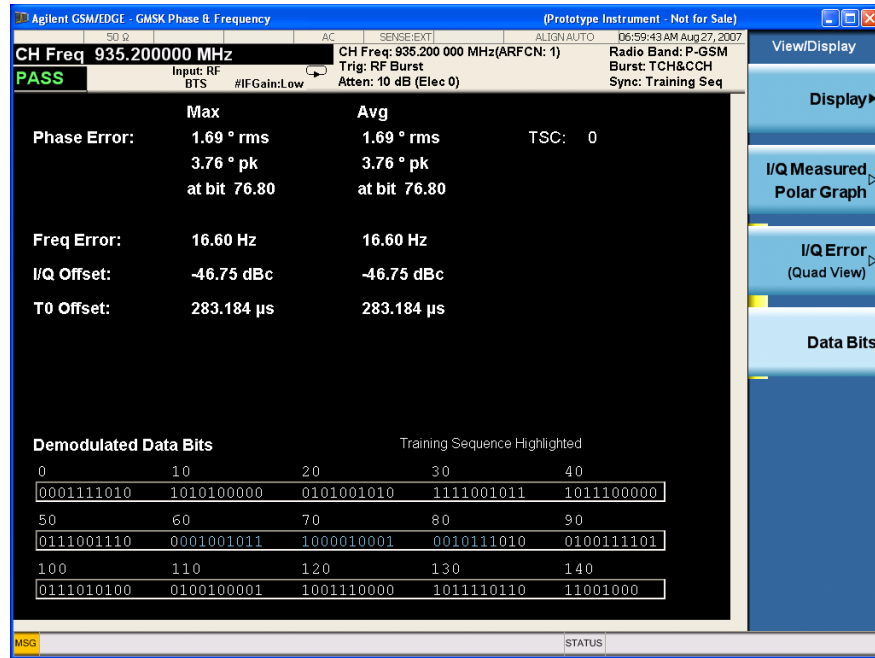
Figure 2-9 GMSK Phase and Frequency Error Result - Polar View



10	Display the Phase Error vs. Frequency information. Press View/Display, Data Bits . The demodulated bits in this display are Symbol State bits, and do not represent encoded message data. See below for an example of this view.
----	--

Step **Notes**

Figure 2-10 GMSK Phase and Frequency Error Result - Data Bits



For More Information

For more details about changing measurement parameters, see “GMSK Phase and Frequency Error Measurement Concepts” on page 103.

If you have a problem, and get an error message, refer to the *Instrument Messages* manual.

Troubleshooting Hints

Poor phase error indicates a problem with the I/Q baseband generator, filters, or modulator in the transmitter circuitry. The output amplifier in the transmitter can also create distortion that causes unacceptably high phase error. In a real system, poor phase error reduces the ability of a receiver to correctly demodulate, especially in marginal signal conditions. This ultimately affects range.

Occasionally, a Phase and Frequency Error measurement may fail the prescribed limits at only one point in the burst, for example at the beginning. This could indicate a problem with the transmitter power ramp or some undesirable interaction between the modulator and power amplifier.

GMSK Output RF Spectrum (ORFS) Measurements

This section explains how to make a GSM Output RF Spectrum measurement on a base station. This test verifies that the modulation, wideband noise, and power level switching spectra are within limits and do not produce significant interference in the adjacent base transceiver station (BTS) channels.

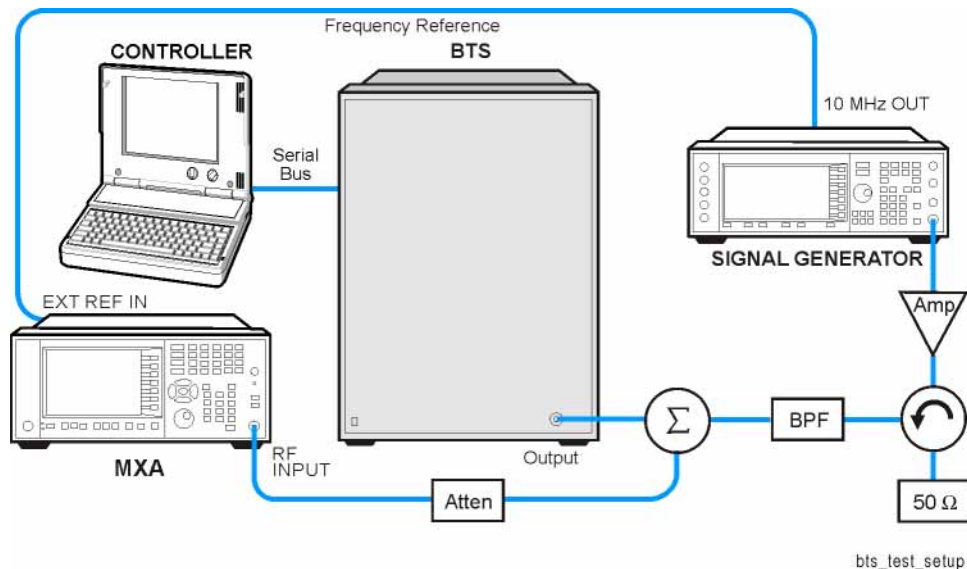
NOTE This measurement is designed for GSM. For the EDGE Output RF Spectrum measurement see “EDGE Output RF Spectrum (ORFS) Measurements” on page 63.

Configuring the Measurement System

This example shows a base station (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 2-11

GMSK ORFS Measurement System



1. Using the appropriate cables, adapters, and circulator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect the base transmission station simulator or signal generator to the BTS through a circulator to initiate a link constructed with sync and pilot channels, if required.
3. Connect a BNC cable between the 10 MHz OUT port of the signal generator and the EXT REF IN port of the analyzer.
4. Connect the system controller to the BTS through the serial bus cable to control the BTS operation.

NOTE If the signal being measured has more than one active slot in a frame, the default RF Burst trigger must be changed, and an external event trigger must be provided to synchronize the frame. Otherwise the measurement may trigger randomly on any burst in an active slot. This is true for all ORFS time domain measurements.

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:

BTS: Symbol Rate: 270.833 kbps
Frequency: 935.2000 MHz (ARFCN number 1)
Output Power: -3 dBW (0.5 W)

Measurement Procedure

Step	Notes
1 Select GSM/EDGE Mode.	Press Mode , GSM/EDGE/EDGE Evo .
2 Preset the analyzer.	Press Mode Preset .
3 Select a trigger source.	Press Trigger .
4 Select the desired center frequency or ARFCN.	Press FREQ Channel .
5 Select the desired burst type.	Press Burst Type .
6 If your signal of interest contains more than 1 Training Sequence, select a standard Training Sequence.	<p>Press TSC to select a standard Training Sequence (numbered 0-9), to which the measurement will synchronize.</p> <p>The default setting for TSC is Auto, which automatically correlates to any one of the standard Training Sequences numbered 0-9. Training Sequence synchronization is applicable only when Periodic Timer Trigger and Periodic Time Sync Source are off.</p>
7 Initiate the measurement.	Press Meas , GMSK Output RF Spectrum .
8 Select the Meas Type .	<p>Press Meas Setup, Meas Type.</p> <p>See “Measurement Types” on page 37 below for details of available measurement types.</p>
9 Select the Meas Method .	<p>Press Meas Setup, Meas Method.</p> <p>See “Measurement Methods” on page 38 below for details of available measurement methods.</p>
10 If you change the Meas Type or Meas Method , re-initiate the measurement.	<p>Press Restart.</p> <p>You can also set Meas Control to Measure Cont for continuous measurements.</p>

Measurement Types

The **Meas Type** key accesses a menu that lets you select the measurement type that is optimized for the type of spectral distortion being investigated.

Mod & Switch - Performs both Modulation and Switching measurements, which measures the spectrum due to the 0.3 GMSK modulation and noise, and Switching (transient) measurements.

Modulation - Measures the spectrum optimized for distortion due to the 0.3 GMSK modulation and noise.

Switching - Measures the spectrum optimized for distortion due to switching transients (burst ramping).

Full Frame Modulation (FAST)- Improves measurement speed by acquiring a full frame of data and reduces actual average number. This feature can only be used when all slots in the transmitted frame are active. Use of an external trigger can enhance measurement speed when this feature is used. When **Full Frame Modulation (FAST)** is selected, the current measurement defaults to the multi-offset measurement method. Therefore, the single offset key and swept key in Meas Method menu are grayed out and these two features are not available.

Measurement Methods

The **Meas Method** key accesses a menu that lets you select the measurement mode.

Multi-Offset - Automatically makes measurements at all offset frequencies in the selected list (**Standard**, **Short**, or **Custom**). Press **Multi-Offset Freq List** to select a list of offsets to measure.

Multi-Offset measurements may be made with either **Modulation** or **Switching** measurement types.

Offset measurement results are displayed as tabular data.

Single Offset (Examine) - Makes a measurement at a single offset frequency as set by the **Single Offset Freq** softkey. This allows detailed examination of the time-domain waveform at the specified offset frequency.

Single Offset (Examine) measurements may be made with either **Modulation** or **Switching** measurement types.

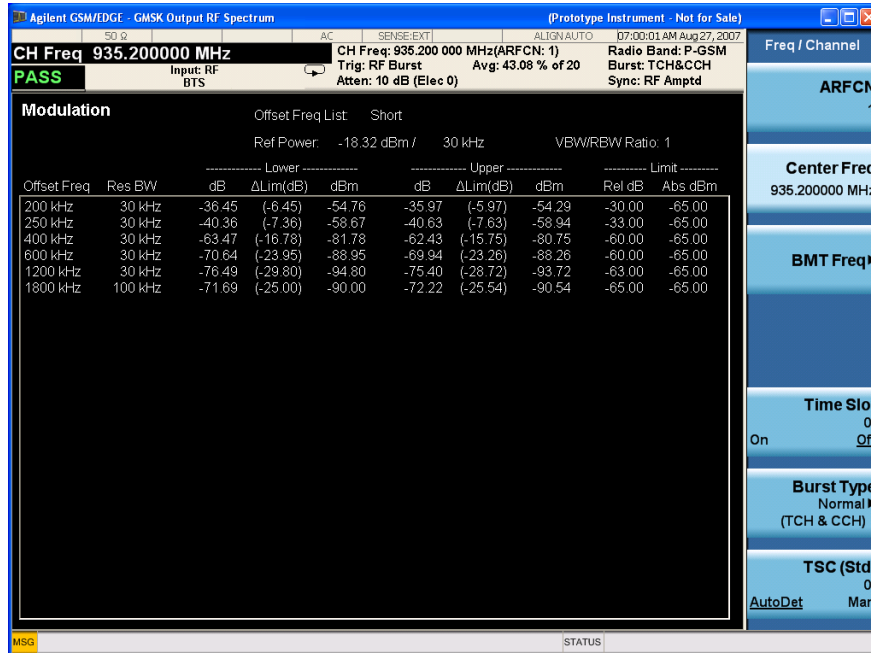
Single offset measurement results are displayed in a time domain plot, with the measurement offset shown as a gate by white vertical lines. See [Figure 2-13 on page 40](#).

Swept - Makes a measurement using time-gated spectrum analysis to sweep the analyzer with the gate turned on for the desired portion of the burst when Meas Type is set to Modulation. When Meas Type is set to Switching, turns off the gate and sweeps with peak detector and appropriate sweep time. The limits mask is applied to the spectrum plot, and the Worst Frequency parameters are displayed. This selection is only available if **Meas Type** is set to **Modulation** or **Switching**. See [Figure 2-16 on page 41](#).

GMSK ORFS Measurement Results

- Modulation Power** - When **Meas Method** is set to **Multi-Offset**, and **Meas Type** is set to **Modulation**, **Mod and Switch**, or **Full Frame Modulation**, measurement results may be viewed as absolute powers in tabular form. The data displays offsets from any of the **Multi-Offset Freq List** settings: **Standard**, **Short**, and **Custom**. The **Modulation Power** view is the default view for ORFS measurements.

Figure 2-12 GMSK ORFS - Example (Short List) Modulation Power View



- Single Offset (Examine)** - Makes a measurement at a single offset frequency as set by the **Offset Freq** softkey.

Single offset measurement results are displayed as a power waveform in a time domain plot, with the measurement offset shown as a gate by white vertical lines. The red vertical lines represent the additional effective measurement window when **Fast Avg** is **ON** (default setting).

You can select the **Single Offset (Examine)** view by pressing **Meas Setup**, **Meas Method**, and then **Single Offset (Examine)**.

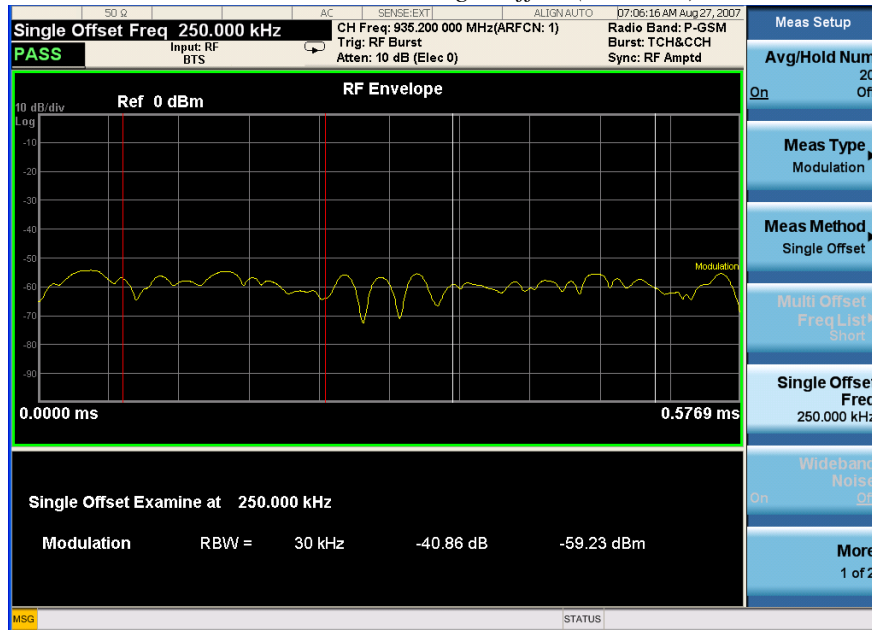
NOTE

The signal being displayed below is the useful part of slot 0, which in this example, is the only active slot in the frame. If any other slots are active, the default RF Burst trigger must be changed, and an external event trigger must be provided to synchronize the frame. Otherwise the measurement may trigger randomly on any burst in an active slot. This is true for all ORFS time domain measurements.

GMSK Output RF Spectrum (ORFS) Measurements

Figure 2-13

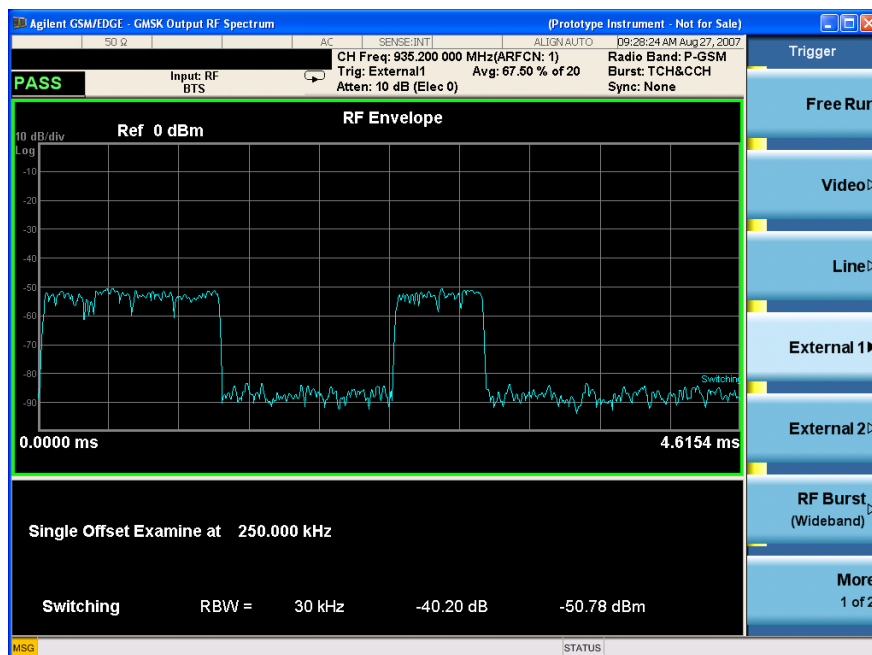
GMSK ORFS Result - Modulation Single Offset (Examine) View



- Switching Single Offset measurement results are displayed in a time domain plot, but the waveform of the entire frame is displayed. In this example, slots 0, 1, and 4 are active. Use the external trigger to maintain frame synchronization. **Fast Avg** is not available for this measurement.

Figure 2-14

GMSK ORFS Result - Switching Single Offset (Examine) View

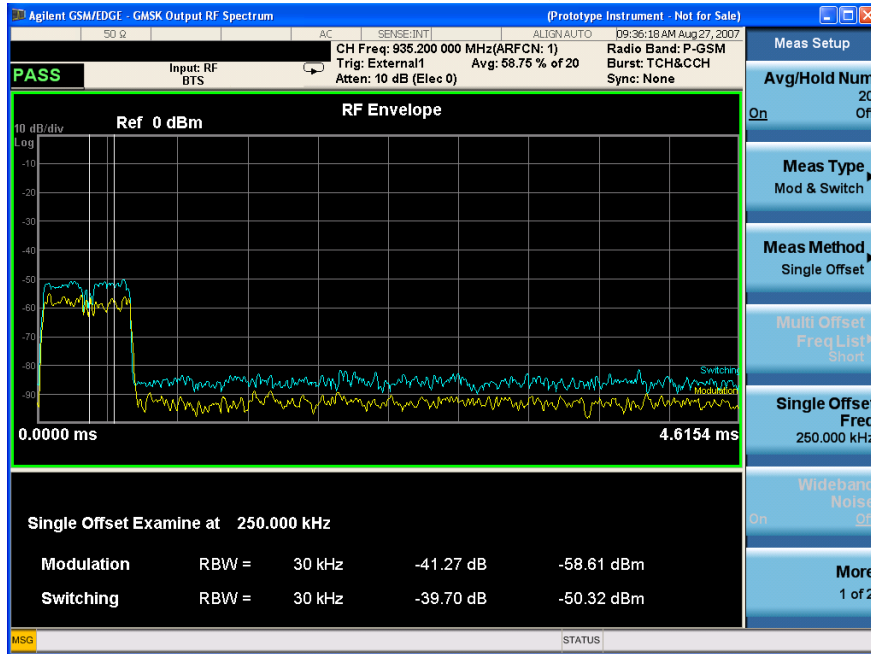


- Combination Modulation and Switching (**Mod & Switch**) Single Offset measurement results are displayed in a time domain plot, but the waveform of the entire frame is displayed. The blue trace is the Switching data and the yellow trace is the Modulation data, with the measurement gates shown.

In this example, slots 1 and 4 are active. Use the external trigger to maintain frame synchronization. **Fast Avg** is not available for this measurement.

Figure 2-15

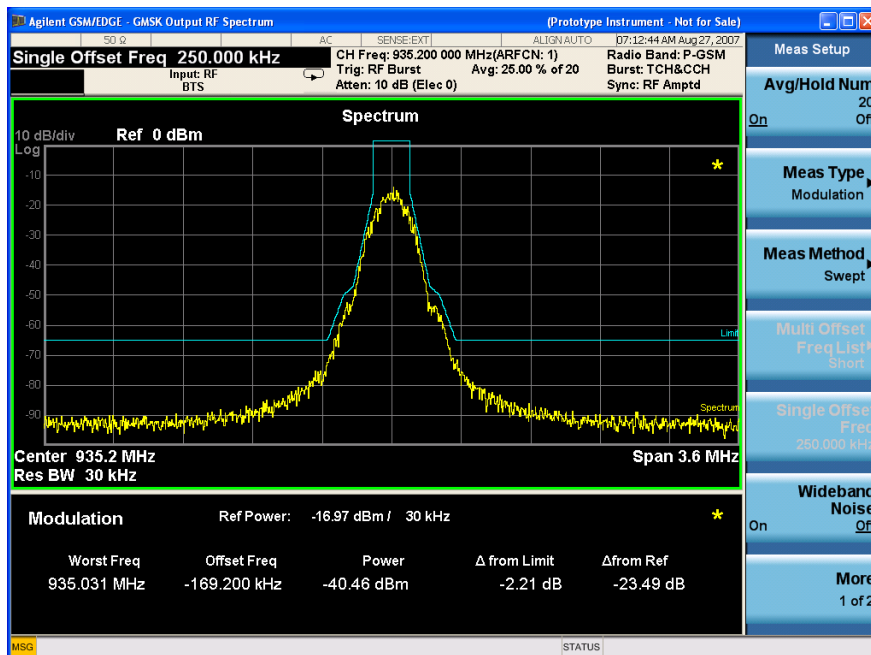
GMSK ORFS Result - Mod & Switch Single Offset (Examine) View



- **Swept** - When **Meas Type** is set to Modulation and **Meas Method** is set to **Swept**, measurement results may be viewed in the spectrum domain, with the limit mask applied to the spectrum plot, and the Worst Frequency parameters displayed.

Figure 2-16

GMSK ORFS Result - Example Modulation Swept View

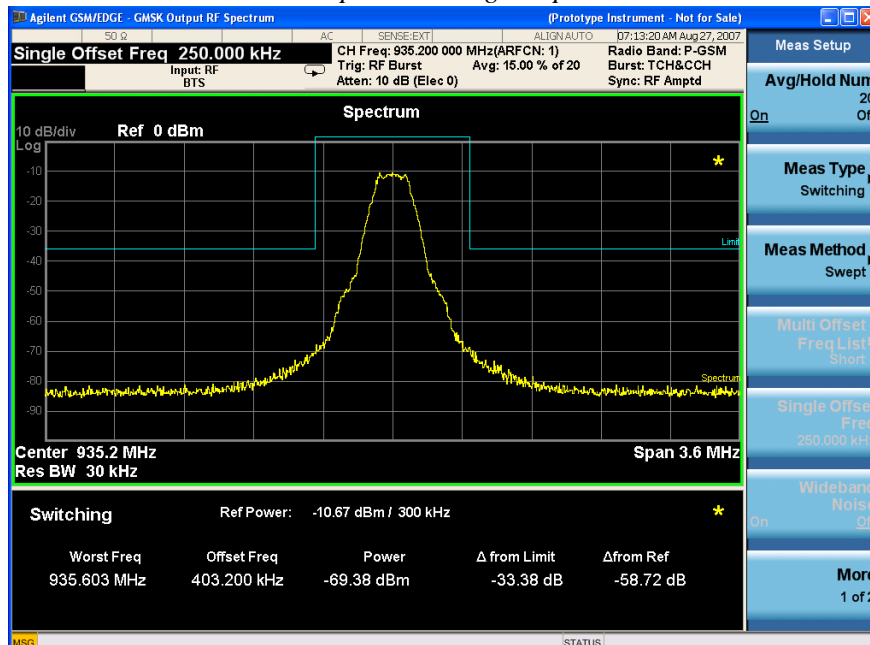


GMSK Output RF Spectrum (ORFS) Measurements

- **Swept** - When **Meas Type** is set to **Switching** and **Meas Method** is set to **Swept**, measurement results may be viewed in the spectrum domain, with the limit mask applied to the spectrum plot, and the **Worst Frequency** parameters displayed.

