Measurement Guide

Agilent Technologies E7495A/B

Base Station Test Set

For firmware revision A.03.00 and above

Agilent Technologies

Manufacturing Part Number: E7495-90031
Supersedes E7495-90023

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1 Getting Started

Introduction

The E7495A/B Base Station Test Set is designed to simplify the job of installing and maintaining base stations. By combining all important base station diagnostic tools in one rugged instrument, the E7495A/B lets you get your work done in the shortest time at each base station.

Basic test functionality includes:

- Spectrum Analysis
- Two Port Insertion Loss
- One Port Insertion Loss
- Return Loss
- Distance to Fault

You can optionally add these measurements:

- Adjacent Channel Power
- CDMA Over Air
- CDMA Analyzer
- WCDMA/UMTS Analyzer
- WCDMA/UMTS Over Air
- GSM Analyzer
- Channel Scanner
- T1
- E1
- CW/cdmaOne/cdma2000 Reverse Link Signal Generator
- Power Meter
- DC Bias output (internal, available on the E7495B only)

In Getting Started, you will learn how to set up the E7495A/B, and you will learn to perform one basic measurement to start getting familiar with the range of tools contained in the test set.

If you are a new user, also recommended is E7495A Quick Basics, an

HTML-based tutorial available on the CD that comes with the test set.

After the Getting Started chapter, you will find, in alphabetical order, one chapter on each E7495A/B measurement. General information on batteries, caring for the E7495A/B, and how to return the instrument for service follows.

Unpacking the E7495A/B Test Set

Unpack and inspect the shipping container and its contents thoroughly to ensure that nothing was damaged during shipment.

If the contents are damaged or defective, contact your nearest Agilent Technologies sales and service office. Keep the shipping materials for the carrier's inspection.

Verify that all the parts were include in the shipping container.

The basic test set package for the E7495A includes:

- E7495A/B Base Station Test Set
- Shoulder strap
- One battery
- Two 10 dB pads
- AC/DC converter
- Two N-to-N barrels
- Open/short connector
- Two attenuator 10 dB coaxial connectors
- Load connector
- GPS antenna
- 64 MB PCMCIA memory card
- CD ROM containing electronic (PDF) version of Measurement Guide, E7495A Quick Basics tutorial, and application notes
- Base Station Test Set Accessories kit (pn E7495-60044) includes:
    - Accessories case
    - Two 2-ft. cables
    - 10-ft. cable
    - Two N-to-7/16" connectors
    - Soft carrying case
    - High power attenuator

- Measurement Guide (this manual)
- Soft carrying case loading card

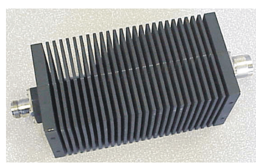
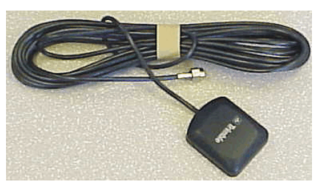
The standard test set package for the E7495B includes:

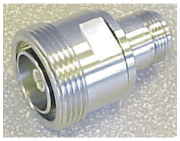
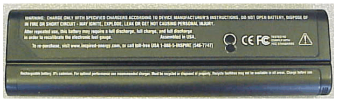
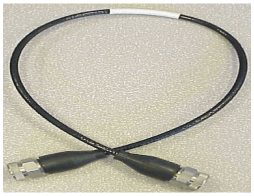
- E7495A/B Base Station Test Set
- Shoulder strap
- One battery
- Two 10 dB pads
- AC/DC converter
- Two N-to-N barrels
- Open/short connector
- Two attenuator 10 dB coaxial connectors
- Load connector
- GPS antenna
- 64 MB PCMCIA memory card
- CD ROM containing electronic (PDF) version of Measurement Guide, E7495A Quick Basics tutorial, and application notes

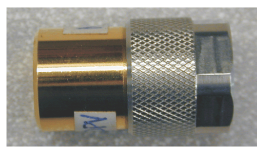
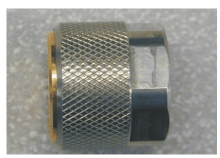
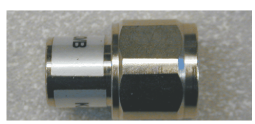
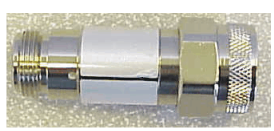
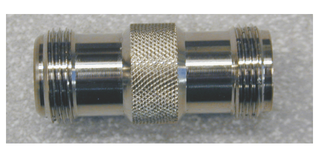
E7495B-800 Base Station Test Set accessories kit contains, in addition to the standard package:

- Soft carrying case
- 10-ft. cable
- Two 2-ft. cables
- Two N-to-7/16” connectors
- High power attenuator
- Measurement Guide (this manual)
- Soft carrying case loading card

E7495A/B Cables, Connectors, and Accessories

Part Number	Picture	Description
0950-4404		AC/DC adapter 24 VDC 100W
0950-4409		PCMCIA 64MB Flash memory card
0955-1458 (E7495A) 0955-1599 (E7495B)		High power attenuator (40 dB 100W)
1150-2085		GPS antenna, SMA M
1250-2908		Adapter, N (Female) to 7/16ths (Male)

Part Number	Picture	Description
1250-2810		Adapter, N (Female) to 7/16ths (Female)
1420-0883		Battery
8120-8862 Quantity 2		Cable, 2 ft N (m) - N (m)
8121-1315		Cable, 10 ft (3.048m) N (m) - N (m)
E7495-20165		Shoulder strap

Part Number	Picture	Description
E7495-80014		Soft carrying case
E7495-60059		Coax Accessories: Case, plastic and foam (5000-0911)
		Open, 50 ohm, N-type male (1250-3421)
		Short, 50 ohm, N-type male (1250-3424)
		Load, 50 ohm, N-type male (1250-3423)
		Attenuator, fixed 6 GHZ max 10 dB N type (0955-1534)
		Adapter, 50 ohm, N-type F-F (1250-3422)

Test set options

Test set part number	Description
E7495A/B, option 200	cdmaOne/cdma 2000 direct connect test, includes: CA-ASSY RF 50 ohm, BNC, male to male cable 10 ft (pn 8121-1230)
E7495A/B, option 210	cdmaOne/cdma 2000 over-air test (requires option 200 and 810, 811, or 812)
E7495A/B, option 220	Channel scanner
E7495A/B, option 240	W-CDMA (UMTS) analyzer
E7495B, option 300	DC bias
E7495A/B, option 500	CW signal generator
E7495A/B, option 510	CW/cdmaOne/cdma2000 reverse link signal generator
E7495A/B, option 51B	Return to Agilent repair
E7495A/B, option 50C	Return to Agilent for calibration
E7495A/B, option 600	Power meter (requires 8482A/8481A power sensor), includes: power sensor cable 3.01MT (pn E9288-60002)
E7495A/B, option 700	T-1 Analyzer, includes: Y-bantams to alligator, 10-foot cable (pn 8121-1026) Y-bantams to RJ-45, 10-foot cable (pn 8121-1025) Y-bantams to Y-bantams, 10-foot cable (pn 8121-1024) Bantam looping cable (quantity 2)

Test set part number	Description
E7495A/B, option 710	E-1 Analyzer, includes: Balun, 75 - 120 ohm adapter (0950-4551) 75 ohm BNC, four connectors, 10-foot cable (quantity 2) (8121-1228) 75 ohm BNC jumper cable, 4” length (quantity 2)
E7495B, option 800	BSTS accessories: 40 dB attenuator (pn 0955-1599) soft carrying case (pn E7495-80014) manual (pn E7495-90031) soft carrying case loading card (pn E7495-90003)
E7495A/B, option 810	Cellular antenna and pre-selector filter, includes: Cellular antenna (pn 1150-2061) preselector filter (pn 0955-1527 RF TNC to N connector (pn 1200-1897) for option 210
E7495A/B, option 811	PCS Antenna and pre-selector filter, includes: PCS antenna (pn 1150-5059) preselector filter (pn 0955-1526) RF TNC to N connector (pn 1200-1897) for option 210
E7495A/B, option 812	Korean PCS Antenna and pre-selector filter, includes: Korean PCS antenna (pn 1150-5059) preselector filter (pn 0955-1590) RF TNC to N connector (pn 1200-1897) for option 210

Test set part number	Description
E7495A/B, option 813	European W-CDMA antenna and pre-selector filter, includes: W-CDMA antenna 2.1-2.17 GHz (pn E6455-80003) preselector filter (pn 0955-1667) RF TNC to N connector (pn 1200-1897) for option 210
E7495A/B, option 820	External charger/battery pack/DC adapter, includes: Battery 10.8 V 6 A-HR LI-ION (pn 1420-0883) External power supply AC/DC adapter 24 VDC 100 W (pn 0950-4404) DC car adapter DC to DC adaptor output 19 VDC 70 W (pn 0950-4412) dual battery charger, 12 V AT 1 A (pn 0950-4276)
E7495A/B, option 8482	Power Sensor, 100 kHz to 4.2 GHz:
E7495A/B, option 840	Hard transit case (pn E7495-80016)
E7495A/B, option 900	UK power cord
E7495A/B, option 901	AUS/NZ/CH power cord
E7495A/B, option 902	Euro power cord
E7495A/B, option 903	US power cord
E7495A/B, option 906	Swiss power cord
E7495A/B, option 912	Denmark power cord
E7495A/B, option 917	So Af/India power cord
E7495A/B, option 918	Japan power cord
E7495A/B, option 919	Israel power cord
E7495A/B, option 920	Argentinean power cord
E7495A/B, option 921	Chilean power cord

Test set part number	Description
E7495A/B, option 922	China power cord
E7495A/B, option 927	Thailand power cord

Your First 15 Minutes with the E7495A/B

Spend 15 minutes getting acquainted with the test set:

- "Get to Know the Layout of the E7495A/B" on page 28
- "Install a Battery" on page 31
- "Practice Using the Three-way Power Button" on page 31
- "Make Your First Measurement (Two Port Insertion Loss)" on page 32

CAUTION The maximum power for the RF In and RF Out port is 20 dBm (100 mW). The maximum power for the Power Sensor port is 24 dBm (300 mW). When directly coupled to a base station, the test set can be damaged by excessive power applied to any of these three ports.

To prevent damage in most situations when you directly couple the test set to a base station, use the high power attenuator between the test set and the BTS.

Get to Know the Layout of the E7495A/B

Number	Description
1	**Power button**. Powers the test set on and off, and puts it into standby mode. • To power **on**, press the power button. When the test set is on, the right LED is lit. • To put into **standby** mode while the power is on, press the button about 1 second. In standby mode—which conserves the battery and provides quicker startup—the left LED is lit. For more information about the power button states, refer to “Practice Using the Three-way Power Button” on page 31. • To power **off**, press the button and hold down until you see both LEDs go out, approximately 5 seconds.
2	• **Preset.** Recalls the power-up state, applying Agilent defaults or the defaults you define using the Save State button. • **Brightness**.Changes the brightness of the display in four increments. To increase or decrease the brightness, press the button repeatedly. • **Help**. Displays online help. • **ESC/Lcl.** Stops the active function and clears the active function text from the display. Pressing **ESC/Lcl** after the test set has been placed in remote mode switches to local mode and enables front-panel control. • **Mode.** Displays a menu of measurement modes. • **Save Data**. Saves the non-trace measurement data to either a PCMCIA or CompactFlash card. • **Save State.** Saves the state of all measurement parameters to non-volatile memory in the test set. You can save multiple states, each with its own name. • **System**. Displays menu of non-measurement operations including configuration, system status updates, data manipulation, and basic system functions testing. • **Print Screen**. Prints the current screen image to either a PCMCIA or CompactFlash card. • **Recall State**. Recalls the state of all measurement parameters you saved in non-volatile memory using the Save State button.
3	**Number keypad**. Used for entry of values for many test parameters.

Number	Description
4	• **Rotary knob.** Allows incremental changes to values for such things as carrier frequency, reference level, and marker positions. Rotate clockwise to increase values, counterclockwise to decrease values. The speed at which you turn the knob affects the rate at which the values are changed. • **Down Arrow**. Decreases the active function value. The increment size depends upon the current measurement. Each press results in a single increment change. For those parameters with fixed values, the next value in a sequence is selected each time you press the button. • **Up Arrow**. Increases the active function value.
5	**Battery LEDs**. Show remaining charge capacity and charging status of batteries. For details, see “Viewing Battery Status” on page 427.
6	**menu keys.** Allow you to select measurement modes and other settings for configuring and performing measurements, and for other E7495A/B functions.

Install a Battery

	Step	Notes
1.	Open the battery door.	Turn the latch counterclockwise several times until loose. Then pull the battery door open.
2.	Insert the battery.	Insert one or two batteries.
3.	Close the battery door.	Turn the latch clockwise until tight to secure the battery door.

For more information about the batteries, including battery installation and removal, refer to Chapter 20 , “Working with Batteries.”

Practice Using the Three-way Power Button

The E7495A/B Test Set power button is designed to provide additional convenience when you want to pause between measurements, then quickly start again. Besides working like a standard on-off button, the E7495A/B power button also lets you put the test set into standby mode, which conserves battery usage and provides a quick startup when you are ready to resume measurements.

	Step	Notes
•	To **power on** the test set, press the button.	As soon as you press the power button, the right LED goes on. The full power-up sequence can take up to 2 minutes.
•	To put the test set into **standby** mode while the power is on, press the button briefly -- for about a second.	When in standby mode, the left LED is lit. When you power on the test set again, the startup takes only about 30 seconds.
•	To **power off** the test set, press the button and hold until both LEDs above the button go off. This usually takes about 5 seconds.	When you hold down the button, at first both LEDs are lit. After about 5 seconds, both go out.

Make Your First Measurement (Two Port Insertion Loss)

The two port insertion loss measurement is perhaps the most fundamental test set measurement. It quantifies exactly how much loss is incurred as a signal travels through a cable or other device. You must account for the signal loss of a connecting cable in order to produce accurate measurement results for a variety of other measurements.

You can perform this measurement anywhere using these devices (all provided with the E7495A and provided as part of option 800 for the E7495B):

Needed for normalization:

- Normalization jumper cable (2 ft.)
- Two 10 dB pads

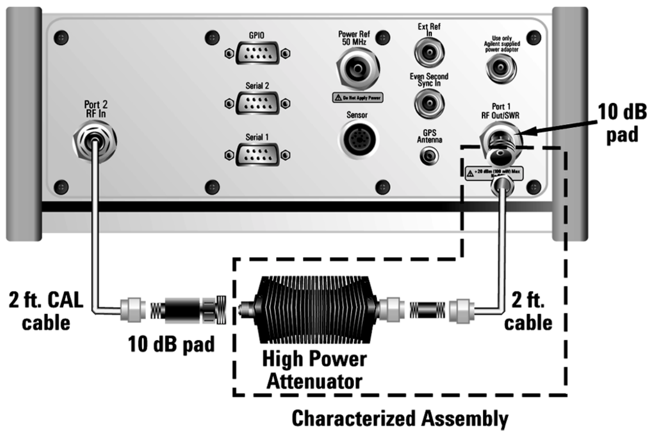
Devices whose insertion loss you measure:

- Test cable (2 ft.)

- Test cable (10 ft.)
- High power attenuator
- N-N barrel

	Step	Notes
1.	Select two port insertion loss. a. **Mode** b. [Antenna/Cable] c. [Two Port Insertion Loss]	In this and other procedures, front-panel buttons are indicated with bold text, menu keys with brackets.
2	Enter the start frequency. a. Enter the frequency using the number keypad. b. Press [Hz], [kHz], [MHz], or [GHz].	
3	Enter the stop frequency. a. Enter the frequency using the number keypad. b. Press [Hz], [kHz], [MHz], or [GHz].	
4	Normalize the test set. a. [Normalize] b. Follow the Normalize Wizard.	The Normalize Wizard, built into the test set, displays instructions to guide you through normalization.
5	Attach the device whose insertion loss you want to measure between the two 10 dB pads.	

Step	Notes



Insertion loss measurement of high power attenuator and cable.

For more information, see “Two Port Insertion Loss” on page 47.

Using the Soft Carrying Case

The E7495A/B soft carrying case is ergonomically designed to hold the test set as well as its cables and accessories. The soft carrying case allows you to carry all your gear up to a base station while keeping your hands free.

WARNING **To avoid overheating, always disconnect the test set from the AC adapter before storing the test set in the soft carrying case.**

If you prefer to leave the test set connected to the AC adapter while inside the soft carrying case, you can disconnect the AC adapter from its power source to prevent overheating.

What Goes Where in the Soft Carrying Case

Contacting Agilent Technologies

For help with product selection and configuration, technical and application assistance, consulting and integration services, rental and leasing options, refurbished equipment, product purchases, repair, calibration, education and training please go to http://www.agilent.com/find/assist

If you do not have access to the Internet, call the appropriate number shown in below or contact your local Agilent Technologies Sales and Service Office.

Americas +1-800-829-4444

Australia +1-800-629-485

Europe, Africa, Middle East +32 (0)2 404-9340

Singapore +1-800-375-8100

More Information from Agilent

For more information about Agilent's E7495A/B Base Station Test Set, go to http://www.agilent.com/find/e7495b

For more information about Agilent's solutions for the communications industry, visit our web site at http://www.agilent.com/comms/industry

E7495A/B Base Station Test Set Product Updates

For information about E7495A/B Base Station Test Set updates, go to

http://www.agilent.com/find/e7495b

2 One Port Insertion Loss

Measuring One Port Insertion Loss

The one port insertion loss measurement allows you to quantify signal loss in a cable or other device without connecting both ends to the test set. This measurement can be especially useful in measuring the loss of a feedline connected to the antenna on a tower.

This measurement is less accurate than two port insertion loss, however. Therefore, when it's practical to connect both ends of a device to the test set—for example, for your cables or high power attenuator—it is better to use two port insertion loss.

NOTE Test signals can cause interference. When testing cables attached to antennas, test signals are radiated. Verify that the signal used for the test cannot cause interference to another antenna.

NOTE The one port insertion loss calibration is the same calibration as performed for two other measurements: return loss and distance to fault (as long as you use the manual frequency method). If you make the calibration for any of these three measurements, the calibration will apply to the other two measurements—and "Calibrated" will be displayed on the screen for all three.

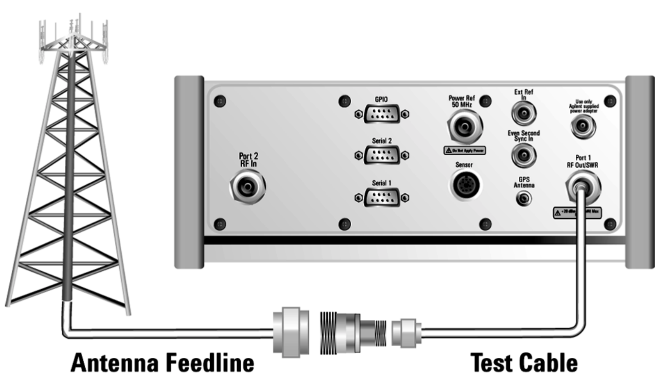
The calibration remains valid until you power off the test set or change the start or stop frequency.

Performing a Basic One Port Insertion Loss Measurement

Select the desired frequency range and calibrate the test set (using a calibrated Open, Short, and Load connector) for a one port insertion loss measurement.

	Step	Notes
1	**Mode**	
2	[Antenna/Cable]	

	Step	Notes
3	[One Port Insertion Loss]	The one port insertion loss measurement takes a few seconds to load.
4	[Start Freq]	
5	Enter the start frequency using the number keypad.	
6	[Hz], [kHz], [MHz], or [GHz]	
7	[Stop Freq]	
8	Enter the stop frequency using the keypad.	The stop frequency should be larger than the start frequency.
9	[Hz], [kHz], [MHz], or [GHz]	
10	[Calibrate]	Follow the instructions of the Calibration Wizard. The test set will calibrate over the desired frequency range.
11	Connect the antenna feedline and antenna.	Connect the antenna feedline cable to the RFout/SWR port.



	Step	Notes
12	Disconnect the feedline at the top of the tower, and connect a short connector to the feedline.	This step is necessary to get a good mismatch for the measurement.
13	[Level]	Below the trace on the screen is a table displaying the average insertion loss. If the trace is not visible, you can change the reference level or use Autoscale to have the test set select a reference level for you. • To choose Autoscale, press [Autoscale]. • To set the level manually, press [Ref Level], enter a value using the number keypad, then press [dB].

Setting Average, Sweep, and Restart

Setting the Sweep

You can select either continuous or single sweep. Continuous sweep provides repeated, ongoing measurements. Single sweep performs a single measurement that is repeated only when you push the Single button.

To set sweep:

	Step	Notes
1	[Average/Sweep]	
2	[Continuous] or [Single]	Each time you press this softkey, the selected option changes.

Setting Averaging

You can choose to have averaging on or off and set the number of averages you want to take. When turned on, the Agilent E7495A/B does a running average:

- A running average computes the new result as the weighted sum of the last result and the new measurement. The last result is weighted by (n – 1)/n. The new result is weighted by 1/n. Each new measurement produces a new result.

Averaging applies to the following measurement metrics and the control channel view only:

- Freq Error
- Noise Floor
- EVM
- PCDE
- Carrier Feedthrough
- Chan Pwr
- CPICH power

- all the delta powers
- Control Channel Graph

To set averaging:

	Step	Notes
1	Set the number of averages.	
	a. [Average]	
	b. Enter the number of averages using the number keypad.	
	c. [Enter]	
2	Set averaging On or Off.	
	a. [Average/Sweep]	
	b. [Averaging]	
	c. [Off] or [On]	

NOTE These two steps can be performed in any order. However, if you turn averaging on and a large number of averages has previously been set, there may be a delay before you can change number of averages.

Setting Restart

When you have averaging turned on, you can restart the averaging by pressing the Restart menu key. This restarts the averaging for running average in either Continuous or Single sweep mode. It also resets the Amplifier Capacity and Traffic metrics.

To restart averaging:

	Step	Notes
1	[Average/Sweep]	
2	[Restart]	

Adding a Marker

Markers can be used on traces to help you visually track up to four signals. Each marker has the following settings:

- **Type**: Provides three options, including:
  - **Off**
  - Normal: Places a diamond-shaped, colored marker, along with a number, 1-4, on the trace.
  - Delta: Associated with a normal marker. Therefore, a normal marker must exist prior to creating the delta marker. The delta marker displays the difference between the normal marker position and the delta marker position. Only one delta marker can be associated with a given normal marker. The normal marker must be active when Delta is selected.
- **Marker to Peak**: Places the active marker on the current greatest value of the trace.
- **Marker to Next Peak**: Places the active marker on the current second greatest value of the trace.
- **Marker to Min**: Places the active marker on the current lowest value of the trace.
- **Marker to Next Min**: Places the active marker on the current second lowest value of the trace.

To add a marker to a trace

	Step	Notes
1	[Marker]	
2	[Marker]	
3	[1], [2], [3], or [4]	
4	[Type]	
5	[Off], [Normal], or [Delta]	
6	Locate the marker relative to the trace: [Marker to Peak], [Marker to Next Peak], [Marker to Min], or [Marker to Next Min]	

Setting One Port Insertion Loss Interference Rejection

Other signals can interfere with one port insertion loss measurements. When making a one port insertion loss measurement in the presence of known or suspected interference, you can minimize the effect of the interference on the measurement by activating interference rejection in the test set.

NOTE Use of interference rejection will increase the measurement time. Interference rejection should be used if a known interfering signal exists or if the one port insertion loss measurement displays suspicious characteristics such as a spike or rapid movements in the noise floor.

To activate interference rejection:

	Step	Notes
1	[Setup]	
2	On [Interference Rejection] select **On**.	Each time you press this softkey, the selected option changes.

3 Two Port Insertion Loss

Measuring Two Port Insertion Loss

This test measures the loss of a cable or other devices over a specified frequency range.

Insertion loss measurements are important in accurately quantifying the amount of loss a signal will incur as it passes through a cable, attenuator, or any other device. In S-parameter terms, insertion loss is referred to as an S_{21} measurement. “S” stands for scattering.

NOTE Any cable added to your measurement configuration will add some loss that must be accounted for. For example, a jumper cable placed between the test set and the antenna feedline (or other device) you are connecting will add some loss to the measurement.

If you add a jumper cable to your measurement configuration, you must normalize out the loss associated with the cable. Otherwise, your measurement results will be inaccurate, and you will probably adjust transmit parameters in error.

