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User Guide

BTS Master™

MT8222A

High Performance Base Station Analyzer
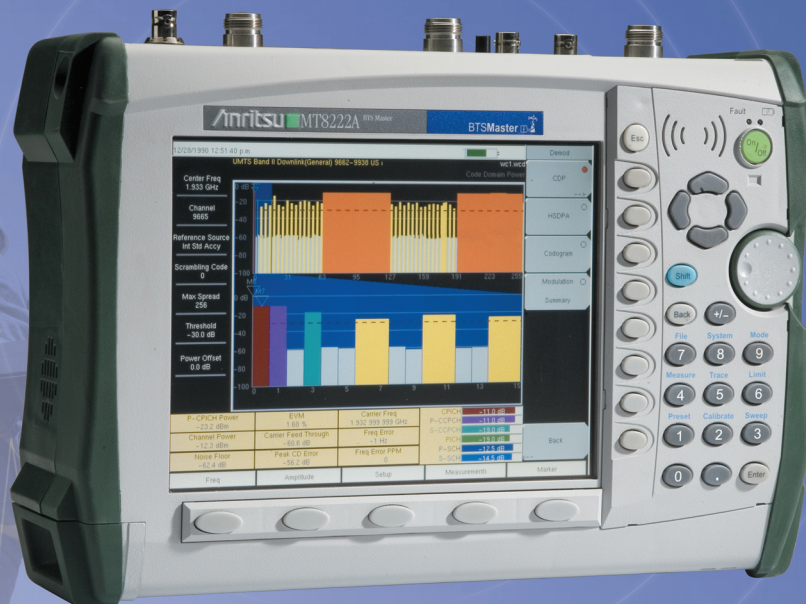
Anritsu

MT8222A

BTS Master

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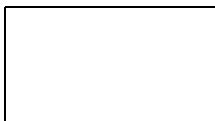
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VxWorks Runtime License 2000-1189	WindML Target License 2000-1372
NI Device License 2000-1486	WindRiver USB Runtime License 2000-1421

Table 1-1.

DECLARATION OF CONFORMITY

Manufacturer's Name: ANRITSU COMPANY

Manufacturer's Address: Microwave Measurements Division
490 Jarvis Drive
Morgan Hill, CA 95037-2809
USA

declares that the product specified below:

Product Name: BTS Master

Model Number: MT8222A

conforms to the requirement of:

EMC Directive 89/336/EEC as amended by Council Directive 92/31/EEC & 93/68/EEC
Low Voltage Directive 73/23/EEC as amended by Council directive 93/68/EEC

Electromagnetic Interference: EN61326-1:1997 A1:1998 A2:2001 A3:2003

Emissions: EN55011:1998 A1:1999 A2:2002 Group 1 Class A

Immunity: EN 61000-4-2:1995 A1:1998 A2:2001 - 4kV CD, 8kV AD
EN 61000-4-3:2002 A1:2002 - 3V/m
EN 61000-4-4:2004 - 0.5kV SL, 1kV PL
EN 61000-4-5:1995 A1:2001 - 1kV L-L, 2kV L-E
EN 61000-4-6:1996 A1:2001 - 3V
EN 61000-4-11:1994 A1:2001 - 1 cycle @ 100%

Electrical Safety Requirement:

Product Safety: The Product Complies when used with Company supplied Power Supply
(tested to IEC 60950-1:2001)

_____
Eric McLean, Corporate Quality Director

Morgan Hill, CA   _17 APRIL 2006_
Date

European Contact: For Anritsu product EMC & LVD information, contact Anritsu LTD, Rutherford Close,
Stevenage Herts, SG1 2EF UK, (FAX 44-1438-740202)

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CE marking

C-tick Conformity Marking

Anritsu affixes the C-tick marking onto its conforming products in accordance with the electromagnetic compliance regulations of Australia and New Zealand in order to indicate that these products conform to the EMC regulations of Australia and New Zealand.

C-tick marking

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Chapter 1
General Information

Introduction

This chapter provides a description, performance specifications, optional accessories, preventive maintenance, and calibration requirements for the Anritsu Handheld MT8222A BTS Master model listed below. Throughout this manual, this instrument may be referred to as a BTS Master.

Description

The MT8222A BTS Master is an integrated multi-functional base station test tool that eliminates the need to carry and to learn to use multiple test sets. The MT8222A measurement capabilities include spectrum analyzer smart measurements, precision return loss, VSWR, cable loss, distance-to-fault, two port gain/loss, one port and two port magnitude and phase, interference analysis, spectrogram, and power meter.

RF, advanced demodulation, and over-the-air (OTA) measurements can be applied to WCDMA/HSDPA, GSM/GPRS/EDGE, Fixed WiMAX, Mobile WiMAX, CDMA and EVDO, DVB-T/H, and TD-SCDMA.

Additional capabilities include location information, enhanced frequency reference oscillator accuracy, power monitor, T1 measurements (including Vpp), E1 - 2 Mb/s measurements, T3 measurements, and listening to DS0/VF channels.

The BTS Master base model has cable and antenna analysis, spectrum analysis, and an internal power meter. The cable and antenna analysis is performed by a handheld Vector Network Analyzer that is designed to make accurate vector-corrected 1-port and 1-path, 2-port magnitude and phase measurements from 10 MHz to 4 GHz, and 6 GHz is optional.

The MT8222A BTS Master is also a synthesizer-based handheld spectrum analyzer that provides quick and accurate measurement results. Measurements can be easily made by using the main instrument functions: frequency, span, amplitude, and bandwidth. Dedicated keys for one-button measurements of field strength, channel power, occupied bandwidth, Adjacent Channel Power Ratio (ACPR), and Carrier to Interference Ratio (C/I) make the MT8222A the ideal choice for the field. A familiar calculator-type keypad allows for fast data entry.

In transmitter analyzer mode, the MT8222A BTS Master displays six markers and the marker table in Code Domain Power and Codogram displays. In Spectrum Analyzer mode, a full range of marker capabilities (such as peak, center, and delta functions) are provided for faster, more comprehensive analysis of displayed signals. Upper and lower multi-segmented limit lines are available to create quick, simple pass/fail measurements. A menu option provides for an audible alert when the limit value is exceeded. A vertical line marker is available with the histogram displays of BERT measurements in the T1/T3 Analyzer. Markers are not available in GSM mode.

Time and date stamping of measurement data is automatic. The internal memory provides for the storage and recall of more than 1000 traces and more than 1000 measurement setups. The bright daylight-viewable, high-resolution color liquid crystal display (LCD) provides easy viewing in a variety of lighting conditions. BTS Master is capable of approximately three hours of continuous operation from a fully charged battery and can be operated from a 12 Vdc source, which also simultaneously charges the battery.

Anritsu Master Software Tools, a PC-based software program, provides for storing measurement data. Master Software Tools can also convert the BTS Master display into several graphic formats. Master Software Tools supports all of the options that are provided with the BTS Master.

Measurements may be stored in internal memory, in a Compact Flash module, or in a USB Flash drive. Stored measurements can be downloaded to a PC by using the included USB and Ethernet cables. Once stored, the graphic trace can then be displayed, scaled, or enhanced with markers and limit lines. Historical graphs can be overlaid with current data by using the PC mouse in a drag-and-drop fashion. The underlying data can be extracted and used in spreadsheets or for other analytical tasks.

Options

The following options are available for the MT8222A:

Option Number [a]	Description
MT8222A-005[b]	Power Monitor (requires external detector)
MT8222A-010	Bias Tee variable voltage
MT8222A-019	High Accuracy Power Meter (PSN50 sensor not included)
MT8222A-025	Interference Analysis
MT8222A-026	6 GHz Cable and Antenna Analyzer (10 MHz to 6 GHz)
MT8222A-027	Channel Scanner
MT8222A-028	CW Signal Generator (requires CW Signal Generator Kit)
MT8222A-031	GPS Receiver (includes GPS antenna, Anritsu Part Number: 2000-1410)
MT8222A-033[c]	cdmaOne and CDMA2000 1xRTT Over The Air (OTA) Measurements
MT8222A-034[c]	EVDO Over The Air (OTA) Measurements
MT8222A-035[c]	WCDMA/HSDPA Over The Air (OTA) Measurements
MT8222A-037	Mobile WiMAX Over the Air (OTA) Measurements
MT8222A-038	TD-SCDMA Over the Air (OTA) Measurements
MT8222A-040	GSM/GPRS/EDGE RF Measurement
MT8222A-041	GSM/GPRS/EDGE Demodulation
MT8222A-042	CDMA RF Measurements
MT8222A-043	cdmaOne and CDMA2000 1xRTT Demodulator

Option Number [a]	Description
MT8222A-044	WCDMA/HSDPA RF Measurement
MT8222A-045	WCDMA Demodulator
MT8222A-046	Fixed WiMAX RF Measurement
MT8222A-047	Fixed WiMAX Demodulator
MT8222A-051[b]	T1/FT1 BERT (Bit-Error-Rate-Tester)
MT8222A-052[b]	E1 - 2 Mb/s Bit-Error-Rate-Tester (BERT)
MT8222A-053[b]	T3/T1/FT1 BERT (Bit-Error-Rate-Tester)
MT8222A-060	TD-SCDMA RF Measurements
MT8222A-061	TD-SCDMA Demodulator
MT8222A-062	EVDO RF Measurements
MT8222A-063	EVDO Demodulator
MS2721B-064	DVB-T/H Digital Video Measurements
MT8222A-065[d]	WCDMA/HSDPA Demodulator
MT8222A-066	Mobile WiMAX RF Measurements
MT8222A-067	Mobile WiMAX Demodulator
MT8222A-078	DVB-T/H SFN Analyzer

a. All options, except Options MT8222A-051, MT8222A-052, and MT8222A-053, can be installed by an Anritsu Service Center. Some options cannot be installed on instruments older than serial number 0701001 (01 January 2007).

b. Option 5 and Option 51, Option 52, and Option 53 are mutually exclusive.

c. Requires Option 31 GPS.

d. Option 65 includes Option 45.

Accessories

Standard Accessories

The following standard accessories are supplied with the MT8222A:

Part Number	Description
10580-00156	MT8222A User's Guide
65681	MT8222A Soft Carrying Case
2300-498	Master Software Tools Program CD ROM
633-44	MT8222A Rechargeable Li-Ion Battery
40-168	MT8222A AC-DC Adapter
806-141	MT8222A Automotive Cigarette Lighter 12 Volt DC Adapter
3-806-152	Cross-over Ethernet Cable, 7 feet (213 cm)
2000-1371	Ethernet Cable, 7 feet (213 cm)
3-2000-1498	USB A/5-pin mini-B Cable, 10 feet
3-2000-1500	256 MB Compact Flash Memory Module
2000-1520-R	2 GB USB Flash Drive

One year Warranty (includes battery, firmware, software, and Certificate of Calibration and Conformance)

CAUTION

When using the Automotive Cigarette Lighter 12 VDC Adapter, Anritsu Part Number 806-141, always verify that the supply is rated for a minimum of 60 Watts @ 12 VDC, and that the socket is clear of any dirt or debris. If the adapter plug becomes hot to the touch during operation, discontinue use immediately.

Optional Accessories

The following optional accessories are available for the MT8222A:

Part Number	Description
633-44	Rechargeable Battery, Li-Ion
760-243-R	Transit Case for Anritsu MT8222A BTS Master
790-641	Cable Lock
800-109	Detector Extender Cable, 7.6 m (25 ft.)
800-111	Detector Extender Cable, 30.5 m (100 ft.)

Part Number	Description
1091-26	N(m) to SMA(m) DC to 18 GHz, 50 ohm
1091-27	N(m) to SMA(f) DC to 18 GHz, 50 ohm
1091-80	N(f) to SMA(m) DC to 18 GHz, 50 ohm
1091-81	N(f) to SMA(f) DC to 18 GHz, 50 ohm
2000-767	Precision Open/Short/Load, DC to 4 GHz, 7/16 DIN(m), 50 ohm
2000-768	Precision Open/Short/Load, DC to 4 GHz, 7/16 DIN(f), 50 ohm
2000-1374	Dual External, Li-Ion Charger with Universal Power Supply
2000-1410	Magnet Mount GPS Antenna with 3 m (15 ft.) Cable
2000-1501-R	256 MB USB Flash Drive
2000-1520-R	2 GB USB Flash Drive
1N50C	Limiter, N(m) to N(f), 50 ohm, 10 MHz to 18 GHz
22N50	Open/Short, DC to 18 GHz, N(m), 50 ohm
22NF50	Open/Short, DC to 18 GHz, N(f), 50 ohm
42N50-20	Attenuator, 20 dB, 5 watt, DC to 18 GHz, N(m)-N(f)
42N50A-30	Attenuator, 30 dB, 50 watt, DC to 18 GHz, N(m)-N(f)
SM/PL-1	Precision Load, DC to 6 GHz, 42 dB, N(m), 50 ohm
SM/PLNF-1	Precision Load, DC to 6 GHz, 42 dB, N(f), 50 ohm
OSLN50LF-1	Precision Open/Short/Load, DC to 6 GHz, 42 dB, 50 ohm, N(m)
OSLNF50LF-1	Precision Open/Short/Load, DC to 6 GHz, 42 dB, 50 ohm, N(f)

Cables

806-16	Bantam Plug to Bantam Plug
806-116	Bantam Plug to BNC
806-117	Bantam "Y" Plug to RJ48
806-176-R	Bantam Plug to alligator clips
806-177-R	RJ48 to RJ48
3-806-169	72-inch (1.8 m), BNC to BNC, 75 ohm RG59 type coax cable

Part Number	Description
High Accuracy Power Meter Accessories	
PSN50	High Accuracy Power Sensor, 50 MHz to 6 GHz
3-2000-1498	USB A/mini-B cable, 10 ft
3-1010-122	Attenuator, 20 dB, 5 Watt, DC to 12.4 GHz, N(m)-N(f)
3-1010-123	Attenuator, 30 dB, 50 Watt, DC to 8.5 GHz, N(m)-N(f)
3-1010-124	Attenuator (Uni-directional), 40 dB, 100 Watt, DC to 8.5 GHz, N(m)-N(f)
1010-127-R	Attenuator, 30 dB, 150 Watt, DC to 3 GHz, N(m)-N(f)
Adapters	
510-90	7/16 DIN(f) to N(m), DC to 7.5 GHz, 50 ohm
510-91	7/16 DIN(f) to N(f), DC to 7.5 GHz, 50 ohm
510-92	7/16 DIN(m) to N(m), DC to 7.5 GHz, 50 ohm
510-93	7/16 DIN(m) to N(f), DC to 7.5 GHz, 50 ohm
510-96	7/16 DIN(m) to 7/16 DIN(m), DC to 7.5 GHz, 50 ohm
510-97	7/16 DIN(f) to 7/16 DIN(f), DC to 7.5 GHz, 50 ohm
510-102	N(m) to N(m) 90° right angle, DC to 11 GHz, 50 ohm
Precision Adaptors	
34NN50A	Precision Adapter, DC to 18 GHz, 50 ohm, N(m) to N(m)
34NFNF50	Precision Adapter, DC to 18 GHz, 50 ohm, N(f) to N(f)
Directional Antennas	
2000-1411	Portable Yagi Antenna, 10 dBd, N(f), 822 to 900 MHz
2000-1412	Portable Yagi Antenna, 10 dBd, N(f), 885 to 975 MHz
2000-1413	Portable Yagi Antenna, 10 dBd, N(f), 1.71 to 1.88 GHz
2000-1414	Portable Yagi Antenna, 9.3 dBd, N(f), 1.85 to 1.99 GHz
2000-1415	Portable Yagi Antenna, 10 dBd, N(f), 2.4 to 2.5 GHz
2000-1416	Portable Yagi Antenna, 10 dBd, N(f), 1.92 to 2.17 GHz

Part Number	Description
Portable Antennas	
2000-1030	SMA(m), 1.71 to 1.88 GHz, 50 ohm
2000-1031	SMA(m), 1.85 to 1.99 MHz, 50 ohm
2000-1032	SMA(m), 2.4 to 2.5 GHz, 50 ohm
2000-1035	SMA(m), 896 to 941 MHz, 50 ohm
2000-1200	SMA(m), 806 to 869 MHz, 50 ohm
2000-1361	SMA(m), 5725 to 5825 MHz, 50 ohm
2000-1473	SMA(m), 870 to 960 MHz, 50 ohm
2000-1474	SMA(m), 1.71 to 1.88 GHz, 50 ohm
2000-1475	SMA(m), 1920 to 1980, 2.11 to 2.17 GHz, 50 ohm
61532	Antenna Kit: 2000-1030, 2000-1031, 2000-1032, 2000-1035, 2000-1200, and 2000-1361
Band Pass Filters	
1030-105-R	890-915 MHz Band, N(m) to N(f), 50 ohm
1030-106-R	1710-1790 MHz Band, N(m) to N(f), 50 ohm
1030-107-R	1910-1990 MHz Band, N(m) to N(f), 50 ohm
1030-109-R	824-849 MHz Band, N(m) to SMA(f), 50 ohm
1030-110-R	880-915 MHz Band, N(m) to SMA(f), 50 ohm
1030-111-R	1850-1910 MHz Band, N(m) to SMA(f), 50 ohm
1030-112-R	2400-2484 MHz Band, N(m) to SMA(f), 50 ohm
1030-114-R	806-869 MHz Band, N(m) to SMA(f), 50 ohm
Attenuator	
42N50A-30	30 dB, 50 Watt, DC to 18 GHz, N(m) to N(f)

Part Number	Description
Test Port Cables, Armored	
15NN50-1.5C	1.5 meters, N(m)-N(m), 6 GHz, 50 ohm
15NNF50-1.5B	1.5 meters N(m) to N(f), 18 GHz,50 ohm
15NN50-3.0C	3.0 meters, N(m)-N(m), 6 GHz, 50 ohm
15NN50-5.0C	5.0 meters, N(m)-N(m), 6 GHz, 50 ohm
15NNF50-1.5C	1.5 meters, N(m)-N(f), 6 GHz, 50 ohm
15NNF50-3.0C	3.0 meters, N(m)-N(f), 6 GHz, 50 ohm
15NN50-5.0C	5.0 meters, N(m)-N(m), 6 GHz, 50 ohm
15ND50-1.5C	1.5 meters, N(m)-7/16 DIN(m), 6 GHz, 50 ohm
15NDF50-1.5C	1.5 meters, N(m)-7/16 DIN(f), 6 GHz, 50 ohm
CW Signal Generator Kit	
67276	CW Signal Generator Kit (includes the 4 parts listed below)
65-54	Attenuator, 0-90 dB (1 dB and 10 dB steps), 2.5 GHz, N-f, N-f
510-102	Adaptor, 90 Deg., N-m, N-m
SC7651	Power Splitter, 50 Ohm, N-f, N-m, N-f
67263	Cable, N-m, N-m

Power Monitor Detectors

The Anritsu 560 Series Detectors use zero-biased Schottky diodes. Measurement range is −40 dBm to +16 dBm using single cycle per sweep AC detection, auto-zeroing with DC detection during the frequency sweep. Extender cables can be used with the MT8222A BTS Master with Option 5 installed.

Model	Frequency Range	Impedance	Return Loss	Input Conn	Frequency Response
560-7N50B	0.01 to 20 GHz	50Ω	15 dB, <0.04 GHz 22 dB, <8.00 GHz 17 dB, <18.0 GHz 14 dB, <20.0 GHz	N(m)	±0.5 dB, <18 GHz ±1.25 dB, <20 GHz
560-7S50B	0.01 to 20 GHz	50Ω	15 dB, <0.04 GHz 22 dB, <8.00 GHz 17 dB, <18.0 GHz 14 dB, <20.0 GHz	WSMA(m)	±0.5 dB, <18 GHz ±2.0 dB, <20 GHz
560-7K50	0.01 to 40 GHz	50Ω	12 dB, <0.04 GHz 22 dB, <8.00 GHz 17 dB, <18.0 GHz 15 dB, <26.5 GHz 14 dB, <32.0 GHz 13 dB, <40.0 GHz	K(m)	±0.5 dB, <18 GHz ±1.25 dB, <26.5 GHz ±2.2 dB, <32 GHz ±2.5 dB, <40 GHz
560-7VA50	0.01 to 50 GHz	50Ω	12 dB, <0.04 GHz 19 dB, <20.0 GHz 15 dB, <40.0 GHz 10 dB, <50.0 GHz	V(m)	±0.8 dB, <20 GHz ±2.5 dB, <40 GHz ±3.0 dB, <50 GHz

Preventive Maintenance

BTS Master preventive maintenance consists of cleaning the unit and inspecting and cleaning the RF connectors on the instrument and all accessories. Clean the BTS Master with a soft, lint-free cloth dampened with water or water and a mild cleaning solution.

CAUTION: To avoid damaging the display or case, do not use solvents or abrasive cleaners.

Clean the RF connectors and center pins with a cotton swab dampened with denatured alcohol. Visually inspect the connectors. The fingers of N(f) connectors and the pins of N(m) connectors should be unbroken and uniform in appearance. If you are unsure whether the connectors are good, gauge the connectors to confirm that their dimensions are correct.

Visually inspect the test port cables. The test port cable should be uniform in appearance, not stretched, kinked, dented, or broken.

Calibration Requirements

The BTS Master loads factory calibration data during start-up, eliminating the need for daily calibration checks. In WCDMA modes, an additional automatic calibration is done as the internal temperature of the unit changes to insure the best possible measurement results.

Although BTS Master does not require daily field calibration, Anritsu recommends annual calibration and performance verification by local Anritsu service centers. Anritsu service centers are listed in this chapter.

ESD Cautions

The MT8222A, like other high performance instruments, is susceptible to ESD (electrostatic discharge) damage. Coaxial cables and antennas often build up a static charge, which (if allowed to discharge by connecting directly to the MT8222A without discharging the static charge) may damage the MT8222A input circuitry. MT8222A operators must be aware of the potential for ESD damage and take all necessary precautions.

Operators should exercise practices outlined within industry standards such as JEDEC-625 (EIA-625), MIL-HDBK-263, and MIL-STD-1686, which pertain to ESD and ESDS devices, equipment, and practices. Because these apply to the MT8222A, it is recommended that any static charges that may be present be dissipated before connecting coaxial cables or antennas to the MT8222A. This may be as simple as temporarily attaching a short or load device to the cable or antenna prior to attaching to the MT8222A. It is important to remember that the operator may also carry a static charge that can cause damage. Following the practices outlined in the above standards will ensure a safe environment for both personnel and equipment.

Anritsu Reference Documents

The following URL is an Internet link to the BTS Master product page.

BTS Master product page link.

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http://www.us.anritsu.com/BTSMaster
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A table at the bottom of the web page presents Internet links to related literature and software. Examples include the following types of documents:

• Application Notes

• Brochures

• Data Sheets

• Instruction Sheets

• Technical Notes

• White Papers

Battery Replacement

The battery can be replaced without the use of tools. The battery compartment is located on the lower left side of the instrument. Slide the battery door down, towards the bottom of the instrument, to remove it. Remove the battery pack from the instrument by pulling straight out on the battery lanyard. Replacement is the opposite of removal.

Battery Compartment
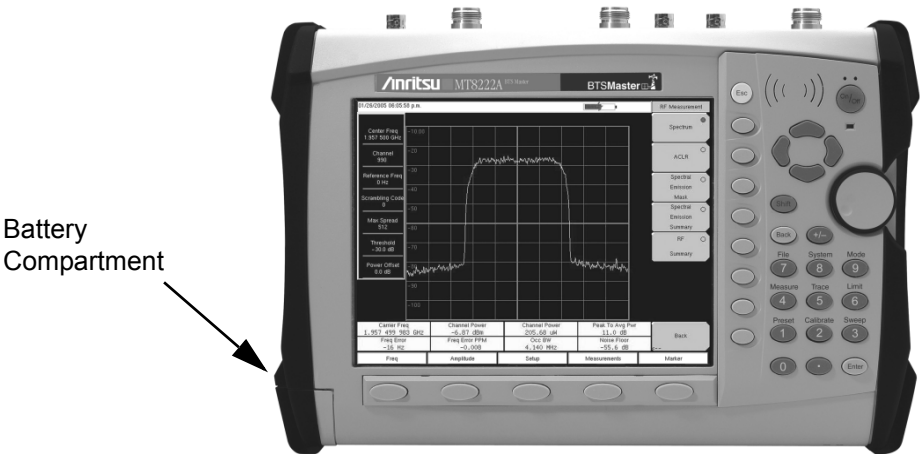
Figure 1-1. Battery Compartment

NOTE: Use only Anritsu approved batteries, adapters and chargers with this instrument.

The battery supplied with the BTS Master may need charging before use. The battery can be charged in the BTS Master, using either the AC-DC Adapter (40-168) or the 12-Volt DC adapter (806-141), or separately in the optional Dual Battery Charger (2000-1374).

CAUTION
When using the Automotive Cigarette Lighter 12 VDC Adapter, Anritsu Part Number 806-141, always verify that the supply is rated for a minimum of 60 Watts @ 12 VDC, and that the socket is clear of any dirt or debris. If the adapter plug becomes hot to the touch during operation, discontinue use immediately.

NOTE: Anritsu Company recommends removing the battery for long-term storage of the instrument.

Soft Carrying Case

The instrument can be operated while in the soft carrying case. On the back of the case is a large storage pouch for accessories and supplies.

To install the instrument into the soft carrying case:

1. The front panel of the case is secured with hook and loop fasteners. Fully open the front panel of the case.
2. Place the soft carrying case face down on a stable surface, with the front panel fully open and laying flat.
3. Fully open the zippered back of the case.

> NOTE: Two zippers provide access around the back of the case. The zipper closer to the front of the case opens the case back, and allows access to install and remove the unit. The zipper closer to the back of the case opens a support panel that can be used to provide support for improved stability and air flow while the instrument is in the case. This support panel also contains the storage pouch.

4. Insert the unit face down into the case, taking care that the connectors are properly situated in the case top opening.

Figure 1-2. Instrument Inserted Into the Soft Carrying Case

5.   Close the back panel and secure with the zipper.

FRONT PANEL

SUPPORT PANEL

Figure 1-3. Instrument Installed in Soft Case

The soft carrying case includes a detachable shoulder strap which can be connected to the D-rings on the upper corners of the case as required for comfort or convenience.

Tilt Bail Stand

The supplied Tilt Bail can be used for desktop operation. The tilt bail provides a backward tilt for improved stability and air flow.

To deploy the tilt bail, pull the bottom of the tilt bail away from the back of the unit.
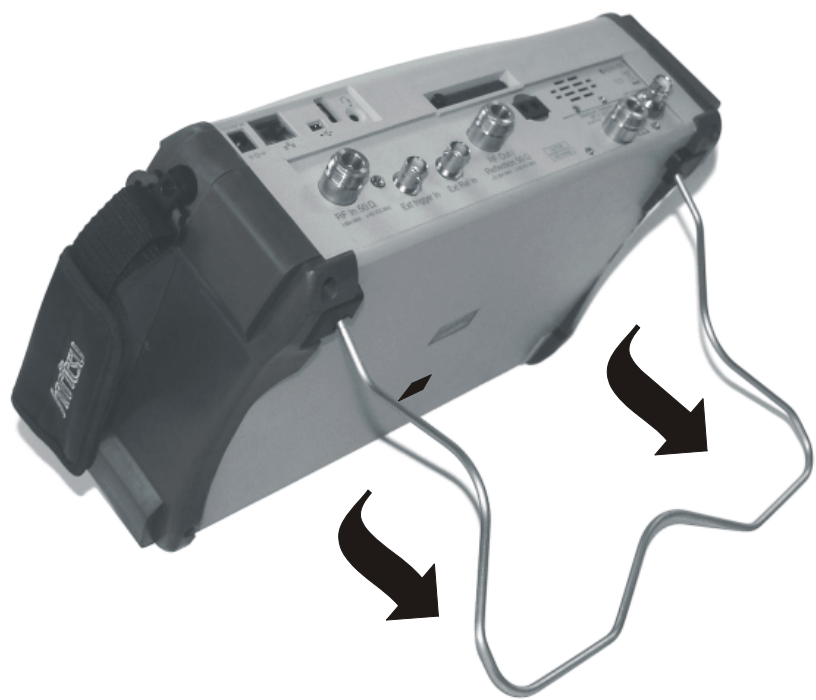
Figure 1-4. Tilt Bail

To store the tilt bail, push the bottom of the bail towards the back of the unit and snap the bail into the clip on the back of the unit.

Chapter 2
Quick Start Guide

Introduction

This chapter provides a brief overview of the Anritsu MT8222A BTS Master. The intent of this chapter is to provide the user with a starting point for making basic measurements. For more detailed information, refer to the specific measurement mode chapters later in this manual.

Turning the MT8222A On for the First Time

The Anritsu MT8222A BTS Master is capable of approximately three hours of continuous operation from a fully charged, field-replaceable battery (see Chapter 1). The MT8222A can also be operated from a 12 Vdc source (which will also simultaneously charge the battery). This can be achieved with either the Anritsu AC–DC Adapter (Anritsu part number 40-168) or 12 Vdc Automotive Cigarette Lighter Adapter (Anritsu part number 806-141). Both items are included as standard accessories (see the list of accessories in Chapter 1).

CAUTION

When using the Automotive Cigarette Lighter 12 VDC Adapter, Anritsu Part Number 806-141, always verify that the supply is rated for a minimum of 60 Watts @ 12 VDC, and that the socket is clear of any dirt or debris. If the adapter plug becomes hot to the touch during operation, discontinue use immediately.

To turn on the MT8222A, press the **On/Off** button on the front panel (Figure 2-1).
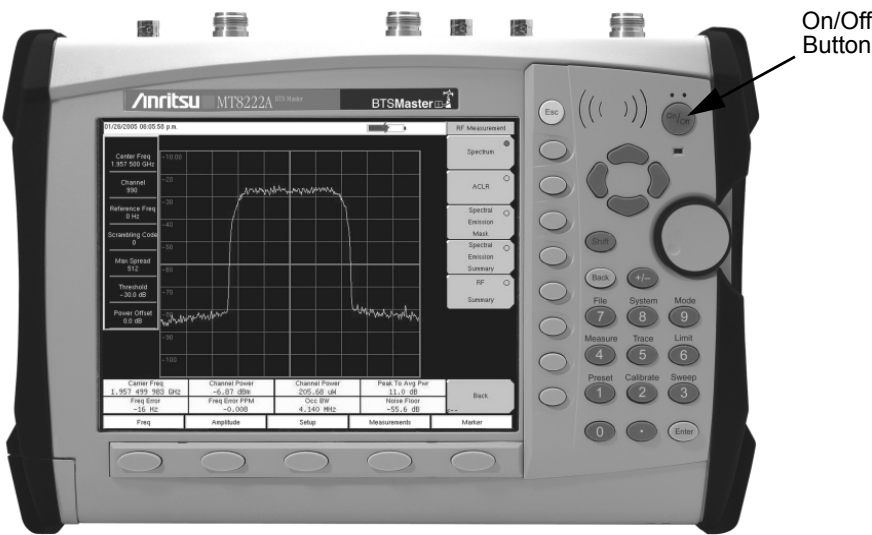
Figure 2-1. MT8222A On/Off Button

The MT8222A BTS Master takes approximately sixty seconds to complete power warm-up and to load the application software. At the completion of this process, the instrument is ready to be used.

Front Panel Overview

The BTS Master menu-driven interface is easy to use and requires little training. Hard keys on the front panel are used to initiate function-specific menus. Five function hard keys are located below the display. These keys will vary in function depending upon the selected mode of operation.

A rotary knob and 21 hard keys are located to the right of the display. Nine of the hard keys are dual purpose, depending upon the current mode of operation. The dual-purpose keys are labeled with a number on the key itself. The alternate function is printed on the panel above each of these nine keys. Use the shift key to access the functions printed on the panel. The **Escape** key, used for aborting data entry, is the round button located above the soft keys. The rotary knob, the four arrow keys, and the keypad can be used to change the value of an active parameter. The rotary knob can also be pressed to duplicate the action of the **Enter** key.

Eight soft keys are located to the right of the display. They change function depending upon the current menu selection. The current soft key function is indicated in the active function block (soft key labels) to the right of the display. The locations of the keys are shown in Figure 2-2, below.
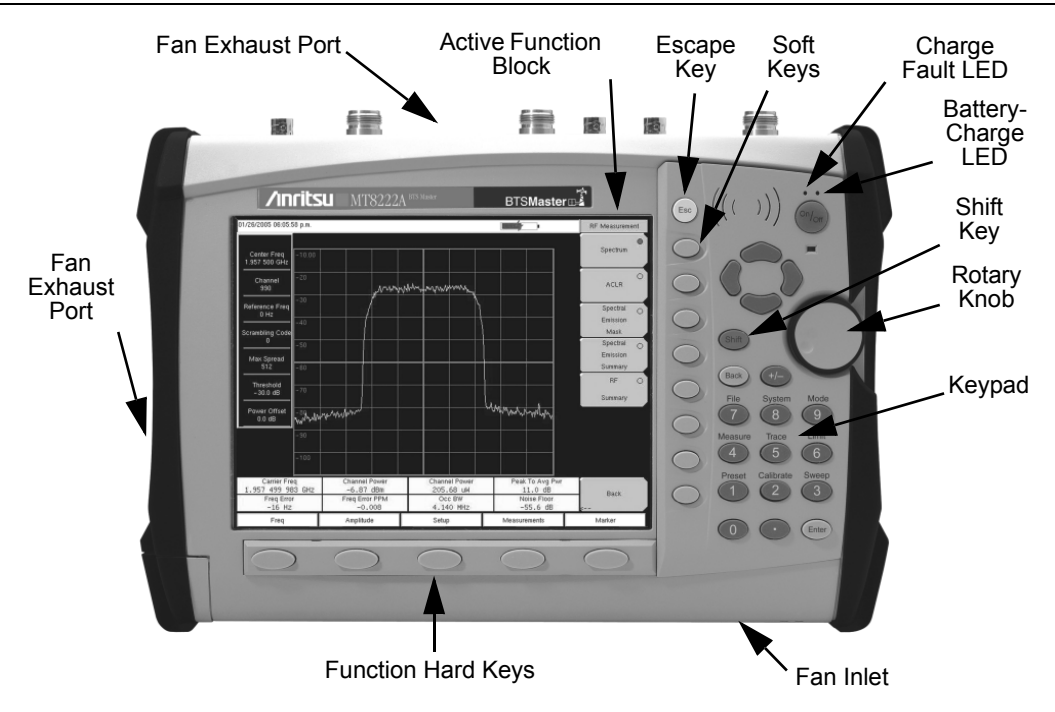
Figure 2-2. Front Panel Overview

Other features on the front panel include:

Battery Charge LED (green)

The Battery Charge LED will flash if the battery is charging, and remain on steady when the battery is fully charged.

Charge Fault LED (red)

The Charge Fault LED will remain on steady under a battery charger fault condition. Fault conditions include a battery cell voltage that is too low to charge, or a battery temperature outside the temperature range (−5º C to +50º C) to charge.

Fan Inlet and Exhaust Ports

It is important to keep the fan inlet and exhaust ports clear of obstructions at all times for proper ventilation and cooling of the instrument.

Display Overviews

Figure 2-3 illustrates some of the key information areas of the MT8222A display. Refer to Chapter 4 for more detailed key descriptions of the Cable and Antenna Analyzer.
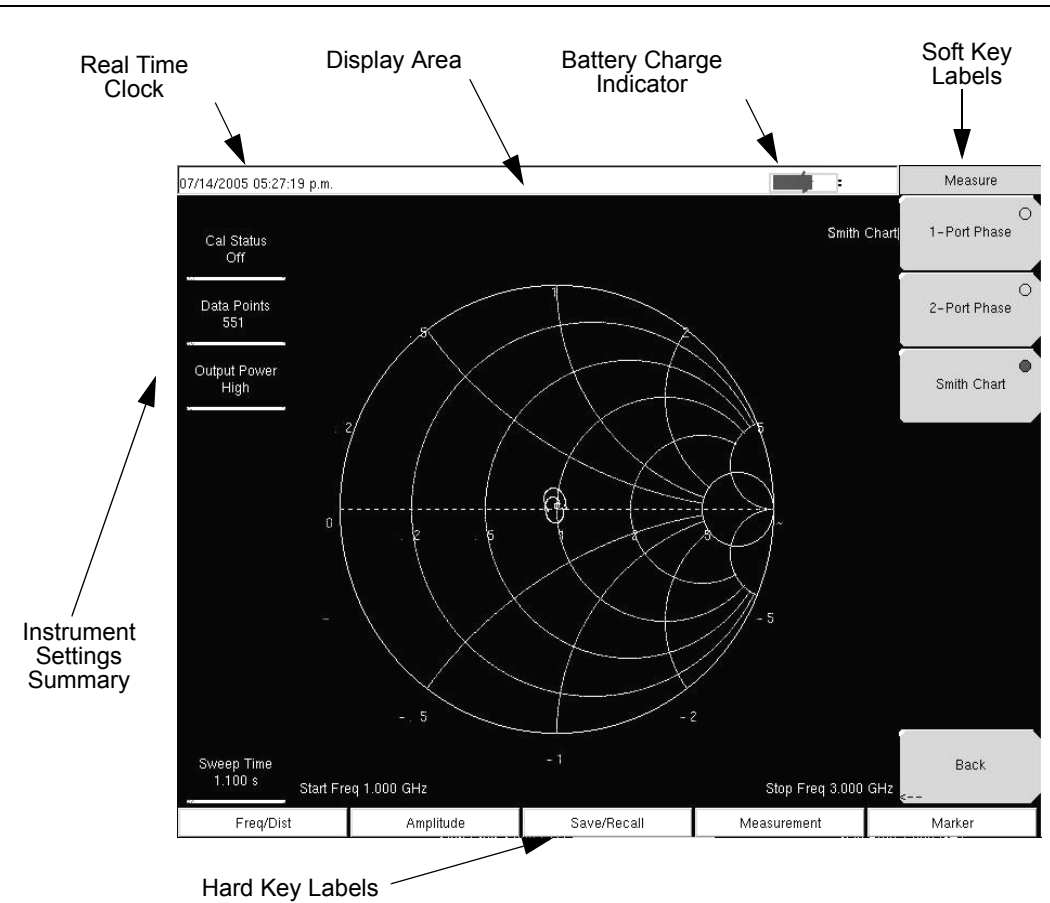
Figure 2-3. Cable and Antenna Analyzer Smith Chart Display

Figure 2-4 illustrates some of the key information areas of the MT8222A Spectrum Analyzer display. Refer to Chapter 3 for more detailed key descriptions of the Spectrum Analyzer.
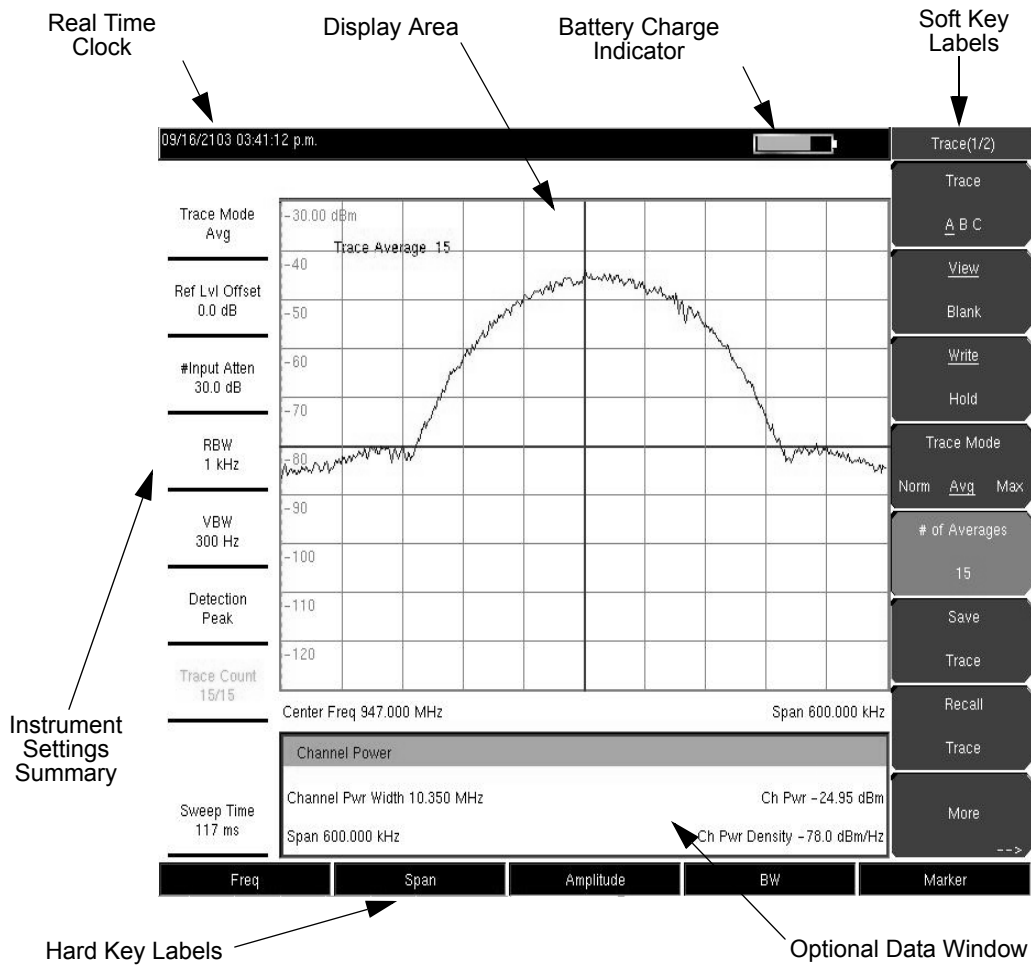
Figure 2-4. Spectrum Analyzer Display Overview

Figure 2-5 illustrates some of the information areas that are unique to the MT8222A BTS/WCMDA Signal Analyzer CDP display.
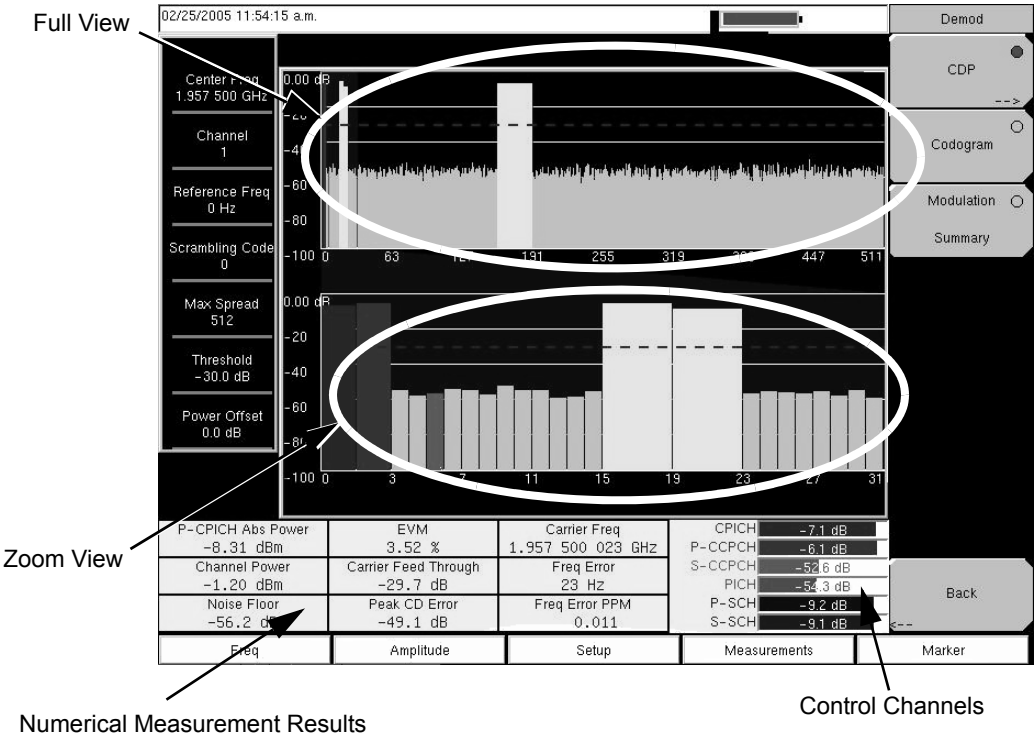
Figure 2-5. WCDMA Signal Analyzer CDP Display Overview

Front Panel Keys

The term hard key refers to all of the buttons on the instrument face except for the vertical row of gray buttons adjacent to the measurement display. The eight vertically arranged gray buttons are called soft keys, and they are used to activate virtual soft key buttons within the measurement display screen.

Esc Key

Pressing this key cancels any setting that is currently being made.

Enter Key

Press this key to finalize data input. Pressing the rotary knob performs this same function.

Arrow Keys

The four arrow keys (between the rotary knob and the **Esc** key) are used to scroll up, down, left, or right. The arrow keys can often be used to change a value or to change a selection from a list. This function is similar to the function of the rotary knob. The arrow keys are also used to move markers.

Shift Key

Pressing the **Shift** key and then a number key executes the function that is indicated in blue text above the number key. When the **Shift** key is active, its icon is displayed at the top-right of the measurement display area between the battery charge indicator and the soft key menu label.

11/10/2005 01:46:42 p.m.		Shift
	Continuous	Measuring

Figure 2-6. Shift Key Icon

Back Key

Press this key to delete only one character, one number, or the range that is specified by the cursor.

Code (+/-) Key

Press this key to change the sign of numbers that are entered with the number keys.

Number Keypad

These keys are used to directly input numbers.

Rotary Knob

Turning the rotary knob changes numerical values, scrolls through selectable items from a list, and moves markers. Values or items may be within a dialog box or an edit window.

Pressing this knob finalizes the input function in the same manner as pressing the **Enter** key.

Function Hard Keys

These five function keys are horizontally arranged adjacent to the measurement display screen along the lower edge. These buttons have no labels. As with the soft keys, they are positioned to accompany virtual key labels that are presented in the measurement display area to match instrument modes and functions. These function hard key labels change to match specific instrument Mode settings. In other words, each Mode has a specific set of Function Hard Keys. For details about the Mode settings, refer to the section *Mode Selector Menu* .

Soft Keys

These eight gray keys have no labels. They are arranged adjacent to the measurement display screen along the right-hand edge. As with the function hard keys, they are positioned to accompany virtual soft key labels that are presented in the measurement display area to match instrument modes and measurement functions. These soft key labels (also called the Active Function Block) change as instrument measurement settings change. The MT8222A BTS Master uses four types of soft keys. The following soft key section describes how these keys are used:

Parameter Setting

Pop-up list boxes or edit boxes are used to provide selection lists and selection editors. Scroll through a list of items or parameters with the arrow keys or the rotary knob. Select numerical values by scrolling with the arrow keys or rotary knob or by entering the digits directly from the number keypad. These list boxes and edit boxes frequently display a range of possible values or limits for possible values.

Finalize the input by pressing the rotary knob or the **Enter** key. At any time before finalizing the input, press the escape (**Esc**) key to abort the change and retain the previously existing setting.

Some parameters (such as for antennas or couplers) can be added to list boxes by creating them and importing them through the use of Master Software Tools.

Text Entry

When entering text (as when saving a measurement) the soft key menu for Text Entry displays the characters (alphabet, hyphen, and underscore) in 6 letters per soft key. Characters can be entered by using the rotary knob or by using the soft keys.

The rotary knob scrolls through the characters in a pop-up window and is pressed to select each character in sequence.

Alternatively, press the a b c / d e f soft key (for example) to open another soft key menu with a separate key for each of these six letters. The menu returns to the complete character set after an individual letter (or character) is entered.

Use the arrow keys to navigate within a name or character string. Use the **Shift** key for capital letters. Press the **Enter** key or the rotary knob to finalize a text entry.

Refer to Figures 2-7, 2-8, and 2-9.
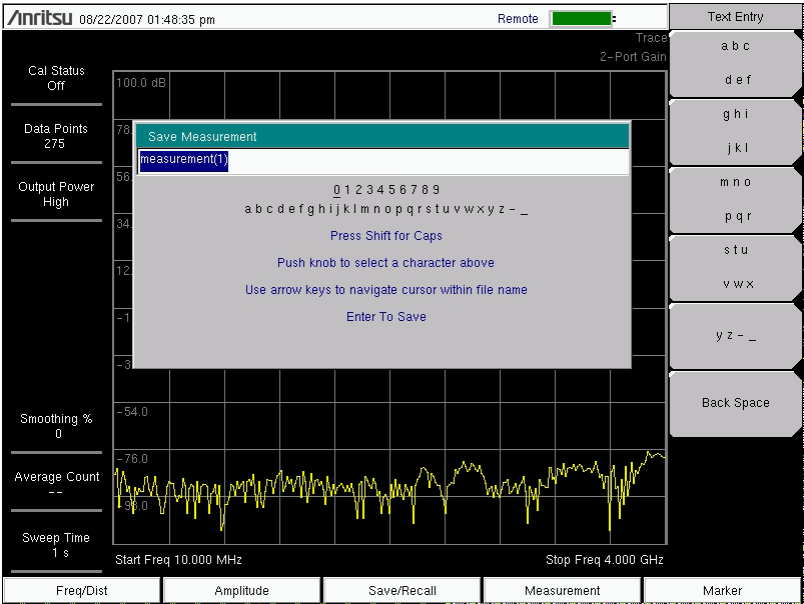
Figure 2-7. Text Entry Menu – Lower Case
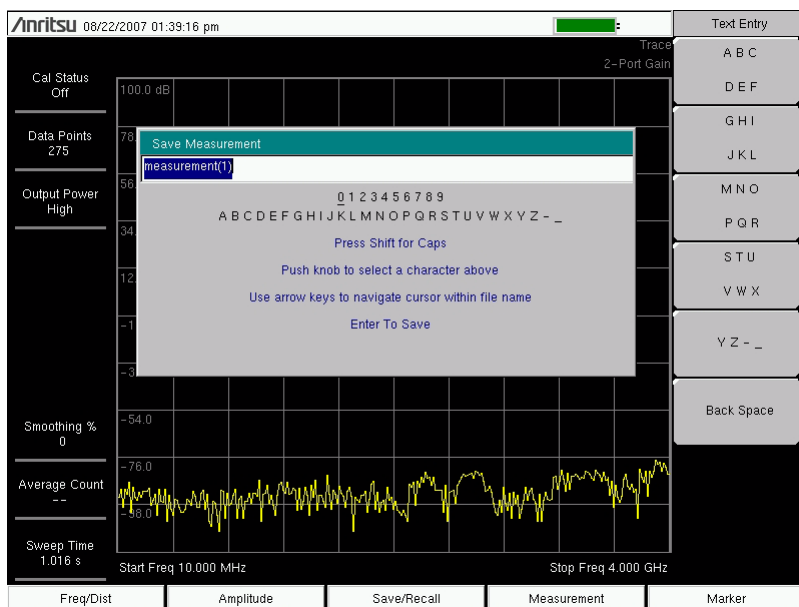
Figure 2-8. Text Entry Menu – Upper Case

Rotary Knob has
scrolled to letter h
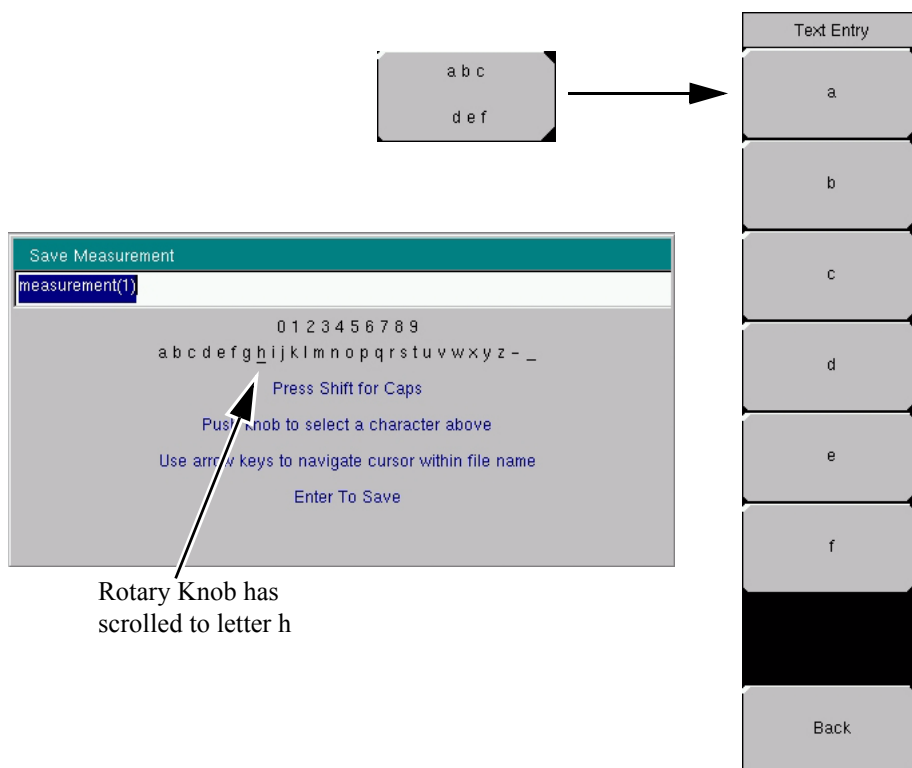
Figure 2-9. Text Entry Menu – Selecting Characters

Test Panel Connectors

The connectors and indicators that are located on the test panel are shown in Figure 2-10 and Figure 2-11 and are described in the following text.
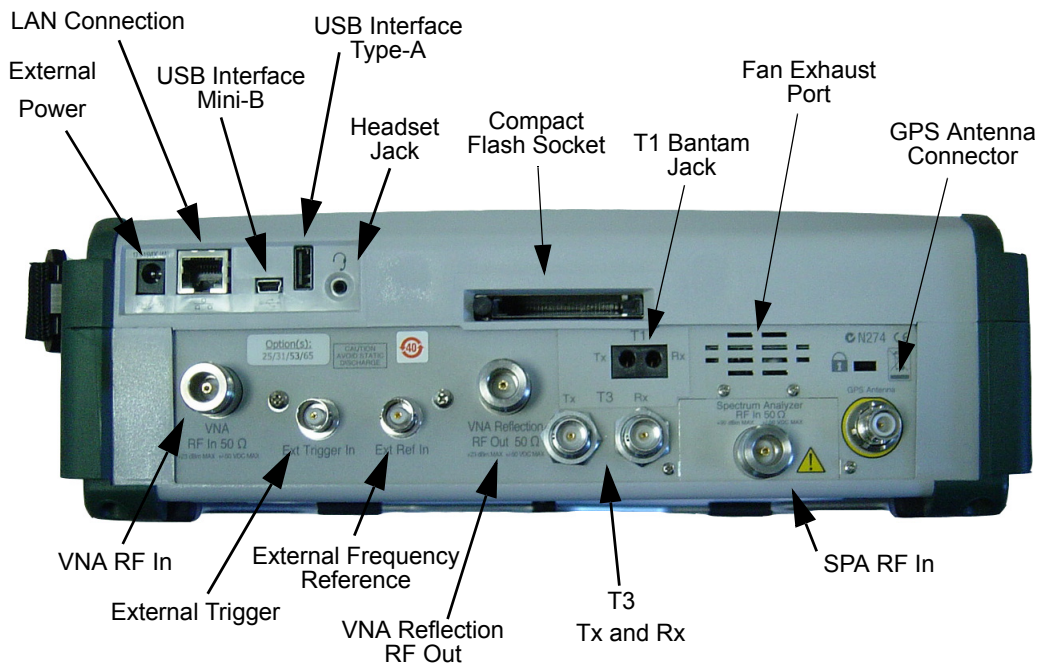
Figure 2-10. Test Panel Connectors, including T1 and T3
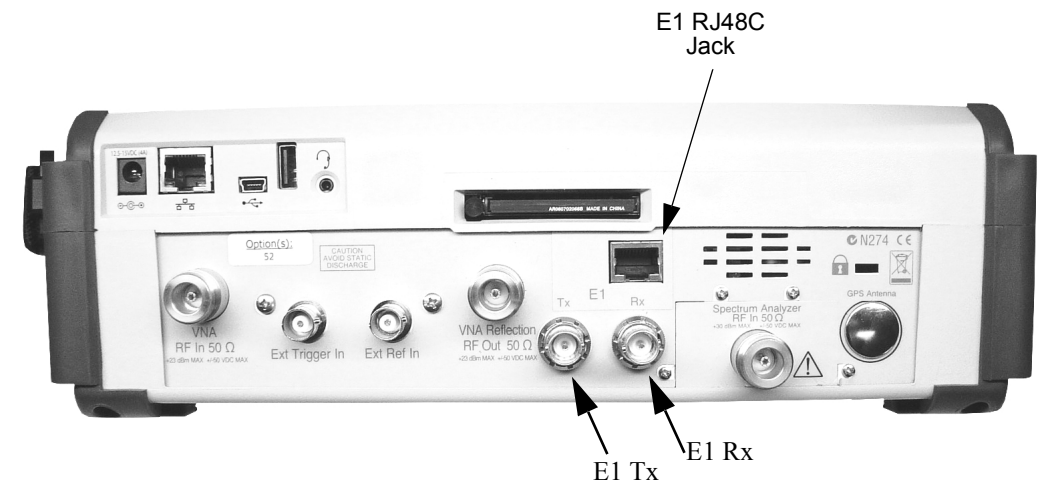
Figure 2-11. Test Panel Connectors, E1

External Power

The external power connector is used to power the unit and for battery charging. Input is 12 Vdc to 15 Vdc at up to 5.0 A. A green flashing indicator light near the power switch shows that the instrument battery is being charged by the external charging unit. The indicator is steadily illuminated when the battery is fully charged.

> **WARNING:** When using the AC-DC Adapter, always use a three-wire power cable connected to a three-wire power line outlet. If power is supplied without grounding the equipment in this manner, the user is at risk of receiving a severe or fatal electric shock.

LAN Connection

The RJ-45 connector is used to connect the BTS Master to a local area network. Integrated into this connector are two LEDs. The amber LED shows the presence of a 10 Mbit/s LAN connection when on, and a 100 Mbit/s LAN connection when off. The green LED flashes to show that LAN traffic is present. The instrument IP address is set by pressing the **Shift** key, then the **System** (8) key followed by the System Options soft key and the Ethernet Config soft key. The instrument Ethernet address can be set automatically using DHCP, or manually by entering the desired IP address, gateway address and subnet mask.

Dynamic Host Configuration Protocol (DHCP) is an Internet protocol that automates the process of setting IP addresses for devices that use TCP/IP, and is the most common method of configuring a device for network use. To determine if a network is set up for DHCP, connect the MT8222A to the network and select DHCP protocol in the Ethernet Config menu.

Turn the BTS Master off, and then on. If the network is set up for DHCP, the assigned IP address should be displayed briefly after the power up sequence.

To display the IP address with the instrument on, press the **Shift** key, then the **System** key, then the System Options soft key and the Ethernet Config soft key. The IP address will be displayed as shown in Figure 2-12.
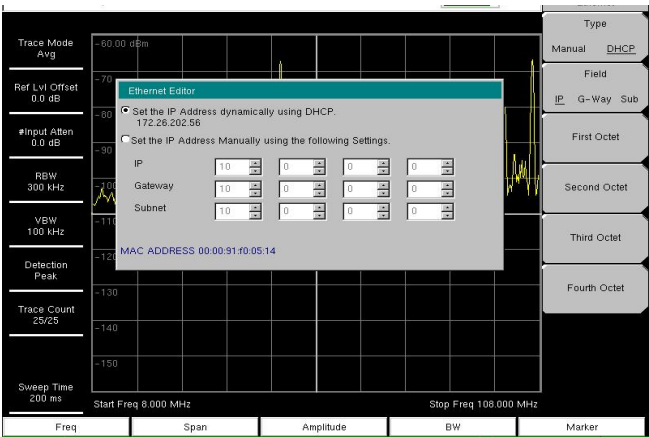
Figure 2-12. IP Address Assigned Using DHCP

More about DHCP

DHCP stands for Dynamic Host Configuration Protocol. It is a protocol that allows a server to dynamically assign IP addresses to devices that are connected to the network. Most networks include a DHCP server to manage IP addresses. When a DHCP server is available on the network, DHCP is the preferred IP address assignment mode.

When using DHCP, no setup is required to lease and use a dynamic IP address. In a dynamic IP operation, the IP address in use may change from use to use. The DHCP server hands out IP addresses on a first come, first served basis. As soon as the device is disconnected from the network, the IP address that it was using becomes available to lease to the next unit that requests an IP address. Normally, some amount of lag time is present on the DHCP server end, so if the device is connected again reasonably soon, it may end up with the same address.

> NOTE: The MT8222A must be connected to the network *before* it is turned on in order for DHCP to function. Key elements of the DHCP lease are performed only during the instrument startup operations, or when switching from manual to DHCP.

When a DHCP server is not available, a Static IP address can be used. A Static IP address is a fixed address. Once set, it will always remain the same and care must be taken to not conflict with other equipment on the network.

When using a static IP address on an established network, always request a Static IP address from the network administrator. Randomly choosing a Static IP address on an established network may result in duplicate IP addresses or other conflicts.

Three parameters must be set prior to using a Static IP address:

IP Address
This is the Static IP address on the network.

Default Gateway
Often when a static IP address is assigned, a default gateway is also identified. If the default gateway is unknown, then type in the Static IP address so that the Static IP address and Default Gateway are the same number.

Subnet Mask
This parameter is usually extracted from the Static IP address based on the class of the address and determines the destination of any broadcast messages that might be sent from the instrument. It can be customized if necessary. The subnet mask may also be provided with the Static IP address.

Example 1

In this example, a Static IP address has been chosen because there is no network available. The instrument is connected to the network port on the PC with a crossover Ethernet cable (not included). This is also referred to as Direct Connect:

IP Address: 10.0.0.2
Default Gateway: 10.0.0.2
Subnet Mask: 255.255.0.0

Example 2

In this example, the Static IP address has been assigned with an associated gateway and subnet mask:

    IP Address: 153.56.100.42
    Default Gateway: 153.56.100.1
    Subnet Mask: 255.255.252.0

A few tools that are built into the Microsoft Windows operating system can assist in making some determinations about the network the PC is plugged into. Typing ipconfig at a command prompt will display information about the in-use parameters of the PC and its network connection. Below is an example of the typical results expected.

> NOTE: The ipconfig display does not report if the information is from a DHCP server or a Static IP setup.

    Y:\>ipconfig
    Windows 2000 IP Configuration
    Ethernet adapter Local Area Connection:
    Connection-specific DNS Suffix. : us.anritsu.com
    IP Address. . . . . : 172.26.202.172
    Subnet Mask . . . . : 255.255.252.0
    Default Gateway . . . . : 172.26.200.1

Another tool that can find out if a selected IP address is already on the network is ping. Ping is a harmless way to determine if an address is found on the network, and if it is found, for it to reply. Greatly simplified, ping sends out a request to a specific address to determine if it is there. If it is found, it will respond by sending back what was sent to it. If it is not found, the response will be "request timed out" meaning that there was no reply from that IP address.

    Y:\>ping 172.26.202.172
    Pinging 172.26.202.172 with 32 bytes of data:
    Reply from 172.26.202.172: bytes=32 time<10ms TTL=128
    Reply from 172.26.202.172: bytes=32 time<10ms TTL=128
    Reply from 172.26.202.172: bytes=32 time<10ms TTL=128
    Reply from 172.26.202.172: bytes=32 time<10ms TTL=128
    Ping statistics for 172.26.202.172:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milliseconds:
    Minimum = 0 ms, Maximum = 0 ms, Average = 0 ms

USB Interface - Type Mini-B

The USB 2.0 interface can be used to connect the MT8222A BTS Master directly to a PC. The first time the MT8222A is connected to a PC, the normal USB device detection by the computer operating system will take place. The CD-ROM shipped with the instrument contains a driver for Windows XP that is installed when Master Software Tools is installed. Drivers are not available for earlier versions of the Windows operating system. During the driver installation process, place the CD-ROM in the computer drive and specify that the installation wizard should search the CD-ROM for the driver.

> NOTE: For proper detection, Master Software Tools should be installed on the PC prior to connecting the BTS Master to the USB port.

USB Interface - Type A

The MT8222A BTS Master can also be a USB Host and allow various USB Flash Memory devices to be connected to the instrument for storing measurements, setups, and so forth.

Headset Jack

The headset jack provides audio output from the built-in AM/FM/SSB demodulator for testing and troubleshooting wireless communication systems. The jack accepts a 2.5 mm 3-wire miniature phone plug such as those commonly used with cellular telephones.

Ext Trigger

A TTL signal applied to the External Trigger female BNC input connector causes a single sweep to occur. In the Spectrum Analyzer mode, it is used in zero span, and triggering occurs on the rising edge of the signal. After the sweep is complete, the resultant trace is displayed until the next trigger signal arrives.

Ext Freq Ref

BNC female connector for connection of an external frequency reference or external trigger. Press the Ext Ref Freq soft key under the System menu to select the frequency of the external reference from the list presented (on page 5-7).

RF Detector

RF detector connector for Power Monitor measurements (Option 5). Refer to the table of available RF Detectors on page 1-9.

SPA RF In

50 Ω Type-N female connector.

VNA Reflection/RF Out

RF output, 50 Ω impedance, for reflection measurements. Maximum input is +23 dBm at ±50 Vdc.

VNA RF In

50 Ω Type-N female connector.

T1, T3 Bantam Jacks

BERT tester (Option 51 and Option 53) Bantam jacks for transmit and receive.

GPS Antenna Connector

GPS antenna connection.

> NOTE: The GPS antenna connection on the BTS Master is fitted with a reverse BNC connector to help prevent damage to the GPS circuitry.
> There is a DC voltage present on this connector. Do not connect anything other than the Anritsu GPS antenna (part number 2000-1410) to this port.

Compact Flash

Accepts a 256 MB Compact Flash Memory Module, Anritsu Part Number 3-2000-1500 or other commercially available equivalent. The contents of the internal memory can be copied to and from a removable Compact Flash card. The flash card can be up to 512 MB.

Symbols and Indicators

The following symbols and indicators convey the instrument status or condition on the display.

Cal Status On:

The BTS Master has been calibrated with discrete Open, Short, and Load components.

Cal Status Off:

The BTS Master has not been calibrated.

Battery Symbol:

The battery symbol above the display indicates the charge remaining in the battery. The colored section inside the symbol changes size and color with the charge level.

Figure 2-13. Battery Status

Green: Battery is 30 to 100% charged
Yellow: Battery is 10 to 30% charged
Red: Battery 0 to 10% charged

When the battery is charging, either from the AC-DC Adapter (40-168) or the 12 Volt DC adapter (806-141), the symbol changes to that shown in Figure 2-14:
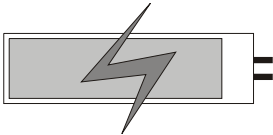
Figure 2-14. Battery Charging Status

The Battery Charge LED flashes when the battery is charging, and remains on steady when the battery is fully charged.

> NOTE: Use only Anritsu approved batteries, adapters and chargers with this instrument.

The battery symbol is replaced by a red plug body to indicate that the instrument is running from external power and is not charging the battery (or the battery is not present). When the external AC adaptor is connected, the battery automatically receives a charge, and the battery symbol with the lightning bolt is displayed (Figure 2-14). When the battery is fully charged, the charging circuit shuts off and the red plug body is displayed, as shown in Figure 2-15.

Figure 2-15. Battery Not Charging or Not Available

Hold

The BTS Master is on hold. To resume sweeping, toggle from Hold to Run in the Sweep menu.

Single Sweep

Single Sweep is selected. Press Continuous sweep to resume sweeping.

Self Test

At power on, the BTS Master runs through a series of quick checks to ensure that the system is functioning properly. The System self test runs a series of tests that are related to the instrument. The Application Self Test runs a series of tests that are related to the current operating mode of the instrument.

If the self test fails, if the battery is fully charged, and if the BTS Master is within the specified operating temperature range, then contact your Anritsu Service Center.

To initiate a self test when the system is already powered up:

1.   Press the **Shift** key and then the **System** (8) key.
2.   Press the Self Test soft key. The Self Test results will be displayed.
3.   Press the **Esc** key to continue.

Mode Selector Menu

To access the functions under the Mode menu, press the **Shift** key, then the **Mode** (9) key. Use the directional arrow keys or the rotary knob to highlight the selection and press the **Enter** key to select. The list of modes that appears in this menu will vary depending upon the options that are installed and activated in your instrument. Figure 2-16 is an example of the Mode menu. Your instrument may not show the same list.
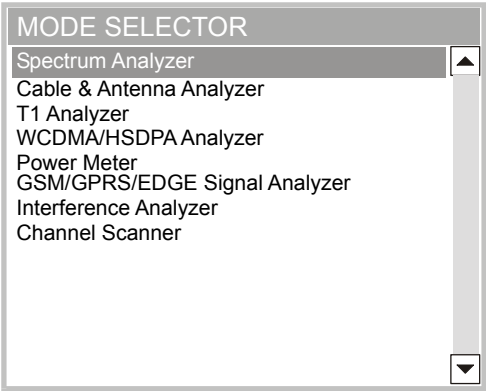
Figure 2-16. Mode Selector Menu

System
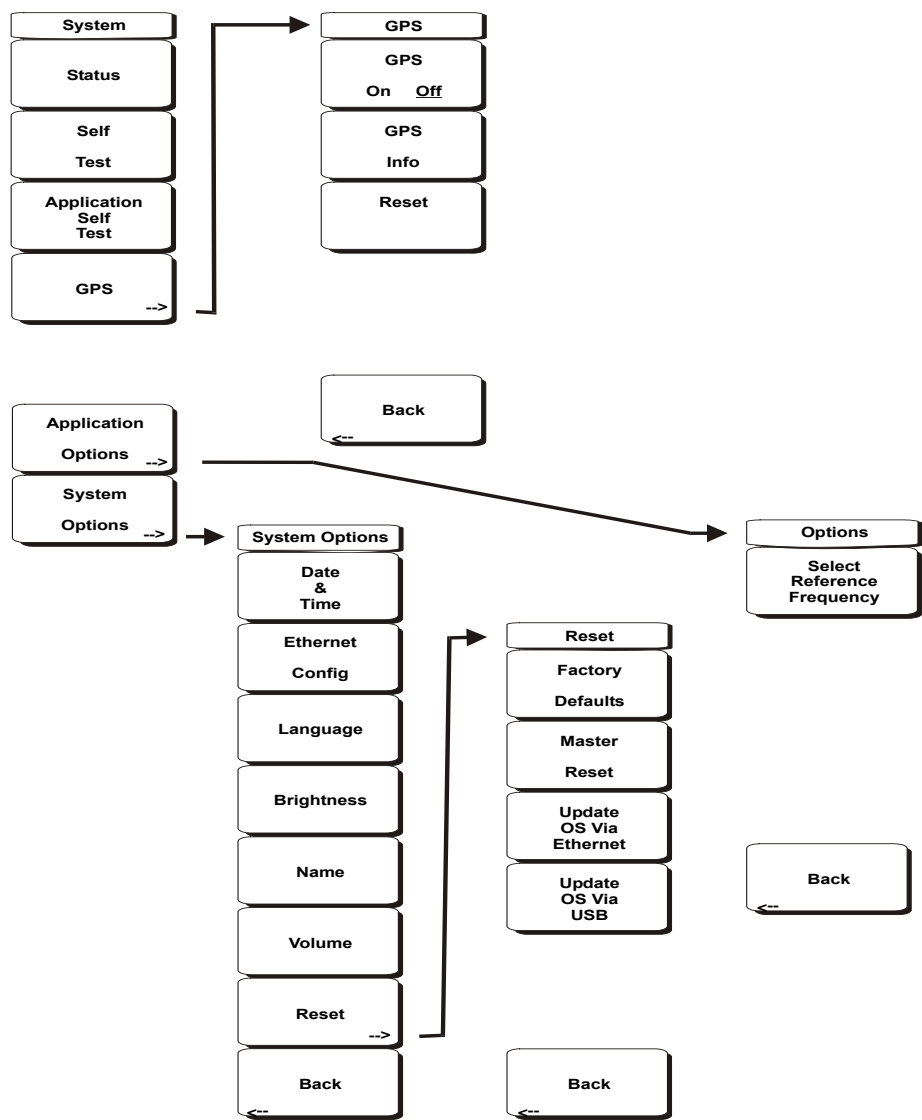
Figure 2-17. Complete System Menu

To access the functions under the System menu, press the **Shift** key, then the **System** (8) key.

Status
Pressing this soft key displays the current system status, including the operating system and firmware versions, temperatures and other details such as current battery information. Press **Esc** or **Enter** to return to normal operation.

Self Test
This soft key initiates a series of diagnostic tests that test the components of the instrument. A display will list the individual tests with a pass or fail indication. Press **Esc** or **Enter** to return to normal operation.

Application Self Test

This soft key initiates a series of diagnostic tests related to the performance of the BTS Master in WCDMA mode. A display will list the individual tests with a pass or fail indication. Press **Esc** or **Enter** to return to normal operation.

GPS

If the GPS option is installed, the GPS menu will be displayed.

GPS On/Off

Turns the GPS on or off.

GPS Info

Displays the current GPS information.

Reset

Resets the GPS for a new location.

Back

Returns to the previous (System) menu.

Application Options

This soft key presents a menu to select application options.

Select Reference Frequency

This soft key brings up a dialog box for selecting the Reference Frequency. Use the rotary knob or the **Up/Down** arrow keys to highlight the Reference Frequency and press **Enter** to select, or press the **Esc** key to cancel.

Back

Returns to the previous (System) menu.

System Options

This key opens a selection of system option soft keys.

Date and Time

This soft key brings up a dialog box for setting the current date and time. Use the soft keys or the **Left/Right** arrow keys to select the field to be modified. Use the keypad, the **Up/Down** arrow keys or the rotary knob to select the date and time. Press **Enter** to accept the changes, or press the **Esc** key to return to normal operation without changing anything.

Ethernet Configuration

This soft key brings up a dialog box to set the IP address of the instrument.

Type Manual/DHCP

This soft key selects whether the address will be entered manually, or supplied automatically by a network DHCP server. If Manual is selected, use the soft keys or the **Left/Right** arrow keys to select the field to be modified. Use the keypad, the **Up/Down** arrow keys or the rotary knob to enter the input. Press **Enter** to accept the changes, or press the **Esc** key to return to normal operation without changing anything.

Language

This soft key brings up a selection box allowing selection from a list of built-in languages for the BTS Master displays. The languages currently available are English, French, German, Spanish, Japanese, Chinese, Korean, and Italian.

In addition, a custom language may be selected if it has been defined using the Master Software Tools software and loaded into the MT8222A. Two custom languages may be loaded into the instrument using Master Software Tools. If a mode does not have language translations available, English is the default language. Press **Enter** to accept the change, or press the **Esc** key to return to normal operation without changing anything.

Brightness

The brightness of the display can be adjusted to optimize viewing under a wide variety of lighting conditions. Use the keypad, the **Up/Down** arrow keys or the rotary knob to select a brightness level from 1 to 9, 9 being the brightest. Press **Enter** to accept the change.

Name

Opens a dialog box to name the instrument. The unit can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the name.

Volume

The current volume setting is displayed on the screen. Use the keypad, the **Up/Down** arrow keys or the rotary knob to change the volume and press the **Enter** key to accept the change.

Reset

Opens a menu of reset and update options.

Factory Defaults

Restores the instrument to the factory default values, including Ethernet, language and brightness settings. Press the **Enter** key to initiate the reset, and turn the unit off, then on again to complete. Press **Esc** to return to normal operation without resetting.

Master Reset

This will restore factory setting to all system parameters, including Time/Date, Ethernet, language and brightness settings. Also, all user files in the internal memory are deleted, and the original language and antenna files are restored.

Press the **Enter** key to initiate the reset, and turn the unit off, then on again to complete. Press **Esc** to return to normal operation without resetting.

Update OS Via Ethernet

Press this soft key to update the instrument operating system via the Ethernet connection. Press Enter to begin the update, or press **Esc** to return to normal operation without updating.

Update OS Via USB

Press this soft key to update the instrument operating system via the USB connection. Press Enter to begin the update, or press **Esc** to return to normal operation without updating.

NOTE: The Update OS via Ethernet and Update OS via USB selections are accomplished in conjunction with the Master CodeLoader program, supplied with Master Software Tools. Improper use of the Master CodeLoader program could render the system unusable.

Back
Returns to the previous (System Options) menu.

Back
Returns to the previous (System) menu.

Chapter 3
Spectrum Analyzer

Introduction

Spectrum analyzer measurements include the use of additional functions beyond frequency, span, amplitude and marker functions. The first section of this chapter presents the soft key menus available when Spectrum Analyzer mode is selected. The next section focuses on resolution bandwidth, video bandwidth, sweep, and attenuator functions. The Field Measurements section presents brief examples demonstrating field strength, occupied bandwidth, channel power, adjacent channel power ratio, and carrier to interference ratio (C/I) tests.

Getting Started

Spectrum Analyzer Mode

To prepare for spectrum analyzer measurements, the MT8222A must be configured for Spectrum Analyzer Mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Spectrum Analyzer and press the **Enter** key to select.

For additional information about the Mode menu, refer to *Mode Selector Menu* on page 2-16.

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* on page 2-5.

Making Spectrum Analyzer Measurements

Required Equipment

- MT8222A Handheld Spectrum Analyzer

- Optionally, an antenna that is appropriate for the frequency range to be measured

Making a Measurement

To make a measurement, locate and display the signals of interest by selecting the desired frequency, span, and amplitude value, as explained below.

NOTE: In most cases, information and parameters can be entered into the BTS Master through the keypad, the directional arrows, or the rotary knob. The numerical keypad enters the information directly. The up and down arrow keys change a frequency parameter by the value entered through the Freq Step soft key (default value is 1 MHz). The left and right arrow keys change the frequency parameter by one graticule, that is, one-tenth of the total span. The rotary knob changes the frequency parameter by one pixel per step. In normal mode, the screen has 551 pixels across its width, and in full-screen mode, the screen has 661 pixels across its width. Choose whichever method is most convenient to enter the required information.

1. Connect the input signal or antenna to the RF In test port.
2. Press the **Freq** key to display the Frequency menu. The measurement frequency can be set using 3., 4., or 5., below.
3. To enter a center frequency, press the Center Freq soft key and enter the desired center frequency.
4. To set a specific frequency band, press the Start Freq soft key and enter the desired start frequency, then press the Stop Freq soft key and enter the desired stop frequency.
5. To set the span, press the **Span** key to display the Span menu and enter the span. For a full span, press the Full Span soft key. Selecting a full span will override any previously set Start and Stop frequencies. For a single frequency measurement, press the Zero Span soft key.

NOTE: To quickly move the span value up or down, press the Span Up 1-2-5 or Span Down 1-2-5 soft keys. These keys facilitate a zoom-in, zoom-out feature in a 1-2-5 sequence.

Setting the Amplitude

6. Press the **Amplitude** key.

NOTE: To change the current measurement units, press the Units soft key and select the required units from the soft keys presented. Press the Back soft key to return to the Amplitude menu.

7. Press the Reference Level soft key and use the **Up/Down** arrow keys or the keypad to set the reference level. Press **Enter** to set the reference level.
8. Press the Scale soft key and use the **Up/Down** arrow keys or the keypad to enter the desired scale. Press **Enter** to set the scale.

NOTE: The Scale parameter cannot be changed when linear units are selected (Watts or Volts).
Press the Amplitude soft key and select Auto Atten coupling of the attenuator setting and the reference level to help ensure that harmonics and spurs are not introduced into the measurements. See *Attenuator Functions on page 3-6* for more information.

Selecting a Signal Standard

Selecting a signal standard sets the center frequency, channel spacing, integration bandwidth, and span for the first channel of the selected standard. Appendix A contains a table of the signal standards available in the instrument.

To select a signal standard:

1.   Press the **Freq** key to display the Frequency menu.
2.   Press the Signal Standard soft key and use the **Up/Down** arrow keys or the rotary knob to highlight the desired signal standard. Press **Enter** to select the highlighted signal standard.
3.   Press the Channel# soft key to choose the required channel. By default, if a channel number has not yet been entered, then the lowest channel number for that standard is automatically selected. The channel numbers that can be selected correspond to the channel numbering schemes of the various signal standards.

Setting Bandwidth Parameters

Both resolution bandwidth (RBW) and video bandwidth (VBW) can be automatically or manually coupled to the frequency span. That is, the wider the span, the wider the RBW. The ratio of the span width to the resolution bandwidth is 300:1 by default and, if necessary, can be changed as follows:

1.   Press the BW key.
2.   Press the Span/RBW soft key. The current Span/RBW ratio is shown as part of the soft key label. Change the value using the keypad, the directional arrows, or the rotary knob.

When auto coupling between the span and the RBW is selected, it is indicated on the left side of the display as RBW XXX, where XXX is the bandwidth value. If manual RBW coupling is selected, then a "#" symbol is shown in front of RBW on the left side of the display, and the resolution bandwidth can be adjusted independently of the span. If a non-existent resolution bandwidth is entered, then the BTS Master selects the next higher resolution bandwidth. If a value greater than the widest RBW is entered, then the widest RBW will be selected.

Auto coupling of the VBW links the video bandwidth to the resolution bandwidth, so that the wider the RBW, the wider the VBW. Auto coupling is indicated on the left side of the display as VBW XXX. If manual VBW coupling is selected, then a "#" symbol is shown in front of VBW on the left side of the display, and the video bandwidth can be adjusted independently of the RBW. If a non-existent video bandwidth is entered, then the instrument will select the next higher video bandwidth. If a value greater than the widest VBW is entered, then the widest VBW will be selected.

The ratio of the resolution bandwidth to the video bandwidth can be changed by pressing the **BW** key, the RBW/VBW soft key, and then using the keypad, the directional arrows, or the rotary knob to set the ratio. The current value of the ratio is shown as part of the soft key label.

Setting Sweep Parameters

To set the sweep parameters, press the **Shift** key and then the **Sweep** (3) key.

Single/Continuous

When this soft key is pressed the instrument toggles between single sweep and continuous sweep. In single sweep mode, after the sweep the instrument waits in Hold mode until the Manual Trigger soft key is pressed or another triggering mode is selected.

Trigger Type

To select a specific type of triggering, press the Trigger Type soft key. Selections are:

Free Run

The default trigger type is "Free Run" in which the instrument begins another sweep as soon as one is finished.

External

A TTL signal applied to the External Trigger BNC input connector causes a single sweep to occur. This mode is used in zero span, and triggering occurs on the rising edge of the signal. After the sweep is complete, the resultant trace is displayed until the next trigger signal arrives.

Video

This mode is used in zero span to set the power level at which a sweep is initiated. The power level can be set from -120 dBm to $+20$ dBm. Trigger is based on the measured signal level. If no signal reaches or exceeds the trigger level, there will be no trace on the screen.

Change Trigger Position

This soft key is used in conjunction with video triggering to set the horizontal position on the display where a signal that meets the video triggering criterion will be placed. The value can be from 0% to 100%. Zero percent places the triggering event at the left edge of the screen while 100% places the triggering at the right edge of the screen. When the trigger position is any value other than 0%, the portion of the trace before the trigger event is displayed very quickly because the trace data is stored in memory. The portion of the trace after the trigger point is painted on the screen at the normal rate as the signal is swept.

Resolution Bandwidth

Resolution Bandwidth is determined by the intermediate frequency (IF) filter bandwidth. The spectrum analyzer traces the shape of the IF filter as it tunes past a signal. If more than one IF filter is used in a spectrum analyzer, the narrowest one dominates and is considered the resolution bandwidth. The choice of resolution bandwidth depends on several factors. Filters take time to settle. That is, when a signal first appears at the input of the filter, it will take a while before the signal appears at the output. Additionally, the output of the filter will take some time to settle to the correct value, so that it can be measured. The narrower the filter bandwidth (resolution bandwidth) the longer the settling time needs to be and so the slower the sweep speed.

The choice of resolution bandwidth will depend upon the signal being measured. If two closely-spaced signals are to be measured individually, then a narrow bandwidth is required. If a wider bandwidth is used, then the energy of both signals will be included in the measurement. Thus, the wider bandwidth does not have the ability to look at frequencies selectively but instead simultaneously measures all signals falling within the resolution bandwidth. Therefore, a broadband measurement would include all signals and noise within the measurement bandwidth into a single measurement.

On the other hand, a narrow-band measurement will separate the frequency components, resulting in a measurement that includes separate peaks for each signal. There are advantages to each. The ultimate decision will depend upon the type of measurement required by the user.

There is always some amount of noise present in a measurement. Noise is often broadband in nature; that is, it exists at a broad range of frequencies. If the noise is included in the measurement, the measured value could be in error (too large) depending upon the noise level. With a wide bandwidth, more noise is included in the measurement. With a narrow bandwidth, less noise enters the resolution bandwidth filter, and the measurement is more accurate. If the resolution bandwidth is narrower, the noise floor will drop on the spectrum analyzer display. This is because the IF filter of the analyzer has been made narrower in bandwidth, which lets in less noise. As the measured noise level drops, smaller signals that were previously obscured by the noise can now be measured.

Video Bandwidth

Spectrum analyzers typically use another type of filtering after the detector called video filtering. This filter also affects the noise on the display but in a different manner than the resolution bandwidth. In video filtering, the average level of the noise remains the same but the variation in the noise is reduced. Hence, the effect of video filtering is a "smoothing" of the signal noise. The resultant effect on the analyzer's display is that the noise floor compresses into a thinner trace, while the position of the trace remains the same.

Changing the video bandwidth (VBW) does not improve sensitivity, but it does improve discernability and repeatability when making low-level measurements. As a general rule of thumb, most field spectrum analyzer measurements are made at a video bandwidth that is a factor of 10 to 100 less than the resolution bandwidth. In the MT8222A BTS Master, this ratio can be specified in the BW menu. For a resolution bandwidth of 30 kHz, the typical video bandwidth setting options are either 3 kHz or 300 Hz.

Sweep Limitations

With some spectrum analyzers, the user has control over sweep time (the elapsed time of each sweep, sometimes called scan time). An analyzer cannot be swept arbitrarily fast while maintaining its specified accuracy, but will have a sweep rate limitation depending upon the resolution bandwidth, video bandwidth, and frequency range selected. The sweep rate is not usually chosen by the user but is determined by the frequency range swept divided by the sweep time. The limitation on sweep rate comes from the settling or response time of the resolution and video bandwidth filters. If an analyzer is swept too quickly, the filters do not have time to respond, and the measurement is inaccurate. Under such conditions, the analyzer display tends to have a "smeared" look to it, with the spectral lines being wider than normal and shifted to the right.

Fortunately, the Anritsu Handheld BTS Master is designed to relieve the user from having to calculate the sweep speed or experiment to discover a sweep speed that yields accurate results. When changing the RBW and VBW with BTS Master, the sweep speed automatically changes to the fastest sweep speed that will yield accurate results. The sweep speed will be faster for a wide RBW or VBW and slower for a narrow RBW or VBW. The sweep speed can also be changed manually, by pressing the SWEEP key and selecting the Min Sweep Time soft key. Enter a sweep time from 0.05 ms to 4294 seconds. If the minimum sweep time entered by the user is less than the value needed to assure accurate results, the value that delivers accurate results will be used. Regardless of the minimum sweep time setting, the BTS Master will never sweep faster than the RBW and VBW settings will allow. BTS Master is designed to assure that no uncalibrated measurement conditions will occur.

Attenuator Functions

Attenuation adjusts the hand held spectrum analyzer input attenuator. In Auto mode, as the reference level is increased, the attenuation is increased. In Manual mode, the input attenuation can be adjusted using the keypad or the **Up/Down** arrow keys. The attenuator range is 0 dB to 65 dB, in 5 dB steps. When the preamplifier is on, input attenuation can be either 0 dB or 10 dB.

Preamplifier Operation

The preamplifier can be turned on and off by pressing the **Amplitude** key, then selecting the Preamp On/Off soft key. The preamplifier has a gain of approximately 25 dB and generally will lower the noise floor by that amount. When the preamplifier is on, input attenuation can be either 0 dB or 10 dB.

Preamplifier Measurement Example

Figure 3-1 and Figure 3-2 show the same signal with the preamplifier off and then on. Notice that when the preamplifier is turned on, the noise floor drops significantly allowing spectral regrowth components that were lost in the noise without the preamplifier to become easily visible.

NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.
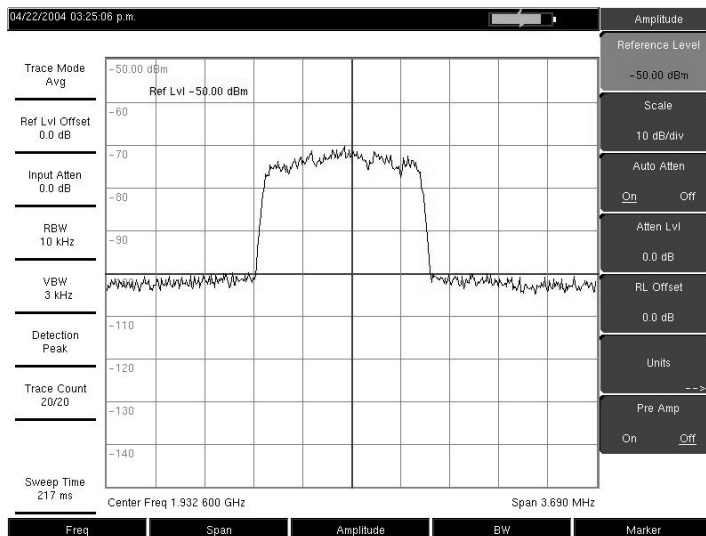
Figure 3-1. Preamplifier Off
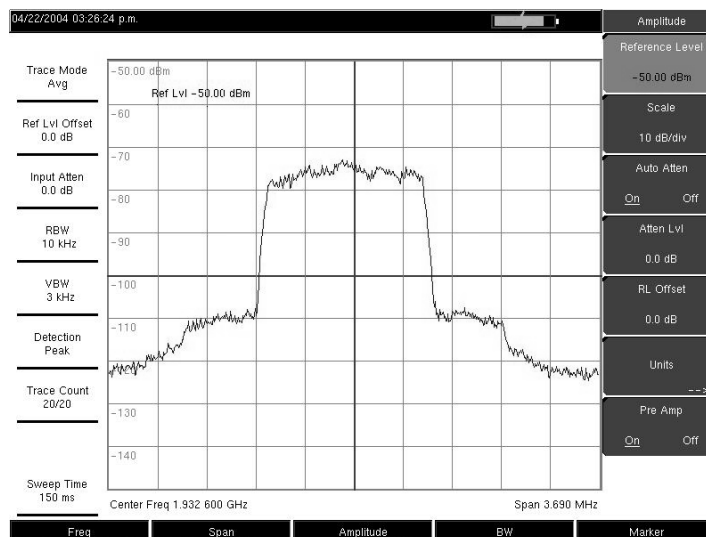
Figure 3-2. Preamplifier On

Field Measurements

In Spectrum Analyzer mode, smart one-button measurements are built into the MT8222A BTS Master for field strength, occupied bandwidth, channel power, adjacent channel power ratio, and carrier to interference ratio (C/I) tests. In addition, AM/FM/SSB demodulation is available to aid in the identification of interfering signals. This section presents brief examples demonstrating the use of these measurements.

Occupied Bandwidth Measurement

Occupied bandwidth (OBW) is a common measurement performed on radio transmitters. This measurement calculates the bandwidth containing the total integrated power occupied in a given signal bandwidth. There are two different methods of calculation depending upon the technique used to modulate the carrier.

% Down Method
The occupied frequency bandwidth is calculated as the bandwidth containing the specified percentage of the transmitted power.

dBc Down Method
The occupied frequency bandwidth is defined as the bandwidth between the upper and lower frequency points at which the signal level is a desired number of dB below the peak carrier level.

Required Equipment

• Anritsu MT8222A Handheld Spectrum Analyzer

• Test Port Extension Cable, Anritsu part number 15NNF50 - 1.5C

• 30 dB, 50 Watt, bi-directional, DC – 18 GHz, N(m) – N(f), Attenuator, Anritsu 42N50A-30 (required if the power level being measured is >+30 dBm)

Procedure

1. Using the test port extension cable and the 30 dB, 50 watt, bi-directional attenuator (if needed) connect the MT8222A to the appropriate transmitter test port or signal source.
2. Press the **Freq** key followed by the Center Freq soft key and enter the center frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the **Enter** key has the same affect as the MHz soft key.
3. If the attenuator was connected in 1., then press the **Amplitude** key and press the RL Offset soft key and set the reference level offset to – 30 dB to compensate for the loss in the attenuator.
4. Press the **Amplitude** key then press the Reference Level soft key to set the appropriate reference level.
5. Press the Atten Lvl soft key to set the input attenuation level or leave Auto Atten set to On.
6. Press the **BW** key to set the resolution bandwidth and video bandwidth if desired.
7. Press the **Shift** key then the **Measure** (4) key followed by the OCC BW soft key. Choose the measurement method (dBc Down or % Down) by pressing the Method soft key. The selected method is underlined.
8. Press the dBc or % soft keys to adjust the settings as needed. Common values are 99% and 30 dBc.
9. Press the On/Off soft key to start the measurement. An information box will appear below the graph while occupied bandwidth measurement is on.
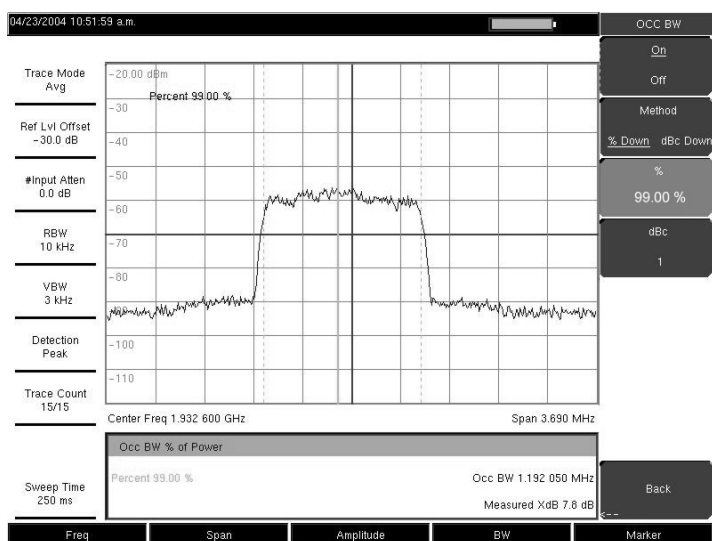
Figure 3-3. Occupied Bandwidth Results Using the % of Power Method

Figure 3-3 shows the occupied bandwidth results using the percent of power method on a CDMA signal. Occupied Bandwidth is a constant measurement; after it is turned on, it remains on until it is turned off by pressing the On/Off soft key again. Occupied bandwidth is calculated at the end of each sweep.

Channel Power Measurement

Channel power measurement is one of most common measurements for a radio transmitter. This test measures the output power, or channel power, of a transmitter over the frequency range. Out-of-specification power measurements indicate system faults, which can be in the power amplifiers or in filter circuits. Channel Power measurements can be used to validate transmitter performance, comply with government regulations, or to keep overall system interference at a minimum.

Frequency and span settings for many signal standards can be automatically set by pressing the **Frequency** key and then the Signal Standard soft key. Choose the desired standard and press **Enter**. Press the Channel # soft key to enter the channel number at which the measurement is to take place.

GSM Channel Power Measurement

Global Systems for Mobile (GSM) communication is a globally accepted standard for digital cellular communication. There are a number of frequency bands allocated to GSM mobile phones that use a combination of Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA). Within each band are approximately one hundred available carrier frequencies on 200 kHz spacing (FDMA), and each carrier is broken up into time-slots so as to support eight separate conversations (TDMA). GSM uses the Gaussian Minimum Shift Keying (GMSK) modulation method.

Required Equipment

• MT8222A Handheld BTS Master

• Test Port extension cable, Anritsu 15NNF50 - 1.5C

Procedure

1. Using the test port extension cable, connect the signal source to the RF In test port of the MT8222A.
2. Press the **Amplitude** key and press the Reference Level soft key to set the reference level to −20 dBm. Adjust the values given in this procedure to match your measurement conditions.
3. Press the Scale soft key and set the scale to 10 dB/division.
4. Press the **BW** key and verify that RBW Auto and VBW Auto are On.
5. Press the **Freq** key followed by the Signal Standard soft key. Scroll through the dialog box using the rotary knob or **Up/Down** arrow keys to highlight the GSM900 standard for the measurement and press **Enter**.
6. Press the Channel# soft key and enter the channel number using the keypad, the arrow keys, or the rotary knob. For this example, select Channel 60.
7. Press the **Shift** key then the **Measure** (4) key and press the Channel Power soft key.
8. Press the Center Freq soft key and verify that the center frequency of the BTS Master is set to that of the GSM signal, in this case 947.0 MHz.
9. Press the Int BW soft key and enter 200 kHz for the integration bandwidth, or set the integration bandwidth appropriate for the particular application.
10. Press the Span soft key and enter 800 kHz as the channel span, or set the channel span to a value appropriate for the particular application.
11. Make the measurement by pressing the Measure soft key. The MT8222A displays the measurement results in the message area.

> NOTE: Channel Power is a constant measurement. After it is turned on, it will remain on until it is turned off by pressing the On/Off soft key again.

GSM Adjacent Channel Power Measurement

Required Equipment

• MT8222A Handheld Spectrum Analyzer

• 30 dB, 50 watt, Bi-Directional, DC - 18 GHz, N(m) - N(f), Attenuator, Anritsu 42N50A-30 (if required for the power level being measured)

• Test Port extension cable, Anritsu 15NNF50 - 1.5C

Procedure

1. Using the test port extension cable and 30 dB attenuator, connect the signal source to the input of the attenuator, and connect the output of the attenuator to the RF In test port of the MT8222A.
2. If the attenuator was connected in 1., press the RL Offset soft key and set the reference level offset to −30 dB to compensate for the loss of the attenuator.
3. Press the **Amplitude** key and press the Reference Level soft key to set the reference level to 60 dBm.
4. Press the Atten Lvl soft key to set the input attenuation level needed for the measurement. This value depends on the input power level and any external attenuator. Enter an attenuation level to achieve roughly −40 dBm at the input mixer.
5. Press the **BW** key and verify that RBW Auto and VBW Auto are On.
6. There are two ways to set the measurement parameters. If the signal standard and channel are known, press the **Freq** key and set the Signal Standard and Press Channel soft keys for the signal to be measured then skip to 12. If the signal standard and channel are not known, follow the procedure in 7. through 12. below.
7. Press the **Freq** key, press the Center Freq soft key, and enter the desired center frequency.
8. Press the **Shift** key then the **Measure** key and press the ACPR soft key.
9. Press the Main Ch BW soft key, and enter the main channel bandwidth.
10. Press the Adj Ch BW soft key, and enter the adjacent channel bandwidth.
11. Press the Ch Spacing soft key, and enter the channel spacing.
12. Make the measurement by pressing the On/Off soft key. The detection method is automatically changed to RMS Average.

Solid vertical lines are drawn on the display to indicate the main channel. Dashed vertical lines define the adjacent channels. The MT8222A will display the measurement results in the message area.

> NOTE: Adjacent Channel Power Ratio is a constant measurement. After it is turned on, it will remain on until it is turned off by pressing the On/Off soft key again.

Out-of-Band Spurious Emission Measurement

Required Equipment

- MT8222A Handheld Spectrum Analyzer
- Test Port extension cable, Anritsu 15NNF50 - 1.5C

Procedure

1. Using the test port extension cable, connect the signal source to the RF In test port of the MT8222A.
2. Press the **Freq** key, press the Center Freq soft key, and enter the center frequency.
3. Press the **Span** key. Set the span wide enough to include the primary channel bandwidth and upper and lower channel bandwidths.
4. Press the **Amplitude** key, then press the Reference Level soft key and set the reference level to −20 dBm.
5. Press the Auto Atten soft key set the attenuation to On.
6. Press the **BW** key and use the RBW and VBW soft keys to set the resolution bandwidth to 3 kHz and the video bandwidth to 300 Hz.
7. Press the **Marker** key and press the Marker 1 2 3 4 5 6 soft key to select marker 1. The underlined number indicates the active marker.
8. Press the On/Off soft key and use the arrow keys, the keypad and the knob to move the marker over one of the spurs.
9. Compare the value of the marker to the specified allowable level of out-of-band spurious emissions for the corresponding channel transmit frequency.
10. Repeat 8. and 9. for the remaining spurs. Use either Marker 1 again, or choose another marker. Figure 3-4 shows a simulated out-of-band spurious signal 21.000 MHz from the carrier using a delta marker.
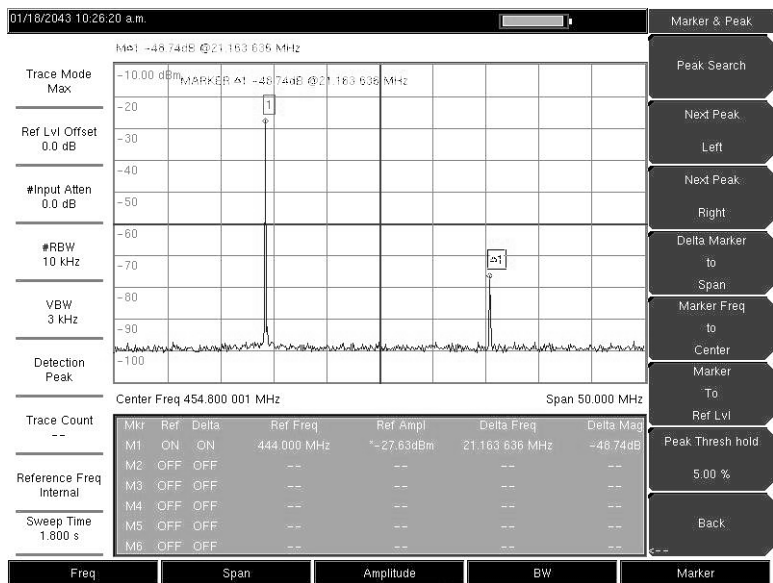
Figure 3-4. Simulated Out-of-Band Spurious Emission Measurement

In-band/Out-of-Channel Measurements

The in-band/out-of-channel measurements are those measurements that measure distortion and interference within the system band, but outside of the transmitting channel. These measurements include in-band spurious emissions and adjacent channel power ratio (also called spectral regrowth). There are stringent regulatory controls on the amount of interference that a transmitter can spill to neighboring channels. In order to determine compliance with the allowable level of spurious emissions, two parameters need to be specified:

- Measurement channel bandwidth
- Allowable level of spurious emissions

In-band Spurious Measurement

Required Equipment

- MT8222A Handheld Spectrum Analyzer
- 30 dB, 50 watt, Bi-Directional, DC - 18 GHz, N(m) - N(f), Attenuator, Anritsu 42N50A-30
- Test Port extension cable, Anritsu 15NNF50 - 1.5C

Procedure

1. Using the test port extension cable and 30 dB, 50 watt, (Bi-directional) attenuator, connect the MT8222A to appropriate transmit test port.
2. Press the **Freq** key, press the Center Freq soft key, and enter the center frequency.
3. Press the **Span** key. Set the span wide enough to include the primary channel bandwidth and upper and lower channel bandwidths.
4. Press the **Amplitude** key and then press the Reference Level soft key to set the reference level to −20 dBm.
5. Press the RL Offset soft key to set the reference level offset to −30 dB to compensate for the loss of the attenuator
6. Press the Auto Atten soft key set the attenuation to On.
7. Press the **BW** key and use the RBW and VBW soft keys to set the resolution bandwidth to 10 kHz and the video bandwidth to 300 Hz.
8. Press the **Marker** key and press the Marker 1 2 3 4 5 6 soft key to select marker 1. The underlined number indicates the active marker.
9. Press the On/Off soft key and use the arrow keys, the keypad and the knob to move the marker over one of the spurs.
10. Compare the value of the marker to the specified allowable level of in-band/out-of-channel spurious emissions for the corresponding channel transmit frequency.
11. Repeat 9. and 10. for the remaining spurs. Use either Marker 1 again, or choose another marker.

Figure 3-5 shows a simulated in-band spur at 1.625 MHz from the carrier frequency. The carrier is measured by M1. The delta marker on M1 shows the signal at fc + 1.625 MHz to be 60.17 dB down from the carrier. These values should be compared against the specification for the transmitter being tested.
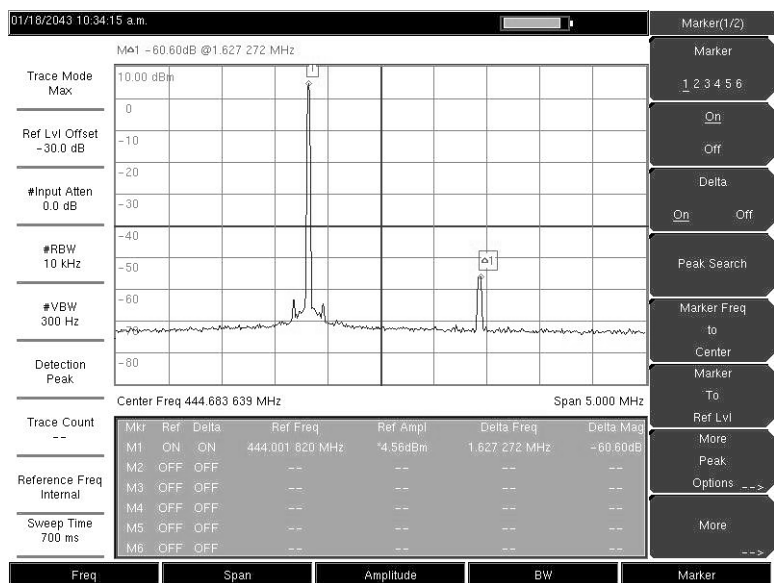
Figure 3-5. In-band Spurious Measurement

NOTE: The resolution bandwidth of a spectrum analyzer is determined by the intermediate frequency (IF) filter bandwidth. The MT8222A traces the shape of the IF filter as it sweeps past a signal. Therefore, if two equal-amplitude signals are very close to each other, the measurement result can appear to be one single response because the IF or resolution bandwidth is not small enough to resolve the two signals. Similarly, if two signals are not equal in amplitude but are very close together, the smaller signal may not be seen because it is hidden under the large response.

Field Strength

Required Equipment

- MT8222A Handheld Spectrum Analyzer

- Portable Antenna for which antenna factors or antenna gain and bandwidth data are available.

Procedure

1. Press the **Shift** key then the **Measure** key and press the Field Strength soft key.
2. Press the Antenna soft key and use the **Up/Down** arrow keys or the rotary knob to select the desired antenna. Press the **Enter** key to select.

> NOTE: Select an antenna from the standard list available in the MT8222A, or use the Antenna Editor feature of Anritsu Master Software Tools to define a custom antenna and upload the antenna information to the MT8222A antenna list.

3. Connect the antenna to the MT8222A.
4. Press the **Freq** key, press the Center Freq soft key, and enter the center frequency.
5. Press the **Span** key. Set the span wide enough to include the primary channel bandwidth and upper and lower channel bandwidths.
6. Press the **BW** key and verify that RBW Auto and VBW Auto are On.
7. To change the units of measurement, press the **Amplitude** hard key, then press the Units soft key and press dBm, dBV, dBmV, or dBµV.
8. Press either the Volts or Watts soft key, as required. The MT8222A automatically adjusts the measurement by the antenna factors selected. Marker values will be displayed in the same units as selected for the amplitude.

Antenna Calculations

The following is a list of various antenna calculations should you find it necessary to convert from one to another:

Conversion of signal levels from W to V in a 50 ohm system:

$P = V^2/R$

where:

P = power in Watts
V = voltage level in Volts
R = resistance in ohms

Note that 1 mW = 10^{-3} W and 1 µV = 10^{-6} V.

For power in dBm, and voltage in dB (µV).

$V_{dB(\mu V)} = P_{(dBm)} + 107$ dB

Power density to field strength. An alternate measure of field strength to electric field is power density:

$Pd = E^2/120\pi$

where:

E = field strength in V/m

P = Power density in W/m

Power density at a point:

$P_d = P_t G_t/(4\ \pi r^2)$

In the far field, where electric and magnetic fields are related by the impedance of free space:

Where P_d = power density in W/m

P_t = power transmitted in Watts

G_r = gain of transmitting antenna

r = distance from the antenna in meters

AM/FM/SSB Demodulation

The BTS Master built-in demodulator for AM, narrowband FM, wideband FM and single sideband (selectable USB and LSB) allows a technician to hear an interfering signal to ease identification. The demodulated signal can be heard using either the built-in speaker, or through a monaural headset connected to the 2.5-mm jack on the test panel.

Demodulation Procedure

1. Press the **Shift** key followed by the **Measure** (4) key and the AM/FM Demod soft key.
2. Press the Demod Type soft key and select FM Wide Band, FM Narrow Band, AM, USB, or LSB to match the modulation format of the signal.
3. Press the Back soft key.
4. Press the Demod Freq soft key and use the keypad or rotary knob to enter the center frequency of the signal to be demodulated. For USB and LSB signals, fine tune the signal by adjusting the Beat Freq Osc. By default the BFO frequency is set to zero, meaning that the re-injected carrier is exactly at the demodulation frequency. The Beat Freq Osc soft key allows adjustment of the beat frequency oscillator to fine tune the signal through a span of ±10000 Hz.
5. Press the On/Off soft key to enable the measurement.
6. Press the Volume soft key and use the **Up/Down** arrow keys or rotary knob to change the audio volume from 0% to 100%. For most headsets a volume of 40% is adequate.
7. The Demod Time soft key sets the time the BTS Master will demodulate the signal. Enter a value from 100 ms to 500 seconds.

Carrier to Interference Ratio Measurement

Carrier to Interference Ratio (C/I) Measurement is a two-step process, first measuring the carrier level and then, with the carrier turned off, measuring the remaining signals and noise in the band of interest. After the two measurements are complete, the ratio of the carrier level to the noise plus interference is displayed using three assumptions:

• The interferer is a narrowband frequency hopping signal (NB FHSS)

• The interferer is a wideband frequency hopping signal (WB FHSS)

• The interferer is a broadband signal (BB).

The primary application for this type of measurement is determining the magnitude of interference problems for 802.11b, 802.11g and 802.11a access points (hot spots).

Procedure

1. Press the **Frequency** key followed by the Signal Standard soft key. Select the appropriate signal standard based on the signal to be measured and press **Enter**.
2. Press the Select Channel soft key, select the operating channel of the access point being measured and press **Enter**.
3. Press the **Shift** key followed by the **Measure** (4) key and the C/I soft key.
4. Press the Center Freq soft key and enter the desired frequency, unless a Signal Standard and Channel have already been selected in the **Frequency** menu.
5. If needed, press the Span soft key and set an appropriate span width for the signal to be measured.
6. If the signal environment includes slow frequency hopping signals, such as cordless telephones, press the Min Sweep Time soft key to set a sweep time of one second or more to give a good chance of capturing instances of the interfering signal.
7. Press the On/Off soft key and follow the on-screen prompts to complete the measurement.

> NOTE: Access to the transmitter is required to complete this procedure as the transmitted carrier must be turned off for the second portion of the measurement.

8. After the measurement is complete, the measurement box gives results for the three different signal types. Some measurement results may show as Error, and this is to be expected.

The following figures show the C/I measurement steps, ready to measure the carrier, with the carrier measured, and the measurement results.
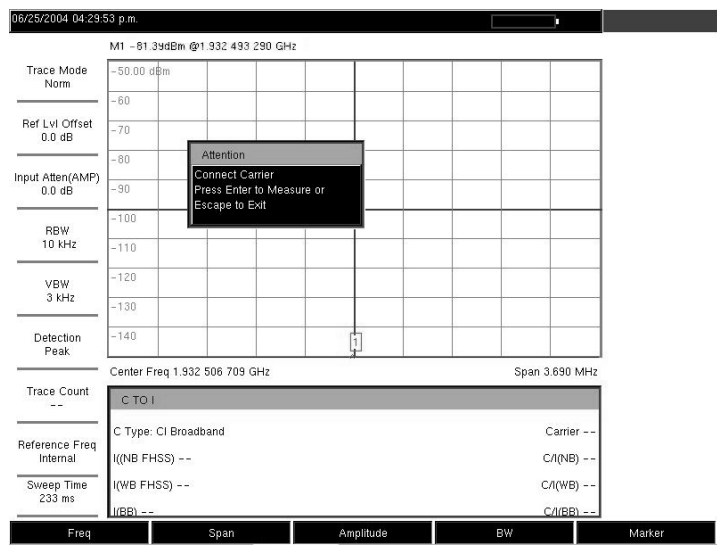
Figure 3-6. C/I Measurement, Ready to Measure the Carrier
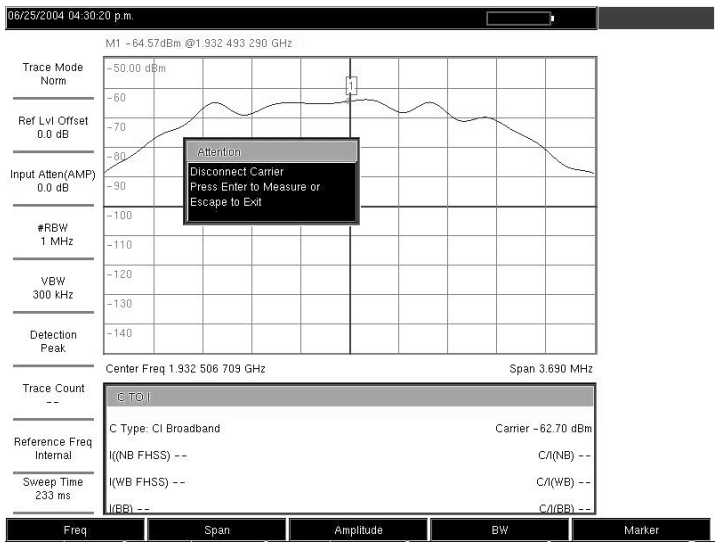
Figure 3-7. C/I Measurement, Carrier Measured
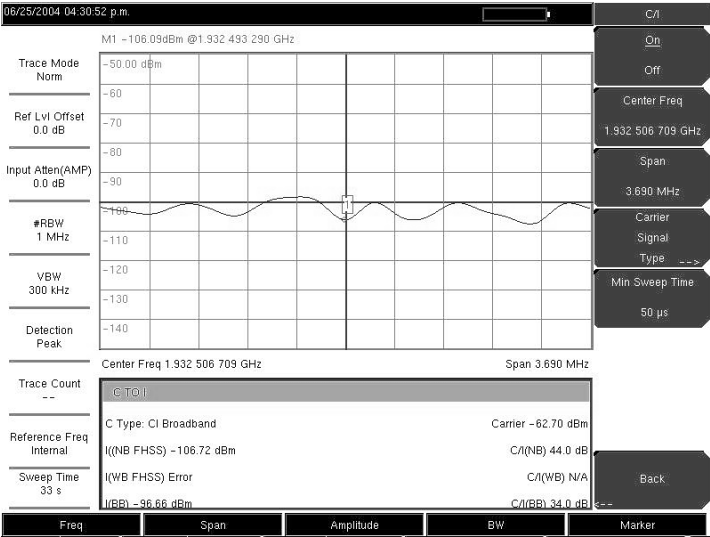
Figure 3-8. C/I Measurement, Results

Amplitude
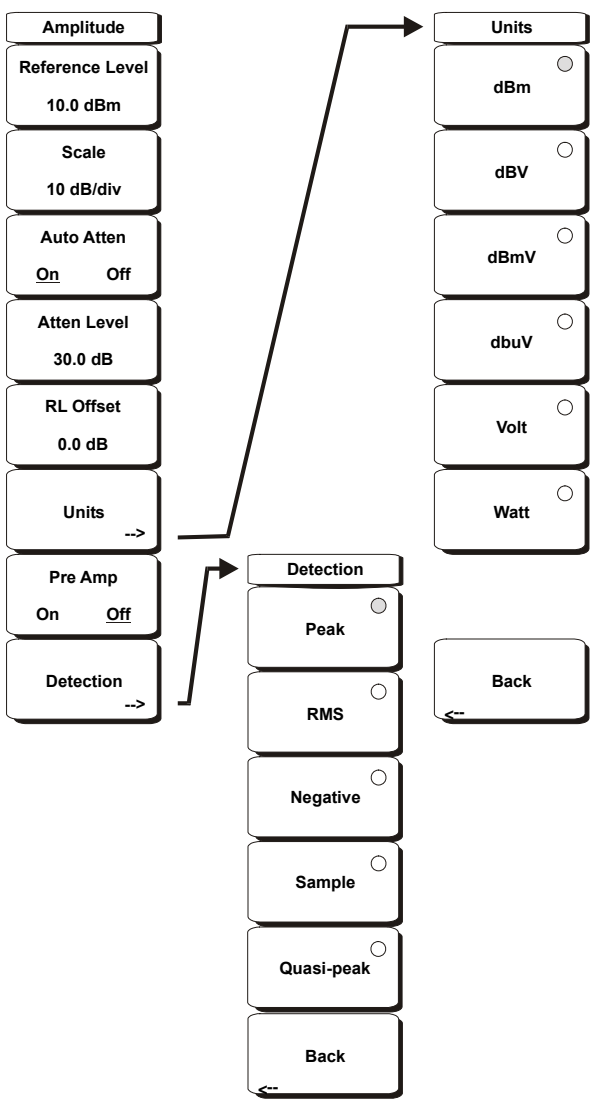
Figure 3-9. Spectrum Analyzer Mode Amplitude Menu

Reference Level
The reference level is the top graticule line on the display, and can be set from +30 dBm to
−130 dBm. A value may be entered from the key pad, using the ± key as the minus sign.
After entering the value press the dBm soft key or the **Enter** key. The **Up/Down** arrow keys
change the reference level in 10 dB steps, and the **Left/Right** arrow keys change the value
by 1 dB. The rotary knob changes the value by 0.1 dB per detent.

The reference level value may be modified by the reference level offset value to
compensate for an external attenuator, as discussed later in this chapter.

Scale
The scale can be set in 1 dB steps from 1 dB per division to 15 dB per division. The value
can be changed using the keypad, the rotary knob or the **Up/Down** arrow keys.

Auto Atten On/Off

Input attenuation can be either tied to the reference level (On) or manually selected (Off). When input attenuation is tied to the reference level, attenuation is increased as higher reference levels are selected to make sure the instrument input circuits are not saturated by large signals that are likely to be present when high reference levels are required.

Atten Lvl

Input attenuation can be set from 0 to 65 dB, in 5 dB steps. Press this soft key and use the keypad, the rotary knob or the **Up/Down** arrow keys to change the attenuation value. When the Preamplifier is turned on, the allowed attenuation settings are 0 dB and 10 dB.

RL Offset

Reference Level Offset compensates for the presence of input attenuation or gain external to the instrument. Enter a positive value to compensate for an external amplifier or a negative value to compensate for an external attenuator. Use the ± key to enter the negative sign when a negative attenuation value is being entered.

Units

Select the display units from this soft key menu:

dBm
dBV
dBmV
dBµV
Volt
Watt

Press the Back soft key to return to the Amplitude menu.

Pre Amp On/Off

This soft key turns the low-noise front-end preamplifier on or off. The preamplifier lowers the noise floor by approximately 25 dB. To assure accurate measurement results, the largest signal into the instrument input when the preamplifier is turned on should be <−50 dBm.

Detection

Several detection methods tailor the performance of the instrument to meet specific measurement requirements. In general, there are more measurement points across the screen than display points. The various detection methods are different ways of dealing with selecting which measurement point will be shown at each display point.

Peak

This method causes the largest measurement point to be shown for each display point, and assures that a narrow peak is not missed.

RMS

This method performs a root-mean-square calculation of all the measurement points in each display point, and is particularly useful in displaying the average value of noise.

Negative

This method causes the smallest measurement point to be shown for each display point. Typically this mode is used to help detect small discrete signals in the presence of nearly equal values of noise. The display points that contain only noise will tend to show lower amplitudes than those that contain discrete signals.

Sample

This is the fastest detection method because for each display point, only one frequency point is measured. Use this method when speed is of paramount importance and the possibility of missing a narrow peak is not important.

Quasi-peak

When this selection is made resolution bandwidths and video bandwidths of 200 Hz, 9 kHz and 120 kHz are available. This detection method is designed to meet CISPR requirements.

Back

Returns to the previous menu.

BW (Bandwidth)

BW

| RBW |
| 3 MHz |

| Auto RBW |
| <u>On</u>   Off |

| VBW |
| 1 MHz |

| Auto VBW |
| <u>On</u>   Off |

| RBW/VBW |
| 3 |

| Span/RBW |
| 300 |
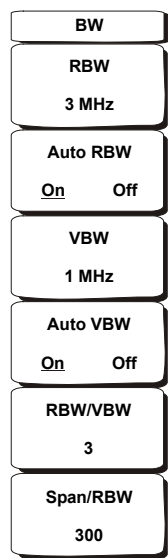
Figure 3-10. Spectrum Analyzer Mode Bandwidth Menu

RBW

The current resolution bandwidth value is displayed in this soft key. The RBW can be changed using the keypad, the **Up/Down** arrow keys, or the rotary knob. The range is 10 Hz to 3 MHz in a 1-3 sequence, from 10 Hz to 30 Hz to 100 Hz, and so on.

Auto RBW

When Auto RBW is On, the instrument selects the resolution bandwidth based on the current span width. The ratio of span width to RBW can be specified using the Span/RBW soft key.

VBW

The current video bandwidth value is displayed in this soft key. The VBW can be changed using the keypad, the **Up/Down** arrow keys, or the rotary knob. The range is 1 Hz to 3 MHz in a 1-3 sequence.

Auto VBW

When Auto VBW is On, the instrument selects the video bandwidth based on the resolution bandwidth. The ratio of video bandwidth to resolution bandwidth can be set using the RBW/VBW soft key.

RBW/VBW

This soft key displays the ratio between resolution bandwidth and video bandwidth. To change the ratio, press this soft key and use the keypad, the **Up/Down** arrow keys, or the rotary knob to select a new ratio. The default ratio is 3. When the quasi-peak detector is selected the RBW/VBW ratio is changed to 1.

Span/RBW

This soft key displays the ratio between the span width and the resolution bandwidth. The default value is 300, meaning that the span width is approximately 300 times the resolution bandwidth. The value is approximate because resolution bandwidth filters come in discrete steps while span width can be set to any value up to 7.1 GHz. To change the ratio, press this soft key and use the keypad, the **Up/Down** arrow keys, or the rotary knob to select a new ratio.

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File

Figure 3-11. Spectrum Analyzer Mode File Menu

To access the functions under the File menu, press the **Shift** key, then the **File** (7) key.

Save
Measurements may be saved to the internal memory or to a Type-1 Compact Flash module. The BTS Master is shipped with a 256 MB Compact Flash Memory Module, Anritsu Part Number 3-2000-1500. The removable compact flash card can be up to 512 MB. Compact Flash modules with greater storage capacity may not function properly, and should be properly tested before relying on them. A USB Flash drive with at least 256 MB storages may be used to store all measurements that may be stored internally.

Save Setup
Opens a dialog box to name and save the current operating settings, allowing them to be recalled later to return the instrument to the state it was in at the time the setup was saved. The saved setup can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the Left/Right directional arrows to move the cursor position. Press **Enter** to save the setup.

3-25

Save Measurement

Initiates a dialog box to name and save the current active Trace A. The saved measurement trace can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the measurement trace. Measurements are saved in a directory called /usr on the Compact Flash memory module and the USB Flash Drive.

NOTE: If a measurement has been previously saved, the Save Measurement dialog box will open with the previously saved name displayed. To save the new measurement with a similar name (for example, Trace-1, Trace-2, and so forth) simply press the Right directional arrow and add the changes. To create a completely new name, use the keypad, the rotary knob or press the soft key for each letter.

Save On Event…

Save on Event allows the automatic saving of measurements based on either exceeding the upper or lower limit line, completing a sweep, or both. Files are named LIM followed by the date and time (LIMyyyymmddhhmmss) or,. EOS followed by the date and time (EOSyyyymmddhhmmss), depending upon which choice caused the measurement to be saved.

… Crossing Limit On/Off

Selecting On causes a measurement to be automatically saved if it exceeds either the upper or lower limit line.

If no limit line is turned on, pressing this soft key causes the instrument to beep and delivers an on-screen message that says "You must have a limit on first." The message goes away after approximately 3 seconds.

The file name is created at the time the sweep completes and will be time-stamped by the instrument as the file is saved internally, within about 3 seconds after the time in the file name.

… Sweep Complete On/Off

Selecting On causes a measurement to be automatically saved when the sweep is finished. This is very useful for slow sweeps because it frees the operator from having to wait at the instrument for the proper time to save a measurement.

The file name is created at the time that sweep completes and will be internally time-stamped about 2 seconds later.

Save Then Stop On/Off

This soft key selects the choice of saving once, or continually saving measurements that meet the criteria for saving. If the instrument is sweeping quickly, and automatic saving on sweep complete is turned on, a large number of files can be saved. The instrument is able to save more than 1000 measurements. However, the time delay when preparing to recall a saved measurement can be significant – almost a minute to bring up the list when there are 600 saved measurements.

Clear All

Pressing this soft key turns off Crossing Limit, Sweep Complete and Save Then Stop.

Back

Returns to the previous menu.

Save Screen as JPEG

This function saves a measurement trace as a graphics file. The saved measurement can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the measurement after entering the file name. The file is saved in the internal memory with the specified name, with .jpg appended.

Directory Management

Sort Method
<u>Name</u> Type Date

File lists can be sorted by the name of the file, the type of file (SPA file, STP file, and so forth.) or by the date that the file was saved.

Sort
Ascend <u>Descend</u>

Selects whether the selected sort is sorted from lowest to highest (ascending) or highest to lowest (descending). When sorting by name, the sort will place file names that start with numbers before file names that start with letters (an ASCII sort).

Current Location
<u>Int</u> USB CF

This choice lets you select where measurements and setups will be saved. Pressing the soft key selects the storage location to be the internal memory, USB Flash drive, or Compact Flash memory module. The "current location" and the "copy to destination" will never be the same. Changing the current location to save files causes the "copy to destination" to be automatically changed if the selected storage location is the same as the selected current location.

Copy to Destination
Int USB <u>CF</u>

This choice lets you select where measurements and setups in the "current location" will be copied. The "current location" and the "copy to destination" may not be the same. If you change the destination to which the instrument will copy files, the current location is automatically changed if the current location is the same as the selected copy to destination.

Copy From Current Location To Destination

Pressing this soft key causes all measurements, setups, and jpg files that are stored in the user-selected "current location" to be copied to the "copy to destination". If no storage module is installed in the instrument, then an error message is displayed.

Format Compact Flash

This selection erases all files on an installed Compact Flash module. A message is displayed warning that all files will be erased. Press Enter to confirm that you want to erase and Esc to quit without erasing. In addition to erasing all files stored on the Compact Flash, the /usr directory is created for storage of measurements, setups and jpg files.

Back

The Back key returns to the previous menu.

Recall
Recall Setup
This soft key brings up a selection box that allows selection and recall of a previously stored instrument setup in the current storage location. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved setup, and press **Enter**, the rotary knob, or the Recall soft key to select. All current instrument settings are replaced by the stored setup information. Press the **Esc** key to cancel the recall.

Recall Measurement
Brings up a selection box that allows recall of a previously stored measurement trace from the currently selected storage location. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved measurement trace, and press **Enter**, the rotary knob, or the Recall soft key to select. A recalled trace may be displayed as trace A, in place of the live trace, or as trace B or C along with the live trace. Use the rotary knob or the **Up/Down** arrow keys to highlight the recalled trace option, and press the **Enter** key to select. Press the **Esc** key to cancel the recall.

To remove a recalled measurement trace from the screen, press the **Shift** key and the **Trace** (5) key to open the Trace menu. Use the Trace soft key to select the trace to be removed from the screen and use the View/Blank soft key to view or blank the trace. Use the Trace key to select an active trace after blanking a recalled trace.

Directory Management '
See *Directory Management on page 3-27*.

Back
Returns to the previous menu.

Delete
Brings up a selection box that shows all stored setups and traces in the currently selected location (See *Directory Management on page 3-27*). The list shows the setup and measurement names, the type (stp for a saved setup, spa for a saved trace, jpg for a JPEG file) and the date and time the information was saved. Use the rotary knob or the **Up/Down** arrow keys to highlight the file to be deleted, and press **Enter**, or the Delete soft key to delete. Press the **Esc** key to cancel the operation. Note that there is no mechanism to retrieve deleted files.

Delete Selected File
Use the up and down arrow buttons or the rotary knob to select the file that is to be deleted. Press Enter to confirm that you want to delete the file or Esc to exit without deleting.

Delete ALL Measurements
Deletes all measurements of the current mode in the currently selected storage location. The memory from which measurements will be deleted is set in the Directory Management menu and is the Current Location.

Delete ALL Mode Files
Deletes all measurements of the type saved in the current operating mode of the instrument. In addition all jpg and setup files (regardless of the mode) are deleted.

Delete ALL Contents
Deletes all measurements, jpg files and setup files of ALL measurement types.

Back
The Back key returns to the previous menu.

Freq (Frequency)

Freq

Center Freq
3.550 GHz

Start Freq
0 Hz

Stop Freq
7.100 GHz

Span
7.100 GHz

Freq Step
1.000 MHz

Signal
Standard

Channel
- -

Figure 3-12. Spectrum Analyzer Mode Frequency Menu

The tuning frequency range for the MT8222A can be entered in several different ways depending upon what makes the most sense for the user or for the application. The center frequency and span can be specified, the start and stop frequencies can be entered, or a signal standard and channel number can be selected from the built-in list.

Center Frequency

Press the **Freq** key followed by the Center Freq soft key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the **Enter** key has the same affect as the MHz soft key.

NOTE: When using the up and down arrows, the frequency moves in steps defined by the value entered using the Freq Step soft key.
When using the left or right arrow keys, the frequency of the active parameter moves by 10% of the current frequency span. If the instrument is in zero span, the left and right arrows do nothing.
Turning the rotary knob changes the active frequency parameter in increments of one display point for each click of the knob. There are 551 display points across the screen (661 points in full-screen mode).

Start Frequency

Press the **Freq** key followed by the Start Freq soft key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If a start frequency higher than the current stop frequency is entered, the stop frequency will be changed to yield a 10 Hz span.

Stop Frequency

Press the **Freq** key followed by the Stop Freq soft key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If a stop frequency lower than the current start frequency is entered, the start frequency will be changed to yield a 10 Hz span.

Span

Press the **Freq** key followed by the Span soft key and enter the desired span. The Span menu is used to set the frequency range over which the instrument will sweep. For the MT8222A, the span can be set from 10 Hz to 7.1 GHz. Span can also be set to zero span.

The soft key shows the current value for span in units of GHz, MHz, kHz, or Hz. When the Span button is pressed, span becomes the active parameter and may be changed. Use the keypad, the directional arrow keys or the rotary knob to increase or decrease the span frequency. If the span is changed using the **Up/Down** arrow keys, the span changes by the value of the Frequency Step for each key press.

Freq Step

Press the **Freq** key followed by the Freq Step soft key to enter the desired frequency step size. The frequency step specifies the amount by which a frequency will change when the **Up/Down** arrow keys pressed. The center frequency, start frequency, and stop frequency values can be changed using Freq Step. The active parameter will be changed by the frequency step when the **Up/Down** arrow keys are pressed. If Freq Step is the active parameter, nothing happens when the arrow keys are pressed. The frequency step size can be any value from 1 Hz to 7.1 GHz with a resolution of 1 Hz.

Use the keypad or the rotary knob to change the Frequency Step size.

Signal Standard

Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard and press **Enter** to select.

When a signal standard is selected, the center frequency and span for the first channel of the particular standard is automatically tuned. Other settings, such as channel spacing and integration bandwidth, are also automatically entered. Appendix A contains a table of the signal standards that are in the instrument firmware.

Channel

Use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the spectrum analyzer display.

Limit

To access the functions under the Limit menu, press the **Shift** key, then the **Limit** (6) key. The Limit menu soft keys are shown in Figure 3-13.

Limit Envelope		Limit		Edit
Create Envelope		Limit Upper Lower		Frequency ## Hz
Update Envelope Amplitude		On Off		Amplitude ### dBm
Upper Points ##		Limit Edit -->		Add Point
Upper Offset ## dB		Limit Move -->		Add Vertical
Upper Shape Square Slope		Limit Envelope -->		Delete Point
		Limit Advanced -->		Next Point Left
Back <--		Limit Alarm On Off		Next Point Right
		Set Default Limit		Back <--

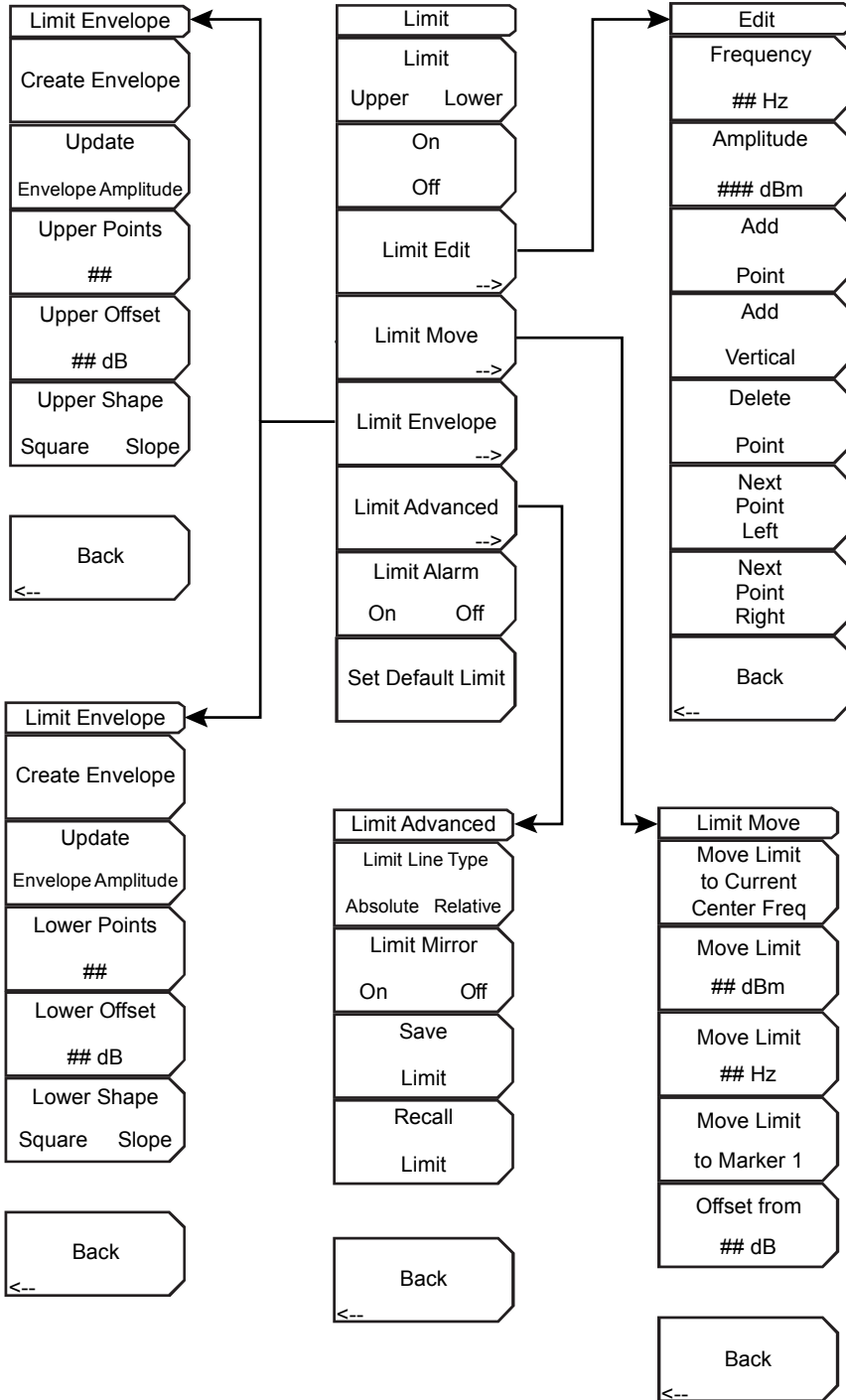| Limit Envelope		Limit Advanced		Limit Move
Create Envelope		Limit Line Type Absolute Relative		Move Limit to Current Center Freq
Update Envelope Amplitude		Limit Mirror On Off		Move Limit ## dBm
Lower Points ##		Save Limit		Move Limit ## Hz
Lower Offset ## dB		Recall Limit		Move Limit to Marker 1
Lower Shape Square Slope				Offset from ## dB
Back <--		Back <--		Back <--

Figure 3-13. Limit Menu

Two types of limit lines can be specified, lower limit lines and upper limit lines. Limit lines can be used for visual reference only, or for pass/fail criteria using the limit alarm (refer to *Limit Alarm On   Off* on page 3-36). Limit alarm failures are reported whenever a signal is above the upper limit line or below the lower limit line.

Each limit line can consist of a single segment, or as many as 40 segments across the entire frequency span of the instrument. These limit segments are retained regardless of the current frequency span of the instrument, which allows the configuring of specific limit envelopes at various frequencies of interest without having to re-configure them each time the frequency is changed.

Limit Menu

Limit
Upper   Lower
This soft key selects which limit line will be active for editing. The limit line that is currently selected for editing is <u>underlined</u>.

On / Off
This soft key turns the active limit line (upper or lower) on or off.

Limit Edit
This soft key displays a submenu that allows creating or editing of single or multi-segment limit lines. The currently active limit point is marked by a red circle on the display.

Frequency, ## Hz
Press this soft key to set the frequency of a limit line inflection point. The frequency of each inflection point in a limit line can be individually set. When a new point is added, it takes on a value halfway between two existing points, or it takes on the stop frequency of the current sweep if no point is higher in frequency than the one being added. See the Add Point soft key description for more details. Use the keypad, the **Left/Right** arrow keys, or the rotary knob to change the frequency of an inflection point.

Amplitude, ### dBm
Press this soft key to set the amplitude of a limit line inflection point. The amplitude of each inflection point can also be individually set. By default, when a new point is added, it takes on the amplitude that is on the limit line at the frequency where the point was added. Use the keypad (using the ± key to set a negative value), the **Up/Down** arrow keys, or the rotary knob to move the point to the desired value. The unit of the amplitude limit is the same as the current vertical amplitude unit. See the Add Point soft key description for more details.

Add Point
Press this soft key to a limit line inflection point. The precise behavior of this soft key depends upon which inflection point is active at the time that the key is pressed. If the active limit point is somewhere in the middle of a multi-segment limit line, then a new limit point is added that is halfway between the currently active point and the point immediately to its right. The amplitude of the inflection point will be such that it falls on the limit line. For example, if a limit point exists at 2.0 GHz with an amplitude of −30 dBm, and if the next point is 3.0 GHz with an amplitude of −50 dBm, then the added point will be at 2.5 GHz with an amplitude of −40 dBm. The frequency and amplitude values of the new point can be adjusted as needed with the Frequency and Amplitude soft keys.

If the last limit point is active (assuming it is not at the right edge of the display), then the new limit point will be placed at the right edge of the display at the same amplitude as the point immediately to its left. Points may not be added beyond the current sweep limits of the instrument.

Add Vertical
In many measurement masks, step changes occur in the value of the limit line. Press this soft key to add two inflection points. The two inflection points share the same frequency and are centered midpoint between adjacent measured points. The magnitudes of the points are set by using a visually intuitive algorithm that is based upon the adjacent inflection points.

You can adjust the magnitudes independently, but the frequencies of the two points remain linked and are adjusted as a vertical pair. Setting a discrete frequency, a limit inflection point will keep that exact frequency and place the limit point appropriately regardless of the frequency span. This is especially useful for emission mask verification.

Delete Point
Press this soft key to delete the currently active point. The active point becomes the point that is immediately to the left of the point that was deleted.

Next Point Left
Press this soft key to select the inflection point that is immediately to the left of the active point, making this newly selected point active for editing or deletion. With each key press, the active point becomes that point to the left of the previously active point, until the newly selected active point becomes the leftmost point on the screen.

Next Point Right
Press this soft key to select the limit point immediately to the right of the active point, making this newly selected point active for editing or deletion. With each key press, the active point becomes that point to the right of the previously active point, until the newly selected active point becomes the rightmost point on the screen.

Back
Press this soft key to return to the **Limit** soft key menu.

Limit Move
Press this soft key to display the Limit Move soft key menu.

Move Limit to Current Center Freq
Pressing this soft key moves the center of the existing limit line to the center frequency of the measurement. The span of the existing limit line is not changed by doing this. Use this soft key as an easy way to get an existing limit line on screen. If no limit line is turned on, then a new, flat default limit line is turned on and is located 2.5 divisions (2.5 graticule lines) from the top of the screen for the upper limit line or 2.5 divisions from the bottom of the screen for the lower limit line.

Move Limit, ## dB or Move Limit, ## dBm
If the limit line is flat, then use this soft key to move the limit line to an absolute power point in dBm. If the limit line is not flat, then use this soft key to move the limit line up or down by the selected number of dB. Use the keyboard to enter the desired value. The entire line moves by the amount that is entered. The limit line can also be moved by using the rotary knob. Turn the rotary knob clockwise to move the line to higher power levels.

Move Limit, ## Hz

Pressing this soft key allows you to adjust the frequencies of the limit line. All inflection points are moved by the value entered. The rotary knob can also be used to make this adjustment. Turn the rotary knob clockwise to move the limit line to higher frequencies.

Move Limit to Marker 1

Press this soft key to move the frequency and amplitude of the center frequency of the limit line to at the frequency and amplitude of Marker 1 (assuming that the Offset from soft key is set to 0 dB).

Offset from ## dB

Press this soft key to set a limit line offset value from Marker 1 amplitude. This feature moves the limit line amplitude and frequency as needed to place the center of the limit line the user-specified number of dB from the position of Marker 1. Positive values place the limit line above Marker 1, and negative values place the limit line below Marker 1.

Back

Press this soft key to return to the **Limit** soft key menu.

Limit Envelope

A limit envelope is very useful when you want to easily detect new signals in the presence of other preexisting signals. Use the limit envelope function to automatically create upper or lower limit lines that are based upon the on-screen measured spectrum analysis values. Refer to Figure 3-14 for an example limit envelope.

Press this soft key to open the Limit Envelope soft key menu.

Create Envelope

Press this soft key to generate the envelope using the Limit Envelope characteristics. If the default results are not satisfactory, then you can make adjustments to the amplitude and frequency of each inflection point, and you can add or delete inflection points.

Update Envelope Amplitude

While working on your envelope (or if your signal amplitude changes), you may want to adjust the amplitude of the current limit without changing the frequencies of the inflection points. Pressing this soft key makes those amplitude adjustments without frequency adjustments.

Upper Points, ## (if Upper Limit is selected)
Lower Points, ## (if Lower Limit is selected)

Use this soft key to define how many inflection points you want for the selected upper or lower limit envelopes. The value can be between 2 and 41. Note that the upper and lower limit lines do not need to have the same number of points.

Upper Offset, ## dB (if Limit is toggled to Upper)
Lower Offset, ## dB (if Limit is toggled to Lower)

This soft key is used to define how far away from the measured signal the upper or lower envelope will be placed. The limits are ±100 dB. For an upper envelope, usually the value will be positive in order to place the envelope above the signal. for a lower envelope, the value will usually be negative in order to place the envelope below the signal.

Upper Shape, Square/Slope (if Limit is toggled to Upper)
Lower Shape, Square/Slope (if Limit is toggled to Lower)
Press this soft key to choose whether the default for the upper or lower envelope will
be with flat tops and reasonably vertical lines to change level or whether the envelope
will have sloped lines between adjacent inflection points. When the square envelope
type is selected, two inflection points are used for each horizontal segment. You can
toggle between a square envelope and a sloped envelope by pressing this soft key.

Back
Press this soft key to return to the **Limit** soft key menu
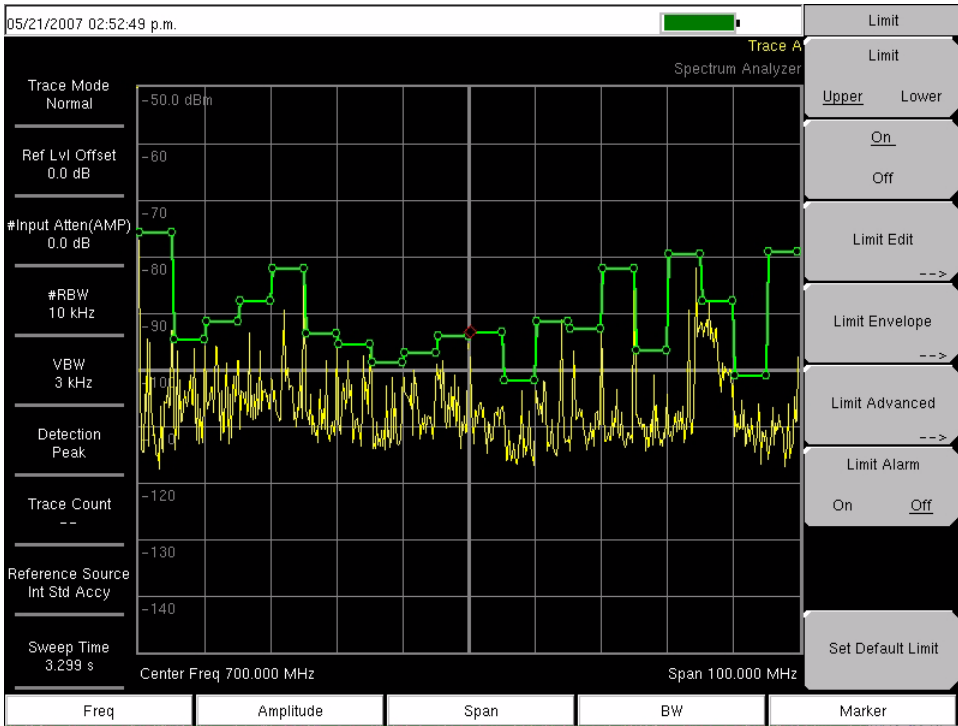
Figure 3-14. Example Limit Envelope, Square

Limit Advanced
Press this soft key to open the Limit Advanced soft key menu. The advanced limit line
section offers several useful functions. In this section, you can create either an **absolute**
limit line (which is one based upon the frequencies that are entered for each inflection
point) or a **relative** limit line (which is based upon the delta frequencies between the center
frequency and the inflection points). Both types of limit lines can be saved and recalled.

Limit Advanced soft key menu:

Limit Line Type
Absolute   Relative
Press this soft key to choose to have either limit line be absolute or be relative. The
upper and lower limit lines may be different. This soft key may be used at any time
while working with limit lines.

Absolute limit lines set the limit inflection points based upon the entered frequencies
for each point.

Relative limit lines set the limit inflection points relative to the current center frequency.

Regardless of how a limit line is set up, saved, or recalled, it can be changed between absolute and relative by toggling with this soft key.

Limit Mirror
On   Off
Press this soft key to turn the Limit Mirror feature On and Off.

Many emission masks are symmetrical. The low frequency side is identical to the upper side. The Limit Mirror feature allows you to create half of the limit line and get the other half built automatically. This feature can work in either of two ways:

Turn Limit Mirror On before beginning to build a limit line. As you add a point on either side of the center frequency, another point is automatically added on the opposite side of the center frequency.

Leave Limit Mirror Off until half of the limit line is built, then turn On Limit Mirror. the other half of the limit line is built automatically.

Save Limit
Pressing this soft key opens a dialog to save the current upper and lower limit lines. You can name the saved limit line yourself or accept the name that is suggested by the instrument (which is based upon a previously saved name). If you did not intend to save the limit line, then press **Esc** to stop the dialog and avoid saving the limit line.

Recall Limit
Pressing this soft key opens a dialog box to recall a saved limit line. The dialog box presents a list of saved limit lines. Highlight the desired limit line and press **Enter**. If you decide not to recall a limit line, then press **Esc** to stop the dialog.

If the saved limit is a relative limit, then it is recalled centered about the current center frequency. If the saved limit is an absolute limit, then it is recalled to the frequency at which it was created.

If you recall an absolute limit, and if it is off screen, then you will see the left or right limit off-screen indicator on the edge of the screen.

Back
Press this soft key to return to the **Limit** soft key menu.

Limit Alarm
On   Off
Pressing this soft key toggles the alarm function ON and OFF for the currently active limit line. When ON, an alarm beep will occur when a data point exceeds the limit.

Set Default Limit
Pressing this soft key deletes all limit points for the currently active limit line and sets the default limit line value, which is a single limit whose position is 2.5 graticule lines from the top of the screen (for the upper limit line) or 2.5 graticule lines from the bottom of the screen (for the lower limit line), depending upon which limit is active. The inactive limit line is not altered.

Marker

Figure 3-15. Spectrum Analyzer Mode Marker Menu

Press the **Marker** function hard key to open the Marker menu. The MT8222A is equipped with six markers. Any or all markers can be employed simultaneously.

Marker 1 2 3 4 5 6
Use this soft key to select the active marker. The underlined marker number is the active marker. Each press of the soft key moves the underline to the next marker number. Pressing the **Shift** button causes subsequent button presses to move from higher marker numbers to lower numbers. Press the **Shift** button again to change back to the original direction.

On/Off
This soft key turns the active marker, selected by the Marker soft key above, On or Off.

Delta On/Off
This function turns on a delta marker and prompts for a delta offset frequency, either positive or negative from the frequency of the currently active marker.

Peak Search
This soft key places the currently active marker on the highest signal amplitude currently displayed on screen.

Marker Freq to Center

This soft key changes the center frequency to place the currently active marker at the center of the display.

Marker to Ref Level

This soft key causes the amplitude of the currently active marker to become the reference level, which is the top horizontal line of the display.

More Peak Options

This soft key brings up a secondary menu of soft keys for more peak searching options.

Peak Search

This soft key places the currently active marker on the highest amplitude signal currently on screen.

Next Peak Left

From the current position of the active marker, the instrument searches to the left (toward lower frequencies) for a peak signal that rises at least a certain amount above the average noise level. If no such peak is found, the marker is placed at the left end of the trace. The Peak Threshold soft key allows the user to specify the performance of peak searching.

Next Peak Right

From the current position of the active marker, the instrument searches to the right (toward higher frequencies) for a peak signal that rises at least a certain above the average noise level. If no such peak is found, the marker is placed at the right end of the trace. The Peak Threshold soft key allows the user to specify the performance of peak searching.

Delta Marker to Span

Sets the total span width to the value of the delta marker. If the delta marker is zero, the span is set to 10 Hz. If there is no delta marker, or the delta marker value is set to less than 10 Hz, then the span will be set to 10 Hz.

Marker Freq to Center

Sets the center frequency to the frequency of the currently active marker.

Marker to Ref Lvl

.Sets the reference level, top graticule line, to the amplitude of the currently active marker.

Peak Threshold

This soft key allows the user to specify how far above the average noise floor a signal must rise before it is considered a peak.

Back

Returns to the higher-level menu.

More

Opens a submenu of further Marker options.

Marker Noise

This marker option turns the markers into noise markers with units of dBm/Hz. When this option is selected, the detection method is automatically changed to RMS and the displayed value is compensated for the noise bandwidth of resolution bandwidth filter.

Marker Table

Pressing this soft key causes a table to be displayed below the sweep window. The table is automatically sized to display all markers that are turned on. In addition to the marker frequency and amplitude, the table also shows delta frequencies and amplitude deltas for all markers that have deltas entered for them.

All Markers Off

This soft key turns off all markers.

Counter Marker On Off

Sets the frequency counter mode for all markers. Marker frequency values are normally limited in resolution to individual display pixels. Each pixel may represent multiple frequencies. Using Counter Marker in association with Marker to Peak will result in the exact frequency of the peak within the pixel to a resolution of 1 Hz.

Set Marker To Channel8

If a signal standard has been selected, pressing this soft key brings up a dialog box to select a channel. Select a channel number for the current signal standard, and the active marker will be set to the center frequency of the channel.

If no signal standard has been selected, a message "No standard selected. Press Enter or Escape to Continue." is displayed. Press either button to leave the settings as they were before the soft key was pressed.

Marker Style Fixed Tracking

This soft key changes the behavior of the reference markers. If Fixed is selected, reference markers stay at the amplitude they were at when the associated delta marker was turned on. If Tracking is selected, the amplitude of the reference marker changes as the signal amplitude is changed. Note that the reference marker tracks the amplitude, not the frequency of a signal.

Marker 1 Reference On Off

This soft key selects whether Marker 1 is the reference for all six delta markers, or whether each of the six reference markers has an associated delta marker.