Figure 2-17

GMSK ORFS Result - Example Switching Swept View

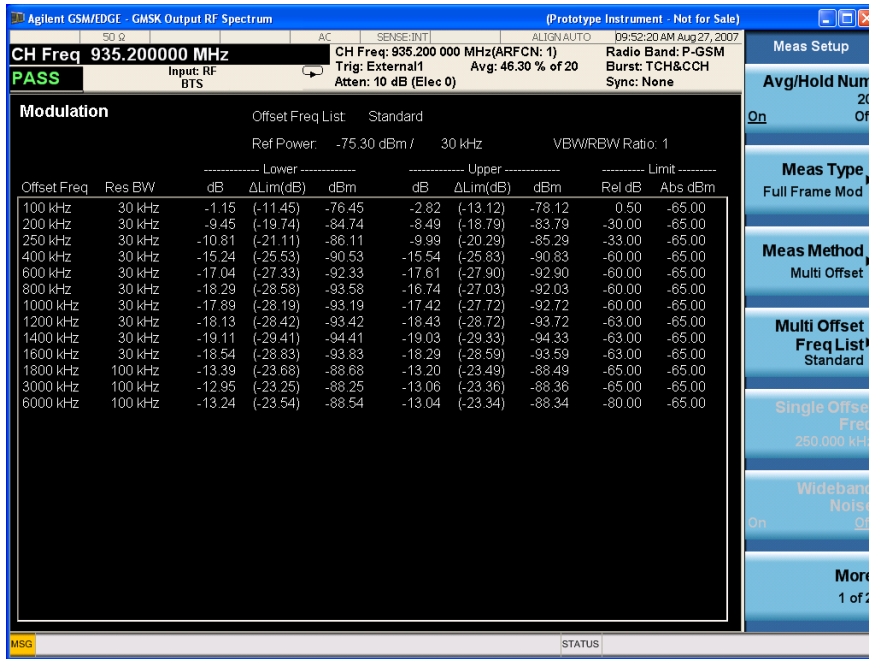


- **Full Frame Mode (FAST)** - When **Meas Method** is set to **Multi-Offset**, and **Meas Type** is set to **Full Frame Mode (FAST)**, measurement results may be viewed as relative and absolute powers in tabular form. The data displays offsets from any of the **Multi-Offset Freq List** settings: **Standard**, **Short**, and **Custom**.

To measure **Full Frame Mode (FAST)**, all slots in the frame must be active. In the example below, slots 6 and 7 were inactive and **Multi-Offset Freq List** is set to **Standard**.

Figure 2-18

GMSK ORFS Result - Full Frame Modulation (FAST) View



For More Information

For more details about changing measurement parameters, see “GMSK Output RF Spectrum Measurement Concepts” on page 106.

If you have a problem, and get an error message, refer to the *Instrument Messages* manual.

GMSK Output RF Spectrum (ORFS) Measurements

GMSK Transmitter Band Spurious Signal (Tx Band Spur) Measurements

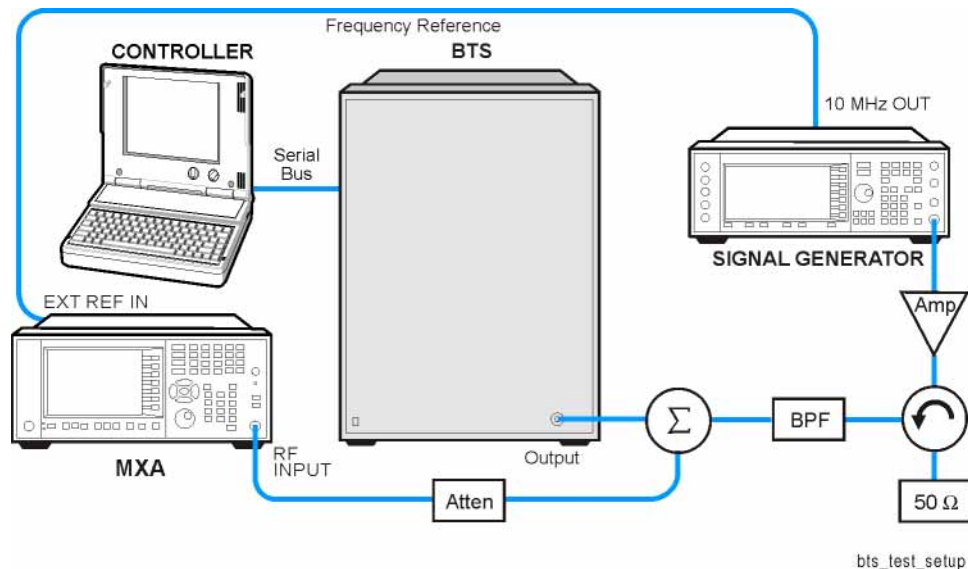
This section explains how to make a GMSK Tx Band Spur measurement on a GSM base station (BTS). Good measurement results verify that the transmitter does not transmit undesirable energy into the transmit band. If undesirable energy is present, it may cause interference for other users of the GSM system.

NOTE This measurement is designed for GSM BTS testing only. For the EDGE Tx Band Spur measurement see “EDGE Transmitter Band Spur Measurements” on page 75.

Configuring the Measurement System

This example shows a base station (BTS) under test, set up to transmit RF power, and being controlled remotely by a system controller. The signal generator and combiner network is optional. The transmitting signal is connected to the analyzer RF input port.

Figure 2-19 GMSK Transmitter Band Spurious Measurement System



1. Using the appropriate cables, adapters, and circulator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect the base transmission station simulator or signal generator to the BTS through a circulator to initiate a link constructed with sync and pilot channels, if required.
3. Connect a BNC cable between the 10 MHz OUT port of the signal generator and the EXT REF IN port of the analyzer.

GMSK Transmitter Band Spurious Signal (Tx Band Spur) Measurements

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:

BTS: Symbol Rate: 270.833 kbps
Frequency: 935.2000 MHz (ARFCN number 1)
Output Power: -3 dBW (0.5 W)

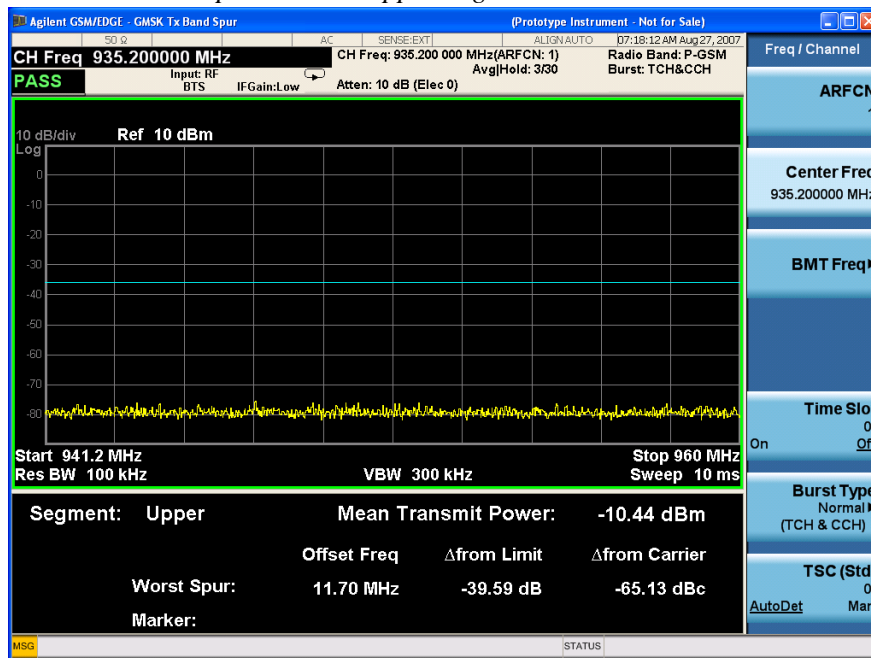
Measurement Procedure

Step	Notes
1 Select GSM/EDGE Mode.	Press Mode , GSM/EDGE/EDGE Evo .
2 Preset the analyzer.	Press Mode Preset .
3 Select the desired center frequency or ARFCN.	Press FREQ Channel .
4 Initiate the measurement.	Press Meas , GMSK Tx Band Spur .

Results

Figure 2-20

GMSK Tx Band Spur Result - Upper Segment



For More Information

For more details about changing measurement parameters, see [“GMSK Tx Band Spur Measurement Concepts”](#) on page 110.

If you have a problem, and get an error message, refer to the *Instrument Messages* manual.

Troubleshooting Hints

Almost any fault in the transmitter circuits can manifest itself as spurious of one kind or another. Make sure the transmit band is correctly selected and the frequency is either the Bottom, Middle, or Top channel. The “Carrier freq not allowed with BMT (Bottom/Middle/Top only)” message usually indicates the transmit band and/or carrier frequency is not correct.

EDGE Power vs. Time (PVT) Measurements

This section explains how to make an EDGE Power versus Time (PvT) measurement on an EDGE base station. Good PvT measurement results verify that the transmitter output power has the correct amplitude, shape, and timing for the EDGE format.

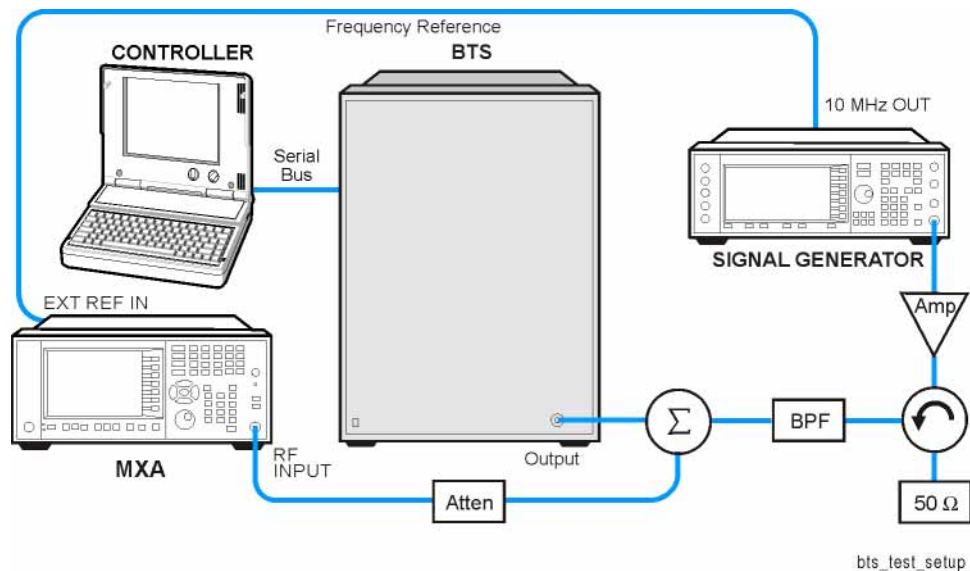
NOTE This measurement is designed for EDGE. For the GSM PvT measurement see “GMSK Power vs. Time (PvT) Measurements” on page 23.

Configuring the Measurement System

This example shows a base station (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 2-21

EDGE Pwr vs. Time Measurement System



1. Using the appropriate cables, adapters, and circulator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect the base transmission station simulator or signal generator to the BTS through a circulator to initiate a link constructed with sync and pilot channels, if required.
3. Connect a BNC cable between the 10 MHz OUT port of the signal generator and the EXT REF 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:

BTS: Symbol Rate: 270.833 kbps
 Frequency: 935.2000 MHz (ARFCN number 1)
 Output Power: -3 dBW (0.5 W)

Measurement Procedure

Step	Notes
1 Select GSM/EDGE Mode.	Press Mode, GSM/EDGE/EDGE Evo.
2 Preset the analyzer.	Press Mode Preset.
3 Select a trigger source.	Press Trigger.
4 Select the desired band.	Press Radio, Band. This determines the frequency and band-related presets. Our example uses the default setting, P-GSM.
5 Select the desired center frequency or ARFCN.	Press FREQ Channel.
6 Select the desired burst type.	Press Burst Type.
7 If your signal of interest contains more than 1 Training Sequence, select a standard Training Sequence	Press TSC to select a standard Training Sequence (numbered 0-7), to which the measurement will synchronize. The default setting for TSC is Auto Det , which automatically correlates to any one of the standard Training Sequences numbered 0-7.
8 Initiate the measurement.	Press Meas, EDGE Power vs Time.
9 Select the desired power control level.	Press Mode Setup, Radio, Pwr Cntl Level (PCL). Our example uses the default setting of 1.

Results

The views available under the **View/Display** menu are **Burst** (Figure 2-22 on page 52), **Rise & Fall** (Figure 2-23 on page 52), and **Multi-Slot** (Figure 2-24 on page 53).

Information shown in the settings panel at the top of the displays include:

- **Atten** - This value reflects the **Internal RF Atten** setting.
- **Sync** - The **Burst Sync** setting used in the current measurement
- **Trig** - The **Trigger Source** setting used in the current measurement

The Mean Transmit Power is displayed at the bottom left of the Burst and Rise & Fall views:

- **Mean Transmit Power** - This is the RMS average power across the “useful” part of the burst, or the 147 bits centered on the transition from bit 13 to bit 14 (the “T0” time point) of the 26 bit training sequence. An RMS calculation is performed and displayed regardless of the averaging mode selected for the trace data.

If Averaging is set to On, the result displayed is the RMS average power of all bursts measured. If Averaging is set to Off, the result is the RMS average power of the single burst measured. This is a different measurement result from Mean Transmit Power, below.

The **Current Data** displayed at the bottom of the Burst and Rise & Fall views include:

- **Mean Transmit Power** - This result appears only if Averaging = ON. It is the RMS average of power across the “useful” part of the burst, for the current burst only. If a single measurement of “n” averages has been completed, the result indicates the Mean Transmit Power of the last burst. The RMS calculation is performed and displayed regardless of the averaging mode selected for the trace data. This is a different measurement result from Mean Transmit Power above.
- **Max Pt.** - Maximum signal power point of the most recently acquired data, in dBm
- **Min Pt.** - Minimum signal power point of the most recently acquired data, in dBm
- **Burst Width** - Time duration of burst at -3 dB below the mean power in the useful part of the burst
- **Mask Ref Pwr Midamble** - The Mask Reference Power is the average power in dBm of the middle 16 symbols in the midamble. The times displayed are the corresponding start and stop times of the middle 16 symbols.
- **1st Error Pt** - (Error Point) The time (displayed in ms or μ s) indicates the point on the X Scale where the first failure of a signal was detected. Use a marker to locate this point in order to examine the nature of the failure. The 1st Error Pt. data is displayed only when there is a limit failure.

EDGE Power vs. Time (PVT) Measurements

Figure 2-22

EDGE Power vs. Time Result - Burst View

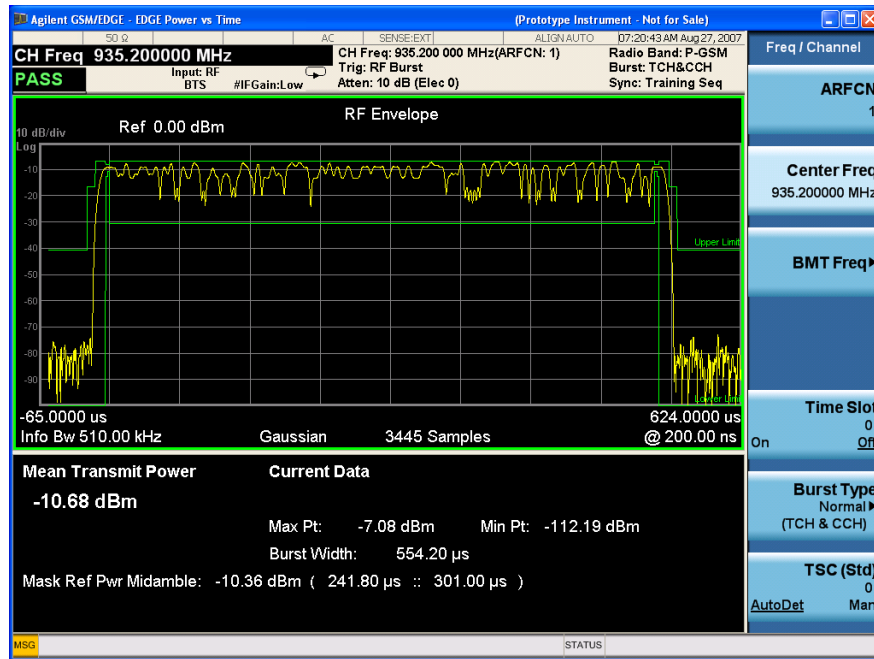


Figure 2-23

EDGE Power vs. Time Result - Rise & Fall View

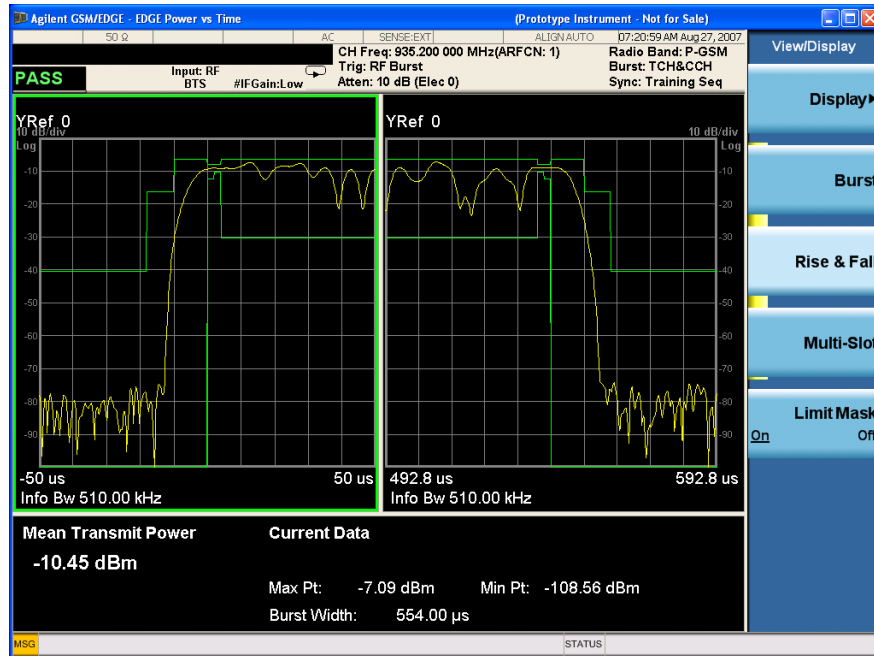
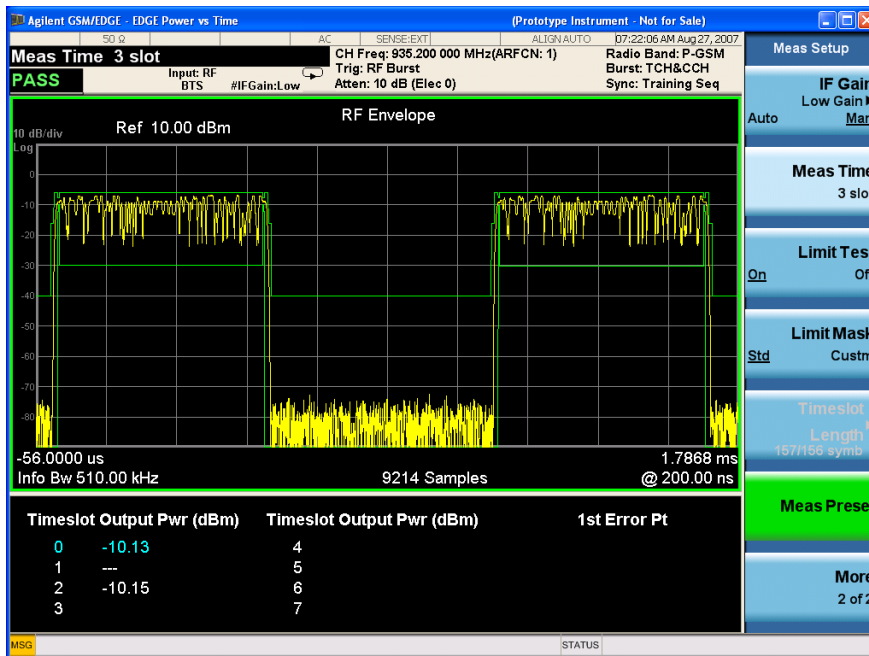


Figure 2-24

EDGE Result - Multi-Slot View (3 slots shown)



The table in the lower portion of the multi-slot view shows the output power in dBm for each timeslot, as determined by the integer (1 to 8) entered in the **Meas Setup**, **Meas Time** setting. Output power levels are presented for the active slots; a dashed line appears for any slot that is inactive. The timeslot that contains the burst of interest is highlighted in blue.

Use the **Meas Time** key located in the **Meas Setup** menu to select up to eight slots. Use the **Time Slot** and **TSC** keys in the **FREQ/Channel** menu to select the slot you wish to activate. Setting **Time Slot** to **ON** and selecting a specific slot results in activating a measurement of that slot only (**Time Slot On** can be used to isolate a failure to a specific slot). When **Time Slot** is set to **OFF**, all active slots are tested against the mask.

Using a signal generator, you can synchronize the multi-slot view so the frame (or portion of the frame) you are viewing starts with the slot you have selected. See [“EDGE Power vs. Time Measurement Concepts” on page 112](#).

You can switch from the multi-slot view directly to the **Burst** or **Rise & Fall** views of the slot that is currently active. The **Scale/Div** key under the **Span/X Scale** menu can be used to enlarge your view of this signal.

For More Information

For more details about changing measurement parameters, see [“EDGE Power vs. Time Measurement Concepts” on page 112](#).

If you have a problem, and get an error message, refer to the *Instrument Messages* manual.

Troubleshooting Hints

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

EDGE Error Vector Magnitude (EVM) Measurements

This section explains how to make an EDGE Error Vector Magnitude (EVM) measurement on an EDGE base station. EVM provides a measure of modulation accuracy. The EDGE 8 PSK modulation pattern uses a rotation of $3\pi/8$ radians to avoid zero crossing, thus providing a margin of linearity relief for amplifier performance.