Insertion loss measurements have a variety of uses. However, the example procedures focus on two kinds of two port insertion loss measurements that you need as preparation for other test set measurements:

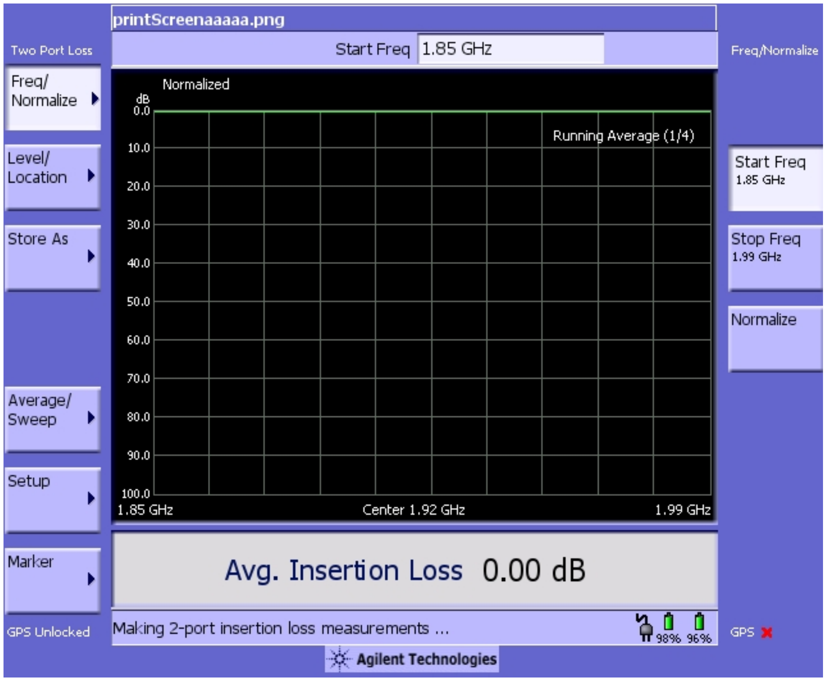
- Measuring the 10 ft. test cable, 2 ft. normalization cable, and high power attenuator provides values you can store as RF in loss and RF out loss. RF in loss is used with the Spectrum Analyzer and Channel Scanner. RF out loss is used with the Signal Generator. RF out loss is the measured loss of cables and other devices between the E7495A/B RF Out (Port 1) and the receiver under test.
- Measuring the high power attenuator and 2 ft. normalization cable provides stored Power Meter Loss (PM loss), which is needed for using the Power Meter. PM loss is the measured loss of cables and other devices between the signal source and the power sensor.

Before you perform a two port insertion loss measurement, you must first normalize the measured values for insertion loss by compensating for the loss associated with the devices (adapters, cables) that connect the E7495 Base Station Test Set to the device or assembly being tested. Otherwise, the loss introduced by these connecting devices is added to the loss of the device under test.

Performing a Basic Two Port Insertion Loss Measurement

	Step	Notes
1	**Mode**	
2	[Antenna/Cable]	
3	[Two Port Insertion Loss]	The insertion loss measurement takes a few seconds to load.
4	[Start Freq]	
5	Enter the start frequency of interest using the number keypad.	
6	[Hz], [kHz], [MHz], or [GHz]	
7	[Stop Freq]	
8	Enter the stop frequency of interest using the number keypad.	The stop frequency should be larger than the start frequency.
9	[Hz], [kHz], [MHz], or [GHz]	
10	[Normalize]	Follow the instructions of the Normalize Wizard.
11	Connect the device whose insertion loss you want to measure.	

Figure 3-1 **Two Port Insertion Loss Measurement Results, After Normalization.**



Setting Average, Sweep, and Restart

Setting the Sweep

You can select either continuous or single sweep. Continuous sweep provides repeated, ongoing measurements. Single sweep performs a single measurement that is repeated only when you push the Single button.

To set sweep:

	Step	Notes
1	[Average/Sweep]	
2	[Continuous] or [Single]	Each time you press this softkey, the selected option changes.

Setting Averaging

You can choose to have averaging on or off and set the number of averages you want to take. Averaging only applies to the data, not the trace. You can select from the following types of averaging:

- **Off**: Disables averaging.
- **Running:** Computes the new result as the weighted sum of the last result and the new measurement. The last result is weighted by (n – 1)/n. The new result is weighted by 1/n. Each new measurement produces a new result.
- **Max Hold**: Is not an average, but on a point by point basis, displays the maximum amplitude for the given frequency or channel since Max Hold was turned on. It is updated when a new maximum occurs.
- **Group Average:** Makes the requested number of measurements, averages the measurement data, and displays the average as a single result trace. Measurement time will vary based on the requested number of averages and can take minutes for very large number of averages.
- **Group Max Hold:** Makes the requested number of measurements before returning a single trace result. This trace is the maximum

value seen at each trace point over the requested number of averages (measurements).

To set averaging:

	Step	Notes
1	Set the number of averages. a. [Average] b. Enter the number of averages using the number keypad. c. [Enter]	
2	Select the type of averaging you want to apply. a. [Average/Sweep] b. [Averaging] c. [Off], [Running Average], [Max Hold], [Group Average], or [Group Max Hold]	

NOTE These two steps can be performed in any order. However, if you turn averaging on and a large number of averages has previously been set, there may be a delay before you can change number of averages.

Setting Restart

When you have averaging turned on, you can restart the averaging by pressing the Restart menu key. This restarts the averaging for running average and max hold average in either Continuous or Single sweep mode.

To restart averaging:

	Step	Notes
1	[Average/Sweep]	

	Step	Notes
2	[Restart]	

Adding a Marker

Markers can be used on traces to help you visually track up to four signals. Each marker has the following settings:

- **Type**: Provides three options, including:
  - **Off**
  - **Normal**: Places a diamond-shaped, colored marker, along with a number, 1-4, on the trace.
  - **Delta**: This is associated with a normal marker. Therefore, a normal marker must exist prior to creating the delta marker. The delta marker displays the difference between the normal marker position and the delta marker position. Only one delta marker can be associated with a given normal marker. The normal marker must be active when Delta is selected.
- **Marker to Peak**: Places the active marker on the current greatest value of the trace.
- **Marker to Next Peak**: Places the active marker on the current second greatest value of the trace.
- **Marker to Min**: Places the active marker on the current lowest value of the trace.
- **Marker to Next Min**: Places the active marker on the current second lowest value of the trace.

To Add a Marker to a Trace:

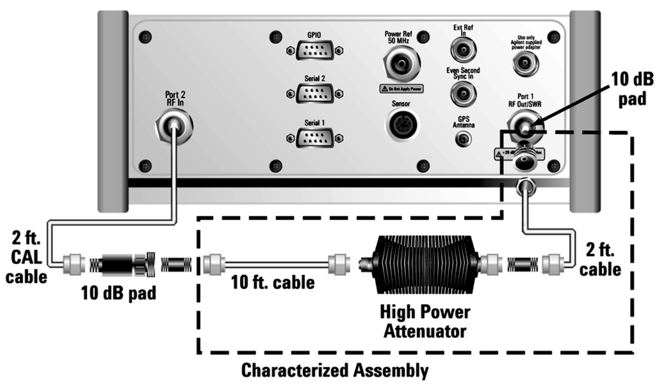
	Step	Notes
1	[Marker]	
2	[Marker]	
3	[1], [2], [3], or [4]	
4	[Type]	

	Step	Notes
5	[Off], [Normal], or [Delta]	
6	Locate the marker relative to the trace: [Marker to Peak], [Marker to Next Peak], [Marker to Min], or [Marker to Next Min]	

Measuring Two Port Insertion Loss for Spectrum Analyzer, Channel Scanner, CDMA Analyzer, and Signal Generator

To prepare to perform spectrum analysis, Tx analysis (CDMA, W-CDMA, etc.), and signal generator measurements, you must store RF in loss and RF out loss values.

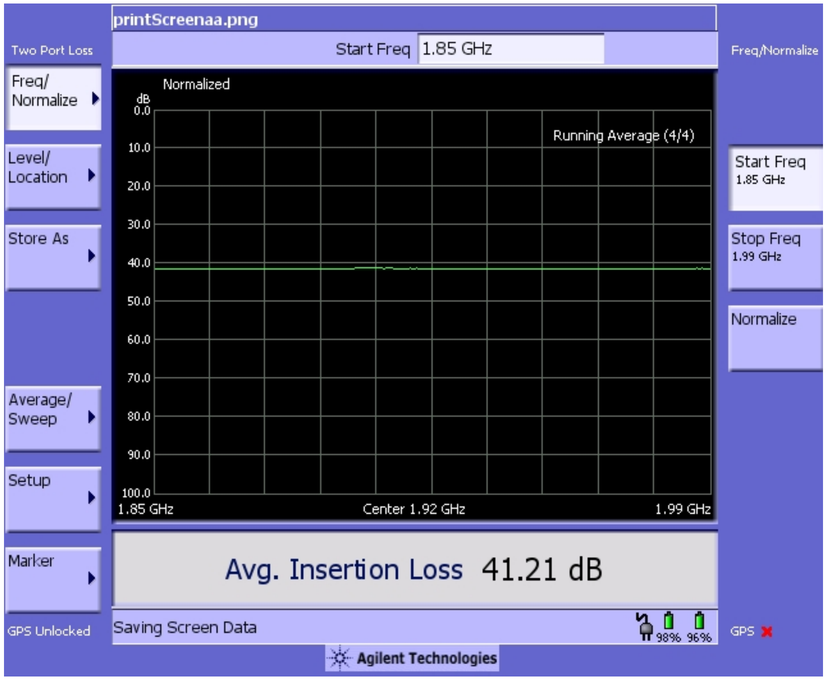
	Step	Notes
1	Connect the cable or device.	Connect the 10 ft. cable, high power attenuator, and other 2 ft. cable (not used for normalization) between the two 10 dB pads that were used for normalization.



	Step	Notes
2	[Level]	If the insertion loss trace is not visible, you can change the reference level or use Autoscale to have the test set select a reference level for you. • Press [Autoscale] to display the trace so that it fills the screen from top to bottom. • Press [Ref Level] and then enter the appropriate value and press [dBm] to manually select a level for the trace.
3	[Store As]	

	Step	Notes
4	[Store As RF IN Loss]	Saves the RF in loss value for use in other measurements.
5	[Store As RF OUT Loss]	Saves the RF out loss value for use in other measurements.

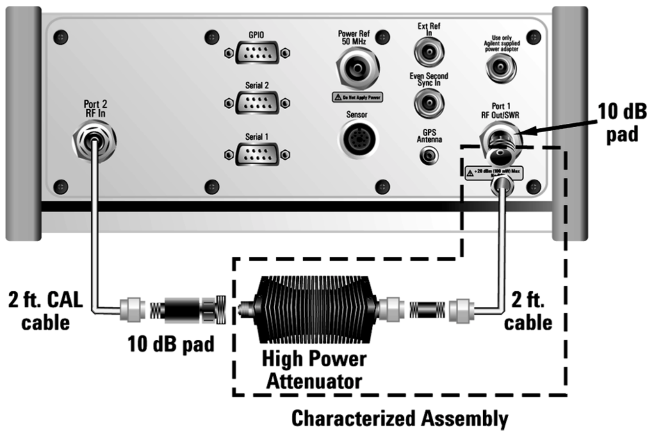
Figure 3-2 Two Port Insertion Loss Measurement Results, Including Effects of 2 ft. Cable, 10 ft. Cable, and High Power Attenuator.



Measuring Insertion Loss for Power Meter

Before making a power measurement, you need to store a PM loss value that will compensate for the loss of the devices you use to connect to the transmitter.

	Step	Notes
1	Connect the cable or device.	Connect the high power attenuator and other 2 ft. cable (not used for normalization) between the two 10 dB pads that were used for normalization.



	Step	Notes
2	[Level]	If the insertion loss trace is not visible, you can change the reference level or use Autoscale to have the test set select a reference level for you. • Press [Autoscale] to display the trace so that it fills the screen from top to bottom. • Press [Ref Level] and then enter the appropriate value and press [dBm] to manually select a level for the trace.
3	[Store As]	
4	[Store As PM Loss]	Saves the loss for use with the power measurement.

Determining The Lowest (Worst) Insertion Loss and Its Frequency

	Step	Notes
1	[Marker]	
2	On [Type] select **Normal**.	Each time you press this softkey, the selected option changes.
3	[Marker to Peak]	Places a marker on the highest peak. The marker value is displayed in the upper right.

Determining the Highest (Best) Insertion Loss and Its Frequency

	Step	Notes
1	[Marker]	
2	On [Type] select **Normal**.	Each time you press this softkey, the selected option changes.
3	[Marker to Min]	Places a marker on the lowest peak. The marker value is displayed in the upper right.

Using the Delta Marker to Measure a Difference in Insertion Loss or Frequency

	Step	Notes
1	[Marker]	
2	On [Type] select **Normal**.	Each time you press this softkey, the selected option changes.
3	[Marker to Peak]	

	Step	Notes
4	On [Type] select **Delta**.	Each time you press this softkey, the selected option changes.
5	[Marker to Min]	Two markers, for Normal and Delta, are displayed. The marker values are displayed in the upper right.

Activating Interference Rejection

Other signals sometimes interfere with insertion loss measurements when measuring the isolation between antennas. When measuring isolation between antennas in the presence of known or suspected interference, you can minimize the effect of the interference by activating Interference Rejection in the test set.

NOTE Use of interference rejection will increase the measurement time. Interference rejection should be used if a known interfering signal exists or if the insertion loss measurement displays suspicious characteristics such as a spike or rapid movements in the noise floor.

To Activate Interference Rejection (During a Two Port Insertion Loss Measurement):

	Step	Notes
1	[Setup]	
2	On [Interference Rejection] select **On**.	Each time you press this softkey, the selected option changes.

Optimizing Dynamic Range

The test set optimizes measurement accuracy by default, at the expense of dynamic range. But there may times when you prefer to gain dynamic range and lose some accuracy. For example, when measuring sector isolation on adjacent antennas, you may want to see a relatively large dynamic range, and your results will not be impaired significantly by 1 to 2 dB less accuracy. Optimizing for dynamic range gains you approximately 30 dB of dynamic range.

	Step	Notes
1	[Setup]	
2	On [Optimize] select **Range**.	Each time you press this softkey, the selected option changes.

4 Adjacent Channel Power

Using the Adjacent Channel Power Measurement

Adjacent Channel Power measures the power of the carrier and the power of the noise in its adjacent channels. The measurement results can help you determine whether the power is set correctly and whether the transmitter filter is working properly. Once you have set the limits, you can easily see whether a test falls within those limits using the mask feature and the color-coded metrics. You can measure the adjacent channel power on one to three adjacent channels on each side of your center channel in the CDMA, UMTS, TDMA, GSM Edge and GPRS, AMPS, NMT-450, Tetra, and iDEN channel bands.

CAUTION When measuring multiple adjacent channels, the combined channel power must not exceed +20 dBm at the RF In port.

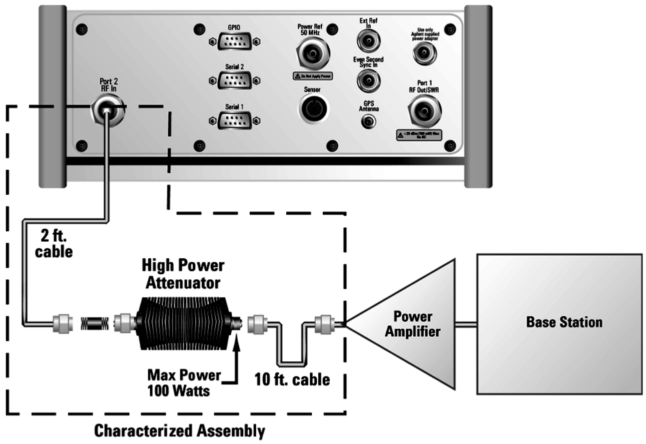
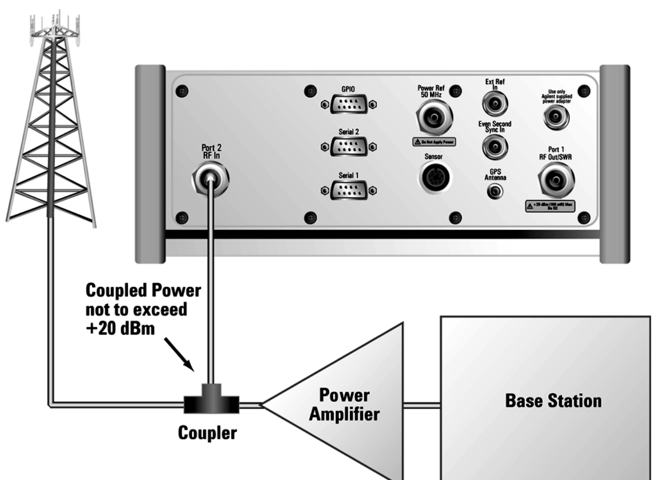
CAUTION The maximum power for the RF In and RF Out port is 20 dBm (100 mW). The maximum power for the Power Sensor port is 24 dBm (300 mW). When directly coupled to a base station, the test set can be damaged by excessive power applied to any of these three ports.

To prevent damage in most situations when you directly couple the test set to a base station, use the high power attenuator between the test set and the BTS.

NOTE For complex modulation such as CDMA, the frequency error measurement is not accurate.

Performing a Basic Adjacent Channel Power Measurement

Step	Notes
1. Select Adjacent Channel Power. a. **Mode** b. [Spectrum Analyzer/Tools] c. [Adjacent Channel Power]	
2 Select the channel standard. a. [Chan Std] b. Select the standard using the up and down arrow buttons. c. [Select]	
3 On [Units] select **Chan**.	Each time you press this softkey, the selected option changes. (The instructions in this manual show selections for Channel.)
4 Setup the frequency/channel you want to view. a. [Freq/Chan] b. [Channel] c. Enter the number on the number keypad. d. [Fwd] or [Rev]	
5 Connect to the base station.	
6 Set the level/location. a. [Level/Location] b. [Autoscale] to turn on c. [Select]	If the adjacent channel power trace is not visible, you can change the reference level or use Autoscale to have the test set select a reference level for you.

Step	Notes
	 **Out-of-service connection**
	 **In-service connection (valid for center channel; adjacent channel measurements may not be valid because there may be active adjacent channels.)**

Setting the Adjacent Channel Power Format

When performing an adjacent channel power measurement, several measurement settings must be specified. The measurement settings include bandwidth and measurement time for the center channel. In addition, the measurement settings for the adjacent channels are:

- number of adjacent channels
- offset of the first adjacent channel from the center channel
- offset of the adjacent channels from each other
- measurement bandwidth and measurement time for each adjacent channel

These settings determine how the DSP measures the center channel and its adjacent channels. Depending on the modulation type of the signal you are trying to measure (CDMA, GSM, etc.), different measurement bandwidths, times, and offsets are required.

Default adjacent channel power measurement settings, called ACP formats, are provided in the E7495A/B base station test sets. Generally, the ACP format is determined by the channel standard you select. However, to accommodate your particular situation, you can decouple the default formats from the channel standard, or you can change each measurement setting independently. The three methods of selecting your measurement settings are:

- **Channel**: Each channel standard has an associated ACP format. With this method, the optimum measurement bandwidth and measurement time for the modulation type are automatically selected when you set the channel standard. For example, when you select GSM-950 as the channel standard, with this method the test set selects the bandwidth and time and adjacent channel offsets for the GSM format.
- **List**: Select the ACP format from a list of values that are set automatically—independent of the channel standard.
- **Custom**: Manually set all parameters: the measurement bandwidth and measurement time for the center and adjacent channel(s), the offset from the center channel for the first adjacent channel, and the offset between adjacent channels.

To Select the Channel Format Type:

Step	Notes
1. [ACP Format]	
2. [Format Type]	Each time you press this softkey, the selected option changes. The option you select determines which buttons on the right are active.
3. [Chan]	
4. Select the standard you want. a. [Chan Std] b. Select the standard using the up and down arrow buttons. c. [Select]	Channel BW/Time is available, but all buttons are grayed out, enabling you only to view the settings. To change any of the settings, choose Cust.

To Select the List Format Type:

Step	Notes
1. [ACP Format]	
2. [Format Type]	Each time you press this softkey, the selected option changes. The option you select determines which buttons on the right are active.
3. [List]	
4. Select the format you want. a. [Format List] b. Select the standard using the up and down arrow buttons. c. [Select]	Channel BW/Time is available, but all buttons are grayed out, enabling you only to view the settings. To change any of the settings, choose Cust.

To Select the Custom Format Type:

Step	Notes
1. [ACP Format]	
2. [Format Type]	Each time you press this softkey, the selected option changes. The option you select determines which buttons on the right are active.
3. [Cust]	
4. Set the carrier and adjacent channel bandwidth. a. [Channel BW/Time] b. [Center Chan Meas BW] c. Enter the center channel bandwidth on the number keypad. d. [GHZ] or [MHz] or [kHz] or [Hz] e. [Center Chan Meas Time] f. Enter the center channel measurement time on the number keypad. g. [ms] h. [Adj Chan Meas BW] i. Enter the adjacent channel bandwidth on the keypad. j. [GHZ] or [MHz] or [kHz] or [Hz] k. [Adj Chan Meas Time] l. Enter the adjacent channel measurement time on the keypad. m. [ms] n. [Back]	

5 Set the offset from the carrier to the first adjacent channel.

   a. [Ctr to Adj Step Size]

   b. Enter the offset on the number keypad.

   c. [GHZ] or [MHz] or [kHz] or [Hz]

6 Set the offset between adjacent channels.

   a. [Adj to Adj Step Size]

   b. Enter the offset on the number keypad.

   c. [GHZ] or [MHz] or [kHz] or [Hz]

7 Set the number of adjacent channels (from 0-3).

   a. Enter the number on the number keypad.

   b. [Enter]

Setting Average, Sweep, and Restart

Setting the Sweep

You can select either continuous or single sweep. Continuous sweep provides repeated, ongoing measurements. Single sweep performs a single measurement that is repeated only when you push the Single button.

To set sweep:

	Step	Notes
1	[Average/Sweep]	
2	[Continuous] or [Single]	Each time you press this softkey, the selected option changes.

Setting Averaging

You can choose to have averaging on or off and set the number of averages you want to take. Averaging only applies to the data, not the trace. You can select from the following types of averaging:

- **Off**: Disables averaging.
- **Running:** Computes the new result as the weighted sum of the last result and the new measurement. The last result is weighted by (n – 1)/n. The new result is weighted by 1/n. Each new measurement produces a new result.
- **Max Hold**: Is not an average, but on a point by point basis, displays the maximum amplitude for the given frequency or channel since Max Hold was turned on. It is updated when a new maximum occurs.
- **Group Average:** Makes the requested number of measurements, averages the measurement data, and displays the average as a single result trace. Measurement time will vary based on the requested number of averages and can take minutes for very large number of averages.
- **Group Max Hold:** Makes the requested number of measurements before returning a single trace result. This trace is the maximum

value seen at each trace point over the requested number of averages (measurements).

To set averaging:

	Step	Notes
1	Set the number of averages. a. [Average] b. Enter the number of averages using the number keypad. c. [Enter]	
2	Select the type of averaging you want to apply. a. [Average/Sweep] b. [Averaging] c. [Off], [Running Average], [Max Hold], [Group Average], or [Group Max Hold]	

NOTE

These two steps can be performed in any order. However, if you turn averaging on and a large number of averages has previously been set, there may be a delay before you can change number of averages.

Setting Restart

When you have averaging turned on, you can restart the averaging by pressing the Restart menu key. This restarts the averaging for running average and max hold average in either Continuous or Single sweep mode.

To restart averaging:

	Step	Notes
1	[Average/Sweep]	

	Step	Notes
2	[Restart]	

Displaying Accurate Peak Power (Recommended for Pulsed Signals)

For pulsed signals, you can get a more accurate measurement of the signal's peak or average power by using the Peak Power Detector option in the test set.

The test set measures average power of signals by default. But for non-constant-duty-cycle signals such as GSM, an average power reading fails to accurately show amplitude when the signal is on if other timeslots in the frame are powered off.

If the [Power Detector] menu key is grayed out, the test set needs to be upgraded in order to measure pulsed signals. Contact the Agilent Service Center for upgrade information.

If it is not a peak signal, it is probably better to select Average for a more accurate result.

To Display Peak Power:

	Step	Notes
1.	[Setup]	
2.	On [Power Detector] select **Pk**.	Each time you press this softkey, the selected option changes.

Setting the Control Units

In some instances you may be provided specifications by engineering in either dBm or watts. You can switch between the two units in order to make it easier to interpret measurement results.

To Change Units on the Y-Axis:

	Step	Notes
1.	[Level/Location]	

Step	Notes
2. [Units]	Each time you press this softkey, the selected option changes.
3. [dBm] or [Watts]	There is no change made to the Y-axis. The change is to the units for entry. The reference level changes on the graph, but not the axis labels.

Setting the Range Control

The autoranging feature, built into the test set, helps ensure accurate measurements by changing front-end amplifier gain as needed, when a strong signal threatens to overload the test set. When this occurs, the noise floor rises (as gain is decreased), then falls again when the strong signal stops. To select this feature:

- On [Range Ctrl] select **Auto** to enable the E7495A and E7495B to continuously adjust the noise floor to the optimum setting.