Back

Returns to the previous menu.
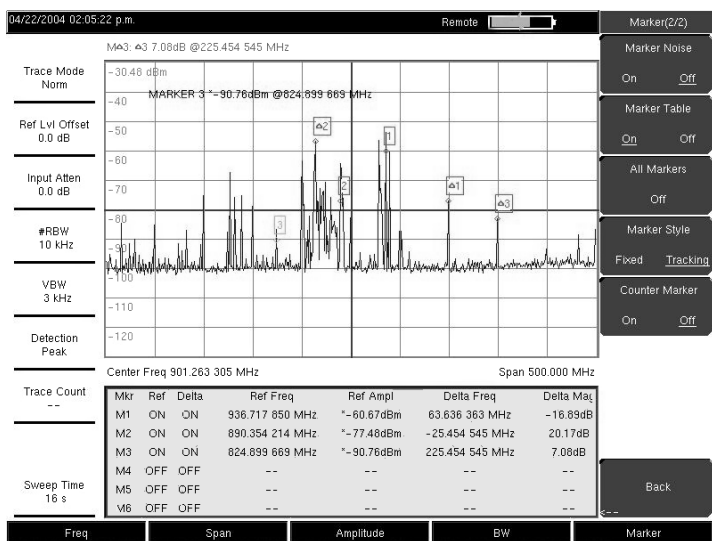
Figure 3-16. Markers

Measure

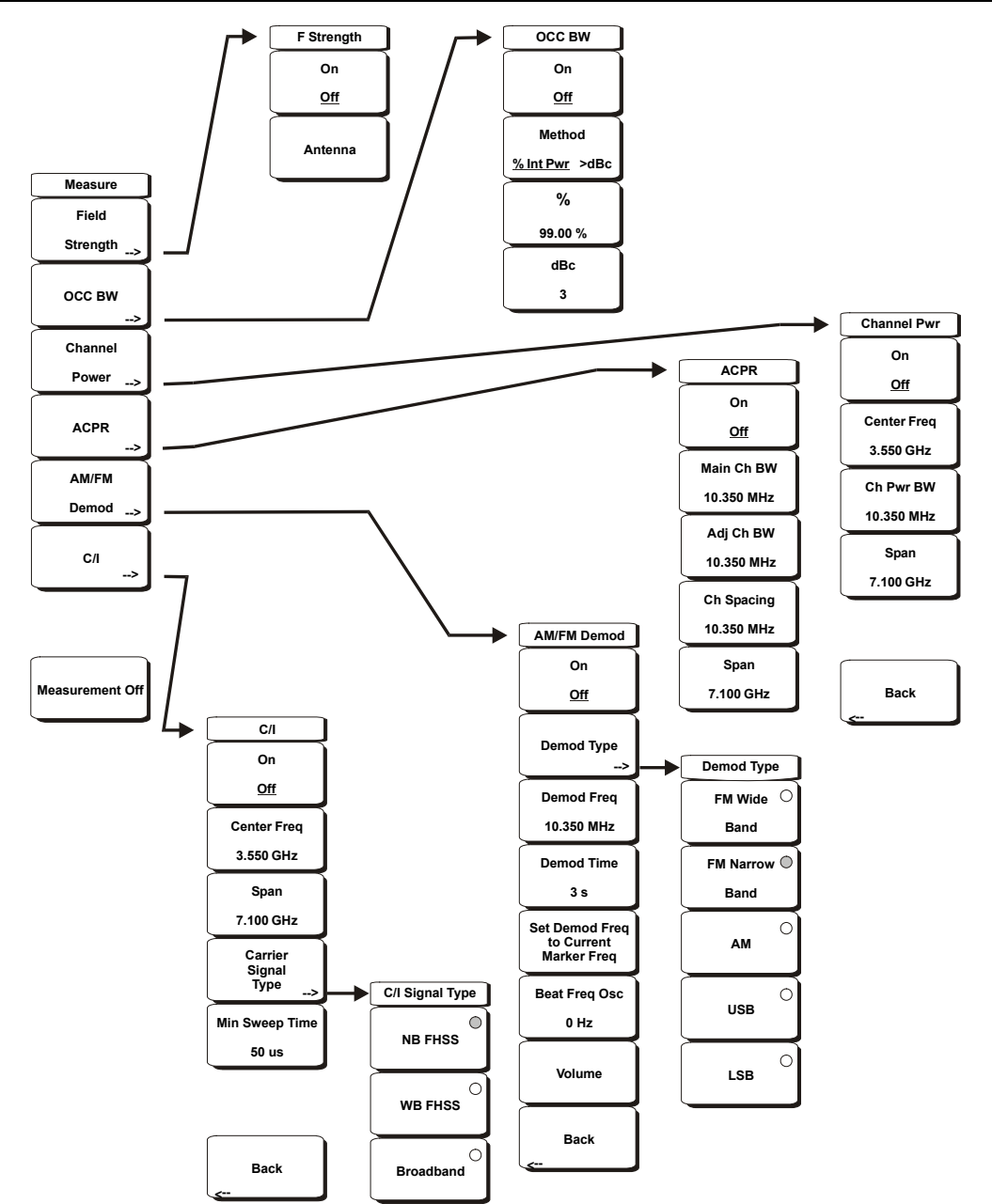**Figure 3-17. Spectrum Analyzer Mode Measure Menu**

To access the functions under the Measure menu, press the **Shift** key, then the **Measure** (4) key.

Field Strength

This measurement allows the use of an antenna with known gain characteristics and measures the field strength over the frequency range of the antenna in units of dBm/meter, dbV/meter, dBmV/meter, dBμV/meter, volts/meter or watts/meter.

On Off

Turns field strength measurements on or off.

Antenna

This soft key brings up a dialog box that lists all the antennas for which the instrument has data, including both standard antennas and custom antenna that have been added using Master Software Tools. Use the **Up/Down** arrow keys or the rotary knob to select the desired antenna and press **Enter**.

Back

Returns to the previous menu.

OCC BW

Activates the occupied bandwidth menu. Select either % or dBc method of occupied bandwidth measurement.

Method % Int Pwr / >dBc

Select either the % of Power (default) or dB Down measurement method as displayed in the message area.

%

Use the keypad, the directional arrow keys or the rotary knob to enter the percent of power, from 0% to 99%.

dBc

Use the keypad, the directional arrow keys or the rotary knob to enter the dBc value (0 dBc to 10 dBc).

Back

Returns to the previous menu.

Channel Power

Activates the Channel Power measurement function. Channel Power and Channel Power Density are measured based on the selection in the Units menu.

On Off

Begins or ends the channel power measurement. When the measurement is on, Ch Pwr will appear below the display. The detection method will automatically be changed to RMS Average when the measurement is started. The detection method can be modified by pressing the **Shift** and the **Sweep** keys and pressing the Detection soft key.

Center Freq

Activates the center frequency function, and sets the center frequency of the BTS Master for the channel power measurement. Use the keypad, the directional arrow keys or the rotary knob to enter the center frequency.

Int BW

Sets the integration bandwidth for channel power measurement. Modifying this value automatically adjusts the channel span to maintain the same ratio. Use the keypad, the directional arrow keys or the rotary knob to enter the integration bandwidth.

Span

Sets the channel span for channel power measurement. Use the keypad, the directional arrow keys or the rotary knob to enter the channel span.

Back

Returns to the previous menu.

ACPR

Accesses a menu of Adjacent Channel Power Ratio measurement options:

On Off

Begins or ends the ACPR measurement.

Main Ch BW

Sets the bandwidth of the main channel for ACPR measurement. Use the keypad, the directional arrow keys or the rotary knob to enter the a specific frequency. When using the keypad, press the GHz, MHz, kHz, or Hz soft key to accept the frequency input. Changing this value automatically changes the adjacent channel bandwidth and channel spacing.

Adj Ch BW

Sets the bandwidth of the adjacent channels for ACPR measurement. Use the keypad, the directional arrow keys or the rotary knob to enter the a specific frequency. When using the keypad, press the GHz, MHz, kHz, or Hz soft key to accept the frequency input.

Ch Spacing

Sets the channel spacing between the main and adjacent channels. Use the keypad, the directional arrow keys or the rotary knob to enter the a specific frequency. When using the keypad, press the GHz, MHz, kHz, or Hz soft key to accept the frequency input. This value must be greater than or equal to half of the main channel bandwidth, plus half of the adjacent channel bandwidth.

Back

Returns to the previous menu.

AM/FM Demod

The user can select AM, Narrow Band FM (300 µs de-emphasis), Wide Band FM (50 µs de-emphasis), Upper Sideband or Lower Sideband.

On Off

Turns AM/FM Demodulation on or off.

Demod Type

Provides soft keys to select the type of signal to be demodulated:

FM Wide Band
FM Narrow Band
AM
USB
LSB

Demod Freq

Use the keypad, the directional arrow keys or the rotary knob to enter the center frequency of the signal to be demodulated. This frequency does not have to be within the current frequency sweep range to which the instrument is set.

Demod Time

Use the keypad, the directional arrow keys or the rotary knob to increase or decrease the demodulation time, and press the **Enter** key to select. The demodulation time can be set from 100 milliseconds to 200 seconds. The instrument sweeps one time for every demodulation period. Sweeping pauses during the demodulation time.

Set Demod Freq to Current Marker Freq

Sets the demodulation frequency to the frequency of the current marker.

Beat Freq Osc
Sets the beat frequency of the oscillator to exactly set the demodulation frequency of USB and LSB signals.

Volume
The current volume setting is displayed on the screen. Use the **Up/Down** arrow keys or rotary knob to change the volume, and press the **Enter** key to select.

Back
Returns to the previous menu.

C/I
The Carrier to Interference ratio is a two-step measurement sequence that first measures the amplitude of a carrier, then, with the carrier turned off, measures the amplitude of all other interfering signals within the channel bandwidth.

On Off
Starts and stops the carrier to interference measurement.

Center Freq
Use the keypad, the directional arrow keys or the rotary knob to enter the center frequency.

Span
Use the keypad, the directional arrow keys or the rotary knob to enter the frequency span.

Carrier Signal Type
Opens a menu to select the carrier signal type.

NB FHSS (Narrow Band Frequency Hopping Spread Spectrum)
Use this setting when the signal being measured is 802.11b.

WB FHSS (Wide Band Frequency Hopping Spread Spectrum)
Use this setting when the signal being measured is 802.11a or 802.11g.

Broadband
Use this setting when the signal being measured is a digital modulation format such as CDMA, GSM, and so forth.

Back
Returns to the previous menu.

Min Sweep Time
Set the minimum sweep time for the measurement.

Back
Returns to the previous menu.

Measurement Off
Turns the measurement off.

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Mode

To access the functions under the Mode menu, press the **Shift** key, then the **Mode** (9) key. Use the directional arrow keys or the rotary knob to highlight the selection and press the **Enter** key to select. The list of modes that appears in this menu will vary depending upon the options that are installed and activated in your instrument. is an example of the Mode menu. Your instrument may not show the same list.

Preset

```
┌─────────────┐
│   Preset    │
├─────────────┤
│   Preset    │
├─────────────┤
│    Save     │
│   Setup     │
├─────────────┤
│   Recall    │
│   Setup     │
└─────────────┘
```
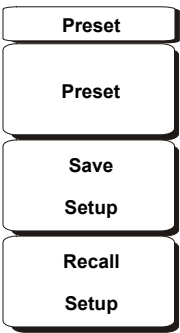
Figure 3-18. Spectrum Analyzer Mode Preset Menu

To access the functions under the Preset menu, press the **Shift** key, then the **Preset** (1) key.

Preset
This key resets the instrument to the default starting conditions of full band sweep, 10 dBm log reference level, 10 dB/division scaling, 0 dB reference level offset, all measurements turned off and trigger set to free run.

Save Setup
Opens a dialog box to name and save the current operating settings, allowing them to be recalled later to return the instrument to the state it was in at the time the setup was saved. The saved setup can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the setup.

Recall Setup
This soft key brings up a selection box that allows selection and recall of a previously stored instrument setup. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved setup, and press **Enter**, the rotary knob, or the Recall soft key to select. All current instrument settings are replaced by the stored setup information. Press the **Esc** key to cancel the recall.
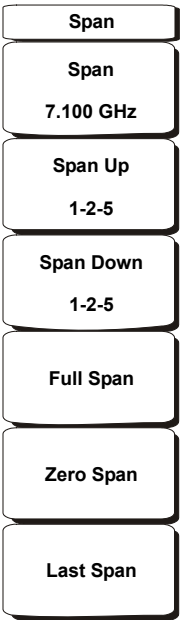
Span

Span
Span 7.100 GHz
Span Up 1-2-5
Span Down 1-2-5
Full Span
Zero Span
Last Span

Figure 3-19. Spectrum Analyzer Mode Span Menu

Press the **Span** function key to access the Span menu. The Span menu is used to set the frequency range over which the instrument will sweep. For the MT8222A, the span can be set from 10 Hz to 7.1 GHz. The Span can also be set to zero span.

Span
This soft key shows the current value for span in units of GHz, MHz, kHz, or Hz. When the Span button is pressed, span becomes the active parameter and may be changed. Use the keypad, the directional arrow keys or the rotary knob to increase or decrease the span frequency. If the span is changed by using the up and down arrow keys, the span changes by the value of the Frequency Step entered in the Frequency menu.

Span Up 1-2-5
This is a convenient way to quickly arrive at a wider span value. The first time the soft key is pressed, the span value increases to the nearest even value that starts with 1, 2, or 5. For example if the span is 1.8 MHz, pressing the soft key for the first time changes the span to 2.0 MHz, the next press takes the value to 5.0 MHz and so on.

Span Down 1-2-5
This is a convenient way to narrow the frequency span. The first time the soft key is pressed, the span value decreases to the nearest even value that starts with 1, 2, or 5. For example if the span is 1.8 MHz, pressing the soft key for the first time changes the span to 1.0 MHz, the next press takes the value to 500 kHz, then 200 kHz and so on.

Full Span
Pressing this button sets the span to cover the entire tunable spectrum of the MT8222A from 0 Hz to 7.1 GHz.

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Zero Span

This soft key sets zero span. In this mode the display shows amplitude changes at a single frequency. This function is frequently used to allow the easy monitoring of power variations over time. For example, if information about the amplitude of an 802.11a access point signal is needed, the access point frequency would be set as the center frequency, resolution bandwidth would be set to a value wide enough to encompass the signal and the tester would walk around the access point usable area while the BTS Master records the amplitude using slow sweep.

Last Span

This soft key returns the span to the most recent span value immediately before a change was made.

Sweep
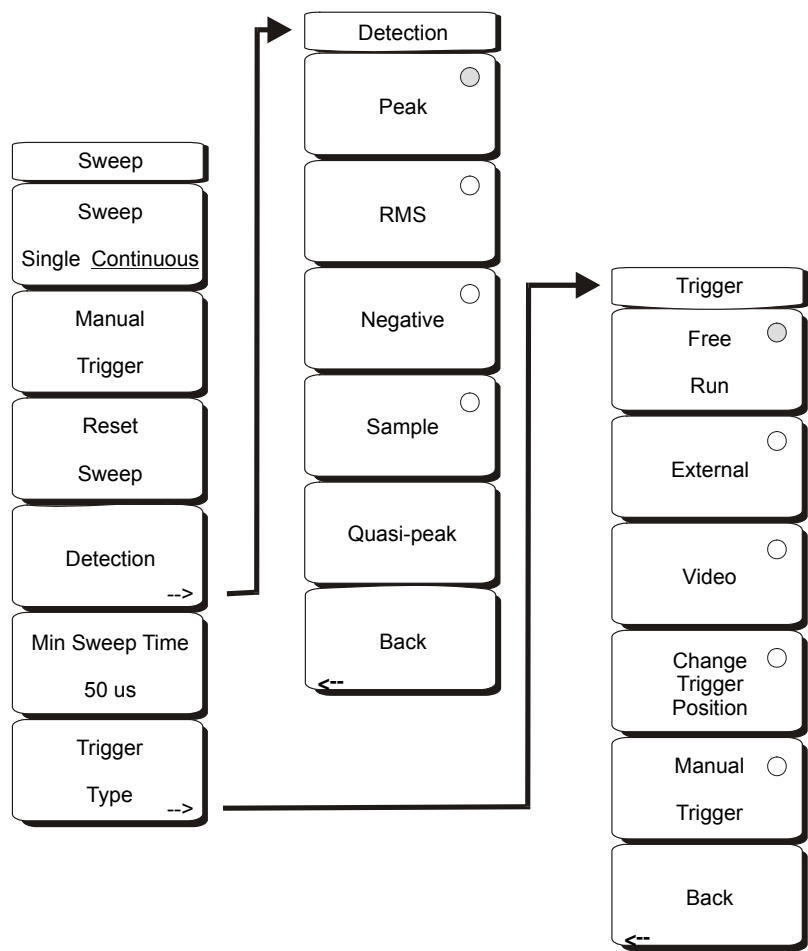
Figure 3-20. Spectrum Analyzer Mode Sweep Menu

To access the functions under the Sweep menu, press the **Shift** key, then the **Sweep** (3) key.

Sweep Single/Continuous
This soft key toggles between continuous sweep and single sweep. In single sweep mode, the results of a sweep are displayed on the screen while the instrument awaits a trigger event to start a new sweep.

Manual Trigger
Pressing this soft key causes the instrument to make a single sweep when the instrument is in single sweep mode. This key has no function when the instrument is in continuous sweep mode.

Reset Sweep
This soft key stops the current sweep, clears trace averaging results, clears the maximum hold results, if selected, and restarts the sweep at the left side of the screen.

Detection

Several detection methods tailor the performance of the instrument to meet specific measurement requirements. In general, more measurement points exist across the screen than display points. The various detection methods are different ways of dealing with selecting which measurement point will be shown at each display point.

Peak

This method causes the largest measurement point to be shown for each display point, and assures that a narrow peak is not missed.

RMS

This method performs a root-mean-square calculation of all the measurement points in each display point, and is particularly useful in displaying the average value of noise.

Negative

This method causes the smallest measurement point to be shown for each display point. Typically this mode is used to help detect small discrete signals in the presence of nearly equal values of noise. The display points that contain only noise will tend to show lower amplitudes than those that contain discrete signals.

Sample

This is the fastest detection method because for each display point only one frequency point is measured. Use this method when speed is of paramount importance and the possibility of missing a narrow peak is not important.

Quasi-peak

Selects the quasi-peak detector. When the quasi-peak detector is selected, the allowed resolution bandwidths are 200 Hz, 9 kHz, and 120 kHz. The RBW/VBW ratio is set to 1 so that the video bandwidth is the same as the resolution bandwidth.

Back

Returns to the previous menu.

Min Sweep Time

This function allows a minimum sweep time to be specified. Use the keypad, the directional arrow keys or the rotary knob to set the minimum sweep time from 50 microseconds to 600 seconds. When using the keypad, the available time units are minutes, seconds, milliseconds and microseconds.

If the required sweep time for accurate measurement is longer than the specified minimum, then the time required for accurate measurements will prevail.

Trigger Type

Sets the type of trigger to be used.

Free Run

In this mode, a new sweep is started immediately upon completion of an old sweep. No trigger event is required to initiate a sweep.

External

A TTL signal applied to the External Trigger BNC input connector causes a single sweep to occur. This mode is used in zero span, and triggering occurs on the rising edge of the signal. After the sweep is complete, the resultant trace is displayed until the next trigger signal arrives.

Video

This mode is used in zero span to set the power level at which a sweep is initiated. The power level can be set from −120 dBm to +20 dBm. The trigger is based on the measured signal level. If no signal reaches or exceeds the trigger level, there will be no trace on the screen. This mode is used in Zero Span.

Change Trigger Position

This soft key is used in conjunction with video triggering to set the horizontal position on the display where a signal that meets the video triggering criterion will be placed. The value can be from 0% to 100%. Zero percent places the triggering event at the left edge of the screen while 100% places the triggering at the right edge of the screen. When the trigger position is any value other than 0%, the portion of the trace before the trigger event is displayed very quickly because the trace data is stored in memory. The portion of the trace after the trigger point is displayed on the screen at the normal rate as the signal is swept. This mode is used in Zero Span.

Manual Trigger

This soft key can be used in zero span to immediately trigger a sweep when the trigger type is set to External or Video.

Back

Returns to the previous menu.
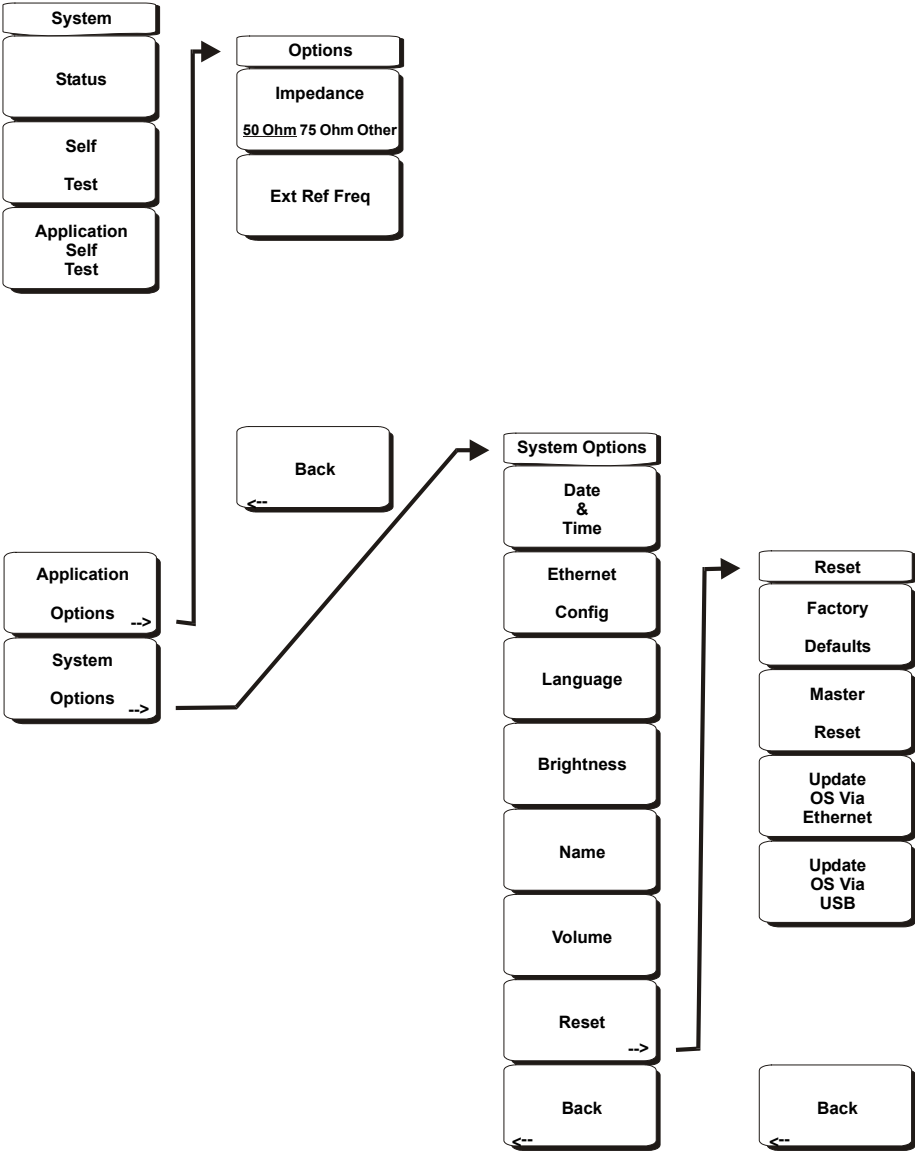
System

Figure 3-21. Spectrum Analyzer Mode System Menu

To access the functions under the System menu, press the **Shift** key, then the **System** (8) key.

Status
Pressing this soft key displays the current system status, including the operating system and firmware versions, temperatures and other details such as current battery information. Press **Esc** or **Enter** to return to normal operation.

Self Test
This soft key initiates a series of diagnostic tests that test the components of the instrument. A display will list the individual tests with a pass or fail indication. Press **Esc** or **Enter** to return to normal operation.

Application Self Test

This soft key initiates a series of diagnostic tests related to the performance of the spectrum analyzer. A display will list the individual tests with a pass or fail indication. Press **Esc** or **Enter** to return to normal operation.

Application Options

This soft key presents a menu to select application options.

Impedance 50 Ohm/75 Ohm/Other

Select either 50 ohm, 75 ohm, or Other impedance value. Selecting 75 ohm selects the 7.5 dB loss of the Anritsu 12N50-75B adapter. For other adapters, select Other and enter the appropriate loss.

Ext Ref Freq

Select the frequency of the external reference from the list presented ().

Back

Returns to the previous menu.

System Options

This key opens a selection of system option soft keys.

Date and Time

This soft key brings up a dialog box for setting the current date and time. Use the soft keys or the **Left/Right** arrow keys to select the field to be modified. Use the keypad, the **Up/Down** arrow keys or the rotary knob to select the date and time. Press **Enter** to accept the changes, or press the **Esc** key to return to normal operation without changing anything.

Ethernet Configuration

This soft key brings up a dialog box to set the IP address of the instrument.

Type Manual/DHCP

This soft key selects whether the address will be entered manually, or supplied automatically by a network DHCP server. If Manual is selected, use the soft keys or the **Left/Right** arrow keys to select the field to be modified. Use the keypad, the **Up/Down** arrow keys or the rotary knob to enter the input. Press **Enter** to accept the changes, or press the **Esc** key to return to normal operation without changing anything.

Language

This soft key brings up a selection box allowing selection from a list of built-in languages for the BTS Master displays. The languages currently available are English, French, German, Spanish, Japanese, Chinese, Korean, and Italian. In addition, a custom language may be selected if it has been defined using the Master Software Tools software and loaded into the MT8222A. The only limit regarding the number of languages that may be loaded into the instrument is the amount of space available in the memory. If a mode does not have language translations available, English is the default language. Press **Enter** to accept the change, or press the **Esc** key to return to normal operation without changing anything.

Brightness

The brightness of the display can be adjusted to optimize viewing under a wide variety of lighting conditions. Use the keypad, the **Up/Down** arrow keys or the rotary knob to select a brightness level from 1 to 9, 9 being the brightest. Press **Enter** to accept the change.

Name

Opens a dialog box to name the instrument. The unit can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the name.

Volume

The current volume setting is displayed on the screen. Use the keypad, the **Up/Down** arrow keys or the rotary knob to change the volume and press the **Enter** key to accept the change.

Reset

Opens a menu of reset and update options.

Factory Defaults

Restores the instrument to the factory default values, including Ethernet, language and brightness settings. Press the **Enter** key to initiate the reset, and turn the unit off, then on again to complete. Press **Esc** to return to normal operation without resetting.

Master Reset

This will restore factory setting to all system parameters, including Time/Date, Ethernet, language and brightness settings. Also, all user files in the internal memory are deleted, and the original language and antenna files are restored. Press the **Enter** key to initiate the reset, and turn the unit off, then on again to complete. Press **Esc** to return to normal operation without resetting.

Update OS Via Ethernet

Press this soft key to update the instrument operating system via the Ethernet connection. Press Enter to begin the update, or press **Esc** to return to normal operation without updating.

Update OS Via USB

Press this soft key to update the instrument operating system via the USB connection. Press Enter to begin the update, or press **Esc** to return to normal operation without updating.

Back

Returns to the previous menu.

Trace

Figure 3-22. Spectrum Analyzer Mode Trace Menu

To access the functions under the Trace menu, press the **Shift** key, then the **Trace** (5) key. The MT8222A is capable of displaying up to three traces, one with live data, and the other two either with stored data or trace math data.

Trace <u>A</u>, B, C
This soft key selects which trace is the active trace. The active trace is the one that is underlined. As the key is pressed, the underline advances from A to B to C and back to A.

View Blank
This soft key toggles the currently active trace to be either visible or hidden.

Write/Hold
Selects if the currently active trace will continue to sweep and be updated or to hold the current trace on screen. This is not applicable to trace B or trace C unless trace math involving trace A is active.

Trace Mode Norm/Avg/Max
With this soft key the function of the active trace can be modified:

Normal - the trace shows current data

Avg - the trace shows a running average of a number of traces. The number is determined by the next soft key, # of Averages.

Max - the trace shows the cumulative maximum value of each display point over many traces.

of Averages
Sets the number of traces that are used for the calculation of the average display value from 1 to 65535.

Save/Recall
Pressing this soft key opens a list of save and recall function soft keys, as explained in the **File** menu section .

Detection
Several detection methods tailor the performance of the instrument to meet specific measurement requirements. In general, there are more measurement points across the screen than display points. The various detection methods are different ways of dealing with selecting which measurement point will be shown at each display point.

Peak
This method causes the largest measurement point to be shown for each display point, and assures that a narrow peak is not missed.

RMS
This method performs a root-mean-square calculation of all the signals in each display, and is particularly useful in displaying the average value of noise.

Negative
This method causes the smallest measurement point to be shown for each display point. Typically this mode is used to help detect small discrete signals in the presence of nearly equal values of noise. The display points that contain only noise will tend to show lower amplitudes than those that contain discrete signals.

Sample
This is the fastest detection method because for each display point only one frequency point is measured. Use this method when speed is of paramount importance and the possibility of missing a narrow peak is not important.

Back
Returns to the previous menu.

More
A–>B
Copies the contents of trace A into trace B. Doing so overwrites the previous contents of trace B.

A–>C
Copies the contents of trace A into trace C. Doing so overwrites the previous contents of trace C.

B<–>C
Swaps the contents of traces B and C.

A – B–>C
Subtracts the value of trace B from trace A and places the results in trace C. This function is very useful for observing the changes in values of live trace A compared to a trace stored in trace B. Display scaling can be set to a value that makes the differences easy to see.

B – A–>C
Subtracts the value of trace A from trace B and places the results in trace C. This function is very useful for observing the changes in values of live trace A compared to a trace stored in trace B. Display scaling can be set to a value that makes the differences easy to see.

Full Screen
Increases size of the X-Y display by hiding the data labels on the left side of the display.

Back
Returns to the previous menu.

Chapter 4
Cable & Antenna Analyzer

Introduction

The BTS Master offers a wide range of display options for 1-port and 1-path 2-port vector corrected measurements.

Cable and antenna analyzer measurements include Return Loss, VSWR, Cable Loss, Distance-To-Fault RL, Distance-To-Fault VSWR,1-Port Phase, Smith Chart, 2-Port Gain, and 2-Port Phase.

This chapter describes the MT8222A BTS Master keys in Cable & Antenna Analyzer mode. The major sections are arranged in alphabetical order with soft key menus listed in the order they appear from top to bottom.

Getting Started

Cable & Antenna Analyzer Mode

To prepare for cable and antenna analyzer measurements, the MT8222A must be configured for Spectrum Analyzer Mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Cable & Antenna Analyzer and press the **Enter** key to select.

For additional information about the Mode menu, refer to *Mode Selector Menu* on page 2-16.

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* on page 2-5.

Set the Frequency Range

Regardless off what measurement is being made, the frequency range for the desired measurement must be set before calibrating the BTS Master. Changing the frequency after calibration is performed will invalidate the calibration. Press the **Freq/Dist** function hard key below the display to bring up the Freq menu.

Setting the Start and Stop Frequencies

Set the Start Frequency by pressing Start Freq soft key and entering the desired frequency in Hz, kHz, MHz, or GHz using the keypad, the arrow keys, or the rotary knob.

Set the Stop Frequency by pressing the Stop Freq soft key and entering the desired frequency in Hz, kHz, MHz, or GHz using the keypad, the arrow keys, or the rotary knob.

NOTE: The Start Frequency MUST be lower than the Stop Frequency.

The frequency range can also be set using the Center Freq and Span soft keys. For example, to set a frequency range of 1850 MHz to 1990 MHz, set the Center Frequency to 1920 MHz and the frequency Span to 140 MHz.

Setting the Signal Standard

The Signal Standard list contains common frequency standards and displays the standard name, frequency of operation, and channel number. Pressing the Signal Standard soft key will display the list. Use the rotary knob or **Up/Down** arrow keys to highlight the desired signal standard. Once highlighted, press **Enter** to select the highlighted standard.

The Center Frequency and Span will automatically tune to the first channel of the selected standard. Press Channel to enter the Channel number for the selected Frequency Standard. Appendix A contains a table of the signal standards that are available in the instrument firmware. The Signal Standard table can be edited and custom signal standards can be defined using Master Software Tools.

Calibration

For accurate results, the BTS Master must be calibrated at the ambient temperature after allowing for warm up time and before making any measurements. The BTS Master must be re-calibrated whenever the setup frequency changes or when a test port extension cable is added, removed or replaced.

The 1-port calibration is an OSL-calibration removing source match, directivity, and frequency response errors.

The 2-port calibration is a 1-path 2-port calibration and removes transmission response errors and transmission source match errors in addition to reflection error terms.

> NOTE: If a Test Port Extension Cable is to be used, the BTS Master must be calibrated with the Test Port Extension Cable in place. The Test Port Extension Cable is a phase stable cable and is used as an extension cable on the test port to ensure accurate and repeatable measurements. This phase stable cable can be moved and bent while making a measurement without causing errors in the measurement.

1-Port Calibration Procedure (OSL)

1. If a test port extension cable is to be used, connect the cable to the RF Out connector on the BTS Master. The calibration components will be connected at the end of the cable.
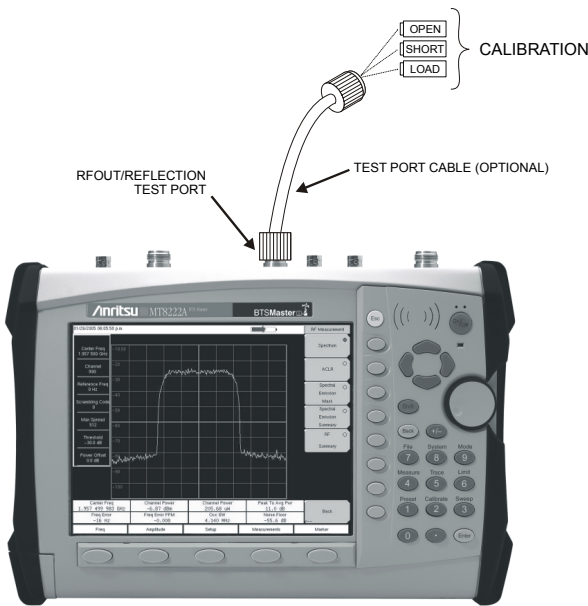

Figure 4-1. 1-Port Calibration

2. Set the frequency range as described in the earlier section.
3. Press the **Shift** key and then the **Calibrate** (2) key.
4. Verify that the Device Under Test (DUT) connector, as shown on the DUT Connector soft key, is appropriate for the test setup. To choose a different connector, press the DUT Connector soft key and use the rotary knob or **Up/Down** arrow keys to highlight the appropriate connector and press the rotary knob or **Enter** to select.

NOTE: If the none of the connectors shown in the DUT Connector Selector list are suitable for the application, there are two selections, User 1 and User 2, that can be custom defined. To edit the characteristics, select User 1 or User 2 and press **Enter**. Press the Configure DUT User 1 or Configure DUT User 2 soft key. The menu allows editing of the offset lengths for the Open and Short, and the capacitance values for the Open. To change a value, press the appropriate soft key, enter the proper value using the numeric keypad, and press **Enter** to accept. When all values are correct, press the Back soft key to return to the Calibration menu.

5. Press the Start Cal soft key.
6. Connect the Open to the RF Out port (or to the end of the test port extension cable) and press the **Enter** key.
7. When prompted, connect the short to the RF Out port (or to the end of the test port extension cable) and press the **Enter** key.
8. When prompted, connect the Load to the RF Out port (or to the end of the test port extension cable) and press the **Enter** key.
9. Verify that calibration has been performed properly by checking that the Cal Status On message is now displayed at the top of the status window.

2-Port Calibration Procedure (OSLIT)

1. If a test port extension cable is to be used, connect the cable to the RF Out and/or RF In connector on the BTS Master. The calibration components will be connected at the end of the cable.
2. Set the frequency range as described in the earlier section.
3. Press the **Shift** key and then the **Calibrate** (2) key.
4. Verify that the Device Under Test connector, as shown on the DUT Connector soft key, is appropriate for the test setup. To choose a different connector, press the DUT Connector soft key and use the rotary knob or **Up/Down** arrow keys to highlight the appropriate connector and press the rotary knob or **Enter** to select.

NOTE: If the none of the connectors shown in the DUT Connector Selector list are suitable for the application, there are two selections, User 1 and User 2, that can be custom defined. To edit the characteristics, select User 1 or User 2 and press **Enter**. Press the Configure DUT User 1 or Configure DUT User 2 soft key. The menu allows editing of the offset lengths for the Open and Short, and the capacitance values for the Open. To change a value, press the appropriate soft key, enter the proper value using the numeric keypad, and press **Enter** to accept. When all values are correct, press the Back soft key to return to the Calibration menu.

5. Press the Cal Power soft key to set the power level to Low (-35 dBm) or High (0 dBm).
6. Press the Start Cal soft key.
7. Connect the Open to the RF Out port (or to the end of the test port extension cable) and press the **Enter** key.
8. When prompted, connect the short to the RF Out port (or to the end of the test port extension cable) and press the **Enter** key.
9. When prompted, connect the Loads to the RF Out port (or to the end of the test port extension cable) and to the RF In port (or to the end of the test port extension cable) and press the **Enter** key.
10. Connect the RF Out port to the RF In port, including any test port extension cables used in the prior steps, and press the **Enter** key.

11. Verify that calibration has been performed properly by checking that the Cal Status On message is now displayed at the top of the status window.
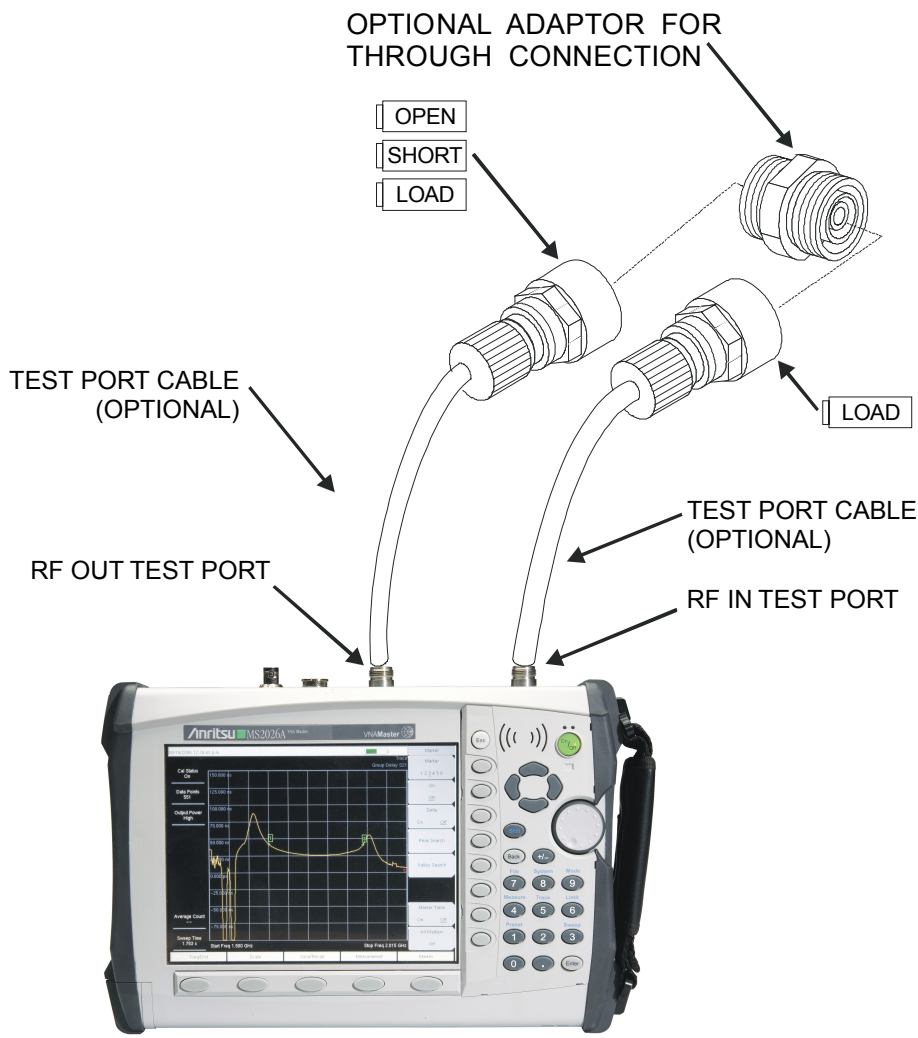
OPTIONAL ADAPTOR FOR
THROUGH CONNECTION

OPEN

SHORT

LOAD

LOAD

TEST PORT CABLE
(OPTIONAL)

TEST PORT CABLE
(OPTIONAL)

RF OUT TEST PORT

RF IN TEST PORT

Figure 4-2. 2-Port Calibration

Using the Markers

Pressing the **Marker** function hard key below the display will bring up the Marker menu.

Press the Marker 1 2 3 4 5 6 soft key to select a marker. The underlined number indicates the active marker.

The On/Off soft key turns the selected marker On or Off. Use the arrow keys, the keypad or the rotary knob to move the marker. The current value for the selected marker is shown above the upper left corner of the graph.

The Delta soft key is available for each marker giving a total of 6 Delta markers.

The Marker Table soft key displays a table of up to six Markers and 6 Delta Markers simultaneously, showing frequency and amplitude respectively.

The Peak Search soft key moves the currently selected marker to the peak of the trace.

The Valley Search soft key moves the currently selected marker to the valley of the trace.

> NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.
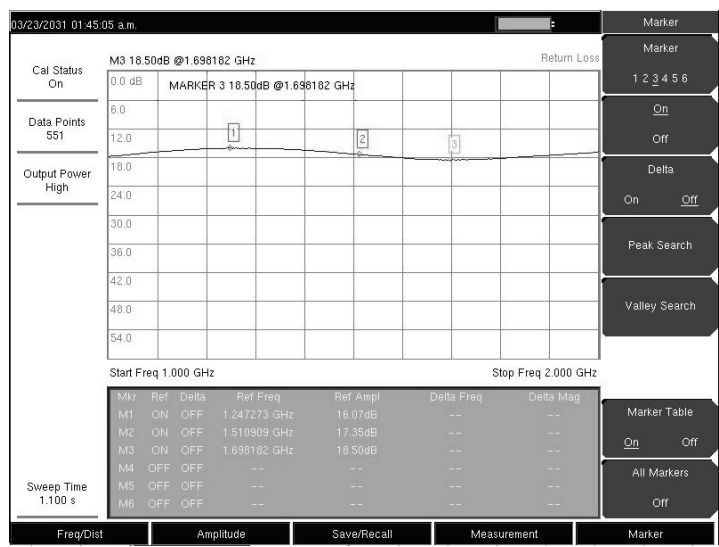

Figure 4-3. The Marker Table

Using Limit Lines

To access the functions under the Limit menu, press the **Shift** key, then the **Limit** (6) key.

Two types of limit lines can be specified, lower limit lines and upper limit lines. Limit lines can be used for visual reference only, or for pass/fail criteria using the limit alarm. Limit alarm failures are reported whenever a signal is above the upper limit line or below the lower limit line.

Each limit line can consist of a single segment, or as many as 40 segments across the entire frequency span of the instrument. These limit segments are retained regardless of the current frequency span of the instrument, allowing the configuring of specific limit envelopes at various frequencies of interest without having to re-configure them each time the frequency is changed. To clear the current limit setup configuration and return to a single limit segment starting at the current start frequency and ending at the current stop frequency, press the Clear Limit soft key.

The Limit Upper/Lower soft key selects which limit line will be active for editing. The limit line that is currently selected for editing is underlined.

The On/Off soft key turns the currently selected limit line (upper or lower) on or off.

The Limit Edit soft key displays a submenu that allows the creation or editing of single or multi-segment limit lines. The currently active limit point is marked by a red circle on the display.

The Limit Alarm soft key selects, for the currently active limit line, if an alarm beep will occur when a data point exceeds the limit.

The Clear Limit soft key deletes all limit points for the currently active limit line and defaults to a single limit whose amplitude value will be selected to make it visible on the screen. The other limit line is not altered.

Setting up Non-segmented Limit Lines

1. Press the **Shift** key, then the **Limit** (6) key.
2. Press the On/Off soft key to turn on the upper or lower limit line.
3. Press the Limit Edit soft key.
4. Press the Move Limit soft key and use the number keys to enter the new limit value and press the **Enter** key. The Move Limit soft key will move the entire limit line so that the active limit point will move to the new limit value. The Limit value can also be adjusted using the up and down arrow keys or the rotary knob.
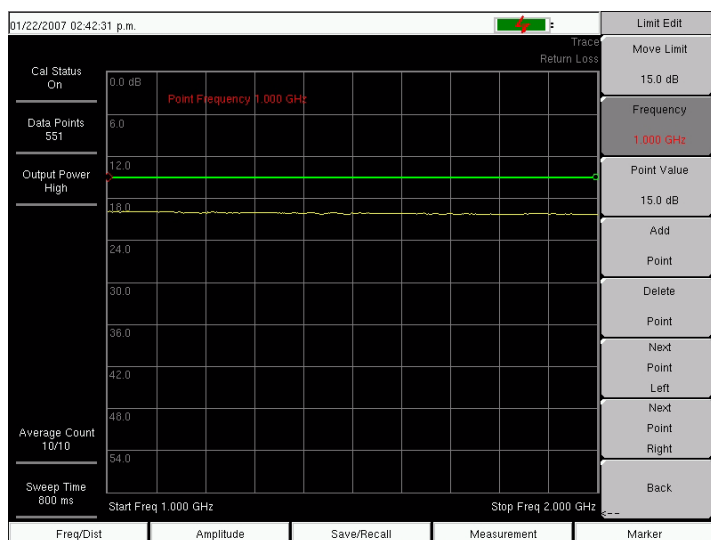
Figure 4-4. Non-segmented Limit Lines

Setting up Segmented Limit Lines

Segmented Limit Lines can be useful if there are different specifications for different frequency ranges. The following procedure creates segmented Limit Lines for a Return Loss Measurement. Limits are set to 12 dB between 1000 MHz and 1400 MHz and 15 dB between 1600 MHz and 2000 MHz.

1. Press the **Shift** key, then the **Limit** (6) key.
2. Press the On/Off soft key to turn on the upper or lower limit line.
3. Press the Limit Edit soft key.
4. Press the Move Limit soft key and use the number keys to enter a limit value of 12 dB. The limit value can also be moved using the arrow keys or the rotary knob.
5. Press the Add Point soft key.
6. Press the Frequency soft key and use the number keys to enter 1400 MHz.
7. Press the Add Point soft key.
8. Press the Frequency soft key and use the number keys to enter 1600 MHz.
9. Press the Point Value soft key and use the number keys to enter 15 dB.
10. Press the Add Point soft key.
11. Press the Frequency soft key and use the number keys to enter 2000 MHz.
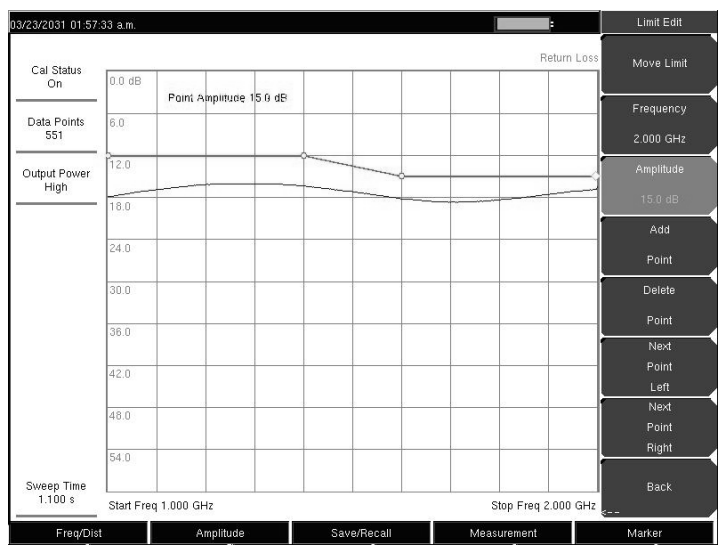12. Press the Value soft key and use the number keys to enter 15 dB.

Figure 4-5. Segmented Limit Lines

Using Trace Math

Trace Math menu is an excellent tool for comparing two traces. It is possible to upload traces using Master Software Tools, store those traces in memory, and compare the stored trace with a more recent trace. It is also possible to use the trace math features to normalize the trace and obtain a reference for S21 measurements where a full 2-port calibration is not needed. The trace math menu can be used to add or subtract logarithmic data (multiply and divide linear data).

The Trace Math menu is accessed by pressing the **Shift** key and the **Trace** (5) key.

Example 1

Comparing the Return Loss data for two five meter cables, Cable A and Cable B.

1. Press the **Measurement** function hard key and press the Return Loss soft key.
2. Connect Cable B to the BTS Master RF Out port.
3. Press the **Shift** key and the **Trace** (5) key.
4. Press the Copy Trace To Display Memory soft key.
5. Connect Cable A to the BTS Master RF Out port and perform the same Return Loss measurement over the same frequency range.
6. Press the Recall Trace soft key to view the Return Loss measurement of Trace A.
7. Press the Show Memory soft key to view the Return Loss measurement of Trace B.
8. Press the Trace Plus Memory soft key to view the Return Loss measurement of Trace A and Trace B at the same time.
9. Press the Trace Minus Memory soft key to look at the difference in Return Loss between the two cables.
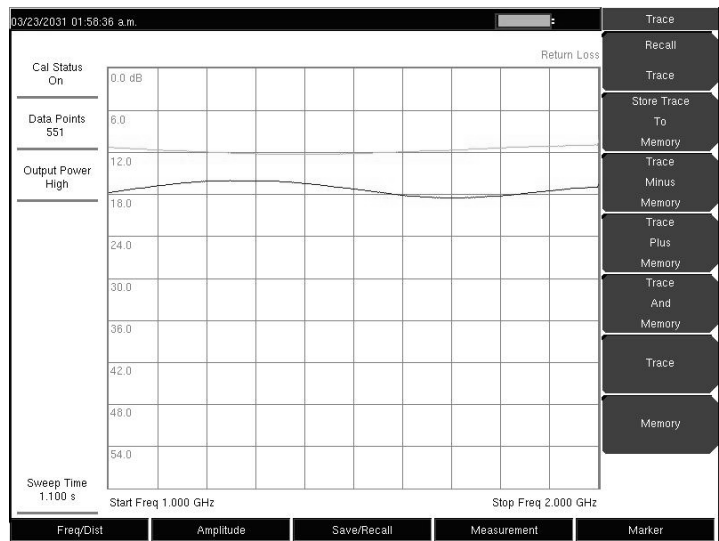

Figure 4-6. Trace Menu Showing Trace and Memory

Example 2

Using the Trace Menu to normalize a trace for Transmission measurement. Please note that normalizing the trace will not give the same accuracy as a calibrated 2-port measurement.

> NOTE: The BTS Master should be calibrated to ensure accurate measurements. The instrument incorporates internal gain stages that can negatively affect measurement accuracy if used uncalibrated. This effect can be exaggerated when using trace math to compare measurements with different gains.

1. Press the **Measurement** function hard key and press the 2-Port Gain soft key.
2. Press the **Freq/Dist** function hard key and enter the Start and Stop frequencies.
3. Press the **Shift** key and the **Trace** (5) key.
4. Press the Copy Trace To Display Memory soft key.
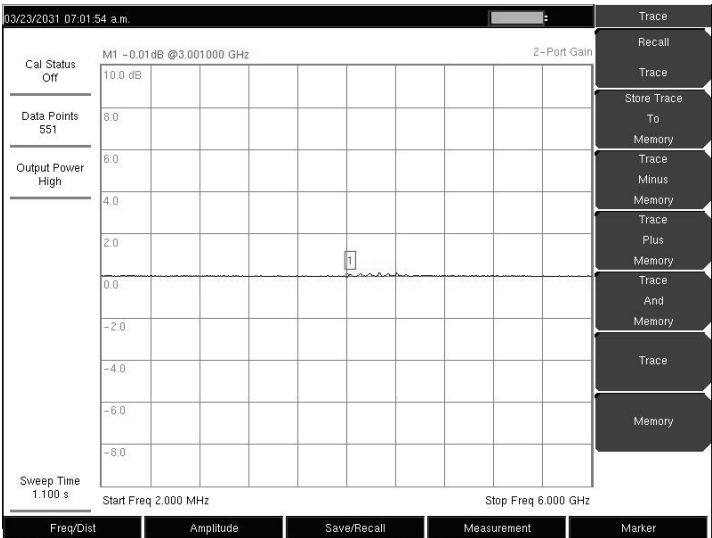5. Press the Trace Minus Memory soft key to see the trace normalized around 0 dB.

Figure 4-7. Normalizing Trace Using Trace Math

Return Loss/VSWR

Return Loss is used to characterize RF components and systems. The Return Loss indicates how well the system is matched by taking the ratio of the reflected signal to the incident signal, measuring the reflected power in dB. The 1-port Measurement data can also be displayed linearly as VSWR, or by using Master Software Tools to display the reflection coefficient.

Procedure

1.   If a test port extension cable is to be used, connect it to the RF Out connector.
2.   Press the **Measurement** function hard key and press Return Loss.
3.   Press the **Freq/Dist** function hard key and set the Start Frequency and Stop Frequency.
4.   Press the **Shift** key, then the **Calibrate** (2) key.
5.   Press the Cal Type soft key to set the calibration to 1-Port.
6.   Press the Start Cal soft key and perform a 1-port OSL calibration at the connector or at end of the extension cable. When the Calibration is finished, Cal Status On should be displayed in the upper left part of the display and the trace should be centered around 0 dB when the short or open is connected.
7.   Connect the test port extension cable to the Device Under Test (DUT).
8.   Press the **Save/Recall** function hard key and save the measurement.
9.   Press the **Measurement** function hard key and press the VSWR soft key to view the match in VSWR.
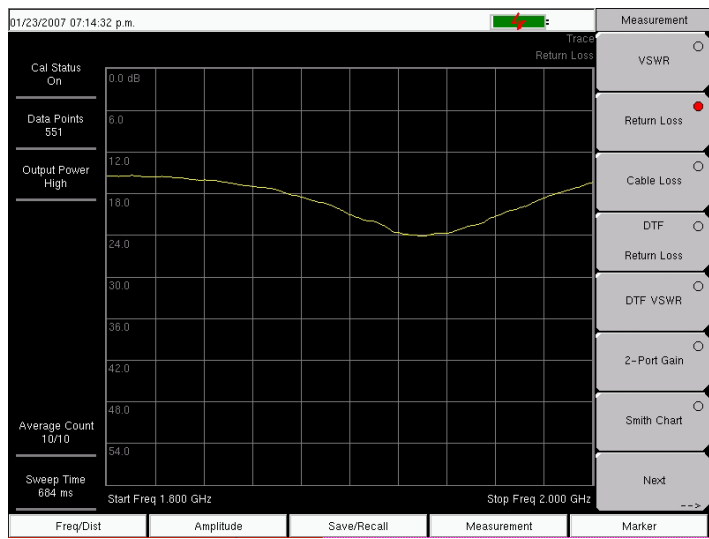

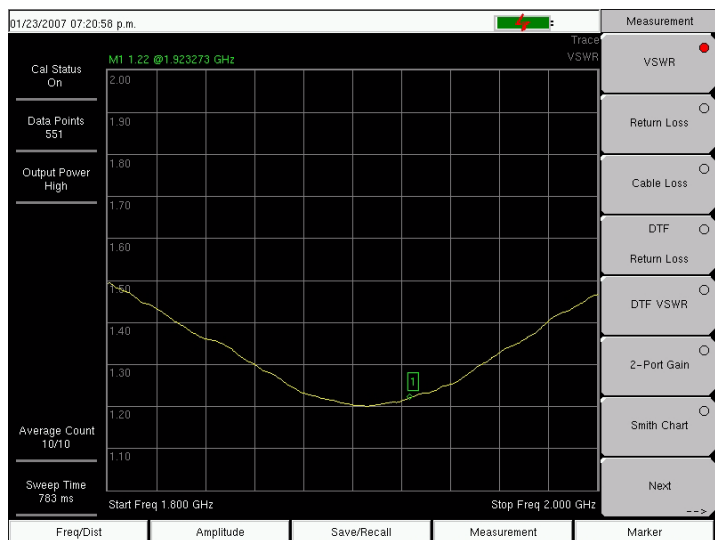**Figure 4-8. Return Loss Measurement of an Antenna System**

Figure 4-9. VSWR Measurement of an Antenna System

Cable Loss

The cable test verifies the signal attenuation level of the cable. This test can be done using the Cable Loss or Return Loss Measurement with a short or an open connected at the end of the system. The advantage of using the Cable Loss measurement is that the BTS Master takes care of the math and there is no need to compute anything. Cable Loss is a Return Loss measurement, but it also takes into consideration that the signal travels in both directions.

Procedure

1. If a test port extension cable is to be used, connect it to the RF Out connector on the BTS Master.
2. Press the **Measurement** function hard key and press Cable Loss.
3. Press the **Freq/Dist** function hard key and set the Start Frequency and Stop Frequency.
4. Press the **Shift** key, then the **Calibrate** (2) key.
5. Press the Cal Type soft key to set the calibration to 1-Port.
6. Press the Start Cal soft key and perform a 1-port OSL calibration at the connector or at end of the extension cable.
   When the Calibration is finished, Cal Status On should be displayed in the upper left part of the display and the trace should be centered around 0 dB when the short or open is connected.
7. Connect the test port extension cable to the Feed Line.
8. Press the **Save/Recall** function hard key and save the measurement.
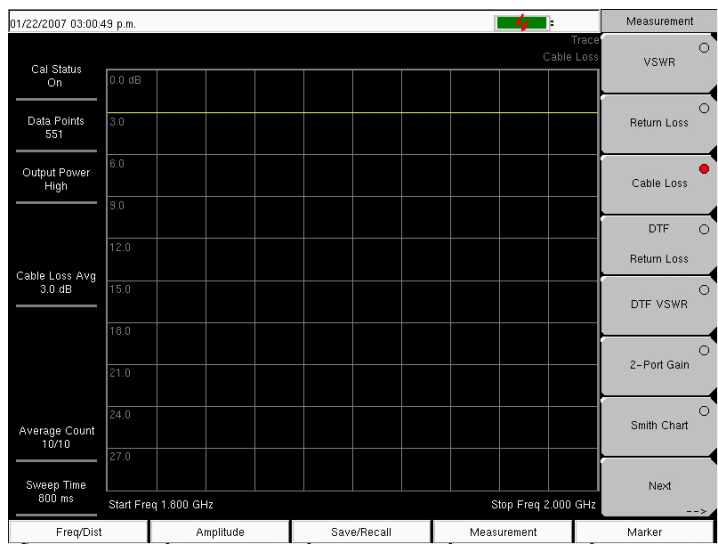   Note that average Cable Loss: (peak + valley)/2 is displayed in the status window

Figure 4-10. Cable Loss of Transmission Line

Distance-To-Fault (DTF)

The DTF measurement displays return loss (or VSWR) values versus distance. If the frequency measurements fail or indicate a problem in the system, then the DTF measurement can be used to identify and pinpoint the exact location of the problem. The DTF measurement shows the return loss value of all the individual components including connector pairs and cable components.

To measure the distance of a cable, DTF measurements can be made with an open or a short connected at the end of the cable. The peak indicating the end of the cable should be between 0 dB and 5 dB.

An open or short should not be used when DTF is used for troubleshooting because the open/short will reflect everything and the true value of a connector might be misinterpreted and a good connector could look like a failing connector.

A 50 ohm load is the best termination for troubleshooting DTF problems because it will be 50 ohm over the entire frequency range. The antenna can also be used as a terminating device but the impedance of the antenna will change over different frequencies because the antenna is only designed to have 15 dB or better return loss in the passband of the antenna.

DTF measurement is a frequency domain measurement and the data is transformed to the time domain using mathematics. The distance information is obtained by analyzing how much the phase is changing when the system is swept in the frequency domain.

Frequency selective devices such as TMAs (Tower Mounted Amplifiers), duplexers, filters, and quarter wave lightning arrestors change the phase information (distance information) if they are not swept over the correct frequencies. Care needs to be taken when setting up the frequency range whenever a TMA is present in the path. For more TMA details, see Appendix D.

Because of the nature of the measurement, maximum distance range and fault resolution is dependent on the frequency range and number of data points. The BTS Master will take care of all the math but it is important to know that if the cable is longer than DMax, the only way to be able to improve the horizontal range is to reduce the frequency span or to increase the number of data points. Similarly, the fault resolution is inversely proportional to the frequency range and the only way to improve the fault resolution is to widen the frequency span.

The BTS Master is equipped with a cable list including most of the common cables used today. Once the correct cable has been selected, the BTS Master will update the propagation velocity and the cable attenuation values to correspond with the cable. These values can also be entered manually and can be uploaded via Master Software Tools. Incorrect propagation velocity values will affect the distance accuracy and inaccurate cable attenuation values will affect the accuracy of the magnitude value.
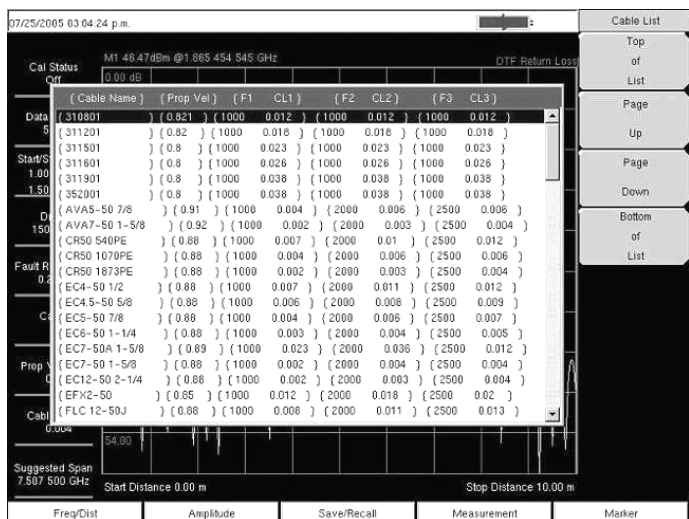
Figure 4-11. Cable List Example

Example 1

Figure 4-12 shows a DTF measurement of a cable with a short at the end of the cable.
Figure 4-13 shows a DTF measurement of a good cable with a load. Figure 4-14 shows a
DTF measurement of a cable with a fault. This measurement is done to determine the length
of the cable. The return loss value marking the end of the cable will be between 0 dB and
5 dB.

Procedure

1.   Press the **Measurement** function hard key and press DTF Return Loss.
2.   Press the **Freq/Dist** function hard key and set the Start Frequency and Stop Frequency.
3.   Press the Next soft key and use the Units soft key to select meters or feet.
4.   Use the Data Points soft key to select the number of Data Points.
5.   Press the Back soft key and use the Stop Dist soft key to enter the Stop Distance. Make
      sure that Stop Distance is smaller than Dmax.
6.   Press the **Shift** key, then the **Calibrate** (2) key.
7.   Press the Cal Type soft key to set the calibration to 1-Port.
8.   Press the Start Cal soft key and perform a 1-port OSL calibration at the connector or at
      end of the extension cable.
      When the Calibration is finished, Cal Status On should be displayed in the upper left
      part of the display, and the trace should be centered around 0 dB when the short or
      open is connected.
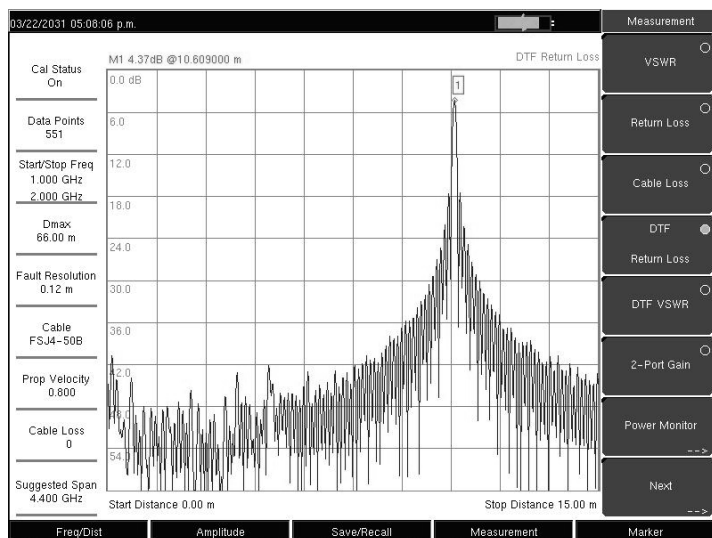9.   Press the **Marker** function hard key and press the Peak Search soft key.

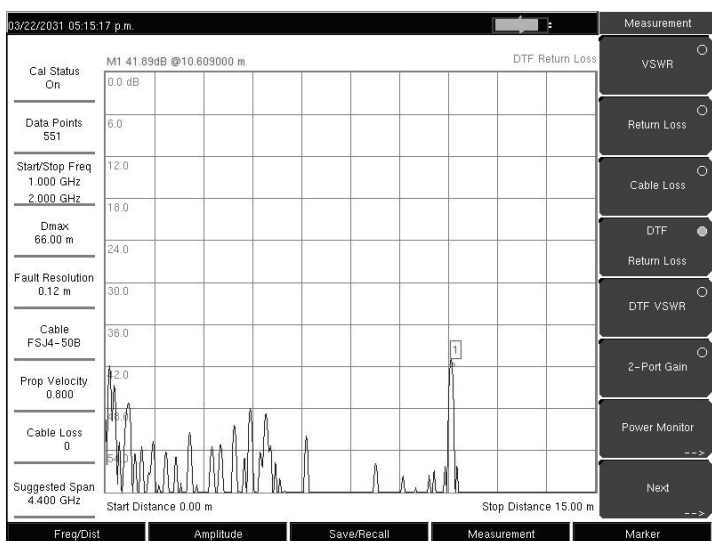**Figure 4-12. DTF Measurement With a Short at the End of Cable**

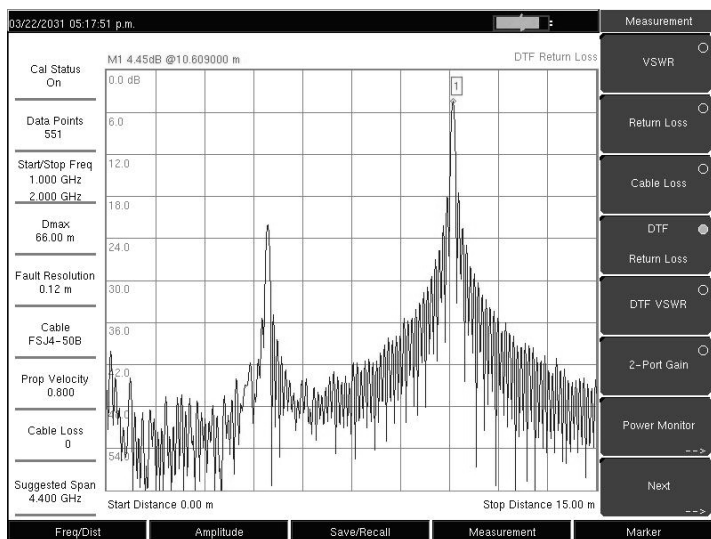**Figure 4-13. DTF Measurement of Good Cable With a Load**

Figure 4-14. DTF Measurement of Cable With a Fault

Example 2

Distance-To-Fault Transmission Line Test

The Distance-To-Fault transmission line test verifies the performance of the transmission line assembly (for example, RF feedline and jumper cables) and its components and identifies the fault locations in the transmission line system. This test determines the return loss value of each connector pair, cable component and cable to identify the problem location. This test can be performed in the DTF-Return Loss or DTF-VSWR mode. Typically, for field applications, the DTF-Return Loss mode is used. To perform this test, disconnect the antenna and connect the load at the end of the transmission line.

Procedure

1. Press the **Measurement** function hard key and press DTF Return Loss.
2. Press the **Freq/Dist** function hard key and set the Start Dist and Stop Dist.
3. Press the Next soft key and use the Units soft key to select meters or feet. The factory default is meters.
4. Use the Data Points soft key to select the number of Data Points. The default is 275.
5. Press the Start Freq and Stop Freq soft keys and enter the desired frequencies.
6. Press the Cable soft key and select the desired cable. The unit automatically sets the cable propagation velocity and cable loss.

> NOTE: If the desired cable is not on the list, use the Master Software Tools Cable Editor to add the new cable information and load the list into the unit.
> Selecting the right propagation velocity, attenuation factor and distance is very important for accurate measurements, otherwise the fault can not be accurately identified.

7. Press the **Shift** key, then the **Calibrate** (2) key.
8. Press the Cal Type soft key to set the calibration to 1-Port.

9.   Press the Start Cal soft key and perform a 1-port OSL calibration at the connector or at end of the extension cable. Follow the instructions on the display. When the Calibration is finished, Cal Status On should be displayed in the upper left part of the display.

Fault Resolution

Fault resolution is the system's ability to separate two closely spaced discontinuities. If the fault resolution is 10 feet and there are two faults 5 feet apart, the BTS Master will not be able to show both faults unless Fault Resolution is improved by widening the frequency span.

Fault Resolution (m) $= 1.5*10^8*\text{vp} /\Delta F$

DMax

DMax is the maximum horizontal distance that can be analyzed. The Stop Distance can not exceed Dmax. If the cable is longer than Dmax, Dmax needs to be improved by increasing the number of datapoints or lowering the frequency span (ΔF). Note that the datapoints can be set to 137, 275, or 551.

Dmax = (Datapoints-1)*Fault Resolution

Suggested Span

If the frequency span is set to the suggested span, the Stop Distance will equal Dmax giving the best fault resolution for the given conditions. With Stop Dist entered in meters, the following relationship can be obtained:

Suggested Span(Hz) = (Datapoints-1)$*1.5*10^8*$vp / Stop Dist

2-Port Gain Measurements

There are two power levels available with 2-port measurements: High (0 dBm) and Low (−35 dBm). The low power setting should be used when making direct gain measurements of amplifiers. This will ensure that the amplifier is operating in the linear region. The High power setting is ideal when characterizing passive devices but can also be used when making relative gain or antenna-to-antenna isolation measurements in the field.

The Variable Bias Tee Option (Option 10) can be used to place between +12 V and +24 V, in 3 V steps, on the center conductor of the RF In port. It is designed to deliver 500 mA at +12 V and 250 mA at +24 V.

Example 1

This example describes a Gain measurement of a TMA (Tower Mounted Amplifier) using the built-in bias tee (Option 10).

Procedure

1. Press the **Measurement** function hard key and press 2-port Gain.
2. Press the **Freq/Dist** function hard key and set the Start Frequency and Stop Frequency.
3. Connect test port extension cables to the RF Out port and the RF In port.
4. Press the **Shift** key, then the **Calibrate** (2) key.
5. Press the Cal Type soft key to set the calibration to 2-Port.
6. Press the Cal Power soft key and set power to Low.
7. Press the Start Cal soft key and perform a 2-port OSL calibration at the end of the extension cables. See *2-Port Calibration Procedure (OSLIT) on page 4-4*.
8. Connect the RF Out cable to the ANT port of the TMA.
9. Connect the RF In cable to RX port of the TMA.
10. Press the **Shift** key, then the **Sweep** (3) key.
11. Press the Bias Tee soft key and select the appropriate voltage for the amplifier. Note that the voltage will be applied to the center conductor of the RF In port.
12. Turn on the Bias Tee by pressing the Bias Tee On/Off soft key.
13. Press the **Marker** function hard key and turn on Marker 1 by pressing the Marker soft key to select the number 1 and pressing the On/Off soft key.
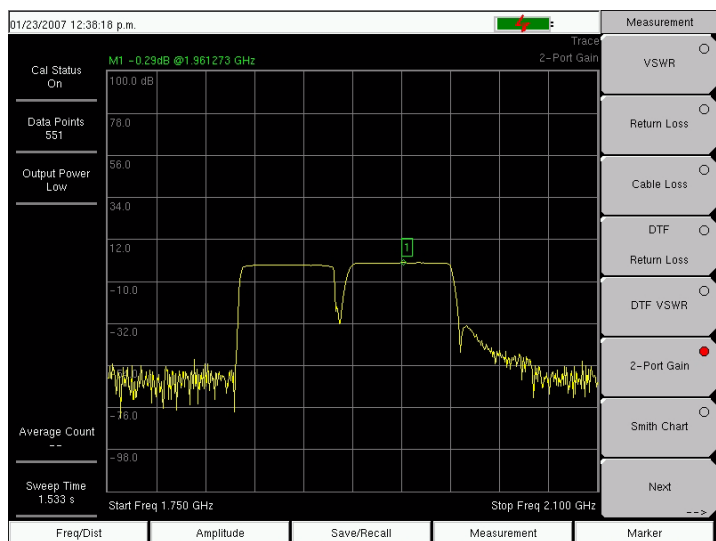
Figure 4-15. 2-Port Gain of a TMA

Phase Measurements

The BTS Master can display both S11 and S21 phase. 2-Port Phase measurements can use both High (0 dBm) and Low (−30 dBm) power settings.

1-Port Phase Measurement

The following example compares the phase of two cables using a 1-port phase measurement.

The dynamic range and phase uncertainty are better with 2-port phase measurements.

Procedure

1. Press the **Measurement** function hard key
2. Press the Next soft key.
3. Press the 1-port Phase soft key.
4. Press the **Freq/Dist** function hard key and set the Start Frequency and Stop Frequency.
5. Press the **Shift** key, then the **Calibrate** (2) key and perform a 1-port calibration at the desired reference plane. See *1-Port Calibration Procedure (OSL) on page 4-3*.
6. Connect Cable A to the RF Out reference plane.
7. Press the **Shift** key, then the **Trace** (5) key.
8. Press the Store Trace to Memory soft key.
9. Remove Cable A and connect Cable B to the RF Out reference plane.
10. Press the Trace Minus Memory soft key to view the difference in phase between the two cables.

2-Port Phase Measurement

The following example compares the phase of two cables using a 2-port phase measurement.

Figure 4-16 shows the difference in phase of cable A and cable B. The Trace Math menu is turned on and both Trace A and Trace A − Trace B are displayed.

Procedure

1. Press the **Measurement** function hard key
2. Press the Next soft key.
3. Press the 2-port Phase soft key.
4. Press the **Freq/Dist** function hard key and set the Start Frequency and Stop Frequency.
5. Press the **Shift** key, then the **Calibrate** (2) key and perform a 2-port calibration at the end of a phase stable cable. See *2-Port Calibration Procedure (OSLIT) on page 4-4*.
6. Connect Cable A (the reference cable) between the RF Out and RF In connectors.
7. Press the **Shift** key, then the **Trace** (5) key.
8. Press the Store Trace to Memory soft key.
9. Remove Cable A and connect Cable B (the cable under evaluation).
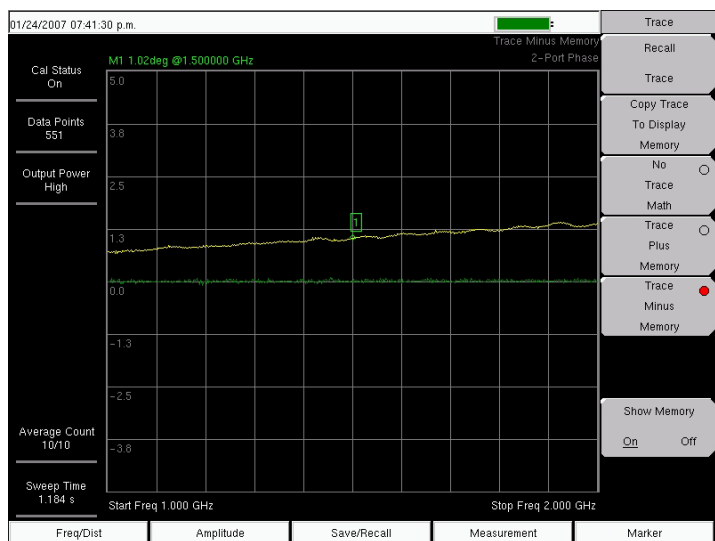10. Press the Trace Minus Memory soft key to view the difference in phase between the two cables.

Figure 4-16. 2-Port Phase Measurement

Smith Chart

The BTS Master can display 1-port measurements in a standard Normalized 50 ohm Smith Chart. When markers are used, the real and imaginary components of the Smith Chart value are displayed.

Anritsu Master Software Tools includes more options and a calculator that can easily show what the return loss, VSWR, or reflection coefficient values of a specific Smith Chart value are.

Limit Lines in a Smith Chart will appear as circles (constant reflection coefficient) and can be entered in VSWR units.

Smith Chart Measurement

The following example shows how a Smith Chart can be used to measure the match of an antenna.

Procedure

1. Press the **Measurement** function hard key.
2. Press the Smith Chart soft key.
3. Press the **Freq/Dist** function hard key and set the Start Frequency and Stop Frequency.
4. Press the Start Cal soft key and perform a 1-port calibration. See *1-Port Calibration Procedure (OSL)*
5. Connect the antenna to the RF Out connector on the BTS Master.
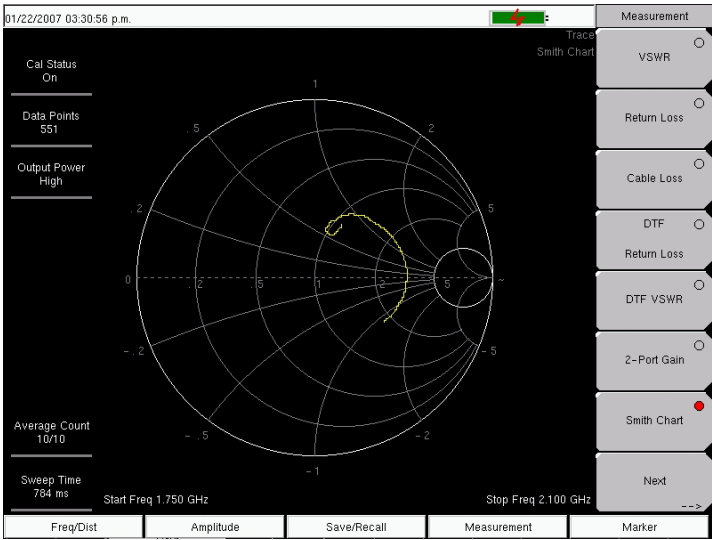
Figure 4-17. Smith Chart Measurement

Figure 4-17 represents a typical Smith Chart display. This is an example only. The measurement that is displayed on your instrument may be different.

Measurement Uncertainties

The uncertainty graphs provide measurement uncertainty at 23 °C after vector correction for the standard N connector type. Errors are worst-case contributions of residual directivity, source match, frequency response, network analyzer dynamic range, and connector repeatability. For the 1-path 2-port measurements, transmission tracking, crosstalk and physical load match termination was added. OSLN50-1 calibration components were used.
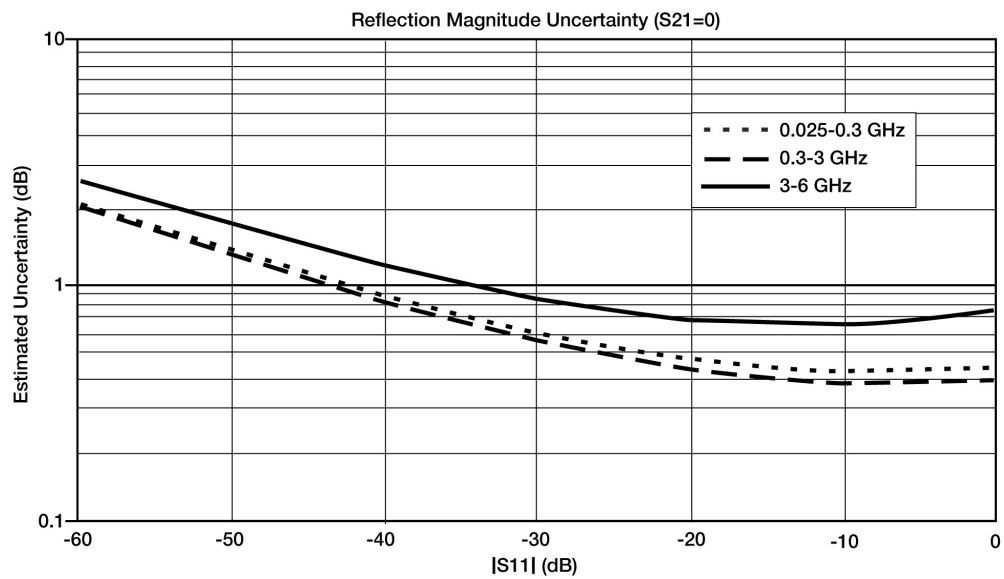
Figure 4-18. Measurement Uncertainty – S21 Magnitude
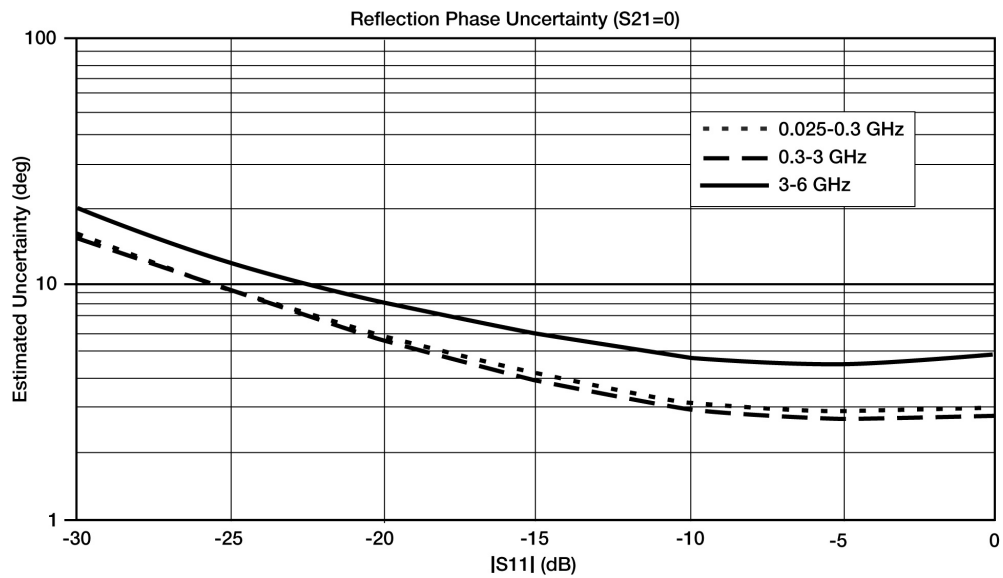
Figure 4-19. Measurement Uncertainty – S21 Phase
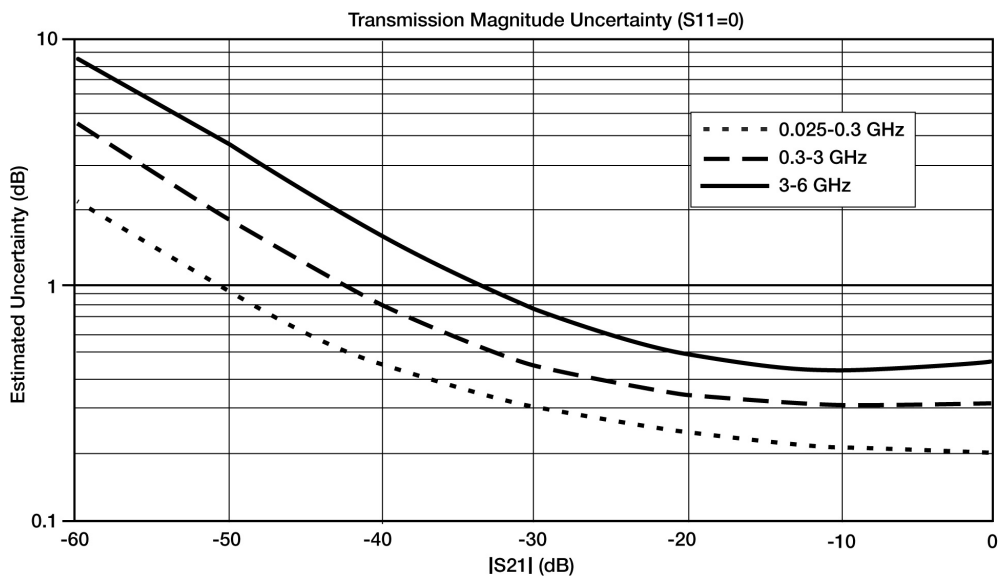
Figure 4-20. Measurement Uncertainty – S11 Magnitude
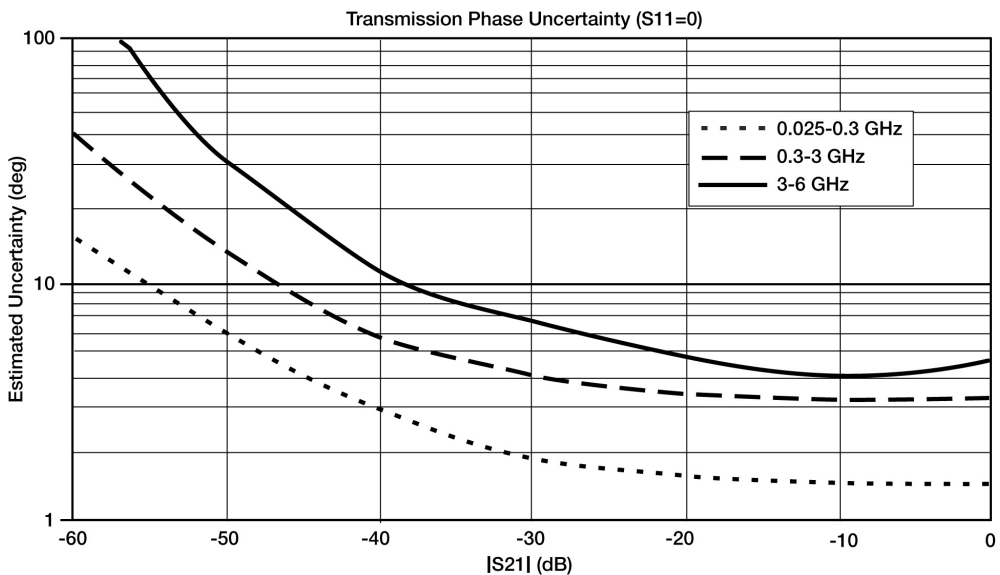
Figure 4-21. Measurement Uncertainty – S11 Phase

Amplitude
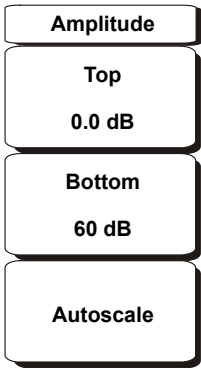
Figure 4-22. Cable & Antenna Analyzer Amplitude Menu

To access the functions under the Amplitude menu, press the **Amplitude** function hard key.

Top
Sets the top amplitude value.

Bottom
Sets the bottom amplitude value.

Autoscale
Adjusts the Top and Bottom values so that the trace will be shown in the middle of the display.
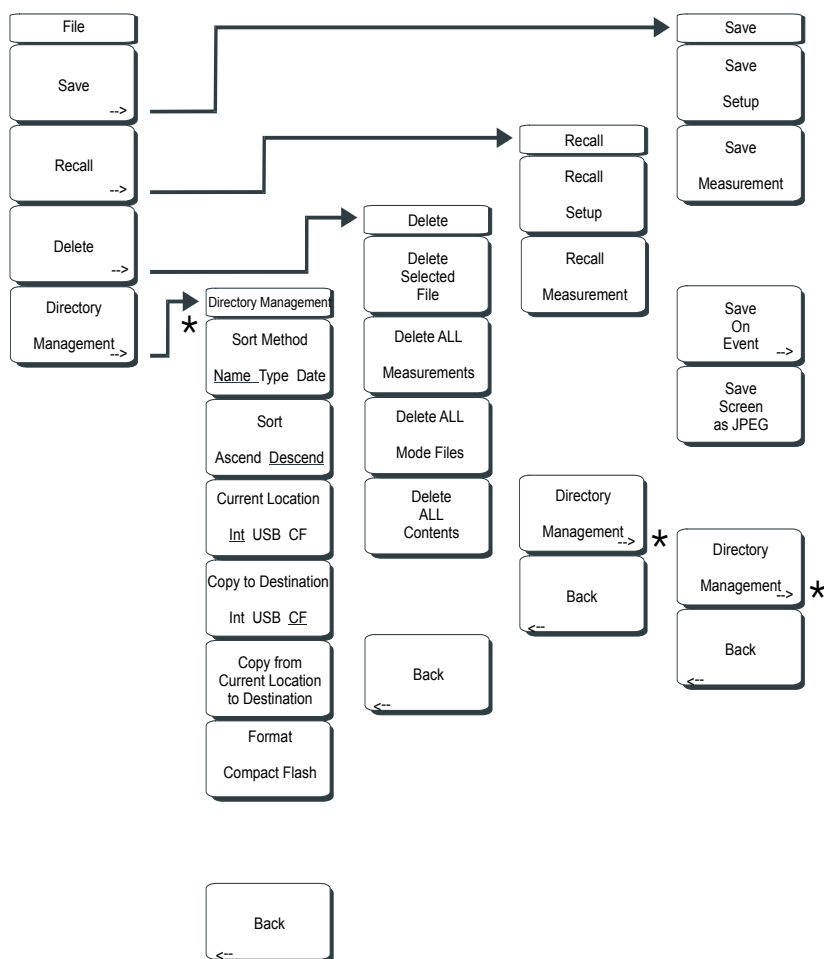
File

Figure 4-23. Cable & Antenna Analyzer File Menu

To access the functions under the File menu, press the **Shift** key, then the **File** (7) key.

Save
Measurements may be saved to the internal memory or to a Type-1 Compact Flash module. The BTS Master is shipped with a 256 MB Compact Flash Memory Module, Anritsu Part Number 3-2000-1500. The removable compact flash card can be up to 512 MB. Compact Flash modules with greater storage capacity may not function properly, and should be properly tested before relying on them. A USB Flash drive with at least 256 MB of storage may be used to store all measurements that may be stored internally.

Save Setup
Opens a dialog box to name and save the current operating settings, allowing them to be recalled later to return the instrument to the state it was in at the time the setup was saved. The saved setup can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the Left/Right directional arrows to move the cursor position. Press **Enter** to save the setup.

Save Measurement

Initiates a dialog box to name and save the current active trace A. The saved measurement trace can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the measurement trace. Measurements are saved in a directory called /usr on the Compact Flash memory module and the USB Flash Drive.

NOTE: If a measurement has been previously saved, the Save Measurement dialog box will open with the previously saved name displayed. To save the new measurement with a similar name (for example, Trace-1, Trace-2, and so forth) simply press the Right directional arrow and add the changes. To create a completely new name, use the keypad, the rotary knob or press the soft key for each letter.

Save On Event…

Not implemented in WiMAX mode.

Save Screen as JPEG

This function saves a measurement trace as a graphics file. The saved measurement can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the measurement after entering the file name. The file is saved in the internal memory with the specified name, with .jpg appended.

Directory Management
Sort Method
<u>Name</u>   Type   Date

File lists can be sorted by the name of the file, the type of file (SPA file, STP file, and so forth) or by the date that the file was saved.

Sort
Ascend   <u>Descend</u>

Selects whether the selected sort is sorted from lowest to highest (ascending) or highest to lowest (descending). When sorting by name, the sort will place file names that start with numbers before file names that start with letters (an ASCII sort).

Current Location
<u>Int</u>   USB   CF

This choice lets you select where measurements and setups will be saved. Pressing the soft key selects the storage location to be the internal memory, USB Flash drive, or Compact Flash memory module. The "current location" and the "copy to destination" will never be the same. Changing the current location to save files causes the "copy to destination" to be automatically changed if the selected storage location is the same as the selected current location.

Copy to Destination
Int   USB   <u>CF</u>

This choice lets you select where measurements and setups in the "current location" will be copied. The "current location" and the "copy to destination" may not be the same. If you change the destination to which the instrument will copy files, the current location is automatically changed if the current location is the same as the selected copy to destination.

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Copy From Current Location To Destination

Pressing this soft key causes all measurements, setups, and jpg files that are stored in the user-selected "current location" to be copied to the "copy to destination". If no storage module is installed in the instrument, then an error message is displayed.

Format Compact Flash

This selection erases all files on an installed Compact Flash module. A message is displayed warning that all files will be erased. Press Enter to confirm that you want to erase and Esc to quit without erasing. In addition to erasing all files stored on the Compact Flash, the /usr directory is created for storage of measurements, setups and jpg files.

Back

The Back key returns to the previous menu.

Recall
Recall Setup

This soft key brings up a selection box that allows selection and recall of a previously stored instrument setup in the current storage location. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved setup, and press **Enter**, the rotary knob, or the Recall soft key to select. All current instrument settings are replaced by the stored setup information. Press the **Esc** key to cancel the recall.

Recall Measurement

Brings up a selection box that allows recall of a previously stored measurement trace from the currently selected storage location. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved measurement trace, and press **Enter**, the rotary knob, or the Recall soft key to select. A recalled trace may be displayed as trace A, in place of the live trace, or as trace B or trace C along with the live trace. Use the rotary knob or the **Up/Down** arrow keys to highlight the recalled trace option, and press the **Enter** key to select. Press the **Esc** key to cancel the recall.

To remove a recalled measurement trace from the screen, press the **Shift** key and the **Trace** (5) key to open the Trace menu. Use the Trace soft key to select the trace to be removed from the screen and use the View/Blank soft key to view or blank the trace. Use the Trace key to select an active trace after blanking a recalled trace.

Directory Management

See *Directory Management *.

Back

Returns to the previous menu.

Delete

Brings up a selection box that shows all stored setups and traces in the currently selected location (See *Directory Management *.) The list shows the setup and measurement names, the type (stp for a saved setup, spa for a saved trace, jpg for a JPEG file) and the date and time the information was saved. Use the rotary knob or the **Up/Down** arrow keys to highlight the file to be deleted, and press **Enter**, or the Delete soft key to delete. Press the **Esc** key to cancel the operation. Note that there is no mechanism to retrieve deleted files.

Delete Selected File

Use the up and down arrow buttons or the rotary knob to select the file that is to be deleted. Press Enter to confirm that you want to delete the file or Esc to exit without deleting.

Delete ALL Measurements

Deletes all measurements of the current mode in the currently selected storage location. The memory from which measurements will be deleted is set in the Directory Management menu and is the Current Location.

Delete ALL Mode Files

Deletes all measurements of the type saved in the current operating mode of the instrument. In addition all jpg and setup files (regardless of the mode) are deleted.

Delete ALL Contents

Deletes all measurements, jpg files and setup files of ALL measurement types.

Back

The Back key returns to the previous menu.

Freq/Dist

The **Freq/Dist** function hard key opens the Freq menu, or the Freq/Dist menu, depending upon the type of measurement selected with the Measurement menu .

Pressing the **Freq/Dist** function hard key after selection of VSWR, Return Loss, or Cable Loss on the Measurement menu will open the Freq menu.

Figure 4-24. Cable & Antenna Analyzer Freq Menu

Start Frequency
Press the Start Freq soft key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If a start frequency higher than the current stop frequency is entered, the stop frequency will be changed to yield a 10 Hz span.

Stop Frequency
Press the Stop Freq soft key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If a stop frequency lower than the current start frequency is entered, the start frequency will be changed to yield a 10 Hz span.

Center Frequency
Press the Center Freq soft key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the **Enter** key has the same affect as the MHz soft key.

Span
Press the Span soft key and enter the desired span. The Span menu is used to set the frequency range over which the instrument will sweep. For the MT8222A, the span can be set from 10 Hz to 7.1 GHz. Span can also be set to zero span.

The soft key shows the current value for span in units of GHz, MHz, kHz, or Hz. When the Span button is pressed, span becomes the active parameter and may be changed. Use the keypad, the directional arrow keys or the rotary knob to increase or decrease the span frequency. If the span is changed using the **Up/Down** arrow keys, the span changes by the value of the Frequency Step for each key press.

Signal Standard
Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard and press **Enter** to select.

When a signal standard is selected, the center frequency and span for the first channel of the particular standard is automatically tuned. Other settings, such as channel spacing and integration bandwidth, are also automatically entered. Appendix A contains a table of the signal standards that are in the instrument firmware.

Channel
Use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the spectrum analyzer display.

Pressing the **Freq/Dist** function hard key after selection of DTF Return Loss, or DTF VSWR on the Measurement menu will open the Freq/Dist menu.
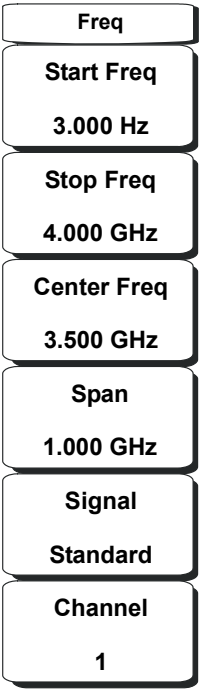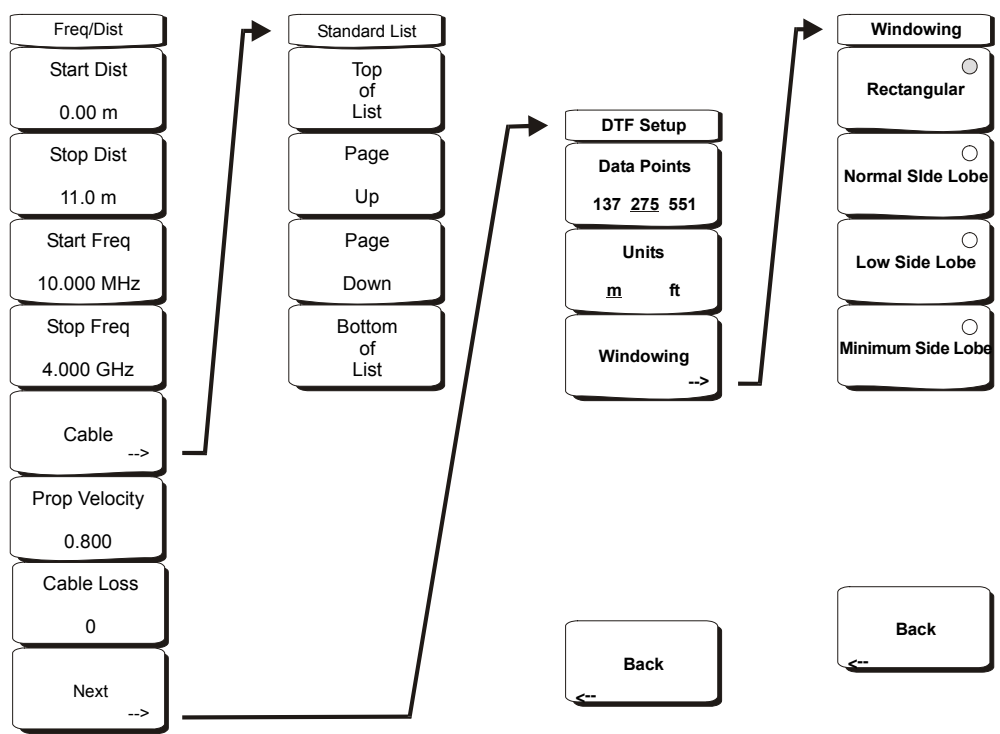

Figure 4-25. Cable & Antenna Analyzer Freq/Dist Menu

Start Dist
Press the Start Dist soft key and enter the desired start distance using the keypad, the arrow keys, or the rotary knob.

Stop Dist
Press the Stop Dist soft key and enter the desired stop distance using the keypad, the arrow keys, or the rotary knob.

Start Freq
Press the Start Freq soft key and enter the desired start frequency using the keypad, the arrow keys, or the rotary knob.

Stop Freq
Press the Stop Freq soft key and enter the desired stop frequency using the keypad, the arrow keys, or the rotary knob.

Cable
The Cable soft key opens a list of available cable specifications (see Appendix E). Using the keypad, the arrow keys, or the rotary knob, select the desired cable and press **Enter**.

Top of List
Moves the highlight to the top of the cable list.

Page Up
Moves the highlight up one page.

Page Down
Moves the highlight down one page.

Bottom of List
Moves the highlight to the bottom of the cable list.

Back
Returns to the previous menu.

NOTE: When a cable is selected from this list, propagation velocity and cable loss are automatically set by the unit.

Prop Velocity
Press the Prop Velocity soft key and enter the applicable propagation velocity for the selected cable using the keypad, the arrow keys, or the rotary knob and press **Enter**.

Cable Loss
Press the Cable Loss soft key and enter the loss for the selected cable using the keypad, the arrow keys, or the rotary knob and press **Enter**.

Next
Opens the DTF Setup menu.

Data Points
Select 137, 275, or 551 data points.

Units
Select meters or feet.

Windowing
Opens the Windowing menu. Refer to Appendix C for more information on windowing.

Back
Returns to the previous menu.

Limit

To access the functions under the Limit menu, press the **Shift** key, then the **Limit** (6) key. The Limit menu soft keys are shown in Figure 4-26.
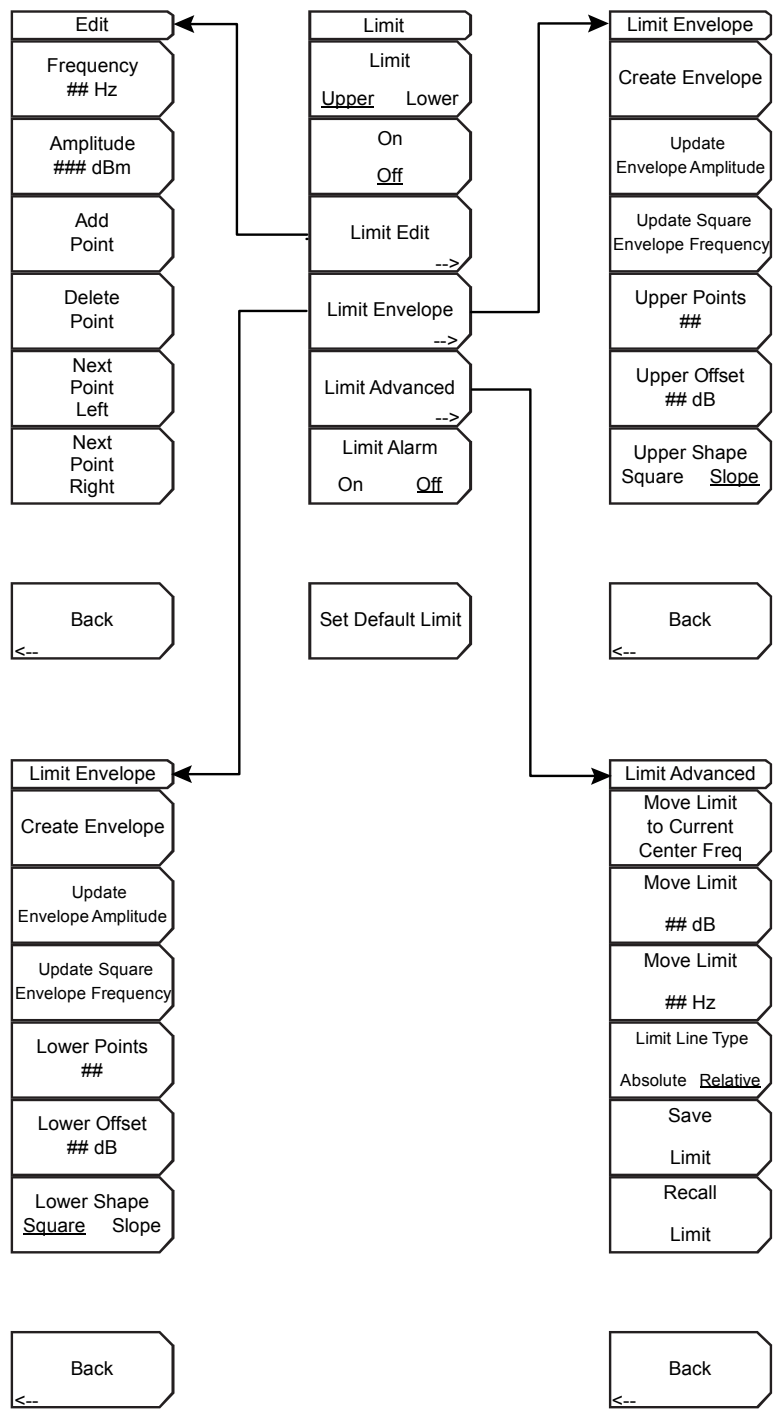

Figure 4-26. Limit Menu Soft Keys

Two types of limit lines can be specified, lower limit lines and upper limit lines. Limit lines can be used for visual reference only, or for pass/fail criteria using the limit alarm (refer to *Limit Alarm, On/Off*). Limit alarm failures are reported whenever a signal is above the upper limit line or below the lower limit line.

Each limit line can consist of a single segment, or as many as 40 segments across the entire frequency span of the instrument. These limit segments are retained regardless of the current frequency span of the instrument, which allows the configuring of specific limit envelopes at various frequencies of interest without having to re-configure them each time the frequency is changed.

Limit Upper/Lower
This soft key selects which limit line will be active for editing. The limit line that is currently selected for editing is <u>underlined</u>.

On/Off
This soft key turns the active limit line (upper or lower) on or off.

Limit Edit
This soft key displays a submenu that allows creating or editing of single or multi-segment limit lines. The currently active limit point is marked by a red circle on the display.

Frequency, ## Hz
The frequency of each inflection point in a limit line can be individually set. When a new point is added, it takes on a value halfway between two existing points, or it takes on the stop frequency of the current sweep if no point is higher in frequency than the one being added. See the Add Point soft key description for more details. Use the keypad, the **Left/Right** arrow keys, or the rotary knob to change the frequency of an inflection point.

Amplitude, ### dBm
The amplitude of each inflection point can also be individually set. By default, when a new point is added, it takes on the amplitude that is on the limit line at the frequency where the point was added. Use the keypad (using the ± key to set a negative value), the **Up/Down** arrow keys, or the rotary knob to move the point to the desired value. The unit of the amplitude limit is the same as the current vertical amplitude unit. See the Add Point soft key description for more details.

Add Point
The precise behavior of this soft key depends upon which inflection point is active at the time that the key is pressed. If the active limit point is somewhere in the middle of a multi-segment limit line, then a new limit point is added that is halfway between the currently active point and the point immediately to its right. The amplitude of the inflection point will be such that it falls on the limit line. For example, if a limit point exists at 2.0 GHz with an amplitude of −30 dBm, and if the next point is 3.0 GHz with an amplitude of −50 dBm, then the added point will be at 2.5 GHz with an amplitude of −40 dBm. The frequency and amplitude values of the new point can be adjusted as needed with the Frequency and Amplitude soft keys.

If the last limit point is active (assuming it is not at the right edge of the display), then the new limit point will be placed at the right edge of the display at the same amplitude as the point immediately to its left. Points may not be added beyond the current sweep limits of the instrument.

Delete Point
This soft key deletes the currently active point. The active point becomes the point that is immediately to the left of the point that was deleted.

Next Point Left

This soft key selects the inflection point that is immediately to the left of the active point, making this newly selected point active for editing or deletion. With each key press, the active point becomes that point to the left of the previously active point, until the newly selected active point becomes the leftmost point on the screen.

Next Point Right

This soft key selects the limit point immediately to the right of the active point, making this newly selected point active for editing or deletion. With each key press, the active point becomes that point to the right of the previously active point, until the newly selected active point becomes the rightmost point on the screen.

Back

Press this soft key to return to the Limit soft key menu.

Limit Envelope

A limit envelope is very useful when you want to easily detect new signals in the presence of other preexisting signals. Use the limit envelope function to automatically create upper or lower limit lines that are based upon the on-screen measured spectrum analysis values. Refer to Figure 4-27 for an example limit envelope.

Press this soft key to open the Limit Envelope soft key menu.

Create Envelope

Press this soft key to generate the envelope using the Limit Envelope characteristics. If the default results are not satisfactory, then you can make adjustments to the amplitude and frequency of each inflection point, and you can add or delete inflection points.

Update Envelope Amplitude

While working on your envelope (or if your signal amplitude changes), you may want to adjust the amplitude of the current limit without changing the frequencies of the inflection points. Pressing this soft key makes those amplitude adjustments without frequency adjustments.

Update Square Envelope Frequency

Press this soft key to adjust the envelope frequency. If the magnitudes of two adjacent limit inflection points are the same (a horizontal line), then the frequencies of the next two limit inflection points are tested.

If the magnitudes of two adjacent limit inflection points are further than two sweep points apart (a gradual slope indicating a narrower span), then the second inflection point is brought back closer to the first inflection point so that the slope increases to near vertical.

If the magnitudes of two adjacent limit inflection points are closer than two sweep points apart (so close that the second inflection point may not be able to be displayed), then the second inflection point is pushed further out from the first inflection point so that the slope becomes near vertical.

If the user has adjusted the magnitude of some limit inflection points so that the horizontal lines are no longer horizontal, then the algorithm will probably have difficulty with the update, and unintended results may occur.

Upper Points, ## (if Upper Limit is selected)
Lower Points, ## (if Lower Limit is selected)

Use this soft key to define how many inflection points you want for the selected upper or lower limit envelopes. The value can be between 2 and 41. Note that the upper and lower limit lines do not need to have the same number of points.

Upper Offset, ## dB (if Limit is toggled to Upper)
Lower Offset, ## dB (if Limit is toggled to Lower)

This soft key is used to define how far away from the measured signal the upper or lower envelope will be placed. The limits are ±100 dB. For an upper envelope, usually the value will be positive in order to place the envelope above the signal. for a lower envelope, the value will usually be negative in order to place the envelope below the signal.

Upper Shape, Square/Slope (if Limit is toggled to Upper)
Lower Shape, Square/Slope (if Limit is toggled to Lower)

With this soft key you can choose whether the default for the upper or lower envelope will be with flat tops and reasonably vertical lines to change level or whether the envelope will have sloped lines between adjacent inflection points. When the square envelope type is selected, two inflection points are used for each horizontal segment. You can toggle between a square envelope and a sloped envelope by pressing this soft key.

Back

Press this soft key to return to the Limit soft key menu
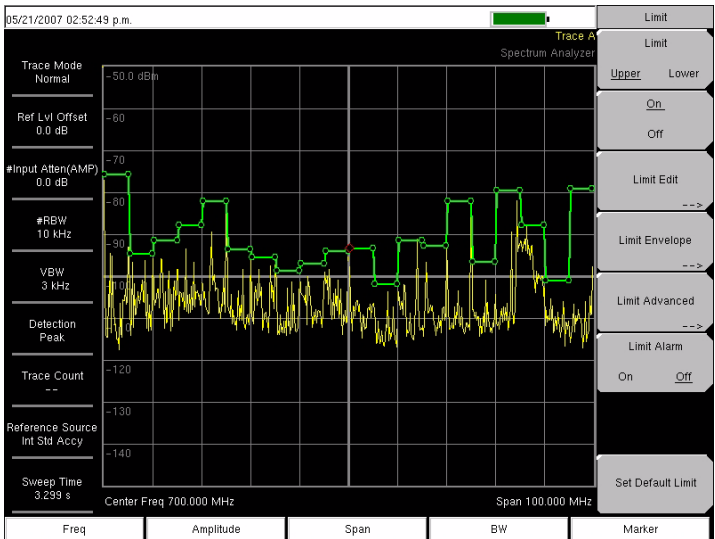
Figure 4-27. Example Limit Envelope, Square

Limit Advanced

The advanced limit line section offers several useful functions. In this section, you can create either an **absolute** limit line (which is one based upon the frequencies that are entered for each inflection point) or a **relative** limit line (which is based upon the delta frequencies between the center frequency and the inflection points). Both types of limit lines can be saved and recalled.

Press this soft key to open the Limit Advanced soft key menu.

Move Limit to Current Center Freq

Pressing this soft key moves the center of the existing limit line to the center frequency of the measurement. The span of the existing limit line is not changed by doing this. Use this soft key as an easy way to get an existing limit line on screen. If no limit line is turned on, a new, flat default limit line is turned on and is located 2.5 divisions (2.5 graticule lines) from the top of the screen for the upper limit line or 2.5 divisions from the bottom of the screen for the lower limit line.

Move Limit, ## dB or Move Limit, ## dBm

If the limit line is flat, then use this soft key to move the limit line to an absolute power point in dBm. If the limit line is not flat, then use this soft key to move the limit line up or down by the selected number of dB. Use the keyboard to enter the desired value. The entire line moves by the amount that is entered. The limit line can also be moved by using the rotary knob. Turn the rotary knob clockwise to move the line to higher power levels.

Move Limit, ## Hz

Pressing this soft key allows you to adjust the frequencies of the limit line. All inflection points are moved by the value entered. The rotary knob can also be used to make this adjustment. Turn the rotary knob clockwise to move the limit line to higher frequencies.

Limit Line Type, Absolute/Relative

You can choose to have either limit line be either absolute or relative. The upper and lower limit lines may be different. This soft key may be used at any time while working with limit lines.

Absolute limit lines set the limit inflection points based upon the entered frequencies for each point.

Relative limit lines set the limit inflection points relative to the current center frequency.

Regardless of how a limit line is set up, saved, or recalled, it can be changed between absolute and relative by toggling with this soft key.

Save Limit

Pressing this soft key opens a dialog to save the current upper and lower limit lines. You can name the saved limit line yourself or accept the name that is suggested by the instrument (which is based upon a previously saved name). If you did not intend to save the limit line, then press **Esc** to stop the dialog and avoid saving the limit line.

Recall Limit

Pressing this soft key opens a dialog box to recall a saved limit line. The dialog box presents a list of saved limit lines. Highlight the desired limit line and press **Enter**. If you decide not to recall a limit line, then press **Esc** to stop the dialog.

If the saved limit is a relative limit, then it is recalled centered about the current center frequency. If the saved limit is an absolute limit, then it is recalled to the frequency at which it was created.

If you recall an absolute limit, and if it is off screen, then you will see the left or right limit off-screen indicator on the edge of the screen.

Back

Press this soft key to return to the Limit soft key menu.

Limit Alarm, On/Off

Pressing this soft key toggles the alarm function ON and OFF for the currently active limit line. When ON, an alarm beep will occur when a data point exceeds the limit.

Set Default Limit

Pressing this soft key deletes all limit points for the currently active limit line and sets the default limit line value, which is a single limit whose position is 2.5 graticule lines from the top of the screen (for the upper limit line) or 2.5 graticule lines from the bottom of the screen (for the lower limit line), depending upon which limit is active. The inactive limit line is not altered.

Mode

To access the functions under the Mode menu, press the **Shift** key, then the **Mode** (9) key. Use the directional arrow keys or the rotary knob to highlight the selection and press the **Enter** key to select. The list of modes that appears in this menu will vary depending upon the options that are installed and activated in your instrument. Figure 4-28 is an example of the Mode menu. Your instrument may not show the same list.


```
MODE SELECTOR
Spectrum Analyzer                     ▲
Cable & Antenna Analyzer
T1 Analyzer
WCDMA/HSDPA Analyzer
Power Meter
GSM/GPRS/EDGE Signal Analyzer
Interference Analyzer
Channel Scanner


                                      ▼
```
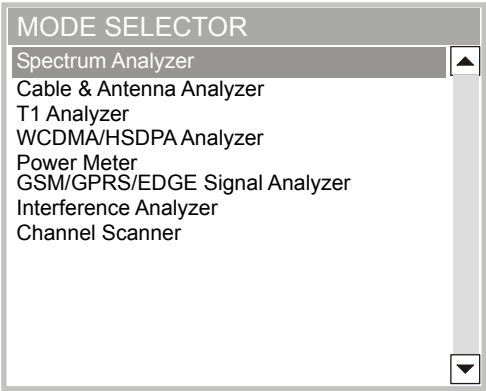
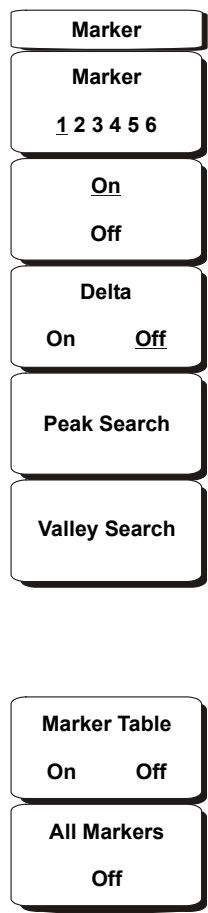**Figure 4-28. Cable & Antenna Analyzer Mode Menu**

Marker

Figure 4-29. Cable & Antenna Analyzer Marker Menu

To access the functions under the Marker menu, press the **Marker** function hard key.

Marker 1 2 3 4 5 6
Use this soft key to select the active marker. The underlined marker number is the active marker. Each press of the soft key moves the underline to the next marker number.

On/Off
This soft key make the active marker, selected by the Marker soft key above, active for editing. It does this without changing the value of the associated Delta marker. However, if the marker is currently active for editing, pressing the On/Off key causes the selected marker and the associated Delta marker to be turned off.

Delta On/Off
If the Delta marker is on, but not active for editing, pressing this soft key makes the Delta marker active for editing. If the marker is currently active for editing, pressing the On/Off key causes the delta marker to be turned off.

Peak Search
This soft key places the currently active marker on the highest signal amplitude currently displayed on screen.

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Valley Search
This soft key places the currently active marker on the lowest signal amplitude currently displayed on screen.

Marker Table
Pressing this soft key causes a table to be displayed below the sweep window. The table is automatically sized to display all markers that are turned on. In addition to the marker frequency and amplitude, the table also shows delta frequencies and amplitude deltas for all markers that have deltas entered for them.

All Markers Off
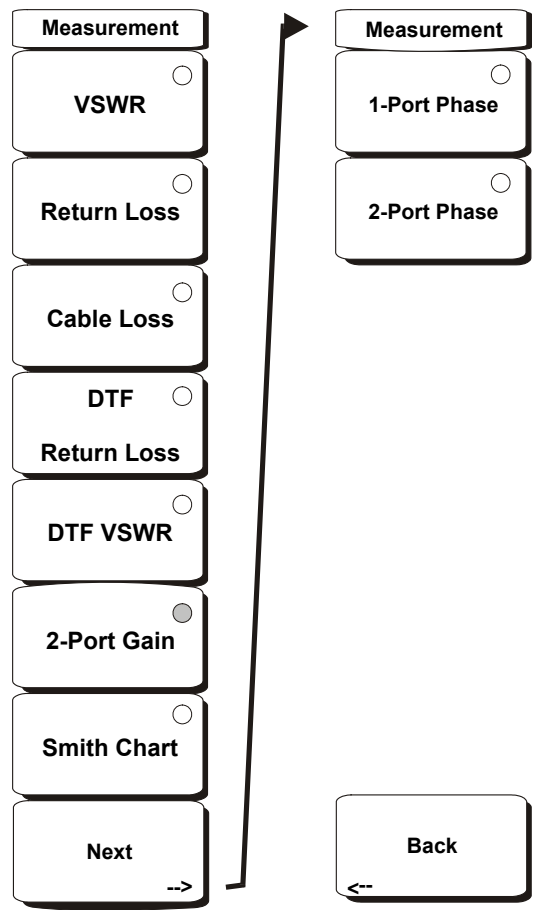This soft key turns off all markers and the marker table.

Measurement

Figure 4-30. Cable & Antenna Analyzer Measurement Menu

To access the functions under the Measurement menu, press the **Measurement** function hard key.

VSWR
Press the VSWR soft key to view the match in VSWR.

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Return Loss

Return Loss is used to characterize RF components and systems. The Return Loss indicates how well the system is matched by taking the ratio of the reflected signal to the incident signal, and measuring the reflected power in dB.

Cable Loss

The cable loss test verifies the signal attenuation level of the cable.

DTF Return Loss

The DTF measurement displays return loss (or VSWR) values versus distance. If the frequency measurements fail or indicate a problem in the system, then the DTF measurement can be used to identify and pinpoint the exact location of the problem. The DTF measurement shows the return loss value of all the individual components including connector pairs and cable components.

DTF VSWR

The DTF measurement displays return loss (or VSWR) values versus distance. If the frequency measurements fail or indicate a problem in the system, then the DTF measurement can be used to identify and pinpoint the exact location of the problem. The DTF measurement shows the return loss value of all the individual components including connector pairs and cable components.

2-Port Gain

Used to measure the gain of tower mounted amplifiers.

Smith Chart

Displays the measurement results as a Smith Chart.

Next

Opens an additional menu.

1-Port Phase

Used for phase matching of cables.

2-Port Phase

Used for phase matching of cables.

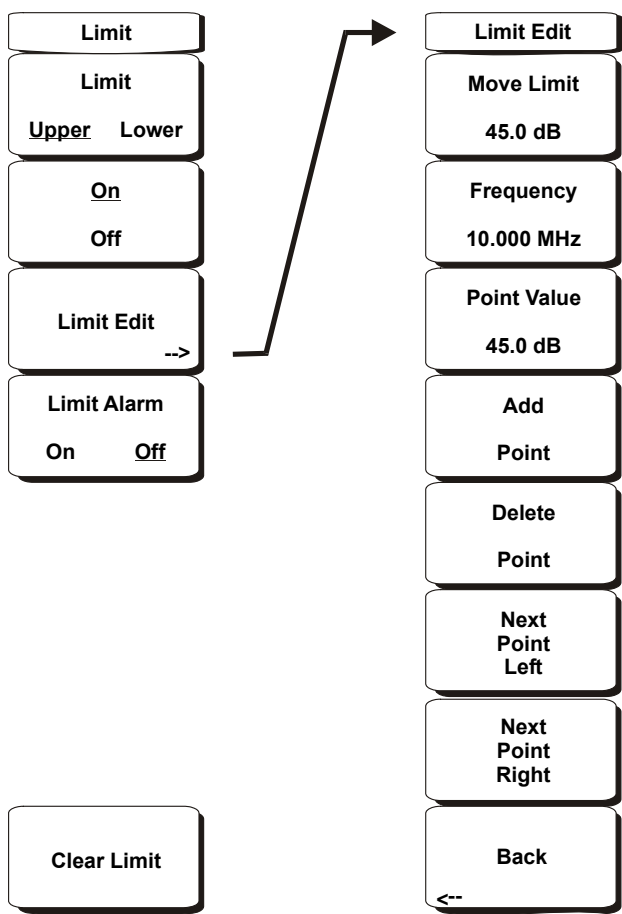#### Back

Returns to the previous menu.

Limit

Figure 4-31. Cable & Antenna Analyzer Limit Menu

To access the functions under the Limit menu, press the **Shift** key, then the **Limit** (6) key.

Two types of limit lines can be specified, lower limit lines and upper limit lines. Limit lines can be used for visual reference only, or for pass/fail criteria using the limit alarm. Limit alarm failures are reported whenever a signal is above the upper limit line or below the lower limit line.

Each limit line can consist of a single segment, or as many as 40 segments across the entire frequency span of the instrument. These limit segments are retained regardless of the current frequency span of the instrument, allowing the configuring of specific limit envelopes at various frequencies of interest without having to re-configure them each time the frequency is changed. To clear the current limit setup configuration and return to a single limit segment starting at the current start frequency and ending at the current stop frequency, press the Clear Limit soft key.

Limit Upper/Lower
This soft key selects which limit line will be active for editing. The limit line that is currently selected for editing is underlined.

On/Off
This soft key turns the active limit line (upper or lower) on or off.

Limit Edit

A submenu is displayed by this soft key that allows the creation or editing of single or multi-segment limit lines. The currently active limit point is marked by a red circle on the display.

Move Limit

This soft key allows an entire single or multi-segment limit line to be moved up or down by the number of dB entered using the keypad, the **Up/Down** arrow keys, or the rotary knob. The units for this amount will be the current display units as selected under the **Amplitude** menu.

Frequency

The frequency of each point in a limit line can be individually set. When a new point is added, it takes on a value halfway between two existing points, or the stop frequency of the current sweep if there is no point higher in frequency than the one being added. See the Add Point soft key description for more details. Use the keypad, the **Left/Right** arrow keys or the rotary knob to change the frequency of a point.

Amplitude

The amplitude of each limit point can also be individually set. By default, when a new point is added, it takes on the amplitude that is on the limit line at the frequency where the point was added. Use the keypad, using the ± key as the minus sign, the **Up/Down** arrow keys or the rotary knob to move the point to the desired value. The unit of the amplitude limit is the same as the current vertical amplitude unit. See the Add Point soft key description for more details.

Add Point

The precise behavior of this soft key depends on which limit point is active at the time the key is pressed. If the active limit point is somewhere in the middle of a multi-segment limit line, a new limit point will be added that is halfway between the currently active point and the point immediately to its right. The amplitude of the point will be such that it falls on the limit line. For example, if there is a limit point at 2.0 GHz with an amplitude of -30 dBm and the next point is 3.0 GHz with an amplitude of -50 dBm, the added point will be at 2.5 GHz with an amplitude of -40 dBm. The frequency and amplitude values of the new point can be adjusted as needed with the Frequency and Amplitude soft keys.

If the last limit point is active (assuming it is not at the right edge of the display) the new limit point will be placed at the right edge of the display at the same amplitude as the point immediately to its left.

Points may not be added beyond the current sweep limits of the instrument.

Delete Point

This soft key deletes the currently active point. The active point becomes the one immediately to the left of the point that was deleted.

Next Point Left

This soft key selects the limit point immediately to the left of the active point, making it active for editing or deletion. With each key press, the indicator of which point is active moves one limit point to the left until it reaches the left edge of the screen.

Next Point Right

This soft key selects the limit point immediately to the right of the active point, making it active for editing or deletion. With each key press, the indicator of which point is active moves one limit point to the right until it reaches the right edge of the screen.

Back
Returns to the higher-level Limit menu.

Limit Alarm
This soft key selects, for the currently active limit line, if an alarm beep will occur when a data point exceeds the limit.

Clear Limit
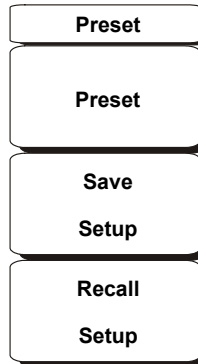This soft key deletes all limit points for the currently active limit line.

Preset

Figure 4-32. Cable & Antenna Analyzer Preset Menu

To access the functions under the Preset menu, press the **Shift** key, then the **Preset** (1) key.

Preset
This key resets the instrument to the default starting conditions of full band sweep, 10 dBm log reference level, 10 dB/division scaling, 0 dB reference level offset, all measurements turned off and trigger set to free run.

Save Setup
Opens a dialog box to name and save the current operating settings, allowing them to be recalled later to return the instrument to the state it was in at the time the setup was saved. The saved setup can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the setup.

Recall Setup
This soft key brings up a selection box that allows selection and recall of a previously stored instrument setup. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved setup, and press **Enter**, the rotary knob, or the Recall soft key to select. All current instrument settings are replaced by the stored setup information. Press the **Esc** key to cancel the recall.

Save/Recall

To access the Save and Recall functions, press the **Save/Recall** function hard key. Pressing this key opens the menu for *File on page 4-28* menu. Refer to Figure 4-23.
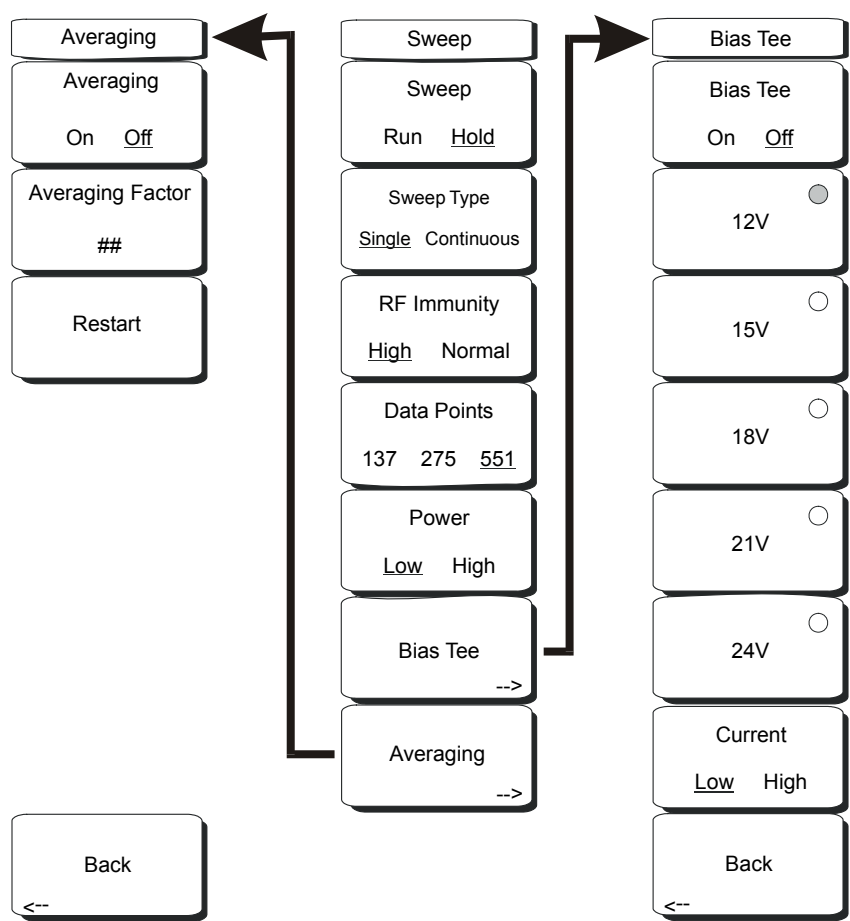
Sweep

Figure 4-33. Cable & Antenna Analyzer Sweep Menu

To access the functions under the Sweep menu, press the **Shift** key, then the **Sweep** (3) key.

Sweep Run/Hold
Press the soft key to select Run or Hold. The currently selected condition is underlined.
Hold pauses the sweep. To resume sweeping, press the soft key to select Run.

Sweep Type
Press the soft key to select Single or Continuous. The currently selected condition is
underlined. Selecting Single Sweep will allow the instrument to sweep once and hold.
Press the soft key again to resume continuous sweeping.

RF Immunity
Press the soft key to select High or Normal. The BTS Master uses a special dithering
technique to improve immunity to interfering signals. Selecting High turns the dithering
on. Selecting Normal turns the dithering off.

Selecting RF Immunity Normal reduces sweep speed for both frequency and DTF measurements. In a controlled environment, this reduced immunity should not be a problem. In the field however, there can be stray signals from nearby or co-located transmitters that can affect frequency and DTF measurements. Making the same measurement with RF Immunity set to both High and Normal with no appreciable difference between the two settings is a good indicator that it is safe to make the measurements with RF Immunity set to Normal.

Data Points
Press the soft key to select 137, 275, or 551 data points. The resolution can be changed before or after calibration. The BTS Master uses the highest setting of 551 data points for the calibration regardless of the display setting.

Power
With 2-port measurements, the power level can be changed between High and Low output power. Press the soft key to select High or Low. Low (approximately −35 dBm) allows for 2-port measurements where the output level could saturate an active device, such as an amplifier. High (approximately 0 dBm), can be used for all other measurements. Output power levels can only be changed for 2-port measurements. The power level is set to High for 1-port measurements.

Bias Tee
The built-in variable power supply can be turned on as needed to place between +12 V and +24 V, in 3 V steps, on the center conductor of the RF In port. For +12 V, +15 V, and +18 V settings, the current can be set to Low or High. The status window to the left of the display shows the current and voltage information that can be stored as well.
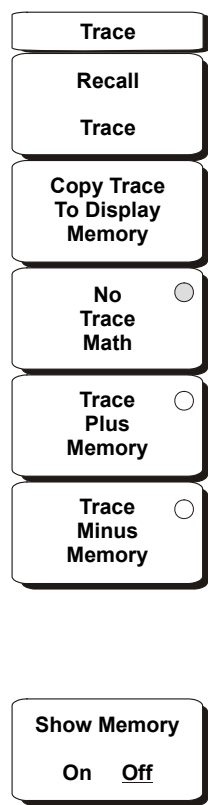
Trace

Figure 4-34. Cable & Antenna Analyzer Trace Menu

To access the functions under the Trace menu, press the **Shift** key, then the **Trace** (5) key.

Recall Trace
Brings up a selection box that allows recall of a previously stored measurement trace. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved measurement trace, and press **Enter**, the rotary knob, or the Recall soft key to select. Press the **Esc** key to cancel the recall.

Copy Trace To Display Memory
This function copies the current trace to the display memory.

No Trace Math
When this soft key is selected, the active trace is shown as is.

Trace Plus Memory
Displays the active trace and the recalled trace at the same time.

Trace Minus Memory
Display the difference between the active trace and the recalled trace.

Show Memory On/Off
Display the trace in the display memory.

Chapter 5
WCDMA/HSDPA Signal Analyzer

Introduction

The MT8222A BTS Master offers three WCDMA/HSDPA options and one WCDMA option: WCDMA/HSDPA RF Measurements (Option 44), WCDMA Demodulator (Option 45), WCDMA/HSDPA Demodulator (Option 65) and WCDMA/HSDPA Over The Air (OTA) (Option 35) measurements. Connect the MT8222A to any Node B/BTS for accurate RF and demodulator measurements.

> NOTE: The WCDMA/HSDPA Demodulator option demodulates both WCDMA and HSDPA signals. The WCDMA Demodulator only demodulates WCDMA signals.

The BTS Master can measure node B transmitter performance over the air by connecting an antenna or by connecting the node B equipment directly to the MT8222A BTS Master. To measure a WCDMA signal over the air, connect the appropriate frequency band antenna to the BTS Master RF In connector.

To connect the node B equipment directly to the BTS Master, connect the power amplifier of the node B equipment to the RF In connector of the BTS Master using a coupler or attenuator.

> NOTE: The maximum input damage level of the RF In port is +30 dBm. To prevent damage always use a coupler or high power attenuator.

WCDMA/HSDPA Measurements

NOTE: Use an applicable band pass filter to eliminate out of band signals that can cause mixer saturation.

Carrier Frequency

Carrier Frequency is the selected transmitter operating center frequency entered by the user or calculated from the signal standard and channel number entered by the user.

Carrier Feedthrough

Carrier Feedthrough measures the amount of unmodulated signal that is leaking through the transmitter and is displayed in the Code Domain Power display. The WCDMA 3GPP specification does not specify carrier feedthrough measurement.

CDP

Code Domain Power displays how much of the channel power is in each Orthogonal Variable Spreading Factor (OVSF). Power is normalized to the channel power, so if a code reads -10 dB, it means that the code is 1/10th of the channel power. Colors are applied according to Table 5-5-1, following:

Table 5-1. Channel Power Colors

Parameter	Description	Color	Viewable on Display
CPICH	Common Pilot Channel	Red	All CDP views
P-CCPCH	Primary Common Control Physical Channel	Magenta	All CDP views
S-CCPCH	Secondary Common Control Physical Channel	Cyan	All CDP views
PICH	Paging Indicator Channel	Green	All CDP views
P-SCH	Primary Sync Channel	Navy Blue	Control Channels
S-SCH	Secondary Sync Channel	Blue	Control Channels
Traffic	WCDMA Traffic	Yellow	All CDP views
Noise	Noise	Grey	All CDP views
HS-PDSCH	High Speed Physical Downlink Shared Channel	Orange	HSDPA Screen and CDP Screen when the WCDMA/HSDPA option is installed

NOTE: In WCDMA specification the P-SCH and S-SCH are not assigned spreading codes and therefore do not appear in the code domain power display. They have special non-orthogonal scrambling codes and are on 10% of the time.

Channel Power

Channel power is the total power transmitted in the 3.8 MHz WCDMA channel specified. Channel Power measures the node B/base station transmitting power across the entire 3.84 MHz WCDMA (BTS) channel. Channel power is displayed in dBm and Watts.

For Over the Air (OTA) measurements, the channel power will vary as the signal path from the node B transmitter to the MT8222A BTS Master varies.

Scrambling Code

In the WCDMA specification the scrambling code can be from 0 to 511. If the scrambling code is known, its value can be entered and the test set can decode and display the code domain power of the signal. If the scrambling code is unknown, the BTS Master can be set to auto scrambling so that the test set can lock onto the strongest code to decode and display the code domain power of the signal.

Spreading Factor (also called OVSF codes)

According to the 3GPP standard the spreading factor can be from 4 to 512, and the BTS Master can be set to a maximum spreading factor of 256 or 512.

Freq Error

Frequency error is the difference between the received center frequency and the specified center frequency. This is tied to the external frequency reference accuracy and is typically useful only with a good external frequency reference.

Codogram

When Codogram is selected the screen displays the changes in code power levels over time.

Noise Floor

The average power of inactive codes in the code domain, as displayed in the CDP measurement display.

Threshold

The Active Channel Threshold Level can be set to indicate which code channels are considered active. Any code channels exceeding this power level are considered active traffic channels and any code channels below this power level are considered inactive (or noise). A horizontal red line on the screen represents the threshold level. The BTS Master can set this level automatically based on the received signal, or the user can manually enter a value in the Threshold setup menu.

Occupied Bandwidth

The measured occupied bandwidth is calculated as the bandwidth containing 99% of the total integrated power within the transmitted spectrum around the selected center frequency.

EVM (Error Vector Magnitude)

The Error Vector Magnitude is the ratio in percent of the difference between the reference waveform and the measured waveform. EVM metrics are used to measure the modulation quality of a transmitter. The 3GPP standard requires that the EVM not exceed 17.5%.

Symbol EVM (@EVM)

Symbol EVM is defined as the EVM for a single code channel.

Peak to Average Power

Peak to Average power is the ratio of the peak power and the RMS power of the signal calculated over one frame interval and is displayed in dB.

Peak CD Error (Peak Code Domain Error)

PCDE takes the noise and projects the maximum impact it will have on all OVSF codes. PCDE is the maximum value for the code domain error for all codes (both active and inactive).

In the 3GPP standard, in order to address the possibility of uneven error power distribution in WCDMA, the EVM measurement has been supplemented with PCDE. The 3GPP standard requires that the PCDE not exceed -33 dB at a spreading factor of 256.

Ec

Ec is a measurement of energy. Ec is determined by multiplying CPICH by the chip time.

Ec/Io

The pilot power compared to the total channel power. Ec/Io is displayed in text-only displays and in OTA measurement displays.

Pilot Dominance

The strength of the strongest pilot compared to the next strongest pilot in the same channel. This should be >10 dB in order to make good measurements.

Total Power

The total power of all the scrambling codes, also called (Io) and displayed in dBm.

CPICH Abs Power

CPICH Abs power is the energy over one chip of the Common Pilot Channel power displayed in dBm.

P-CCPCH Abs Power

P-CCPCH Abs power is the absolute Primary Common Control Physical Channel power displayed in dBm.

S-CCPCH Abs Power

S-CCPCH Abs power is the absolute Secondary Common Control Physical Channel power displayed in dBm.

P-SCH Abs Power

P-SCH Abs power is the absolute Primary Sync Channel power displayed in dBm.

S-SCH Abs Power

S-SCH Abs power is the absolute Secondary Sync Channel Power displayed in dBm.

PICH

PICH is the paging indicator channel power.

HSDPA Power versus Time Display

Select the code and set the time to display how the code is varying over time. In CDP view, HSDPA signals are displayed in orange.

Constellation

In the HSDPA view, the symbol constellation for the selected code is displayed (16QAM or QPSK).

Measurement Setup

WCDMA/HSDPA Mode

To prepare for WCDMA/HSDPA measurements, the MT8222A must be configured for WCDMA/HSDPA mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight WCDMA/HSDPA Signal Analyzer and press the **Enter** key to select.

For additional information about the Mode menu, refer to *Mode Selector Menu* on page 2-16.

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* on page 2-5.

Setting up the Measurement Frequency

The measurement frequency can be set by entering the center frequency or by selecting the applicable signal standard and channel, which allows the MT8222A BTS Master to automatically set the frequency.

To enter the center frequency:

1. Press the **Freq** function hard key.
2. Press the Center Freq soft key.
3. Enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the **Enter** key has the same affect as pressing the MHz soft key.
4. Press the **Enter** key to set the Center Frequency. The current setting is shown on the left side of the display.

To select a signal standard:

1. Press the **Freq** function hard key.
2. Press the Signal Standard soft key.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard and press **Enter** to select. When a signal standard is selected, the center frequency for the first channel of the selected standard is automatically tuned.

4. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.

The current settings are displayed on the left side of the screen.

Power Offset for Compensating External Loss

To get accurate results the external attenuation should be compensated using power offset. In power offset mode the compensation factor is in dB. The external attenuation is caused by using an external cable or external high power attenuator.

1. Press the **Amplitude** function hard key.
2. Press the Power Offset soft key and use the keypad, the arrow keys, or the rotary knob to enter the desired offset value. Press the **Enter** key to set the Power Offset. The value entered is displayed on the left side of the screen.

Scrambling Code Setup

The MT8222A BTS Master can set up a scrambling code automatically or manually.

In Auto mode the unit automatically locks on to the strongest scrambling code in the signal. In Manual mode the desired code is manually entered and the unit looks only for that specific scrambling code.

To set up auto scrambling:

1. Press the **Setup** function hard key.
2. Press the Scrambling Code soft key to select Auto

To manually set up a Scrambling Code:

1. Press the **Setup** function hard key.
2. Press the Scrambling Code soft key to select Manual and use the keypad, the arrow keys, or the rotary knob to enter the desired Scrambling Code, as shown on the left side of the screen. Press the **Enter** key to set the scrambling code.

Maximum Spreading Factor Setup

In a WCDMA system, the number of chips per data symbol is called the Spreading Factor. The lower the spreading factor the higher the data rate. According to the 3GPP standard, the spreading factor can vary from 4 to 512 and the maximum spreading factor is either 256 or 512. The MT8222A BTS Master can be set to 256 or 512 maximum spreading factors. To set up the maximum spreading factor:

1. Press the **Setup** function hard key.
2. Press the Max Spreading Factor soft key to select either 256 or 512.

External Reference Frequency Setup

In order to get the best frequency accuracy measurements, it is important to use an external reference frequency attached to the BTS Master Ext Ref In connector. Most node B equipment has a reference frequency available on a BNC connector. To configure the BTS Master to use an external reference frequency:

1. Press the **Setup** function hard key.
2. Press the Select Reference Frequency soft key to display a list of the available reference frequencies:

Table 5-2. Reference Frequencies

1 MHz
1.2288 MHz
1.544 MHz
2.048 MHz
2.4576 MHz
4.8 MHz
4.9152 MHz
5 MHz
9.8304 MHz
10 MHz
13 MHz
19.6608 MHz

3. Use the **Up/Down** arrow keys or the rotary knob to highlight the applicable reference frequency on the list and press the **Enter** key to set the reference frequency.

As the BTS Master locks to the source, the Reference Freq value is displayed in the user settable parameters to the left of the display.

S-CCPCH Spreading Factor, S-CCPCH Code and PICH Code setup

In the 3GPP specification, two optional control channels are provided for S-CCPCH and PICH. These codes can have different spreading codes and spreading factors. In the BTS Master the S-CCPCH spreading factor and S-CCPCH and PICH codes can be manually entered.

NOTE: For the most accurate results, manually enter the S-CCPCH spreading and S-CCPCH and PICH codes before taking the measurement.

1. Press the **Setup** function hard key.
2. Press the S-CCPCH Spread soft key and manually enter the desired spreading factor.
3. Press the S-CCPCH Code soft key and manually enter the desired spreading code.

4.   Press the PICH Code soft key and manually enter the desired spreading code.

NOTE: The S-CCPCH spreading factor default value is 256. The default
S-CCPCH Code is 3 and the default PICH code is 16.

Threshold Setup

The threshold level is an advanced setting that can be set to indicate which codes are
considered active. In the Code Domain Power screen the threshold level is indicated by a
horizontal dotted red line. Any code channels exceeding this power level are considered
active traffic channels and any code channels below this power level are considered inactive
or noise. The threshold level can be manually set by:

1.   Press the **Setup** function hard key.
2.   Press the Threshold soft key and select either On or Off.

NOTE: Threshold can only be set in Codogram or Code Domain Power
modes. The default threshold level is −30 dB.

Filtered versus Unfiltered Power

In the MT8222A BTS Master the ACLR measurement uses the filtered channel power to
determine the ACLR values and it is listed as filtered on the display. In all other screens the
unfiltered channel power is displayed as channel power.

WCDMA/HSDPA RF Measurements (MT8222A-044)

The WCDMA/HSDPA RF Measurements consist of three measurements: Spectrum, Adjacent Channel Leakage Ratio (ACLR) and Spectral Emission Mask. To make WCDMA RF measurements, connect the MT8222A BTS Master to the node B equipment following the instructions.

> NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.

Band Spectrum Setup

Displays the selected band spectrum. The cursor can be moved to select the desired channel using the directional arrow keys or the rotary knob. The Channel Number can also be directly entered using the numerical keypad.

> NOTE: Selecting Channel Spectrum after selecting a channel using the cursor will display the measurements for the selected signal.

Band Spectrum Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight WCDMA/HSDPA Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Signal Standard soft key and select the applicable WCDMA standard.
5. Press the **Measurements** function hard key and the RF Measurements soft key.
6. Press the Band Spectrum soft key to display the band spectrum.
7. Move the cursor, using the directional arrow keys or the rotary knob, to select the desired channel. The Channel Number can also be directly entered using the numerical keypad.
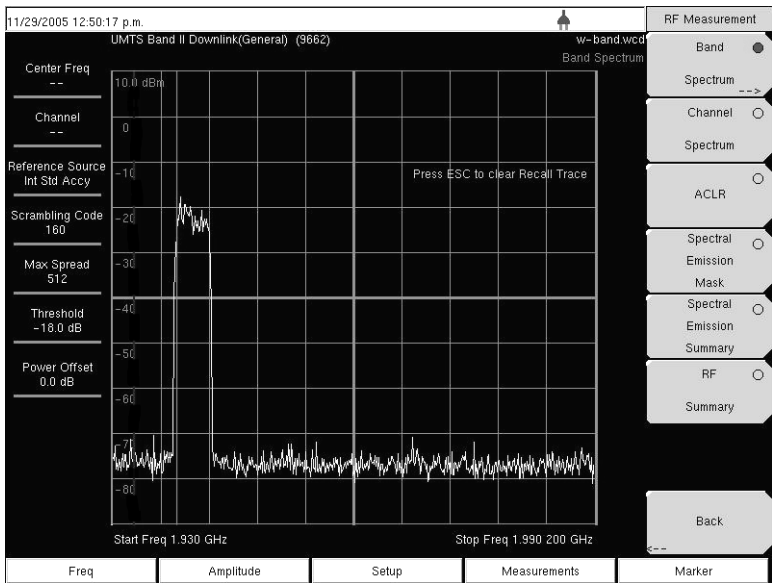

Figure 5-1. Band Spectrum

Channel Spectrum Setup

The channel spectrum screen displays the selected channel signal and the following measurements: channel power in dBm and Watts, occupied bandwidth, and peak to average power. When Channel Spectrum is selected, the unit automatically displays the measurements for the selected signal.

Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight WCDMA/HSDPA Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable WCDMA standard.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
6. Press the **Setup** function hard key.
7. For the most accurate frequency measurements, press the Select Reference Frequency soft key to display a list of the available reference frequencies and select the desired reference frequency or activate the GPS (if equipped) and synchronize the BTS Master to High Internal accuracy.
8. Press the **Measurements** function hard key.
9. Press the RF Measurements soft key.
10. Press the Channel Spectrum soft key to activate the spectrum measurement.

> NOTE: Using the Band Spectrum cursor, select the desired channel and the unit will automatically display the measurements for the selected channel when the Channel Spectrum key is selected.
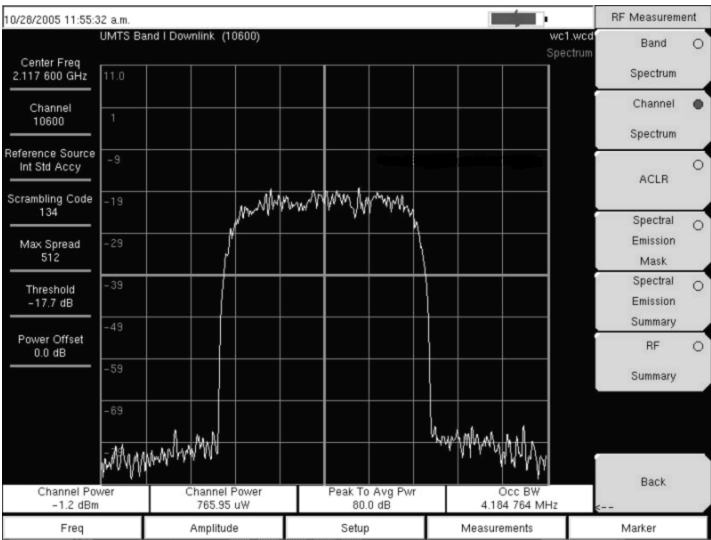

Figure 5-2. RF Measurement Example

ACLR Measurement Setup

ACLR (Adjacent Channel Leakage Ratio) is defined as the ratio of the amount of leakage power in an adjacent channel to the total transmitted power in the main channel and is displayed in table format under the bar graph. The 3GPP standard specifies one main channel and two adjacent channels. The ACLR screen displays the main channel power and the power of two adjacent channels on each side as a bar graph.

The channel spacing is −10 MHz, −5 MHz, +5 MHz and +10 MHz and the channels are color coded. The 3GPP standard requires the adjacent channel power leakage ratio to be better than 45 dB at 5MHz offset and 50 dB at 10MHz offset.

The BTS Master can also make ACLR measurements for multi-channel systems by measuring the main channels and the adjacent channels, from one to four channels. The ACLR screen can display up to 12 channels total.

In the ACLR measurement mode the filtered channel power is used to determine ACLR values and is listed as filtered on the display.

The following procedure is for one main channel two adjacent channels.

Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight WCDMA/HSDPA Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable WCDMA standard.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
6. Press the **Measurements** function hard key.
7. Press the RF Measurement soft key.

> NOTE: In the MT8222A BTS Master the ACLR measurement uses the filtered channel power to determine the ACLR values and it is listed as filtered on the display. In all other screens the unfiltered channel power is displayed as channel power.

8. Press the ACLR soft key to activate the ACLR measurement.

> NOTE: Using the Band Spectrum cursor, select the required channel and press the ACLR soft key. The BTS Master will display the measurement.
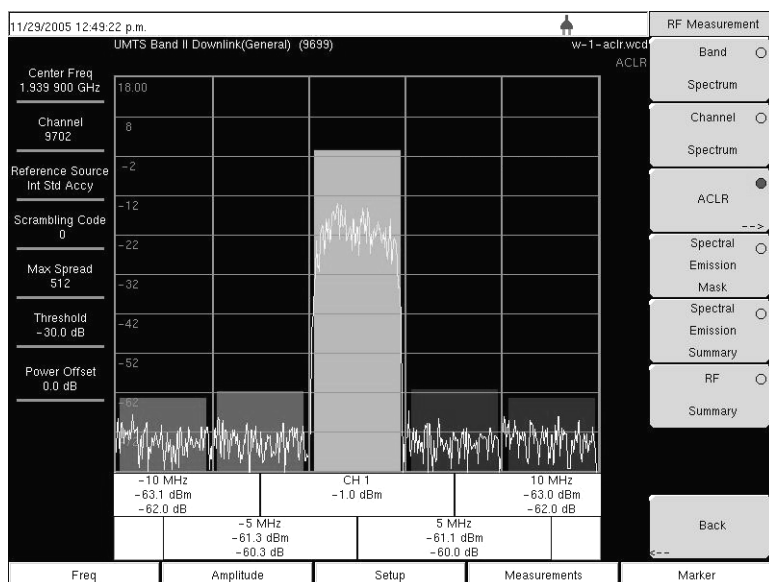
Figure 5-3. ACLR Measurement Example

9.   Press the ACLR soft key again and select one main channel and two adjacent channels.

Multi-channel ACLR Procedure

1.   Press the **Shift** key, then the **Mode** (9) key.
2.   Use the directional arrow keys or the rotary knob to highlight WCDMA/HSDPA Signal Analyzer and press the **Enter** key to select.
3.   Press the **Freq** function hard key.
4.   Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable WCDMA standard.
5.   Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
6.   Press the **Measurements** function hard key.
7.   Press the RF Measurement soft key.
8.   Press the ACLR soft key to activate the ACLR measurement.
9.   Press the ACLR soft key again and select the number of main and adjacent channels. For this example four main channels and four adjacent channels are selected
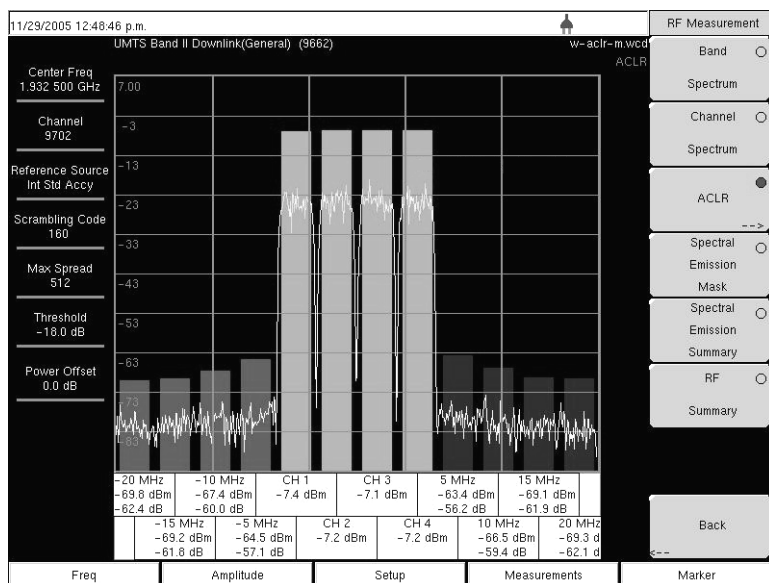
Figure 5-4. ACLR Multi-channel Measurement Example

Spectral Emission Mask Setup

The Spectral Emission Mask displays the selected signal and the mask as defined in the 3GPP specification. The mask varies depending upon the input signal. The BTS Master also indicates if the signal is within the specified limits by displaying PASSED or FAILED. The emission mask is also displayed in a table format with different frequency ranges and whether the signal PASSED/FAILED in that region.