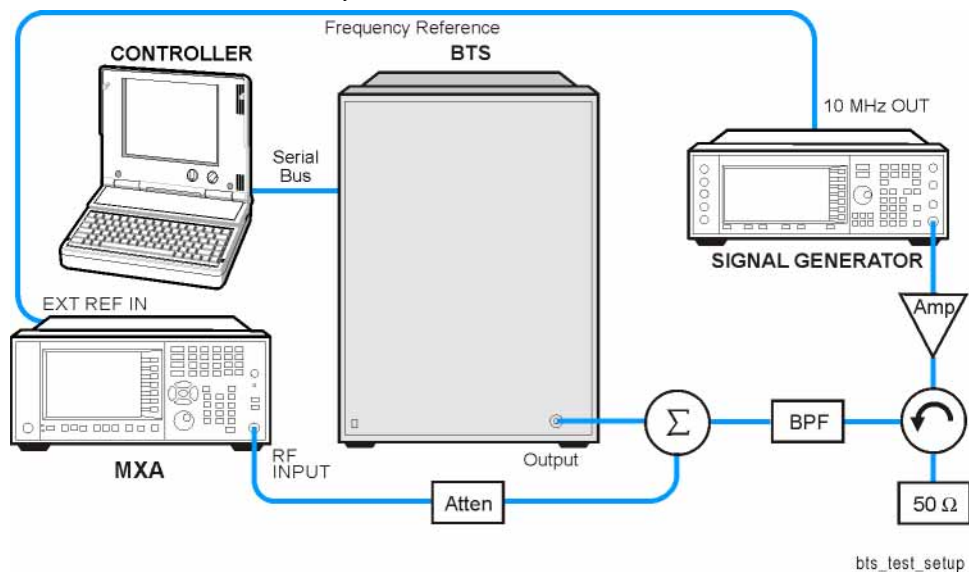
NOTE This is an EDGE only measurement.

Configuring the Measurement System

This example shows a base station (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 2-25

EDGE EVM Measurement System



1. Using the appropriate cables, adapters, and circulator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect the base transmission station simulator or signal generator to the BTS through a circulator to initiate a link constructed with sync and pilot channels, if required.
3. Connect a BNC cable between the 10 MHz OUT port of the signal generator and the EXT REF 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:

BTS: Symbol Rate: 270.833 kbps
Frequency: 935.2000 MHz (ARFCN number 1)
Output Power: -3 dBW (0.5 W)

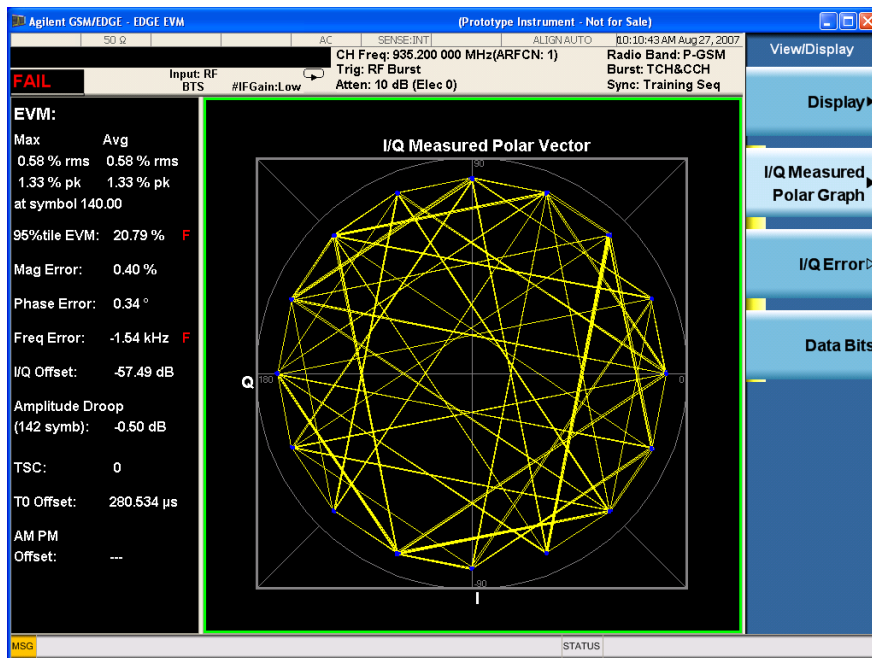
Measurement Procedure

Step	Action	Notes
1 Select GSM/EDGE Mode.	Press Mode , GSM/EDGE/EDGE Evo .	
2 Preset the analyzer.	Press Mode Preset .	
3 Select a trigger source.	Press Trigger .	
4 Select the desired center frequency or ARFCN.	Press FREQ Channel .	
5 Select the desired burst type.	Press Burst Type .	
6 If your signal of interest contains more than 1 Training Sequence, select a standard Training Sequence	Press TSC to select a standard Training Sequence (numbered 0-9), to which the measurement will synchronize.	The default setting for TSC is Auto Det , which automatically correlates to any one of the standard Training Sequences numbered 0-9.
7 Initiate the measurement.	Press Meas, EDGE EVM .	Figure 2-26 below shows a measurement result with the graphic and text windows. The measured summary data is shown in the left window and the dynamic vector trajectory of the I/Q demodulated signal is shown as a polar vector display in the right window.

EDGE Error Vector Magnitude (EVM) Measurements

Step	Action	Notes
------	--------	-------

Figure 2-26 EDGE EVM Result - I/Q Polar Graph View



8 Perform Polar modulation analysis.

Press **Meas Setup, Burst Sync, Polar Modulation**.

The analyzer searches the training sequence on the amplitude path and phase path, and tries to sync. Polar modulation analysis measures the time delay adjustment between the Amplitude path and Phase path for Polar modulation. When **Polar Modulation** is selected, the timing offset of amplitude path to phase path is always calculated.

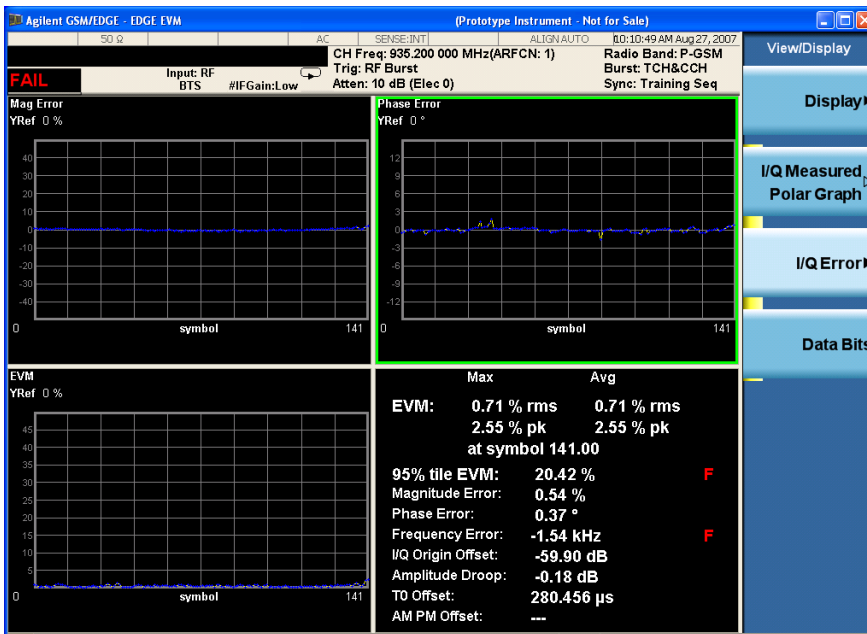
The displayed time delay values are called **AMPM Offset** and **T0 Offset**. They are shown in the I/Q Measured Polar Graph view, I/Q Error view, and Data bits view. You can select time (seconds) or symbols as the display unit using **Time Offset Unit** in the **Display** key menu.

The **Polar Mod Align On/Off** key is located in the **Meas Setup** menu. The **Polar Mod Align** setting determines whether the timing offsets are used (when set to On) for compensation in the EVM calculation.

Figure 2-26 above shows the **I/Q Polar Graph View**.

Step	Action	Notes
9	Display a plot of constellation “dots” or states without the vector lines.	Press View/Display, I/Q Measured Polar Graph, I/Q Polar Vect/Constln, Constellation.
10	Display a four-pane view of the Magnitude Error, Phase Error, and EVM graphs, along with a summary of the measurement data.	<p>Press View/Display, I/Q Error.</p> <p>You can select any of the graph windows for individual display or adjustment by pressing Next Window and moving the green selection box to the desired window. Press Zoom to expand the window to full screen, or to go back to the Quad-View.</p> <p>In Figure 2-27 below (showing the I/Q Error View), a sine modulation is apparent in the EVM and Phase Error data. This could due to an FM impairment that is not discernible in the other EVM views.</p>

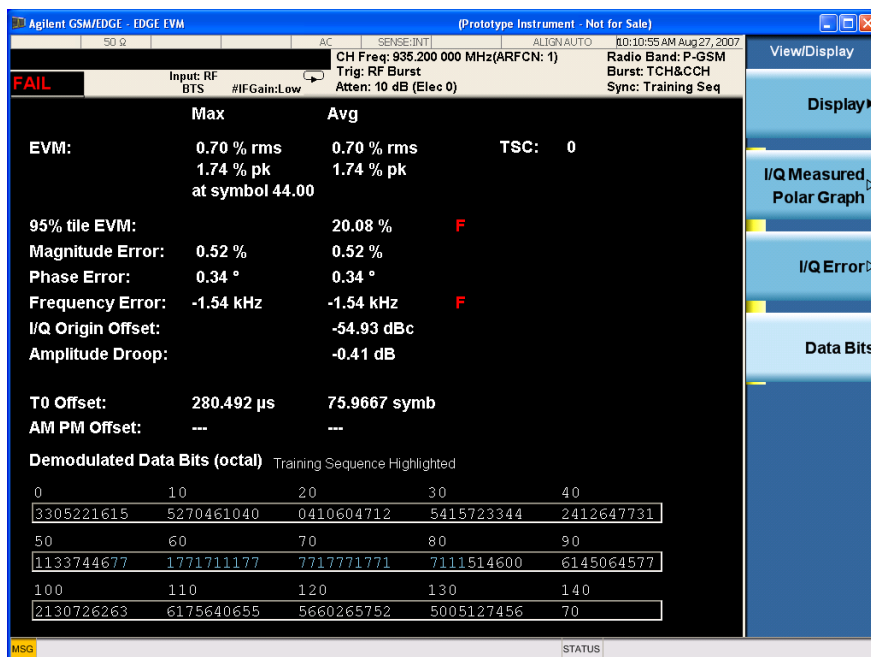
Figure 2-27 EDGE EVM Result - I/Q Error View



EDGE Error Vector Magnitude (EVM) Measurements

Step	Action	Notes
11	Display a summary of measurement data, with the symbol state bits.	<p>Press View/Display, Data Bits.</p> <p>As shown in Figure 2-28 below, the training sequence is highlighted in blue, and remains constant with repeated measurement updates.</p> <p>The data bits in this display are Symbol State bits, and do not represent encoded message data.</p>

Figure 2-28 EDGE EVM Result - Data Bits View



For More Information

For more details about changing measurement parameters, see [“EDGE EVM Measurement Concepts”](#) on page 119.

If you have a problem, and get an error message, refer to the *Instrument Messages* manual.

Troubleshooting Hints

Use the spectrum (frequency domain) measurement to verify that the signal is present and approximately centered on the display.

The data used for testing can have a detrimental effect on the EVM results, causing erratic or falsely high EVM, especially in the case of sending all 0 bits with the Trigger Source set to RF Burst. In that unique situation, better results may be obtained using Free Run or Video triggers.

Poor EVM indicates a problem at the I/Q baseband generator, filters, and/or modulator in the transmitter circuitry. The output amplifier in the transmitter can also create distortion that causes unacceptably high EVM. In a real system, poor EVM

EDGE Error Vector Magnitude (EVM) Measurements

reduces the ability of a receiver to correctly demodulate the signal, especially in marginal signal conditions. Poor EVM may also indicate that a measurement restart was not performed after the signal level was changed. Press **Restart** after a change in the input signal to ensure that an auto-attenuation adjustment is performed.

The I/Q Error Quad View display may be used to determine where modulation or demodulation errors are introduced into the complex modulated path.

EDGE Error Vector Magnitude (EVM) Measurements

EDGE Output RF Spectrum (ORFS) Measurements

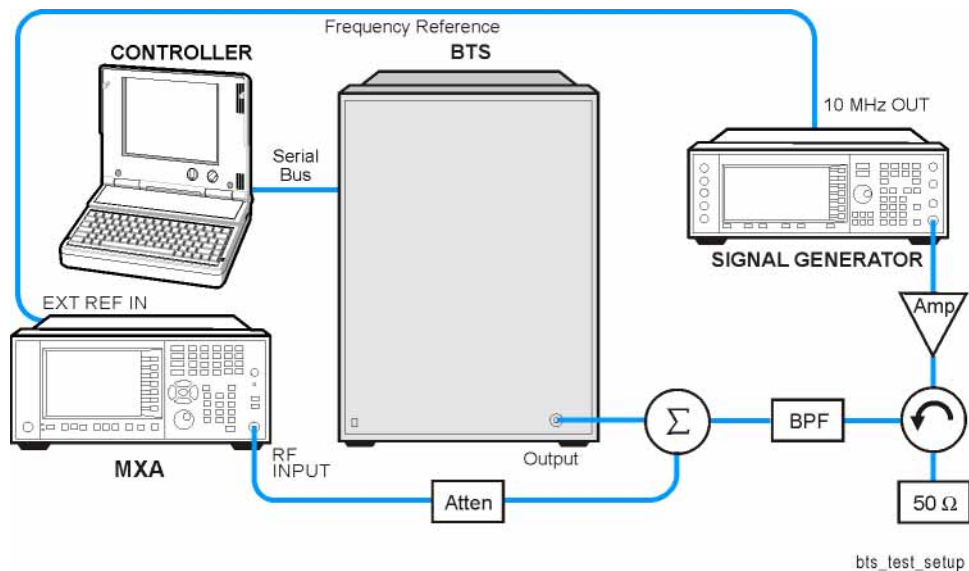
This section explains how to make an EDGE Output RF Spectrum measurement on an EDGE base station. This test verifies that the modulation, wideband noise, and power level switching spectra are within limits and do not produce significant interference in the adjacent base transceiver station (BTS) channels.

NOTE This measurement is designed for EDGE. For the GSM Output RF Spectrum measurement see “GMSK Output RF Spectrum (ORFS) Measurements” on page 35.

Configuring the Measurement System

This example shows a base transceiver station (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 2-29 EDGE ORFS Measurement System



1. Using the appropriate cables, adapters, and circulator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect the base transmission station simulator or signal generator to the BTS through a circulator to initiate a link constructed with sync and pilot channels, if required.
3. Connect a BNC cable between the 10 MHz OUT port of the signal generator and the EXT REF IN port of the analyzer.
4. Connect the system controller to the BTS through the serial bus cable to control the BTS operation.

NOTE If the signal being measured has more than one active slot in a frame, the default RF Burst trigger must be changed, and an external event trigger must be provided to synchronize the frame. Otherwise the measurement may trigger randomly on any burst in an active slot. This is true for all ORFS time domain measurements.

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:

BTS: Symbol Rate: 270.833 kbps
Frequency: 935.2000 MHz (ARFCN number 1)
Output Power: -3 dBW (0.5 W)

Measurement Procedure

Step	Notes
1 Select GSM/EDGE Mode.	Press Mode , GSM/EDGE/EDGE Evo .
2 Preset the analyzer.	Press Mode Preset .
3 Select a trigger source.	Press Trigger .
4 Toggle the burst alignment to 1/2 Bit Offset .	Press Mode Setup , Demod , Burst Align .
5 Select the desired center frequency or ARFCN.	Press FREQ Channel .
6 Select the desired burst type.	Press FREQ Channel , Burst Type .
7 If your signal of interest contains more than 1 Training Sequence, select a standard Training Sequence	Press TSC to select a standard Training Sequence (numbered 0-9), to which the measurement will synchronize. The default setting for TSC is Auto , which automatically correlates to any one of the standard Training Sequences numbered 0-9. Training Sequence synchronization is applicable only when Periodic Timer Trigger and Periodic Time Sync Source are off.
8 Initiate the measurement.	Press Meas , EDGE Output RF Spectrum .
9 Select the Meas Type .	Press Meas Setup , Meas Type . For details of available measurement types, see “Measurement Types” on page 65 below.
10 Select the Meas Method .	Press Meas Setup , Meas Method . For details of available measurement methods, see “Measurement Methods” on page 66 below.
11 If desired, set continuous measurements.	Set Meas Control to Measure Cont .

Measurement Types

The **Meas Type** key accesses a menu that lets you select the measurement type that is optimized for the type of spectral distortion being investigated.

Mod & Switch - Performs both Modulation and Switching measurements, which measures the spectrum due to modulation and noise, and also measures Switching (transient) spectrum measurements.

Modulation - Measures the spectrum optimized for distortion due to modulation and noise.

Switching - Measures the spectrum optimized for distortion due to switching transients (burst ramping).

Full Frame Modulation (FAST)- Improves measurement speed by acquiring a full frame of data and reduces actual average number. This feature can only be used when all slots in the transmitted frame are active. Use of an external trigger can enhance measurement speed when this feature is used. When **Full Frame Modulation (FAST)** is selected the current measurement defaults to the multi-offset measurement method. Therefore, the single offset key and swept key in Meas Method menu are grayed out and these two features are not available.

Measurement Methods

The **Meas Method** key accesses a menu that lets you select the measurement mode.

Multi-Offset - Automatically makes measurements at all offset frequencies in the selected list (**Standard**, **Short**, or **Custom**).

Press **Multi-Offset Freq List** to select a list of offsets to measure.

Multi-Offset measurements may be made with either **Modulation** or **Switching** measurement types.

Offset measurement results are displayed as tabular data.

Single Offset (Examine) - makes a measurement at a single offset frequency as set by the **Single Offset Freq** softkey.

Single Offset (Examine) measurements may be made with either **Modulation** or **Switching** measurement types.

Single offset measurement results are displayed in a time domain plot, with the measurement offset shown as a gate by white vertical lines. See [Figure 2-31 on page 68](#).

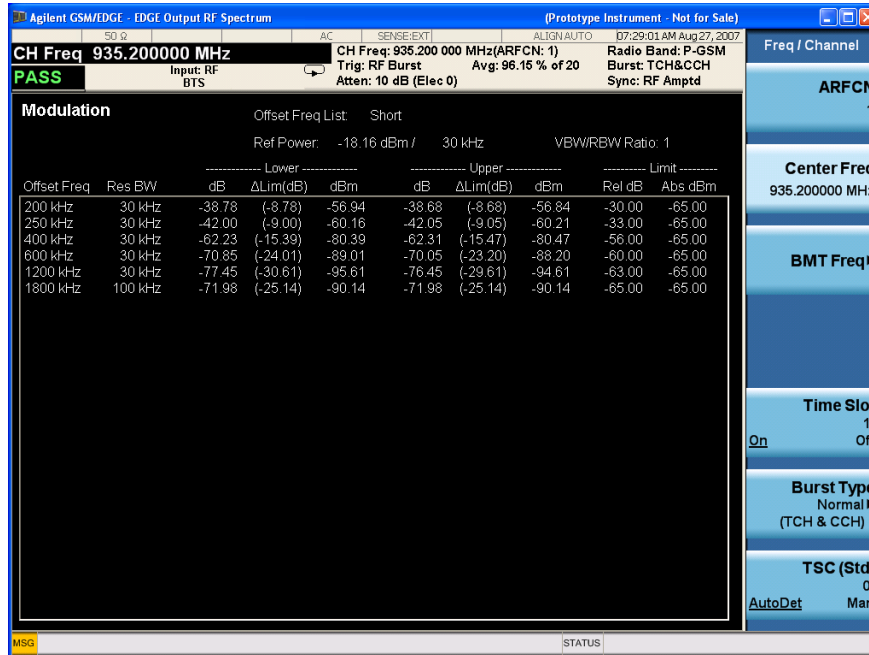
Swept - Makes a measurement using time-gated spectrum analysis to sweep the analyzer with the gate turned on for the desired portion of the burst when Meas Type is set to Modulation. When Meas Type is set to Switching, turn off the gate and sweep with peak detector, appropriate sweep time. The limits mask is applied to the spectrum plot, and the **Worst Frequency** parameters are displayed. This selection is only available if **Meas Type** is set to **Modulation**. See [Figure 2-34 on page 71](#).

EDGE ORFS Measurement Results

- **Modulation Power** - When **Meas Method** is set to **Multi-Offset**, and **Meas Type** is set to **Modulation**, **Mod and Switch**, or **Full Frame Modulation**, measurement results may be viewed as absolute powers in tabular form. The data displays offsets from any of the **Multi-Offset Freq List** settings: **Standard**, **Short**, and **Custom**. The **Modulation Power** view is the default view for ORFS measurements.

Figure 2-30

EDGE ORFS - Example (Short List) Modulation Power View



- **Single Offset (Examine)** - makes a measurement at a single offset frequency as set by the **Single Offset Freq** softkey.

Single offset measurement results are displayed as a power waveform in a time domain plot, with the measurement offset shown as a gate by white vertical lines. The red vertical lines represent the additional effective measurement window when **Fast Avg** is **ON** (default setting).

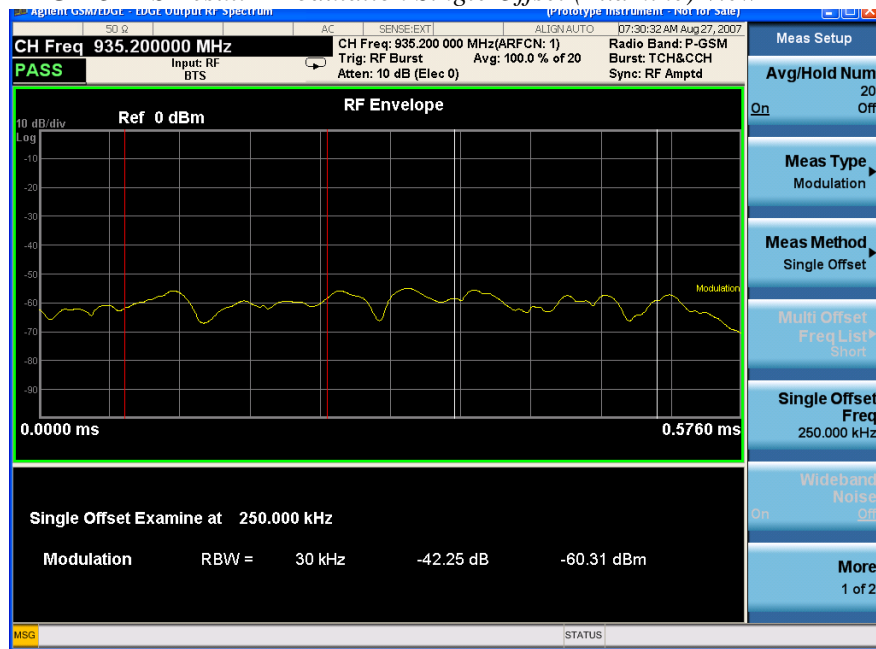
NOTE

The signal being displayed below is the useful part of slot 0, which in this example, is the only active slot in the frame. If any other slots are active, the default RF Burst trigger must be changed, and an external event trigger must be provided to synchronize the frame. Otherwise the measurement may trigger randomly on any burst in an active slot. This is true for all ORFS measurements.