If you prefer a fixed noise floor, you can disable autoranging in two ways using the Setup function within Spectrum Analyzer:

- On [Range Ctrl] select **Hold** to fix the noise floor at the current level. A subsequent strong signal—even outside the measurement range—may cause an inaccurate reading due to overloading the front-end of the test set.
- On [Range Ctrl] select **Max** to fix the noise floor at the current level until a strong signal comes in. In that case, the floor will rise to maintain accuracy, but will not return to its lower level after the strong signal stops.

Step	Notes
1. [Setup]	
2. [Range Ctrl]	
3. [Auto] [Hold] or [Max]	

Setting the Analyzer Input Gain

Normally the E7495A and E7495B are set to add the most gain in the receive path to boost low-level signals. If the signal is high, there is no reason to add gain. When you're measuring a strong signal, select low sensitivity to reduce the gain in the receive path and lower the noise floor. For a low level signal, select high.

Step	Notes
1. [Setup]	
2. [Sensitivity]	
3. [Low] or [High]	

Setting the Pass/Fail Limits

The E7495A and E7495B use generic defaults, rather than standard defaults. You can change those to accommodate your base station settings.

- **Power Limits**: Sets the high and low limits of the center channel, as well as the high limit of the adjacent channels. Center channel limits are set in dBm and are absolute. Adjacent channel limits are set in dB and are relative to the center channel power. The settings you choose define the shape of the mask displayed on the screen. To measure only the outer frequencies, turn off the mask. These settings affect the metrics color display: red is fail, green is pass.
- **Frequency Limits**: Sets the high and low frequency limits for the center channel only. These settings affect the metrics color display: red is fail, green is pass.

To Change Power Limits:

Step	Notes
1. [Setup]	
2. [Power Limits]	
3. [Power Limits]	
4. [On] or [Off]	

Step	Notes
5. Set the center channel upper limit. a. [Center Chan High Limit] b. Enter the number on the number keypad. c. [dBm]	
6 Set the center channel lower limit. a. [Center Chan Low Limit] b. Enter the number on the number keypad. c. [dBm]	
7 Set the adjacent channel 1 upper limit. a. [Adj Chan 1 High Limit] b. Enter the number on the number keypad. c. [dB]	
8 Set the adjacent channel 2 upper limit. a. [Adj Chan 2 High Limit] b. Enter the number on the number keypad. c. [dB]	
9 [Back]	

To Change Frequency Limits:

Step	Notes
1. [Setup]	

Step	Notes
2. [Frequency Limits]	
3. [On] or [Off]	
4. Set the upper limit. a. [Frequency High Limit] b. Enter the number on the number keypad. c. [GHZ] or [MHz] or [kHz] or [Hz]	
5 Set the lower limit. a. [Frequency Low Limit] b. Enter the number on the number keypad. c. [GHZ] or [MHz] or [kHz] or [Hz]	

W-CDMA (UMTS) Adjacent Channel Leakage Power Ratio (ACLR) Measurements

One of the most important measurements on RF signals for digital communication systems is the leakage power into the adjacent channels. A quantitative figure of merit is adjacent channel power ratio (ACPR) or adjacent channel leakage ratio (ACLR). The ACLR measurement determines how much of the transmitted power is allowed to leak into the first and second neighboring carriers (high side and low side). Leakage of RF power into adjacent channels or bands can cause major interference to occur on another carrier's network.

The measurement of ACLR is defined as the ratio of the average power in the adjacent frequency channel to the average power in the transmitted frequency channel. It is reported in dBc (dB relative to the main carrier).

Test models are used to have pre-defined test conditions for base station conformance test of ACLR. Under 3GPP TS 25.141, four types of test models are defined. Each test model consists of PCCPCH (Primary Common Control Physical Channel), PICH (Paging Indication Channel), CPICH (Common Pilot Channel), SCH (Synchronization Channel) and some DPCHs (Dedicated Physical Channels).

Figure 4-1 Sample Measurement of ACLR on a Valid 3GPP W-CDMA UMTS Signal

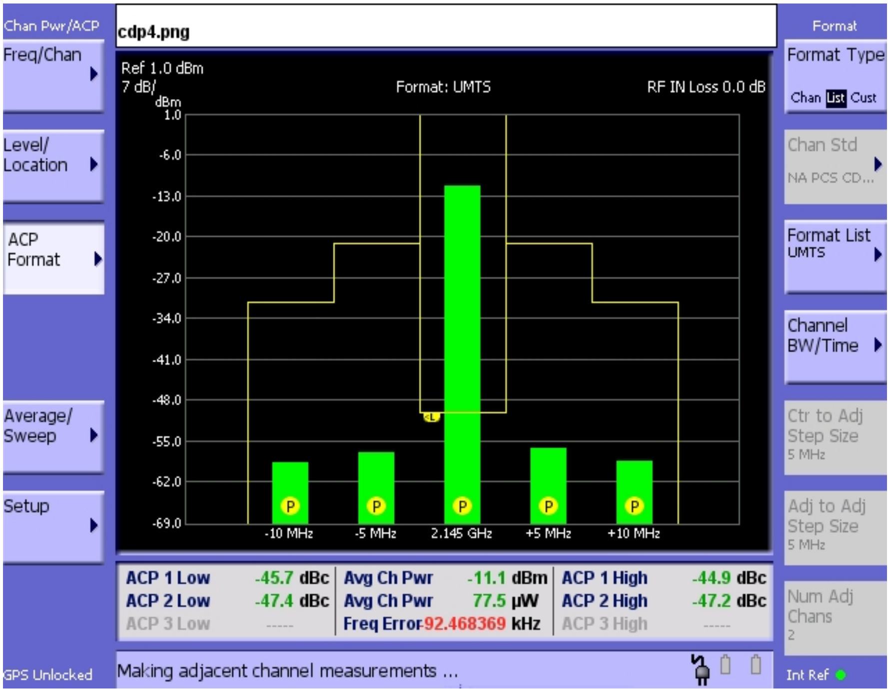


Figure 4-1 is an example of the measurement results as a bar graph of the power levels at different offsets. This gives you a quick reading of respective powers. The bar graph is green with 'P' on the bar graph, indicating the ACLR measurement passes at the 5 MHz and 10 MHz offsets.

NOTE The 3GPP standard for W-CDMA (UMTS) requires the adjacent channel power leakage ratio to be better than 45 dB at 5 MHz offset and 50 dB at 10 MHz offset.

---

5 CDMA Analyzer

Using the CDMA Analyzer

CDMA transmitter measurements verify proper transmitter performance and are typically made with the base station out of service. Important metrics are frequency error, PN and time offsets, channel power, waveform quality (estimated Rho), carrier feedthrough, noise floor, pilot power, and the delta powers between the pilot and the page, sync and quick paging code channels.

For information about CDMA over air measurements, refer to the “CDMA Over Air” chapter.

CAUTION The maximum power for the RF In and RF Out port is 20 dBm (100 mW). The maximum power for the Power Sensor port is 24 dBm (300 mW). When directly coupled to a base station, the test set can be damaged by excessive power applied to any of these three ports.

To prevent damage in most situations when you directly couple the test set to a base station, use the high power attenuator between the test set and the BTS.

Common CDMA Tx Analyzer Measurements

Preparing to Make CDMA Tx Analyzer Measurements

The first step in measuring CDMA transmitter performance is to take the base station out of service. The next step is to choose the type of time reference available. The measurement configuration depends upon the type of time reference you choose to use. Optimally, a GPS time reference is desired. GPS provides an independent time reference that can help determine if the base station under test is synchronized with the rest of the network. Base stations not synchronized with the rest of the network are referred to as island cells.

NOTE If a GPS time reference is unavailable, you must connect to the even second pulse from the base station.

You must also know the channel or frequency and the PN Offset of the CDMA signal to be analyzed. Each base station sector has a unique PN Offset. For more information on PN Offsets refer to the “Adding a

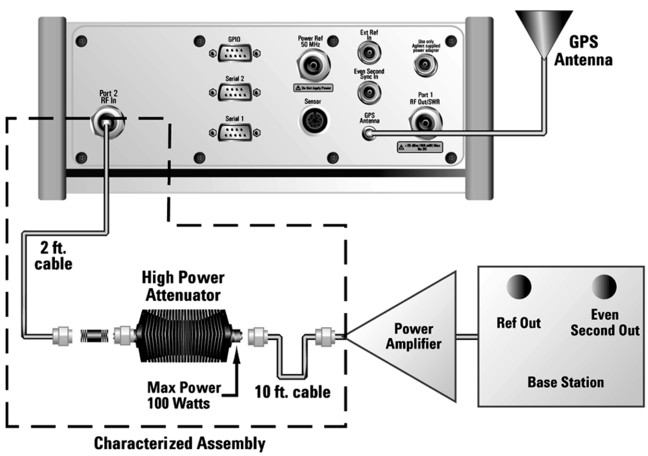
Marker" on page 94.

Performing a Basic CDMA Transmitter Measurement

Once you have taken the base station out of service and made the proper connections, you can perform CDMA transmitter measurements.

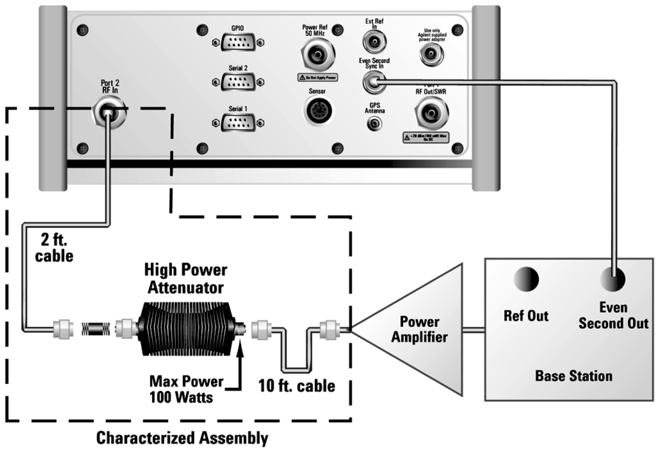
	Step	Notes
1.	**Mode**	
2.	[Tx Analyzer]	
3.	[CDMA Analyzer]	
4.	[Chan Std]	
5.	Highlight the channel standard you want using the up and down arrow buttons.	
6.	[Select]	
7.	On [Units] select **Chan** or **Freq**.	Each time you press this softkey, the selected option changes.
8.	Enter the channel or frequency using the number keypad.	
9.	[Fwd]	Selects the forward CDMA channel.
10.	[Fr/Time Ref]	
11.	[GPS] or [External Even Sec]	GPS is the preferred time reference. But if a view of the sky (satellites) is not available, use External Even Sec. When using Even Second, the base station timing is relative to itself.

Step	Notes
12. On [PN Offset] select **Auto** or **Manual**.	The test set defaults to Auto mode. The other choice is Manual. • In Auto mode the test set finds the PN Offset and displays the value in the metrics display at the bottom of the screen. The Time Offset is derived from the found PN Offset. • In Manual mode you must enter the PN Offset, which appears in the metrics display. The Time Offset is derived from the entered PN Offset.
13. Connect to the base station.	

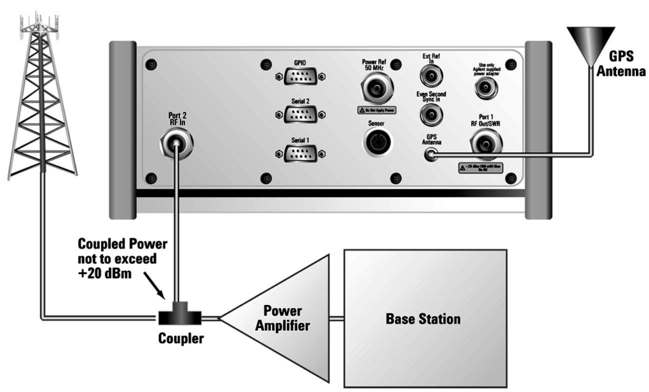


Connections for out of service CDMA measurements with GPS receiver as timing reference

Step	Notes

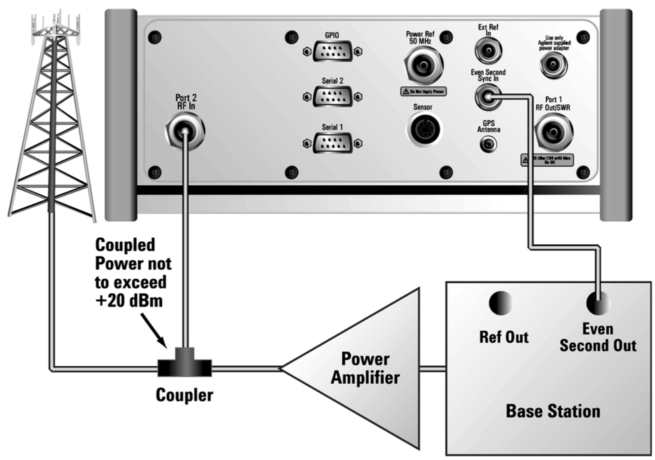


Connections for out of service CDMA measurements with base station even second as timing reference



Connections for in service CDMA measurements with GPS receiver as timing reference

Step	Notes



Connections for in service CDMA measurements with base station even second as timing reference

NOTE During a CDMA Analyzer measurement, a yellow triangle symbol may temporarily appear beside “GPS” in the lower right. The yellow triangle indicates that the test set is re-synching with the GPS even second pulse. Once the test set is synched, a green dot appears in place of the triangle. If the GPS is unavailable, a red X appears.

Interpreting the Display

The CDMA Tx Analyzer screen is divided into two sections:

- The trace display, the graphic bar chart taking up most of the screen
- The metrics display, a table of values at the bottom of the screen

The *trace display* contains a code domain power display. In this display 128 Walsh codes are shown in bit-reversed order to represent the combined code channels for the varying data rate traffic channels. The Y-axis labels display the relative power (dB) or absolute power (dBm), threshold level, and dB/division. The X-axis labels display active channel numbers. Active code channels shown on the display include:

- Pilot (red)
- Page (green)
- Sync (blue)
- Quick page (light blue)
- IS-95 traffic (yellow)
- cdma2000 traffic (orange)
- Unknown traffic (tan)
- Noise (light gray)

The *metrics display* shows 12 measurement parameters displayed below the trace display in three columns and four rows—each with a value and units. For more information about the parameters in the metric display, refer to "Metrics Provided by the CDMA Tx Analyzer Measurement" on page 96.

The frequency indicator is at the bottom left, the time reference indicator at the bottom right. For each indicator the text indicates which reference you have chosen. A green LED indicates a locked condition, a red "X," an unlocked condition.

Optional CDMA Tx Analyzer Measurement Settings

You can change several optional measurement parameters in the CDMA Tx Analyzer:

- "Setting the Channel or Frequency Step" on page 88
- "Setting the PN Increment" on page 89
- "Setting the CDMA Transmitter Reference Level" on page 89
- "Setting the Active Channel Threshold Level and Auto Threshold Level" on page 90
- "Setting Measurement Time" on page 91
- "Setting Quick Page Channel" on page 91
- "Setting Average, Sweep, and Restart" on page 93
- "Adding a Marker" on page 94

Setting the Channel or Frequency Step

You can set the channel or frequency step so you can quickly increment to the next channel or frequency using the up and down arrow buttons.

	Step	Notes
1.	[Chan Step] or [Freq Step]	This choice depends on the [Units] mode you are using.
2.	Enter the desired channel or frequency step using the number keypad.	
3.	[Enter]	Notice (and verify) the number you entered below the Chan Step or Freq Step text on the corresponding button.

Setting the PN Increment

The PN Increment allows you to choose the increment step for the PN Offset. Typically the PN Increment is set to 1 when measuring CDMA transmitter performance while connected to the base station via RF cable.

	Step	Notes
1.	[PN Inc]	
2.	Enter the PN Increment using the number keypad.	The maximum value you can enter is 15.
3.	[Enter]	

Setting the CDMA Transmitter Reference Level

You can set the CDMA transmitter reference level to display either relative power (dB) or absolute power (dBm). The test set defaults to relative. The top graticule (horizontal line) represents the total power in the CDMA channel. The scale per division is set to 5 dB per division.

If the reference level is set to relative, the reference level is relative to the total power (in dB) in the CDMA channel. If the reference level is set to absolute, the reference level displays the actual power (in dBm) in the CDMA channel.

To Set the CDMA Transmitter Reference Level:

	Step	Notes
1.	[Level]	
2.	On [Reference] select **Abs** or **Rel**.	Each time you press this softkey, the selected option changes.
3.	[RF IN Loss]	

	Step	Notes
4.	Enter the RF in loss using the number keypad.	If you are using a cable and attenuator connected to the base station power amplifier, enter the combined cable and attenuator RF in loss here. The RF in loss can be obtained by measuring the Insertion loss. See “Two Port Insertion Loss” on page 47. **Note:** If data had been previously entered in [RF IN Loss], that data will be lost and replaced by the value you enter here.
5.	[dB]	

NOTE The insertion loss of the test cable and high power attenuator must be accounted for to obtain accurate CDMA power measurements such as channel power and pilot power. The insertion loss of the test cable/attenuator combination are accounted for as the RF IN Loss, which is an offset applied to the power measurements by the test set.

Setting the Active Channel Threshold Level and Auto Threshold Level

The active channel threshold level is an advanced setting that 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. The test set can set this level automatically, or you can manually enter a value.

In Auto mode the threshold level moves as the noise fluctuates. The threshold level is set by the test set at an optimal offset above the average noise floor. In Auto mode, you can alter the Auto Threshold Offset. The recommended and default setting is 0 dB. A negative value moves the threshold lower (closer to the noise floor) and is a more aggressive setting that increases the likelihood of interpreting an inactive channel as active. A positive value moves the threshold higher (away from the noise floor) and is a more conservative setting that increases the likelihood of interpreting an active channel as inactive.

In Manual mode the threshold level is fixed and does not move as the noise fluctuates.

To Set the Active Channel Threshold Level (While in CDMA Tx Analyzer Mode):

	Step	Notes
1.	[Setup]	
2.	On [Thresh Lvl] select **Auto** or **Manual**.	Each time you press this softkey, the selected option changes. If you choose Manual, you must enter the threshold you want using the number keypad, then press [dB].
3.	[Auto Thres Offset]	The default value is 0 dB. Optionally, you can enter a negative (more aggressive) or positive (more conservative) value, then press [dB].

Setting Measurement Time

The measurement time setting allows you to alter the speed at which measurements are made. Three choices exist: Slow, Average, and Fast. The test set defaults to Average. Slow measurement time provides a more accurate measurement at the expense of time. Fast measurement time provides a quicker measurement at the expense of accuracy. Average measurement time strikes a balance between measurement speed and accuracy.

To Set the Measurement Time:

	Step	Notes
1.	[Setup]	
2.	On [Meas Time] select **Slow**, **Avg**, or **Fast**.	Each time you press this softkey, the selected option changes.

Setting Quick Page Channel

With the advent of cdma2000, a new control channel called the quick page channel (QPCH) has been added. The QPCH is used to improve standby time in the phone and may or may not be enabled. The QPCH is generally channel number 80. Note that the QPCH is a bursted channel. In other words, it is not on all the time. You may have to wait to see the QPCH show up on the trace. The Delta QPCH Power parameter on the metric display can help you determine the level of the QPCH. The QPCH is also a single-wide channel: it only occupies one of the 128 channels. The pilot, paging, and sync control channels are double-wide channels and occupy two of the 128 channels on the display.

To Set the QPCH (While in CDMA Tx Analyzer Mode):

	Step	Notes
1.	[Setup]	
2.	On [Quick Page Channel] select **Off** or **Ch 80**.	Each time you press this softkey, the selected option changes.

Setting Average, Sweep, and Restart

Setting the Sweep

You can select either continuous or single sweep. Continuous sweep provides repeated, ongoing measurements. Single sweep performs a single measurement that is repeated only when you push the Single button.

To set sweep:

	Step	Notes
1	[Average/Sweep]	
2	[Continuous] or [Single]	Each time you press this softkey, the selected option changes.

Setting Averaging

You can choose to have averaging on or off and set the number of averages you want to take. When turned on, the Agilent E7495A/B does a running average:

- A running average computes the new result as the weighted sum of the last result and the new measurement. The last result is weighted by (n – 1)/n. The new result is weighted by 1/n. Each new measurement produces a new result.

To set averaging:

	Step	Notes
1	Set the number of averages. a. [Average] b. Enter the number of averages using the number keypad. c. [Enter]	

	Step	Notes
2	Set averaging On or Off. a. [Average/Sweep] b. [Averaging] c. [Off] or [On]	

CDMA Analyzer

NOTE These two steps can be performed in any order. However, if you turn averaging on and a large number of averages has previously been set, there may be a delay before you can change number of averages.

Setting Restart

When you have averaging turned on, you can restart the averaging by pressing the Restart menu key. This restarts the averaging for running average in either Continuous or Single sweep mode.

To restart averaging:

	Step	Notes
1	[Average/Sweep]	
2	[Restart]	

Adding a Marker

Markers can be used on traces to help you visually track up to four signals. Each marker has the following settings:

- **Type**: Provides three options, including:
  - **Off**
  - **Normal**, which places a diamond-shaped, colored marker, along with a number, 1-4, on the trace.
  - **Delta**, is associated with a normal marker. Therefore, a normal marker must exist prior to creating the delta marker. The delta marker displays the difference between the normal marker position and the delta marker position. Only one delta marker can

be associated with a given normal marker. The normal marker must be active when Delta is selected.

- **Marker to Peak**: Places the active marker on the current greatest value of the trace.
- **Marker to Next Peak**: Places the active marker on the current second greatest value of the trace.

Step	Notes
1. [Marker]	
2. [Marker]	
3. [1], [2], [3], or [4]	
4. [Type]	
5. [Off], [Normal], or [Delta]	
6. Locate the marker relative to the trace: • [Marker to Peak] or • [Marker to Next Peak]	

Metrics Provided by the CDMA Tx Analyzer Measurement

This section contains descriptions of the individual CDMA transmit parameters in the metric display of the screen. The “Interpretation of CDMA Tx Analyzer Measurement Results” section contains expected result values and possible causes of error if the expected results are not met.

Frequency Error

Frequency error is the frequency difference between your transmitter's actual center frequency and the frequency (or channel) you entered.

PN Offset

The PN Offset is a “short code” sequence that provides a unique identifier for each sector of each cell site. The PN Offsets are applied to the I and Q signals before modulation. PN Offsets are offset in time by 52.08 µs and they repeat every 26.666 ms. This yields 512 unique short code sequences (0-511). The mobile phone needs the PN Offset to decode information in the Sync and Paging channels, which are transmitted by the base station.

Time Offset

The Time Offset compares the PN Offset timing with the overall system time. This measurement checks the start of the PN offset in comparison to the Even Second clock signal. For example, PN Offset 0 should repeat exactly on the rising edge of the Even Second clock. PN Offset 1 should repeat 52.08 µs after the rising edge of the Even Second clock, and so forth. Any error in time from that event is reported as a Time Offset.

Channel Power

Channel Power is the integrated power within a defined bandwidth. For CDMA the channel bandwidth is defined to be 1.25 MHz. Channel Power measures the power the base station is transmitting across the entire 1.25 MHz CDMA channel.

Estimated Rho

Estimated Rho is the measure of the modulation quality for a CDMA transmitter. This measurement is analogous to measuring FM accuracy and distortion in an AMPS network or EVM in a TDMA system. A Rho value of 1.0 is perfect, indicating that all of the power is being transmitted correctly.

Carrier Feedthrough

Carrier Feedthrough is a result of the RF carrier signal feeding through the I/Q modulator and riding on the output circuitry without being modulated. Carrier Feedthrough is a common cause of bad Rho measurements.

Noise Floor

Noise Floor is the average power of all the inactive channels.

Pilot Power

Pilot Power is the total power in the Pilot code channel, expressed in dBm. The transmit power of the Pilot Channel signal for a given base station is normally constant.

Delta Page Power

Delta Page Power is the amplitude difference between the Paging Channel and Pilot Channel, expressed in dB. The transmit power of the Paging Channel is constant and can be set at a value relative to the Pilot Power. A common value is -4 dB relative to the Pilot.

Delta Sync Power

Delta Sync Power is the amplitude difference between the Sync Channel and Pilot Channel, expressed in dB. The transmit power of the Sync Channel is constant and may be set at a value relative to the Pilot Power. A common value is -10 dB relative to the Pilot.

Delta Quick Page Channel Power

Delta Quick Page Channel (QPCH) Power is the amplitude difference between the Quick Page Channel and Pilot Channel, expressed in dB. The QPCH is a bursted channel and is not on all the time. In order to capture the level of the QPCH, the statistic measures and holds the peak level of the QPCH. Until a QPCH has been measured, the value will be dashes. When “on”, the level of the QPCH is constant and is set at a value relative to the Pilot Power. The QPCH digital gain level can be set to 2, 1, 0, -1, -2, -3, -4, and -5 dB relative to the Pilot.

Interpretation of CDMA Tx Analyzer Measurement Results

This section contains expected result values and possible causes of error if the expected results are not met.