The 3GPP specification specifies four masks depending upon the base station output power:

- P ≥ 43 dBm

- 39 ≤P < 43 dBm

- 31 ≤P < 39 dBm

- P <31 dBm

Procedure

1. Press the **Shift** key, then the **Mode** (9) key. The available modes are Spectrum Analyzer and WCDMA Signal Analyzer.
2. Use the directional arrow keys or the rotary knob to highlight WCDMA/HSDPA Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable WCDMA standard.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
6. Press the **Measurements** function hard key.
7. Press the RF Measurements soft key.
8. Press the Spectral Emission Mask soft key to activate the Spectral Emission Mask measurement.

9. Press the Spectral Emission Summary soft key to display the Spectral Emission Summary table.
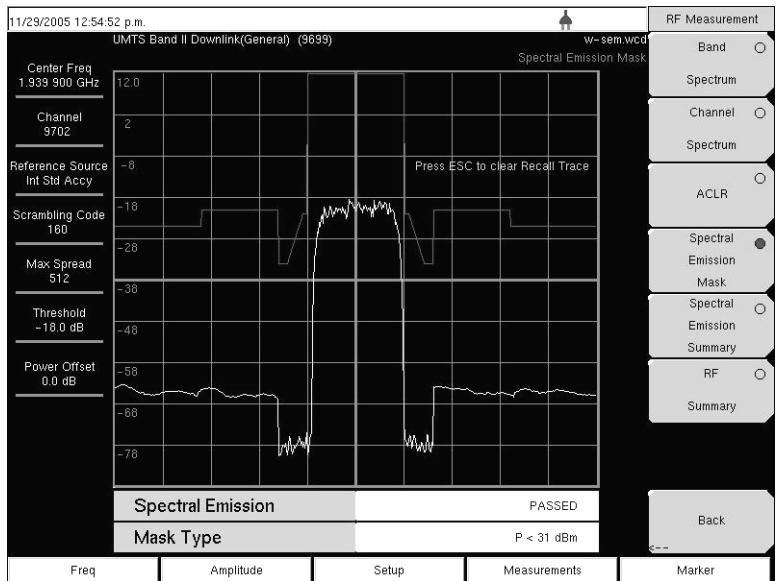

Figure 5-5. Spectral Emission Mask Measurement Example
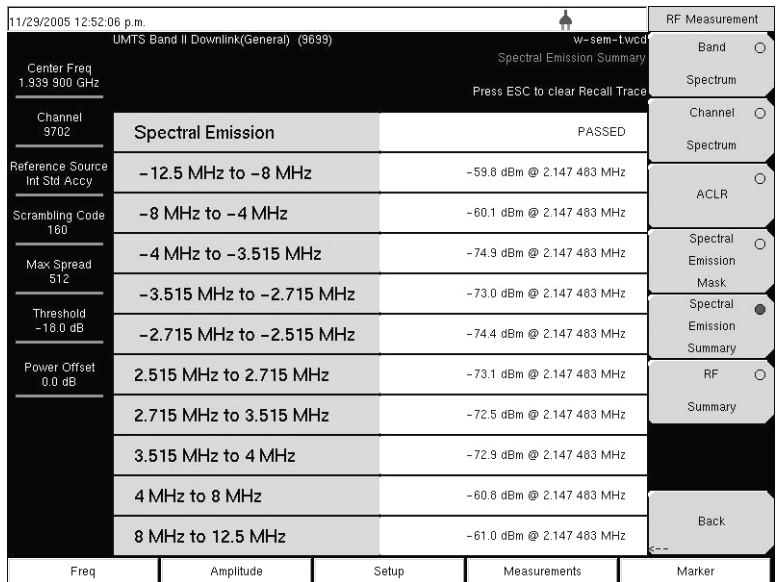
For a Spectral Emission Summary:

Figure 5-6. Spectral Emission Mask Measurement Summary Example

RF Summary

The RF Summary displays the critical transmitter performance measurements in the table format, without demodulating the WCDMA/HSDPA signal. The parameters displayed in the RF summary table are Channel Power in dBm and Watts, Carrier Frequency, Frequency Error, Spectral emission Pass/Fail criteria, Occupied Bandwidth, Peak to Average Power, ACLR at −10 MHz, −5 MHz, 5 MHz and 10 MHz channels.

Figure 5-7. RF Summary Example

Demodulator

In the demodulator mode the MT8222A BTS Master is connected to the node B equipment and the unit will demodulate the WCDMA signal. The WCDMA/HSDPA demodulator has Code Domain Power (CDP), HSPDA, Codogram and Modulation Summary screens.

> NOTE: The WCDMA/HSDPA Demodulator option demodulates both WCDMA and HSDPA signals. The WCDMA Demodulator only demodulates WCDMA signals.

Zoom Function

In CDP and Codogram measurements, the Zoom function can be activated to zoom in on selected OVSF codes. The Zoom function can be set to start from a particular OVSF code.

> NOTE: Press CDP or Codogram twice to activate the zoom function. The arrow in the lower right corner of the soft key indicates a sub menu is available.

Code Domain Power (CDP) Setup

The Code Domain Power (CDP) display includes spreading factor (OVSF codes) 256 or 512 with zoom in on codes. The BTS Master can zoom to 32, 64 and 128 codes and the user can input the zoom code to start the zoom in from the entered OVSF codes. The demodulator also displays CPICH, P-CCPCH, S-CCPCH, PICH, P-SCH and S-SCH power in the table format. For WCDMA/HSDPA Demodulator, the HSDPA codes are also displayed.

Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight WCDMA/HSDPA Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable WCDMA standard.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
6. Press the **Setup** function hard key.
7. Press the Scrambling Code soft key to select Auto so that the MT8222A will automatically detect the scrambling code.
8. Press the Select Reference Frequency soft key to display a list of the available reference frequencies and select the desired reference frequency to get accurate frequency measurements or activate the GPS (if equipped) and synchronize the BTS Master to High Internal accuracy.
9. Connect the external reference to the Ext RF Input BNC connector and wait for the unit to recognize the external reference () and lock up to it.
10. Press the S-CCPCH Spread soft key to manually set the S-CCPCH spreading. The MT8222A BTS Master will display the default S-CCPCH spreading factor of 256 in all the views. Set the S-CCPCH spreading factor to show accurate results.
11. Press the S-CCPCH Code soft key to enter the correct S-CCPCH code. The MT8222A BTS Master will display the default S-CCPCH code of 3 in all the views. Set the S-CCPCH code to show accurate results.

12. Press the PICH Code soft key to enter the correct PICH code. The MT8222A BTS Master will display the default PICH code of 16 in all the views. Set the PICH code to show accurate results.

13. Press the Threshold soft key to manually set the Threshold level which determines which codes are active. The default value is −30 dB.

14. Press the **Measurements** function hard key.

15. Press the Demodulator soft key to activate the demodulator menu.

16. Press the CDP soft key to activate the CDP measurement.

17. Press the CDP soft key again to activate the zoom function.

18. Press the Zoom soft key to select the appropriate zoom level. The Zoom key toggles between 32, 64, and 128.

19. Press the Zoom Start soft key to manually enter the zoom start code.

20. Press the Back soft key to go back to the CDP measurement.

NOTE: The blue color block on the CDP screen represents the selected zoom codes and the same codes are displayed in the zoom screen.
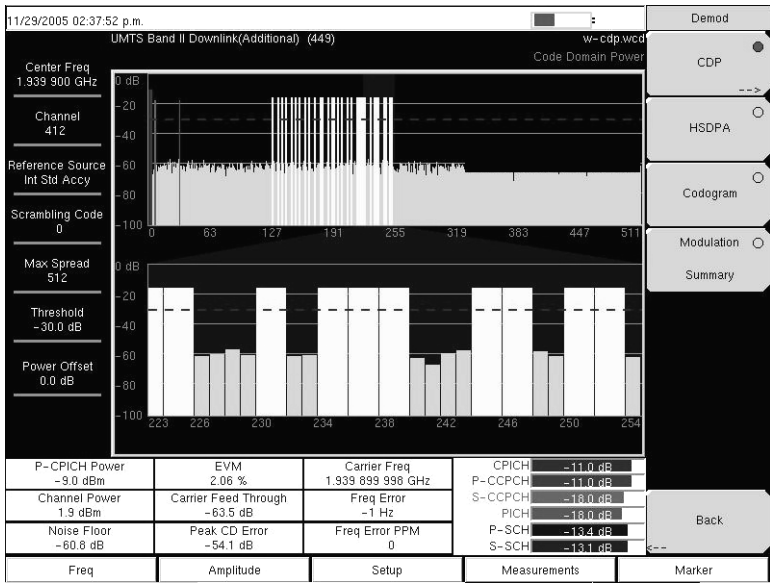

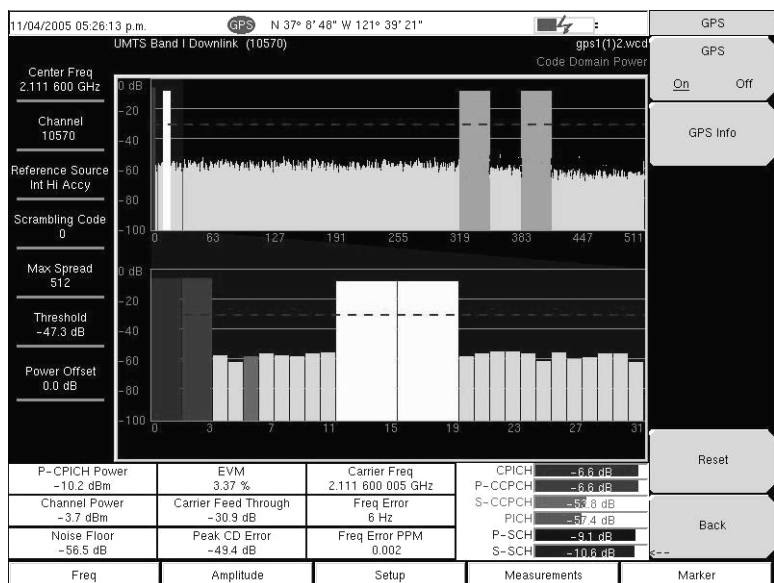**Figure 5-8. WCDMA Code Domain Power Measurement Screen Example**

Figure 5-9. Code Domain Power Measurement Screen with GPS High Accuracy Example
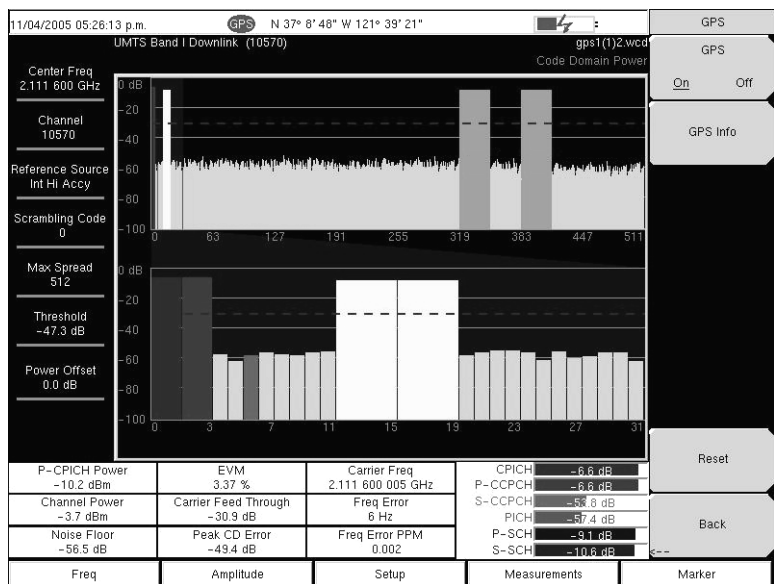

Figure 5-10. HSDPA Code Domain Power Measurement Screen Example

Activating Markers

1. Press the **Marker** function hard key to display the Marker menu.
2. Press the Marker soft key to select the appropriate marker (1 through 6). The underlined marker number is the currently selected marker.
3. Press the On/Off soft key to activate the selected marker.
4. Press the Marker Table soft key to display the Marker table. The marker table is displayed on the screen below the CDP measurements table.

> NOTE: Markers can be used to read the individual code power, symbol EVM (@ EVM) and type of code and can be activated in all the WCDMA/HSDPA measurements.
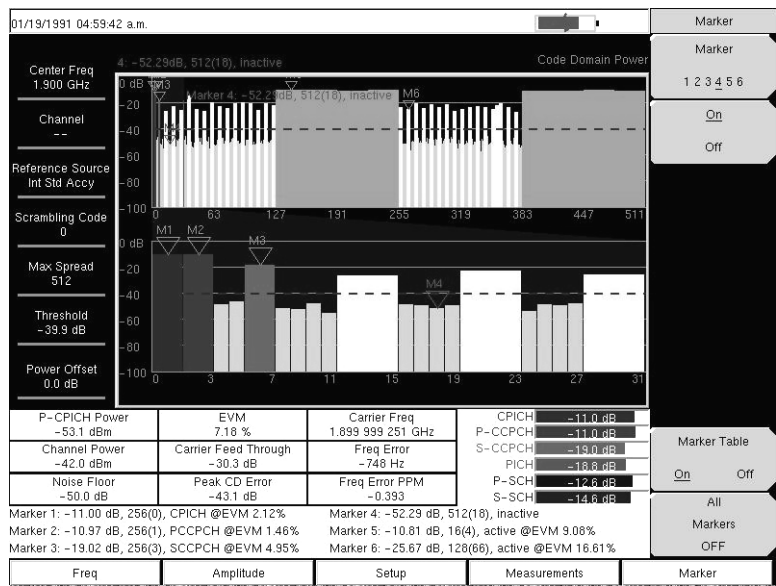

Figure 5-11. Code Domain Power Measurement Screen Example with Markers Activated

HSDPA Setup

HSDPA displays the spreading factor (OVSF codes) 256 or 512 codes and high speed downlink physical shared channel codes HS-PDSCH. The right or left active codes can be selected using the cursor. The selected code power versus time and constellation are displayed. The demodulator also displays CPICH, P-CCPCH, S-CCPCH, PICH, P-SCH and S-SCH power in the table format.

> NOTE: This screen is available with the WCDMA/HSDPA demod option only.

Procedure

1. Press the Demodulator soft key to activate the demodulator menu.
2. Press the HSDPA soft key to activate the HSDPA measurement. The red dot on the soft key indicates HSDPA is selected.
3. Press the HSDPA soft key again to display the HSDPA measurement signal parameters.
4. Press the Total Time soft key to set the time or the Single Sweep Time soft key to set the time for the power versus time display. The maximum time is 72 hours.
5. Use the cursor to select the desired code. The code parameters are displayed on the screen.
6. Press the IQ Persistence soft key and use the keypad or rotary knob to set the IQ Persistence to 2. The BTS Master will display the constellation diagram after the first sample, and then update the constellation diagram after the second sample. IQ Persistence can be set as high as 48. When the maximum is reached, the first sample is replaced, and so on.

> NOTE: The WCDMA modulation type is QPSK, and the HSDPA modulation is 16QAM or QPSK.

Activating Markers

1. Press the **Marker** function hard key to display the Marker menu.
2. Press the Marker soft key to select the appropriate marker (1 through 6). The underlined marker number is the currently selected marker.
3. Press the On/Off soft key to activate the selected marker.
4. Press the Marker Table soft key to display the Marker table. The marker table is displayed on the screen below the measurements table.

> NOTE: Markers can be used to read the individual code power, symbol EVM (@ EVM) and type of code and can be activated in all the WCDMA/HSDPA measurements. See Figure 5-11.

Codogram Setup

Codogram displays the code power levels over time. Two graphs are displayed on the screen, the top one displays all the selected OVSF codes and the bottom one displays the selected OVSF zoom codes.

Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight WCDMA/HSDPA Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable WCDMA standard.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
6. Press the **Setup** function hard key.
7. Press the Scrambling Code soft key to select Auto so that the MT8222A will automatically detect the scrambling code.
8. Press the Select Reference Frequency soft key to display a list of the available reference frequencies and select the desired reference frequency to get accurate frequency measurements.
9. Press the S-CCPCH Spread soft key to manually set the S-CCPCH spreading. The MT8222A BTS Master will display the default S-CCPCH spreading factor of 256 in all the views. Set the S-CCPCH spreading factor to show accurate results.
10. Press the S-CCPCH Code soft key to enter the correct S-CCPCH code. The MT8222A BTS Master will display the default S-CCPCH code of 3 in all the views. Set the S-CCPCH code to show accurate results.
11. Press the PICH Code soft key to enter the correct PICH code. The MT8222A BTS Master will display the default PICH code of 16 in all the views. Set the PICH code to show accurate results.
12. Press the Threshold soft key to manually set the Threshold level which determines which codes are active. The default value is -30dB.
13. Press the **Measurements** function hard key.
14. Press the Demodulator soft key to activate the demodulator menu.
15. Press the Codogram soft key to activate the Codogram measurement.
16. Press the Codogram soft key to activate the zoom function and to set the time for the measurement.
17. Press the Zoom soft key to select the appropriate zoom level. The Zoom key toggles between 32, 64, and 128.
18. Press the Zoom Start soft key to manually enter the zoom start code.
19. Press the Total Time or Single Sweep Time soft key to set the required time.
20. Press the Back soft key to go back to the Codogram measurement.

> NOTE: The blue color block on the Codogram screen represents the selected zoom codes and the same codes are displayed in the zoom screen.
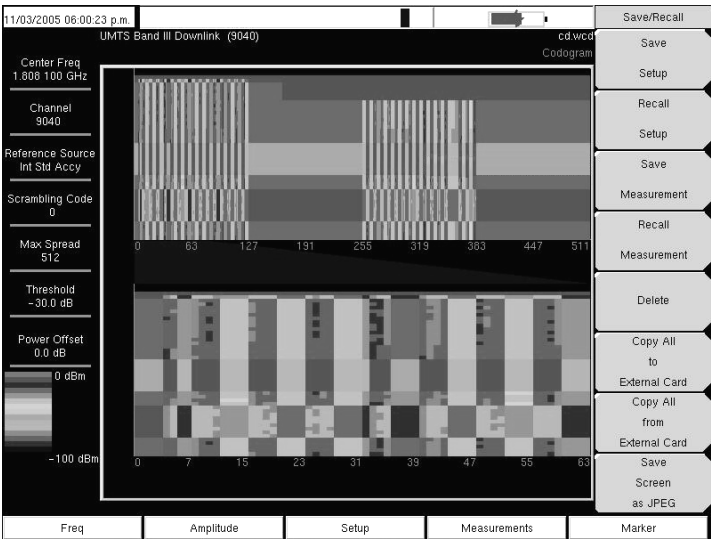> Save the data before making any measurements, otherwise the data will be lost.

Figure 5-12. Codogram Measurement Screen Example

Over The Air Measurements Setup (MT8222A-035)

In Over The Air (OTA) mode the MT8222A BTS Master is not connected to the node B equipment. The OTA screen displays six strongest scrambling codes as bar graphs and underneath the bar graphs the scrambling code number, CPICH, Ec/Io, Ec and pilot dominance related to the strongest scrambling code are displayed in the table format.

In Over The Air measurement the Scrambling Code can be set to Auto to automatically measure and display the six strongest scrambling codes, or Manual, to look for the set scrambling codes.

The OTA measurement screen can be locked by pressing the Code Lock On/Off soft key. The Display Unit soft key can be used to display the OTA bar graph by selecting CPICH or Ec/Io. The default display is CPICH. The Sort By soft key can display the scrambling codes sorted by Power or Code.

> NOTE: Press Reset to activate the OTA measurement in a different location for accurate results.

Procedure

1.   Press the **Shift** key, then the **Mode** (9) key.
2.   Use the directional arrow keys or the rotary knob to highlight WCDMA/HSDPA Signal Analyzer and press the **Enter** key to select.
3.   Connect the appropriate antenna to the RF In connector to make OTA measurements.
4.   Press the **Freq** function hard key.
5.   Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable WCDMA standard.
6.   Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
7.   Press the **Measurements** function hard key.
8.   Press the Over the Air soft key to activate the Over The Air measurement.
9.   Press the Over the Air soft key again to display the OTA soft key menu.
10. Press the Scrambling Code soft key and select Auto to automatically detect the six scrambling codes.
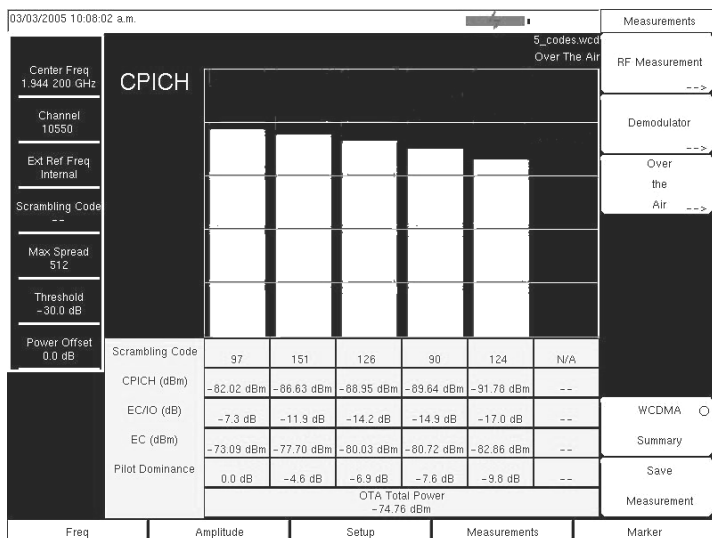
Figure 5-13. OTA Measurement Screen Example

11. To only look for specific scrambling codes, press the Scrambling Code soft key to highlight Manual, then use the Manual Code soft key to select the specific code and the On/Off soft key to turn the selected code on or off. The Code Lock soft key locks the code, so that the code will not change with each update.

WCDMA Summary Setup

WCDMA summary displays the critical WCDMA measurements from RF and demodulation measurements.
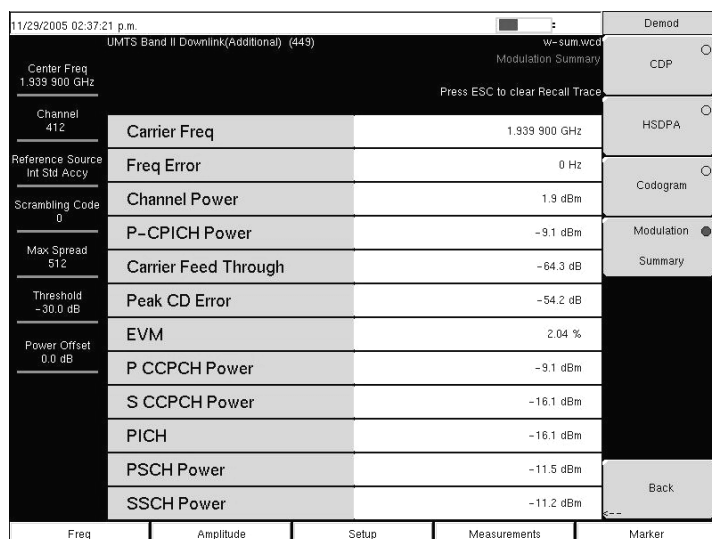
Figure 5-14. WCDMA Summary Measurement Screen Example

WCDMA Summary Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight WCDMA/HSDPA Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable WCDMA standard.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
6. Press the **Setup** function hard key.
7. Press the Scrambling Code soft key to select Auto so that the MT8222A will automatically detect the scrambling code.
8. Press the Select Reference Frequency soft key to display a list of the available reference frequencies, Select the desired reference frequency to get accurate frequency measurements or activate the GPS (if equipped) and synchronize the BTS Master to High Internal accuracy.
9. Connect the external reference to the Ext RF Input BNC connector and wait for the unit to recognize the external reference and lock to it.
10. Press the S-CCPCH Spread soft key to manually set the S-CCPCH spreading. The BTS Master will display the default S-CCPCH spreading factor of 256 in all the views. Set the S-CCPCH spreading factor to show accurate results.
11. Press the S-CCPCH Code soft key to enter the correct S-CCPCH code. The BTS Master will display the default S-CCPCH code of 3 in all the views. Set the S-CCPCH code to show accurate results.
12. Press the PICH Code soft key to enter the correct PICH code. The BTS Master will display the default PICH code of 16 in all the views. Set the PICH code to show accurate results.
13. Press the Threshold soft key to manually set the Threshold level which determines which codes are active. The default value is −30dB.
14. Press the **Measurements** function hard key.
15. Press the WCDMA Summary soft key.

Pass/Fail Mode Setup

The BTS Master stores the five test models specified in the 3GPP specification (TS 125.141) for testing base station performance and recalls these models for quick easy measurements. After selection of a test model, the BTS Master displays test results in tabular format with clear PASS or FAIL indications that include min/max threshold.

Using Master Software Tools, a custom test list can be created and downloaded into the BTS Master. All critical parameters can be selected for pass/fail testing, including each individual code power level, the spreading factor and symbol EVM.

Pass/Fail Mode Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight WCDMA/HSDPA Signal Analyzer and press the **Enter** key to select.
3. Connect the appropriate antenna to the RF In connector to make OTA measurements.
4. Press the **Freq** function hard key.
5. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable WCDMA standard.
6. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
7. Press the **Measurements** function hard key.
8. Press the Pass/Fail Mode soft key to display the pass/fail mode menu.

Press the Select Pass/Fail Test soft key and select the applicable Test Model to activate the measurement.
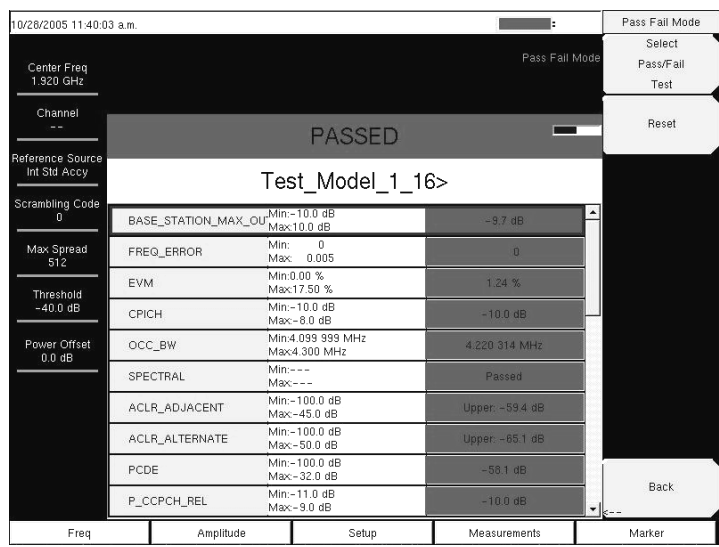

Figure 5-15. Pass/Fail Mode Example Screen

WCDMA/HSDPA Signal Analyzer Menus

Amplitude

```
┌─────────────────────┐
│     Amplitude       │
├─────────────────────┤
│       Scale         │
│                     │
│        — —          │
├─────────────────────┤
│    Power Offset     │
│                     │
│      0.0 dB         │
├─────────────────────┤
│    Auto Range       │
│                     │
│   On        Off     │
├─────────────────────┤
│      Adjust         │
│                     │
│      Range          │
└─────────────────────┘
```

Figure 5-16. WCDMA/HSDPA Amplitude Menu

Scale
The scale can be set in 1 dB steps from 1 dB per division to 15 dB per division. The value can be changed using the keypad, the rotary knob, or the **Up/Down** arrow keys.

Power Offset
Choose power offset to have the BTS Master automatically adjust for the loss through any external cables, attenuators and couplers. The power can be offset from 0 dB to 100 dB. Press the Power Offset key, enter the values and press the dB soft key.

Auto Range
Adjusts the reference level automatically when Auto Range is activated. Toggles between On and Off.

Adjust Range
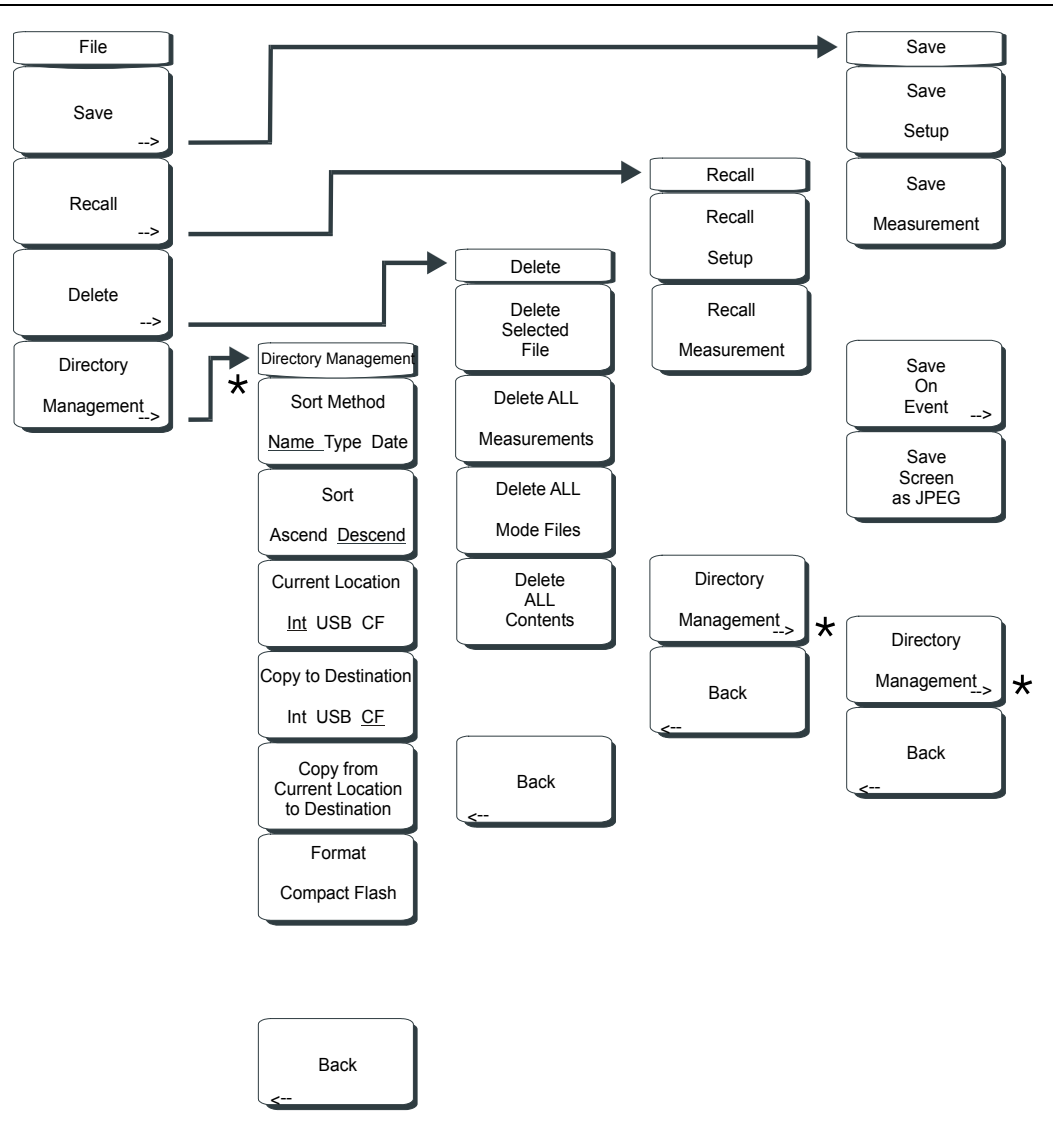Adjust the range adjusts the reference level to be optimal based on the measured signal.

File

Figure 5-17. WCDMA/HSDPA File Menu

To access the functions under the File menu, press the **Shift** key, then the **File** (7) key.

Save

Measurements may be saved to the internal memory or to a Type-1 Compact Flash module. The BTS Master is shipped with a 256 MB Compact Flash Memory Module, Anritsu Part Number 3-2000-1500. The removable compact flash card can be up to 512 MB. Compact Flash modules with greater storage capacity may not function properly, and should be properly tested before relying on them. A USB Flash drive with at least 256 MB of storage may be used to store all measurements that may be stored internally.

Save Setup

Opens a dialog box to name and save the current operating settings, allowing them to be recalled later to return the instrument to the state it was in at the time the setup was saved. The saved setup can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the Left/Right directional arrows to move the cursor position. Press **Enter** to save the setup.

Save Measurement

Initiates a dialog box to name and save the current active trace A. The saved measurement trace can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the measurement trace. Measurements are saved in a directory called /usr on the Compact Flash memory module and the USB Flash Drive.

> NOTE: If a measurement has been previously saved, the Save Measurement dialog box will open with the previously saved name displayed. To save the new measurement with a similar name (for example, Trace-1, Trace-2, and so forth) simply press the Right directional arrow and add the changes. To create a completely new name, use the keypad, the rotary knob or press the soft key for each letter.

Save On Event…
Not implemented in this mode.

Save Screen as JPEG

This function saves a measurement trace as a graphics file. The saved measurement can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the measurement after entering the file name. The file is saved in the internal memory with the specified name, with .jpg appended.

Directory Management
Sort Method
<u>Name</u> Type Date

File lists can be sorted by the name of the file, the type of file (SPA file, STP file, and so forth) or by the date that the file was saved.

Sort
Ascend <u>Descend</u>

Selects whether the selected sort is sorted from lowest to highest (ascending) or highest to lowest (descending). When sorting by name, the sort will place file names that start with numbers before file names that start with letters (an ASCII sort).

Current Location
<u>Int</u>   CF

This choice lets you select where measurements and setups will be saved. Pressing the soft key toggles between storing files on the internal memory or a Compact Flash memory module. The "current location" and the "copy to destination" will never be the same. Changing the current location to save files causes the "copy to destination" to be automatically changed if the selected storage location is the same as the selected current location.

Copy to Destination
Int CF

This choice lets you select where measurements and setups in the "current location" will be copied. The "current location" and the "copy to destination" may not be the same. If you change the destination to which the instrument will copy files, the current location is automatically changed if the current location is the same as the selected copy to destination.

Copy From Current Location To Destination

Pressing this soft key causes all measurements, setups, and jpg files that are stored in the user-selected "current location" to be copied to the "copy to destination". If no storage module is installed in the instrument, then an error message is displayed.

Format Compact Flash

This selection erases all files on an installed Compact Flash module. A message is displayed warning that all files will be erased. Press Enter to confirm that you want to erase and Esc to quit without erasing. In addition to erasing all files stored on the Compact Flash, the /usr directory is created for storage of measurements, setups and jpg files.

Back

The Back key returns to the previous menu.

Recall
Recall Setup

This soft key brings up a selection box that allows selection and recall of a previously stored instrument setup in the current storage location. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved setup, and press **Enter**, the rotary knob, or the Recall soft key to select. All current instrument settings are replaced by the stored setup information. Press the **Esc** key to cancel the recall.

Recall Measurement

Brings up a selection box that allows recall of a previously stored measurement trace from the currently selected storage location. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved measurement trace, and press **Enter**, the rotary knob, or the Recall soft key to select. A recalled trace may be displayed as trace A, in place of the live trace, or as trace B or C along with the live trace. Use the rotary knob or the **Up/Down** arrow keys to highlight the recalled trace option, and press the **Enter** key to select. Press the **Esc** key to cancel the recall.

To remove a recalled measurement trace from the screen, press the **Shift** key and the **Trace** (5) key to open the Trace menu. Use the Trace soft key to select the trace to be removed from the screen and use the View/Blank soft key to view or blank the trace. Use the Trace key to select an active trace after blanking a recalled trace.

Directory Management

See *Directory Management* .

Back

Returns to the previous menu.

Delete

Brings up a selection box that shows all stored setups and traces in the currently selected location (See *Directory Management on page 5-29*.) The list shows the setup and measurement names, the type (stp for a saved setup, spa for a saved trace, jpg for a JPEG file) and the date and time the information was saved. Use the rotary knob or the **Up/Down** arrow keys to highlight the file to be deleted, and press **Enter**, or the Delete soft key to delete. Press the **Esc** key to cancel the operation. Note that there is no mechanism to retrieve deleted files.

Delete Selected File

Use the up and down arrow buttons or the rotary knob to select the file that is to be deleted. Press Enter to confirm that you want to delete the file or Esc to exit without deleting.

Delete ALL Measurements

Deletes all measurements of the current mode in the currently selected storage location. The memory from which measurements will be deleted is set in the Directory Management menu and is the Current Location.

Delete ALL Mode Files

Deletes all measurements of the type saved in the current operating mode of the instrument. In addition all jpg and setup files (regardless of the mode) are deleted.

Delete ALL Contents

Deletes all measurements, jpg files and setup files of ALL measurement types.

Back

The Back key returns to the previous menu.
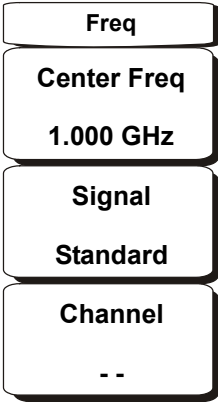
Freq (Frequency)

```
┌─────────────────┐
│      Freq       │
├─────────────────┤
│   Center Freq   │
│                 │
│    1.000 GHz    │
├─────────────────┤
│     Signal      │
│                 │
│    Standard     │
├─────────────────┤
│    Channel      │
│                 │
│      - -        │
└─────────────────┘
```

Figure 5-18. WCDMA/HSDPA Freq Menu

Center Freq
Press the **Freq** key followed by the Center Freq soft key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the **Enter** key has the same affect as pressing the MHz soft key.

Signal Standard
Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard and press **Enter** to select. When a signal standard is selected, the center frequency and span for the first channel of the selected standard is automatically tuned. Other settings, such as channel spacing and integration bandwidth, are also automatically entered. Appendix A contains a table of the signal standards that are in the instrument firmware.

Channel
Use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is automatically tuned to the center frequency of the selected WCDMA channel.
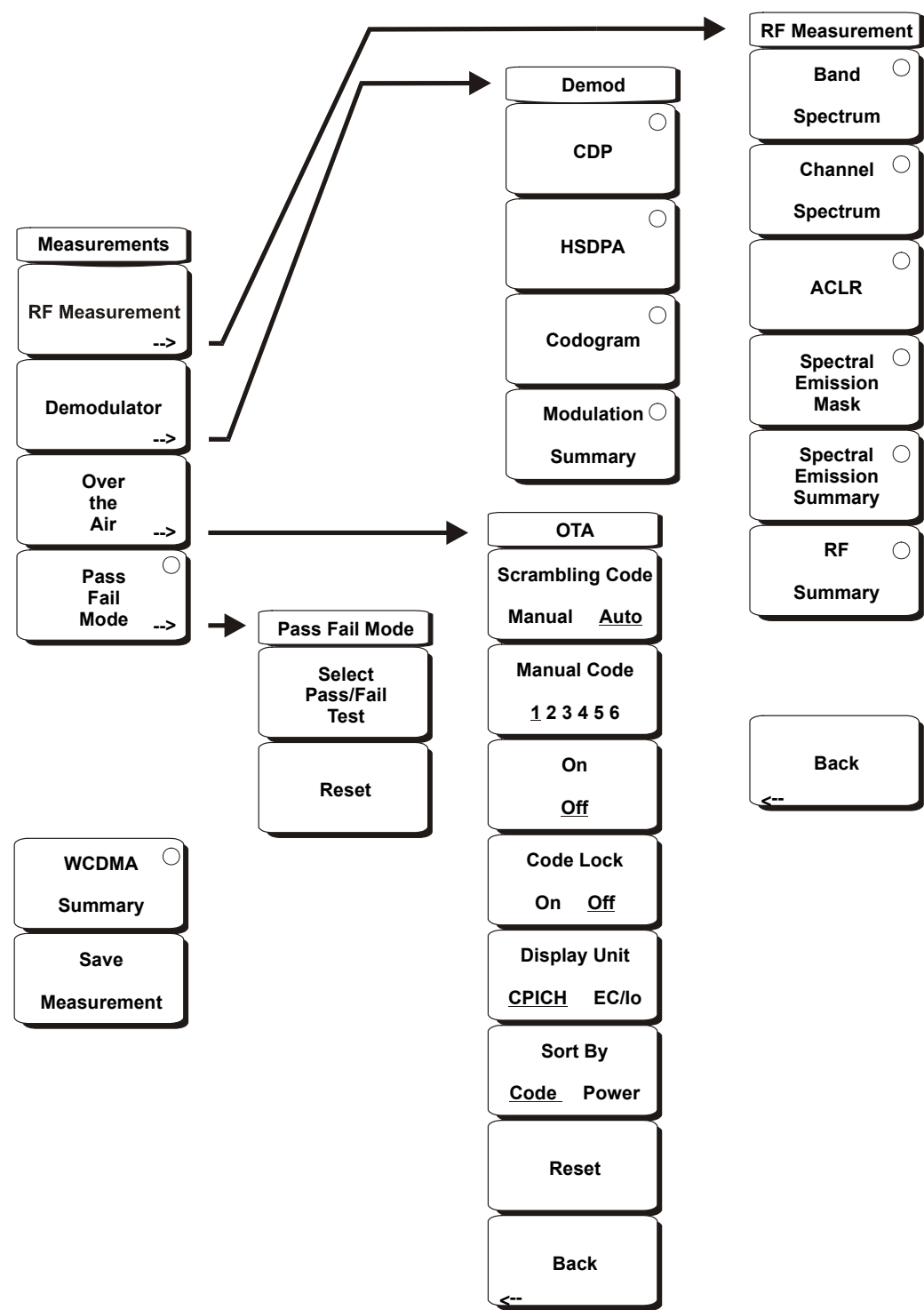
Measurements

Figure 5-19. WCDMA/HSDPA Measurements Menu

RF Measurement

Opens the RF measurement menu.

Band Spectrum

Displays the spectrum of the selected band.

Ref Level

Sets the required reference level.

Scale

Changes the scale.

Band Channel

Use the cursor to select the required channel and the unit analyzes the selected channel signal.

Previous Band

The unit automatically selects the previous band.

Next Band

The unit automatically selects the next band.

Back

Returns to the previous menu.

Channel Spectrum

Displays the spectrum of the selected channel. The screen also displays Channel Power in dBm and watts, Peak to Average power and Occupied Bandwidth.

ACLR

Displays the Adjacent Channel Leakage Ratio (ACLR). The user can set the main channels and adjacent channels from 1 channel to 4 channels. This screen can display up to 12 channels total.

Display Trace

Select ON to display the trace.

Select # of Main Channels

Set the main channels from 1 channel to 4 channels.

Select # of Adjacent Channels

Set the adjacent channels from 1 channel to 4 channels.

Spectral Emission Mask

Displays the received signal and the mask based on received signal strength.

Spectral Emission Summary

Displays the spectral emission mask in table format and whether the received signal passed in each frequency range.

RF Summary

Displays the RF measurements in table form.

Back

Returns to the previous menu.

Demodulator

BTS Master in demodulator mode demodulates the received WCDMA signal. The demodulator has three displays, CDP, Codogram and Modulation Summary.

CDP

When Code Domain Power (CDP) is selected the screen displays all the selected OVSF codes and selected OVSF zoom codes in the graphical format. The display also displays P-CPICH Abs power, EVM, Carrier Frequency, Channel Power, Carrier Feedthrough, Frequency Error in Hz and PPM, Noise Floor and Peak CD Error. The screen also displays control channel view with CPICH, P-CCPCH, S-CCPCH, PICH, P-SCH and S-SCH powers in the table format. If the marker is set on the code, the marker will display the code number, power and Symbol EVM.

Zoom

Select a zoom function of 32, 64, or 128 codes.

Zoom Start

Enter the required zoom start code. For example, to start at code 2, enter 2.

NOTE: For the WCDMA/HSDPA demodulator option, the CDP screen displays HSDPA and WCDMA signals. P-CPICH Abs power, EVM, Carrier Frequency, Channel Power, Carrier Feedthrough, Frequency Error in Hz and PPM, Noise Floor and Peak CD Error are also displayed. The screen displays CPICH, P-CCPCH, S-CCPCH, PICH, P-SCH and S-SCH powers in the table format. If the marker is set on the code, the marker will display the code number, power and Symbol EVM.

HSDPA

When HSDPA is selected the screen displays all the selected OVSF including high speed data channel codes and selected OVSF with high speed codes in the graphical format. The selected code Power versus time and Constellation diagram will be displayed. The display also displays control channel view with P-CPICH Abs power, EVM, Carrier Frequency, Channel Power, Carrier Feedthrough, Frequency Error in Hz and PPM, Noise Floor and Peak CD Error. The screen also displays CPICH, P-CCPCH, S-CCPCH, PICH, P-SCH and S-SCH powers in the table format.

NOTE: This screen is available with the WCDMA/HSDPA demod option only.

Next Active Code Left

Select the next active code left.

Next Active Code Right

Select the right side active code.

Total Time

Set the time for the power versus time screen. The maximum total time is 72 hours.

Single Sweep Time

Set the single sweep time. The unit automatically calculates the total time.

IQ Persistence

Set the number of samples before displaying the screen (maximum 48).

Back

Returns to the previous menu.

Codogram

When Codogram is selected the screen displays the changes in code power levels over time. Two graphs are displayed on the screen, the top one displays all the selected OVSF codes and the bottom one displays the selected OVSF zoom codes.

Zoom

Select a zoom function of 32, 64, or 128 codes.

Zoom Start

Enter the required zoom start code. For example, to start at code 2, enter 2.

Total Time

Use the keypad, the **Up/Down** arrow keys, or the rotary knob to enter the total time to display the changes in code power levels. The maximum total time for Codogram is 72 hours.

Single Sweep Time

Single sweep time is related to total time. Use the keypad, the **Up/Down** arrow keys, or the rotary knob to set the single sweep time.

Modulation Summary

Displays the demodulation parameters in the table format.

Back

Returns to the previous menu.

Over the Air

Displays the WCDMA/HSDPA Over The Air Measurements, six scrambling codes, CPICH, Ec/Io, Ec, Pilot Dominance and OTA total power.

Scrambling Code

Set the scrambling codes manually or auto.

Manual Code

Set the manual codes manually.

On/Off

Switch On/Off the manual codes.

Code Lock

Lock the measured codes.

Display Unit

Display the codes by CPICH or Ec/Io.

Sort By

Sort the measured codes by code numbers or power.

Reset

Reset the measurement screen.

Back

Returns to the previous menu.

Pass/Fail Mode

The BTS Master saves the five test model conditions specified in the 3GPP specification to test the base station. After the selected test model, the unit displays whether the base station passed or failed the test. Using Master Software Tools, a custom test list can be created and downloaded into the unit. All critical measurements can be selected for pass fail testing including each individual code power, spreading factor and symbol EVM. The results are displayed in table format with clear identification of pass/fail results including min/max thresholds and measured results.

Select Pass/Fail Test

Select the parameters file from the list.

Reset

Restart the measurement.

Back

Returns to the previous menu

WCDMA Summary

Displays the critical WCDMA measurements in a table format.

Save Measurement

Initiates a dialog box to name and save the current measurement. The saved measurement can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the measurement WCDMA/HSDPA measurements are saved with a .wcd extension. GSM/EDGE measurements are saved with a .edg extension.

NOTE: If a measurement has been previously saved, the Save Measurement dialog box will open with the previously saved name displayed. To save the new measurement with a similar name (for example, Trace-1, Trace-2, and so forth) simply press the Right directional arrow and add the changes. To create a completely new name, use the keypad, the rotary knob or press the soft key for each letter.

Mode

To access the functions under the Mode menu, press the **Shift** key, then the **Mode** (9) key. Use the directional arrow keys or the rotary knob to highlight the selection and press the **Enter** key to select.
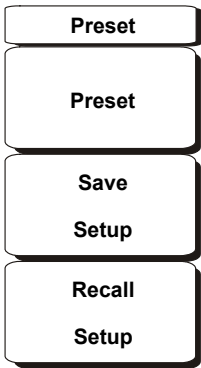
Preset

Figure 5-20. WCDMA/HSDPA Preset Menu

To access the functions under the Preset menu, press the **Shift** key, then the **Preset** (1) key.

Preset
This key resets the instrument to the default starting conditions of full band sweep, 10 dBm log reference level, 10 dB/division scaling, 0 dB reference level offset, all measurements turned off and trigger set to free run.

Save Setup
Opens a dialog box to name and save the current operating settings, allowing them to be recalled later to return the instrument to the state it was in at the time the setup was saved. The saved setup can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the setup.

Recall Setup
This soft key brings up a selection box that allows selection and recall of a previously stored instrument setup. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved setup, and press **Enter**, the rotary knob, or the Recall soft key to select. All current instrument settings are replaced by the stored setup information. Press the **Esc** key to cancel the recall.
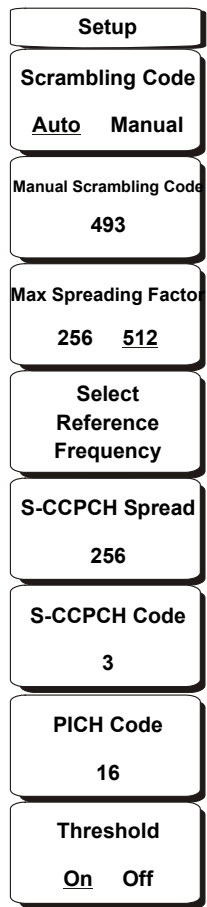
Setup

Figure 5-21. WCDMA/HSDPA Setup Menu

Auto Scrambling
Press the Auto Scrambling soft key to automatically select the scrambling code. This key toggles Auto Scrambling On or Off.

Scrambling Code
Press the Scrambling Code soft key to manually enter the scrambling code using the number keys or the rotary knob.

Max Spreading Factor
Press the Max spreading factor to toggle between 256 codes and 512 codes.

Select Reference Frequency
Press Select reference frequency and select from the displayed list using **Up/Down** arrow keys or rotary knob and press enter.

S-CCPCH Spread
Press S-CCPCH Secondary Common Control Physical Channel soft key to enable the S-CCPCH spreading factor and enter the desired code. The default value is 256.

S-CCPCH Code
Press S-CCPCH code to enable and enter the S-CCPCH code. The default value is 3.

PICH Code
Press PICH to activate Paging Indicator Channel and enter the desired code. The default value is 16.

Threshold
Change the measurement threshold by pressing threshold soft key and entering a desired value and pressing enter soft key. The default value is −30 dB.
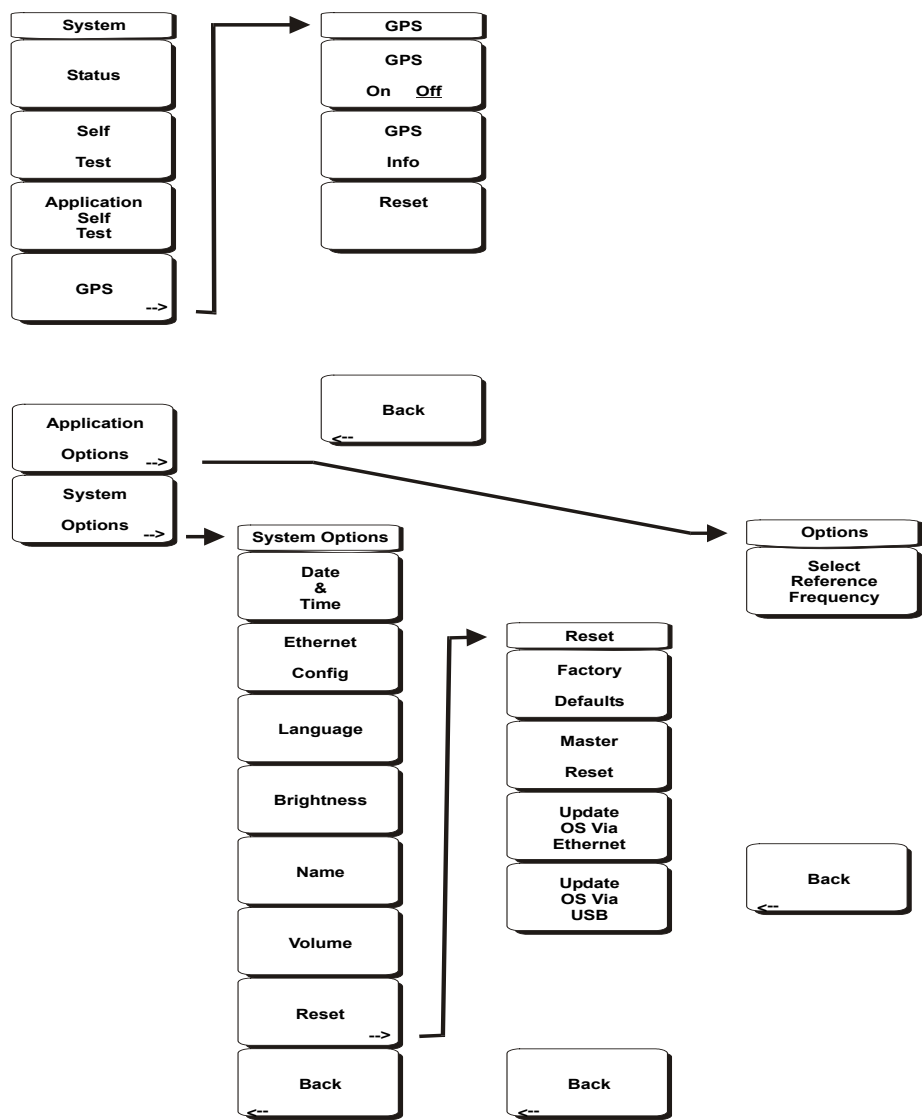
System

Figure 5-22. WCDMA/HSDPA System Menu

To access the functions under the System menu, press the **Shift** key, then the **System** (8) key. For details about these soft keys, refer to *System* on page 2-17.

Chapter 6
GSM/GPRS/EDGE Signal Analyzer

Introduction

Global Systems for Mobile (GSM) communication is a globally accepted standard for digital cellular communication. GSM uses a combination of Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA). Within each band are approximately one hundred available carrier frequencies on 200 kHz spacing (FDMA), and each carrier is broken up into time-slots so as to support eight separate conversations (TDMA). Each channel has an uplink and a downlink. GSM uses the Gaussian Minimum Shift Keying (GMSK) modulation method.

GPRS/EDGE is an extension of GSM technology and is applicable to data services. GSM uses Gaussian Minimum Shift Keying (GMSK) modulation and EGDE uses 8PSK Phase Shift Keying modulation.

The GSM/GPRS/EDGE frequency ranges are 380-400 MHz, 410-430 MHz, 450-468 MHz, 478-496 MHz, 698-746 MHz, 747-792 MHz, 806-866 MHz, 824-894 MHz, 890-960 MHz, 880-960 MHz, 876-960 MHz, 870-921 MHz and 1710-1990 MHz.

The MT8222A BTS Master features two GSM/GPRS/EDGE measurement modes: RF Measurements (Option 40) and Demodulator (Option 41). The MT8222A can be directly connected to any GSM/GPRS/EDGE base station for accurate measurements. When a physical connection is not available or required, the MT8222A can receive and demodulate GSM/GPRS/EDGE signals over the air.

GSM/GPRS/EDGE RF measurements provide views of spectrum, power versus time (frame), power versus time (slot) with mask and summary screens.

The spectrum view displays channel spectrum and multi-channel spectrum. The channel spectrum screen includes channel power, burst power, average burst power, frequency error, modulation type and Training Sequence Code (TSC). The multi-channel spectrum displays as many as ten channels and, using the cursor to select a channel, can display the measurements for just the selected channel.

GSM/GPRS/EDGE Demodulator (Option 41) demodulates GSM/GPRS/EDGE signals and displays the results of detailed measurements to analyze transmitter modulation performance. Results are shown for phase error (rms), phase error peak, EVM (rms), EVM (peak), origin offset, C/I, modulation type and magnitude error (rms) and a vector diagram of the signal.

This chapter describes the MT8222A BTS Master keys in GSM/GPRS/EDGE Signal Analyzer mode. The major sections are arranged in alphabetical order with soft key menus listed in the order they appear from top to bottom.

> NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.

Getting Started

GSM/GPRS/EDGE Signal Analyzer Mode

To prepare for GSM/GPRS/EDGE signal analyzer measurements, the MT8222A must be configured for Spectrum Analyzer Mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight GSM/GPRS/EDGE Signal Analyzer and press the **Enter** key to select.

For additional information about the Mode menu, refer to *Mode Selector Menu* on page 2-16.

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* on page 2-5.

External Reference Frequency Setup

For the best frequency accuracy measurements, it is important to use an external reference frequency attached to the BTS Master Ext Ref In connector. Most base stations have a reference frequency available on a BNC connector that can be used for this purpose. To configure the BTS Master to use an external reference frequency:

1. Press the **Setup** function hard key.
2. Press the Ext Ref Freq soft key to display a list of the available reference frequencies.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight the applicable reference frequency on the list and press the **Enter** key to set the reference frequency.

As the BTS Master locks to the source, the Reference Source value is displayed in the Instrument Setting Summary to the left of the display.

GSM/GPRS/EDGE RF Measurements

GSM RF measurements consists of Spectrum, Power versus Time (frame), Power versus Time (slot), Summary and Demodulator. To make GSM/GPRS/EDGE measurements connect the unit to the base station following the instructions.

> **CAUTION:** The maximum input power without damage is +30 dBm on the RF In port. To prevent damage, always use a coupler or high power attenuator.

1. Press the **Shift** key, then the **Mode** (9) key, using rotary knob or **Up/Down** arrow keys select GSM/GPRS/EDGE Signal Analyzer and press the **Enter** key to select.
2. Press the **Freq** function hard key.
3. Press the Center Freq soft key and enter the desired frequency, or press the Signal Standard soft key and select the applicable GSM standard.
4. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
5. Press the **Setup** function hard key.
6. Press the GSM/EDGE soft key and highlight Auto to automatically select the GSM or EDGE signal.

> NOTE: Highlight GSM or EDGE to set the instrument to measure only a GSM or EDGE signal.

7. Press the Ext Ref Freq soft key to display a list of the available reference frequencies and select the desired reference frequency to get accurate frequency measurements as described in the previous section, or activate the GPS (if equipped) to get GPS High Accuracy frequency error measurements.

Measurement Display

Press the **Measurements** function hard key to select measurement display options.

To display Spectrum, press the Spectrum soft key. Press the Channel Spectrum soft key for a single channel, or the Multi-Channel Spectrum soft key to display the multi-channel spectrum.
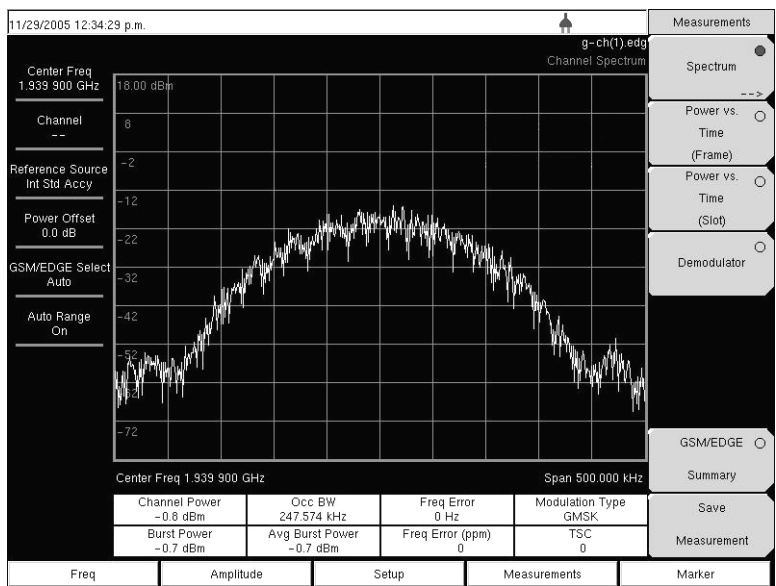

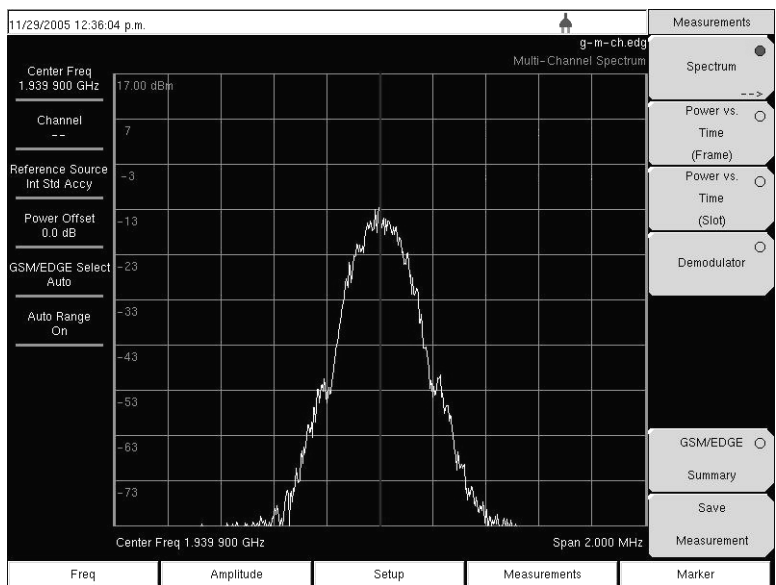**Figure 6-1. GSM Single Channel Measurement Example**

Figure 6-2. GSM Multi-channel Measurement Example

To display Power versus Time (Frame) press the Power versus Time (Frame) soft key to activate the Power versus Time (Frame) measurement.
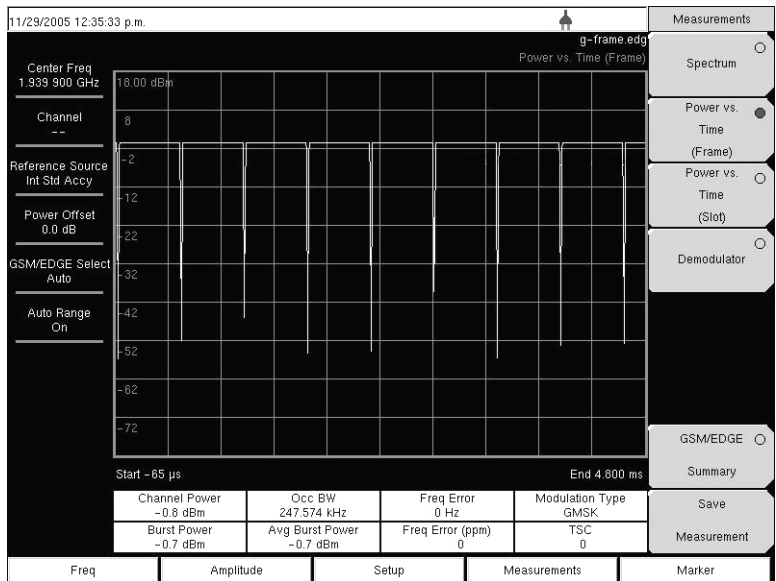

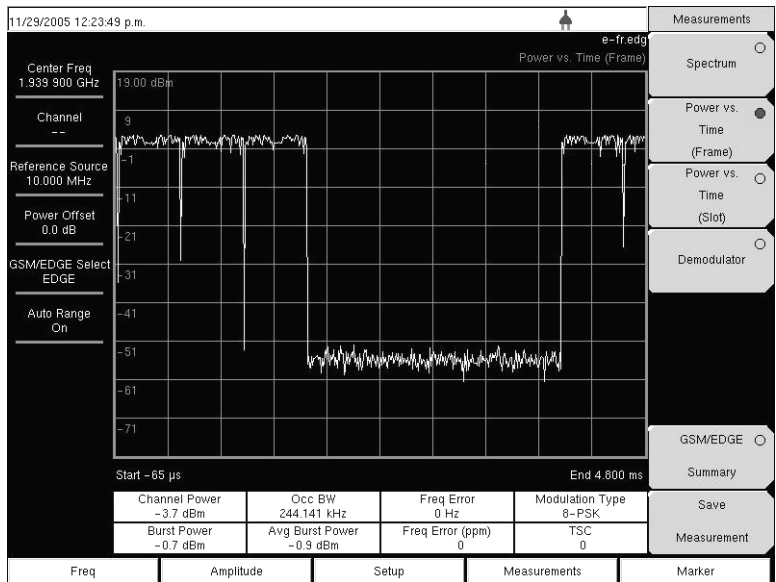Figure 6-3. GSM Power versus Time (Frame) Measurement Example

Figure 6-4. EDGE Power versus Time (Frame) Measurement Example

To display Power versus Time (Slot) press the Power versus Time (Slot) soft key to activate the Power versus Time (Slot) measurement. The mask is according to the 3GPP TS 05.05 specification. The MT8222A displays the first slot information.
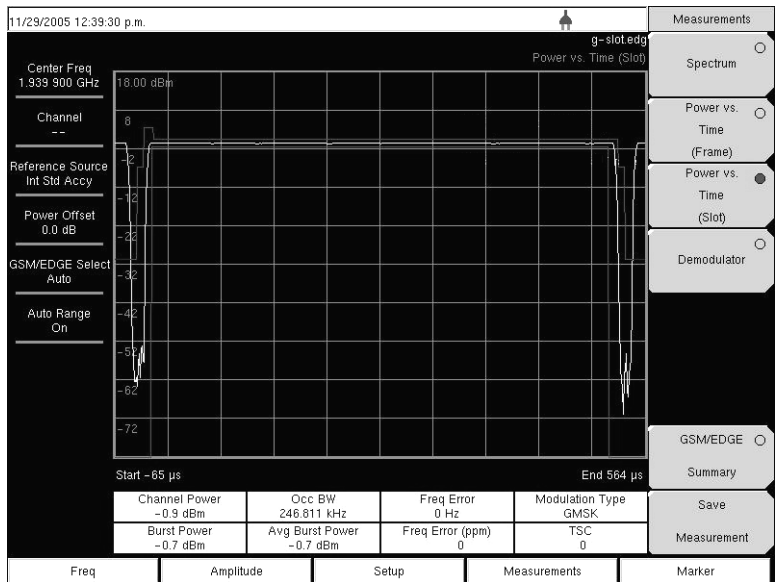

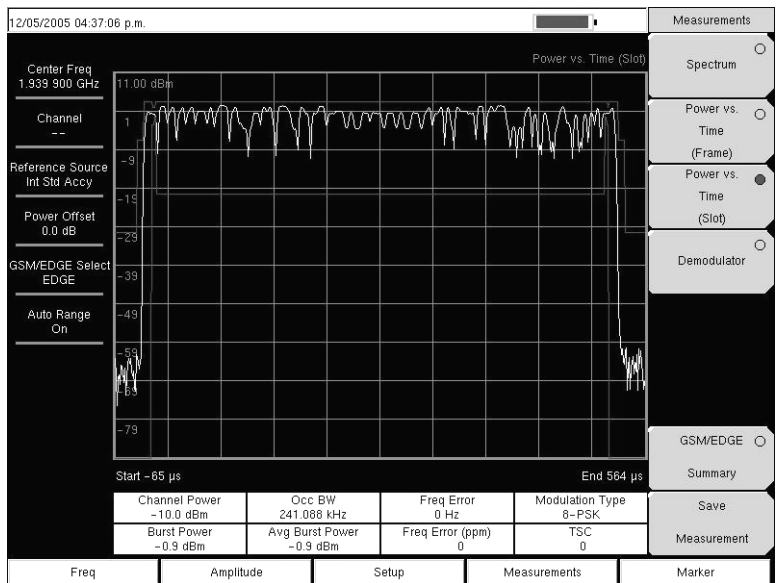**Figure 6-5. GSM Power versus Time (Slot) Measurement Example**

Figure 6-6. EDGE Power versus Time (Slot) Measurement Example

Demodulator

This measurement demodulates the GSM/GPRS/EDGE signal and displays the vector with Phase Error, EVM, Origin Offset, C/I, Modulation Type and Magnitude Error (as applicable). To demodulate the GSM/EDGE signal:

1. Press the **Shift** key, then the **Mode** (9) key, using rotary knob or up/down arrow keys select GSM/GPRS/EDGE Signal Analyzer and press the **Enter** key to select.
2. Press the **Freq** function hard key.
3. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable GSM standard.
4. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
5. Press the **Setup** function hard key.
6. Press the GSM/EDGE soft key and highlight Auto to automatically select the GSM or EDGE signal.

> NOTE: Highlight GSM or EDGE to set the instrument to measure only a GSM or EDGE signal.

7. Press the Ext Ref Freq soft key to display a list of the available reference frequencies and select the desired reference frequency to get accurate frequency measurements as described in the previous section, or activate the GPS (if equipped) to get GPS High Accuracy frequency error measurements.
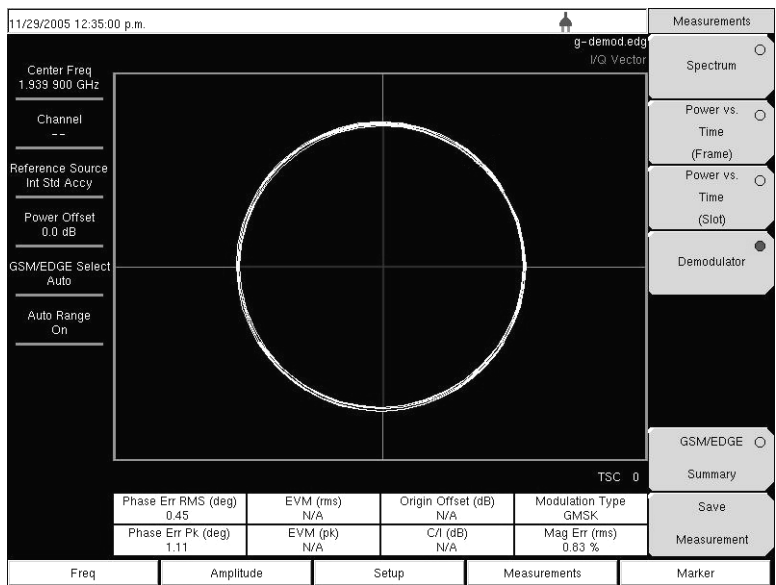8. Press the **Measurements** function hard key.
9. Press the Demodulator soft key.

Figure 6-7. GSM Demodulator Measurement Example

> NOTE: Using multi-channel spectrum, channel cursor, select the channel and press the Demodulator soft key and the unit will demodulate the selected channel.
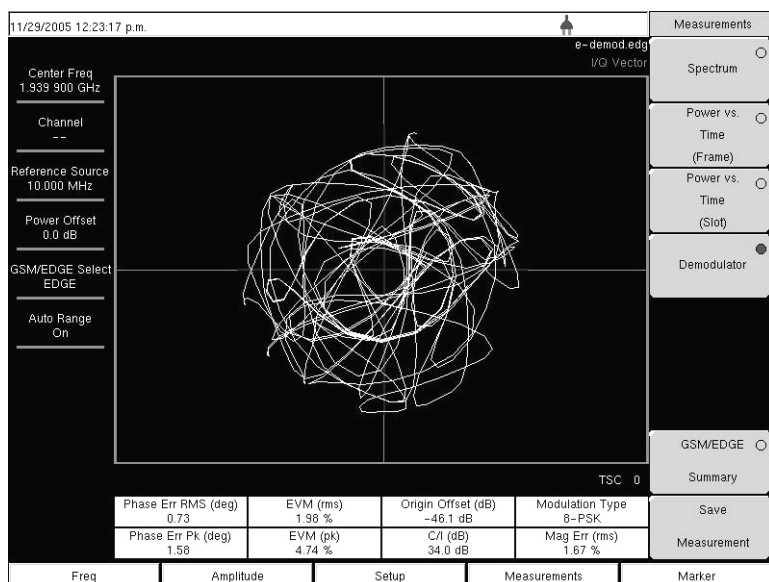
Figure 6-8. EDGE Demodulator Measurement Example

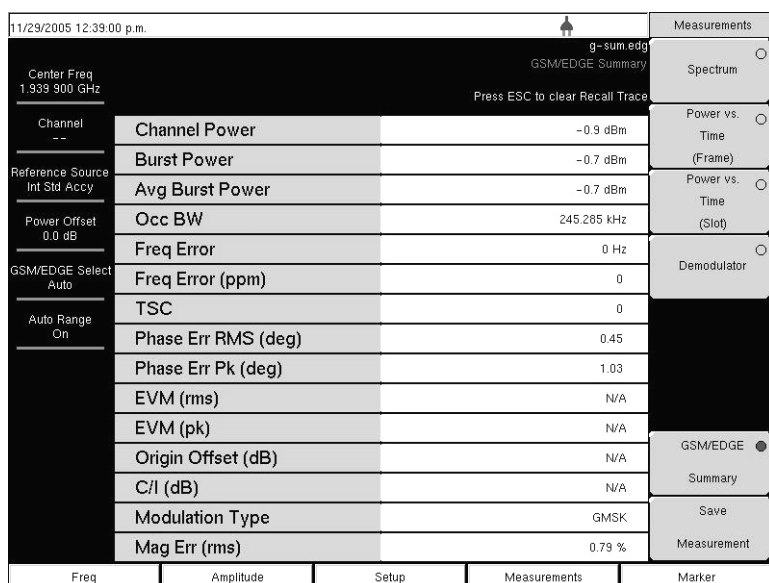To display the GSM/EDGE Summary screen, press the GSM/EDGE Summary soft key.

Figure 6-9. GSM Summary Screen Example

11/29/2005 12:33:55 p.m.	

e-sum.edg
GSM/EDGE Summary
Press ESC to clear Recall Trace

Center Freq
1.939 900 GHz

Channel
--

Reference Source
10.000 MHz

Power Offset
0.0 dB

GSM/EDGE Select
EDGE

Auto Range
On

Channel Power	-4.2 dBm
Burst Power	-1.2 dBm
Avg Burst Power	-1.0 dBm
Occ BW	242.233 kHz
Freq Error	0 Hz
Freq Error (ppm)	0
TSC	0
Phase Err RMS (deg)	0.62
Phase Err Pk (deg)	1.50
EVM (rms)	1.97 %
EVM (pk)	4.26 %
Origin Offset (dB)	-53.2 dB
C/I (dB)	34.1 dB
Modulation Type	8-PSK
Mag Err (rms)	1.68 %

Measurements

Spectrum

Power vs.
Time
(Frame)

Power vs.
Time
(Slot)

Demodulator

GSM/EDGE
Summary

Save
Measurement

| Freq | Amplitude | Setup | Measurements | Marker |

Figure 6-10. EDGE Summary Screen Example

GSM/GPRS/EDGE Mode Pass/Fail

The BTS Master can store test sets for testing base station performance and can recall these test sets for quick, easy measurements. These test sets are for reference only and can be edited using Master Software Tools. When a test set is selected, the BTS Master displays the test results in a tabular format with PASS or FAIL indications that include min/max thresholds.
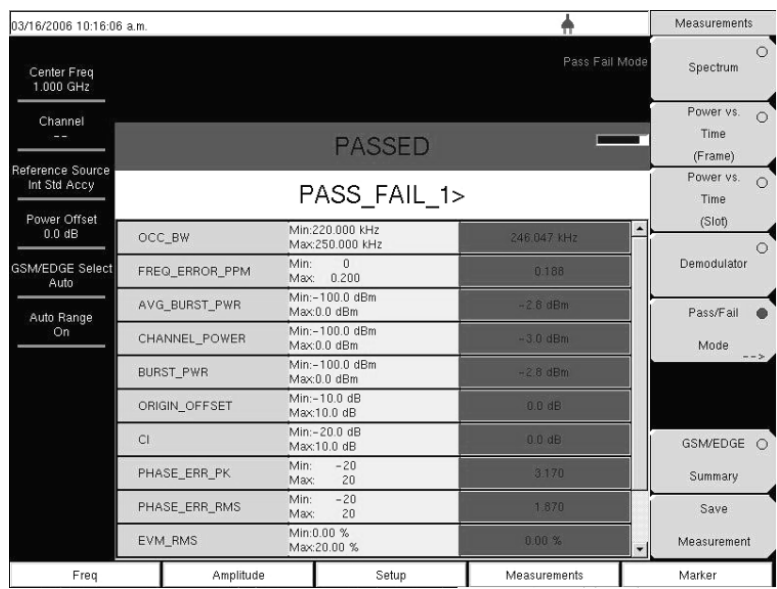

Figure 6-11. Pass/Fail Mode Example Screen

Using Master Software Tools, a custom test set can also be created and downloaded into the BTS Master. All measurement parameters can be selected for pass/fail testing.

Pass/Fail Mode Procedure

1. Press the **Shift** key, then the **Mode** (9) key, using rotary knob or **Up/Down** arrow keys select GSM/GPRS/EDGE Signal Analyzer and press the **Enter** key to select.
2. Press the **Freq** function hard key.
3. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable GSM standard.
4. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
5. Press the **Measurements** function hard key.
6. Press the Pass/Fail Mode soft key to activate Pass/Fail Mode.
7. Press the Pass/Fail Mode soft key to display the Pass/Fail Mode menu and then press the Select Pass/Fail Test soft key to display the available test sets.
8. Use the rotary knob or **Up/Down** arrow keys to select the applicable test set and to activate the measurement.
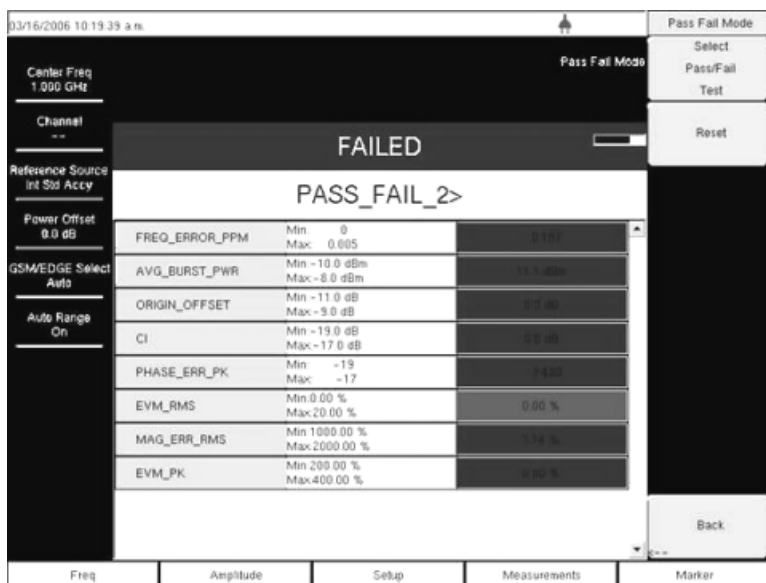
Figure 6-12. Pass/Fail Mode Test Results Example

Refer to the Master Software Tools documentation for information on creating a custom pass/fail test set.

Measurement Results

Average Burst Power

The average burst power over 10 measured burst power values. This average is restarted when a new frequency is selected.

Channel Power

Channel power measures the average power in a GSM/EDGE frame in the frequency specified. Out of specification power indicates system faults. Channel power is expressed in dBm.

Freq Error

The difference between the received frequency and the specified frequency is the frequency error. This number is only as accurate as the frequency reference used, and is typically only useful with a good external frequency reference or GPS. Frequency error is displayed in both Hz and ppm.

Meas Occ BW

The occupied bandwidth is calculated as the bandwidth containing 99% of the transmitted power.

Burst Power

Burst power is the average power over the useful part of the first active burst GSM/EDGE slot. A GSM/EDGE signal has eight time slots in a frame.

TSC

The Training Sequence Code detected in the first active burst is displayed. GSM/EDGE base stations may use Training Sequence Codes 0-7. If no valid TSC is detected 'Not Found' is displayed.

Phase Err RMS (deg)

The RMS phase error in degrees between the received signal and an ideal reconstructed reference signal of the first active slot.

Phase Err Pk (deg)

The peak phase error in degrees between the received signal and an ideal reconstructed reference signal of the first active slot.

EVM (rms)

The RMS (%) of all the error vectors between the ideal reconstructed reference symbol points and the received symbol points divided by the RMS value of the signal present in the first active slot. This measurement is performed for 8PSK modulated signals (EDGE) only.

EVM (pk)

The peak (%) of all the error vectors between the ideal reconstructed reference symbol points and the received symbol points divided by the RMS value of the signal present in the first active slot. This measurement is performed for 8PSK modulated signals (EDGE) only.

Origin Offset (dB)

Origin Offset is the carrier leakage component of the measured signal in dB and this measurement is applicable to EDGE signal only.

Carrier to Interference Ratio – C/I (dB)

Carrier to Interference Ratio is the ratio of the desired carrier power to the undesired signal power (interferer) in dB. This value is an estimate that is derived from the measured RMS EVM value. This measurement is applicable to an EDGE signal only.

Modulation type

The modulation type can be GMSK (for GSM signals) or 8PSK (for EDGE signals).

Mag Err (rms)

The RMS of the magnitude error between the received signal and an ideal reconstructed reference signal of the first active slot in %.

GSM/GPRS/EDGE Menus

Amplitude

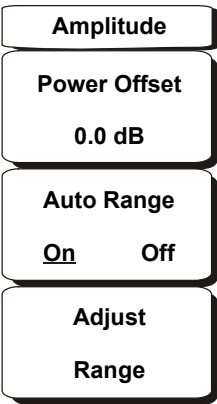The **Amplitude** function hard key opens the following soft key menu keys:

Figure 6-13. GSM/GPRS/EDGE Mode Amplitude Menu

Power Offset
Choose power offset to have the BTS Master automatically adjust for the loss through any external cables, attenuators and couplers. The power can be offset from −100 dB to +100 dB. Press the Power Offset key, enter the values and press the dB soft key. Press **Esc** to cancel.

> NOTE: By default, the BTS Master will automatically change attenuation, preamplifier and digital gain settings to make the best GSM measurements.

Auto Range
When Auto Range is activated, the BTS Master adjusts the reference level automatically. Pressing the Auto Range soft key toggles between On and Off.

Adjust Range
This soft key adjusts the reference level to be optimal based on the measured signal. Adjust range is used only when the Auto Range setting is Off.

Freq (Frequency)

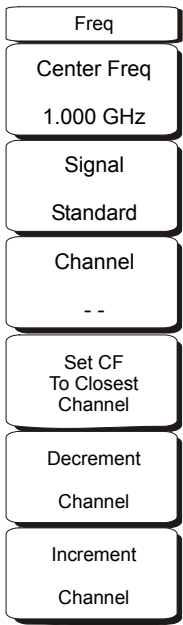The **Freq** function hard key opens the following soft key menu:

Figure 6-14. WCDMA/HSDPA and GSM/GPRS/EDGE Mode Freq Menu

Center Freq
Press the **Freq** key followed by the Center Freq soft key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the **Enter** key has the same affect as pressing the MHz soft key.

Signal Standard
Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard and press **Enter** to select. When a signal standard is selected, the center frequency and span for the first channel of the selected standard is automatically tuned. Other settings, such as channel spacing and integration bandwidth, are also automatically entered. Appendix A contains a table of the signal standards that are in the instrument firmware.

Channel
Use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is automatically tuned to the center frequency of the selected GSM/EDGE channel.

Set CF To Closest Channel
Press the soft key to change the center frequency to the closest channel.

Decrement Channel
Use the **Up/Down** arrow keys or the rotary knob to decrease the channel number one channel.

Increment Channel
Use the **Up/Down** arrow keys or the rotary knob to increase the channel number one channel.

Setup

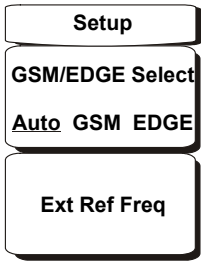The Setup function hard key opens the following soft key menu:

Figure 6-15. GSM/GPRS/EDGE Mode Setup Menu

GSM/EDGE Select

This soft key toggles between Auto, GSM and EDGE. Auto allows the instrument to search for a GSM or EDGE signal automatically. Selecting GSM or EDGE sets the instrument to measure only a GSM or EDGE signal.

Ext Ref Freq

Press the Ext Ref Freq soft key to select the frequency of the external reference from the list. Use the arrow keys or the rotary knob to highlight the desired frequency and press the **Enter** key to select. Press the **Esc** key to cancel.

Measurements

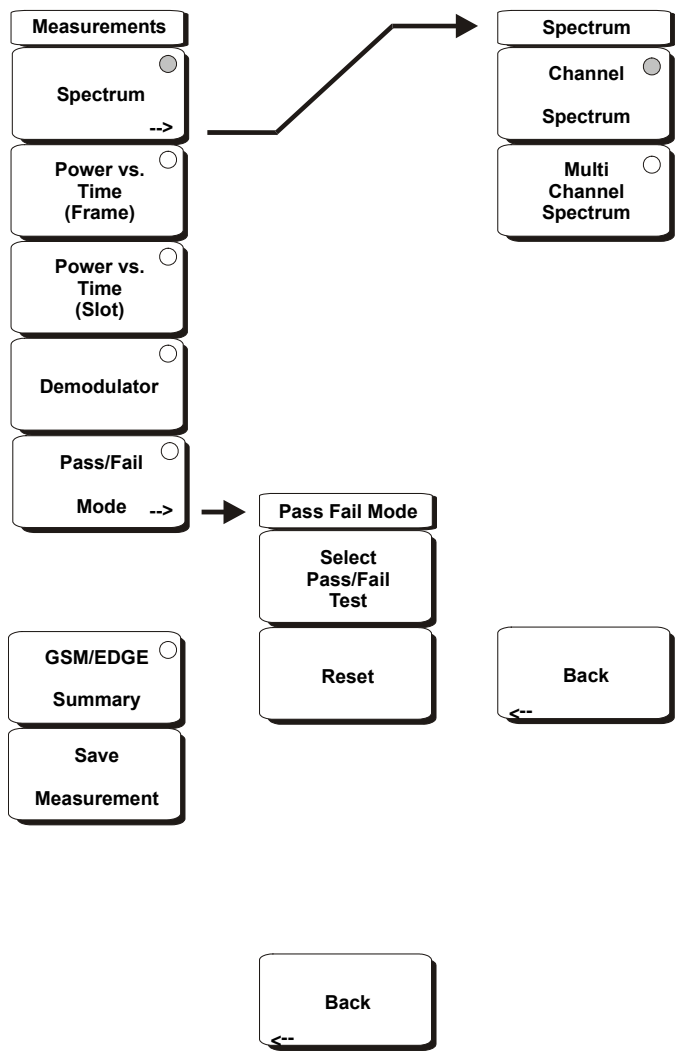The Measurements function hard key opens the following soft key menu:

Figure 6-16. GSM/GPRS/EDGE Mode Measurements Menu

Spectrum
Opens the spectrum menu.

Channel Spectrum
Displays the spectrum of the selected channel. The screen also displays Channel Power, Burst Power, Frequency Error in PPM and Hz, Occupied Bandwidth and the Training Sequence Code (TSC).

Multi-Channel Spectrum
Displays the spectrum of ten GSM/EDGE channels.

Channel Cursor
Select Channel Cursor to place the cursor at a specific channel location. Use the rotary knob or the **Up/Down** arrow keys to select the channel. Press the **Enter** key to select.

Freq Cursor
Select Freq Cursor to place the cursor at a specific frequency. Use the rotary knob or the **Up/Down** arrow keys to select the frequency. Press the **Enter** key to select.

Power versus Time (Frame)
Displays approximately eight and a half slots of the GSM/EDGE signal frame starting from the first active slot found. The screen also displays Channel Power, Burst Power, Frequency Error in PPM and Hz, Occupied Bandwidth and Training Sequence Code (TSC).

Power versus Time (Slot)
Displays the first active slot of the GSM/EDGE signal capture. The mask is as specified in 3GPP TS 05.05. The screen also displays Channel Power, Burst Power, Frequency Error in PPM and Hz, Occupied Bandwidth and Training Sequence Code (TSC).

Demodulator
Displays the IQ vector of the GSM/EDGE signal. The screen also displays Phase Err RMS, Phase Err Pk, EVM (rms), EVM (pk), Origin Offset (dBc), C/I (dB), Modulation Type and Magnitude Error (rms).

NOTE: GSM uses GMSK modulation and EDGE uses 8PSK modulation. EVM (rms), EVM(pk), Orgin Offset, C/I are not measured for GSM signals (shows N/A on the display).

Pass/Fail Mode
Displays the Pass/Fail measurements in a table format with clear pass or fail indicators that include min/max thresholds and actual measured results.

Select Pass/Fail Test
Display the available test sets.

Reset
Resets the Pass/Fail Mode test.

Back
Returns to the previous menu.

GSM/EDGE Summary
Displays the measurement results in a table format.

Save Measurement
Initiates a dialog box to name and save the current measurement. The saved measurement trace can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the measurement trace.

NOTE: If a measurement has been previously saved, the Save Measurement dialog box will open with the previously saved name displayed. To save the new measurement with a similar name (for example, Trace-1, Trace-2, and so forth) simply press the Right directional arrow and add the changes. To create a completely new name, use the keypad, the rotary knob or press the soft key for each letter. GSM measurements are saved with a .gsm file extension, and GSM/EDGE measurements are saved with an .edg extension.

Chapter 7
CDMA Signal Analyzer

Introduction

The BTS Master MT8222A offers three CDMA options:

- Option 33, cdmaOne and CDMA2000 1xRTT (OTA), requires Option 31

- Option 42, CDMA RF measurements

- Option 43, cdmaOne and CDMA2000 1xRTT demodulator

The BTS Master can measure CDMA signals over the air (OTA) with an antenna or by directly connecting the BTS Master to the base station.

Getting Started

CDMA Mode

To prepare for CDMA measurements, the MT8222A must be configured for CDMA mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight **CDMA Signal Analyzer** and press the **Enter** key to select.

For additional information about the Mode menu, refer to *Mode Selector Menu* on page 2-16.

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* on page 2-5.

CDMA Measurement Setup

The BTS Master can measure CDMA performance over the air (OTA) with an antenna, or by connecting the base station directly to the BTS Master.

To measure a CDMA signal over the air, connect the appropriate frequency band antenna to the BTS Master RF Input and connect an Anritsu GPS antenna to the BTS Master GPS connector.

To connect the base station to the BTS Master, connect the power amplifier of the base station to the RF In port of the BTS Master by using a coupler or attenuator.

> **CAUTION:** The maximum input damage level of the RF In port is +30 dBm. To prevent damage always use a coupler or high power attenuator.

Measurement Frequency Setup

The measurement frequency can be set by entering the center frequency or by selecting the applicable signal standard and channel, which allows the BTS Master to automatically set the frequency.

To Enter the Center Frequency:

1. Press the **Freq** function hard key.
2. Press the Center Freq soft key.
3. Enter desired frequency by using the keypad, the arrow keys, or the rotary knob.

If entering a frequency using the keypad, then the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the **Enter** key has the same affect as pressing the MHz soft key.

4. Press the **Enter** key to set the Center Frequency. The current setting is shown on the left side of the measurement screen.

Figure 7-1. Frequency Setup

To Select A Signal Standard:

1.   Press the **Freq** function hard key.
2.   Press the Signal Standard soft key.
3.   Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard, and press **Enter** to select. When a signal standard is selected, the center frequency for the first channel of the selected standard is automatically tuned.
4.   Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the screen. The current settings are displayed on the left side of the measurement screen.

NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.

Power Offset Setup (for Compensating External Loss)

To get accurate results, the external attenuation should be compensated using power offset. In power offset mode, the compensation factor is in dB. The external attenuation is caused by using an external cable or by using an external high power attenuator.

1.   Press the **Amplitude** function hard key.
2.   Press the Power Offset soft key and use the keypad, the arrow keys, or the rotary knob to enter the desired offset value. Press the **Enter** key to set the Power Offset. The entered value is displayed on the left side of the measurement screen.

Figure 7-2. Power Offset

PN Select Setup

The BTS Master needs a timing reference in order to determine PN Offset and timing errors. This reference comes from the base station when it is connected to the BTS Master, or it can be recovered from GPS when a GPS antenna is connected to the BTS Master. The setup for this function is as follows:

1. Press the **Setup** function hard key.
2. Press the PN Setup soft key to open the PN setup menu.
3. Press the PN Trigger soft key to toggle through No trigger, GPS, or External.
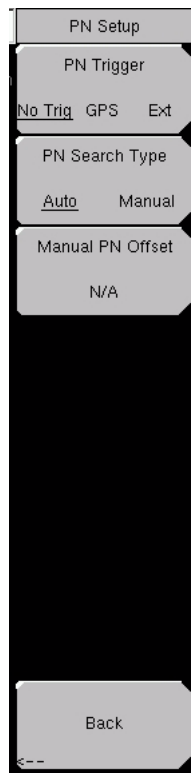
Figure 7-3. PN Setup

No Trigger If both GPS and external timing are unavailable, then you may choose No Trigger for the PN search.

GPS BTS Master uses GPS as the timing reference.

External BTS Master uses an external, even-second time mark as the timing reference. The time mark is usually available at the base station on a BNC connector labeled "ESTM" or "PP2S". ESTM must be connected to the External Trigger In connector on the BTS Master.

4. Press the PN Search Type soft key to toggle between Auto or Manual. In Auto mode, the BTS Master automatically detects the strongest pilot, while in Manual mode it searches only for the specified PN.

> NOTE: If Manual Search Type is selected, then press Manual PN Offset and enter the desired PN value.

5. Press Back to return to the previous menu.

Walsh Codes Setup

Walsh Codes setup is used to select whether cdmaOne (Walsh Codes 64) or CDMA2000 1xRTT (Walsh Codes 128) is required for the measurements. When 128 codes is selected, the upper CDP (Code Domain Power) graph displays the CDP in bit-reversed order.

1. Press the **Setup** function hard key.
2. Press the Walsh Codes soft key, and the key is toggled between 64 codes and 128 codes.

Figure 7-4. Walsh Codes Setup

External Reference Frequency Setup

In order to get the best frequency accuracy measurements, an external reference frequency must be attached to the BTS Master Ext Ref In connector, or a GPS connection must be attached to the BTS Master GPS connector. Most base stations have a reference frequency that is available on a BNC connector.

To configure the BTS Master to use an external reference frequency, perform the following:

1. Press the **Setup** function hard key.
2. Press the external reference frequency (Ext. Ref. Freq) soft key to display a list of the available reference frequencies:

Table 7-1. External Reference Frequencies for EVDO

1 MHz	2.4576 MHz	9.8304 MHz
1.2288 MHz	4.8 MHz	10 MHz
1.544 MHz	4.9152 MHz	13 MHz
2.048 MHz	5 MHz	19.6608 MHz

3. Use the **Up/Down** arrow keys or the rotary knob to highlight the applicable reference frequency on the list, and then press the rotary knob or the **Enter** key to set the reference frequency.
   As the BTS Master locks to the source, the Reference Freq value is displayed within the user-settable parameters that are shown to the left of the measurement screen.

GPS Setup

GPS provides improved accuracy in the timing circuit, which reduces frequency error. To configure the BTS Master to use GPS, use the following procedure:

1. Install the Anritsu GPS antenna to the GPS antenna connection on the BTS Master connector panel.
    One antenna that is now available from Anritsu and that is suitable for this purpose is the 2000-1410 Magnet Mount GPS Antenna with 5 m (15 ft.) cable.

> **CAUTION:** Note that the GPS antenna connection on the BTS Master is fitted with a reverse BNC connector to help prevent damage to the GPS circuitry. A DC voltage is present on this connector. Never connect anything other than the Anritsu GPS antenna to this port.

2. Press the **Shift** key and the **System** (8) key to open the system options menu. Refer to Figure 7-22 *CDMA System Menu on page 7-34*.
3. Press the GPS soft key to open the GPS menu.
4. Press the GPS On/Off soft key to turn the GPS feature on or off. When GPS is first turned on, the GPS icon (shown in Figure 7-5) is displayed in red:

Figure 7-5. GPS Icon, Red

When the GPS receiver is tracking at least three satellites, the GPS icon changes to green, as shown in Figure 7-6:

Figure 7-6. GPS Icon, Green

> NOTE: As long as three minutes may be required for the Ref Freq status to change to GPS High Accuracy in the Status menu. Status is displayed on the left side of the measurement screen.

5. Press the GPS Info soft key to view the number of tracked satellites, latitude, longitude, altitude, UTC timing information, and so forth.

> NOTE: To reset the GPS, press the Reset soft key. The green GPS icon with a red cross appears when GPS satellite tracking is lost (Figure 7-7). This occurs after being active (tracking three or more satellites).

Figure 7-7. GPS Icon, Green with Red Cross

Within three minutes of satellite acquisition, the reference oscillator will have an accuracy of less than 25 PPB (parts per billion). The OCXO internal standard accuracy is ±0.3 PPM. The correction factor that is applied to the internal OCXO allows the instrument to maintain GPS frequency accuracy for three days, even when the instrument is obstructed from receiving signals from the GPS satellites. In order to acquire data from the GPS satellites, the instrument must have line-of-sight to the satellites, or the antenna must be placed outside without any obstructions.

After GPS High Accuracy is achieved, the internal reference is adjusted and will hold this adjusted value even when GPS satellites can no longer be received. This status is indicated by "Internal High Accuracy" showing in the Status menu displayed on the left side of the measurement screen. This improved frequency accuracy of better than 50 ppm will hold for up to three days.

NOTE: When the GPS feature is not enabled, the reference source will display either "Internal Standard Accuracy" or a user-selected external reference frequency in the Status menu on the left side of the measurement screen.

NOTE: CDMA base stations have GPS available at the cell Site. Connect the BTS Master to the base station GPS connector to make accurate frequency error and timing measurements.

CDMA RF Measurement Setup

To make CDMA RF measurements, connect the BTS Master to the base station and follow these setup instructions:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight CDMA Signal Analyzer, and press the **Enter** key to select.
3. Follow the setup instructions in the measurement section to make accurate measurements.
4. Press Measurement and RF Measurement soft keys to open measurement menu.

Channel Spectrum Setup

This measurement displays the spectrum of the specified channel and channel power, occupied bandwidth, and peak-to-average power.

From the Measurement menu, use the following procedure for Channel Spectrum:

1. Press the RF Measurement soft key to open the RF Measurement menu.
2. Press Channel Spectrum to display the active measurement.
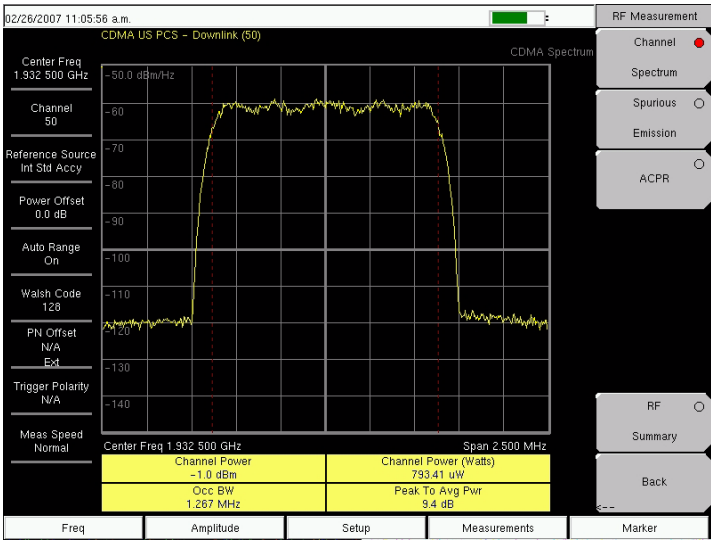
Figure 7-8. Channel Spectrum RF Measurement

Spurious Emission Setup

This measurement displays the spectrum of the input signal at specific offsets (based upon the Signal Standard, which is selected from the frequency (**Freq**) menu). Markers are automatically tuned to measure the input power at these offsets and to determine a PASS or FAIL according to limits that are set by the signal standard. A blue mask is also calculated and shown on the spectrum to visually check for pass fail conditions.

From the Measurement menu, use the following procedure for Spurious Emission:

1. Press the RF Measurement soft key.
2. Press the Spurious Emission soft key to activate the measurement. The red dot on the soft key indicates that it is selected.
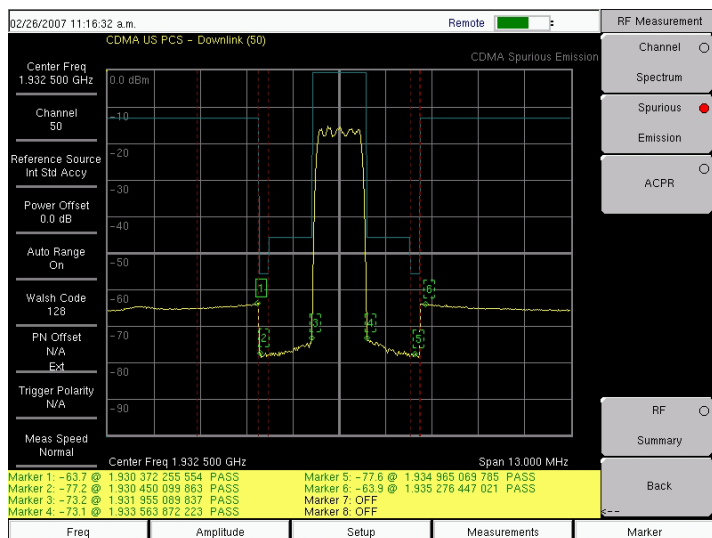
Figure 7-9. RF Measurement, Spurious Emission

ACPR Setup

ACPR (Adjacent Channel Power Ratio) is defined as the ratio of the amount of leakage power in an adjacent channel to the total transmitted power in the main channel and is displayed in table format under the bar graph.

From the Measurement menu, use the following procedure for ACPR:

1. Press the RF Measurement soft key.
2. Press the ACPR soft key to activate the ACPR measurement. The red dot on the soft key indicates that it is selected.
3. Press the ACPR soft key again to specify the Number of Carriers in a multi-carrier configuration and to specify Carrier BW.
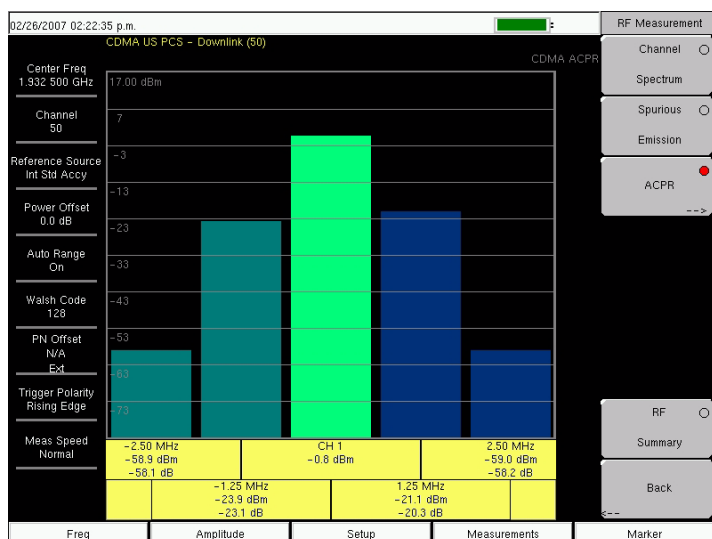
Figure 7-10. RF Measurement, ACPR

CDMA Demodulator Measurements Setup

CDMA demodulator measurements are selected by pressing the **Measurements** hard key.

CDMA demodulator measurements include Code Domain Power (CDP), CDP table, and modulation summary. To demodulate cdmaOne and CDMA2000 1xRTT signals, connect the BTS Master to the base station following the setup instructions.

To make CDMA Demodulator measurements, connect the BTS Master to the base station and follow these setup instructions:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight CDMA Signal Analyzer, and press the **Enter** key to select.
3. Follow the setup instructions in the measurement section to make accurate measurements.
4. Press the **Freq** function hard key.
5. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable CDMA standard.
6. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
7. Press the **Setup** key to open the Setup menu.
8. Press the PN Setup soft key and choose No Trig, GPS, or External.
9. Press the PN Search Type soft key and select Auto search or Manual search by toggling the soft key.

> NOTE: If Manual Search is selected, then press Manual PN Offset soft key and enter the PN value manually.

10. Press Back to go to the previous (**Setup**) menu.
11. Press the Walsh Codes soft key to choose 64 codes or 128 codes depending upon the transmitting signal.
12. Press the **Measurement** key to open measurements menu.
13. Press the Demodulator soft key to activate the Demodulator measurements menu.

CDP Setup

The CDP screen displays 64 Walsh Codes or 128 Walsh Codes. Pilot, Sync, Paging, and Quick Paging codes are displayed in a control channel table for easy viewing. Pilot power, channel power, Rho, channel carrier feedthrough, RMS phase error, Frequency Error, and Noise Floor measurements are displayed as numerical values.

From the Demodulator measurement menu, use the following procedure for CDP:

1. Press the CDP soft key to display the Code Domain Power menus. This may require pressing the CDP soft key a second time.
2. Press the Zoom soft key to activate zoom for 16, 32, or 64 codes.
3. Press the Zoom Start Index soft key and enter desired location manually.
4. Press CDP Units to select either Relative Power (in dB) or Absolute power (in dBm).
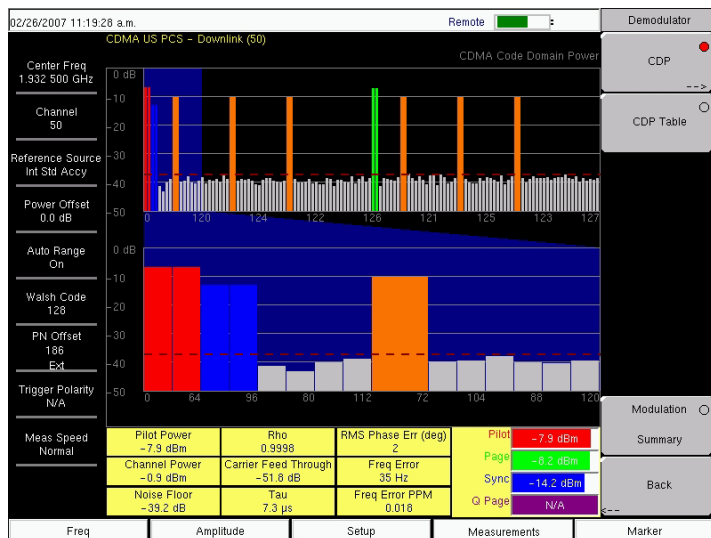
Figure 7-11. Demodulator Menu with CDP Measurement

CDP Table View Setup

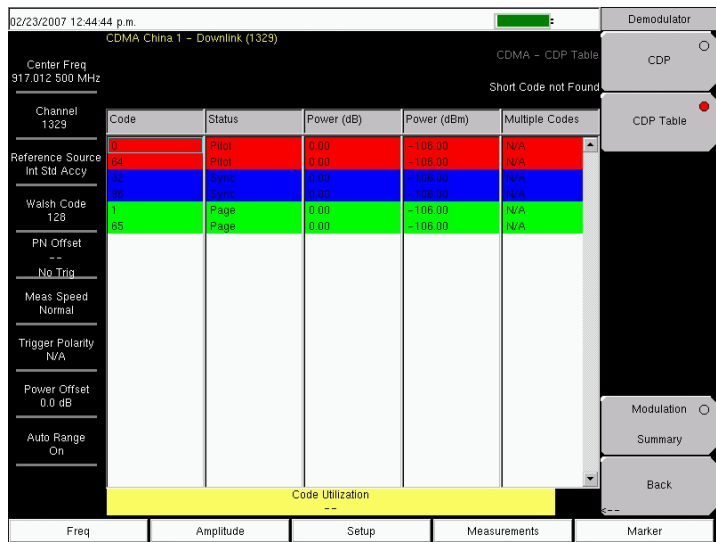The CDP table view displays all of the active codes in a tabular format.

Figure 7-12. CDP Table

From the Demodulator measurement menu, use the following procedure for CDP Table view:

1. Press the CDP soft key to display the Code Domain Power menus.
2. Press the Zoom soft key to activate zoom for 16, 32, or 64 codes.
3. Press the Zoom Start Index soft key and enter the desired location manually.
4. Press CDP units to select either Relative Power (in dB) or Absolute power (in dBm).
5. Press Back to go back to the previous menu.
6. Press the CDP Table soft key to display the measurements.

CDMA Over-The-Air Measurement Setup

OTA (over-the-air) testing provides field technicians with the ability to monitor hard-to-reach pole-top base stations. Traditionally, the repair process for pole-top base stations entailed pulling down the failed base station, then installing a new one. The failed base station was then returned to the manufacturer or repair depot for service. If a base station was determined to be healthy (no trouble found, or NTF), then the cost of the process was incurred unnecessarily. OTA testing provides information about the health of the base station, thereby improving the likelihood that a correct decision will be made with regard to the base station condition. The result is fewer NTFs and elimination of associated costs.

If you choose to measure CDMA performance over the air with an antenna, then additional setup is required, as explained in the setup section. The BTS Master needs a timing reference to determine PN Offset and timing errors. This reference comes from the base station GPS when it is connected to the BTS Master or it can be recovered from GPS when a GPS antenna is connected to the BTS Master.
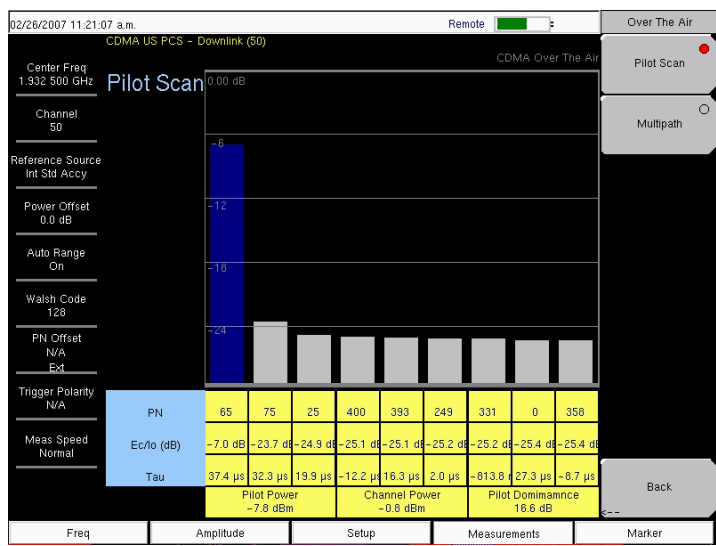

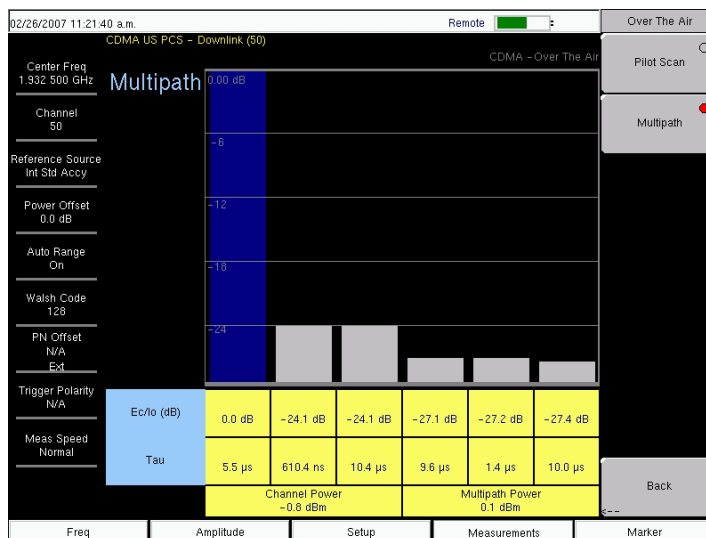**Figure 7-13. Over The Air Pilot Scan Measurement**

Figure 7-14. Over The Air Pilot Multipath Measurement

To make CDMA OTA measurements, connect the BTS Master to the base station and follow these setup instructions:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight CDMA Signal Analyzer, and press the **Enter** key to select.
3. Follow the setup instructions for GPS.
4. GPS setup is described previously. See *GPS Setup on page 7-7* After GPS setup is complete, continue the OTA measurement setup as follows:
5. Press the Walsh Codes soft key to choose 64 codes or 128 codes depending upon the transmitting signal.
6. Press the **Measurement** key to open the Measurements menu.
7. Press the OTA soft key to activate Over-The-Air measurements.

Pilot Scan Setup

From the Over The Air menu, press the Pilot Scan soft key to display the nine strongest pilots, the PN codes, Ec/Io, Tau, Pilot Power, Channel Power, and Pilot Dominance.

Multipath Setup

From the Over The Air menu, press the Multipath soft key to measure and display multipath parameters.

Pass Fail Setup

The BTS Master stores user-defined Pass Fail criteria for testing base station performance and recalls these models for quick, easy measurements. After selection of a test file, the BTS Master displays test results in tabular format with clear PASS or FAIL indications that include minimum/maximum threshold.
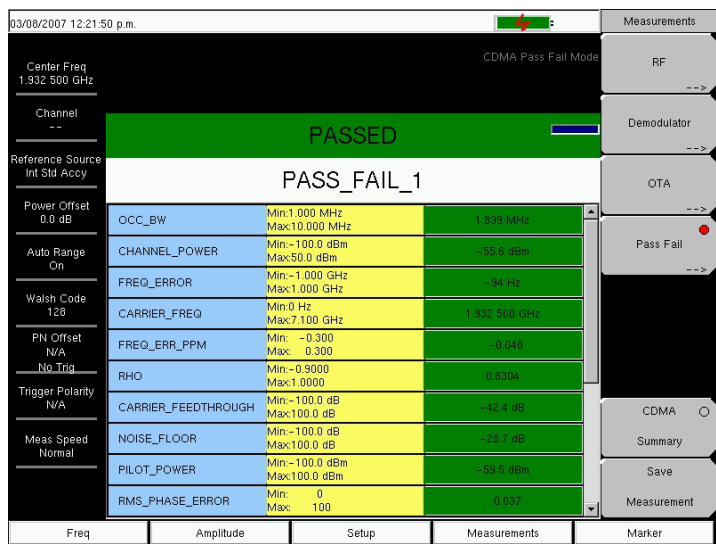

Figure 7-15. Pass Fail Measurement

Using Master Software Tools, a custom test list can be created and downloaded into the BTS Master. All critical parameters can be selected for pass fail testing.

From the Measurements menu, use the following procedure for Pass Fail setup:

1. Press the Pass Fail Mode soft key to display the pass fail measurements.
2. Press the Pass Fail Mode soft key again to display the Pass Fail Mode menu.
3. Press the Select Pass/Fail Test soft key and select the applicable Test Model to activate the measurement.
4. Press Reset to reset the pass fail function and begin a new pass fail test.

CDMA Measurement Descriptions

Code Division Multiple Access (CDMA) is used in spread spectrum systems to achieve multiple access. The frequency spectrum of a signal is spread by using a code that is not correlated with the data signal. This code is unique to each recipient. A distinction can be made among signals because the codes are chosen to have low cross-correlation values. By matching the send and receive codes, the receiver is able to properly translate the message or data.

RF

Channel Spectrum

This function includes (below the measurement display) a table view of Channel Power (in dBm and Watts), Occ BW, and Peak To Avg Pwr.

Occupied BW

The occupied bandwidth is calculated as the bandwidth containing 99% of the transmitted power.

Peak to Average Power

This is a ratio of the peak envelope power to the average power, in dB

Spurious Emission

This function includes a measurement display with eight fixed markers. The marker values are displayed below the measurement and include the power and frequency at each marker along with a pass fail indication.

ACPR

This function displays from 1 to 5 channels (carriers) and two adjacent channels on each side. The power of each channel is displayed below the measurement graph and includes the frequency and power in each of the 4 adjacent channels.

RF Summary

This function displays a table view of Channel Power (in dBm and Watts), Spurious Emission, Occ BW, and Peak To Avg Pwr.

Demodulator

Code Domain Power

Code Domain Power (CDP) displays how much of the channel power is in each Walsh Code. Power is normalized to the channel power and. therefore, a code reading of −10 dB means that the power in that code is 1/10th of the channel power. The upper half of the measurement display shows all of the channels, and the lower half shows a zoom view of selected channels. The number of zoom channels and the starting position (relative to the upper display) are set with CDP soft keys for Zoom and Zoom Start Index. A colored background in the upper display indicates the channels that are in the lower, zoom display. Colors are applied according to the following table:

Pilot	Red
Sync	Blue
Page	Green
Quick Page	Purple
IS95 Traffic	Yellow
CDMA2000 Traffic	Orange
Noise	Grey

Carrier Feedthrough

Carrier Feedthrough measures the amount of unmodulated signal that is leaking through the transmitter.

Frequency Error

Frequency error is the difference between the received center frequency and the specified center frequency. This is only as accurate as the frequency reference that is used and is typically only useful with a good quality external frequency reference.

Noise Floor

Noise floor is the average power in the unused Walsh Codes.

Paging Code Power

Paging Code Power is a measure of Page Walsh Code power, displayed in dBm.

Q Paging Power

Q Paging Power is Quick Page Walsh Code 80 power, displayed in dBm.

Rho

Rho is a measure of modulation quality and measures the amount of power that is correctly transmitted. An rho of 1.0 indicates a perfect signal. The standard requires >0.912, and common measurements are >0.94. Due to environmental factors, rho values are typically poor (<0.9) when measured over the air, and are usually useful only when connected to a base station.

Sync Power

Sync Power is a measure of Sync Walsh Code power, displayed in dBm.

Tau

Tau is the timing error. It is the timing offset, or the difference in time between when the PN sequence (or short code) restarts, and when the PN sequence should restart. A base station needs to be aligned in time to an absolute reference such as GPS. This cannot be measured if the PN search is set to No Trigger.

Note that during OTA measurement, Tau increases as the BTS Master gets farther from the transmitter. If the BTS Master is connected to the base station, then a Tau of 10 μs or less is specified, and 5 μs is typical. If the timing error becomes too large, mobiles may have trouble when being handed off to this particular base station.

CDP Table

This function displays a table view of the channels with channel code number, status, power (dB and dBm), and whether multiple codes are used. Overall code utilization is displayed as a percent at the bottom of the measurement screen.

Modulation Summary

This function displays a table view of the values of Pilot Power, Channel Power, Freq error, Freq error PPM, Carrier Freq, Rho, Noise floor, RMA Phase Err (deg), and Tau.

OTA

Pilot Scan

The strongest nine received PNs are displayed as bar graphs, and the PN numbers are displayed at the bottom of the bar graphs.

For each PN, a table displays PN number, Ec/Io, and Tau. Also shown are Pilot Power, Channel Power, and Pilot Dominance.

Pilot Power Pilot power is the total power in the pilot channel. This is normally a constant for a base station. When the BTS Master is connected to the base station, if the measured power is unexpected, then check that the entered power offset is correct and that the connections are tight. Unexpected readings may indicate an incorrect power setting at the base station. For Over The Air (OTA) measurements, the pilot power will vary as the signal path from the transmitter to receiver varies.

Channel Power Channel power is the total power that is broadcast in the specified CDMA channel.

Pilot Dominance Pilot Dominance is a measure of the strength of the strongest pilot compared to the next strongest pilot in the same channel. This should be >10 dB to make good demodulator measurements.

Multipath

The length of the bar represents the relative strength in the path. Six paths are displayed.

For each path, a table below the bar graph displays Ec/Io and Tau. Also shown are Channel Power and Multipath Power.

Multipath Power Multipath Power is a measure of the total power in the dominant signal (spread in time due to multipath echoes) relative to its power in the main transmission path. This value should be <0.4 dB to make good measurements.

Ec/Io

Ec/Io is the pilot power compared to the total channel power.
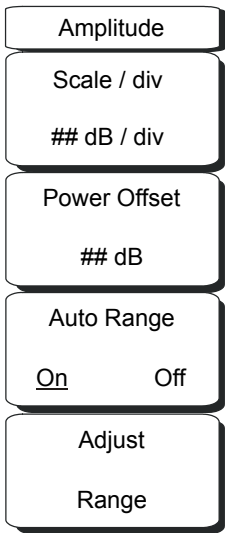
CDMA MENUS

Amplitude Menu

```
┌─────────────────────┐
│     Amplitude       │
├─────────────────────┤
│    Scale / div      │
│                     │
│    ## dB / div      │
├─────────────────────┤
│    Power Offset     │
│                     │
│       ## dB         │
├─────────────────────┤
│    Auto Range       │
│                     │
│   On        Off     │
├─────────────────────┤
│     Adjust          │
│                     │
│     Range           │
└─────────────────────┘
```

Figure 7-16. CDMA Amplitude Menu

Scale/div
The scale can be set in 1 dB steps from 1 dB per division to 15 dB per division. The value can be changed using the keypad, the rotary knob, or the **Up/Down** arrow keys.

Scale changes the y-axis scale. This applies to the Spectrum view only. When in any other view, the display is "--".

Power Offset
Choose power offset to have the BTS Master automatically adjust for the loss that occurs through any external cables, attenuators, and couplers. The power can be offset from 0 dB to 100 dB. Press the Power Offset key, enter the values, and press the dB soft key.

Auto Range
Pressing this soft key toggles between On and Off. This function adjusts the reference level automatically when Auto Range is activated.

Adjust Range
Pressing this soft key changes the Auto Range setting to Off and performs a manual Auto Range operation, which adjusts the internal reference level to be optimal based upon the measured signal.
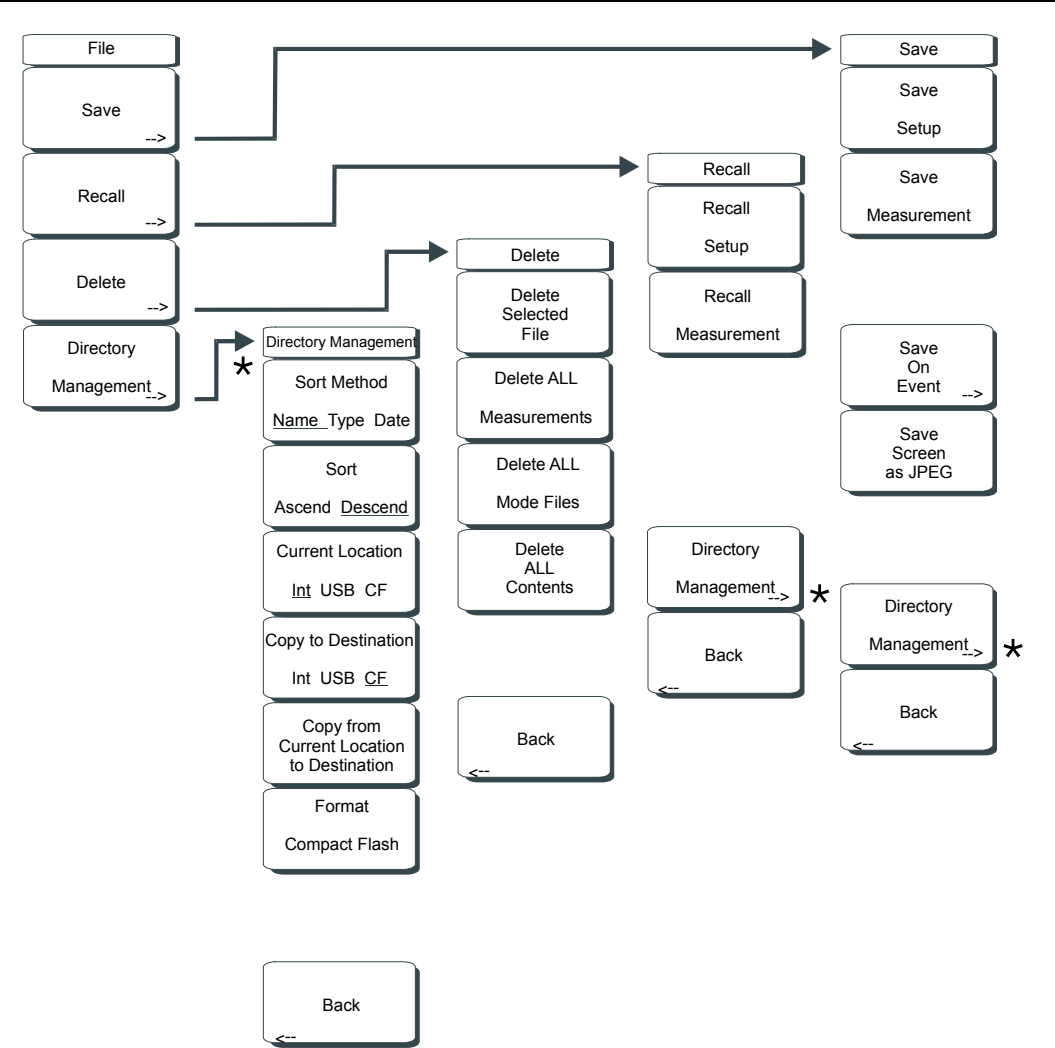
File Menu

File

Save
-->

Recall
-->

Delete
-->

Directory
Management
-->

*

Directory Management

Sort Method
Name Type Date

Sort
Ascend Descend

Current Location
Int USB CF

Copy to Destination
Int USB CF

Copy from
Current Location
to Destination

Format
Compact Flash

Back
<--

Delete

Delete
Selected
File

Delete ALL
Measurements

Delete ALL
Mode Files

Delete
ALL
Contents

Back
<--

Recall

Recall
Setup

Recall
Measurement

Directory
Management
-->

*

Back
<--

Save

Save
Setup

Save
Measurement

Save
On
Event -->

Save
Screen
as JPEG

Directory
Management
-->

*

Back
<--

Figure 7-17. CDMA File Menu

To access the functions under the File menu, press the **Shift** key, then the **File** (7) key.

Save
Measurements may be saved to the internal memory or to a Type-1 Compact Flash module. The BTS Master is shipped with a 256 MB Compact Flash Memory Module, Anritsu Part Number 3-2000-1500. The removable compact flash card can be up to 512 MB. Compact Flash modules with greater storage capacity may not function properly, and should be properly tested before relying on them. A USB Flash drive with at least 256 MB storages may be used to store all measurements that may be stored internally.

Save Setup
Opens a dialog box to name and save the current operating settings, allowing them to be recalled later to return the instrument to the state it was in at the time the setup was saved. The saved setup can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the Left/Right directional arrows to move the cursor position. Press **Enter** to save the setup.

Save Measurement

Initiates a dialog box to name and save the current active trace A. The saved measurement trace can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the measurement trace. Measurements are saved in a directory called /usr on the Compact Flash memory module and the USB Flash Drive.

> NOTE: If a measurement has been previously saved, the Save Measurement dialog box will open with the previously saved name displayed. To save the new measurement with a similar name (for example, Trace-1, Trace-2, and so forth) simply press the Right directional arrow and add the changes. To create a completely new name, use the keypad, the rotary knob or press the soft key for each letter.

Save On Event…

Not applicable in CDMA analyzer mode.

Save Screen as JPEG

This function saves a measurement trace as a graphics file. The saved measurement can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the measurement after entering the file name. The file is saved in the internal memory with the specified name, with .jpg appended.

Directory Management

Sort Method, <u>Name</u>   Type   Date

File lists can be sorted by the name of the file, the type of file (SPA file, STP file, and so forth.) or by the date that the file was saved.

Sort, Ascend   <u>Descend</u>

Selects whether the selected sort is sorted from lowest to highest (ascending) or highest to lowest (descending). When sorting by name, the sort will place file names that start with numbers before file names that start with letters (an ASCII sort).

Current Location, <u>Int</u>   USB   CF

This choice lets you select where measurements and setups will be saved. Pressing the soft key selects the storage location to be the internal memory, USB Flash drive, or Compact Flash memory module. The "current location" and the "copy to destination" will never be the same. Changing the current location to save files causes the "copy to destination" to be automatically changed if the selected storage location is the same as the selected current location.

Copy to Destination, Int   USB   <u>CF</u>

This choice lets you select where measurements and setups in the "current location" will be copied. The "current location" and the "copy to destination" may not be the same. If you change the destination to which the instrument will copy files, the current location is automatically changed if the current location is the same as the selected copy to destination.

Copy From Current Location To Destination

Pressing this soft key causes all measurements, setups, and jpg files that are stored in the user-selected "current location" to be copied to the "copy to destination". If no storage module is installed in the instrument, then an error message is displayed.

Format Compact Flash

This selection erases all files on an installed Compact Flash module. A message is displayed warning that all files will be erased. Press Enter to confirm that you want to erase and Esc to quit without erasing. In addition to erasing all files stored on the Compact Flash, the /usr directory is created for storage of measurements, setups and jpg files.

Back

Returns to the previous (File) soft key menu.

Recall

Pressing this soft key opens the Recall soft key menu.

Recall Setup

This soft key brings up a selection box that allows selection and recall of a previously stored instrument setup in the current storage location. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved setup, and press **Enter**, the rotary knob, or the Recall soft key to select. All current instrument settings are replaced by the stored setup information. Press the **Esc** key to cancel the recall.

Recall Measurement

Brings up a selection box that allows recall of a previously stored measurement trace from the currently selected storage location. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved measurement trace, and press **Enter**, the rotary knob, or the Recall soft key to select.

Directory Management '

See *Directory Management *.

Back

Returns to the previous (File) soft key menu.

Delete

Brings up a selection box that shows all stored setups and traces in the currently selected location (See *Directory Management *). The list shows the setup and measurement names, the type (stp for a saved setup, spa for a saved trace, jpg for a JPEG file) and the date and time the information was saved. Use the rotary knob or the **Up/Down** arrow keys to highlight the file to be deleted, and press **Enter**, or the Delete soft key to delete. Press the **Esc** key to cancel the operation. Note that there is no mechanism to retrieve deleted files.

Delete Selected File

Use the up and down arrow buttons or the rotary knob to select the file that is to be deleted. Press Enter to confirm that you want to delete the file or Esc to exit without deleting.

Delete ALL Measurements

Deletes all measurements of the current mode in the currently selected storage location. The memory from which measurements will be deleted is set in the Directory Management menu and is the Current Location.

Delete ALL Mode Files

Deletes all measurements of the type saved in the current operating mode of the instrument. In addition all jpg and setup files (regardless of the mode) are deleted.

Delete ALL Contents
Deletes all measurements, jpg files and setup files of ALL measurement types.

Back
Returns to the previous (File) soft key menu.
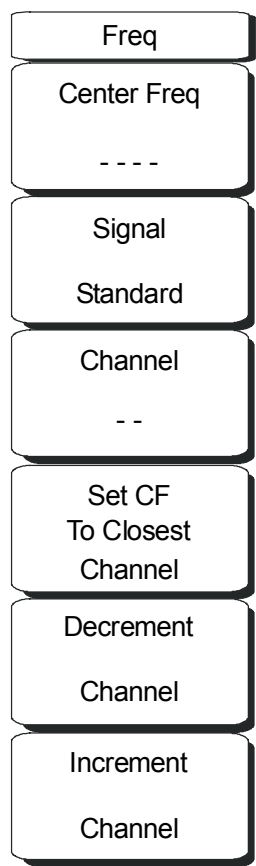
Freq (Frequency) Menu

Figure 7-18. CDMA Frequency Menu

Center Freq
Press the **Freq** key followed by the Center Freq soft key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency by using the keypad, the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the **Enter** key has the same affect as pressing the MHz soft key.

Signal Standard
Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard and press **Enter** to select. When a signal standard is selected, the center frequency and span for the first channel of the selected standard are automatically tuned. Other settings (such as channel spacing and integration bandwidth) are also automatically entered. Appendix A contains a table of the signal standards that are in the instrument firmware. The Signal Standards dialog box includes all of the CDMA standards.

Channel
Use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is automatically tuned to the center frequency of the selected CDMA channel. The Channel Editor dialog box indicates the selected signal standard. The range of channels and the channel step size depend upon the selected standard.

Set CF To Closest Channel
Press this soft key to change the center frequency to the closest channel.

Decrement Channel
Use this soft key to decrease the channel number. Channel number is decremented by one channel or by a step size. Depending upon the signal standard and upon the selected channel, pressing this soft key decrements the channel number by a standard step size.

Increment Channel
Use this soft key to increase the channel number. Channel number is incremented by one channel or by a step size. Depending upon the signal standard and upon the selected channel, pressing this soft key increments the channel number by a standard step size.

Limit Menu

This menu function is not implemented in the CDMA mode.

Marker Menu
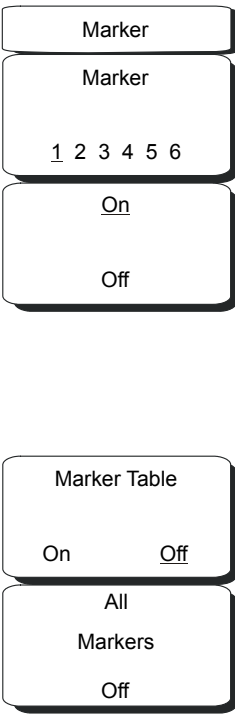
Figure 7-19. CDMA Marker Menu

Marker Soft Key Menu
In CDMA mode, markers are available only for CDP and Spectrum measurements.

Marker, 1 2 3 4 5 6
Press this soft key to select a marker. The selected marker is underlined on the soft key image. Each press of the soft key moves the selection to the next marker number. Use the On Off soft key to turn the marker On or Off.

On, Off
Press this soft key to turn On or Off the marker that is currently selected (shown underlined) on the Marker, 1 2 3 4 5 6 key.

Marker Table
Pressing this soft key opens a display of a marker table below the measurement display. The marker table indicates the values of all active markers.

All Markers Off
Pressing this soft key turns OFF all markers.

Measurements Menu
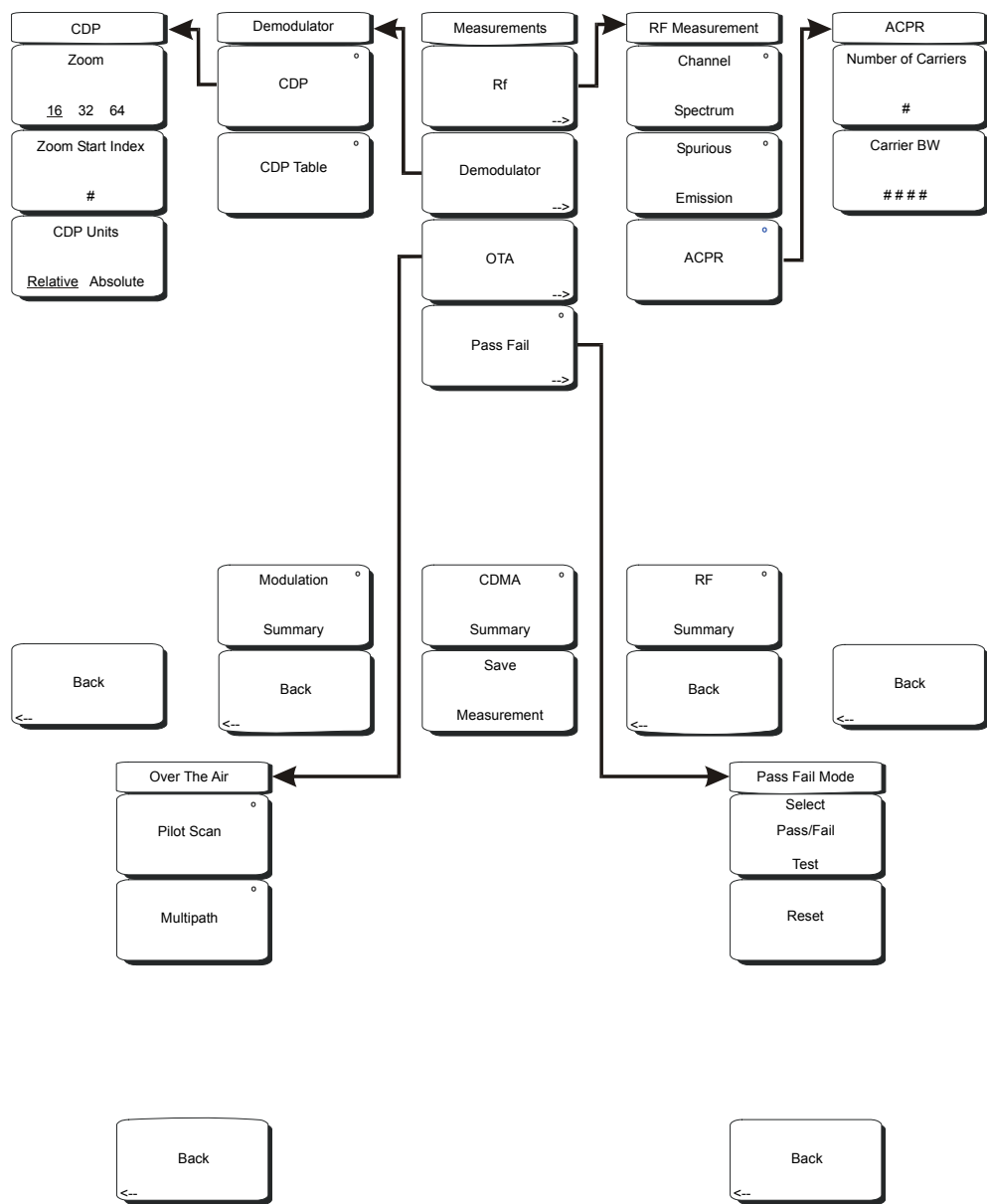
Figure 7-20. CDMA Measurements Menu

RF
Pressing this soft key opens the RF Measurement soft key menu.

Channel Spectrum
Pressing this soft key displays the channel spectrum of the input signal (2.5 MHz span). The screen also displays numeric values of Channel Power in dBm and watts, Peak to Average power in dB, and Occupied Bandwidth (Occ BW).

Spurious Emission
Pressing this soft key displays the received signal and the mask, based upon received signal strength.

ACPR

Pressing this soft key displays the Adjacent Channel Power Ratio (ACPR). The instrument displays one or more main channels and two adjacent channels on each side of the main channel. A data window below the channel measurement display indicates the power in each channel. When this soft key is active (an arrow on the key symbol indicates that a sub menu is available), another key press opens the ACPR soft key menu.

Number of Carriers

Press this soft key to set the number of main channels from 1 to 5. Change the number of main channels with the arrow keys or the rotary knob, then press the rotary knob or the **Enter** key. Or change the number of channels by pressing a number on the numeric keypad, press the Enter soft key, and then press the **Enter** key. The adjacent channels remain displayed.

Carrier BW

Press this soft key and use the numeric keypad to enter a frequency. The soft key menu displays units of GHz, MHz, kHz, and Hz. After choosing the units, press the **Enter** key. If the **Enter** key is used without first selecting units, then the default units are MHz, and the **Enter** key must be pressed a second time to set the frequency. You can also use the arrow keys or rotary knob to change the carrier bandwidth in 1 Hz increments, then press the rotary knob or the **Enter** key to set the frequency.

Back

Returns to previous (RF Measurement) soft key menu.

RF Summary

Pressing this soft key displays a summary of all the RF numerical measurement results in a table format.

Back

Returns to previous (Measurements) soft key menu.

Demodulator

In demodulator mode, the BTS Master demodulates the received CDMA signal. The demodulator has three measurement displays: CDP, CDP Table, and Modulation Summary.

CDP

The first press of this soft key displays the Code Domain Power and also displays an arrow on the soft key symbol (to indicate that a sub menu is available).

When Code Domain Power (CDP) is selected, the screen displays all of the selected Walsh Codes and the selected Walsh Codes zoom codes in a graphical format. Depending upon the Walsh Code set parameter, this display includes either 64 Walsh Codes or 128 Walsh Codes. When 128 Walsh Codes is selected, the top CDP graph displays the CDP in bit-reversed order. The screen also displays the following Control channels in table format: Pilot, Page, Sync, and Quick Page. If the marker is set on the code, then the marker displays the code number, power, and code type.

The codes are color coded as follows:

Pilot in Red
Page in Green
Sync in Blue
cdmaOne (IS95) Traffic in Yellow
CDMA2000 1xRTT Traffic in Orange

An additional press of the CDP soft key opens the CDP soft key menu.

Zoom
Pressing this soft key toggles through a zoom function of 16, 32, or 64 codes.

Zoom Start Index
Press this soft key, then enter the required zoom start index. For example, to start at code 120, which is the 15th code power that is displayed, press the 1 key and the 5 key on the numeric keypad, then press either the Enter soft key (which appears when the numeric keypad is used) or the **Enter** key.

Also, press this soft key, then use the arrow keys or rotary knob to change the zoom start index. The CDP soft key menu remains after pressing the rotary knob or the **Enter** key.

CDP units
Use this soft key to toggle between Relative units (in dB) or Absolute units in (dBm). When units are Relative, the code power is measured relative to Channel Power.

Back
Returns to previous (Demodulator) soft key menu.

CDP Table
This screen shows the power of the codes in a tabular format. The table displays the following 5 columns:

Code number
Status: Pilot, Page, Sync, All Traffic (Color Coded rows)
Relative Power (in dB)
Absolute Power (in dBm)
Multiple codes: A number indicating how many codes are used up by a particular user (traffic)

Modulation Summary
Pressing this soft key displays a summary of all the modulation-related numerical measurements in a table format, with rows for: Pilot Power, Channel Power, Freq Error, Freq Error PPM, Carrier Freq, Rho, Noise Floor, RMS Phase Err (deg), and Tau.

Back
Returns to previous (Measurements) soft key menu.

OTA
Soft key to open the Over The Air soft key menu. OTA displays the CDMA Over The Air measurements, which include: Pilot Codes, Ec/Io (dB), Tau, Pilot Power, Channel Power, Pilot Dominance, and Multipath.

Pilot Scan
Displays the power of the 9 strongest PNs in histogram graphical format. The strongest PN or the user-selected PN is color coded blue, those colored red are probably real pilots, and the remaining, which are color coded gray, are probably noise.

Multipath
Displays 6 multipaths in histogram graphical format. The strongest is color coded blue. The remaining are color coded red, or are color coded gray if noise. The unit also displays Ec/Io (dB), Tau, Channel Power, and Multipath Power.

Back
Returns to previous (Measurements) soft key menu.

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Pass Fail
The first press of this soft key puts the BTS Master into Pass Fail Mode. The next press of the soft key opens the Pass Fail Mode soft key menu.

Select Pass/Fail Test
This soft key function allows the selection of a user-defined file that specifies a list of measurements with pass fail criteria. Select a test model by using the arrow keys or rotary knob. This mode will sequentially assess the appropriate measurements and indicate a pass or fail state based upon the test model criteria. Custom pass fail tests can be created by using Master Software Tools.

Reset
Press this soft key to restart the measurement.

Back
Returns to previous (Measurements) soft key menu.

CDMA Summary
Pressing this soft key displays a summary of all of the CDMA-related numerical measurements in a table format.

Save Measurement
Pressing this soft key opens a dialog box to name and save the current measurement. Press **Enter** to save the CDMA measurement, which is saved with a **.cdma** extension.

Mode Menu

To access the functions under the Mode menu, press the **Shift** key, then the **Mode** (9) key. Use the directional arrow keys or the rotary knob to highlight the selection and press the **Enter** key to select. The list of modes that appears in this menu will vary depending upon the options that are installed and activated in your instrument. Figure 4-28 on page 4-41 is an example of the Mode menu. Your instrument may not show the same list.

Preset Menu

To access the functions under the Preset menu, press the **Shift** key, then the **Preset** (1) key.

Preset
This key resets the instrument to the default starting conditions.

Save Setup
See the *Save* description under the File menu.

Recall Setup
See the *Recall* description under the File menu.

Setup Menu
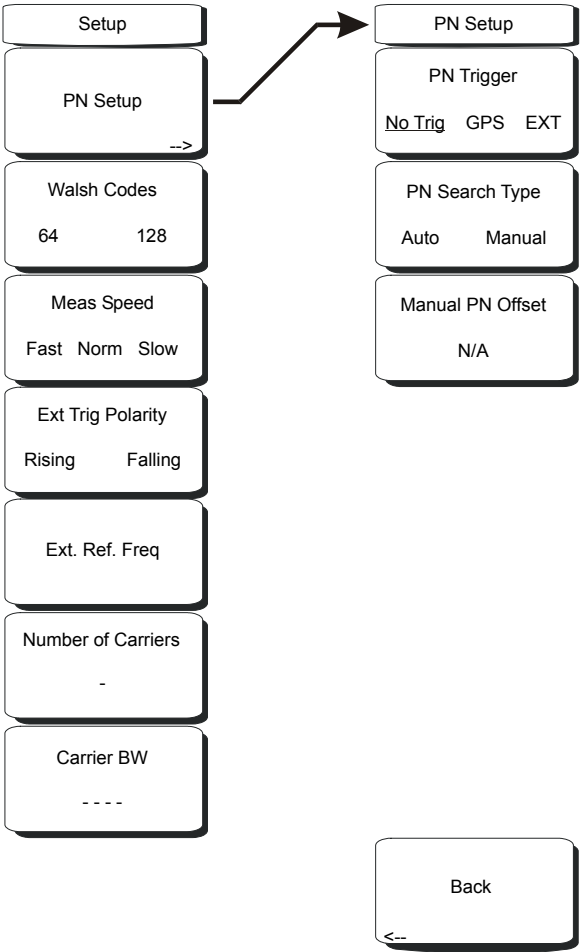
Figure 7-21. CDMA Setup Menu

PN Setup
Press this soft key for the PN Setup menu.

PN Trigger
Press this soft key to toggle through "No Trig" (no trigger), "GPS", and "Ext" (external trigger).

PN Search Type
Press this soft key to toggle between "Auto" and "Manual" PN search. In the Auto mode, the BTS Master automatically searches for the strongest PN. When using manual setup, enter the required PN offset to limit the search. Auto search is available only when the trigger selection is GPS or External. If "No Trig" is selected, then pressing this soft key causes an error message to be displayed, stating "Applicable only when PN Type is GPS or External".

Manual PN Offset

Press this soft key to manually set the PN offset. Use the arrow keys, rotary knob, or numeric keypad to choose an offset, then press the rotary knob or the **Enter** key to select the value. Editing this value automatically changes the PN Search Type to Manual.

The Manual PN Offset function is available only when the trigger selection is GPS or External. If "No Trig" is selected, then pressing this soft key causes an error message to be displayed, stating "Applicable only when PN Type is GPS or External".

Back

Press this soft key to return to the previous (Setup) soft key menu.

Walsh Codes
Press this soft key to toggle between 64 codes and 128 codes.

Meas Speed
Press this soft key to toggle through "Fast", "Norm" (normal), and "Slow" measuring speed.

Ext Trig Polarity
Press this soft key to toggle between Rising edge and Falling edge trigger polarity.

Ext. Ref. Freq
Pressing this soft key opens a list box of reference frequencies. Use the arrow keys or the rotary knob to choose a specific reference frequency, then press the rotary knob or the **Enter** key to select the frequency. Press the **Esc** key to keep the previously set reference frequency.

List Box: 1 MHz, 1.2288 MHz, 1.544 MHz, 2.048 MHz, 2.4576 MHz, 4.8 MHz, 4.9152 MHz, 5 MHz, 9.8304 MHz, 10 MHz, 13 MHz, 19.6608 MHz

Number of Carriers
Press this soft key to set the number of required channels. After pressing the soft key, use the arrow keys, rotary knob, or number keypad to enter the number of channels. Press the rotary knob or the **Enter** key to set the new number. This affects the ACPR and Spurious Emissions measurements.

Carrier BW
Press this soft key to set the carrier bandwidth. After pressing the soft key, use the arrow keys, rotary knob, or number keypad to enter the carrier bandwidth. Press the rotary knob or the **Enter** key to set the new number.

Sweep Menu

To access the functions under the Sweep menu, press the **Shift** key, then the **Sweep** (3) key.

Sweep
Press this soft key to toggle between Single and Continuous sweep modes. Selecting Single sets the instrument to make 1 measurement and stop. Selecting Continuous sets the instrument to continuously make measurements.

Trigger Sweep
When the Sweep state is Single, pressing this soft key triggers a new measurement every time it is pressed. It does nothing when Sweep state is Continuous.

System Menu

System		GPS
Status		**GPS** On **Off**
Self Test		**GPS Info**
Application Self Test		**Reset**
GPS -->		

Application Options -->	**Back** <--	
System Options -->	**System Options**	**Options**

System Options:
- **Date & Time**
- **Ethernet Config**
- **Language**
- **Brightness**
- **Name**
- **Volume**
- **Reset** -->
- **Back** <--

Reset:
- **Factory Defaults**
- **Master Reset**
- **Update OS Via Ethernet**
- **Update OS Via USB**
- **Back** <--

Options:
- **Ext. Ref. Freq**
- **Back** <--

Figure 7-22. CDMA System Menu

To access the functions under the System menu, press the **Shift** key, then the **System** (8) key.

Status
Pressing this soft key displays the current system status, including the operating system and firmware versions, temperatures and other details such as current battery information. Press **Esc** or **Enter** to return to normal operation.

Self Test
This soft key initiates a series of diagnostic tests that test the components of the instrument. A display will list the individual tests with a pass or fail indication. Press **Esc** or **Enter** to return to normal operation.

Application Self Test
This soft key initiates a series of diagnostic tests related to the performance of the BTS Master in CDMA mode. A display will list the individual tests with a pass or fail indication. Press **Esc** or **Enter** to return to normal operation.

GPS
If the GPS option is installed, the GPS menu will be displayed.

GPS On/Off
Turns the GPS On or Off.

GPS Info
Displays the current GPS information.

Reset
Resets the GPS for a new location.

Back
Returns to the previous (System) soft key menu.

Application Options
This soft key presents a menu to select application options.

Ext. Ref. Freq
Pressing this soft key opens a list box for selecting a Reference Frequency. Use the rotary knob or the **Up/Down** arrow keys to highlight the desired external reference frequency and press the rotary knob or the **Enter** key to select, or press the **Esc** key to cancel.

Back
Returns to the previous (System) soft key menu.

System Options
This key opens a selection of system option soft keys.

Date and Time
This soft key brings up a dialog box for setting the current date and time. Use the soft keys or the **Left/Right** arrow keys to select the field to be modified. Use the keypad, the **Up/Down** arrow keys or the rotary knob to select the date and time. Press **Enter** to accept the changes, or press the **Esc** key to return to normal operation without changing anything.

Ethernet Configuration

This soft key brings up a dialog box to set the IP address of the instrument.

Type Manual/DHCP

This soft key selects whether the address will be entered manually, or supplied automatically by a network DHCP server. If Manual is selected, use the soft keys or the **Left/Right** arrow keys to select the field to be modified. Use the keypad, the **Up/Down** arrow keys or the rotary knob to enter the input. Press **Enter** to accept the changes, or press the **Esc** key to return to normal operation without changing anything.

Language

This soft key brings up a selection box allowing selection from a list of built-in languages for the BTS Master displays. The languages currently available are English, French, German, Spanish, Japanese, Chinese, Korean, and Italian.

In addition, a custom language may be selected if it has been defined using the Master Software Tools software and loaded into the MT8222A. Two custom languages may be loaded into the instrument using Master Software Tools. If a mode does not have language translations available, English is the default language. Press **Enter** to accept the change, or press the **Esc** key to return to normal operation without changing anything.

Brightness

The brightness of the display can be adjusted to optimize viewing under a wide variety of lighting conditions. Use the keypad, the **Up/Down** arrow keys or the rotary knob to select a brightness level from 1 to 9, 9 being the brightest. Press **Enter** to accept the change.

Name

Opens a dialog box to name the instrument. The unit can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the name.

Volume

The current volume setting is displayed on the screen. Use the keypad, the **Up/Down** arrow keys or the rotary knob to change the volume and press the **Enter** key to accept the change.

Reset

Opens a menu of reset and update options.

Factory Defaults

Restores the instrument to the factory default values, including Ethernet, language and brightness settings. Press the **Enter** key to initiate the reset, and turn the unit off, then on again to complete. Press **Esc** to return to normal operation without resetting.

Master Reset

This will restore factory setting to all system parameters, including Time/Date, Ethernet, language and brightness settings. Also, all user files in the internal memory are deleted, and the original language and antenna files are restored.