EDGE Output RF Spectrum (ORFS) Measurements

Figure 2-31

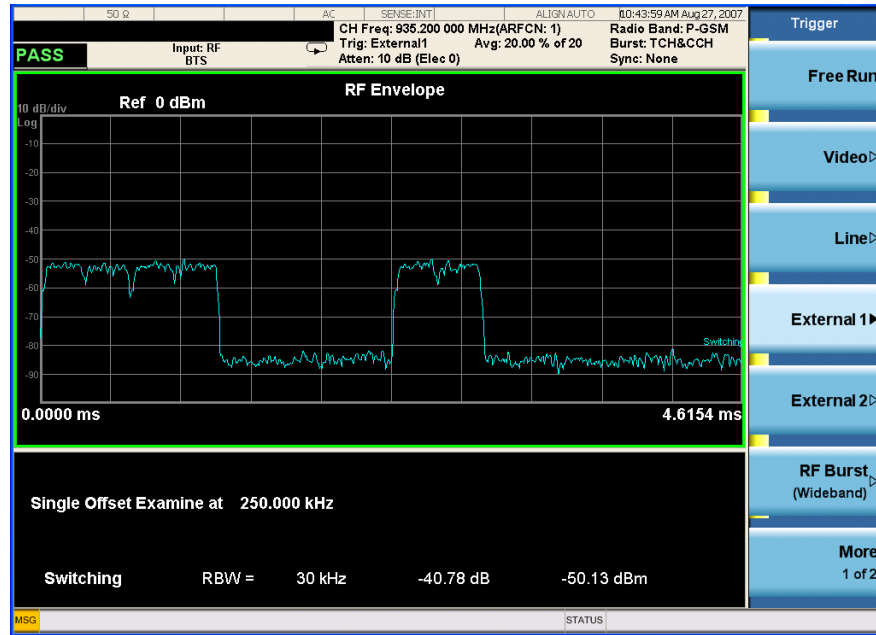
EDGE ORFS Result - Modulation Single Offset (Examine) View



- Switching Single Offset measurement results are displayed in a time domain plot, but the waveform of the entire frame is displayed. In this example, slots 0, 1, and 4 are active. Use the external trigger to maintain frame synchronization. **Fast Avg** is not available for this measurement.

Figure 2-32

EDGE ORFS Result - Switching Single Offset (Examine) View



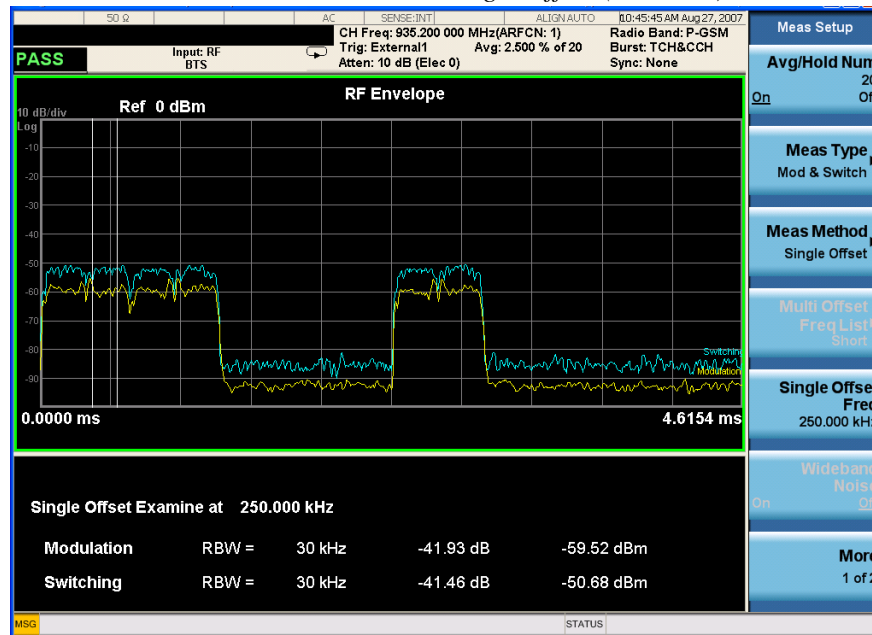
EDGE Output RF Spectrum (ORFS) Measurements

- Combination Modulation and Switching (**Mod & Switch**) Single Offset measurement results are displayed in a time domain plot, but the waveform of the entire frame is displayed. The blue trace is the Switching data and the yellow trace is the Modulation data, with the measurement gates shown.

In this example, slots 0, 1, and 4 are active. Use the external trigger to maintain frame synchronization. **Fast Avg** is not available for this measurement.

Figure 2-33

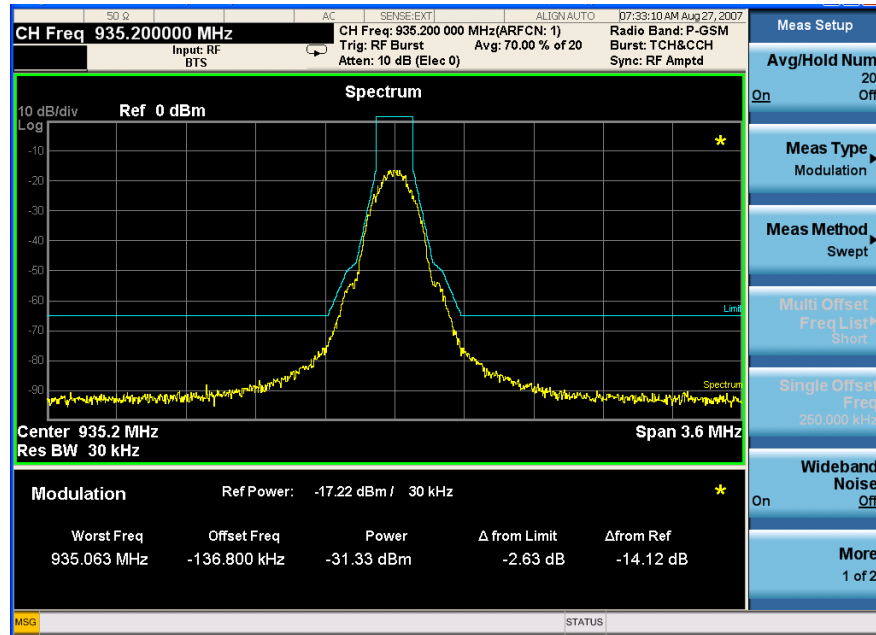
EDGE ORFS Result - Mod & Switch Single Offset (Examine) View



- **Swept** - When **Meas Type** is set to Modulation and **Meas Method** is set to **Swept**, measurement results may be viewed in the spectrum domain, with the limit mask applied to the spectrum plot, and the Worst Frequency parameters displayed.

Figure 2-34

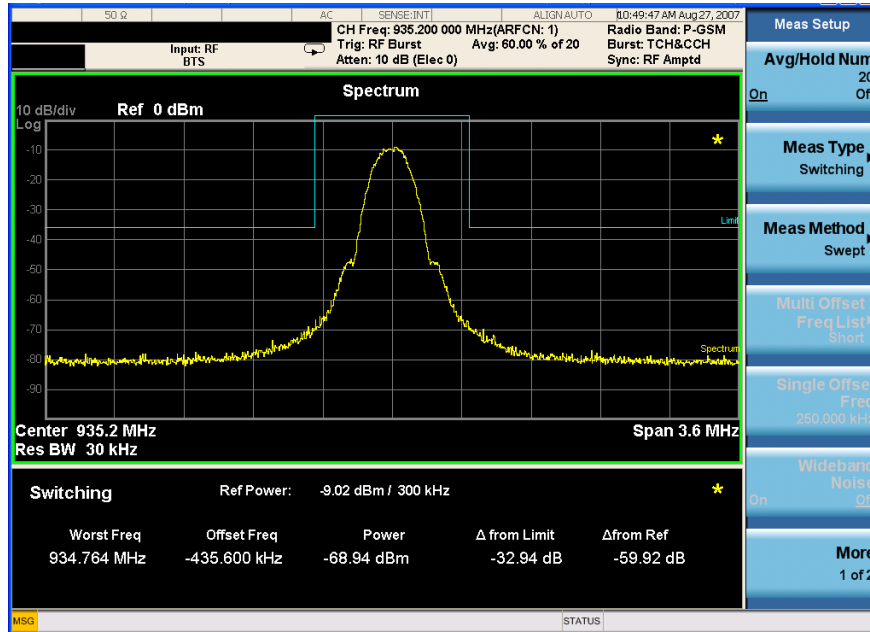
EDGE ORFS Result - Example Modulation Swept View



EDGE Output RF Spectrum (ORFS) Measurements

- **Swept** - When **Meas Type** is set to **Switching** and **Meas Method** is set to **Swept**, measurement results may be viewed in the spectrum domain, with the limit mask applied to the spectrum plot, and the Worst Frequency parameters displayed.

Figure 2-35 *EDGE ORFS Result - Example Modulation Swept View*

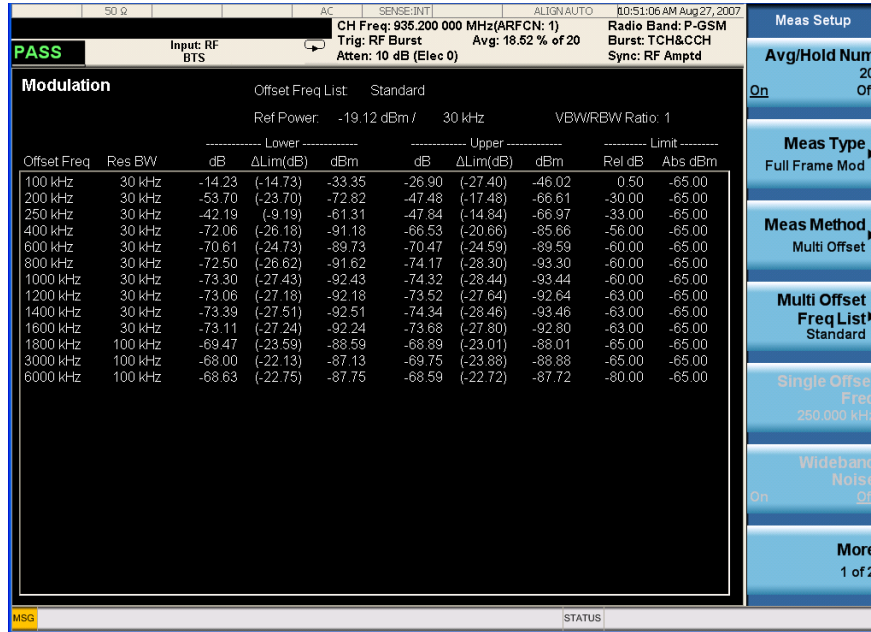


- **Full Frame Mode (FAST)** - When **Meas Method** is set to **Multi-Offset**, and **Meas Type** is set to **Full Frame Mode (FAST)**, measurement results may be viewed as relative and absolute powers in tabular form. The data displays offsets from any of the **Multi-Offset Freq List** settings: **Standard**, **Short**, and **Custom**.

To measure **Full Frame Mode (FAST)**, all slots in the frame must be active. In the example below, slots 6 and 7 were inactive and **Multi-Offset Freq List** is set to **Standard**.

Figure 2-36

EDGE ORFS Result - Full Frame Modulation (FAST) View



For More Information

For more details about changing measurement parameters, see “EDGE Output RF Spectrum Measurement Concepts” on page 123.

If you have a problem, and get an error message, refer to the *Instrument Messages* manual.

EDGE Output RF Spectrum (ORFS) Measurements

EDGE Transmitter Band Spur Measurements

This section explains how to make an EDGE Tx Band Spur measurement on an EDGE base station (BTS). Good measurement results verify that the transmitter does not transmit undesirable energy into the transmit band. This energy may cause interference for other users of the EDGE system.

NOTE

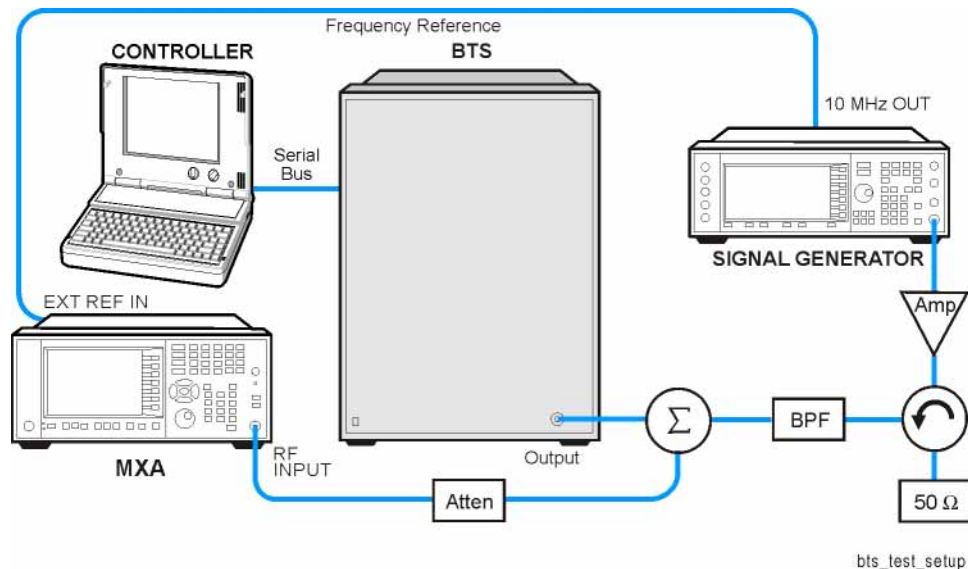
This measurement is designed for EDGE BTS testing only. For the GSM Tx Band Spur measurement see [“GMSK Transmitter Band Spurious Signal \(Tx Band Spur\) Measurements”](#) on page 45.

Configuring the Measurement System

This example shows a base station (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 2-37

EDGE Transmitter Band Spurious Measurement System



1. Using the appropriate cables, adapters, and circulator, connect the output signal of the BTS to the RF input of the analyzer.
2. Connect the base transmission station simulator or signal generator to the BTS through a circulator to initiate a link constructed with sync and pilot channels, if required.
3. Connect a BNC cable between the 10 MHz OUT port of the signal generator and the EXT REF 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:

BTS: Symbol Rate: 270.833 kbps
 Frequency: 935.2000 MHz (ARFCN number 1)
 Output Power: -3 dBW (0.5 W)

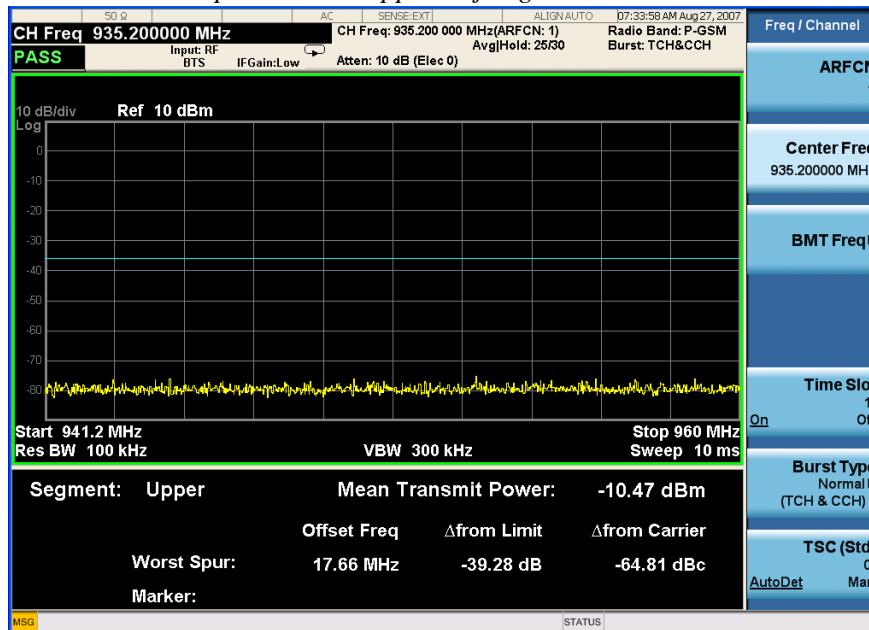
Measurement Procedure

Step	Notes
1	Select GSM/EDGE Mode. Press Mode , GSM/EDGE/EDGE Evo .
2	Preset the analyzer. Press Mode Preset .
3	Select the desired center frequency or ARFCN. Press FREQ Channel .
4	Initiate measurement. Press Meas, Tx Band Spur .

Results

Figure 2-38

EDGE Tx Band Spur Result - Upper Adj Segment



For More Information

For more details about changing measurement parameters, see “EDGE Tx Band Spur Measurement Concepts” on page 128.

If you have a problem, and get an error message, refer to the *Instrument Messages* manual.

Troubleshooting Hints

Almost any fault in the transmitter circuits can manifest itself in spurious results of one kind or another. Make sure the transmit band is correctly selected and the frequency is either the Bottom, Middle, or Top channel. The “Carrier freq not allowed with BMT (Bottom/Middle/Top only)” message usually indicates the transmit band and/or carrier frequency is not correct.

EDGE Transmitter Band Spur Measurements

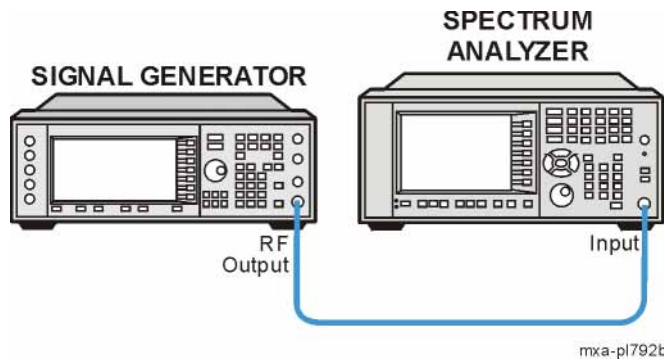
Monitor Spectrum Measurements

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

This example shows a signal generator test set up to transmit RF power. The transmitting signal is connected to the RF input port of the analyzer. Connect the equipment as shown in [Figure 2-39](#) below.

Figure 2-39

Monitor Spectrum Measurement



1. Using the appropriate cables and adapters, connect the output signal of the signal generator to the RF input of the analyzer.
2. For best frequency accuracy, connect a BNC cable between the 10 MHz REF IN port of the signal generator (if available) and the 10 MHz EXT REF OUT port of the analyzer.

Measurement Procedure

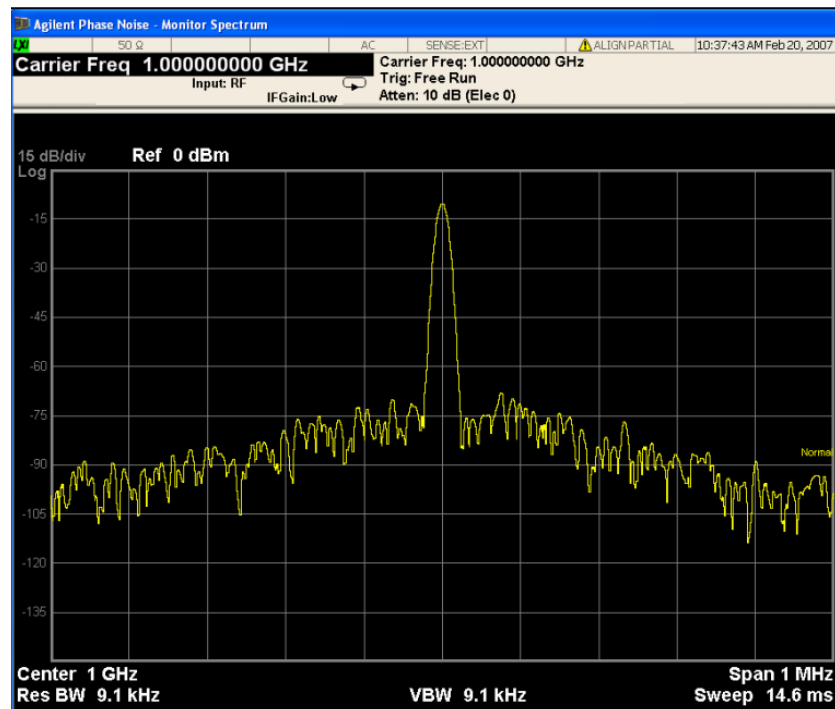
Step	Action	Notes
1 Set up the signal source.	<ol style="list-style-type: none"> a. Set the mode to GSM. b. Set the frequency to 935.2 MHz. c. Set the amplitude to -15 dBm. d. Set the data format to framed. e. Set the frame repeat to continuous. 	
2 Connect signal source to analyzer.	Connect the source RF OUTPUT to the analyzer RF INPUT, as shown in Figure 2-39 above.	
3 Select the GSM/EDGE mode.	Press Mode, GSM/EDGE/EDGE Evo.	
4 Preset the analyzer.	Press Mode Preset.	

Monitor Spectrum Measurements

Step	Action	Notes
5	Set the measurement center frequency: Press FREQ Channel , enter a numerical frequency using the front-panel keypad, and select a units key, such as MHz .	
6	Set the measurement span frequency: Press SPAN X Scale , enter a numerical span using the front-panel keypad, and select a units key, such as MHz .	
7	Initiate the measurement. Press Meas, Monitor Spectrum .	A display with a Spectrum window appears when you activate a Spectrum measurement. Changing the FREQ, Span, or AMPTD settings will affect only the active window.
8	If desired, toggle trace display. Press Trace/Detector, Select Trace and select the trace(s) desired for display, then toggle Display to Show .	The default display shows the Current (yellow trace) data. To make viewing the display easier, you can view either the Current trace or Average separately.