Frequency Error

The standards specify very tight Frequency Error performance. In the PCS bands, the 0.05 parts-per-million specification translates to only 99 Hz at a carrier frequency of 1980 MHz or 40 Hz at 850 MHz cellular frequencies. Frequency Error shows up as uncorrelated power that adds to the noise floor or shows up in other Walsh codes.

If a particular site loses its reference to GPS time, its reference signals will begin to drift over time. Phones already using the site can remain on the air because they derive their timing from the signals transmitted by the base station. However, phones using other sites/sectors may be prevented from using the site because they are confused by the error in frequency. This creates what is known as the “island cell” effect. By itself, the cell is still functional. To the rest of the system, it's inaccessible.

This island cell effect can be caused by a failure in the site's GPS receiver and timebase distribution network. Using the test set's Internal GPS receiver provides an independent time reference that will allow you to determine if this cell site is out of sync with the rest of the network (“island cell” effect).

PN Offset

Verify that the PN Offset is correct. If you are in Manual mode, the PN Offset will display the value you entered. Make sure the Time Offset is small (less than 3 μs). If the Time Offset is greater than expected, see the section on Time Offset below. If you are in Auto mode, the test set will tune to the PN Offset with the least amount of Time Offset. If an incorrect PN Offset is displayed, the Time Offset will likely be very small.

Time Offset

The CDMA standards specify a maximum offset of 10 μs; generally 5 μs is a recommended maximum. If the Time Offset is large enough, an “island cell” can occur. The “island cell” effect was mentioned already when discussing Frequency Error.

A phone moving outward toward the limit of its cell will need to acquire the adjacent cell in order to hand off. If the time offset of the target cell is too far from that of the current site, the handoff may not happen.

The dependence of the phone on correct system time limits the physical distance to a target cell's antenna. Each PN Offset is 52.08 µs; if the propagation delay is too long, the received PN Offset may be different from the value designated on the Sync channel. This difference can confuse the phone, causing the handoff to fail.

Another cause of timing error is a bad GPS receiver or timing distribution network within the base station. To test your base station's GPS and timing distribution system, you can use the internal GPS receiver to generate an accurate timing reference for the test set to use while performing base station tests.

Channel Power

When making channel power measurements, make sure you have accounted for the loss of the test cable and high power attenuator you are using. If you do not know the loss of your test cable and high power attenuator configuration, perform an insertion loss measurement and enter the insertion loss as the RF IN Loss value. For more information see “Two Port Insertion Loss” on page 47.

If the channel power is lower than expected, verify you have a good connection to the RF output of the base station. Also, verify the cable you are using to connect to the base station is not faulty. A low channel power may also indicate a bad power amplifier.

Inaccurate channel power (high or low) may indicate an incorrect power setting at the base station.

Estimated Rho

The CDMA base station standard specifies that Rho must be greater than 0.912. Typical values for a healthy base station are greater than 0.94.

Rho failures can indicate problems in:

- Compression in linear amplifiers
- Magnitude and phase errors in the IQ modulator

- Phase non-linearity (group delay)
- Spurious signals in the transmission path
- Carrier feedthrough

Because the uncorrelated power appears as interference to the phones, poor Rho performance will affect the sector's capacity. The added interference can require that the signal on traffic channels be raised to overcome the interference. This may, in turn, be seen as further interference. At some point, the site will have to shed calls in order to supply the remaining calls with enough signal versus the interference in the system.

Carrier Feedthrough

A good carrier feedthrough level is less than -25 dB. The IS-97 standard does not specify carrier feedthrough; however, this measurement provides an additional tool to troubleshoot the base station's transmitter.

In the frequency domain, carrier feedthrough can show up as an uncorrelated energy spike that can be seen on the spectrum analyzer by closely spanning into the top of the CDMA signal. The effects of carrier feedthrough can also show up as higher noise levels on the Code Domain Power screen. The inactive Walsh codes will be pushing the -27 dB specification for noise. Carrier feedthrough can be caused by the lack of isolation across the mixer and cavity of the transmitter's I/Q modulator. Shielding can help reduce carrier feedthrough.

Noise Floor

A good noise floor value is between -40 dB and -45 dB for modern base stations. If the noise floor is above these values (for example, -20 dB), the modulator may be the source of the added noise. Another possibility is a problem with the base station's channel card. The channel card generates the individual Walsh codes.

Pilot Power

If the measured value of pilot power is more than +/-0.5 dB different from the intended setting, it may indicate the following:

- There has been a change made to the digital gain setting of the pilot channel.
- The base station power amplifier has a problem.

Delta Page Power

If the measured value of Delta Page Power is more than +/-0.5 dB different from the intended setting, it may indicate that the digital gain setting for the Paging Channel has been changed.

Delta Sync Power

If the measured value of Delta Sync Power is more than +/- 0.5 dB different from the intended setting, it may indicate that the digital gain setting for the sync channel has been changed.

Delta Quick Page Channel Power

If the measured value of Delta QPCH Power is more than +/-0.5 dB different from the intended setting, it may indicate that the digital gain setting for the QPCH has been changed.

6 CDMA Over Air

Using the CDMA Over Air Tool

CDMA over air measurements provide a quick method of verifying CDMA transmitter performance. These transmitter measurements can be made on a base station from the convenience of your vehicle without taking the base station out of service. Over air measurements are especially useful in maintaining hard-to-access cell sites such as pole top base stations. The CDMA Over Air option may also be used to measure signals at a coupled port on the transmitter.

For out-of-service CDMA transmitter measurements, the CDMA Tx Analyzer option is recommended. For more information refer to "CDMA Analyzer" on page 81.

CAUTION To achieve valid over-the-air measurements, the test set must be stationary (not moving). An alternative is to make these measurements from a coupled port at the base station.

CDMA Over Air Measurements

Preparing to Make CDMA Over Air Measurements

An important consideration when making CDMA over air measurements is your location relative to the base station. There must be no obstructions between your location and the base station antennas. Also, the GPS antenna must be able to "see" the satellites to obtain lock. Using Internal GPS for the time reference has the same advantages mentioned for CDMA Tx Analyzer measurements ("island cell" detection).

You must know the channel or frequency and the PN offset of the CDMA signal to be analyzed. Each base station sector has a unique PN offset. For more information on PN offsets refer to the "Metrics Provided by CDMA Over Air Measurements" on page 121.

Performing a Basic CDMA Over Air Measurement

Once you have connected the proper antenna to the test set, chosen a stationary location, and verified that you have a clear view of the base station antennas, you can perform CDMA over air measurements.

If this is the first CDMA over air measurement for this base station, you must find a location that meets the criteria for making a valid measurement. Your location must have a dominant pilot and very low multipath power. If you have made CDMA over air measurements at this location before and know it provides valid measurements, skip to "Performing a Basic CDMA Over Air Measurement" on page 106.

Criteria for Making Valid CDMA Over Air Measurements

The first step in making valid W-CDMA over air measurements is to identify a target base station to measure. Then, for your measurements to be valid, you must find a location near the target base station with a sufficiently strong W-CDMA signal. CDMA over air measurements will experience interference from other CDMA signals on the same RF channel and from multipath echoes. The code domain power view measures two key parameters to indicate these effects:

- Pilot dominance—The difference between the energy of the strongest pilot channel and the combined energy in the second and third strongest pilot channels (expressed in dB). Ideally, this value should be very large (> 16 dB)
- Multipath power—The amount of power, of the dominant pilot signal, that is dispersed outside the main correlation peak due to multipath echoes (expressed in dB). Ideally, this value should be very small (< 0.1 dB).

The table below shows the quality of the over air code domain measurements with respect to pilot dominance and multipath power.

Measurement Quality	Pilot Dominance	Multipath Power
Very good	> 16 dB	< 0.1 dB
Fair	> 10 dB	< 0.4 dB
Marginal	> 8 dB	< 0.7 dB

The default measurement limits for pilot dominance and multipath power are set to give "fair" measurement quality. If these limits are met, the pilot dominance and multipath power values will be displayed in green. When the pilot dominance and multipath power parameters are outside the acceptable limits, the parameters will turn red. If this occurs, you must move to a different location that meets the "fair" criteria defined above.

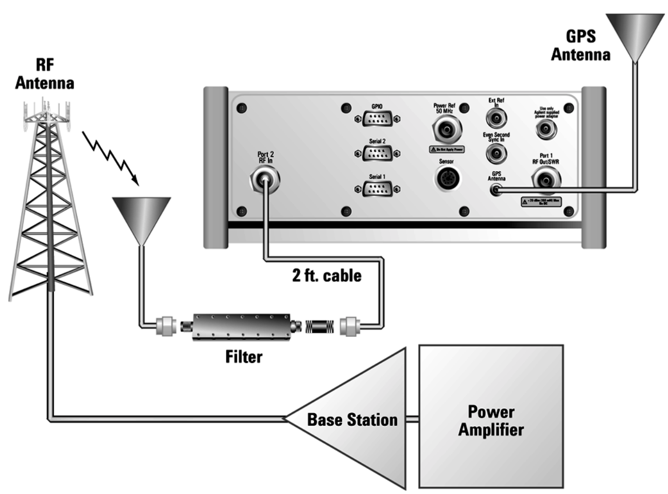
In general, you should always use a preselector filter for the band of interest to prevent strong signals from swamping out the signal of interest. Agilent offers these preselectors and antennas:

- Option 810—Cellular downlink band preselector and antenna
- Option 811—PCS downlink band preselector and antenna
- Option 812—Korean PCS downlink band preselector and antenna

Performing a Basic CDMA Over Air Measurement

	Step	Notes
1	**Mode**	
2	[Over Air]	
3	[CDMA Over Air]	
4	[Chan Std]	
5	Select the channel standard you want using the up and down arrow buttons.	
6	[Select]	
7	On [Units] select **Chan** or **Freq**.	Each time you press this softkey, the selected option changes.
8	[Channel] or [Frequency]	• If you selected **Chan** in the previous step, select [Channel]. • If you selected **Freq**, select [Frequency].
9	Enter the channel or frequency using the number keypad.	
10	[Fwd]	Selects the forward CDMA channel.

	Step	Notes
11	Verify that on [Fr/Time Ref] **GPS** is selected. If not, press [Fr/Time Ref], then press [GPS].	
12	On [PN Offset] select **Auto** or **Manual**.	The test set defaults to Auto mode. • In Auto mode the test set finds the PN offset of the strongest pilot signal and displays the value in the metrics display. The delay is derived from the found PN offset. • In Manual mode you must enter the PN offset using the number keypad. The delay is derived from the entered PN offset.
13	[Level/Location]	
14	[RF IN Loss]	
15	Set the FR IN Loss to 0 dB using the number keypad.	
16	[dB]	
17	Connect to the antenna.	



NOTE The test set does not record data for post-processing. It provides a snapshot of CDMA base station transmit parameters at that location.

NOTE During a CDMA over air measurement, a yellow triangle symbol may temporarily appear beside “GPS” in the lower right. The yellow triangle indicates that the test set is re-synching with the GPS even second pulse. Once the test set is synched, a green dot appears in place of the triangle. If the GPS is unavailable, a red X appears.

Displaying Location Information Using GPS

If you are making CDMA over air measurements at a location you previously established as valid, Agilent recommends using GPS to verify that you are at the location from which you previously measured.

If you are making CDMA over air measurements from a new location, once you validate that the location provides a dominant pilot and low multipath power, Agilent recommends that you record the latitude and longitude coordinates of this location using GPS. Later measurements should be made from this precise location to provide performance trends.

To Display GPS Location Information (While in the CDMA Over Air Mode):

	Step	Notes
1	[Level/Location]	
2	On [GPS Location] select **On**.	Displays GPS satellite location information. Uses the internal GPS to capture the location of a measurement. The GPS information can be used to return to the same location. The Time Ref (Freq/Chan/Time Ref mode) button must be set to Internal GPS for this function to be active. Information includes logitude, latitude, altitude (feet/meters), and number of satellites tracked. Each time you press this softkey, the selected option changes.

	Step	Notes
3	Highlight [On]	Toggle to [On] to display GPS satellite location information. Toggle to [Off] to remove the location information

NOTE If you prefer to have an electronic copy of the location information, see "Saving Data" on page 379.

Setting Amplifier Capacity Metrics

The Amplifier Capacity measurement is an estimate of the amount of power amplifier capacity that is being used, expressed in percent of maximum. Amplifier capacity properties must be properly set to make valid amplifier capacity measurements. Amplifier capacity metrics are amplifier capacity, peak amplifier capacity, and average amplifier capacity.

A CDMA base station is typically set up with a specified amount of power allocated to the pilot channel, and specified power settings of the paging and sync channels are defined relative to the pilot channel. Occasionally, the paging and sync channels power settings will also be specified in absolute power units (watts or dBm). Given the pilot, paging, and sync power setup values and the maximum power output of the amplifier, the percentage amplifier capacity setup parameters can be determined.

To Set Amplifier Capacity Properties (While in CDMA Over Air Mode):

	Step	Notes
1	[Reset/Amp Cap]	
2	On [Amp Cap] select **On**.	
3	[Pilot Pwr]	
4	Enter the pilot power in watts, using the number keypad.	The pilot power is the total power in the dominant pilot signal, expressed in dBm.
5	[W]	

CDMA Over Air

	Step	Notes
6	[Max PA Pwr]	
7	Enter the maximum power amplifier power in watts, using the number keypad.	A base station power amplifier is specified to have a maximum power limit.
8	[W]	
9	[Delta Page Pwr]	
10	Enter the Delta Page Pwr in dB, using the number keypad.	The delta paging is the amplitude difference between the paging channel and pilot channel, expressed in dB.
11	[dB]	
12	[Delta Sync Pwr]	
13	Enter the Delta Sync Pwr in dB, using the number keypad.	The delta sync is the amplitude difference between the sync channel and pilot channel, expressed in dB.
14	[dB]	

Interpreting the Display

The CDMA Tx Analyzer screen is divided into three sections: the code domain trace display, strongest pilot trace display, and metrics display.

The *code domain trace display* contains 128 Walsh codes, which are shown in a bit-reversed order to represent the combined code channels for the varying data rate traffic channels. The Y-axis labels display the relative power (dB) or absolute power (dBm), threshold level, and dB/division. The X-axis labels display active channel numbers. Active code channels shown on the display include:

- Pilot (red)
- Page (green)
- Sync (blue)
- Quick page (light blue)
- IS-95 traffic (yellow)

- cdma2000 traffic (orange)
- Unknown traffic (tan)
- Noise (light gray)

The *strongest pilot trace display* contains the pilot dominance and multipath power parameters. Awareness of these two parameter values helps you be sure that you are making valid measurements on the sector of interest.

The *metrics display* shows 18 measurement parameters displayed below the trace display in three columns and six rows—each with a value and units. For more information about the metric display, refer to “Metrics Provided by CDMA Over Air Measurements” on page 121.

The frequency indicator is at the bottom left corner of the screen, the time reference indicator at the bottom right. For each indicator the text indicates which reference you have chosen. A green LED indicates a locked condition. A red “X” indicates an unlocked condition.

Optional CDMA Over Air Measurement Settings

You can alter several optional measurement parameters in CDMA Over Air:

- Channel or Frequency Step
- PN Increment
- Transmitter Reference Level
- Active Channel Threshold Level and Auto Threshold Offset
- Amplifier Capacity Metrics Reset
- Measurement Time
- Quick Page Channel
- Sweep (Continuous or Single)
- Averaging (# of averages)

Setting the Channel or Frequency Step

You can set the channel or frequency step so you can quickly increment to the next channel or frequency using the Up Arrow and Down Arrow buttons.

	Step	Notes
1	[Chan Step] or [Freq Step]	This choice depends on the [Units] mode you are using.
2	Enter the desired channel or frequency step using the number keypad.	
3	[Enter]	Notice (and verify) the number you entered below the Chan Step or Freq Step text on the corresponding button.

Setting the PN Increment (PN Inc)

The PN Increment allows you to choose the increment step for the PN Offset. Typically the PN Increment is set to 1 when measuring CDMA transmitter performance while connected to the base station via RF cable.

	Step	Notes
1	[PN Inc]	
2	Enter the PN Offset increment you want using the number keypad.	The maximum value you can enter is a PN increment of 15.
3	[Enter]	Verify that the number you entered below the PN Inc text on the corresponding button.

Setting the Transmitter Reference Level

You can set the CDMA transmitter reference level to display either relative power (dB) or absolute power (dBm). The test set defaults to relative. The top graticule (horizontal line) represents the total power in the CDMA channel. The scale per division is set to 5 dB per division.

If the reference level is set to relative, the reference level is relative to the total power (in dB) in the CDMA channel. If the reference level is set to absolute, the reference level displays the actual power (in dBm) in the CDMA channel.

	Step	Notes
1	[Level]	
2	On [Reference] select **Abs** or **Rel**.	Each time you press this softkey, the selected option changes.

Setting the Active Channel Threshold Level and Auto Threshold Level

The active channel threshold level is an advanced setting that 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 test set can set this level automatically, or you can manually enter a value.

In Auto mode the threshold level moves as the noise fluctuates. The threshold level is set by the test set at an optimal offset above the average noise floor. If you choose Auto mode, you can alter the auto threshold offset. The recommended and default setting is 0 dB. A negative value moves the threshold lower (closer to the noise floor) and is a more aggressive setting that increases the likelihood of interpreting an inactive channel as active. A positive value moves the threshold higher (away from the noise floor) and is a more conservative setting that increases the likelihood of interpreting an active channel as inactive.

In Manual mode the threshold level is fixed and does not move as the noise fluctuates.

To Set the Active Channel Threshold Level (While in CDMA Over Air):

	Step	Notes
1	[Setup]	
2	On [Thresh Lvl] select **Auto** or **Manual**.	Each time you press this softkey, the selected option changes. If you choose Manual, you must enter the threshold you want using the number keypad, then press [dB].
3	[Auto Thres Offset]	The default value is 0 dB. Optionally, you can enter a negative (more aggressive) or positive (more conservative) value, then press [dB].

Resetting Amplifier Capacity and Traffic Metrics

the amplifier capacity metrics such as the peak and average amplifier capacity and peak and average utilization can be reset. If you prefer to reset these parameters manually, you may do so using the [Reset Metrics] menu key. The test set may automatically reset these parameters for you if you are using the PN Offset Auto mode.

In PN Offset Auto mode, if the test set finds a new dominant pilot (from a stronger base station signal), the peak and average amplifier capacity values will be reset. The test set will decode the signal containing the new dominant pilot and gather new amplifier capacity data for this signal. In PN Offset Manual mode if the test set finds a new dominant pilot, the signal will not be decoded and the test set will display noise in the code domain power display. The amplifier capacity metrics will be unaffected and the test set will not gather data until the desired signal becomes dominant again.

To Manually Reset the Amplifier Capacity Metrics (While in CDMA Over Air):

	Step	Notes
1	[Reset/Amp Cap]	
2	[Reset Metrics]	

Setting Measurement Time

The Measurement Time setting allows you to alter the speed at which measurements are being made. Three choices exist: Slow, Average, and Fast. The test set defaults to Average. Slow measurement time provides a more accurate measurement at the expense of time. Fast measurement time provides a quicker measurement at the expense of accuracy. Average measurement time strikes a balance between measurement speed and measurement accuracy.

	Step	Notes
1	[Setup]	
2	On [Meas Time] select **Slow**, **Avg**, or **Fast**.	Each time you press this softkey, the selected option changes.

Setting Quick Page Channel

With the advent of cdma2000, a new control channel called the quick page channel (QPCH) has been added. The QPCH is used to improve standby time in the phone and may or may not be enabled. The QPCH is generally channel number 80. Note that the QPCH is a bursted channel. In other words, it is not on all the time. You may have to wait to see the QPCH show up on the trace. The Delta QPCH Power parameter on the metric display can help you determine the level of the QPCH. The QPCH is also a single-wide channel: it only occupies one of the 128 channels. The pilot, paging, and sync control channels are double-wide channels and occupy two of the 128 channels on the display.

To Set the QPCH (While in CDMA Tx Over Air):

	Step	Notes
1	[Setup]	
2	On [Quick Page Channel] select **Off** or **Ch 80**.	Each time you press this softkey, the selected option changes.

CDMA Over Air

Setting Average, Sweep, and Restart

Setting the Sweep

You can select either continuous or single sweep. Continuous sweep provides repeated, ongoing measurements. Single sweep performs a single measurement that is repeated only when you push the Single button.

To set sweep:

	Step	Notes
1	[Average/Sweep]	
2	[Continuous] or [Single]	Each time you press this softkey, the selected option changes.

Setting Averaging

You can choose to have averaging on or off and set the number of averages you want to take. Averaging only applies to the data, not the trace. When turned on, the Agilent E7495A/B does a running average:

- A running average computes the new result as the weighted sum of the last result and the new measurement. The last result is weighted by (n – 1)/n. The new result is weighted by 1/n. Each new measurement produces a new result.

To set averaging:

	Step	Notes
1	Set the number of averages. a. [Average] b. Enter the number of averages using the number keypad. c. [Enter]	

	Step	Notes
2	Set averaging On or Off. a. [Average/Sweep] b. [Averaging] c. [Off] or [On]	

NOTE These two steps can be performed in any order. However, if you turn averaging on and a large number of averages has previously been set, there may be a delay before you can change number of averages.

Setting Restart

When you have averaging turned on, you can restart the averaging by pressing the Restart menu key. This restarts the averaging for running average in either Continuous or Single sweep mode.

To restart averaging:

	Step	Notes
1	[Average/Sweep]	
2	[Restart]	

Adding a Marker

Markers can be used on traces to help you visually track up to four signals. Each marker has the following settings:

- **Type**: Provides three options, including:
  - **Off**
  - **Normal**, which places a diamond-shaped, colored marker, along with a number, 1-4, on the trace.
  - **Delta**, is associated with a normal marker. Therefore, a normal marker must exist prior to creating the delta marker. The delta marker displays the difference between the normal marker position and the delta marker position. Only one delta marker can

be associated with a given normal marker. The normal marker must be active when Delta is selected.

- **Marker to Peak**: Places the active marker on the current greatest value of the trace.
- **Marker to Next Peak**: Places the active marker on the current second greatest value of the trace.

	Step	Notes
1	[Marker]	
2	[Marker]	
3	[1], [2], [3], or [4]	
4	[Type]	
5	[Off], [Normal], or [Delta]	
6	Locate the marker relative to the trace: • [Marker to Peak] or • [Marker to Next Peak]	

Metrics Provided by CDMA Over Air Measurements

This section contains descriptions of the individual CDMA transmit parameters in the metric display of the screen. "Interpretation of CDMA Over Air Measurement Results" on page 126 contains expected result values and possible causes of error if the expected results are not met.

Frequency Error

Frequency error is the frequency difference between your transmitter's actual center frequency and the frequency (or channel) you entered.

PN Offset

The PN Offset is a "short code" sequence that provides a unique identifier for each sector of each cell site. The PN Offsets are applied to the I and Q signals before modulation. PN Offsets are offset in time by 52.08 µs and they repeat every 26.666 ms. This yields 512 unique short code sequences (0-511). The mobile phone needs the PN Offset to decode information in the Sync and Paging channels, which are transmitted by the base station.

Delay

The pilot delay is a measure of the time of the arrival of the pilot signal from the base station with respect to GPS time. It is expressed in µs of delay. Delay is a combination of propagation delay and base station timing error.

IS-95 specifies that the base station timing must be within +/-10 µs of its assigned value. Many base station manufactures specify that the timing must be within +/-3 µs. For example, if you are parked near the transmit antenna, the propagation delay is less than 1 µs. The measured value of delay should be within the recommended limit, which is greater than -10 µs and less than +10 µs. As you move away from the transmit antenna, propagation delay needs to be considered—about 1 µs for every 1000 feet. So, if you are parked ½ mile from the transmit antenna, the additional propagation delay would be approximately 2.5 µs. The measured value of delay should be greater than -7.5 µs and less than +12.5 µs.

Below is a table showing various delays vs. distance.

Distance	Delay
0.1 mi	0.56 µs
0.25 mi	1.36 µs
0.5 mi	2.72 µs
1 mi	5.28 µs
5 mi	26.4 µs

Estimated Rho

Estimated Rho is the measure of the modulation quality for a CDMA transmitter. This measurement is analogous to measuring FM accuracy and distortion in an AMPS network or EVM in a TDMA system. A Rho value of 1.0 is perfect, indicating that all of the power is being transmitted correctly.

Carrier Feedthrough

Carrier Feedthrough is a result of the RF carrier signal feeding through the I/Q modulator and appearing at the transmitter port. Carrier Feedthrough is a common cause of bad Rho measurements.

Noise Floor

Noise Floor is the average signal to interference ratio (Ec/Io) of all the inactive channels.

Channel Power

Channel Power is the total power within a defined bandwidth. For CDMA the channel bandwidth is defined to be 1.25 MHz. Channel Power measures the power the base station is transmitting across the entire 1.25 MHz CDMA channel.

Pilot Power

Pilot Power is the total power in the Pilot code channel, expressed in dBm. The transmit power of the Pilot Channel signal for a given base station is constant.