Press the **Enter** key to initiate the reset, and turn the unit off, then on again to complete. Press **Esc** to return to normal operation without resetting.

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Update OS Via Ethernet

Press this soft key to update the instrument operating system via the Ethernet connection. Press Enter to begin the update, or press **Esc** to return to normal operation without updating.

Update OS Via USB

Press this soft key to update the instrument operating system via the USB connection. Press **Enter** to begin the update, or press **Esc** to return to normal operation without updating.

NOTE: The Update OS via Ethernet and Update OS via USB selections are accomplished in conjunction with the Master CodeLoader program, which is supplied with Master Software Tools. Improper use of the Master CodeLoader program could render the system unusable.

Back

Returns to the previous (System Options) soft key menu.

Back

Returns to the previous (System) soft key menu.

Chapter 8
EVDO Signal Analyzer

Introduction

The BTS Master MT8222A offers three EVDO options:

• Option 34, EVDO Over the Air (OTA) Measurements, requires Option 31

• Option 62, EVDO RF measurements

• Option 63, EVDO Demodulator, Rev. A compatible

CDMA2000 1xEVDO has a chip rate of 1.2288 MHz, the same as cdmaOne and CDMA2000 1xRTT. Each chip lasts for a duration of 0.8138 microseconds. In downlink, an EVDO signal can be time-divided into "half slots." Each half slot has 1024 chips.

The 1024 chips in a half slot can be further time-divided into three different channels: Pilot, MAC, and Data. The Pilot Channel provides synchronization for the EVDO Access Terminals (for example, cell phones, laptops, and so forth.). The MAC (Medium Access Control) Channel controls the overall EVDO traffic. The Data Channel transmits data to various users.

The Pilot and MAC Channels are always active in an EVDO signal, but the Data Channel may sometimes transmit no data. When no data is transmitted, the half slot is considered idle. Otherwise, it is called an active slot.

The BTS Master can measure EVDO signals over the air (OTA) by connecting the antenna to the unit or by directly connecting the BTS Master to the base station.

Getting Started

EVDO Mode

To prepare for EVDO measurements, the MT8222A must be configured for EVDO mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight EVDO Signal Analyzer and press the **Enter** key to select.

For additional information about the Mode menu, refer to *Mode Selector Menu* on page 2-16.

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* on page 2-5.

EVDO Measurement Setup

The BTS Master can measure EVDO performance over the air (OTA) with an antenna, or by connecting the base station directly to the BTS Master.

To measure an EVDO signal over the air, connect the appropriate frequency band antenna to the BTS Master RF Input, and connect an Anritsu GPS antenna to the BTS Master GPS connector.

Setting up the Measurement Frequency

The measurement frequency can be set by entering the center frequency or by selecting the applicable signal standard and channel, which allows the BTS Master to automatically set the frequency.

To enter the center frequency:

1. Press the **Freq** function hard key.
2. Press the Center Freq soft key.
3. Enter the desired frequency by using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, then the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the **Enter** key has the same affect as pressing the MHz soft key.
4. Press the **Enter** key to set the Center Frequency. The current setting is shown on the left side of the measurement screen.

To select a signal standard:

1. Press the **Freq** function hard key.
2. Press the Signal Standard soft key.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard, and press **Enter** to select. When a signal standard is selected, the center frequency for the first channel of the selected standard is automatically tuned.
4. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display. The current settings are displayed on the left side of the measurement screen.

Power Offset for Compensating External Loss

In order to get accurate results, the external attenuation should be compensated by using power offset. In power offset mode, the compensation factor is in dB. The external attenuation is caused by using an external cable or by an external high power attenuator.

1. Press the **Amplitude** function hard key.
2. Press the Power Offset soft key and use the keypad, the arrow keys, or the rotary knob to enter the desired offset value. Press the rotary knob or the **Enter** key to set the Power Offset. The value that is entered is displayed on the left side of the measurement screen.

PN Select

The BTS Master needs a timing reference in order to determine PN Offset and timing errors. This reference comes from the base station when it is connected to the BTS Master, or it can be recovered from GPS when a GPS antenna is connected to the BTS Master.

The setup menu for this function is:

1. Press the **Setup** function hard key.
2. Press the PN Setup function soft key to open up the PN Setup menu.
3. Press the PN Trigger soft key to toggle through No trigger, GPS, and External.
   No Trigger: If both GPS and external timing are unavailable, then you may choose No Trigger for the PN search.
   GPS: The BTS Master uses GPS as the timing reference.
   External: The BTS Master uses an external even-second time mark as the timing reference. The time mark is usually available at the base station on a BNC connector labeled "ESTM" or "PP2S". ESTM must be connected to the Ext. Trig. In connector on the BTS Master.
4. Press the PN Search Type soft key to toggle between Auto and Manual. In Auto mode, the BTS Master automatically detects the strongest pilot, while in Manual mode it searches only for the specified PN.

> NOTE: If Manual Search Type is selected, then press Manual PN Offset and enter the desired PN value.

5. Press Back to go back to the previous (Setup) menu.

MAC Codes Setup

MAC Walsh Codes setup is used to select 64 codes or 128 codes.

1. Step 1. Press the **Setup** function hard key.
2. Step 2. Press the Walsh Codes soft key to toggle between 64 codes and 128 codes.

External Reference Frequency Setup

In order to get the best frequency accuracy measurements, an external reference frequency must be attached to the BTS Master Ext Ref In connector, or a GPS connection must be attached to the BTS Master GPS connector. Most base stations have a reference frequency that is available on a BNC connector.

To configure the BTS Master to use an external reference frequency, perform the following:

1. Press the **Setup** function hard key.
2. Press the external reference frequency (Ext. Ref. Freq) soft key to display a list of the available reference frequencies:

Table 8-1. External Reference Frequencies for EVDO

1 MHz	2.4576 MHz	9.8304 MHz
1.2288 MHz	4.8 MHz	10 MHz
1.544 MHz	4.9152 MHz	13 MHz
2.048 MHz	5 MHz	19.6608 MHz

3. Use the **Up/Down** arrow keys or the rotary knob to highlight the applicable reference frequency on the list, and then press the rotary knob or the **Enter** key to set the reference frequency.
    As the BTS Master locks to the source, the Reference Freq value is displayed within the user-settable parameters that are shown to the left of the measurement screen.

GPS setup

GPS gives accurate timing and frequency error. See *GPS Setup on page 7-7* or See *Activating the GPS Feature on page 18-1*.

To configure the BTS Master to use GPS, perform the following:

1. Install the Anritsu GPS antenna to the GPS antenna connection on the BTS Master connector panel.

One antenna now available from Anritsu that is suitable for this purpose is the 2000-1410 Magnet Mount GPS Antenna with 5 m (15 ft.) cable.

> NOTE: The GPS antenna connection on the BTS Master is fitted with a reverse BNC connector to help prevent damage to the GPS circuitry. A direct current voltage is present on this connector. Never connect anything other than the Anritsu GPS antenna to this port.

2. Press the **Shift** key then the **System** (8) key to open the system options menu.
3. Press the GPS soft key to open the GPS menu.
4. Press the GPS On/Off soft key to turn the GPS feature on or off. When GPS is first turned on, the GPS icon is displayed in red. For a graphic image, refer to Figure 7-5 or *Activating the GPS Feature on page 18-1*.

When the GPS receiver is tracking at least three satellites, the GPS icon changes to green. For a graphic image, refer to .

> NOTE: As long as three minutes may be required for the Ref Freq status to change to GPS High Accuracy in the Status menu, which is displayed on the left side of the measurement screen.

5. Press the GPS Info soft key to view the number of tracked satellites, latitude, longitude, altitude, and UTC timing information, and so forth.

> NOTE: To reset the GPS, press the Reset soft key. The green GPS icon with a red cross appears when GPS satellite tracking is lost. This occurs after being active (tracking three or more satellites).

For a graphic image, refer to .

Within three minutes of satellite acquisition, the reference oscillator will have an accuracy of less than 25 PPB (parts per billion). The accuracy of the OCXO internal standard is ±0.3 PPM. The correction factor that is applied to the internal OCXO allows the instrument to maintain GPS frequency accuracy for three days even when the instrument is obstructed from receiving signals from the GPS satellites. In order to acquire data from the GPS satellites, the user must have line-of-sight to the satellites, or the antenna must be placed outside without any obstructions to the satellites.

After GPS High Accuracy is achieved, and the internal reference is adjusted, this status will be indicated by "Internal High Accuracy" showing in the Status menu, which is displayed on the left side of the measurement screen. When the GPS feature is not enabled, the reference source displays either "Internal Standard Accuracy" or a user-selected external reference frequency in the Status menu on the left side of the measurement screen.

> NOTE: EVDO base stations have GPS available at the cell Site. Connect the BTS Master to the base station GPS connector to make accurate frequency error and timing measurements.

EVDO RF Measurements Setup

To make EVDO RF measurements, connect the BTS Master to the base station following the setup instructions.

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight EVDO Signal Analyzer and press the **Enter** key to select.
3. Follow the setup instructions in the measurement section to make accurate measurements.
4. Press the Measurement and RF Measurement soft keys to open the measurement menu.

Channel Spectrum Setup

This measurement displays the spectrum of the specified channel and channel power, occupied bandwidth, and peak-to-average power.

From the RF Measurement menu, press Channel Spectrum to display the active measurement.
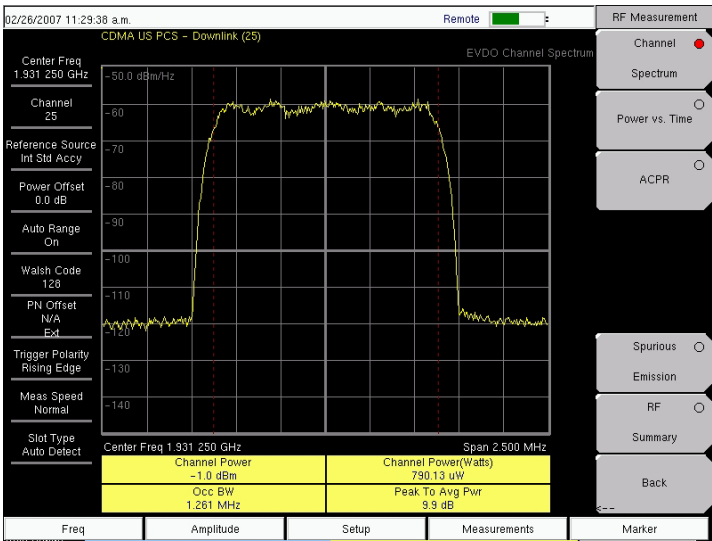
Figure 8-1. EVDO Channel Spectrum Measurement Display

Power vs Time Setup

From the RF Measurement menu, press Power vs Time to display the active measurement
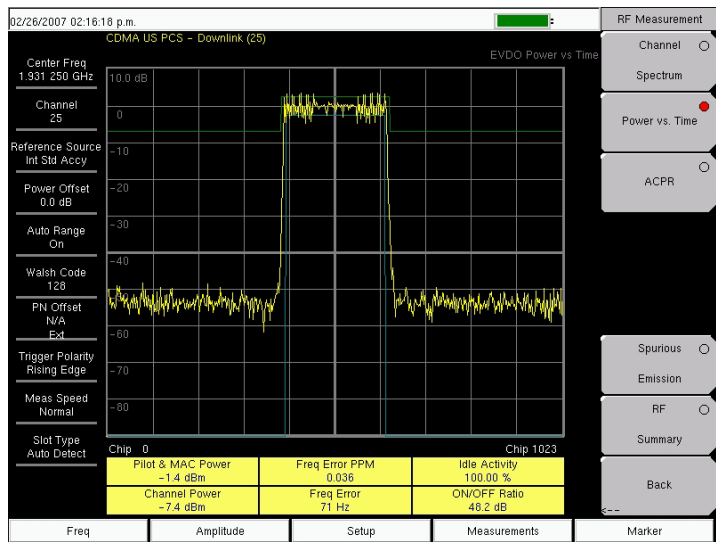
Figure 8-2. EVDO Power Versus Time Measurement Display

ACPR Setup

ACPR (Adjacent Channel Power Ratio) is defined as the ratio of the amount of leakage power in an adjacent channel to the total transmitted power in the main channel and is displayed in table format under the bar graph.

From the RF Measurement menu, use the following procedure for ACPR:

1. Press the ACPR soft key to activate the ACPR measurement. The red dot on the soft key indicates that it is selected.
2. Press the ACPR soft key again to specify the Number of Carriers in a multi-carrier configuration and to specify Carrier BW.
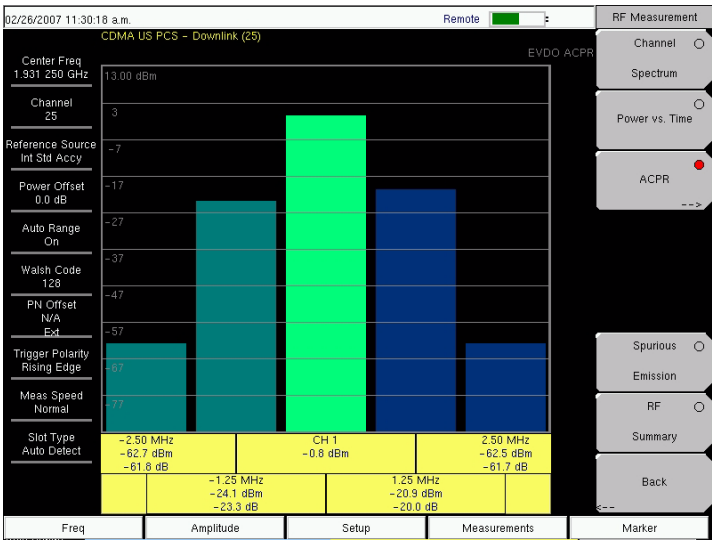
Figure 8-3. EVDO ACPR Measurement Display

Spurious Emission Setup

The Spurious Emission test examines emissions at frequencies that are outside of the assigned EVDO channel. Spurious emission should be measured at the base station RF output port by using a direct cable connection.
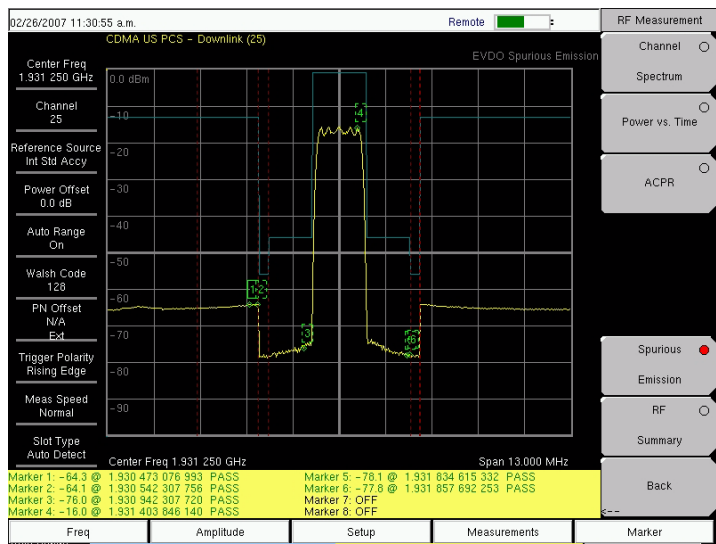
Figure 8-4. EVDO Spurious Emission Measurement Display

To perform the test, select the correct band class and channel number. A band-class-specific mask will be shown on the screen. Maximum emission power in each frequency offset region will be highlighted by markers. Typical resolution bandwidths (RBW) that are used in the emission test are 30 KHz and 1 MHz. Due to the variable RBW in some band classes, the spectrum can appear to have "steps".

For accurate EVDO emission measurements, users are required to input an all-idle or all-active signal, and to set the BTS Master slot setting accordingly. The emission mask is drawn according to the following document: *Recommended Minimum Performance Standards for cdma2000 High Rate Packet Data Access Network*. (See 3GPP2 C.S0032-A or TIA-864-A for details.)

> NOTE: (1) In the case of a multi-carrier EVDO signal, the BTS Master "Number of Carrier" setting can be changed (setting it to a maximum of 5 carriers).
> NOTE: (2) When the center frequency of a signal is entered directly (instead of giving Band Class and Channel Number info), the BTS Master automatically determines the most likely band class and its emission mask, according to the specified frequency.

From the RF Measurement menu, press the Spurious Emission soft key to activate the measurement. The red dot on the soft key indicates that it is selected.

EVDO Demodulator Measurements Setup

EVDO demodulator measurements include, CDP MAC, CDP Data, MAC CDP table, and Modulation Summary. To demodulate EVDO signals, connect the BTS Master to the base station by using the following setup instructions:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight EVDO Signal Analyzer, and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable EVDO standard.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
6. Press the **Setup** key to open Setup menu.
7. Press the PN Setup soft key and choose the trigger type: No Trigger (No Trig), GPS, or External (Ext).
8. Press PN Search Type soft key to toggle between Auto and Manual search.

NOTE: If Manual Search is selected, then press the Manual PN Offset soft key and enter the PN value manually.

9. Press Back to go to the previous menu.
10. Press the Walsh Codes soft key to choose 64 codes or 128 codes.
11. Press the **Measurement** key to open the measurements menu.
12. Press the Demodulator soft key to activate the Demodulator measurements menu.

CDP MAC Setup

Pressing this soft key displays the CDP MAC codes. The lower part of the screen displays the zoom codes.
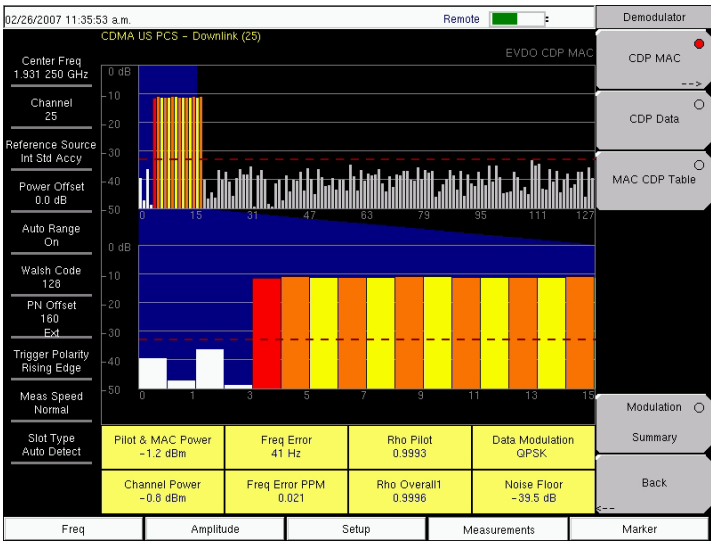
Figure 8-5. EVDO CDP MAC Measurement Display

From the Demodulator menu, use the following procedure for CDP MAC measurements:

1. Press the CDP MAC soft key to display MAC codes.
2. Press the CDP MAC soft key again to display the CDP MAC soft key menu.
3. Press the Zoom soft key and select 16 codes, 32 codes, or 64 codes.
4. Press the Zoom Start soft key and enter the desired zoom starting code.
5. Press the CDP Units soft key to select Relative Power (in dB) or Absolute Power (in dBm).

Marker Setup (Activating Markers)

1. Press the **Marker** function hard key to display the Marker menu.
2. Press the Marker soft key to select the appropriate marker (1 through 6). The underlined marker number is the currently selected marker.
3. Press the **On/Off** soft key to toggle the selected marker On or Off.
4. Press the Marker Table soft key to display the Marker table. The marker table is displayed on the measurement screen below the CDP measurements table.

CDP Data Setup

CDP Data displays the data I (In phase) and Q (Quadrature phase) codes.

Figure 8-6. EVDO CDP Data Measurement Display

From the Demodulator menu, use the following procedure for CDP Data measurements:

1. Press the CDP Data soft key to display the codes.
2. Press the CDP Data soft key again to display the CDP Data soft key menu.
3. Press the CDP Units soft key to select Relative Power (in dB) or Absolute Power (in dBm).

MAC CDP Table Setup

The MAC CDP Table View displays all of the active codes in a tabular format.
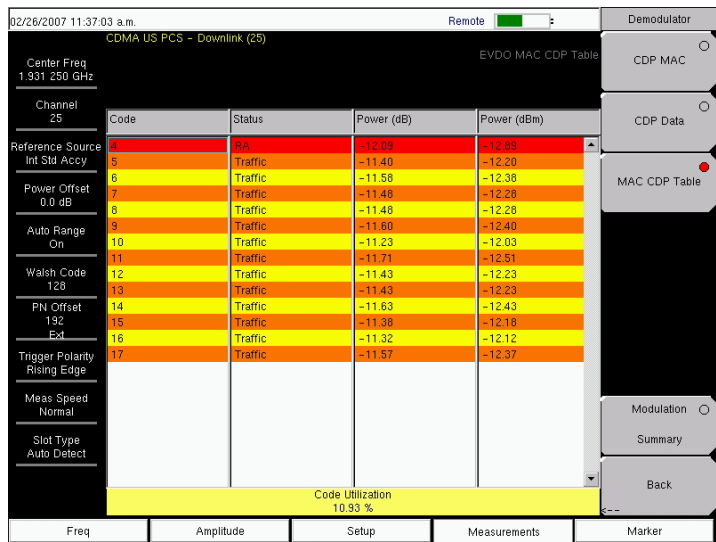
Figure 8-7. EVDO MAC CDP Table Measurement Display

From the Demodulator menu, use the following procedure to enter MAC CDP Table View:

1.   Press the MAC CDP Table soft key to display the Code Domain Power table view.

EVDO Modulation Summary Setup

The EVDO modulation summary view displays EVDO critical RF and demodulator measurements in tabular format.
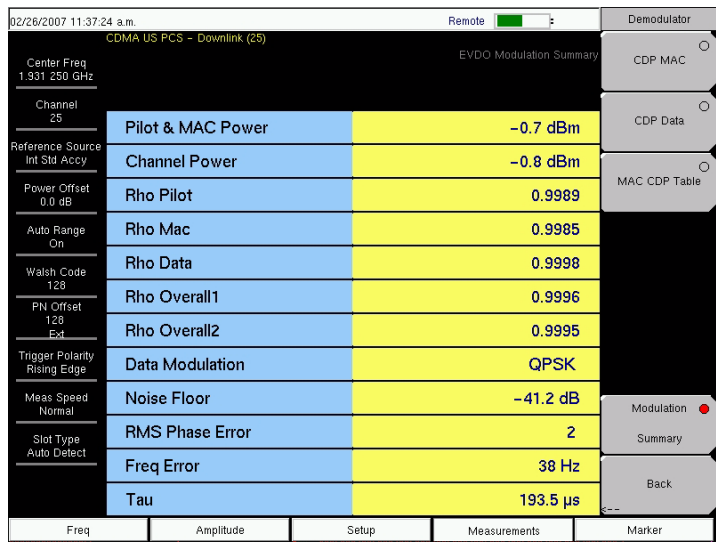
Figure 8-8. EVDO Demodulator Modulation Summary Measurement Display

The following is the procedure to enter the EVDO Demodulator Modulation Summary view:

From the Demodulator menu, press the Modulation Summary soft key to display the summary of measurements.

EVDO Over-The-Air Measurement Setup

OTA (over-the-air) testing provides field technicians with the ability to monitor hard-to-reach pole-top base stations. Traditionally, the repair process for pole-top base stations entailed pulling down the failed base station, then installing a new one. The failed base station was then returned to the manufacturer or repair depot for service. If a base station was determined to be healthy (a no trouble found (NTF) event), then the cost of the process was incurred unnecessarily. OTA testing provides information about the health of the base station, thereby improving the likelihood that a correct decision will be made with regard to the base station. The result is fewer NTFs and elimination of their associated costs.

If you choose to measure EVDO performance over the air with an antenna, then additional setup is required, as explained in the setup section. The BTS Master needs a timing reference in order to determine PN Offset and timing errors. This reference comes from the base station GPS when it is connected to the BTS Master, or it can be recovered from GPS when a GPS antenna is connected to the BTS Master.

To make EVDO OTA measurements, connect the BTS Master to the base station and perform the following setup procedure:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight EVDO Signal Analyzer, and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable EVDO standard.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display.
6. Press the **Setup** key to open the Setup menu.
7. Press the PN Setup soft key and choose GPS.
8. Press the PN Search Type soft key and select Auto.

NOTE: Follow the GPS setup procedure in the Setup section.

9. Press the **Setup** key to open the Setup menu.
10. Press the Walsh Codes soft key to toggle between 64 codes and 128 codes depending upon the transmitting signal.

NOTE: 64 Walsh Codes can be displayed when the unit is in 128 code mode. The Walsh Codes will be repeated on the measurement screen.

11. Press the **Measurements** key to open the measurements menu.
12. Press the OTA soft key to activate Over The Air measurements.

The following procedures are used to display the OTA Pilot Scan and Multipath views:

From the Over-The-Air menu, press the Pilot Scan soft key to display the nine strongest pilots, the PN codes, Ec/Io, Tau, Pilot Power, Channel Power, and Pilot dominance.
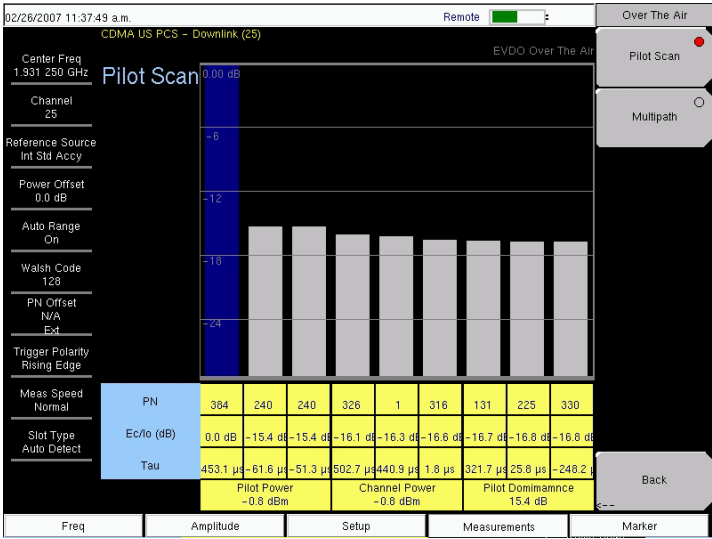
Figure 8-9. EVDO OTA Pilot Scan Measurement Display

From the Over-The-Air menu, press the Multipath soft key to display six channels of multipath parameters, including Ec/Io, Tau, Channel Power, and Multipath Power.
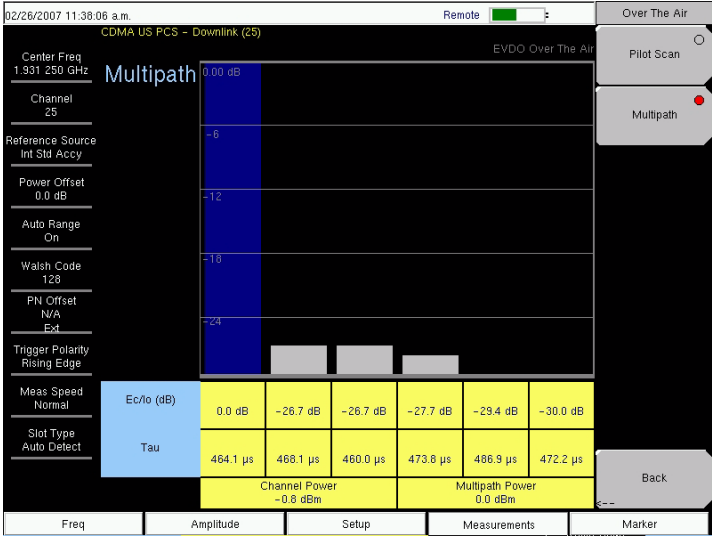
Figure 8-10. EVDO OTA Multipath Measurement Display

Pass Fail Setup

The BTS Master stores user-defined pass fail criteria test models for testing base station performance and recalls these models for quick, easy measurements. After selection of a test model, the BTS Master displays test results in tabular format with clear PASS or FAIL indications that include min/max threshold.

Using Master Software Tools, a custom test list can be created and downloaded into the BTS Master. All critical parameters can be selected for pass fail testing.
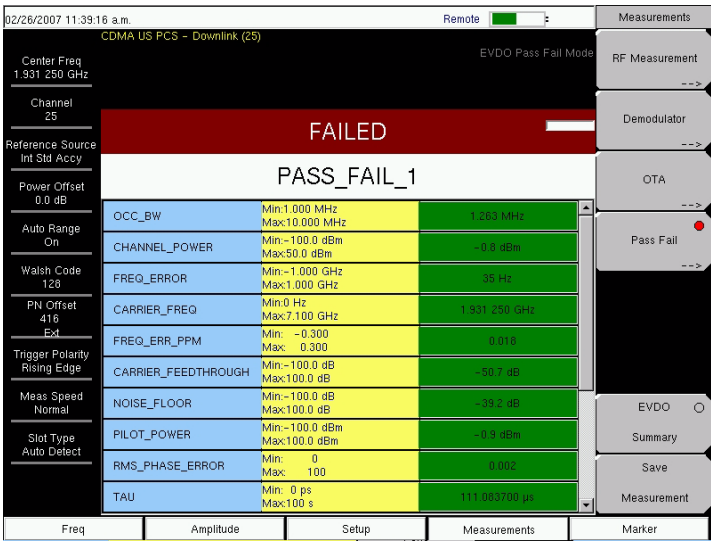
Figure 8-11. EVDO Pass Fail Measurement Display

From the Measurements menu, use the following procedure to enter the Pass Fail Mode:

1. Press the Pass Fail soft key to display pass fail criteria.
2. Press the Pass Fail soft key again to open the Pass Fail soft key menu.
3. Press the Select Pass/Fail Test soft key and select the applicable Test Model to activate the measurement.
4. Press the Reset soft key to reset the pass fail function and begin a new pass fail test.

EVDO Summary Setup

EVDO summary displays EVDO critical RF and demodulator measurements in tabular format.
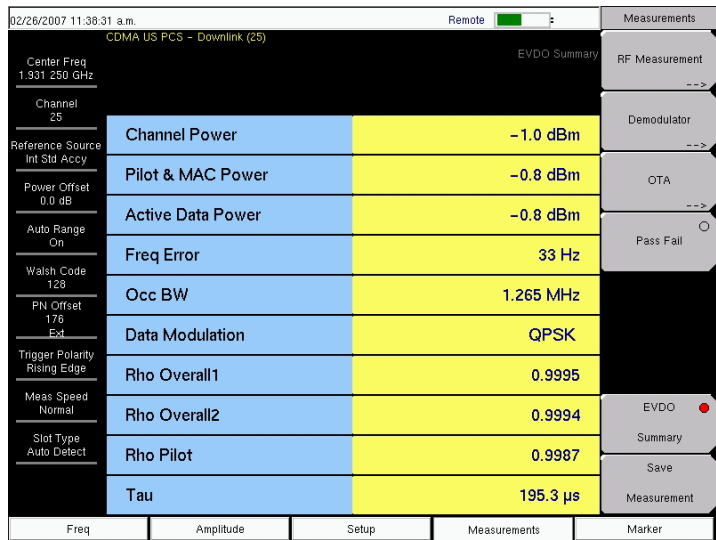
Figure 8-12. EVDO Summary Measurement Display

From the Measurements menu, press the EVDO Summary soft key to display the measurements in tabular format.

From the Measurements menu, press the Save Measurement soft key to open a dialog box in order to name and save the current measurement.

EVDO Measurement Descriptions

Pilot & MAC Power: The Pilot & MAC power shows the average power of the Pilot and MAC Channels. It is an absolute number that is expressed in dBm or Watts.

Active Data Power: Active Data Power is the average power of the Data Channel. When the slot is active, the data power should be very similar to the MAC & Pilot power (less than 2.5 dB difference). When the slot is idle, the Active Data Power should be at least 7 dB below the MAC & Pilot power if the BTS Master is connected directly to a base station.

Channel Power: During an active slot, Channel Power should be similar to Pilot & MAC power and should also be similar to Active Data Power. During an idle slot, channel power should be somewhere between the Pilot & MAC power and Data Power, because it is a weighted average of the two. When measuring an EVDO station with live traffic, channel power will vary according to how busy the downlink is, because channel power also depends upon the percentage of idle slots and active slots in the BTS Master captured sample.

Noise Floor: Noise floor is the average power of the inactive MAC channels, relative to the total MAC channel power. It is expressed in dB. When connected to a good EVDO source, the noise floor should be −31.5 dB or below. When noise or distortion is present (for example, in an over-the-air measurement), the noise floor can be considerably higher.

Freq Error: Frequency error is the difference between the received center frequency and the specified center frequency. This is only as accurate as the frequency reference that is being used and is typically more useful with a good external frequency reference or GPS.

Data Modulation: The BTS Master can determine the data channel modulation type automatically. EVDO data channel has three modulation types: QPSK, 8PSK, and 16QAM. When the slot is idle, the BTS Master displays "Idle".

PN Offset: Each EVDO base station is identified by a unique PN Offset in its pilot signal. This is similar to CDMA.

Tau: Tau measures the time delay from the input trigger to the "start of a slot." This means that Tau can be much larger than what is commonly seen in CDMA if the signal is not synchronized to the trigger.

> NOTE: The EVDO PN must be aligned with the start of an EVDO slot, in addition to referencing the external trigger or GPS signal. Therefore, when the user connects an external trigger that is poorly aligned with the EVDO signal slots, the BTS Master may report a Tau value that is very large in magnitude, in order to give the best possible PN Offset estimation.

Rho: Rho is a number between 0 and 1. A good signal should have a Rho that is close to 1. When connected to a good EVDO source, all Rhos should be 0.97 or above, and should decrease when the channel power is too weak. When noise or distortion is present, for example in an over-the-air measurement, Rhos can drop dramatically.

Rho Pilot: Rho Pilot is an indicator of the quality of the Pilot Channel.

Rho Data: Rho Data is an indicator of the quality of the Data Channel.

Rho MAC: Rho MAC is an indicator of the quality of the MAC Channel.

Rho Overall 1 and 2: Rho Overall 1 and 2 are both indicators of the overall quality of the EVDO signal during an active slot. They differ from each other in the sense that Rho Overall 1 measures from the beginning to the end of a half slot, while Rho Overall 2 measures from the middle of one half slot to the middle of another half slot. In general, they should have similar values.

Carrier Feedthrough: Carrier Feedthrough measures the amount of unmodulated signal that is leaking through the transmitter.

CDP Data: The Data Channel in EVDO consists of 16 "I" sub channels and 16 "Q" sub channels. Each of these channels should have a power of approximately −15.05 dB relative to the total Data Channel power. When connected to a good signal source, the Data Code Min is usually larger than −15.5 dB, and the Data Code Max is usually less than −14.6 dB. The smaller the difference between these two values, the better the signal quality.

CDP MAC: MAC channels are Walsh despread into 64 sub-channels (physical layer Subtype 0 or 1) or 128 sub-channels (physical layer Subtype 2). See the menu description for CDP MAC for color code details.

Pilot Scan: The strongest 9 PNs that are received are displayed. The length of the bar represents the absolute or relative power of the signal in dBm or dB. The strongest PN or the user-selected PN is color coded blue, those colored red are probably real pilots, and the remaining, which are color coded gray, are probably noise.

> NOTE: This graph is not meaningful if the PN search is set to No Trigger.

Multipath: The length of the bar represents the relative power in the signal path in dB. Ec/Io and Tau are displayed below each bar. The strongest signal is color coded blue. The remaining signals are color coded red, or they are color coded gray if they are due to system noise.

Pilot Dominance: Pilot Dominance is a measure of the strength of the strongest pilot compared to the next strongest pilot in the same channel. This should be >10 dB in order to make good demodulator measurements.

Multipath Power: Multipath Power is a measure of the total amount of power in the dominant signal (that is being spread in time due to multipath echoes) relative to its power in the main transmission path. This should be <0.4 dB in order to make good measurements.

Ec/Io: The pilot power compared to the total channel power during the pilot time slot.

Occ BW: The occupied bandwidth is calculated as the bandwidth containing 99% of the transmitted power in a 2.5 MHz span.

Active Data Power: The average power of the data channel portion of the active EVDO slot that is captured. If no active slots are captured, then the unit will display N/A.

Power vs. Time Graph: This view shows the time domain view of an EVDO half-slot. The Slot Type selection in the Setup menu determines the priorities regarding which slot is displayed.

Idle or Active Activity %: This shows the estimated percentage of idle or active slots in the total number of slots captured. Expect the idle percent (%) to be low and the active percent to be high when many EVDO users are connected to a base station.

EVDO Menus

Amplitude

See *Amplitude Menu on page 7-20*.

File

See *File Menu on page 7-21*.

Frequency

See *Freq (Frequency) Menu on page 7-25*.

Limit

See *Limit Menu on page 7-27*.

Marker

Markers are available only in CDP MAC and Spectrum measurements.

See *Marker Menu on page 7-27* for other descriptions.

Marker Table

This functions turns On and Off a marker table in the CDP MAC view only. The marker table indicates the values of all active markers.

Measurements Menu

Also refer to the similar CDMA *Measurements Menu on page 7-28*.
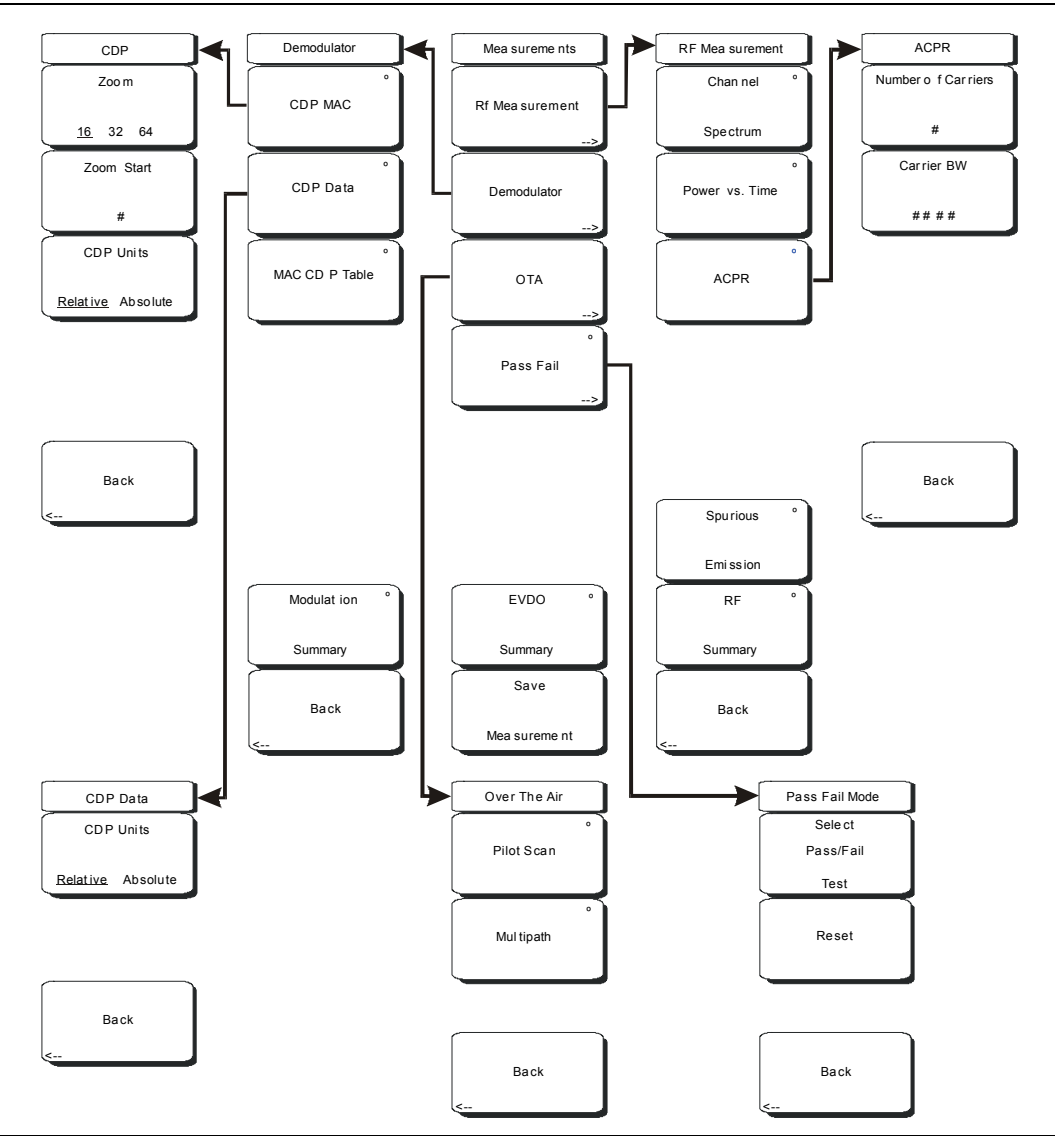
Figure 8-13. EVDO Measurements Menu

RF Measurement
EVDO includes Power vs. Time, and the Spurious Emission soft key is located further
down. The menu functions are similar to CDMA, except for the following:

Power vs. Time

Pressing this soft key displays a power versus time measurement. This view shows the time domain view of an EVDO half-slot. The Slot Type selection in the Setup menu determines the priority of which slot is displayed. Below the measurement display, numerical values are included for:

Pilot and Mac Power in dBm
Freq Error in Hz and PPM
Channel Power in dBm
ON/OFF Ratio: Power ratio (in dB) of Pilot and MAC power to the data power in an idle slot
Idle Activity: Percentage of idle slots relative to total slots in the captured signal

Demodulator

Pressing this soft key opens the Demodulator soft key menu with the following four functions.

CDP MAC

The first press of this soft key begins a CDP MAC measurement and also displays an arrow on the soft key (to indicate that a sub menu is available). The Code Domain Power (CDP) MAC view displays all of the Pilot and MAC codes in a color coded graphical format. MAC channels are Walsh despread into 64 sub-channels (physical layer Subtype 0 or Subtype 1) or 128 sub-channels (physical layer Subtype 2).

The bottom half of the CDP graph area shows a zoomed-in view of the code powers. A blue mask behind the zoomed-in area is duplicated in the upper graph to indicate which signals are in the zoom view.

The numerical results displayed in this view are

Pilot and MAC Power (dBm)
Channel Power (dBm)
Freq Error in Hz and PPM
Rho Pilot
Rho Overall1
Data Modulation
Noise Floor (dB)

The codes are color coded according to the following list:

Reserved Channels in White
Inactive channels in Gray
Reverse Activity (RA) in Red
Active channels alternate between Orange and Yellow

Zoom, 16, 32, 64

Press this soft key to select one of these three settings to view 16, 32, or 64 carriers in the measurement display.

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Zoom Start

Press this soft key, then enter the required zoom start index. For example, to start at code 2, which is the second code power that is displayed, press the 2 key on the numeric keypad, then press either the Enter soft key (which appears when the numeric keypad is used) or the **Enter** key.

Also, press this soft key, then use the arrow keys or rotary knob to change the zoom start index. The CDP soft key menu remains after pressing the rotary knob or the **Enter** key.

Back

Returns to previous (Demodulator) soft key menu.

CDP Data

The first press of this soft key displays EVDO CDP Data. The next press of the soft key opens the CDP Data soft key menu. The Code Domain Power (CDP) Data view displays only the data code powers. The display is split into the I (In phase) data and Q (Quadrature phase) data components. Each contains 16 sub-channels.

The numerical results that are displayed in this view are:

Active Data Power (dBm)
Data Modulation Type
Rho Pilot
Rho Overall1
Max Data CDP
Min Data CDP

CDP Units, Relative Absolute

Press this soft key to toggle between Relative units (in dB) or Absolute units in (dBm). Select **Relative** to show CDP power values in dB relative to Pilot and MAC Power, or **Absolute** to show power values in dBm.

Back

Returns to previous (Demodulator) soft key menu.

MAC CDP Table

This screen shows the power of the codes in a tabular format. The table displays the following 4 columns:

Code number
Status: RA, Active, Pilot, Page, Sync, All Traffic (Color Coded rows)
Relative Power (in dB)
Absolute Power (in dBm)
Code Utilization is displayed in percent (%) at the bottom of the table. It is a number indicating how many codes are used by a particular user (traffic).

Modulation Summary

Pressing this soft key displays a summary of all the modulation-related numerical measurement results in a table format, with rows for: Pilot & MAC Power, Channel Power, Rho Pilot, Rho MAC, Rho Data, Rho Overall1, Rho Overall2, Data Modulation, Noise Floor, RMS Phase Err, Freq Error, and Tau.

Back

Returns to previous (Measurements) soft key menu.

OTA

Soft key to open the Over The Air soft key menu. OTA displays the EVDO Over The Air measurements, which include: Pilot Codes, Ec/Io (dB), Tau, Pilot Power, Channel Power, Pilot Dominance, and Multipath.

Pilot Scan

Displays the power of the 9 strongest PNs in histogram graphical format. The strongest PN or the user-selected PN is color coded blue, those colored red are probably real pilots, and the remaining, which are color coded gray, are probably noise. PN, Ec/Io, and Tau are displayed below each PN bar graph signal. Pilot Power (dBm), Channel Power (dBm), and Pilot Dominance (dB) are displayed below the graph.

Multipath

Displays six multipaths in histogram graphical format. The strongest is color coded blue. The remaining signals are color coded red, or they are color coded gray if they are due to system noise. The numerical results that are displayed in this view are Ec/Io (dB) and Tau for each path. Channel Power, and Multipath Power are displayed below the graph.

Back

Returns to previous (Measurements) soft key menu.

Pass Fail

The first press of this soft key puts the BTS Master into Pass Fail Mode. The next press of the soft key opens the Pass Fail Mode soft key menu. See *Pass Fail on page 7-31*.

Select Pass/Fail Test

This soft key function allows the selection of a user-defined file that specifies a list of measurements with pass fail criteria. Select a test model by using the arrow keys or rotary knob. This mode will sequentially assess the appropriate measurements and indicate a pass or fail state based upon the test model criteria. Custom pass fail tests can be created by using Master Software Tools.

Reset

Press this soft key to restart the measurement.

Back

Returns to previous (Measurements) soft key menu.

EVDO Summary

Pressing this soft key displays a summary of all of the EVDO-related numerical measurements in a table format.

Save Measurement

Pressing this soft key opens a dialog box to name and save the current measurement. Press **Enter** to save the EVDO measurement, which is saved with a **.evdo** extension. See *Save Measurement on page 7-31*.

Mode Menu

To access the functions under the Mode menu, press the **Shift** key, then the **Mode** (9) key. Use the directional arrow keys or the rotary knob to highlight the selection and press the **Enter** key to select. The list of modes that appears in this menu will vary depending upon the options that are installed and activated in your instrument. Figure 4-28 on page 4-41 is an example of the Mode menu. Your instrument may not show the same list.

Setup

See *Setup Menu on page 7-32*. Items that are different are shown below

Walsh Codes
This allows you to toggle between 64 and 128 MAC indices. Note that MAC 128 is applicable only to Rev. A physical layer subtype 2.

Slot Type
Press this soft key to toggle through Auto, Active, and Idle slot types. Selecting **Active** makes the Power vs Time display an active slot if one is available. Selecting **Idle** makes the Power vs Time display an idle slot if one is available. Selecting **Auto** makes the Power vs Time show an Idle slot, or an Active slot if no idle slot is available. This setting also affects the type of power trigger that is used in a Spurious Emission Test.

System

See *System Menu on page 7-34*.

Preset

See *Preset Menu on page 7-31*.

Sweep

See *Sweep Menu on page 7-33*.

Trace

This menu is not available in EVDO mode.

Chapter 9
TD-SCDMA Signal Analyzer

Introduction

The TD-SCDMA Signal Analyzer offers three options: RF Measurements, Demodulator, and Over-the-Air (OTA) measurements. Three display types are provided for RF Measurements: Channel Spectrum display, Power versus Time display, or the RF Summary table. Demodulator measurements can be viewed in either the CDP Data display or the Modulation Summary table. The Over-the-Air Code Scan measurement displays the power of all 32 sync codes in sequential order. The Tau Scan measurement displays the codes based on Tau values.

Options for TD-SCDMA are:

   TD-SCDMA Over-the-Air (OTA) Measurements (Option 38)
   TD-SCDMA RF Measurements (Option 60)
   TD-SCDMA Demodulator (Option 61)

This chapter is divided into three major sections: setup and measurements, menu descriptions, and keypad functions.

Mode Selection

Set the instrument to TD-SCDMA Signal Analyzer measurement mode. Refer to section "Mode Selector Menu" on page 2-16.

TD-SCDMA Measurements General Setups

The following measurements can be made when the test instrument is set to TD-SCDMA Signal Analyzer mode.

Frequency Setup

The measurement frequency can be set by entering the center frequency or by selecting the applicable signal standard and channel, which allows the test instrument to automatically set the frequency.

Setting the measurement frequency by entering the center frequency:

1. Press the **Freq** function hard key.
2. Press the Center Freq soft key. The frequency value on the face of the virtual soft key turns red, ready for editing.
3. Enter the required frequency using the keypad, the arrow keys, or the rotary knob. When entering a frequency using the keypad, the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the **Enter** key has the same affect as pressing the MHz soft key.
4. Press the **Enter** key to set the Center Frequency. The current setting is displayed in the Instrument Settings Summary on the left side of the measurement screen.

Setting the measurement frequency by selecting a signal standard:

1. Press the **Freq** function hard key.
2. Press the Signal Standard soft key to open the Signal Standards list box.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard and press **Enter** to select. When a signal standard is selected, the center frequency for the channel of the selected standard is automatically tuned. Press the **Esc** key to abort any changes.
4. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display. The current settings are displayed in the Instrument Settings Summary on the left side of the measurement screen.

Amplitude Setup

Scale, Reference Level, and Units

Set up the amplitude parameters:

1. Press the **Amplitude** function hard key.
2. Press the Scale/div soft key. The value on the face of the virtual soft key turns red, which indicates that it is ready to be edited. Use the keypad, the arrow keys, or the rotary knob to change the desired scale value. Press the **Enter** key to set the new Scale/div value.
3. Press the Auto Range soft key to toggle auto ranging On or Off. The active state is underlined on the face of the virtual soft key. If On, then the reference level is adjusted automatically. If Off, then press the Adjust Range soft key to manually adjust the reference level once.
4. Press the Units soft key to set the measurements to the desired units: dBm or Watts.

Power Offset for Compensating External Loss

To get accurate results, compensation must be provided for any external attenuation by using power offset. In power offset mode, the compensation factor is in dB. External attenuation can be caused by using an external cable or external high-power attenuator.

• Press the Power Offset soft key. The value on the face of the virtual soft key turns red, ready for editing. Use the keypad, the arrow keys, or the rotary knob to change the desired offset value. Press the **Enter** key to set the Power Offset. The current setting is displayed in the Instrument Settings Summary on the left side of the measurement screen.

General Setup

External Reference Frequency Setup

The use of an external reference frequency (that is attached to the Instrument Ext Ref In connector) is important in order to get the best frequency accuracy measurements. Most base stations have a reference frequency that is available on a BNC connector. To configure the BTS Master to use an external reference frequency:

1. Press the **Setup** function hard key.
2. Press the Advanced Settings soft key
3. Press the External Reference Frequency (Ext. Ref. Freq) soft key to display a list box of available reference frequencies: 1 MHz, 1.2288 MHz, 1.544 MHz, 2.048 MHz, 2.4576 MHz, 4.8 MHz, 4.9152 MHz, 5 MHz, 9.8304 MHz, 10 MHz, 13 MHz, and 19.6608 MHz.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight the applicable reference frequency on the list and press the **Enter** key to set the reference frequency. As the BTS Master locks to the source, the Reference Frequency value setting is displayed in the Instrument Settings Summary on the left side of the measurement screen.
5. Press Back to return to the **Setup** menu.

Measure Speed

• Press the Meas Speed soft key to toggle among Fast, Norm, and Slow speeds.

TD-SCDMA RF Measurements

The following parameters are measured in the RF Measurement mode.

Channel Power

Channel power measures the average time domain power within the 1.6 MHz channel bandwidth and is expressed in dBm.

Channel Power (RRC)

Channel Power (RRC) is similar to Channel Power but is measured after being filtered by using the Root Raised Cosine (RRC) filter. It is usually smaller than channel power.

Slot x Pwr

X denotes slots 0 through 6. This is the power in each of the 7 slots, excluding the gap.

Occ BW

Occupied bandwidth is the calculated bandwidth containing 99% of the total integrated power occupied in the span. Span is 5 MHz when Number of Carrier is set to 1. For all other values, span is set to 1.6 MHz.

DwPTS Pwr

The power in the Downlink Pilot slot, excluding the gap.

UpPTS Pwr

The power in the Uplink Pilot Slot, excluding the gap.

DL-UL Delta Power

The average difference between the active DL slots and the active UL slots, including pilot slots. UL and DL slots are selected according to the Uplink Switch Point setting. Without UL data slot and without UpPTS, the DL-UL Delta Power value is not applicable.

On/Off Ratio

The ratio of the power between the on and off portions of the Downlink slots.

Slot PAR

The peak to average power in the selected (or auto detected) slot. The highest 0.1% power of the slot is used as the peak.

Left Channel Power

The channel power of the 1.6 MHz channel left of the main channel. This is useful in the multi-carrier environments.

Right Channel Power

The channel power of the 1.6 MHz channel right of the main channel. This is useful in the multi-carrier environments.

Left Channel Occ BW

This is the occupied bandwidth of the channel left of the main channel and is useful in a multi-carrier environment. This value is N/A when Number of Carriers is set to 1.

Right Channel Occ BW

This is the occupied bandwidth of the channel right of the main channel and is useful in a multi-carrier environment. This value is N/A when Number of Carriers is set to 1.

Measurement Setup

- Follow the procedures in section "TD-SCDMA Measurements General Setups" on page 9-2.
- Continue with the following setups for the specific RF measurements.
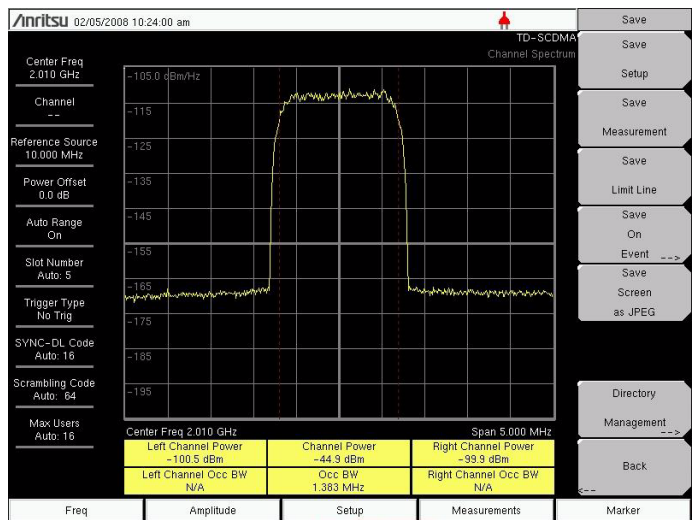
Figure 9-1. Channel Spectrum Measurement

1. Press the **Setup** function hard key.
2. Press the Advanced Settings soft key.
   a) Press the Number of Carriers soft key. The current value on the face of the virtual soft key turns red and is ready to be edited.
   b) Use the **Up/Down** arrow keys, the rotary knob, or the numeric keypad to set a new value. Then press **Enter**.
   c) Press the Back soft key to return to the **Setup** menu
3. Press the **Measurements** function hard key.
4. Press the RF Measurement soft key.
5. Press the Channel Spectrum soft key to activate this RF measurement view.
6. Press the Back soft key again to return to the **Measurements** menu.

Power versus Time

The Power versus Time view shows the time domain view.

1. Press the **Setup** function hard key.
   a) Press the Slot Selection soft key. The Slot Selection list box and menu open. Use the **Up/Down** arrow keys or the rotary knob to highlight Auto or 0 through 6 and press the **Enter** key. Use the Auto soft key for a quicker means to select that option.
   b) Press the Trigger soft key. The **Trigger** menu opens.
      1) Press the Trigger Type soft key to select No Trig, GPS, or Ext. The active state is underlined on the face of the virtual soft key.
      2) Press the Ext Trigger Polarity soft key to select either Rising or Falling trigger edge.
      3) Press the Back soft key to return to the **Setup** menu.
   c) Press the Advanced Settings soft key to continue with setups under the **Advanced Settings** menu.
   d) Press the Number of Carriers soft key. The current value on the face of the virtual soft key turns red and is ready to be edited. Use the **Up/Down** arrow keys, rotary knob, or numeric keypad to set a new value and press the **Enter** key.
   e) Press the Back soft key to return to the **Setup** menu.
   f) Press the Uplink Switch Point soft key. The current value on the face of the virtual soft key turns red and is ready to be edited. Use the **Up/Down** arrow keys, rotary knob, or numeric keypad to set a new value and press the **Enter** key.
2. Press the **Measurements** function hard key.
3. Press the RF Measurement soft key.
4. Press the Power vs. Time soft key to activate this RF measurement view. Press this key again to set up the **Power vs. Time** measurement.
   a) Press the View soft key to toggle the measurement view to Sub-Frame or Slot.
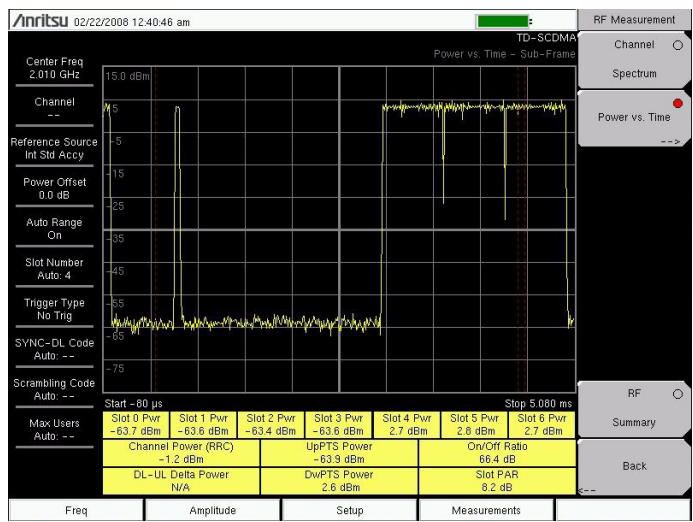
Figure 9-2. Power vs. Time: Sub-Frame Measurement

   b) Press the Slot Selection soft key. The Slot Selection list box and menu open. Use the **Up/Down** arrow keys or the rotary knob to highlight Auto or 0 through 6 and press **Enter**. Use the Auto soft key for a quicker means to select that option.
   c) Press the Back soft key to return to the **RF Measurement** menu.
5. Press the Back soft key again to return to the **Measurements** menu.

9-6
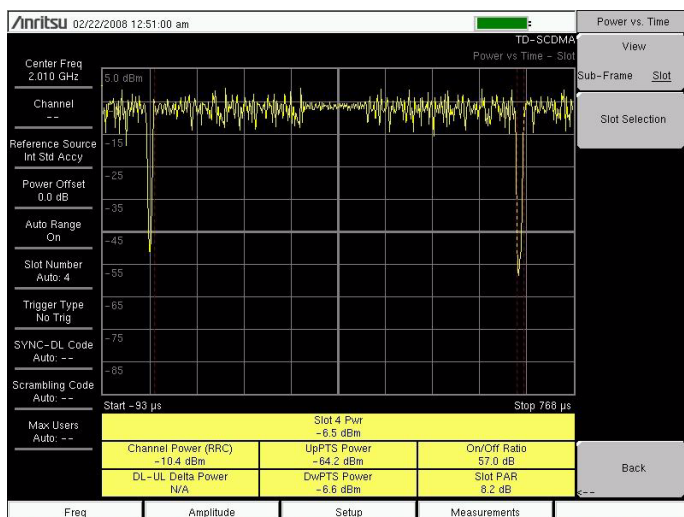
Figure 9-3. Power vs. Time: Slot Measurement

RF Summary

The RF Summary displays the critical RF transmitter performance measurements in a table format, without demodulating the TD-SCDMA signal. The parameters that are displayed in the RF summary table are Channel Power (dBm), Channel Power (RRC) (dBm), Occupied Bandwidth (Hz), DwPTS Power (dBm), UpPTS Power (dBm), On/Off Ratio (dB), Slot PAR (dB), Left Channel Power (dBm), Right Channel Power (dBm), Left Channel Occupied Bandwidth, and Right Channel Occupied Bandwidth.

1. Press the **Setup** function hard key. (For a few of the setup parameters, you will have the choice of selecting the Auto option in a list box or an Auto soft key. The Auto soft key allows you a means of immediate selection rather the scrolling through the list box, highlighting Auto, and pressing the **Enter** key.)

   a) Press the Slot Selection soft key. The Slot Selection list box and menu open.
      - In the list box, use the **Up/Down** arrow keys or the rotary knob to highlight Auto or slot 1 through slot 6 and press the **Enter** key.

   b) Press the Trigger soft key. The Trigger menu opens.
      1) Press the Trigger Type soft key to toggle through the three trigger types: No Trig, GPS, and Ext. The active state is underlined on the face of the virtual soft key.
      2) Press the Ext Trigger Polarity soft key to toggle either Rising or Falling trigger edge.
      3) Press the Back soft key to return to the **Setup** menu.

   c) Press the Uplink Switch Point soft key. The current value on the face of the virtual soft key turns red and is ready to be edited. Use the **Up/Down** arrow keys, rotary knob, or numeric keypad to set a new value and press the **Enter** key.

   d) Press the Advanced Settings soft key to continue with setups under the **Advanced Settings** menu.

   e) Press the Number of Carriers soft key. The current value on the face of the virtual soft key turns red and is ready to be edited. Use the **Up/Down** arrow keys, rotary knob, or numeric keypad to set a new value and press the **Enter** key.

   f) Press the Back soft key to return to the **Setup** menu.

2. Press the **Measurements** function hard key.

3. Press the RF Measurement soft key.
4. In the **RF Measurement** menu, press the RF Summary soft key to view the primary RF measurements in a table.

TD-SCDMA Demodulator
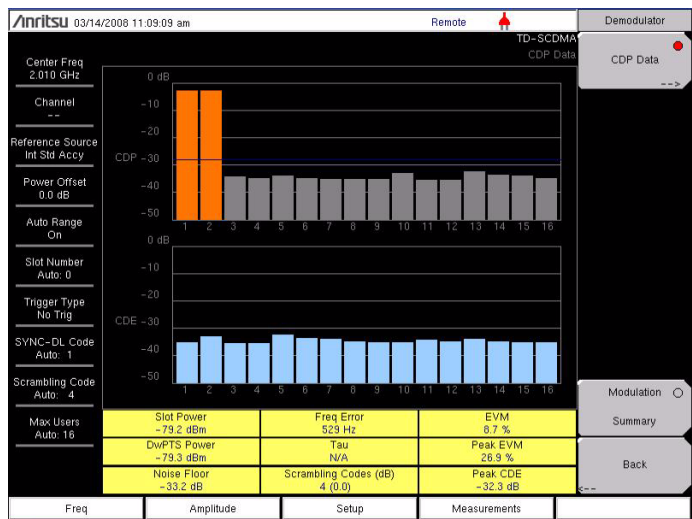
Figure 9-4. Demodulator Measurement – CDP Data

The following parameters are measured in the Demodulator option.

Slot Power

The power measured in the selected slot, excluding the gap. If Slot Selection is set to Auto, then the instrument searches for an active downlink slot and uses the detected slot number for measuring slot power.

DwPTS Pwr

The power in the Downlink Pilot slot, excluding the gap.

EVM

The Error Vector Magnitude (EVM) is the ratio (in percent) of the difference between the reference waveform and the measured waveform. EVM metrics are used to measure the modulation quality of a transmitter. The EVM value displayed by the BTS Master is the root mean square EVM of the measured downlink slot data.

Peak EVM

The peak of the measured EVM.

Freq Error

Frequency error is the difference between the received center frequency and the specified center frequency. This value is linked to the external frequency reference accuracy and is typically useful only with a good external frequency reference or GPS reference.

Freq Error PPM

Frequency error, expressed in parts per million (ppm).

Tau

Tau is the timing delay of the frame starting point in reference to the occurrence of a trigger. When no trigger is used, Tau values are relative to the most dominant SYNC-DL code.

Noise Floor

Noise floor is the average of inactive codes powers (dB) from the code domain power (CDP).

Peak CDE

The peak of the Code Domain Error (CDE) is the remnant power in the code domain after the useful signal is extracted.

Scrambling Codes

The display format is **Scrambling Code # (relative power in dB)**. A measure of the relative powers of the 4 scrambling codes (relative to Slot Power) that correspond to the detected SYNC-DL code. Only those scrambling codes with high relative power are displayed. Typically, only one scrambling code is displayed unless significant interference occurs from neighboring codes.
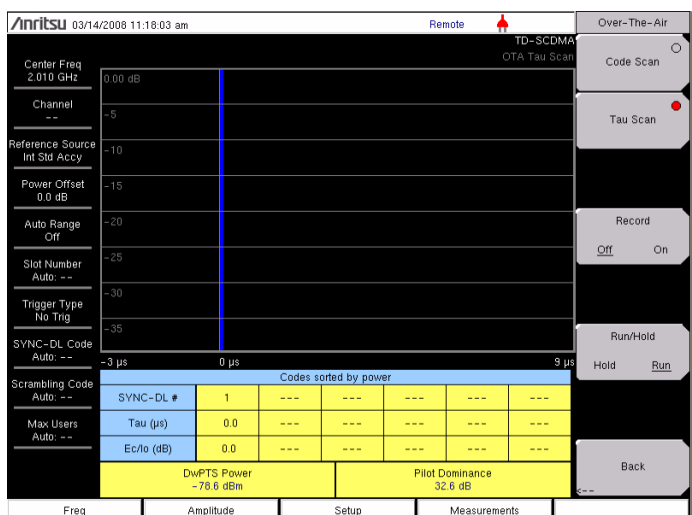
Measurement Setup

1. Follow the procedures described in section "TD-SCDMA Measurements General Setups" on page 9-2.
2. Press the **Setup** function hard key. (For a few of the setup parameters, you will have the choice of selecting the Auto option in a list box or an Auto soft key. The Auto soft key allows you a means of immediate selection rather than scrolling through the list box, highlighting Auto, and pressing the **Enter** key.)
   a) Press the Slot Selection soft key. The Slot Selection list box and menu open.
      - In the list box, use the **Up/Down** arrow keys or the rotary knob to highlight Auto or slot 1 through slot 6 and press the **Enter** key.
   b) Press the Trigger soft key. The Trigger menu opens.
      1) Press the Trigger Type soft key to toggle through the three trigger types: No Trig, GPS, and Ext. The active state is underlined on the face of the virtual soft key.
      2) Press the Ext Trigger Polarity soft key to toggle either Rising or Falling trigger edge.
      3) Press the Back soft key to return to the **Setup** menu.
   c) Press the Uplink Switch Point soft key. The numerical value on the face of the virtual soft key turns red and is ready to be edited. Use the **Up/Down** arrow keys, rotary knob, or numerical keypad to set a new value and press the **Enter** key.
   d) Press the SYNC-DL Code soft key. The SYNC-DL Code list box opens.
      - In the list box, use the **Up/Down** arrow keys or the rotary knob to highlight Auto or code 0 through code 31 and press the **Enter** key.
   e) Press the Scrambling Midamble Code soft key. The Scrambling/Midamble Code list box opens.
      - In the list box, use the **Up/Down** arrow keys or the rotary knob to highlight Auto or code 0 through code 127 and press the **Enter** key.
   f) Press the Max Users soft key. The Maximum Users list box opens.
      - In the list box, select Auto or 2 through 16 and press the **Enter** key.
   g) Press the Meas Speed soft key to toggle through the measuring speeds: Fast, Norm, and Slow.
   h) Press the Advanced Settings soft key to continue with setups in the **Advanced Settings** menu.
   i) Press the Tau Offset soft key to enter a tau offset value.
   j) Press the Back soft key to return to the **Setup** menu.

CDP Data

1. Press the **Measurements** function hard key.
2. Press the Demodulator soft key.
3. Press the CDP Data soft key once to select the CDP Data measurement and again to open the **CDP Data menu**.
4. In the **CDP Data** menu, press the CDP Units soft key to toggle Relative or Absolute.
5. Press the Back soft key to return to **Demodulator** menu.
6. Press the Back soft key again to return to the **Measurements** menu.

Modulation Summary

The Modulation Summary displays the critical Modulation transmitter performance measurements in a table format by demodulating the TD-SCDMA signal that is displayed in the Modulation Summary table: Slot Power, EVM, Peak EVM, Freq Error, Freq Error PPM, Tau, Noise Floor, Carrier Feed Through, and Peak CDE.

1. Press the **Measurements** function hard key.
2. Press the Demodulator soft key.
3. Press the Modulation Summary soft key to display the modulation summary table.
4. Press the Back soft key to return to the **Measurements** menu.

CDP and CDE

Code Domain Power (CDP) and Code Domain Error (CDE) are displayed with color coding as described in the following table:

Table 9-1. Color Legend for CDP and CDE

Display Color	Code Type
Orange	Active Codes
Gray	Idle Codes
Light Blue	Code Domain Errors

TD-SCDMA Over-the-Air (OTA) Measurements
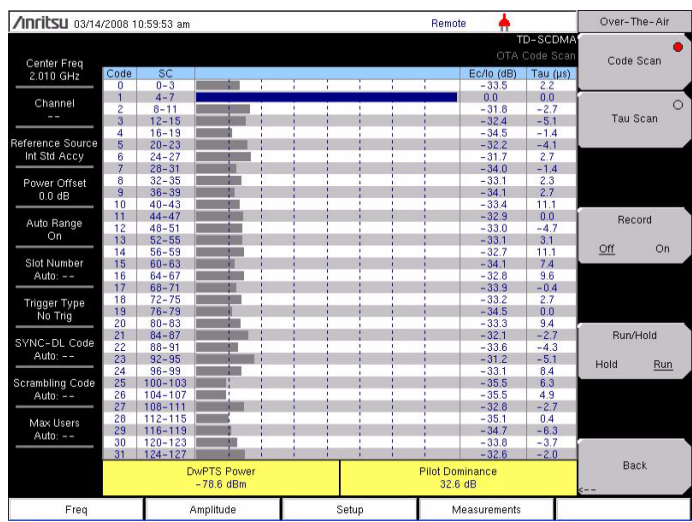
Figure 9-5. Over-The-Air Code Scan

Code Scan

Scans and displays the power of all 32 SYNC-DL codes in sequential order, including Ec/Io (dB) and Tau (µs). DwPTS Power and Pilot Dominance values are displayed below the table of codes. The Scrambling Codes (SC) corresponding to each SYNC-DL code are also displayed next to each code (for easy reference).

Tau Scan

Displays the code power versus Tau in a bar graph format. The horizontal axis (Tau) has dynamic scale. The six strongest SYNC-DL codes are displayed below the bar graph with their Tau (us) and Ec/Io (dB) values. DwPTS Power and Pilot Dominance values are displayed below the table of the six strongest codes.

DwPTS Pwr

The power in the Downlink Pilot slot, excluding the gap.

Pilot Dominance

Pilot dominance is a measure of the strength of the strongest code compared to the next strongest code in the same channel.

Figure 9-6. Over-The-Air Tau Scan

Measurement Setup

1. Follow the procedures described in section "TD-SCDMA Measurements General Setups" on page 9-2.
2. Press the **Setup** function hard key.
   a) Press the Trigger soft key. The Trigger menu opens.
      1) Press the Trigger Type soft key to toggle through the three trigger types: No Trig, GPS, and Ext. The active state is underlined on the face of the virtual soft key.
      2) Press the Ext Trigger Polarity soft key to toggle either Rising or Falling trigger edge.
      3) If necessary, press the Tau Offset soft key to specify a Tau Offset value.
      4) Press the Back soft key to return to the **Setup** menu.
3. Continue with the following setups for the specific OTA measurements.

Code Scan

1. Press the **Measurements** function hard key.
2. Press the OTA soft key. The Over-the-Air menu is displayed.
3. Press the Code Scan soft key to activate this measurement view.

Tau Scan

1. Press the **Measurements** function hard key.
2. Press the OTA soft key.
3. Press the Tau Scan soft key to activate this measurement view.

TD-SCDMA Pass/Fail Measurements

The following is an example of a Pass/Fail measurement.

Measurement Setup

1. Follow the procedures described in section "TD-SCDMA Measurements General Setups" on page 9-2.
2. Press the **Measurements** hard key.
3. Press the Pass/Fail soft key to activate the test.
4. Press the Pass/Fail soft key again to display the **Pass/Fail** menu.
5. Press the Select Pass/Fail Test soft key. Use the **Up/Down** arrow keys or the rotary knob to highlight the desired test mode in the Select Test list box and press the Select Test soft key.
6. Press the Reset soft key to begin a new pass/fail test measurement.
7. Press the Back soft key to return to the **Measurements** menu.
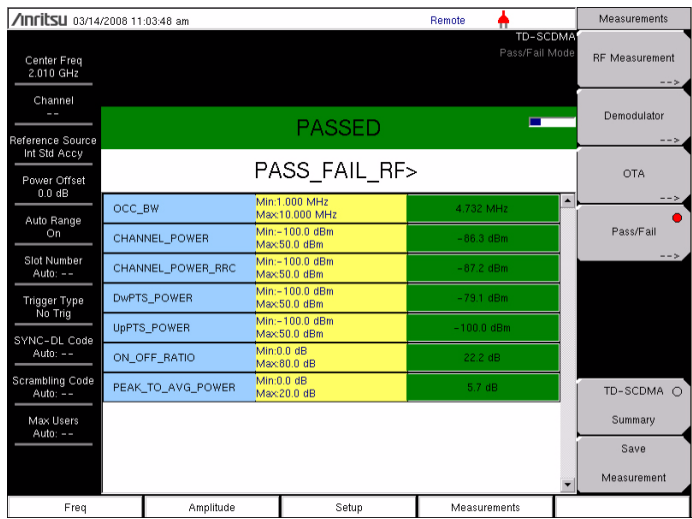
Figure 9-7. Pass/Fail Measurement

Menus

The following menus are specific to the TD-SCDMA Signal Analyzer mode.

Freq (Frequency) Menu
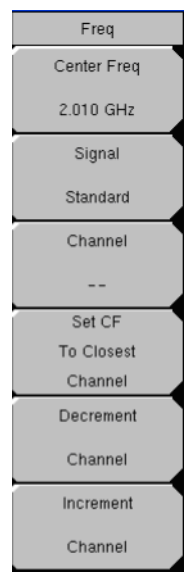
Figure 9-8. Frequency Menu

Press the **Freq** function hard key to display the **Freq** soft key menu.

Center Freq
Press this soft key to set the receiver center frequency to the desired value. Enter the frequency (2.7 GHz is the maximum value that can be entered) by using the keypad, the arrow keys, or the rotary knob. When entering a frequency using the keypad, the soft key labels will change to **Units**: GHz, MHz, kHz, and Hz. Press the appropriate units soft key. Pressing the **Enter** key has the same affect as pressing the MHz soft key.

Signal Standard
Press this soft key to open the Signal Standards list box. Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard and press **Enter** to select. When a signal standard is selected, the center frequency and span for the first channel of the selected standard are automatically tuned. Other settings, such as channel spacing and integration bandwidth, are also automatically entered.

Channel
Press this soft key to open the Channel Editor list box in order to select a channel number within the range of the selected signal standard. Use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number. The center of the channel is automatically tuned to the center frequency of the selected channel.

Set CF to Closet Channel
Press this soft key to move the center frequency to the closest frequency that matches a channel number in the current signal standard.

Decrement Channel
Press this soft key to decrement the channel by one channel.

Increment Channel
Press this soft key to increment the channel by one channel.

Amplitude Menu
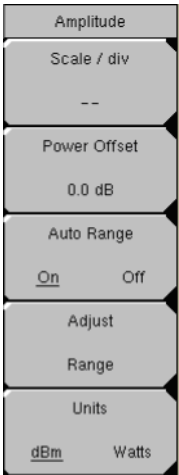
Figure 9-9. Amplitude Menu

Press the **Amplitude** function hard key to display the **Amplitude** soft key menu.

Scale/div
Press this soft key to change the scale of the y-axis in the measurement display. This setting applies to the Channel Spectrum, and CDP Data views only. The range of the scale can be set from 1 dB/div to 15 dB/div in steps of 1 dB/div.

Power Offset
Press this soft key to have the instrument automatically adjust for the loss through any external cables, attenuators, and couplers. The power can be offset from –100 dB to +100 dB with 0.1 dB resolution by using the rotary knob (larger step resolution using the **Up/Down** and **Left/Right** arrow keys.) You can also press the Power Offset soft key, use the keypad to enter the offset values, and press the dB soft key.

Auto Range
Press this soft key to toggle the Auto Range function between On and Off. The reference level adjusts automatically when On is underlined.

Adjust Range
Press this soft key to perform an Auto Range operation once. Auto Range is automatically turned Off, and the Auto Range operation is performed one time when the Adjust Range soft key is pressed.

Units
Press this soft key to view the power measurements in either dBm or Watts.

Setup Menu
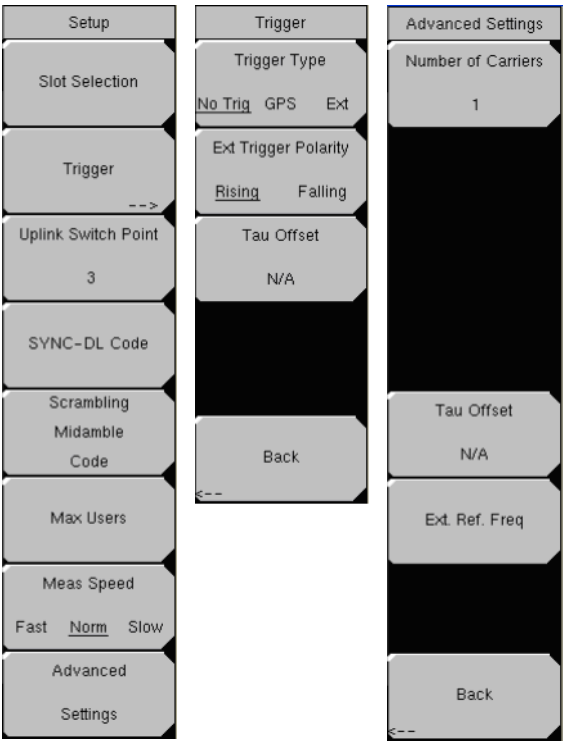
Figure 9-10. Setup Menu

Press the **Setup** function hard key to display the **Setup** soft key menu.

Slot Selection
Press this soft key to open the Slot Selection list box. Use the arrow keys or the rotary knob to highlight Auto or one of the six slots. If Auto is selected, then the active slot is automatically detected. Press the **Enter** key to select.
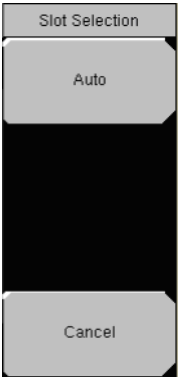
Figure 9-11. Slot Selection Menu

Auto

Automatically looks for an active downlink slot. Auto in the Slot Selection window and the Auto soft key have the same function. The Auto soft key allows for a slightly quicker selection of the Auto function.

Cancel

Disregards any entry and returns to the **Setup** menu.

Trigger

Press this soft key to list the **Trigger** menu, to set up the trigger parameters, and to set up the Tau Offset.

Trigger Type
No Trig   GPS   Ext

Select a trigger type by pressing this soft key to toggle among No Trig, GPS, or Ext. The active state is underlined on the face of the virtual soft key.

Ext Trigger Polarity
Rising   Falling

Press this soft key to toggle either Rising or Falling polarity of external trigger.

Tau Offset

Press this soft key to add an offset (5 sec is the maximum offset that can be entered) to the current Tau value.

Back

Press this soft key to return to the **Setup** menu.

Uplink Switch Point

Press this soft key to set an uplink switch point. This is the slot number of the last uplink timeslot. Slots from the next timeslot to the end of the sub-frame are considered downlink. The default value is 3. The range of values are 0 through 6, where 0 is no uplink.

SYNC-DL Code

Press this soft key to open the SYNC-DL Code list box. Use the **Up/Down** arrow keys or the rotary knob to highlight Auto or 0 through 31 and press **Enter**. If Auto is selected, then the active SYNC-DL code is displayed.

Auto

Automatically seeks the active SYNC-DL code. "Auto" in the SYNC-DL Code list box and the "Auto" soft key have the same function. The Auto soft key allows for a slightly quicker selection of the Auto function.

Cancel

Disregards any entry and returns to the **Setup** menu.

Scrambling Midamble Code

Press this soft key to open the Scrambling/Midamble Code list box. Use the **Up/Down** arrow keys or the rotary knob to highlight Auto or 0 through 127 and press **Enter**. If Auto is selected, the active Scrambling/Midamble code is displayed.

Auto

Automatically looks for the Scrambling/Midamble code. "Auto" in the Scrambling/Midamble Code window and the "Auto" soft key have the same function. The Auto soft key allows for a slightly quicker selection of the Auto function.

Cancel

Disregards any entry and returns to the **Setup** menu.

Max Users

Press this soft key to open the Maximum Users window. Use the **Up/Down** arrow keys or the rotary knob to highlight Auto or 2 through 16 and press **Enter**. If Auto is selected, then the maximum number of users is listed.

Auto

Automatically looks for the maximum number of users. Auto in the Maximum Users list box and the Auto soft key have the same function. The Auto soft key allows for a slightly quicker selection of the Auto function.

Cancel

Disregards any entry and returns to the Setup menu.

Meas Speed

Press this soft key to toggle the desired scan speeds: Fast, Norm, and Slow. The active state is underlined on the face of the virtual soft key.

Advanced Settings

Press this soft key to continue setting up the measurement parameters. The **Advanced Settings** soft key menu is displayed.

Number of Carriers

Press this soft key to select the number or carriers present in the signal. Press this soft key to place the value in edit mode (value is colored red). Use the numeric keypad, **Up/Down** arrow keys, or rotary knob to enter the new value. Press the Enter key to set. Range of values is 1-5.

Tau Offset

Press this soft key to add an offset (5 sec is the maximum offset that can be entered) to the current Tau value.

Ext. Ref. Freq.

Press this soft key to select the desired external Reference Frequency by using the **Up/Down** arrow keys or the rotary knob and then pressing **Enter**. The following external Reference Frequencies are available: 1 MHz, 1.2288 MHz, 1.544 MHz, 2.048 MHz, 2.4576 MHz, 4.8 MHz, 4.9152 MHz, 5 MHz, 9.8304 MHz, 10 MHz, 13 MHz, and 19.6608 MHz. The default external Reference Frequency is 10 MHz.

Back

Press this soft key to return to the **Setup** menu.

Measurements Menu
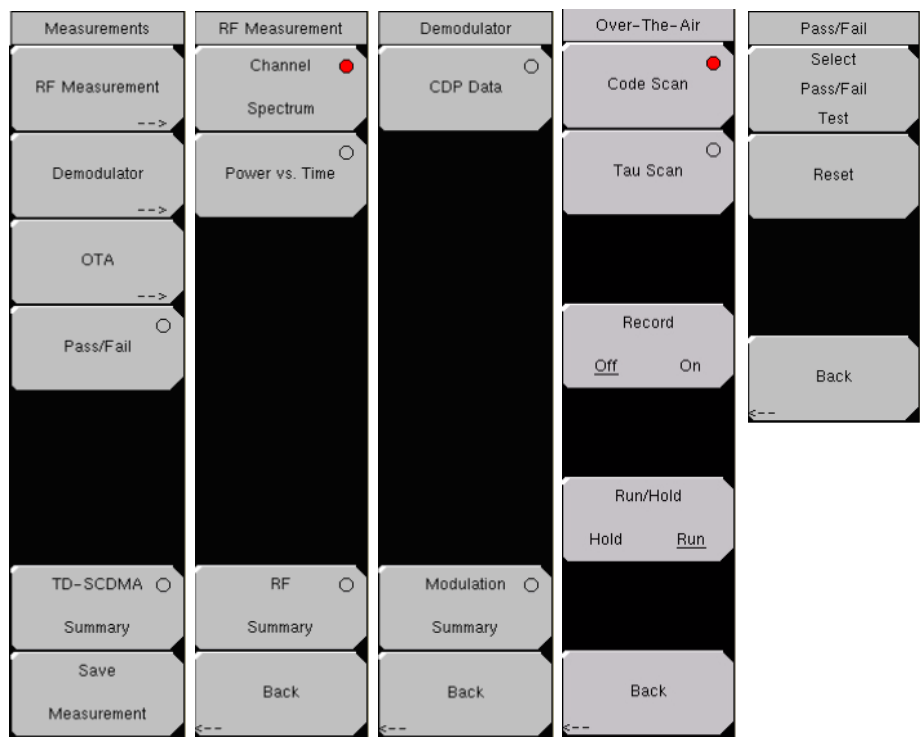
Figure 9-12. Measurements Menu

RF Measurements

Press this soft key to display the RF Measurement soft key menu.

Channel Spectrum

Press this soft key to displays the spectrum of the input signal. The span is automatically set to 5 MHz. Beneath the graph, values for the following, measurements are displayed: Left Channel Power, Channel Power, Right Channel Power, Occ BW, Left Channel Occ BW, and Right Channel Occ BW. Channel Power is displayed in dBm or watts depending on unit selection.

Power vs. Time

Press this soft key once to place the measurement display in power versus time view. When active, the soft key becomes a soft key. Press this soft key to further set up the display.
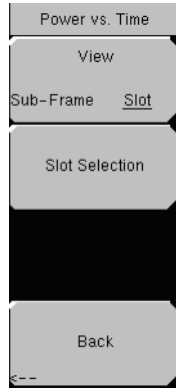
Figure 9-13. Power Versus Time Menu

View

Press this soft key to display the Power vs. Time graph in either the Sub-Frame view or the Slot view.

Slot Selection

Press this soft key to open the Slot Selection list box. Use the **Up/Down** arrow keys or the rotary knob to highlight Auto or one of the six slots. If Auto is highlighted, then the active slot is displayed. Press the **Enter** key to select.

Auto

Automatically looks for an active downlink slot. Auto in the Slot Selection window and the Auto soft key have the same function. The Auto soft key allows for a slightly quicker selection of the Auto function.

Cancel

Disregards any entry and returns to the **Power vs. Time** menu.

Back

Press this soft key to return to the **RF Measurement** menu.

RF Summary

Press this soft key to display the following RF measurements in table format:

Channel Power
Channel Power (RRC)
Occ BW
DwPTS Pwr
UpPTS Pwr
On/Off Ratio
Slot PAR
Left Channel Power
Right Channel Power
Left Channel Occ BW
Right Channel Occ BW

Back

Press this soft key to return to the **Measurements** menu.

Demodulator

Press this soft key to display the **Demodulator** soft key menu and to set up demodulator testing.

CDP Data

Press this soft key once to activate this test. When active, the soft key becomes a soft key. Press this soft key to list the **CDP Data** menu and further set up the measurement.

CDP Units

Press this soft key to select either Relative units (dB) or Absolute units (dBm).

Back

Press this soft key to return to the **Demodulator** menu.

Modulation Summary

Press this soft key to view the performance of the transmitter demodulated TD-SCDMA signal in table format. The following parameters are displayed in the table:

Slot Power (dBm)
EVM
Peak EVM
Freq Error
Freq Error PPM
Tau
Noise Floor
Carrier Feed Through
Peak CDE

Back

Press this soft key to return to the **Measurements** menu.

OTA

Press this soft key to display the Over-The-Air soft key menu.

Code Scan

Press this soft key to display the 32 sync codes in table format. Displayed below the table are DwPTS Power (in dBm) and Pilot Dominance (in dB).

Tau Scan

Press this soft key to display the code power versus Tau in bar graph format. Code numbers are displayed at the top of each bar. A table below the bar graph shows the 6 strongest codes (identified by number) and the Tau (in µs) and the Ec/Io (in dB).

Record
Off   On

Pressing this soft key so that On is underlined (selected) sets the BTS Master to automatically record all OTA measurements that are taken while in the Run mode. Before recording occurs, the name of a log file is flashed on the screen. This is the file in which all recorded data is stored. Selecting Off stops all recording and closes the log file. When pressed again, recording begins in a new file. If Record is turned On when the measurement is a non-OTA measurement (such as Spectrum), then no action is performed.

Run/Hold
Hold   Run

Press this soft key to set the BTS Master into either Run mode or Hold mode. Hold mode prevents the BTS Master from taking any new measurements and freezes the current measurement. Run mode allows the BTS Master to continually take measurements.

When Record is already toggled On, pressing the Run/Hold soft key toggles the taking of measurements on and off to continue appending new measurements within the same log file, rather than creating a new log file.

Back

Press this soft key to return to the **Measurements** menu.

Pass/Fail

Press this soft key to activate the Pass/Fail test. When active, the soft key becomes a soft key. Press this soft key to display the Pass/Fail soft key menu and set up pass/fail testing.

Figure 9-14. Pass/Fail Menu

Select Pass/Fail Test

Press this soft key to open the Select Test list box and select a test type. Choose from: PASS_FAIL_RF>, PASS_FAIL_DEMOD>, and PASS_FAIL_ALL>. The soft key menu displays one key: Select Test. Press Select Test or press Esc to cancel your choice.

Reset

Press this soft key to restart the measurement or to begin a new pass/fail test measurement.

Back

Press this soft key to return to the **Measurements** menu.

TD-SCDMA Summary
Press this soft key to display a table of the TD-SCDMA measurements. The following
measurement values are displayed in the table:

Channel Power
Occ BW
Slot Power
DwPTS Power
UpPTS Power
On/Off Ratio
Freq Error
Freq Error PPM
EVM
Peak CDE
Tau

Save Measurement
Press this soft key to save a measurement. You may accept the default filename or enter
your own filename. Refer to section "Text Entry" on page 2-7.

Chapter 10
Channel Scanner

Introduction

This chapter presents Channel Scanner information and procedures. The Channel Scanner option (Option 27) measures the signal power of multiple transmitted signals. The power can be displayed as either a bar graph or a text display showing the channel power of selected channels for a given air interface standard, or the manually entered channels. Up to 20 channels can be measured.

The operating frequency range for Channel Scanner mode can either be set manually, or the desired air interface standard can be selected from the Signal Standard and channel list in the instrument. When the channels are selected from the Signal Standard list, all frequency related parameters for the standard are automatically set to the appropriate values. The frequency and bandwidth settings can be manually entered using the Scan Frequencies selection if none of the available air interface standards meet the measurement need. A custom channel list can also be created to allow up to 20 independent channels to be defined.

Getting Started

Channel Scanner Mode

To prepare for Channel Scanner measurements, the MT8222A must be configured for Channel Scanner mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Channel Scanner and press the **Enter** key to select.

For additional information about the Mode menu, refer to *Mode Selector Menu* .

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* .

Sample Procedure

The following procedure demonstrates a common channel scanner setup.

1. On the BTS Master, press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Channel Scanner and press the **Enter** key to select.
3. Press the **Scanner** key to activate the Scanner menu. The power can be scanned using a signal standard and channel numbers or by entering a start frequency, frequency step size and bandwidth. The channels can be customized using the Scan Custom List or Custom Setup. For this example, select the channels by pressing the Scan Channels soft key, then the Signal Standard soft key. Select the CDMA US PCS signal standard.
4. Press the Number of Channels soft key and enter 20.
5. Press the **Amplitude** key and set the Reference Level and Scale so that the power of all the channels is displayed on the screen.
6. Press the **Measurements** key to activate the Measurement menu.
7. Press the Display soft key and select Graph display to display the measurements in the graph format.
8. Press the Channel Units soft key and select Channel to display the measurements in channel format.
9. Press the Units Display soft key and choose Max to display the maximum measured power for each channel.
10. Press the Color Code soft key and select Dual to display the measurements in dual colors.

> NOTE: Measurements can be made when the base station is in service, out of service, or over the air.

Custom Setup Measurements

Procedure

1. On the BTS Master, press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Channel Scanner and press the **Enter** key to select.
3. Press the **Custom Setup** key.
4. Press the Number of Channels soft key to define how many channels to include in the custom list. This choice can be changed later if needed.
5. Press the Edit List soft key to bring up the list of channels. The channel highlighted in blue is the channel active for editing. Use the up and down arrows to select the channel to edit. Each channel can be set up differently.
6. Press either the Select Signal Standard soft key or the Set Freq soft key. If the Select Signal Standard soft key was pressed, select the desired air interface standard from the dialog box displayed. When a standard is selected, the usual bandwidth for that standard is automatically set. The bandwidth can be changed if desired. After the air interface standard is selected, press the Set Channel soft key to enter the desired channel number.
   If the Set Freq soft key was pressed, the frequency value of the active channel will be highlighted in a red box. Use the rotary knob or the numeric key pad to enter the desired center frequency in Hz, kHz, MHz, or GHz.
7. Press the Set Bandwidth soft key and use the rotary knob or numeric keypad to enter the desired value in Hz, kHz, MHz, or GHz.
8. Repeat 5. through 7. for all channels.

Custom Setup Example

This example explains how to monitor several signals, plus a potential intermodulation product, to see if there is a correlation between the nearby signals and an intermittent interference problem.

The signals on or near the rooftop are:

- An FM broadcast station at 106.5 MHz

- A paging transmitter at 157.86 MHz

- Three cellular sites:
  US CDMA PCS channel 50 (1932.5 MHz)
  AMP/EIA 553 channel 525 (885.750 MHz)
  GSM 1800 channel 512 (1805.2 MHz)

- A Ham repeater at 147.36 MHz

- A Ham repeater at 446.5 MHz

- A land mobile repeater at 451.7875 MHz

- A public safety repeater at 485.5625 MHz

- In addition, the site is near the flight path of an airport. The approach frequency is 121.4 MHz.

Set up a measurement channel for each of the signals to be observed plus extra channels for any intermodulation products to be observed.

After the channels are set up, press | Shift | File | Save | Save Setup| and name the setup for easy recall later.

Amplitude
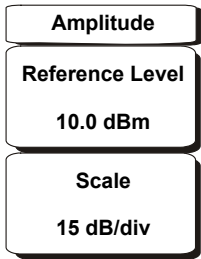
Figure 10-1. Channel Scanner Mode Amplitude Menu

Reference Level
Activates the amplitude reference level function which sets the amplitude at the top of the display. Valid reference levels are from +30 dB to −130 dBm.

Scale
Activates the scale function which sets the dB/division value from 1 dB/div to 15 dB/div in 1 dB steps.

Custom Setup
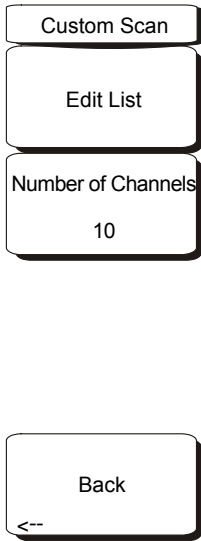
Figure 10-2. Channel Scanner Mode Custom Setup Menu

Edit List
Edit the Signal Standard, Channel, Frequency and Bandwidth for selected item.

Number of Channels
Sets the number of channels to be displayed (1 to 20).

Back
Returns to the previous menu.

Measurements

```
┌─────────────────────────┐
│     Measurements        │
├─────────────────────────┤
│        Display          │
│                         │
│    Graph     Table      │
├─────────────────────────┤
│       Max Hold          │
│                         │
│   On   5 sec   Off      │
├─────────────────────────┤
│    Channel Units        │
│                         │
│   Channel     Freq      │
└─────────────────────────┘


┌─────────────────────────┐
│     Units Display       │
│                         │
│    Current     Max      │
├─────────────────────────┤
│      Color Code         │
│                         │
│    Single     Dual      │
└─────────────────────────┘
```

Figure 10-3. Channel Scanner Mode Measurements Menu

Display Graph/Table
Toggles the display between table and graph formats (see Figure 10-4 and Figure 10-5 below)

NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.
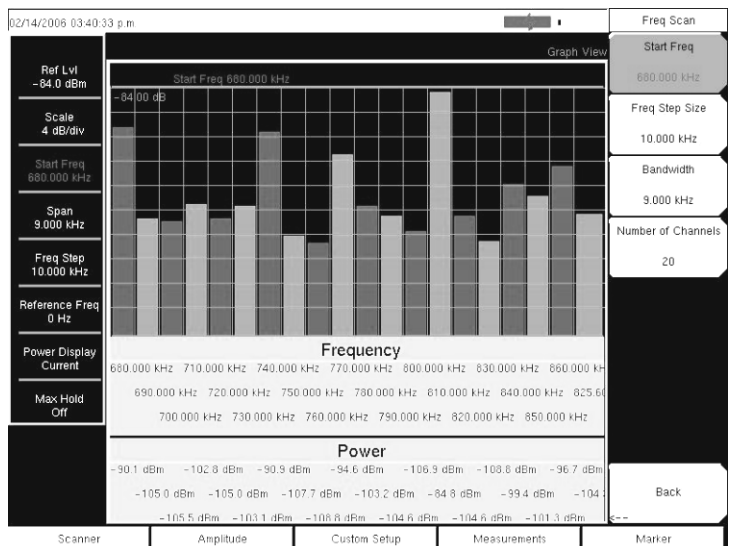
Figure 10-4. Channel Scanner Mode Sample Graph Display
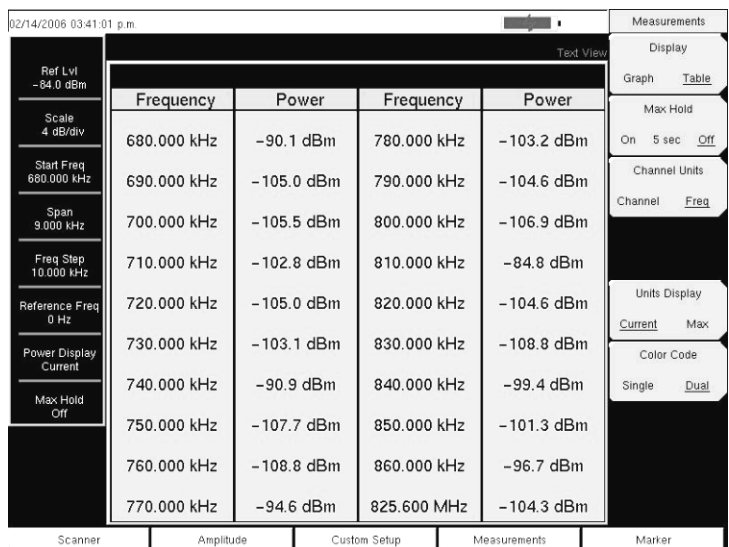
Figure 10-5. Channel Scanner Mode Sample Table Display

Max Hold On/5 sec/Off

Turns on or off small yellow lines for every channel/frequency on the display that indicate the highest level that channel or frequency has reached. The 5 sec option holds the small yellow line at the highest level in the last 5 seconds.

Channel Units Channel/Freq

Toggles the display channel units between channel number and frequency.

Units Display Current/Max

The current power units are displayed at the bottom of the channels, or the maximum power is displayed (activated only when Max Hold is set to On or 5 sec).

Color Code Single/Dual

The channels can be represented in one color or two alternating colors.

Scanner
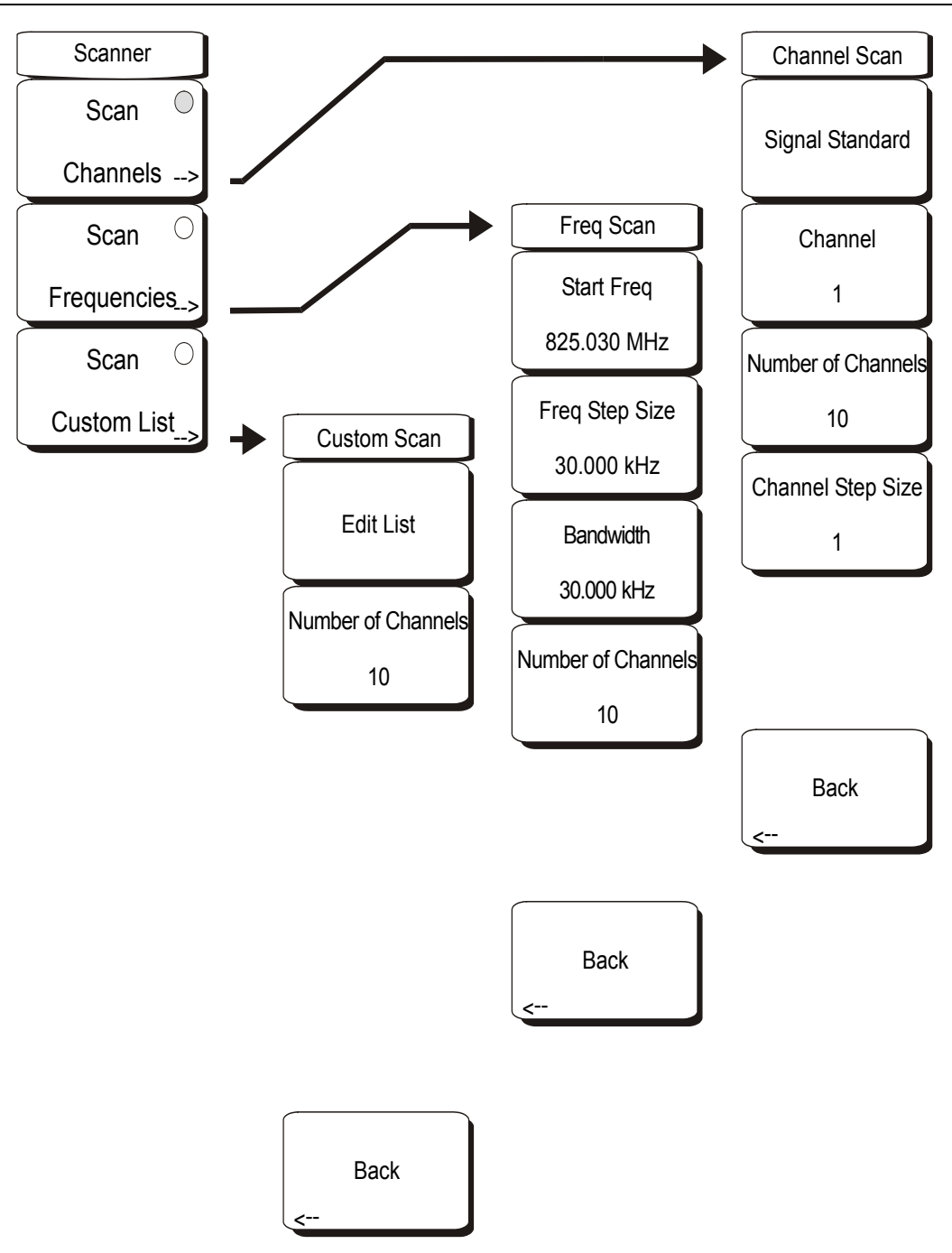
Figure 10-6. Channel Scanner Mode Scanner Menu

Scan Channels
Press Scan Channels to activate the scan channel menus:

Signal Standard
Sets the signal standard.

Channel
Sets the starting channel on the display.

Number of Channels
Sets the number of channels to be displayed. From 1 to 20 channels can be displayed.

Channel Step Size
Sets the number of channels to skip between displayed channels.

Back
Returns to the previous menu.

Scan Frequencies
Press Scan Frequencies to activate the scan frequencies menu:

Start Freq
Sets the center frequency of the first channel to be displayed.

Freq Step Size
Sets the spacing between frequencies on the display.

Bandwidth
The channel bandwidth can be manually entered in GHz, MHz, kHz, or Hz.

Number of Channels
Sets the number of channels to be displayed (1 to 20).

Back
Returns to the previous menu.

Scan Custom List
Edit List
Edit the Signal Standard, Channel, Frequency and Bandwidth for a selected standard.

Number of Channels
Sets the number of channels to be displayed (1 to 20).

Back
Returns to the previous menu.

Chapter 11 Interference Analyzer

Introduction

Many wireless networks operate in complicated signal environments. Three or four base station antennas may be located on the same tower, and can create interference problems, which can affect system capacity and coverage.

The Interference Analyzer option adds three measurement capabilities to the BTS Master:

- Spectrogram
- Signal Strength
- RSSI (Received Signal Strength Indicator)

The instrument also has a spectrum mode which displays signals in a traditional spectrum analyzer view.

The following menus are available in Interference Analyzer (Option 25) mode.

Getting Started

Interference Analyzer Mode

To prepare for Interference Analyzer measurements, the MT8222A must be configured for Interference Analyzer mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Interference Analyzer and press the **Enter** key to select.

For additional information about the Mode menu, refer to *Mode Selector Menu* on page 2-16.

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* on page 2-5.

Spectrogram

A Spectrogram is a three dimensional representation of frequency, time and power useful for identifying intermittent interference. Color is used to represent power levels.

Procedure

The following procedure demonstrates one example of an Interference Analyzer Spectrogram setup.

1. Press the **Shift** key, then the **Mode** (9) key, using rotary knob or **Up/Down** arrow keys select Interference Analyzer and press the **Enter** key to select.
2. Press the **Freq** function hard key.
3. Press the Signal Standard soft key and select the desired air interface standard from the dialog box displayed. Alternatively, choose the appropriate soft keys and enter the center, start and stop frequencies and the span.
4. For the most effective spectrogram display, press the **Amplitude** key, press the Reference Level soft key and set the reference level such that the largest signal to be displayed will be near the top of the spectrum analyzer area of the screen. The reference value required can be determined by observing the color of the highest signal and changing the reference level to place that value near the top of the spectrum analyzer area.
5. Press the Scale soft key and set the scale value to place the lowest signal near the bottom of the screen. In general, 4 dB/division or 5 dB/division will be good starting values.
6. Press the **BW** function hard key and set Auto RBW and Auto VBW On, or set the applicable RBW and VBW values by pressing the RBW and VBW soft keys.
7. Press the **Measurements** function hard key and the Spectrogram soft key.
8. Set the time between sweeps by pressing the Sweep Interval soft key, or set the total time for a full spectrogram by pressing the Time Span soft key.
9. To change the time between sweeps, press the Sweep Interval soft key and use the rotary knob or keypad to set the time from 0 seconds to 660 seconds. Entering the time interval value causes the corresponding time span value to be automatically computed. The time span can be viewed or changed by pressing the Time Span soft key and using the rotary knob or keypad to set the span. As expected, changing the time span will automatically change the sweep interval.

> NOTE: Setting a Sweep Interval value >0 will change the detection method to Max Hold, so that any event within the time interval will be captured to the screen. This allows for extended measurement times to be set.

10. To set the total time span for a complete display, press the Time Span soft key and use the rotary knob or keypad to enter a time between 1 minute and 4320 minutes (72 hours). Entering a time span value causes the corresponding sweep interval value to be automatically computed and shown when the Sweep Interval soft key is pressed.
11. The instrument can be set so that spectrogram plots can be automatically saved when the display is full. Press the Auto Save soft key to toggle auto save On or Off.
12. The Time Cursor soft key is used to turn on the horizontal time cursor. Use the **Up/Down** arrow key to move the cursor vertically through the spectrogram. The date and time that the measurement at the cursor position was taken is displayed at the top of the screen.

> NOTE: When the Time Cursor is activated and is not on the zero trace position, the unit will automatically stop making measurements.

13. Press the **Marker** key to place up to six markers on the signal and display the power and frequency at each marker position.

NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.
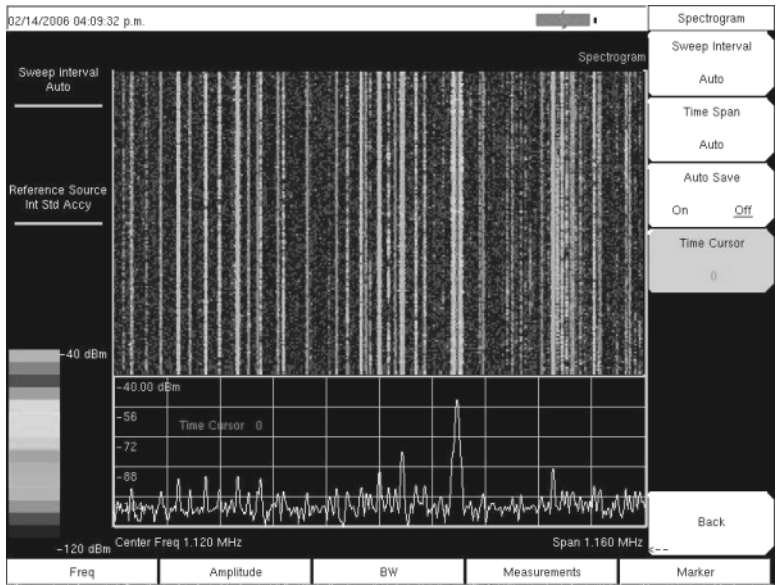
Figure 11-1. Interference Analyzer Mode Sample Spectrogram Display

Signal Strength

The Signal Strength meter is useful for tracking down the source of an interfering signal. This measurement is done at a single frequency in zero span. The power at a frequency (in dBm and watts) is displayed along with an optional audible indicator. Connect a directional antenna and the frequency of the audible indicator increases as the measured signal strength increases. This mode is especially useful when attempting to locate an emitter using a directional antenna.

For field strength measurements, antenna factors are included. Antenna factors for all antennas offered by Anritsu are stored in the unit. Custom antenna factors can be created and downloaded into the instrument using Anritsu Master Software Tools software.

Procedure:

The following procedure demonstrates a common Interference Analyzer Signal Strength setup.

1. Press the **Shift** key, then the **Mode** (9) key, using rotary knob or **Up/Down** arrow keys select Interference Analyzer and press the **Enter** key to select.
2. Press the **Freq** function hard key to set the desired frequency. Press the Center soft key, and use the soft keys to tune the center frequency to place the signal of interest in the center of the display.
3. Connect the appropriate directional antenna to the RF In port and press the **Measurements** key.
4. Press the Signal Strength soft key to activate the signal strength measurement menu.
5. Press the Auto Scale soft key to automatically scale the display range, or set the desired and maximum and minimum values by pressing the Max Level and Min Level soft keys.
6. Press the Speaker On/Off soft key to turn on the audio output.
7. If necessary, press the Volume soft key to set the speaker or headphone volume to a comfortable level. Use the **Up/Down** arrow keys to adjust the volume.
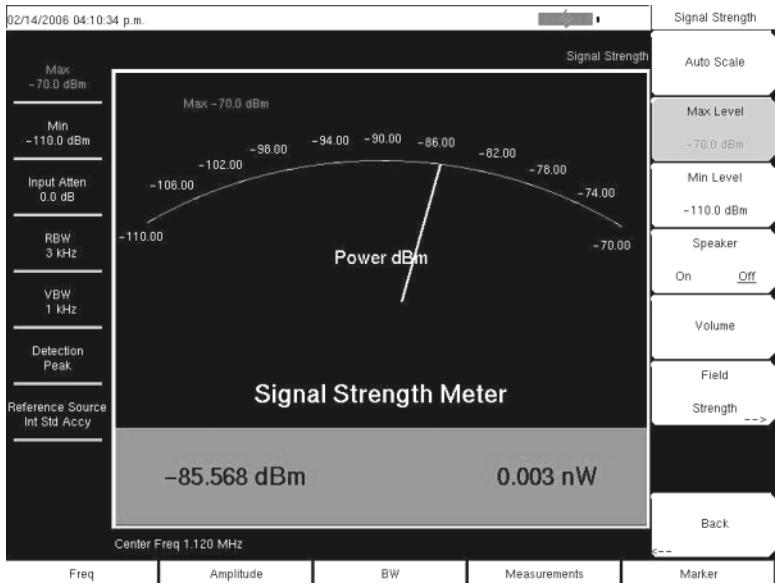
Figure 11-2. Interference Analyzer Mode Signal Strength Display

RSSI

The Received Signal Strength Indicator, RSSI. is useful for observing signal strength at a single frequency over time.

Procedure

The following procedure demonstrates a common Interference Analyzer RSSI setup. To select Interference Analyzer mode:

1. Press the **Shift** key, then the **Mode** (9) key, using rotary knob or **Up/Down** arrow keys select Interference Analyzer and press the **Enter** key to select.
2. Press the **Freq** function hard key to set the desired frequency. Press the Center soft key, and use the soft keys to tune the center frequency to place the signal of interest in the center of the display.
3. Press the **Measurements** key and press the RSSI soft key.
4. Press the Time Interval soft key to set the time between adjacent measurement points. This time may be set from 70 ms to 1 minute.
5. Press the Time Span soft key to set the overall time span for the RSSI measurement. This time can be set from zero, to give manual control of the time span, to a maximum of seven days. After the specified time span, the measurement is halted. depending upon the time interval selected, the data will scroll to the left once the trace fills the screen.
6. Press the Auto Scale key to automatically set the reference level and scale factor to place the trace on the screen.

> NOTE: The Time Span only captures the last display, not the entire time of the Time Span. Use a longer time interval to extend the effective trace capture time.

7. To store the RSSI data, press the Auto Save On/Off soft key to turn on data logging. The data is named Log – followed by the time at which the data was stored. Each screen full of 551 data points will be stored as a separate display, and up to seven days of data can be saved. The unit saves the data in the saved trace directory and it can be recalled by selecting recall trace measurement.
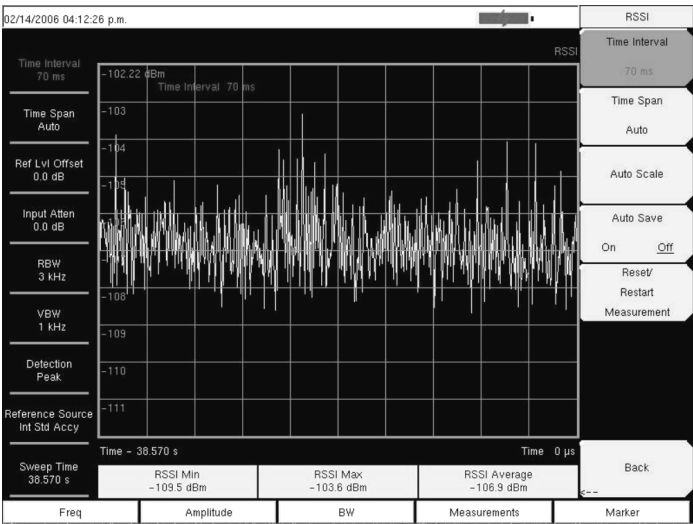
Figure 11-3. Interference Analyzer Mode RSSI Display

Amplitude
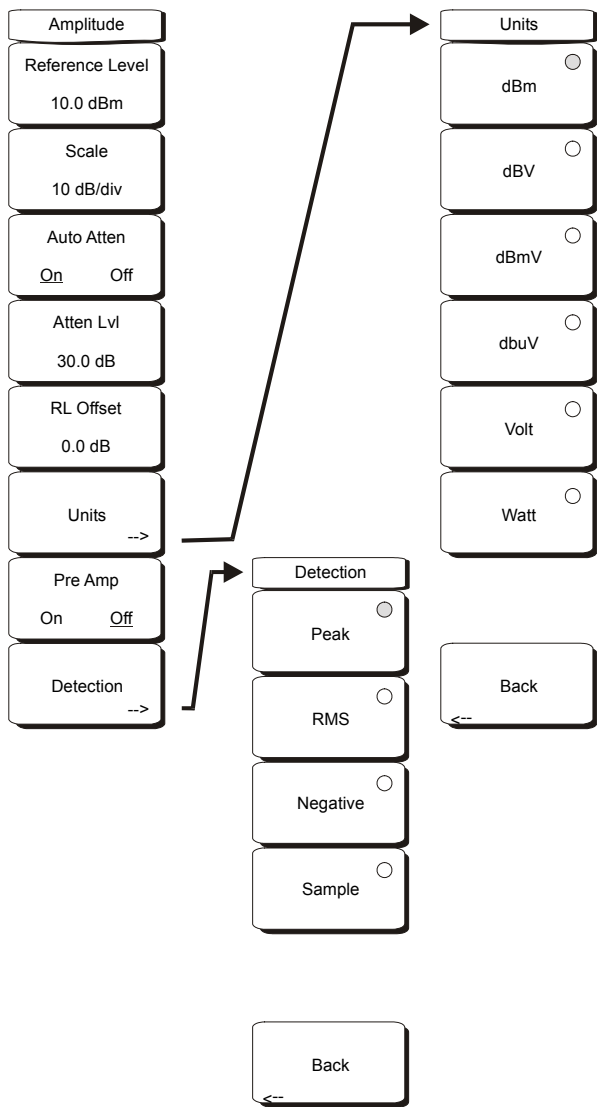
Figure 11-4. Interference Analyzer Mode Amplitude Menu

Reference Level
The reference level is the top graticule line on the display, and can be set from +30 dBm to
–150 dBm. A negative value may be entered from the key pad, using the ± key as the
minus sign. After entering the value press the dBm soft key or the **Enter** key. The
Up/Down arrow keys change the reference level in 10 dB steps, and the **Left/Right** arrow
keys change the value by 1 dB. The rotary knob changes the value by 0.1 dB per detent.

The reference level value may be modified by the reference level offset value to
compensate for an external attenuator, as discussed later in this chapter.

Scale
The scale can be set in 1 dB steps from 1 dB per division to 15 dB per division. The value
can be changed using the keypad, the rotary knob or the **Up/Down** arrow keys.

Auto Atten On/Off

Input attenuation can be either tied to the reference level (On) or manually selected (Off). When input attenuation is tied to the reference level, attenuation is increased as higher reference levels are selected to make sure the instrument input circuits are not saturated by large signals that are likely to be present when high reference levels are required.

Atten Lvl

Input attenuation can be set from 0 dB to 65 dB, in 5 dB steps. Press this soft key and use the keypad, the rotary knob or the **Up/Down** arrow keys to change the attenuation value. When the Preamplifier is turned on, the allowed attenuation settings are 0 dB and 10 dB.

RL Offset

Reference Level Offset compensates for the presence of input attenuation or gain external to the instrument. Enter a positive value to compensate for an external amplifier or a negative value to compensate for an external attenuator. Use the ± key to enter the negative sign when a negative attenuation value is being entered.

Units

Select the display units from this soft key menu:

dBm
dBV
dBmV
dBμV
Volt
Watt

The Units soft key is only available in the Spectrum view. Press the Back soft key to return to the Amplitude menu.

Pre Amp On/Off

This soft key turns the low-noise front-end preamplifier on or off. The preamplifier lowers the noise floor by approximately 25 dB. To assure accurate measurement results, the largest signal into the instrument input when the preamplifier is turned on should be <–50 dBm.

BW (Bandwidth)

```
┌─────────────┐
│     BW      │
├─────────────┤
│    RBW      │
│    3 MHz    │
├─────────────┤
│  Auto RBW   │
│  On    Off  │
├─────────────┤
│    VBW      │
│    1 MHz    │
├─────────────┤
│  Auto VBW   │
│  On    Off  │
├─────────────┤
│  RBW/VBW    │
│      3      │
├─────────────┤
│  Span/RBW   │
│    300      │
└─────────────┘
```
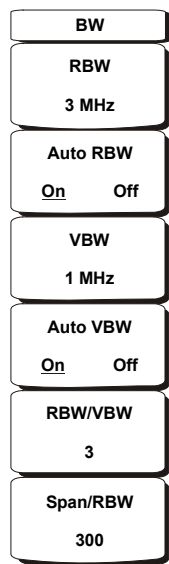
Figure 11-5. Interference Analyzer Mode BW Menu

RBW

The current resolution bandwidth value is displayed in this soft key. The RBW can be changed using the keypad, the **Up/Down** arrow keys, or the rotary knob. The range is 10 Hz to 3 MHz in a 1-3 sequence, from 10 Hz to 30 Hz to 100 Hz, and so on.

Auto RBW

When Auto RBW is On, the instrument selects the resolution bandwidth based on the current span width. The ratio of span width to RBW can be specified using the Span/RBW soft key.

VBW

The current video bandwidth value is displayed in this soft key. The VBW can be changed using the keypad, the **Up/Down** arrow keys, or the rotary knob. The range is 1 Hz to 3 MHz in a 1-3 sequence.

Auto VBW

When Auto VBW is On, the instrument selects the video bandwidth based on the resolution bandwidth. The ratio of video bandwidth to resolution bandwidth can be set using the RBW/VBW soft key.

RBW/VBW

This soft key displays the ratio between resolution bandwidth and video bandwidth. To change the ratio, press this soft key and use the keypad, the **Up/Down** arrow keys, or the rotary knob to select a new ratio. The default ratio is 3.

Span/RBW

This soft key displays the ratio between the span width and the resolution bandwidth. The default value is 300, meaning that the span width is approximately 300 times the resolution bandwidth. The value is approximate because resolution bandwidth filters come in discrete steps while span width can be set to any value up to 7.1 GHz. To change the ratio, press this soft key and use the keypad, the **Up/Down** arrow keys, or the rotary knob to select a new ratio.
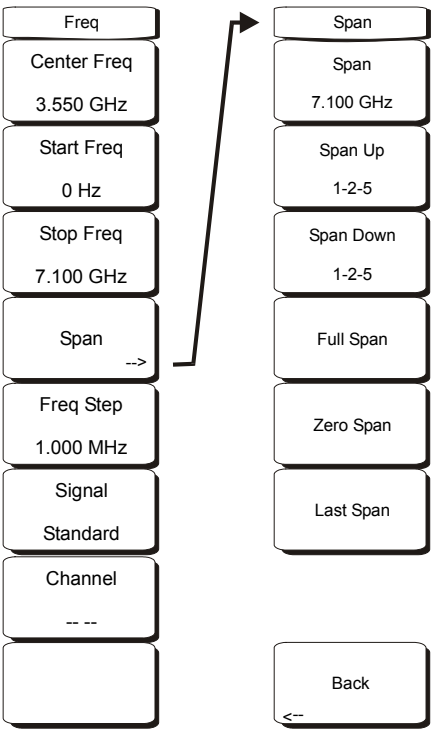
Freq

Figure 11-6. Interference Analyzer Mode Freq Menu

The tuning frequency range for the MT8222A can be entered in several different ways depending upon what makes the most sense for the user or for the application. The center frequency and span can be specified, the start and stop frequencies can be entered, or a signal standard and channel number can be selected from the built-in list.

Center Freq
Press the **Freq** key followed by the Center Freq soft key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the **Enter** key has the same affect as the MHz soft key.

> NOTE: When using the up and down arrows, the frequency moves in steps defined by the value entered using the Freq Step soft key. When using the left or right arrow keys, the frequency of the active parameter moves by 10% of the current frequency span. If the instrument is in zero span, then the left and right arrows do nothing.
> Turning the rotary knob changes the active frequency parameter in increments of one display point for each click of the knob. There are 551 display points across the screen (661 points in full-screen mode).

Start Freq
Press the **Freq** key followed by the Start Freq soft key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If a start frequency higher than the current stop frequency is entered, the stop frequency will be changed to yield a 10 Hz span.

Stop Freq

Press the **Freq** key followed by the Stop Freq soft key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If a stop frequency lower than the current start frequency is entered, the start frequency will be changed to yield a 10 Hz span.

Span

Press the **Freq** key followed by the Span soft key and enter the desired span. The Span menu is used to set the frequency range over which the instrument will sweep. For the MT8222A, the span can be set from 10 Hz to 7.1 GHz. The span can also be set to zero.

The soft key shows the current value for span in units of GHz, MHz, kHz, or Hz. When the Span button is pressed, span becomes the active parameter and may be changed. Use the keypad, the directional arrow keys or the rotary knob to increase or decrease the span frequency. If the span is changed using the **Up/Down** arrow keys, the span changes by the value of the Frequency Step for each key press.

Freq Step

Press the **Freq** key followed by the Freq Step soft key to enter the desired frequency step size. The frequency step specifies the amount by which a frequency will change when the **Up/Down** arrow key is pressed. The center frequency, start frequency, and stop frequency values can be changed using Freq Step. The active parameter will be changed by the frequency step when the **Up/Down** arrow keys are pressed. If Freq Step is the active parameter, nothing happens when the arrow keys are pressed. The frequency step size can be any value from 1 Hz to 7.1 GHz with a resolution of 1 Hz.

Use the keypad or the rotary knob to change the Frequency Step size.

Signal Standard

Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard and press **Enter** to select.

When a signal standard is selected, the center frequency and span for the first channel of the particular standard is automatically tuned. Other settings, such as channel spacing and integration bandwidth, are also automatically entered. Appendix A contains a table of the signal standards that are in the instrument firmware.

Channel --

Use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the spectrum analyzer display.

Limit

Press the **Shift** key and the **Limit** (6) key to open the Limit menu. For a description of the limit feature in the Interference Analyzer mode, refer to *Limit* on page 4-45.

Marker
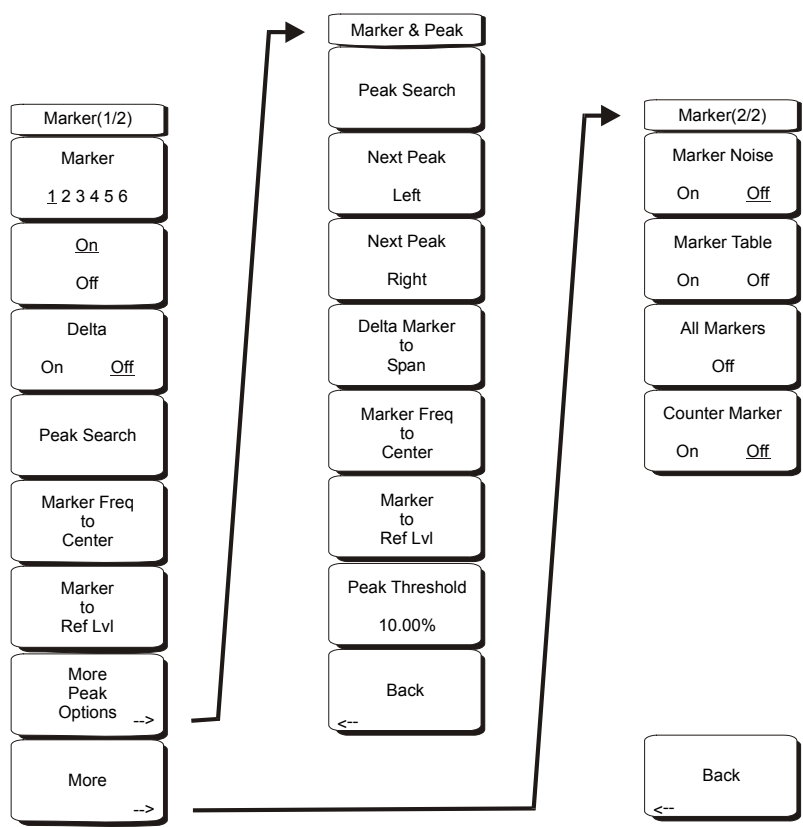
Figure 11-7. Interference Analyzer Mode Marker Menu

Markers are available in Spectrum and Spectrogram measurements. Press the **Marker** function hard key to open the Marker menu. The MT8222A is equipped with six markers. Any or all markers can be employed simultaneously.

Marker 1 2 3 4 5 6
Use this soft key to select the active marker. The underlined marker number is the active marker. Each press of the soft key moves the underline to the next marker number.

On/Off
This soft key turns the active marker, selected by the Marker soft key above, on or off.

Delta On/Off
This function turns on a delta marker and prompts for a delta offset frequency, either positive or negative from the frequency of the currently active marker.

Peak Search
This soft key places the currently active marker on the highest signal amplitude currently displayed on screen.

Marker Freq to Center
This soft key changes the center frequency to place the currently active marker at the center of the display.

Marker to Ref Level

This soft key causes the amplitude of the currently active marker to become the reference level, which is the top horizontal line of the display.

More Peak Options

This soft key brings up a secondary menu of soft keys for more peak searching options.

Peak Search

This soft key places the currently active marker on the highest amplitude signal currently on screen.

Next Peak Left

From the current position of the active marker, the instrument searches to the left (toward lower frequencies) for a peak signal that rises at least a certain amount above the average noise level. If no such peak is found, the marker is placed at the left end of the trace. The Peak Threshold soft key allows the user to specify the performance of peak searching.

Next Peak Right

From the current position of the active marker, the instrument searches to the right (toward higher frequencies) for a peak signal that rises at least a certain above the average noise level. If no such peak is found, the marker is placed at the right end of the trace. The Peak Threshold soft key allows the user to specify the performance of peak searching.

Delta Marker to Span

Sets the total span width to the value of the delta marker. If the delta marker is zero, the span is set to 10 Hz. If there is no delta marker, or the delta marker value is set to less than 10 Hz, then the span will be set to 10 Hz.

Marker Freq to Center

Sets the center frequency to the frequency of the currently active marker.

Marker to Ref Lvl

Sets the reference level, top graticule line, to the amplitude of the currently active marker.

Peak Threshold

This soft key allows the user to specify how far above the average noise floor a signal must rise before it is considered a peak. This feature can be especially useful in noisy environments, where there are a lot of small noise spikes. The default peak threshold is 10%. In noisy environments, increase the peak threshold to avoid stopping on noise spikes or small signals.

Back

Returns to the higher-level menu.

More

Opens a submenu of further Marker options.

Marker Noise

This marker option turns the markers into noise markers with units of dBm/Hz. When this option is selected, the detection method is automatically changed to RMS and the displayed value is compensated for the noise bandwidth of resolution bandwidth filter.

Marker Table

Available only in Spectrum view, pressing this soft key causes a table to be displayed below the sweep window. The table is automatically sized for all possible markers and delta markers. In addition to the marker frequency and amplitude, the table also shows delta frequencies and amplitude deltas for all markers that have deltas entered for them.

All Markers Off

This soft key turns off all markers and the marker table, if it is on.

Counter Marker On Off

Sets the frequency counter mode for all markers. Marker frequency values are normally limited in resolution to individual display pixels. Each pixel may represent multiple frequencies. Using Counter Marker in association with Marker to Peak will result in the exact frequency of the peak within the pixel to a resolution of 1 Hz.

Back

Returns to the previous menu.
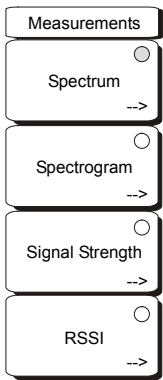
Measurements

Figure 11-8. Interference Analyzer Mode Measurements Menu

NOTE: The red circle on the soft key indicates the currently active measurement.

Spectrum
Pressing the Spectrum soft key sets the instrument to a traditional spectrum analyzer display. When Spectrum is active, pressing the Spectrum soft key opens a menu for Spectrum Analyzer measurements.

Spectrogram
Pressing the Spectrogram soft key sets the instrument to display a spectrogram. When Spectrogram is active, pressing the Spectrogram soft key opens a menu of spectrogram settings.

Signal Strength
Pressing the Signal Strength soft key sets the instrument to display signal strength. When Signal Strength is active, pressing the Signal Strength soft key opens a menu of signal strength settings.

RSSI
Pressing the RSSI soft key sets the instrument to display RSSI (Received Signal Strength Indicator). When RSSI is active, pressing the RSSI soft key opens a menu of RSSI settings.

Mode Menu

To access the functions under the Mode menu, press the **Shift** key, then the **Mode** (9) key. Use the directional arrow keys or the rotary knob to highlight the selection and press the **Enter** key to select. The list of modes that appears in this menu will vary depending upon the options that are installed and activated in your instrument. is an example of the Mode menu. Your instrument may not show the same list.

Signal Strength
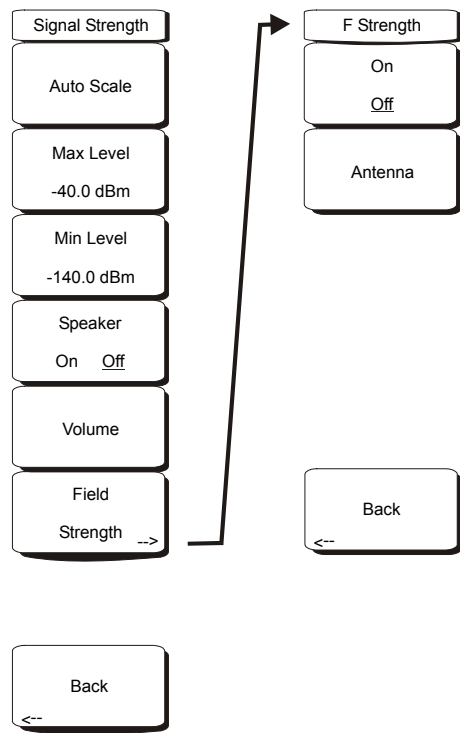
Figure 11-9. Interference Analyzer Mode Signal Strength Menu

Auto Scale
Press the Auto Scale soft key to automatically scale the display range.

Max Level
Set the desired maximum display range value by pressing the Max Level soft key.

Min Level
Set the desired maximum display range value by pressing the Max Level soft key.

Speaker On/Off
Press the Speaker On/Off soft key to turn on the audio output.

Volume
If necessary, press the Volume soft key to set the speaker or headphone volume to a comfortable level. Use the **Up/Down** arrow keys to adjust the volume.

Field Strength
This measurement allows the use of an antenna with known gain characteristics and measures the field strength over the frequency range of the antenna in units of dBm/meter^2, dbV/meter^2, dBmV/meter^2, dBμV/meter^2, volts/meter or watts/meter.

On Off
Turns field strength measurements on or off.

Antenna

This soft key brings up a dialog box that lists all the antennas for which the instrument has data, including both standard antennas and custom antenna that have been added using Master Software Tools. Use the **Up/Down** arrow keys or the rotary knob to select the desired antenna and press **Enter**.

Back

Returns to the previous menu.

Spectrogram
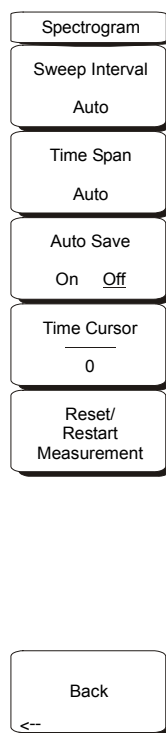
Figure 11-10. Interference Analyzer Mode Spectrogram Menu

Sweep Interval
Press the Sweep Interval soft key and use the rotary knob or keypad to set the time from 0 seconds to 60 seconds.

Time Span
To set the total time span for a display, press the Time Span soft key and use the rotary knob or keypad to enter a time between 1 minute and 4320 minutes (72 hours). When the time span is reached, the measurement stops. When set to zero (Auto) time span, the measurement runs continuously. Entering a time span value causes the corresponding sweep interval value to be automatically computed and shown when the Sweep Interval soft key is pressed.

Auto Save
When the Time Span is set to an interval other than Auto, the spectrogram plots can be automatically saved when the waterfall display is full by pressing the Auto Save soft key.

Time Cursor
The Time Cursor is used to view the spectrum at any spot in the spectrogram display. Press the Time Cursor soft key to turn on the horizontal time cursor. Use the **Up/Down** arrow key to move the cursor vertically through the spectrogram. The date and time that the measurement at the cursor position was taken is displayed at the top of the screen.

Reset/Restart Measurement
Resets or Restarts the measurement.
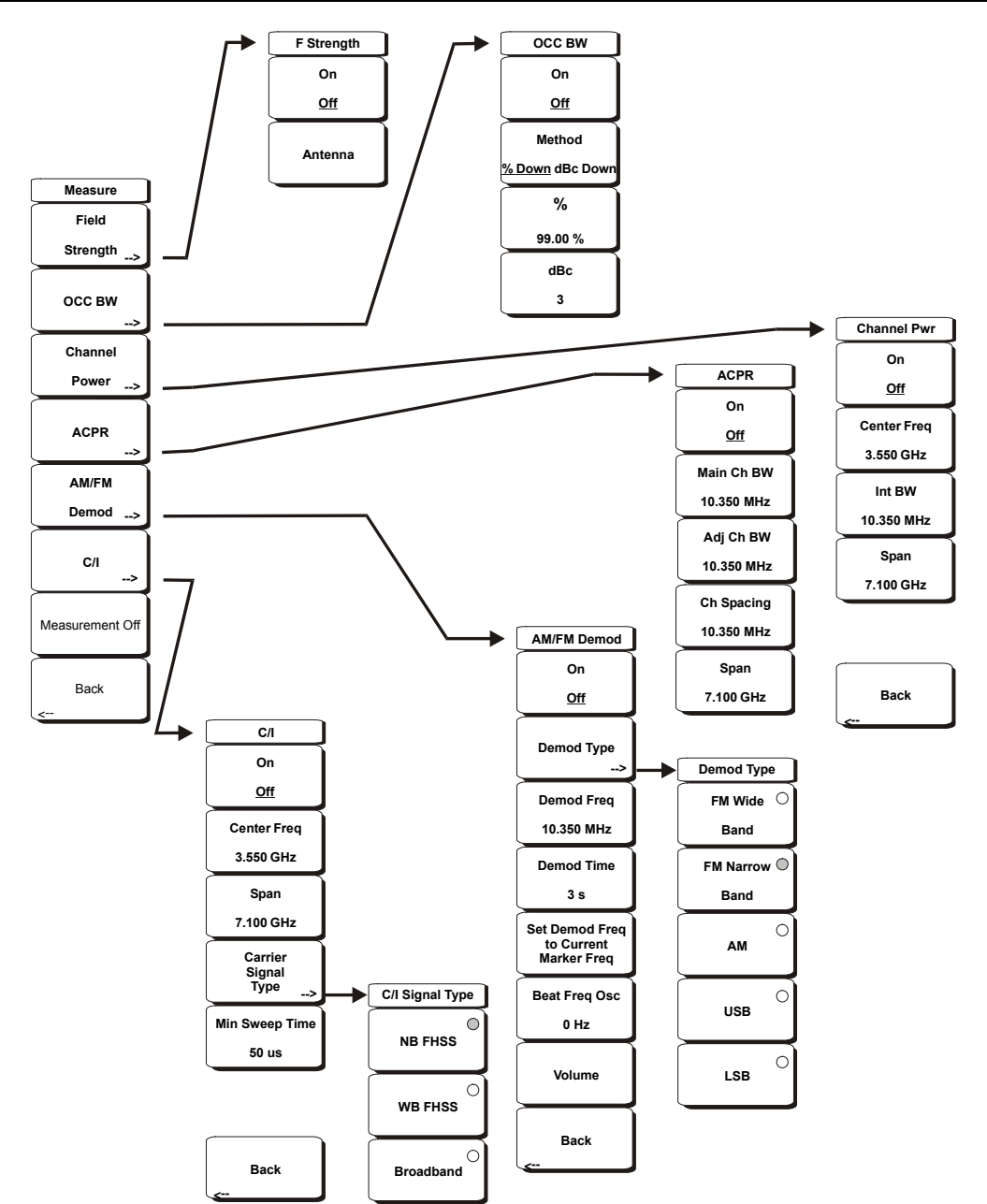
Spectrum

Figure 11-11. Interference Analyzer Mode Spectrum Menu

Field Strength

This measurement allows the use of an antenna with known gain characteristics and measures the field strength over the frequency range of the antenna in units of $dBm/meter^2$, $dbV/meter^2$, $dBmV/meter^2$, $dB\mu V/meter^2$, volts/meter or watts/meter.

On Off

Turns field strength measurements on or off.

Antenna

This soft key brings up a dialog box that lists all the antennas for which the instrument has data, including both standard antennas and custom antenna that have been added using Master Software Tools. Use the **Up/Down** arrow keys or the rotary knob to select the desired antenna and press **Enter**.

Back

Returns to the previous menu.

OCC BW

Activates the occupied bandwidth menu. Select either % or dBc method of occupied bandwidth measurement.

Method % Down/dBc Down

Select either the % of Power (default) or dB Down measurement method as displayed in the message area.

%

Use the keypad, the directional arrow keys or the rotary knob to enter the percent of power, from 0% to 99%.

dBc

Use the keypad, the directional arrow keys or the rotary knob to enter the dBc value (0 to 120 dB).

Back

Returns to the previous menu.

Channel Power

Activates the Channel Power measurement function. Channel Power and Channel Power Density are measured based on the selection in the Units menu.

On Off

Begins or ends the channel power measurement. When the measurement is on, Ch Pwr will appear below the display. The detection method will automatically be changed to RMS Average when the measurement is started. The detection method can be modified by pressing the **Shift** and the **Sweep** keys and pressing the Detection soft key.

Center Freq

Activates the center frequency function, and sets the center frequency of the BTS Master for the channel power measurement. Use the keypad, the directional arrow keys or the rotary knob to enter the center frequency.

Int BW

Sets the integration bandwidth for channel power measurement. Modifying this value automatically adjusts the channel span to maintain the same ratio. Use the keypad, the directional arrow keys or the rotary knob to enter the integration bandwidth.

Span

Sets the channel span for channel power measurement. Use the keypad, the directional arrow keys or the rotary knob to enter the channel span.

Back

Returns to the previous menu.

ACPR

Accesses a menu of Adjacent Channel Power Ratio measurement options:

On Off

Begins or ends the ACPR measurement.

Main Ch BW

Sets the bandwidth of the main channel for ACPR measurement. Use the keypad, the directional arrow keys or the rotary knob to enter the a specific frequency. When using the keypad, press the GHz, MHz, kHz, or Hz soft key to accept the frequency input. Changing this value automatically changes the adjacent channel bandwidth and channel spacing.

Adj Ch BW

Sets the bandwidth of the adjacent channels for ACPR measurement. Use the keypad, the directional arrow keys or the rotary knob to enter the a specific frequency. When using the keypad, press the GHz, MHz, kHz, or Hz soft key to accept the frequency input.

Ch Spacing

Sets the channel spacing between the main and adjacent channels. Use the keypad, the directional arrow keys or the rotary knob to enter the a specific frequency. When using the keypad, press the GHz, MHz, kHz, or Hz soft key to accept the frequency input. This value must be greater than or equal to half of the main channel bandwidth, plus half of the adjacent channel bandwidth.

Back

Returns to the previous menu.

AM/FM Demod

The user can select AM, Narrow Band FM (300 μs de-emphasis), Wide Band FM (50 μs de-emphasis), Upper Sideband or Lower Sideband.

On Off

Turns AM/FM Demodulation on or off.

Demod Type

Provides soft keys to select the type of signal to be demodulated:

> FM Wide Band
> FM Narrow Band
> AM
> USB
> LSB

Demod Freq

Use the keypad, the directional arrow keys or the rotary knob to enter the center frequency of the signal to be demodulated. This frequency does not have to be within the current frequency sweep range to which the instrument is set.

Demod Time

Use the keypad, the directional arrow keys or the rotary knob to increase or decrease the demodulation time, and press the **Enter** key to select. The demodulation time can be set from 100 milliseconds to 200 seconds. The instrument sweeps one time for every demodulation period. Sweeping pauses during the demodulation time.

Set Demod Freq to Current Marker Freq

Sets the demodulation frequency to the frequency of the current marker.

Beat Freq Osc

Sets the beat frequency of the oscillator to exactly set the demodulation frequency of USB and LSB signals.

Volume

The current volume setting is displayed on the screen. Use the **Up/Down** arrow keys or rotary knob to change the volume, and press the **Enter** key to select.

Back

Returns to the previous menu.

C/I

The Carrier to Interference ratio is a two-step measurement sequence that first measures the amplitude of a carrier, then, with the carrier turned off, measures the amplitude of all other interfering signals within the channel bandwidth.

On Off

Starts and stops the carrier to interference measurement.

Center Freq

Use the keypad, the directional arrow keys or the rotary knob to enter the center frequency.

Span

Use the keypad, the directional arrow keys or the rotary knob to enter the frequency span.

Carrier Signal Type

Opens a menu to select the carrier signal type.

NB FHSS (Narrow Band Frequency Hopping Spread Spectrum)

Use this setting when the signal being measured is 802.11b.

WB FHSS (Wide Band Frequency Hopping Spread Spectrum)

Use this setting when the signal being measured is 802.11a or 802.11g.

Broadband

Use this setting when the signal being measured is a digital modulation format such as CDMA, GSM, and so forth.

Back

Returns to the previous menu.

Min Sweep Time

Set the minimum sweep time for the measurement.

Back

Returns to the previous menu.

RSSI

Figure 11-12. Interference Analyzer Mode RSSI Menu

Time Interval
Press the Time Interval soft key to set the time between adjacent measurement points. This time may be set from 70 ms to 1 minute.

Time Span
Press the Time Span soft key to set the overall time span for the RSSI measurement. This time can be set from zero, to give manual control of the time span, to a maximum of seven days. After the specified time span, the measurement is halted. depending upon the time interval selected, the data will scroll to the left once the trace fills the screen.

Auto Scale
Press the Auto Scale soft key to automatically set the reference level and scale factor to place the trace on the screen.

Auto Save On/Off
To store the RSSI data, press the Auto Save On/Off soft key to turn on data logging. The data is named Log – followed by the time at which the data was stored. Each screen full of 551 data points will be stored as a separate display, and can be saved for up to seven days. The unit saves the data in the saved trace directory and it can be recalled by selecting recall trace measurement.

Reset/Restart Measurement
Resets or Restarts the measurement. The RSSI trace is erased and begins anew at the right side of the display.

Back
Returns to the previous menu.

Chapter 12 Power Meter

Introduction

The Internal Power Meter is a standard feature on the BTS Master. The BTS Master can display measured power in dBm, dBV, dBmV, dBµV, Volts, or Watts. No external sensor is required. The internal Power Meter frequency span can be set from 1 kHz to 100 MHz. The Full Band soft key conveniently sets the frequency range to 100 MHz on the current center frequency in order to simulate a broadband measurement.

The Max and Min values of the analog display can be set in the Amplitude Menu. The scale of the analog display reflects the Unit selection. Relative Power is a useful feature to obtain the power reading with respect to a certain power level. For instance, if the power level at the input is 10 dBm, then the Relative Power can be turned on, and the display then shows 0 dB. 15 dBm would show as 5 dB with the Relative turned on at 10 dBm.

Getting Started

Power Meter Mode

To prepare for Power Meter measurements, the MT8222A must be configured for Power Meter mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Power Meter and press the **Enter** key to select.

For additional information about the Mode menu, refer to *Mode Selector Menu* .

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* .

Procedure

The following procedure demonstrates power meter setup options:

Sweep Frequency

• Press the **Freq** function hard key to set the desired frequency sweep. Choose the appropriate soft keys and enter the start and stop frequency, the center frequency and the span, or press the Signal Standard soft key and select the channel and Uplink or Downlink or select the full band.

Changing the Display Units

The power reading can be displayed in dBm or Watts. To change the displayed units:

1. Press the **Amplitude** function hard key.
2. Press the Units soft key and select the display units.
3. Press the Back soft key to return to the Power Meter menu.

Displaying Relative Power

Relative power can be selected through the Amplitude menu.

1. With the desired base power level input to the BTS Master, press the **Amplitude** function hard key.
2. Press the Relative soft key.

NOTE: Relative power is displayed as dB.

NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.

Set the Pass Fail Limits

Maximum and minimum limits can be set. The following is the procedure for setting the limits.

1. On the BTS Master, press the **Limit** function hard key, or press the **Shift** key, then the **Limit** (6) key.
2. Press the Upper Limit soft key and use the directional arrow keys, the key pad, or the rotary knob to set the desired upper limit, then press **Enter**.
3. Press the Lower Limit soft key and use the directional arrow keys, the key pad, or the rotary knob to set the desired lower limit, then press **Enter**.

If the power is between the limits, then the measurement displays in green.

Figure 12-1. Power Meter Display, Passed

If the power is not between the limits, then the measurement displays in red.

Figure 12-2. Power Meter Display, Failed

Power Meter Mode Menus

Amplitude
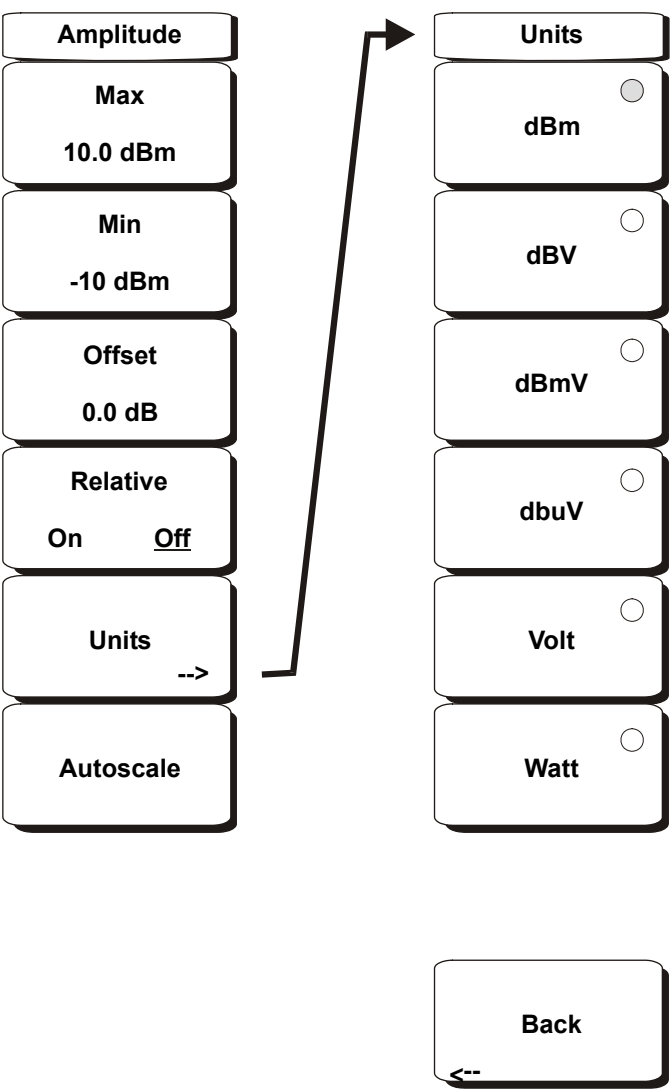
Figure 12-3. Power Meter Mode Amplitude Menu

Max
Sets the maximum value on the display.

Min
Sets the minimum value on the display.

Offset
Turns offset ON or OFF. When on, a value of ±100 dB can be entered.

Relative

Selects whether relative power is ON or OFF. This measurement shows the relative level of the desired base power level input to the BTS Master. When ON, the message Relative: On nnn dB (where nnn dB is the current relative value) will show in the message area. The units will be automatically reverted to dBm if necessary.

Units

Choose from the menu of amplitude related units.

    dBm
    dBV
    dBmV
    dBµV
    Volt
    Watt
    Back
    Return to the previous menu.

> NOTE: Changing the units will turn Relative OFF, if it was ON.

Autoscale

Adjusts the Top and Bottom values so that the needle will be shown in the middle of the analog display.

Average

RMS Averaging
Acquisition
Fast Med Slow
Running Averages
1
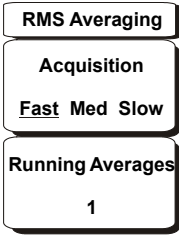
Figure 12-4. Power Meter Mode Average Menu

Acquisition

Sets the measurement speed. Choose from Fast, Medium, or Slow.

Running Average

Sets the average of the number of traces. Enter the desired number using the keypad, the rotary knob, or the arrow keys.
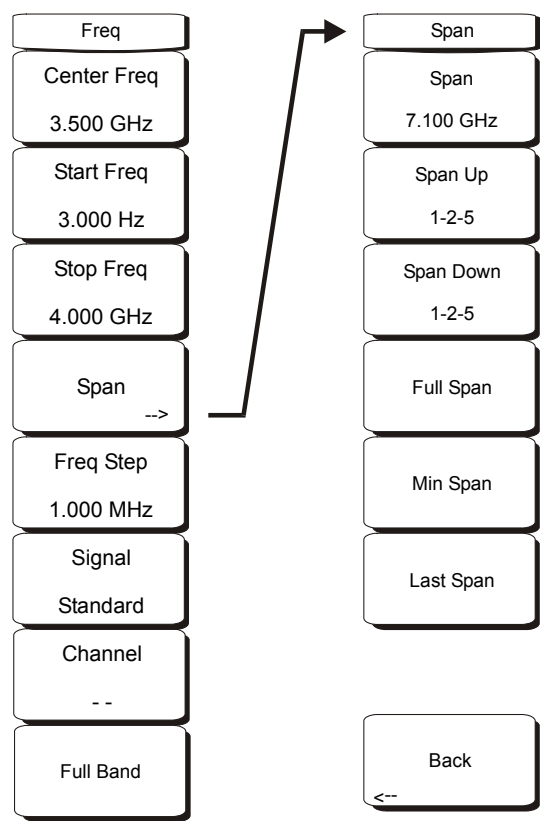
Freq

Figure 12-5. Power Meter Mode Freq Menu

Center Freq
Sets the frequency at the center of the measurement. Frequencies can be entered in units of GHz, MHz, kHz, or Hz. Enter the frequency by using the keypad, the rotary knob, or the arrow keys. When the center frequency is entered, the labeling below the analog display shows the center frequency and the span in the most appropriate units based upon the value.