Figure 2-40

Monitor Spectrum Measurement - Spectrum and I/Q Waveform (Default View)



9	If desired, select continuous measurement. Press Cont.
---	--

IQ Waveform (Time Domain) Measurements

This section 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.

Setting Up and Making Measurements

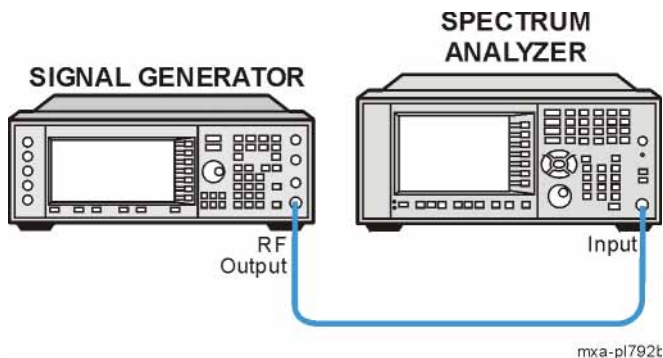
Configuring the Measurement System

The 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.

This example shows a signal generator test set up to transmit RF power. The transmitting signal is connected to the RF input port of the analyzer. Connect the equipment as shown.

Figure 2-41

Monitor Spectrum Measurement



1. Using the appropriate cables and adapters, connect the output signal of the signal generator to the RF input of the analyzer.
2. For best frequency accuracy, connect a BNC cable between the 10 MHz OUT port of the signal generator and the EXT REF IN port of the analyzer.

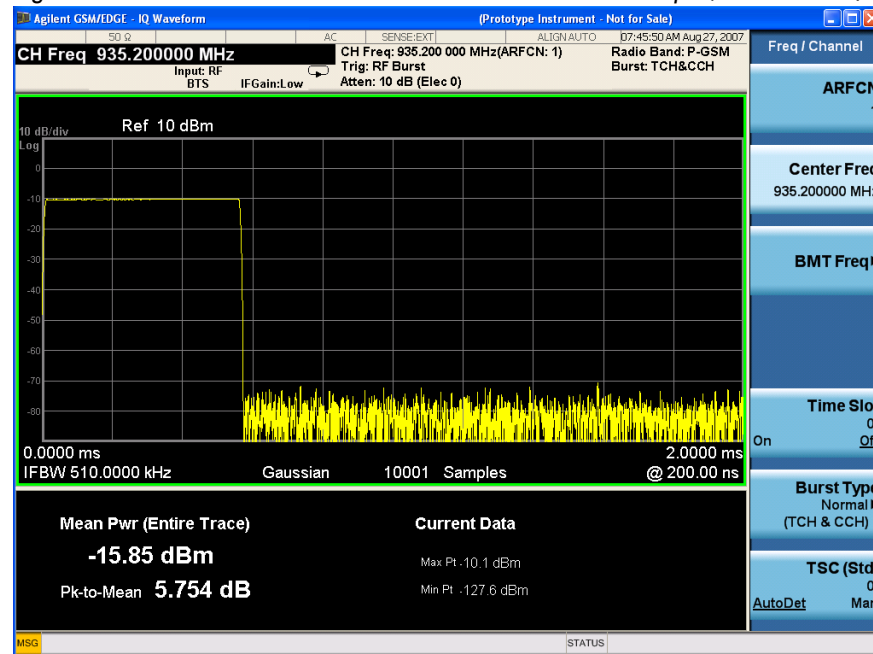
Measurement Procedure

Step	Action	Notes
1	Setup the signal sources.	
	a. Set the mode to GSM.	
	b. Set the frequency 935.2 MHz.	
	c. Set the amplitude to -15 dBm.	
	d. Set the data format to framed.	
	e. Set the frame repeat to continuous.	

IQ Waveform (Time Domain) Measurements

Step	Action	Notes
2	Connect the signal source to the analyzer.	Connect the source RF OUTPUT to the analyzer RF INPUT as shown in Figure 2-41 .
3	Select GSM/EDGE Mode.	Press Mode , GSM/EDGE/EDGE Evo .
4	Preset the analyzer.	Press Mode Preset .
5	Set the measurement center frequency.	Press FREQ Channel , enter a numerical frequency using the front-panel keypad, and select a units key, for example MHz .
6	Initiate the IQ Waveform measurement.	Press Meas, IQ Waveform . The default display (Figure 2-42 below) shows the RF Envelope of the current data. The measured values for the mean power and peak-to-mean power are shown in the text window.

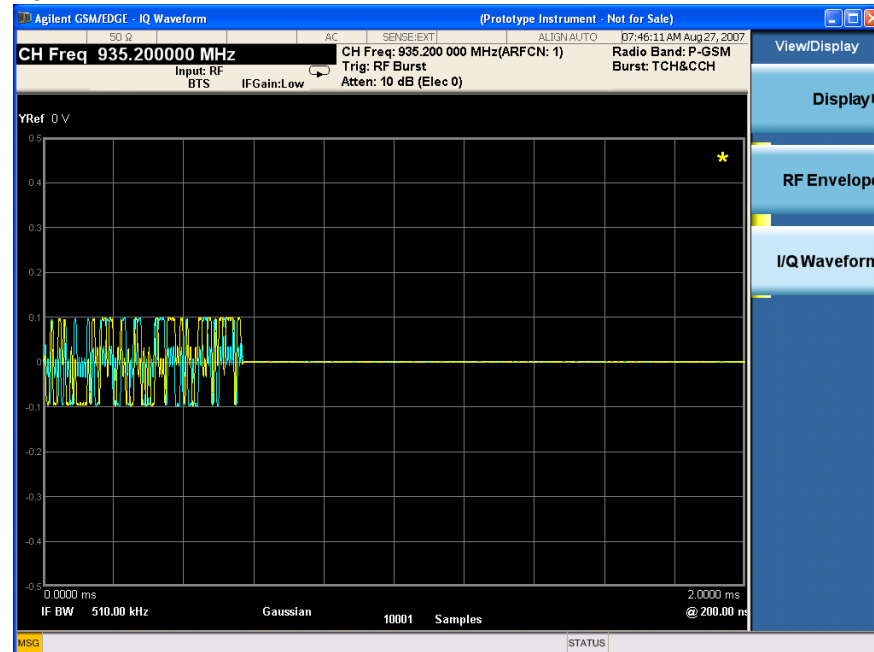
Figure 2-42 Waveform Measurement - RF Envelope (Default View)



7	Select the IQ Waveform view.	Press View/Display, IQ Waveform . The IQ Waveform window (Figure 2-43 below) provides a view of I and Q waveforms together on the same graph in terms of voltage versus time in linear scale.
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Step	Action	Notes
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Figure 2-43 Waveform Measurement - IQ Waveform View



8	Activate a marker on the I/Q Waveform trace.	<p>Press Marker, Properties, Marker Trace, I/Q Waveform.</p> <p>Rotate the 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.</p>
---	--	--

9	If desired, set up continuous measurements.	Press Cont .
---	---	---------------------

10	If desired, examine keys available to change measurement parameters from their default conditions.	Press Meas Setup to display menu.
----	--	--

IQ Waveform (Time Domain) Measurements

Using Option BBA Baseband I/Q Inputs

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

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

Table 2-2 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
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.

Using Option BBA Baseband I/Q Inputs

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:

Mode	Description
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	Notes
1 Select measurement.	Select a measurement that supports baseband I/Q inputs.
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.
3 Select the appropriate circuit location and probe(s) for measurements.	For details see "Selecting Input Probes for Baseband Measurements" on page 135 in the Concepts chapter.
4 Select baseband I/Q input connectors.	

Step	Notes
5 Set up the I Path (if required).	<p>If you have set the I/Q Path to I+jQ or to I Only, press I Setup.</p> <ol style="list-style-type: none"> Select whether Differential (Balanced) inputs is On or Off. Select the input impedance, Input Z. Input a Skew value in seconds. Set up the I Probe by pressing I Probe <ol style="list-style-type: none"> Select probe Attenuation Calibrate the probe. Press Calibrate... to start the calibration procedure. Follow the calibration procedure, clicking Next at the end of each step.
6 Set up the Q Path (if required).	<p>If you have set the I/Q Path to I+jQ or to Q Only, press Q Setup.</p> <ol style="list-style-type: none"> Select whether Differential (Balanced) inputs is On or Off. Select the input impedance, Input Z. Input a Skew value in seconds. Set up the Q Probe by pressing Q Probe <ol style="list-style-type: none"> Select probe Attenuation Calibrate the probe. Press Calibrate... to start the calibration procedure. Follow the calibration procedure, clicking Next at the end of each step.
7 Select the reference impedance.	<p>Press Reference Z, then input a value from one ohm to one megohm.</p> <p>The impedance selected is shown at the top of the measurement screen.</p>
8 Calibrate the cable (if required).	<p>If you using cables that were not calibrated in the probe calibration step, press I/Q Cable Calibrate...</p> <p>Follow the calibration procedure, clicking Next at the end of each step.</p>
9 Make the desired measurement.	

Using Option BBA Baseband I/Q Inputs

3 Concepts

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

What is GSM and EDGE?

The Global System for Mobile communication (GSM) digital communications standard defines a voice and data over-air interface between a mobile radio and the system infrastructure. This standard was designed as the basis for a digital cellular radio communications system. A base station control center (BSC) is linked to multiple base transceiver station (BTS) sites which provide the required coverage.

EDGE (Enhanced Data Rates for GSM Evolution) enhances the GSM standard by implementing a new modulation format and filtering designed to provide higher data rates in the same spectrum. EDGE and GSM signals can be transmitted on the same frequency, occupying different timeslots, and both use existing GSM equipment. EDGE has also been adopted as the basis for IS-136HS.

The GSM digital communications standard employs an 8:1 Time Division Multiple Access (TDMA) allowing eight channels to use one carrier frequency simultaneously. The 270.833 kbits/second raw bit rate is modulated on the RF carrier using Gaussian Minimum Shift Keying (GMSK).

The standard includes multiple traffic channels, a control channel, and a cell broadcast channel. The GSM specification defines a channel spacing of 200 kHz.

GSM 900, GSM 450, GSM 480, GSM 700, GSM 850, DCS 1800, and PCS 1900 are GSM-defined frequency bands. The term GSM 900 is used for any GSM or EDGE system operating in the 900 MHz band, which includes P-GSM, E-GSM, and R-GSM. Primary (or standard) GSM 900 band (P-GSM) is the original GSM band. Extended GSM 900 band (E-GSM) includes all the P-GSM band plus an additional 50 channels. Railway GSM 900 band (R-GSM) includes all the E-GSM band plus additional channels. GSM 450, GSM 480, GSM 700, and GSM 850 are additional GSM-defined frequency bands, that provide additional bandwidth availability.

DCS 1800 is an adaptation of GSM 900, created to allow for smaller cell sizes for higher system capacity. PCS 1900 is intended to be identical to DCS 1800 except for frequency allocation and power levels. The term GSM 1800 is sometimes used for DCS 1800, and the term GSM 1900 is sometimes used for PCS 1900. For specifics on the bands, refer to [Table 3-1](#).

Table 3-1 *EDGE and GSM Band Data*

	P-GSM (GSM 900)	E-GSM (GSM 900)	R-GSM (GSM 900)	DCS 1800 (GSM 1800)	PCS 1900 (GSM 1900)	GSM 450	GSM 480	GSM 700	GSM 850
Uplink (MS Transmit) (MHz)	890 to 915	880 to 915	876 to 915	1710 to 1785	1850 to 1910	450.4 to 457.6	478.8 to 486	777 to 792	824 to 849
Downlink (BTS Transmit) (MHz)	935 to 960	925 to 960	921 to 960	1805 to 1880	1930 to 1990	460.4 to 467.6	488.8 to 496	747 to 762	869 to 894
Range (ARFCN)	1 to 124	0 to 124 and 975 to 1023	1 to 124 and 955 to 1023	512 to 885	512 to 810	259 to 293	306 to 340	438 to 511	128 to 251
TX/RX Spacing (Freq.) (MHz)	45	45	45	95	80	45	45	30	45
TX/RX Spacing (Time) (timeslots)	3	3	3	3	3	3	3	3	3
Modulation Data Rate									
GMSK (kbits/s)	270.833	270.833	270.833	270.833	270.833	270.833	270.833	270.833	270.833
8PSK (kbits/s):	812.499	812.499	812.499	812.499	812.499	812.499	812.499	812.499	812.499
Frame Period	4.615 ms	4.615 ms	4.615 ms	4.615 ms	4.615 ms	4.615 ms	4.615 ms	4.615 ms	4.615 ms
Timeslot Period	576.9 μ s	576.9 μ s	576.9 μ s	576.9 μ s	576.9 μ s	576.9 μ s	576.9 μ s	576.9 μ s	576.9 μ s
GSM Bit and Symbol Period	3.692 μ s	3.692 μ s	3.692 μ s	3.692 μ s	3.692 μ s	3.692 μ s	3.692 μ s	3.692 μ s	3.692 μ s
EDGE Symbol Period	3.692 μ s	3.692 μ s	3.692 μ s	3.692 μ s	3.692 μ s	3.692 μ s	3.692 μ s	3.692 μ s	3.692 μ s
Modulation									
GSM	0.3	0.3 GMSK	0.3	0.3	0.3	0.3	0.3	0.3	0.3
EDGE	GMSK	$3\pi/8$	GMSK	GMSK	GMSK	GMSK	GMSK	GMSK	GMSK
	$3\pi/8$	8PSK	$3\pi/8$	$3\pi/8$	$3\pi/8$	$3\pi/8$	$3\pi/8$	$3\pi/8$	$3\pi/8$
	8PSK		8PSK	8PSK	8PSK	8PSK	8PSK	8PSK	8PSK
Channel Spacing	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz
TDMA Mux	8	8	8	8	8	8	8	8	8
Voice Coder Bit Rate	13 kbits/s	13 kbits/s, 5.6 kbits/s	13 kbits/s	13 kbits/s	13 kbits/s	13 kbits/s	13 kbits/s	13 kbits/s	13 kbits/s

Concepts

What is GSM and EDGE?

The framing structure for GSM and EDGE measurements is based on a hierarchical system consisting of timeslots, TDMA frames, multiframes, superframes, and hyperframes. One timeslot consists of 156.25 (157) symbol periods including tail, training sequence, encryption, guard time, and data bits. Eight of these timeslots make up one TDMA frame. Either 26 or 51 TDMA frames make up one multiframe. Frames 13 and 26 in the 26 frame multiframe are dedicated to control channel signaling. For more detail about timeslots see [“Timeslots” on page 93](#).

Frequently Used Terms

Mobile Stations and Base Transceiver Stations

The cellular system includes the following:

- Base transceiver stations, referred to as BTS
(frequency ranges dependent on the standard; refer to [Table 3-1 on page 91](#))
- Mobile stations, referred to as MS
(frequency ranges dependent on the standard; refer to [Table 3-1 on page 91](#))

Uplink and Downlink

Uplink is defined as the path from the mobile station to the base transceiver station.
Downlink is the path from the base transceiver station to the mobile station.

ARFCN

An ARFCN is the Absolute Radio Frequency Channel Number used in EDGE and GSM systems. Each RF channel is shared by up to eight mobile stations using Time Division Multiple Access (TDMA). The ARFCN is an integer (in a range dependent on the chosen standard, refer to [Table 3-1 on page 91](#)) which designates the carrier frequency.

Timeslots

EDGE and GSM use Time Division Multiple Access (TDMA) which divides each RF channel into eight individual timeslots, thus allowing eight users to share a single carrier frequency. Users are synchronized to transmit in series, each in their assigned timeslot. A user may only transmit every 4.62 ms during their timeslot which is 577 μ s long. The eight timeslots are numbered 0 to 7. The 4.62 ms required to cycle through all eight timeslots is called a frame.

In a GSM signal each 577 μ s timeslot has a length of 156.25 bit periods, which consists of 148 data bits and 8.25 guard bits.

For an EDGE signal each 577 μ s timeslot has a length of 156.25 symbol periods, which consist of 142 data symbols of 3 bits each, 8.25 guard symbols of 3 bits each, and 6 “tail bit” symbols of 3 bits each, for a total of 426 data bits, 18 “tail bits” and 24.75 guard bits. The same frame length of 4.62 ms is required to cycle through the frame.

In a TDMA system, the shape and timing of each transmitted burst must be controlled carefully to avoid overlapping timeslots.

Transmit Power (Burst Power) Measurement Concepts

Purpose

Transmit Power is the measure of in-channel power for GSM and EDGE systems. Mobile stations and base transceiver stations 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. GSM and EDGE 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 base transceiver station, 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

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

This measurement can use either of two calculation methods - the "Above Threshold" or the "Measured Burst Width" methods. The measured Transmit Carrier Power will be very nearly the same for these two methods. The measured Transmit Carrier Power is 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 TSC (Training Sequence Code).

Above Threshold Method

This method uses the "power-above-threshold" method instead of the "useful part of the burst" method defined in the GSM standards. A time record is captured, then the analyzer averages only those points in the time record that exceed the user-specified threshold level. No attempt is made to position the burst, or to calculate and display burst widths. You can use this to measure continuous signals, or bursted signals where the Measured Burst Width method is too restrictive. 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 or EDGE Power vs. Time measurements, which also measure the power ramping of the burst.

Measured Burst Width

This method uses the threshold level to calculate the burst center and averages those points that lie within a user-specified burst width that is centered upon the burst. When Burst Width Mode is set to manual you may enter a fixed-time value in seconds or specify the burst width as a percentage of the last measured burst width (the result is in bottom-left corner of display). If you specify the burst width as a percentage, the fixed-value time is instantaneously calculated and displayed in the softkey.

For both Methods

The analyzer attenuator is automatically set to the optimum value based on the measured carrier power level, to get the best dynamic range when restarted, if Pre-Adjust for Min Clip (in AMPTD Y Scale menu) is set to any other setting than Off.

Max/Min Hold Traces exist only as a visible reference, they do not affect the measurement results. Measurement results are calculated by the latest acquired data and Measure Trace. Max/Min Hold Traces are held during the averaging cycle.

GMSK Power vs. Time Measurement Concepts

Purpose

NOTE This measurement is designed for GSM. For EDGE measurements see [“EDGE Power vs. Time Measurement Concepts” on page 112](#)

Power vs. Time (PvT) measures the mean transmit power during the “useful part” of GSM bursts and verifies that the power ramp fits within the defined mask. Power vs. Time also lets you view the rise, fall, and “useful part” of the GSM burst. Using the “Multi-Slot” function, up to eight slots in a frame can be viewed at one time.

GSM is a Time Division Multiple Access (TDMA) scheme with eight 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 TDMA burst.

The Power vs. Time measurement provides masks for both BTS (Base Transceiver Station) and MS (mobile station). The timing masks are referenced to the transition from bit 13 to bit 14 of the midamble training sequence. For GMSK measurements, the 0 dB reference is determined by measuring the mean transmitted power during the “useful part” of the burst. You can also define a user configurable limit mask to apply to the measured burst using SCPI commands.

The GSM specifications defines the “useful part” of the normal GSM burst as being the 147 bits centered on the transition from bit 13 to bit 14 (the “T0” time point) of the 26 bit training sequence.

This measurement supports Burst Type (defined in **FREQ/Channel** menu): Normal (TCH & CCH), Sync (SCH) and Access (RACH). Selected Burst Type would be displayed in the Meas Bar.

The PvT measurement may also be used to measure GPRS (General Packet Radio Service) signals. See [“Making GPRS PvT measurements” on page 99](#) for details.

Measurement Method

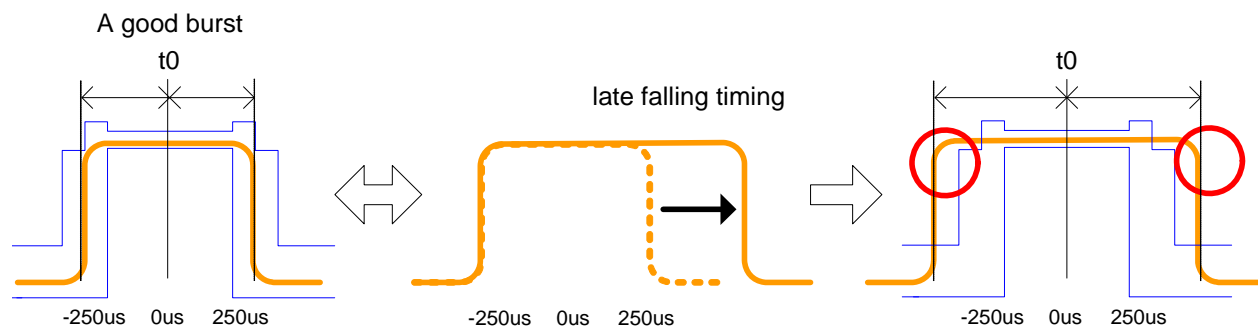
The analyzer acquires a GSM signal in the time domain. The “T0” point and the useful part are computed. The average power in the useful part is then computed and displayed, and the GSM limit mask is applied. A **Pass** annunciator appears in the analyzer display when the burst fits within the bounds of the mask.

There are three methods of the burst synchronization used to determine the t0 position:

If Burst Sync is set to **Training Seq**, a GSM demodulation is performed to find “T0”. If Burst Sync is set to **RF Amptd**, an approximation of “T0” is used without performing a demodulation.