Pilot Ec/Io

The Pilot Ec/Io is the ratio of the pilot power to all the other power in the channel, expressed in dB. Since Ec and Io are measured individually, the system can detect poor signal quality and tell you if it is caused by low Ec or high Io. This helps you quickly resolve coverage versus interference issues.

Delta Page Power

Delta Page Power is the amplitude difference between the Paging Channel and Pilot Channel, expressed in dB. The transmit power of the Paging Channel is constant and can be set at a value relative to the Pilot Power. A common value is -4 dB relative to the Pilot. It is important to know what the intended settings are for each carrier and sector of your base station.

Delta Sync Power

Delta Sync Power is the amplitude difference between the Sync Channel and Pilot Channel, expressed in dB. The transmit power of the Sync Channel is constant and may be set at a value relative to the Pilot Power. A common value is -10 dB relative to the Pilot. It is important to know what the intended settings are for each carrier and sector of your base station.

Delta Quick Page Channel Power

Delta Quick Page Channel (QPCH) Power is the amplitude difference between the Quick Page Channel and Pilot Channel, expressed in dB. The QPCH is a bursted channel and is not on all the time. In order to capture the level of the QPCH, the statistic measures and holds the peak level of the QPCH. Until a QPCH has been measured, the value will be dashes. When “on”, the level of the QPCH is constant and is set at a value relative to the Pilot Power. The QPCH digital gain level can be set to 2, 1, 0, -1, -2, -3, -4, and -5 dB relative to the Pilot. It is important to know what the intended settings are for each carrier and sector of your base station.

Amplifier Capacity

Assuming the Amplifier Capacity parameters are set properly, the Amplifier Capacity measurement is an estimate of the amount of power amplifier capacity that is being used, expressed in percent of maximum. When an amplifier is transmitting at maximum output power, it is said to be at 100% of its capacity. For example, an amplifier with a maximum output power of 12 watts would be at 50% of capacity when transmitting 6 watts and at 100% of capacity when transmitting at 12 watts.

The percentage of amplifier capacity increases as the number or level of the traffic channels increase.

Peak Amplifier Capacity

Peak Amplifier Capacity is the peak level of all the valid Amplifier Capacity measurements while on the same PN offset. In PN Offset Auto mode this measurement is reset if the PN offset changes or the Reset Metrics button is used. In PN Offset Manual mode this measurement is reset only if the Reset Metrics button is used.

Average Amplifier Capacity

Average Amplifier Capacity is the average level of all the valid Amplifier Capacity measurements while on the same PN offset. In PN Offset Auto mode this measurement is reset if the PN offset changes or the Reset Metrics button is used. In PN Offset Manual mode this measurement is reset only if the Reset Metrics button is used.

Utilization

Utilization is a ratio of the active Walsh codes to the total 128 Walsh codes, expressed in percent. Even though active control channels such as the pilot are included in the utilization measurement, utilization is an indication of the traffic that is being carried by the base station.

For example, a CDMA signal with a pilot, paging, and sync channel, two IS-95 traffic channels, and one eight-wide cdma2000 data channel, would use 18 Walsh codes. Each control channel would use two Walsh codes, each IS-95 channel would use two Walsh codes, and the cdma2000 channel would use 8 Walsh codes for a total or 18 Walsh codes. Eighteen Walsh codes in use out of the 128 total Walsh codes would result in a utilization of 14%.

Peak Utilization

Peak Utilization is the peak level of all the valid Utilization measurements while on the same PN offset. In PN Offset Auto mode this measurement is reset if the PN offset changes or the Reset Metrics button is used. In PN Offset Manual mode this measurement is reset only if the Reset Metrics button is used.

Average Utilization

Average Utilization is the average level of all the valid Utilization measurements while on the same PN offset. In PN Offset Auto mode this measurement is reset if the PN offset changes or the Reset Metrics button is used. In PN Offset Manual mode this measurement is reset only if the Reset Metrics button is used.

Interpretation of CDMA Over Air Measurement Results

This section contains expected result values and possible causes of error if the expected results are not met.

Frequency Error

The standards specify very tight Frequency Error performance. In the PCS bands, the 0.05 parts-per-million specification translates to only 99 Hz at a carrier frequency of 1980 MHz or 40 Hz at 850 MHz cellular frequencies. Frequency Error shows up as uncorrelated power that adds to the noise floor or shows up in other Walsh codes.

If a particular site loses its reference to GPS time, its reference signals will begin to drift over time. Mobiles already using the site can remain on the air because they derive their timing from the signals transmitted by the base station. However, mobiles using other sites/sectors may be prevented from using the site because they are confused by the error in frequency. This creates what is known as the “island cell” effect. By itself, the cell is still functional. To the rest of the system, it's inaccessible.

This island cell effect can be caused by a failure in the site's GPS receiver and timebase distribution network. Using the test set's Internal GPS receiver provides an independent time reference that will allow you to determine if this cell site is out of sync with the rest of the network (island cell effect).

PN Offset

Verify the PN Offset is correct. If you are in Manual mode, the PN Offset will display the value you entered. Make sure the Time Offset is small (less than 3 µs). If the Time Offset is greater than expected, see the section on Time Offset below. If you are in Auto mode, the test set will tune to the PN Offset with the least amount of Time Offset. If an incorrect PN Offset is displayed, the Time Offset will likely be very small.

Delay

The Delay (Pilot Delay) should be within the following limits:

- Less than +/- 10 µs if the receiving antenna is next to the base

CDMA Over Air

station, or

- Less than +/- 10 µs + 1 µs for every 1000 feet you are away from the base station.

If the measured value of the Delay falls outside of the expected range, consider the following problems:

- The GPS receiver is not working correctly, and the base station timing is incorrect.
- The base station main oscillator is not working correctly, and the base station timing is incorrect.
- The GPS receiver is not locked to the GPS satellites.

Estimated Rho

The CDMA base station standard specifies that Rho must be greater than 0.912. Typical values for a healthy base station are greater than 0.94. When measuring Rho over-the-air, these values can only be achieved under very good conditions for multipath power and pilot dominance. For example, a Multipath Power of < 0.1 dB and a Pilot Dominance of > 15 dB is required to measure Rho of 0.912. For more on the affects of pilot dominance and multipath power on Estimated Rho see "Criteria for Making Valid CDMA Over Air Measurements" on page 105.

Verify that the Estimated Rho meets the following criteria:

- Greater than 0.8 if the Multipath Power and Pilot Dominance properties remain at the defaults of 0.4 dB and 10 dB, respectively, or
- Greater than 0.912 if you have set the Multipath Power and Pilot Dominance properties to 0.1 dB and 15 dB, respectively.

Poor Rho performance affects the base station capacity because the uncorrelated power appears as interference to the mobiles. The added interference will require an increase in the traffic channel level to overcome the interference. This may, in turn, be seen as further interference. At some point, the site will have to shed calls in order to supply the remaining calls with enough signal versus the interference in the system.

If Estimated Rho is lower than expected, check the following:

- External interference may be degrading the CDMA signal. Use the spectrum analyzer to verify that no spurious signals are present in the band of the transmitter.

- Compression may be occurring in the base station power amplifier.
- There may be errors in the base station IQ modulator.

Carrier Feedthrough

A good Carrier Feedthrough level is less than -25 dB. The IS-97 standard does not specify Carrier Feedthrough; however, this measurement provides an additional tool to troubleshoot the base station's transmitter.

In the frequency domain, Carrier Feedthrough can show up as an uncorrelated energy spike that can be seen on the spectrum analyzer by closely spanning into the top of the CDMA signal. The effects of Carrier Feedthrough can also show up as higher noise levels on the Code Domain Power screen. The inactive Walsh codes will be pushing the -27 dB specification for noise. Carrier Feedthrough can be caused by the lack of isolation across the mixer and cavity of the transmitter's I/Q modulator.

Noise Floor

A good Noise Floor value is between -20 dB and -30 dB and depends on the quality of the signal. If the Noise Floor is above these values (for example, -20 dB), the modulator may be the source of the added noise. Another possibility is a problem with the base station's channel card. The channel card generates the individual Walsh codes.

Channel Power

If the Channel Power is lower than expected, verify you are in a location that meets the criteria to provide valid measurements.

Inaccurate Channel Power (high or low) may indicate an incorrect power setting at the base station.

Pilot Power

If the Pilot Power has varied significantly from previous readings at the same location, it may indicate the following:

- There has been a change made to the digital gain setting of the Pilot Channel.
- The base station power amplifier has a problem.
- The transmit antenna system has been changed or damaged.

Pilot Ec/Io

A high value of Ec/Io means there is less interference from other base stations and noise and is an indicator of base station performance. When Ec/Io is mapped it can be used to determine areas that have low coverage.

Delta Page Power

If the measured value of Delta Page Power is more than +/-0.5 dB different from previous measurements at the same location, it may indicate that the digital gain setting for the Paging Channel has been changed from the intended setting.

Delta Sync Power

If the measured value of Delta Sync Power is more than +/- 0.5 dB different from previous measurements at the same location, it may indicate that the digital gain setting for the Sync Channel has been changed from the intended setting.

Delta Quick Page Channel Power

If the measured value of Delta QPCH Power is more than +/-0.5 dB different from previous measurements at the same location, it may indicate that the digital gain setting for the QPCH has been changed from the intended setting.

Amplifier Capacity

The Amplifier Capacity metric provides an instantaneous reading of how much of the amplifier’s capacity is currently being used. More meaningful information is provided by the Peak and Average Amplifier Capacity metrics gathered over a 10 to 15 minute interval.

Peak Amplifier Capacity

If the Peak Amplifier Capacity is greater than 100%, the traffic at this base station has caused the base station amplifier to exceed its maximum power rating. This is not desirable, and you should contact your RF engineering department as soon as possible. This problem can result in system degradation or damage to the amplifier.

You can get an indication of how often the amplifier capacity is being exceeded by watching the Amplifier Capacity measurement. This is an instantaneous measurement of the amplifier capacity.

Average Amplifier Capacity

If the Average Amplifier Capacity is greater than 85%, the base station power amplifier is close to its maximum power limit. Further increase in traffic on this base station could cause system performance problems or damage to the power amplifier. You should notify your RF Engineering Department as soon as possible.

Utilization

The Utilization metric provides an instantaneous reading of the percentage of the traffic channels currently being used. More meaningful information is provided by the Peak and Average Utilization metrics gathered over a 10 to 15 minute interval.

Peak Utilization

If the Peak Utilization of this base station is greater than 65%, this is a warning that peak traffic rates at this base station are getting very high. It is possible that calls could be getting blocked or dropped. You should contact RF engineering as soon as possible.

Average Utilization

If the Average Utilization of this base station is greater than 45%, the base station is carrying a great deal of traffic. It may be time to consider adding another carrier or another base station. You should contact RF engineering.

7 Channel Scanner

Using the Channel Scanner

The Channel Scanner measures the power of multiple transmitted signals. It is most useful for measuring channel power in TDMA, GSM, AMPS, and iDEN channel bands. Channel power may be measured on a single channel or across multiple channels or frequencies. The Channel Scanner can be used to measure TDMA, AMPS, GSM and iDEN adjacent channel power.

CAUTION When measuring multiple channels, the combined channel power must not exceed +20 dBm at the RF In port.

CAUTION The maximum power for the RF In and RF Out port is 20 dBm (100 mW). The maximum power for the Power Sensor port is 24 dBm (300 mW). When directly coupled to a base station, the test set can be damaged by excessive power applied to any of these three ports.

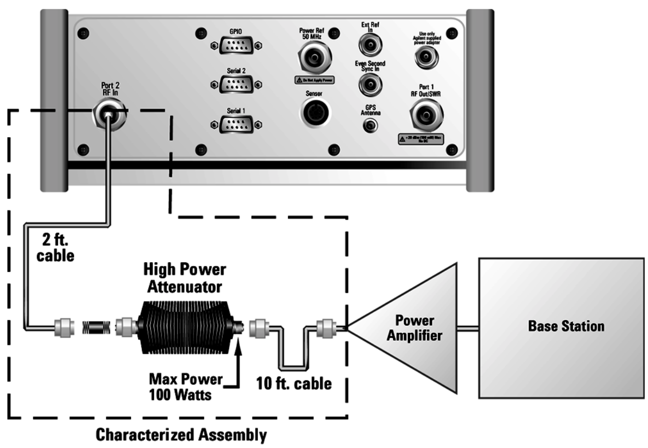
To prevent damage in most situations when you directly couple the test set to a base station, use the high power attenuator between the test set and the BTS.

NOTE For complex modulation such as CDMA, the frequency error measurement is not accurate.

Performing a Basic Channel Scanner Measurement

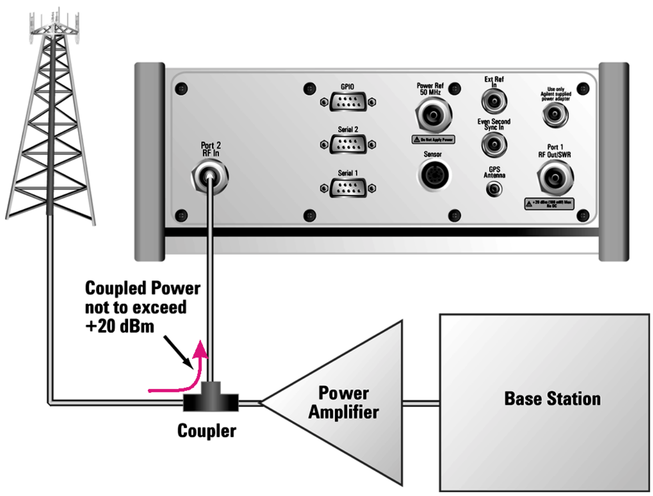
	Step	Notes
1	Select Channel Scanner. a. **Mode** b. [Spectrum Analyzer/Tools] c. [Channel Scanner]	
2	Select the channel standard. a. [CS Chan Std] b. Select the standard using the up and down arrow buttons. c. [Select]	
3	On [CS Units] select **Chan**.	Each time you press this softkey, the selected option changes.
4	On [Scan Mode] select **Range**.	Each time you press this softkey, the selected option changes.
5	Select the start channel. a. [Start Chan] b. Enter the start channel using the number keypad. c. [Fwd] or [Rev]	
6	Enter the CS step size. a. [CS Step Size] b. Enter the step size using the number keypad. c. [Enter]	

	Step	Notes
7	Enter the number of channels. a. [Num Chans] b. Enter the number using the number keypad. c. [Enter]	If you want to use the Channel Scanner to measure adjacent channel power, set the number of channels to 3, and make the start channel (Step 5) one lower than the channel of interest.
8	Connect to the base station.	

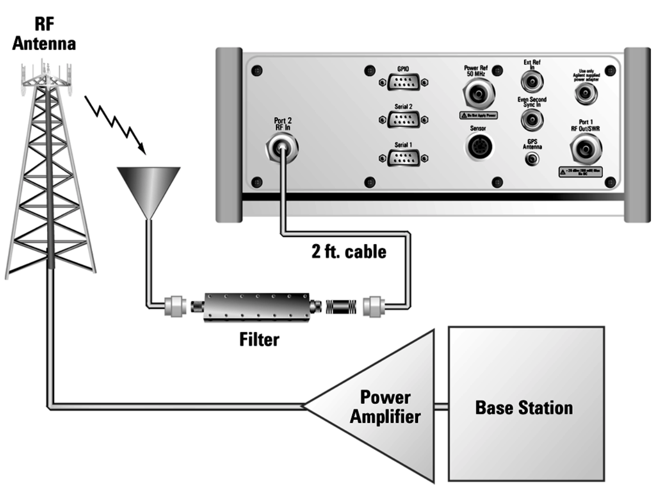


Out of service connection

Step	Notes



In service connection



Over the air measurement connection

NOTE The *autoranging* feature, built into the test set, helps ensure accurate measurements by changing front-end amplifier gain as needed when a strong signal threatens to overload the test set. When this occurs, the noise floor rises (as gain is decreased), then falls again when the strong signal stops.

If you prefer a fixed noise floor, you can disable autoranging in two ways using the Setup function within Spectrum Analyzer:

- On [Range Ctrl] select **Hold** to fix the noise floor at the current level. A subsequent strong signal—even outside the measurement range—may cause an inaccurate reading due to overloading the front-end of the test set.
- On [Range Ctrl] select **Max** to fix the noise floor at the current level until a strong signal comes in. In that case, the floor will rise to maintain accuracy, but will not return to its lower level after the strong signal stops.

Displaying Accurate Peak Power (Recommended for Pulsed Signals)

For pulsed signals, you can get a more accurate measurement of the signal's peak or average power by using the Peak Power Detector option in the test set.

The test set measures average power of signals by default. But for non-constant-duty-cycle signals such as GSM, an average power reading fails to accurately show amplitude when the signal is on if other timeslots in the frame are powered off.

If the [Power Detector] menu key is grayed out, the test set needs to be upgraded in order to measure pulsed signals. Contact the Agilent Service Center for upgrade information.

	Step	Notes
1	[Setup]	
2	On [Power Detector] select **Pk**.	Each time you press this softkey, the selected option changes.

Entering the Channels with a List Instead of a Range

	Step	Notes
1	Select Channel Scanner. a. **Mode** b. [Spectrum Analyzer/Tools] c. [Channel Scanner]	
2	Select the channel standard. a. [CS Chan Std] b. Select the standard using the up and down arrow buttons. c. [Select]	
3	On [CS Units] select **Chan**.	Each time you press this softkey, the selected option changes.
4	On [Scan Mode] select **List**.	Each time you press this softkey, the selected option changes.
5	Enter channels into the list. a. Use [Insert Row] to add a channel, then enter its number using the number keypad and [Fwd] or [Rev] to complete each entry. b. Use [Delete Row] to remove channels you do not want displayed. Select a channel you want to remove using the up and down arrow buttons. Then press [Delete Row] to remove the selected channel. c. [Ok]	

Entering the Channel Power Measurement Bandwidth and Time

When performing a channel power measurement, you must specify a measurement bandwidth and measurement time. These parameters determine how the DSP measures each channel on the Channel Scanner. Depending on the modulation format of signal you are trying to measure (CDMA, GSM, etc.), different measurement bandwidths and times are required. You have three ways of selecting these parameters:

- Press [Format/BW], then on [Format Type] select **Chan**. Each channel standard has an associated modulation format. With this method, the optimum measurement bandwidth and measurement time for the modulation format are automatically selected when you set the channel standard. For example, when you select GSM-950 as the channel standard, with this method the test set selects the bandwidth and time for the GSM format.
- Press [Format/BW], then on [Format Type] select **List**, and then select the format from a list—independently of the channel standard.
- Select [Format/BW], then on [Format Type] select **Cust**. Then select the measurement bandwidth and measurement time for each channel.

Setting Average, Sweep, and Restart

Setting the Sweep

You can select either continuous or single sweep. Continuous sweep provides repeated, ongoing measurements. Single sweep performs a single measurement that is repeated only when you push the Single button.

To set sweep:

	Step	Notes
1	[Average/Sweep]	
2	[Continuous] or [Single]	Each time you press this softkey, the selected option changes.

Setting Averaging

You can choose to have averaging on or off and set the number of averages you want to take. Averaging only applies to the data, not the trace. You can select from the following types of averaging:

- **Off**: Disables averaging.
- **Running:** Computes the new result as the weighted sum of the last result and the new measurement. The last result is weighted by (n – 1)/n. The new result is weighted by 1/n. Each new measurement produces a new result.
- **Max Hold**: Is not an average, but on a point by point basis, displays the maximum amplitude for the given frequency or channel since Max Hold was turned on. It is updated when a new maximum occurs.
- **Group Average:** Makes the requested number of measurements, averages the measurement data, and displays the average as a single result trace. Measurement time will vary based on the requested number of averages and can take minutes for very large number of averages.
- **Group Max Hold:** Makes the requested number of measurements before returning a single trace result. This trace is the maximum

value seen at each trace point over the requested number of averages (measurements).

To set averaging:

	Step	Notes
1	Set the number of averages. a. [Average] b. Enter the number of averages using the number keypad. c. [Enter]	
2	Select the type of averaging you want to apply. a. [Average/Sweep] b. [Averaging] c. [Off], [Running Average], [Max Hold], [Group Average], or [Group Max Hold]	

NOTE These two steps can be performed in any order. However, if you turn averaging on and a large number of averages has previously been set, there may be a delay before you can change number of averages.

Setting Restart

When you have averaging turned on, you can restart the averaging by pressing the Restart menu key. This restarts the averaging for running average in either Continuous or Single sweep mode.

To restart averaging:

	Step	Notes
1	[Average/Sweep]	
2	[Restart]	

Displaying Frequency or Power

You can display frequency or power values above the bars in the trace display. The displayed frequency is the average instantaneous frequency when the signal is active.

For CDMA type signals, the frequency option is not recommended; accurate frequencies for CDMA are not displayed.

	Step	Notes
1	[Setup]	
2	On [Display Value] select **Off**, **Freq**, or **Pwr**.	Each time you press this softkey, the selected option changes. Choosing **Off** displays no values above the bars.

8 Distance to Fault

Measuring Distance to Fault

A signal is transmitted from the RF OUT/SWR port of the test set to the cable-under-test. The signals reflected from faults in the cable are received by the test set.

In performing this measurement, the test set uses frequency domain reflectometry. The changing interference of the transmitted and reflected signals contains information about the distance to one or more faults. This information can be used to find the physical distance to the faults. The distance displayed on the test set is the physical distance to the probable faults, corrected for the cable loss and velocity propagation factor of the cable.

The test set provides two ways of measuring distance to fault:

- **Manual Frequency Range**. You select the start and stop frequencies, which define the measured distance. Generally, the typical start and stop frequencies you use will result in a measured distance that will be larger than the distance over which you want to look for faults. To help isolate faults over the length of interest, you can set a displayed distance less than the measured distance. The displayed distance is set using the [Displayed Distance] menu key on the [Freq/Dist/Calibrate] menu. Keep in mind that there are 256 measurement points across the measured distance. Therefore, the measurement points across the chosen displayed length will be a ratio of displayed distance to measured distance times 256. The higher the ratio, the less measurement resolution. In most causes, the resolution will be adequate to determine the faults, but if more resolution is needed you can increase the span between the start and stop frequencies (which will decrease the measured distance) or use the other approach, automatic frequency range. If the measurement distance is not long enough for the cable you are testing, reduce the span between the start and stop frequencies (which will increase the measurement distance) or use automatic frequency range.
- **Automatic Frequency Range**. You select the measurement distance, and the test set automatically selects the start and stop frequencies. This measurement distance is set using the [Distance] menu key on the [Freq/Dist/Calibrate] menu. In this mode, the displayed and measured differences are the same. There are 256 measurement points across the distance you set. This approach

provides the maximum measurement resolution across the selected distance. The disadvantage is that the start and stop frequencies are automatically set and may limit the test set's ability to sweep through filters or lighting protectors. This mode is best used for checking a cable that has no frequency limiting devices.

NOTE Test signals can cause interference. When testing cables attached to antennas, test signals are radiated. Verify that the signal used for the test cannot cause interference to another antenna.

NOTE The distance to fault calibration for manual frequency range is the same calibration as performed for the return loss and one port insertion loss measurements. If you make the calibration for any of these three measurements, the calibration will apply to the other measurements—and "Calibrated" will be displayed on the screen for all three.

The calibration remains valid until you power off the test set or change the start or stop frequency.

The distance to fault calibration for the auto frequency range is unique, however. It is not applicable to return loss or one port insertion loss, or even to the manual frequency range method for distance to fault.

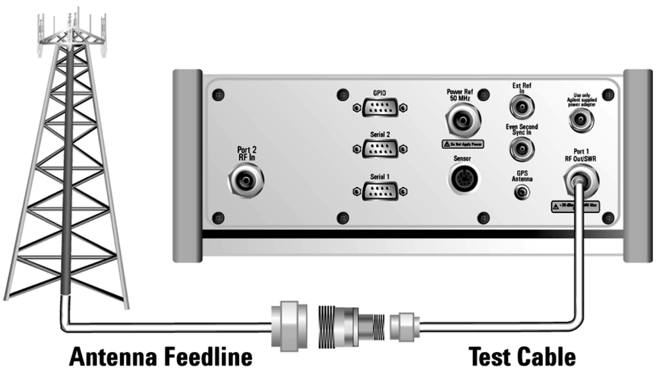
For distance to fault measurements, separate calibrations need to be performed for each frequency range mode.

Performing a Basic Distance to Fault Measurement (Manual Frequency Range)

	Step	Notes
1	**Mode**	
2	[Antenna/Cable]	
3	[Distance to Fault]	The distance to fault measurement takes a few seconds to load.
4	On [Freq Range] select **Manual**.	Each time you press this softkey, the selected option changes.