Start Freq
Enter a start frequency by using the keypad, the rotary knob, or the arrow keys. If the entered start frequency is greater than the current stop frequency, then the stop frequency is automatically adjusted to be 1 kHz greater than the start frequency (Min Span).

Stop Freq
Enter a stop frequency by using the keypad, the rotary knob, or the arrow keys. If the entered stop frequency is lower than the current start frequency, then the start frequency is automatically adjusted to be 1 kHz less than the stop frequency (max span).

Span
Opens the Span menu.

Span
Sets the width of the measurement window in GHz, MHz, kHz, or Hz. The center frequency and span are displayed in the message area at the bottom of the status window. The span can be entered with the keypad and by then selecting units (GHz, MHz, kHz, or Hz) with the soft keys or with the arrow keys to change an already selected frequency. Finish with **ENTER**, or press **ESC** to restore.

Span Up 1 - 2 - 5
Increases the span to the next multiple of 1, 2, or 5.

Span Down 1 - 2 - 5
Decreases the span to the next multiple of 1, 2, or 5.

Full Span
Sets the span to 100 MHz on the current center frequency. Adjusts the center frequency if it is at the edge of the limit of the instrument.

Min Span
Changes the span to 1 kHz.

Last Span
Returns the span to the previous value.

Back
Returns to the previous menu.

Freq Step
Sets the interval that is used by the arrow keys. Enter the step amount by using the keypad, the rotary knob, or the arrow keys.

Signal Standard
Opens the signal standard menu, showing the currently selected signal standard and a complete list of signal standards.

Channel
Sets the channel information for the selected standard. If the particular standard has not been used before, then the channel number will default to the lowest legal channel number for that standard. If that standard has been used before, then the last used channel will be the default.

Full Band
Sets the frequency of the unit to a 100 MHz span on the current center frequency.

Limit

Figure 12-6. Power Meter Mode Limit Menu

Limit
Turns the limits ON or OFF.

Upper Limit
Sets the upper limit.

Lower Limit
Sets the lower limit.

Chapter 13
High Accuracy Power Meter

Introduction

The MT8222A BTS Master with Option MT8222A-019 and sensor PSN50 can be used to make High Accuracy Power Measurements from 50 MHz to 6 GHz. This high performance sensor option provides true RMS measurements from -30 dBm to $+20$ dBm with accurate measurements for both CW and complex digitally modulated signals.

> NOTE: The PSN50 sensor is not included with Option MT8222A-019.

The power values are displayed in both dBm and Watts. The Relative Power feature allows the display of power changes with respect to a desired reference value in both dB and % (percent). Limit values can be turned on as needed to indicate if a measurement is within or outside specified limits. Running averaging and a Max/Hold feature are also available.

The MT8222A BTS Master connects to the PSN50 High Accuracy Power Sensor with a standard USB A/mini-B cable (3-2000-1498).

The zeroing feature improves the accuracy between -20 dBm and -30 dBm by removing measured system noise. Calibration factors can be used to correct both efficiency and mismatch loss.

Attenuators can be used to ensure that the power does not exceed the specified measurement range. The Enter Offset feature allows entering offset values for any cables and attenuators.

Getting Started

High Accuracy Power Meter Mode

To prepare for High Accuracy Power Meter measurements, the MT8222A must be configured for High Accuracy Power Meter mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight High Accuracy Power Meter and press the **Enter** key to select.

For additional information about the Mode menu, refer to *Mode Selector Menu* on page 2-16.

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* on page 2-5.

Required Equipment

- MT8222A BTS Master

- High Accuracy Power Sensor, PSN50

- USB cable, 3-2000-1498

- 30 dB, 50 W, bi-directional, DC-8.5 GHz, N(m)-N(f), Attenuator, 3-1010-123

Procedure

Turning on the BTS Master and the Sensor

1. Connect the USB A/mini-B cable between the High Accuracy Power Sensor and the
   BTS Master.
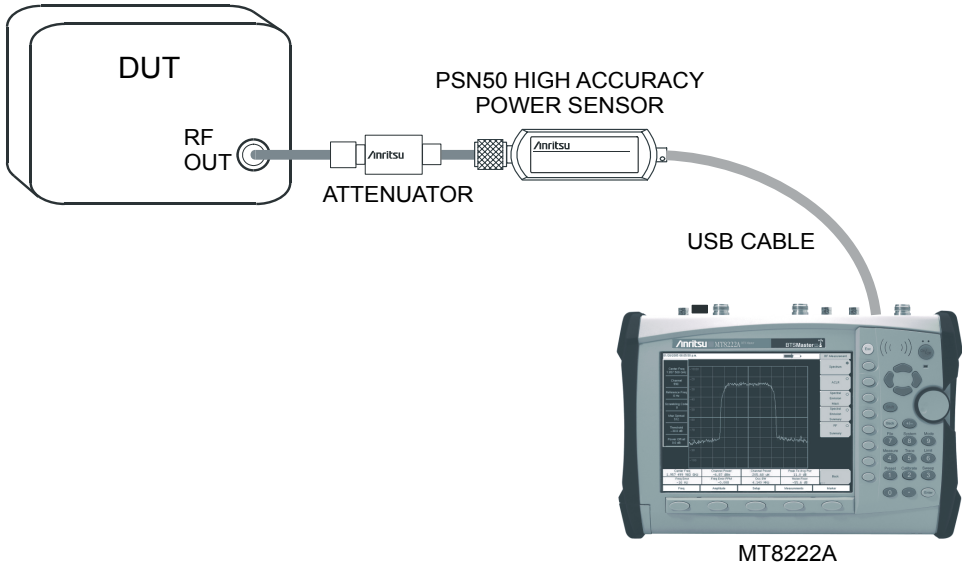
Figure 13-1. High Accuracy Power Meter Setup Example

2. Press the **ON/OFF** key on the BTS Master.
3. Press the **Shift** key, then the **Mode** (9) key. Use the **Up/Down** arrow keys or rotary
   knob to select High Accuracy Power Meter mode and press **Enter.**

Zero and Cal

1. Press the **Zero/Cal** key and press the Cal Factor soft key. Enter the Center Frequency or
   press the Signal Standard key and the **Up/Down** arrow keys to select a particular
   standard. The Cal Factors will be derived for the corresponding center frequency. The
   channel number is not required because the cal factor frequencies are rounded to the
   nearest 500 MHz. The Cal Factor message in the display window will show ON if the
   Cal Factor command has been properly sent to the sensor.
2. With no power applied to the sensor, press the **Zero** soft key to zero the sensor. This
   step is recommended when making power measurements below –20 dBm.

Changing the Scale of the Analog Display

1. Press the **Amplitude** key.
2. Press the Auto Scale soft key to align the needle in the middle of the analog display. The maximum and minimum values align accordingly.
3. Press the Max soft key and use the numeric key pad to manually set the maximum value of the analog display.
4. Press the Min soft key and use the numeric key pad to manually set the minimum value of the analog display.

NOTE: With no offset, the maximum value for the display is the upper measurement range, which is +20 dBm. With an offset, such as with 10 dB of attenuation, the upper value can be set to +30 dBm. With an offset of xx dB, the upper value can be set to +20 dBm plus xx dB.

Using Attenuators

1. Press the **Amplitude** key and press the Enter Offset soft key.
2. Enter the offset value for the attenuator at the frequency of operation.

Displaying Relative Power

1. Press the **Amplitude** key.
2. With the desired base power level input to the sensor, press the Relative soft key. The power reading will show 0 dB and 100%. If measuring a 10 dBm signal, and if the Relative key is pressed, then a drop to 7 dBm will show as -3 dB and 50%.

Averaging/Max Hold/Run Hold

1. Press the **Average** key.
2. Press the Running Averages key. Use the numeric keypad to enter the desired number of averages.
3. Press the Max Hold soft key to toggle between Max Hold On and Max Hold Off. If averaging is selected, then Max Hold will display the maximum value of the non-averaged data.

Limits

1. Press the **Limit** key.
2. Press the Lower Limit soft key. Enter the lower limit value in dBm or in Watts.
3. Press the Upper Limit soft key. Enter the upper limit value in dBm or in Watts.
4. Press the Limit On/Off soft key to turn the Limits on and off. The number display will turn green or red if the measurement is passing of failing.
5. Press the **Amplitude** key and press the Units soft key to change between dBm and Watts.

> NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.
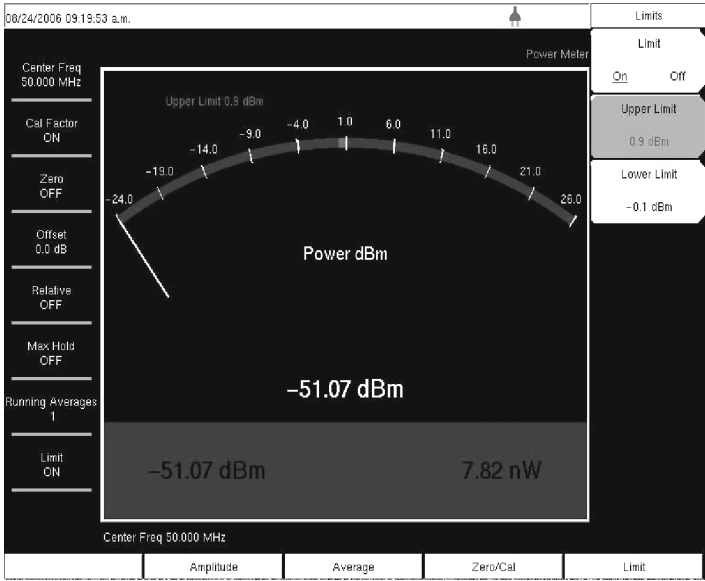
Figure 13-2. Limits Menu

Saving the Measurement

1. Press the **Shift** key, then the **File** (7) key.
2. Press the Save soft key.
3. Press the Save Measurement soft key and use the Text Entry soft keys to enter the desired file name.
4. Press the Save Screen as JPEG soft key to save an image of the screen as a JPEG. file.

Menus

Menu choices are shown in the following illustrations.
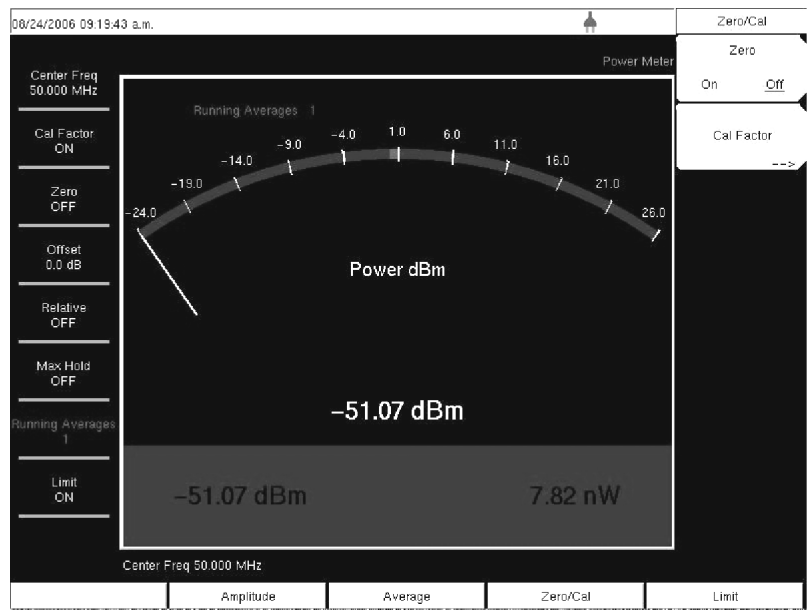
Figure 13-3. Zero/Cal Menu
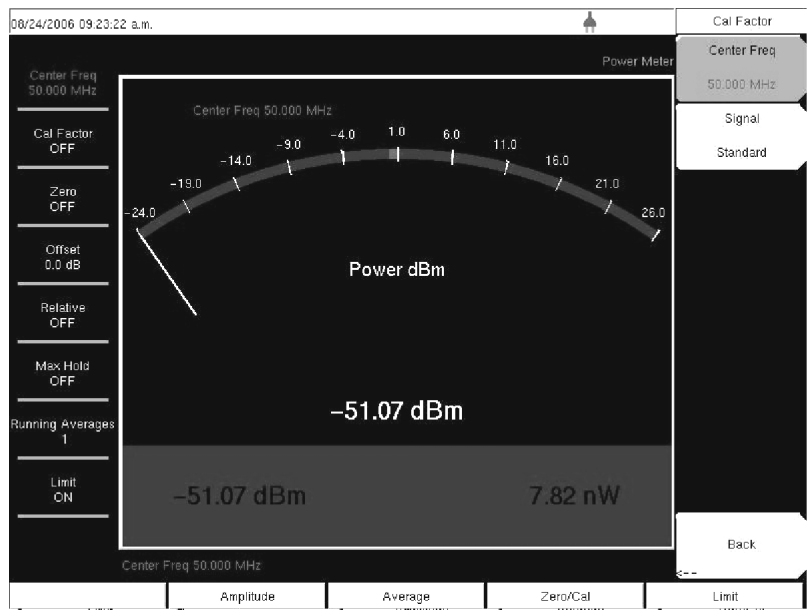
Figure 13-4. Cal Factor Menu

Zero/Cal Menu
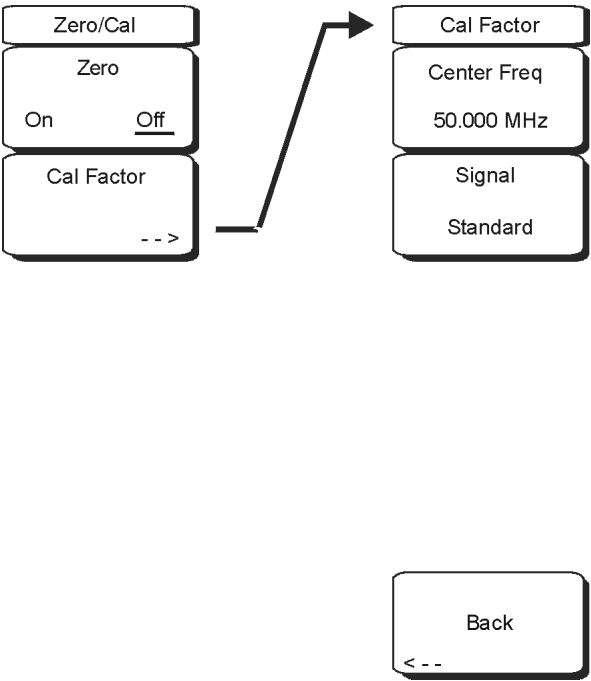
Figure 13-5. Zero/Cal and Cal Factor Soft Key Menus
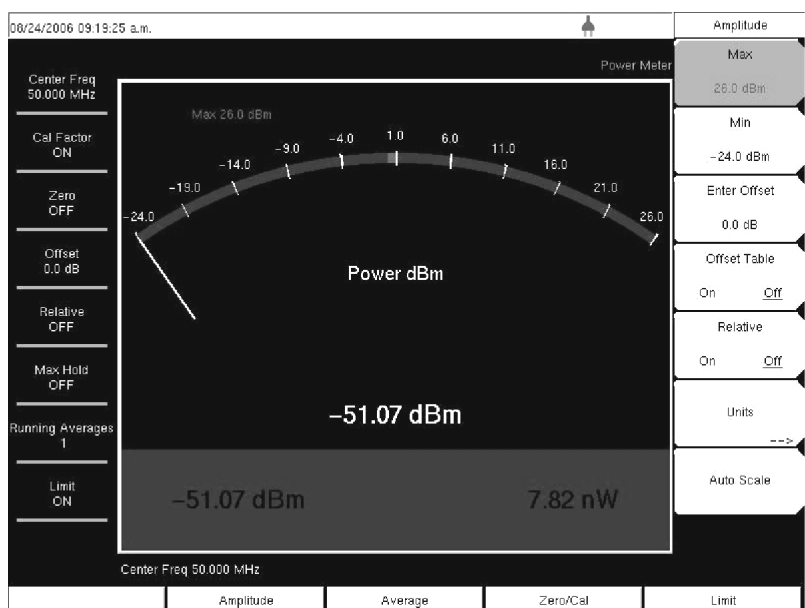
Figure 13-6. Amplitude Menu
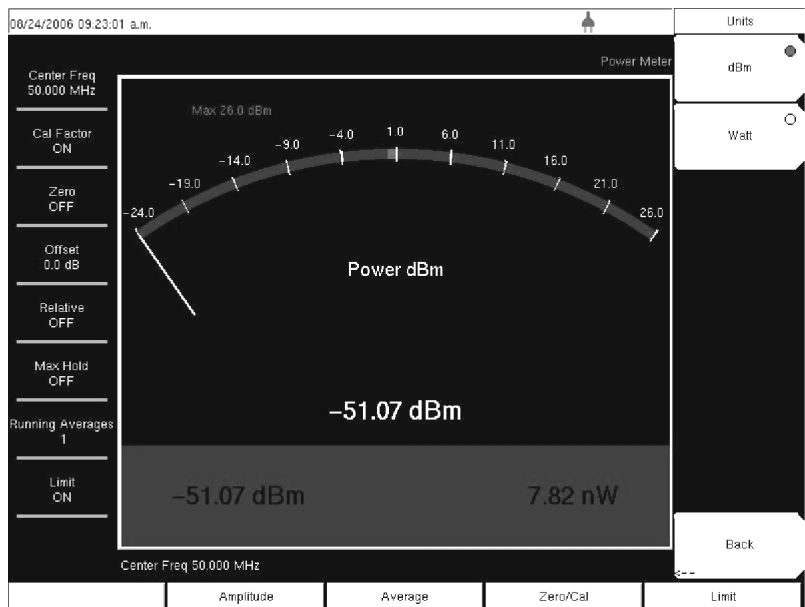
Figure 13-7. Units Menu

Amplitude Menu .
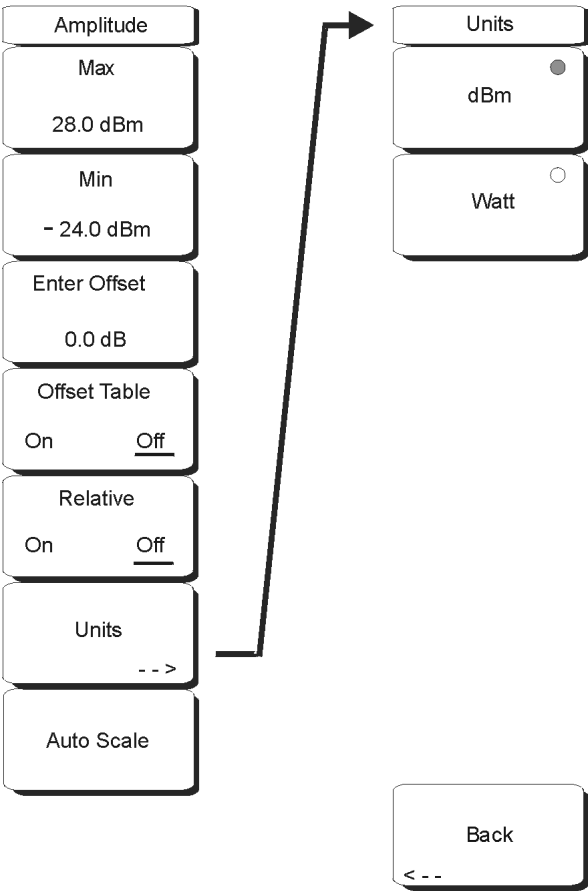
Figure 13-8. Amplitude and Units Soft Key Menus
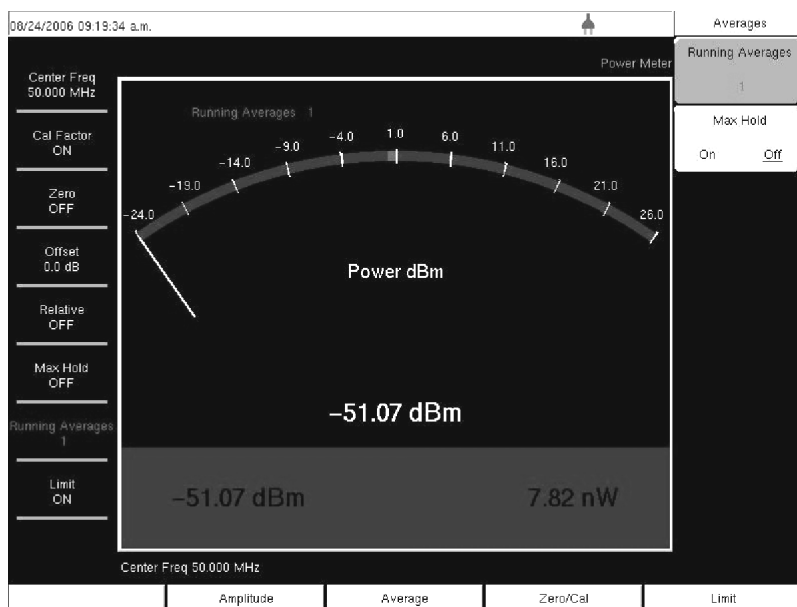
Figure 13-9. Averages Menu

Averages Menu
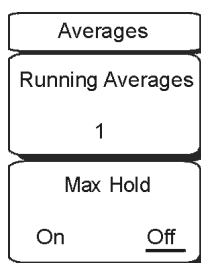
Figure 13-10. Averages Soft Key Menu
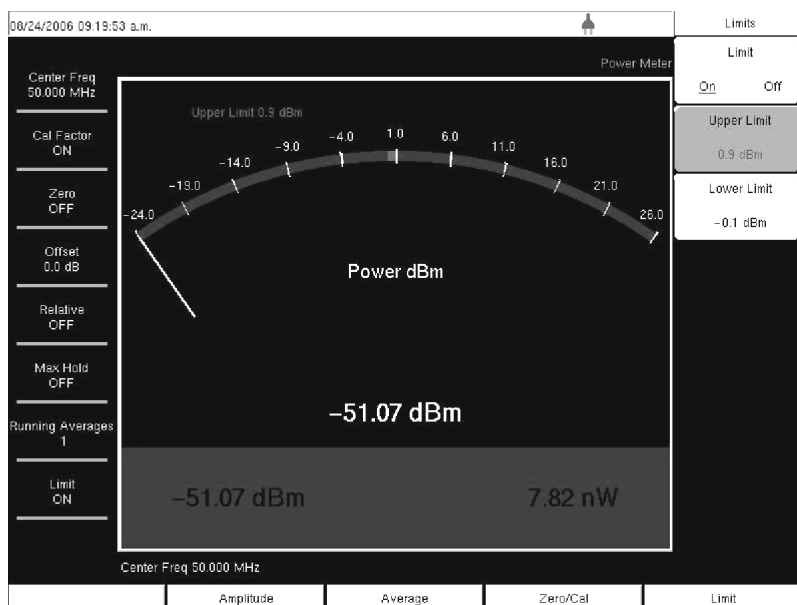
Figure 13-11. Limits Menu

Limits Menu
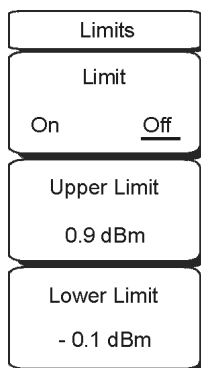
Figure 13-12. Limits Soft Key Menu

Mode Menu

To access the functions under the Mode menu, press the **Shift** key, then the **Mode** (9) key. Use the **Up/Down** arrow keys or the rotary knob to highlight the selection, and press the **Enter** key to select. The list of modes that appears in this menu will vary depending upon the options that are installed and activated in your instrument. Figure 4-28 on page 4-41 is an example of the Mode menu. Your instrument may not show the same list.

Chapter 14
T1 Analyzer

Introduction

This chapter provides a brief description of T1 circuits as well as T1 measurements, and also explains how to measure T1 performance using the Anritsu MT8222A BTS Master with Option 51 installed.

T1 Fundamentals

Wireless service providers use wired T1 circuits as the backhaul links to connect a Base Transceiver Station (BTS) to a Mobile Switching Center (MSC). The quality of the service that is provided over those T1 lines has a direct effect on the quality of service that is experienced by the wireless service provider customers. Call setup failures, dropped calls, and data errors can often be attributed to the T1 backhaul facilities. An example of a typical wireless network backhaul T1 link is shown in Figure 14-1.

In the United States, wireless service providers generally lease T1 lines from a Local Exchange Carrier (LEC), so a joint effort is often required to analyze and troubleshoot a T1 line.

T1 is an American National Standard Institute (ANSI) standard, used mostly in North America, in parts of Japan, and in some Asian countries. Technically, a T1 line is a digital transmission facility consisting of wire pairs and regenerators carrying a DS1 signal. **T1** refers to the physical properties of the line, for example, 1.544 MHz with a specific pulse shape, and so forth. **DS1** refers to the digital signal carrying the information at a rate of 1.544 Mb/s.

A DS1 signal contains twenty-four 8-bit DS0 channels. The channel signals are repeated 8000 times per second, resulting in a bandwidth of 64 kHz per channel (8 X 8000 = 64,000). The channels are organized into 192-bit frames, and a framing bit is added to enable synchronization to the DS1 signal (193 bits total). The frequency of the T1 signal is 193 X 8000 = 1.544 MHz. Two types of DS1 framing formats are used: Super Frame (SF), formed from 12 basic frames, and Extended Super Frame, formed from 24 basic frames.
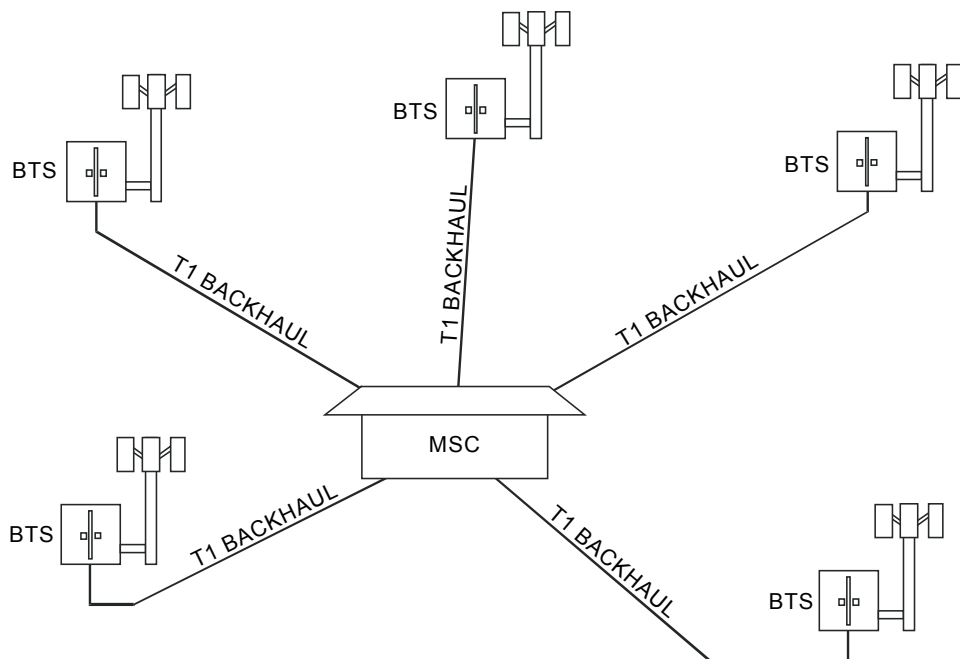
Figure 14-1. Typical Wireless Network T1 Backhaul Links

Network Equipment

One possible network topology is shown in Figure 14-2.

Figure 14-2. One Possible T1 Network Topology

The circuit between the MSC (Mobile Switching Center) and BTS (Base Transceiver Station) may pass through the LEC central office (see Figure 14-3), or through multiple central offices. It may also pass through multiple pieces of transmission equipment. At the BTS, the T1 line typically terminates on a Network Interface Unit (NIU). The NIU may be a very simple device having only a remote loop back capability, or it may provide very sophisticated performance monitoring capabilities. Its capabilities may or may not be accessible to the wireless service provider technician.

Some repeaters may exist in the circuit when the signal is traveling long distances. Repeaters are full duplex devices that regenerate or restore the pulse shape and amplitude. Two possible network topologies are shown in Figure 14-2 and Figure 14-3.
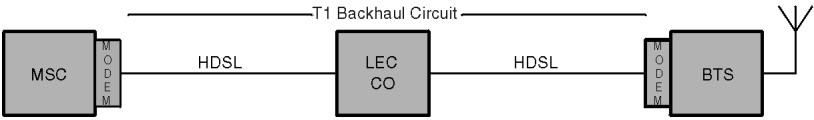
Figure 14-3. BTS and MSC Configuration

The configuration in Figure 14-3 uses a High-speed Digital Subscriber Line (HDSL) in the T1 circuit, which enables full duplex T1 service over a single pair of wires without repeaters. In most cases, the wireless service provider technician may not be concerned with the repeaters or HDSL.

BTS Master T1 Display

Refer to Figure 14-6 for an illustration of the following areas of the BTS Master display screen. The T1 data display area of the BTS Master includes the real time clock and the GPS and battery indicators (at the top), the measurement data (in the middle), the instrument settings summary (at the left side), the soft key labels (at the right side), and the hard key labels (at the bottom). The soft key labels vary in relation to the function hard key selection.

In T1 measurements, the instrument settings summary shows the T1 configuration, including: Test Mode, Line Code, Tx Clock, Receive Input, Framing Mode, Error Type, Pattern, Payload Type, Loop Code, Tx LBO, and Measure.

The upper part of the measurement data display has an area that is highlighted in yellow, which reports historical and current pass/fail conditions for parameters relating to Rx (Receive), DS1, and Tx (Transmit) testing (refer to Figure 14-4). For Rx, the parameters are Signal, Frame Sync, and Pattern Sync. For DS1, the parameters are Alarms, Errors, and B8ZS. For Tx, the parameters are Alarm ON, Error ON, and Loop ON.

Figure 14-4. T1 Parameters for Historical and Pass/Fail Conditions

The columns of historical data (for Rx and DS1) are labeled with an **H**. The adjacent columns display current (present time) conditions. The B8ZS indicator for DS1 displays only the current condition (no historical data). The **H** indicators turn red when an error has occurred previous to the current pass/fail condition. These error indications are cleared by pressing the Clear History soft key in the Measurements menu. The Tx column indicators display ON/OFF status for Alarm, Error, and Loop testing.

The remainder of the measurement display is used for setups, configurations, and measurement display, which changes with the selected function.

The T1 function hard key labels are: **Configuration**, **Pattern/Loop**, **Error/Alarm**, **Measurements,** and **Start/Stop**.

Getting Started

T1 Mode

To prepare for T1 measurements, the MT8222A must be configured for T1 mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight **T1 Analyzer** and then press the **Enter** key or the rotary knob to select this mode.

For additional information about the Mode menu, refer to *Mode Selector Menu* on page 2-16.

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* on page 2-5.

Testing T1 Circuits

T1 circuit testing can be performed with either of two methods: In-service and Out-of-service testing.

In-service testing is done during the routine maintenance and troubleshooting phase. This can be done on live data without removing the T1 circuit from service. Monitoring live data allows wireless service provider technicians to detect alarms, bipolar violations (BPV), and frame errors, but bit errors cannot be measured. Bit errors may, however, be estimated by measuring CRC errors or frame errors. For a step-by-step example of in-service testing, refer to *In-Service Measurements on page 14-9*.

Out of Service testing is done when the T1 circuit is initially installed and before final acceptance from the LEC. At that time, the circuit should be subjected to critical testing in order to guarantee the level of service per contract. Out of service testing may also be performed when the circuit performance is very poor. For a step-by-step example of out of service testing, refer to *Out-Of-Service Measurements on page 14-11*.

T1 Configuration Screen

Display the configuration screen by pressing the **Configuration** function hard key. This function is used to configure the **Signal Setup** and **Payload Setup**.

Signal Setup allows the user to set up the Test Mode, Line Code, Tx Clock, Tx LBO, Rx Input, and Framing information.

Payload Setup allows the user to configure the Payload Type, Payload DS1 Channel, Payload DS0 Channel, and Other Channels that are to be tested.

Soft keys for the T1 Configuration Menu are described in section *Configuration Menu* on page 14-17.

Signal Setup

Test Mode: AUTO

When AUTO is selected, the BTS Master first compares the connected signal with the current status of frame sync and pattern sync. If both are synchronized with the connected signal, then no further action is taken. If the signals are not already synchronized, then the AUTO function searches for a Line Code to match the connected signal, then searches for the framing mode of the connected signal, then searches for a matching signal pattern.
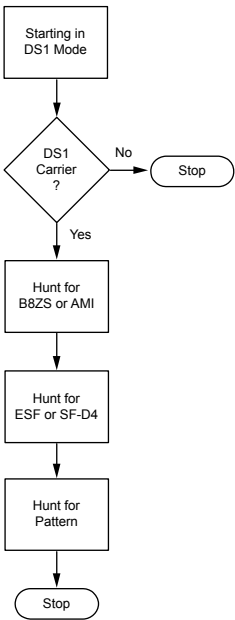
Figure 14-5. AUTO Configuration

Line Code: B8ZS or AMI

B8ZS and Alternate Mark Inversion (AMI) are two different line coding formats that are used in T1 networks.

In the AMI format, a binary one is represented by a pulse, and a zero is indicated by the lack of a pulse. To eliminate any DC offset, the binary one pulses are bipolar (they alternate in polarity). Because the pulses are alternating in polarity, the line code is called Alternate Mark Inversion (AMI). If two consecutive pulses have the same polarity, then a Bipolar Violation (BPV) has occurred.

When no traffic is present on a channel, AMI coding can result in long strings of zeros on the circuit. These zeros can cause the receiving equipment to have timing errors. The method used in T1 systems to maintain the density of ones (as opposed to zeros) in the data stream is known as binary 8-zero substitution, or B8ZS. For the B8ZS scheme, any time that eight consecutive zeros are detected in the data stream, the transmitter substitutes a fixed pattern of ones, zeros, and BPVs in place of those 8 zeros. The BPV is used to distinguish between a real data sequence of ones and zeros versus the fixed B8ZS pattern. Because the B8ZS fixed pattern is a known pattern, the terminating receivers can recognize the pattern and substitute the original string of 8 zeros in place of the fixed pattern.

14-5

TxClock: Internal, External, Recovered

Internal Clock: The internal clock uses an internal oscillator: 1.544 Mbps ±5 ppm

Recovered Clock: The transmit clock uses the frequency recovered from the received signal.

External Clock: An external clock can be applied to the External Frequency Reference Input.

Tx LBO (Transmit Line Build Out): 0 dB, −7.5 dB, or −15 dB

Possible values for LBO are 0 dB, −7.5 dB, or −15 dB. When performing a test toward the far end of a circuit at a Digital System Cross-Connect (DSX), this will usually be 0 dB. The other values might be used when close to the equipment under test.

Rx Input: Terminate, Monitor, or Bridge

Terminate: Select Terminate for out-of-service testing. The signal is terminated with 100 ohms.

Monitor: The connection to the circuit is made through a monitor jack. The jack is isolated from the circuit with resistors, and the signal is typically 20 dB down from the nominal signal level. When Monitor is selected, 20 dB of flat gain is added at the receiver input.

Bridge: The input impedance of the receiver is greater than 1000 ohms. The bridged mode is used when connecting directly to an in-service T1, 1.544 MHz circuit in order to avoid causing a "hit" on the signal and to avoid disrupting service.

Framing: ESF or SF-D4

ESF: Extended Super Frame, in which 24 frames are grouped together as an Extended Super Frame (ESF).

SF-D4: Super Frame D4, in which 12 frames are grouped together as a Super Frame (SF).

Payload Setup

Payload Type: 1.544Mb, Nx64kb, 64kb, 56kb, 16kb, or 8kb

The Payload Type identifies which portion of the T1 data stream is to be tested.

1.544 Mb: Full T1 data stream test.

Nx64kb: Selected combinations of 64 kb channels are tested. This mode is referred to as fractional T1.

64kb: A single 64 kb channel is tested.

56kb: Data stream as a result of bit robbing.

16kb: 2 consecutive bits within a single 64 kb channel are tested.

8kb: A single bit within a selected 64 kb channel is tested.

Payload DS0 Channel: # (Number)

Set up the necessary channels and sub-channels when testing payloads Nx64kb to 8kb.

Other Channels: All ones or Idle

Set the other channels (that are not being tested) as IDLE or set them to All Ones.

T1 Pattern/Loop Screen

Access the test pattern screen by pressing the **Pattern/Loop** key, which includes 12 defined patterns and up to six user-defined patterns. The user-defined patterns can be created by pressing the Set User Pattern soft key. Refer to *Set User Pattern*. on page 14-20.

The available patterns are: QRSS, PRBS-9(511), PRBS-11(2047), PRBS-15, PRBS-20, PRBS-23, All Ones, All Zeros, T1 Daly, 1 in 8, 2 in 8, 3 in 24, or one of six user-defined patterns (labeled User Pattern 1 through User Pattern 6). The defined patterns are listed in Table 14-2.

Inverse patterns can be used. Loop codes can be selected and used as loop up or loop down.

Soft keys for the Pattern/Loop Menu are described in section *Pattern/Loop Menu* on page 14-20. For a list of test pattern description, refer to Table 14-2, *"Defined Test Patterns"* on page 14-29.

T1 Error/Alarm Screen

The Error/Alarm screen includes all of the errors and alarms that can be added to the transmission path. Press the **Error/Alarm** function hard key to display the Error/Alarm menu.

Soft keys for the Alarm/Error Menu are described in section *Error/Alarm Menu* on page 14-22.

Bit Error: Inserts errors in the BER pattern. Bit errors can be selected by pressing Bit Error. A burst between 1 and 1000 can be selected by pressing the Bit Error soft key. The Error Off/On soft key is used to turn the burst ON or OFF.

BER (Bit Error Rate): Errors can be added to the transmission path by pressing the BER soft key. Valid bit errors can be quickly set by pressing a preset soft key: 1E–2, 1E–3, 1E–4, 1E–5, 1E–6, and 1E–7. For preset BER rates, refer to Table 14-1. Pressing the Error Off/On soft key turns the error signal ON (keeps errors adding) or OFF (stops the errors).

Table 14-1. Bit Error Rates

BER Rate	Errors Inserted
1E–2	1 error is inserted for every 100 bits introduced
1E–3	1 error is inserted for every 1000 bits introduced
1E–4	1 error is inserted for every 10,000 bits introduced
1E–5	1 error is inserted for every 100,000 bits introduced
1E–6	1 error is inserted for every 1,000,000 bits introduced
1E–7	1 error is inserted for every 10,000,000 bits introduced

BPV: In a bipolar signal, this is a rule violation in which a 1 (mark or pulse) has the same polarity as the previous 1 (mark or pulse). A burst between 1 and 1000 can be selected by pressing the BPV soft key.

Frame Bit Error: Inserts errors in the framing bits. Frame Bit errors can be selected by pressing Frame Bit Error. A burst between 1 and 1000 can be selected by pressing the Burst soft key. The Error On/Off soft key is used to turn the burst ON or OFF.

AIS Alarm On/Off: When the AIS (Alarm Indication Signal) alarm is turned ON, the data is replaced with an unframed signal of all ones. AIS is also called the Blue Alarm.

RAI Alarm On/Off: When the RAI (Remote Alarm Indication) alarm is turned ON, a signal is transmitted from the terminal equipment in the outgoing direction when it determines that it has lost the incoming signal, or when it receives an AIS signal in the incoming direction. RAI is also called the Yellow Alarm.

Error Off/On: This soft key turns the error signal ON or OFF.

T1 Measurement Screen

BERT: Three different displays are available to view results. They are Table, Histogram, and Event List.

Rx Signal: Displays Rx Signal measurements.

VF: Displays VF level measurements. The sub menu allows setting channel number, transmit frequency, transmit level, and audio volume (of the BTS Master).

Measure Time: Sets the time period of testing, from 1 minute to 3 days.

Clear History: Clears the Event List and any of the red History indicators in the yellow highlighted area of the data display.

Save Results: This soft key opens the File menu. See *Spectrum Analyzer Mode File Menu on page 3-25*.

Soft keys for the Measurement Menu are described in section *Measurements Menu* on page 14-25.

Start/Stop Key

Press this function key to start or stop the measurement that is currently set up on the BTS Master.

In-Service Measurements

In service testing can be done only when the equipment has a test port. When testing a T1 circuit that is in service, the access to the circuit must be bridged or via a monitor port, in order to avoid disrupting service. Even when the T1 circuit is down, these tests will help to verify and identify the correct fault circuit. The following measurements can be used to check the T1 performance during regular maintenance:

• Vpp Measurement

• Carrier

• Frame Sync

• CRC Errors, for Extended Super Frame (ESF)

• BPV

• Frequency

Required Equipment

• MT8222A BTS Master with Option 51

• Bantam Cables, Anritsu Part Number 806-16

Measurement Setup Procedure

1. While in the T1 Analyzer mode, press the **Configuration** function hard key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight **Test Mode** and select DS1.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight **Line Code** and press the B8ZS or AMI line coding soft key.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight **Tx Clock** and select Internal, Recovered, or External. For more **Tx Clock** information, refer to *TxClock: Internal, External, Recovered* on page 14-6.
5. Use the **Up/Down** arrow keys or the rotary knob to highlight **Rx Input** and press the Bridge or Monitor soft key, as appropriate for the connection.

> NOTE: If Monitor access is pressed, 20 dB of gain is added to the receive path. The Bridge or Monitor selection must be made before the BTS Master is connected to the circuit.

6. Use the **Up/Down** arrow keys or the rotary knob to highlight **Framing** and press the ESF or SF-D4 framing soft key.

> NOTE: The setup parameters are displayed in the instrument settings summary on the left side of the screen. The status window on the top of the screen is always displayed.

7. Connect the Rx cable to one of the pairs.
8. Press the **Measurement** function hard key, then the BERT soft key, then the Table soft key. Press the **Start/Stop** function hard key to activate the measurement.
9. Verify Rx **Signal**, **Frame Sync**, **CRC**, and **BPV**.
10. Press Rx Signal (**Measurements** menu) and verify Vpp and Frequency. When very close to the Tx source, the signal should be between 4.8 Vpp and 7.2 Vpp. The frequency should be 1.544 MHz ±7.7 Hz (±5 ppm).
11. Move the Rx connection to the other pair on the circuit under text and then repeat the tests.

NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.

Figure 14-6. T1 Signal Setup for DS1

Vpp Measurement Procedure

This test measures the amplitude of the output signal from the PCM port to the DSX and receiving station. These measurements provide detailed information on the T1 circuit.

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the Rx Signal soft key to select the Vpp measurement.
3. Press the **Start/Stop** function hard key to activate the Vpp measurement.

NOTE: The Vpp measurement is displayed in both Vpp and dBdsx.

The Vpp should meet the criteria of the service provider. When very close to the transmitter, the signal level must be 4.8 to 7.2 Vpp. Further from the transmitter, the Vpp will be lower.

Figure 14-7. Vpp Measurement

VF, DS0 Test Procedure for In-Service Measurements

1. After the unit is correctly configured, press the **Measurements** function hard key and the VF soft key to activate the VF Measurements.
2. Press the Channel soft key and use the directional arrow keys, rotary knob, or key pad to enter the desired channel, then press **Enter**. The received VF level and frequency on the selected channel are displayed.
3. For audio monitoring, press the Audio soft key to toggle audio monitoring ON.

When a test tone is present on the channel, the level and frequency report will indicate whether the channel is healthy. If speech is present on the channel, then the channel performance can be judged from the audio quality.

Out-Of-Service Measurements

Out-of-service measurements are performed when the T1 circuit is not in service or is inactive. Typically these tests are done during initial installation, during circuit acceptance by the wireless service provider, or when the performance of the circuit is below acceptable levels.

Two methods of performing out-of-service testing are: end-to-end and loopback testing. End-to-end testing requires a technician and a unit at each end of the circuit. Loopback testing requires a loopback at one end of the circuit and a unit and technician at the other end to measure the round trip BER of the T1 circuit.

The ANSI T1 standard defines in-band and out-of-band loop codes. In-band codes are transmitted in place of payload data and are repeated continuously for a period of five seconds. They can be used either with SF D4 or ESF. Out-of-band loop codes can be used only with the ESF framing format, because an out-of-band communication link does not exist for SF D4.

14-11

The following measurements can be used to check T1 performance during out of service testing:

- Vpp
- Carrier
- Frame Sync
- CRC Errors, for Extended Super Frame (ESF)
- BPV
- BER
- Frequency

Required Equipment

- MT8222A BTS Master with Option 51
- Bantam Cables, Anritsu Part Number 806-16 (2 cables required)

Measurement Setup Procedure

1. Press the **Configuration** function hard key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight **Line Code** and press the B8ZS or AMI coding soft key.
3. Select one of the three **Tx Clock** types: Internal, Recovered, or External.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight **Tx LBO** and select either the 0 dB, −7.5 dB, or −15 dB transmitter signal level soft key as appropriate to the measurement.
5. Use the **Up/Down** arrow keys or the rotary knob to highlight **Rx Input** and press the Terminate soft key.
6. Use the **Up/Down** arrow keys or the rotary knob to highlight **Framing** and press the ESF or SF-D4 soft key as appropriate for the measurement.
7. Press the **Pattern/Loop** function hard key to activate the pattern and loop code menu.
8. Press the Select Pattern soft key, use the **Up/Down** arrow keys, or use the rotary knob to highlight the appropriate pattern, and press the Select Pattern soft key or press **Enter**. The selected pattern can be reversed (only supported for PRBS patterns) by pressing the Inverse Pattern soft key.

> NOTE: Up to six user-defined patterns can be created by pressing the Set User Pattern soft key and pressing the User-Pat 1 through User-Pat 6 soft keys. Use the **Up/Down** arrow keys, rotary knob, or key pad to enter the desired pattern. Table 14-2 on page 14-29 summarizes the T1 patterns that are available in the MT8222A.

9. Connect the Tx and Rx ports to the circuit under test.
10. Verify carrier and frame sync before proceeding.

Activate Remote Loop Up and Loop Down Code

1. Press the **Pattern/Loop** function hard key to activate the pattern and loop code menus.
2. Press the Select Loop Code soft key to display the Loop menu. Press either the CSU or the NIU soft key.
3. Select either In-Band or Data Link by toggling the Link Type soft key. (This selection is for ESF only.) Press Back to return to the previous menu.

> NOTE: Custom user-defined codes can be created by pressing the Loop Code User 1 or Loop Code User 2 soft key and using the **Up/Down** arrow keys, rotary knob, or key pad to enter the desired loop code.

4. Press the Remote Loop Up soft key to activate the Loop Code.
5. Press the Remote Loop Down soft key to deactivate the Loop Code.

> NOTE: The current setup parameters are displayed in the instrument settings summary table on the left side of the screen.

To Set Errors/Alarms

1. Press the **Error/Alarm** function hard key to activate the Error/Alarm menu.
2. Press the Bit Error, BER, BPV, or Frame Bit Error soft key, as applicable to the measurement.
3. Press the AIS Alarm or RAI Alarm soft key. These two soft key toggle between ON and OFF. The alarm status is displayed in the yellow highlighted area of the upper part of the measurement data display.

Vpp and Frequency Measurement Procedure

This test measures the amplitude of the output signal from the PCM port at the DSX (Digital System Cross-Connect) and receiving station.

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the Rx Signal soft key to activate the Vpp measurement.

> NOTE: The Vpp measurement is displayed in both Vpp and dBdsx.

The Vpp should meet the criteria of the service provider. When very close to the transmitter, the signal level must be 4.8 to 7.2 Vpp. Further from the transmitter, the Vpp will be lower. Figure 14-8 shows a typical Vpp measurement display (which may not be the same as shown on your instrument). The frequency should be 1.544 MHz ±5 ppm.

If the measurement meets the customer requirements for this system, then proceed to the BERT measurement.
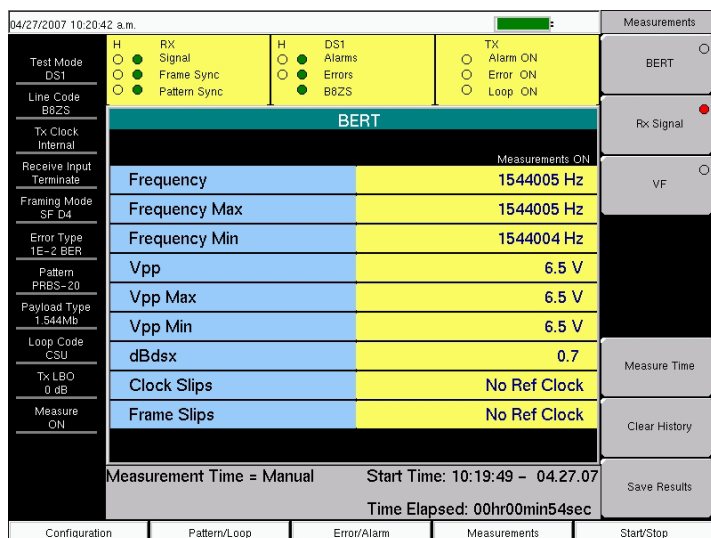
Figure 14-8. Vpp Out-of-Service Measurement

BERT Measurement Procedure

Basic BERT Measurement Procedure

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the BERT soft key to activate the BERT menu.
3. Press the Table soft key to display the measurements in table format, or press Histogram or Event List.
4. From the BERT menu, press the Back soft key. Then from the Measurements menu, press the Measure Time soft key and use the **Up/Down** arrow keys, rotary knob, or key pad to enter the duration of the measurement. Then press **Enter**.
5. Press the **Start/Stop** function hard key to start and stop the measurement.

> NOTE: The measurement time is set in the Measure Time menu (1 min, 3 min, 5 min, 15 min, 30 min, 1 hour, 2 hours, 3 hours, 1 day, 2 days, 3 days, or Manual). Manual runs indefinitely and allows the user to terminate the measurement at any time.

Soft keys for the BERT menu are described in section *Measurements Menu* .

Quick Check

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the BERT soft key to activate the BERT menu.
3. Press the Table soft key to display the measurements in the table format.
4. Press the **Start/Stop** function hard key to activate the measurements. To stop the measurements, press the **Start/Stop** key again.
5. If the results are within specifications, then **RESULTS OK** is displayed in a green box at the center of the screen. If any errors occur, then the errors/measurement results are displayed in the table..

> NOTE: **RESULTS OK** can be cleared by pressing **Esc**.

Histogram Display

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the BERT soft key to activate the BERT menu.
3. Press the Histogram soft key to display the data in histogram format.
4. Press the Histogram soft key again to configure the histogram parameters, which are Zoom, Window Size, and Time Units.
5. Press the **Start/Stop** function hard key to activate the measurement.

To Insert Errors/Alarms

1. Press the **Error/Alarm** function hard key to activate the Error/Alarm menu.
2. Press the Error Off/On soft key to toggle the selected error type ON. Confirm that <u>On</u> is underlined. (Press the Error Off/On soft key to turn OFF the errors.)

Event List

The BERT measurement **Event List** updates errors, signal loss, frame loss, and alarms (AIS ON, AIS OFF, RAI ON, and RAI OFF) every second. The data is displayed as a log list.

DS0 Testing

The DS0 test feature enables testing on each of the 24 channels of the T1 line. The receive channel is decoded, and the VF level and frequency are measured and displayed. The signal is also connected to a speaker, enabling the testing technician to make an audible assessment of the signal quality of the circuit. If the circuit is out of service, the tester can insert a test tone on the transmit channel for measurement either at a remote location with another test set, or locally with a loopback. VF is displayed above 100 Hz and up to 3000 Hz.

Measuring Clock and Frame Slips in T1 Analyzer Mode

If a T1 - 1.544 Mb/s BITS (Building Integrated Timing Source) reference clock is available, then it can be used to measure clock slips and frame slips on the circuit under test. If two or more T1 - 1.544 Mb/s circuits are present, then one of these can be used as a reference. The reference circuit (in this configuration) should be out of service because it will be terminated by the clock recovery circuit in the BTS Master.

To count clock slips, connect the reference clock to the Ext Ref In connector on the BTS Master. The presence of the clock is automatically detected, and when a measurement is started, the number of clock slips and frame slips are reported. When the clock frequencies are very close, the clock slip count will hover around zero. If the frequency of the circuit under test is higher than the reference frequency, then the count will grow positive. If the frequency of the circuit under test is lower than the reference frequency, then the count will grow negative. One frame slip is counted for 193 clock slips.

Figure 14-9. Histogram Display

Histogram Explanations

Data Resolution

If data resolution is set to a small value, then you can zoom in to see in detail when faults have occurred. However, small resolution takes up larger file sizes when saved. The maximum number of records is capped at 86,400, so if the user is interested in history longer than one day, then the resolution must be set higher than one second. If the data resolution is changed, then the entire histogram must be reset.

Display Window

The display window is the length of time shown on the histogram screen. More data may be stored than is shown. This parameter allows a user to zoom in or zoom out to see either more time on the screen or more resolution. The minimum and maximum values are based upon the data resolution.

Turning the rotary knob while in the Histogram view scrolls a vertical yellow marker line across the histogram graph.

Time Offset

Time offset is the offset in time of the right side of the screen from the start of the measurement. The screen may be moved left or right with this parameter. Using this feature together with a small display window provides the ability to zoom in on an event that happened some time in the past.

Time Units

If Relative is selected (underlined), then the histogram axis will be labeled with time since the start of the measurement record.

If Absolute is selected, then the histogram axis will be labeled with absolute times that are based on the system clock.

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Soft Key Menus

Configuration Menu

Figure 14-10. T1 Configuration Soft Key Menus

Signal Setup

Test Mode

AUTO
Press this soft key to automatically select a Framing Mode and Pattern to match the connected signal. For additional explanation of the use of this key, refer to section *Test Mode: AUTO* .

Line Code

Select either AMI or B8ZS line code format. For additional information, refer to section *Line Code: B8ZS or AMI* .

B8ZS
Press this soft key for B8ZS.

AMI
Press this soft key for AMI.

Tx Clock

Internal
Press this soft key to use an internal clock, for testing toward the equipment at the local site.

Recovered
Press this soft key when you want the transmit clock to use the frequency that is recovered from the received signal.

External
Press this soft key to use an external reference clock.

Tx LBO

0 dB, −7.5 dB, or −15 dB
Press one of these soft keys depending upon whether you are testing toward local equipment or toward the far end of a circuit. For additional information, refer to section *Tx LBO* on page 14-6.

Rx Input

Terminate
Press this soft key to terminate the circuit in 100 ohms.

Monitor
Press this soft key to perform a monitor test by using the monitor jack at a DSX. This selection properly terminates the signal coming from the DSX monitor jack and compensates for the 20 dB loss found at that jack.

Bridge
Press this soft key to connect to the circuit with >1000 ohms.

Framing

ESF
Press this soft key for Extended Super Frame format.

SF−D4
Press this soft key for Super Frame D4 format.

Payload Setup

Payload Type

The payload type identifies which portion of the T1 data stream is to be accessed for testing. For additional information, refer to section *Payload Setup* on page 14-6.

Payload DS0 Channel

Edit
Press this soft key to set up the necessary channels and sub-channels when testing payloads Nx64kb through 8kb.

Other Channels

All ones
Press this soft key to set channels that are not being tested to contain all ones (no zeros).

Idle
Press this soft key to set channels that are not being tested to be idle.

Pattern/Loop Menu
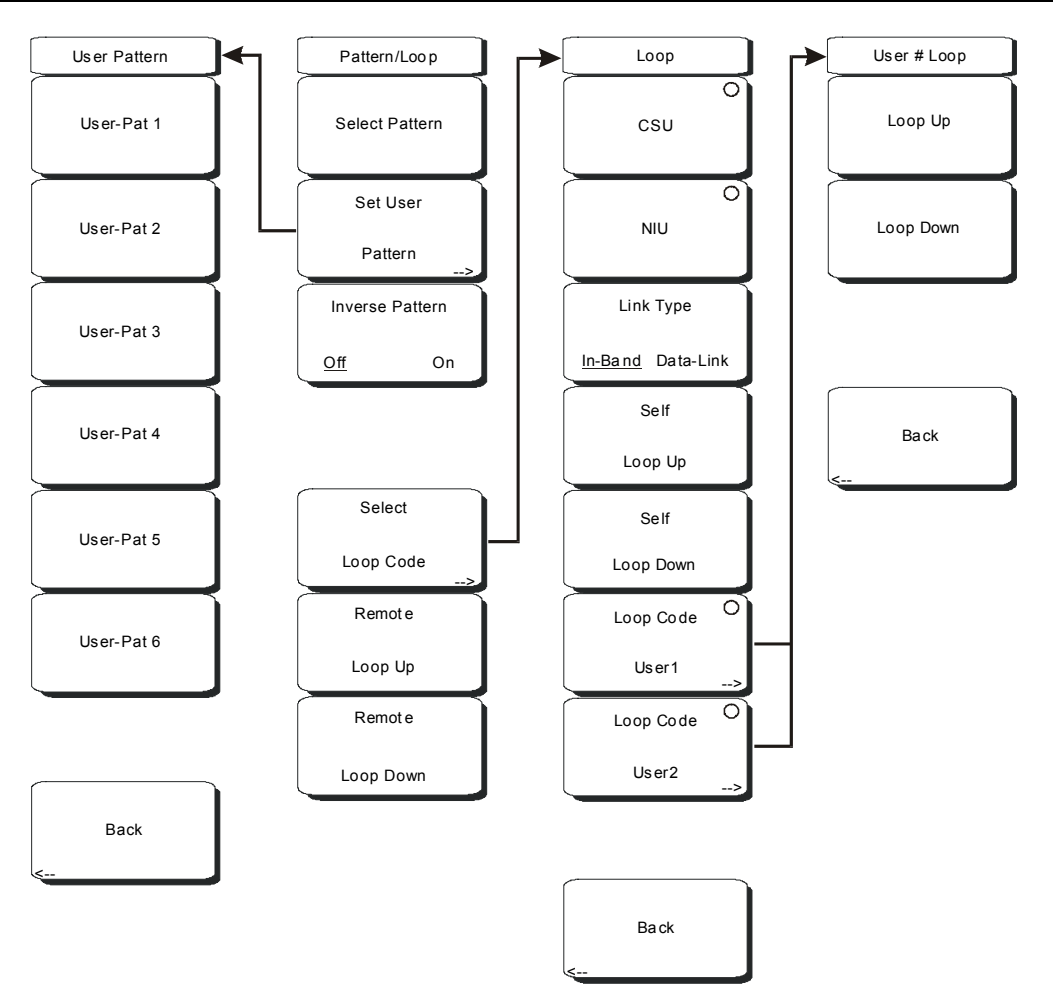
Figure 14-11. T1 Pattern/Loop Menu

Select Pattern
After highlighting a pattern, press this soft key to select the highlighted pattern.

Set User Pattern
Use this soft key to set a specific user pattern in one or more of the six available user patterns.

User-Pat #
These six soft keys each select a different user pattern. Set the patterns by entering zeros or ones, up to a maximum of 24 bits. Press **Enter** to continue or **Esc** to abort.

Inverse Pattern, Off/On
This soft key toggles the Inverse Pattern function OFF and ON. The inverse pattern function is supported only for PRBS patterns.

Select Loop Code

This soft key opens the Loop soft key menu, from which you can select 1 of 7 loop configurations.

CSU

Press this soft key to select CSU (Channel Service Unit) codes.

NIU

Press this soft key to select NIU (Network Interface Unit) codes.

Link Type

Press this soft key to toggle between In-Band and Data-Link. Use Data-Link when framing is ESF.

Self Loop Up

Press this soft key to activate internal loop back.

Self Loop Down

Press this soft key to deactivate internal loop back, reverting the MT8222A to a through mode.

Loop Code User1 and Loop Code User2

Press one of these soft keys to set the user Loop Up and Loop Down codes.
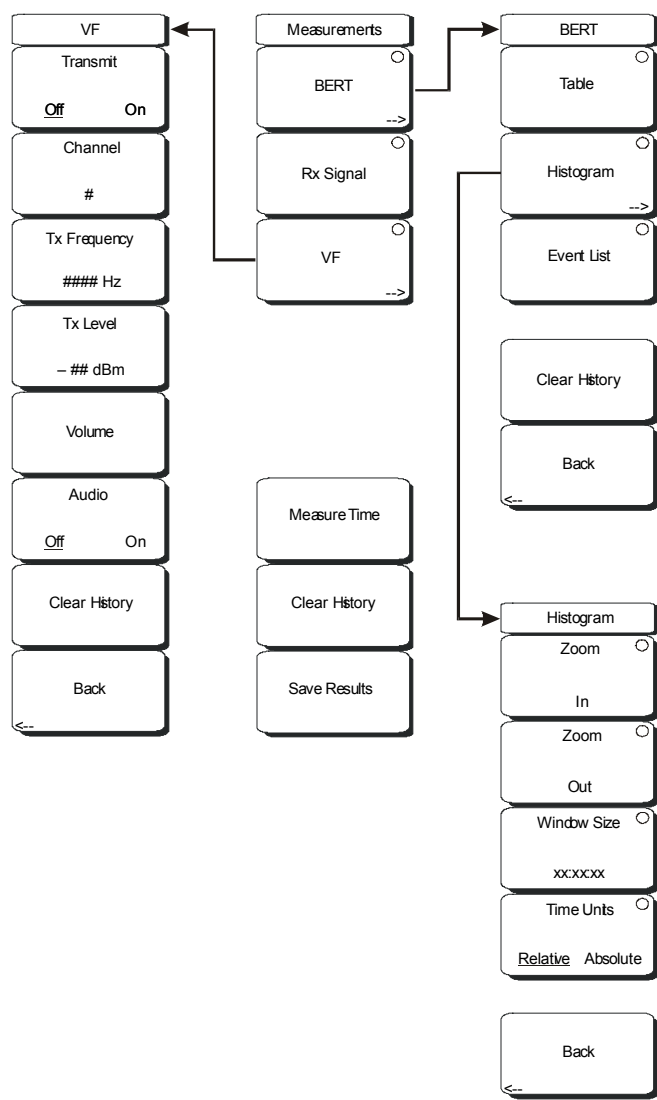
Figure 14-12. T1 Error/Alarm Menu

When not active, some soft keys have no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when these soft keys are active.

Bit Error

Use this soft key to insert a bit error. Press this soft key once to select the function. Press the key again to display the Bit Error soft key menu. The "Error Type" field in the instrument settings summary table at the left side of the measurement display changes to "### BIT", where ### is the burst setting.

Burst

A burst can contain from 1 to 1000 errors. Set this parameter by pressing the Burst soft key and then using the rotary knob, arrow keys, or number keypad. The following text appears in red at the top of the BERT table: **Bit Error Insert ###**. The number digits appear as they are pressed on the number keypad. Then press the rotary knob or the **Enter** key. If you use the number keypad to enter the burst setting, then the Burst soft key label changes to Enter. The soft key can be used to enter the parameter value.

Back: Press this soft key to return to the Error/Alarm menu.

BER

Errors can be added to the transmission path by pressing the BER soft key. Valid BER include 1E–2, 1E–3, 1E–4, 1E–5, 1E–6, and 1E–7. If a BER value of 1E–3 is selected, then 1 error will be introduced for every 1000 bits in the transmission path. Pressing ON keeps adding errors. Pressing OFF stops the errors. Press this soft key once to select the function. The "Error Type" field in the instrument settings summary table at the left side of the measurement display changes to "1E–# BER", where # indicates the bit error rate setting. Press the key again to display the Bit Error Rate soft key menu. Choose from the six rate options and press Back to continue.

Bit Error Rate Menu

Rate 1E–#

These six soft keys are labeled with number 1E–2 through number 1E–7. Use these soft keys to select a bit error rate.

Back

Press this soft key to return to the Error/Alarm menu.

BPV

Use this soft key to configure error bits for bipolar violation testing. Press this soft key once to select the function. The "Error Type" field in the instrument settings summary table at the left side of the measurement display changes to "### BPV", where ### is the burst setting. Press the key again to set the Burst rate. See *Burst on page 14-23*. Press the Back soft key to return to the Error/Alarm menu.

Frame Bit Error

Use this soft key to insert a frame bit error. Press this soft key once to select the function. The "Error Type" field in the instrument settings summary table at the left side of the measurement display changes to "### FRAME", where ### is the burst setting. Press the key again to enter the Frame Bit Error menu and set the burst rate. See *Burst on page 14-23*. Press the Back soft key to return to the Error/Alarm menu.

AIS Alarm On/Off

When the AIS is turned ON, the data is replaced with an unframed signal of all ones. Press this soft key to turn ON the AIS Alarm function. The "Error Type" field in the instrument settings summary table at the left side of the measurement display changes to "Error Type AIS". The Alarm ON circle indicator (in the yellow TX portion of the upper part of the measurement data display) is displayed in red when this parameter is ON. Selecting this function automatically turns the Error, Off/On soft key function to OFF, and its circle indicator (in the yellow TX portion of the upper display) is displayed as an open circle. Pressing this soft again turns the alarm OFF, its circle indicator is displayed as an open circle, and the Bit Error soft key becomes active (its circle indicator is displayed in red).

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RAI Alarm On/Off

If the terminal loses its incoming signal, then an RAI signal is transmitted in the outgoing direction. RAI is also called Yellow Alarm. Press this soft key to turn ON the RAI Alarm function. The "Error Type" field in the instrument settings summary table at the left side of the measurement display changes to "Error Type AIS". The Alarm ON circle indicator (in the yellow TX portion of the upper part of the measurement data display) is displayed in red when this parameter is ON. Selecting this function automatically turns the Error, Off/On soft key function to OFF, and its circle indicator (in the yellow TX portion of the upper display) is displayed as an open circle. Pressing this soft again turns the alarm Off, its circle indicator is displayed as an open circle, and the Bit Error soft key becomes active (its circle indicator is displayed in red).

Error, Off/On

This soft key is active only when the BER soft key is active. Press this soft key to toggle Error Off and On. The Error ON circle indicator (in the yellow TX portion of the upper display) is displayed in green when this parameter is ON.

Measurements Menu

Figure 14-13. T1 Measurements Menu

When not active, some soft keys have no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when these soft keys are active.

BERT
Press this soft key to open the BERT soft key menu and select the display type for viewing test results, choosing from: Table, Histogram, or Event List.

Table
Press this soft key to view test results in table format.

Histogram

Press this soft key to view test results in the histogram screen display. Press the soft key again to configure the histogram screen.

Zoom In

Use this soft key to change the graph display width to a smaller value. The graphical display units are described in the Window Size soft key description.

Zoom Out

Use this soft key to change the graph display width to a larger value. The graphical display units are described in the Window Size soft key description.

Window Size, ##:##:##

This soft key displays the time units in the format 0d:00:00:00, in days, hours, minutes, and seconds (0d:HH:MM:SS). Seconds are 00 by default and cannot be changed. When the setting is less than 1 day, the day units are not shown, and the format is 00:00:00 (HH:MM:SS).

Setting the time sets a display graph width of 1, 5, or 15 minutes; 1, 6, or 12 hours; or 1, 2, or 3 days. When pressed, the soft key color changes to a darker background, and the numeric value is displayed in red. The labels (Display Window ##:##:00) in the graph area of the display are also in red. The red color indicates that the time is being changed. The red label at the top line of the histogram and the one below the histogram remain red while the value is open to change. When the numeric value has been set, the upper label is removed, and the lower label changes to plain text, showing the setting.

Use the arrow keys to change the values from 1 minute to 3 days in the 9 increments that are available. The value can also be set by using the number keys. Press an appropriate number or numbers, and the soft key menu changes to time increments: days, hours, minutes, seconds. For example, entering 3600 and pressing seconds sets the display width to 1 hour, and entering 3601 and pressing seconds sets the display width to 6 hours (the next available increment).

Time

days

hours

minutes

seconds

Figure 14-14. Histogram Window Size Time Units

Press the desired time units soft key to enter the time value in days, hours, or minutes (seconds, for example, can be used in multiples for any of the discrete hour, minute, or day settings, but the number of seconds in the final setting are always 00). The Window Size soft key remains active (available for change) until you press the **Enter** key or the Rotary Knob.

Turning the rotary knob while in the Histogram view scrolls a vertical yellow marker line across the histogram graph.

Time Units, Relative or Absolute
This soft keys toggles between Relative and Absolute time. The units are displayed at the bottom edge of the histogram.

Back
Press this soft key to return to the BERT menu.

Event List
Press this soft key to view test results in the Event List format.

Clear History
Press this soft key to clear any red History indicators in the yellow-highlighted, upper portion of the measurement display.

Back
Press this soft key to return to the Measurements menu.

Rx Signal
Press this soft key to display Rx Signal measurements.

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VF

Press this soft key to display VF level measurements. Press the soft key again to open the VF menu for configuration.

Transmit, Off/On

This soft key toggles Transmit OFF and ON.

Channel

This soft key opens a dialog box to select a channel value from 1 (minimum) to 24 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value, and then press **Enter** to continue, or press **Esc** to abort.

Tx Frequency

This soft key opens a dialog box to select a frequency from 100 Hz (minimum) to 3000 Hz (maximum). Use the numeric keys to enter a value, or use the arrow keys or the rotary knob to select a default value, and then press **Enter** to continue, or press **Esc** to abort.

Tx Level

This soft key opens a dialog box to select a Tx Level from –30 dBm (minimum) to 0 dBm (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value, and then press **Enter** to continue, or press **Esc** to abort.

Volume

This soft key opens a dialog box to set the volume from 0 (minimum) to 90 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value in increments of 5, and then press **Enter** to continue, or press **Esc** to abort.

Audio, Off/On

This soft key toggles Audio OFF and ON.

Clear History

Press this soft key to clear any red History indicators in the yellow-highlighted, upper portion of the measurement display.

Back

Press this soft key to return to the Measurements soft key menu.

Measure Time

This soft key opens a dialog box to set the measurement time. Choose from 12 settings, which range from 1 minute (minimum) to 3 days (maximum). You can also choose Manual, which runs any length of time, indefinitely, until the **Stop/Start** function hard key is pressed. Use the arrow keys or the rotary knob to enter a value, and then press **Enter** or the Rotary Knob to continue, or press **Esc** to abort.

Clear History

Press this soft key to erase the history of displayed events and measurements. Also, clears any red History indicators in the yellow-highlighted, upper portion of the measurement display.

Save Results

Press this soft key to save the results of a measurement. See *File on page 3-25*.

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Table 14-2. Defined Test Patterns

Pattern	Description	Application
QRSS	1,048,575 bit pattern	Simulates live traffic including both high and low-density sequences
1 IN 8	Eight bit pattern of a 1 and 7 zeros	Checks clock recovery on circuits optioned for B8ZS
2 IN 8	Eight bit pattern of 2 ones and 6 zeros	Used to determine correct optioning of AMI or B8ZS line coding
3 IN 24	24 bit pattern with 3 ones and 15 consecutive zeros. 12.5% ones density	Stresses AMI optioned circuits for minimum ones density and maximum consecutive zeros performance. Forces zero substitutions in B8ZS optioned circuits
ALL ONES	All ones sent as payload in a framed sequence	Stresses ability of circuit to operate under maximum power conditions
ALL ZEROS	All zeros sent as payload in a framed sequence	Checks for B8ZS optioning. Circuit will drop if optioned for AMI
T1-DALY	Framed 55 octet sequence which changes rapidly from high to low density	Stresses timing recovery and ability of automatic line build out and equalizer circuits to respond quickly to changing ones density
PRBS-9 (511)	511 bit pseudo-random pattern	Test sub-rate DDS circuits operating below 56 kbps
PRBS-11 (2047)	2047 bit pseudo-random pattern	Test 56 kbps DDS circuits
PRBS-15	32,767 bit pseudo-random pattern. Generates up to 14 consecutive zeros and 15 consecutive ones	Tests to CCITT Recommendations O.151 and G.703. Provides maximum number of zeros for testing non-B8ZS circuits
PRBS-20	1,048,575 bit pseudo-random pattern Generates up to 19 consecutive zeros and 20 consecutive ones	Used to test synchronous T1 circuits only
PRBS-23	8,388,607 bit pseudo-random pattern Generates up to 22 consecutive zeros and 23 consecutive ones	Used to test synchronous T1 circuits

Chapter 15
T1/T3 Analyzer

Introduction

This chapter provides a brief description of T1 and T3 circuits as well as T1 and T3 measurements, and also explains how to measure T1 and T3 performance using the Anritsu MT8222A BTS Master with Option 53 installed.

The first part of the chapter describes T1 technology and testing, and the second part describes T3 technology and testing. A *Glossary* provides definitions of some T1/T3 terms.

T1 Fundamentals

Wireless service providers use wired T1 circuits as the backhaul links to connect a Base Transceiver Station (BTS) to a Mobile Switching Center (MSC). The quality of the service that is provided over those T1 lines has a direct effect on the quality of service that is experienced by the wireless service provider customers. Call setup failures, dropped calls, and data errors can often be attributed to the T1 backhaul facilities. An example of a typical wireless network backhaul T1 link is shown in Figure 15-1.

In the United States, wireless service providers generally lease T1 lines from a Local Exchange Carrier (LEC), so a joint effort is often required to analyze and troubleshoot a T1 line.

T1 is an American National Standard Institute (ANSI) standard, used mostly in North America, in parts of Japan, and in some Asian countries. Technically, a T1 line is a digital transmission facility consisting of wire pairs and regenerators carrying a DS1 signal. **T1** refers to the physical properties of the line, for example, 1.544 MHz with a specific pulse shape, and so forth. **DS1** refers to the digital signal carrying the information at a rate of 1.544 Mb/s.

A DS1 signal contains twenty-four 8-bit channels. The channel signals are repeated 8000 times per second, resulting in a bandwidth of 64 kHz per channel (8 X 8000 = 64,000). The channels are organized into 192-bit frames, and a framing bit is added to enable synchronization to the DS1 signal. The frequency of the T1 signal is 193 X 8000 = 1.544 MHz. Two types of DS1 framing formats are used: Super Frame (SF), formed from 12 basic frames, and Extended Super Frame, formed from 24 basic frames.
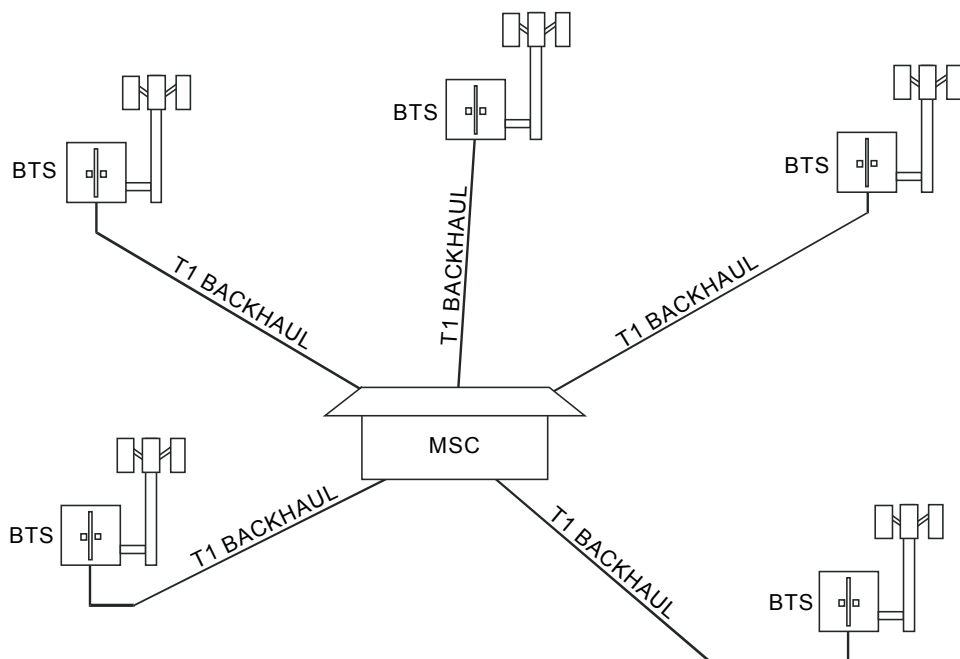
Figure 15-1. Typical Wireless Network T1 Backhaul Links

Network Equipment

One possible network topology is shown in Figure 15-2.

Figure 15-2. One Possible T1 Network Topology

The circuit between the MSC (Mobile Switching Center) and BTS (Base Transceiver Station) may pass through the LEC central office (see Figure 15-3), or through multiple central offices. It may also pass through multiple pieces of transmission equipment. At the BTS, the T1 line typically terminates on a Network Interface Unit (NIU). The NIU may be a very simple device having only a remote loop back capability, or it may provide very sophisticated performance monitoring capabilities. Its capabilities may or may not be accessible to the wireless service provider technician.

Some repeaters may exist in the circuit when the signal is traveling long distances. Repeaters are full duplex devices that regenerate or restore the pulse shape and amplitude. Two possible network topologies are shown in Figure 15-2 and Figure 15-3.
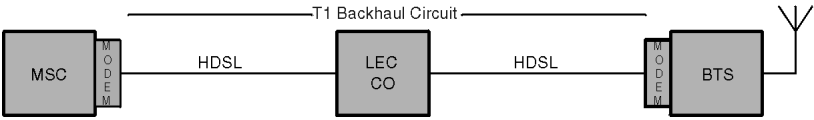
Figure 15-3. BTS and MSC Configuration

The configuration in Figure 15-3 uses a High-speed Digital Subscriber Line (HDSL) in the T1 circuit, which enables full duplex T1 service over a single pair of wires without repeaters. In most cases, the wireless service provider technician may not be concerned with the repeaters or HDSL.

BTS Master T1 Display

Refer to Figure 15-5 for an illustration of the following areas of the BTS Master display screen. The T1 data display area of the BTS Master includes the real time clock and the GPS and battery indicators (at the top), the measurement data (in the middle), the instrument settings summary (at the left side), the soft key labels (at the right side), and the hard key labels (at the bottom). The soft key labels vary in relation to the function hard key selection.

In T1 measurements, the instrument settings summary shows the T1 configuration, including: Test Mode, Line Code, Tx Clock, Receive Input, Framing Mode, Error Type, Pattern, Payload Type, Loop Code, Tx LBO, and Measure.

The upper part of the measurement data display has an area that is highlighted in yellow, which reports historical and current pass/fail conditions for parameters relating to Rx (Receive), DS1, and Tx (Transmit) testing (refer to Figure 15-4). For Rx, the parameters are Signal, Frame Sync, and Pattern Sync. For DS1, the parameters are Alarms, Errors, and B8ZS. For Tx, the parameters are Alarm ON, Error ON, and Loop ON.

Figure 15-4. T1 Parameters for Historical and Pass/Fail Conditions

The columns of historical data (for Rx and DS1) are labeled with an **H**. The adjacent columns display current (present time) conditions. The B8ZS indicator for DS1 displays only the current condition (no historical data). The **H** indicators turn red when an error has occurred previous to the current pass/fail condition. These error indications are cleared by pressing the Clear History soft key in the Measurements menu. The Tx column indicators display ON/OFF status for Alarm, Error, and Loop testing.

The remainder of the measurement display is used for setups, configurations, and measurement display, which changes with the selected function.

The T1 function hard key labels are: **Configuration**, **Pattern/Loop**, **Error/Alarm**, **Measurements,** and **Start/Stop**.

Getting Started

T1/T3 Mode

To prepare for T1 measurements, the MT8222A must be configured for T1 mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight **T1/T3 Analyzer** and then press the **Enter** key or the rotary knob to select this mode.

For additional information about the Mode menu, refer to *Mode Selector Menu* on page 2-16.

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* on page 2-5.

Testing T1 Circuits

T1 circuit testing can be performed with either of two methods: In-service and Out-of-service testing.

In-service testing is done during the routine maintenance and troubleshooting phase. This can be done on live data without removing the T1 circuit from service. Monitoring live data allows wireless service provider technicians to detect alarms, bipolar violations (BPV), and frame errors, but bit errors cannot be measured. Bit errors may, however, be estimated by measuring CRC errors or frame errors. For a step-by-step example of in-service testing, refer to *In-Service Measurements on page 15-11*.

Out of Service testing is done when the T1 circuit is initially installed and before final acceptance from the LEC. At that time, the circuit should be subjected to critical testing in order to guarantee the level of service per contract. Out of service testing may also be performed when the circuit performance is very poor. For a step-by-step example of out of service testing, refer to *Out-Of-Service Measurements on page 15-13*.

T1 Configuration Screen

Display the configuration screen by pressing the **Configuration** function hard key. This function is used to configure the **Signal Setup** and **Payload Setup**.

Signal Setup allows the user to set up the Test Mode, Line Code, Tx Clock, Tx LBO, Rx Input, and Framing information.

Payload Setup allows the user to configure the Payload Type, Payload DS1 Channel, Payload DS0 Channel, and Other Channels that are to be tested.

Soft keys for the T1 Configuration Menu are described in section *Configuration Menu* on page 15-19.

Signal Setup

Test Mode: AUTO, DS1, DS3

Displays the selected signal test mode.

DS1 sets the BTS Master in T1 testing mode. DS3 test mode is for testing T3/DS3 signals.

When AUTO is selected, the BTS Master first compares the connected signal with the current status of frame sync and pattern sync. If both are synchronized with the connected signal, then no further action is taken.

If the current mode is DS1, then when AUTO is pressed, the BTS Master first seeks the frame sync (ESF or SF-D4). If frame sync is found, then the Framing Mode is displayed in the instrument settings summary (at the left side of the data display area). Then the BTS Master seeks the pattern sync, stepping through all possible patterns. If pattern sync is found, then the Pattern is displayed in the instrument settings summary. The framing mode and pattern are thereby set, and the BTS Master is ready for use on the connected circuit.

For additional explanation of the use of this key, refer to section *AUTO Signal Setup Explanation* .

Line Code: B8ZS or AMI

B8ZS and Alternate Mark Inversion (AMI) are two different line coding formats that are used in T1 networks.

In the AMI format, a binary one is represented by a pulse, and a zero is indicated by the lack of a pulse. To eliminate any DC offset, the binary one pulses are bipolar (they alternate in polarity). Because the pulses are alternating in polarity, the line code is called Alternate Mark Inversion (AMI). If two consecutive pulses have the same polarity, then a Bipolar Violation (BPV) has occurred.

When no traffic is present on a channel, AMI coding can result in long strings of zeros on the circuit. These zeros can cause the receiving equipment to have timing errors. The method used in T1 systems to maintain the density of ones (as opposed to zeros) in the data stream is known as binary 8-zero substitution, or B8ZS. For the B8ZS scheme, any time that eight consecutive zeros are detected in the data stream, the transmitter substitutes a fixed pattern of ones, zeros, and BPVs in place of those 8 zeros. The BPV is used to distinguish between a real data sequence of ones and zeros versus the fixed B8ZS pattern. Because the B8ZS fixed pattern is a known pattern, the terminating receivers can recognize the pattern and substitute the original string of 8 zeros in place of the fixed pattern.

TxClock: Internal, External, Recovered

Internal Clock: The internal clock uses an internal oscillator: 1.544 Mbps ±5 ppm

Recovered Clock: The transmit clock uses the frequency recovered from the received signal.

External Clock: An external clock can be applied to the External Frequency Reference Input.

Tx LBO (Transmit Line Build Out): 0 dB, −7.5 dB, or −15 dB

Possible values for LBO are 0 dB, −7.5 dB, or −15 dB. When performing a test toward the far end of a circuit at a Digital System Cross-Connect (DSX), this will usually be 0 dB. The other values might be used when close to the equipment under test.

Rx Input: Terminate, Monitor, or Bridge

Terminate: Select Terminate for out-of-service testing. The signal is terminated with 100 ohms.

Monitor: The connection to the circuit is made through a monitor jack. The jack is isolated from the circuit with resistors, and the signal is typically 20 dB down from the nominal signal level. When Monitor is selected, 20 dB of flat gain is added at the receiver input.

Bridge: The input impedance of the receiver is greater than 1000 ohms. The bridged mode is used when connecting directly to an in-service T1, 1.544 MHz circuit in order to avoid causing a "hit" on the signal and to avoid disrupting service.

Framing: ESF or SF-D4

ESF: Extended Super Frame, in which 24 frames are grouped together as an Extended Super Frame (ESF).

SF-D4: Super Frame D4, in which 12 frames are grouped together as a Super Frame (SF).

Payload Setup

Payload Type: 1.544Mb, Nx64kb, 64kb, 56kb, 16kb, or 8kb

The Payload Type identifies which portion of the T1 data stream is to be tested.

1.544 Mb: Full T1 data stream test.

Nx64kb: Selected combinations of 64 kb channels are tested. This mode is referred to as fractional T1.

64kb: A single 64 kb channel is tested.

56kb: Data stream as a result of bit robbing.

16kb: 2 consecutive bits within a single 64 kb channel are tested.

8kb: A single bit within a selected 64 kb channel is tested.

Payload DS0 Channel: # (Number)

Set up the necessary channels and sub-channels when testing payloads Nx64kb to 8kb.

Other Channels: All ones or Idle

Set the other channels (that are not being tested) as IDLE or set them to All Ones.

T1 Pattern/Loop Screen

Access the test pattern screen by pressing the **Pattern/Loop** key, which includes 12 defined patterns and up to six user-defined patterns. The user-defined patterns can be created by pressing the Set User Pattern soft key. Refer to *Set User Pattern*.

The available patterns are: QRSS, PRBS-9(511), PRBS-11(2047), PRBS-15, PRBS-20, PRBS-23, All Ones, All Zeros, T1 Daly, 1 in 8, 2 in 8, 3 in 24, or one of six user-defined patterns (labeled User Pattern 1 through User Pattern 6). The defined patterns are listed in Table 15-1.

Inverse patterns can be used. Loop codes can be selected and used as loop up or loop down.

Soft keys for the Pattern/Loop Menu are described in section *Pattern/Loop Menu*

Table 15-1. Defined Test Patterns

Pattern	Description	Application
QRSS	1,048,575 bit pattern	Simulates live traffic including both high and low-density sequences
1 IN 8	Eight bit pattern of a 1 and 7 zeros	Checks clock recovery on circuits optioned for B8ZS
2 IN 8	Eight bit pattern of 2 ones and 6 zeros	Used to determine correct optioning of AMI or B8ZS line coding
3 IN 24	24 bit pattern with 3 ones and 15 consecutive zeros. 12.5% ones density	Stresses AMI optioned circuits for minimum ones density and maximum consecutive zeros performance. Forces zero substitutions in B8ZS optioned circuits
ALL ONES	All ones sent as payload in a framed sequence	Stresses ability of circuit to operate under maximum power conditions
ALL ZEROS	All zeros sent as payload in a framed sequence	Checks for B8ZS optioning. Circuit will drop if optioned for AMI
T1-DALY	Framed 55 octet sequence which changes rapidly from high to low density	Stresses timing recovery and ability of automatic line build out and equalizer circuits to respond quickly to changing ones density
PRBS-9 (511)	511 bit pseudo-random pattern	Test sub-rate DDS circuits operating below 56 kbps
PRBS-11 (2047)	2047 bit pseudo-random pattern	Test 56 kbps DDS circuits
PRBS-15	32,767 bit pseudo-random pattern. Generates up to 14 consecutive zeros and 15 consecutive ones	Tests to CCITT Recommendations O.151 and G.703. Provides maximum number of zeros for testing non-B8ZS circuits
PRBS-20	1,048,575 bit pseudo-random pattern Generates up to 19 consecutive zeros and 20 consecutive ones	Used to test synchronous T1 circuits only

Table 15-1. Defined Test Patterns

Pattern	Description	Application
PRBS-23	8,388,607 bit pseudo-random pattern Generates up to 22 consecutive zeros and 23 consecutive ones	Used to test synchronous T1 and T3 circuits

T1 Error/Alarm Screen

The Error/Alarm screen includes all of the errors and alarms that can be added to the transmission path. Press the **Error/Alarm** function hard key to display the Error/Alarm menu.

Soft keys for the Alarm/Error Menu are described in section *Error/Alarm Menu* .

Bit Error: Inserts errors in the BER pattern. Bit errors can be selected by pressing Bit Error. A burst between 1 and 1000 can be selected by pressing the Bit Error soft key. The Error Off/On soft key is used to turn the burst ON or OFF.

BER (Bit Error Rate): Errors can be added to the transmission path by pressing the BER soft key. Valid bit errors can be quickly set by pressing a preset soft key: 1E–2, 1E–3, 1E–4, 1E–5, 1E–6, and 1E–7. For preset BER rates, refer to Table 15-2. Pressing the Error Off/On soft key turns the error signal ON (keeps errors adding) or OFF (stops the errors).

Table 15-2. Bit Error Rates

BER Rate	Errors Inserted
1E–2	1 error is inserted for every 100 bits introduced
1E–3	1 error is inserted for every 1000 bits introduced
1E–4	1 error is inserted for every 10,000 bits introduced
1E–5	1 error is inserted for every 100,000 bits introduced
1E–6	1 error is inserted for every 1,000,000 bits introduced
1E–7	1 error is inserted for every 10,000,000 bits introduced

BPV: In a bipolar signal, this is a rule violation in which a 1 (mark or pulse) has the same polarity as the previous 1 (mark or pulse). A burst between 1 and 1000 can be selected by pressing the BPV soft key.

Frame Bit Error: Inserts errors in the framing bits. Frame Bit errors can be selected by pressing Frame Bit Error. A burst between 1 and 1000 can be selected by pressing the Burst soft key. The Error On/Off soft key is used to turn the burst ON or OFF.

AIS Alarm On/Off: When the AIS (Alarm Indication Signal) alarm is turned ON, the data is replaced with an unframed signal of all ones. AIS is also called the Blue Alarm.

RAI Alarm On/Off: When the RAI (Remote Alarm Indication) alarm is turned ON, a signal is transmitted from the terminal equipment in the outgoing direction when it determines that it has lost the incoming signal, or when it receives an AIS signal in the incoming direction. RAI is also called the Yellow Alarm.

Error Off/On: This soft key turns the error signal ON or OFF.

T1 Measurement Screen

BERT: Three different displays are available to view results. They are Table, Histogram, and Event List.

Rx Signal: Displays Rx Signal measurements.

VF: Displays VF level measurements. The sub menu allows setting channel number, transmit frequency, transmit level, and audio volume (of the BTS Master).

Measure Time: Sets the time period of testing, from 1 minute to 3 days.

Clear History: Clears the Event List and any of the red History indicators in the yellow highlighted area of the data display.

Save Results: This soft key opens the File menu. See *Spectrum Analyzer Mode File Menu on page 3-25*.

Soft keys for the Measurement Menu are described in section *Measurements Menu* on page 15-27.

Start/Stop Key

Press this function key to start or stop the measurement that is currently set up on the BTS Master.

In-Service Measurements

In service testing can be done only when the equipment has a test port. When testing a T1 circuit that is in service, the access to the circuit must be bridged or via a monitor port, in order to avoid disrupting service. Even when the T1 circuit is down, these tests will help to verify and identify the correct fault circuit. The following measurements can be used to check the T1 performance during regular maintenance:

- Vpp Measurement
- Carrier
- Frame Sync
- CRC Errors, for Extended Super Frame (ESF)
- BPV
- Frequency

Required Equipment

- MT8222A BTS Master with Option 53
- Bantam Cables, Anritsu Part Number 806-16

Measurement Setup Procedure

1. While in the T1/T3 Analyzer mode, press the **Configuration** function hard key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight **Test Mode** and select DS1.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight **Line Code** and press the B8ZS or AMI line coding soft key.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight **Tx Clock** and select Internal, Recovered, or External. For more **Tx Clock** information, refer to *TxClock: Internal, External, Recovered* .
5. Use the **Up/Down** arrow keys or the rotary knob to highlight **Rx Input** and press the Bridge or Monitor soft key, as appropriate for the connection.

> NOTE: If Monitor access is selected, 20 dB of gain is added to the receive path. The Bridge or Monitor selection must be made before the BTS Master is connected to the circuit.

6. Use the **Up/Down** arrow keys or the rotary knob to highlight **Framing** and press the ESF or SF-D4 framing soft key.

> NOTE: The setup parameters are displayed in the instrument settings summary on the left side of the screen. The status window on the top of the screen is always displayed.

7. Connect the Rx cable to one of the pairs.
8. Press the **Measurement** function hard key, then the BERT soft key, then the Table soft key. Press the **Start/Stop** function hard key to activate the measurement.
9. Verify Rx **Signal**, **Frame Sync**, **CRC**, and **BPV**.
10. Press Rx Signal (**Measurements** menu) and verify Vpp and Frequency. When very close to the Tx source, the signal should be between 4.8 Vpp and 7.2 Vpp. The frequency should be 1.544 MHz ±7.7 Hz (±5 ppm).
11. Move the Rx connection to the other pair on the circuit under text and then repeat the tests.

NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.

Figure 15-5. T1 Signal Setup for DS1

Vpp Measurement Procedure

This test measures the amplitude of the output signal from the PCM port to the DSX and receiving station. These measurements provide detailed information on the T1 circuit.

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the Rx Signal soft key to select the Vpp measurement.
3. Press the **Start/Stop** function hard key to activate the Vpp measurement.

NOTE: The Vpp measurement is displayed in both Vpp and dBdsx.

The Vpp should meet the criteria of the service provider. When very close to the transmitter, the signal level must be 4.8 to 7.2 Vpp. Further from the transmitter, the Vpp will be lower.

Figure 15-6. Vpp Measurement

VF, DS0 Test Procedure for In-Service Measurements

1. After the unit is correctly configured, press the **Measurements** function hard key and the VF soft key to activate the VF Measurements.
2. Press the Channel soft key and use the directional arrow keys, rotary knob, or key pad to enter the desired channel, then press **Enter**. The received VF level and frequency on the selected channel are displayed.
3. For audio monitoring, press the Audio soft key to toggle audio monitoring ON.

When a test tone is present on the channel, the level and frequency report will indicate whether the channel is healthy. If speech is present on the channel, then the channel performance can be judged from the audio quality.

Out-Of-Service Measurements

Out-of-service measurements are performed when the T1 circuit is not in service or is inactive. Typically these tests are done during initial installation, during circuit acceptance by the wireless service provider, or when the performance of the circuit is below acceptable levels.

Two methods of performing out-of-service testing are: end-to-end and loopback testing. End-to-end testing requires a technician and a unit at each end of the circuit. Loopback testing requires a loopback at one end of the circuit and a unit and technician at the other end to measure the round trip BER of the T1 circuit.

The ANSI T1 standard defines in-band and out-of-band loop codes. In-band codes are transmitted in place of payload data and are repeated continuously for a period of five seconds. They can be used either with SF D4 or ESF. Out-of-band loop codes can be used only with the ESF framing format, because an out-of-band communication link does not exist for SF D4.

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The following measurements can be used to check T1 performance during out of service testing:

- Vpp
- Carrier
- Frame Sync
- CRC Errors, for Extended Super Frame (ESF)
- BPV
- BER
- Frequency

Required Equipment

- MT8222A BTS Master with Option 53
- Bantam Cables, Anritsu Part Number 806-16 (2 cables required)

Measurement Setup Procedure

1. Press the **Configuration** function hard key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight **Line Code** and press the B8ZS or AMI coding soft key.
3. Select one of the three **Tx Clock** types: Internal, Recovered, or External.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight **Tx LBO** and select either the 0 dB, –7.5 dB, or –15 dB transmitter signal level soft key as appropriate to the measurement.
5. Use the **Up/Down** arrow keys or the rotary knob to highlight **Rx Input** and press the Terminate soft key.
6. Use the **Up/Down** arrow keys or the rotary knob to highlight **Framing** and press the ESF or SF-D4 soft key as appropriate for the measurement.
7. Press the **Pattern/Loop** function hard key to activate the pattern and loop code menu.
8. Press the Select Pattern soft key, use the **Up/Down** arrow keys, or use the rotary knob to highlight the appropriate pattern, and press the Select Pattern soft key or press **Enter**. The selected pattern can be reversed (only supported for PRBS patterns) by pressing the Inverse Pattern soft key.

> NOTE: Up to six user-defined patterns can be created by pressing the Set User Pattern soft key and pressing the User-Pat 1 through User-Pat 6 soft keys. Use the **Up/Down** arrow keys, rotary knob, or key pad to enter the desired pattern. Table 15-1 on page 15-7 summarizes the T1 patterns that are available in the MT8222A.

9. Connect the Tx and Rx ports to the circuit under test.
10. Verify carrier and frame sync before proceeding.

Activate Remote Loop Up and Loop Down Code

1. Press the **Pattern/Loop** function hard key to activate the pattern and loop code menus.
2. Press the Select Loop Code soft key to display the Loop menu. Press either the CSU or the NIU soft key.
3. Select either In-Band or Data Link by toggling the Link Type soft key. (This selection is for ESF only.) Press Back to return to the previous menu.

> NOTE: Custom user-defined codes can be created by pressing the Loop Code User 1 or Loop Code User 2 soft key and using the **Up/Down** arrow keys, rotary knob, or key pad to enter the desired loop code.

4. Press the Remote Loop Up soft key to activate the Loop Code.
5. Press the Remote Loop Down soft key to deactivate the Loop Code.

> NOTE: The current setup parameters are displayed in the instrument settings summary table on the left side of the screen.

To Set Errors/Alarms

1. Press the **Error/Alarm** function hard key to activate the Error/Alarm menu.
2. Press the Bit Error, BER, BPV, or Frame Bit Error soft key, as applicable to the measurement.
3. Press the AIS Alarm or RAI Alarm soft key. These two soft key toggle between ON and OFF. The alarm status is displayed in the yellow highlighted area of the upper part of the measurement data display.

Vpp and Frequency Measurement Procedure

This test measures the amplitude of the output signal from the PCM port at the DSX (Digital System Cross-Connect) and receiving station.

4. Press the **Measurements** function hard key to activate the Measurements menu.
5. Press the Rx Signal soft key to activate the Vpp measurement.

> NOTE: The Vpp measurement is displayed in both Vpp and dBdsx.

The Vpp should meet the criteria of the service provider. When very close to the transmitter, the signal level must be 4.8 to 7.2 Vpp. Further from the transmitter, the Vpp will be lower. Figure 15-7 shows a typical Vpp measurement display (which may not be the same as shown on your instrument). The frequency should be 1.544 MHz ±5 ppm.

If the measurement meets the customer requirements for this system, then proceed to the BERT measurement.
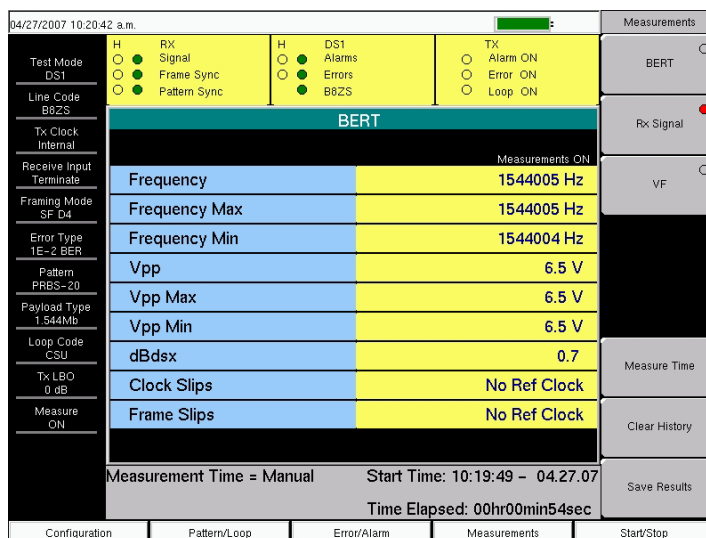
Figure 15-7. Vpp Out-of-Service Measurement

BERT Measurement Procedure

Basic BERT Measurement Procedure

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the BERT soft key to activate the BERT menu.
3. Press the Table soft key to display the measurements in table format, or press Histogram or Event List.
4. From the BERT menu, press the Back soft key. Then from the Measurements menu, press the Measure Time soft key and use the **Up/Down** arrow keys, rotary knob, or key pad to enter the duration of the measurement. Then press **Enter**.
5. Press the **Start/Stop** function hard key to start and stop the measurement.

NOTE: The measurement time is set in the Measure Time menu (1 min, 3 min, 5 min, 15 min, 30 min, 1 hour, 2 hours, 3 hours, 1 day, 2 days, 3 days, or Manual). Manual runs indefinitely and allows the user to terminate the measurement at any time.

Soft keys for the BERT menu are described in section *Measurements Menu* .

Quick Check

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the BERT soft key to activate the BERT menu.
3. Press the Table soft key to display the measurements in the table format.
4. Press the **Start/Stop** function hard key to activate the measurements. To stop the measurements, press the **Start/Stop** key again.
5. If the results are within specifications, then **RESULTS OK** is displayed in a green box at the center of the screen. If any errors occur, then the errors/measurement results are displayed in the table..

NOTE: **RESULTS OK** can be cleared by pressing **Esc**.

Histogram Display

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the BERT soft key to activate the BERT menu.
3. Press the Histogram soft key to display the data in histogram format.
4. Press the Histogram soft key again to configure the histogram parameters, which are Zoom, Window Size, and Time Units.
5. Press the **Start/Stop** function hard key to activate the measurement.

To Insert Errors/Alarms

1. Press the **Error/Alarm** function hard key to activate the Error/Alarm menu.
2. Press the Error Off/On soft key to toggle the selected error type ON. Confirm that <u>On</u> is underlined. (Press the Error Off/On soft key to turn OFF the errors.)

Event List

The BERT measurement **Event List** updates errors, signal loss, frame loss, and alarms (AIS ON, AIS OFF, RAI ON, and RAI OFF) every second. The data is displayed as a log list.

DS0 Testing

The DS0 test feature enables testing on each of the 24 channels of the T1 line. The receive channel is decoded, and the VF level and frequency are measured and displayed. The signal is also connected to a speaker, enabling the testing technician to make an audible assessment of the signal quality of the circuit. If the circuit is out of service, the tester can insert a test tone on the transmit channel for measurement either at a remote location with another test set, or locally with a loopback. VF is displayed above 100 Hz and up to 3000 Hz.

Measuring Clock and Frame Slips in T1/T3 Analyzer Mode

If a T1 - 1.544 Mb/s BITS (Building Integrated Timing Source) reference clock is available, then it can be used to measure clock slips and frame slips on the circuit under test. If two or more T1 - 1.544 Mb/s circuits are present, then one of these can be used as a reference. The reference circuit (in this configuration) should be out of service because it will be terminated by the clock recovery circuit in the BTS Master.

To count clock slips, connect the reference clock to the Ext Ref In connector on the BTS Master. The presence of the clock is automatically detected, and when a measurement is started, the number of clock slips and frame slips are reported. When the clock frequencies are very close, the clock slip count will hover around zero. If the frequency of the circuit under test is higher than the reference frequency, then the count will grow positive. If the frequency of the circuit under test is lower than the reference frequency, then the count will grow negative. One frame slip is counted for 193 clock slips.

Figure 15-8. Histogram Display

Histogram Explanations

Data Resolution

If data resolution is set to a small value, then you can zoom in to see in detail when faults have occurred. However, small resolution takes up larger file sizes when saved. The maximum number of records is capped at 86,400, so if the user is interested in history longer than one day, then the resolution must be set higher than one second. If the data resolution is changed, then the entire histogram must be reset.

Display Window

The display window is the length of time shown on the histogram screen. More data may be stored than is shown. This parameter allows a user to zoom in or zoom out to see either more time on the screen or more resolution. The minimum and maximum values are based upon the data resolution.

Turning the rotary knob while in the Histogram view scrolls a vertical yellow marker line across the histogram graph.

Time Offset

Time offset is the offset in time of the right side of the screen from the start of the measurement. The screen may be moved left or right with this parameter. Using this feature together with a small display window provides the ability to zoom in on an event that happened some time in the past.

Time Units

If Relative is selected (underlined), then the histogram axis will be labeled with time since the start of the measurement record.

If Absolute is selected, then the histogram axis will be labeled with absolute times that are based on the system clock.

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Soft Key Menus

Configuration Menu

DS1

Signal Setup   Payload Setup

Test Mode	Tx LBO	Payload Type	Payload DS0 Channel
AUTO	0 dB	1.544Mb	Edit
DS1	– 7.5 dB	Nx64kb	**Other Channels**
DS3	– 15 dB	64kb	All ones

Line Code	Rx Input		Idle
B8ZS	Terminate	56kb	
AMI	Monitor	16kb	
	Bridge	8kb	

Tx Clock	
Internal	
Recovered	Framing
External	ESF
	SF–D4

Figure 15-9. T1 Configuration Soft Key Menus

Signal Setup

Test Mode

Select from one of three soft keys for the type of test mode desired.

AUTO
Press this soft key to automatically select a Framing Mode and Pattern to match the connected signal. For additional explanation of the use of this key, refer to section *AUTO Signal Setup Explanation* .

DS1
Press this soft key for T1 testing.

DS3
Press this soft key for T3 testing.

Line Code

Select either AMI or B8ZS line code format. For additional information, refer to section *Line Code: B8ZS or AMI* on page 15-5.

B8ZS
Press this soft key for B8ZS.

AMI
Press this soft key for AMI.

Tx Clock

Internal
Press this soft key to use an internal clock, for testing toward the equipment at the local site.

Recovered
Press this soft key when you want the transmit clock to use the frequency that is recovered from the received signal.

External
Press this soft key to use an external reference clock.

Tx LBO

0 dB, −7.5 dB, or −15 dB
Press one of these soft keys depending upon whether you are testing toward local equipment or toward the far end of a circuit. For additional information, refer to section *Tx LBO* on page 15-6.

Rx Input

Terminate
Press this soft key to terminate the circuit in 100 ohms.

Monitor
Press this soft key to perform a monitor test by using the monitor jack at a DSX. This selection properly terminates the signal coming from the DSX monitor jack and compensates for the 20 dB loss found at that jack.

Bridge
Press this soft key to connect to the circuit with >1000 ohms.

Framing

ESF
Press this soft key for Extended Super Frame format.

SF−D4
Press this soft key for Super Frame D4 format.

Payload Setup

Payload Type

The payload type identifies which portion of the T1 data stream is to be accessed for testing. For additional information, refer to section *Payload Setup* on page 15-6.

Payload DS0 Channel

Edit

Press this soft key to set up the necessary channels and sub-channels when testing payloads Nx64kb through 8kb.

Other Channels

All ones

Press this soft key to set channels that are not being tested to contain all ones (no zeros).

Idle

Press this soft key to set channels that are not being tested to be idle.
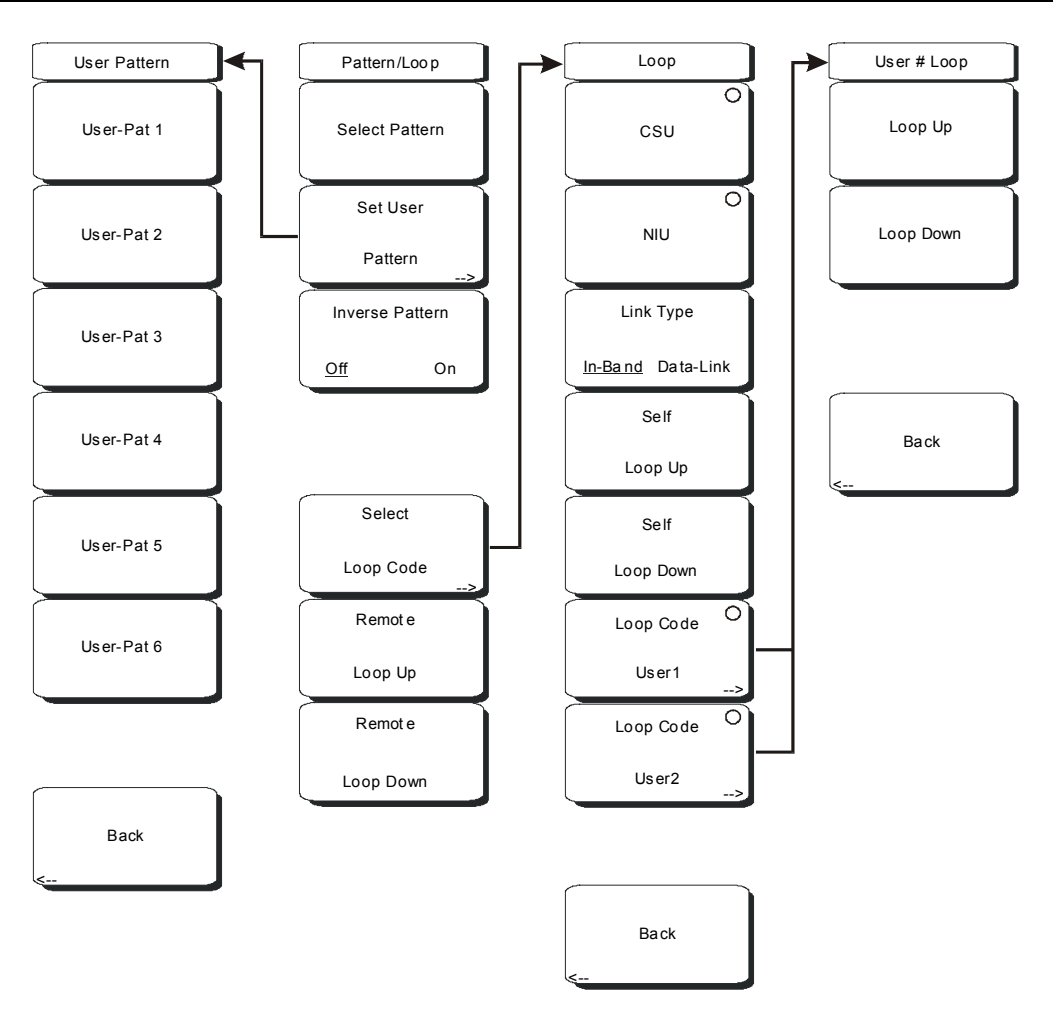
Figure 15-10. T1 Pattern/Loop Menu

Select Pattern
After highlighting a pattern, press this soft key to select the highlighted pattern.

Set User Pattern
Use this soft key to set a specific user pattern in one or more of the six available user patterns.

User-Pat #
These six soft keys each select a different user pattern. Set the patterns by entering zeros or ones, up to a maximum of 24 bits. Press **Enter** to continue or **Esc** to abort.

Inverse Pattern, Off/On
This soft key toggles the Inverse Pattern function OFF and ON. The inverse pattern function is supported only for PRBS patterns.

Select Loop Code
This soft key opens the Loop soft key menu, from which you can select 1 of 7 loop configurations.

CSU
Press this soft key to select CSU (Channel Service Unit) codes.

NIU
Press this soft key to select NIU (Network Interface Unit) codes.

Link Type
Press this soft key to toggle between In-Band and Data-Link. Use Data-Link when framing is ESF.

Self Loop Up
Press this soft key to activate internal loop back.

Self Loop Down
Press this soft key to deactivate internal loop back, reverting the MT8222A to a through mode.

Loop Code User1 and Loop Code User2
Press one of these soft keys to set the user Loop Up and Loop Down codes.

Figure 15-11. T1 Error/Alarm Menu

When not active, some soft keys have no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when these soft keys are active.

Bit Error
Use this soft key to insert a bit error. Press this soft key once to select the function. Press the key again to display the Bit Error soft key menu. The "Error Type" field in the instrument settings summary table at the left side of the measurement display changes to "### BIT", where ### is the burst setting.

Burst

A burst can contain from 1 to 1000 errors. Set this parameter by pressing the Burst soft key and then using the rotary knob, arrow keys, or number keypad. The following text appears in red at the top of the BERT table: **Bit Error Insert ###**. The number digits appear as they are pressed on the number keypad. Then press the rotary knob or the **Enter** key. If you use the number keypad to enter the burst setting, then the Burst soft key label changes to Enter. The soft key can be used to enter the parameter value.

Back: Press this soft key to return to the Error/Alarm menu.

BER

Errors can be added to the transmission path by pressing the BER soft key. Valid BER include 1E–2, 1E–3, 1E–4, 1E–5, 1E–6, and 1E–7. If a BER value of 1E–3 is selected, then 1 error will be introduced for every 1000 bits in the transmission path. Pressing ON keeps adding errors. Pressing OFF stops the errors. Press this soft key once to select the function. The "Error Type" field in the instrument settings summary table at the left side of the measurement display changes to "1E–# BER", where # indicates the bit error rate setting. Press the key again to display the Bit Error Rate soft key menu. Choose from the six rate options and press Back to continue.

Bit Error Rate Menu

Rate 1E–#

These six soft keys are labeled with number 1E–2 through number 1E–7. Use these soft keys to select a bit error rate.

Back

Press this soft key to return to the Error/Alarm menu.

BPV

Use this soft key to configure error bits for bipolar violation testing. Press this soft key once to select the function. The "Error Type" field in the instrument settings summary table at the left side of the measurement display changes to "### BPV", where ### is the burst setting. Press the key again to set the Burst rate. See *Burst on page 15-25*. Press the Back soft key to return to the Error/Alarm menu.

Frame Bit Error

Use this soft key to insert a frame bit error. Press this soft key once to select the function. The "Error Type" field in the instrument settings summary table at the left side of the measurement display changes to "### FRAME", where ### is the burst setting. Press the key again to enter the Frame Bit Error menu and set the burst rate. See *Burst on page 15-25*. Press the Back soft key to return to the Error/Alarm menu.

AIS Alarm On/Off

When the AIS is turned ON, the data is replaced with an unframed signal of all ones. Press this soft key to turn ON the AIS Alarm function. The "Error Type" field in the instrument settings summary table at the left side of the measurement display changes to "Error Type AIS". The Alarm ON circle indicator (in the yellow TX portion of the upper part of the measurement data display) is displayed in red when this parameter is ON. Selecting this function automatically turns the Error, Off/On soft key function to OFF, and its circle indicator (in the yellow TX portion of the upper display) is displayed as an open circle. Pressing this soft again turns the alarm OFF, its circle indicator is displayed as an open circle, and the Bit Error soft key becomes active (its circle indicator is displayed in red).

RAI Alarm On/Off

If the terminal loses its incoming signal, then an RAI signal is transmitted in the outgoing direction. RAI is also called Yellow Alarm. Press this soft key to turn ON the RAI Alarm function. The "Error Type" field in the instrument settings summary table at the left side of the measurement display changes to "Error Type AIS". The Alarm ON circle indicator (in the yellow TX portion of the upper part of the measurement data display) is displayed in red when this parameter is ON. Selecting this function automatically turns the Error, Off/On soft key function to OFF, and its circle indicator (in the yellow TX portion of the upper display) is displayed as an open circle. Pressing this soft again turns the alarm Off, its circle indicator is displayed as an open circle, and the Bit Error soft key becomes active (its circle indicator is displayed in red).

Error, Off/On

This soft key is active only when the BER soft key is active. Press this soft key to toggle Error Off and On. The Error ON circle indicator (in the yellow TX portion of the upper display) is displayed in green when this parameter is ON.

Measurements Menu

Figure 15-12. T1 Measurements Menu

When not active, some soft keys have no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when these soft keys are active.

BERT

Press this soft key to open the BERT soft key menu and select the display type for viewing test results, choosing from: Table, Histogram, or Event List.

Table

Press this soft key to view test results in table format.

Histogram

Press this soft key to view test results in the histogram screen display. Press the soft key again to configure the histogram screen.

Zoom In

Use this soft key to change the graph display width to a smaller value. The graphical display units are described in the Window Size soft key description.

Zoom Out

Use this soft key to change the graph display width to a larger value. The graphical display units are described in the Window Size soft key description.

Window Size, ##:##:##

This soft key displays the time units in the format 0d:00:00:00, in days, hours, minutes, and seconds (0d:HH:MM:SS). Seconds are 00 by default and cannot be changed. When the setting is less than 1 day, the day units are not shown, and the format is 00:00:00 (HH:MM:SS).

Setting the time sets a display graph width of 1, 5, or 15 minutes; 1, 6, or 12 hours; or 1, 2, or 3 days. When pressed, the soft key color changes to a darker background, and the numeric value is displayed in red. The labels (Display Window ##:##:00) in the graph area of the display are also in red. The red color indicates that the time is being changed. The red label at the top line of the histogram and the one below the histogram remain red while the value is open to change. When the numeric value has been set, the upper label is removed, and the lower label changes to plain text, showing the setting.

Use the arrow keys to change the values from 1 minute to 3 days in the 9 increments that are available. The value can also be set by using the number keys. Press an appropriate number or numbers, and the soft key menu changes to time increments: days, hours, minutes, seconds. For example, entering 3600 and pressing seconds sets the display width to 1 hour, and entering 3601 and pressing seconds sets the display width to 6 hours (the next available increment).

Figure 15-13. Histogram Window Size Time Units

Press the desired time units soft key to enter the time value in days, hours, or minutes (seconds, for example, can be used in multiples for any of the discrete hour, minute, or day settings, but the number of seconds in the final setting are always 00). The Window Size soft key remains active (available for change) until you press the **Enter** key or the Rotary Knob.

Turning the rotary knob while in the Histogram view scrolls a vertical yellow marker line across the histogram graph.

Time Units, Relative or Absolute

This soft keys toggles between Relative and Absolute time. The units are displayed at the bottom edge of the histogram.

Back

Press this soft key to return to the BERT menu.

Event List

Press this soft key to view test results in the Event List format.

Clear History

Press this soft key to clear any red History indicators in the yellow-highlighted, upper portion of the measurement display.

Back

Press this soft key to return to the Measurements menu.

Rx Signal

Press this soft key to display Rx Signal measurements.

VF

Press this soft key to display VF level measurements. Press the soft key again to open the VF menu for configuration.

Transmit, Off/On

This soft key toggles Transmit OFF and ON.

Channel

This soft key opens a dialog box to select a channel value from 1 (minimum) to 24 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value, and then press **Enter** to continue, or press **Esc** to abort.

Tx Frequency

This soft key opens a dialog box to select a frequency from 100 Hz (minimum) to 3000 Hz (maximum). Use the numeric keys to enter a value, or use the arrow keys or the rotary knob to select a default value, and then press **Enter** to continue, or press **Esc** to abort.

Tx Level

This soft key opens a dialog box to select a Tx Level from −30 dBm (minimum) to 0 dBm (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value, and then press **Enter** to continue, or press **Esc** to abort.

Volume

This soft key opens a dialog box to set the volume from 0 (minimum) to 90 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value in increments of 5, and then press **Enter** to continue, or press **Esc** to abort.

Audio, Off/On

This soft key toggles Audio OFF and ON.

Clear History

Press this soft key to clear any red History indicators in the yellow-highlighted, upper portion of the measurement display.

Back

Press this soft key to return to the Measurements soft key menu.

Measure Time

This soft key opens a dialog box to set the measurement time. Choose from 12 settings, which range from 1 minute (minimum) to 3 days (maximum). You can also choose Manual, which runs any length of time, indefinitely, until the **Stop/Start** function hard key is pressed. Use the arrow keys or the rotary knob to enter a value, and then press **Enter** or the Rotary Knob to continue, or press **Esc** to abort.

Clear History

Press this soft key to erase the history of displayed events and measurements. Also, clears any red History indicators in the yellow-highlighted, upper portion of the measurement display.

Save Results

Press this soft key to save the results of a measurement. See *File on page 3-25*.

T3 Fundamentals

A T3 circuit (also referred to as a DS3 circuit) is formed by multiplexing together 28 T1 signals in a two-step process. In the first stage of the two-step process, 4 T1 (DS1) signals are combined to form a T2 (DS2) signal. Overhead bits are interleaved with the user data to enable framing. Stuff bits are also added to each of the T1 signals to compensate for differences in frequency. Seven T2 signals are then combined to form a T3 signal. Overhead bits are interleaved with the T2 data for framing and error detection at the T3 level.

Two methods are used for combining the seven T2 signals. One method is called M13 framing, and the other method is called C-bit framing.

M13 Framing

M13 multiplexers perform bit stuffing when forming the DS2 signals from the DS1 signals. The DS2 signals that are formed in this manner are synchronous to each other, but the M13 framing assumes that the T2 signals are asynchronous and also uses all 21 DS3 C-bits for bit stuffing control. This second stage of bit stuffing is not strictly necessary.

C-bit Framing

The second method is called C-bit framing, and assumes that the T2 signals are synchronous. The C-bit parity format does not use the DS3-level C-bits for bit stuffing control. With C-bit framing, the bits that were used by M13 framing to control stuffing are instead used for other functions.

With M13 framing, two of the overhead bits (called P-bits) are used for a parity check. If the parity of the P-bits does not match the parity of the data, then a P-bit error is reported. The parity calculation is repeated on each section of the circuit, so P-bit errors cannot be used to assess the health of the circuit from end to end.

With C-bit framing, the DS3-level overhead bits (that were not used for bit stuffing) are used for other functions, including a C-bit parity check, a Far End Block Error (FEBE) report, and a Far End Alarm and Control (FEAC) channel. The C-bit parity bits are set at the originating equipment and are not modified by intervening equipment. They therefore provide an end-to-end parity check. When the receiving equipment detects a C-bit parity error, it sends an error report back to the originating equipment in the FEBE channel. The FEAC channel is used to report alarm and status information from the far-end terminal to the near-end terminal.

DS3 Path Parity Bits: The three C-bits in subframe 3 of the DS3 signal (which are designated CP-bits) are used to carry the DS3 path parity information. At the DS3 terminal equipment (TE) transmitter, the CP-bits are set to the same value as the two P-bits. Because the CP-bits will pass through the network unchanged (except in the case of errors), the DS3 TE receiver can determine if an error occurred in an M-frame by computing the parity based upon the contents of the given M-frame and then comparing this parity value with the parity received in the CP-bits in the following M-frame.

Far-End Block Error (FEBE) Function

The FEBE function uses the three C-bits in subframe 4 of the DS3 signal. This is illustrated in the following example (refer to Figure 15-14):

The near-end terminal equipment (TE) continuously monitors its incoming direction of transmission (west-bound in Figure 15-14) for the occurrence of a framing or parity error event. Upon detecting a framing or parity error event via the west-bound CP-bits, the near-end TE will count the event as a C-bit parity error, and indicate (via the east-bound FEBE bits) to the far-end TE that an error has occurred. The C-bit parity error is indicated via the east-bound FEBE bits by setting the three FEBE bits to "000" in order to indicate the error. The three FEBE bits are set to "111" if no parity error event has occurred. Because the DS3 terminal equipment (TE) monitors both the CP-bits and FEBE bits (as well as the FEAC channel), the overall performance of the DS3 path can be determined at either end of the path for both directions of transmission.
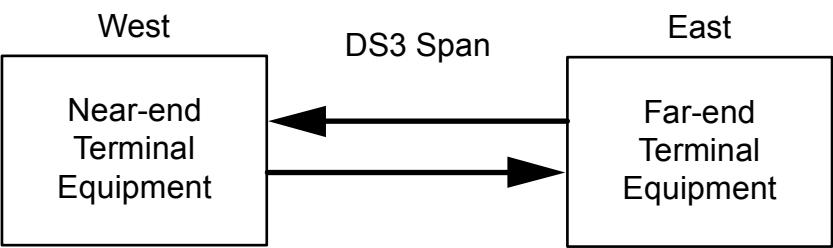
Figure 15-14. DS3 Far-End Block Error (FEBE)

T3 Display

The T3 data display area includes the real time clock and the GPS and battery indicators (at the top), the measurement data (in the middle), the instrument settings summary (at the left side), the soft key labels (at the right side), and the hard key labels (at the bottom). The soft key labels vary in relation to the function hard key selection.

The instrument settings summary shows the status of the T3 configuration, including: Test Mode, Line Coding, Clock Source, Receive Input, Framing Mode, Error Insert, Pattern, Payload Type, Loopback Type, LBO Select, and Measure.

The upper part of the measurement data display has an area that is highlighted in yellow, which reports historical and current pass/fail conditions for parameters relating to Rx (Receive), DS3, DS1, and Insert testing. See Figure 15-15 for an example of this display when testing DS1 from DS3. For Rx, the parameters are Signal, Frame Sync, and Pattern Sync. For DS3, the parameters are Alarms, Errors, and B3ZS. For DS1, the parameters are Alarms, Errors, and B8ZS. For Insert, the parameters are Alarm ON, Error ON, and Loop ON.
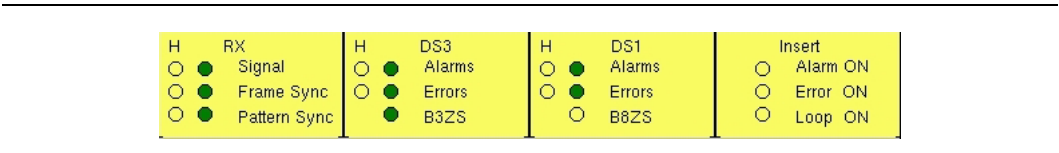
Figure 15-15. T3 Parameters for Historical and Pass/Fail Conditions

The columns of historical data (for Rx, DS3, and DS1) are labeled with an H. The adjacent columns display current (present time) conditions. The B3ZS indicator for DS3 displays only the current condition (no historical data). The H indicators turn red when an error has occurred previous to the current pass/fail condition. These history error indications are cleared by pressing the Clear History soft key in the Measurements menu. The Insert column indicators display ON/OFF status for Alarm, Error, and Loop testing. Two views are presented for this status window: DS3 with DS3 full payload, and DS3 with DS1 payload. The B8ZS light is OFF in this configuration (as shown in Figure 15-15) because the DS3 signal does not use B8ZS encoding. Compare this with Figure 15-4 on page 15-3, which is for DS1 only.

The remainder of the measurement display is used for set ups, configurations, and measurement display, which changes with the selected function.

The T3 function hard key labels are: **Configuration**, **Pattern/Loop**, **Error/Alarm**, **Measurements,** and **Start/Stop**.

T3 Configuration Screen

The configuration screen is accessed by pressing the Configuration function hard key. This menu is used to configure the Signal Setup and the Payload Setup. The Signal Setup allows the user to set up the Test Mode, Line Code, Tx Clock, Tx LBO, Rx Input, and Framing information. The Payload Setup allows the user to set up the Payload Type, Payload DS1 Channel, Payload DS0 Channel, Payload Frame, and Other Channels.

Soft keys for the Configuration/Test Mode Menu are described in section *Configuration Menu* on page 15-39.

Test Mode: Auto, DS1, or DS3

For an explanation of the use of the AUTO soft key, refer to section *AUTO Signal Setup Explanation* on page 15-60.

Pressing the DS3 soft key sets the BTS Master in T3 testing mode. The DS1 soft key is for T1/DS1 signals only and is not appropriate for testing DS3 signals.

Line Code: B3ZS and AMI

B3ZS and Alternate Mark Inversion (AMI) are two different line coding formats that are used in T3 networks.

In the AMI format, a binary one is represented by a pulse, and a zero is indicated by the lack of a pulse. To eliminate any DC offset, the binary one pulses alternate in polarity. Because the pulses are alternating in polarity, the line code is called Alternate Mark Inversion (AMI). If two consecutive pulses have the same polarity, then a Bipolar Violation (BPV) has occurred.

When no traffic is present on a channel, AMI coding can result in long strings of zeros on the circuit. These zeros can cause the receiving equipment to have timing errors. The method used in T3 systems to maintain the density of ones (as opposed to zeros) in the data stream is known as binary 3-zero substitution, or B3ZS.

B3ZS (Bipolar 3-Zero Substitution) is a line code in which bipolar violations (BPV) are deliberately inserted if the stream of user data contains strings of 3 or more consecutive zeros. It is used to ensure that the system has a sufficient number of bipolar transitions to maintain system synchronization when the user data stream contains an insufficient number of ones to do so. Compare this with B8ZS, *Line Code: B8ZS or AMI* on page 15-5.

Tx Clock: Internal or Recovered

The Internal clock uses an internal oscillator, 44.736 Mbps ±5 ppm. With Recovered clock, the transmit clock uses the frequency that is recovered from the received signal.

Tx LBO: Low or DSX

Tx LBO sets the Tx signal level. Select Low when testing the signal near the receiving equipment (less than 225 feet), and select DSX when testing from more than 225 feet.

Rx Input: DSX3 or Monitor

Select DSX3 for testing at the cross-connect point of a T3 line. Select Monitor when the connection to the circuit is made through a monitor jack. The jack is isolated from the circuit with resistors, and the signal is typically 20 dB down from the nominal signal level. When Monitor is selected, 20 dB of flat gain is added at the receiver input.

Framing: M13, C-Bit, or Unframed

Select M13, C-bit, or Unframed, as required.

Payload Type: 45Mb, 1.544Mb, Nx64kb, 64kb, 56kb, 16kb, or 8kb

The Payload Type identifies which portion of the T3 data stream is to be accessed for testing.

Payload Type 45Mb is selected for testing a full T3 data stream. 1.544Mb is selected for testing 1 channel of the 28 DS1 channels. Nx64kb is selected for testing combinations of 64 kb channels. 64kb is selected for testing a single 64 kb channel. 56kb is selected when the data stream is created as a result of bit robbing. 16kb is selected for testing 2 consecutive bits within a single 64 kb channel. 8kb is selected for testing a single bit within a selected 64 kb channel.

Payload DS1 Channel

Uses the Edit Channel soft key to set up the necessary channels and sub-channels, selecting 1 of 28 DS1 channels.

Payload DS0 Channel

Uses the Edit Channel soft key to set up the necessary channels and sub-channels when testing payloads Nx64kb to 8kb.

Payload Frame: ESF or SF-D4

Set the payload frame for either ESF or SF-D4.

Other Channels: All ones, Broadcast, or AIS

Set the other channels (that are not being tested) to All Ones, Broadcast, or AIS.

Pattern/Loop Menu

The Pattern/Loop menu includes 12 defined patterns (refer to Table 15-3). Up to 6 user-defined patterns can be created by pressing the Set User Pattern soft key.

Use this function to select a pattern, to set and select a user pattern, to use an inverse pattern, to select a loop code, or to loop up or loop down.

Soft keys for the Pattern/Loop Menu are described in section *Pattern/Loop Menu – Part 1* .

Table 15-3. Pattern Descriptions and Applications

Pattern	Description	Application
QRSS	1,048,575 bit pattern	Simulates live traffic including both high and low-density sequences
1 IN 8	Eight bit pattern of a 1 and 7 zeros	Checks clock recovery on circuits optioned for B3ZS
2 IN 8	Eight bit pattern of two ones and 6 zeros	Used to determine correct optioning of AMI or B3ZS line coding
3 IN 24	24 bit pattern with 3 ones and 15 consecutive zeros. 12.5% ones density	Stresses AMI optioned circuits for minimum ones density and maximum consecutive zeros performance. Forces zero substitutions in B3ZS optioned circuits
ALL ONES	All ones sent as payload in a framed sequence	Stresses ability of circuit to operate under maximum power conditions
ALL ZEROS	All zeros sent as payload in a framed sequence	Checks for B3ZS optioning. Circuit will drop if optioned for AMI
1010	Alternating 1s and 0s	Stresses ability of circuit to operate under 50% power conditions
PRBS-9 (511)	511 bit pseudo-random pattern	Test sub-rate DDS circuits operating below 56 kbps
PRBS-11 (2047)	2047 bit pseudo-random pattern	Test 56 kbps DDS circuits
PRBS-15	32,767 bit pseudo-random pattern. Generates up to 14 consecutive zeros and 15 consecutive ones	Tests to CCITT Recommendations O.151 and G.703. Provides maximum number of zeros for testing non-B8ZS circuits
PRBS-20	1,048,575 bit pseudo-random pattern Generates up to 19 consecutive zeros and 20 consecutive ones	Used to test synchronous T1 circuits only
PRBS-23	8,388,607 bit pseudo-random pattern Generates up to 22 consecutive zeros and 23 consecutive ones	Used to test synchronous T1 and T3 circuits

Error/Alarm Menu

The Error/Alarm menu includes all of the errors and alarms that can be added to the transmission path. Press the **Error/Alarm** key to access the menu.

Soft keys for the Error/Alarm Menu are described in section *Error/Alarm Menu* on page 15-46.

To add an error to the transmission path, press Error Ins Setup to choose an error type. For example, press DS3 Frame Bit Error to insert errors into the framing bits. A burst between 1 and 1000 can be selected by pressing the DS3 Frame Bit Error soft key again and then the Burst soft key. After the burst size is set, the Error Insert On/Off soft key is used to turn the burst on.

Valid BER (Bit Error Rate) can be quickly set by pressing a preset soft key: 1E–2, 1E–3, 1E–4, 1E–5, 1E–6, and 1E–7. For preset BER rates, refer to Table 15-2 on page 15-9. Pressing Error Insert On keeps errors adding. Pressing Error Insert Off stops the errors.

To add an alarm to the transmission path, press Alarm Ins Setup to choose an alarm type. For example, press DS3 AIS Alarm and then press Alarm Insert Off/On until "On" is underlined. Data is replaced with the AIS alarm signal.

DS3 AIS (Alarm Indication Signal) Alarm: When the AIS is turned ON, the data is replaced with properly framed `1010...` pattern.

DS3 RAI (Remote Alarm Indication) Alarm: The remote alarm indication is a signal that is transmitted from the terminal equipment in the outgoing direction when it determines that it has lost the incoming signal, or when it receives an AIS signal in the incoming direction.

DS3 Idle Alarm: When Idle Alarm is pressed, the data is replaced with a properly framed `1100...` pattern.

Measurement Screen

Soft keys for the Measurement Menu are described in section *Measurements Menu for DS3 with DS1 Payload* on page 15-50.

BERT: Three different displays are available to view results: Table (DS1 or DS3), Histogram, and Event List:

Rx Signal: Displays Rx Signal measurements.

VF: Displays VF level measurements. Press the soft key a second time to select Channel number, Tx Frequency, Tx Level, and Volume.

Measure Time: Set up the measurement time period from 1 minute minimum to 3 days maximum.

Clear History: Clears the Event List and any of the red History indicators in the yellow highlighted area of the upper measurement display. History is updated each second.

BERT Histogram Display

Histogram Settings, Zoom In and Zoom Out

The zoom in and zoom out features can be used to change the resolution of the data in the histogram display at the cursor location. When the cursor passes the 10% and 90% time points of the histogram display, the time window starts scrolling back in time or ahead in time. If you need to see a detailed view of a fault occurrence, then you can use the Zoom In function to change the resolution to as small as 5 seconds per division. Maximum window size is 72 hours (6 hours/div). When more than 72 hours of data are collected, the last 72 hours are shown.

Window Size

The window size adjusts the length of time that is shown on the histogram screen. More data may be stored than is shown. This parameter allows you to zoom in or zoom out to see either more time on the screen or more resolution. The minimum (1 minute) window size value and maximum (3 days) window size value are based upon the data resolution that is selected with the zoom in and zoom out features.

Turning the rotary knob while in the Histogram view scrolls a vertical yellow marker line across the histogram graph.

Time Units

If Relative is selected (underlined on the soft key label), then the histogram axis is labeled with time since the start of the measurement record. If Absolute is selected, then the histogram axis is labeled with absolute times based upon the system clock.

Start/Stop Key

Press this function key to start or stop the measurement that is currently set up on the BTS Master.

Soft Key Menus

Configuration Menu
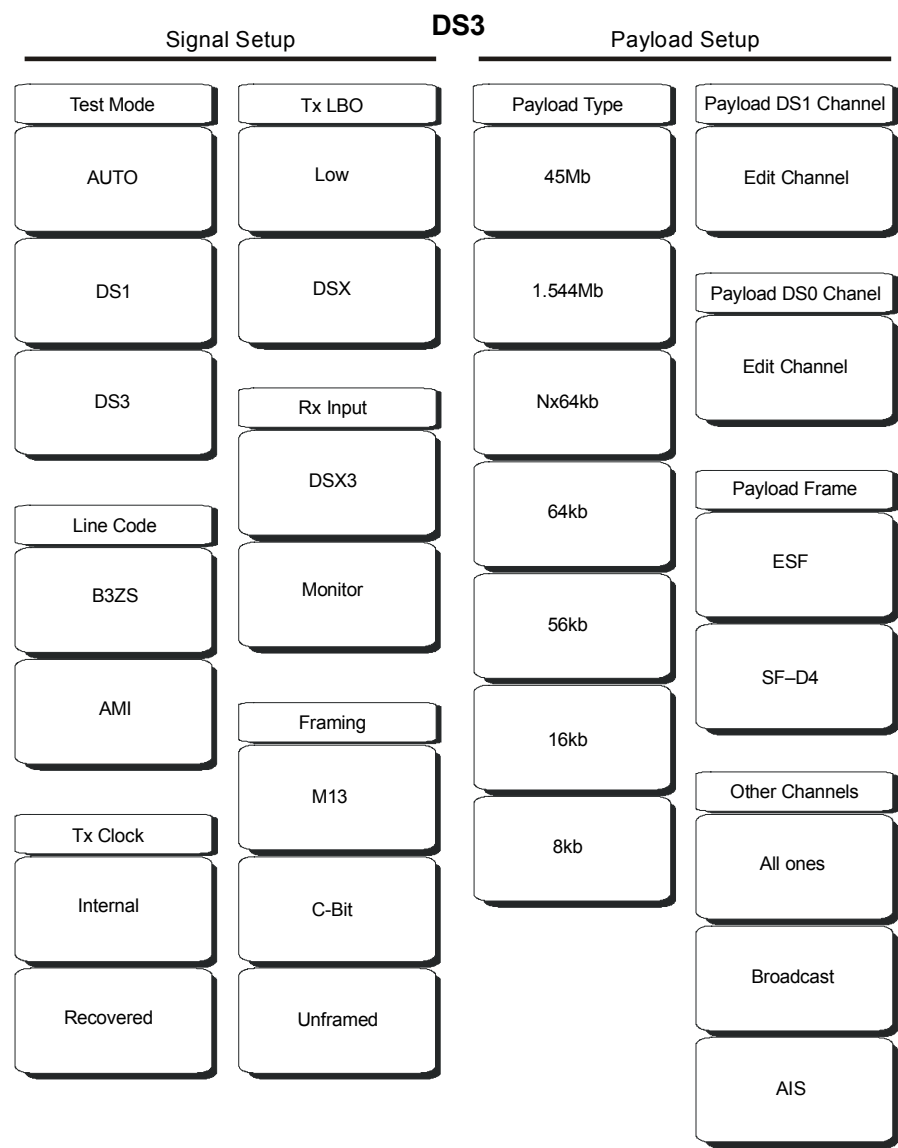
Figure 15-16. T3 Configuration Soft Key Menus

Signal Setup Menus

Test Mode

While in DS3 test mode, select DS1 to change modes.

AUTO
Refer to section *AUTO Signal Setup Explanation* .

DS1
Press this soft key when connected to a 1.5 MHz T1 circuit.

DS3

Press this soft key when connected to a 45 Mhz T3 circuit.

Line Code

AMI

Press this soft key to select Alternate Mark Inversion (AMI) line coding.

B3ZS

Press this soft key to select B3ZS line coding.

Tx Clock

Internal

Press this soft key to select the internally generated Tx Clock.

Recovered

Press this soft key to select a clock signal that is recovered from the receive path.

Tx LBO

Low

Press this soft key to test the signal near the Base Transceiver Station (within 225 feet).

DSX

Press this soft key to select a signal configuration in order to test at the cross-connect point (more than 225 feet).

Rx Input

Terminate

Press this soft key to select terminate mode. This terminates the circuit in 75 ohms.

Monitor

Press this soft key to add +20 dB gain to the receive path.

Framing

M13

Press this soft key to test the M13 framing format.

C-Bit

Press this soft key to select the C-bit parity format, which redefines the use of the C-bits in the M13 frame, thereby making it possible to provide in-service, end-to-end path performance monitoring of the DS3 signal and in-band data links.

Unframed

Press this soft key to select testing without any framing format. The full pattern is transmitted without any formatting. No fractional T1 or subrate testing can be performed when unframed is selected.

Payload Setup

The Payload Setup identifies which portion of the T3 data stream is to be accessed for testing.

Payload Type

45Mb
Press this soft key to select full T3 data stream testing.

1.544Mb
Press this soft key to select 1 of the 28 T1 channels.

Nx64kb
Press this soft key to select combinations of 64 kb channels for testing. This mode is referred to as fractional T1.

64kb
Press this soft key to select a single 64 kb channel for testing.

56kb
Press this soft key to select and test a data stream that has been reduced in size as a result of bit robbing.

16kb
Press this soft key to select 2 consecutive bits for testing within a single 64 kb channel.

8kb
Press this soft key to select a single bit for testing within a selected 64 kb channel.

Payload DS1 Channel

1.544Mb
Press this soft key to select 1 of the 28 DS1 channels.

Nx64kb
Press this soft key to select combinations of 64 kb channels to be tested.

64kb
Press this soft key to select a single 64 kb channel for testing.

56kb
Press this soft key to select and test a data stream that has been reduced in size as a result of bit robbing.

16kb
Press this soft key to select 2 consecutive bits for testing within a single 64 kb channel.

8kb
Press this soft key to select a single bit for testing within a selected 64 kb channel.

Payload DS0 Channel

Edit Channel
Edit channel and sub-channels when testing payloads from Nx64kb to 8kb.

Payload Frame

ESF
Press this soft key to set the payload frame for ESF.

SF–D4
Press this soft key to set the payload frame for SF-D4.

Other Channels

All ones, Broadcast, AIS
Press these soft keys to set the other channels (those channels that are not being tested) to All ones, to Broadcast, or to AIS.

Pattern/Loop Menu – Part 1
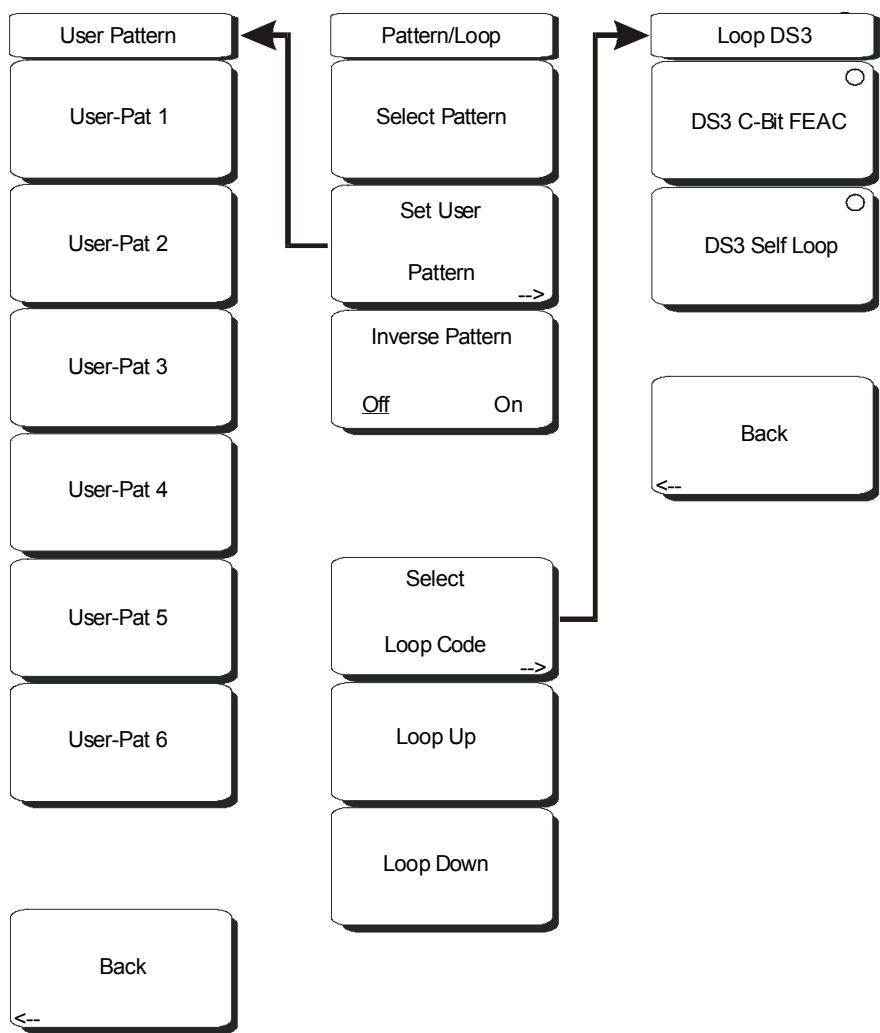
Figure 15-17. T3 Pattern/Loop Menu – Payload 45 Mb

Pattern/Loop

Select Pattern, Set User Pattern, Inverse Pattern, Off/On, Select Loop Code, Loop Up, and Loop Down all function the same as with smaller payloads. Refer to section *Pattern/Loop* on page 15-43.

With a payload of 45 Mb, only a DS3 signal can be tested, and the soft key menu offers a reduced set of functions.

Select Loop Code
Press this soft key to display the Loop DS3 menu.

Loop DS3
DS3 C-Bit FEAC
Press this soft key to set the DS3 loop code to C-Bit FEAC.

DS3 Self Loop
Press this soft key to activate a Self Loop test.

Back
Press this soft key to return to the Pattern/Loop menu.

Pattern/Loop Menu – Part 2

Pattern/Loop	User Pattern	Loop DS3–DS1	Loop	User # Loop
Select Pattern	User-Pat 1	Stuff Bit ○	CSU ○	Loop Up
Set User Pattern -->	User-Pat 2	C-Bit FEAC ○	NIU ○	Loop Down
Inverse Pattern Off On	User-Pat 3	Self Loop ○	Link Type In-Band Data-Link	
	User-Pat 4	DS1 Loopcodes ○ -->		Back <--
Select Loop Code -->	User-Pat 5		Loop Code ○ User1 -->	
Loop Up	User-Pat 6	Back <--	Loop Code ○ User2 -->	
Loop Down	Back <--		Back <--	
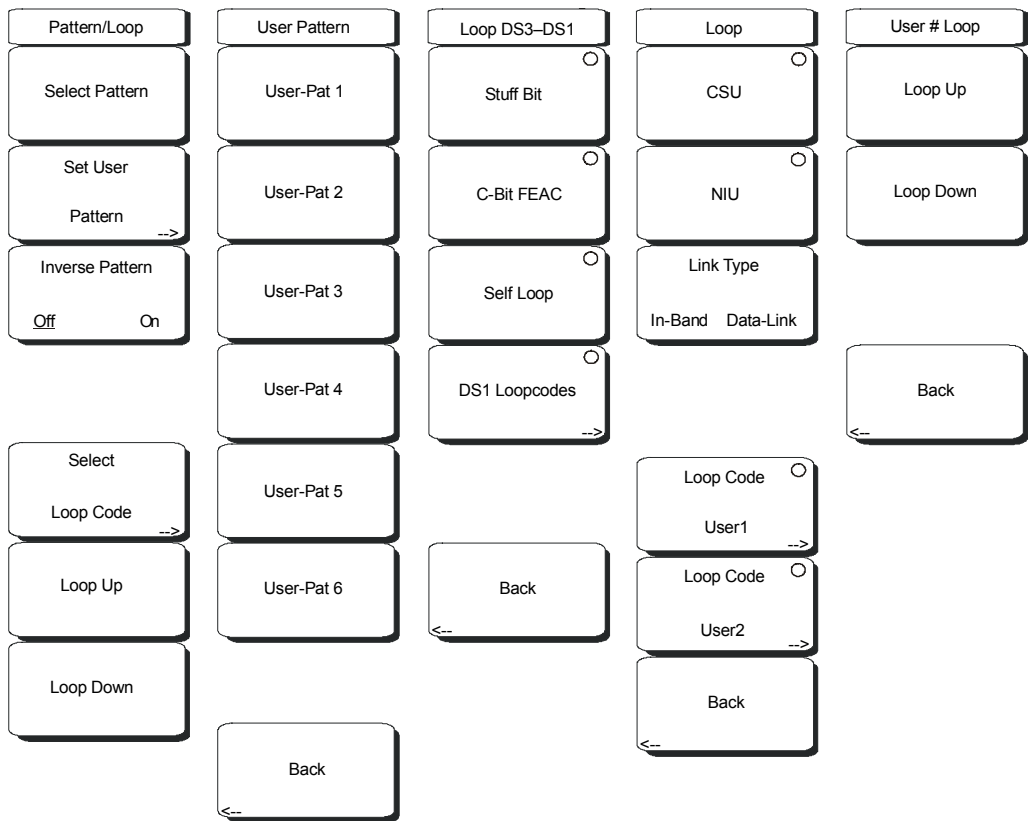
Figure 15-18. T3 Pattern/Loop Menu – Payloads Less Than 45 Mb

Pattern/Loop

Select Pattern
After highlighting a pattern, use this soft key to select the pattern.

Set User Pattern
Use this soft key to select a specific user pattern from a list of six patterns, which can be configured separately.

User Pattern

User-Pat #
These six soft keys each select a different pattern. Enter zeros or ones, up to a maximum of 24 bits. Press **Enter** to continue, or press **Esc** to abort.

Back
Returns to the Pattern menu.

Inverse Pattern, Off/On
Press this soft key to toggle the Inverse Pattern function OFF and ON.

Select Loop Code
Press this soft key to display the Loop DS3-DS1 menu.

Loop DS3–DS1

Stuff Bit

Press this soft key once to select the Stuff Bit loop code. Press this soft key again to select one or more channels for testing.

DS1, #

Press this soft key to insert DS1 loopback channels (minimum 1 through maximum 28).

Select All

Press this soft key to select all 28 DS1 channels.

Back

Press this soft key to return to the Loop DS3-DS1 menu.

C-Bit FEAC

Press this soft key to set the loop code to C-Bit FEAC. Press the soft key again to select channels for testing.

DS1, #

Press this soft key to insert DS1 loopback channels (minimum 1 through maximum 28).

Select All

Press this soft key to select all 28 DS1 channels.

Back

Press this soft key to return to the Loop DS3-DS1 menu.

Self Loop

Press this soft key to loop back the circuit Rx to the circuit under test Tx.

DS1 Loop Codes

Press this soft key to display the Loop menu.

Loop

CSU

Press this soft key to select Channel Service Unit (CSU) for the loop code.

NIU

Press this soft key to select Network Interface Unit (NIU) for the loop code.

Link Type

Press this soft key to toggle between In-Band and Data-Link types of link.

Loop Code User1

Press this soft key once to select Loop Code User1, and press it again to configure the loopback loop code for User1.

Loop Code User2

Press this soft key once to select Loop Code User2, and press it again to configure the loopback loop code for User2.

User1 Loop and User2 Loop

Loop Up

Press this soft key for loop up.

Loop Down

Press this soft key for loop down.

Back

Press this soft key to return to the Loop menu.

Back

Press this soft key to return to the Loop DS3–DS1 menu.

Back

Press this soft key to return to the Pattern/Loop menu.

Loop Up

Press this soft key to initiate a loopback.

Loop Down

Press this soft key to remove a loopback.

Error/Alarm Menu
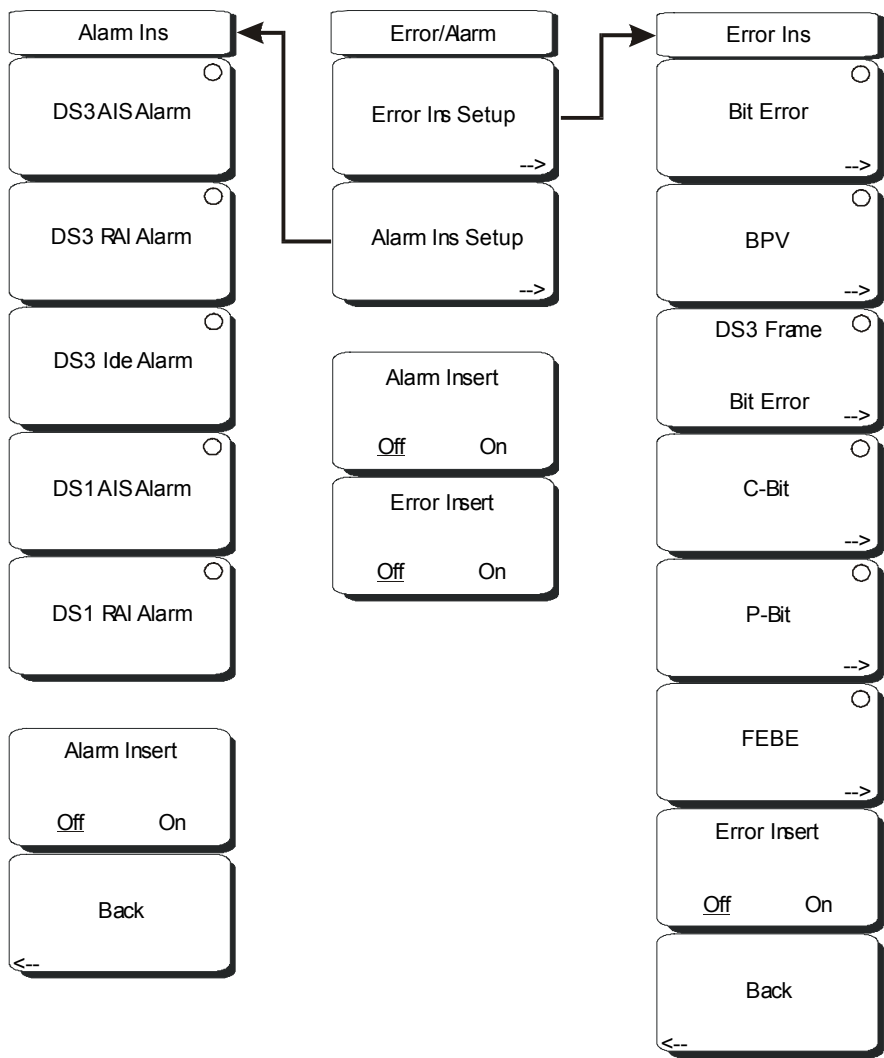
Figure 15-19. T3 Error/Alarm Menu – Part 1

When not active, some soft keys have no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when these soft keys are active.