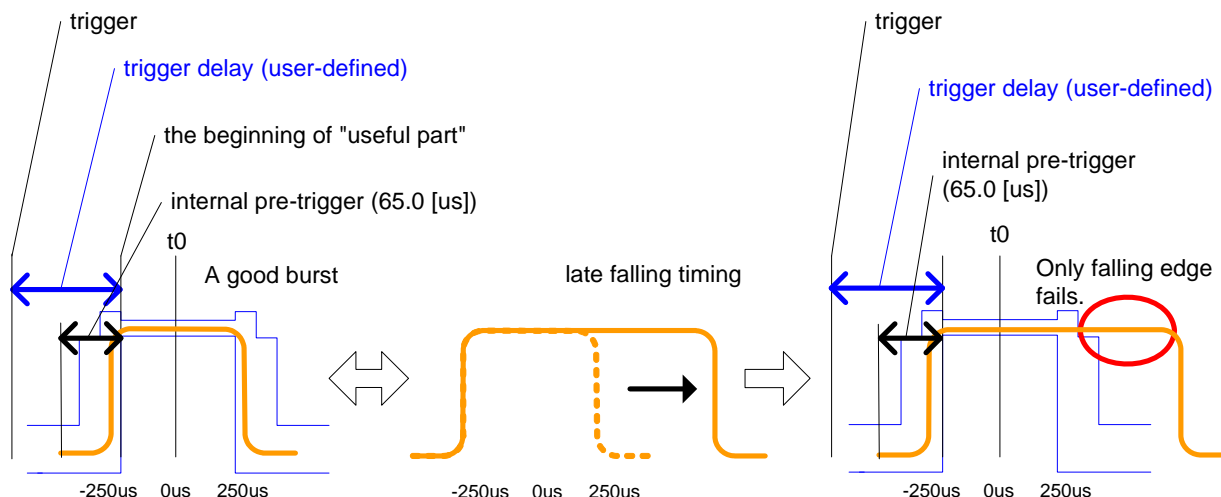
- **Training Sequence** - a GSM demodulation is performed and t_0 is determined based on the demodulated training sequence (TSC) as defined by the selected standard. This method requires a GSM signal with a valid TSC. In addition, the t_0 position would be offset by the RF Sync Delay set under the Mode Setup menu.
- **RF Amplitude** - t_0 is determined based on the burst-on duration, in other words, the ramping-up and ramping-down interval. The position of the training sequence is not considered in this method. The resulting t_0 always points to the center of the burst. Since this method always puts t_0 at the center of the burst, there is no way to tell if a problem in the burst is on the rising-edge or falling-edge. In addition, the t_0 position would be offset by the RF Sync Delay set under the Mode Setup menu.
- **None** - t_0 does not synchronize with the burst. T_0 is determined solely by the trigger signal and user-defined trigger delay time value. This method controls only the position of the limit-mask relative to the trigger. This method is only meaningful when an external trigger is present. If you specify a positive trigger delay, the time domain RF Envelope moves to the left. If you specify a negative trigger delay, the time domain RF Envelope moves to the right. The limit mask maintains the same position on the time-axis. If you specify a zero trigger delay, the beginning of the trace is 65.0 [μ s] before the useful part of the burst signal. This means the measurement always pre-triggers earlier than the actual trigger event by 65.0 [μ s]. The RF Sync Delay, set under the Mode Setup menu, does not affect the t_0 position in this method.

Figure 3-1 RF Amplitude Method with a Late Falling Time



If the burst gets longer because of a late falling timing, the RF Amplitude method automatically adjusts the limit mask so that t_0 stays at the center of the burst. Therefore, the measurement cannot tell which edge is out-of-specification and both edges would fail.

Figure 3-2 Method Set to None with a Late Falling Time



If the burst gets longer because of a late falling timing or early rising time, with the method set to None, the falling edge of the burst will always fall outside of the mask. Therefore, the measurement cannot tell which edge is out-of-specification.

Measurement Adjustments

There are five keys that are frequently used to change power vs. time measurement settings. The first three are the **Time Slot**, **Burst Type**, and **TSC (Std)** keys located in the **FREQ/Channel** menu. The fourth is the **Trigger** front-panel key where you can set the trigger source. The fifth is the **Burst Sync** key located in the **Meas Setup** menu.

First, press **Trigger**. The trigger source determines how the analyzer acquires a frame of data. If **External 1** or **External 2** is selected an external, known reference in time will be provided for the data acquisition. If **RF Burst** is selected the rising edge of a burst is used to initiate data acquisition.

Once data is acquired, the time record is interpreted as a sequence of eight slots. When an **External 1** or **External 2** trigger source is selected, the trigger is assumed to be positioned near the beginning of the base station timeslot. However, if the external trigger is more than 25% away from the burst, the analyzer does not identify the burst and fails to place a mask on it. If the external trigger is too far away from the burst, you can compensate for this by entering a value for the external trigger delay to bring the burst back into the alignment range of the mask. When the external trigger is not coincident in time with the beginning of the base station timeslot, press **Trigger** and select the trigger; once the trigger is selected **Trig Delay** enables you to enter a value for trigger delay.

When **Trigger** is set to **RF Burst**, data acquisition is delayed until the rising edge of an active timeslot burst. The issue of timeslot tolerance then applies to any subsequent active time bursts within the frame. Thus, the analyzer uses the rising edge of the RF burst to define the beginning of the first timeslot of the data record.

The analyzer does not perform the protocol analysis that is necessary to identify which absolute slot number a frame is triggering on. If it is necessary to position the measurement on an absolute slot within the GSM frame, an external trigger must be used. As an alternative, a burst of interest can be identified by placing a unique training sequence in it, and setting **TSC (Std)** to manual; this requires that you are able to configure the burst to contain a specified training sequence.

When **Burst Sync** is set to **Training Seq** the analyzer demodulates the burst to identify the training sequence and bit timing, so it can accurately position the limit mask according to the standard. In this case, the **Burst Type** setting (the choices are **Normal**, **Sync**, and **Access**) tells the analyzer demodulation algorithm which burst bit structure should be used.

If **Burst Sync** is set to **RF Amptd**, demodulation is not used and the analyzer then positions the mask in relation to the rising edge of the RF burst.

The timeslot feature is an offset feature that is used to select the “burst of interest”. The “burst of interest” represents the portion of the acquired data record that receives analysis for interpretation as a valid burst; this is the burst to which a limit mask is applied and for which power calculations are generated. When the multi-slot view is selected, all slots in the view are tested for application of the limit mask, but the burst of interest is the one that is indicated in blue text in the multi-slot table.

For example, if **Time Slot** is set to **On** and 3 is selected, the burst of interest is offset by 3 slots from the beginning of the acquired time record, and the limit mask is applied to this burst. If the selected timeslot attempts to locate a burst of interest where no burst is active, the mask application fails. Timeslot functions as a time pointer offset in the acquired data record, regardless of the **Trig Source** setting.

If **Burst Sync** is set to **Training Seq**, the value you entered under **TSC (Std)** is applied. When **TSC (Std)** is set to manual, demodulation searches for that specific training sequence number. If it is not found, a limit mask is not applied, and an error is reported. When **TSC (Std)** is set to **Auto Det**, demodulation searches the burst of interest for any of the eight standard training sequences, and uses it for to find the true center of the burst so the mask can be applied accurately.

Making GPRS PvT measurements

You can make PvT measurements of GPRS signals if you have at least one inactive slot. The inactive slot is necessary to allow synchronization of multi-slot bursts. Refer to the next section, , to configure the measurement timeslots.

Making Multi-Slot Measurements

First set **Meas Time** to the number of slots you want to view, then activate the **Multi-Slot** view, which is found in the **View/Display** menu.

You can use the following method to ensure that timeslots 0 - 7 in the transmitted frame correlate with timeslots 0 - 7 as viewed in the analyzer:

- Use an external trigger. The Keysight ESG signal generator series, for example, has an “event 1” rear panel output which triggers at the beginning of the frame. Connect the trigger from the signal generator to an external trigger input connector on the analyzer, then select the appropriate connector using the **Trigger Source** key in the **Trigger** menu.

Selecting the Burst of Interest

The burst of interest is indicated in blue text in the table shown below the multi slot view. Press the **Burst** view key to view the burst of interest.

- If a timeslot contains a burst with a standard training sequence that is unique to the frame, the specified training sequence can be used to select the timeslot in which the burst of interest occurs. Set **Trigger** to **RF Burst**, set **Burst Sync** to **Training Seq.**, and in the **Freq/Channel** menu set **Time Slot** to **OFF**. Then set **TSC (Std)** to **Man** (manual) and enter the training sequence number.
- If only one timeslot in a given frame contains a burst with a standard training sequence, then the specified training sequence can be used to select the timeslot in which the burst of interest occurs. Set **Trigger** to **RF Burst**, **Burst Sync** to **Training Seq.**, and in the **Freq/Channel** menu set **Time Slot** **OFF**. Then set **TSC (Std)** to **Auto Det.**, and the trigger automatically searches through the available standards for a matching training sequence number.

Changing the View

The **View/Display** key accesses a menu that allows you to select the desired view of the measurement from the following selections:

- **Burst** - views the entire burst of interest as determined by the current trigger source, burst sync, training sequence, and timeslot settings. To view a different burst of interest you must set these parameters for the selected timeslot. To view multiple slots use the **Multi-Slot** key described below. See [Figure 2-4, “GMSK Power vs. Time Result - Burst View” on page 26.](#)
- **Rise & Fall** - zooms in on the rising and falling portions of the burst being tested. See [Figure 2-5, “GMSK Power vs. Time Result - Rise & Fall View” on page 26.](#)

NOTE

The limit test is still performed on the entire burst (viewed using the **Burst** menu) when **Rise & Fall** is selected.

- **Multi-Slot** - views the entire sweep as specified by the current **Meas Time** setting. Power levels for each active slot are listed in a table below the timeslot display. Also shown in the table under **1st Error Pt.** is the point in time at which the signal level first exceeds the limit, which helps to identify the slot where a failure first occurs. The **1st Error Pt.** date is displayed only when there is an limit failure.

Use the **Meas Time** key located in the **Meas Setup** menu to select up to eight slots. Use the **Time Slot** and **TSC** keys in the **FREQ/Channel** menu to select the slot you wish to activate. Setting **Time Slot** to **ON** and selecting a specific slot results in activating a measurement of that slot only (**Time Slot On** can be used to isolate a failure to a specific slot). When **Time Slot** is set to **OFF**, all active slots are tested against the mask.

Using a signal generator you can synchronize the multi-slot view so the frame (or portion of the frame) you are viewing starts with the slot you have selected. See [“Making Multi-Slot Measurements” on page 99](#).

You can switch from the multi-slot view directly to the burst or rise and fall views of the slot that is currently active. The **Scale/Div** key under the **Span/X Scale** menu can be used to enlarge your view of this signal.

Changing the Display

The **Limit Mask** key allows you to turn the limit mask on and off. This also disables the mask limit test, but still calculates the power in the useful part.

Measurement Results

The views available under the **View/Display** menu are **Burst**, **Rise & Fall**, and **Multi-Slot**. See [“Changing the View” on page 100](#).

Information shown in the settings panel at the top of the displays include:

- **Atten** - This value reflects the **Internal RF Atten** setting.
- **Sync** - The **Burst Sync** setting used in the current measurement
- **Trig** - The **Trigger Source** setting used in the current measurement

The Mean Transmit Power is displayed at the bottom left of the Burst and Rise & Fall views:

- **Mean Transmit Power** - This is the RMS average power across the “useful” part of the burst, or the 147 bits centered on the transition from bit 13 to bit 14 (the “T0” time point) of the 26 bit training sequence. An RMS calculation is performed and displayed regardless of the averaging mode selected for the trace data.

If Averaging is set to On, the result displayed is the RMS average power of all bursts measured. If Averaging is set to Off, the result is the RMS average power of the single burst measured. This is a different measurement result from Mean Transmit Power, below.

The **Current Data** displayed at the bottom of the Burst and Rise & Fall views include:

- **Mean Transmit Power** - This result appears only if Averaging is set to On. It is the RMS average of power across the “useful” part of the burst, for the current burst only. If a single measurement of “n” averages has been completed, the result indicates the Mean Transmit Power of the last burst. The RMS calculation

Concepts

GMSK Power vs. Time Measurement Concepts

is performed and displayed regardless of the averaging mode selected for the trace data. This is a different measurement result from Mean Transmit Power, above.

- **Max Pt.** - Maximum signal power point of the most recently acquired data, in dBm
- **Min Pt.** - Minimum signal power point of the most recently acquired data, in dBm
- **Burst Width** - Time duration of burst at -3 dB below the mean power in the useful part of the burst
- **1st Error Pt** - (Error Point) The time (displayed in ms or μ s) indicates the point on the X Scale where the first failure of a signal was detected. Use a marker to locate this point in order to examine the nature of the failure. The 1st Error Pt. date is displayed only when there is an limit failure.

The table in the lower portion of the multi-slot view shows the output power in dBm for each timeslot, as determined by the integer (1 to 8) entered in the **Meas Setup**, **Meas Time** setting. Output power levels are presented for the active slots; a dashed line appears for any slot that is inactive. The timeslot that contains the burst of interest is highlighted in blue.

GMSK Phase and Frequency Error Measurement Concepts

NOTE This measurement is designed for GSM only.

Purpose

Phase and frequency error are the measures of modulation quality for GSM systems. Since GSM systems use relative phase to transmit information, the phase and frequency accuracy of the transmitter are critical to the systems' performance and ultimately affect range.

GSM receivers rely on the phase and frequency quality of the 0.3 GMSK signal in order to achieve the expected carrier to noise performance. A transmitter with high phase and frequency error is often still able to support phone calls during a functional test. However, it tends to create difficulty for mobiles trying to maintain service at the edges of the cell, with low signal levels, or under difficult fading and Doppler conditions.

Measurement Method

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

The analyzer samples the transmitter output in order to capture the actual phase trajectory. This is then demodulated and the ideal phase trajectory is mathematically derived. Subtracting one from the other results in an error signal.

This measurement allows you to display these errors numerically and graphically on the analyzer display. It also allows you to view a binary representation of the demodulated data bits.

Measurement Adjustments

NOTE The factory default settings provide a GSM compliant measurement. For special requirements, you may need to change some of the settings. Press **Meas Setup, More, Restore Meas Defaults** at any time to return all parameters for the current measurement to their default settings.

You can select the desired ARFCN, center frequency, timeslot, burst type, and TSC (Training Sequence Code).

You can also select the type of carrier to measure. Press **Mode Setup, Radio, Carrier** and select **Burst** to measure a burst carrier, or **Cont** to measure a continuous carrier from a non-bursting base station.

When **Training Sequence** is selected as the burst sync for this measurement, the **Time Slot** selection to determine which timeslot to measure. For example, if **Time Slot** is set to 2, the measurement is made on the timeslot number 2. Be careful when adding delay in the Trigger setup, as this measurement does not take into account trigger delay when checking for a valid burst. If there is sufficient delay added (usually more than 25% of a timeslot), the burst might not be detected.

You can make measurements of continuous GMSK signals by synchronizing the measurement to the training sequence. When using the training sequence as the burst sync, the entire data record is demodulated, and the measurement searches for a training sequence. To select a specific training sequence press **Frequency, TSC (Std)** to toggle from **AUTO** to any of 8 standard sequences numbered from 0 to 7.

You can also make continuous carrier measurements without synchronization. Set **Burst Sync** to **RF Amplitd** in the **Meas Setup** menu. The measurement begins demodulation without searching for a sync word.

Press **Meas, Phase & Freq** to immediately make Phase and Frequency Error the active measurement.

Changing the View

The **View/Display** key allows you to select the desired view of the measurement from the following:

- **I/Q Error (Quad-View)** - Provides a combination view including

Window 1: Phase Error

Window 2: Phase Error with Freq

Window 3: RF Envelope

Window 4: Numeric Results

Any of these windows can be selected (using the **Next Window** key) and made full size (using the **Zoom** key).

- **I/Q Measured Polar Vector** - Provides a view of numeric results and a polar vector graph.

Window 1: Numeric Results

Window 2: Polar Vector Graph

- **Data Bits** - Provides a view of the numeric results and data bits with the sync word (TSC) highlighted.

The menus under the **SPAN X Scale** and **AMPTD Y Scale** keys are context dependent upon the selected window (graph type). The **SPAN X Scale** parameters are in units of time or bits, dependent on the view selected. The **AMPTD Y Scale** parameters are in units of dB or degrees, dependent on the view selected. All of the softkey labels are blank when **I/Q Measured Polar Vector**, or **Data Bits** are selected.

Changing the Display

The **Display** key allows you to turn the bit dots on and off.

GMSK Output RF Spectrum Measurement Concepts

Purpose

NOTE This measurement is designed for GSM. For EDGE Output RF Spectrum measurements see [“EDGE Output RF Spectrum Measurement Concepts” on page 123.](#)

The Output RF Spectrum measurement is the GSM version of the adjacent channel power (ACP) measurement. Either a single offset is measured with corresponding traces or up to 15 offsets are measured and a table is displayed. In spectrum due to modulation or switching transient measurements a sweep spectrum display of -1.8 MHz to +1.8 MHz or -3.8 MHz to +3.8 MHz from the carrier can be viewed.

The output RF spectrum measurements determine the spectral energy emitted into the adjacent channels. Excessive amounts of energy spilling into an adjacent frequency channel could interfere with signals being transmitted to other MS or BTS. The measurements are divided into two main groups: spectrum due to the 0.3 GMSK modulation and noise, and spectrum due to switching transients (burst ramping).

Since GSM is a TDMA format, RF power is being switched on and off depending on whether the actual burst is being transmitted. The switching of power causes spectral splatter at frequencies other than that being transmitted by the carrier. Fast transitions in the time domain causes switching transients that have high frequency content associated with them.

NOTE The default output RF spectrum measurements do not perform tests at frequency offsets greater than 1800 kHz from the carrier.

Measurement Method

In this measurement, the transmitter (source) is set to transmit a GSM frame at a given channel (frequency). The analyzer acquires a time record at a particular offset from the channel being transmitted. The method of acquiring the time record is either a FFT/Inverse-FFT method, or a direct time domain (DTD) method, depending on the offset. These two methods, and when they are used, are described below. When the offset is zero, the analyzer is said to be measuring the carrier. For a given offset frequency from the carrier, the transmitter must not exceed a certain power level relative to the carrier. The GSM specification defines the offsets and their maximum absolute and relative power levels.

The general steps in making the measurement are as follows:

- Acquire time record (using either FFT or DTD methods, described below)
- Synchronize for gating on the carrier - finds 50% and 90% portion of burst for Spectrum Due to Modulation portion of the test
- Measure power of the carrier
- Compare each offset power to reference to get relative power level

The method of acquiring the time record is dependent on accuracy and dynamic range. With no pre-ADC filter (infinite bandwidth), the entire IF bandwidth of the IF signal is hitting the analog to digital converter (ADC). The ADC gain is set based on the peak level at its input. The dynamic range (noise floor) of the ADC is dependent on the gain selected. For the type of signals being measured, the highest energy within the IF bandwidth is at the carrier. Therefore, the lowest dynamic range (highest noise floor) of the ADC occurs when the full energy of the carrier is input to the ADC.

All offsets measured using the FFT method are done with the analyzer tuned such that the carrier is at the center of the IF bandwidth. Therefore, the dynamic range of the offsets measured using the FFT method is the same as that for the carrier. The dynamic range requirement generally increases as the offset frequency increases. If the dynamic range requirement exceeds what is available by FFT method, the direct time domain (DTD) method utilizing the pre-ADC filter is used.

The **Min Freq Using Direct Time** key setting is the first offset frequency which is measured using the DTD method. Its range is determined by assuring no aliasing occurs on FFT offsets and that the dynamic range requirements are met.

The FFT method acquires a wideband signal in a flattop filter. An FFT is performed to get the spectrum of the GSM signal. The resolution bandwidth filter can now be applied mathematically to the spectrum at multiple offsets, with an inverse-FFT performed on the data which passes the filter. In this way, multiple offsets are acquired from one time record and LO setting. Since the resolution bandwidth filter is a mathematical formula, it can be any shape and size, and is perfect. The measurement uses the 5-pole synchronously tuned filter that the GSM standard specifies.

The primary disadvantage to the FFT method is that the acquisition must include the carrier. The high energy of the carrier causes the ADC to range down, thus lowering the dynamic range. At large offsets, the dynamic range requirement is very challenging so the direct time domain (DTD) method is used. The LO is tuned to the particular offset and the pre-ADC filter is used to reduce the carrier. This allows the ADC to range up, giving higher dynamic range. The disadvantage to this method is that each offset measured has its own time record acquisition and LO tune position, and this causes the measurement to slow down compared to FFT offsets. The 5-pole synchronously tuned filter is approximated by utilizing a digital Gaussian filter and setting its equivalent noise bandwidth to that of the 5-pole synchronously tuned filter. For these DTD offset frequencies, the filter has closer-to-ideal 5-pole behavior (< 1% tolerance) than does a 10% tolerance, 5-pole analog filter.

Regardless of how the time record is obtained for a particular offset, the power must be measured and compared to the reference power. There are two measurements being made for the test: output RF spectrum due to modulation and the output RF spectrum due to switching transients. The GSM standard specifies which offsets get which tests. In these two modes, the following conditions are met:

- In the output RF spectrum due to modulation measurement, the average value during at least 40 bits between bit 87 and 132 (approximately equivalent to the 50% to 90% portion of the burst, excluding midamble) is retained. The vertical lines mark the section of the burst over which the measurement is made. If multiple bursts are examined, an average of the average values is calculated. The relative power (difference between the average power of the burst at zero offset and the average power of the burst at the indicated offset) and the absolute power are displayed.
- In the output RF spectrum due to switching transients, the peak value of the whole frame is retained. The reference power of reference due to switching is the average power of the useful part of the burst with at least 300 kHz RBW. The relative power (difference between the mean transmit power of the burst at zero offset and the peak power of the burst at the indicated offset) and the absolute power are displayed.

The GSM standard specifies the tests are run on specified offsets from the carrier. The analyzer identifies this as single offset or multiple offset modes. The measurement made in these two modes is the same, except that the multiple offset mode automatically makes the measurement at all the specified offsets frequencies and lists the results in a table at the end of the measurement.

In the output RF spectrum due to modulation measurement, setting the modulation method to discrete obtains results from specified offsets from the carrier as defined in the standard; the results are displayed in a table. When set to sweep, the measurement obtains results of a span extending to 1800 kHz from both sides of the carrier, measured in with 30 kHz RBW; the results are displayed as a spectrum.

The GMSK ORFS Modulation result view shows a single-offset (Examine) trace for an entire GSM slot. The vertical bars show the portion used to measure power due to modulation.

The RF envelope trace is displayed. If averaging is turned on, the trace is then averaged with previous traces. For the modulation measurement, you may select the type of trace averaging, either log-power averaged (Video) or power averaged (RMS). For the switching transients measurement, the peak of the traces is used. For modulation, the displayed value is the average of points within the vertical bars. For transients, the displayed value is the max of all points for all traces (Max of Peak) over the entire frame.

Changing the View

If the Multi-Offset measurement has been chosen and the Meas Type is Mod & Switch, pressing the **View/Display** key allows you to select the desired view of the current measurement. If the Meas Type is Modulation, the **Switching Margin and Limit** view is unavailable. If the Meas Type is Switching, the **Modulation Margin & Limit** view is unavailable.

GMSK ORFS Measurements on a Single Bursted Slot

The analyzer can be set up to make an ORFS measurement on a single bursted EDGE slot if all of the offsets measured are less than the Min Freq Using Direct Time using the following procedure:

Step	Notes
1 Select GSM/EDGE Mode.	Press Mode, GSM .
2 Select GMSK Output RF Spectrum measurement.	Press Meas, GMSK Output RF Spectrum .
3 Set the Min Freq Using Direct Time to be greater than the furthest offset measured.	Press Meas Setup, More, Advanced, Min Freq Using Direct Time . The maximum value that can be set is 775.0 kHz.
4 Set the measurement type.	Press Meas Setup, Meas Type, Modulation .
5 Set the offsets to be measured.	Press Meas Setup, Multi-Offset Freq List, Custom .
6 Set the appropriate trigger type.	Press Trig Source and select either Trigger 1, Trigger 2, or RF Burst . If the selection is RF Burst, adjust the RF burst trigger Peak Level so that the analyzer does not trigger when there is no signal present. Press Trigger, RF Burst , and then, Trig Delay .
7 Initiate the measurement.	Press Restart or the Single front-panel key, or send a remote command.