	Step	Notes
5	[Start Freq]	
6	Enter the start frequency using the number keypad.	
7	[Hz], [kHz], [MHz], or [GHz]	
8	[Stop Freq]	
9	Enter the stop frequency using the number keypad.	
10	[Hz], [kHz], [MHz], or [GHz]	
11	On [Units] select **Meters** or **Feet**.	Each time you press this softkey, the selected option changes.
12	[Displayed Distance]	
13	Enter the distance window using the number keypad.	The distance you can enter cannot be greater than the distance displayed in the Measured Distance window at the top right. If you need a larger distance, reduce the start and stop frequency span.
14	Enter the length of the cable using the number keypad.	
15	[Cable Type]	
16	On [Cable Type] on the right, select **RG**, **BTS**, or **Cust**.	Each time you press this softkey, the selected option changes.
17	[Select Cable]	
18	Select the cable using the up and down arrow buttons.	
19	[Select]	

	Step	Notes
20	[Freq/Dist/ Calibrate]	
21	[Calibrate]	Follow the Calibration Wizard.
22	Connect the antenna feedline and antenna.	Connect the antenna feedline to the RF OUT/SWR port.

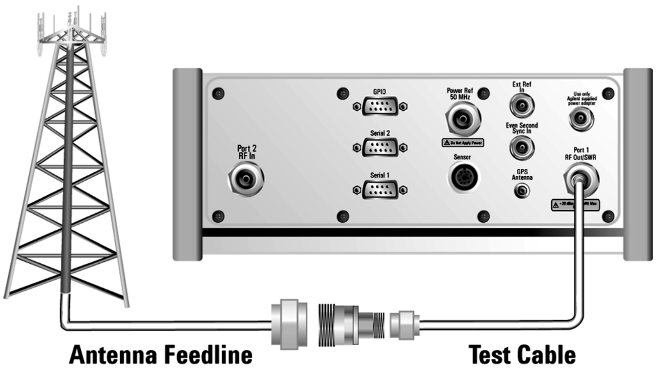


23	(Recommended) [Level] [Autoscale]	If you prefer to set the level manually, after pressing [Level], press [Ref Level]. Then enter the value you want using the number keypad and press [dB].

Performing a Basic Distance to Fault Measurement (Automatic Frequency Range)

	Step	Notes
1	**Mode**	
2	[Antenna/Cable]	
3	[Distance to Fault]	The distance to fault measurement takes a few seconds to load.

	Step	Notes
4	On [Freq Range] select **Auto**.	Each time you press this softkey, the selected option changes.
5	On [Units] select **Meters** or **Feet**.	Each time you press this softkey, the selected option changes.
6	[Distance]	
7	Enter the length of the cable using the number keypad.	The greatest accuracy is obtained when you enter a cable length slightly greater than the cable length being tested. If you are not sure of the cable length, enter a value 1.25 times the estimated length. Depending on the return loss of the antenna or device at the end of the cable, you may see a high relative mismatch displayed at the actual length of the cable
8	[Cable Type]	
9	On [Cable Type] on the right, select **RG**, **BTS**, or **Cust**.	Each time you press this softkey, the selected option changes.
10	[Select Cable]	
11	Select the cable using the up and down arrow buttons.	
12	[Select]	
13	[Freq/Dist/ Calibrate]	
14	[Calibrate]	Follow the Calibration Wizard.
15	Connect the antenna feedline and antenna.	Connect the antenna feedline to the RF OUT/SWR port.



	Step	Notes
16	(Recommended) [Level] [Autoscale]	If you prefer to set the level manually, after pressing [Level], press [Ref Level]. Then enter the value you want using the number keypad and press [dB].

Viewing a Single Distance to Fault Sweep

	Step	Notes
1	[Average/Sweep]	
2	[Single]	Activates the single sweep. Press [Continuous] if you want to start multiple sweeps.

Setting Interference Rejection for a Distance to Fault Measurement

Other signals can interfere with distance to fault measurements. When making a distance to fault measurement in the presence of known or suspected interference, you can minimize the effect of the interference on the measurement by activating interference rejection in the test set.

NOTE Use of interference rejection will increase the measurement time. Interference rejection should be used if a known interfering signal exists or if the distance to fault measurement displays suspicious characteristics such as a spike or rapid movements in the noise floor.

To Activate Interference Rejection:

	Step	Notes
1	[Setup]	
2	On [Interference Rejection] select **On**.	Each time you press this softkey, the selected option changes.

Displaying the Top Three Faults

When measuring distance to fault, you can display the top three faults with markers on the trace

	Step	Notes
1	[Setup]	
2	On [Fault Indicators] select **On**.	Each time you press this softkey, the selected option changes.

Setting Average, Sweep, and Restart

Setting the Sweep

You can select either continuous or single sweep. Continuous sweep provides repeated, ongoing measurements. Single sweep performs a single measurement that is repeated only when you push the Single button.

To set sweep:

	Step	Notes
1	[Average/Sweep]	
2	[Continuous] or [Single]	Each time you press this softkey, the selected option changes.

Setting Averaging

You can choose to have averaging on or off and set the number of averages you want to take. Averaging only applies to the data, not the trace. You can select from the following types of averaging:

- **Off**: Disables averaging.
- **Running:** Computes the new result as the weighted sum of the last result and the new measurement. The last result is weighted by (n – 1)/n. The new result is weighted by 1/n. Each new measurement produces a new result.
- **Max Hold**: Is not an average, but on a point by point basis, displays the maximum amplitude for the given frequency or channel since Max Hold was turned on. It is updated when a new maximum occurs.
- **Group Average:** Makes the requested number of measurements, averages the measurement data, and displays the average as a single result trace. Measurement time will vary based on the requested number of averages and can take minutes for very large number of averages.
- **Group Max Hold:** Makes the requested number of measurements before returning a single trace result. This trace is the maximum

value seen at each trace point over the requested number of averages (measurements).

To set averaging:

	Step	Notes
1	Set the number of averages. a. [Average] b. Enter the number of averages using the number keypad. c. [Enter]	
2	Select the type of averaging you want to apply. a. [Average/Sweep] b. [Averaging] c. [Off], [Running Average], [Max Hold], [Group Average], or [Group Max Hold]	

NOTE These two steps can be performed in any order. However, if you turn averaging on and a large number of averages has previously been set, there may be a delay before you can change number of averages.

Setting Restart

When you have averaging turned on, you can restart the averaging by pressing the Restart menu key. This restarts the averaging for running average in either Continuous or Single sweep mode.

To restart averaging:

	Step	Notes
1	[Average/Sweep]	
2	[Restart]	

Adding a Marker

Markers can be used on traces to help you visually track up to four signals. Each marker has the following settings:

- **Type**: Provides three options, including:
  - **Off**
  - **Normal**, which places a diamond-shaped, colored marker, along with a number, 1-4, on the trace.
  - **Delta**, is associated with a normal marker. Therefore, a normal marker must exist prior to creating the delta marker. The delta marker displays the difference between the normal marker position and the delta marker position. Only one delta marker can be associated with a given normal marker. The normal marker must be active when Delta is selected.
- **Marker to Peak**: Places the active marker on the current greatest value of the trace.
- **Marker to Next Peak**: Places the active marker on the current second greatest value of the trace.
- **Marker to Min**: Places the active marker on the current lowest value of the trace.
- **Marker to Next Min**: Places the active marker on the current second lowest value of the trace.

	Step	Notes
1	[Marker]	
2	[Marker]	
3	[1], [2], [3], or [4]	
4	[Type]	
5	[Off], [Normal], or [Delta]	
6	Locate the marker relative to the trace: [Marker to Peak] or [Marker to Next Peak] or [Marker to Min] or [Marker to Next Min]	

9 E1 Analyzer

E1 Analyzer

Making E1 Measurements

The Agilent E7495A/B provide a simple solution for all your E1 testing needs, from basic transmission testing to BERT testing. For more information about E1 testing, refer to “Measurement Results” on page 175.

Steps for Performing a Basic E1 Analyzer Measurement

	Step	Notes
1	[Mode]	
2	[Backhaul]	
3	[E1 Analyzer]	
4	[Get Started/ Test Mode]	The tests are listed on the buttons on the right. Pressing a test mode button will provide you with information about the test and the test options available.
5	[Setup]	Configure the E1 analyzer for the measurement.
6	[Display]	Setup your view of the measurement results.
7	[Control]	Modify the measurement setup and inject errors as you perform the measurement.

Making Selections from the Setup Button

- **Rx Input**: The Primary and Secondary inputs are both affected by this setting.
  — **Terminate -** sets the input impedance to 75 Ohms. Can be performed only when the E1 circuit is interrupted (connected into a jack that interrupts the circuit).
  — **Monitor -** sets the input impedance to 75 Ohms, inserts 20 dB

gain, and should be selected when connected to a 'Monitor' jack.

— **Bridge -** sets the input impedance >1000 Ohms and should be selected when bridging on to an E1 circuit.

- **Line Code**: Configures the test set to transmit and expect to receive a line code that is compatible with the circuit's provisioning. There are two types of line coding used in E1 networks:

— **AMI -** Alternate Mark Inversion is a traditional line code.

— **HDB3 -** High Density Bipolar 3 replaces runs of 4 zeroes with a special code that is not compatible with AMI. It allows greater flexibility of data patterns by enhancing repeater synchronization by increasing pulse density, thereby providing greater throughput.

- **Framing**: Configures the test set to transmit and expect to receive a particular framing pattern that is compatible with the circuit's provisioning. It enables the test set to receive the E1 signal and to then synchronize, identify, and extract the individual channels.

— **Unframed -** Causes the test set to simulate a loss of frame condition.

— **PCM30 -** A framing format consisting of 30 traffic channels, 1 slot reserved for the frame alignment signal (FAS) and 1 slot reserved for common channel signaling.

— **PCM30 + CRC4 -** A framing format consisting of 30 traffic channels, 1 slot reserved for the frame alignment signal (FAS) with CRC and 1 slot reserved for common channel signaling.

— **PCM31 -** A framing format consisting of 30 traffic channels, 1 slot reserved for the frame alignment signal (FAS)

— **PCM31 +CRC4 -** A framing format consisting of 30 traffic channels, 1 slot reserved for the frame alignment signal (FAS) with CRC

- **Pattern:** Configures the test set to expect a particular test pattern. Many test patterns are available to 'stress' the circuit in a particular manner or to gain maximum insight into a particular problem.
- **Tx Pattern:** Allows you to select either Normal or Inverted patterns.
- **Tx Clock**: Configures the test set to use one of the following methods to derive the transmit clock frequency.

— **Internal -** The transmit clock is derived within the test set and is independent of the incoming signal. This is useful when the device or line under test is configured to synchronize on the incoming signal. In this case the return clock frequency of the return signal should match the transmit clock frequency of the test set.

— **Primary Rx -** The transmit clock frequency is derived from the signal received at the Primary Rx jack on the test set.

— **Secondary Rx -** The transmit clock frequency is derived from the signal received at the Secondary Rx jack on the test set.

- **Timeslot**: Applicable only in the Channel BERT mode. Sets the active channel to be tested for BERT.
- **Fill Data**: When performing Channel BERT testing this configures the source of data transmitted in the unused slots. For drop-and-insert testing this field is typically set to Secondary Rx.

— **All 1's -** Set this mode to maintain a sufficient 1's density on the unused channels during testing. All 1's are typically transmitted on unused channels in live E1 circuits.

— **Idle -** Set this mode to accommodate specific troubleshooting such as to exercise a circuit provisioned for HDB3.

— **Primary Rx -** Fills the unused slots with Primary Rx data.

— **Secondary Rx -** Fills the unused slots with Secondary Rx data.

- **Slip Reference:** Selects the reference for the frame slip measurement.

— **None -** This selection disables the frame slip measurement.

— **Internal -** In this mode the test set compares the framing of the incoming signal with the test set's internal clock. Three conditions are necessary when using this mode: The far end must be receiving a signal from this test set. The transmit clock on the far end must be configured to synchronize on the incoming signal. The Tx Clock on this test set must be set to internal.

— **Second Rx -** In this mode the test set compares the frame clock timing of the received signal on the Primary Rx jack with the frame clock timing of the received signal on the Secondary Rx jack.

- **Second Tx**: Selects the source of data of the signal available at the Secondary Tx jack.
  - **AIS -** The signal at the Secondary Rx jack is an unframed all ones aka. AIS.
  - **Second Rx -** The Secondary Rx signal is buffered and looped back to the Secondary Tx jack.
  - **Primary Rx -** The signal at the Primary Rx jack is buffered and internally routed to the Secondary Tx jack.

Making Selections from the Display/Sound Buttons

Configure the following for the measurement you're doing:

- **Status**: Allows you to select which status panel is active.
- **Alarms**: Displays those errors occurring on either the primary or secondary channel, depending on your selection. Displays in the bottom-right of the screen.
- **Results**: Can choose an error and select results you want to drill down to; shows more metrics on error you select. Displays in bottom-right of screen.
- **Sound**: Enables you to turn sound on and off. Use sound mostly to listen for drop outs and/or changes in the signal.
- **Volume**: Enables you to set the volume of speaker output.

Making Selections from the Control Button

On the Control button, the available buttons are unique to the test mode you select. Once you set up your display, you can change settings, such as patterns, alarm injections, etc., while you make the measurement.

- **Pattern:** Configures the test set to send and expect to receive a particular test pattern. Many test patterns are available to 'stress' the circuit in a particular manner or to gain maximum insight into a particular problem.
- **Alarm/Error**: Enables a list of available alarms and conditions that can be transmitted on the Primary Tx channel. The alarm or condition is invoked by pressing the Inject button.

To troubleshoot your E1 line, you can monitor for errors or alarms. Inject errors to see how the system responds.

— **Loss of Signal Alarm -** The test ceases to send a signal.

— **Loss of Frame Alarm -** Disables the frame pattern.

— **FAS Distant Alarm -** Sets the Remote Alarm Indicator bit in timeslot 0 of the odd frames to simulate an FAS distant alarm.

— **MFAS Distant Alarm -** Sets every sixth bit of each timeslot 16 in the zero frame to simulate an MFAS distant alarm.

— **AIS Alarm -** Alarm Indication Signal (AIS) sends an unframed, all one's pattern.

— **TS-16 AIS Alarm -** Sets all bits in timeslot 16.

— **BPV Error -** The test set forces a single bipolar violation error with each press of the Inject button.

— **FAS Error -** Causes an error in the frame alignment signal.

— **MFAS Error -** Causes an error in the multi-frame alignment signal.

— **CRC-4 Error -** Causes the test set to generate a CRC error. Note that this is possible only when CRC-4 frame modes are selected.

— **FEB (E-Bit) Error -** Causes the test set to set the E bit on odd frames.

— **Pattern Error -** The test set forces an error in the transmitted pattern with each press of the Inject button.

- **Timeslot**: Applicable only in the Channel BERT mode. Sets the active channel to be tested for BERT.
- **Fill Data**: When performing Channel BERT testing this configures the source of data transmitted in the unused slots. For drop-and-insert testing this field is typically set to Secondary Rx.

— **All 1's -** Set this mode to maintain a sufficient 1's density on the unused channels during testing. All 1's are typically transmitted on unused channels in live E1 circuits.

— **Idle -** Set this mode to accommodate specific troubleshooting such as to exercise a circuit provisioned for HDB3.

— **Primary Rx -** Fills the unused slots with Primary Rx data.

— **Secondary Rx -** Fills the unused slots with Secondary Rx data.

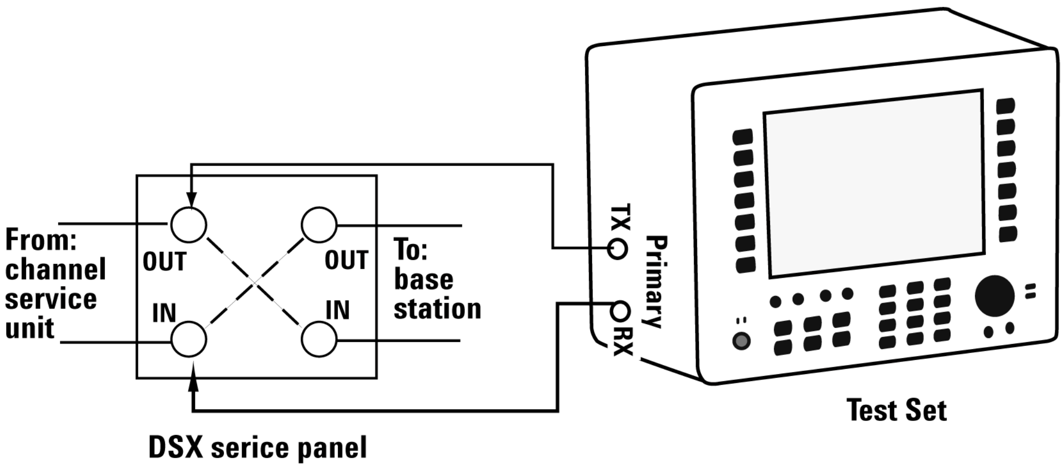
- **Inject**: Causes the error or condition that is currently displayed on the button to occur. Some selections cause a single event to occur, while others maintain a constant state. The text on the button changes to reflect the appropriate action.

Sample Hard Loop/End-End Full E1 BERT Test

You can use this test mode to perform measurements such as BERT on an E1 circuit. This example explains how to setup a hard-loop/ene-end full E1 BERT test. A hard loop test requires one test set at one end, and a hard loop at the other. An end-end test requires a test set at each end, but enables the troubleshooter to identify the direction of the trouble. The E1 circuit is not available for service when using this test mode.

During the commissioning or startup phase of an E1 circuit, a several day end-end or hard loop test is often performed. This type of test provides the most comprehensive level of information, but does require that the circuit be taken out of service for the duration of the test. The test results provide more granular resolution on root cause problems than does a monitor test.

Figure 9-1 Sample End to End Connection Using a Terminate Connection with a Dsx Service Panel



Sample Hard Loop/End-End Full E1 Test:

	Step	Notes
1	[Mode]	
2	[Backhaul]	
3	[E1 Analyzer]	
4	[Get Started/ Test Mode]	
5	[Hard Loop/End-End]	Use this test mode to perform measurements such as BERT on an E1 circuit. The far-end signal must be derived from either a hard loop or from a second test set. The E1 circuit is not available for service when using this test mode.
6	[Full E1 BERT]	Select this to perform a BERT test on a full E1 Circuit.
7	[Auto Config]	Enables the Auto Configuration buttons.

	Step	Notes
8	[Start Primary Auto Config]	Causes the test set to analyze the incoming E1 signal and align the setup choices to the properties of that signal.
9	[Back]	
10	[Setup]	
11	Setup Rx input. a. [Rx Input] b. [Terminate]	The test set must be connected to a jack that interrupts the E1 circuit.
12	Setup line code. a. [Line Code] b. [HDB3]	This assumes the circuit is provisioned for HDB3 (High Density Bipolar 3). A E1-line code in which bipolar violations are deliberately inserted if user date contains a string of 4 or more consecutive zeros.
13	Setup framing. a. [Framing] b. [PCM31 + CRC4]	This assumes that the circuit has been provisioned for PCM31 + CRC4.
14	Setup pattern. a. [Pattern] b. [QRSS]	
15	Setup Tx pattern. a. [Tx Pattern] b. [Normal]	

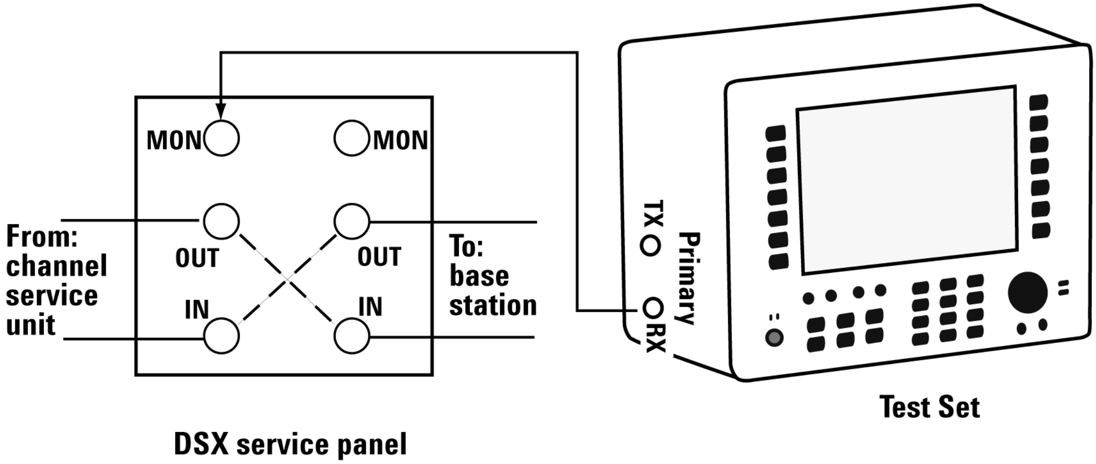
	Step	Notes
16	Setup Tx clock. a. [Tx Clock] b. [Internal]	This is the default selection after test set preset and covers the situation when a hard loop is configured at the far end. If a separate test set is utilized at each end then the test set on one end should have the Tx Clock set to Primary Rx (assuming the incoming signal is connected to this jack). Another alternative is to use a second E1 circuit connected to the Secondary Rx jack to establish proper timing.
17	Setup slip reference. a. [Slip Ref] b. [None]	Disables the frame slip measurement.
18	Setup second Tx. a. [Second Tx] b. [AIS]	Use the default condition.
19	[Display/Sound]	Enables the display and sound options on the right-hand buttons.
20	Setup the status. a. [Status] b. [Pri]	Activates only the Primary Status pane. The inactive channel should be deactivated to cease the display of invalid measurements.
21	Setup alarms. a. [Alarms] b. [Pri]	This selection causes the Alarm pane to toggle between Primary and Secondary. Use [Pri] to observe the Primary Results in the Alarm Panel. Each time you press this softkey, the selected option changes.
22	Setup results display. a. [Results] b. Use up and down buttons to select. c. [Select]	Displays a list of results information that can be displayed in the Results pane. Make a selection based on the need of the application. [Control] enables several right-hand soft keys that control choices specific to each test mode.

	Step	Notes
23	Setup to inject an error. a. [Control] b. [Alarm/Error] c. Use the Up and Down arrow buttons to select. d. [Select] e. [Inject]	Allows you to select and then inject the alarm or error you want to test. Causes the error or condition that is currently displayed on the Inject button to occur. Note that some selections cause a single event to occur while others maintain a constant state. The text on the button changes to reflect the appropriate action.

Sample Monitor Full E1 Test

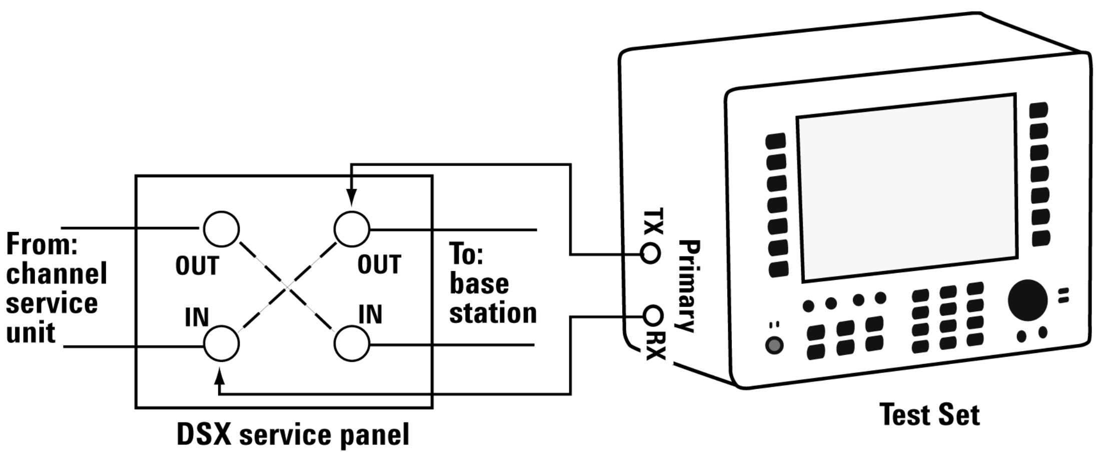
This example shows how to monitor an E1 circuit without disrupting service. During this test the source of signal from the far end can be either live data or pattern data from a second test set. This mode is very similar to End-to-End Hard Loop mode, with the exception that the signal present on the Primary Tx jack is a buffered replica of the signal present on the Primary Rx jack. When monitor jacks are not available, this feature allows the technician to break into a live E1 and pass that signal through the test set thereby keeping the circuit in-service. This is useful for monitoring long-term statistics, of an E1 circuit.

Figure 9-2 Sample Monitor Mode with a Monitor Port Connection



When using the above sample connection for monitoring an E1 circuit with a monitor port, you should set Rx Input to monitor.

Figure 9-3 Sample Monitor Mode without a Monitor Port



When using the above sample connection for terminating an E1 circuit, you should set Rx Input to terminate.