BIT Error
Burst ○

Rate 1E–2 ○

Rate 1E–3 ○

Rate 1E–4 ○

Rate 1E–5 ○

Rate 1E–6 ○

Rate 1E–7 ○

Back
<--

Error Ins
Bit Error ○
-->

BPV ○
-->

DS3 Frame ○
Bit Error
-->

C-Bit ○
-->

P-Bit ○
-->

FEBE ○
-->

Error Insert
Off   On

Back
<--

BPV Error
Burst
##

Back
<--

Frame Bit Error
Burst
##

Back
<--

C-Bit Error
Burst
##

Back
<--

P-Bit Error
Burst
##

Back
<--

FEBE Error
Burst
##
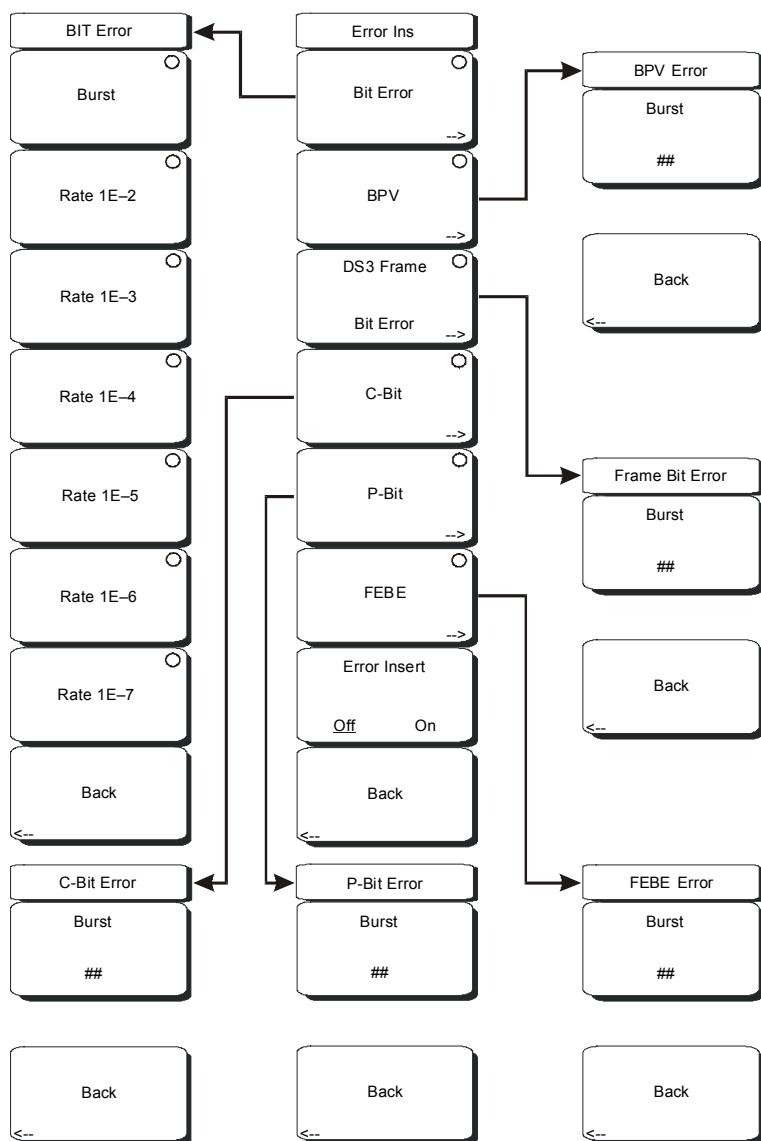
Back
<--

Figure 15-20. T3 Error/Alarm Menu – Part 2

When not active, some soft keys have no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when these soft keys are active.

Error/Alarm

Error Ins Setup

Press this soft key to display the Error Ins (Insert) soft key menu.

Error Ins (Insert)

Bit Error

Press this soft key once to activate the BIT Error function. Press this soft key again to display the Bit Error soft key menu in order to select Burst or any one of the Rate 1E-# soft keys. Bit errors are inserted into the payload vehicle, whichever that is (full DS3, T1, FT1, and so forth.)

BIT Error

Burst

Press this soft key to configure the Burst count.

Rate 1E–# (2 through 7)

Press this soft key to set the BIT Error rate to one of the six preset values.

BPV

Press this soft key once to activate the BPV error function. Press this soft key again to configure the Burst count.

DS3 Frame Bit Error

Press this soft key once to activate DS3 frame bit errors. Press this soft key again to configure the Burst count.

C-Bit

Press this soft key once to activate the C-Bit error function. Press this soft key again to configure the Burst count.

P-Bit

Press this soft key once to activate the P-Bit error function. Press this soft key again to configure the Burst count.

FEBE

Press this soft key once to activate the FEBE error function. Press this soft key again to configure the Burst count.

Error Insert Off/On

Press this soft key to toggle error inserts ON and OFF during tests. This soft key toggles error inserts ON until turned OFF only for BER options. For any other error type, error insertion is toggled ON and then immediately OFF.

Back

Press this soft key to return to the Error/Alarm menu.

Alarm Ins Setup

Press this soft key to display the Alarm Ins soft key menu. Select one of the five alarms for testing – DS3 AIS Alarm, DS3 RAI Alarm, DS3 Idle Alarm, DS1 AIS Alarm, and DS1 RAI Alarm. The soft key label for the selected alarm displays the circle indicator in red to show that the key function is active.

Alarm Ins (Insert)

DS3 AIS Alarm

Press this soft key to insert AIS alarm signaling.

DS3 RAI Alarm

Press this soft key to insert RAI alarm signaling.

DS3 Idle Alarm

Press this soft key to insert an Idle Alarm pattern.

DS1 AIS Alarm

Press this soft key to insert AIS alarm signaling. Data is replaced with an unframed signal of all ones.

DS1 RAI Alarm

Press this soft key to insert RAI alarm signaling. RAI alarms send a signal from terminal equipment in the outgoing direction. this is useful when the incoming signal is lost or when an AIS signal is received (incoming direction).

Alarm Insert Off/On
Press this soft key to toggle the selected alarm signal OFF and ON.

Back
Press this soft key to return to the Error/Alarm menu.

Alarm Insert Off/On
Press this soft key to toggle the selected alarm signal OFF and ON.

Error Insert Off/On
Press this soft key to toggle the selected error insert OFF and ON.

Measurements Menu for DS3 with DS1 Payload

VF		Measurements		BERT
Transmit		BERT		DS1 Table
Off On		-->		DS3 Table
Channel		Rx Signal		Histogram
#				-->
Tx Frequency		VF		Event List
#### Hz		-->		
Tx Level				Clear History
– ## dBm				Back
Volume				<—
Audio		Measure Time		Histogram
Off On				Zoom
Clear History		Clear History		In
Back		Save Results		Zoom
<—				Out

Window Size

xx:xx:xx

Time Units

Relative   Absolute

Back

<—
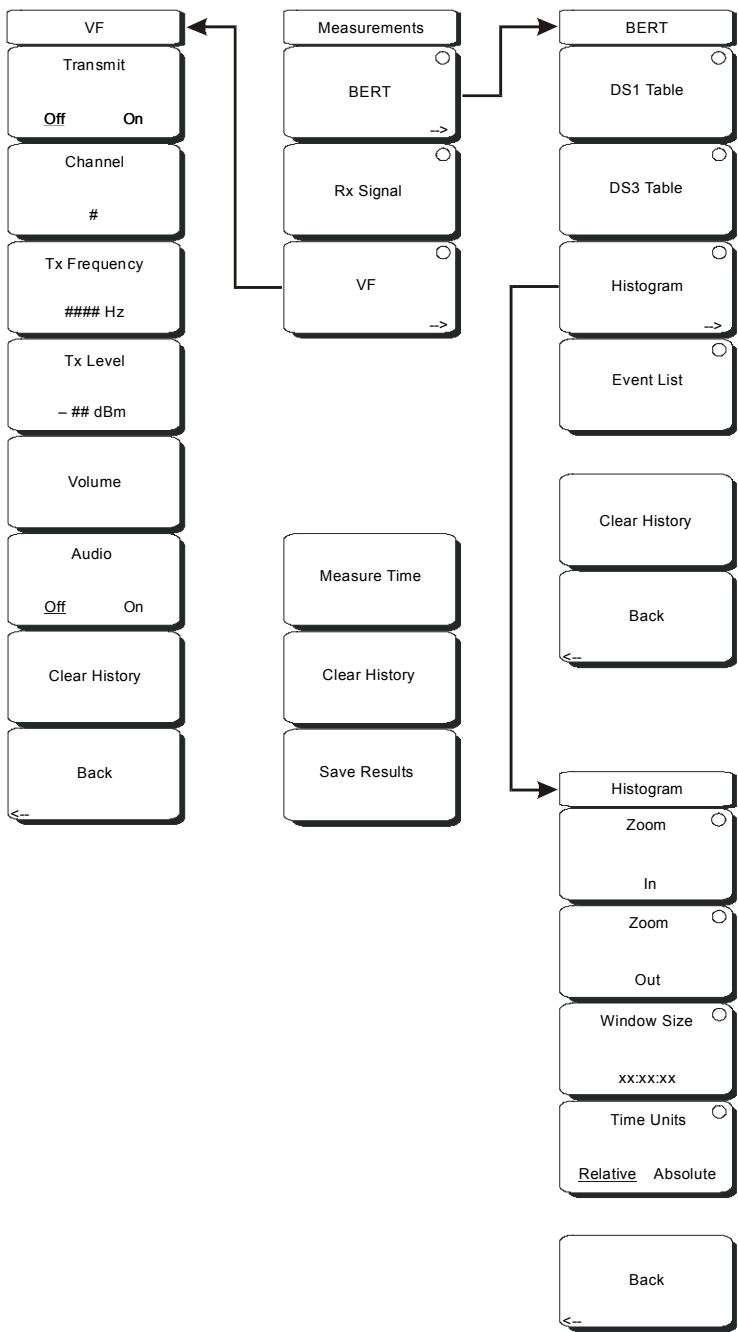
Figure 15-21. T3 Measurements Menu with DS1 Payload

When not active, some soft keys have no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when these soft keys are active.

Measurements

When the configuration is for the DS3 Test Mode with a DS1 Payload Type, the Measurement menu offers a VF soft key, and the BERT menu offers two Table soft keys

BERT

This soft key displays the BERT menu. Press this soft key once to select the desired test results view.

BERT

When the configuration is for a DS3 Test Mode with a DS1 Payload Type, the BERT measurement menu offers two Table soft keys.

DS1 Table

Press this soft key to display the 10 BERT parameters and their settings in a table format.

DS3 Table

Press this soft key to display the DS3 Results table that consists of BPV, Frame Bits, P-bit Errors, C-bit Errors, and FEBE Errors.

Histogram

Press this soft key once to make it active and to display a histogram of parameters. Press the soft again to display the Histogram soft key menu. Configure the histogram with the following menu keys.

Histogram

Zoom In

Use this soft key to change the graph display width to a smaller value. The graphical display units are described in the Window Size soft key description.

Zoom Out

Use this soft key to change the graph display width to a larger value. The graphical display units are described in the Window Size soft key description.

Window Size, ##:##:##

This soft key displays the time units in the format 0d:00:00:00, in days, hours, minutes, or seconds (0d:HH:MM:SS). Seconds are 00 by default and cannot be changed. When the setting is less than 1 day, the day units are not shown, and the format is 00:00:00 (HH:MM:SS).

Setting the time sets a display graph width of 1, 5, or 15 minutes; 1, 6, or 12 hours; 1, 2, or 3 days. When pressed, the soft key color changes to a darker background, and the numeric value is displayed in red. The labels (Display Window ##:##:00) in the graph area of the display are also in red. The red color indicates that the time is being changed. The red label at the top line of the histogram and the one below the histogram remain red while the value is open to change. When the numeric value has been set, the upper label is removed, and the lower label changes to plain text, showing the setting.

Use the arrow keys to change the values from 1 minute to 3 days in the 9 increments that are available. The value can also be set by using the number keys. Press an appropriate number or numbers, and the soft key menu changes to Time increments, as shown in Figure 15-13 . For more details about entering time, refer to section *Window Size, ##:##:##* .

Turning the rotary knob while in the Histogram view scrolls a vertical yellow marker line across the histogram graph.

Time Units, Relative or Absolute

This soft keys toggles between relative and absolute time. The units are displayed at the bottom edge of the histogram.

Back

Press this soft key to return to the BERT menu.

Event List

Press this soft key to display a chronological event list with 4 columns. The column labels are "Date", "Time", "Event Type", and "Events."

Clear History

Press this soft key to erase the history of displayed events and measurements. Pressing this soft key also clears any red History indicators in the yellow-highlighted upper measurement display.

Back

Press this soft key to return to the Measurements soft key menu.

Rx Signal

This soft key activates Rx Signal for testing.

VF

Press this soft key once to display the frequency and power of VF signals. Press the soft key again to display the VF soft key menu.

VF

Transmit: Off/On

This soft key toggles VF transmission OFF and ON.

Channel number

This soft key opens a dialog box to select a channel value from 1 (minimum) to 24 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value, and then press **Enter** to continue, or press **Esc** to abort.

Tx Frequency

This soft key opens a dialog box to select a frequency in Hz from 100 (minimum) to 3000 (maximum). Use the numeric keys to enter a value, or use the arrow keys or the rotary knob to select a default value, and then press **Enter** to continue, or press **Esc** to abort.

Tx Level

This soft key opens a dialog box to select a Tx level in dBm from –30 (minimum) to 0 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value, and then press **Enter** to continue, or press **Esc** to abort.

Volume

This soft key opens a dialog box to set the volume from 0 (minimum) to 90 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value in increments of 5, and then press **Enter** to continue, or press **Esc** to abort.

Audio, Off/On

This soft key toggles Audio Off and On.

Clear History

Press this soft key to erase the history of displayed events and measurements. Also, clears any red History indicators in the Upper Status Window.

Back

Press this soft key to return to the Measurements soft key menu.

Measure Time

This soft key opens a dialog box to set the measurement time. Choose from 12 settings, which range from 1 minute (minimum) to 3 days (maximum). You can also choose Manual, which runs any length of time, indefinitely, until the **Stop/Start** function hard key is pressed. Use the arrow keys or the rotary knob to enter a value, and then press **Enter** or the Rotary Knob to continue, or press **Esc** to abort.

Clear History

Press this soft key to erase the history of displayed events and measurements. Also, clears any red History indicators in the Upper Status Window.

Save Results

Press this soft key to save the results of a measurement. See *File on page 3-25*.

Measurements Menu for DS3 with Full Payload
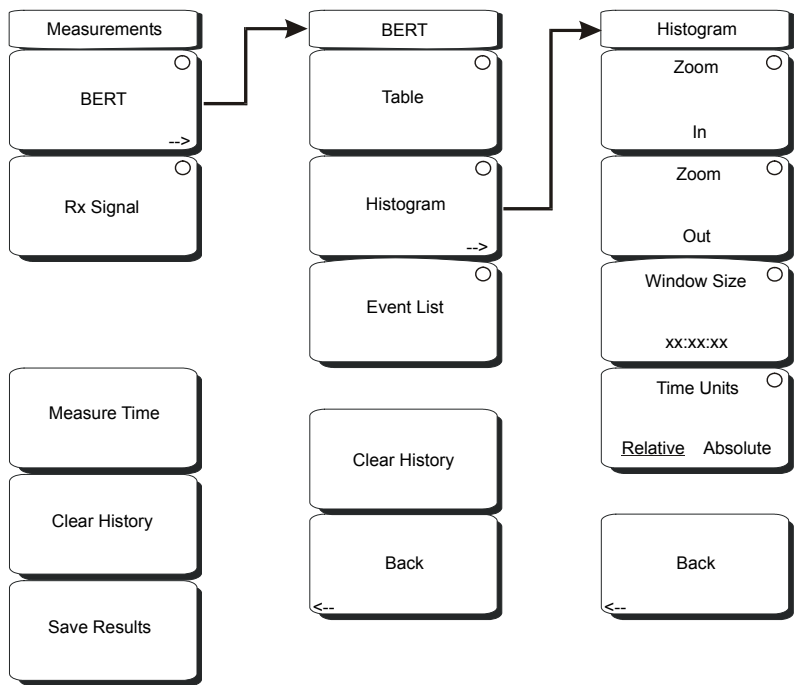
Figure 15-22. T3 Measurements Menu with Full DS3 Payload

When the configuration is for a DS3 Test Mode with a Payload Type of 45 Mb, the Measurement menu offers no VF soft key, and the BERT menu offers only one Table soft key.

Table
Press this soft key to display the BERT parameters and their settings in a table format.

In-Service Testing

In order to avoid disrupting service, Monitor receiver settings must be used when testing a T3 circuit that is in service. The following measurements are used to check T3 performance during regular maintenance:

- Vpp measurement
- Carrier Frequency
- Frame Bit Errors
- C-bit Errors
- FEBE Errors
- P-bit Errors
- Bipolar Violations

Required Equipment

- MT8222A BTS Master with Option 53
- BNC Cables, Anritsu Part Number 3-806-169

Measurement Setup Procedure

See *T1/T3 Mode* .

1. Press the **Configuration** function hard key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight **Line Code** and press the B3ZS or the AMI coding soft key.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight **Tx Clock** and select Recovered.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight **Rx Input** and select Monitor.
5. Use the **Up/Down** arrow keys or the rotary knob to highlight **Framing** and select M13, C-Bit, or Unframed.

> NOTE: The setup parameters are displayed in the instrument settings summary table on the left side of the measurement display.

6. Connect to the Monitor jack on one direction of the circuit under test.

Soft keys for the Configuration Test Mode Menu are described in section *Configuration Menu* .

Rx Signal Measurement Procedure

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the BERT soft key and check P-bit errors, C-bit errors, and FEBE errors. Press the Back key to return to the Measurements menu.
3. Press the Rx Signal soft key and verify Frequency and Vpp. When close to the transmitter, the Vpp result should be between 0.72 Vpp and 1.7 Vpp. The Frequency should be 44.736 MHz ±895 Hz (±20 ppm).
4. Move the connection to the other circuit pair and repeat these measurements.

Out-Of-Service Measurements

Out-of-service measurements are performed when the T3 circuit is not in service or is inactive. Typically, these tests are done during initial installation, during circuit acceptance by the wireless service provider, or when the results of the in-service measurements indicate significant errors. These measurements provide detailed information about the T3 circuit.

Out-of-service testing is performed using end-to-end testing, which requires a technician and a T3 tester at each end of the circuit, or it is performed by establishing a loopback at the remote end of the circuit.

The following measurements are used to check the T3 performance during out-of-service testing:

• Vpp

• Carrier Frequency

• Frame Sync

• Pattern Sync

• P-bits

• C-bits

• FEBE

• Insert Errors/Alarms

• BER

Required Equipment

• MT8222A BTS Master with Option 53

• BNC Cables, Anritsu Part Number 3-806-169

BERT Measurement Setup Procedure

1. In the T1/T3 Analyzer mode, press the **Configuration** function hard key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight **Line Code** and press the B3ZS or the AMI coding soft key.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight **Tx Clock** and select Internal or Recovered.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight **Tx LBO** and select either Low or DSX.
5. Use the **Up/Down** arrow keys or the rotary knob to highlight **Rx Input** and select DSX3.
6. Use the **Up/Down** arrow keys or the rotary knob to highlight Framing and select M13, C-Bit, or Unframed.

The remaining steps of this procedure (7. through 15.) apply only when using M13 or C-bit framing and testing at T3 subrates.

7. Use the **Up/Down** arrow keys or the rotary knob to highlight **Payload Type** and select from 45Mb, 1.544Mb, Nx64kb, 64kb, 56kb, 16kb, or 8kb (framed modes only).

8. Use the **Up/Down** arrow keys or the rotary knob to highlight **Payload DS1 Channel.** Selections depend upon the payload type and are available only with Nx64kb, 64kb, 56kb, 16kb, or 8kb. Select one of the 28 DS1 channels. Press the Edit Channel soft key and select the channel from the list by using the **Up/Down** arrow keys or the rotary knob. Press Select Channel and press **Enter** to select the channel number in the edit box.

9. Use the **Up/Down** arrow keys or the rotary knob to highlight **Payload DS0 Channel.** Selections depend upon the payload type and are available only with Nx64kb, 64kb, 56kb, 16kb, or 8kb. Press the Edit Channel soft key and select the channel from the list using the **Up/Down** channel or the rotary knob. Press **Enter** to select the channel number in the edit box.

10. Use the **Up/Down** arrow keys or the rotary knob to highlight **Payload Frame** and select either ESF or SF–D4.

11. Use the **Up/Down** arrow keys or the rotary knob to highlight **Other Channels** and select All Ones, Broadcast, or AIS.

12. Press the **Pattern/Loop** function hard key to activate the Pattern/Loop menu.

13. Use the **Up/Down** arrow keys or the rotary knob to highlight the appropriate pattern, and then press the Select Pattern soft key or the **Enter** key.

14. Connect the BTS Master Rx BNC jack to the circuit Tx jack, and the BTS Master Tx BNC jack to the circuit Rx jack.

15. If a test set is not connected to the far end, then set up a loopback.

Basic BERT Measurement Procedure

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the BERT soft key to activate the BERT menu.
3. Press either the DS1 Table or the DS3 Table soft key to display the measurements in the table format, or press Histogram or Event List.
4. From the BERT menu, press the Back soft key. Then from the Measurements menu, press the Measure Time soft key and use the **Up/Down** arrow keys, rotary knob, or key pad to enter the duration of the measurement. Then press **Enter**.
5. Press the **Start/Stop** function hard key to start and stop the measurement.

> NOTE: The measurement time is set in the Measure Time menu (1 min, 3 min, 5 min, 15 min, 30 min, 1 hour, 2 hours, 3 hours, 1 day, 2 days, 3 days, or Manual). Manual runs indefinitely and allows the user to terminate the measurement at any time.

Soft keys for the BERT menu are described in section *Measurements Menu for DS3 with DS1 Payload* .

Quick Check

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the BERT soft key to activate the BERT menu.
3. Press the DS1 Table or the DS3 Table soft key to display the measurements in the table format.
4. Press the **Start/Stop** function hard key to activate the measurements. To stop the measurements, press the **Start/Stop** key again. If the results are acceptable, then **RESULTS OK** is displayed in a green box at the center of the screen. If any errors are detected, then the errors or the measurement results are displayed in the table.

> NOTE: **RESULTS OK** can be cleared by pressing **Esc**.

Histogram Display

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the BERT soft key to activate the BERT menu.
3. Press the Histogram soft key to display the data in Histogram format.
4. Press the Histogram soft key again to open the Histogram soft key menu. Then press the Zoom In soft key to zoom in by adjusting the horizontal (minutes/div) scale.
5. Press the Zoom Out soft key to zoom out by adjusting the horizontal (minutes/div) scale.
6. Press the Time Units soft key to toggle between **Relative** and **Absolute** time units.
7. Press the Window Size soft key to set the time units of the histogram display.

Soft keys for the Histogram menu are described in section *Measurements Menu for DS3 with DS1 Payload* .

To Insert Errors/Alarms

1. Press the **Error/Alarm** function hard key to activate the Error/Alarm menu.
2. Press the Error Ins Setup soft key to open the Error Ins (Error Insert) soft key menu.
3. Select an error type from the soft key menu, as applicable to the measurement.
   - Bit Error
   - BPV
   - DS3 Frame Bit Error
   - C-Bit
   - P-Bit
   - FEBE

   If Bit Error is selected, then press the Bit Error key again to select a burst number between 1 and 1000 or a bit error rate of 1E–2, 1E–3, 1E–4, 1E–5, 1E–6, or 1E–7. Refer to Figure 15-2 . If another type of error is selected (BPV, DS3 Frame Bit, and so forth), then press that soft again to select a burst number between 1 and 1000.
4. Press the Alarm Ins Setup soft key to insert an alarm. The 5 alarm types that are available are:
   - DS3 AIS Alarm
   - DS3 RAI Alarm
   - DS3 Idle alarm
   - DS1 AIS Alarm
   - DS1 RAI Alarm
5. Press the Alarm Insert Off/On soft key to toggle the selected alarm between ON and OFF. The alarm status is displayed in the yellow Insert section of the upper measurement display.
6. After you have selected an error type and an alarm type, you can press the Alarm Insert and Error Insert soft keys from the main Error/Alarm soft key menu in order to turn these functions ON and OFF.

Event List

The BERT measurement Event List updates errors, signal loss, frame loss, and alarms every second. Alarms are: AIS ON, AIS OFF, RAI ON, and RAI OFF. The data is displayed as a log list.

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Rx Signal Measurement Procedure

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the Rx Signal soft key to activate the Rx Signal menu.
3. Verify frequency and voltage.

For frequency and voltage specifications, refer to *Rx Signal Measurement Procedure*

VF Channel Access Testing

The VF Channel Access test feature enables testing on each of the 1 to 24 DS1 64kb DS0 channels from one of the 28 T1 sub-channels on the T3 signal. The receive channel is decoded, and the VF level and frequency are measured and displayed. The signal is also connected to a speaker, enabling you to make an audible assessment of the signal quality of the circuit. If the circuit is out of service, then you can insert a test tone on the transmit channel for measurement at a remote location with another test set, or locally with a loopback.

Configuration

Before conducting channel tests, the T3 interface must be properly configured. Press the **Configuration** function hard key to display the Signal Setup and Payload Setup windows. Select the correct Framing Mode, Line Coding, and Clock Source. If the testing is in-service, then the Receive Input must be configured for Monitor mode.

> NOTE: The receive mode must be set up before connecting to the circuit in order to avoid creating a "hit" on the customer data.

If the testing is in-service, then the BTS Master transmit pair should not be connected to the circuit. If the measurement is out-of-service, then the Receive Input mode should be Terminate, and the BTS Master transmitter can be safely connected to the circuit. The current configuration of the T3 interface is displayed in the instrument settings summary table at the left of the measurement display.

Channel Tests

After the unit is correctly configured, select the VF Channel Access menu to perform tests at the DS0 channel level. Press the Channel soft key to select specific channels. Either enter a specific channel number from the keypad or scroll through the channels with the **Up/Down** arrow keys. The received VF level and frequency on the selected channel are displayed, and the decoded signal is connected to a speaker for audio monitoring. When a test tone is present on the channel, the level and frequency report indicate whether the channel is healthy. If speech is present on the channel, then the channel performance can be judged from the audio quality. An overview of channel utilization can be obtained by quickly scrolling through the channels.

If the circuit is out of service, then you can connect to the transmit pair and insert a test tone on the selected channel (note that transmit and receive must be on the same channel). Two menus enable selection of transmit level and frequency. The frequency can be entered from the keypad, or scrolled to common test frequencies (404 Hz, 1004 Hz, 1804 Hz, and 2713 Hz) with the **Up/Down** arrow keys. To check the performance of channel level equipment, the test tone can be measured at a remote location with another VF channel test set.

Soft keys for the VF menu are described in section *Measurements Menu for DS3 with DS1 Payload*

AUTO Signal Setup Explanation

When AUTO is selected, the BTS Master first compares the connected signal with the current status of frame sync and pattern sync. If both are matched with the connected signal, then no further action is taken.

The BTS Master will also hunt for signal. If the BTS Master is configured for DS1, and if no DS1 signal is present, then it will change mode to DS3 and test for a signal at the DS3 rate. If the BTS Master is configured for DS3, and if no DS3 signal is detected, then it will change mode to DS1 and test for a signal at the DS1 rate. The AUTO algorithm does not hunt for subrate payloads.

If the current mode is DS1, then when AUTO is pressed, the BTS Master first seeks the frame sync (ESF or SF-D4). If frame sync is found, then the Framing Mode is displayed in the instrument settings summary (at the left side of the data display area). Then the BTS Master seeks the pattern sync, stepping through all possible patterns. If pattern sync is found, then the Pattern is displayed in the instrument settings summary. The framing mode and pattern are thereby set, and the BTS Master is ready for use on the connected circuit.

If the current mode is DS3, then the current DS3 Framing Mode and Line Code configuration are used when testing for Pattern. The default Framing Mode is C-Bit, and the default Line Code is B3ZS. The BTS Master does not search for Framing Mode when configured for DS3. If pattern sync is found, then the Pattern is displayed in the instrument settings summary. The framing mode and pattern are thereby set, and the BTS Master is ready for use on the connected circuit.

The following figures illustrate the logic of AUTO configuration.
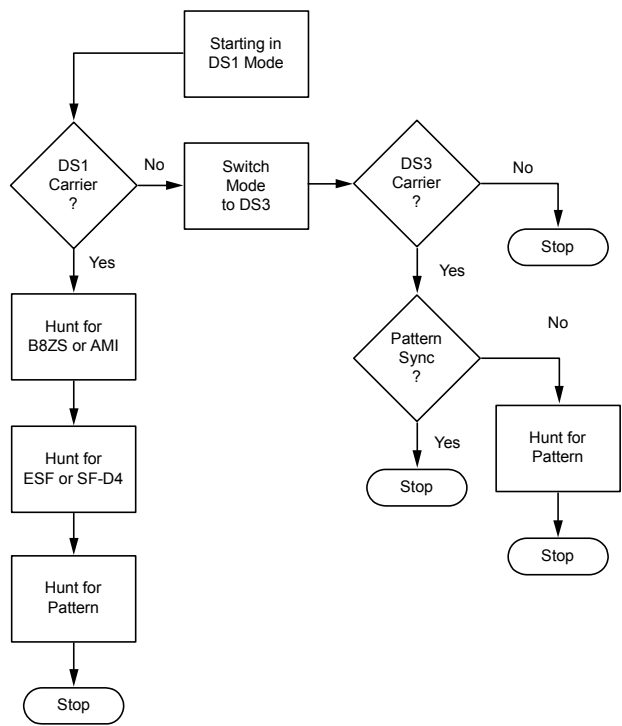
Figure 15-23. DS1 AUTO Configuration
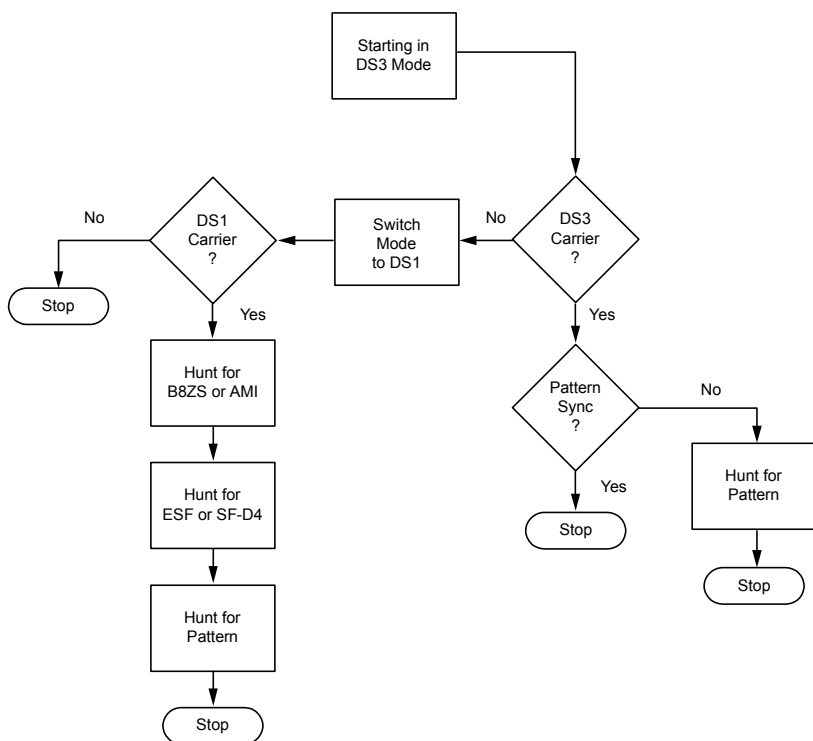
Figure 15-24. DS3 AUTO Configuration

Glossary

Alternate Mark Inversion (AMI)

A three level serial line code for transmitting binary digits. A format in T1 transmission systems in which binary digits are sent with equal time periods and in which zeros have zero amplitude, and ones (marks) have equal amplitudes that alternates in polarity (positive and negative).

Backhaul

A term that is commonly used for a circuit that is used to carry signals from one point in a network back to another point, For example, a signal may be carried from the Base Transceiver Station (BTS) site back to the Mobile Switching Center (MSC).

CRC

Cyclic Redundancy Check. A bit pattern determined by a formula, applied to a block of data, and used to verify data integrity over a communications link.

CSU

Channel Service Unit or CSU/DSU (where DSU is Data Service Unit) is a device that terminates a digital channel on a customer's premises. A CSU is located between the incoming digital line and the customer's equipment.

D4

Refers to a "D4" channel bank, but is commonly used to refer to the signal framing originally used by the D4 channel bank. Also called Super Frame.

DSX

Digital Cross-connect. A manual cross-connect point that primarily serves as a test access point for DS1signals and for substituting operational equipment when necessary.

ESF

Extended Super Frame is a framing format that is employed in T1 systems. The ESF format consists of 24 consecutive T1 frames (each T1 frame containing 24 DS0 signals). This format provides FPS bits for framing, CRC bits for error checking, and FDL bits for maintenance-signaling information that is out-of-band from payload data.

FDL

Facility Data Link refers to the bits that are included as part of ESF framing format and that provide an out-of-band path for communication of performance data.

Framing

The digital bit stream is organized into fixed units, called frames. A frame typically consists of a block of data (payload) plus overhead bits that are used for frame synchronization and for out-of-band communication.

LBO

Line Build Out. An electrical network that is used to simulate a length of cable.

LEC

Local Exchange Carrier. Local service provider.

Loopback

A type of diagnostic test in which the transmitted signal is returned to the sending device after passing through a network or devices. A transmission facility may be said to be in loopback when it is set up in a condition such that a received signal is returned towards the sender.

M13

A multiplexer in the digital hierarchy that multiplexes 28 DS1 signals into a single DS3 signal.

NIU

Network Interface Unit, may also be called a Network Interface Device (NID). The NIU is a device that is placed at the demarcation point between the network and the customer premises. It typically provides regeneration, isolation, and testing loopback capabilities. It may also provide performance monitoring information, which is available either locally or via the FDL on ESF circuits.

PCM

Pulse Code Modulation is a common method of encoding an analog voice signal into a digital bit stream.

Timing Measurements

Available Seconds (AS)

The count of available seconds since the beginning of the test. Available seconds equals the total test time minus any unavailable seconds.

Degraded Minutes (DGRM)

The count of Degraded Minutes since the start of the test. A Degraded Minute occurs when there is a 10-6 bit error rate during 60 available, non-severely bit errored seconds.

Errored Second (ES)

The number of seconds with at least one error.

Error Free Seconds (EFS)

The count of error free seconds since the beginning of the test. Error free seconds equals the total test time minus the number of errored seconds.

Severely Errored Seconds (SES)

This is the count of Severely Errored Seconds since the beginning of the test. A second with a bit error rate of 10-3 or higher is a severely errored second. Severely errored seconds are not counted during unavailable time. Loss of signal (LOS), loss of frame (LOF) and loss of pattern synchronization (LOP) are treated as severely errored seconds.

Unavailable Seconds (UAS)

This is the count of UnAvailable Seconds that have occurred since the beginning of the test. Unavailable time begins at the onset of 10 consecutive severely errored seconds, and ends after 10 consecutive non-severely errored seconds. The onset of unavailable seconds cause the SES count to be adjusted downward by 10. When unavailable time ends, the UAS count is adjusted downward by 10.

Chapter 16
E1 - 2 Mb/s Analyzer

Introduction

This chapter provides a brief description of an E1 - 2 Mb/s circuit and E1 - 2 Mb/s measurements and also explains how to setup and measure E1 - 2 Mb/s performance by using the Anritsu BTS Master MT8222A with Option 52 installed.

Getting Started

E1 - 2 Mb/s Mode

To prepare for E1 - 2 Mb/s measurements, the MT8222A must be configured for E1 - 2 Mb/s mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight E1 - 2 Mb/s Analyzer and then press the **Enter** key.

For additional information about the Mode menu, refer to *Mode Selector Menu* on page 2-16.

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* on page 2-5.

Testing E1 - 2 Mb/s Circuits

E1 - 2 Mb/s circuit testing can be performed with either of two methods: In Service testing and Out of Service testing. In Service testing is done during a routine maintenance and troubleshooting phase. This can be accomplished without removing the E1 - 2 Mb/s circuit from service and without interrupting live traffic. Monitoring live traffic allows the wireless service provider technician to detect alarms, bipolar violations (BPV), and frame errors, but bit errors cannot be measured. However, bit errors may be estimated by measuring CRC errors and E-bit errors.

Out of Service testing is done when the E1 - 2 Mb/s is initially installed and before final acceptance from the service provider. At that time the circuit should be subjected to critical testing to guarantee the level of service per contract. Out of Service testing may also be performed when the circuit performance is very poor. For Out of Service testing, the E1 - 2 Mb/s circuit should be removed from service to allow detailed performance testing.

In Service Testing

In order to avoid disrupting service, the Bridged or Monitor receiver settings must be used when testing an E1 - 2 Mb/s circuit that is in service. The following measurements are used to check the E1 - 2 Mb/s performance during regular maintenance:

- Vpp measurement
- Carrier Frequency
- Frame Sync
- CRC errors and E-bits
- Clock and Frame Slips
- VF (audible assessment of the signal quality of the circuit)

E-bits and CRC are very useful for in-service testing to monitor E1 - 2 Mb/s BER performance. Even when the E1 - 2 Mb/s circuit is down, these tests can be useful to identify the faulty section of the circuit. If the primary errors that are present or detected are E-bit errors, then the transmit path is most likely to be faulty. If the primary errors that are present or detected are CRC errors, then the receive path is most likely to be faulty.

Required Equipment

• MT8222A BTS Master with Option 52

• The appropriate connection interfaces from the MT8222A to the E1 circuit under test are: 75 ohm coax, 120 ohm RJ48c and 75 ohm RJ48c. E1 cables with any of these interfaces and with the appropriate interface for their respective E1 circuit panel are sufficient for performing E1 tests.

Measurement Setup Procedure

1. Press the **Configuration** function hard key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight Line Code and press the HDB3 or the AMI coding soft key.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight Tx Clock and select Internal, Recovered, or External.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight Input Connector. Select from RJ48 120 ohms, RJ48 75 ohms, and BNC 75 ohms.
5. Use the **Up/Down** arrow keys or the rotary knob to highlight Rx Input. Select from Terminate, Monitor, or Bridge. For In Service testing, select Bridge or Monitor, depending upon the available access to the circuit.
6. Use the **Up/Down** arrow keys or the rotary knob to highlight Framing. Select PCM30, PCM30CRC, PCM31, or PCM31CRC.

> NOTE: The setup parameters are displayed in the setup summary table on the left side of the screen.

> NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.

Figure 16-1. Configuration Rx Input

Soft keys for the Configuration menus are shown and described in section *Configuration Menu Soft Keys* and in Figure 16-15.

Rx Signal Measurement Procedure

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the Rx Signal soft key to activate Rx Signal measurement.
3. Press the **Start/Stop** hard key to start and stop the measurement.

```
01/16/2007 11:24:02 a.m.                                    [====]        Save

            H    RX              H    2 Mbits          TX                  Save
 Test Mode  O ●  Signal          O ●  Alarms      O    Alarm ON
     E1     O ●  FAS             O ●  Errors       O    Error  ON          Setup
 Line Code  O ●  Pattern Sync
   HDB3                                                                    Save
 Tx Clock                          BERT                                  Measurement
 Internal
 Receive Input
 Terminate     Frequency                          2048003 Hz
 Framing Mode  Frequency Max                       2048007 Hz
   PCM30       Frequency Min                       2048003 Hz
                                                                            Save
 Error Type    Vpp                                     4.1 V                 On
 1E–2 BER                                                                   Event  -->
   Pattern     Vpp Max                                 4.1 V                 Save
    QRSS       Vpp Min                                 4.1 V               Screen
 Payload Type                                                             as JPEG
  2.048Mb      dBdsx                                   –1.3
 Impedance     Clock Slips                              --
  75 Ohms      Frame Slips                              --                Directory
  Measure                                                                Management
   OFF                                                                      -->
            Measurement Time = Manual        Start Time:
                                                                            Back
                                             Time Elapsed: 00hr00min00sec  <--
  Configuration        Pattern         Error/Alarm    Measurements    Start/Stop
```

Figure 16-2. Rx Signal Measurement

Out-Of-Service Measurements

Out-of-service measurements are performed when the E1 - 2 Mb/s circuit is not in service or is inactive. Typically these tests are done during initial installation, during circuit acceptance by the wireless service provider, or when the results of the in-service measurements indicate errors. These measurements provide detailed information on the E1 - 2 Mb/s circuit.

Out-of-service testing is performed using end-to-end testing, which requires a technician and an E1 - 2 Mb/s tester at each end of the circuit, or by establishing a loopback at the remote end of the circuit.

The following measurements are used to check the E1 - 2 Mb/s performance during out-of-service testing:

- Vpp
- Carrier Frequency
- CRC Errors
- Frame Sync
- Pattern Sync
- E-Bits
- Insert Errors/Alarms

BERT Measurement Setup Procedure

1. Press the **Configuration** function hard key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight Line Code and press the HDB3 or the AMI coding soft key.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight Tx Clock and select Internal, Recovered, or External.
4. Use the **Up/Down** arrow keys or the rotary knob to highlight Input Connector. Select from RJ48 120 ohms, RJ48 75 ohms, and BNC 75 ohms.
5. Use the **Up/Down** arrow keys or the rotary knob to highlight Rx Input. Select from Terminate, Monitor, or Bridge. For In Service testing, select Bridge or Monitor.
6. Use the **Up/Down** arrow keys or the rotary knob to highlight Framing. Select PCM30, PCM30CRC, PCM31, or PCM31CRC.
7. Use the **Up/Down** arrow keys or the rotary knob to highlight Payload Type. Select 2.048 Mb, Nx64kb, 64kb, 16kb, or 8kb.
8. Use the **Up/Down** arrow keys or the rotary knob to highlight Payload Channel. Selections depend upon the payload type and are only available with Nx64kb, 64kb, 16kb, or 8kb.
9. Press Edit Channel and select the channel from the list using the **Up/Down** channel or the rotary knob. Press Select Channel and **Enter** to select the channel number from the list.
10. Use the **Up/Down** arrow keys or the rotary knob to highlight Other Channels. Selections depend upon the payload type and are only available with Nx64kb, 64kb, 16kb, or 8kb. Select All Ones or Idle.
11. Press the **Pattern** hard key to activate the pattern menu.
12. Use the **Up/Down** arrow keys or the rotary knob to highlight the appropriate pattern, and then press **Enter.**

BERT Measurement Procedure

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the BERT soft key to activate the BERT menu.
3. Press the Table soft key to display the measurements in the table format.
4. Press Histogram to display the data in a histogram display.
5. Press the Measure Time soft key and use the **Up/Down** arrow keys, rotary knob, or
6. key pad, and enter the duration of the measurement. Then press **Enter.**
7. Press the **Start/Stop** hard key to start and stop the measurement.

NOTE: The LEDs are updated continuously even when measurements are stopped.

NOTE: The measurement time can be set up in two ways: Manual (continuous), or by setting a fixed value in the Measure Time menu (1 min, 3 min, 5 min, 15 min, 30 min, 1 hour, 2 hours, 3 hours, 1 day, 2 days, or 3 days).
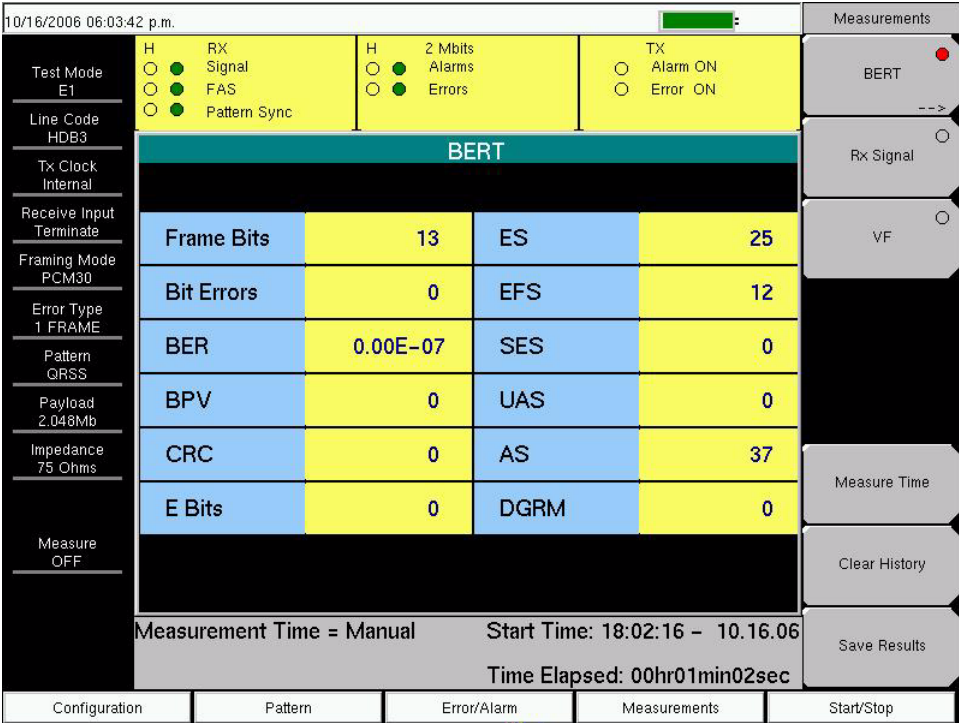
Figure 16-3. BERT Table Menu

Soft keys for the BERT menu are shown in Figure 16-22 and are described in section *Measurements Menu Soft Keys* .

Quick Check

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the BERT soft key to activate the BERT menu.
3. Press the Table soft key to display the measurements in the table format.
4. Press the **Start/Stop** function hard key to activate the measurements. To stop the measurements, press the **Start/Stop** key again.
5. If the results are okay, then RESULTS OK is displayed in a green box at the center of the screen. If the results are not okay, then the errors or measurement results are displayed in the table.

NOTE: RESULTS OK can be cleared by pressing **Esc.**

Histogram Display

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the BERT soft key to activate the BERT menu.
3. Press the Histogram soft key to display the data in Histogram format.
4. Press the Histogram soft key again and press Zoom In to zoom in by adjusting the horizontal (minutes/div) scale.
5. Press the Zoom Out soft key to zoom out by adjusting the horizontal (minutes/div) scale.
6. Press the Time Units soft key to select between Relative and Absolute time units.
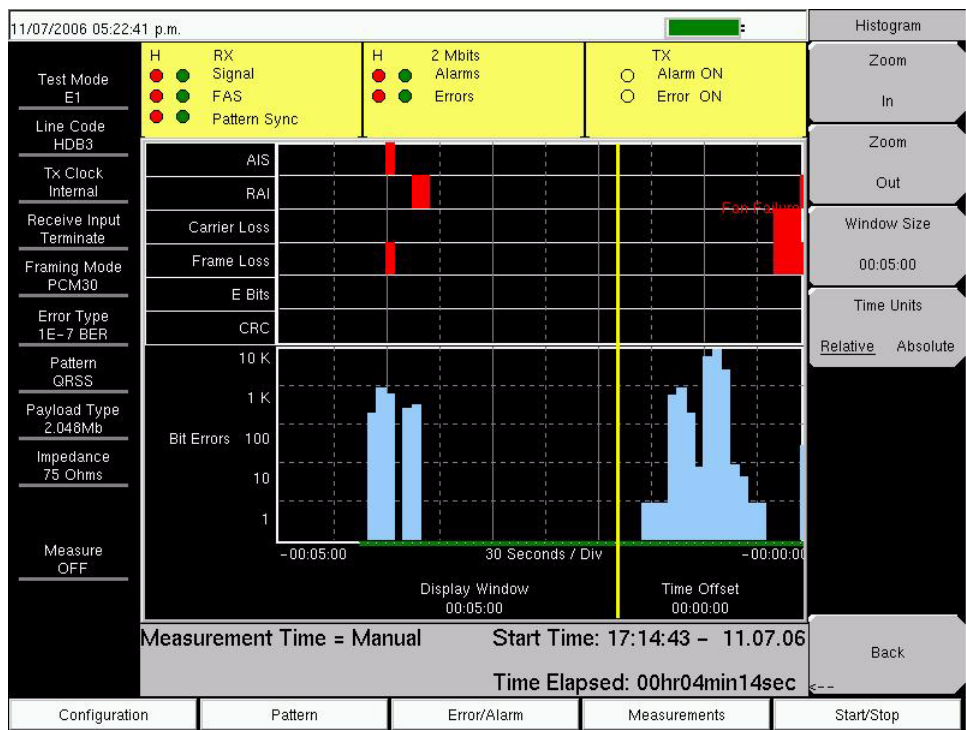
Figure 16-4. Histogram Display

Soft keys for the Histogram menu are shown in Figure 16-22 and are described in section *Measurements Menu Soft Keys* .

Histogram Settings

Zoom In and Zoom Out

The zoom in and zoom out features can be used to change the resolution of the data in the histogram display at the cursor location. When the cursor passes the 10% and 90% time points of the histogram display, the time window starts scrolling back in time or ahead in time. If you need to see a detailed view of a fault occurrence, then you can use the zoom in function to change the resolution to as small as 5 seconds per division. Maximum window size is 72 hours (6 hours/div). When more than 72 hours of data are collected, the last 72 hours are shown.

Window Size

The window size adjusts the length of time that is shown on the histogram screen. More data may be stored than is shown. This parameter allows you to zoom in or zoom out to see either more time on the screen or more resolution. The minimum (1 minute) window size and maximum (3 days) window size values are based upon the data resolution that is selected with the zoom in and zoom out features.

Time Units

If Relative is selected (underlined), then the histogram axis is labeled with time since the start of the measurement record. If Absolute is selected, then the histogram axis is labeled with absolute times based upon the system clock.

Rx Signal Measurement Procedure

1. Press the **Measurements** function hard key to activate the Measurements menu.
2. Press the Rx Signal soft key to activate the Rx Signal menu.

To Insert Errors/Alarms

1. Press the **Error/Alarm** function hard key to activate the Error/Alarm menu.
2. Press the Bit Error (1–1000 Burst), BER, or Frame Bit Error soft key, as applicable to the measurement.

> NOTE: If Bit Error is pressed, then press the Bit Error key again to select a burst number between 1 and 1000. If BER is pressed, then press BER again and select the bit error rate to be 1E-2, 1E-3, 1E-4, 1E-5, 1E-6, or 1E-7. If Frame Bit Error is pressed, then press Frame Bit Error again and select a burst number between 1 and 1000.

3. Press the AIS Alarm or RAI Alarm soft key. These two soft keys toggle between ON and OFF. The alarm status is displayed in the measurement status bar.

01/16/2007 12:50:41 p.m.

Error/Alarm

	H	RX	H	2 Mbits		TX		
Test Mode E1	○ ●	Signal	○ ●	Alarms		○	Alarm ON	Bit Error ○
	○ ●	FAS	○ ●	Errors		○	Error ON	
Line Code HDB3	○ ●	Pattern Sync						

BERT

BER ●
-->

Frame Bits	0	ES	0
Bit Errors	0	EFS	0
BER		SES	0
BPV	0	UAS	0
CRC	0	AS	0
E Bits	0	DGRM	0

Tx Clock Internal
Receive Input Terminate
Framing Mode PCM30
Error Type 1E–2 BER
Pattern QRSS
Payload Type 2.048Mb
Impedance 75 Ohms

Measure OFF

Measurement Time = Manual   Start Time:

Time Elapsed: 00hr00min00sec

Frame Bit ○
Error
AIS Alarm ○
On/Off
RAI Alarm ○
On/Off

Error
Off   On

Configuration	Pattern	Error/Alarm	Measurements	Start/Stop

Figure 16-5. Event List

Event List

The Event List updates errors, signal loss, frame loss, and alarms every second. Alarms are: AIS ON, AIS OFF, RAI ON, and RAI OFF. The data is displayed as a log list.

VF Channel Access Testing

The VF Channel Access test feature enables testing on each of the 32 channels of the E1 - 2 Mb/s line. The receive channel is decoded, and the VF level and frequency are measured and displayed. The signal is also connected to a speaker, enabling the tester to make an audible assessment of the signal quality of the circuit. If the circuit is out of service, then the tester can insert a test tone on the transmit channel for measurement at a remote location with another test set, or locally with a loopback.

Configuration

Before conducting channel tests, the E1 - 2 Mb/s interface must be properly configured. From the Setup menu, select the correct Framing Mode, Line Coding, and Clock Source. If the testing is in-service, then the Receive Input must be configured for either Bridged or Monitor modes. The receive mode should be set up before connecting to the circuit in order to avoid creating a "hit" on the customer data. If the testing is in-service, then the BTS Master transmit pair should not be connected to the circuit. If the measurement is out-of-service, then the Receive Input mode should be Terminate, and the BTS Master transmitter can be safely connected to the circuit. The current configuration of the E1 - 2 Mb/s interface is displayed in the status window at the bottom of the screen.

Channel Tests

After the unit is correctly configured, select the VF Channel Access menu to perform tests at the channel level. Press the Select Channel soft key to select specific channels. Either enter a specific channel number from the keypad or scroll through the channels with the **Up/Down** arrow keys. The received VF level and frequency on the selected channel are displayed, and the decoded signal is connected to a speaker for audio monitoring. When a test tone is present on the channel, the level and frequency report indicate whether the channel is healthy. If speech is present on the channel, then the channel performance can be judged from the audio quality. A overview of channel utilization can be formed by quickly scrolling through the channels.

If the circuit is out-of-service, then the user can connect to the transmit pair and insert a test tone on the selected channel (note that transmit and receive must be on the same channel). Two menus enable selection of transmit level and frequency. The frequency can be entered from the keypad, or scrolled to common test frequencies (404 Hz, 1004 Hz, 1804 Hz, and 2713 Hz) with the **Up/Down** arrow keys. To check the performance of channel level equipment, the test tone can be measured at a remote location with another VF channel test set.
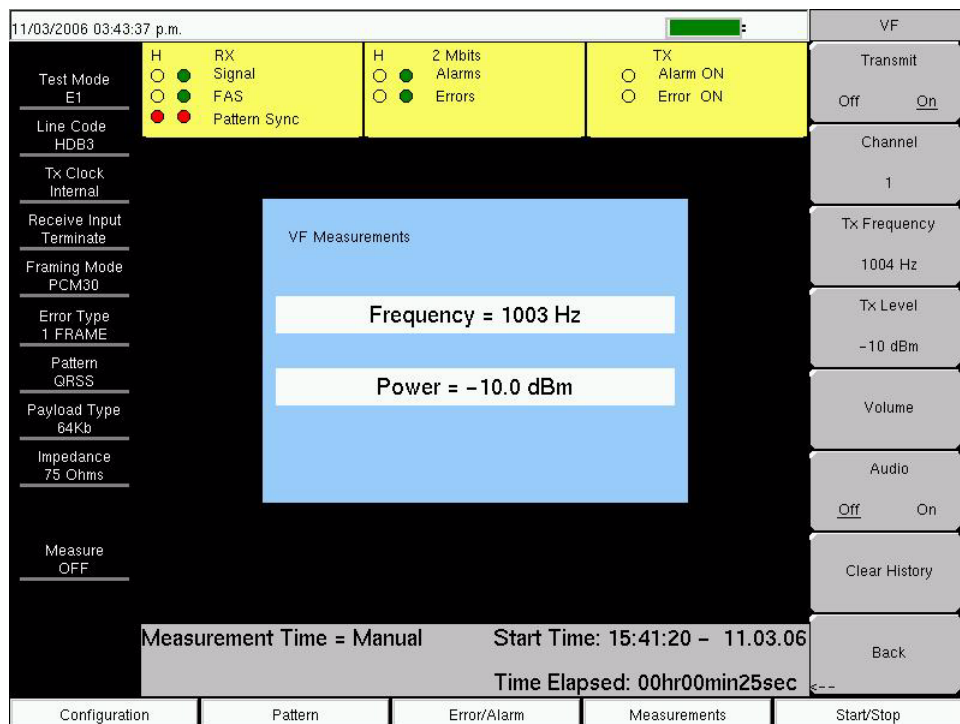
Figure 16-6. VF Measurements

Soft keys for the VF menu are shown in Figure 16-22 and are described in section *Measurements Menu Soft Keys on page 16-35*.

G.821 Measurement Definitions

The following error parameters were developed for testing error performance of digital links in terms of performance parameters.

Errored Second (ES)

This is the number of seconds with at least one error.

Error Free Seconds (EFS)

This is the count of error free seconds since the beginning of the test. Error free seconds equals the total test time minus the number of errored seconds.

Available Seconds (AS)

This is the count of available seconds since the beginning of the test. Available seconds equals the total test time minus any unavailable seconds.

Severely Errored Seconds (SES)

This is the count of Severely Errored Seconds since the beginning of the test. A second with a bit error rate of 10^{-3} or higher is a severely errored second. Severely errored seconds are not counted during unavailable time. Loss of signal (LOS), loss of frame (LOF), and loss of pattern synchronization (LOP) are treated as severely errored seconds

Unavailable Seconds (UAS)

This is the count of UnAvailable Seconds that have occurred since the beginning of the test. Unavailable time begins at the onset of 10 consecutive severely errored seconds, and ends after 10 consecutive non-severely errored seconds. The onset of unavailable seconds causes the SES count to be adjusted downward by 10. When unavailable time ends, the UAS count is adjusted downward by 10.

Degraded Minutes (DGRM)

This is the count of Degraded Minutes since the start of the test. A Degraded Minute occurs when a 10^{-6} bit error rate exists during 60 available, non-severely bit errored seconds.

E1 - 2 Mb/s Fundamentals

Wireless service providers use wired E1 - 2 Mb/s circuits as the backhaul links to connect a Base Transceiver Station (BTS) to a Mobile Switching Center (MSC). The quality of the service that is provided over those E1 - 2 Mb/s lines has a direct effect on the quality of service that is experienced by the wireless service provider customers. Call setup failures, dropped calls, data errors, and noise can often be attributed to the E1 - 2 Mb/s backhaul facilities. An example of typical wireless network backhaul E1 - 2 Mb/s links is shown in Figure 16-7.
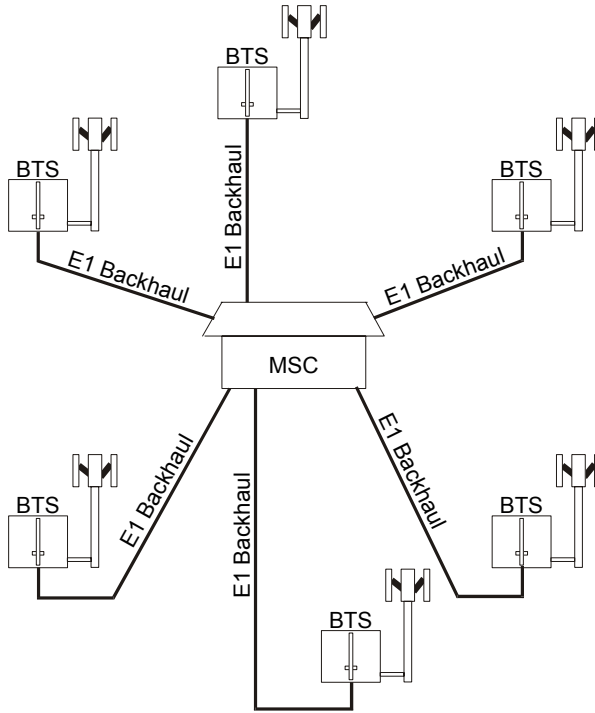
Figure 16-7. Typical Wireless Network Backhaul E1 - 2 Mb/s Link

E1 - 2 Mb/s is a digital signal that carries information at a rate of 2 Mbps. The E1 - 2 Mb/s signal is organized into frames, which are defined in ITU-T recommendations G.704 and G.706. Four framing types are defined: PCM30, PCM31, PCM30CRC, and PCM31CRC. Each 2 Mb/s frame contains 256 bits (32 timeslots, each containing 8 bits) at a repetition rate of exactly 8 kHz. The first timeslot (timeslot zero, TS0) is reserved for framing, error checking, and alarm signals. In PCM31, the remaining 31 timeslots can be used for traffic (TS1 – TS31), either encoded telephone or data signals. In PCM30, timeslot 16 (TS16) is reserved for channel associated signaling (CAS). Framing types PCM30 CRC and PCM31 CRC add a CRC-4 check to the framing format.

FAS and NFAS Words

The transmit and receive ends of the transmission path are synchronized with a frame alignment byte or signal (FAS = Si0011011) that is transmitted in TS0 of every second frame (frames 0, 2, 4, 6, and so on). A "nonframe alignment signal" (NFAS) is transmitted in TS0 of the alternate frames (that is, frames 1, 3, 5, 7 and so on).

After an FAS word has been correctly received, a '1' is expected in bit 2 of the NFAS word that is received in the next frame. If this occurs, and if the next frame contains a valid FAS word, then frame alignment is achieved. The receiving equipment can then correctly identify the individual 64 kb/s channels in the frame. If three frame alignment words in four are received in error, then the terminal equipment declares loss of frame synchronization and initiates re synchronization

Frame format G.704/G.706

125 µs

1 frame = 256 bits

3.9 µs
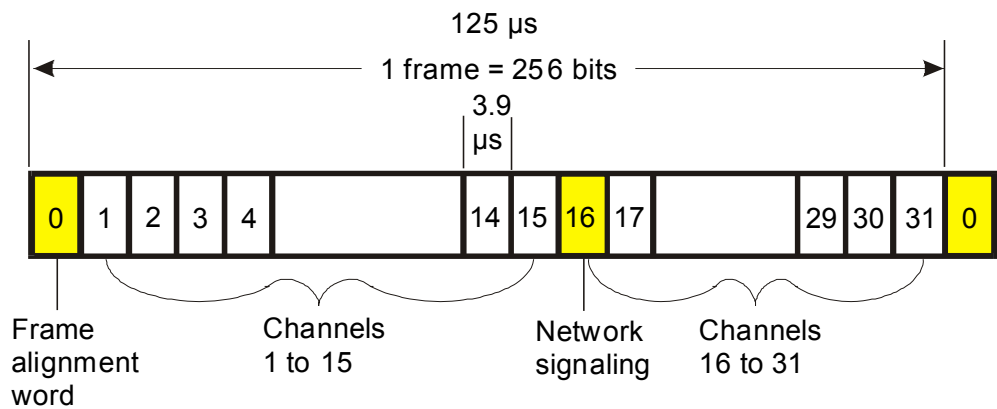
All time slots contain 8 bit words (PCM, data, sub-rate, data n x 64 kb/s)

Figure 16-8. Transmission Frame Alignment

CRC-4 Framing

When the PCM30 and PCM31 framing formats are used exclusively for PCM voice transmission, the frame alignment is very reliable. However, when data is transmitted on the link, the traffic can contain the FAS and NFAS bit patterns, and false framing is possible.

To improve the reliability of the standard framing formats, recommendation G.704 specifies the use of a CRC-4 cyclic redundancy check for 2 Mb/s systems. CRC-4 framing provides reliable protection against incorrect synchronization, and also provides a means of predicting bit error ratio (BER) performance during normal operation. The CRC-4 remainder is calculated on complete blocks of data, and the 4-bit remainder is transmitted to the far end, using the first bit in the FAS of each even numbered frame (C1–C4). At the receiving end, the receiver makes the same calculation and compares its results with those in the received signal. If the two 4-bit words differ, then the receiving equipment determines that one or more errors are present in the payload. Every bit of the block is checked so that an accurate estimate of block error rate (or errored seconds) is made while the link is in service.
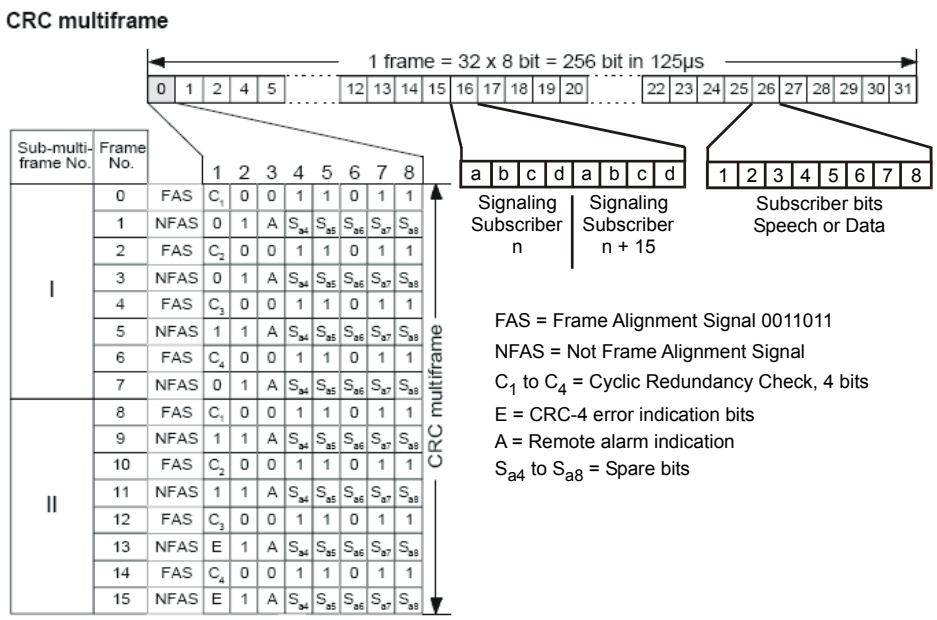
Figure 16-9. CRC-4 Framing

To enable the receiver to locate the four bits (C1, C2, C3, and C4) that form the remainder, an additional frame (called the CRC multiframe) is formed. A CRC multiframe alignment bit pattern (001011) is used to synchronize the receiver to this frame. The pattern is inserted in the first bit position of the NFAS in frames 1, 3, 5, 7, 9, and 11. The CRC-4 multiframe is further divided into sub-multiframes (SMF) I and II, both of which span eight normal PCM frames. Because each PCM frame is 125 uS long, each SMF is 1 mS long, and one thousand CRC-4 error checks are made every second.

The first bits of frame 13 and frame 15 are called E-bits, and are used to indicate that data blocks with bit errors were detected from the far end. When no errors are detected in the received data, both E-bits are set to one (1). When an error is detected in SMF I, the receiving equipment sets the E-bit in frame 13 to zero (0). The E-bit in frame 15 indicates error status from SMF II in the same way. As a result, the local equipment can use the E-bits to monitor the performance of both the transmit and receive paths.

Signaling

Signaling is used in networks to set up the connections between the transmitting and receiving ends of a circuit. Two methods are available to carrying signaling information in E1 - 2 Mb/s frames: common channel signaling (CCS) and channel associated signaling (CAS). With CCS, the signaling data is carried in each channel. For CAS, the signaling data for all thirty channels is carried in TS16. The signaling information for each channel consists of four bits that are called ABCD bits. Historically, the state of the ABCD bits represented the On-hook and Off-hook states of a dial-pulse telephone.

The 8 bits in TS16 are not sufficient to hold the signaling information for all 30 channels in a single E1 - 2 Mb/s frame. Therefore, when CAS is used, a signaling multiframe structure is required in order to distribute the signaling information over 16 E1 - 2 Mb/s frames. After the equipment has gained primary frame alignment, it searches in timeslot 16 for the signaling multiframe alignment signal (MFAS) (0000) in bits 1 to 4. After the MFAS signal is located, the signaling information is extracted in the 15 frames following the MFAS, with the ABCD bits (for two channels) contained in each TS16.

If CCS (common channel signaling) is used, then signaling multiframe alignment is unnecessary. Timeslot 16 is used as a 64 kb/s data channel for CCS messages, or it can be turned over to revenue-earning traffic, yielding a total of 31 channels for the payload (PCM31).

Network Equipment

One possible network topology is shown in Figure 16-10.
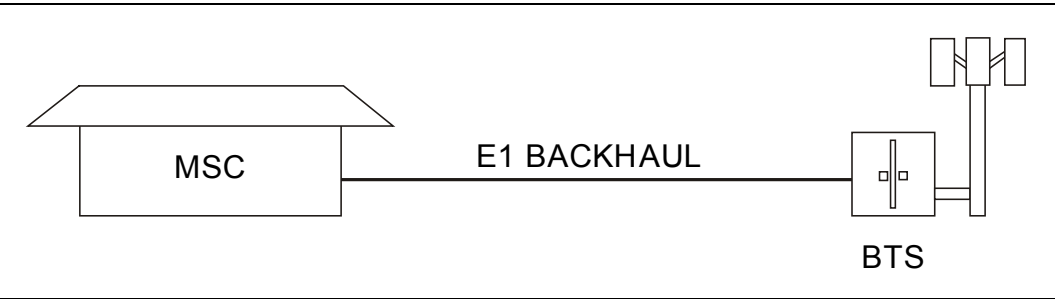
Figure 16-10. One Possible E1 - 2 Mb/s Network Topology

The circuit between the MSC (Mobile Switching Center) and BTS (Base Transceiver Station) passes through the central office, or through multiple central offices. Within each office, it may also pass through multiple pieces of transmission equipment. An interface unit is located at the MSC and BTS. The interface unit may be a simple device having only a remote loop back capability, or it may provide sophisticated performance monitoring capabilities. Its capabilities may or may not be accessible to the wireless service provider technician.

BTS Master E1 - 2 Mb/s Display

The E1 - 2 Mb/s display consists of the main display window, the left status display window, and the upper status display window.

The Left Status Display Window shows the status of E1 - 2 Mb/s key parameters, including the Test Mode, Line Code, TxClock, Receive Input, Framing Mode, Error Type, Pattern, Payload, Impedance, and Measurement Status.

The bottom hard keys control the soft keys on the right. Five active hard keys are provided: **Configuration, Pattern, Error/Alarm, Measurements, Start/Stop.**

The Upper Status Display Window shows status of the Receive (Rx), Transmit (Tx), and Alarm/Error parameters. The Rx shows the history and current status of the Signal, Frame Alignment Signal (FAS), and the Pattern Sync. The first column shows the history, and the second column shows the current status. A red indicator signifies an error, and a green indicator signifies no error. The history can be cleared by pressing **Measurements** and then Clear History.

> NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.
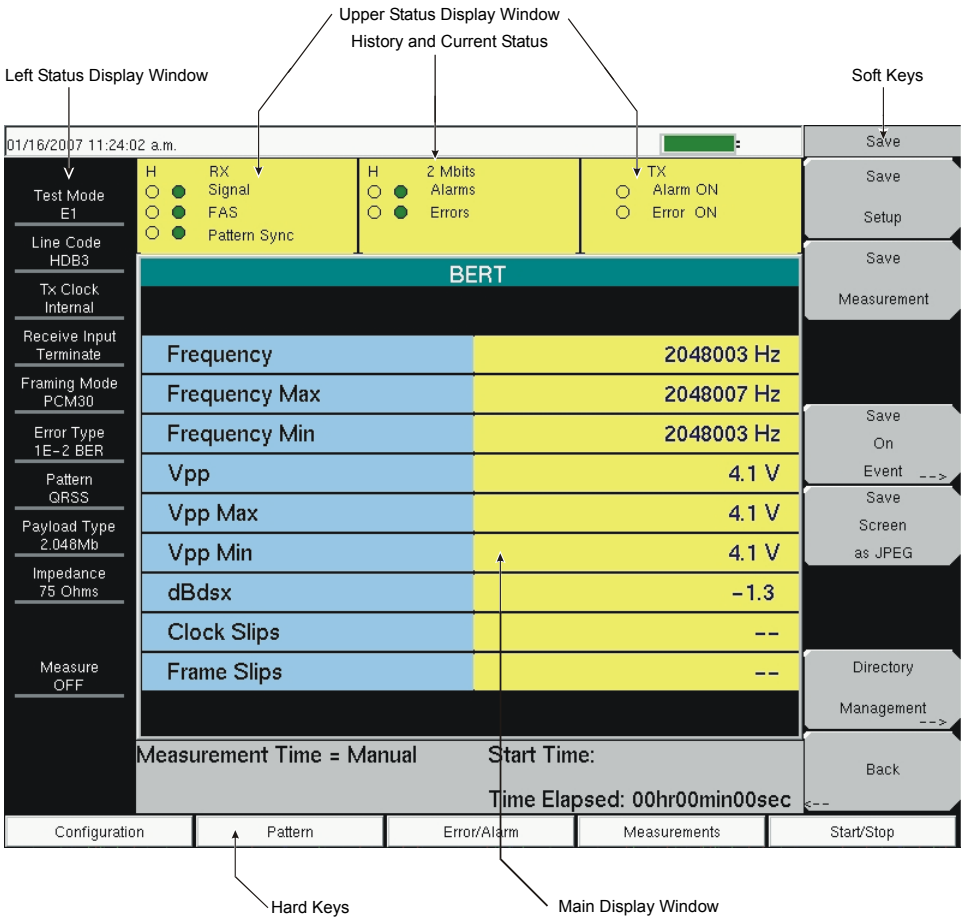
Figure 16-11. E1 - 2 Mb/s Display Overview

Configuration Menu

The configuration is accessed by pressing the **Configuration** hard key. This menu is used to configure the Signal Setup and Payload Setup. The Signal Setup allows the user to set up the Line Code, Tx Clock, Input Connector, Rx Input, and Framing information. The Payload Setup allows the user to set up the payload type and payload channels for payload types other than 2.048 Mb.
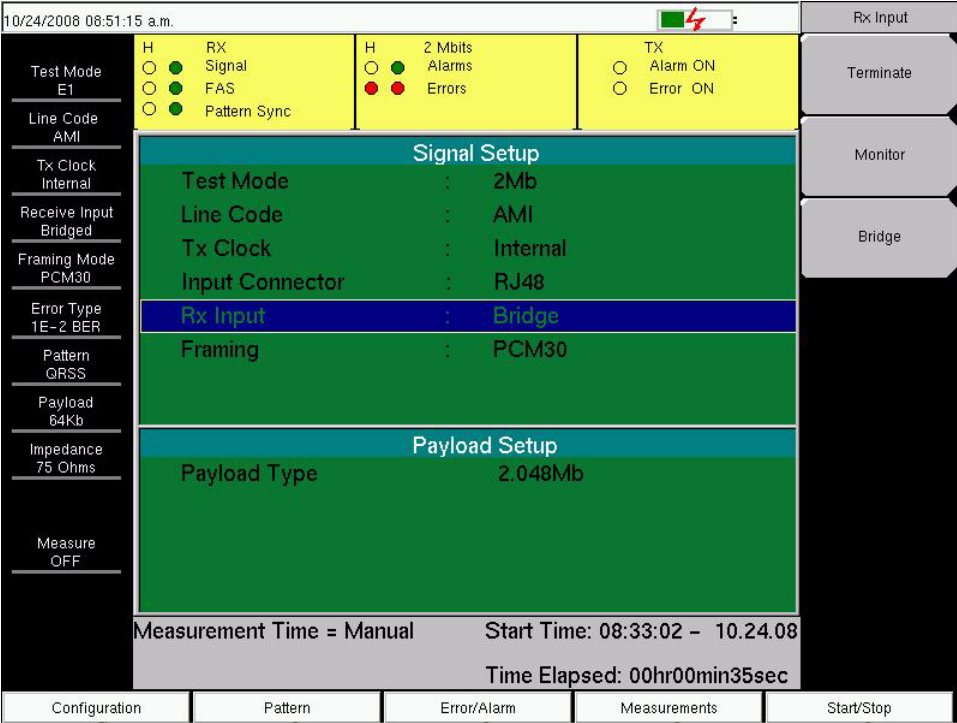
Figure 16-12. Configuration Setup

Soft keys for the Configuration menu are shown and described in section *Configuration Menu Soft Keys* and in Figure 16-15.

Test Mode: 2Mb

E1 - 2 Mb/s is a 2.048 Mbit/s signal consisting of 32 individual timeslots. Each timeslot has individual 64 kbit/s channels of data.

Line Code: AMI and HDB3

Alternate Mark Inversion (AMI) and High Density Bipolar 3 (HDB3) are two different line coding formats used in E1 - 2 Mb/s networks.

In the AMI format, a binary one is represented by a pulse, and a zero is indicated by the lack of a pulse. To eliminate any DC offset, the pulses alternate in polarity. Because the pulses are alternating in polarity, the line code is called Alternate Mark Inversion (AMI). If two consecutive pulses have the same polarity, then a Bipolar Violation (BPV) has occurred.

When no traffic is present on a channel, AMI coding can result in long strings of zeros on the circuit. This can cause the receiving equipment to have timing errors. HDB3 is a line coding format which also has no DC offset, but which replaces strings of 4 or more zeros with a specific code containing a BPV. The next HDB3 insertion uses the opposite polarity to maintain a net zero DC offset on the circuit. The HDB3 code is detected and removed by the receiving equipment.

TxClock: Internal, External, Recovered

Internal Clock: The internal clock uses an internal oscillator: 2.048 Mbps ± 5 ppm

Recovered Clock: The transmit clock uses the frequency recovered from the received signal.

External Clock: An external clock can be applied to the External Frequency Reference Input.

Input Connector

RJ48, 120 Ω

RJ48, 75 Ω

BNC, 75 Ω

Rx Input

Terminate: The signal is terminated in 120 ohms or 75 ohms.

Bridge: The input impedance of the receiver is greater than 1000 ohms. The bridged mode is used when connecting directly to an in-service E1 - 2 Mb/s circuit in order to avoid causing a "hit" on the signal and to avoid disrupting service.

Monitor: The connection to the circuit is made through a monitor jack. The jack is isolated from the circuit with resistors, and the signal is typically 20 dB down from the nominal signal level. When Monitor is selected, 20 dB of flat gain is added at the receiver input.

Measuring Clock and Frame Slips in E1 - 2 Mb/s Mode

If an E1 - 2 Mb/s SETS (Synchronous Equipment Timing Source) reference clock is available, then it can be used to measure clock slips and frame slips on the circuit under test. If two or more E1 - 2 Mb/s circuits are present, then one of these can be used as a reference. The reference circuit (in this configuration) should be out of service because it will be terminated by the clock recovery circuit in the BTS Master.

To count clock slips, connect the reference clock to the Ext Ref In connector on the BTS Master. The presence of the clock is automatically detected, and when a measurement is started, the number of clock slips and frame slips are reported. When the clock frequencies are very close, the clock slip count will hover around zero. If the frequency of the circuit under test is higher than the reference frequency, then the count will grow positive. If the frequency of the circuit under test is lower than the reference frequency, then the count will grow negative. One frame slip is counted for 256 clock slips.

Framing

PCM30: 30 voice or data channels, TS16 is used for CAS, no CRC-4 multiframe.

PCM30 CRC: 30 voice or data channels, TS16 is used for CAS, with CRC-4 multiframe.

PCM31: 31 voice or data channels, no CRC-4 multiframe.

PCM31 CRC: 31 voice or data channels, with CRC-4 multiframe.

Payload Type

The Payload identifies which portion of the 2 Mb/s data stream will be accessed for testing.

2.048 Mb: The entire data stream (except for TS0, and TS16 when CAS is active) is tested.

Nx64kb/s: Selected combinations of 64 kb channels are tested. This mode is referred to as fractional E1 - 2 Mb/s.

64 kb: A single 64 kb channel is tested.

16 kb: 2 consecutive bits within a single 64 kb channel are tested.

8 kb: A single bit within a selected 64 kb channel is tested.

Pattern Menu

The pattern menu can be accessed by pressing the **Pattern** hard key on the bottom. It includes 12 defined patterns. Up to six user-defined patterns can be created by pressing the Set User Pattern soft key.
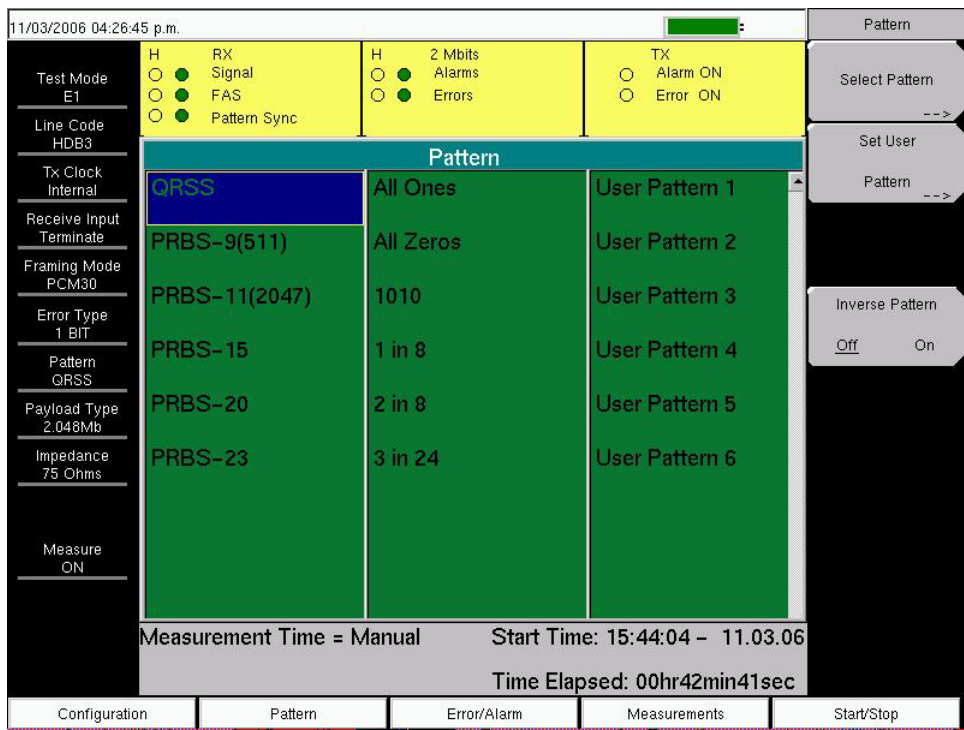
Figure 16-13. Pattern Menu

Soft keys for the Pattern menu are shown and described in section *Pattern Menu Soft Keys on page 16-31* and Figure 16-20.

QRSS

- 1,048,575-bit pattern. An output bit is forced to one whenever the previous 14 bits are zero.

- Simulates live traffic including both high-density and low-density sequences.

1 IN 8 (also 1 IN 7)

- 8-bit pattern of a 1 and 7 zeros.

- Checks clock recovery on circuits optioned for HDB3.

2 IN 8

- 8-bit pattern of 2 ones and 6 zeros.

- Used to determine correct optioning of AMI or HDB3 line coding.

3 IN 24

- 24-bit pattern with 3 ones and also with 15 consecutive zeros. 12.5% ones density.
- Stresses AMI optioned circuits for minimum ones density and maximum consecutive zeros performance. Forces zero substitutions in HDB3 optioned circuits.

ALL ONES

- All ones sent as payload in a framed sequence.
- Stresses ability of circuit to operate under maximum power conditions.

ALL ZEROS

- All zeros sent as payload in a framed sequence.
- Checks for HDB3 optioning. Circuit will drop if optioned for AMI.

PRBS-15

- 32,767-bit pseudo-random pattern.
- Tests to CCITT recommendations O.151 and G.703. Provides maximum number of zeros for testing non-HDB3 circuits.

PRBS-20

- 1,048,575-bit pseudo-random pattern.

PRBS-23

- 8,388,607-bit pseudo-random pattern.

NOTE: Custom user-defined codes can be created by pressing the *Set User Pattern* soft key. See *Set User Pattern on page 16-31*.

Error/Alarm

The Error/Alarm menu includes all the errors and alarms that can be added to the transmission path. Press the **Error/Alarm** hard key to access the Error/Alarm menu.
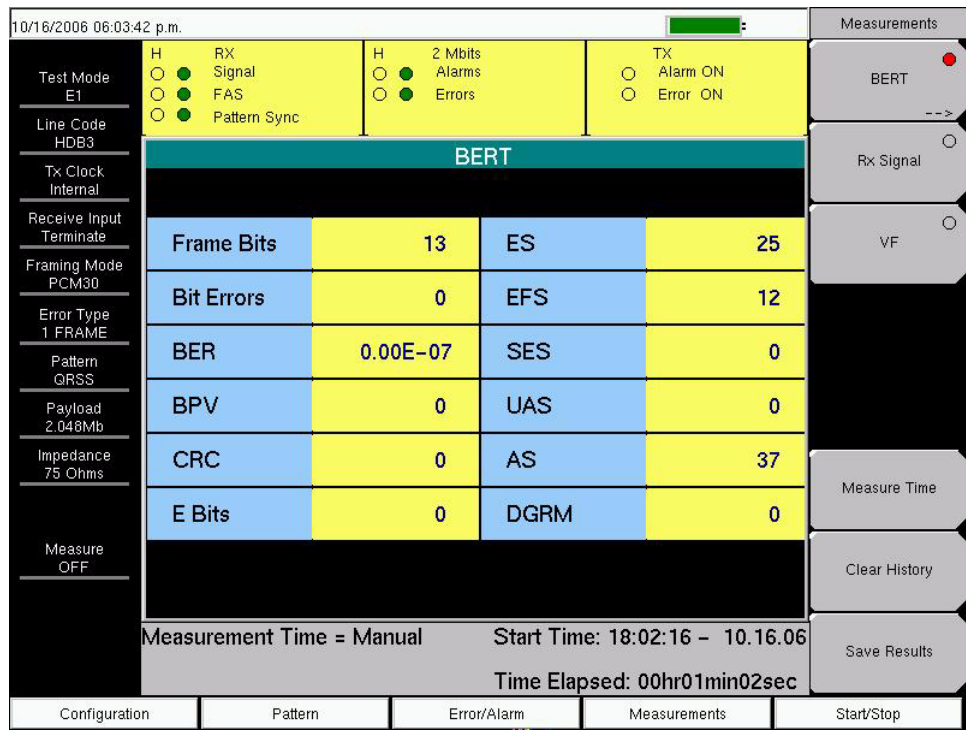
Figure 16-14. Alarm/Error Menu

Soft keys for the Alarm/Error menu are shown and described in section *Error/Alarm Menu Soft Keys on page 16-32* and Figure 16-21.

Frame Bit Errors: Inserts errors in the framing bits. Frame Bit errors can be selected by pressing Frame Bit Error. A burst between 1 and 1000 can be selected by pressing the Bit Error soft key. The Error On/Off soft key is used to turn the burst on.

Bit Errors: Inserts errors in the BER pattern. Bit errors can be selected by pressing Bit Error. A burst between 1 and 1000 can be selected by pressing the Bit Error soft key. The Error On/Off soft key is used to turn the burst on.

BER (Bit Error Rate): Errors can be added to the transmission path by pressing the BER soft key. Valid BER include 1E–2, 1E–3, 1E–4, 1E–5, 1E–6, and 1E–7. If a BER value of 1E–3 is selected, then 1 error for every 1000 bits will be introduced. Pressing ON keeps errors adding. Pressing OFF stops the errors.

AIS (Alarm Indication Signal) Alarm: When the AIS is turned on, the data is replaced with an unframed signal of all ones.

RAI (Remote Alarm Indicator) Alarm: If the terminal loses its incoming signal, then an RAI signal is transmitted in the outgoing direction. RAI is also called Yellow Alarm.

Soft Key Menus

The following soft key menus are specific to the Anritsu BTS Master MT8222A with Option 52 installed.

Function Hard Keys: **Configuration, Pattern, Error/Alarm, Measurements, Start/Stop**

Configuration Menu Soft Keys

Configuration Menu
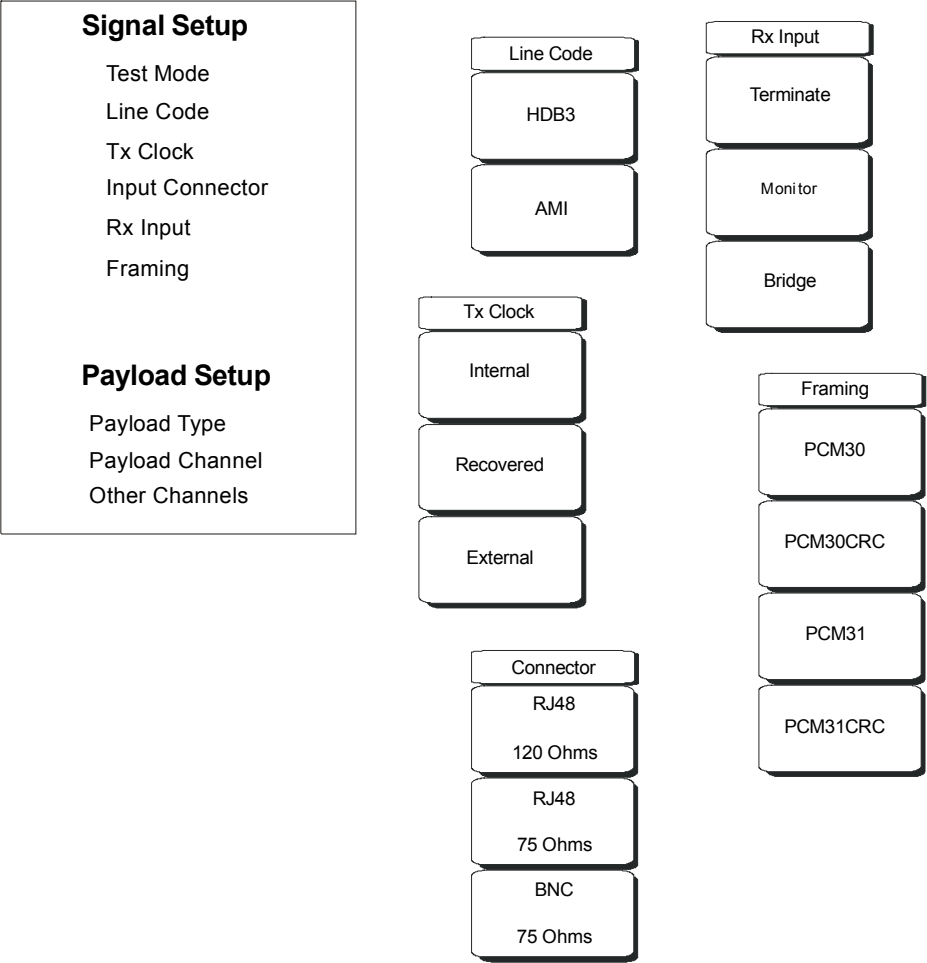
Figure 16-15. Signal Setup Soft Key Menus

Signal Setup

Test Mode
This signal setup has no soft keys.

Line Code
See *Line Code: AMI and HDB3* .

HDB3
This soft key selects High Density Bipolar 3 (HDB3) line coding.

AMI
This soft key selects Alternate Mark Inversion (AMI) line coding.

Tx Clock

See *Measuring Clock and Frame Slips in E1 - 2 Mb/s Mode* .

Internal
This soft key selects the internally generated Tx Clock.

Recovered
This soft key selects a clock signal that is recovered from the receive path.

External
This soft key selects a clock from an external reference.

Input Connector

RJ48, 120 Ohms
This soft key selects the 120 ohm RJ48 connector.

RJ48, 75 Ohms
This soft key selects the 75 ohm RJ48 connector.

BNC, 75 Ohms
This soft key selects the 75 ohm BNC connector.

Rx Input

Terminate
This soft key selects terminate mode. Terminations on the receive side can be 75 ohm or 120 ohm, or can be bridged for higher resistance.

Monitor
This soft key adds +20 dB gain to the receive path.

Bridge
This soft key sets up a bridged connection with >1000 ohms.

Framing

PCM30, PCM30CRC, PCM31, and PCM31CRC
These soft keys select the framing format.

Payload Setup

2.048Mb

Select this payload type to test all user channels, the entire data stream (except for TS0, and TS16 when CAS is active).

Nx64kb, 64kb, 16kb, and 8kb

In these payload types, the Channel Selection Dialog Box allows selection of one or more channels for testing, from 1 through 31. Press the Edit Channel soft key to open the Channel Selection Dialog Box.

Use the arrow keys or the rotary knob to scroll through the channels. Press the Select Channel soft key to select a channel or to clear an existing selection. Then press the **Enter** key or the **Rotary Knob** to enter the selection. If the Back soft key is pressed, then any changes to channel selection are ignored, the dialog box is closed, and the Payload Sub Channel soft key menu is displayed.

Nx64kb

In this payload type, any number of channels can be selected, including all or none. Because multiple channels can be selected, the Channel Selection soft key menu offers two additional soft keys: Select All Channels and Clear All Channels. Refer to Figure 16-16.

64kb

Use this payload type to select a single 64 kb channel.

16kb

Use this payload type to select 2 consecutive bits within a single 64 kb channel.

8kb

Use this payload type to select a single bit within a selected 64 kb channel.
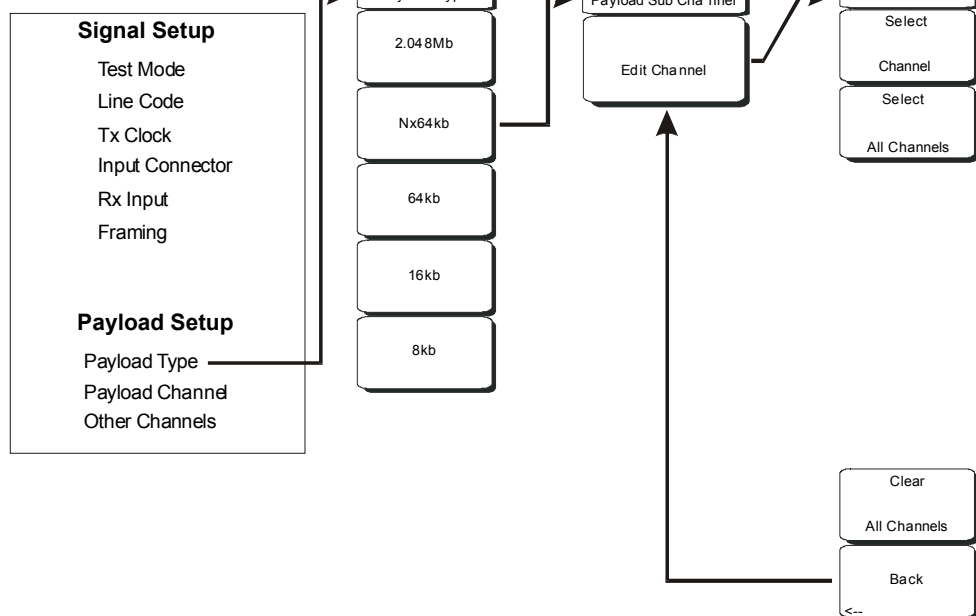
Figure 16-16. Payload Setup Soft Key Menus for Type Nx64kb
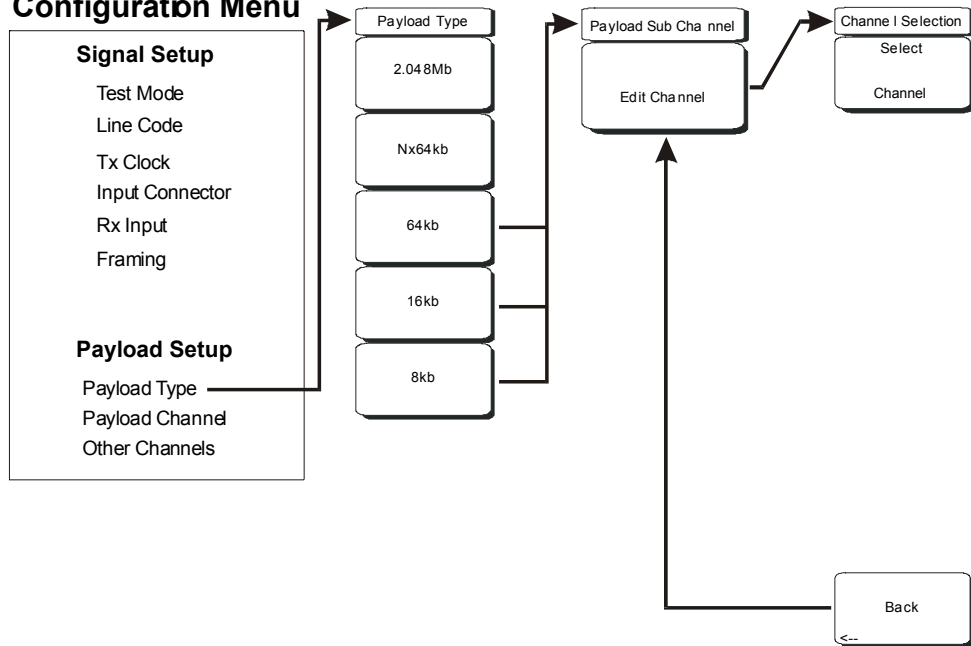
Figure 16-17. Payload Setup Soft Key Menus for Types 64kb, 16kb, and 8kb

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Configuration Menu

Signal Setup

   Test Mode

   Line Code

   Tx Clock

   Input Connector

   Rx Input

   Framing

Payload Setup

   Payload Type

   Payload Channel

   Other Channels

Payload Sub Channel
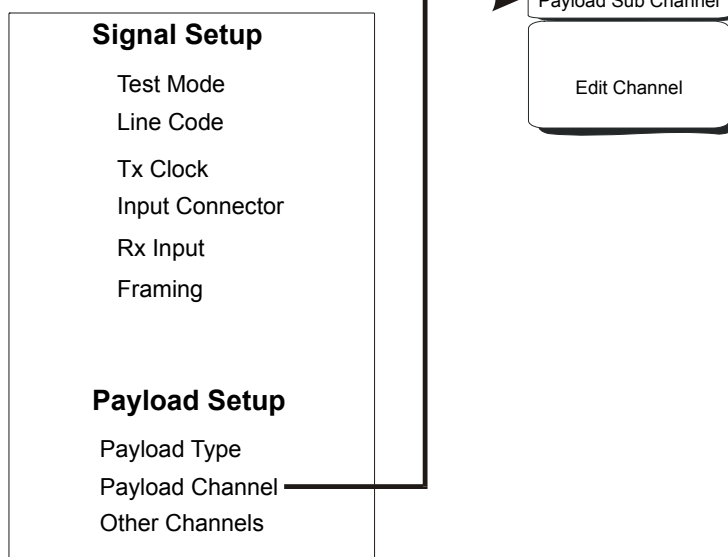
Edit Channel

Figure 16-18. Payload Setup Soft Key Menu for Payload Channel

Payload Channel

Payload Sub Channel

Edit Channel
Pressing this soft key opens the Channel Selection Dialog Box and the Channel Selection soft key menu.

Configuration Menu

Signal Setup

Test Mode

Line Code

Tx Clock

Input Connector

Rx Input

Framing

Payload Setup

Payload Type

Payload Channel

Other Channels

Other Channels

All Ones

Idle
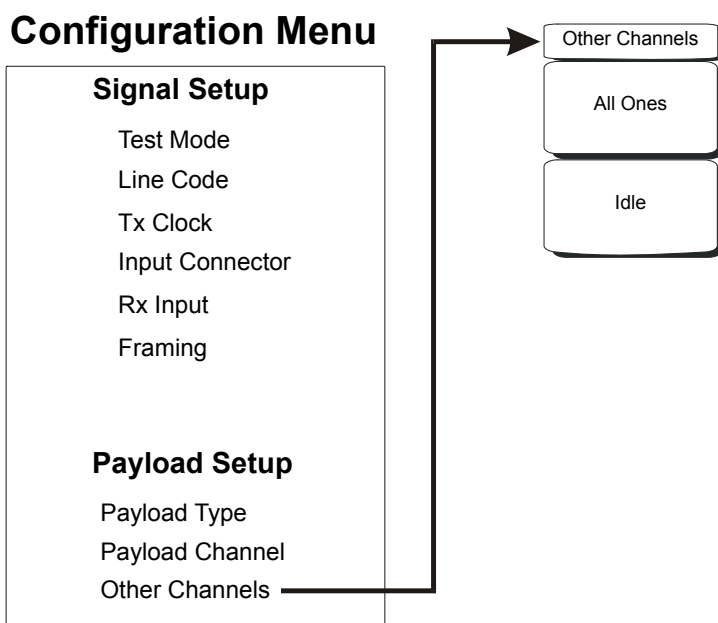
Figure 16-19. Payload Setup Soft Key Menu for Other Channels

Other Channels

When this configuration line is selected, the Other Channels soft key menu is displayed.

Other Channels

All Ones

Press this soft key to set all unselected channels to "all ones."

Idle

Press this soft key to set all unselected channels to "idle."

Pattern Menu Soft Keys
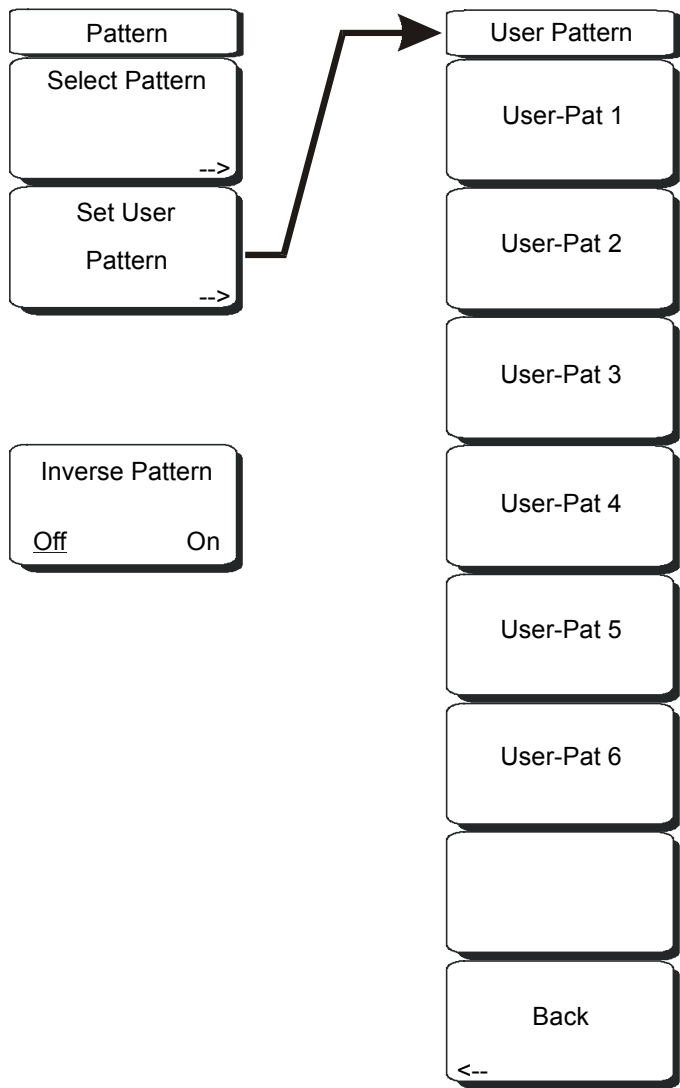
Figure 16-20. Pattern Soft Keys

Pattern Soft Keys

Select Pattern
After highlighting a pattern, use this soft key to select the pattern.

Set User Pattern
Use this soft key to select a specific user pattern from a list of six patterns, which can be configured separately.

User-Pat #
These six soft keys each select a different pattern. Enter zeros or ones, up to a maximum of 24 bits. Press **Enter** to continue or **Esc** to abort.

Back
Returns to the Pattern menu.

Inverse Pattern, Off/On
This soft key toggles the Inverse Pattern function Off and On.

Error/Alarm Menu Soft Keys
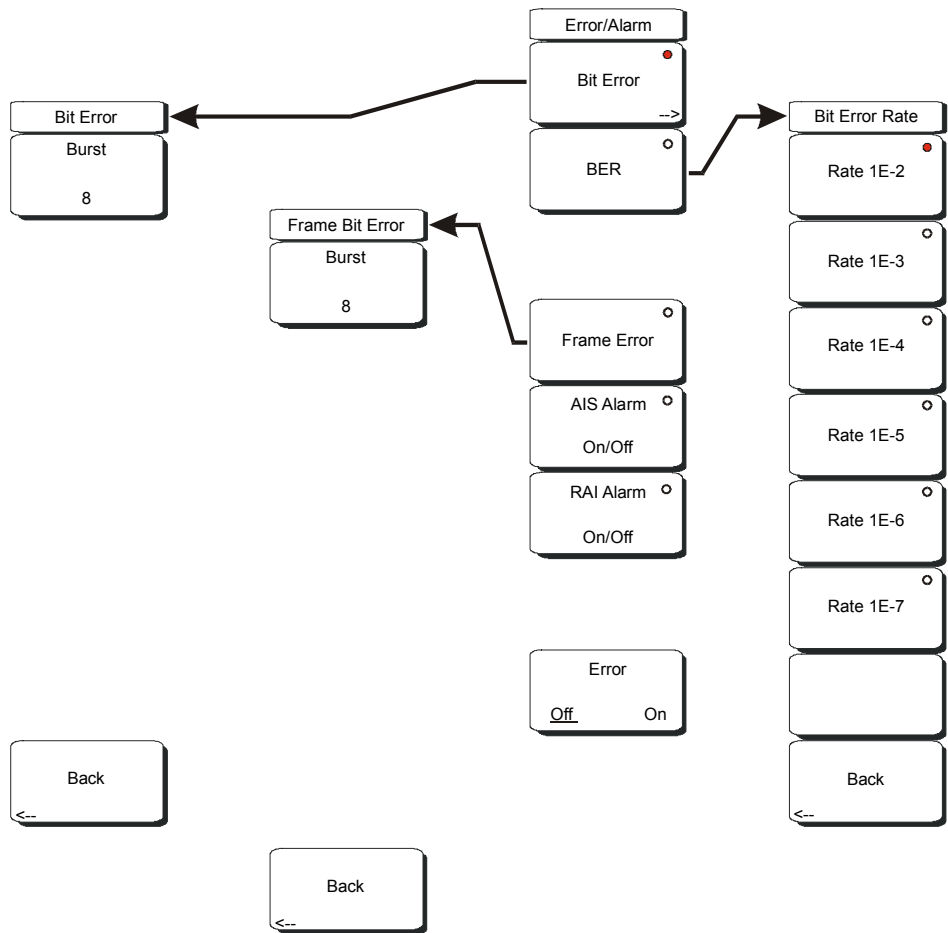
Figure 16-21. Error/Alarm Soft Keys

Error/Alarm Soft Keys

Bit Error
Use this soft key to insert a bit error. If not already selected, press this soft key once to select the function, and the soft key label displays the circle indicator in red (to show that the key is active). Press the key again to enter the Bit Error menu. When not active, this soft key has no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when this soft key is active.

Burst #
Bit Error Insert, 1 to 1000. Set this parameter by pressing the Burst soft key and then using the rotary knob, arrow keys, or number keypad. Then press the rotary knob or the **Enter** key. If you use the number keypad, then the Burst soft key label changes to Enter, and the soft key is used to enter the parameter value.

Back

Press this soft key to return to the Error/Alarm menu.

BER

If not already selected, press this soft key once to select the function, and the soft key label displays the circle indicator in red (to show that the key is active). Press the key again to enter the Bit Error Rate menu. Choose from the six rate options and press Back to continue. When not active, this soft key has no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when this soft key is active.

Bit Error Rate Soft Keys

Rate 1E-#

These six soft keys are labeled with number 1E-2 through number 1E-7. Use these soft keys to select a bit error rate.

Back

Press this soft key to return to the Error/Alarm menu.

Frame Bit Error

Use this soft key to insert a frame bit error. If not already selected, press this soft key once to select the function, and then the soft key label displays the circle indicator in red (to show that the key is active). Press the key again to enter the Frame Bit Error menu. When not active, this soft key has no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when this soft key is active.

Burst #

Frame Error Insert, 1 to 1000. Set this parameter by pressing the Burst soft key and then using the rotary knob, arrow keys, or number keypad. Then press the rotary knob or the **Enter** key. If you use the number keypad, then the Burst soft key label changes to Enter, and the soft key can be used to enter the parameter value.

Back

Press this soft key to return to the Error/Alarm menu.

AIS Alarm, On/Off

Press this soft key to turn ON the AIS Alarm function, and the soft key label displays the circle indicator in red (to show that the key is active). "Error Type AIS" is displayed in the Error Type message (in the instrument settings summary area at the left of the display window). The Alarm ON circle indicator (in the TX portion of the upper status display window) is displayed in red when this parameter is ON. Selecting this function automatically turns the Error, Off/On soft key function to Off, and its circle indicator in the TX portion of the upper status display window is displayed as an open circle. Pressing this soft again turns the alarm Off, its circle indicator is displayed as an open circle, and the Bit Error soft key becomes active (its circle indicator is displayed in red).

RAI Alarm, On/Off

Press this soft key to turn ON the RAI Alarm function, and the soft key label displays the circle indicator in red (to show that the key is active). "Error Type RAI" is displayed in the Error Type message (in the instrument settings summary area at the left of the display window). The Alarm ON circle indicator (in the TX portion of the upper status display window) is displayed in red when this parameter is ON. Selecting this function automatically turns the Error, Off/On soft key function to Off, and its circle indicator in the TX portion of the upper status display window is displayed as an open circle. Pressing this soft again turns the alarm Off, its circle indicator is displayed as an open circle, and the Bit Error soft key becomes active (its circle indicator is displayed in red).

Error, Off/On

This soft key is active only when the BER soft key is active. Press this soft key to toggle Error Off and On. The Error ON circle indicator (in the TX portion of the upper status display window) is displayed in green when this parameter is ON.

Measurements Menu Soft Keys

Figure 16-22. Measurements Soft Keys

Measurements Soft Keys

BERT
This soft key opens the BERT menu. If not already selected, press this soft key once to select the function, and the soft key label displays the circle indicator in red (to show that the key is active). Press the key again to enter the BERT menu. When not active, this soft key has no arrow to indicate a sub menu, and the circular indicator has a plain background. The circular indicator with a red background and the sub menu arrow appear only when this soft key is active.

Table
Press this soft key to display the 12 BERT parameters and their settings in a table format. The circular indicator changes to a red background when this key has been pressed.

Histogram
Press this soft key once to make it active and to display a histogram of parameters, as shown in Figure 16-4 on page 16-8. Press the soft again to bring up the Histogram soft key menu. The circular indicator with a red background and the sub menu arrow appear only when this soft key is active.

Zoom In
Use this soft key to change the graph display width to a smaller value.

Zoom Out
Use this soft key to change the graph display width to a larger value.

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Window Size, (numeric indication)

This soft key displays the time units in the format 0d:00:00:00, in days, hours, minutes, or seconds (0d:HH:MM:SS). Seconds are 00 by default and cannot be changed. When the setting is less than 1 day, the day units are not shown, and the format is 00:00:00 (HH:MM:SS).

Setting the time sets a display graph width of 1, 5, or 15 minutes; 1, 6, or 12 hours; or 1, 2, or 3 days. When pressed, the soft key color changes to a darker background, and the numeric value is displayed in red. The labels (Display window 00:10:00) in the graph area of the display are also in red. The red color indicates that the time can be changed.

Use the arrow keys to change the values from 1 minute to 3 days in the 9 increments that are available. The value can also be set by using the number keys. Press an appropriate number or numbers, and the soft key menu changes to Time increments, as shown in Figure 16-23.

Figure 16-23. Histogram Time Units Menu

Press the time units soft key to enter the time value. The Window Size soft key remains active until you press the **Enter** key or the **Rotary Knob.**

Turning the rotary knob in the Histogram view scrolls a vertical yellow marker line across the histogram graph.

Time Units, Relative or Absolute

This soft keys toggles between relative and absolute time.

Back

Press this soft key to return to the BERT menu.

Event List

Press this soft key to display a chronological event list with 4 columns. The column labels are "Date", "Time", "Event Type", and "Events."

Clear History

Press this soft key to erase the history of displayed events and measurements.

Back

Press this soft key to return to the Measurements soft key menu.

Rx Signal

This soft key has an indicator which is displayed with a red background when the function is active. The soft key opens a BERT list that includes the following indications and their values:

- Frequency
- Frequency Max
- Frequency Min
- Vpp
- Vpp Max
- Vpp Min
- dBdsx
- Clock slips
- Frame Slips

VF

Press this soft key once to display the frequency and power of VF signals. Press the soft key again to open the VF soft key menu.

Transmit, Off/On

This soft key toggles Transmit Off and On.

Channel number

This soft key opens a dialog box to select a channel value from 1 (minimum) to 31 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value, and then press **Enter** to continue, or press **Esc** to abort.

Tx Frequency

This soft key opens a dialog box to select a frequency in Hz from 100 (minimum) to 3000 (maximum). Use the numeric keys to enter a value, or use the arrow keys or the rotary knob to select a default value, and then press **Enter** to continue, or press **Esc** to abort.

Tx Level

This soft key opens a dialog box to select a Tx level in dBm from –30 (minimum) to 0 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value, and then press **Enter** to continue, or press **Esc** to abort.

Volume

This soft key opens a dialog box to set the volume from 0 (minimum) to 90 (maximum). Use the arrow keys, the rotary knob, or the numeric keys to enter a value in increments of 5, and then press **Enter** to continue, or press **Esc** to abort.

Audio, Off/On

This soft key toggles Audio Off and On.

Clear History

Press this soft key to erase the history of displayed events and measurements.

Back

Press this soft key to return to the Measurements soft key menu.

Measure Time

This soft key opens a dialog box to set the measurement time from 1 minute (minimum) to 3 days (maximum). Use the arrow keys or the rotary knob to enter a value, and then press **Enter** or the **Rotary Knob** to continue, or press **Esc** to abort.

Clear History
Press this soft key to erase the history of displayed events and measurements.

Save Results
Press this soft key to save the results of a measurement.

Mode Menu

To access the functions under the Mode menu, press the **Shift** key, then the **Mode** (9) key. Use the directional arrow keys or the rotary knob to highlight the selection and press the **Enter** key to select. The list of modes that appears in this menu will vary depending upon the options that are installed and activated in your instrument. is an example of the Mode menu. Your instrument may not show the same list.

Chapter 17
Power Monitor

Introduction

When equipped with Option 5, Power Monitor, the BTS Master can be used for making power measurements with broadband RF detectors, such as those listed in the table of available RF Detectors . The power monitor displays the measured power results in dBm or Watts.

Procedure

1. Connect the power sensor to the BTS Master RF Detector port.
2. Turn the BTS Master on.
3. Press the **Measurement** function hard key and press the Power Monitor soft key.

Zeroing the Power Monitor

• With no power applied to the DUT, press the Zero soft key. Wait for a few seconds while the BTS Master accumulates data samples of the quiescent power. When complete, Zero: On is displayed in the message area.

Measuring High Input Power Levels

1. Insert an attenuator between the DUT and the RF Detector to protect the BTS Master so that the power level is less than or equal to +16 dBm.
2. Press the Offset soft key and enter the attenuation, in dB, using the keypad, the arrow keys, or the rotary knob.
3. Press the **Enter** key to complete the entry.
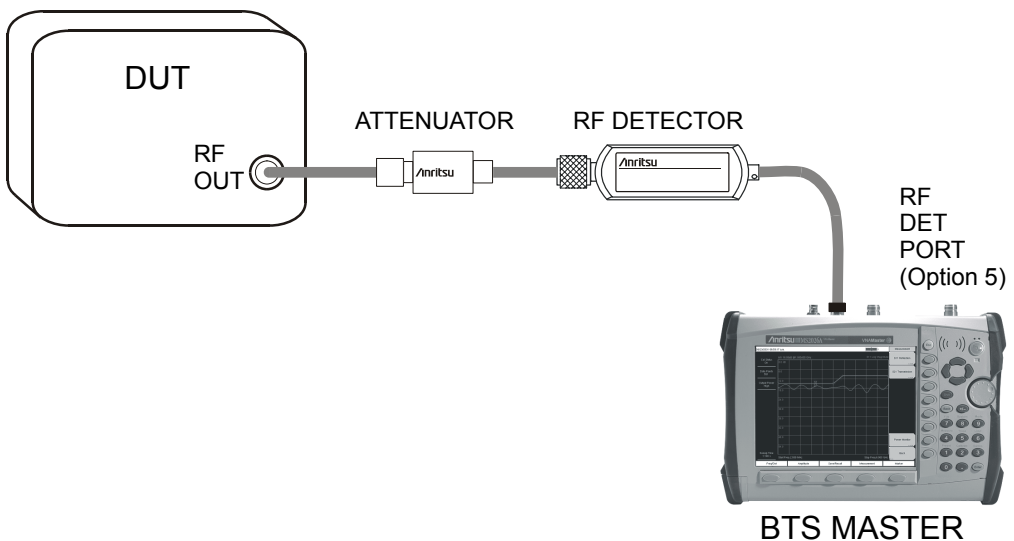
Figure 17-1. Power Measurement Setup With Attenuator

Display Power in dBm or in Watts

Press the Units soft key to toggle between dBm and Watts.

Relative Power

With the desired base power level input to the BTS Master, press the Relative soft key. The power reading will show 100% because it is measuring the same power level.

If the power is lowered by 3 dB, the relative power will show 50%.

If the power in Watts is increased from 1 Watt to 2 Watts, the relative power will show 200%.

> NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.
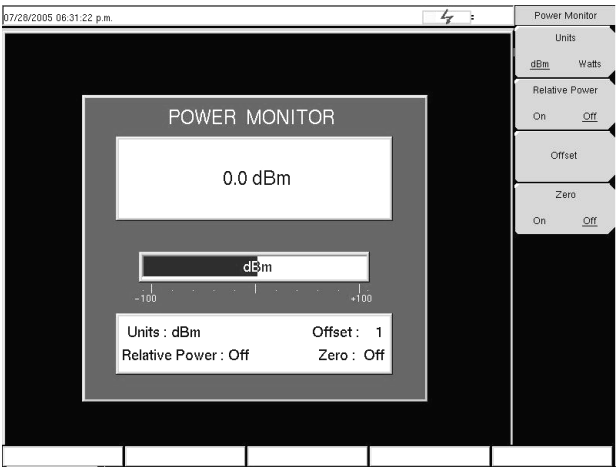
Figure 17-2. Power Monitor Display

Chapter 18
GPS Option

Introduction

The MT8222A BTS Master is available with a built-in GPS receiver feature (Option 31) that can provide latitude, longitude, altitude, and UTC timing information. This option also enhances frequency reference oscillator accuracy.

Within three minutes of satellite acquisition, the reference oscillator will have an accuracy of better than 25 ppb (parts per billion). The OCXO internal standard accuracy is ±0.3 PPM. The correction factor applied to the internal OCXO allows the instrument to maintain GPS frequency accuracy for three days at better than 50 ppb, even when the instrument is obstructed from receiving signals from the GPS satellites.

In order to acquire data from the GPS satellites, the user must have line-of-sight to the satellites or the antenna must be placed outside with out any obstructions. The following GPS antenna is provided with the unit:

• 2000-1410 Magnet Mount GPS Antenna with 15-foot cable

Activating the GPS Feature

To activate the GPS feature:

1. Install the Anritsu GPS antenna to the GPS antenna connection on the BTS Master connector panel.

> NOTE: The GPS antenna connection on the BTS Master is fitted with a reverse BNC connector to help prevent damage to the GPS circuitry. There is a DC voltage present on this connector. Do not connect anything other than the Anritsu GPS antenna to this port.

2. Press the **Shift** then **System** (8) keys to open the system options.
3. Press the GPS soft key to open the GPS menu.
4. Press the GPS On/Off soft key to turn the GPS feature on or off. When GPS is first turned on, the GPS icon below will be displayed in red:

Figure 18-1. GPS Icon, Red

When the GPS receiver is tracking at least three satellites, the GPS icon will change to green.

Figure 18-2. GPS Icon, Green

NOTE: As long as three minutes may be required for the Ref Freq status to change to GPS High Accuracy in the Status menu that is displayed on the left side of the screen.

5.   Press the GPS Info soft key to view the number of tracked satellites, latitude, longitude, altitude, and UTC timing information, and so forth.

NOTE: Press the Reset soft key to reset the GPS.

The green GPS icon with a red cross (below) appears when GPS satellite tracking is lost.

Figure 18-3. GPS Icon, Green with Red Cross

When GPS High Accuracy is achieved, the internal reference is adjusted and will hold this adjusted value even when GPS satellites can no longer be received. This status will be indicated by Internal High Accuracy showing in the Status menu displayed on the left side of the screen. This improved accuracy will hold for up to 72 hours.

NOTE: When the GPS feature is not enabled, the reference source will display either "Internal Standard Accuracy" or a user selected external reference frequency in the Status menu on the left side of the screen.

Chapter 19
Fixed WiMAX Signal Analyzer

Introduction

The MT8222A BTS Master offers two Fixed WiMAX options: Fixed WiMAX RF Measurements and Fixed WiMAX Demodulator. Connect the BTS Master to any Fixed WiMAX BTS for accurate RF and demodulator measurements. The BTS Master works for FDD and TDD networks.

The BTS Master can measure WiMAX BTS transmitter performance over the air by connecting an antenna or by connecting the BTS equipment directly to the BTS Master. To connect the BTS equipment directly to the BTS Master, connect the power amplifier of the BTS equipment to the RF In connector of the BTS Master using a coupler or attenuator. To measure a WiMAX signal over the air, connect the appropriate frequency band antenna to the BTS Master RF In connector.

> **CAUTION:** The maximum (without damage) input level of the RF In port is +30 dBm. To prevent damage, always use a coupler or high power attenuator.

Instrument Options for Fixed WiMAX

Fixed WiMAX RF Measurements (Option 46)

Fixed WiMAX Demodulator (Option 47)

Fixed WiMAX Measurements

The following measurements can be made when the BTS Master is set to Fixed WiMAX mode.

Channel Power (RSSI)

Channel power measures the average time domain power within the selected bandwidth and is expressed in dBm. Received Signal Strength Indicator (RSSI) is vendor-defined in the standard and is typically the same as Channel Power.

Occupied BW

The occupied bandwidth is calculated as the bandwidth containing 99% of the transmitted power in the given RF Span.

Data Burst Power

Data Burst power is the RMS power over the data burst part of the WiMAX downlink subframe.

Preamble Power

Preamble power is the RMS power over the preamble part of the WiMAX downlink subframe.

Crest Factor

Crest Factor is the ratio of the peak to average power over the entire downlink subframe.

Freq Error

The difference between the received frequency and the specified frequency is the frequency error. This number is only as accurate as the frequency reference used. Frequency error is displayed in both Hz and ppm.

EVM (Error Vector Magnitude)

The Error Vector Magnitude is the ratio in percent of the difference between the reference waveform and the measured waveform. EVM metrics are used to measure the modulation quality of a transmitter. Both rms and peak values over an entire downlink subframe are displayed.

Relative Constellation Error (RCE)

Relative Constellation Error is similar to EVM but is expressed in dB (RCE = 20 log(EVM in %/100). Both rms and peak values over an entire downlink subframe are displayed.

Carrier Frequency

Carrier Frequency is the measured frequency of the input signal after demodulation, and is the same as the tuned Center Frequency of the instrument plus the measured Frequency Error from demodulation.

Base Station ID

Each transmitter has a unique ID. The BTS Master displays the ID as Base Station ID by decoding the FCH part of the downlink frame.

Adjacent Subcarrier Flatness (Peak)

Adjacent Subcarrier Flatness is the absolute difference between the adjacent sub carriers.

Measurement Setup

To prepare for Fixed WiMAX measurements, the BTS Master must be configured for Fixed WiMAX Signal Analyzer mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Fixed WiMAX Signal Analyzer and press the **Enter** key to select.

For additional information about the Mode menu, refer to *Mode Selector Menu* on page 2-16.

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* on page 2-5.

Setting up the Measurement Frequency

The measurement frequency can be set by entering the center frequency or by selecting the applicable signal standard and channel, which allows the BTS Master to automatically set the frequency.

To set the measurement frequency by entering the center frequency:

1. Press the **Freq** function hard key.
2. Press the Center Freq soft key.
3. Enter the required frequency using the keypad, the arrow keys, or the rotary knob. When entering a frequency using the keypad, the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the **Enter** key has the same affect as pressing the MHz soft key.
4. Press the **Enter** key to set the Center Frequency. The current setting is shown on the left side of the display.

To set the measurement frequency by selecting a signal standard:

1. Press the **Freq** function hard key.
2. Press the Signal Standard soft key.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard and press **Enter** to select. When a signal standard is selected, the center frequency for the channel of the selected standard is automatically tuned.
4. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display. The current settings are displayed on the left side of the screen.

Power Offset for Compensating External Loss

To get accurate results, any external attenuation should be compensated using power offset. In power offset mode the compensation factor is in dB. External attenuation can be caused by using an external cable or external high power attenuator.

1. Press the **Amplitude** function hard key.
2. Press the Power Offset soft key and use the keypad, the arrow keys, or the rotary knob to enter the desired offset value. Press the **Enter** key to set the Power Offset. The value entered is displayed on the left side of the screen.

Bandwidth Setup

The 802.16-2004 standard specifies a bandwidth from 1.25 MHz to 20 MHz. The BTS Master bandwidth can be manually set from 1.25 MHz to 10 MHz.

To set the bandwidth:

1.   Press the **Setup** function hard key.
2.   Press the Bandwidth soft key to display a set of available bandwidths: 1.25 MHz, 1.5 MHz, 1.75 MHz, 2.50 MHz, 3.0 MHz, 3.5 MHz, 5 MHz, 5.5 MHz, 6.0 MHz, 7 MHz, and 10 MHz.
3.   Use the **Up/Down** arrow keys or the rotary knob to highlight the applicable bandwidth on the list and press the **Enter** key to set the bandwidth. The selected bandwidth is displayed in the user settable parameters to the left of the display.

CP Ratio (G) Setup

The 802.16-2004 standard specifies CP ratios from 1/4 to 1/32. With the BTS Master, a specific CP ratio can be manually set. The BTS Master offers support for the following ratios: 1/4, 1/8, 1/16, 1/32.

To set the CP ratio:

1.   Press the **Setup** function hard key.
2.   Press the CP Ratio (G) soft key to display the available ratios: 1/4, 1/8, 1/16, 1/32.
3.   Use the **Up/Down** arrow keys or the rotary knob to highlight the applicable ratio and press the **Enter** key to set the ratio. The selected ratio is displayed in the user settable parameters to the left of the display.

Span Setup

To set the span for Spectrum View:

1.   Press the **Setup** function hard key.
2.   Press the Span soft key to display the available spans: 5 MHz, 10 MHz, 20 MHZ, 30 MHz.
3.   Use the **Up/Down** arrow keys or the rotary knob to highlight the applicable span on the list and press the **Enter** key to set the span.

Frame Length Setup

To set the frame length:

1.   Press the **Setup** function hard key.
2.   Press the Frame Length soft key to toggle through the available frame length selections: 2.5 ms, 5 ms, 10 ms.

External Reference Frequency Setup

In order to get the best frequency accuracy measurements, it is important to use an external reference frequency attached to the BTS Master Ext Ref In connector. Most base stations have a reference frequency available on a BNC connector. To configure the BTS Master to use an external reference frequency:

1. Press the **Setup** function hard key.
2. Press the Ext. Reference Frequency soft key to display a list of the available reference frequencies: 1 MHz, 1.2288 MHz, 1.544 MHz, 2.048 MHz, 2.4576 MHz, 4.8 MHz, 4.9152 MHz, 5 MHz, 9.8304 MHz, 10 MHz, 13 MHz, 19.6608 MHz.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight the applicable reference frequency on the list and press the **Enter** key to set the reference frequency. As the BTS Master locks to the source, the Reference Freq value is displayed in the user settable parameters to the left of the display.

> NOTE: Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.

Fixed WiMAX RF Measurements

Fixed WiMAX RF Measurements consists of three measurements: Spectrum, Power versus Time and Adjacent Channel Leakage Ratio (ACPR). The following sections describe how to make Fixed WiMAX RF measurements.

Spectrum

The Spectrum screen displays the spectrum of the input signal and channel power in dBm and occupied bandwidth measurements.

Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Fixed WiMAX Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable standard from the Signal Standards list presented and press the **Enter** key.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard and press the **Enter** key. The center of the channel is tuned to the center of the display.
6. Press the **Setup** function hard key.
7. Set the bandwidth, frame length, and CP Ratio as described in the measurement setup section.
8. For the most accurate frequency measurements, press the Ext. Ref. Freq soft key to display a list of the available reference frequencies and select the desired reference frequency, or activate the GPS (if equipped) and synchronize the BTS Master to Internal High Accuracy.
9. Press the **Measurements** function hard key.
10. Press the RF soft key.
11. Press the Spectrum soft key to activate the spectrum measurement.

**Figure 19-1. Spectrum View**

Power versus Time

The Power versus Time view shows the time domain view of a WiMAX 802.16-2004 OFDM signal over approximately one frame. The preamble is always 3 dB higher than the data. The screen also displays Channel Power (RSSI), Data Burst Power, Preamble Power and Crest Factor.

Procedure

1.   Press the **Shift** key, then the **Mode** (9) key.
2.   Use the directional arrow keys or the rotary knob to highlight Fixed WiMAX Signal Analyzer and press the **Enter** key to select.
3.   Press the **Freq** function hard key.
4.   Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable standard from the Signal Standards list presented and press the **Enter** key.
5.   Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard and press the **Enter** key. The center of the channel is tuned to the center of the display.
6.   Press the **Setup** function hard key.
7.   Set the bandwidth, frame length, and CP Ratio as described in the measurement setup section.
8.   For the most accurate frequency measurements, press the Ext. Ref. Freq soft key to display a list of the available reference frequencies and select the desired reference frequency, or activate the GPS (if equipped) and synchronize the BTS Master to Internal High Accuracy.
9.   Press the **Measurements** function hard key.
10.   Press the RF soft key.
11.   Press the Power versus Time soft key to activate the measurement.
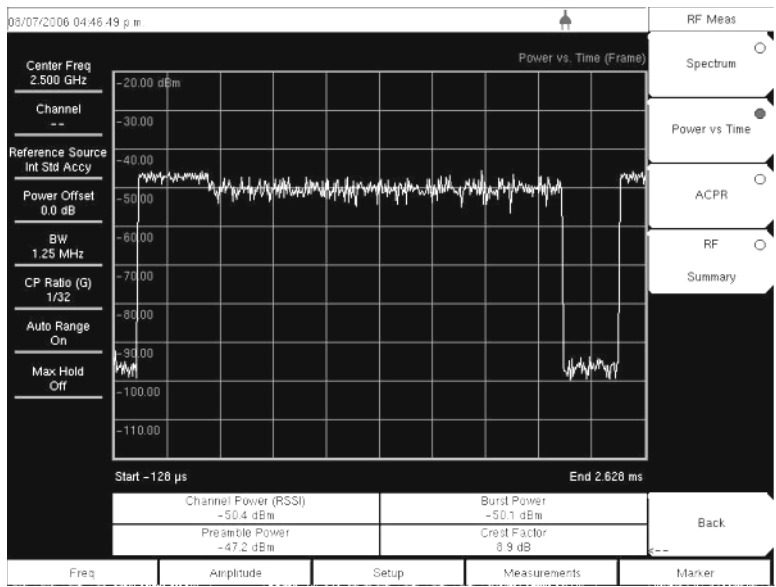
Figure 19-2. Power versus Time View

Adjacent Channel Power Ratio (ACPR)

The ACPR view shows one main channel and two adjacent channels and displays the power levels for each channel (both absolute and relative). The channel spacing matches the selected bandwidth and the channels are color coded.

Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Fixed WiMAX Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable standard from the Signal Standards list presented and press the **Enter** key.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard and press the **Enter** key. The center of the channel is tuned to the center of the display.
6. Press the **Setup** function hard key.
7. Set the bandwidth, frame length, and CP Ratio as described in the measurement setup section.
8. For the most accurate frequency measurements, press the Ext. Ref. Freq soft key to display a list of the available reference frequencies and select the desired reference frequency, or activate the GPS (if equipped) and synchronize the BTS Master to Internal High Accuracy.
9. Press the **Measurements** function hard key.
10. Press the RF soft key.
11. Press the ACPR soft key to activate the measurement.
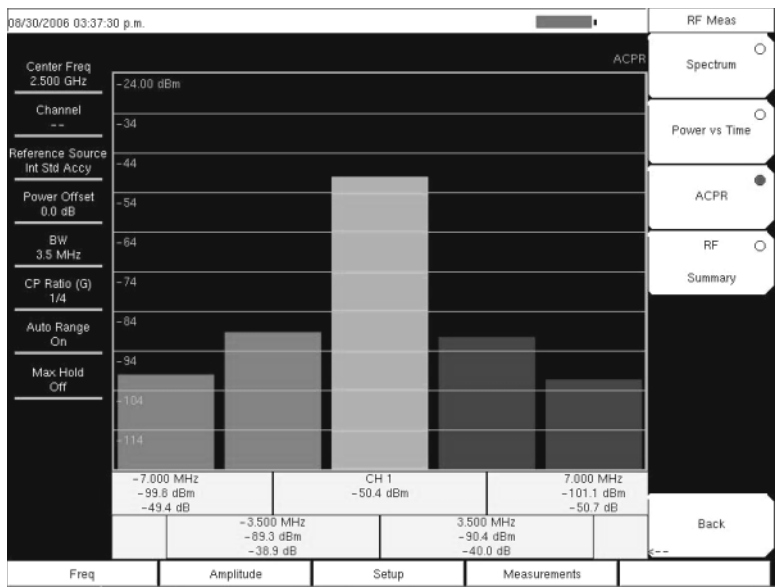
Figure 19-3. ACPR View

RF Summary

The RF Summary displays the critical RF transmitter performance measurements in a table format, without demodulating the WiMAX signal. The parameters displayed in the RF summary table are Channel Power in dBm, Data Burst power in dBm, Preamble power in dBm, Occupied Bandwidth and Crest Factor.

Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Fixed WiMAX Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable standard from the Signal Standards list presented and press the **Enter** key.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard and press the **Enter** key. The center of the channel is tuned to the center of the display.
6. Press the **Setup** function hard key.
7. Set the bandwidth, frame length, and CP Ratio as described in the measurement setup section.
8. For the most accurate frequency measurements, press the Ext. Ref. Freq soft key to display a list of the available reference frequencies and select the desired reference frequency, or activate the GPS (if equipped) and synchronize the BTS Master to Internal High Accuracy.
9. Press the **Measurements** function hard key.
10. Press the RF soft key.
11. Press the RF Summary soft key to activate the measurement.
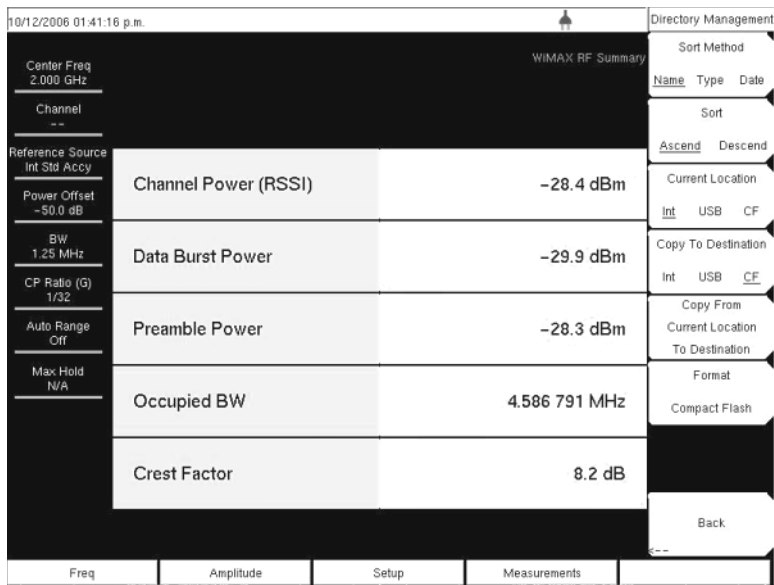
Figure 19-4. RF Summary View

Fixed WIMAX Demodulator

The BTS Master will demodulate a Fixed WiMAX Signal from a Base Station and can display the results in Constellation, Spectral Flatness, EVM versus Sub Carrier, EVM versus Symbol and Modulation Summary views.

Constellation

The BTS Master displays the constellation of the demodulated data symbols over one frame. The various constellations are color coded as follows: modulation:

- BPSK is shown in orange
- QPSK is shown in purple
- 16QAM is shown in green
- 64QAM is shown in yellow

The numerical results displayed in this view are: RCE (rms) in dB, RCE (pk) in dB, EVM (rms) in %, EVM (pk) in %, Freq Error in Hz, Freq Error in ppm, Carrier Frequency in Hz, Base Station ID.

Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Fixed WiMAX Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable standard from the Signal Standards list presented and press the **Enter** key.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard and press the **Enter** key. The center of the channel is tuned to the center of the display.
6. Press the **Setup** function hard key.
7. Set the bandwidth, frame length, and CP Ratio as described in the measurement setup section.
8. For the most accurate frequency measurements, press the Ext. Ref. Freq soft key to display a list of the available reference frequencies and select the desired reference frequency, or activate the GPS (if equipped) and synchronize the BTS Master to Internal High Accuracy.
9. Press the **Measurements** function hard key.
10. Press the Demodulator soft key.
11. Press the Constellation soft key to activate the measurement.
12. Press the Constellation soft key again to activate the reference points menu.
13. Press the Reference Points soft key to switch the reference points On or Off (see Figure 19-5 and Figure 19-6 on the next page).
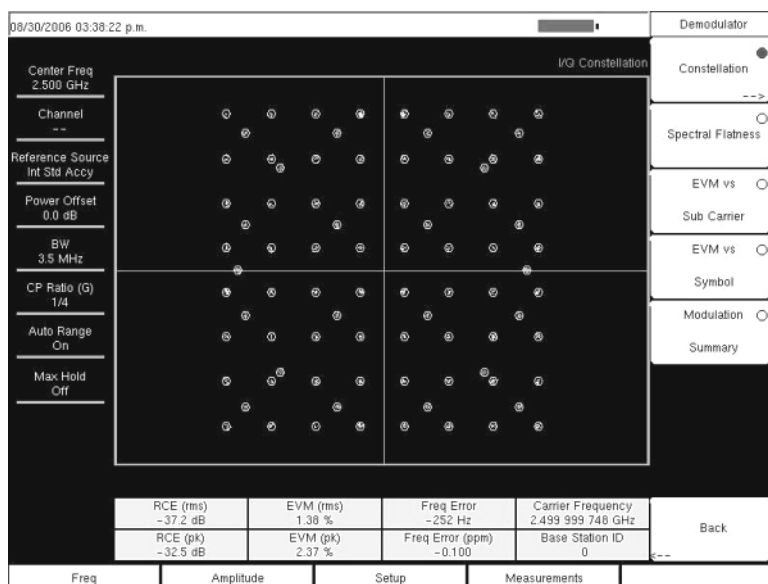
Figure 19-5. Constellation with Reference Points On
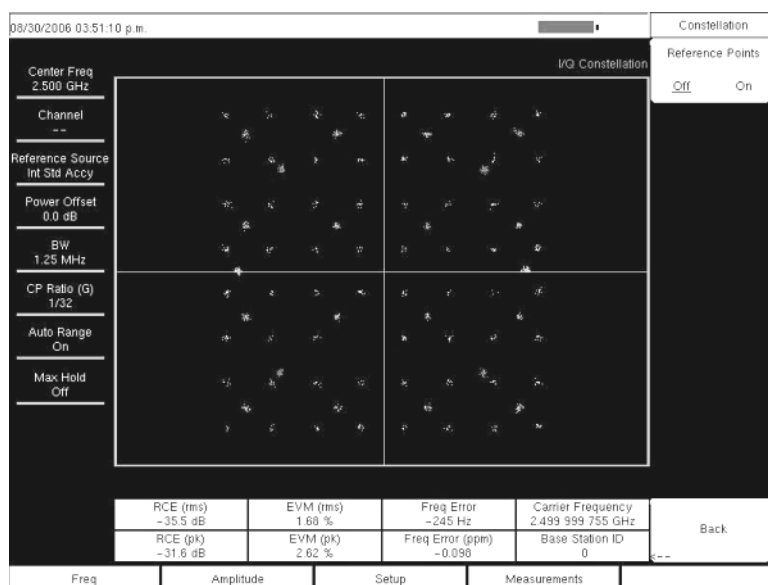
Figure 19-6. Constellation with Reference Points Off

Spectral Flatness

The Spectral Flatness view shows the data collected from the preamble at the channel estimation step. The deviation of the Spectral Flatness from the average over all the carriers is shown in dB. A mask that conforms to the specification is overlaid on the trace. Green color on the mask indicates pass and red indicates regions of the mask where it fails. The specification for the mask is:

$\pm$0 to 50 subcarriers < $\pm$2 dB,
$\pm$50 to 100 subcarriers < +2 dB and -4 dB

This mask is referenced from the average of all 200 subcarrier amplitude values. The numerical result displayed in this view is the adjacent sub-carrier flatness (in dB).

Procedure

1.   Press the **Shift** key, then the **Mode** (9) key.
2.   Use the directional arrow keys or the rotary knob to highlight Fixed WiMAX Signal Analyzer and press the **Enter** key to select.
3.   Press the **Freq** function hard key.
4.   Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable standard from the Signal Standards list presented and press the **Enter** key.
5.   Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard and press the **Enter** key. The center of the channel is tuned to the center of the display.
6.   Press the **Setup** function hard key.
7.   Set the bandwidth, frame length, and CP Ratio as described in the measurement setup section.
8.   For the most accurate frequency measurements, press the Ext. Ref. Freq soft key to display a list of the available reference frequencies and select the desired reference frequency, or activate the GPS (if equipped) and synchronize the BTS Master to Internal High Accuracy.
9.   Press the **Measurements** function hard key.
10.   Press the Demodulator soft key.
11.   Press the Spectral Flatness soft key to activate the measurement.
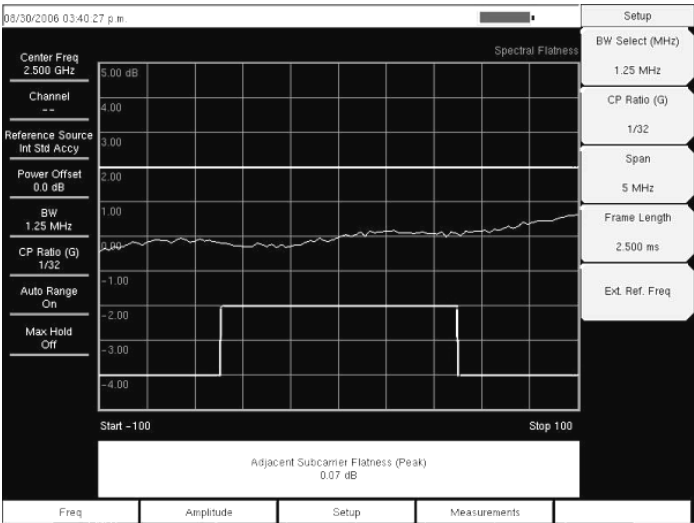
Figure 19-7. Spectral Flatness View

EVM versus SubCarrier

This view shows the EVM (rms) values versus OFDM sub-carriers. There are eight pilot sub-carriers shown in orange and 192 data sub carriers in yellow. The numerical results displayed in this view are: RCE (rms) in dB, RCE (pk) in dB, EVM (rms) in %, EVM (pk) in %, Freq Error in Hz, Freq Error in ppm, Carrier Frequency in Hz, Base Station ID.

Procedure

1.   Press the **Shift** key, then the **Mode** (9) key.
2.   Use the directional arrow keys or the rotary knob to highlight Fixed WiMAX Signal Analyzer and press the **Enter** key to select.
3.   Press the **Freq** function hard key.
4.   Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable standard from the Signal Standards list presented and press the **Enter** key.
5.   Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard and press the **Enter** key. The center of the channel is tuned to the center of the display.
6.   Press the **Setup** function hard key.
7.   Set the bandwidth, frame length, and CP Ratio as described in the measurement setup section.
8.   For the most accurate frequency measurements, press the Ext. Ref. Freq soft key to display a list of the available reference frequencies and select the desired reference frequency, or activate the GPS (if equipped) and synchronize the BTS Master to Internal High Accuracy.
9.   Press the **Measurements** function hard key.
10.   Press the Demodulator soft key.
11.   Press the EVM versus SubCarrier soft key to activate the measurement.
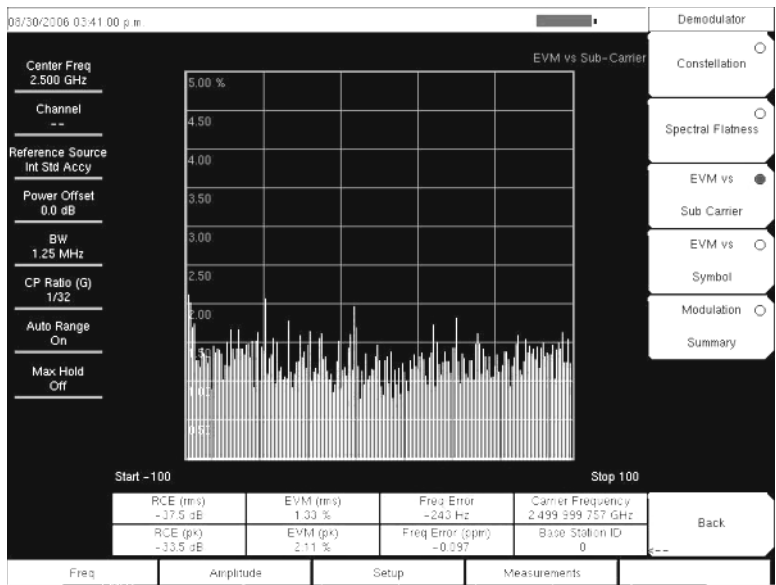
Figure 19-8. EVM versus SubCarrier View

EVM versus Symbol

This view shows the EVM (rms) values versus OFDM symbols. The numerical results displayed in this view are: RCE (rms) in dB, RCE (pk) in dB, EVM (rms) in %, EVM (pk) in %, Freq Error in Hz, Freq Error in ppm, Carrier Frequency in Hz, Base Station ID.

Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Fixed WiMAX Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable standard from the Signal Standards list presented and press the **Enter** key.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard and press the **Enter** key. The center of the channel is tuned to the center of the display.
6. Press the **Setup** function hard key.
7. Set the bandwidth, frame length, and CP Ratio as described in the measurement setup section.
8. For the most accurate frequency measurements, press the Ext. Ref. Freq soft key to display a list of the available reference frequencies and select the desired reference frequency, or activate the GPS (if equipped) and synchronize the BTS Master to Internal High Accuracy.
9. Press the **Measurements** function hard key.
10. Press the Demodulator soft key.
11. Press the EVM versus Symbol soft key to activate the measurement.
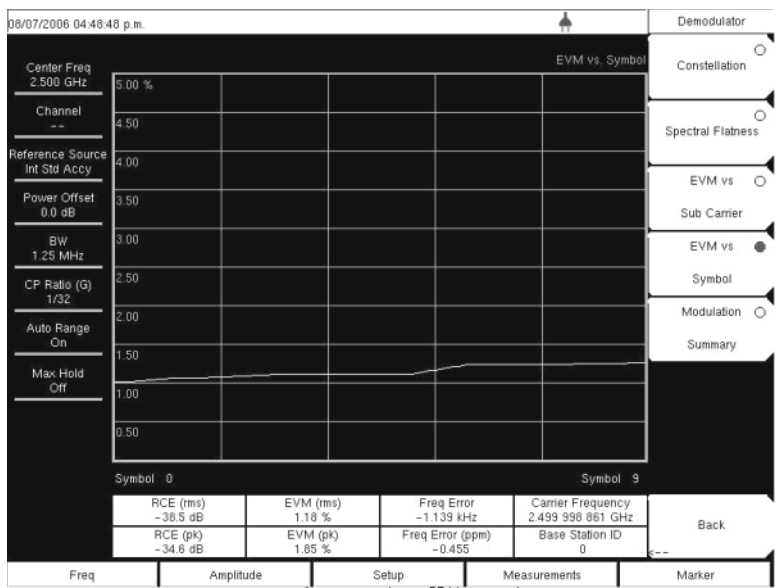
Figure 19-9. EVM versus Symbol View

Modulation Summary

The Modulation Summary displays the critical Modulation transmitter performance measurements in a table format by demodulating the WiMAX signal. The parameters displayed in the Modulation summary table RCE (rms) in dB, RCE (pk) in dB, EVM (rms) in %, EVM (pk) in %, Freq Error in Hz, Freq Error in ppm, Carrier Frequency in Hz, Base Station ID.

Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Fixed WiMAX Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable standard from the Signal Standards list presented and press the **Enter** key.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard and press the **Enter** key. The center of the channel is tuned to the center of the display.
6. Press the **Setup** function hard key.
7. Set the bandwidth, frame length, and CP Ratio as described in the measurement setup section.
8. For the most accurate frequency measurements, press the Ext. Ref. Freq soft key to display a list of the available reference frequencies and select the desired reference frequency, or activate the GPS (if equipped) and synchronize the BTS Master to Internal High Accuracy.
9. Press the **Measurements** function hard key.
10. Press the Demodulator soft key.
11. Press the Modulation Summary soft key to activate the measurement.
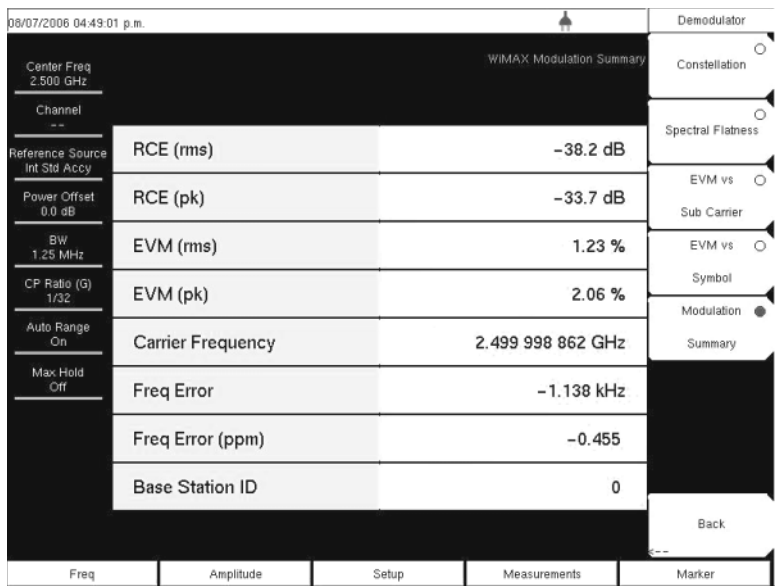
Figure 19-10. Modulation Summary View

Pass/Fail Mode

The Pass/Fail mode allows selection of a user-defined file that specifies a list of measurements with pass/fail criteria. This mode sequences through the appropriate measurements and indicates a pass or fail state based on the criteria. Using Master Software Tools, a custom test list can be created and downloaded into the unit. All critical measurements can be selected for pass fail testing. The results are displayed in a table format with clear identification of pass/fail results including min/max thresholds and measured results.

Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Fixed WiMAX Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable standard from the Signal Standards list presented and press the **Enter** key.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard and press the **Enter** key. The center of the channel is tuned to the center of the display.
6. Press the **Setup** function hard key.
7. Set the bandwidth, frame length, and CP Ratio as described in the measurement setup section.
8. For the most accurate frequency measurements, press the Ext. Ref. Freq soft key to display a list of the available reference frequencies and select the desired reference frequency, or activate the GPS (if equipped) and synchronize the BTS Master to Internal High Accuracy.
9. Press the **Measurements** function hard key.
10. Press the Pass/Fail Mode soft key.
11. Press the Pass/Fail Mode soft key again to activate the sub-menu.
12. Press the Select Pass/Fail Test soft key to view a list of pass/fail test definition files.
13. Use the **Up/Down** arrow keys or the rotary knob to highlight the applicable pass/fail test on the list and press the **Enter** key to select.
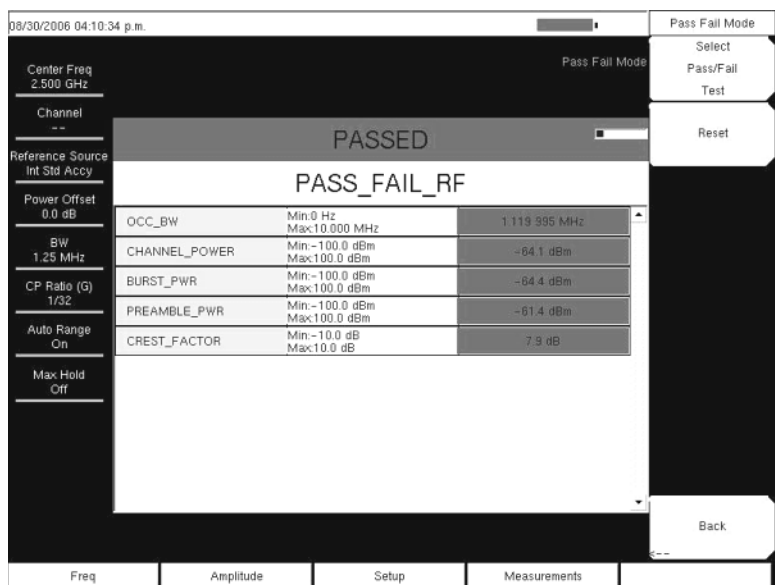
Figure 19-11. Pass/Fail Mode

WiMAX Summary

The WiMAX Summary is a summary of critical Fixed WiMAX measurements from the RF and Demodulation measurements.