GMSK Tx Band Spur Measurement Concepts

Purpose

NOTE This measurement is designed for GSM. For EDGE Tx Band Spur measurements see “EDGE Tx Band Spur Measurement Concepts” on page 128.

The Tx Band Spur measurement checks that the transmitter does not transmit undesirable energy into the transmit band. This energy may cause interference for other users of the GSM system.

Measurement Method

This is a base station only measurement. The transmitter should be set at its maximum output power on all time slots. This measurement is performed at RF channels B (bottom), M (middle), and T (top). Refer to the following table.

Band	Tx Band Edge (MHz)		BOTTOM		MIDDLE		TOP	
	Low	High	Freq (MHz)	ARFCN	Freq (MHz)	ARFCN	Freq (MHz)	ARFCN
P-GSM	935	960	935.20 0	1	947.60 0	63	959.80 0	124
E-GSM	925	960	925.20 0	975	942.60 0	38	959.80 0	124
R-GSM	921	960	921.20 0	955	940.60 0	28	959.80 0	124
DCS 1800	1805	1880	1805.2 0	512	1842.6 0	699	1879.8 0	885
PCS 1900	1930	1990	1930.2 0	512	1960.0 0	661	1989.8 0	810

The transmit band spectrum is measured in several frequency segments using resolution bandwidths as specified by the standard (see the list below).

Frequency Offset	Resolution Band width
≥ 1.8 MHz and < 6 MHz and inside Tx band	30 kHz
≥ 6 MHz and inside Tx band	100 kHz

The mean transmit power is measured first using the “power-above-threshold” method (see the Transmit Power measurement for detail), and then used as a reference for the measurement limit lines if limits are used. The spectrums, which are below or above the carrier frequency and within the transmit band, are measured.

For each spectrum segment, the measurement looks for the spectrum peak closest to the limit and saves the data. The peak of the selected segment is reported as the **Worst Spur**. The amplitude difference from the peak to the limit line (Δ from Limit), and from the peak to the mean transmit power (Δ from Carrier) are displayed. The frequency difference from the peak to the carrier frequency (Offset Freq) is also displayed. If the peak goes above the limit line, the display indicates **FAIL**. When the marker is on, press the **Peak Search** key, then the active marker is placed at the peak of the displayed segment.

Changing the View

The **View/Display** key allows you to further examine the desired spectrum segment. Each of these choices selects a different part of the frequency spectrum for viewing:

Lower Segment	lower Tx band edge to -6 MHz offset from the channel frequency
Lower Adj Segment	-6 MHz to -1.8 MHz offset from the channel frequency
Upper Adj Segment	+1.8 MHz to +6 MHz offset from the channel frequency
Upper Segment	+6 MHz offset from the channel frequency to the upper Tx band edge

EDGE Power vs. Time Measurement Concepts

Purpose

NOTE This measurement is designed for EDGE. For GSM Power vs. Time measurements see ["GMSK Power vs. Time Measurement Concepts" on page 96.](#)

Power vs. Time (PvT) measures the mean transmit power during the “useful part” of GSM bursts and verifies that the power ramp fits within the defined mask. Power vs. Time also lets you view the rise, fall, and “useful part” of the GSM burst. Using the “Multi-Slot” function, up to eight slots in a frame can be viewed at one time.

GSM is a Time Division Multiple Access (TDMA) scheme with eight 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 TDMA burst.

The Power vs. Time measurement provides masks for both BTS (Base Transceiver Station) and MS (mobile station). The timing masks are referenced to the transition from bit 13 to bit 14 of the midamble training sequence. For GMSK measurements, the 0 dB reference is determined by measuring the mean transmitted power during the “useful part” of the burst. You can also define a user configurable limit mask to apply to the measured burst using SCPI commands.

The GSM specifications defines the “useful part” of the normal GSM burst as being the 147 bits centered on the transition from bit 13 to bit 14 (the “T0” time point) of the 26 bit training sequence.

This measurement supports Burst Type (defined in **FREQ/Channel** menu): Normal (TCH & CCH), Sync (SCH) and Access (RACH). Selected Burst Type would be displayed in the Meas Bar.

Measurement Method

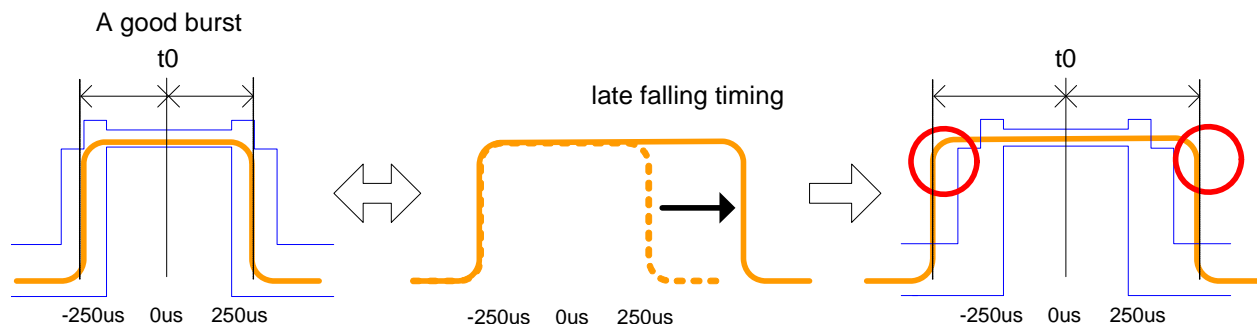
The analyzer acquires a EDGE signal in the time domain. The “T0” point and the useful part are computed. The average power in the useful part is then computed and displayed, and the EDGE limit mask is applied. A **Pass** annunciator appears in the analyzer display when the burst fits within the bounds of the mask.

There are three methods of the burst synchronization used to determine the t0 position:

If Burst Sync is set to **Training Seq.**, a EDGE demodulation is performed to find “T0”. If Burst Sync is set to **RF Amptd.**, an approximation of “T0” is used without performing a demodulation.

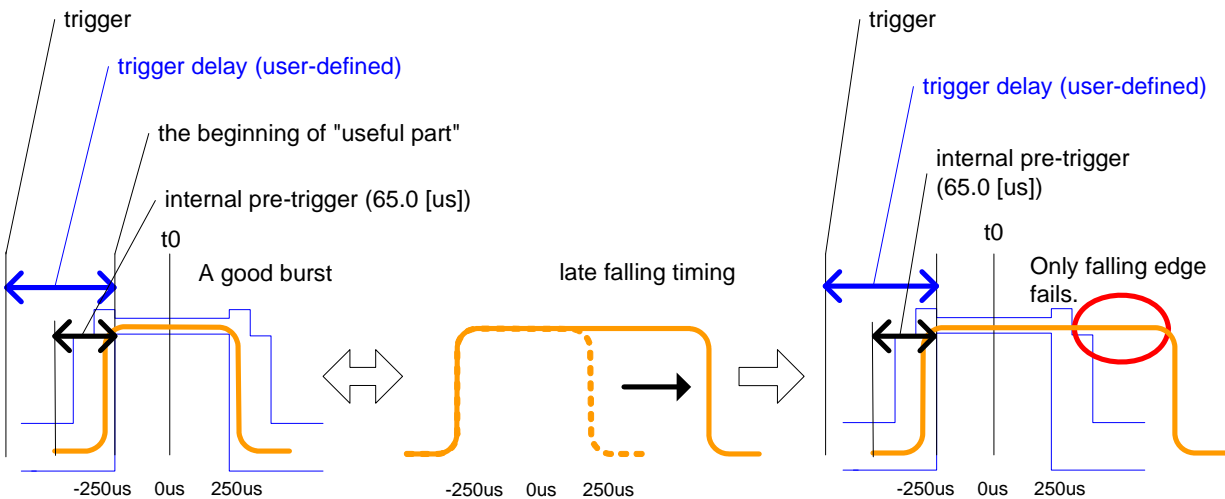
- **Training Sequence** - a EDGE demodulation is performed and t_0 is determined based on the demodulated training sequence (TSC) as defined by the selected standard. This method requires a EDGE signal with a valid TSC. In addition, the t_0 position would be offset by the RF Sync Delay set under the Mode Setup menu.
- **RF Amplitude** - t_0 is determined based on the burst-on duration, in other words, the ramping-up and ramping-down interval. The position of the training sequence is not considered in this method. The resulting t_0 always points to the center of the burst. Since this method always puts t_0 at the center of the burst, there is no way to tell if a problem in the burst is on the rising-edge or falling-edge. In addition, the t_0 position would be offset by the RF Sync Delay set under the Mode Setup menu.
- **None** - t_0 does not synchronize with the burst. T_0 is determined solely by the trigger signal and user-defined trigger delay time value. This method controls only the position of the limit-mask relative to the trigger. This method is only meaningful when an external trigger is present. If you specify a positive trigger delay, the time domain RF Envelope moves to the left. If you specify a negative trigger delay, the time domain RF Envelope moves to the right. The limit mask maintains the same position on the time-axis. If you specify a zero trigger delay, the beginning of the trace is 65.0 [μ s] before the useful part of the burst signal. This means the measurement always pre-triggers earlier than the actual trigger event by 65.0 [μ s]. The RF Sync Delay, set under the Mode Setup menu, does not affect the t_0 position in this method.

Figure 3-3 RF Amplitude Method with a Late Falling Time



If the burst gets longer because of a late falling timing, the RF Amplitude method automatically adjusts the limit mask so that t_0 stays at the center of the burst. Therefore, the measurement cannot tell which edge is out-of-specification and both edges would fail.

Figure 3-4 Method Set to None with a Late Falling Time



If the burst gets longer because of a late falling timing or early rising time, with the method set to None, the falling edge of the burst will always fall outside of the mask. Therefore, the measurement cannot tell which edge is out-of-specification.

Measurement Adjustments

There are five keys that are frequently used to change power vs. time measurement settings. The first three are the **Time Slot**, **Burst Type**, and **TSC (Std)** keys located in the **FREQ/Channel** menu. The fourth is the **Trigger** front-panel key where you can set the trigger source. The fifth is the **Burst Sync** key located in the **Meas Setup** menu.

First, press **Trigger**. The trigger source determines how the analyzer acquires a frame of data. If **External 1** or **External 2** is selected an external, known reference in time will be provided for the data acquisition. If **RF Burst** is selected the rising edge of a burst is used to initiate data acquisition.

Once data is acquired, the time record is interpreted as a sequence of eight slots. When an **External 1** or **External 2** trigger source is selected, the trigger is assumed to be positioned near the beginning of the base station timeslot. However, if the external trigger is more than 25% away from the burst, the analyzer does not identify the burst and fails to place a mask on it. If the external trigger is too far away from the burst, you can compensate for this by entering a value for the external trigger delay to bring the burst back into the alignment range of the mask. When the external trigger is not coincident in time with the beginning of the base station timeslot, press **Trigger** and select the trigger; once the trigger is selected **Trig Delay** enables you to enter a value for trigger delay.

When **Trigger** is set to **RF Burst**, data acquisition is delayed until the rising edge of an active timeslot burst. The issue of timeslot tolerance then applies to any subsequent active time bursts within the frame. Thus, the analyzer uses the rising edge of the RF burst to define the beginning of the first timeslot of the data record.

The analyzer does not perform the protocol analysis that is necessary to identify which absolute slot number a frame is triggering on. If it is necessary to position the measurement on an absolute slot within the EDGE frame, an external trigger must be used. As an alternative, a burst of interest can be identified by placing a unique training sequence in it, and setting **TSC (Std)** to manual; this requires that you are able to configure the burst to contain a specified training sequence.

When **Burst Sync** is set to **Training Seq** the analyzer demodulates the burst to identify the training sequence and bit timing, so it can accurately position the limit mask according to the standard. In this case, the **Burst Type** setting (the choices are **Normal**, **Sync**, and **Access**) tells the analyzer demodulation algorithm which burst bit structure should be used.

If **Burst Sync** is set to **RF Amptd**, demodulation is not used and the analyzer then positions the mask in relation to the rising edge of the RF burst.

The timeslot feature is an offset feature that is used to select the “burst of interest”. The “burst of interest” represents the portion of the acquired data record that receives analysis for interpretation as a valid burst; this is the burst to which a limit mask is applied and for which power calculations are generated. When the multi-slot view is selected, all slots in the view are tested for application of the limit mask, but the burst of interest is the one that is indicated in blue text in the multi-slot table.

For example, if **Time Slot** is set to **On** and 3 is selected, the burst of interest is offset by 3 slots from the beginning of the acquired time record, and the limit mask is applied to this burst. If the selected timeslot attempts to locate a burst of interest where no burst is active, the mask application fails. Time Slot functions as a time pointer offset in the acquired data record, regardless of the **Trig Source** setting.

If **Burst Sync** is set to **Training Seq**, the value you entered under **TSC (Std)** is applied. When **TSC (Std)** is set to manual, demodulation searches for that specific training sequence number. If it is not found, a limit mask is not applied, and an error is reported. When **TSC (Std)** is set to **Auto**, demodulation searches the burst of interest for any of the eight standard training sequences, and uses it for to find the true center of the burst so the mask can be applied accurately.

Making GPRS PvT measurements

You can make PvT measurements of GPRS signals if you have at least one inactive slot. The inactive slot is necessary to allow synchronization of multi-slot bursts. Refer to the next section, , to configure the measurement timeslots.

Making Multi-Slot Measurements

First set **Meas Time** to the number of slots you want to view, then activate the **Multi-Slot** view, which is found in the **View/Display** menu.

You can use the following method to ensure that timeslots 0 - 7 in the transmitted frame correlate with timeslots 0 - 7 as viewed in the analyzer:

- Use an external trigger. The Keysight ESG signal generator series, for example, has an “event 1” rear panel output which triggers at the beginning of the frame. Connect the trigger from the signal generator to an external trigger input connector on the analyzer, then select the appropriate connector using the **Trigger Source** key in the **Meas Setup** menu.

Selecting the Burst of Interest

The burst of interest is indicated in blue text in the table shown below the multi slot view. Press the **Burst** view key to view the burst of interest.

- If a timeslot contains a burst with a standard training sequence that is unique to the frame, the specified training sequence can be used to select the timeslot in which the burst of interest occurs. Set **Trigger** to **RF Burst**, set **Burst Sync** to **Training Seq.**, and in the **Freq/Chan** menu set **Timeslot** to **OFF**. Then set **TSC (Std)** to **Man** (manual) and enter the training sequence number.
- If only one timeslot in a given frame contains a burst with a standard training sequence, then the specified training sequence can be used to select the timeslot in which the burst of interest occurs. Set **Trigger** to **RF Burst**, **Burst Sync** to **Training Seq.**, and in the **Freq/Chan** menu set **Timeslot** **OFF**. Then set **TSC (Std)** to **Auto**, and the trigger automatically searches through the available standards for a matching training sequence number.

Changing the View

The **View/Display** key accesses a menu that allows you to select the desired view of the measurement from the following selections:

- **Burst** - views the entire burst of interest as determined by the current trigger source, burst sync, training sequence, and timeslot settings. To view a different burst of interest you must set these parameters for the selected timeslot. To view multiple slots use the **Multi-Slot** key described below. See [Figure 2-4, “GMSK Power vs. Time Result - Burst View” on page 26.](#)
- **Rise & Fall** - zooms in on the rising and falling portions of the burst being tested. See [Figure 2-5, “GMSK Power vs. Time Result - Rise & Fall View” on page 26.](#)

NOTE

The limit test is still performed on the entire burst (viewed using the **Burst** menu) when **Rise & Fall** is selected.

- **Multi-Slot** - views the entire sweep as specified by the current **Meas Time** setting. Power levels for each active slot are listed in a table below the timeslot display. Also shown in the table under **1st Error Pt.** is the point in time at which the signal level first exceeds the limit, which helps to identify the slot where a failure first occurs. The **1st Error Pt.** date is displayed only when there is an limit failure.

Use the **Meas Time** key located in the **Meas Setup** menu to select up to eight slots. Use the **Time Slot** and **TSC** keys in the **FREQ/Channel** menu to select the slot you wish to activate. Setting **Time Slot** to **ON** and selecting a specific slot results in activating a measurement of that slot only (**Time Slot On** can be used to isolate a failure to a specific slot). When **Time Slot** is set to **OFF**, all active slots are tested against the mask.

Using a signal generator you can synchronize the multi-slot view so the frame (or portion of the frame) you are viewing starts with the slot you have selected. See [“Making Multi-Slot Measurements” on page 99](#).

You can switch from the multi-slot view directly to the burst or rise and fall views of the slot that is currently active. The **Scale/Div** key under the **Span/X Scale** menu can be used to enlarge your view of this signal.

Changing the Display

The **Limit Mask** key allows you to turn the limit mask on and off. This also disables the mask limit test, but still calculates the power in the useful part.

Measurement Results

The views available under the **View/Display** menu are **Burst**, **Rise & Fall**, and **Multi-Slot**. See [“Changing the View” on page 116](#).

Information shown in the settings panel at the top of the displays include:

- **Atten** - This value reflects the **Internal RF Atten** setting.
- **Sync** - The **Burst Sync** setting used in the current measurement
- **Trig** - The **Trigger Source** setting used in the current measurement

The Mean Transmit Power is displayed at the bottom left of the Burst and Rise & Fall views:

- **Mean Transmit Power** - This is the RMS average power across the “useful” part of the burst, or the 147 bits centered on the transition from bit 13 to bit 14 (the “T0” time point) of the 26 bit training sequence. An RMS calculation is performed and displayed regardless of the averaging mode selected for the trace data.

If Averaging is set to On, the result displayed is the RMS average power of all bursts measured. If Averaging is set to Off, the result is the RMS average power of the single burst measured. This is a different measurement result from Mean Transmit Power, below.

The **Current Data** displayed at the bottom of the Burst and Rise & Fall views include:

- **Mean Transmit Power** - This result appears only if Averaging is set to On. It is the RMS average of power across the “useful” part of the burst, for the current burst only. If a single measurement of “n” averages has been completed, the result indicates the Mean Transmit Power of the last burst. The RMS calculation

Concepts

EDGE Power vs. Time Measurement Concepts

is performed and displayed regardless of the averaging mode selected for the trace data. This is a different measurement result from Mean Transmit Power, above.

- **Max Pt.** - Maximum signal power point of the most recently acquired data, in dBm
- **Min Pt.** - Minimum signal power point of the most recently acquired data, in dBm
- **Burst Width** - Time duration of burst at -3 dB below the mean power in the useful part of the burst
- **Mask Ref Pwr Midamble** - The Mask Reference Power is the average power in dBm of the middle 16 symbols in the midamble. The times displayed are the corresponding start and stop times of the middle 16 symbols.
- **1st Error Pt** - (Error Point) The time (displayed in ms or μ s) indicates the point on the X Scale where the first failure of a signal was detected. Use a marker to locate this point in order to examine the nature of the failure. The 1st Error Pt. date is displayed only when there is a limit failure.

The table in the lower portion of the multi-slot view shows the output power in dBm for each timeslot, as determined by the integer (1 to 8) entered in the **Meas Setup**, **Meas Time** setting. Output power levels are presented for the active slots; a dashed line appears for any slot that is inactive. The timeslot that contains the burst of interest is highlighted in blue.

EDGE EVM Measurement Concepts

Purpose

EVM (Error Vector Magnitude) is the measure of modulation quality for EDGE. Since EDGE uses $3\pi/8$ PSK modulation, the transmitter phase, frequency, and amplitude accuracy are critical to the communications system performance. EVM also ultimately affects range.

EDGE receivers rely on the quality of the $3\pi/8$ PSK modulation signal to achieve the expected carrier to noise ratio. A transmitter with high EVM is often still able to support phone calls during a functional test. However, it tends to create difficulty for mobiles trying to maintain service at the edge of the cell, with low signal levels, or under difficult fading and Doppler conditions.

Measurement Method

EVM is measured by calculating the difference between the actual received signal and a theoretical, ideal signal; this theoretical signal is derived mathematically from data sampled from the transmitted signal.

The EVM measurement allows you to view error results numerically and graphically in the analyzer display. The graph windows display EVM Phase Error and Mag Error. The text window displays EVM in % rms, % peak at the highest symbol number, and 90% EVM; Mag Error in % rms; Phase Error in degrees; Freq Error in Hz; Droop in dB/symbol (Droop is stated in dB across the 142 symbol burst; it also allows you to view demodulated symbols), I/Q Offset in dB, and T0 Offset in seconds.