Sample Monitoring Procedure

	Step	Notes
1	[Mode]	
2	[Backhaul]	
3	[E1 Analyzer]	
4	[Get Started/ Test Mode]	
5	Setup monitoring. a. [Monitor] b. [Monitor Full E1]	Use this test mode to monitor live data on the E1 line without affecting service. The simplest hookup for monitoring does not require the test Set Tx outputs to be connected. In some cases, you may connect the Tx outputs t the E1 circuit. For those cases, the Tx primary and secondary transmitted signals are regenerated from the received signal on the corresponding line. Choose [Monitor Full E1] to monitor performance of a full E1 Circuit.
6	Setup auto configuration. a. [Auto Config] b. [Primary Auto Config]	Causes the test set to analyze the incoming E1 signal and to align the setup choices to that signal.
7	[Back]	Shifts focus back to the main mode selection buttons.
8	Setup the Rx Input. a. [Setup] b. [Rx Input] c. [Terminate]	This assumes the test set is connected into a jack that interrupts the E1 circuit. Note: If you are connected to a monitor port, select [Monitor] instead of [Terminate].
9	Setup line code. a. [Line Code] b. [HDB3]	This assumes the circuit is provisioned for HDB3.

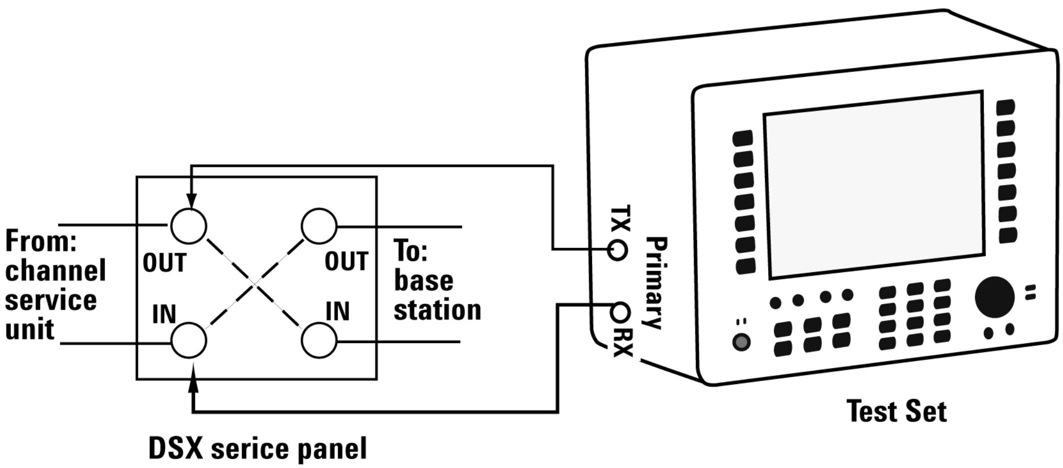
	Step	Notes
10	Setup framing. a. [Framing] b. [PCM31 + CRC4]	This assumes that the circuit has been provisioned for PCM31 + CRC4.
11	Setup pattern. a. [Pattern] b. [QRSS]	Set to the pattern sent by the far-end.
12	Setup Tx Pattern. a. [Tx Pattern] b. [Normal]	
13	Setup Tx clock. a. [Tx Clock] b. [Internal]	This selection is not applicable in Monitor mode because the Primary Tx signal is a buffered replica of the signal applied to the Primary Rx jack and is not affected by this setting. Internal is the default selection after test set preset.
14	[More 1 of 2]	Displays further options. Choose [More 2 of 2] to return to the previous list of options.
15	Setup the slip reference. a. [Slip Ref] b. [None]	Disables the frame slip measurement.
16	Setup the second Tx. a. [Second Tx] b. [AIS]	Use the default condition.
17	[Display]	Enables the [Display] options on the right-hand buttons.

	Step	Notes
18	Setup the status display. a. [Status] b. [Pri]	Activates only the Primary Status pane. The inactive channel should be deactivated to cease the display of invalid measurements.
19	Setup alarms. a. [Alarms] b. [Pri]	This selection causes the Alarm pane to toggle between Primary and Secondary. Use the Pri selection to observe the Primary Results in the Alarm Panel.
20	Setup the results display. a. [Results] b. Use the up and down buttons to move to the desired choice. c. [Select]	Enables a list of results information that can be displayed in the Results pane. Make a selection based on the need of the application.

Setting Up Delay Test Mode

Use this test mode to have the test set measure the round trip delay of an E1 circuit. It is necessary to have a loop condition at the far end during this test. The best accuracy is obtained when a hard loop exists at the far end. Be aware that devices placed in loopback may add additional delay. During this mode a pattern consisting of a zero inserted into a string of ones is transmitted and analyzed to determine the delay in the path. The selected test pattern is sent as filler during the calculation interval.

Figure 9-4 Delay Connection Diagram



Sample Delay Mode Test Procedure

	Step	Notes
1	[Mode]	
2	[Backhaul]	
3	[E1 Analyzer]	
4	[Get Started/ Test Mode]	
5	Perform Delay test. a. [Delay] b. [Full E1]	Use this test mode to measure the delay between the Primary Tx and Rx ports. Use this measured delay to determine the approximate distance between near-end and far-end. The far-end of the line must be manually looped during this test. Since a signal is being sent on the E1 line, service on the E1 will be effected. Delay measurements require full E1 bandwidth.

	Step	Notes
6	[Setup]	Select this to display a list of setup choices that pertain to this test mode.
7	Setup Rx Input. a. [Rx Input] b. [Terminate]	This assumes the test set is connected into a jack that interrupts the circuit.
8	Setup Line Code. a. [Line Code] b. [AMI] or [HDB3]	This assumes that the circuit is provisioned for AMI or HDB3.
9	Setup Framing. a. [Framing] b. [Unframed] or [PCM30] or [PCM30 + CRC4] or [PCM31] or [PCM31 + CRC4]	This assumes that the circuit has been provisioned for the option you select.
10	Setup the Pattern. a. [Pattern] b. Use the up and down arrow buttons to move to a pattern. c. [Select]	
11	Setup the Tx Pattern. a. [Tx Pattern] b. [Normal] or [Invert]	
12	Setup the Tx Clock. a. [Tx Clock] b. [Internal] or [Primary Rx]	None of the options available on [More 1 of 2] are available in Delay mode.

Turning On Sound

You can listen to a single channel at a time in channel test modes. Sound is disabled when you are in full E1 test modes.

	Step	Notes
1	[Mode]	
2	[Backhaul]	
3	[E1 Analyzer]	
4	[Get Started/ Test Mode]	
5	[Hard Loop/End-End] or [Monitor]	
6	Select Channel mode.	
7	[Display/Sound]	
8	[Sound]	
9	[On] or [Off]	Each time you press this softkey, the selected option changes.
10	Set the volume. a. [Volume] b. Enter the volume level from 1 to 10. c. [Enter]	

Setting Up E1 Diagnostics

The diagnostic tests available for E1 include:

- **RAM -** During the RAM test, the memory on the E1 measurement module is tested. Memory hardware failures are detected.
- **ROM -** The ROM test verifies the integrity of the code by performing a checksum measurement.
- **Loop Back -** The loop back test is a functional test of the transmitting and receiving hardware. It attempts to send various signal patterns and levels and then to verify the measured values. It

is important that this test be done using the short jumpers provided with the E7495A/B.

If any of the above tests fail, contact your service center.

	Step	Notes
1	[Mode]	
2	[Backhaul]	
3	[E1 Analyzer]	
4	[Tests]	
5	[Verification]	
6	[Continue]	The test is performed and results are reported on the screen.

Patterns

Many test patterns are available to 'stress' the circuit in a unique way or to gain maximum insight into a particular problem. Much has been written to guide the troubleshooter to select the proper pattern. Below is a list of the patterns available in the test set.

- 2E6-1
- 2E9-1
- 2E11-1
- 2E15-1
- 2E20-1
- QRSS- A pseudorandom pattern that simulates live traffic on a circuit. It is a very common test pattern
- 2E23-1
- All 0's - A pattern that is often selected to verify HDB3 provisioning.
- 1:7 - An eight-bit pattern that contains a single 1. Used to test clock recovery.
- 1:4 - A 5-bit pattern with a single 1.
- 1:2 - A 3-bit pattern with a single 1.

E1 Analyzer

- All 1's - A pattern that causes line drivers to consume the maximum amount of current. If framing is set to 'Unframed' the resulting pattern is equivalent to an Alarm Indication Signal (AIS).

Measurement Results

Alarm Indicators

- **Signal Loss** - The test set encountered the absence of data on the E1 signal. A frame pulse may or may not be present.
- **Frame Loss** - The test set encountered an unexpected frame pattern. The frame pattern did not match the one selected in 'Setup.'
- **AIS Alarm** - The test set encountered an unframed all-ones signal.
- TS 16 AIS Alarm - The test set encountered all ones in every timeslot sixteen.
- **FAS Distant Alarm -** The test set detected a FAS alarm being sent from the far end.
- **MFAS Distant Alarm -** The test set detected an MFAS alarm being sent from the far end.
- **Pattern Inv** - The pattern of the signal applied to the test set is inverted.

Results Indicators

- **(Code) BPV -** A momentary indicator that responds when a bipolar violation occurs on the incoming signal applied to the Receive jack. HDB3 codes are not considered a BPV and will not activate this indicator when the test set is set to AMI mode.
- **FAS -** A momentary indicator that responds to a disruption in the frame alignment signal.
- **MFAS -** A momentary indicator that responds to a disruption in the multi-frame alignment signal. This indicator is applicable in only PCM-30 framing modes.
- **CRC-4 -** A momentary indicator that responds to a disruption of the incoming CRC. This indicator is applicable in only CRC-4 framing modes.
- **E-Bit -** A momentary indicator that responds to the E-bit.
- **Pattern** - A momentary indicator that responds to a disruption of the

incoming pattern.

- **Frame Slip -** A momentary indicator that responds when the test set encountered a disruption of the incoming frame pattern.
- **Recv Level -** The voltage level of the signal measured at the Rx jack.
- **Frequency -** The frequency of the signal measured at the Rx jack. The E1 Pulses indicator must be active for this measurement to be displayed.
- **Elapsed Time -** Indicates the amount of elapsed time since the last measurement reset.
- **BPV Errors -** A tally of the number of BPV errors since the last measurement reset.
- **BPV Error Rate -** The percent ratio of BPV errors to total bits transmitted since the last measurement reset.
- **BPV Errd Secs -** The number of one second intervals since the last measurement reset that contained BPV errors.
- **Frame Errors -** A tally of the number of Frame errors since the last measurement reset.
- **Frame Error Rate -** The percent ratio of frame errors to total bits transmitted since the last measurement reset.
- **Frame Errd Secs -** A tally of the number of one-second intervals since the last measurement reset that contained frame errors.
- **Signal Loss -** A tally of the number of one-second intervals since the last measurement reset that contained signal errors.
- **Frame Sync Loss -** A tally of the number of one-second intervals since the last measurement reset that contained frame sync loss.
- **Excess Zeros -** A tally of the number of one-second intervals since the last measurement reset that contained excess zeros.
- **All 1's -** A tally of the number of one-second intervals since the last measurement reset that contained the AIS pattern.
- **Error Free Seconds -** A tally of the number of one-second intervals that were error free since the last measurement reset.
- **Errored Seconds -** A tally of the number of one-second intervals since the last measurement reset that contained errors such as BPVs and frame errors.

- **Severe Errored Seconds -** A tally of the number of one-second intervals since the last measurement reset that were severely errored.
- **Available Seconds -** A tally of the number of one-second intervals since the last measurement reset that were available for service.
- **Unavailable Seconds -** A tally of the number of one-second intervals since the last measurement reset that were unavailable for service.
- **Degraded Minutes -** A tally of the number of one-second intervals since the last measurement reset that were degraded.
- **Slip Rate -** The percent ratio of frames cycle slips of the incoming signal relative to the slip reference choice on the setup menu - since the last measurement reset.
- **Peak + Wander -** The peak amount of positive wander, measured in bit intervals, since the last measurement reset.
- **Peak - Wander -** The peak amount of negative wander, measured in bit intervals, since the last measurement reset.
- **+Frame Slips -** A tally of the number of positive frame slips that occurred since the last measurement reset.
- **–Frame Slips -** A tally of the number of positive frame slips that occurred since the last measurement reset.
- **Bit Errors -** A tally of the number of bit errors that occurred since the last measurement reset.
- **Bit Error Rate -** The percent ratio of bit errors to total bits transmitted since the last measurement reset.
- **Pattern Sync Loss -** A tally of the number of times the pattern detector lost synchronization since the last measurement reset.
- **Test Data Rate -** The measured data rate of the bit stream.

Status Indicators

- **E1 Pulses -** The test set is receiving pulses at the receive jack. Frame pulses alone are not sufficient to activate this indicator. There must be pulses present in the payload field.
- **HDB3 -** A HDB3 pulse pattern was detected on the incoming signal

at the receive jack. Note that only certain patterns transmit HDB3 pulse patterns. The pattern must contain at least 4 consecutive zeroes before a HDB3 pattern is sent. The QRSS pattern will generate HDB3 while an idle E1 circuit transmitting all 1's will not.

- **Frame Sync -** A frame sync pattern matches the one specified in the setup screen on the test set.
- **Pattern Sync -** The received pattern matches the one specified in the setup screen on the test set.

Testing and Fault Mitigation

The complexity of E1 testing certainly parallels or possibly exceeds that of RF tests at a cell site. Shadowing efforts and customer expression have shown that most cell site technicians reduce the complexities of backhaul E1 testing down into a series of well-defined steps. These tests are often not comprehensive but are often sufficient to determine the continuity of an E1 circuit with a high degree of confidence. Often times the test sequence is developed by an experienced technician and is determined by finding the shortest path to an adequate measurement on a particular piece of readily available equipment. E1 testing often involves one technician on each end of a circuit. In the case of wireless, the technician at the switch end, very experienced at backhaul testing, is often working with a field technician that has a broader-based set of knowledge and is often less experienced in backhaul testing. The switch technician quickly develops a test procedure that involves the least amount of verbal instructions with the field technician.

E1 Facility Summary

This next section describes the elements in a typical E1 backhaul facility. Based on this information, typical fault conditions and what procedures are typically followed to restore service to the E1 span.

With almost no exception all circuits leased from the TELCO are routed through at least one central office facility. If this were not the case, planning and managing the repeaters needed for E1 transmission would be an onerous task.

Isolating Faults Using Test Equipment

Test equipment can be used to generate and monitor alarms and errors. Test equipment is connected to the E1 facility in a variety of ways. BNC jacks are often available on the equipment. When the plug is inserted into the jack the circuit is interrupted. Sometimes a monitor jack is available. When a plug is inserted into the monitor jack the circuit is not interrupted and a -20 dB signal is available at the jack. When none of these is available the signal may be monitored at a connection block, sometimes referred to as a “punch-down block”. Table 9-1, “E1 Facility Access Methods,” on page 179 describes the three typical access methods.

Table 9-1 E1 Facility Access Methods

Access method	Test set configuration	Notes
Test Jacks	Terminated	Circuit is broken when plug is inserted into jack. The test equipment is normally set to “Terminate” and provides 75 Ohm termination.
Monitor Jacks	Monitor	The circuit is not interrupted when the plug is inserted into the jack. The actual signal is available at a level 20 dB lower than the original. The test set normally set to “Monitor”, provides a 75 Ohm termination and expects the signal to be 20 dB down from what is usually expected.
Direct Connection to “Punch Down Block”.	Bridged	The circuit is not interrupted in this mode. The test set impedance is greater than 1000 Ohms so that the circuit is minimally affected. Test set is set to “Bridged.”

WARNING **It is important to remember that 90 volts DC may exist between the transmit and receive pair. This voltage can be lethal!**

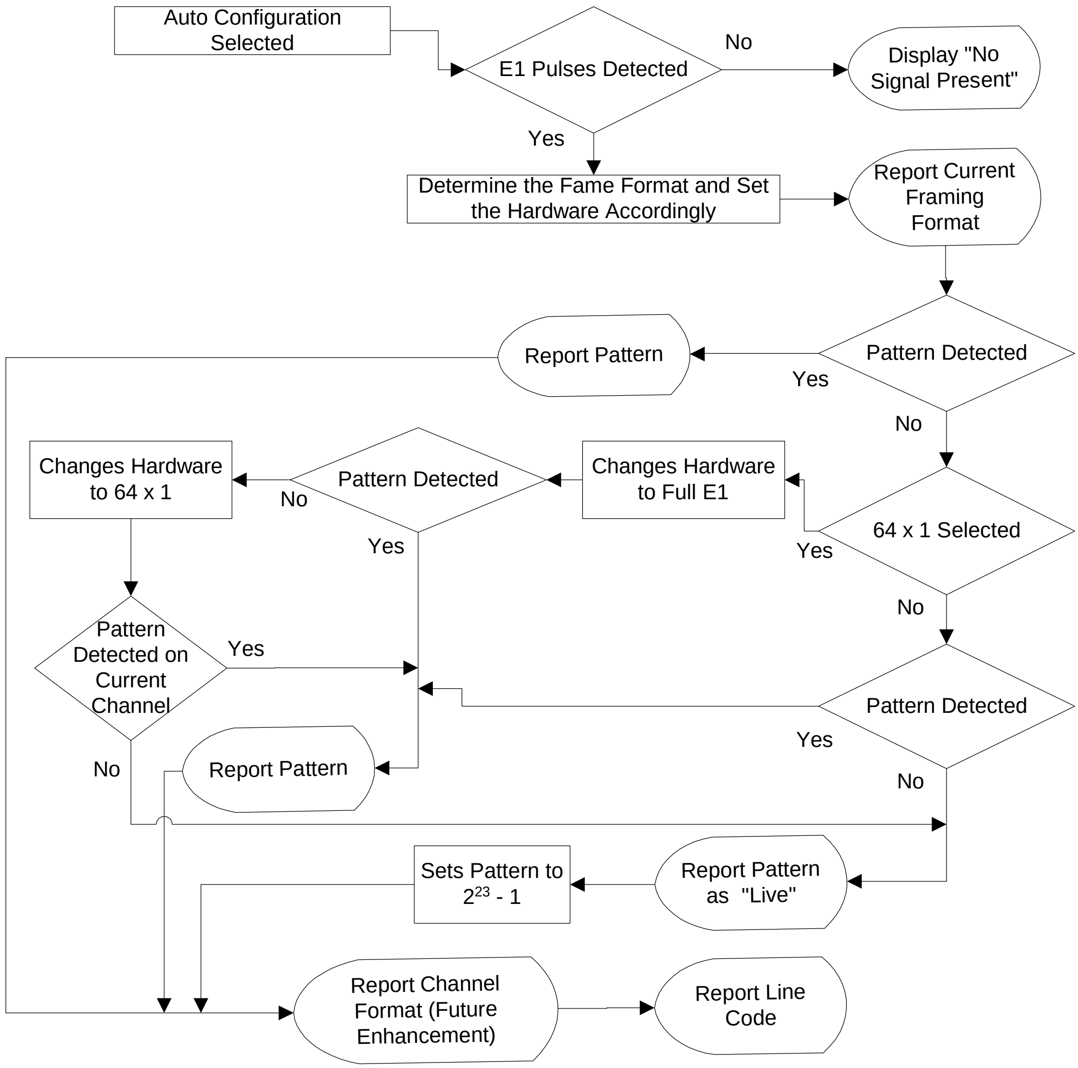
E1 Analyzer

More Information About E1 Testing

Auto Configuration Flow Diagram

Selecting Auto Config causes the test set to analyze the incoming E1 signal and align the setup choices to that signal. If the incoming data pattern is not recognized then 'NA Live Data' is displayed and the pattern selected on the setup screen will remain unchanged. If HDB3 codes are detected then this condition will be indicated and the line code parameter will be set accordingly. If setup was configured for HDB3 prior to selecting 'Auto Config' and the pattern detected does not have sufficient zeros density to warrant HDB3 then 'NA' will be displayed and the line code choice in the setup screen will remain unchanged. Finally, the framing format is detected, displayed and selection changed accordingly on the setup screen.

Figure 9-5 Flow Diagram for Auto Configuration



Terminology

CRC

To an observer, the data on a live E1 Circuit appear to be random. Fortunately there is a way to perform limited testing when the circuit is provisioned for Cyclic Redundancy Checksum (CRC) format. A portion of the frame bits are reserved for a CRC sequence that can be monitored for performance. Simply stated, the CRC bits are calculated on the transmit end and inserted as a pattern on the frame bit. The CRC pattern depends on the pattern of other bits transmitted by the E1 Circuit. The receiving end also computes this pattern and compares it with the CRC that was computed and sent by the transmitting end. Since both ends use the same rules for computing the pattern, the CRC bits will be identical when all the bits involved in the computation agree. The CRC check provides good insight into the end-to-end integrity of the E1 Circuit and should be used in conjunction with other tests that can help determine what the cause of the CRC failure might be.

BPV

The electrical signals on a properly functioning E1 circuit conform to the specification set forth in the standards. The standards specify that the presence of a voltage indicates a data ’1’ and the absence of a voltage represents a data ’0’. Each occurrence of a data one produces a voltage for half a bit interval that is the opposite polarity of the previous bit, hence the name Alternate Mark Inversion (AMI). The alternating nature of the signal ensures that the average DC voltage is zero, allowing it be transformer coupled. Transformer coupling ensures a high degree of common mode rejection to the equipment that processes E1 signals.

High Density Bipolar 3 (HDB3) is an exception to AMI that replaces runs of 4 consecutive zeroes with a special code that violates the AMI rules. It allows greater flexibility of data patters by enhancing repeater synchronization by increasing pulse density thereby providing greater throughput.

When the electrical signal does not adhere to the alternating nature of the waveform specification a BiPolar Violation (BPV) has occurred. This can happen for a number of reasons, many of which are outside the control of the wireless technician. One cause may be from electrical noise radiating from florescent lamps, motors, or spark plug ignition circuits coupling into the copper lines that carry E1 signals. Shielded cable is often chosen for E1 circuits to minimize electrical interference. This shield must be grounded to be effective. When the cable is spliced or terminated the shield on both cables should be connected together. Often the transmit and receive signals are routed in separate cable bundles.

The receive signal is often much weaker that the transmit signal. Cross talk in the cable pairs can cause the transmit signal to appear on the receive pair and interfere with the low-level receive signal.

Frame

Pulses streaming in an E1 circuit would be meaningless if there were no way to organize them in a meaningful structure.

10 Power Meter

Making an Average Power Measurement

Average power measurements provide a key metric in transmitter performance. Transmit power must be set accurately to achieve optimal coverage in wireless networks. If transmit power is set too high due to inaccurate power measurements, undesired interference can occur. If transmit power is set too low, coverage gaps or holes may occur. Either case affects system capacity and translates into decreased revenue for service providers.

Average power can be measured while the base station is active.

CAUTION The maximum power for the RF In and RF Out port is 20 dBm (100 mW). The maximum power for the Power Sensor port is 24 dBm (300 mW). When directly coupled to a base station, the test set can be damaged by excessive power applied to any of these three ports.

To prevent damage in most situations when you directly couple the test set to a base station, use the high power attenuator between the test set and the BTS.

NOTE Average power is a broadband measurement, so if there are other signals present it will also measure their power contributions. If you suspect other signals may be present, it is recommended that you turn off all the other channels and measure average power on the signal of interest alone. Another option is to measure channel power, which filters out other channels. You can measure channel power for CDMA using the CDMA Analyzer or CDMA Over Air tool. For other modulation formats, measure channel power using the Channel Scanner tool.

NOTE If you have not done so, measure the loss of the high power attenuator by using the Insertion Loss measurement. Refer to “Two Port Insertion Loss” on page 47.

NOTE Connect the Power Meter as close as possible to the power amplifier/duplexer output. Do not use a coupled port. The levels of the sensors do not function well at the levels provided by a coupled port.

Making a Basic Average Power Measurement

To make an average power measurement, you connect the power sensor and cable, zero and calibrate the meter, and then take a reading.

When should you zero the Power Meter?

- Every time you use the Power Meter.
- When a 5-degree C. change in temperature occurs.
- Whenever you change the power sensor.
- Every 24 hours.
- Before measuring low level signals—for example, 10 dB above the lowest specified power for your power sensor.

When should you calibrate the Power Meter? Every time you cycle the power on and off.

To Make a Basic Average Power Measurement:

	Step	Notes
1	**Mode**	
2	[Power Meter]	
3	[Zero]	Follow the Zeroing Wizard, which displays instructions on the screen.
4	[Continue]	
5	[Ref CF]	
6	Enter the reference cal factor using the number keypad.	The reference cal factor is printed on the label of the power sensor head.
7	[%]	
8	[Calibrate]	
9	Connect the power sensor to the Power Ref 50 MHz port.	
10	[Continue]	

Power Meter

	Step	Notes
11	[Cal Factor]	
12	Enter the cal factor using the number keypad.	A list of cal factors is printed on the label of the power sensor head. Select one that's within the operating frequency of the base station. Refer to Table 10-1 on page 189 for an example of a power sensor calibration table. Using the example power sensor calibration table, if you were interested in 800 MHz, then: 800 MHz has a Cal Factor percentage of ~98.2 **Note:** Interpolate the Cal Factor from the frequency range provided on the power sensor. The example sensor calibration table shows that 800 MHz is between 300 to 1000 MHz. Since 300 MHz is listed at 98.5 and 1000 MHz (1 GHz) is at 98.1, 800 MHz would be ~98.2.
13	[%]	
14	Connect the external attenuator.	
15	If you have previously stored PM loss from an insertion loss measurement, go to the next step. Or Press [PM Loss] and enter the PM loss value.	