Procedure

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the directional arrow keys or the rotary knob to highlight Fixed WiMAX Signal Analyzer and press the **Enter** key to select.
3. Press the **Freq** function hard key.
4. Press the Center Freq soft key and enter the desired frequency manually, or press the Signal Standard soft key and select the applicable standard from the Signal Standards list presented and press the **Enter** key.
5. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard and press the **Enter** key. The center of the channel is tuned to the center of the display.
6. Press the **Setup** function hard key.
7. Set the bandwidth, frame length, and CP Ratio as described in the measurement setup section.
8. For the most accurate frequency measurements, press the Ext. Ref. Freq soft key to display a list of the available reference frequencies and select the desired reference frequency, or activate the GPS (if equipped) and synchronize the BTS Master to Internal High Accuracy.
9. Press the **Measurements** function hard key.
10. Press the WiMAX Summary soft key.
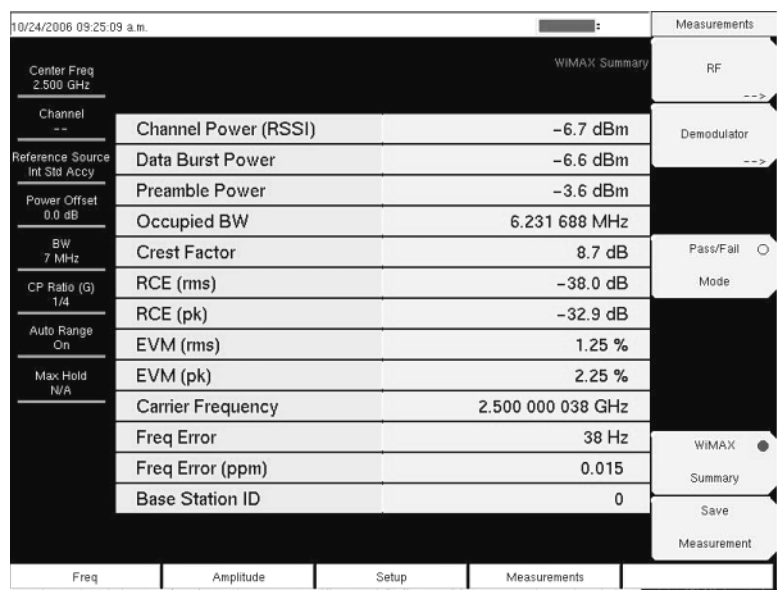
Figure 19-12. WiMAX Summary View

Amplitude
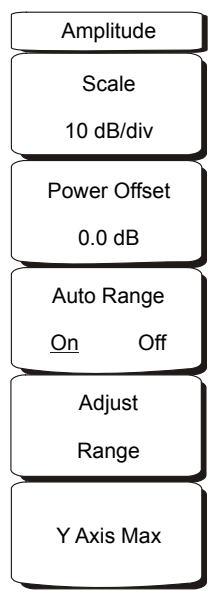
Figure 19-13. Fixed WiMAX Signal Analyzer Mode Amplitude Menu

Scale

Scale changes the y axis scale and can be set from 1 dB/div to 15 dB/div. The units change from dB/div to % when EVM is the y axis value. The default value changes from 10 dB/div to 1 dB/div when the Spectral Flatness view is selected.

Power Offset

Choose power offset to have the instrument automatically adjust for the loss through any external cables, attenuators and couplers. The power can be offset from –100 dB to 100 dB. To set a power offset, press the Power Offset soft key, use the keypad to enter the offset values and press the dB soft key.

Auto Range

When Auto Range is activated the reference level is automatically adjusted. Press the Auto Range soft key to switch between On and Off.

Adjust Range

Adjust Range adjusts the internal reference level to be optimal based on the measured signal. Auto Range is set to the Off state and a manual Auto Range operation is performed once.

Y axis Max

Sets the maximum value of the Y axis. In combination with the Scale control, this allows the user to zoom in and out on the Y axis. This control is available only in the Spectral Flatness and EVM versus Symbol/Sub-carrier views.

File

To access the functions under the File menu, press the **Shift** key, then the **File** (7) key.
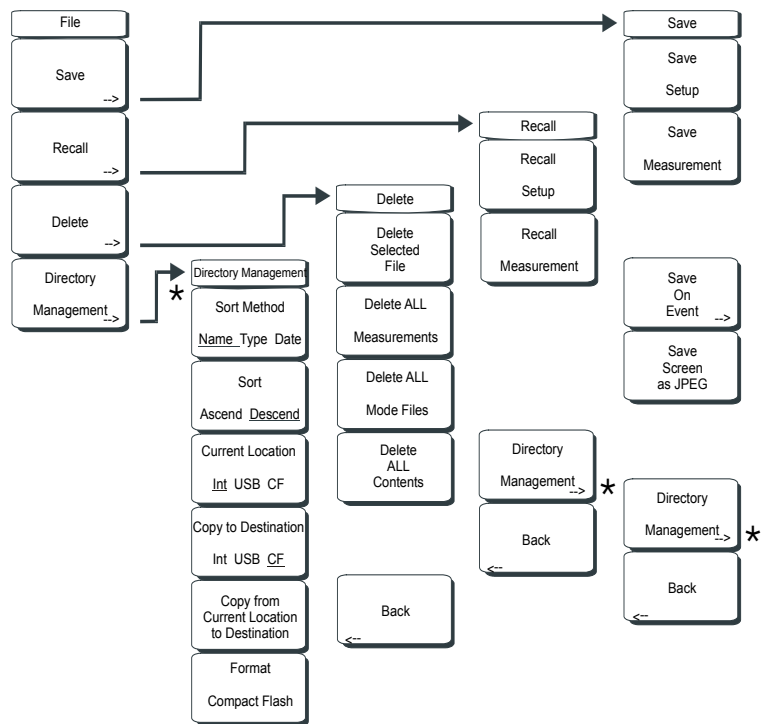
Figure 19-14. Fixed WiMAX Signal Analyzer Mode File Menu

Save

Measurements may be saved to the internal memory or to a Type-1 Compact Flash module. The BTS Master is shipped with a 64 MB Compact Flash Memory Module, Anritsu Part Number 2000-1358. The removable compact flash card can be up to 512 MB. Compact Flash modules with greater storage capacity may not function properly, and should be properly tested before relying on them. A USB Flash drive with at least 64 MB of storage may be used to store all measurements that may be stored internally.

Save Setup

Opens a dialog box to name and save the current operating settings, allowing them to be recalled later to return the instrument to the state it was in at the time the setup was saved. The saved setup can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the Left/ Right directional arrows to move the cursor position. Press **Enter** to save the setup.

Save Measurement

Initiates a dialog box to name and save the current active trace A. For details about entering a filename, refer to section *Text Entry* on page 2-7. Press **Enter** to save the measurement trace. Measurements are saved in a directory called /usr on the Compact Flash memory module and the USB Flash Drive.

NOTE: If a measurement has been previously saved, the Save Measurement dialog box will open with the previously saved name displayed. To save the new measurement with a similar name (for example, Trace-1, Trace-2, and so forth) simply press the Right directional arrow and add the changes. To create a completely new name, use the keypad, the rotary knob or press the soft key for each letter.

Save On Event…
Not implemented in WiMAX mode.

Save Screen as JPEG
This function saves a measurement trace as a graphics file. For details about entering a filename, refer to section *Text Entry* on page 2-7. Press **Enter** to save the measurement after entering the file name. The file is saved in the internal memory with the specified name, with .jpg appended.

Directory Management
Sort Method
<u>Name</u> Type Date
File lists can be sorted by the name of the file, the type of file (SPA file, STP file, and so forth) or by the date that the file was saved.

Sort
Ascend <u>Descend</u>
Selects whether the selected sort is sorted from lowest to highest (ascending) or highest to lowest (descending). When sorting by name, the sort will place file names that start with numbers before file names that start with letters (an ASCII sort).

Current Location
<u>Int</u> USB CF
This choice lets you select where measurements and setups will be saved. Pressing the soft key selects the storage location to be the internal memory, USB Flash drive, or Compact Flash memory module. The "current location" and the "copy to destination" will never be the same. Changing the current location to save files causes the "copy to destination" to be automatically changed if the selected storage location is the same as the selected current location.

Copy to Destination
Int USB <u>CF</u>
This choice lets you select where measurements and setups in the "current location" will be copied. The "current location" and the "copy to destination" may not be the same. If you change the destination to which the instrument will copy files, the current location is automatically changed if the current location is the same as the selected copy to destination.

Copy From Current Location To Destination
Pressing this soft key causes all measurements, setups, and jpg files that are stored in the user-selected "current location" to be copied to the "copy to destination". If no storage module is installed in the instrument, then an error message is displayed.

Format Compact Flash
This selection erases all files on an installed Compact Flash module. A message is displayed warning that all files will be erased. Press Enter to confirm that you want to erase and Esc to quit without erasing. In addition to erasing all files stored on the Compact Flash, the /usr directory is created for storage of measurements, setups and jpg files.

Back
The Back key returns to the previous menu.

Recall
Recall Setup
This soft key brings up a selection box that allows selection and recall of a previously stored instrument setup in the current storage location. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved setup, and press **Enter**, the rotary knob, or the Recall soft key to select. All current instrument settings are replaced by the stored setup information. Press the **Esc** key to cancel the recall.

Recall Measurement
Brings up a selection box that allows recall of a previously stored measurement trace from the currently selected storage location. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved measurement trace, and press **Enter**, the rotary knob, or the Recall soft key to select. A recalled trace may be displayed as trace A, in place of the live trace, or as trace B or trace C along with the live trace. Use the rotary knob or the **Up/Down** arrow keys to highlight the recalled trace option, and press the **Enter** key to select. Press the **Esc** key to cancel the recall.

To remove a recalled measurement trace from the screen, press the **Shift** key and the **Trace** (5) key to open the Trace menu. Use the Trace soft key to select the trace to be removed from the screen and use the View/Blank soft key to view or blank the trace. Use the Trace key to select an active trace after blanking a recalled trace.

Directory Management
See *Directory Management *.

Back
Returns to the previous menu.

Delete
Brings up a selection box that shows all stored setups and traces in the currently selected location (See *Directory Management *.) The list shows the setup and measurement names, the type (stp for a saved setup, spa for a saved trace, jpg for a JPEG file) and the date and time the information was saved. Use the rotary knob or the **Up/Down** arrow keys to highlight the file to be deleted, and press **Enter**, or the Delete soft key to delete. Press the **Esc** key to cancel the operation. Note that there is no mechanism to retrieve deleted files.

Delete Selected File
Use the up and down arrow buttons or the rotary knob to select the file that is to be deleted. Press Enter to confirm that you want to delete the file or Esc to exit without deleting.

Delete ALL Measurements
Deletes all measurements of the current mode in the currently selected storage location. The memory from which measurements will be deleted is set in the Directory Management menu and is the Current Location.

Delete ALL Mode Files
Deletes all measurements of the type saved in the current operating mode of the instrument. In addition all jpg and setup files (regardless of the mode) are deleted.

Delete ALL Contents
Deletes all measurements, jpg files and setup files of ALL measurement types.

Back
The Back key returns to the previous menu.

Freq (Frequency)

Figure 19-15. Fixed WiMAX Signal Analyzer Mode Freq Menu

Center Freq
The Center Freq soft key is used to set the receiver center frequency to the desired value. Enter the frequency using the keypad, the arrow keys, or the rotary knob. When entering a frequency using the keypad, the soft key labels will change to GHz, MHz, kHz, and Hz. Press the appropriate units soft key. Pressing the **Enter** key has the same affect as pressing the MHz soft key.

Signal Standard
Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard and press **Enter** to select. When a signal standard is selected, the center frequency and span for the first channel of the selected standard is automatically tuned. Other settings, such as channel spacing and integration bandwidth, are also automatically entered.

The applicable signal standards (for 10 MHz BW only) are U-NII middle, U-NII upper, CEPT band B, and CEPT band C.

Channel
Use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected Signal Standard. The center of the channel is automatically tuned to the center frequency of the selected channel. The listed channels are from 0 to 199.

Set CF to Closest Channel
This soft key moves the current Center Frequency to the closest frequency that matches a channel number in the current Signal Standard.

Decrement Channel
Press this soft key to decrease the selected channel number by one channel.

Increment Channel
Press this soft key to increase the selected channel number by one channel.

Limit

This function is not implemented in this mode.

Measure

To access the functions under the Measure menu, press the **Shift** key, then the **Measure** (4) key. The Measure key brings up the same menus as the **Measurements** function hard key. Refer to for information on these menus.

Measurements
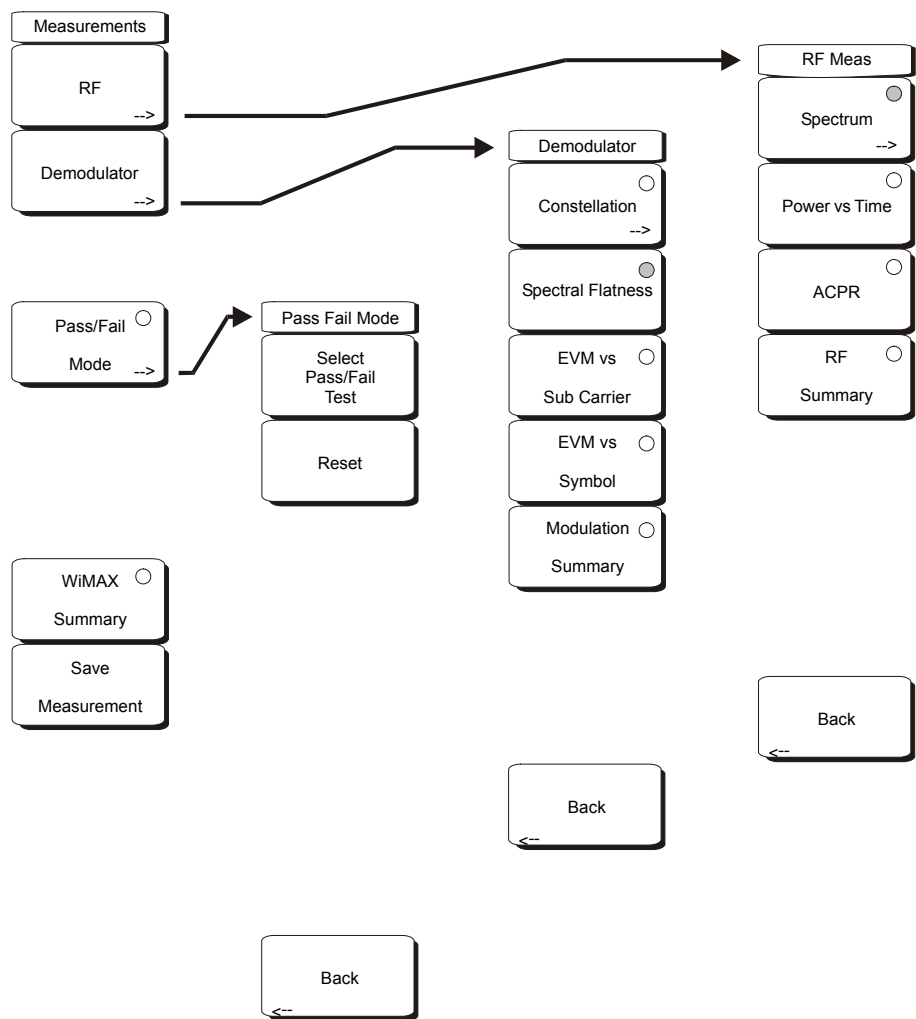
Figure 19-16. Fixed WiMAX Signal Analyzer Mode Measurements Menu

RF

Spectrum

This view displays the spectrum of the input signal. The span is automatically adjusted to the next largest available span based on the bandwidth setting. Channel Power (RSSI) in dBm and Occupied bandwidth measurements are displayed as numerical values.

Span

Opens Span selection dialog. Select the desired Span for the Spectrum view using the **Up/Down** arrow keys or rotary knob and press **Enter**.

The list shows the following choices: 5 MHz, 10 MHz, 20 MHz, 30 MHz

Note: The span value is automatically adjusted to the next largest available span when the BW setting is changed. The user can change the span to any of the above values to override the automatic selection.

Power versus Time

The Power versus Time view shows the time domain view of a WiMAX 802.16-2004 OFDM signal over approximately one frame.

The Channel Power in dBm, Preamble power in dBm, burst power of data bursts in dBm and the Crest Factor are displayed as numerical values.

ACPR (Adjacent Channel Power Ratio)

The ACPR view shows one main channel and two adjacent channels and displays the power levels for each channel (both absolute and relative).

RF Summary

Displays a summary of all the RF numerical measurement results.

Back

Returns to the previous menu.

Demodulator

Constellation

The constellation view shows the constellation of the demodulated data symbols over one frame. The various constellations are color coded as follows:

BPSK is shown in orange
QPSK is shown in purple
16-QAM is shown in green
64-QAM is shown in yellow
The numerical results displayed in this view are:

RCE (rms) in dB
RCE (pk) in dB
EVM (rms) in %
EVM (pk) in %
Freq Error in Hz
Freq Error in ppm
Carrier Frequency in Hz
Base Station ID.

Reference Points

Toggles the display of reference points for the various constellations on the display.

Spectral Flatness

The Spectral Flatness view shows the data collected from the preamble at the channel estimation step. The deviation of the spectral flatness from the average over all the carriers is shown in dB.

A mask that conforms to the specification is overlaid on the trace. Green color on the mask indicates pass and red indicates regions of the mask where it fails.

The specification for the mask is:

±0 to 50 subcarriers < ±2 dB,
±50 to 100 subcarriers < +2 dB and −4 dB

This mask is referenced from the average of all 200 subcarrier amplitude values. Absolute delta of the power between adjacent subcarriers in dB is displayed as a numerical values.

EVM versus Sub Carrier

This view shows the EVM (rms) values versus OFDM subcarriers. The pilot subcarriers are shown in orange.

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EVM versus Symbol

This view shows the EVM (rms) values versus OFDM symbols.

Modulation Summary

Displays a summary of all the Modulation related numerical measurement results.

Back

Returns to the previous menu.

Pass/Fail Mode

Pass/Fail mode allows the selection of a user-defined file that specifies a list of measurements with pass/fail criteria. This mode will sequence through the appropriate measurements and indicate a pass or fail state based on the criteria. A custom test list can be created with Master Software Tools and downloaded into the unit. All critical measurements can be selected for pass fail testing. The results are displayed in table format with clear identification of pass/fail results including min/max thresholds and measured results.

Select Pass/Fail Test

Displays the list of available Pass/Fail tests.

Reset

Resets the Pass/Fail test.

Back

Returns to the previous menu.

WiMAX Summary

Displays a summary of all the WiMAX related numerical measurement results.

Save Measurement

Initiates a dialog box to name and save the current measurement. The saved measurement can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save. WiMAX measurements are saved with a .wmxd extension.

Mode

The contents of the Mode list box depend upon the options installed in the instrument. The current mode is highlighted by default.

To access the functions under the Mode menu, press the **Shift** key, then the **Mode** (9) key. Use the directional arrow keys or the rotary knob to highlight the selection and press the **Enter** key to select. is an example of the Mode menu. Your instrument may not show the same list.
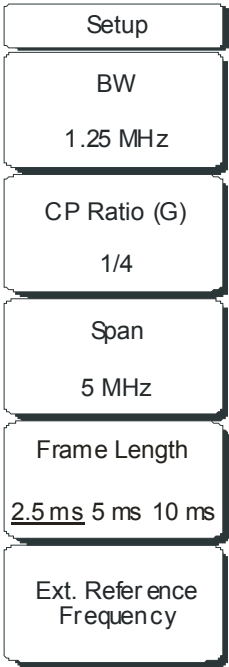
Setup

Figure 19-17. Fixed WiMAX Signal Analyzer Mode Setup Menu

BW
Select the Bandwidth using the **Up/Down** arrow keys or the rotary knob and press **Enter**. The following bandwidths are available: 1.25 MHz, 1.5 MHz, 1.75 MHz, 2.50 MHz, 3.0 MHz, 3.5 MHz, 5 MHz, 5.5 MHz, 6.0 MHz, 7 MHz, or 10 MHz. The default bandwidth is 1.25 MHz.

CP Ratio (G)
Select the desired Cyclic Prefix Ratio using the **Up/Down** arrow keys or the rotary knob and press **Enter**. Available CP Ratios are: 1/4, 1/8, 1/16, and 1/32. The default CP Ratio is 1/4.

Span
Select the desired Span for the Spectrum view using the **Up/Down** arrow keys or the rotary knob and press **Enter**. The available Span selections are: 5 MHz, 10 MHz, 20 MHz, or 30 MHz.

> NOTE: The span value is automatically adjusted to the next largest available span when the BW setting is changed. The span can be changed to any of the above values to override the automatic selection.

Frame Length
Select the frame length by pressing this soft key to toggle through the available selections: 2.5 ms, 5 ms, or 10 ms. The selected value is underlined on the virtual soft key face.

Ext. Ref. Freq

Select the desired External Reference Frequency using the **Up/Down** arrow keys or the rotary knob and press **Enter**. The following External Reference Frequencies are available: 1 MHz, 1.2288 MHz, 1.544 MHz, 2.048 MHz, 2.4576 MHz, 4.8 MHz, 4.9152 MHz, 5 MHz, 9.8304 MHz, 10 MHz, 13 MHz, and 19.6608 MHz. The default External Reference Frequency is 10 MHz.

System

To access the functions under the System menu, press the **Shift** key, then the **System** (8) key.
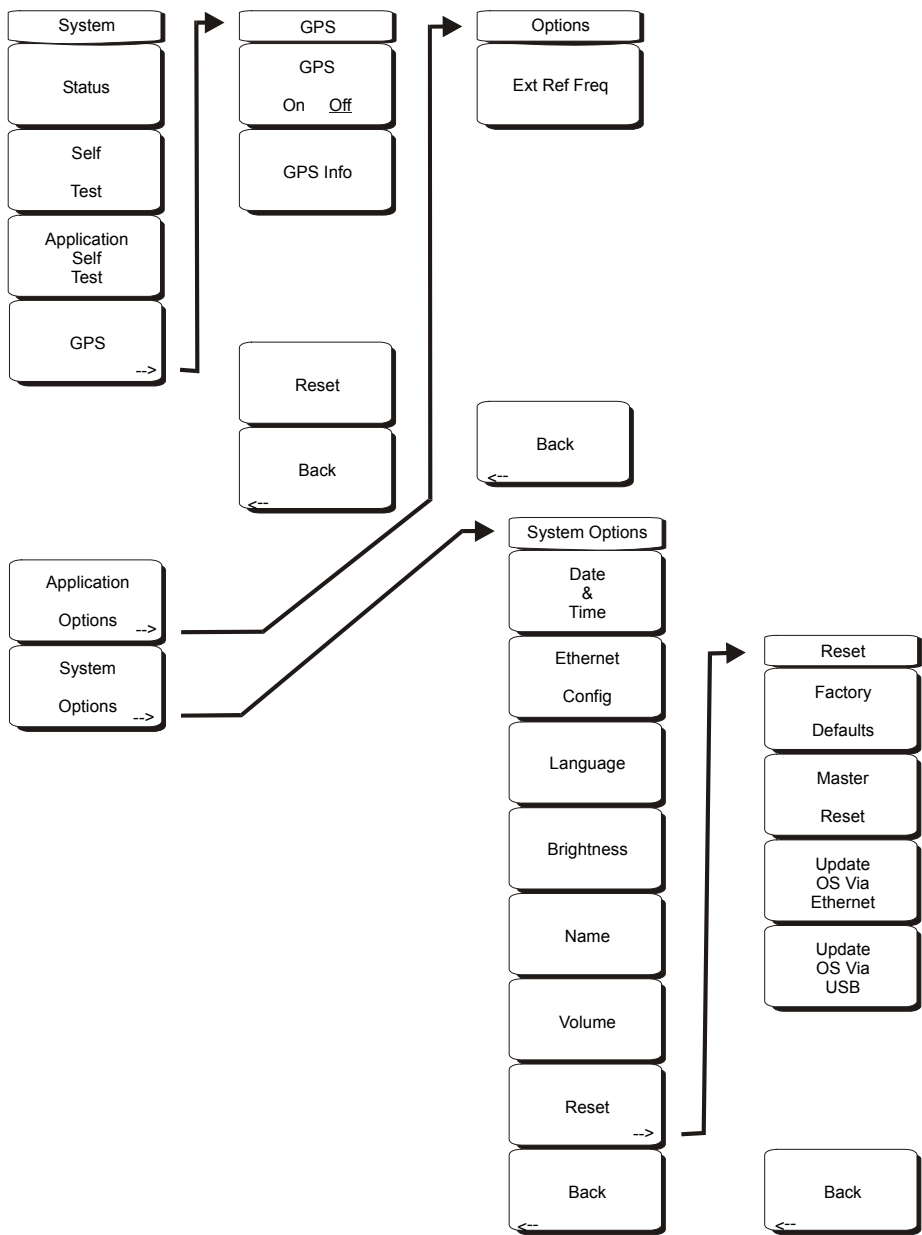
Figure 19-18. Fixed WiMAX Signal Analyzer Mode System Menu

Status

Pressing this soft key displays the current system status, including the operating system and firmware versions, temperatures and other details such as current battery information. Press **Esc** or **Enter** to return to normal operation.

Self Test

This soft key initiates a series of diagnostic tests that test the components of the instrument. A display will list the individual tests with a pass or fail indication. Press **Esc** or **Enter** to return to normal operation.

Application Self Test

This soft key initiates a series of diagnostic tests related to the performance of the spectrum analyzer. A display will list the individual tests with a pass or fail indication. Press **Esc** or **Enter** to return to normal operation.

Application Options

This soft key presents a menu to select application options.

Ext Ref Freq

Select the frequency of the external reference from the list presented.

Back

Returns to the previous menu.

System Options

This key opens a selection of system option soft keys.

Date and Time

This soft key brings up a dialog box for setting the current date and time. Use the soft keys or the **Left/Right** arrow keys to select the field to be modified. Use the keypad, the **Up/Down** arrow keys or the rotary knob to select the date and time. Press **Enter** to accept the changes, or press the **Esc** key to return to normal operation without changing anything.

Ethernet Configuration

This soft key brings up a dialog box to set the IP address of the instrument.

Type Manual/DHCP

This soft key selects whether the address will be entered manually, or supplied automatically by a network DHCP server. If Manual is selected, use the soft keys or the **Left/Right** arrow keys to select the field to be modified. Use the keypad, the **Up/Down** arrow keys or the rotary knob to enter the input. Press **Enter** to accept the changes, or press the **Esc** key to return to normal operation without changing anything.

Language

This soft key brings up a selection box allowing selection from a list of built-in languages for the BTS Master displays. The languages currently available are English, French, German, Spanish, Japanese, Chinese, Korean, and Italian. In addition, up to two custom languages may be selected if they have been defined using the Master Software Tools software and loaded into the BTS Master. Two custom languages may be loaded into the instrument. If a mode does not have language translations available, English is the default language. Press **Enter** to accept the change, or press the **Esc** key to return to normal operation without changing anything.

Brightness

The brightness of the display can be adjusted to optimize viewing under a wide variety of lighting conditions. Use the keypad, the **Up/Down** arrow keys or the rotary knob to select a brightness level from 1 to 9, 9 being the brightest. Press **Enter** to accept the change.

Name

Opens a dialog box to name the instrument. The unit can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the name.

Volume

The current volume setting is displayed on the screen. Use the keypad, the **Up/Down** arrow keys or the rotary knob to change the volume and press the **Enter** key to accept the change.

Reset

Opens a menu of reset and update options.

Factory Defaults

Restores the instrument to the factory default values, including Ethernet, language and brightness settings. Press the **Enter** key to initiate the reset, and turn the unit off, then on again to complete. Press **Esc** to return to normal operation without resetting.

Master Reset

This will restore factory setting to all system parameters, including Time/Date, Ethernet, language and brightness settings. Also, all user files in the internal memory are deleted, and the original language and antenna files are restored. Press the **Enter** key to initiate the reset, and turn the unit off, then on again to complete. Press **Esc** to return to normal operation without resetting.

Update OS Via Ethernet

Press this soft key to update the instrument operating system via the Ethernet connection. Press Enter to begin the update, or press **Esc** to return to normal operation without updating.

Update OS Via USB

Press this soft key to update the instrument operating system via the USB connection. Press Enter to begin the update, or press **Esc** to return to normal operation without updating.

Back

Returns to the previous menu.

GPS

If the GPS option is installed, the GPS menu will be displayed.

GPS On/Off

Turns the GPS on or off.

GPS Info

Displays the current GPS information.

Reset

Resets the GPS for a new location.

Back

Returns to the previous menu.

Application Options

This soft key presents a menu to select application options.

Ext. Ref. Freq

This soft key brings up a dialog box for selecting the External Reference Frequency. Use the rotary knob or the **Up/Down** arrow keys to highlight the Reference Frequency and press **Enter** to select, or press the **Esc** key to cancel.

System Options

This key opens a selection of system option soft keys.

Date and Time

This soft key brings up a dialog box for setting the current date and time. Use the soft keys or the **Left/Right** arrow keys to select the field to be modified. Use the keypad, the **Up/Down** arrow keys or the rotary knob to select the date and time. Press **Enter** to accept the changes, or press the **Esc** key to return to normal operation without changing anything.

Ethernet Config

This soft key brings up a dialog box to set the IP address of the instrument.

Type Manual/DHCP

This soft key selects whether the address will be entered manually, or supplied automatically by a network DHCP server. If Manual is selected, use the soft keys or the **Left/Right** arrow keys to select the field to be modified. Use the keypad, the **Up/Down** arrow keys or the rotary knob to enter the input. Press **Enter** to accept the changes, or press the **Esc** key to return to normal operation without changing anything.

Language

This soft key brings up a selection box allowing selection from a list of built-in languages for the BTS Master displays. The languages currently available are English, French, German, Spanish, Japanese, Chinese, Korean, and Italian.

In addition, a custom language may be selected if it has been defined using the Master Software Tools software and loaded into the BTS Master. Two custom languages may be loaded into the instrument using Master Software Tools. If a mode does not have language translations available, English is the default language. Press **Enter** to accept the change, or press the **Esc** key to return to normal operation without changing anything.

Brightness

The brightness of the display can be adjusted to optimize viewing under a wide variety of lighting conditions. Use the keypad, the **Up/Down** arrow keys or the rotary knob to select a brightness level from 1 to 9, 9 being the brightest. Press **Enter** to accept the change.

Name

Opens a dialog box to name the instrument. The unit can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the name.

Volume

The current volume setting is displayed on the screen. Use the keypad, the **Up/Down** arrow keys or the rotary knob to change the volume and press the **Enter** key to accept the change.

Reset
Opens a menu of reset and update options.

Factory Defaults
Restores the instrument to the factory default values, including Ethernet, language and brightness settings. Press the **Enter** key to initiate the reset, and turn the unit off, then on again to complete. Press **Esc** to return to normal operation without resetting.

Master Reset
This will restore factory setting to all system parameters, including Time/Date, Ethernet, language and brightness settings. Also, all user files in the internal memory are deleted, and the original language and antenna files are restored.

Press the **Enter** key to initiate the reset, and turn the unit off, then on again to complete. Press **Esc** to return to normal operation without resetting.

Update OS Via Ethernet
Press this soft key to update the instrument operating system via the Ethernet connection. Press **Enter** to begin the update, or press **Esc** to return to normal operation without updating.

Update OS Via USB
Press this soft key to update the instrument operating system via the USB connection. Press **Enter** to begin the update, or press **Esc** to return to normal operation without updating.

Back
Returns to the previous menu.

Preset

To access the functions under the Preset menu, press the **Shift** key, then the **Preset** (1) key.

Preset
This key resets the instrument to the default starting conditions.

Save Setup
Opens a dialog box to name and save the current operating settings, allowing them to be recalled later to return the instrument to the state it was in at the time the setup was saved. The saved setup can be named using the keypad to select numbers, the rotary knob to highlight a number or character and pressing the knob to select, or by pressing the soft key for each letter. Use the **Shift** key to select an upper case letter. Use the Left/ Right directional arrows to move the cursor position. Press **Enter** to save the setup.

Recall Setup
This soft key brings up a selection box that allows selection and recall of a previously stored instrument setup in the current storage location. Use the rotary knob or the **Up/Down** arrow keys to highlight the saved setup, and press **Enter**, the rotary knob, or the Recall soft key to select. All current instrument settings are replaced by the stored setup information. Press the **Esc** key to cancel the recall.

Sweep

To access the functions under the Sweep menu, press the **Shift** key, then the **Sweep** (9) key.
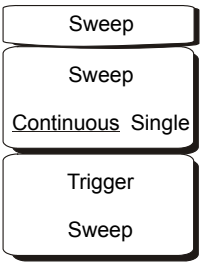
Figure 19-19. Fixed WiMAX Signal Analyzer Mode Sweep Menu

Sweep Continuous/ Single
When Continuous is selected, the instrument continuously makes measurements. When Single is selected, the instrument makes one measurement and then waits for a Trigger Sweep key press to sweep again.

Trigger Sweep
When the Sweep state is set to Single, pressing this soft key triggers a new measurement sweep. This key does nothing when the Sweep state is set to Continuous.

Trace

To access the functions under the Trace menu, press the **Shift** key, then the **Trace** (5) key.

Max Hold

Pressing this soft key toggles Max Hold On and Off. It applies to Spectrum View, EVM versus Subcarrier view, and EVM versus Symbol view. This function allows the Spectrum Trace to hold its peak value from trace to trace. This helps in capturing a representative spectrum of a bursted RF signal such as WiMAX. All Max Hold operations show two traces – one with the max hold values and the other is a live trace with the current measurement results.

Chapter 20
Mobile WiMAX Signal Analyzer

Introduction

The BTS Master MT8222A offers three Mobile WiMAX options for testing WiMAX BTS transmitter performance: Over the Air (OTA), RF, and Demodulator Measurements. OTA Measurements require that an antenna be attached to the Spectrum Analyzer RF In 50Ω connector on the BTS Master. Attach a coupler or attenuator to the same connector to make measurements directly from the WiMAX BTS transmitter.

> **CAUTION:** The maximum (without damage) input level of the RF In port is +30 dBm. To prevent damage, always use a coupler or high power attenuator.

Instrument Options for Mobile WiMAX

Mobile WiMAX Over the Air (OTA) Measurements (Option 37)

Mobile WiMAX RF Measurements (Option 66)

Mobile WiMAX Demodulator (Option 67)

Mobile WiMAX Measurements

The following measurements are made in this mode:

Channel Power (RSSI)

Channel power measures the average time domain power within the selected bandwidth and is expressed in dBm. Received Signal Strength Indicator (RSSI) is vendor-defined and is often the same as Channel Power.

Occupied BW

The occupied bandwidth is calculated as the bandwidth containing 99% of the transmitted power in the given RF Span.

Downlink Burst Power

Downlink Burst power is the RMS power over the downlink portion of the WiMAX frame.

Uplink Burst Power

Uplink Burst power is the RMS power over the uplink portion of the WiMAX frame.

Preamble Power

Preamble power is the RMS power over the preamble part of the downlink subframe.

Freq Error

The difference between the received frequency and the specified frequency is the frequency error. Frequency error is displayed in both Hertz (Hz) and parts-per-million (ppm).

Error Vector Magnitude (EVM)

The Error Vector Magnitude is the ratio in percent of the difference between the reference waveform and the measured waveform. EVM metrics are used to measure the modulation quality of a transmitter. Both rms and peak values over the downlink portion are displayed (the preamble portion is excluded for this measurement).

Relative Constellation Error (RCE)

Relative Constellation Error is similar to EVM but is expressed in dB (RCE = 20 log(EVM in %/100)). Both rms and peak values over an entire downlink subframe are displayed. (The preamble portion is excluded for this measurement).

Carrier Frequency

Carrier frequency is the measured frequency of the input signal after demodulation, and is the same as the tuned center frequency of the instrument plus the measured frequency error from demodulation.

Sector ID

Three cell sectors may produce signals with identical data but with different preambles. The Sector ID may be 0, 1, or 2. The Sector ID is displayed in several of the Demodulator measurements.

Adjacent Subcarrier Flatness (Peak)

Adjacent Subcarrier Flatness is the absolute difference between the adjacent subcarriers in the Spectral Flatness measurement.

Measurement Setup

Set Mode

To prepare for Mobile WiMAX measurements, the BTS Master must be configured for Mobile WiMAX Signal Analyzer mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight Mobile WiMAX Signal Analyzer and press the **Enter** key to select.

For additional information about the Mode menu, refer to *Mode Selector Menu* on page 2-16.

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* on page 2-5.

Setting up the Measurement Frequency

The measurement frequency can be set by entering the center frequency or by selecting the applicable signal standard and channel, which allows the BTS Master to automatically set the frequency.

To Set the Measurement Frequency by Entering the Center Frequency:

1. Press the **Freq** function hard key.
2. Press the Center Freq soft key.
3. Enter the required frequency by using the keypad, the arrow keys, or the rotary knob. When entering a frequency using the keypad, the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate unit key. Pressing the **Enter** key has the same affect as pressing the MHz soft key.
4. Press the **Enter** key to set the Center Frequency. The current setting is shown at the top of the instrument settings summary column on the left side of the screen.

To Set the Measurement Frequency by Selecting a Signal Standard:

1. Press the **Freq** function hard key.
2. Press the Signal Standard soft key.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard, and press **Enter** to select. When a signal standard is selected, the center frequency for the channel of the selected standard is automatically tuned.
4. Press the Channel soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected signal standard. The center of the channel is tuned to the center of the display. The current settings are displayed in the instrument settings summary column on the left side of the screen.

Power Offset for Compensating External Loss

To get accurate results, compensate for any external attenuation by using power offset. In power offset mode, the compensation factor is in dB. External attenuation can be caused by using an external cable or an external high power attenuator.

1. Press the **Amplitude** function hard key.
2. Press the Power Offset soft key and use the keypad, the arrow keys, or the rotary knob to enter the desired offset value. When using the rotary knob, the value changes in increments of 0.1 dB. When using the **Left/Right** arrow keys, the value changes in increments of 1.0 dB. When using the **Up/Down** arrow keys, the value changes in increments of 10.0 dB. The value that is entered is displayed in the instrument settings summary column on the left side of the screen.

Bandwidth Setup

The BTS Master bandwidth can be manually set to 5 MHz, 8.75 MHz, or 10 MHz.

1. Press the **Setup** function hard key.
2. Press the BW (bandwidth) soft key to display a set of available bandwidths: 5 MHz, 8.75 MHz, and 10 MHz.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight the applicable bandwidth on the list, and press the **Enter** key to set the bandwidth. The selected bandwidth is displayed in the instrument settings summary column.

Frame Length Setup

The frame length can be set to 5 ms or 10 ms. For Demodulation and Power versus Time measurements, frame length needs to be set correctly for successful preamble synchronization.

1. Press the **Setup** function hard key.
2. Press the Frame Length soft key to toggle between 5 ms and 10 ms.

Demod Type Setup

The BTS Master can demodulate the signal in three ways: It can demodulate the signal by decoding the downlink map (DL-MAP). It can demodulate the signal based upon manually entered parameters for the DL-MAP (by using an **.xml** file). It can demodulate only the frame control header (FCH) portion of the signal.

1. Press the **Setup** function hard key.
2. If Manual needs to be selected, press the Load Parameter File soft key to load an **.xml** file with the DL-MAP parameters defined using the Anritsu IQProducer software.
3. Press the Demod Type soft key repeatedly to cycle through Auto, Man, and FCH.

Span Setup

1. Press the **Setup** function hard key.
2. Press the Span soft key to display the available spans: 5 MHz, 10 MHz, 20 MHZ, 30 MHz.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight the applicable span on the list, and press the **Enter** key to set the span.

External Reference Frequency Setup

In order to get the best frequency accuracy measurements, the use of an external reference frequency is important. Attach it to the BTS Master Ext Ref In connector. Most base stations have a reference frequency that is available on a BNC connector.

1. Press the **Setup** function hard key.
2. Press the Ext. Ref. Freq soft key to display a list of the available reference frequencies: 1 MHz, 1.2288 MHz, 1.544 MHz, 2.048 MHz, 2.4576 MHz, 4.8 MHz, 4.9152 MHz, 5 MHz, 9.8304 MHz, 10 MHz, 13 MHz, 19.6608 MHz.
3. Use the **Up/Down** arrow keys or the rotary knob to highlight the applicable reference frequency on the list, and press the **Enter** key to set the reference frequency. As the BTS Master locks to the source, the reference frequency value is displayed in the user settable parameters in the instrument settings summary column.

> NOTE: Screen captured images are provided as examples. The image and measurement details that are shown on your instrument may differ from the examples in this user guide.

Mobile WiMAX RF Measurements

Mobile WiMAX RF Measurements consists of three measurement types: Spectrum, Power versus Time, and Adjacent Channel Power Ratio (ACPR).

Setup for RF Measurements

1. Press the **Measurements** function hard key.
2. Press the RF soft key to select one of the following RF measurements.

Spectrum

The Spectrum screen displays the spectrum of the input signal and channel power in dBm and occupied bandwidth.

1. Press the Spectrum soft key to select the spectrum measurement.
2. Press the Spectrum soft key again to open the Spectrum menu and change the Span, if desired. Span choices are: 5 MHz, 10 MHz, 20 MHz, 30 MHz.
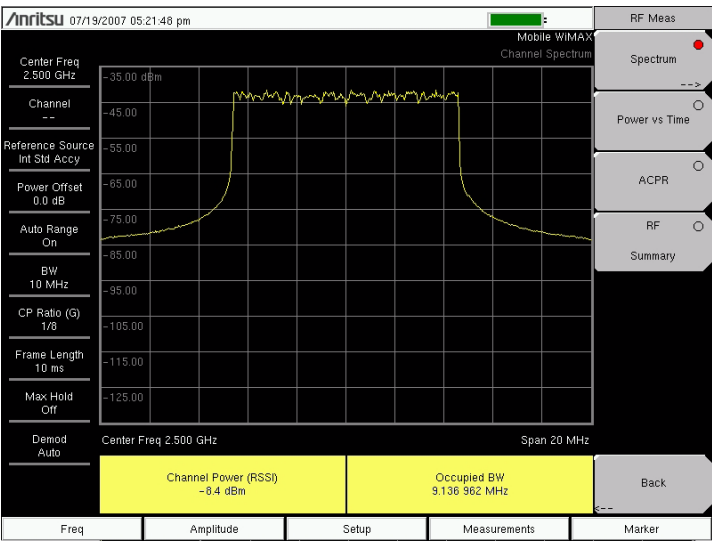
Figure 20-1. Channel Spectrum Measurement

Power versus Time

The Power versus Time view shows the time domain view of a Mobile WiMAX signal over approximately one frame. The screen also displays Channel Power (RSSI), Downlink Burst Power, Uplink Burst Power, and Preamble Power.

• Press the Power vs Time soft key to select the measurement.
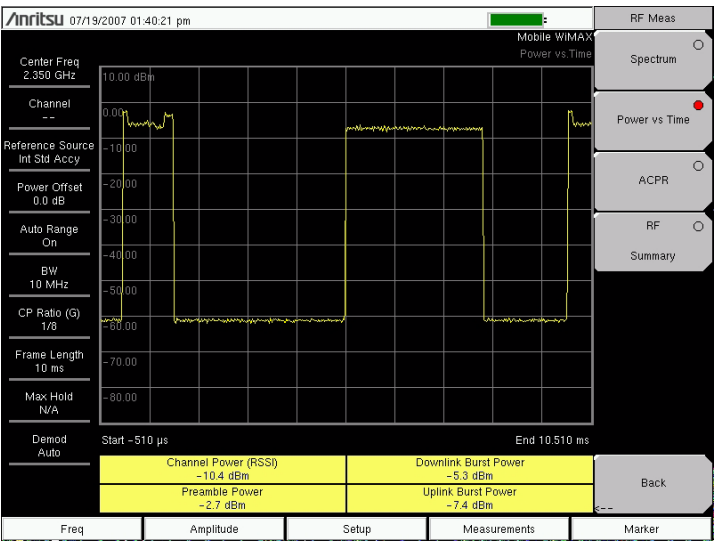
Figure 20-2. Power versus Time Measurement

Adjacent Channel Power Ratio (ACPR)

The ACPR view shows one main channel and two adjacent channels on each side, and also displays the power levels for each channel (both absolute and relative). The channel spacing matches the selected bandwidth, and the channels are color coded.

• Press the ACPR soft key to select the measurement.
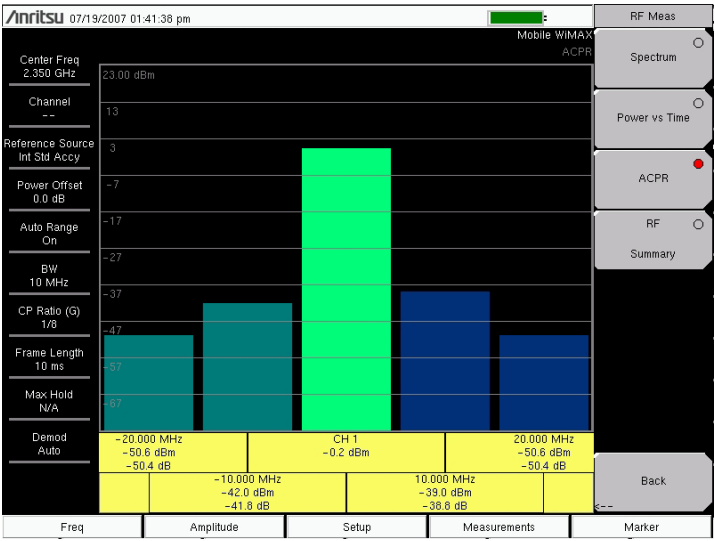
Figure 20-3. Adjacent Channel Power Ratio Measurement

RF Summary

The RF Summary measurement displays the critical RF transmitter performance measurements in a table format, without demodulating the WiMAX signal. The parameters that are displayed in the RF Summary table are Channel Power (dBm), Downlink Burst Power (dBm), Uplink Burst Power (dBm), Preamble Power (dBm), and Occupied Bandwidth (Hz).

• Press the RF Summary soft key to activate the measurement.
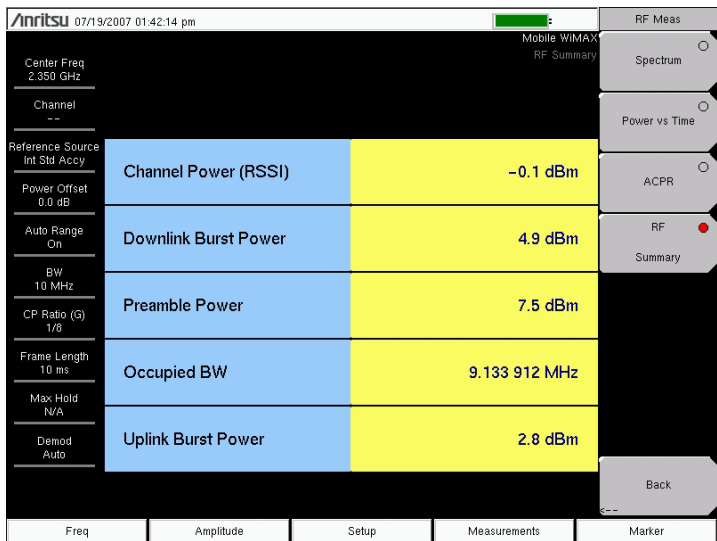
Figure 20-4. RF Summary Measurement

Mobile WIMAX Demodulator

The BTS Master will demodulate a Mobile WiMAX Signal from a Base Station, and it can display the results in Constellation, Spectral Flatness, EVM versus Sub Carrier, EVM versus Symbol, Modulation Summary, and DL-MAP views.

Setup for Demodulator Measurements

1. Press the **Measurements** function hard key.
2. Press the Demodulator soft key to open the Demodulator menu and select one of the following demodulator measurements.

Constellation

The BTS Master displays the constellation of the demodulated data symbols over one frame. The various constellations are color coded as follows:

QPSK is shown in purple
16QAM is shown in green
64QAM is shown in yellow
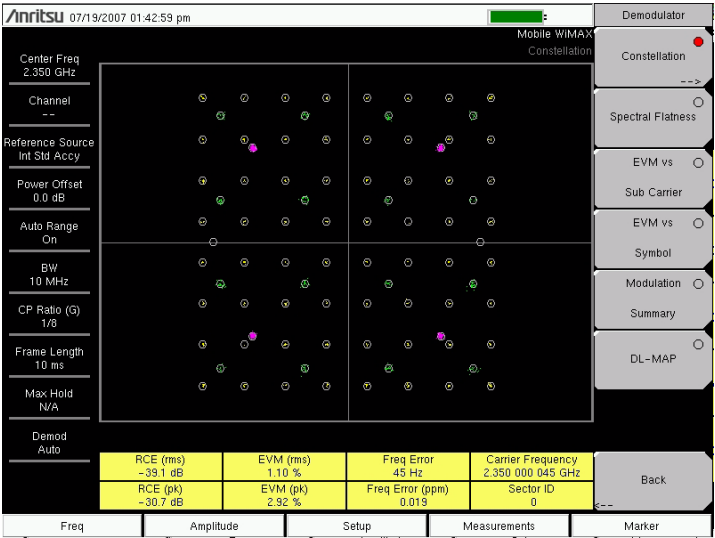
Figure 20-5. Constellation Measurement

The numerical results that are displayed in this view are: RCE$_{RMS}$ (dB), RCE$_{PEAK}$ (dB), EVM$_{RMS}$ (%), EVM$_{PEAK}$ (%), Freq Error (Hz), Freq Error (ppm), Carrier Frequency (Hz), and Sector ID.

1. Press the Constellation soft key to activate the measurement.
2. Press the Constellation soft key again to activate the reference points menu.
3. Press the Reference Points soft key to toggle the reference points On or Off.

Spectral Flatness

The Spectral Flatness view shows the data that is collected from the preamble at the channel estimation step. The deviation of the Spectral Flatness from the average over all of the carriers is shown in dB. A mask that conforms to the specification is overlaid on the trace. Green color on the mask indicates pass, and red color on the mask indicates regions of the mask where the signal fails.

This mask is referenced from the average of all subcarrier amplitude values. The numerical result displayed in this view is the adjacent subcarrier flatness (in dB).

• Press the Spectral Flatness soft key to select the measurement.
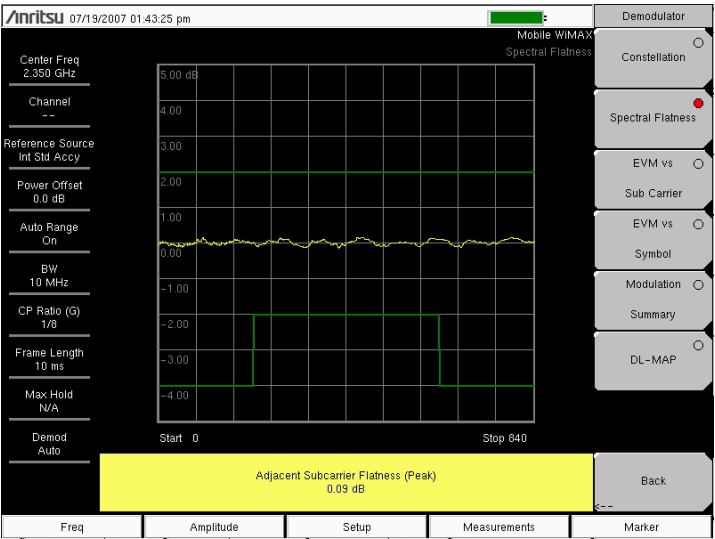
Figure 20-6. Spectral Flatness View

EVM versus Sub Carrier

This view shows the EVM$_{RMS}$ values versus OFDMA subcarriers. The numerical results that are displayed in this view are: RCE$_{RMS}$ (dB), RCE$_{PEAK}$ (dB), EVM$_{RMS}$ (%), EVM$_{PEAK}$ (%), Freq Error (Hz), Freq Error (ppm), Carrier Frequency (Hz), and Sector ID.

• Press the EVM vs Sub Carrier soft key to select the measurement.
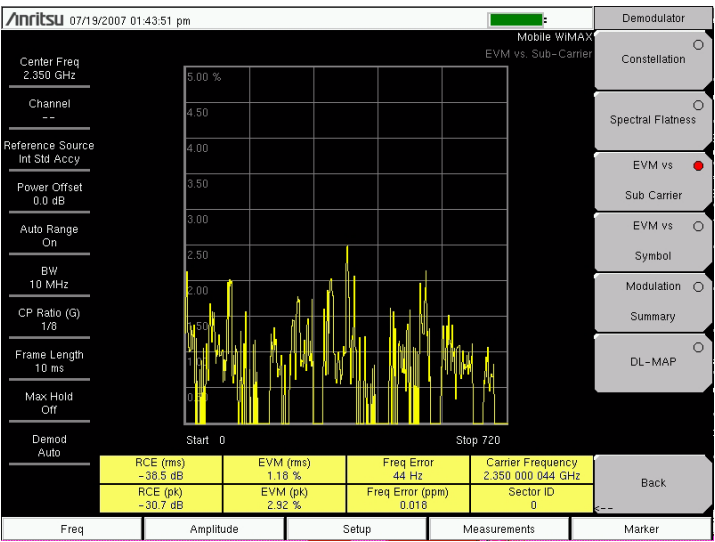
Figure 20-7. EVM versus Sub Carrier Measurement

EVM versus Symbol

This view shows the EVMRMS values versus OFDM symbols. The numerical results that are displayed in this view are: RCERMS (dB), RCEPEAK (dB), EVMRMS (%), EVM^{peak} (%), Freq Error (Hz), Freq Error (ppm), Carrier Frequency (Hz), and Sector ID.

• Press the EVM vs Symbol soft key to select the measurement.
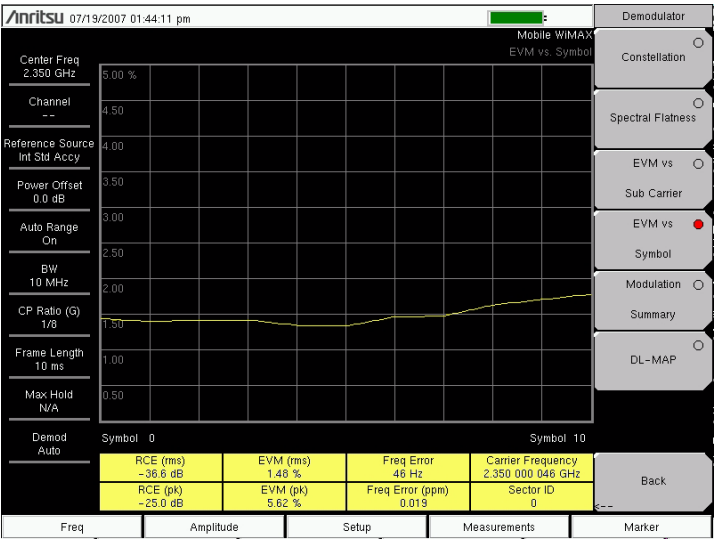
Figure 20-8. EVM versus Symbol Measurement

Modulation Summary

The Modulation Summary measurement displays the critical Modulation transmitter performance measurements in a table format by demodulating the WiMAX signal. The parameters that are displayed in the Modulation summary table are: RCE$_{RMS}$ (dB), RCE$_{PEAK}$ (dB), EVM$_{RMS}$ (%), EVM$_{PEAK}$ (%), Freq Error (Hz), Freq Error (ppm), Carrier Frequency (Hz), and Sector ID.

• Press the Modulation Summary soft key to select the measurement.
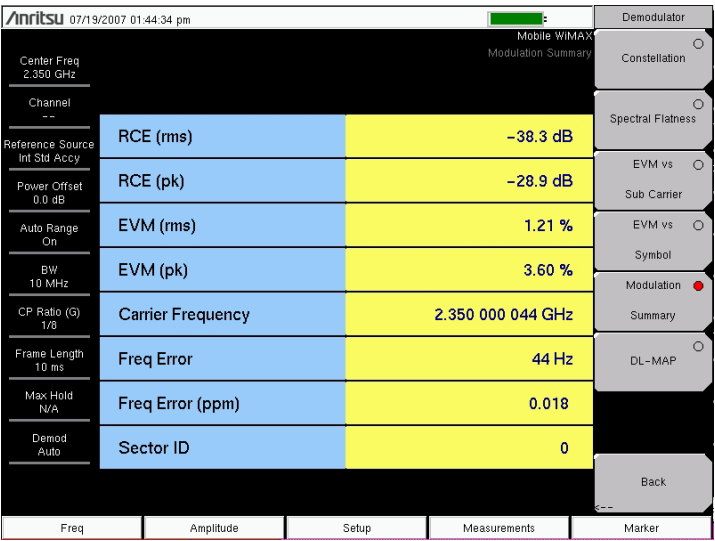
Figure 20-9. Modulation Summary Measurement

DL-MAP

The DL-MAP measurement displays the DL-MAP information either from the decoded results (Auto mode) or from the parsed information, which is from the **.xml** parameter file (Manual mode).

1. Press the DL-MAP soft key to open the DL-MAP Tree, which displays a list of WiMAX parameters.
2. Use the **Up/Down** and **Left/Right** arrow keys to close or open subordinate lists within the map.
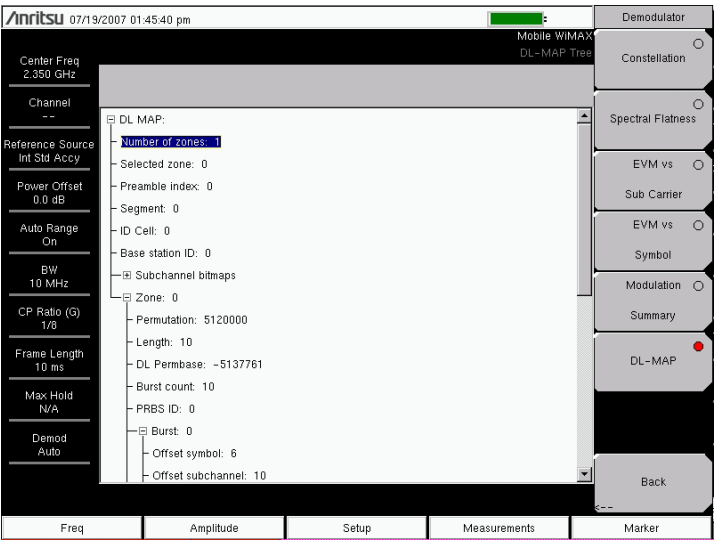
Figure 20-10. DL-MAP Measurement

Mobile WIMAX Over the Air (OTA) Measurements

The Over the Air (OTA) Measurement option consists of a Channel Power Monitor measurement.

Setup for OTA Measurements

1. Press the **Measurements** function hard key.
2. Press the OTA soft key open the OTA menu.
3. Press the Channel Power Monitor soft key to select the measurement.
4. Press the Channel Power Monitor soft key again to open the Channel Power Monitor menu.
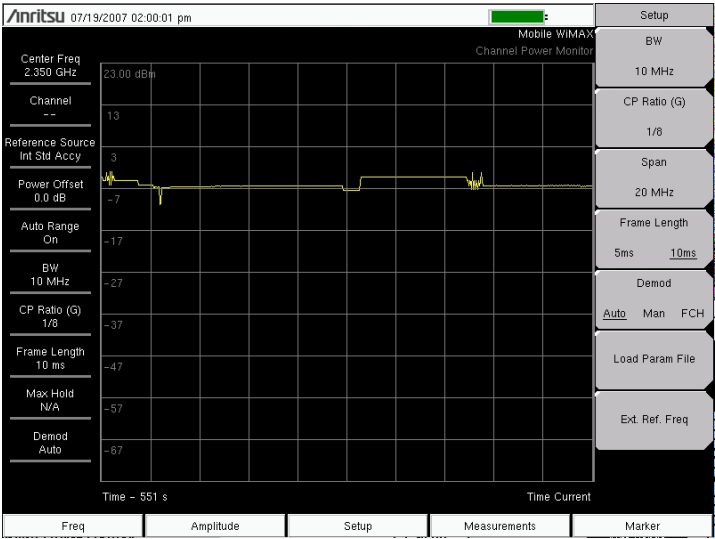
Figure 20-11. Example Channel Power Monitor Measurement

Channel Power Monitor

This measurement displays the Channel Power (RSSI) value over a period of time that you specify. You can also specify the time interval between channel power measurements. Time stamps are recorded along with the power information. If GPS is activated on the instrument, then UTC time is stored, and GPS coordinates are also stored. If GPS is not activated on the instrument, then the internal clock is used.
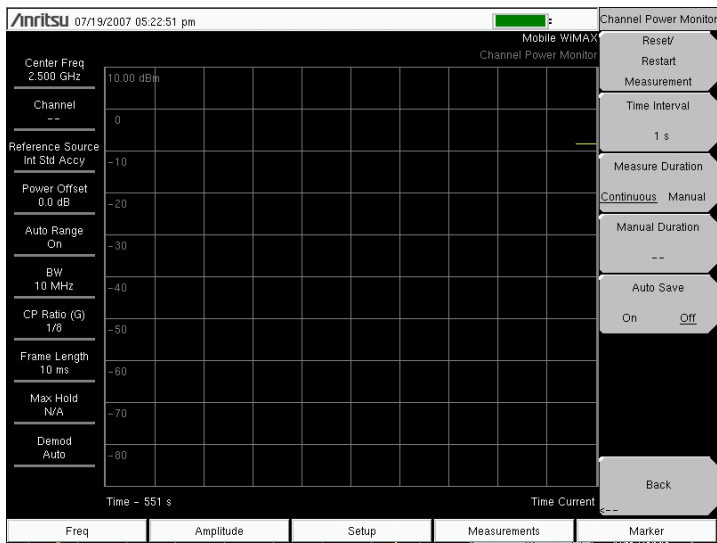
Figure 20-12. Channel Power Monitor Measurement Menu

1. Press the **Measurements** function hard key.
2. Press the OTA soft key.
3. Press the Channel Power Monitor soft key twice, once to select the Channel Power Monitor measurement and again to open the Channel Power Monitor menu.
4. Press the Time Interval soft key to specify measurement update intervals. Use the **Up/Down** or **Left/Right** arrow keys to scroll to the desired interval, 1 sec, 2 sec, or 60 sec, and press **Enter**.
5. Press the Measure Duration soft key to toggle between Continuous and Manual.
6. Press the Manual Duration soft key to manually set a measurement duration.
7. Press the Auto Save button to turn On or Off the automatic measurement saving feature.
8. Press the Reset/Restart Measurement soft key to discard logged Channel Power data and restart logging of the data.

Pass/Fail Mode

The Pass/Fail mode allows selection of a user-defined file that specifies a list of measurements with pass/fail criteria. In this mode, the BTS Master steps in sequence through the appropriate measurements and indicates a pass or fail state based upon the criteria. Using Master Software Tools (MST), a custom test list can be created and downloaded into the unit. All of the critical measurements are available and can be selected for pass/fail testing. The results are displayed in a table format with clear identification of pass/fail results, including minimum and maximum thresholds and measured results.

1. Press the **Measurements** function hard key.
2. Press the Pass/Fail Mode soft key.
3. Press the Pass/Fail Mode soft key again to activate the Pass Fail Mode menu.
4. Press the Select Pass/Fail Test soft key to view a list of pass/fail test definition files.
5. Use the **Up/Down** arrow keys or the rotary knob to highlight the applicable pass/fail test on the list, and press the **Enter** key to select.
6. Press the Reset soft key to begin a new pass/fail test measurement.

WiMAX Summary

The WiMAX Summary is a summary of critical Mobile WiMAX measurements from the RF and Demodulator measurements.

1. Press the **Measurements** function hard key.
2. Press the WiMAX Summary soft key.
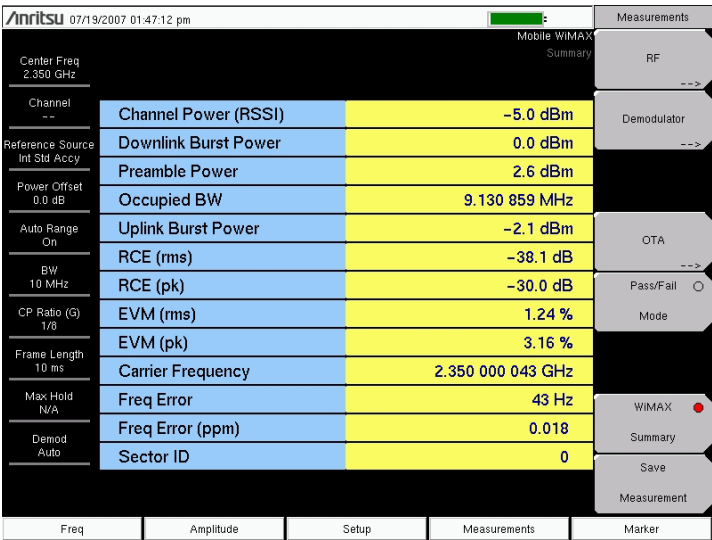
Figure 20-13. WiMAX Summary Display

Menus

The following section describes function hard keys menus, associated soft keys, and submenus.

Freq (Frequency)
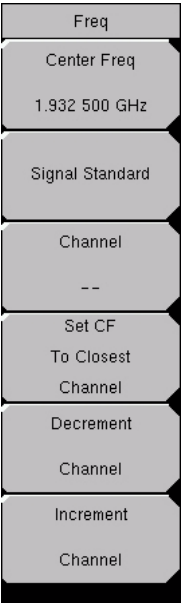
Figure 20-14. Frequency Menu

Center Freq,
Press the Center Freq soft key to set the receiver center frequency to the desired value. Enter the frequency using the keypad, the arrow keys, or the rotary knob. When entering a frequency using the keypad, the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate unit soft key. Pressing a unit soft key finalizes the data input. Pressing the **Enter** key has the same affect as pressing the MHz soft key.

Signal Standard
Pressing this soft key opens the Signal Standards list box. Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard and press **Enter** to select. When a signal standard is selected, the center frequency and span are automatically tuned for the first channel of the selected standard. Other settings, such as channel spacing and integration bandwidth, are also entered automatically.

The applicable signal standards (for 10 MHz BW only) are U-NII middle, U-NII upper, CEPT Band B, and CEPT Band C.

Channel
Press this soft key and use the **Up/Down** arrow keys, the keypad, or the rotary knob to select a channel number for the selected Signal Standard. The BTS Master measurement display is automatically tuned to the center frequency of the selected channel.

Set CF to Closest Channel
Pressing this soft key moves the current Center Frequency to the closest frequency that matches a channel number in the current Signal Standard.

Decrement Channel
Press this soft key to decrease the selected channel number by the specified channel step size for the selected standard.

20-18

Increment Channel
Press this soft key to increase the selected channel number by the specified channel step size for the selected standard.

Amplitude
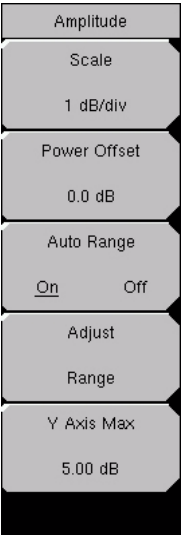
Figure 20-15. Amplitude Menu

Scale, ##
Press this soft key to set the scale of the y-axis on the measurement display. Scale can be set from 1 dB/div to 15 dB/div. The default value is 10 dB/div. When EVM is the y-axis value, the units change from dB/div to %/div. When the Spectral Flatness view is selected, the default value changes from 10 dB/div to 1 dB/div.

Power Offset, ##
Press the Power Offset soft key to set the instrument to automatically adjust for loss through external cables, attenuators, and couplers. Power can be offset (-100 dB to $+100$ dB) by using the rotary knob or the **Up/Down** and **Left/Right** arrow keys. Set the offset value, then press the **Enter** key.

Auto Range, On/Off
Press the soft key to toggle between On and Off. The on or off state is underlined on the virtual soft key face. When On (the default state), the reference level is adjusted automatically (automatic gain ranging).

Adjust Range
Press this soft key to modify the internal reference level to be optimally based upon the measured signal. When the Adjust Range soft key is pressed, Auto Range is set to the Off state, and a manual Auto Range operation is performed once. The BTS Master no longer adjusts the internal gain automatically because Auto Range has been set to Off by pressing this soft key. Press the Auto Range soft key to toggle the setting to On in order to resume automatic gain ranging.

Y Axis Max, ##
Press this soft key to set the maximum value of the y-axis. In combination with the Scale control, this setting allows zooming in and out on the y-axis. This control is available only in the Spectral Flatness view, EVM versus Symbol view, EVM versus Sub Carrier view, and Channel Power Monitor view.
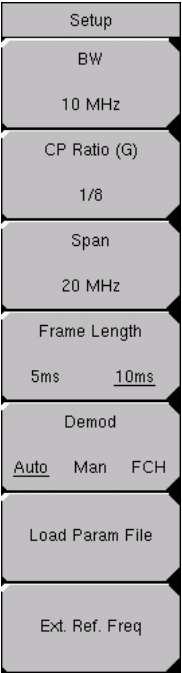
Setup

Figure 20-16. Setup Menu

BW, ##
Press this soft key to open the *Select Bandwidth* list box. Use the **Up/Down** arrow keys or the rotary knob, and then press the **Enter** key. The following three bandwidths are available: 5 MHz, 8.75 MHz, and 10 MHz. The default bandwidth is 5 MHz.

CP Ratio (G), #
The CP Ratio is fixed at 1/8 for Mobile WiMAX. Users cannot change this parameter.

Span, ##
Press this soft key to open the *Span* list box and select the desired span for the Spectrum view. Use the **Up/Down** arrow keys or the rotary knob, and then press the **Enter** key. The available span selections are: 5 MHz, 10 MHz, 20 MHz, and 30 MHz.

NOTE: The span value is automatically adjusted to the next largest available span when the bandwidth setting is changed. The span can be changed to any of the available values in order to override the automatic selection.

Frame Length, #
Press this soft key to toggle between 5 ms and 10 ms for frame length.

Demod, Auto/Man/FCH
Press this soft key to toggle through the available selections for Automatic, Manual, and Frame Control Header: Auto, Man, FCH.

When Auto is chosen, the BTS Master attempts to demodulate the signal, decode the DL-MAP, and use that information to demodulate the data portion of the frame.

When Manual is chosen, a parameter file must be available (you must have already loaded this parameter file). The parameters from this file are used by the BTS Master to demodulate the data bursts.

NOTE: The Manual mode setting is not saved in setup files, nor is it saved when power is turned off. If Demod is set to Manual mode before the instrument is turned off, then the Demod setting becomes Auto mode when the instrument is turned on.

When FCH is chosen, only the FCH portion of the signal is demodulated.

Load Param File
Press this soft key to open the *Parameter Files (XML)* list box and to select the parameters that are stored in an XML file. This file needs to be generated by using the Anritsu IQProducer software.

Ext. Ref. Freq
Press this soft key to open the *External Reference Frequency* list box and select a frequency from the list. The following External Reference Frequencies are available: 1 MHz, 1.2288 MHz, 1.544 MHz, 2.048 MHz, 2.4576 MHz, 4.8 MHz, 4.9152 MHz, 5 MHz, 9.8304 MHz, 10 MHz, 13 MHz, and 19.6608 MHz. The default External Reference Frequency is 10 MHz.
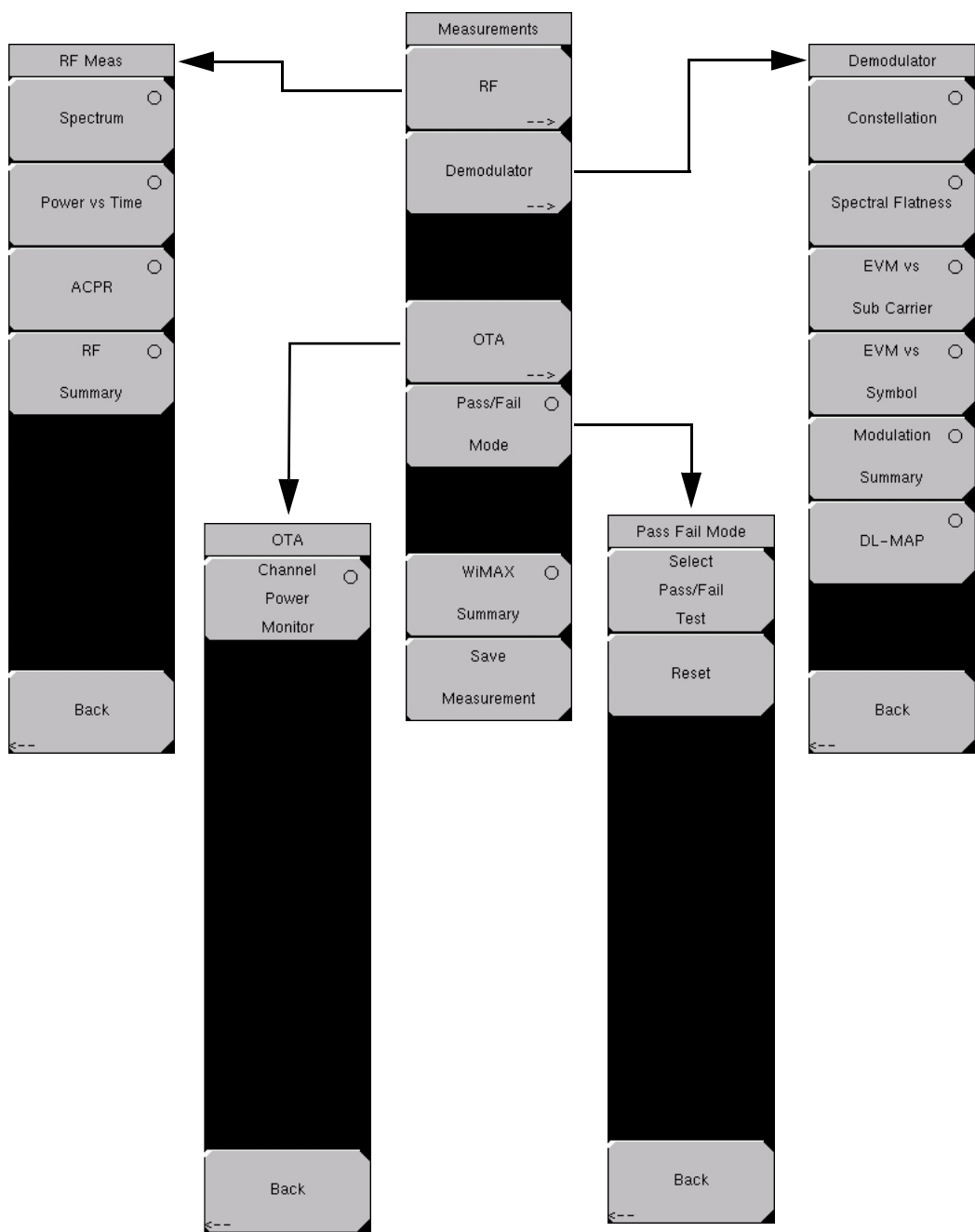
Figure 20-17. Measurements Menu

RF Measurements

Press this soft key to open the RF Meas soft key menu in order to select an RF type of measurement.

RF Meas soft Key Menu

Spectrum

Press this soft key to set the RF measurement type to Spectrum. This view displays the spectrum of the input signal. The span is automatically adjusted to the next largest available span based on the bandwidth setting. Channel Power (RSSI) in dBm and Occupied bandwidth measurements are displayed as numerical values. The Spectrum soft key becomes a soft key that opens the **Spectrum** soft key menu. The **Spectrum** soft key menu has only two soft keys: Span and Back.

Spectrum Soft Key Menu

Span, #

Press this soft key to open the Span list box and to select the desired span for the Spectrum measurement. The list displays the following four choices: 5 MHz, 10 MHz, 20 MHz, and 30 MHz. The default value is 10 MHz.
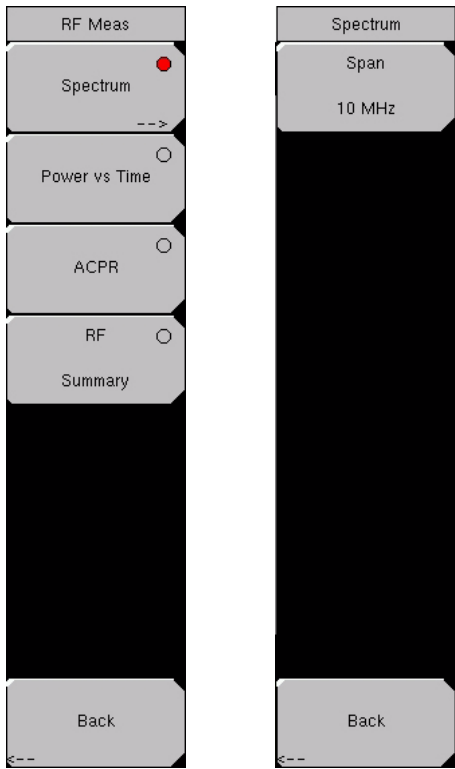
Figure 20-18. RF Spectrum Measurements

NOTE: The span value is automatically adjusted to the next largest available span when the bandwidth setting is changed (by using the **Setup** function hard key and the BW soft key). You can override the automatic selection by using the Span soft key.

Back

Press the Back soft key to return to the previous menu.

Power vs Time

Press the Power vs Time soft key to use this measurement display. The power versus time view shows the time domain view of a WiMAX 802.16e signal over approximately one frame. The BTS Master automatically tries to synchronize to the downlink preamble without the need for an external trigger. If the frame length setting does not match the input signal frame length, then the synchronization will not be reliable.

The Channel Power (dBm), Preamble Power (dBm), Downlink Burst Power (dBm) and Uplink Burst Power (dBm) are displayed as numerical values.

ACPR (Adjacent Channel Power Ratio)

Press the ACPR soft key to show one main channel and two adjacent channels, and to display the power levels for each channel (both absolute power and relative power).

RF Summary

Press the RF Summary soft key to display a summary of all of the RF numerical measurement results.

Back (from the RF Meas soft key menu)

Press the Back soft key to return to the **Measurements** menu.

Demodulator

Press the Demodulator soft key to open the Demodulator soft key menu.
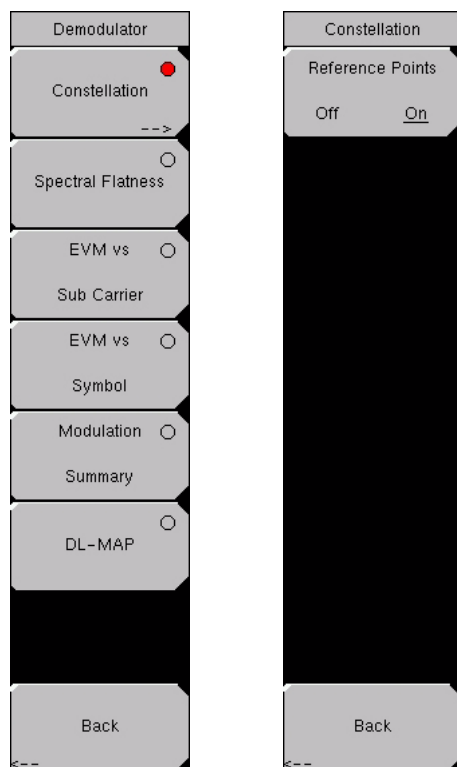
Figure 20-19. Demodulator Menu

Demodulator Soft Key Menu

Constellation

Press the Constellation soft key to set the demodulation to Constellation view.

The constellation view shows the constellation of the demodulated data symbols over one frame. The constellations are color coded as follows:

- QPSK is shown in purple
- 16-QAM is shown in green
- 64-QAM is shown in yellow

The numerical results that are displayed in this view are:

- RCE (rms) in dB
- RCE (pk) in dB
- EVM (rms) in %
- EVM (pk) in %
- Freq Error in Hz
- Freq Error in ppm
- Carrier Frequency in Hz
- Sector ID

The Constellation soft key becomes a soft key that opens the Constellation soft key menu. The Constellation soft key menu has only two soft
keys: Reference Points, Off/On and Back.

Constellation Soft Key Menu

Reference Points, Off/On

Press this soft key to display reference points for the various constellations. The default state is On.

Back (from the Constellation soft key menu)

Press the Back soft key to return to the Demodulator menu.

Spectral Flatness

Press this soft key to show the spectral flatness data that is measured from the preamble at the channel estimation step. The deviation of the spectral flatness from the average of all the carriers is shown in dB. A mask that conforms to the specification is overlaid on the trace. Green color on the mask indicates pass, and red color on the mask indicates fail.

This mask is referenced from the average of all subcarrier amplitude values. Absolute delta of the power between adjacent subcarriers is displayed as a numerical value in dB.

EVM vs Sub Carrier

Press this soft key to display the EVM (rms) values versus subcarriers. Because some subcarriers are not used in OFDMA, their values are set to 0.

EVM vs Symbol

Press this soft key to display the EVM (rms) values versus OFDM symbols.

Modulation Summary

Press this soft key to display a summary of all of the modulation-related numerical measurement results. The following measurements are displayed:

- RCE (rms)
- RCE (pk)
- EVM (rms)
- EVM (pk)
- Carrier Frequency
- Freq Error
- Freq Error (ppm)
- Sector ID

DL-MAP

Press this soft key to display the DL-MAP information from either the decoded results (Auto mode) or the parsed information from the **.xml** parameter file (Manual mode).

Back (from the Demodulator soft key menu)

Press the Back soft key to return to the **Measurement** menu.

OTA

Press the OTA soft key to open the OTA soft key menu. The OTA soft key menu has only two soft keys: Channel Power Monitor and Back.
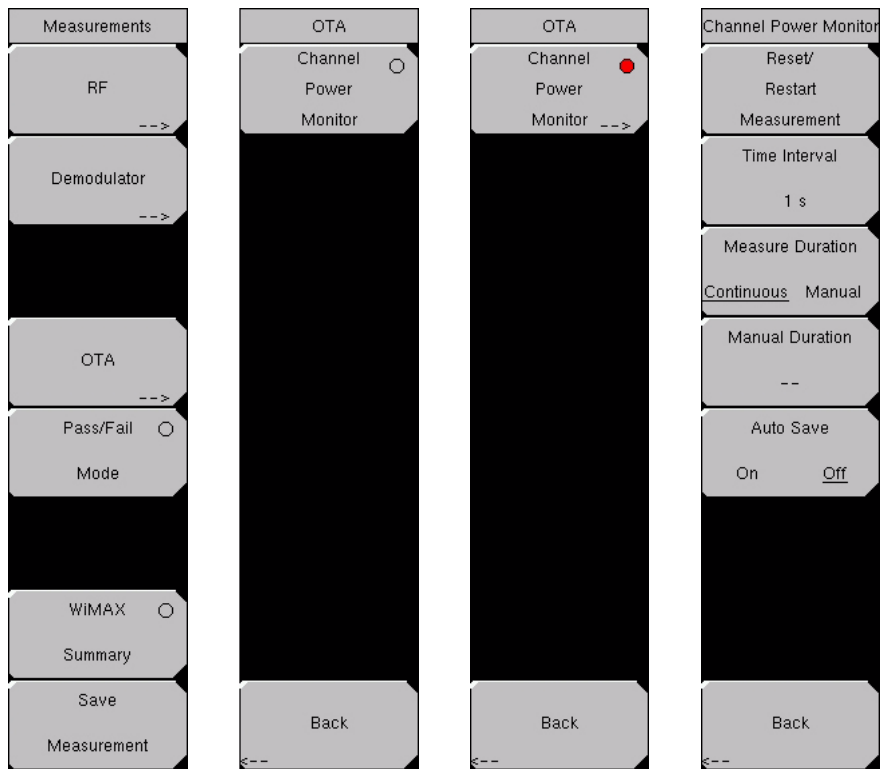
Figure 20-20. OTA Menu

OTA Soft Key Menu

Channel Power Monitor

Press this soft key to display the Channel Power (RSSI) value over a variable time period that is specified with the Measure Duration and Time Interval soft keys.

The Time Interval soft key is used to specify the time interval between channel power measurements. Time stamps are recorded along with the power information. If GPS is activated on the instrument, then UTC time is stored, and GPS coordinates are also stored. If GPS is not activated on the instrument, then the internal clock is used.

The Channel Power Monitor soft key becomes a soft key that opens the Channel Power Monitor soft key menu to set up RSSI (Received Signal Strength Indicator). The menu has five soft keys, which are:

Reset/Start Measurement; Time Interval, #; Measure Duration, Continuous/Manual; Manual Duration, #; Auto Save, On/Off; and Back.

Channel Power Monitor Soft Key Menu

Reset/Restart Measurement

Press this soft key to reset or to restart the measurement. Pressing this soft key discards logged Channel Power data and restarts logging of the data.

Time Interval,

Press this soft key to select a time interval between measurements. Press the rotary knob or the **Enter** key to set the value. If the number keypad is used, then the Time soft key menu opens with four keys: min, s, ms, µs.

Setting the Time Interval specifies how often the instrument measures Channel Power and logs the information.

Measure Duration

Press this soft key to toggle between Continuous and Manual. Pressing this soft key specifies the duration for which Channel Power data is logged.

When Measure Duration is set to Continuous, the instrument continuously monitors Channel Power at the specified time intervals. If Auto Save is On, then the instrument saves the logged data to a file after every 551 data points are collected (1 screenful of data). If the instrument runs out of memory, then it continues measuring but stops writing data to files in memory.

When Measure Duration is set to Manual, the instrument stops monitoring Channel Power after the specified duration. If Auto Save is On, then the instrument saves the logged data to a file at the end of the duration. If the duration causes the unit to log more than 551 data points, then multiple files are saved, one after each set of 551 data points is collected.

Manual Duration

Press this soft key to specify the duration for which the instrument monitors Channel Power. If the Measure Duration is currently set to Continuous, then pressing this soft key automatically changes measurement duration to Manual and allows you to set a value for Manual Duration. The range is from a minimum value of 60 seconds to a maximum value of 259200 seconds (72 hours). After choosing a time duration, press the **Enter** key to set the value. If a numerical value is entered with the number keypad, then the Time soft key menu offers units of min, s, ms, and µs. Regardless of the unit key that you use, the set value is displayed in the corresponding number of seconds (60 min = 3600 s and 60000 ms = 60 s).

Auto Save, On/Off

Press this soft key to toggle between On and Off. When the Auto Save function is On, measurements are automatically saved to file.

When the Auto Save function is active, each 551 data points are saved as a measurement. The amount of available memory in the instrument determines how many measurements can be saved. If the Time Interval and Measure Duration are already set to values that will require more memory than is available, then pressing the Auto Save soft key causes the instrument to reset the Measure Duration to a value that allows saving all of the measurements that are taken. The instrument can continue monitoring the signal, but additional measurements are not saved.

Back (from Channel Power Monitor)

Press this soft key to return to the OTA soft key menu.

Back (from OTA)

Press this soft key to return to the **Measurements** menu.

Pass/Fail Mode
Press this soft key to display the PASS_FAIL table. The Pass/Fail Mode soft key changes to a soft key. Press this soft key to open the Pass Fail Mode soft key menu, which has three soft keys: Select Pass/Fail Test, Reset, and Back. Refer to Figure 20-17 .

A custom list can be created with Master Software Tools and downloaded into the BTS Master. All critical measurements can be selected for pass/fail testing. The results are displayed in table format with clear identification of pass/fail results, including minimum and maximum threshold values and measured results.

Pass/Fail Mode allows the selection of a user-defined file (created with Master Software Tools) that specifies a list of measurements with pass/fail criteria. You can select just those measurements that are of interest to you and create a pass/fail test file. When you press the Select Pass/Fail Test soft key, select a test file, and press the **Enter** key, then the BTS Master measures each parameter and displays the results in the Pass/Fail table.

Pass Fail Mode Soft Key Menu

Select Pass/Fail Test
Press this soft key to select a pass/fail test from the list of available Pass/Fail tests. The default list is:

PASS_FAIL_RF

PASS_FAIL_DEMOD

PASS_FAIL_ALL

Reset
Press this soft key to restart a Pass/Fail test.

Back (from the Pass Fail Mode soft key menu)
Returns to the **Measurements** menu.

WiMAX Summary
Press this soft key to display a summary of all of the WiMAX related numerical measurement results. Refer to Figure 20-17 . These measurements include the following:

- Channel power (dBm)
- Downlink Burst Power
- Preamble Power
- Occupied Bandwidth
- Uplink Burst Power
- RCE (rms)
- RCE (pk)
- EVM (rms)
- EVM (pk)
- Carrier Frequency
- Freq Error
- Freq Error (ppm)
- Sector ID

Save Measurement

Pressing this soft key opens the Save Measurement entry window. Refer to Figure 20-17 on page 20-23. A suggested filename is placed in the edit box by default. Use the Text Entry soft keys to enter a different filename. WiMAX measurements are saved with a **.wmxe** extension. For more information about the Text Entry soft keys, refer to section *Text Entry* on page 2-7.
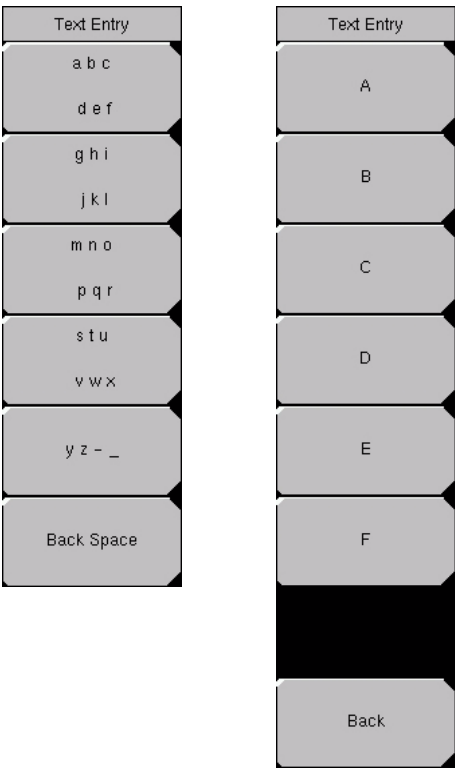
Figure 20-21. Text Entry Soft Keys

Marker

Figure 20-22. Marker Menu

This feature is available only when the Power vs Time measurement is activated. This function hard key opens the Marker menu.

Using Markers in Power versus Time Measurements

Six regular line markers and six delta markers are available. Marker information includes time and power level in dBm. Delta marker information includes delta time and delta power.

Marker, 1 2 3 4 5 6
Press this soft key to select and set up a marker for display.

On/Off
Press this soft key to turn On and Off the selected (underlined) marker in the Marker virtual soft key face.

Delta, On/Off
Press this soft key to turn On a delta marker. You can move the delta marker to read offsets in time and power by using the scroll wheel or by entering a time offset using the number keypad.

All Markers Off
Press this soft key to turn Off all markers and remove them from the display.

Secondary Function Menus

Pressing the **Shift** key and a number key selects the menu function that is printed in blue characters above the number key. Refer to section *Shift Key* on page 2-6.

File

The **File** (7) key menu is the same as the *File* menu on page 19-20 in the *Fixed WiMAX Signal Analyzer* chapter.

Limit

The **Limit** (6) key function is not implemented in the *Mobile WiMAX Signal Analyzer* mode.

Measure

The **Measure** (4) key brings up the same menu as the **Measurements** function hard key. Refer to section *Measurements* on page 20-23 for information about these menus.

Mode

The **Mode** (9) key opens the Mode Selector list box. For information about setting the mode, refer to section *Mode Selector Menu* on page 2-16.

System

The **System** (8) key menu is the same as the *System* menu on page 19-30 in the *Fixed WiMAX Signal Analyzer* chapter.

Preset

The **Preset** (1) key menu is the same as the *Preset* menu on page 19-35 in the *Fixed WiMAX Signal Analyzer* chapter.

Sweep

Press the **Shift** key, then the **Sweep** (3) key to open the Sweep sub menu that allows control over the measurements.

Sweep, Continuous/ Single
Press this soft key to toggle between Continuous and Single. When Continuous is selected, the instrument continuously makes measurements. When Single is selected, the instrument makes one measurement and then waits for a press of the Trigger Sweep soft key to sweep again.

Trigger Sweep
When the Sweep state is set to Single, pressing this soft key triggers a new measurement sweep. This soft key does nothing when the Sweep state is set to Continuous.

Trace

Press the **Shift** key, then the **Trace** (5) key to open the sub menu for Trace functions.

Max Hold, Off/On
Pressing this soft key toggles Max Hold to On or Off. It applies to *Spectrum* view and *EVM vs Sub Carrier* view. This function allows the spectrum trace to hold its peak value from trace to trace. This helps in capturing a representative spectrum of a burst RF signal such as WiMAX. All Max Hold operations show two traces. One trace is a max hold value, and the other is a live trace with the current measurement results.

Chapter 21
CW Signal Generator

Introduction

This chapter presents information and procedures that are used to make measurements by using the optional CW Signal Generator mode (Option 28).

The CW Signal Generator provides a continuous wave (CW) signal from the VNA RF Out port of the instrument. The CW signal is primarily used for testing the sensitivity of receivers. To test receiver sensitivity, connect the signal directly to the receiver that is being measured, and then reduce the output amplitude until the receiver drops the signal.

The external splitter feeds the signal into the RF input of the BTS Master. The display shows the output power and frequency. The amplitude is set by using an external step attenuator. The external splitter and attenuator are purchased separately. They are available as CW Signal Generator kit 67276.

The "fixed" CW signal levels vary as a function of the frequency. The VNA source output is not leveled.

Getting Started

Procedure to Enter CW Signal Generator Mode

To access the functions under the Mode menu, press the **Shift** key, then the **Mode** (9) key. The Mode Selector window pops up. Use the directional arrow keys or the rotary knob to highlight the CW Signal Generator mode, and then press the rotary knob or press **Enter** to select that mode. The list of modes that appears in this menu will vary depending upon the options that are installed and activated in your instrument. Figure 21-1 is an example of the Mode menu. Your instrument may not show the same list.
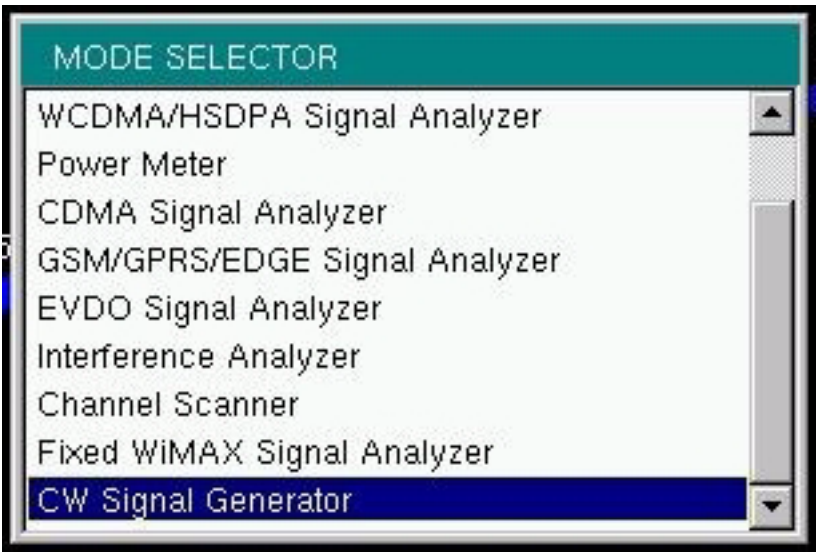
Figure 21-1. CW Signal Generator Mode Selection

For additional information about the Mode menu, refer to *Mode Selector Menu* on page 2-16.

Hard Keys and Soft Keys

For a general description of these key functions, refer to section *Front Panel Keys* on page 2-5.

Testing Receiver Sensitivity

Required Equipment

• BTS Master MT8222A with Option 28

• Step Attenuator, Splitter, and Connectors (from CW Signal Generator kit 67276).

Procedure

The BTS Master provides a CW signal. The signal is connected directly to the receiver that is being measured, and the output amplitude is reduced until the receiver drops the signal. The external splitter feeds the signal into the BTS Master RF input. The display shows the output power and frequency. The amplitude is set using an external step attenuator. The external splitter and attenuator are part of the 67276 CW Signal Generator Kit. Refer to the Optional Accessories table for section *CW Signal Generator Kit* on page 1-8.

1. Enter the CW Signal Generator mode. (Refer to *Getting Started* on page 21-1.)
2. From the CW soft key menu, press the Frequency soft key. You do not need to press the Frequency soft key if it is already active (when active, the numeric frequency setting on the soft key is highlight in red characters). Use the **Up/Down** arrow keys or the rotary knob to change to the desired frequency, or use the keypad to enter the desired frequency and press the MHz soft key. The Units soft key menu opens automatically when the numeric keypad is used to set the frequency.
3. Connect the attenuator to the RF Out port, and connect the splitter to the RF In port and to the DUT (device under test). Figure 21-2 shows this setup.
4. Connect the receiver cable to the output of the power splitter.
5. Adjust the power by using the attenuator knobs until the receiver that is being tested drops the signal.
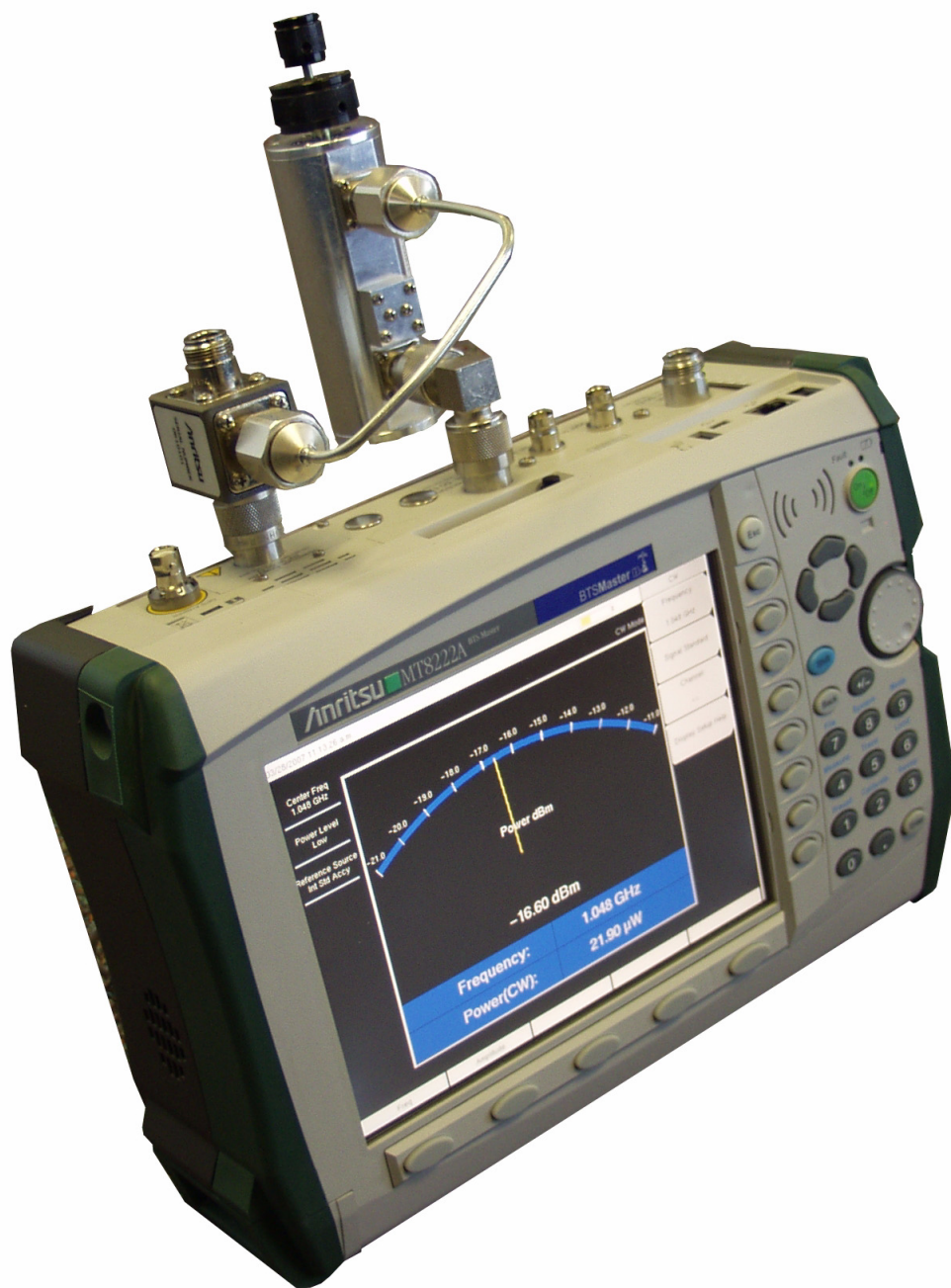
Figure 21-2. BTS Master CW Signal Generator with Attenuator and Splitter

CW Signal Generator Menus

In this mode, only two hard keys are functional: **Freq** and **Amplitude**. The **Freq** hard key selects the CW soft key menu. The **Amplitude** hard key selects the Amplitude soft key menu.

Frequency Menu
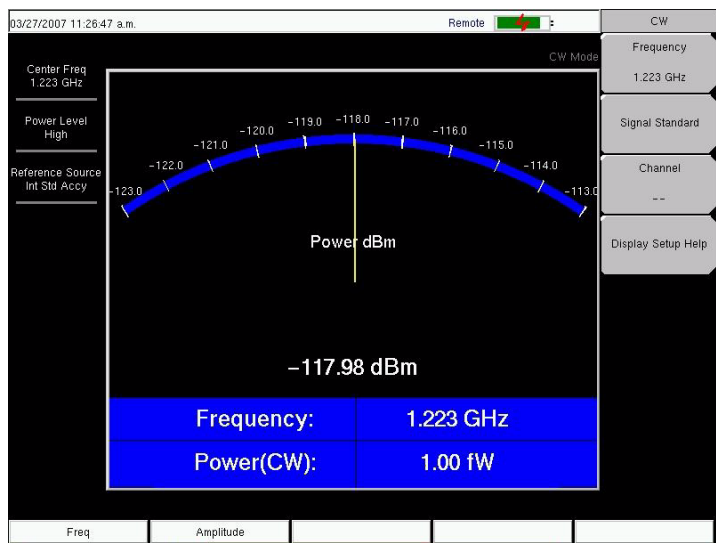
Figure 21-3. CW Signal Generator Frequency (CW) Menu

The CW soft key menu functions are:

Frequency
When this function is active, the numeric frequency value is displayed in red. Press this soft key to enter a CW frequency from 25 MHz to 3000 MHz by using the **Up/Down** arrow keys, the rotary knob, or the numeric keypad. Press the rotary knob or the **Enter** key to set the value. When entering a frequency by using the numeric keypad, the Units menu is displayed. The four units keys are GHz, MHz, kHz, and Hz.

Signal Standard
Press this soft key to open the Signal Standards selection box. Use the **Up/Down** arrow keys or the rotary knob to highlight a signal standard, and press **Enter** or the rotary knob to select the standard.

Channel

Use this soft key to open the Channel Editor dialog box. The current signal standard is displayed along with valid bands. Key in or scroll to the desired band in the current signal standard and press **Enter.** See Figure 21-4.
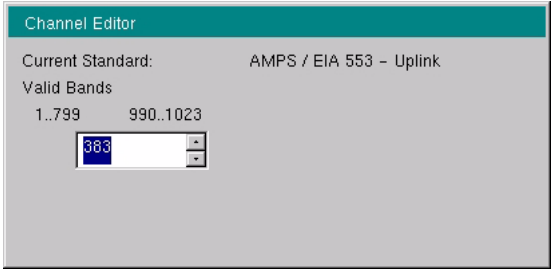
Figure 21-4. CW Signal Generator Channel Editor

Display Setup Help

Press this soft key to display a diagram of the recommended connection setup for using Option 28. The diagram is shown in Figure 21-5
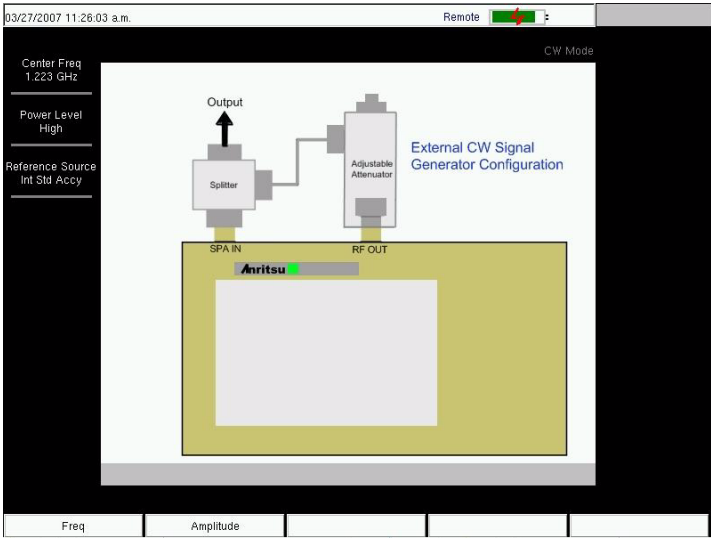
Figure 21-5. CW Signal Generator Setup Help Display

Amplitude Menu
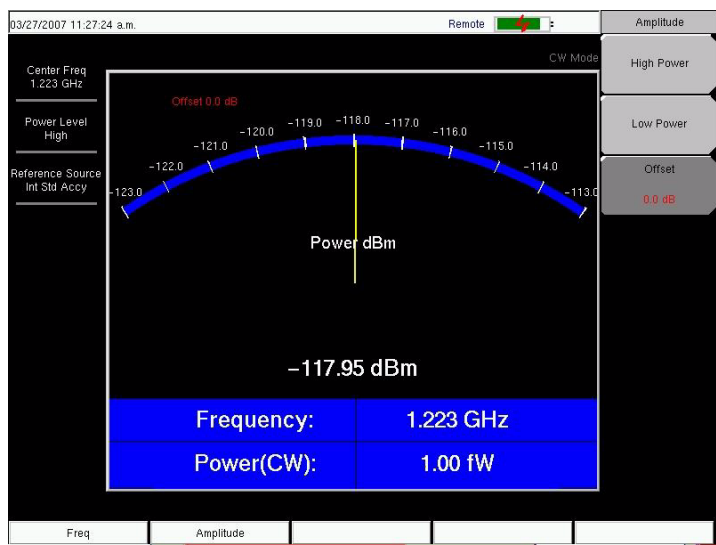
Figure 21-6. CW Signal Generator Amplitude Menu

High Power
Press this soft key to set the output power level to High.

Low Power
Press this soft key to set the output power level to Low.

Offset
Press this soft key to add an offset (in dB) to the amplitude level. This offset compensates for any attenuation that is placed inline between the splitter and the DUT. Offset range is +100 dB to –100 dB.

Additional Menus

In addition to the Frequency and Amplitude menus, the menus that are selected by pressing the **Shift** key and one of the number keys are limited to: **Preset** (1), **File** (7), **System** (8), and **Mode** (9). The other number-key menu selections are not functional in this mode. For an example of the Preset menu, refer to . For an example of the File menu, refer to .

System Menu

For an example of the System menu, refer to .

Application Self Test
Pressing the Application Self Test soft key performs a self test for the current application. This test determines the functional integrity of the hardware associated with this application, including the DC power, the memory, and specific RF components. Press **Esc** when done.

Application Options
This soft key opens the Options soft key menu.

Ext Ref Freq
Press this soft key to set the external reference frequency from 2 MHz to 20 Mhz.

Chapter 22
DVB-T/H Signal Analyzer

Introduction

This chapter provides a brief description of DVB-T/H setup and measurement for signal power and signal analysis with Option 64 on the MT8222A BTS Master. Digital Video Broadcasting (Terrestrial & Handheld) is abbreviated as DVB-T/H.

DVB-T

DVB-T (terrestrial DVB) is a multi-carrier system using approximately 2000 carriers or 8000 carriers, each of which carries QPSK, 16QAM, or 64QAM. QAM (Quadrature Amplitude Modulation) is one available method that is used to increase the amount of information per modulation symbol. With 64QAM, for example, the hierarchical system maps the data onto 64QAM in such a way that a QPSK stream is effectively buried within the 64QAM stream. In addition, the spacing between constellation states can be adjusted to protect the QPSK (HP) stream at the expense of the 64QAM (LP) stream.

Good quality reception allows receivers to resolve the entire 64QAM constellation. In areas with reception of poorer quality, or in the case of mobile or portable reception, receivers may be able to resolve only those portions of the constellation that correspond to QPSK.

In a 64QAM constellation, 6 bits can be coded per 64QAM symbol. In hierarchical modulation, the 2 most significant bit (MSB) would be used for robust mobile service. The remaining 6 bits could contain, for example, an HDTV service. The first two MSB correspond to a QPSK service that is embedded in the 64QAM service.

DVB-H

DVB-H (handheld DVB) uses the DVB-T transmission system as the physical layer and adds extra error correction and time-slicing mechanisms on the link layer. DVB-H carries IP datagrams that are encapsulated by using multi-protocol encapsulation. DVB-H differs from DVB-T by using approximately 4000 carriers (with QPSK, 16QAM, or 64QAM).

A full DVB-H system is defined by combining elements in the physical and link layers as well as service information. DVB-H makes use of the following technology elements for the link layer and the physical layer:

Link layer

- Time-slicing to reduce average power consumption of terminal and to enable smooth and seamless frequency handover

- Forward error correction for multi-protocol encapsulated data (MPE-FEC) for improvement in the C/N (carrier-to-noise ratio) and Doppler performance in mobile channels, also improving tolerance to impulse interference

Physical layer

DVB-T plus the following technical elements specifically targeting DVB-H use:

- DVB-H signalling in TPS-bits to enhance and speed up service discovery. A cell identifier is also carried on TPS-bits in order to support faster signal scan and frequency handover on mobile receivers.

- 4K mode (3409 carriers) for trading off mobility and SFN cell size, allowing single antenna reception in medium SFNs at very high speed, thus adding flexibility in the network design

- Optional in-depth symbol interleaver for 2K (1705 carriers) and 4K (6817 carriers) modes for further improving robustness in mobile environment and impulse noise conditions

- Transmission parameters to operate transmission system in 5 MHz channel bandwidth, even outside traditional broadcasting bands

2k, 4k, 8k Modes

Using a smaller number of subcarriers allows for more inter-carrier spacing and thereby provides more tolerance to echoes that are influenced by Doppler effect. Shorter symbol duration limits the maximum delay of accepted echoes. Using a larger number of subcarriers creates smaller inter-carrier spacing and provides a longer symbol duration. The choice among these three modes is based upon balancing the influence of Doppler effect against the maximum delay of echoes. For receivers that are in motion, signal complexity evolves from the many echoes that are received (which are delayed in the time domain) and also from the frequency shift (the Doppler effect) that distorts both the incoming signal and the echoes.

Guard Intervals

In order to decrease receiver complexity, each OFDM block is extended by a guard interval, placing a copy of the end of the OFDM block at the front of the block, thereby creating a cyclic prefix. The width of a guard interval can be 1/4, 1/8, 1/16, or 1/32 the length of the original block. This fraction represents the ratio between the guard interval and the active symbol period. The overall data capacity is reduced by the same fractional proportion.

Guard Intervals (GI) are used to ensure that distinct transmissions do not interfere with one another. Guard Intervals introduce immunity to propagation delays, echoes, and reflection, to which digital data is normally very sensitive. A GI at the beginning of each symbol allows time for echoes to fade before the active symbol period begins. Protection is inversely proportional to data rate efficiency. A 1/32 GI gives high data rate efficiency and the lowest protection, while a 1/4 GI provides the best protection but the lowest data rate efficiency. Guard intervals help to reduce echo interference at the receiver if the duration of the echoes does not exceed the duration of the guard band.

FFT Start

The FFT Start position is used to synchronize the reading of the OFDM frame. The start can be set at the end of the complete GI, at the beginning of the GI, or can be set to include a fraction of the GI, which is divided into eighths. The FFT Start may be set from 0⁄8 (none of the GI) to 8⁄8 (all of the GI). This control is used in the modulation analysis measurements (constellation and impulse response) and the transmitter carrier MER measurement. The flexibility that is provided by a selection of FFT Start positions allows synchronizing with a strong signal.

If the FFT Start position is set to any of the GI positions (0/8 to 8/8), and if the 0 µs position on the Impulse Response (All) graph is subsequently changed, then the FFT Start position is automatically modified by the BTS Master. If the FFT Start position is set to 0/8 Fixed through 8/8 Fixed, then the FFT Start position is not modified when the 0 µs position is changed on the Impulse Response (All) graph.

Measurement Functions

Signal Power Measurement

The signal power measurement is useful for adjusting antenna angles and for area surveys.

Modulation Analysis, Constellation and Impulse Response

Constellation Measurement

The constellation function is useful for analyzing the condition of the received signal by monitoring the modulation symbol movement. In addition, this function measures the center frequency accurately by using a proprietary signal processing technique.

The Modulation Error Ratio (MER) measurement function, which directly quantifies the modulation signal quality of digital broadcasting signals, is essential for managing signal margin and the fixed deterioration of equipment with time, as well as for maintaining stable broadcast services.

> MER indicates signal deterioration even when BER measurement does not detect errors (error-free range).
> MER is unrelated to modulation parameters, so one MER result can be compared with other MER results.

Impulse Response Measurement

This function measures the difference in time and frequency of multipath signals. By measuring the channel frequency response, the multipath effect and frequency selective fading can be observed. This is useful for adjusting the timing of SFN repeaters.

Tx Carrier MER

This function is useful for transmitter installation or maintenance because it offers a wide dynamic range (50 dB) on the vertical scale for high-performance transmitters and also offers precise checks of each carrier by providing a zoom view for all carriers on the horizontal scale.

Spectrum Monitor

This function displays the frequency response around the desired channel. The variable span supports display of up to 51 channels simultaneously, so that broadcast service signals can be checked at a glance.
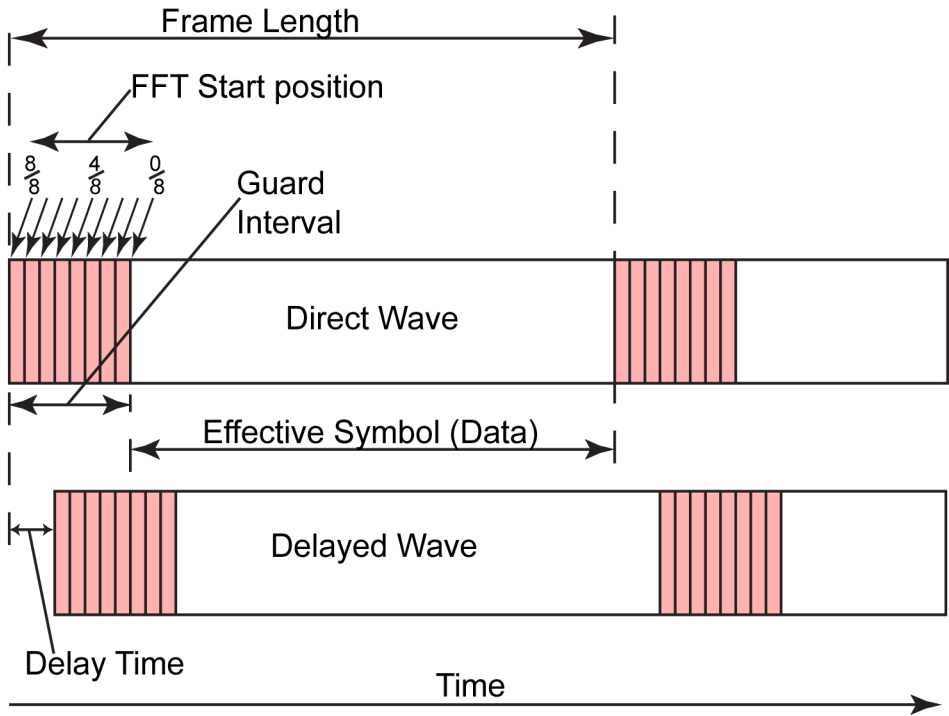
Figure 22-1. FFT Start and Guard Interval

Time-slicing

The objective of time-slicing is to reduce the average power consumption of the terminal and to enable smooth and seamless service handover. Time-slicing consists of sending data in bursts using a significantly higher instantaneous bit rate compared to the bit rate required if the data were transmitted using traditional streaming mechanisms.

To indicate to the receiver when to expect the next burst, the time (delta-t) to the beginning of the next burst is indicated within the burst. Between the bursts, data of the elementary stream is not transmitted, which allows other elementary streams to use the bandwidth otherwise allocated. Time-slicing enables a receiver to stay active only a fraction of the time and still receive bursts of a requested service. Note that the transmitter is constantly on (in other words, the transmission of the transport stream is not interrupted).

Time-slicing also supports the possibility of using the receiver to monitor neighboring cells during the off-times (between bursts). By switching the reception from one transport stream to another during an off period, a quasi-optimum handover decision is possible as well as seamless service handover.

Time-slicing is always used in DVB-H.

MPE-FEC

The objective of MPE-FEC (forward error correction for multi-protocol encapsulated data) is to improve the C/N and Doppler performance in mobile channels and to improve tolerance to impulse interference. This is accomplished through the introduction of an additional level of error correction at the MPE layer. By adding parity information that is calculated from the datagrams and by sending this parity data in separate MPE-FEC sections, error-free datagrams can be output after MPE-FEC decoding, even with bad reception conditions. The use of MPE-FEC is optional.

Hierarchical Modulation

In hierarchical modulation, two separate data streams are modulated onto a single DVB-T stream. One stream, called the High Priority (HP) stream, is embedded within a Low Priority (LP) stream. Receivers with good reception conditions can receive both streams, while those with poorer reception conditions may receive only the High Priority stream. Broadcasters can target two different types of DVB-T receiver with two completely different services. Typically, the LP stream is of a higher bit rate but lower robustness than the HP stream. A broadcaster could choose, for example, to deliver HDTV in the LP stream.

Getting Started

Quick Start Configuration, Setup, and Testing

DVB-T/H Signal Analyzer Mode

To prepare for DVB-T/H measurements, the BTS Master must be configured for DVB-T/H mode, as follows:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight **DVB-T/H Signal Analyzer** and then press the **Enter** key or the rotary knob to select this mode.
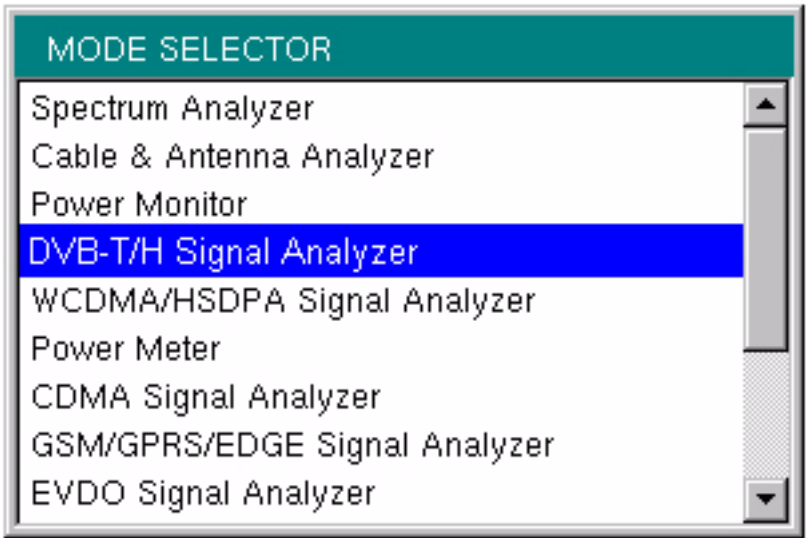
Figure 22-2. Mode Selector Menu

Antenna Setup

The antenna attaches to the BTS Master with a coaxial cable. The antenna and coaxial cable are not supplied with the BTS Master and are to be procured separately.

The antenna factors are different for each antenna. Refer to the documentation for your antenna. Also, remember to add the cable loss to the measurement correction table.

1. Attach the antenna to the Spectrum Analyzer connector on top of the instrument (refer to Figure 22-3).

Select the antenna as follows:

2. Press the **Meas Selection** function hard key.
3. Press the Signal Power soft key.
4. Press the **Meas Setup** function hard key.
5. Press the Antenna (Correction Level) soft key.
6. In the *Select Antenna* list box, scroll to the desired Anritsu antenna model number by using the **Up/Down** arrow keys or the rotary knob, and press the rotary knob or the **Enter** key to select it.

Spectrum
Analyzer input
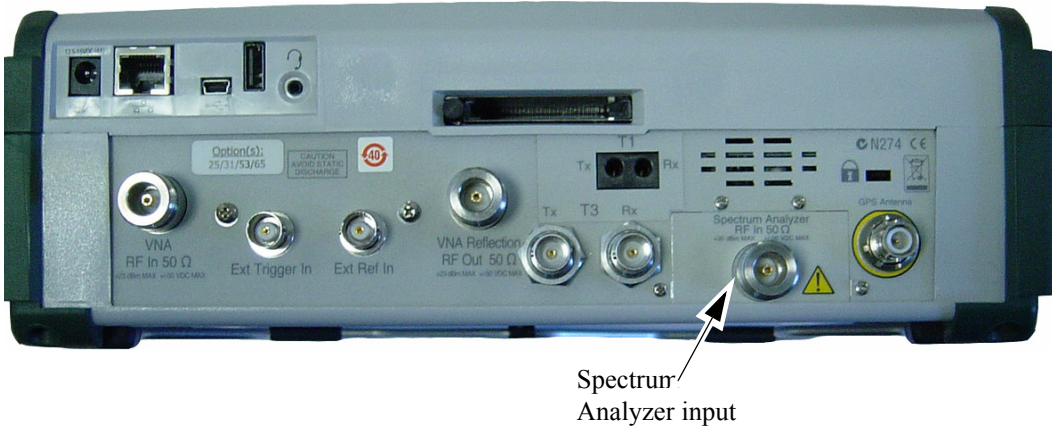
Figure 22-3. BTS Master Connections – Spectrum Analyzer RF in

Measurement Setup and Execution

The function hard keys have the following labels with option 64:

Frequency/Level, Meas Selection, Meas Setup, Execute Measure, Save Files

Frequency and Reference Level Configurations

The following procedure is used to set up the BTS Master for DVB-T/H measurement and analysis:

1. Press the **Frequency/Level** function hard key.
   Configure the parameters as needed: Channel Map, Frequency, Bandwidth, Auto Reference Level, Reference Level, and Pre Amp.
2. Press the Channel Map soft key. The *Select Channel Map* list box opens. Select one of the three choices, and then press the **Enter** key or the rotary knob.
3. If you have selected UHF (Australia) or UHF (Europe), then press the Channel soft key, scroll to the desired channel, and press the **Enter** key. The bandwidth (7 MHz or 8 MHz) and the frequency range are automatically selected by the choice of channel map. The selected channel number is displayed on the face of the Channel soft key. If no channel map (None) is selected, then the Frequency and Band Width soft keys are present in the soft key menu so that these parameters can be set manually.
4. If you have selected **None**, then use the Frequency and Band Width soft keys to set these parameters.
5. Press the Frequency soft key to open the *Frequency Editor* dialog box, which indicates the acceptable range for input. The Units soft key menu displays four units keys: GHz, MHz, kHz, and Hz. If any of these units are not appropriate, then pressing the key displays "Out of range" at the bottom of the Frequency Editor window. Set the frequency by using the **Up/Down** arrow keys, the rotary knob, or the number keys. When the desired range is displayed, press the appropriate units soft key, the rotary knob, or the **Enter** key.
6. Press the Band Width soft key to open the *Select Band Width* list box and select a bandwidth.
7. Press the Auto Reference Level soft key to allow the BTS Master to set an optimum reference level, or press the Reference Level soft key to open the *Reference Level Editor* dialog box. To manually set the dBm reference level, use the **Up/Down** arrow keys, the rotary knob, or the number keys, then press the rotary knob or the **Enter** key. After entering a value by using the number keys, press the **+/-** key to create a negative value.
8. Press the Pre Amp soft key to toggle the this function ON and OFF.

Signal Power Measurement

Select the Test

1. Press the **Meas Selection** function hard key.
2. Press the Signal Power soft key to select this measurement.

Set Up the Test

• Press the **Meas Setup** function hard key to open the Meas Setup (1/2) menu.

  Configure the parameters as needed: Meas Mode, Average Count, Impedance, Impedance Loss, and Antenna.

Measure Mode

1. Press the Meas Mode soft key to open the *Select Meas Mode* list box and choose from: Single, Continuous, Average, Moving Average, or Max Hold. If you select **Average** or **Moving Average**, then also set the Average Count.
2. Press the Average Count soft key to open the *Average Count Editor* dialog box and select a count number within the displayed range.
3. Press the Impedance soft key to toggle through the three impedance parameters: 50 ohm, 75 ohm, and Other. If you select Other, then set the impedance loss.
4. Press the Impedance Loss soft key to open the *Impedance Loss Editor* dialog box and select a dB loss level within the displayed range.
5. Press the Antenna (Correction Level) soft key to open the *Select Antenna* list box, and select the desired Anritsu antenna model number from the list.

> NOTE: If you are not using an Anritsu antenna, then you can create a custom antenna correction with Master Software Tools and upload it into your BTS Master.

Execute the Test

• Press the **Execute Measure** function hard key to begin testing. If the input signal cannot be measured, a message is displayed with red highlighting near the top of the display area, as follows: **Under Level : Increase input level.**

Save the Test Results

• Press the **Save Files** function hard key to save a measurement. A confirmation window opens briefly to indicate that the measurement has been saved.
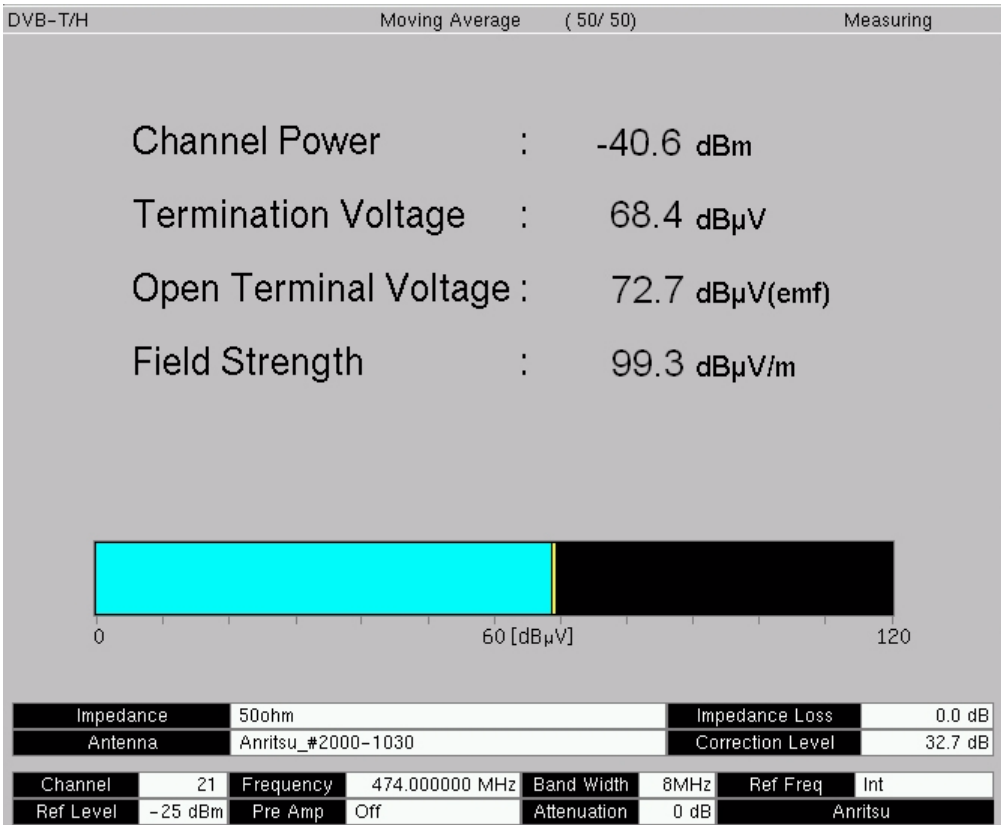
Figure 22-4. Signal Power Measurement

Modulation Analysis

Select the Test

1.   Press the **Meas Selection** function hard key.
2.   Press the Modulation Analysis soft key.

Set Up the Test

1.   Press the **Meas Setup** function hard key to open the Meas Setup (1/2) menu.
      Configure the following parameters: Meas Mode, Detect Parameter, Constellation, or
      Impulse Response.
      Pressing either Constellation or Impulse Response determines the type of modulation
      analysis to be performed, and also determines the subsequent soft keys that are
      displayed after pressing the More soft key.
2.   Press the Meas Mode soft key to open the *Select Meas Mode* list box. Scroll and select
      the desired mode. If you select **Average** or **Moving Average**, then also set the Average
      Count.
3.   Press the Average Count soft key to open the *Average Count Editor* dialog box and
      select a count number within the displayed range.
4.   Press the Detect Parameter soft key to automatically detect for Mode, GI, Modulation,
      and Hierarchy parameters.
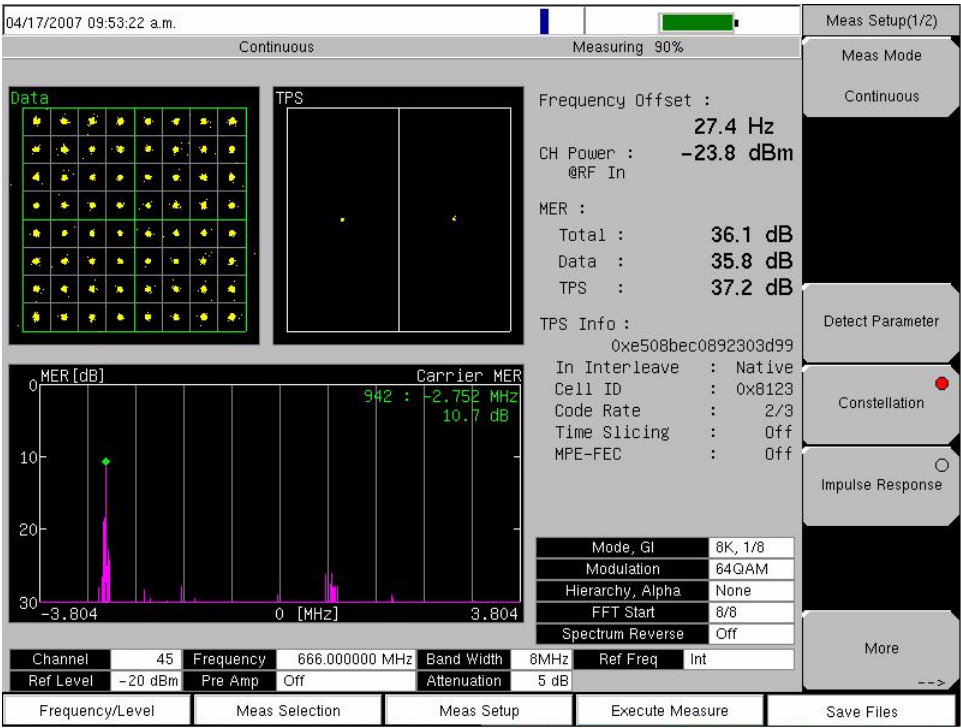
Figure 22-5. Constellation Measurement with Alpha = None

Constellation Configuration

Configure the following parameters: Mode, GI, TPS Info, FFT Start, Spectrum Reverse, Zoom, and Marker. The marker is used only in the Carrier MER graph.

1. Press the Constellation soft key, and then press the More soft key to open the additional Meas Setup (2/2) soft key menu.
2. Press the Mode, GI soft key and scroll to select the desired Guard Interval parameters.
3. Press the TPS Info soft key.
4. From the TPS Info menu, press the Modulation soft key and choose from: QPSK, 16QAM, and 64QAM.
5. If modulation is set to QPSK, then skip this step (the hierarchy soft key is not displayed). Press the Hierarchy, Alpha soft key and choose: None, 1, 2, or 4.
6. Press the Back soft key to return to the Meas Setup (2/2) menu.
7. Press the FFT Start soft key to open the *Select FFT Start* list box and select the desired start position with a guard interval (0/8 indicates no guard interval).
8. Press the Spectrum Reverse On/Off soft key to toggle between On and Off. The active state is underlined on the soft key face.
9. Press the Zoom soft key to open the Zoom menu.
10. Press the Zoom On/Off soft key to toggle between On and Off. The active state is underlined on the soft key face.
11. To use the zoom feature, press the Data soft key or the TPS soft key. **Data** displays an enlarged data constellation, or **TPS** displays an enlarged TPS constellation, only when the zoom function is On. The red circle on either soft key face indicates that the key is active.
12. Press the Back soft key to return to the Meas Setup (2/2) menu while leaving the zoom function as set.
13. Press the Marker On/Off soft key to toggle the marker between On and Off. The active state is underlined on the soft key face.
14. Press the Back soft key to return to the Meas Setup (1/2) menu.
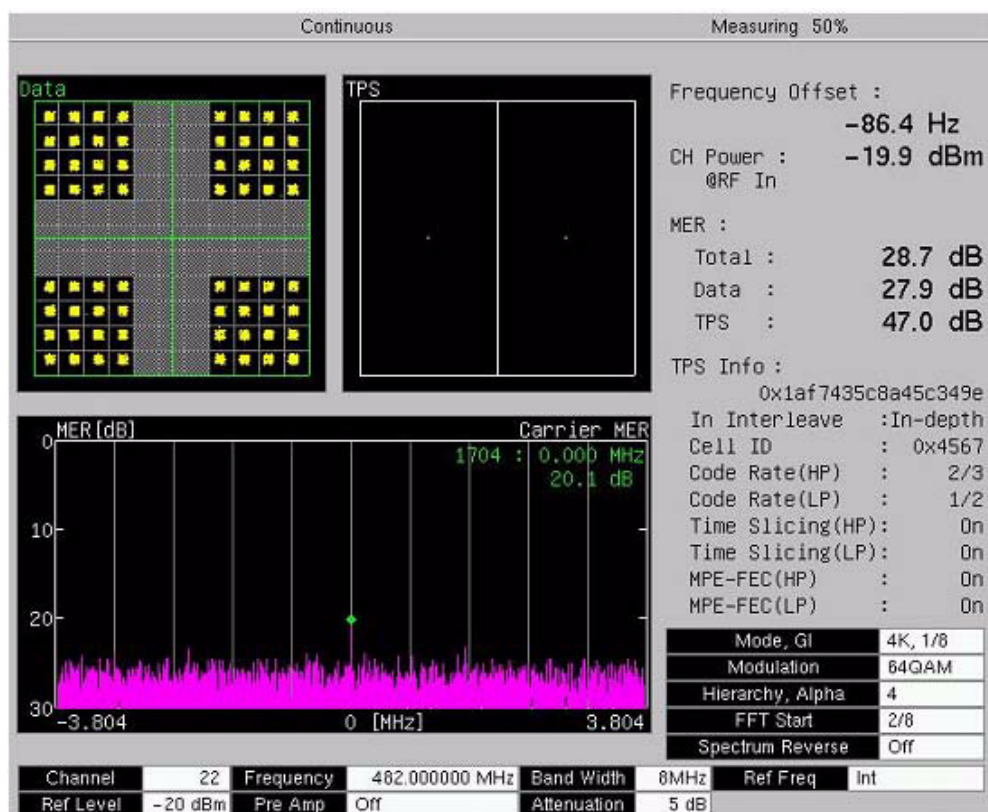
Figure 22-6. Constellation Measurement with Alpha = 4

Impulse Response Configuration

Configure the following parameters: Mode, GI, TPS Info, FFT Start, Spectrum Reverse, Impulse Response, Frequency Response, and Marker.

1. Press the Impulse Response soft key, and then press the More soft key to open the additional Meas Setup (2/2) soft key menu. The Impulse Response (Zoom) graph displays the enlarged portion of the Impulse Response (All) graph that is indicated by the range markers, whether the marker function is On or Off.
2. Press the Mode, GI soft key to open the *Select Mode, GI* list box and scroll to select the desired Guard Interval parameters.
3. Press the TPS Info soft key.
4. From the TPS Info menu, press the Modulation soft key and choose from: QPSK, 16QAM, and 64QAM.
5. Press the Hierarchy, Alpha soft key and choose: None, 1, 2, or 4.
6. Press the Back soft key to return to the Meas Setup (2/2) menu.
7. Press the FFT Start soft key to open the *Select FFT Start* list box and select the desired parameter.
8. Press the Spectrum Reverse On/Off soft key to toggle between On and Off. The active state is underlined on the soft key face.
9. Press the Impulse Response Vertical Range soft key to open the Vertical Range menu. Then select a range (in dB) and press the Back soft key to return to the Meas Setup (2/2) menu.
10. Press the Freq. Response Vertical Range soft key to open the Vertical Range menu. Then select a range (in dB) and press the Back soft key to return to the Meas Setup (2/2) menu.
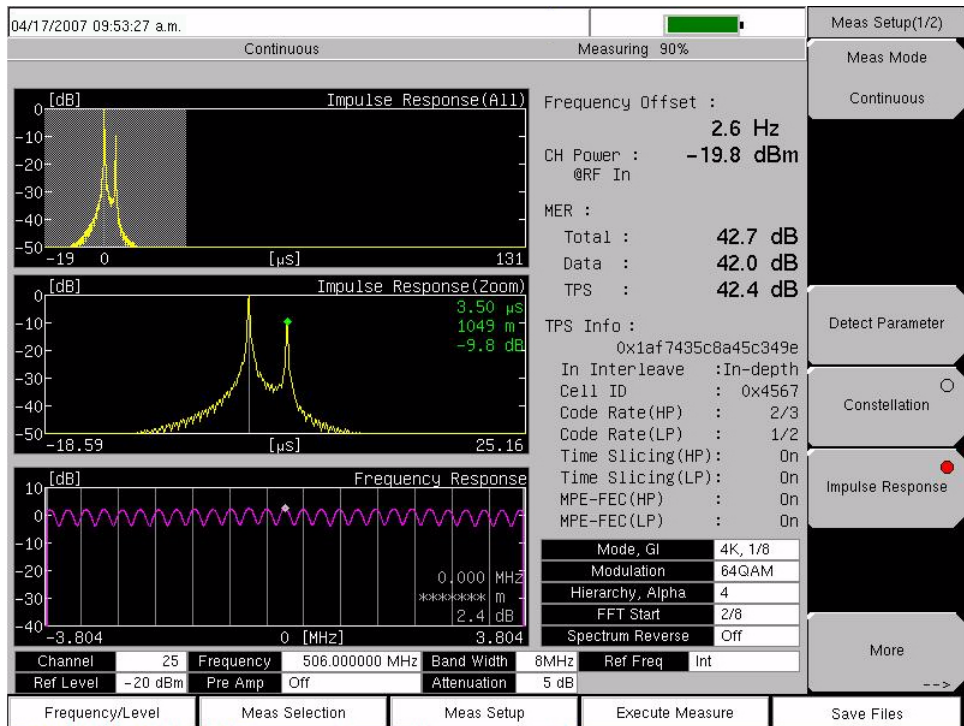
Figure 22-7. Impulse Response Measurement

Configure the Markers

Configure the Markers that are used in the impulse response and frequency graphs.

1. Press the Marker On/Off soft key to toggle the marker between On and Off. Turn the marker ON.
2. Press the Impulse Response soft key to display the range marker in the whole graph of impulse response and to display the signal position marker in the zoom graph of impulse response. Move the marker range with the arrow keys or the rotary knob. Move the position marker in the zoom graph by turning the rotary knob. When the markers are set as desired, press the rotary knob, press the **Enter** key, or press the Frequency Response soft key to use the marker in the Frequency Response graph.

Figure 22-8. Impulse Response (All) Range Marker

The portion of the impulse response signal that is within the range markers is displayed in the zoom graph of impulse response. When the Impulse Response soft key is active, the Detect Max_Level soft key is also displayed.
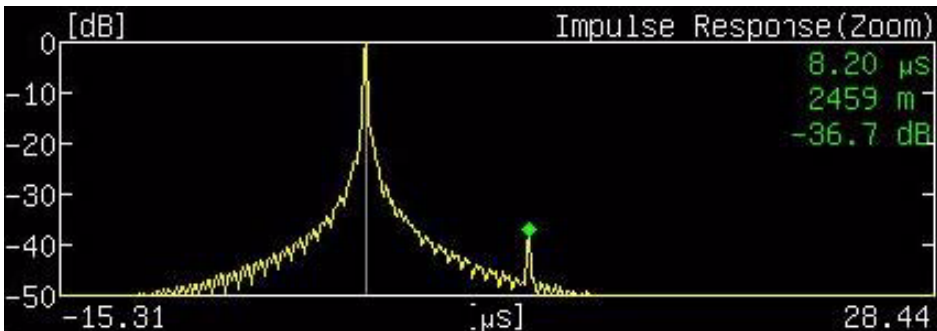
Figure 22-9. Impulse Response (Zoom) Marker

3. Press the Frequency Response soft key to display the marker on the frequency response graph within the channel bandwidth. Move the marker in large increments with the **Up/Down** arrow keys, in increments half as large with the **Left/Right** arrow keys, and in small increments with the rotary knob.
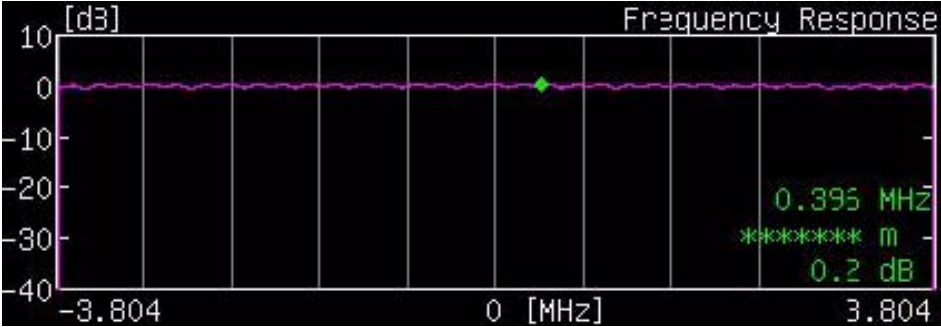
Figure 22-10. Frequency Response Marker

4. Press the Delta Marker On/Off soft key to toggle the additional delta marker function On and Off. The active state is underlined on the soft key face. When ON, this marker function displays the difference of time, distance, and level between two points. When turning On the delta marker while using the impulse response setting, the standard marker becomes the square reference marker and is placed at the center of the impulse response range markers, and the numerical data within the All graph indicates the measurement at the square delta maker. The arrow keys move the range marker, and the rotary knob moves the delta marker. The numerical data that is displayed at the upper right within the Zoom graph indicates the relative value of the delta marker (relative time, distance, and level) to the standard marker (now the square reference marker), based upon the marker position. The square reference maker is displayed in the Zoom graph as long as the range marker (in the ALL graph) is not moved beyond the reference marker after the delta marker function is turned On.
5. When turning On the delta marker while using the frequency response setting, the reference marker is initially placed at the location of the standard (now square) marker. The arrow keys and rotary knob move the delta marker.
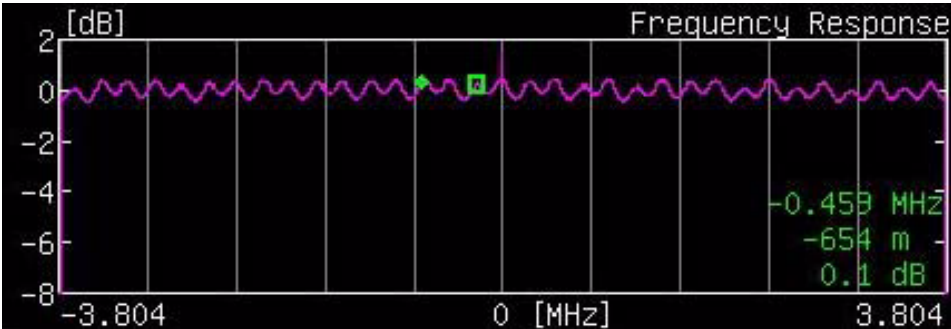
Figure 22-11. Frequency Response Delta Marker

6. Press the Back soft key to return to the Meas Setup (2/2) menu. If the marker or delta marker or both are left On, the arrow keys and rotary knob continue to move the marker.

Execute the Measure

• Press the **Execute Measure** function hard key to begin testing.

Save the Test Results

1. Press the **Save Files** function hard key to save measurements. The instrument can save the displayed measurement results in the JPEG format and CSV format to the internal memory. The measurement results file may be saved either manually by the user or automatically by the instrument.
2. To save the measurement results files automatically, press the **Save Files** function hard key. After a few seconds, the saving is complete, and a confirmation window is displayed briefly.
   In the case of auto saving, the instrument uses the measurement status information, the date, and the time to provide a filename. For filename details, refer to section *Saving Measurement Results* on page 22-19.

Tx Meas Analysis

Select the Test

1. Press the **Meas Selection** function hard key.
2. For Tx Analysis, press the following soft keys in sequence: Tx Meas, Carrier MER, and Back.

Set Up the Test

1. Press the **Meas Setup** function hard key to open the Meas Setup (1/2) menu. Configure the following parameters: Meas Mode, Detect Parameter, Mode, GI, TPS Info, FFT Start, Spectrum Reverse, Vertical Range, and Marker.
2. Press the Meas Mode soft key and select a mode. If you select **Average** or **Moving Average**, then also set the Average Count.
3. Press the Average Count soft key to open the *Average Count Editor* dialog box and select a count number within the displayed range.
4. Press the Detect Parameter soft key, which automatically detects for Mode, GI, Modulation, and Hierarchy parameters.
5. Press the More soft key to open the Meas Setup (2/2) menu and continue configuring Carrier MER(Tx).
6. Press the Mode, GI soft key to open the *Select Mode, GI* list box and scroll to select the desired Guard Interval parameters.
7. Press the TPS Info soft key.
8. From the TPS Info menu, press the Modulation soft key to open the *Select Modulation* list box and choose from: QPSK, 16QAM, and 64QAM.
   If you select QPSK, then the parameter for Hierarchy, Alpha is automatically set to **None**.
9. If you select 16QAM or 64QAM, then press the Hierarchy, Alpha soft key and choose: None, 1, 2, or 4.
10. Press the Back soft key to return to the Meas Setup (2/2) menu.
11. Press the FFT Start soft key to open the *Select FFT Start* list box and select the desired start position with a guard interval (0/8 indicates no guard interval).
12. Press the Spectrum Reverse On/Off soft key to toggle between On and Off. The active state is underlined on the soft key face.
13. Press the Vertical Range soft key to open the Vertical Range menu. Then select a range (in dB) for the Carrier MER(Tx) graph and press the Back soft key to return to the Meas Setup (2/2) menu.

14. Press the Marker soft key to open the marker menu, the press the Marker On/Off soft key to toggle the marker between On and Off. Turn the marker ON so that the zoom markers on the whole graph of Carrier MER(Tx) (All) can be displayed. The Carrier MER soft keys are also displayed.

15. Press the Carrier MER(All) soft key to display the zoom markers on the whole graph of Carrier MER(Tx) (All).

16. Press the Carrier MER (Zoom) soft key to display the marker on the Carrier MER(Tx) (Zoom) graph.

17. Press the Back soft key to return to the Meas Setup (2/2) menu.

Execute the Measure

• Press the **Execute Measure** function hard key to begin testing.

Figure 22-12. Tx Carrier MER Measurement

Save the Test Results

• Press the **Save Files** function hard key to save measurements. For details about saving measurement files, refer to section *Save the Test Results* on page 22-8. For filename details, refer to section *Saving Measurement Results* on page 22-19.

Spectrum Monitor

Select the Test

1. Press the **Meas Selection** function hard key.
2. Press the Spectrum Monitor soft key to configure the spectrum monitor measurements.

Set Up the Test

1. Press the **Meas Setup** function hard key to open the Meas Setup menu.
    Configure the Meas Mode, Span, and Zone Position.
2. Press the Meas Mode soft key to open the *Select Meas Mode* list box and select a mode.
3. Press the Span soft key to open the *Select Span* list box and select a span.
4. Press the Zone Position To Center soft key to set the channel of the current zone marker to the center of the screen.

Execute the Measure

*   Press the **Execute Measure** function hard key to begin testing.

    Spectrum monitor detection is set for RMS for all available span settings.

Save the Test Results

*   Press the **Save Files** function hard key to save measurements. For details about saving measurement files, refer to section *Save the Test Results* . For filename details, refer to section *Saving Measurement Results* .

Figure 22-13. Spectrum Monitor Measurement

Saving Measurement Results

Automatic File Saving

Files are saved in the JPEG format and the CSV format. The filename format uses a string of 3 characters followed by a string of digits for the date and time. The entire character string appears as follows:

```
XXXYYYYMMDD_HHMMSS.csv
```

```
XXXYYYYMMDD_HHMMSS.jpg
```

The "XXX" characters are related to the measurement type, as displayed in Table 22-1. The date is expressed as year (YYYY), month (MM), and day (DD) followed by an underscore, and then the time is expressed as hour (HH), minute (MM), and second (SS), all followed by a period and the file extension (csv or jpg).

Filename Examples (also refer to Figure 22-14):

```
PWR20060712_140225.jpg
```

```
IMP20061203_094507.jpg
```

Table 22-1. Auto File Naming Convention

Measurement Type	Character String
Signal Power	PWR
Spectrum Monitor	SPM
Modulation Analysis/Constellation	CON
Modulation Analysis/Impulse Response	IMP
Tx Meas/Carrier MER<Tx>	CAM

Figure 22-14. Auto Save Confirmation Window

Manual File Saving

To save a measurement manually, refer to Figure 3-11 and to section *Save Measurement* on page 3-26.

Menus

Function Hard keys

In DVB-T/H Signal Analyzer mode (Option 64), the BTS Master displays the following five function hard key menus: **Frequency/Level**, **Meas Selection**, **Meas Setup**, **Execute Measure**, and **Save Files.**

Frequency/Level Menu
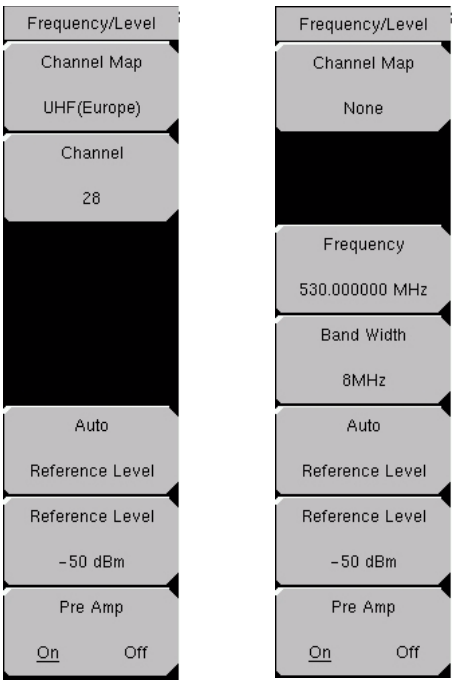
Figure 22-15. Frequency/Level Menu

Channel Map
This soft key opens the *Select Channel Map* list box to allow channel map selections for UHF(Australia), UHF(Europe), or None. Selecting UHF(Australia) sets the bandwidth to 7 MHz, and selecting UHF(Europe) sets the bandwidth to 8 MHz, and a Channel number soft key is added to the Frequency/Level menu. Selecting None adds two soft keys to the Frequency/Level menu in order to allow manual setting of frequency and bandwidth.

Channel ##
If UHF is selected, then the next soft key is Channel. Press this soft key to open the *Channel Editor* dialog box to select a channel within a specified range that is displayed in the window.

If None is selected, then the next soft key is Frequency.

Frequency

If None is selected, then the soft keys for Frequency and Band Width are added to the menu. Press this soft key to open the *Frequency Editor* dialog box to manually select a frequency within a specified range that is displayed in the window. The soft key menu displays units: GHz, MHz, kHz, and Hz.