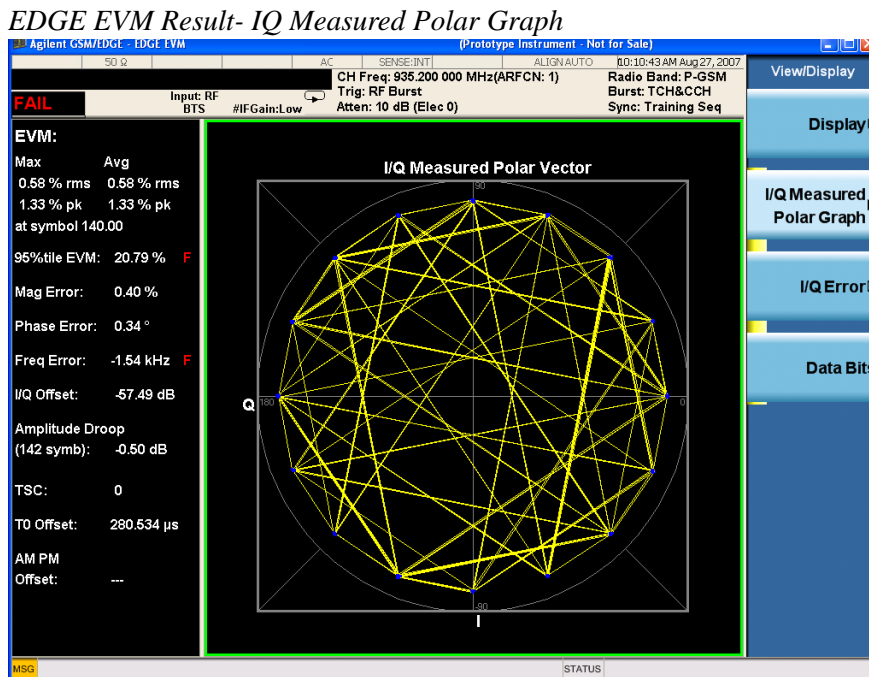
Measurement Adjustments

Changing the View

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

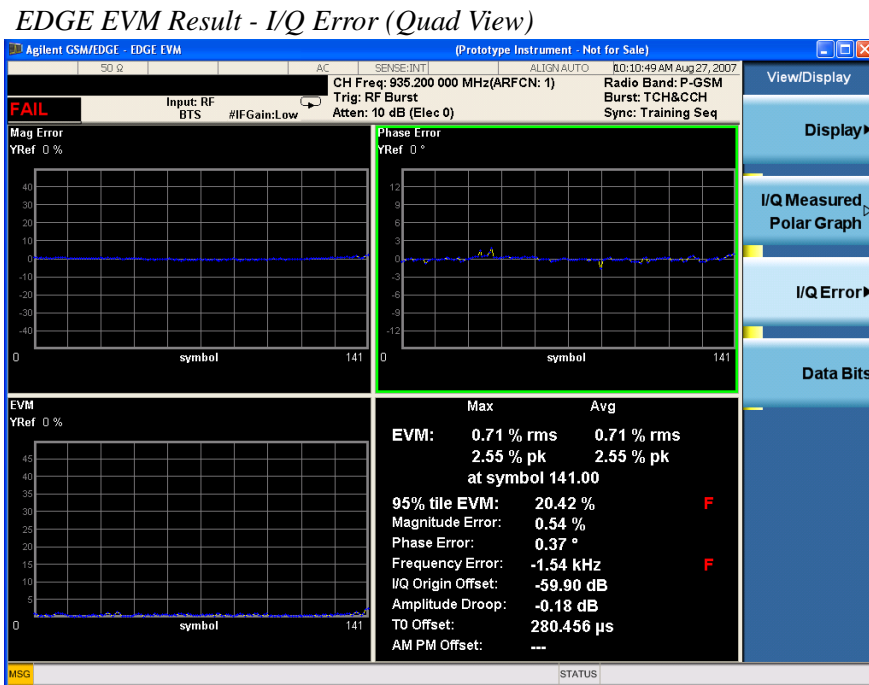
- **IQ Measured Polar Graph** - The measured summary data is shown in the left window and the dynamic vector trajectory of the I/Q demodulated signal is shown as a vector display in the right window. The polar vector view presents a constantly changing display. See [Figure 3-5, "EDGE EVM Result- IQ Measured Polar Graph"](#) on page 120 for an example.

Figure 3-5



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

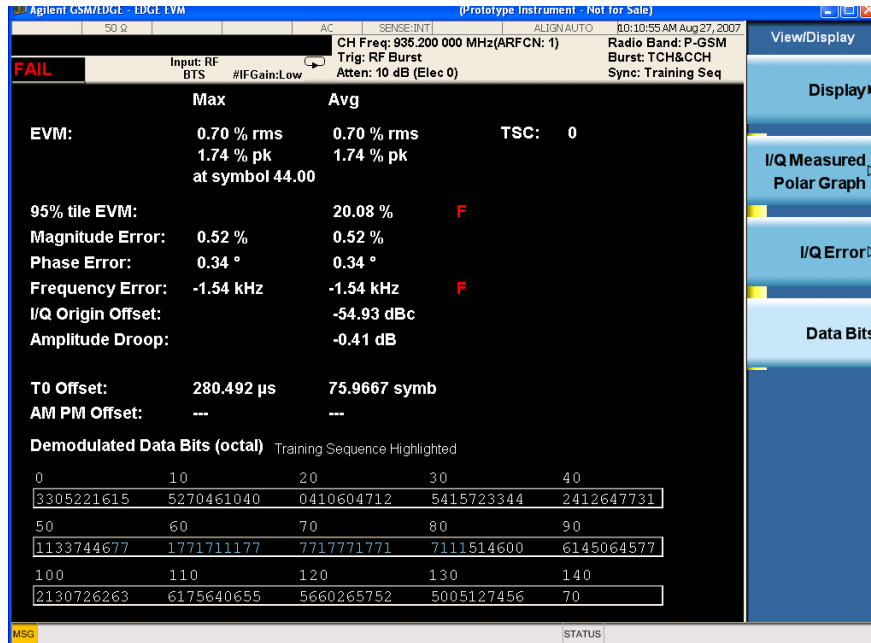
Figure 3-6



- **Data Bits** - Provides a view of the numeric results and data bits (in octal) with the sync word (TSC) highlighted. See Figure 3-7.

Figure 3-7

EDGE EVM Result - Data Bits View



Changing the Display

The **Display** key accesses the menu to allow the following selections for changing the graph displays:

- **Symbol Dots** - Allows you to toggle the symbol dots between **On** and **Off**. The default setting is **On**.

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

- **Scale/Div** - Allows you to define the horizontal scale by changing the symbol value per division. The range is 1 to 500K symbols per division. The default setting is 14.1 symbols per division for BTS and MS device types.
- **Ref Value** - Allows you to set the symbol reference value ranging from 0 to 500K symbols. The default setting is 0.
- **Ref Position** - Allows you to set the reference position to either **Left**, **Ctr** (center) or **Right**. The default setting is **Left**.
- **Auto Scaling** - Allows you to toggle the scale coupling function between **On** and **Off**. The default setting is **On**. This function automatically determines the scale per division and reference value by the magnitude of the measurement results.

When EVM, Phase Error, or Mag Error windows are active in the I/Q Error (Quad-View) display, the **Amplitude Y Scale** key accesses a menu which allows the following selections:

- **Scale/Div** - Allows you to define the vertical scale by changing the value per division, with units, ranges, and default values depending on which display window is active.

Mag Error Window - Units are in Percent, range is from 0.1% to 50.0%, the default is 1.00%.

Phase Error Window - Units are in degrees, range is from 0.01 degrees to 3000 degrees, the default is 1.00 degrees.

EVM Window - Units are in Percent, range is from 0.1% to 50.0%, the default is 1.00%

Since the **Auto Scaling** default is set to **On**, the value displayed in this condition is automatically determined by the measurement results.

- **Ref Value** - Allows you to set the reference value, with units, ranges, and default values depending on which display window is active.

Mag Error Window - Units are in Percent, range is from -500.0% to 500.0%, the default is 0.00%.

Phase Error Window - Units are in degrees, range is from -36000.0 degrees to 36000.0 degrees, the default is 0.00 degrees.

EVM Window - Units are in Percent, range is from -500.0% to 500.0%, the default is 0.00%.

- **Ref Position** - Allows you to set the reference position to **Top**, **Ctr** (center) or **Bot** (bottom).

Mag Error Window - The default is Ctr.

Phase Error Window - The default is Ctr.

EVM Window - The default is Bot.

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

EDGE Output RF Spectrum Measurement Concepts

NOTE This measurement is designed for EDGE. For GSM Output RF Spectrum measurement concepts see [“GMSK Output RF Spectrum Measurement Concepts” on page 106.](#)

Purpose

The Output RF Spectrum measurement is the EDGE version of the adjacent channel power (ACP) measurement. Either a single offset is measured with corresponding traces or up to 15 offsets are measured and a table is displayed. In spectrum due to modulation or switching transient measurements a sweep spectrum display of -1.8 MHz to $+1.8$ MHz or -3.8 MHz to $+3.8$ MHz from the carrier can be viewed.

The output RF spectrum measurements determine the spectral energy emitted into the adjacent channels. Excessive amounts of energy spilling into an adjacent frequency channel could interfere with signals being transmitted to other MS or BTS. The measurements are divided into two main groups: spectrum due to the $3\pi/8$ 8PSK modulation and noise, and spectrum due to switching transients (burst ramping).

Since EDGE is a TDMA format, RF power is being switched on and off depending on whether the actual burst is being transmitted. The switching of power causes spectral splatter at frequencies other than that being transmitted by the carrier. Fast transitions in the time domain causes switching transients that have high frequency content associated with them.

NOTE The default output RF spectrum measurements do not perform tests at frequency offsets greater than 1800 kHz from the carrier.

Measurement Method

In this measurement, the transmitter (source) is set to transmit an EDGE frame at a given channel (frequency). The analyzer acquires a time record at a particular offset from the channel being transmitted. The method of acquiring the time record is either a FFT/Inverse-FFT method, or a direct time domain (DTD) method, depending on the offset. These two methods, and when they are used, are described below. When the offset is zero, the analyzer is said to be measuring the carrier. For a given offset frequency from the carrier, the transmitter must not exceed a certain power level relative to the carrier. The EDGE specification defines the offsets and their maximum absolute and relative power levels.

The general steps in making the measurement are as follows:

- Acquire time record (using either FFT or DTD methods, described below)

- Synchronize for gating on the carrier - finds 50% and 90% portion of burst for Spectrum Due to Modulation portion of the test
- Measure power of the carrier
- Compare each offset power to reference to get relative power level

The method of acquiring the time record is dependent on accuracy and dynamic range. With no pre-ADC filter, signals in the entire IF bandwidth of the analyzer are digitized by the analog to digital converter (ADC). The setting of the ADC gain is based on the peak level at its input. The dynamic range (noise floor) of the ADC is dependent on the gain selected. For the type of signal being measured, the highest energy within the IF bandwidth is at the carrier. Therefore, the lowest dynamic range (highest noise floor) of the ADC occurs when the full energy of the carrier is input to the ADC.

All offsets measured using the FFT method are done with the analyzer tuned such that the carrier is at the center of the IF bandwidth. Therefore, the dynamic range of the offsets measured using the FFT method is the same as that for the carrier. The dynamic range requirement generally increases as the offset frequency increases. If the dynamic range requirement exceeds what is available by FFT method, the direct time domain (DTD) method utilizing the pre-ADC filter is used.

The **Min Freq Using Direct Time** key setting is the first offset frequency which is measured using the DTD method. Its range is determined by assuring no aliasing occurs on FFT offsets and that the dynamic range requirements are met.

The FFT method acquires a wideband signal in a flattop filter. An FFT is performed to get the spectrum of the GSM signal. The resolution bandwidth filter can now be applied mathematically to the spectrum at multiple offsets, with an inverse-FFT performed on the data which passes the filter. In this way, multiple offsets are acquired from one time record and LO setting. Since the resolution bandwidth filter is a mathematical formula, it can be any shape and size, and is perfect. The analyzer uses the 5-pole synchronously tuned filter that is specified by the GSM standard.

The primary disadvantage to the FFT method is that the acquisition must include the carrier. The high energy of the carrier causes the ADC to range down, thus lowering the dynamic range. At large offsets, the dynamic range requirement is very challenging so the direct time domain (DTD) method is used. The LO is tuned to the particular offset and the pre-ADC filter is used to reduce the carrier. This allows the ADC to range up, giving higher dynamic range. The disadvantage to this method is that each offset measured has its own time record acquisition and LO tune position, and this causes the measurement to slow down compared to FFT offsets. The 5-pole synchronously tuned filter is approximated by utilizing a digital Gaussian filter and setting its equivalent noise bandwidth to that of the 5-pole synchronously tuned filter. For these DTD offset frequencies, the filter has closer-to-ideal 5-pole behavior (< 1% tolerance) than does a 10% tolerance, 5-pole analog filter.

Regardless of how the time record is obtained for a particular offset, the power must be measured and compared to the reference power. There are two measurements being made for the test: output RF spectrum due to modulation and the output RF spectrum due to switching transients. The GSM/EDGE standard specifies which offsets get which tests. In these two modes, the following conditions are met:

- In the output RF spectrum due to modulation measurement, the average value during at least 40 bits between bit 87 and 132 (approximately equivalent to the 50% to 90% portion of the burst, excluding midamble) is retained. The vertical lines mark the section of the burst over which the measurement is made. If multiple bursts are examined, an average of the average values is calculated. The relative power (difference between the average power of the burst at zero offset and the average power of the burst at the indicated offset) and the absolute power are displayed.
- In the output RF spectrum due to switching transients, the peak value of the whole frame is retained. The reference power of reference due to switching is the average power of the useful part of the burst with at least 300 kHz RBW. The relative power (difference between the mean transmit power of the burst at zero offset and the peak power of the burst at the indicated offset) and the absolute power are displayed.

The GSM/EDGE standard specifies the tests are run on specified offsets from the carrier. The analyzer identifies this as single offset or multiple offset modes. The measurement made in these two modes is the same, except that the multiple offset mode automatically makes the measurement at all the specified offsets frequencies and lists the results in a table at the end of the measurement.

In the output RF spectrum due to modulation measurement, setting the modulation method to discrete obtains results from specified offsets from the carrier as defined in the standard; the results are displayed in a table. When set to sweep, the measurement obtains results of a span extending to 1800 kHz from both sides of the carrier, measured with 30 kHz RBW; the results are displayed as a spectrum.

The EDGE ORFS Modulation view shows a single-offset (Examine) trace for an entire EDGE slot. The vertical bars show the portion used to measure power due to modulation.

Concepts
EDGE Output RF Spectrum Measurement Concepts

Figure 3-8 *EDGE ORFS Result - Modulation with Single-Offset (Examine)*

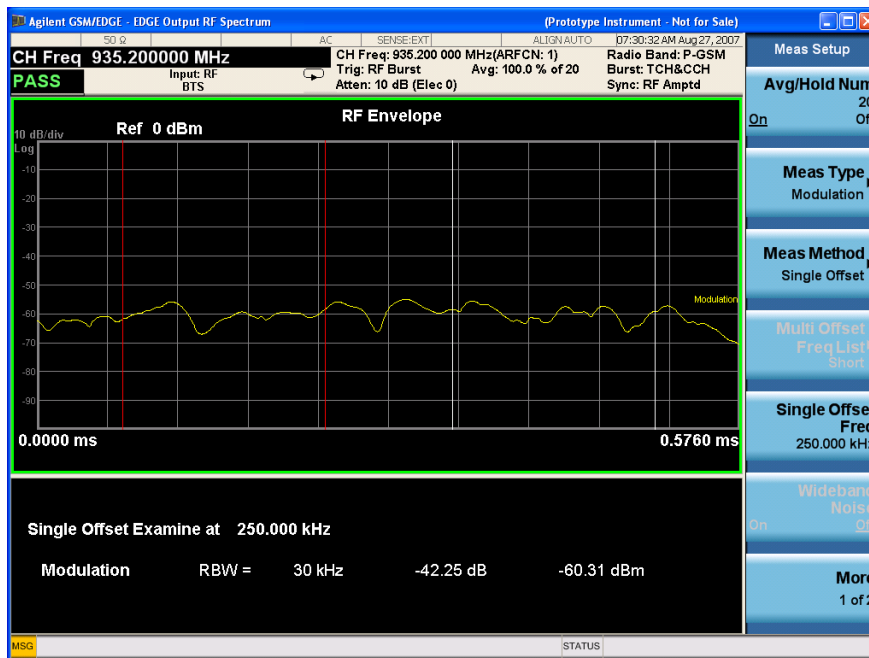
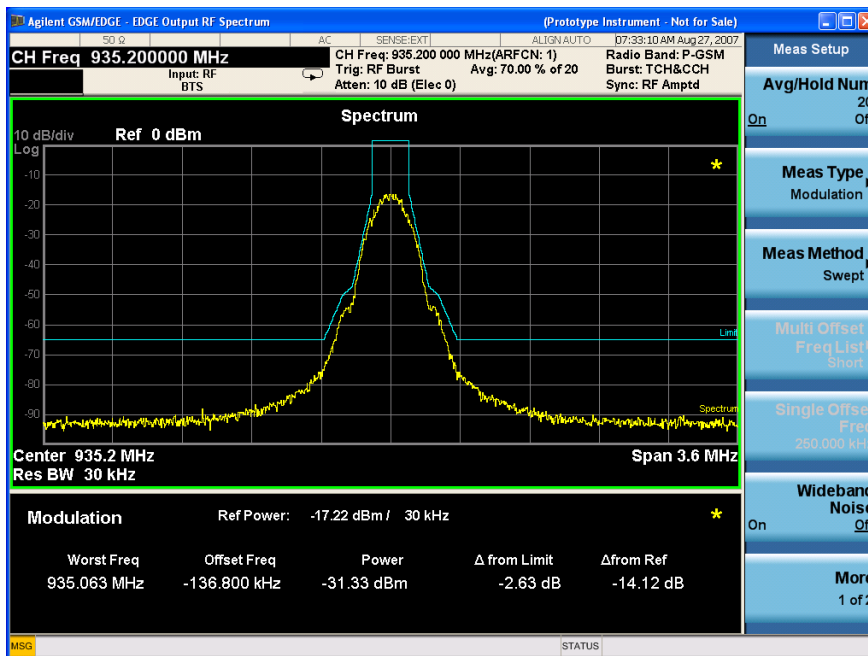


Figure 3-9 *EDGE ORFS Result - Modulation Sweep Spectrum*



The RF envelope trace is displayed. If averaging is turned on, the trace is then averaged with previous traces. For the modulation measurement, you may select the type of trace averaging, either log-power averaged (Video) or power averaged (RMS). For the switching transients measurement, the peak of the traces is used. For modulation, the displayed value is the average of points within the vertical bars. For transients, the displayed value is the max of all points for all traces (Max of Peak) over the entire frame.

EDGE ORFS Measurements on a Single Bursted Slot

The analyzer can be set up to make an ORFS measurement on a single bursted EDGE slot if all of the offsets measured are less than the Min Freq Using Direct Time using the following procedure:

Step	Notes
1 Select GSM/EDGE Mode.	Press Mode, GSM/EDGE .
2 Select the EDGE Output RF Spectrum measurement.	Press Meas, EDGE Output RF Spectrum .
3 Set the Min Freq Using Direct Time to be greater than the furthest offset measured.	Press Meas Setup, More, Advanced, Min Freq Using Direct Time . The maximum value that can be set is 2.0 MHz.
4 Set the measurement type.	Press Meas Setup, Meas Type, Modulation .
5 Set the offsets to be measured.	Press Meas Setup, Multi-Offset Freq List, Custom .
6 Select the appropriate trigger type.	Press Trig Source and select either Trigger 1, Trigger 2, or RF Burst . If the selection is RF Burst, adjust the RF burst trigger Peak Level so that the analyzer does not trigger when there is no signal present. Press Trigger, RF Burst , and then, Trig Delay .
7 Initiate the measurement.	Press Restart or the Single front-panel key, or send a remote command.

EDGE Tx Band Spur Measurement Concepts

Purpose

NOTE This measurement is designed for EDGE. For GSM Tx Band Spur measurements see “GMSK Tx Band Spur Measurement Concepts” on page 110.

The EDGE Tx Band Spur measurement checks that the transmitter does not transmit undesirable energy into the transmit band. This energy may cause interference for other users of the EDGE and GSM systems.

Measurement Method

This is a base station only measurement. The transmitter should be set at its maximum output power on all time slots. This measurement is performed at RF channels B (bottom), M (middle), and T (top). Refer to the following table.

Band	Tx Band Edge (MHz)		BOTTOM		MIDDLE		TOP	
	Low	High	Freq (MHz)	ARFCN	Freq (MHz)	ARFCN	Freq (MHz)	ARFCN
P-GSM	935	960	935.20 0	1	947.60 0	63	959.80 0	124
E-GSM	925	960	925.20 0	975	942.60 0	38	959.80 0	124
R-GSM	921	960	921.20 0	955	940.60 0	28	959.80 0	124
DCS 1800	1805	1880	1805.2 0	512	1842.6 0	699	1879.8 0	885
PCS 1900	1930	1990	1930.2 0	512	1960.0 0	661	1989.8 0	810

The transmit band spectrum is measured in several frequency segments using resolution bandwidths as specified by the standard (see the list below).

Frequency Offset	Resolution Band width
≥ 1.8 MHz and < 6 MHz and inside Tx band	30 kHz
≥ 6 MHz and inside Tx band	100 kHz

The mean transmit power is measured first using the “power-above-threshold” method and the threshold is set to -20 dB (see the Transmit Power measurement for detail), and then used as a reference for the measurement limit lines if limits are used. The spectrums, which are below or above the carrier frequency and within the transmit band, are measured.

For each spectrum segment, the measurement looks for the spectrum peak closest to the limit and saves the data. The peak of the selected segment is reported as the **Worst Spur**. The amplitude difference from the peak to the limit line (Δ from Limit), and from the peak to the mean transmit power (Δ from Carrier) are displayed. The frequency difference from the peak to the carrier frequency (Offset Freq) is also displayed. If the peak goes above the limit line, the display indicates **FAIL**. When Marker is on, press the **Peak Search** key, then the active marker is placed at the peak of the displayed segment.

Measurement Adjustments

Changing the View

The **View/Display** key allows you to further examine the desired spectrum segment. Each of these choices selects a different part of the frequency spectrum for viewing:

Lower Segment	lower Tx band edge to -6 MHz offset from the channel frequency
<hr/>	
Lower Adj Segment	-6 MHz to -1.8 MHz offset from the channel frequency
<hr/>	
Upper Adj Segment	+1.8 MHz to +6 MHz offset from the channel frequency
<hr/>	
Upper Segment	+6 MHz offset from the channel frequency to the upper Tx band edge

Monitor Spectrum (Frequency Domain) Measurement Concepts

Purpose

The Monitor 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. The primary use of Monitor Spectrum is to allow you to visually make sure you have the RF carrier available to the instrument, and the instrument is tuned to the frequency of interest.

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.

The mode waveform measurement data may be displayed using either an RF Envelope window, or an I/Q window which shows the I and Q signal waveforms in parameters of voltage versus time. The advantage of having an I/Q view available while making a waveform measurement is that it allows you to view complex components of the same signal without changing settings or measurements.

The waveform measurement can be used to perform general purpose power measurements in the time domain with excellent accuracy.

Measurement Method

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

Other Sources of GSM/EDGE Measurement Information

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

- Application Note 1298
Digital Modulation in Communications Systems - An Introduction
Part number: 5965-7160E
- Application Note 1312
Understanding GSM Transmitter Measurements for Base Transceiver Stations and Mobile Stations
Part number: 5966-2833E
- Application Note 1361
Measuring EDGE Signals – New and Modified Techniques and Measurement Requirements
Part number: 5980-2508EN

Analyzer Updates at www.keysight.com

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

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

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

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

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

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

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 135.](#)

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 M Ω 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 M Ω probes, the probe will introduce a capacitive load on the circuit, unless a higher attenuation is used at the probe interface. Higher attenuation helps isolate the probe, however, it reduces the signal level and degrades the signal-to-noise-ratio of the measurement. Passive probes are available with a variety of attenuation values for a moderate cost. Many 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:

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

- a. Probe heads are necessary to attach to your device properly. Probe connectivity kits such as the E2668A, E2669A or E2675A are needed. For more details, refer to the 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.)

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.