Band Width

Press this soft key to open the *Select Band Width* list box to select a bandwidth of 7 MHz or 8 MHz.

Auto Reference Level

Press this soft key to automatically set the reference level to an optimum value. This reference level indicates the signal level input to the BTS Master.

The reference level range for input to the instrument is determined by the reference level setting. Immediately after a signal is applied to the instrument, the input attenuator is automatically set according to the reference level. The relationship between the reference level and the input attenuator is fixed. Table 22-2 shows the relationship between the reference level and the input attenuator for each measurement item.

Raising the reference level increases attenuation of the input attenuator, enabling the user to handle a high input level. Note that the noise floor rises in proportion to the attenuation of the input attenuator.

When applying a signal to the instrument, input a signal level that does not exceed the reference level value. If the signal level exceeds the reference level, raise the reference level. For example, if the signal level is 0.5 dBm with preamplifier off, set the reference level to 5 dBm, not to 0 dBm.

If an interfering wave other than the intended signal exists and the power within the frequency range of approximately 100 kHz to 7.1 GHz is 15 dB or more higher than the measurement signal level, set the reference level to take the large signal into account.

Reference Level

Press this soft key to open the *Reference Level Editor* dialog box to select a signal reference value within the specified range that is displayed in the window. If the Pre Amp soft key is On, then the reference level range is from -10 dBm to -50 dBm in 10 dB increments. If the Pre Amp soft key is Off, then the reference level range is from -25 dBm to 20 dBm in 5 dB increments.

Pre Amp On/Off

Pressing this soft key toggles the preamplifier function between On and Off. When the preamplifier is switched On, the reference level is automatically set to -30 dBm. When the preamplifier is switched Off, the reference level is automatically set to -25 dBm.

Table 22-2. Relationship between Reference Level and Input Attenuator

Preamplifier	Attenuation of Input Attenuator (dB)			
	Reference Level (dBm)	Signal Power	Modulation Analysis	Spectrum Monitor
Off	20	40	45	45
Off	15	35	40	40
Off	10	30	35	35
Off	5	25	30	30
Off	0	20	25	25
Off	−5	15	20	20
Off	−10	10	15	15
Off	−15	5	10	10
Off	−20	0	5	5
Off	−25	0	0	0
On	−10	40	40	40
On	−20	30	30	30
On	−30	20	20	20
On	−40	10	10	10
On	−50	0	0	0

Meas Selection Menu
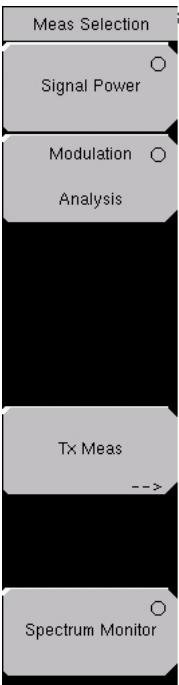
Figure 22-16. Measure Selection Menu

Press the **Meas Selection** function hard key to open the Meas Selection soft key menu.

Signal Power
Press this soft key to measure the channel power and field strength.

Modulation Analysis
Press this soft key to measure MER (Modulation Error Ratio), frequency offset of the modulated signal, constellation, impulse response, and frequency response.

Tx Meas
Press this soft key to open the Tx Meas soft key menu to measure the Carrier MER (Modulation Error Ratio).

Carrier MER
Press this soft key to measure the transmission Carrier MER.

Spectrum Monitor
Press this soft key to display the spectrum of the input signal.

Signal Power Menu
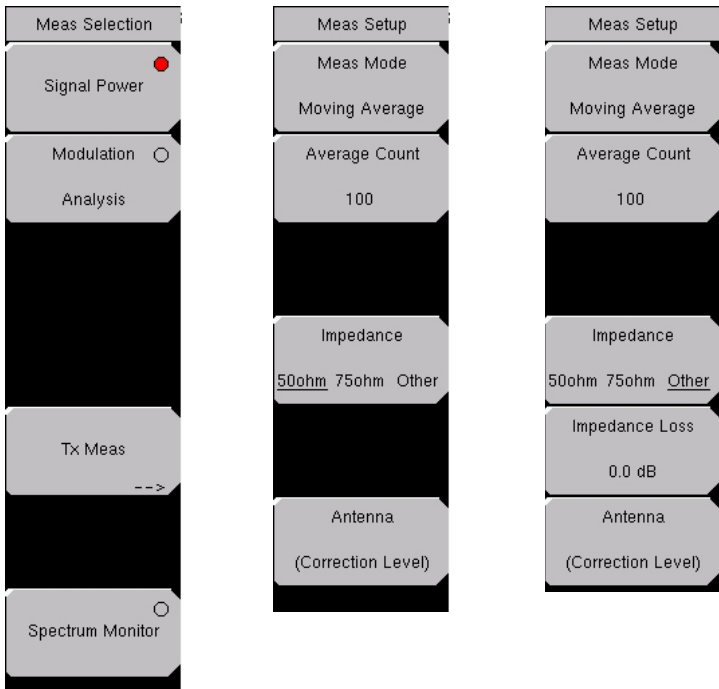
Figure 22-17. Measure Selection Menus for Signal Power

Press the **Meas Selection** function hard key to open the Meas Selection soft key menu.

Signal Power
Press this soft key to make signal power measurements. For an illustration of the measurement display, refer to Figure 22-4 .

Press the **Meas Setup** function hard key to open the Meas Setup soft key menu for Signal Power measurements.

Meas Mode
Press this soft key to open the *Select Meas Mode* list box and select a measurement mode. Five test mode options are available: Single, Continuous, Average, Moving Average, and Max Hold.

> **Single** sets up the test for one measurement. The BTS Master acquires the measurement and displays the results. This mode is useful for capturing screen images.
> **Continuous** sets up the test to take measurements continuously and display the results. The mode is helpful for real-time signal analysis.
> **Average** sets up the test to mathematically average the measurement results for the specified number of measurement, as set with the Average Count soft key.
> **Moving Average** sets up the test to take the number of measurements that are set with the Average Count soft key. An average result is calculated from those measurements and is displayed. Then another measurement is taken, and another average is calculated from the last number of measurements, as set in Average Count, and the display screen is updated. This mode is useful while aiming the antenna.

Example for Moving Average:

First (m1 + m2 + m3 + m4 + m5) = r1   r1 displayed on screen

then (m2 + m3 + m4 + m5 + m6) = r2   r2 displayed on screen

then (m3 + m4 + m5 + m6 + m7) = r3   r3 displayed on screen

then (m4 + m5 + m6 + m7 + m8) = r4   r4 displayed on screen

This cycle of measurement average calculations continues until a different measurement is selected. This mode is useful while aiming the antenna.

Max Hold displays the measurement result that has the largest value. This mode is helpful for acquiring the maximum result, for example, when measuring off-the-air signals that are not stable. The Max Hold setting is available only for Signal Power measurements.

Average Count

Press this soft key to open the *Average Count Editor* dialog box and select a count number. the range is displayed in the window. This count number sets the number of measurements that are included in the averaging calculations for both **Average** and **Moving Average.** When **Single**, **Continuous**, or **Max Hold** is selected as the measurement mode, this soft key is not displayed.
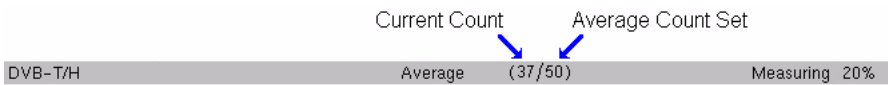
Figure 22-18. Current Count Average Count Display

Impedance, 50ohm, 75ohm, Other

Press this soft key to toggle through the impedance values. The MT8222A impedance is 50 ohms by default, but it can be changed to 75 ohms by pressing this soft key, or it can be changed by using the external impedance converter (by pressing this soft key to toggle to Other).

50 ohms Select this impedance when no converter is used. Impedance loss is automatically set to 0.0 dB.

75 ohms Select this impedance when impedance converter 12N50-75B is used. Impedance loss is automatically set to 7.5 dB.

Other (75 ohms) Set impedance to Other when an impedance converter other than 12N50-75B is used. Use the Impedance Loss soft key to set the insertion loss of the impedance converter that is used as the impedance loss.

Impedance Loss,

This virtual soft key appears only when the Impedance soft key is toggled to Other. Press this soft key to open the *Impedance Loss Editor* dialog box and set impedance loss to match an external impedance converter. Impedance loss range is 0.0 dB to 100.0 dB in steps of 1 dB when using the **Up/Down** arrow keys and in steps of 0.1 dB when using the rotary knob. The impedance loss can also be set by using the numeric keypad. Set the value by pressing the rotary knob, the **Enter** key, or the dB units soft key (which appears when the Impedance Loss soft key is pressed).

Set the impedance loss to 1.9 dB when using the MA1621A as the impedance converter.

Antenna (Correction Level)
Press this soft key to open the *Select Antenna* list box and to select the correction table for the field strength measurement. For details, refer to section *Antenna Setup* on page 22-6.
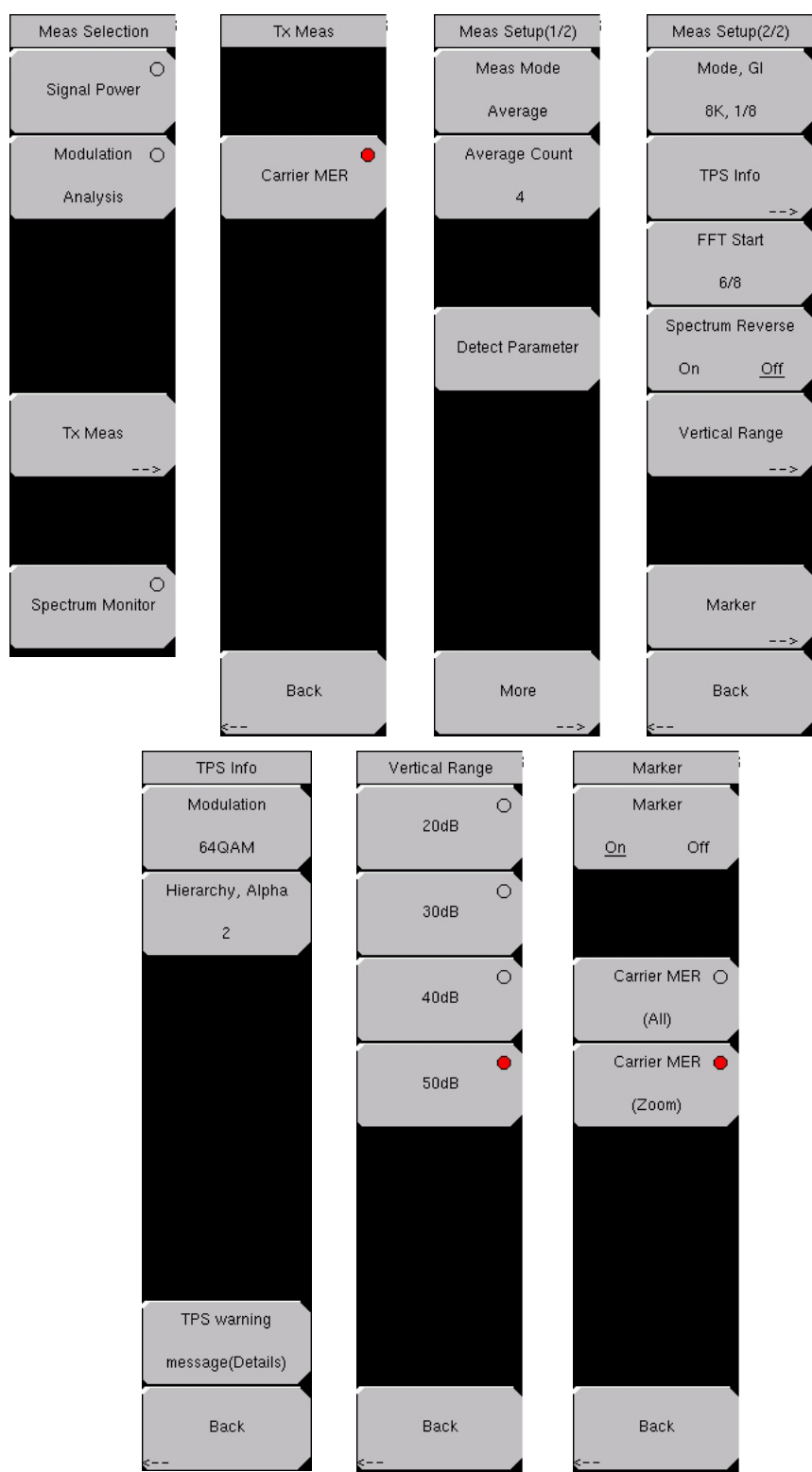
Modulation Analysis, Constellation
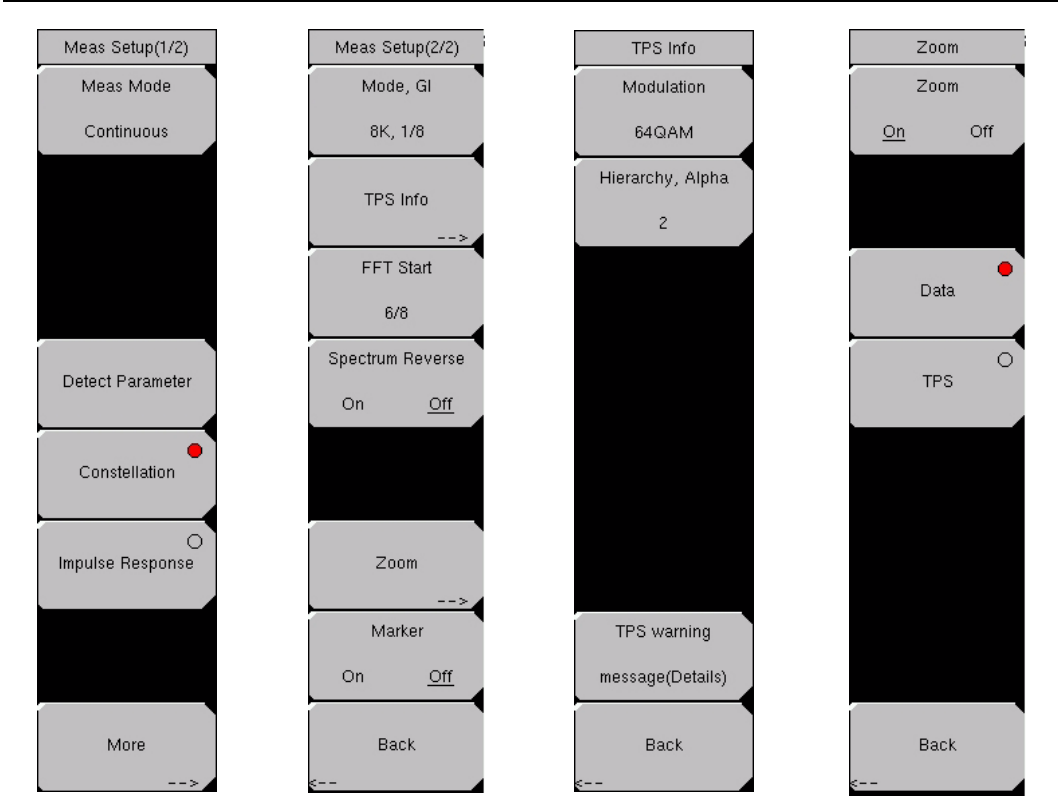
Figure 22-19. Constellation Measurement Menus

Press the **Meas Selection** function hard key to open the Meas Selection soft key menu. Then press the Modulation Analysis soft key to set up the measurement.

Press the **Meas Setup** function hard key to open the Meas Setup(1/2) soft key menu.

Measurement Setup for Constellation Modulation Analysis

Meas Mode
Refer to section *Meas Mode* on page 22-24. Note that Constellation Modulation Analysis does not include Max Hold.

Average Count
When the measurement mode is **Average** or **Moving Average**, this soft key is displayed. Refer to section *Average Count* on page 22-25.

Detect Parameter
Press this soft key to automatically detect TPS and Mode, GI information from the input signal. Measurement begins when parameters are detected. For additional information, refer to *Mode, GI* or *TPS Info* on page 22-27.

Constellation

Press this soft key to configure the software to display the constellation measurement window along with the Frequency Offset, CH Power, MER, and TPS Info.

Impulse Response

Press this soft key to configure the software to display three graphs: Impulse Response (All), Impulse Response (Zoom) and Frequency Response. Additional measurement results that are also displayed on the screen are: Frequency Offset, CH Power, MER, and TPS Info.

More

Press this soft key to display the next page of the Meas Setup (2/2) menu. The soft keys that are displayed in the Meas Setup (2/2) menu differ depending upon the type of measurement, Constellation, Impulse Response, or Tx Meas.

The following setup parameters are for configuring Constellation.

Mode, GI

Press this soft key to open the *Select Mode, GI* list box. Scroll through the list to select the Mode (number of subcarriers) and the Guard Interval. For more information about Mode or Guard Interval, refer to *2k, 4k, 8k Modes* or *Guard Intervals*

TPS Info

Press this soft key to open the TPS Info soft key menu.

> **TPS Info Soft Key Menu**
>
> #### Modulation
>
> Press this soft key to open the *Select Modulation* list box. Scroll to select QPSK, 16QAM, or 64QAM modulation. The selection is displayed on the virtual soft key face. Selecting QPSK automatically sets the Hierarchy, Alpha parameter to None.
>
> #### Hierarchy, Alpha, #
>
> Press this soft key to open the *Select Hierarchy, Alpha* list box. Scroll to select None, 1, 2, or 4. The selection is displayed on the virtual soft key face. This selection is used to shape the 16QAM and 64QAM constellations. A value of $\alpha = 1$ describes an equally-spaced constellation.
>
> #### TPS Warning, message(Details)
>
> Press this soft key to open the TPS Warning, message(Details) message box. The warning and its description are displayed in the window. If measured TPS parameters are questionable, then look in this message box to check for any warnings.
>
> #### Back
>
> Press this soft key to return to the Meas Setup(2/2) soft key menu for constellation measurement display.

FFT Start,

Press this soft key to open the *Select FFT Start* list box. Scroll to select an FFT Start position to synchronize with the data that is used for measurement. A setting of 0/8 uses none of the guard interval and includes only the effective symbol (the data portion of the OFDM frame). A setting of 1/8 adjusts the FFT Start position to use 1/8 of the guard interval, and a setting of 8/8 adjusts the FFT Start position to use all of the guard interval.

Refer to Figure 22-1 for details about the relationship between the FFT Start position and the guard intervals. Signals that arrive with or without interference can be synchronized and measured by adjusting the FFT Start position. When measuring a delayed wave (a signal where one or more earlier, but weaker, signals exist), changing the FFT Start position can filter interference.

Table 22-3. Guard Interval Lengths in Microseconds

Length	2K	4K	8K
1/4	56 µs	112 µs	224 µs
1/8	28 µs	56 µs	112 µs
1/16	14 µs	28 µs	56 µs
1/32	7 µs	14 µs	28 µs

Spectrum Reverse, On/Off
Press this soft key to turn the function On or Off. Use Spectrum Reverse to measure the signal whose sub carrier location is inverted on the frequency axis, such as the IF signal of the transmitter.

Zoom
Press this soft key to open the Zoom soft key menu.

Zoom Soft Key Menu

Zoom, On/Off
Press this soft key to toggle zoom On or Off. When Zoom is Off, the screen displays the Data, TPS, and Carrier MER graphs. When Zoom is On, the screen displays a larger view of either the Data graph or the TPS graph.

Data
Press this soft key (when Zoom is On) to display an enlarged view of the Data graph.

TPS
Press this soft key (when Zoom is On) to display an enlarged view of the TPS graph.

Back
Press this soft key to return to the Meas Setup(2/2) menu.
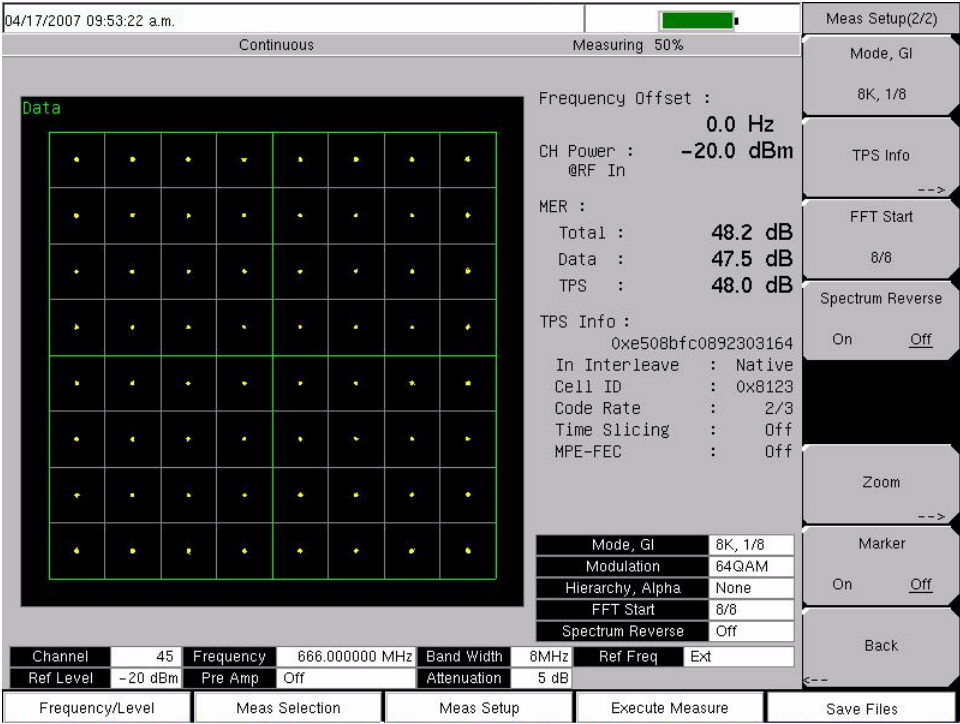
Figure 22-20. Constellation Data Zoom

Marker, On/Off
Press this soft key to toggle the marker On or Off for the Carrier MER graph. The marker is diamond shaped and green. Information relating to the carrier signal at the marker is displayed at the top right of the Carrier MER graph. Use the **Up/Down** and **Left/Right** arrow keys or the rotary knob to move the marker on the graph. The **Up/Down** arrow keys move the marker full range in 6 increments. The **Left/Right** arrow keys move the marker full range in 10 increments. The rotary knob moves the marker in 1 kHz increments across a bandwidth of 8 MHz.

Back
Press this soft key to return to the Meas Setup(1/2) menu.

Modulation Analysis, Impulse Response
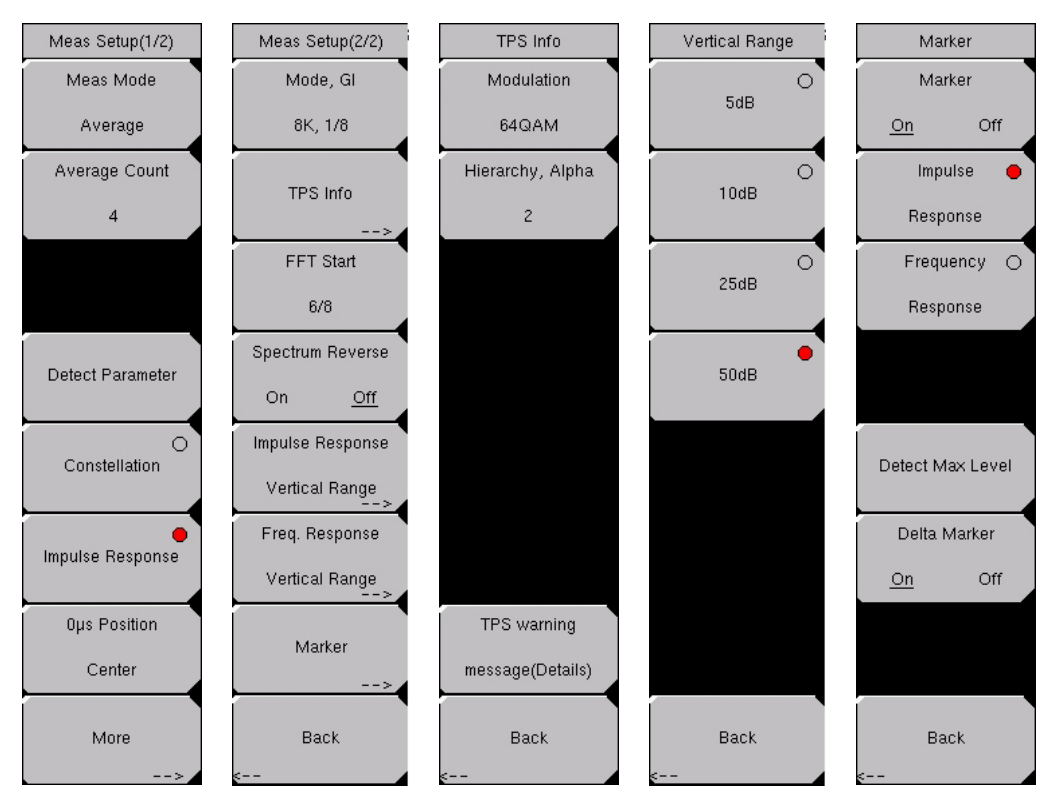
Figure 22-21. Impulse Response Measurement Menus

Press the **Meas Selection** function hard key to open the Meas Selection soft key menu. Then press the Modulation Analysis soft key to set up the measurement.

Press the **Meas Setup** function hard key to open the Meas Setup(1/2) soft key menu.

Measurement Setup for Impulse Response Modulation Analysis

Meas Setup(1/2) Soft Key Menu

Meas Mode
Refer to section *Meas Mode* on page 22-24. Note that Impulse Response Modulation Analysis does not include Max Hold.

Average Count, #
For a description of this soft key, refer to section *Average Count* on page 22-25.

Detect Parameter
Press this soft key to automatically detect TPS and Mode, GI information from the input signal. Measurement begins when parameters are detected. For additional information, refer to *Mode, GI* or *TPS Info* on page 22-27.

Constellation
Refer to section *Constellation* on page 22-27.

Impulse Response
Press this soft key to display the Impulse Response measurements.

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0µs Position, Left/Center/Right
Press this soft key to open the *Select 0µs Position* list box and select a zero microsecond signal display position on the Impulse Response graphs. Changing this setting can affect the FFT Start position. For more information about this relationship, refer to section *FFT Start* .

More
Press this soft key to display the next page of the Meas Setup (2/2) menu. The soft keys that are displayed in the Meas Setup (2/2) menu differ depending upon the type of measurement, Impulse Response, Constellation, or Tx Meas.

Meas Setup(2/2) Soft Key Menu
Mode, GI, ##
Press this soft key to open the *Select Mode, GI* list box. Scroll through the list to select the Mode (number of subcarriers) and the Guard Interval. For more information about Mode or Guard Interval, refer to *2k, 4k, 8k Modes* or *Guard Intervals* .

Table 22-4. Relationship between Signal Mode and Impulse Response

Mode	Impulse Response
2K	4.464 kHz
4K	2.232 kHz
8K	1.116 kHz

TPS Info
Press this soft key to open the TPS Info soft key menu.

TPS Info Soft Key Menu.
Modulation, QPSK/16QAM/64QAM
Press this soft key to open the *Select Modulation* list box and select one of the three modulation types.

Hierarchy, Alpha, #
Press this soft key to open the *Select Hierarchy, Alpha* list box and select a value. The Alpha Hierarchy Mode is used to shape the 16QAM and 64QAM constellations. A value of $\alpha = 1$ describes an equally-spaced constellation. The Hierarchy, Alpha soft key is not displayed if the modulation type is QPSK.

TPS Warning, message (Details)
Press this soft key to open the TPS warning message (Details) message box and read a message description.

Back
Press this soft key to return to the Meas Setup (2/2) menu.

FFT Start, ##
Press this soft key to open the *Select FFT Start* list box and select a value for the starting position for reading effective symbol data. For more information, refer to section *FFT Start* .

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Spectrum Reverse, On/Off

Press this soft key to turn the spectrum reverse function On or Off. Use
Spectrum Reverse to measure the signal whose sub carrier location is inverted on the
frequency axis, such as the IF signal of the transmitter.

Impulse Response Vertical Range

Press this soft key to display the Vertical Range options. Select the vertical range for
the impulse response graph from the Vertical Range soft key menu.

Vertical Range Soft Key Menu

Press a soft key to choose one of the values: 5 dB, 10 dB, 25 dB, or 50 dB.

Frequency Response Vertical Range

Press this soft key to display the Vertical Range options. Select the vertical range for
the impulse response graph from the Vertical Range soft key menu, which is the same
menu that is displayed for Impulse Response Vertical Range.
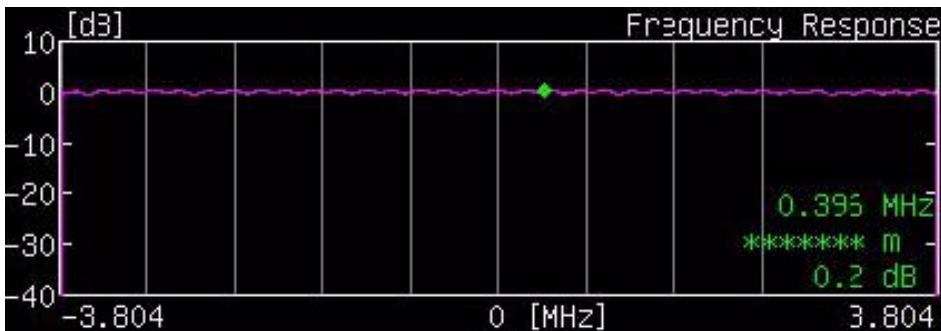
Figure 22-22. Frequency Response with Marker

Marker

Press this soft key to open the Marker soft key menu.

Marker Soft Key Menu

Marker, On/Off

Press this soft key to toggle the marker On or Off for the Impulse Response graph or
the Frequency Response graph. When Marker is Off, only this soft key and the Back
soft key are displayed. When Marker is On, the additional soft keys are displayed.

The Impulse Response (All) graph displays the measurement in µS (on the
horizontal axis) and in dB (on the vertical axis). When Marker is On and
Impulse Response is selected, a pair of green marker lines select approximately 1/6
of the displayed width of the Impulse Response (All) graph. This portion of the
measurement is expanded horizontally in the Impulse Response (Zoom) graph.
This area marked for Zoom can be scrolled left and right on the Impulse
Response (All) graph by pressing the **Up/down** arrow keys (for coarser
movements) or the **Left/Right** arrow keys (for finer movements). Refer also to
section *0µs Position, Left/Center/Right* . The rotary knob moves a
green diamond-shaped marker along the measured signal trace within the Impulse
Response (Zoom) graph. The difference between the reference signal and a delayed
signal is displayed in the upper-right corner of the Impulse Response (Zoom) graph
in microseconds (µS), meters (m), and relative signal strength (dB).

The Frequency Response graph displays the measurement in frequency (on the horizontal axis) and in dB (on the vertical axis). When Marker is On and Frequency Response is selected, a green diamond-shaped marker can be scrolled with the rotary knob or the **Up/Down** and **Left/Right** arrow keys. The difference between the 0 MHz reference point and the signal at the marker is displayed in the lower-right corner of the Frequency Response graph in frequency (MHz, for example), meters (m), and relative signal strength (dB). The frequency and relative power are indicated for the marker position, but the distance (meters) is not relevant with this marker (refer to the soft key description for *Delta Marker, On/Off*).

Impulse Response
Press this soft key to use the marker in the Impulse Response graphs.

Frequency Response
Press this soft key to use the marker in the Frequency Response graphs.

Detect Max Level
Press this soft key to move the marker to the maximum level point (only on the Impulse Response (Zoom) graph). This soft key is displayed only when the Impulse Response soft key is active.

Table 22-5. Marker Range for Impulse Response

Mode	Impulse Response	Frequency Response
7 MHz, 2K	−10.50 to 74.63 µs	−3.234 to +3.234 MHz
7 MHz, 4K	−21.25 to 149.25 µs	−3.281 to +3.281 MHz
7 MHz, 8K	−42.50 to 298.63 µs	−3.305 to +3.305 MHz
8 MHz, 2K	−9.19 to 65.30 µs	−3.696 to +3.696 MHz
8 MHz, 4K	−18.59 to 130.59 µs	−3.750 to +3.750 MHz
8 MHz, 8K	−37.19 to 261.30 µs	−3.777 to +3.777 MHz

Delta Marker, On/Off
Press this soft key to turn On or Off the delta marker function. To use this Delta Marker in the Impulse Response graphs, first (with Delta Marker Off) place the non-delta marker (green diamond) at the desired location within the displayed measurement trace. Then turn Delta Marker On. The Delta Marker is displayed as a fixed green square. The rotary knob and arrow keys move the green diamond marker relative to the fixed green square marker, and the displayed measurements indicate the differences in the signal trace between these two marker locations.

The **Up/Down** arrow keys move the marker in the largest increments, the **Left/Right** arrow keys move the marker approximately half that amount, and the rotary knob moves the marker in the smallest increments.

To use this Delta Marker in the Frequency Response graphs, first (with Delta Marker Off) place the non-delta marker (green diamond) at the desired location within the displayed measurement trace. Then turn Delta Marker On. The difference between the signal at the fixed marker and the signal at the moving marker is displayed in the lower-right corner of the Frequency Response graph in frequency (MHz, for example), meters (m), and relative signal strength (dB).
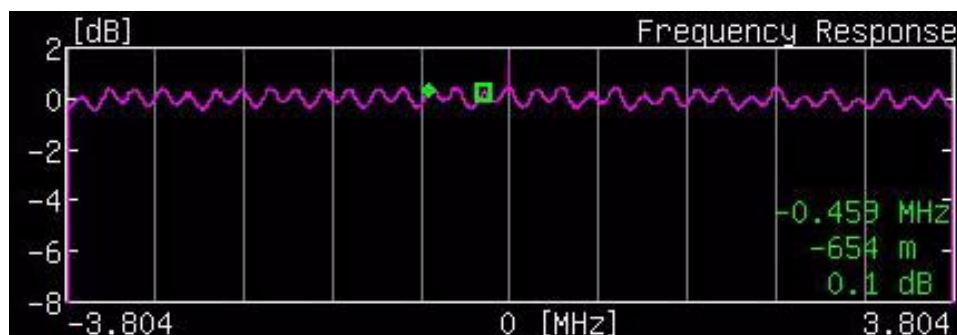
Figure 22-23. Frequency Response with Delta Maker

Back

Press this soft key to return to the Meas Setup(2/2) menu.

Back

Press this soft key to return to the Meas Setup(1/2) menu.

Tx Meas Menu

Figure 22-24. Measure Selection Menus

Press the **Meas Selection** function hard key to open the Meas Selection soft key menu.

Tx Meas
Press this soft key to open the Tx Meas soft key menu.

Carrier MER
Press this soft key to enable the Carrier MER transmission measurement.

Back
Press the Back soft key to return to the Tx Meas menu.

Press the **Meas Setup** function hard key to open the Meas Setup(1/2) soft key menu.

Meas Mode, xxx
Press this soft key to open the *Select Meas Mode* list box and choose from: Single, Continuous, Average, or Moving Average. The selected mode appears on the virtual soft key face. Refer to section *Meas Mode* on page 22-24. Note that Tx Meas Analysis does not include Max Hold.

Average Count,
Press this soft key to open the *Average Count Editor* dialog box and select a count within the indicated range. The selected count appears on the virtual soft key face.

Detect Parameter
Press this soft key to automatically detect TPS and Mode, GI information from the input signal. Measurement begins when parameters are detected. For additional information, refer to *Mode, GI* or *TPS Info* on page 22-27.

More
Press this soft key to open the Meas Setup(2/2) soft key menu.

Mode, GI, xx
Press this soft key to open the *Select Mode, GI* list box. Scroll through the list to select the Mode (number of subcarriers) and the Guard Interval. For more information about Mode or Guard Interval, refer to *2k, 4k, 8k Modes* or to *Guard Intervals* on page 22-2.

TPS Info
Press this soft key to open the TPS Info soft key menu.

TPS Info Soft Key Menu
Refer to *TPS Info Soft Key Menu* on page 22-27.

FFT Start,
Press this soft key to open the *Select FFT Start* list box and select a value for the starting position for reading effective symbol data. For more information, refer to section *FFT Start* on page 22-3.

Spectrum Reverse, On/Off
Press this soft key to turn the spectrum reverse function On or Off. Use Spectrum Reverse to measure the signal whose sub carrier location is inverted on the frequency axis, such as the IF signal of the transmitter.

Vertical Range

Press this soft key to display the Vertical Range options. Select the range from the Vertical Range soft key menu.

Vertical Range Soft Key Menu

Press a soft key to choose one of the values: 20 dB, 30 dB, 40 dB, or 50 dB.

Back

Press this soft key to return to the Meas Setup(2/2) soft key menu.

Marker

Press this soft key to open the Marker soft key menu.

Marker Soft Key Menu

Marker, On/Off

Press this soft key to turn the Marker On and Off. The MER soft keys are not displayed until the Marker is On.

Carrier MER (All)

Press this soft key to use the range marker in the Carrier MER (All) graph. The **Left/Right** arrow keys and the rotary knob move the marker region up and down in frequency. The **Up/Down** arrow keys move the marker region in twice the increment size compared to the other controls. This marker range region indicates the zoomed (enlarged) area that is displayed in the Carrier MER (Zoom) graph. A yellow Trend line shows the trend of the Carrier MER values. The Trend line is calculated by the least-square method, and two calculations are made to determine the curve from the center frequency to each edge of the frequency measurement. The blue (triangular) marker shows the point of minimum MER.
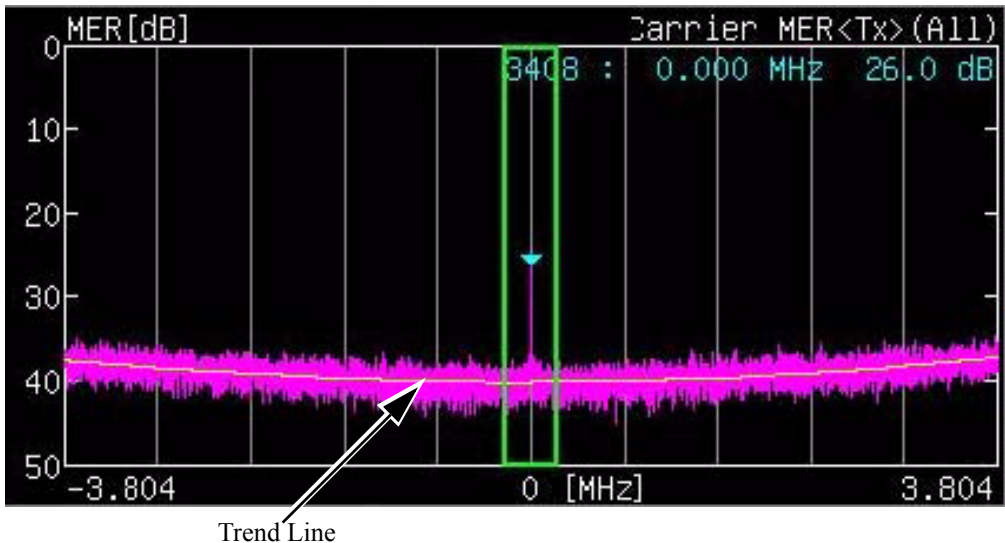
Trend Line

Figure 22-25. Tx Carrier MER with Trend Line

Carrier MER (Zoom)

Press this soft key to use the marker in the Carrier MER (Zoom) graph. The **Up/Down** arrow keys move the green trace marker in the largest increments. The **Left/Right** arrow keys move the marker in increments half the distance of the **Up/Down** arrow keys. The rotary knob moves the marker in the smallest increments. The blue (triangular) marker shows the point of minimum MER. The green (diamond) trace marker follows the value of the measurement and is moved by the keys and rotary knob.
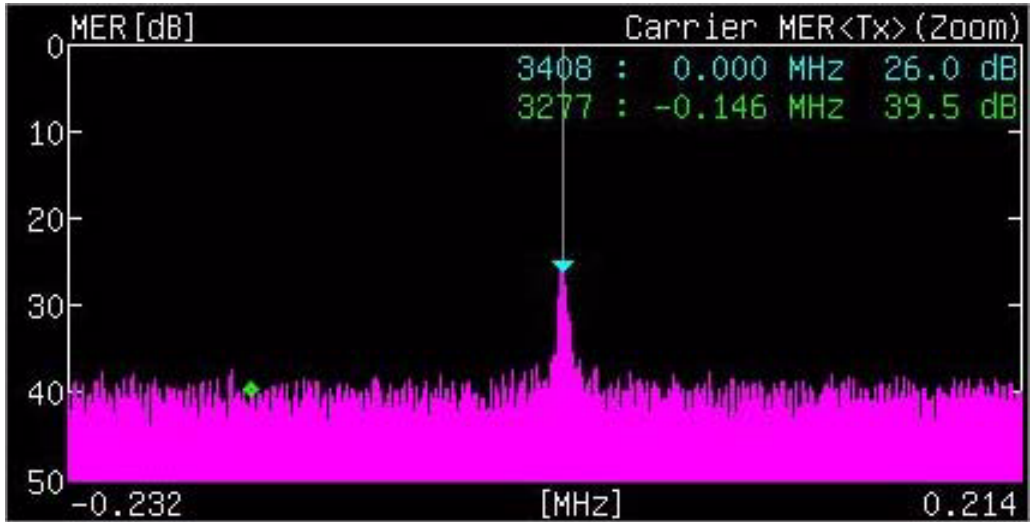
Figure 22-26. Tx Carrier Zoom with Markers

Back

Press this soft key to return to the Meas Setup(2/2) soft key menu.

Back

Press this soft key to return to the Meas Setup(1/2) soft key menu.

Spectrum Monitor Menus
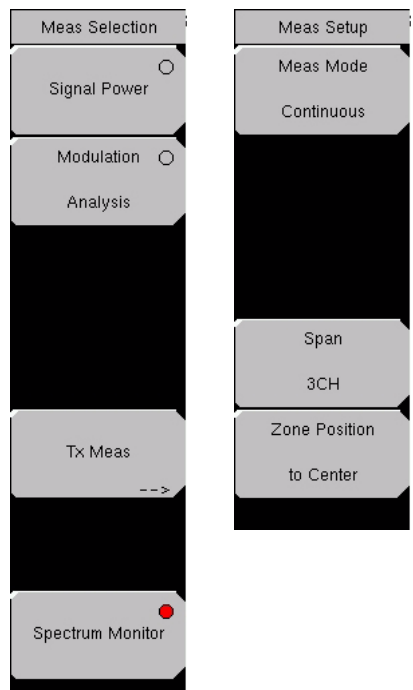
Figure 22-27. Spectrum Monitor Menus

Press the **Meas Selection** function hard key to open the Meas Selection soft key menu.

Spectrum Monitor
Press this soft key to display the spectrum of the input signal.

Press the **Meas Setup** function hard key to open the Meas Setup soft key menu.

Meas Mode, xxx
Press this soft key to open the *Select Meas Mode* list box and choose between Single and Continuous. The selected mode appears on the virtual soft key face.

Single: This mode sets the test for one measurement. The BTS Master acquires the measurement and displays the results. This mode is useful for screen capture of measurements.

Continuous: This mode sets the test for continuos measurements, which are displayed as they are made. This mode is useful for real-time analysis.

Span, #CH
Press this soft key to open the *Select Span* list box and choose the desired number of channels to span in the displayed measurement. When the setting is entered, the measurement is restarted. RMS is set for Detection on the spectrum monitor for all available span settings.

The **Up/Down** arrow keys also change the span selection and restart the measurement.The RBW and VBW values are set internally and are not displayed on the screen.

Table 22-6. Span Relation to Bandwidth

Span	RBW	VBW
1 CH	10 kHz	3 kHz
3 CH	30 kHz	10 kHz
5 CH	100 kHz	30 kHz
11 CH	100 kHz	30 kHz
31 CH	300 kHz	100 kHz
51 CH	1 MHz	300 kHz

Zone Position to Center
Press this soft key to set the channel of the current zone marker at the center of the measurement display and restart the measurement.

The **Left/Right** arrow keys and the rotary knob also move the channel of the current zone marker, but they do not restart the measurement.

Press the **Execute Measure** function hard key at any time to restart the measurement.

Glossary

Alpha Hierarchy

This mode is used to shape the 16QAM and 64QAM constellations. A value of $\alpha = 1$ describes an equally spaced constellation.

Channel Power

The output power of a transmitter over the frequency range in a specific time interval.

dBi

dBi is the dB gain with reference to an isotropic radiator.

FFT

Fast Fourier Transform.

GI

In telecommunications, guard intervals (GI) are used to ensure that distinct transmissions do not interfere with one another. These transmissions may belong to different users (as in TDMA) or to the same user (as in OFDM). Guard intervals introduce immunity to propagation delays, echoes, and reflections, to which digital data is normally very sensitive.

MER

Modulation Error Ratio is a signal-to-noise ratio in a digitally modulated signal. It is a measure that is used to quantify the performance of a digital radio transmitter or receiver in a system using QAM (Quadrature Amplitude Modulation). It includes the parameters amplitude imbalance, quadrature error, and distortion.

MPE

Multiprotocol Encapsulation is a datalink layer protocol that is defined by DVB.

MPE-FEC

MPE-FEC (Multi-Protocol Encapsulation / Forward Error Correction) is a method that is used to deliver additional Forward Error Correction to datagrams that are delivered in MPE sections.

OFDM

Orthogonal Frequency-Division Multiplexing is a digital multi-carrier modulation scheme that uses a large number of closely-spaced orthogonal subcarriers. It allows the transmission of data on multiple adjacent subcarriers, each subcarrier being modulated in a traditional manner with a linear modulation scheme such as QAM (Quadrature Amplitude Modulation). Orthogonality allows the carriers to be placed very close to one another, in such a way that no guard bands are needed, and therefore, no information is sacrificed when using frequency division multiplexing.

Data for transmission is converted into several parallel streams, and each stream is used to modulate a separate subcarrier. Only a small amount of the total data is sent via each subcarrier, and it is sent in a subchannel that is a fraction of the width of the total channel.

QAM

Quadrature Amplitude Modulation (QAM) is a modulation scheme which conveys data by changing (modulating) the amplitude of two carrier waves. These two waves, usually sinusoids, are out of phase with each other by 90° and are thus called quadrature carriers.

QPSK

Quadrature Phase-Shift Keying is a type of digital phase modulation that contains four allowed phases for each transmitted bit.

RBW

Resolution bandwidth is determined by the intermediate frequency (IF) filter bandwidth. The spectrum analyzer traces the shape of its IF filter as it tunes past a signal. If more than one IF filter is used in a spectrum analyzer, then the narrowest one dominates and is considered the resolution bandwidth.

Spectrum Reverse

The signal whose subcarrier location is inverted on the frequency axis, such as the IF signal of the transmitter.

TPS

Transmission Parameter Signaling (TPS) carriers are used for the purpose of signaling parameters related to the transmission scheme, in other words, to channel coding and modulation. The TPS is transmitted in parallel on 17 TPS carriers for the 2K mode and on 68 carriers for the 8K mode. Every TPS carrier in the same symbol conveys the differentially encoded information bit. TPS information includes the following:

- Modulation, including the α value of the QAM constellation pattern

- Hierarchy information

- Guard interval

- Inner code rates

- Transmission mode: 2K or 8K

- Frame number in a super-frame

- Cell identification

Time-Slicing

Time-slicing is a method that is used to deliver MPE sections and MPE-FEC sections in bursts.

VBW

Video bandwidth

Chapter 23
DVB-T/H SFN Analyzer

Introduction

This chapter provides a description of DVB-T/H single frequency network (SFN) setup and measurement for signal power and signal analysis with Option 78 on the MS2721B BTS Master. The user can measure channel power along with the field strength and power of each incoming signal even with several incoming multipath signals. The time for impulse response measurements is longer to allow for the measurement of signals coming from distant sites in the network.

Field strength measurements in SFN environments include Level, Delay, and DU Ratio of each incoming signal along with the time delay between signals.

Measurement Functions

Impulse Response Measurement

This function measures the difference in time and frequency of multipath signals. Measuring the channel frequency response allows observation of the multipath effect and frequency-selective fading. This is useful for adjusting the timing of SFN repeaters.

Inband Spectrum

This function is useful for transmitter installation or maintenance because it offers a wide dynamic range (50 dB) on the vertical scale for high-performance transmitters. It also offers precise checks of each carrier by providing a zoom view for all carriers on the horizontal scale.

Getting Started

Quick Start Configuration, Setup, and Testing

DVB-T/H SFN Analyzer Mode

To configure the instrument for DVB-T/H SFN Analyzer measurements:

1. Press the **Shift** key, then the **Mode** (9) key.
2. Use the **Up/Down** arrow keys or the rotary knob to highlight DVB-T/H SFN Analyzer and then press the **Enter** key or press the rotary knob to select this mode.

Refer to *Mode Selector Menu* on page 2-16 for more information about selecting instrument modes.

Antenna Setup

The antenna attaches to the instrument with a coaxial cable. The antenna and coaxial cable are not supplied with the instrument and are to be procured separately.

The antenna factors are different for each antenna. Refer to the documentation for your antenna. Also, remember to include the cable loss to the measurement correction table when you are entering the antenna factors.

1. Attach the antenna to the Spectrum Analyzer connector on top of the BTS Master (refer to Figure 22-3 *BTS Master Connections – Spectrum Analyzer RF in on page 22-6*).

2. Select the antenna as follows:

   a) Press the **Meas Setup** function hard key.

   b) Press the Impulse Response soft key followed by pressing the More soft key.

   c) Press the Correction Value soft key.

   d) Press the Antenna (Correction Level) soft key. The *Select Antenna* list box opens.

   e) Highlight the desired Anritsu antenna model number and press **Enter**.

   f) Press the Back soft key twice to return to the Meas Setup(1/2) menu.

Measurement Setup and Execution

Of the five function hard keys, only four are used with Option 78. They have the following labels:

Frequency/Level, BLANK, **Meas Setup**, **Execute Measure**, and **Save Files**

Frequency and Reference Level Configurations

The following procedure is used to set up the instrument for DVB-T/H SFN measurement and analysis:

1. Press the **Frequency/Level** function hard key. Configure the following parameters as needed: Channel Map, Frequency, Bandwidth, Auto Reference Level, Reference Level, and Pre Amp.

2. Press the Channel Map soft key. The *Select Channel Map* list box opens. Select one of the three choices, and then press the **Enter** key or the rotary knob.

    a) If you have selected UHF (Australia) or UHF (Europe), then press the Channel soft key, scroll to the desired channel, and press the **Enter** key. The bandwidth (7 MHz or 8 MHz) and the frequency range are automatically selected by the choice of channel map. The selected channel number is displayed on the face of the Channel soft key. If no channel map (None) is selected, then the Frequency and Band Width soft keys are listed in the soft key menu so that these parameters can be set manually.

    b) If you have selected None, then use the Frequency and Band Width soft keys to set these two parameters.

    •   Press the Frequency soft key to open the *Frequency Editor* dialog box, which indicates the acceptable range for input. The Units soft key menu displays four unit keys: GHz, MHz, kHz, and Hz. If any of these units are not appropriate, then pressing the key displays Out of range at the bottom of the Frequency Editor window. Set the frequency by using the **Up/Down** arrow keys, the rotary knob, or the number keys. When the desired range is displayed, press the appropriate unit soft key, the rotary knob, or the **Enter** key.

    •   Press the Band Width soft key to open the *Select Band Width* list box and select either 7 MHz or 8 MHz bandwidth.

3. Press the Auto Reference Level soft key to allow the instrument to set an optimum reference level, or press the Reference Level soft key to open the *Reference Level Editor* dialog box. To manually set the dBm reference level, use the **Up/Down** arrow keys, the rotary knob, or the number keys, then press the rotary knob or press the **Enter** key. After entering a value by using the number keys, press the **+/-** key to create a negative value.

4. Press the Pre Amp soft key to toggle this function ON and OFF.

SFN Measurement

Set Up the Test

1. Press the **Meas Setup** function hard key to list the Meas Setup(1/2) menu.
2. Press the Meas Mode soft key to open the *Select Meas Mode* list box and choose either Single or Continuous.
3. Press the Detect Parameter soft key to automatically detect Mode, GI, and TPS information from the input signal.

Impulse Response Measurement Setup

1. Press the Impulse Response soft key to select the Impulse Response screen. Press the More soft key to list the Meas Setup(2/2) soft key menu in order to continue configuring for Impulse Response parameters.
2. Press the Mode, GI soft key and scroll to select the desired Guard Interval (GI) parameters.
3. Press the TPS Info soft key.
    a) From the TPS Info menu, press the Modulation soft key and choose from: QPSK, 16QAM, and 64QAM.
    b) If modulation is set to 16QAM or 64QAM, then press the Hierarchy, Alpha soft key and choose: None, 1, 2, or 4. If modulation is set to QPSK, then skip this step (the hierarchy soft key is not displayed).
    c) Press the Back soft key to return to the Meas Setup(2/2) menu.
4. Press the FFT Start soft key to open the *Select FFT Start* list box and select the desired start position with a guard interval (GI). The value 0/8 indicates no guard interval.
5. Press the Spectrum Reverse On/Off soft key to toggle between On and Off. The active state is underlined on the virtual soft key face.
6. Press the Correction Value soft key to display the Correction Value menu.
    a) Press the Antenna soft key, highlight the desired Anritsu antenna model number, and press **Enter**.
    b) Press the Impedance soft key to toggle through the following choices: 50 ohm, 75 ohm, or Other.
        If you select Other, then the Impedance Loss soft key is listed. Press the Impedance Loss soft key to open the *Impedance Loss Editor* dialog box and enter a loss level value (in dB) within the displayed range.
    c) Press the Back soft key to return to the Meas Setup(2/2) menu.
7. Press the Impulse Response Vertical Range soft key. Select a range (in dB). The red dot on the virtual soft key face denotes the selected vertical range. Then press the Back soft key to return to the Meas Setup(2/2) menu.
8. Press the Display Waveform soft key to open the Display Waveform soft key menu.
    a) Press the Last Result soft key to toggle On or Off a view of the last waveform (yellow) result.
    b) Press the Power Method soft key to toggle On or Off a display of the delay path profile waveform (light blue) that is created by the power spectrum method.
    c) Press the Transfer Method soft key to toggle On or Off a display of the delay path profile waveform (magenta) that is created by the transfer function method.
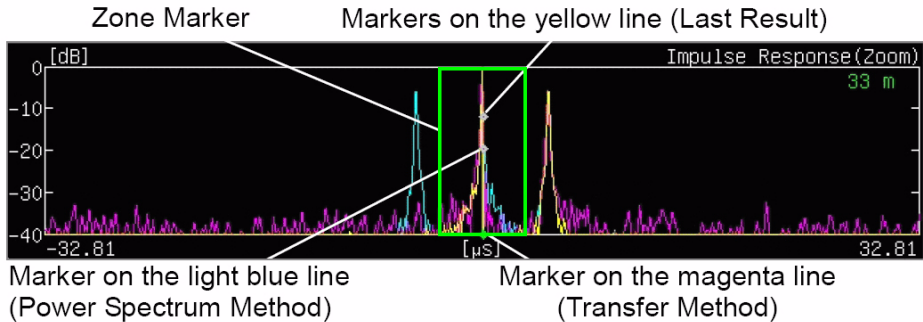   d) Press the Back soft key to return to the Meas Setup(2/2) menu.
9. Press the Back soft key again to return to the Meas Setup(1/2) menu.

10. Press the Marker soft key to open the marker soft key menu.
    a) Press the Marker soft key to toggle between Move the marker and Fix the marker.
    b) Press the Impulse Response soft key to select and configure the marker for Impulse Response (All) view or Impulse Response (Zoom) view.
    c) If Impulse Response Zoom is selected, then press the Marker Mode soft key to select either Normal or Zone.
    d) Press the Unit soft key to select dBµV/m (Field Strength) or dBµV (Termination Voltage)
    e) Press the Detect MaxLevel soft key.
    f) Press the Main to Center of Zoom soft key.
    g) Press the Path to Center of Zoom soft key.
    h) Press the Back soft key to return to the Meas Setup(1/2) menu.

Inband Spectrum Measurement Setup

1. Press the Inband Spectrum soft key to select the Inband Spectrum screen. Press the More soft key to display the Meas Setup(2/2) soft key menu in order to continue configuring for Inband Spectrum parameters.
2. Press the Mode, GI soft key and scroll to select the desired Guard Interval parameters.
3. Press the TPS Info soft key.
    a) From the TPS Info menu, press the Modulation soft key and choose from: QPSK, 16QAM, and 64QAM.
    b) If modulation is set to QPSK, then skip this step (the hierarchy soft key is not displayed).
       Press the Hierarchy, Alpha soft key and choose: None, 1, 2, or 4.
    c) Press the Back soft key to return to the Meas Setup(2/2) menu.
4. Press the FFT Start soft key to open the *Select FFT Start* list box and select the desired start position with a guard interval (GI). A value of 0/8 indicates no guard interval.
5. Press the Spectrum Reverse On/Off soft key to toggle between On and Off. The active state is underlined on the virtual soft key face.
6. Press the Correction Value soft key to display the Correction Value soft key menu. The active state is underlined on the virtual soft key face.
    a) Press the Antenna soft key, highlight the desired Anritsu antenna model number, and press **Enter**.
    b) Press the Impedance soft key to toggle among the choices: 50 ohm, 75 ohm, or Other. The active state is underlined on the virtual soft key face.
    c) Press the Back soft key to return to the Meas Setup(2/2) menu.
7. Press the Inband Spectrum Vertical Range soft key. Select a range (in dB) by pressing a soft key. The red dot denotes the selected vertical range. Then press the Back soft key to return to the Meas Setup(2/2) menu.
8. Press the Back soft key again to return to the Meas Setup(1/2) menu.
9. Press the Marker soft key to display the Marker soft key menu.
    a) Press the Marker soft key to toggle the marker function On or Off.
    b) Press the Delta Marker soft key to toggle the delta marker On or Off.
       Use the arrow keys or the rotary knob to move the marker and the delta marker.
    c) Press the Back soft key to return to the Meas Setup(1/2) menu.

Execute the Test

Press the **Execute Measure** function hard key to begin testing. If the input signal cannot be measured, then a message is displayed with red highlighting near the top of the display area, such as: Under Level : Increase input level. Or: Under range : Reduce Reference Level.
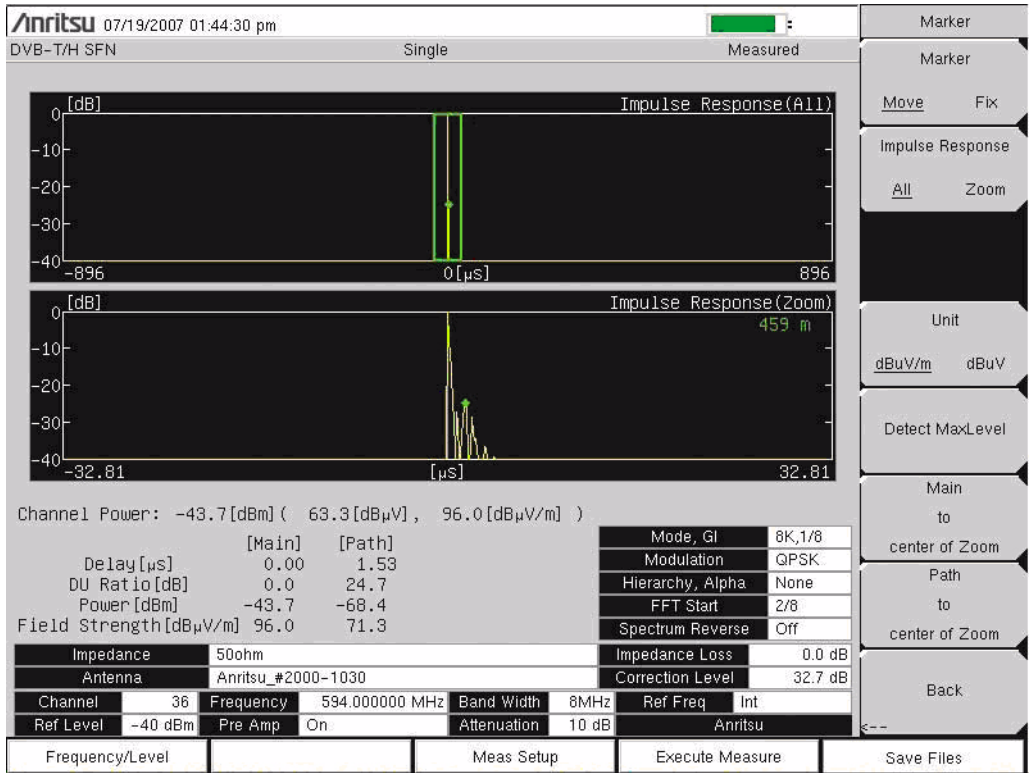
Figure 23-1. Impulse Response Measurement

Save the Test Results

Press the **Save Files** function hard key to save a measurement. A confirmation window opens briefly to indicate that the measurement has been saved.

Saving Measurement Results

Automatic File Saving

Files are saved in the JPEG format and the CSV format. The filename format uses a string of 3 characters followed by a string of digits for the date and time. The entire character string appears as follows:

Impulse Response

```
SFIYYYYMMDD_HHMMSS.csv
SFIYYYYMMDD_HHMMSS.jpg
```

Inband Spectrum

```
SFSYYYYMMDD_HHMMSS.csv
SFSYYYYMMDD_HHMMSS.jpg
```

The date is expressed as year (YYYY), month (MM), and day (DD) followed by an underscore, and then the time is expressed as hour (HH), minute (MM), and second (SS), all followed by a period and the file extension (CSV or JPG).

Manual File Saving

To save a measurement manually, refer to sections *File* and *Save* on page 3-25 and to section *Text Entry* on page 2-7.

Menus

Function Hard keys

In DVB-T/H SFN Analyzer mode (Option 78), the BTS Master displays the following 4 function hard key menu choices: **Frequency/Level**, **Meas Setup**, **Execute Measure**, and **Save Files**.

| Frequency/Level | | Meas Setup | Execute Measure | Save Files |

Figure 23-2. Function Hard Key Menu

Frequency/Level Menu
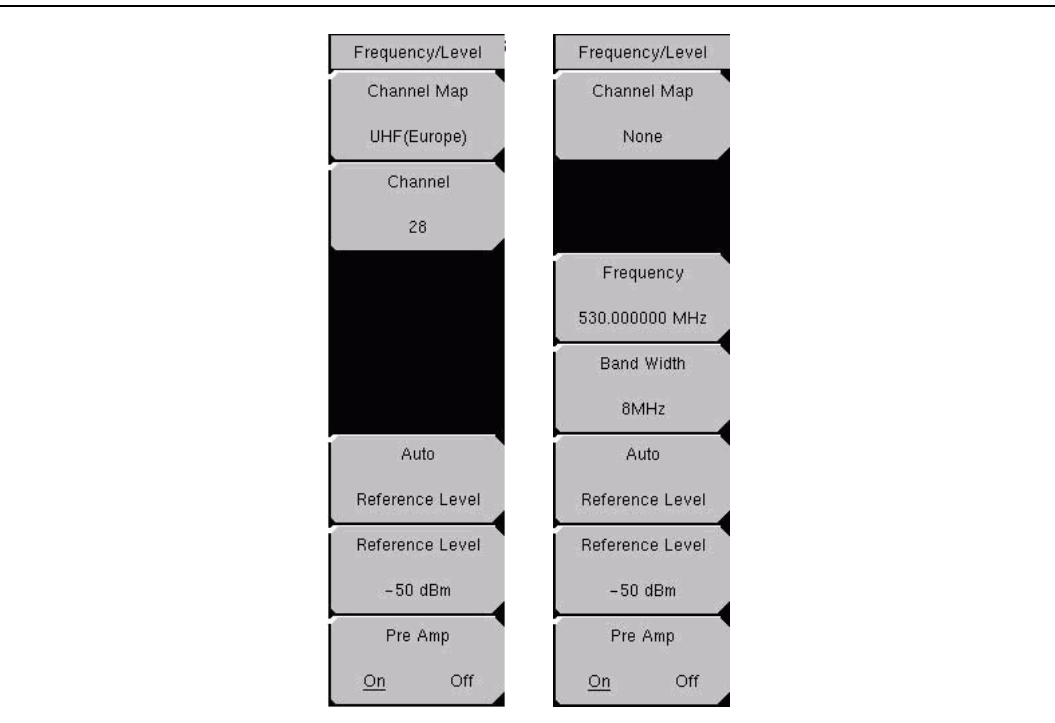
Figure 23-3. Frequency/Level Menus

Channel Map
This soft key opens the *Select Channel Map* list box to allow channel map selections for UHF(Australia), UHF(Europe), or None. Selecting UHF(Australia) sets the bandwidth to 7 MHz, selecting UHF(Europe) sets the bandwidth to 8 MHz, and a Channel Number soft key is added to the **Frequency/Level** menu. Selecting None adds two soft keys to the **Frequency/Level** menu in order to allow manual setting of frequency and bandwidth.

23-7

Channel

If UHF is selected for Channel Map, then the next soft key is Channel ##. Press this soft key to open the *Channel Editor* dialog box to select a channel within a specified range that is displayed in the window. If None is selected, then the next soft key is Frequency.

Frequency

If None is selected for Channel Map, then the soft keys for Frequency and Band Width are added to the menu. Press this soft key to open the *Frequency Editor* dialog box to manually enter or select a frequency within a specified range that is displayed in the window. The Units soft key menu displays virtual soft keys for the following units: GHz, MHz, kHz, and Hz.

Band Width

Press this soft key to open the *Select Band Width* list box to select a bandwidth of 7 MHz or 8 MHz.

Auto Reference Level

Press this soft key to automatically set the reference level to an optimum value. This reference level indicates the signal level input to the instrument.

The reference level range for input to the instrument is determined by the reference level setting. Immediately after a signal is applied to the instrument, the input attenuator is automatically set according to the reference level. The relationship between the reference level and the input attenuator is fixed. Table 23-1 shows the relationship between the reference level and the input attenuator for each measurement item.

Raising the reference level increases attenuation of the input attenuator, enabling the BTS Master to handle a high input level. Note that the noise floor rises in proportion to the attenuation of the input attenuator.

When applying a signal to the instrument, enter a signal level that does not exceed the reference level value. If the signal level exceeds the reference level, then raise the reference level. For example, if the signal level is 0.5 dBm with preamplifier off, then set the reference level to 5 dBm, not to 0 dBm.

If an interfering signal exists other than the intended signal, and if the power (within the frequency range of approximately 100 kHz to 7.1 GHz) is 15 dB or more higher than the measurement signal level, then set the reference level to take the large signal into account.

Reference Level

Press this soft key to open the *Reference Level Editor* dialog box in order to select a signal reference value within the specified range that is displayed in the window. If the Pre Amp soft key is On, then the reference level range is from −10 dBm to −50 dBm in 10 dB increments. If the Pre Amp soft key is Off, then the reference level range is from −25 dBm to 20 dBm in 5 dB increments.

Pre Amp On/Off

Press this soft key to toggle the preamplifier function between On and Off. When the preamplifier is switched On, the reference level is automatically set to −30 dBm. When the preamplifier is switched Off, the reference level is automatically set to −25 dBm.

Table 23-1. Relationship between Reference Level and Input Attenuator

Preamplifier	Reference Level (dBm)	Input Attenuator (dB)
Off	20	45
Off	15	40
Off	10	35
Off	5	30
Off	0	25
Off	−5	20
Off	−10	15
Off	−15	10
Off	−20	5
Off	−25	0
On	−10	40
On	−20	30
On	−30	20
On	−40	10
On	−50	0

Measurement Setup Menus
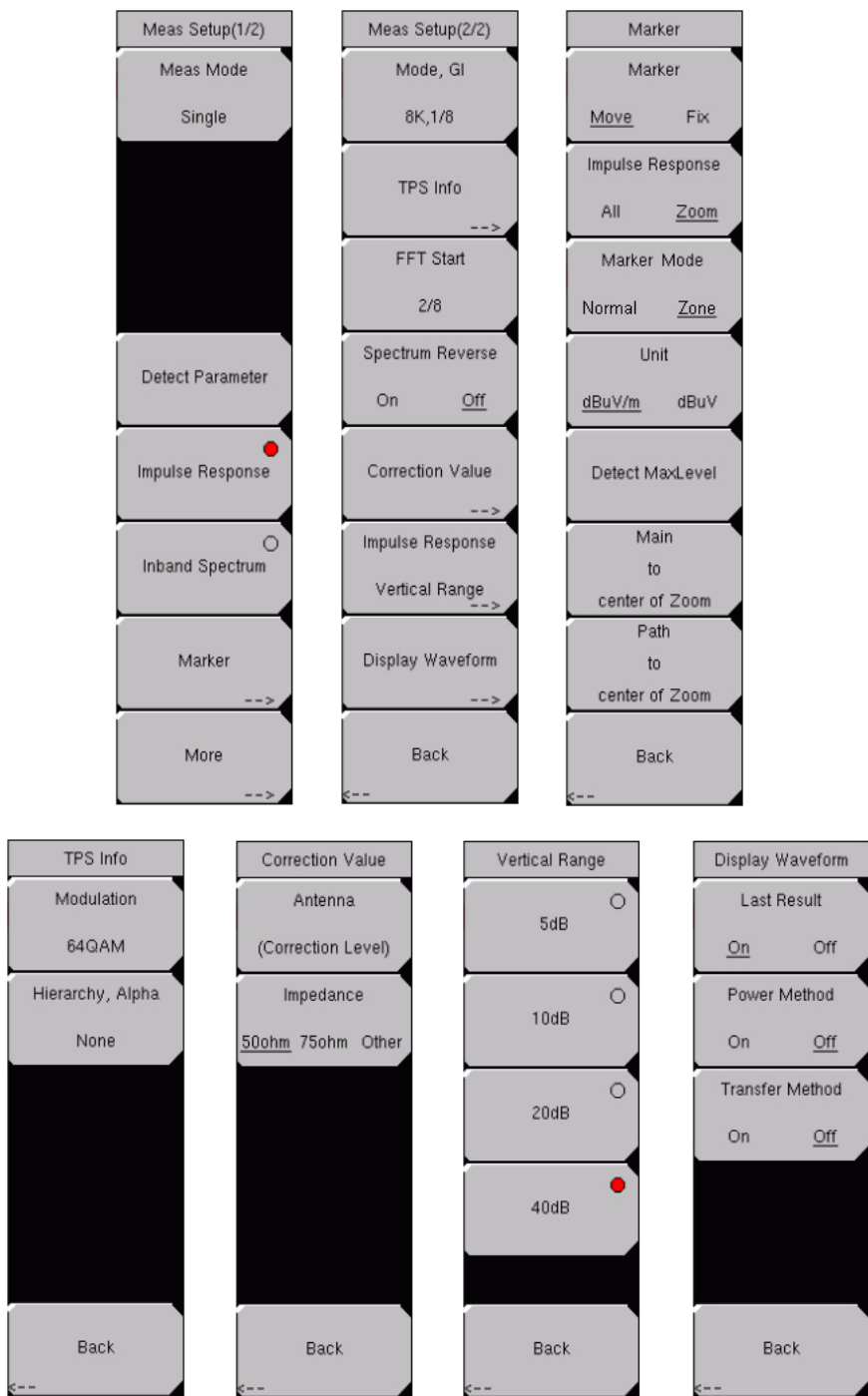
Figure 23-4. Measurement Setup Menus for Impulse Response

Press the **Meas Setup** function hard key to open the Meas Setup(1/2) soft key menu. When
Impulse Response is selected, the available soft key menu options are as shown in
Figure 23-4.

Measure Setup(1/2) Soft Key Menu

Meas Mode

Press this soft key to open the *Select Meas Mode* list box and select a measurement mode. Two test mode options are available: Single and Continuous.

Single sets up the test for one measurement. A measurement is taken, and the results are displayed on the screen. This mode is useful for capturing screen images.

Continuous sets up the test to take measurements continuously and to display the results. The mode is helpful for real-time signal analysis.

Detect Parameter

Press this soft key to automatically detect TPS and Mode, GI information from the input signal. Measurement begins when parameters are detected. For additional information, refer to *Mode, GI* on page 23-15 and *TPS Info* on page 23-15.

Impulse Response

Press this soft key to activate the Impulse Response measurement mode and the associated Meas Setup menus. The red dot in the upper right portion of the virtual soft key face denotes that the measurement mode is selected.

Inband Spectrum

Press this soft key to activate the Inband Spectrum measurement mode and the associated Meas Setup menus.

Marker (Impulse Response Measurement Setup)

Press this soft key to list the Marker soft key menu.

Marker Soft Key Menu

Marker

Press this soft key to select either Move or Fix.

When Move is selected, you are allowed to position the Marker, Enlarged Window, and Zone Marker in the Impulse Response (All) and Impulse Response (Zoom) graphs.
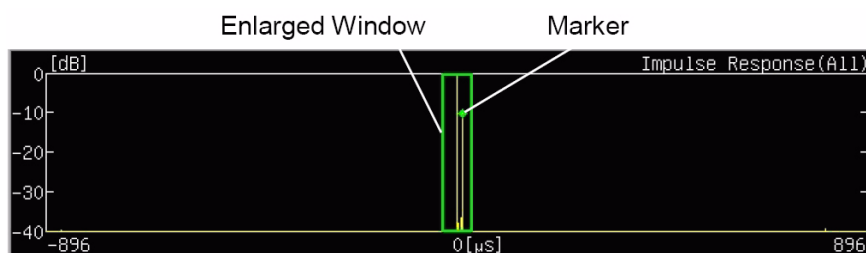
Figure 23-5. Impulse Response (All) Graph with Marker

When Fix is selected, the soft keys for Impulse Response, Marker Mode, Detect MaxLevel, Main to center of Zoom, and Path to center of Zoom are not displayed.

Impulse Response

Press this soft key to toggle between All and Zoom in order to display the marker and the enlarged window on the Impulse Response (All) graph. The enlarged window shows the displayed range of the enlarged Impulse Response (Zoom) graph.

Marker Mode
Press this soft key to select either Normal or Zone. When Zone is selected, the Zone Marker is turned on for display in the Impulse Response (Zoom) graph.
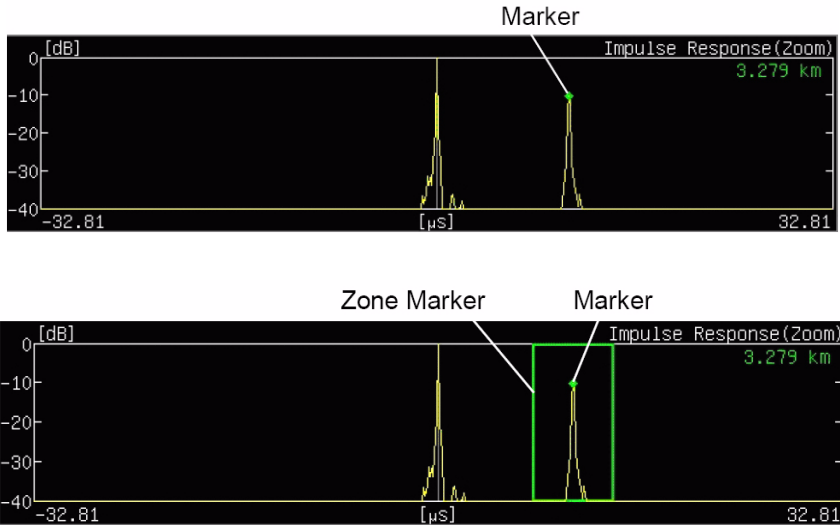
Figure 23-6. Impulse Response (Zoom) Graph with Zone Marker

Unit
Press this soft key to view the Field Strength or the Termination measurement.

Field Strength: dBμV/m

Termination Voltage: dBμV

Detect MaxLevel
Press this soft key to detect the various maximum levels of the Impulse Response (All) and Impulse Response (Zoom) graphs.

Impulse Response (All): Detects the maximum level of the last result within the enlarged window and adjusts the marker to the maximum level.

Impulse Response (Zoom), Marker Mode-Normal: Detects the maximum level of the last result within the enlarged graph and adjusts the marker to the maximum level.

Impulse Response (Zoom), Marker Mode-Zone: Detects the maximum level of the last result within the enlarged graph and adjusts the zone marker to the maximum level, so that the detection position of the maximum level is located at the center. The marker frame is automatically resized in the graph when the maximum level is located at either edge of the enlarged graph.

Main to Center of Zoom
Press this soft key to move the All graph enlarged window so that the main wave (delay time of 0 μs) can be displayed, focusing around the enlarged graph.

Path to Center of Zoom
Press this soft key to move the enlarged window so that the current marker position can be displayed, focusing around the enlarged graph.

23-12

Back
Press this soft key to return to the Meas Setup(1/2) soft key menu.

Press the **Meas Setup** function hard key to open the Meas Setup(1/2) soft key menu. When Inband Spectrum is selected, the available soft key menu options are as shown in
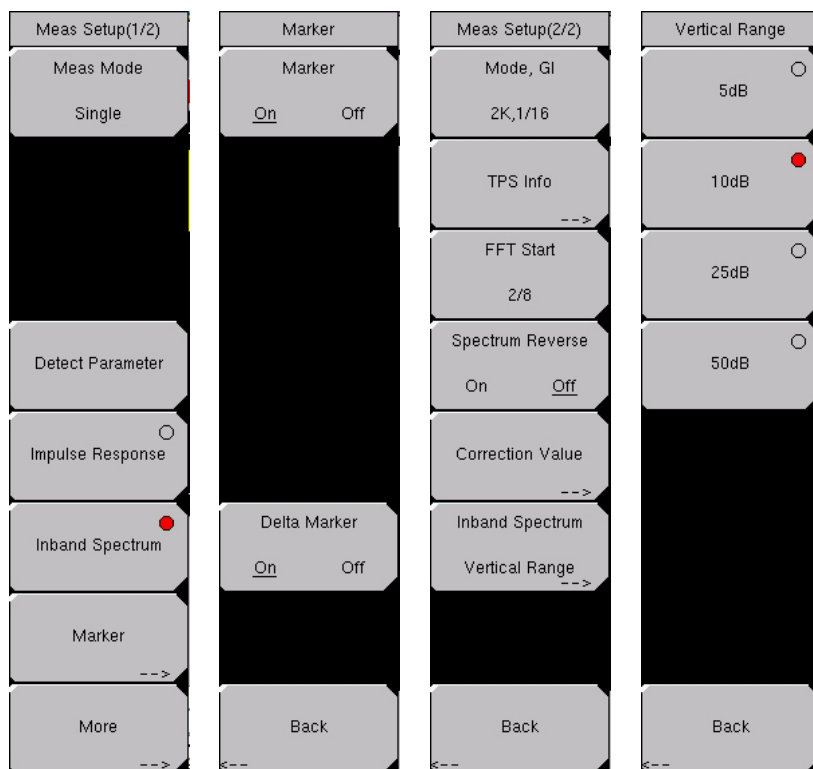
Figure 23-7. Measurement Setup Menus for Inband Spectrum

Marker (Inband Spectrum Measurement Setup)
Press this soft key to open the Marker soft key menu. After turning on the marker or the delta marker, use the **Left/Right** arrow keys to move the marker in steps, or use the rotary knob to move the marker one point at a time.

Marker Soft Key Menu

Marker
Press this soft key to turn Marker On or Off. When On is selected, the diamond shaped marker is displayed. The marker frequency, distance, and level are displayed in green at the bottom-right corner of the graph.

Delta Marker
Press this soft key to turn Delta Marker On or Off. When On is selected, both the Standard Marker (square) and Delta Marker (diamond) are displayed on the graph. Delta Marker data for frequency, distance, and level are in reference to the standard marker position.
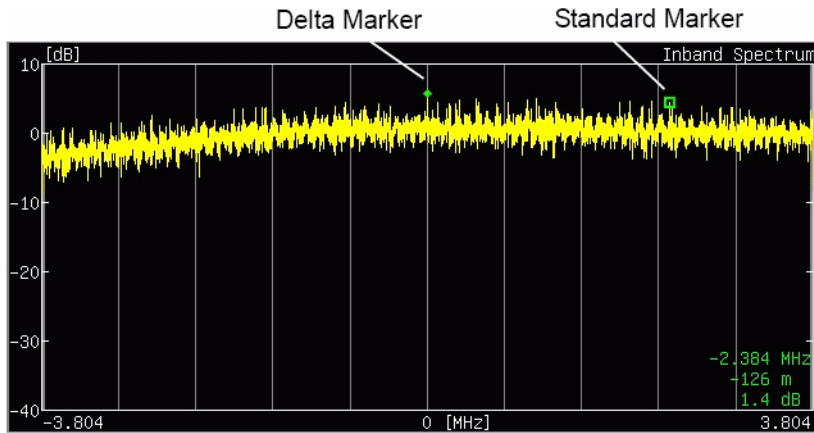
Figure 23-8. Delta Marker, Inband Spectrum Measurement

Back

Press this soft key to return to the Meas Setup(1/2) soft key menu.

More

Press this soft key to open the Measure Setup(2/2) soft key menu to continue setting up either Impulse Response or Inband Spectrum measurements.

The following soft keys provide the same functions in the Inband Spectrum measurements as in the Impulse Response measurements: Mode, GI, TPS Info, FFT Start, Spectrum Reverse, Correction Value, Back. The menus are the same as shown in Figure 23-4.

Measure Setup(2/2) Soft Key Menu

Mode, GI

Press this soft key to open the *Select Mode, GI* list box. Scroll through the list to select the Mode (number of subcarriers) and the Guard Interval. For more information about Mode or Guard Interval, refer to *2k, 4k, 8k Modes* on page 22-2 and *Guard Intervals* on page 22-2.

Table 23-2.   Mode and Guard Interval

Mode	Guard Interval
2K	1/4
2K	1/8
2K	1/16
2K	1/32
4K	1/4
4K	1/8
4K	1/16
4K	1/32
8K	1/4
8K	1/8
8K	1/16
8K	1/32

TPS Info

Press this soft key to open the TPS Info soft key menu.

TPS Info Soft Key Menu

Modulation

Press this soft key to open the *Select Modulation* list box. Scroll to select QPSK, 16QAM, or 64QAM modulation. The selection is displayed on the virtual soft key face. Selecting QPSK automatically sets the Hierarchy, Alpha parameter to None.

Hierarchy, Alpha, #

Press this soft key to open the *Select Hierarchy, Alpha* list box. Scroll to select None, 1, 2, or 4. The selection is displayed on the virtual soft key face. This selection is used to shape the 16QAM and 64QAM constellations. A value of $\alpha = 1$ describes an equally-spaced constellation.

Back

Press this soft key to return to the Meas Setup(2/2) soft key menu.

FFT Start, ##

Press this soft key to open the *Select FFT Start* list box. Scroll to select an FFT Start position in order to synchronize with the data that is used for measurement. A setting of 0/8 uses none of the guard interval and includes only the effective symbol (the data portion of the OFDM frame). A setting of 1/8 adjusts the FFT Start position to use 1/8 of the guard interval, and a setting of 8/8 adjusts the FFT Start position to use all of the guard interval.

Refer to Figure 22-1 *FFT Start and Guard Interval on page 22-4* for details about the relationship between the FFT Start position and the guard intervals. Signals that arrive with or without interference can be synchronized and measured by adjusting the FFT Start position. When measuring a delayed wave (a signal comprising one or more earlier, but weaker, signals), changing the FFT Start position can filter interference.

Table 23-3. Guard Interval Lengths in Microseconds

Length	2K	4K	8K
1⁄4	56 μs	112 μs	224 μs
1⁄8	28 μs	56 μs	112 μs
1⁄16	14 μs	28 μs	56 μs
1⁄32	7 μs	14 μs	28 μs

Spectrum Reverse, On/Off

Press this soft key to turn the Spectrum Reverse function On or Off. Use this function to measure the signal whose subcarrier location is inverted on the frequency axis, such as the IF signal of the transmitter.

Correction Value

Press this soft key to open the Correction Value soft key menu.

Correction Value Soft Key Menu

Antenna (Correction Level)

Press this soft key to open the *Select Modulation* list box. Scroll to select QPSK, 16QAM, or 64QAM modulation. The selection is displayed on the virtual soft key face. Selecting QPSK automatically sets the Hierarchy, Alpha parameter to None.

Impedance

Press this soft key to toggle through the values until the desired value is underlined. The default value is 50 ohms.

50 ohms Select this impedance when no converter is used. Impedance loss is automatically set to 0.0 dB.

75 ohms Select this impedance when impedance converter 12N50-75B is used. Impedance loss is automatically set to 7.5 dB.

Other Set impedance to Other when any impedance converter other than 12N50-75B is used. Selecting this value enables the Impedance Loss soft key.

Impedance Loss

Press this soft key to open the *Impedance Loss Editor.* Type in or scroll to set the insertion loss of the impedance converter. For example, when using an Anritsu MA8994A Impedance Converter, set the insertion loss to 1.8 dB. This soft key appears only when the Impulse soft key is toggled to Other.

Back

Press this soft key to return to the Meas Setup(2/2) soft key menu for constellation measurement display.

Continuing the Measure Setup(2/2) Soft Key Menu

Impulse Response, Vertical Range

Press this soft key to open the Vertical Range soft key menu. Press the soft key that is associated with the desired range.

Table 23-4. Impulse Response, Vertical Range

Vertical Range	Value (dB)
5	0 to -5
10	0 to -10
20	0 to -20
40	0 to -40

Back

Press this soft key to return to the Meas Setup(2/2) soft key menu for constellation measurement display.

Inband Spectrum, Vertical Range

Press this soft key to open the Vertical Range soft key menu. Press the soft key that is associated with the desired range.

Table 23-5. Inband Spectrum Vertical Range

Vertical Range	Value (dB)
5	1 to -4
10	2 to -8
25	5 to -20
50	10 to -40

Back

Press this soft key to return to the Meas Setup(2/2) soft key menu for constellation measurement display.

Display Waveform (Impulse Response graph only)

Press this soft key to open the Display Waveform soft key menu.

Display Waveform Soft Key Menu

Last Result

Press this soft key to turn On or Off a display of the waveform (yellow) last measured.

Power Method

Press this soft key to turn On or Off a display of the delay path profile waveform (light blue) that is created by the power spectrum method.

Transfer Method

Press this soft key to turn On or Off a display of the delay path profile waveform (magenta) that is created by the transfer function method.

Figure 23-9. Display Waveform, Impulse Response Graph

Back

Press this soft key to return to the Meas Setup(2/2) soft key menu for constellation measurement display.

Back

Press this soft key to return to the Meas Setup(1/2) soft key menu.

Appendix A
Signal Standards

Introduction

This appendix provides a list of the signal standards included in the MT8222A BTS Master. The standards that are displayed depend upon the operating mode selected.

Standard	Center (MHz)	Span (MHz)	Valid Channels
AMPS / EIA 553 - Uplink	859	70	1-799, 990-1023
AMPS / EIA 553 - Downlink	859	70	1-799, 990-1023
C-450 (P) - Uplink	463.5	21	1-800
C-450 (P) - Downlink	463.5	21	1-800
C-450 (SA) - Uplink	462.5	15	1-247
C-450 (SA) - Downlink	462.5	15	1-247
CDMA US Cellular - Uplink	859	70	1-799, 990-1023
CDMA US Cellular - Downlink	859	70	1-799, 990-1023
CDMA US PCS - Uplink	1920	140	1-1199
CDMA US PCS - Downlink	1920	140	1-1199
CDMA Korea PCS - Uplink	1810	120	1-599
CDMA Korea PCS - Downlink	1810	120	1-599
CDMA Japan / ARIB - Uplink	878.5	93	1-799, 801-1039, 1041-1199
CDMA Japan / ARIB - Downlink	878.5	93	1-799, 801-1039, 1041-1199
CDMA China - 1 - Uplink	916	88	0-1000, 1329-2047
CDMA China - 1 - Downlink	916	88	0-1000, 1329-2047
CDMA China - 2 - Uplink	910	76	0-1000
CDMA China - 2 - Downlink	910	76	0-1000
cdma2000 Class 0, Korea Cellular - Uplink	859	70	1-799, 990-1023
cdma2000 Class 0, Korea Cellular - Downlink	859	70	1-799, 990-1023
cdma2000 Class 0, N.A. Cellular - Uplink	859	70	1-799, 990-1023
cdma2000 Class 0, N.A. Cellular - Downlink	859	70	1-799, 990-1023

Standard	Center (MHz)	Span (MHz)	Valid Channels
cdma2000 Class 1, N.A. PCS - Uplink	1920	140	0-1199
cdma2000 Class 1, N.A. PCS - Downlink	1920	140	0-1199
cdma2000 Class 2, (TACS Band) - Uplink	916	88	0-1100, 1329-2047
cdma2000 Class 2, (TACS Band) - Downlink	916	88	0-1100, 1329-2047
cdma2000 Class 3, (JTACS Band) - Uplink	878.5	93	1-799, 801-1039, 1041-1199
cdma2000 Class 3, (JTACS Band) - Downlink	878.5	93	1-799, 801-1039, 1041-1199
cdma2000 Class 4, Korea PCS - Uplink	1810	120	0-599
cdma2000 Class 4, Korea PCS - Downlink	1810	120	0-599
cdma2000 Class 5, (NMT-450-20 kHz) - Uplink	472.5	43	1039-1473, 1792-2016
cdma2000 Class 5, (NMT-450-20 kHz) - Downlink	472.5	43	1039-1473, 1792-2016
cdma2000 Class 5, (NMT-450-25 kHz) - Uplink	439.5	57	1-300, 539-871
cdma2000 Class 5, (NMT-450-25 kHz) - Downlink	439.5	57	1-300, 539-871
cdma2000 Class 6, IMT-2000 - Uplink	2045	250	0-1199
cdma2000 Class 6, IMT-2000 - Downlink	2045	250	0-1199
cdma2000 Class 7, N.A. 700 MHz Cellular - Uplink	770	48	0-359
cdma2000 Class 7, N.A. 700 MHz Cellular - Downlink	770	48	0-359
ETACS - Uplink	916	88	0-1000, 1329-2047
ETACS - Downlink	916	88	0-1000, 1329-2047
GSM 900 - Uplink	897.4	40	1-124, 975-1023
GSM 900 - Downlink	942.4	40	1-124, 975-1023
GSM 1800 - Uplink	1747.4	80	512-885
GSM 1800 - Downlink	1842.4	80	512-885

Standard	Center (MHz)	Span (MHz)	Valid Channels
GSM 1900 - Uplink	1879.8	80	512-810
GSM 1900 - Downlink	1959.8	80	512-810
JTACS - Uplink	878.5	93	0-1198 (even numbers only)
JTACS - Downlink	878.5	93	0-1198 (even numbers only)
MATS-E - Uplink	925	70	1-1000
MATS-E - Downlink	925	70	1-1000
N-AMPS / IS-88L - Uplink	859	70	1-799, 990-1023
N-AMPS / IS-88L - Downlink	859	70	1-799, 990-1023
N-AMPS / IS-88M - Uplink	859	70	1-799, 990-1023
N-AMPS / IS-88M - Downlink	859	70	1-799, 990-1023
N-AMPS / IS-88U - Uplink	897.5	147	1-799, 990-1023
N-AMPS / IS-88U - Downlink	897.5	147	1-799, 990-1023
NADC IS136 Cellular - Uplink	859	70	1-799, 990-1023
NADC IS136 Cellular - Downlink	859	70	1-799, 990-1023
NADC IS136 PCS - Uplink	1920	140	1-1199
NADC IS136 PCS - Downlink	1920	140	1-1199
NMT-411-25 kHz - Uplink	420.5	19	539-871
NMT-411-25 kHz - Downlink	420.5	19	539-871
NMT-450-20 kHz - Uplink	460.5	19	1039-1473
NMT-450-20 kHz - Downlink	460.5	19	1039-1473
NMT-450-25 kHz - Uplink	459	18	1-300
NMT-450-25 kHz - Downlink	459	18	1-300
NMT-470-20 kHz - Uplink	486.5	15	1972-2016
NMT-470-20 kHz - Downlink	486.5	15	1972-2016
NMT-900 - Uplink	925	70	1-1000
NMT-900 - Downlink	925	70	1-1000
NMT-900 (Offset) - Uplink	925	70	1025-2023
NMT-900 (Offset) - Downlink	925	70	1025-2023
NTACS - Uplink	878.5	93	1-1199
NTACS - Downlink	878.5	93	1-1199
PDC 800 Analog - Uplink	891.5	97	0-1680

Standard	Center (MHz)	Span (MHz)	Valid Channels
PDC 800 Analog - Downlink	891.5	97	0-1680
PDC 1500 (JDC) - Uplink	1513	72	0-960
PDC 1500 (JDC) - Downlink	1513	72	0-960
PHS - Uplink	1906.5	23	1-77
PHS - Downlink	1906.5	23	1-77
SMR 800 - 12.5 kHz - Uplink	836	60	1-1199
SMR 800 - 12.5 kHz - Downlink	836	60	1-1199
SMR 800 - 25 kHz - Uplink	836	60	1-600
SMR 800 - 25 kHz - Downlink	836	60	1-600
SMR 1500 - Uplink	1483	60	1-479
SMR 1500 - Downlink	1483	60	1-479
TACS - Uplink	925	70	1-1000
TACS - Downlink	925	70	1-1000
UMTS/WCDMA - Uplink	1920	70	9600-9900
UMTS/WCDMA - Downlink	2110	70	10550-10850
UMTS/Region 2 - Uplink	1850	70	9250-9550
UMTS/Region 2 - Downlink	1930	70	9650-9950
802.11a	5170	84	34-161 (not all valid)
802.11b	2442	84	1-14
802.11 DS	2448	72	1-14
802.11 FH	2448.5	93	2-95
802.11g	2442	84	1-14

Appendix B
Error Messages

Introduction

This chapter provides a list of information and error messages that could be displayed on the MT8222A BTS Master. If any error condition persists, contact your local Anritsu Service Center (http://intranet/Mmd/CustomerService/TopPages/ServiceCenters.asp).

Self Test or Application Self Test Error Messages

Overall Status FAILED

One or more elements of the System or Application Self Test has failed. Refer to the other pass fail tests listed below to determine which specific test failed.

ADC Self Test FAILED

The Analog to Digital converter failed to return an answer. Insure that the battery level is adequate for operation or that the temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

DDC FAILED

The Digital Down Converter failed to return a value. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Lock Test FAILED

One or more Phase Lock Loops Failed to properly achieve Lock Status. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Over Power FAILED

RF Power applied to the input connector is too high. Remove or reduce the input power or add additional attenuation. Sometimes out of band frequencies may be present that can cause an Over Power Error. In highly rich RF environments it may be necessary to add an external band pass filter to reduce unwanted interference. See the accessories section for a list of available band pass filters from Anritsu. Out of band frequencies can often be detected by increasing the Span to maximum in the peak detect mode of operation. Another resolution may be to reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Over Power Start FAILED

RF Power applied to the input connector is too high at turn on. See Over Power FAILED error above.

Mixer Saturation: Increase Attenuation

or

Mixer Overdrive FAILED

Too much power applied with too little Attenuation. Increase attenuation. Sometimes even out of band frequencies may be present that would cause a Mixer Overdrive Error. In highly rich RF environments it may be necessary to add an external band pass filter to reduce unwanted interference. See the accessories section for a list available band pass filters from Anritsu. Out of band frequencies can often be detected by increasing the SPAN to maximum in peak detect mode of operation. Another resolution may be to Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Operation Error Messages

ADC Over range: Increase Reference Level

Input signal is too large for the Analog to Digital converter to process. Increase the internal or external attenuation or, if using Auto attenuation, increasing the Reference Level should resolve the error. See also the Mixer Overdrive error above for information on Out of band RF power.

Calibrator Reading Error

Calibration reference source is not providing quality signal. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Fatal Error

Usually caused by a failure to communicate with one section or another. Sometimes resolved by restarting the unit or by Factory Defaults, ESC+ON, resetting of the unit. Under extreme cases the use of MASTER RESET, System+ON, may resolve the issue. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Trace not saved. Please wait for complete sweep and try again.

Attempted to save a measurement trace before the sweep had completed at least once. Wait for at least one complete sweep and try to save again.

Measurement not valid in Zero Span

Attempt was made to make an automated measurement that requires more than ZERO SPAN to accomplish. An example would be Occupied Bandwidth measurement.

The Freq range of the Antenna is invalid for this setup. Please select another Antenna

Choose a start and stop frequency that is within the defined frequency range for the selected antenna compensation table. See also Master Software Tools for creation and Upload of Antenna correction files.

Minimum permitted Sweep time is 50 µs

An attempt was made to set the minimum Sweep time to less than 50 µs.

Invalid Attenuation for Preamp

The only valid attenuation settings while the Preamp is operational are 0 dB and 10 dB. All other settings attempted by the user will result in this message. Select 0 dB or 10 dB or select AUTO Attenuation to let the system determine the correct setting based on the reference level selected.

Valid Attenuations with Preamp on are 0 dB and 10 dB

Same as above

Unable to add additional limit points. %d is the maximum.

Attempted to add an additional limit line point beyond the maximum number of allowed points.

Use Demod type USB or LSB to use Beat Frequency Osc

An attempt to use the Beat Frequency Oscillator while not in Upper or Lower Sideband Demodulation mode.

Trace A/B/C has no data to view

Attempt to turn on or VIEW a trace that has never had data recalled into this trace location. Refer to Recall Trace section for instructions on how to recall stored measurement traces into either Trace A, B or C.

DSP Memory Failure, Address, Ext High, Ext Middle, Ext low, Ext1, Ext2

One of the DSP memory locations has failed. The DSP will attempt to resolve the memory Failure location and Byte. There are two external memory banks (Ext1 = bank one, Ext2 = Bank 2) with three bytes wide (Ext High, Ext Middle and Ext Low. Byte)

Locking to Internal Ref failed

Switching from an external frequency reference to the internal reference has failed. Some additional warm up time may be needed if the unit has been on external reference for a long time or the unit is not warmed up enough.

Locking to External Ref failed; Lock attempt Failed

Switching from an internal frequency reference to the external reference has failed. Verify that the correct external reference frequency value has been selected from the list of valid external reference frequencies. Verify that the level of the external reference frequency is at least 1vp-p.

EEPROM TEST: FAIL

Hardware communications between modules has failed. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

EEPROM TEST: UNKNOWN ERROR

Hardware communications between modules has failed. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Fatal error, Unknown

Hardware communications between modules has failed. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Fatal error, EEPROM failed

Hardware communications between modules has failed. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Fatal error, no SPA board connected

Hardware communications between modules has failed. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Fatal error not decoded by DSP

Hardware communications between modules has failed. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

UNKNOWN ERROR In SPA

Hardware communications between modules has failed. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

DSP version different from released version

May occur during firmware update. Likely cause is incomplete firmware package installation. Finish complete firmware update with Master Code Loader.

Operation not Permitted in Recall Mode

Attempted to perform an operation on a recalled trace. Many operations are valid only on a live or active trace.

Cannot change scale in Linear mode

Linear display mode of operation does not support a scaling change in the same manner as the Log display mode.

Cannot turn on delta marker because Ref Marker is invalid

Delta markers cannot be enabled unless the primary marker is within the displayed span.

Cannot turn on delta marker because Ref Marker is a counter Marker

Delta markers cannot be enabled unless the primary marker is NOT a counter Marker. Turn off the Counter Marker mode of marker operation to use Delta Marker.

Current Marker is not ON

Attempted to use a marker mode or feature for a marker that is not enabled. Turn on the appropriate marker to use this function or switch to a marker that is already enabled.

Marker must be ON to Use the feature

Attempted to use a marker mode or feature for a marker that is not enabled. Turn on the appropriate marker to use this function or switch to a marker that is already enabled.

Triggering valid only in Zero Span

External triggering can only be used while the SPAN is set to 0 (zero)

Cannot change Modes for Recalled/Inactive Traces

Detection modes or other elements such as RBW/VBW, averaging, and so forth, cannot be altered on a recalled trace. The trace is displayed with the same parameters in which it was saved.

Cannot change average for Recalled/Inactive Traces

Cannot set Delta Detection modes or other elements such as RBW/VBW, averaging, and so forth, cannot be altered on a recalled trace. The trace is displayed with the same parameters in which it was saved.

Pretune Calibration Table fault.

Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Lock failed during initialization

One or more of the Phase Lock Loops failed to achieve lock status during startup. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Reference LVL Cal is OFF

Factory Calibration is OFF. Insure that the battery level is adequate for operation or that the temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

IF Cal is OFF

Factory Calibration is OFF. Insure that the battery level is adequate for operation or that the temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Lock failure

One or more of the Phase Lock Loops cannot keep the frequency controlled accurately. Insure that the battery level is adequate for operation and that the temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Cannot set Delta Mkr Freq to Demod Freq

Marker to Demod frequency is only available with a primary marker as the selected marker.

Fan Failure

The system has determined that the fan should be running due to the internal temperature of the unit, but cannot detect that the fan is actually running.

It is important to keep the fan inlet and exhaust ports clear of obstructions. The cooling fan will vary the speed in relation to the internal temperature of the instrument. The fan will turn on at low speed when the internal temperature of the instrument reaches 44°C, and will increase the fan speed to maximum at 54°C. As the internal temperature of the instrument decreases, the fan will reduce speed until the temperature reaches 39°C, at which point the fan will turn off.
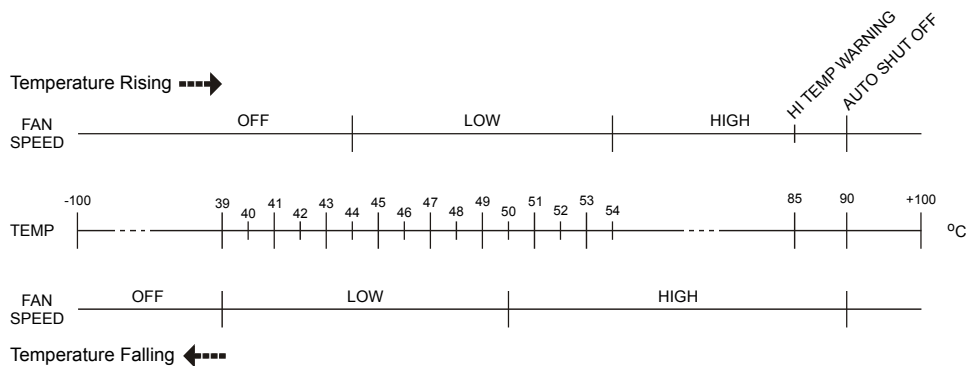
Figure B-1. Fan Speed versus Temperature

High Temp Warning

The internal temperature has reached an excessive level, 85°C. Verify that the ventilation openings are unobstructed and that the fan is running. Internal temperatures may be manually verified by using the SELF TEST function. Turn off the unit and allow the temperature to cool down. If the fault is not resolved and the internal temperature reaches 90°C, a countdown of 10 seconds will begin to give the user a chance to save the current setup before it will turn itself off before internal temperatures can cause any damage. If the error persists after removing any obstructions and allowing the unit to cool, reset to the factory defaults with either Factory Defaults, ESC+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition. If the error persists, contact your Anritsu Service Center.

Copy failed. Please check External Card

Attempt to copy user saved data to external the Compact Flash Card has failed. Do not attempt to remove or power down the unit before the copy has completed. Be sure that the CF is not already full and that it is fully inserted into the CF-Card slot.

PLL Lock Fail

Phase Lock Loop failed to lock.

Power Supply

Power Supply failed. Charge the battery.

VNA EEPROM Fail

Writing and reading of test data to and from the VNA EEPROM failed.

VNA FPGA Fail

Unable to communicate with the VNA PCBA.

VNA Board ID Fail

Readings and voltages associated with the VNA board failed.

PMON PLD Fail

Unable to communicate with the Power Monitor PCBA.

Overall Status FAILED

One or more elements of the System or Application Self Test has failed. Refer to the other pass fail tests listed below to determine which specific test failed.

Lock Test FAILED

One or more Phase Lock Loops Failed to properly achieve Lock Status. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with Factory Defaults, ESC+ON.

Fatal Error

Usually caused by a failure to communicate with one section or another. Sometimes resolved by restarting the unit or by Factory Defaults, ESC+ON, resetting of the unit.

Trace not saved. Please wait for complete sweep and try again.

Attempted to save a measurement trace before the sweep had completed at least once. Wait for at least one complete sweep and try to save again.

Unable to add additional limit points. 41 points is the maximum.

Attempted to add an additional limit line point beyond the maximum number of allowed points.

DSP Memory Failure, Address, Ext High, Ext Middle, Ext low, Ext1, Ext2

One of the DSP memory locations has failed. The DSP will attempt to resolve the memory Failure location and Byte. There are two external memory banks (Ext1 = bank one, Ext2 = Bank 2) with three bytes wide (Ext High, Ext Middle and Ext Low. Byte).

EEPROM TEST: FAIL

Hardware communications between modules has failed. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition.

EEPROM TEST: UNKNOWN ERROR

Hardware communications between modules has failed. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition.

Fatal error, EEPROM failed

Hardware communications between modules has failed. Insure that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults, ESC+ON, or MASTER RESET, System+ON. Caution: Use of MASTER RESET, System+ON, will erase all user saved setups and measurement traces and return the unit to a fully Factory Default condition.

DSP version different from released version

May occur during firmware update. Likely cause is incomplete firmware package installation. Finish the complete firmware update with Master Code Loader.

High Accuracy Power Meter Messages

Warning! Power Supply Error.

Verify that the supply is connected properly.

Warning! RF Power Level is too high.

The specified upper measurement range is +20 dBm. Do not exceed this.

Warning! Sensor not zeroed properly.

The sensor should be zeroed with nothing connected to it.

Warning! Specified temperature range (0 to 50C) exceeded.

The sensor is only specified from 0 to 50C.

Warning! Temperature has changed. Zero sensor again.

Temperature changed more than allowable limit after zeroing sensor.

Fixed WiMAX Messages

Attempting to lock to External Reference

When the instrument detects an external reference frequency has been connected, this message is displayed briefly.

External Reference Locked Successfully

When the instrument has detected an external reference and has successfully locked to the reference, this message is displayed briefly.

External Reference not found. Internal Reference Locked successfully

This message is displayed when the instrument has detected an external reference but couldn't lock to the reference. It automatically switches to the Internal Reference. This could happen if the external reference frequency does not match the specified external reference frequency in the Setup menu.

Lock Failure xx

When there is a lock failure detected from any of the internal LOs, this message is displayed. The xx is usually an error code in hex that can be interpreted by a service center to obtain more information on which LO had the failure.

ADC over range

When the software detects that the internal ADC is being overloaded, this message is displayed. depending upon the gain settings, either a "decrease input power" or "adjust range" message is also displayed with this message.

Out Of Band Saturation

When the software detects that there is too much power outside the current frequency range, this message is displayed. This usually means that the instrument is currently tuned to a frequency with a very low amplitude signal or no signal and there is a strong signal at another frequency outside the current IF bandwidth.

Weak Signal: Increase input power

When the software does not measure enough signal power at the input, this message is displayed. Measurement results are cleared ('--' is seen in the result area). The instrument will continue to check the signal power and start showing results when the power is increased

DL Short Preamble not found

When the software does not detect a Downlink short preamble in the burst, this message is displayed on the screen. All Demodulation measurement results are cleared ('--' is seen in the result area). The short preamble is required for all Demodulation measurements.

The short preamble is also required for the Power versus Time trace to be synchronized but if the preamble is not present, an unsynchronized time domain trace is displayed and all but the Channel Power result is cleared.

The instrument will continue to check for the presence of the short preamble.

DL Long Preamble not found

When the software does not detect a Downlink long preamble in the burst, this message is displayed on the screen. All Demodulation measurement results are cleared ('--' is seen in the result area). The long preamble is required for all Demodulation measurements.

The instrument will continue to check for the presence of the long preamble

FCH decoder failed

This message is displayed when there is an error detected in the FCH decoder that is used to determine the base station ID.

Mobile WiMAX Messages

Attempting to lock to External Reference

When the instrument detects that an external reference frequency has been connected, this message is displayed briefly.

External Reference Locked Successfully

When the instrument has detected an external reference and has successfully locked to the reference, this message is displayed briefly.

External Reference not found.
Internal Reference Locked Successfully

This message is displayed when the instrument has detected an external reference but could not lock to the reference. The instrument automatically switches to the Internal Reference. This can happen if the external reference frequency does not match the specified external reference frequency in the Setup menu.

Lock Failure xx

When a lock failure is detected from any of the internal local oscillators (LOs), this message is displayed. The **xx** is usually an error code in hex that can be interpreted by a service center to obtain more information on which LO had the failure.

ADC over range

When the software detects that the internal ADC (Analog to Digital Converter) is being overloaded, this message is displayed. Depending upon the gain settings, either a "decrease input power" or an "adjust range" message is also displayed with this message.

Out Of Band Saturation

When the software detects that too much power is outside the current frequency range, this message is displayed. This usually means that the instrument is currently tuned to a frequency with a very low amplitude signal or no signal, and a strong signal is present at another frequency outside the current IF bandwidth.

Weak Signal: Increase input power

When the software does not measure enough signal power at the input, this message is displayed. Measurement results are cleared ("--" is seen in the result area). The instrument continues to check the signal power and starts showing results when the power is increased.

DL Short Preamble not found

When the software does not detect a Downlink short preamble in the burst, this message is displayed on the screen. All demodulation measurement results are cleared ("--" is seen in the result area). The short preamble is required for all demodulation measurements.

The short preamble is also required for the Power versus Time trace to be synchronized, but if the preamble is not present, then an unsynchronized time domain trace is displayed, and all data results are cleared except the Channel Power result. The instrument continues to check for the presence of the short preamble.

Demodulation Error

This message is typically displayed if the input signal is a proprietary implementation of Mobile WiMAX.

The **Demodulation Error** is displayed when the following conditions are **not met:**

- FFT size is 1024 or 512
- preamble index is within the range of 0 to 113
- modulation type is QPSK, 16QAM, or 64 QAM
- reserved bit is not zero in DL-MAP
- first zone is not PUSC

DL-MAP not CC encoded

When Demod Type is set to Auto, and the decoded information from the DL-MAP indicates that the encoding type is not Convolutional Coding (CC), then this message is displayed because the instrument supports only Convolutional Coding at this time.

Too many symbols in DL-MAP

When the number of symbols exceeds the maximum number that is supported by the instrument, then this message is displayed.

WCDMA/HSDPA and GSM/GPRS/EDGE Messages

Warning Messages

1. External Reference not found. Internal reference Locked successfully

2. External Reference Locked Successfully

Notifications

1. RF Over Power

2. ADC over range

   a. If Auto Range is ON - ADC over range: Decrease input power.

   b. If Auto Range is Off and if Atten = 65 then ADC over range: Decrease input power.

   c. If Auto Range is Off and Atten is < 65 then ADC over range: Adjust range.

3. Level Under

   a. If Auto Range is ON - No signal detected: Increase input power.

   b. If Auto Range is Off and if Atten = 0 & Preamp is On then no signal detected: Increase input power.

   c. If Auto Range is Off and not (b) then no signal detected: Adjust range.

4. Out of band saturation

5. Poor Range

   a. If Auto Range is ON - Weak signal: Increase input power.

   b. If Auto Range is Off and if Atten = 0 & Preamp is On then Weak signal: Increase input power.

   c. If Auto Range is Off and not (b) then Weak signal: Adjust range

6. Lock Failure

7. Attempting to lock to Internal ref.

8. Attempting to lock to External ref.

CDMA and EVDO Messages

Warning Messages

"No trigger found"

This message is displayed if the PN trigger is setup for External or GPS, and the software does not detect a trigger. Most measurement results that depend on a trigger are then cleared ('--' is seen in the result area).

"Short Code not found"

This message is displayed if no dominant PN short code is found in the input signal. Most demodulation measurement results are then cleared ('--' is seen in the result area).

Interference Analyzer Messages

Information Messages

Attenuation has been changed
Reference Level has been changed
Minimum permitted Sweep time is 10µs
Preamp has been turned off
Preamp has been turned on
Units has been changed to dBm
Reference Locked Successfully
Startup Selftest successful
Startup DSP Memory test successful
Reference LVL Cal is OFF
IF Cal is OFF
Successfully locked
Attempting to lock to Internal ref
Attempting to lock to External ref
Attempting to lock to ext ref
Press ESC to clear Recall Trace
Sweep Stopped After Saving On Event
Connect Carrier\nPress Enter to Measure or Escape to Exit
Disconnect Carrier\nPress Enter to Measure or Escape to Exit
Press Escape to keep old settings, or Enter to use Recalled Values
Changing Active trace to A
Use Min/Max buttons under the Signal Strength Sub-Menu to change measure range
Cannot change scale in Linear mode
Use Min/Max buttons under the Signal Strength Sub-Menu to change display range
Valid Attenuations with Preamp on are 0dB and 10dB
Cannot turn on delta marker because Ref Marker is a counter Marker
Current Marker is not ON
Turning off Delta Marker
ADC Over range: Increase Reference Level
Mixer Saturation: Increase Attenuation

Error Messages

Trace not saved. Please wait for complete sweep and try again.
Measurement has been turned OFF
Measurement not valid in Zero Span
Measurements can not be displayed in Full Screen mode
The Freq range of the Antenna is invalid for this setup. Please select another Antenna
DDC Failure
Lock failed during initialization
Invalid Attenuation for PreAmp Setting
Unable to add additional limit points. %d is the maximum.
Hidden inflection points prevent this action. Decrease Span to reveal hidden points.
Trace A has no data to view
Trace B has no data to view
Trace C has no data to view
Turning off Trace Overlay
Only HOLD is valid for Trace C when trace C is not being updated from A
Auto Save not available when Time Span is Auto
The specified Time span is too big to save all measurements. Automatically adjusted Time
Span to a valid number
DSP Memory Failure
Pretune Calibration Failure
Lock failure %x

Locking to Internal Ref failed
Locking to External Ref failed
Lock attempt Failed
Timed Measurement Done. Press Reset/Restart Meas to continue measuring
Current measurement is stopped when Cursor is not zero
OVER POWER ERROR
Fatal error, Unknown
Fatal error, EEPROM failed
Fatal error, no IA board connected
Fatal error not decoded by DSP
UNKNOWN ERROR In IA
Operation not Permitted in Recall Mode
Operation not Permitted in this Mode
Marker must be ON to Use the feature
Triggering valid only in Zero Span
Only HOLD is valid for Trace B
Cannot change average for Recalled/Inactive Traces
Cannot set Delta Mkr Freq to Demod Freq

Channel Scanner Messages

Information Messages

Reference Locked Successfully
Startup Selftest successful
Startup DSP Memory test successful
Attempting to lock to Internal ref
Attempting to lock to External ref
Attempting to lock to ext ref
Press ESC to clear Recall Trace

Error Messages

Error Recalling Measurement
Not Available when Max Hold is OFF
Operation not Permitted in Recall Mode
ADC Over range: Increase Reference Level
Mixer Saturation: Increase Attenuation

Appendix C
Windowing

Introduction

The theoretical requirement for inverse FFT is for the data to extend from zero frequency to infinity. Side lobes appear around a discontinuity due to the fact that the spectrum is cut off at a finite frequency. Windowing reduces the side lobes by smoothing out the sharp transitions at the beginning and at the end of the frequency sweep. As the side lobes are reduced the main lobe widens thereby reducing the resolution.

In situations where a small discontinuity may be close to a large one, side lobe reduction windowing should be used. When distance resolution is critical, windowing can be reduced.

Examples

The types of windowing in order of increasing side lobe reduction are: rectangular, nominal side lobe, low side lobe, and minimum side lobe. Figure C-1 through Figure C-4 show examples of the types of windowing.
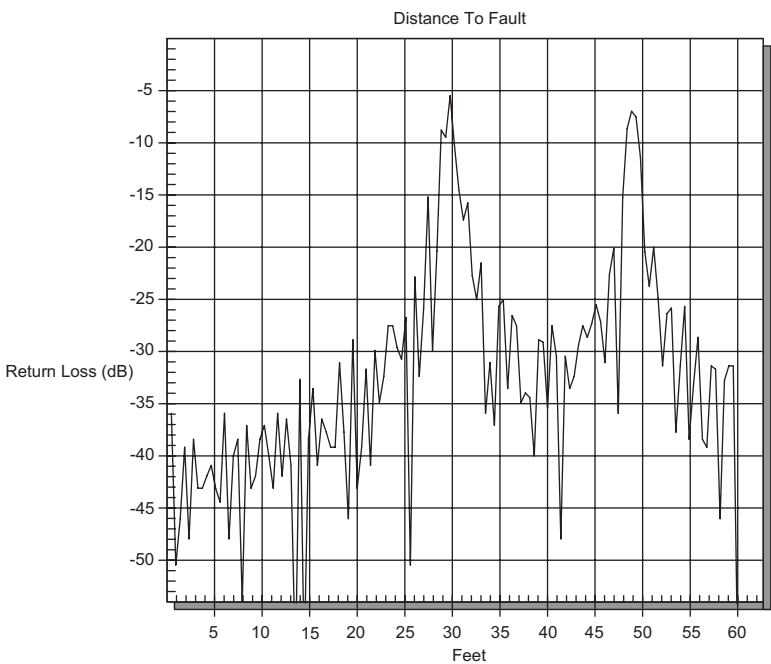
Figure C-1. Rectangular Windowing Example
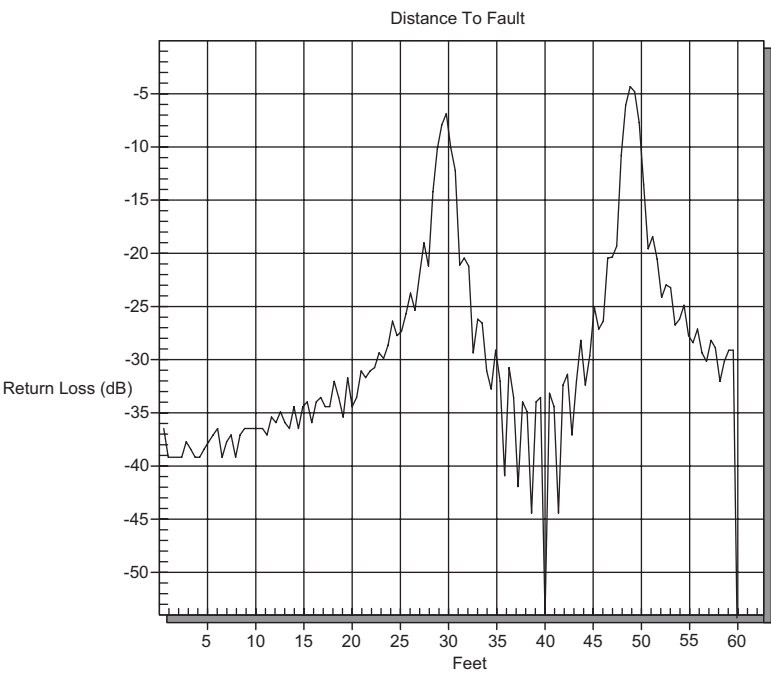
Figure C-2. Nominal Side Lobe Windowing Example
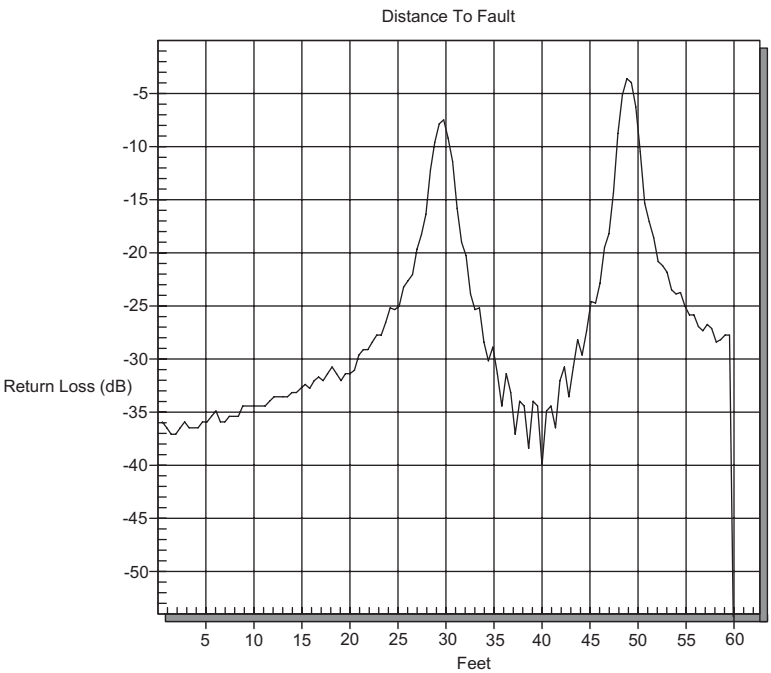
Figure C-3. Low Side Lobe Windowing Example
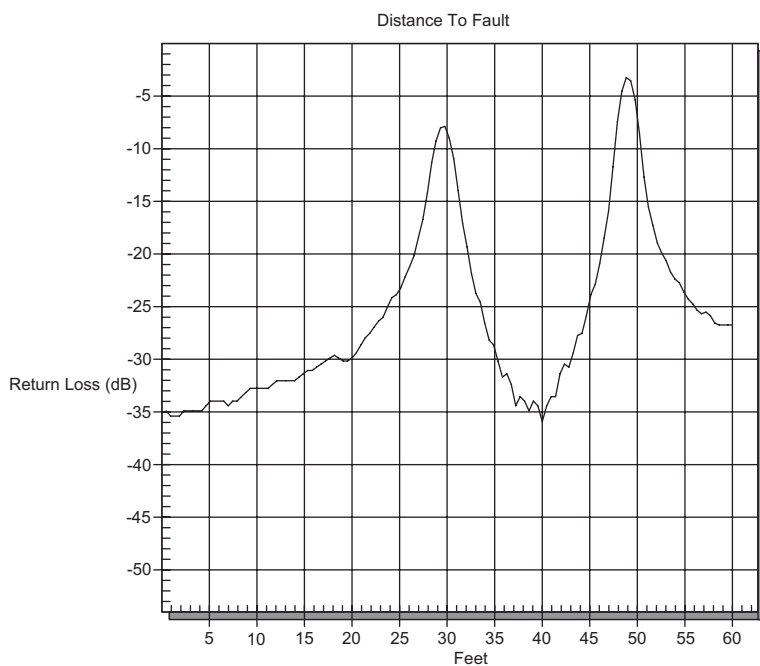
Figure C-4. Minimum Side Lobe Windowing Example

Appendix D
Tower Mounted Amplifiers

Introduction

A Tower Mounted Amplifier (TMA) can be used to amplify the received signal. There are different types of TMA depending upon the system requirements. Three commonly used types are:

• TMA-D - A duplex tower mounted amplifier that combines transmit and receive ports from the radio system and connects to a single antenna. This configuration is specific to systems that use a single antenna configuration.

• TMA-S - A receive-only tower mounted amplifier is installed between the receiving antenna and the radio to boost weak signals. This configuration is common on systems that implement separate antennas for transmitting and receiving.

• TMA-DD - A dual-duplex tower mounted amplifier used for radios systems with a single transmission line connection for transmit and receive. These systems are commonly called transceivers.
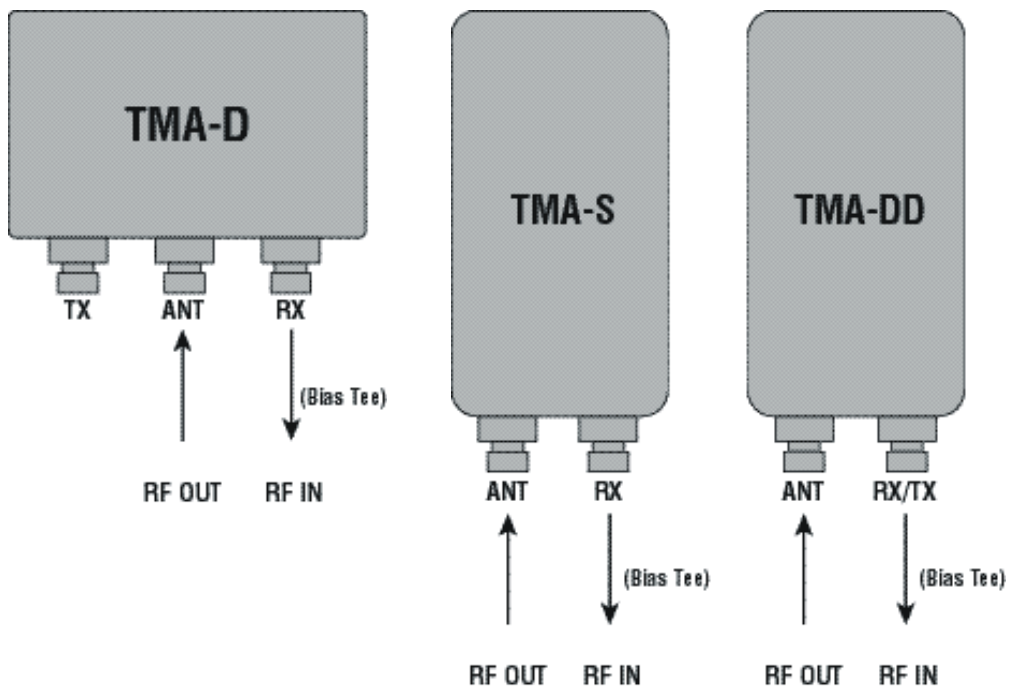
Figure D-1. Tower Mounted Amplifiers

Appendix E
Coaxial Cable Technical Data

Introduction

The table below provides a list of common coaxial cables.

Mfgr.	Cable	Prop. Vel	Freq 1	Loss 1	Freq 2	Loss 2	Freq 3	Loss 3
Andrew	FSJ1-50A (6 GHz)	0.84	1000	0.196	2500	0.313	6000	0.532
Andrew	FSJ2-50 (6 GHz)	0.83	1000	0.133	2500	0.223	6000	0.374
Andrew	FSJ4-50B (6 GHz)	0.81	1000	0.118	2500	0.201	6000	0.348
Andrew	EFX2-50 (6 GHz)	0.85	1000	0.121	2500	0.202	6000	0.341
Andrew	LDF1-50 (6 GHz)	0.86	6000	0.306	6000	0.306	6000	0.306
Andrew	LDF2-50 (6 GHz)	0.88	6000	0.323	6000	0.323	6000	0.323
Andrew	LDF4-50A (6 GHz)	0.88	1000	0.073	2500	0.121	6000	0.218
Andrew	HJ4-50 (6 GHz)	0.914	1000	0.092	2500	0.156	6000	0.257
Andrew	HJ4.5-50 (6 GHz)	0.92	1000	0.054	2500	0.089	6000	0.148
Andrew	AVA5-50 7/8	0.91	1000	0.038	2000	0.055	2500	0.063
Andrew	AVA7-50 1-5/8	0.92	1000	0.022	2000	0.034	2500	0.038
Andrew	EFX2-50	0.85	1000	0.121	2000	0.177	2500	0.202
Andrew	FLC 12-50J	0.88	1000	0.075	2000	0.11	2500	0.134
Andrew	FLC 38-50J	0.88	1000	0.115	2000	0.169	2500	0.19
Andrew	FLC 78-50J	0.88	1000	0.041	2000	0.061	2500	0.072

Mfgr.	Cable	Prop. Vel	Freq 1	Loss 1	Freq 2	Loss 2	Freq 3	Loss 3
Andrew	FLC 114-50J	0.88	1000	0.033	2000	0.05	2500	0.059
Andrew	FLC 158-50J	0.88	1000	0.025	2000	0.038	2500	0.042
Andrew	FSJ1-50A	0.84	1000	0.196	2000	0.285	2500	0.313
Andrew	FSJ2-50	0.83	1000	0.133	2000	0.196	2500	0.223
Andrew	FSJ4-50B	0.81	1000	0.118	2000	0.176	2500	0.201
Andrew	HJ4-50	0.91	1000	0.092	2000	0.137	2500	0.156
Andrew	HJ4.5-50	0.92	1000	0.054	2000	0.079	2500	0.089
Andrew	HJ5-50	0.916	1000	0.042	2000	0.063	2500	0.071
Andrew	HJ7-50A	0.921	1000	0.023	2000	0.034	2500	0.039
Andrew	HJ12-50	0.931	1000	0.019	2000	0.029	2000	0.029
Andrew	HL4RP-50A	0.88	1000	0.074	2000	0.109	2500	0.123
Andrew	LDF4-50A	0.88	1000	0.073	2000	0.107	2500	0.12
Andrew	LDF4.5-50	0.89	1000	0.054	2000	0.08	2500	0.091
Andrew	LDF5-50A	0.89	1000	0.041	2000	0.061	2500	0.07
Andrew	LDF5-50B	0.91	1000	0.041	2000	0.061	2500	0.07
Andrew	LDF6-50	0.89	1000	0.028	2000	0.042	2500	0.048
Andrew	LDF7-50A	0.88	1000	0.024	2000	0.037	2500	0.043
Andrew	LDF12-50	0.88	1000	0.021	2000	0.033	2000	0.033
Andrew	VXL5-50 7/8	0.88	1000	0.045	2000	0.066	2500	0.075

Mfgr.	Cable	Prop. Vel	Freq 1	Loss 1	Freq 2	Los s 2	Freq 3	Loss 3
Andrew	VXL6-50 1-1/4	0.88	1000	0.032	2000	0.048	2500	0.055
Andrew	VXL7-50 1-5/8	0.88	1000	0.024	2000	0.037	2500	0.043
Belden	RG-8/8A	0.86	1000	0.132	2000	0.33	2500	0.22
Belden	RG-9/9A	0.659	1000	0.289	1000	0.289	1000	0.289
Belden	RG-17/17A	0.659	1000	0.18	1000	0.18	1000	0.18
Belden	RG-55/55A/55B	0.659	1000	0.541	1000	0.541	1000	0.541
Belden	RG-58/58B	0.77	1000	0.356	2000	0.528	2500	0.6
Belden	RG-58A/58C	0.73	1000	0.594	1000	0.594	1000	0.594
Belden	RG-142	0.7	1000	0.43	2000	0.663	2500	0.713
Belden	RG-174	0.66	1000	1.115	1000	1.115	1000	1.115
Belden	RG-178B	0.695	1000	1.509	1000	1.509	1000	1.509
Belden	RG-188	0.69	1000	0.951	1000	0.951	1000	0.951
Belden	RG-213	0.66	1000	0.262	1000	0.269	1000	0.269
Belden	RG-214	0.659	1000	0.229	1000	0.292	1000	0.292
Belden	RG-223	0.66	1000	0.476	1000	0.478	1000	0.478
Cablewave	HCC 12-50J	0.915	1000	0.087	2000	0.126	2500	0.137
Cablewave	HCC 78-50J	0.915	1000	0.041	2000	0.061	2500	0.066
Cablewave	HCC 158-50J	0.95	1000	0.022	2000	0.031	2500	0.033
Cablewave	HCC 300-50J	0.96	1000	0.015	1000	0.015	1000	0.015
Cablewave	HCC 312-50J	0.96	1000	0.013	1000	0.013	1000	0.013

Mfgr.	Cable	Prop. Vel	Freq 1	Loss 1	Freq 2	Loss 2	Freq 3	Loss 3
Cablewave	HF 4 1/8 Cu2Y	0.97	1000	0.01	1000	0.01	1000	0.01
Cablewave	HF 5 Cu2Y	0.96	1000	0.007	1000	0.007	1000	0.007
Cablewave	HF 6 1/8 Cu2Y	0.97	1000	0.006	1000	0.006	1000	0.006
Cellflex	LCF78-50JA	0.9	1000	0.039	2000	0.058	2500	0.066
Cellflex	LCFS114-50JA	0.9	1000	0.029	2000	0.044	2500	0.051
Cellflex	LCF158-50JA	0.9	1000	0.024	2000	0.036	2500	0.042
Cellflex	LCF214-50JA	0.88	1000	0.021	2000	0.033	2000	0.033
Cellflex	UCF114-50JA	0.89	1000	0.031	2000	0.047	2000	0.047
Comscope	CR50 540PE	0.88	1000	0.069	2000	0.103	2500	0.116
Comscope	CR50 1070PE	0.88	1000	0.037	2000	0.055	2500	0.064
Comscope	CR50 1873PE	0.88	1000	0.022	2000	0.034	2500	0.04
Eupen	EC4-50-HF 1/2	0.82	1000	0.108	2000	0.161	2500	0.183
Eupen	EC4-50 1/2	0.88	1000	0.074	2000	0.109	2500	0.121
Eupen	EC4.5-50 5/8	0.88	1000	0.056	2000	0.083	2500	0.094
Eupen	EC5-50 7/8	0.88	1000	0.04	2000	0.058	2500	0.066
Eupen	EC6-50 1-1/4	0.88	1000	0.028	2000	0.043	2500	0.048
Eupen	EC7-50 1-5/8	0.88	1000	0.024	2000	0.037	2500	0.042
Eupen	EC7-50A 1-5/8	0.89	1000	0.023	2000	0.035	2500	0.039
Eupen	EC12-50 2-1/4	0.88	1000	0.022	2000	0.034	2500	0.039

E-4

Mfgr.	Cable	Prop. Vel	Freq 1	Loss 1	Freq 2	Los s 2	Freq 3	Loss 3
Nk Cables	RF1/2-50	0.88	1000	0.073	2000	0.107	2500	0.127
Nk Cables	RF1/2-50GHF	0.88	1000	0.073	2000	0.107	2500	0.127
Nk Cables	RF1/2-50BHF	0.88	1000	0.073	2000	0.107	2500	0.127
Nk Cables	RF5/8-50	0.88	1000	0.051	2000	0.075	2500	0.087
Nk Cables	RF5/8-50GHF	0.88	1000	0.051	2000	0.075	2500	0.087
Nk Cables	RF5/8-50BHF	0.88	1000	0.051	2000	0.075	2500	0.087
Nk Cables	RF7/8-50	0.88	1000	0.04	2000	0.059	2500	0.07
Nk Cables	RF7/8-50GHF	0.88	1000	0.04	2000	0.059	2500	0.07
Nk Cables	RF7/8-50BHF	0.88	1000	0.04	2000	0.059	2500	0.07
Nk Cables	RF1 5/8-50	0.88	1000	0.024	2000	0.036	2500	0.042
Nk Cables	RF1 5/8-50GHF	0.88	1000	0.024	2000	0.036	2500	0.042
Nk Cables	RF1 5/8-50BHF	0.88	1000	0.024	2000	0.036	2500	0.042
Nk Cables	RF2 1/4-50	0.88	1000	0.021	2000	0.032	2500	0.041
Nk Cables	RF2 1/4-50GHF	0.88	1000	0.021	2000	0.032	2500	0.041
Nk Cables	RF2 1/4-50BHF	0.88	1000	0.021	2000	0.032	2500	0.041
Nk Cables	RFF3/8-50	0.81	1000	0.147	2000	0.218	2500	0.25
Nk Cables	RFF3/8-50GHF	0.81	1000	0.147	2000	0.218	2500	0.25
Nk Cables	RFF3/8-50BHF	0.81	1000	0.147	2000	0.218	2500	0.25
Nk Cables	RFF1/2-50	0.82	1000	0.112	2000	0.167	2500	0.19

Mfgr.	Cable	Prop. Vel	Freq 1	Loss 1	Freq 2	Loss 2	Freq 3	Loss 3
Nk Cables	RFF1/2-50GHF	0.82	1000	0.112	2000	0.167	2500	0.19
Nk Cables	RFF1/2-50BHF	0.82	1000	0.112	2000	0.167	2500	0.19
Nk Cables	RFF7/8-50	0.88	1000	0.04	2000	0.066	2500	0.076
Nk Cables	RFF7/8-50GHF	0.88	1000	0.04	2000	0.066	2500	0.076
Nk Cables	RFF7/8-50BHF	0.88	1000	0.04	2000	0.066	2500	0.076
Times	LMR100	0.66	1000	0.789	2000	1.15	2500	1.31
Times	LMR200	0.83	1000	0.342	2000	0.49	2500	0.554
Times	LMR240	0.84	1000	0.261	2000	0.377	2500	0.424
Times	LMR400	0.85	1000	0.135	2000	0.196	2500	0.222
Times	LMR500	0.86	1000	0.109	2000	0.159	2500	0.18
Times	LMR600	0.87	1000	0.087	2000	0.128	2500	0.145
Times	LMR900	0.87	1000	0.059	2000	0.086	2500	0.098
Times	LMR1200	0.88	1000	0.044	2000	0.065	2500	0.074
Times	LMR1700	0.89	1000	0.033	2000	0.049	2500	0.057
	310801	0.821	1000	0.115	1000	0.115	1000	0.115
	311201	0.82	1000	0.18	1000	0.18	1000	0.18
	311501	0.8	1000	0.23	1000	0.23	1000	0.23
	311601	0.8	1000	0.262	1000	0.262	1000	0.262
	311901	0.8	1000	0.377	1000	0.377	1000	0.377
	352001	0.8	1000	0.377	1000	0.377	1000	0.377

Appendix F
DVB-T/H Channel Maps

Introduction

The tables in this appendix provide channel mapping for channel frequency, level accuracy, noise floor, frequency accuracy, frequency lock range, and 1 dB compression level.

Channel Maps

The following table provides a list of channels for UHF (Australia). The bandwidth of these channels is 7 MHz.

Table F-1. UHF (Australia) Channel and Frequency Map

Channel (CH)	Center Frequency (MHz)	Lower Bound (MHz)	Upper Bound (MHz)
28	529.5	526	533
29	536.5	533	540
30	543.5	540	547
31	550.5	547	554
32	557.5	554	561
33	564.5	561	568
34	571.5	568	575
35	578.5	575	582
36	585.5	582	589
37	592.5	589	596
38	599.5	596	603
39	606.5	603	610
40	613.5	610	617
41	620.5	617	624
42	627.5	624	631
43	634.5	631	638

Table F-1. UHF (Australia) Channel and Frequency Map

Channel (CH)	Center Frequency (MHz)	Lower Bound (MHz)	Upper Bound (MHz)
44	641.5	638	645
45	648.5	645	652
46	655.5	652	659
47	662.5	659	666
48	669.5	666	673
49	676.5	673	680
50	683.5	680	687
51	690.5	687	694
52	697.5	694	701
53	704.5	701	708
54	711.5	708	715
55	718.5	715	722
56	725.5	722	729
57	732.5	729	736
58	739.5	736	743
59	746.5	743	750
60	753.5	750	757
61	760.5	757	764
62	767.5	764	771
63	774.5	771	778
64	781.5	778	785
65	788.5	785	792
66	795.5	792	799
67	802.5	799	806
68	809.5	806	813

Table F-1. UHF (Australia) Channel and Frequency Map

Channel (CH)	Center Frequency (MHz)	Lower Bound (MHz)	Upper Bound (MHz)
69	816.5	813	820

The following table provides a list of channels for UHF (Europe). The bandwidth of these channels is 8 MHz.

Table F-2. UHF (Europe) Channel and Frequency Map

Channel (CH)	Center Frequency (MHz)	Lower Bound (MHz)	Upper Bound (MHz)
21	474	470	478
22	482	478	486
23	490	486	494
24	498	494	502
25	506	502	510
26	514	510	518
27	522	518	526
28	530	526	534
29	538	534	542
30	546	542	550
31	554	550	558
32	562	558	566
33	570	566	574
34	578	574	582
35	586	582	590
36	594	590	598
37	602	598	606
38	610	606	614

Table F-2. UHF (Europe) Channel and Frequency Map

Channel (CH)	Center Frequency (MHz)	Lower Bound (MHz)	Upper Bound (MHz)
39	618	614	622
40	626	622	630
41	634	630	638
42	642	638	646
43	650	646	654
44	658	654	662
45	666	662	670
46	674	670	678
47	682	678	686
48	690	686	694
49	698	694	702
50	706	702	710
51	714	710	718
52	722	718	726
53	730	726	734
54	738	734	742
55	746	742	750
56	754	750	758
57	762	758	766
58	770	766	774
59	778	774	782
60	786	782	790
61	794	790	798
62	802	798	806
63	810	806	814
64	818	814	822

Table F-2. UHF (Europe) Channel and Frequency Map

Channel (CH)	Center Frequency (MHz)	Lower Bound (MHz)	Upper Bound (MHz)
65	826	822	830
66	834	830	838
67	842	838	846
68	850	846	854
69	858	854	862

Level Accuracy and Noise Floor

The following table provides level accuracy values for UHF (Europe), Channel 21 with the preamplifier Off.

Table F-3. Level Accuracy UHF (Europe) – Channel 21, Preamp Off

Signal Level (dBm)	Reference Level (dBm)	Specification (dB)	Guard Band (dB)
−10	−10	±1.5	0.5
−15	−15	±1.5	0.5
−20	−20	±1.5	0.5
−25	−25	±1.5	0.5
−30	−25	±1.5	0.5
−35	−25	±1.5	0.5
−40	−25	±1.5	0.5
−45	−25	±1.5	0.5
−50	−25	±1.5	0.5
−55	−25	±1.5	0.5
−60	v25	±1.5	0.5
−65	NA	NA	NA

Table F-3. Level Accuracy UHF (Europe) – Channel 21, Preamp Off

Signal Level (dBm)	Reference Level (dBm)	Specification (dB)	Guard Band (dB)
−70	NA	NA	NA
−75	NA	NA	NA
−80	NA	NA	NA
−84	NA	NA	NA

The following table provides level accuracy values for UHF (Europe), Channel 21 with the preamplifier On.

Table F-4. Level Accuracy UHF (Europe) – Channel 21, Preamp On

Signal Level (dBm)	Reference Level (dBm)	Specification (dB)	Guard Band (dB)
−10	NA	NA	NA
−15	NA	NA	NA
−20	−20	±1.5	0.5
−25	−20	±1.5	0.5
−30	−30	±1.5	0.5
−35	−30	±1.5	0.5
−40	−40	±1.5	0.5
−45	−40	±1.5	0.5
−50	−50	±1.5	0.5
−55	−50	±1.5	0.5
−60	−50	±1.5	0.5
−65	−50	±1.5	0.5
−70	−50	±1.5	0.5
−75	−50	±1.5	0.5

Table F-4. Level Accuracy UHF (Europe) – Channel 21, Preamp On

Signal Level (dBm)	Reference Level (dBm)	Specification (dB)	Guard Band (dB)
−80	−50	±1.5	0.5
−84	−50	±1.5	0.5

The following table provides level accuracy values for UHF (Europe), Channel 45 with the preamplifier Off.

Table F-5. Level Accuracy UHF (Europe) – Channel 45, Preamp Off

Signal Level (dBm)	Reference Level (dBm)	Specification (dB)	Guard Band (dB)
−10	−10	±1.5	0.5
−15	−15	±1.5	0.5
−20	−20	±1.5	0.5
−25	−25	±1.5	0.5
−30	−25	±1.5	0.5
−35	−25	±1.5	0.5
−40	−25	±1.5	0.5
−45	−25	±1.5	0.5
−50	−25	±1.5	0.5
−55	−25	±1.5	0.5
−60	−25	±1.5	0.5
−65	NA	NA	NA
−70	NA	NA	NA
−75	NA	NA	NA
−80	NA	NA	NA
−84	NA	NA	NA

The following table provides level accuracy values for UHF (Europe), Channel 45 with the preamplifier On.

Table F-6. Level Accuracy UHF (Europe) – Channel 45, Preamp On

Signal Level (dBm)	Reference Level (dBm)	Specification (dB)	Guard Band (dB)
−10	NA	NA	NA
−15	NA	NA	NA
−20	−20	±1.5	0.5
−25	−20	±1.5	0.5
−30	−30	±1.5	0.5
−35	−30	±1.5	0.5
−40	−40	±1.5	0.5
−45	−40	±1.5	0.5
−50	−50	±1.5	0.5
−55	−50	±1.5	0.5
−60	−50	±1.5	0.5
−65	−50	±1.5	0.5
−70	−50	±1.5	0.5
−75	−50	±1.5	0.5
−80	−50	±1.5	0.5
−84	−50	±1.5	0.5

The following table provides level accuracy values for UHF (Europe), Channel 69 with the preamplifier Off.

Table F-7. Level Accuracy UHF (Europe) – Channel 69

Signal Level (dBm)	Reference Level (dBm)	Specification (dB)	Guard Band (dB)
−10	−10	±1.5	0.5
−15	−15	±1.5	0.5
−20	−20	±1.5	0.5
−25	−25	±1.5	0.5
−30	−25	±1.5	0.5
−35	−25	±1.5	0.5
−40	−25	±1.5	0.5
−45	−25	±1.5	0.5
−50	−25	±1.5	0.5
−55	−25	±1.5	0.5
−60	−25	±1.5	0.5
−65	NA	NA	NA
−70	NA	NA	NA
−75	NA	NA	NA
−80	NA	NA	NA
−84	NA	NA	NA

The following table provides level accuracy values for UHF (Europe), Channel 69 with the preamplifier On.

Table F-8. Level Accuracy UHF (Europe) – Channel 69

Signal Level (dBm)	Reference Level (dBm)	Specification (dB)	Guard Band (dB)
−10	NA	NA	NA
−15	NA	NA	NA
−20	−20	±1.5	0.5
−25	−20	±1.5	0.5
−30	−30	±1.5	0.5
−35	−30	±1.5	0.5
−40	−40	±1.5	0.5
−45	−40	±1.5	0.5
−50	−50	±1.5	0.5
−55	−50	±1.5	0.5
−60	−50	±1.5	0.5
−65	−50	±1.5	0.5
−70	−50	±1.5	0.5
−75	−50	±1.5	0.5
−80	−50	±1.5	0.5
−84	−50	±1.5	0.5

The following table provides noise floor values for UHF (Europe), Channel 21.

Table F-9. Noise Floor UHF (Europe) – Channel 21

Preamplifier Off			Preamplifier On		
Reference Level (dBm)	Maximum Value of Specification (dBm)	Guard Band (dB)	Reference Level (dBm)	Measurement Value (dBm)	Guard Band (dB)
−25	≤−69	0.0	−50	≤−93	0.0

The following table provides noise floor values for UHF (Europe), Channel 45.

Table F-10. Noise Floor UHF (Europe) – Channel 45

Preamplifier Off			Preamplifier On		
Reference Level (dBm)	Measurement Value (dBm)	Maximum Value of Specification (dBm)	Reference Level (dBm)	Measurement Value (dBm)	Guard Band (dB)
−25	≤−69	0.0	−50	≤−93	0.0

The following table provides noise floor values for UHF (Europe), Channel 69.

Table F-11. Noise Floor UHF (Europe) – Channel 69

Preamplifier Off			Preamplifier On	
Reference Level (dBm)	Maximum Value of Specification (dBm)	Reference Level (dBm)	Measurement Value (dBm)	Guard Band (dB)
−25	≤−69	−50	≤−93	0.0

Frequency Accuracy and Frequency Lock Range

The following table provides frequency accuracy values for UHF (Europe), Channels 21, 45, and 69.

Table F-12. Frequency Accuracy UHF (Europe) – Channels 21, 45, and 69

Channel	Preamp	Reference Level (dBm)	Specification Range (Hz)	Guard Band (Hz)
21	Off	−20	≤±0.2	0.1
21	On	−50	≤±0.2	0.1
45	Off	−20	≤±0.2	0.1
45	On	−50	≤±0.2	0.1
69	Off	−20	≤±0.2	0.1
69	On	−50	≤±0.2	0.1

1 dB Compression Level

The following table provides 1 dB compression level values for UHF (Europe), Channel 21 with Preamplifier Off.

Table F-13. 1 dB Compression Level UHF (Europe) – Channel 21, Preamp Off

Signal Level (dBm)	Reference Level (dBm)	Specification Range (dB)	Guard Band (dB)
−25	−25	Dif<1	1.0
−24	−25	Dif<1	1.0
−23	−25	Dif<1	1.0
−22	−25	Dif<1	1.0
−21	−25	Dif<1	1.0
−20	−25	Dif<1	1.0
−19	−25	Dif<1	1.0
−18	−25	Dif<1	1.0
−17	−25	Dif<1	1.0
−16	−25	Dif<1	1.0
−15	−25	Dif<1	1.0
−14	−25	Dif<1	1.0
−13	−25	Dif<1	1.0
−12	−25	Dif<1	1.0
−11	−25	Dif<1	1.0
−10	−25	Dif<1	1.0

The following table provides 1 dB compression level values for UHF (Europe), Channel 21 with Preamplifier On.

Table F-14. 1 dB Compression Level UHF (Europe) – Channel 21, Preamp On

Signal Level (dBm)	Reference Level (dBm)	Specification Range (dB)	Guard Band (dB)
−50	−50	Dif<1	1.0
−49	−50	Dif<1	1.0
−48	−50	Dif<1	1.0
−47	−50	Dif<1	1.0
−46	−50	Dif<1	1.0
−45	−50	Dif<1	1.0
−44	−50	Dif<1	1.0
−43	−50	Dif<1	1.0
−42	−50	Dif<1	1.0
−41	−50	Dif<1	1.0
−40	−50	Dif<1	1.0
−39	−50	Dif<1	1.0
−38	−50	Dif<1	1.0
−37	−50	Dif<1	1.0
−36	−50	Dif<1	1.0
−35	−50	Dif<1	1.0

The following table provides 1 dB compression level values for UHF (Europe), Channel 45 with Preamplifier Off.

Table F-15. 1 dB Compression Level UHF (Europe) – Channel 45, Preamp Off

Signal Level (dBm)	Reference Level (dBm)	Specification Range (dB)	Guard Band (dB)
−25	−25	Dif<1	1.0
−24	−25	Dif<1	1.0
−23	−25	Dif<1	1.0
−22	−25	Dif<1	1.0
−21	−25	Dif<1	1.0
−20	−25	Dif<1	1.0
−19	−25	Dif<1	1.0
−18	−25	Dif<1	1.0
−17	−25	Dif<1	1.0
−16	−25	Dif<1	1.0
−15	−25	Dif<1	1.0
−14	−25	Dif<1	1.0
−13	−25	Dif<1	1.0
−12	−25	Dif<1	1.0
−11	−25	Dif<1	1.0
−10	−25	Dif<1	1.0

The following table provides 1 dB compression level values for UHF (Europe), Channel 45 with Preamplifier On.

Table F-16. 1 dB Compression Level UHF (Europe) – Channel 45, Preamp On

Signal Level (dBm)	Reference Level (dBm)	Specification Range (dB)	Guard Band (dB)
−50	−50	Dif<1	1.0
−49	−50	Dif<1	1.0
−48	−50	Dif<1	1.0
−47	−50	Dif<1	1.0
−46	−50	Dif<1	1.0
−45	−50	Dif<1	1.0
−44	−50	Dif<1	1.0
−43	−50	Dif<1	1.0
−42	−50	Dif<1	1.0
−41	−50	Dif<1	1.0
−40	−50	Dif<1	1.0
−39	−50	Dif<1	1.0
−38	−50	Dif<1	1.0
−37	−50	Dif<1	1.0
−36	−50	Dif<1	1.0
−35	−50	Dif<1	1.0

The following table provides 1 dB compression level values for UHF (Europe), Channel 69 with Preamplifier Off.

Table F-17. 1 dB Compression Level UHF (Europe) – Channel 69, Preamp Off

Signal Level (dBm)	Reference Level (dBm)	Specification Range (dB)	Guard Band (dB)
−25	−25	Dif<1	1.0
−24	−25	Dif<1	1.0
−23	−25	Dif<1	1.0
−22	−25	Dif<1	1.0
−21	−25	Dif<1	1.0
−20	−25	Dif<1	1.0
−19	−25	Dif<1	1.0
−18	−25	Dif<1	1.0
−17	−25	Dif<1	1.0
−16	−25	Dif<1	1.0
−15	−25	Dif<1	1.0
−14	−25	Dif<1	1.0
−13	−25	Dif<1	1.0
−12	−25	Dif<1	1.0
−11	−25	Dif<1	1.0
−10	−25	Dif<1	1.0

The following table provides 1 dB compression level values for UHF (Europe), Channel 69 with Preamplifier On.

Table F-18. 1 dB Compression Level UHF (Europe) – Channel 69, Preamp On

Signal Level (dBm)	Reference Level (dBm)	Specification Range (dB)	Guard Band (dB)
−50	−50	Dif<1	1.0
−49	−50	Dif<1	1.0
−48	−50	Dif<1	1.0
−47	−50	Dif<1	1.0
−46	−50	Dif<1	1.0
−45	−50	Dif<1	1.0
−44	−50	Dif<1	1.0
−43	−50	Dif<1	1.0
−42	−50	Dif<1	1.0
−41	−50	Dif<1	1.0
−40	−50	Dif<1	1.0
−39	−50	Dif<1	1.0
−38	−50	Dif<1	1.0
−37	−50	Dif<1	1.0
−36	−50	Dif<1	1.0
−35	−50	Dif<1	1.0

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