Power Meter

	Step	Notes
16	Connect to the base station.	Connect the power sensor to the signal to be measured. The connection is typically after the output of the power amplifier or duplexer. The connection requires, in addition to the power sensor and attenuator, a 2 ft. cable and two Type-N barrel connectors.

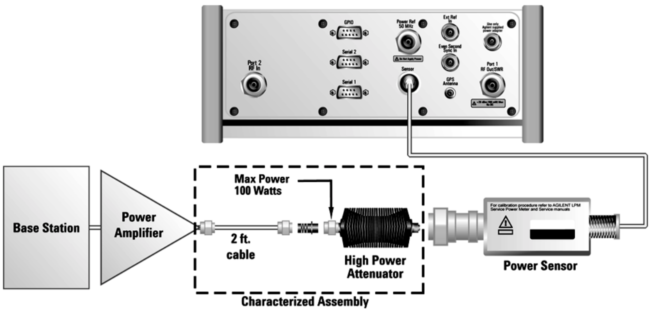


Table 10-1 Example of a Sensor Calibration Table (Agilent 8482A)

MHz	CF%
.1000	97.3
.3000	99.0
1.0	99.0
3.0	99.0
10.0	99.5
30.0	99.1
100	98.8
300	98.5
1000	98.1

Table 10-1 Example of a Sensor Calibration Table (Agilent 8482A)

MHz	CF%
2000	97.4
3000	98.1
4000	90.5

Setting Power Meter Resolution

You can choose from four levels of Power Meter resolution. Higher resolutions provide more accuracy but slow the measurement speed.

	Step	Notes
1	[Mode]	
2	[Power Meter]	
3	[Setup]	
4	On [Resolution] select 1, 2, 3, or 4.	Each time you press this softkey, the selected option changes. • [1] = 1 • [2] = 0.1 • [3] = 0.01 • [4] = 0.001

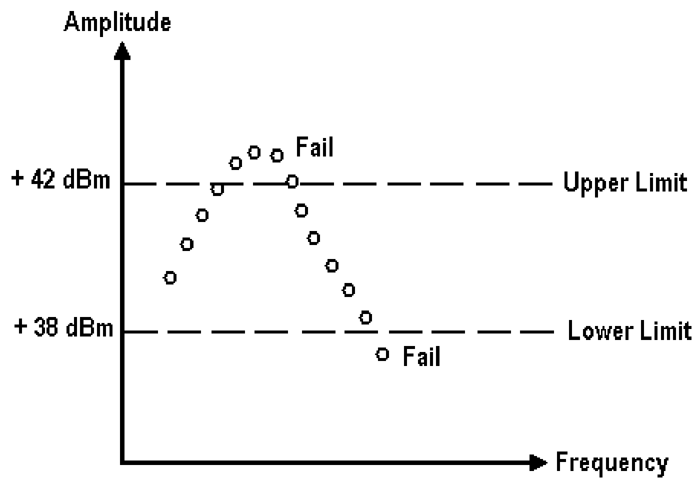
Setting the Power Meter's High and Low End-Points

Changing the high and low end points changes the scale resolution, making it easier to view small changes in power. This does not change the range of the sensor.

	Step	Notes
1	[Mode]	
2	[Power Meter]	
3	[Setup]	
4	[Low End]	
5	Enter the minimum value you want using the number keypad.	
6	[dBm]	
7	[Hi End]	
8	Enter the maximum scale value you want using the number keypad.	
9	[dBm]	

Setting the Power Meter's Upper and Lower Limits

You can configure the Power Meter to detect when a measurement has failed predefined upper and lower limits.



	Step	Notes
1	[Mode]	
2	[Power Meter]	
3	[Setup]	
4	On [Limit] select **On.**	Each time you press this softkey, the selected option changes.
5	[Low Limit]	
6	Enter the low limit using the number keypad.	
7	[dBm]	
8	[Hi Limit]	
9	Enter the high limit using the number keypad.	
10	[dBm]	

11 Return Loss

Measuring Return Loss

Return loss is a measure of reflection characteristics. One way you can use the return loss measurement is to detect problems in the antenna feedline system and the antenna itself. A portion of the incident power will be reflected back to the source from each transmission line fault as well as the antenna. The ratio of the reflected voltages to the incident voltage is called the reflection coefficient. The reflection coefficient is a complex number, meaning it has both magnitude and phase information. In S-parameter terms, Return Loss is referred to as an S_{11} measurement.

NOTE Test signals can cause interference. When testing cables attached to antennas, test signals are radiated. Verify that the signal used for the test cannot cause interference to another antenna.

NOTE The return loss calibration is the same calibration as performed for two other measurements: one port insertion loss and distance to fault (as long as you use the manual frequency method). If you make the calibration for any of these three measurements, the calibration will apply to the other two measurements—and “Calibrated” will be displayed on the screen for all three.

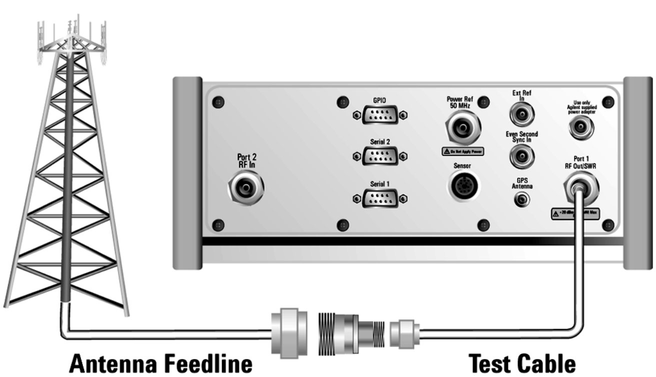
The calibration remains valid until you power off the test set or change the start or stop frequency.

Performing a Basic Return Loss Measurement

Select the desired frequency range and calibrate the test set (using a calibrated Open, Short, and Load connector) for a return loss measurement.

	Step	Notes
1	**Mode**	
2	[Antenna/Cable]	
3	[Return Loss]	The return loss measurement takes a few seconds to load.

	Step	Notes
4	[Start Freq]	
5	Enter the start frequency using the number keypad.	
6	[Hz], [kHz], [MHz], or [GHz]	
7	[Stop Freq]	
8	Enter the stop frequency using the keypad.	The stop frequency should be larger than the start frequency.
9	[Hz], [kHz], [MHz], or [GHz]	
10	[Calibrate]	Follow the instructions of the Calibration Wizard. The test set will calibrate over the desired frequency range.
11	Connect the antenna feedline and antenna.	Connect the antenna feedline cable to the RFout/SWR port.



	Step	Notes
12	[Level]	Below the Return Loss display is a table displaying the frequency return loss, and Standing Wave Ratio (SWR) of the best and worst return losses. These values may be changing rapidly. To isolate a signal, use a single sweep. If the return loss trace is not visible, you can change the reference level or use Autoscale to have the test set select a reference level for you. • To choose Autoscale, press [Autoscale]. • To set the level manually, press [Ref Level], enter a value using the number keypad, then press [dB].

Note: If the return loss measurement is suspicious (less than 5 dB), you may want to perform a distance to fault measurement to determine if a noticeable fault exists and where it may be located. For more information see “Distance to Fault” on page 143.

Isolating a Return Loss Signal Using a Single Sweep

	Step	Notes
1	[Average/Sweep]	
2	[Single]	Activate the single sweep. Press [Continuous] if you want to start multiple sweeps.

Setting Return Loss Interference Rejection

Other signals can interfere with return loss measurements. When making a return loss measurement in the presence of known or suspected interference, you can minimize the effect of the interference on the measurement by activating interference rejection in the test set.

NOTE Use of interference rejection will increase the measurement time. Interference rejection should be used if a known interfering signal exists or if the return loss measurement displays suspicious characteristics such as a spike or rapid movements in the noise floor.

	Step	Notes
1	[Setup]	
2	On [Interference Rejection] select **On**.	Each time you press this softkey, the selected option changes.

Return Loss

Setting Average, Sweep, and Restart

Setting the Sweep

You can select either continuous or single sweep. Continuous sweep provides repeated, ongoing measurements. Single sweep performs a single measurement that is repeated only when you push the Single button.

To set sweep:

	Step	Notes
1	[Average/Sweep]	
2	[Continuous] or [Single]	Each time you press this softkey, the selected option changes.

Setting Averaging

You can choose to have averaging on or off and set the number of averages you want to take. Averaging only applies to the data, not the trace. You can select from the following types of averaging:

- **Off**: Disables averaging.
- **Running:** Computes the new result as the weighted sum of the last result and the new measurement. The last result is weighted by (n – 1)/n. The new result is weighted by 1/n. Each new measurement produces a new result.
- **Max Hold**: Is not an average, but on a point by point basis, displays the maximum amplitude for the given frequency or channel since Max Hold was turned on. It is updated when a new maximum occurs.
- **Group Average:** Makes the requested number of measurements, averages the measurement data, and displays the average as a single result trace. Measurement time will vary based on the requested number of averages and can take minutes for very large number of averages.
- **Group Max Hold:** Makes the requested number of measurements before returning a single trace result. This trace is the maximum

value seen at each trace point over the requested number of averages (measurements).

To set averaging:

	Step	Notes
1	Set the number of averages.	
	a. [Average]	
	b. Enter the number of averages using the number keypad.	
	c. [Enter]	
2	Select the type of averaging you want to apply.	
	a. [Average/Sweep]	
	b. [Averaging]	
	c. [Off], [Running Average], [Max Hold], [Group Average], or [Group Max Hold]	

NOTE These two steps can be performed in any order. However, if you turn averaging on and a large number of averages has previously been set, there may be a delay before you can change number of averages.

Setting Restart

When you have averaging turned on, you can restart the averaging by pressing the Restart menu key. This restarts the averaging for running average in either Continuous or Single sweep mode.

To restart averaging:

	Step	Notes
1	[Average/Sweep]	
2	[Restart]	

Adding a Marker

Markers can be used on traces to help you visually track up to four signals. Each marker has the following settings:

- **Type**: Provides three options, including:
  - **Off**
  - **Normal**, which places a diamond-shaped, colored marker, along with a number, 1-4, on the trace.
  - **Delta**, is associated with a normal marker. Therefore, a normal marker must exist prior to creating the delta marker. The delta marker displays the difference between the normal marker position and the delta marker position. Only one delta marker can be associated with a given normal marker. The normal marker must be active when Delta is selected.
- **Marker to Peak**: Places the active marker on the current greatest value of the trace.
- **Marker to Next Peak**: Places the active marker on the current second greatest value of the trace.
- **Center Freq to Marker**: Scrolls to locate the current marker in the center of the trace.
- **Ref Level to Marker**: Scrolls the trace to place the marker at the top of the screen. To reset the reference level, choose [Level/Location] [Autoscale].

To Add a Marker to a Trace:

	Step	Notes
1	[Marker]	
2	[Marker]	
3	[1], [2], [3], or [4]	
4	[Type]	
5	[Off], [Normal], or [Delta]	

	Step	Notes
6	Locate the marker relative to the trace: • [Marker to Peak] • [Marker to Next Peak]	
7	Locate the trace relative to the marker: • [Center Freq to Marker] • [Ref Level to Marker]	

12 Signal Generator

Signal Generator

Using the Signal Generator

The Signal Generator is used to check base station receivers. It supports both RSSI and CDMA FER measurements. The Signal Generator provides multiple forward and reverse-link modulation types. For a complete list of supported modulation types, press the [Modulation] menu key after you begin the measurement. The test set supports the Agilent 8482A and 8481A power sensors.

CAUTION The maximum power for the RF In and RF Out port is 20 dBm (100 mW). The maximum power for the Power Sensor port is 24 dBm (300 mW). When directly coupled to a base station, the test set can be damaged by excessive power applied to any of these three ports.

To prevent damage in most situations when you directly couple the test set to a base station, use the high power attenuator between the test set and the BTS.

NOTE The lowest level the signal generator can go to is -90 dBm. In order to get a lower level, you must use an external attenuator. You can compensate for the attenuator in the RF Out Loss.

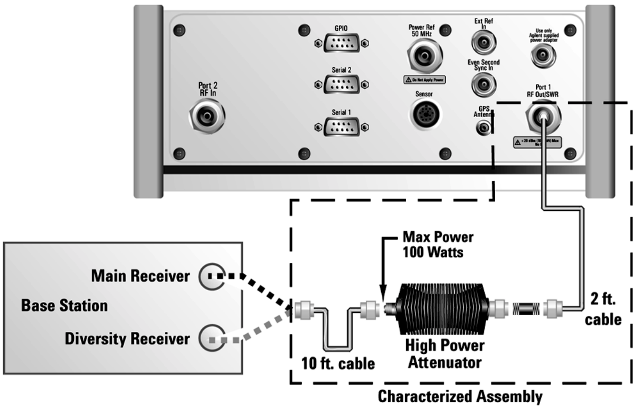
Performing a Basic Signal Generator Measurement

	Step	Notes
1	**Mode**	
2	[Spectrum Analyzer/Tools]	
3	[Signal Generator]	
4	[Freq/Chan/Time Ref]	
5	[Chan Std]	
6	Select the channel standard from the list using the up and down arrow buttons.	

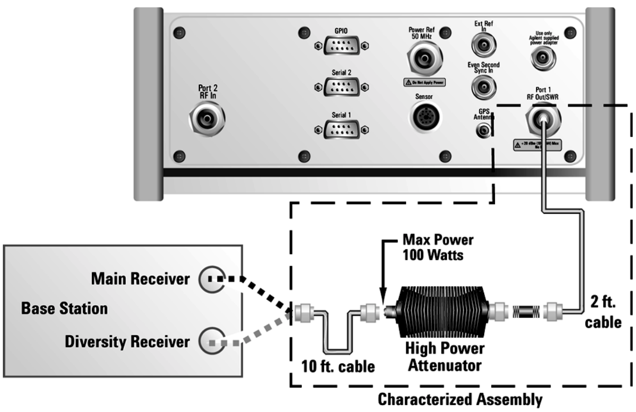
	Step	Notes
7	[Select]	
8	On [Units] select **Chan**.	Each time you press this softkey, the selected option changes. The Units settings are coupled across multiple tools,
9	[Fr/Time Ref]	
10	[GPS] or [External Even Sec]	
11	[Channel]	
12	Enter the channel using the number keypad.	When the channel is set, it is set across all the test set tools, so as you switch between tools, the channel is preset.
13	[Rev]	Always choose the reverse channel when performing a signal generator measurement.
14	[Modulation] If the key is grayed out, go to the step 16. Or If the key is active, go to the next step.	If the [Modulation] menu key is grayed out, your test set does not include the complex modulation option. You have only CW.
15	[Format]	

	Step	Notes
16	Select the modulation type from the list using the up and down arrow keys. a. If you have selected a CDMA Forward Link modulation type, select PN Offset. For other modulation types, you do not need to select PN Offset. b. If you have selected cdma2000 modulation with fundamental channels, you also need to press [R-FCh Pwr].	•
17	[Amplitude]	Changes the RF output power. Amplitude becomes the active function and the current value is shown in the active entry area of the display. To enter a new value for amplitude, turn the rotary knob until the desired value is displayed, use the up and down arrow keys, or enter the value using the number keypad. Then press [dBm].
18	If you have previously stored RF out loss from an insertion loss measurement, go to the next step. Or Press [RF OUT Loss] and enter the RF out loss value.	
19	Connect to the base station.	

Step	Notes

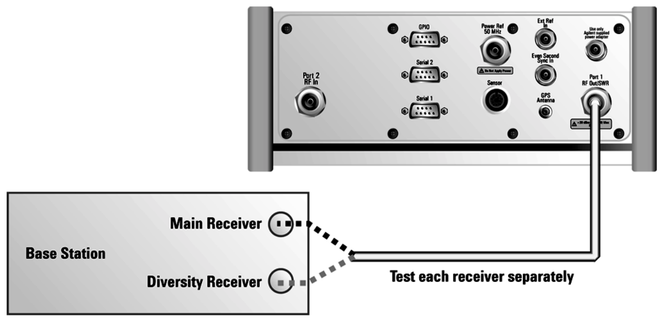


Low level non duplex connection



Low level non duplex connection

	Step	Notes



High level non duplex connection

20	On [RF] select **On**.	Each time you press this softkey, the selected option changes.

Persistent Signal Generator

The signal generator function can be used simultaneously with other measurement functions of the test set. This allows you to use the test set as both the source and the measurement device when making your measurements. To do this, setup the signal generator as described in "Performing a Basic Signal Generator Measurement" on page 204. Then proceed as described below.

	Step	Notes
1	**Mode**	
2	[Spectrum Analyzer/Tools]	
3	[Signal Generator]	
4	[Freq/Chan/Time Ref]	

	Step	Notes
5	On [Persist Sig Gen] select **Yes**.	Each time you press this softkey, the selected option changes. **Yes** turns the persistent signal generator function on and **No** turns the function off. When the persistent signal generator is turned on, an icon ( ) appears in the lower-right corner of the display.
6	**Mode**	
7	Select the desired measurement mode and proceed with your measurements	
17	[Amplitude]	Changes the RF output power. Amplitude becomes the active function and the current value is shown in the active entry area of the display. To enter a new value for amplitude, turn the rotary knob until the desired value is displayed, use the up and down arrow keys, or enter the value using the number keypad. Then press [dBm].

13 Spectrum Analyzer

Using the Spectrum Analyzer

Use the Spectrum Analyzer in direct connect mode to:

- Verify that your transmitted signal does not interfere (produce spurs and harmonics) with other signals.
- Verify spectral integrity—look at a signal to see if it meets expectations, look for unwanted signals.

Use the Spectrum Analyzer in over air mode to look for interference generated by other transmitters that can interfere with your transmit band.

CAUTION The maximum power for the RF In and RF Out port is 20 dBm (100 mW). The maximum power for the Power Sensor port is 24 dBm (300 mW). When directly coupled to a base station, the test set can be damaged by excessive power applied to any of these three ports.

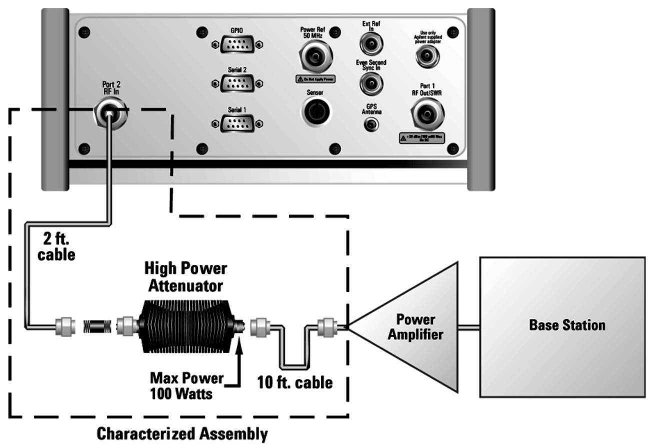
To prevent damage in most situations when you directly couple the test set to a base station, use the **high power attenuator** between the test set and the BTS.

Performing a Basic Spectrum Analyzer Measurement

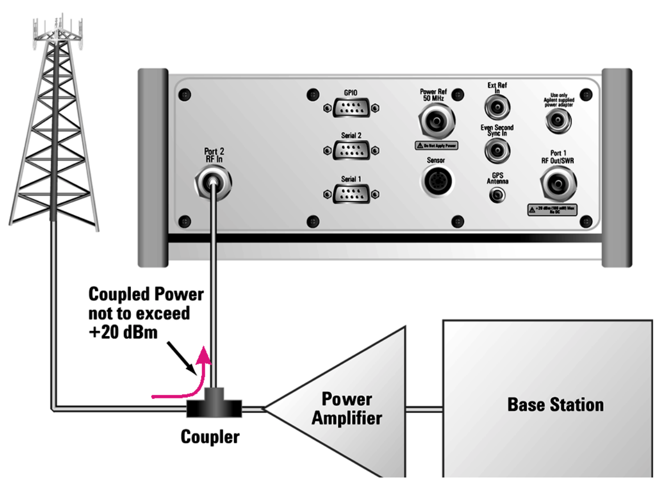
	Step	Notes
1	Select Spectrum Analyzer.	
	a. **Mode**	
	b. [Spectrum Analyzer/Tools]	
	c. [Spectrum Analyzer]	

	Step	Notes
2	Enter the channel standard. a. [Chan Std] b. Select the standard using the up and down arrow buttons. c. [Select] d. On [Units] select **Chan**.	Each time you press the [Units] menu key, the selected option changes.
3	Enter the channel number. a. [Channel] b. Enter the channel number using the number keypad. c. Select [Fwd] or [Rev].	
4	Set the span. a. [Span] b. Enter the frequency using the number keypad. c. [Hz], [kHz], [MHz], or [GHz]	
5	Connect to the base station.	

Step	Notes

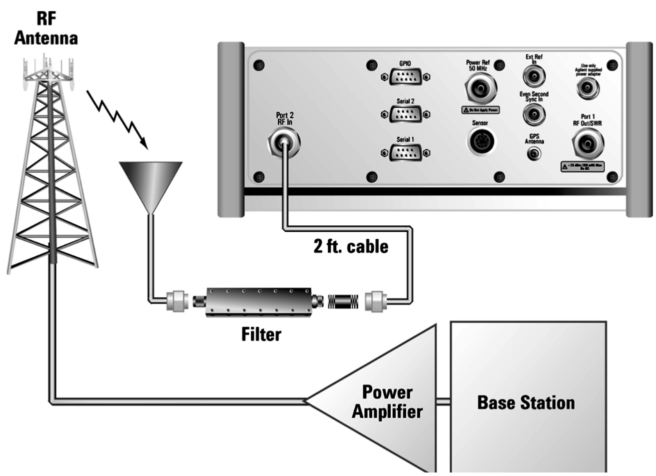


Out of service connection



In service connection

	Step	Notes
6	For an over the air measurement, connect an antenna and an external filter to the RF input.	The external filter is necessary to eliminate out-of-band signals that would otherwise reduce the dynamic range of measurements in the band of interest. The effect of the out-of-band signals is to raise the noise floor, possibly hiding some or all of the signal of interest.



Over the air measurement connection

	Step	Notes
7	Set the level to Autoscale.	
	a. [Level]	
	b. [Autoscale]	
8	(Recommended) Display a marker and set it to peak.	The marker value appears in the upper right.
	a. [Marker]	
	b. On [Type] select **Normal**.	
	c. [Marker to Peak]	

NOTE The autoranging feature, built into the test set, helps ensure accurate measurements by changing front-end amplifier gain as needed when a strong signal threatens to overload the test set. When this occurs, the noise floor rises (as gain is decreased), then falls again when the strong signal stops. You should leave the range control in autorange for general use to insure the accuracy of the measurement results.

If you prefer a fixed noise floor, you can disable autoranging in two ways using the Setup, Range Ctrl function within Spectrum Analyzer:

- On [Range Ctrl] select **Hold** to fix the front-end amplifier gain at the current level. You may use [Rang Up] or [Range Down] to change the noise floor. A word of caution: when you use the Hold setting, a subsequent strong signal—even outside the measurement range—may cause an inaccurate reading due to overloading the front-end of the test set. While in hold, you can adjust the gain of the front-end amplifier with the Range Up and Range Down menu keys. (The Hold setting cannot be saved, leaving the measurement or going into the sleep mode will reset the Range Ctrl to “auto”.)
- On [Range Ctrl] select **Max** to fix the front-end amplifier gain at the current level until a strong signal comes in. In that case, the front-end amplifier gain will be reduced to maintain accuracy, but will not return to its lower level after the strong signal stops.

If the noise floor is too high to measure the signal of interest, reducing the resolution bandwidth will reduce the noise floor, at the expense of the measurement update rate.

Using the Range Control Function:

	Step	Notes
1	Set the Range Ctrl to Hold.	
	a. [Setup]	
	b. [Range Ctrl]	
	c. On [Range Ctrl] select [Hold]	Each time you press this softkey, the selected option changes.
	d. Select [Range Up] or [Range Down]	Use the Range Up or Range Down menu keys to adjust the gain to ensure the accuracy of the measurement results.
2	Set the Range Ctrl to Max.	
	a. [Setup]	
	b. [Range Ctrl]	
	c. On [Range Ctrl] select [Max]	

Setting Average, Sweep, and Restart

Setting the Sweep

You can select either continuous or single sweep. Continuous sweep provides repeated, ongoing measurements. Single sweep performs a single measurement that is repeated only when you push the Single button.

To set sweep:

	Step	Notes
1	[Average/Sweep]	
2	[Continuous] or [Single]	Each time you press this softkey, the selected option changes.

Setting Averaging

You can choose to have averaging on or off and set the number of averages you want to take. Averaging only applies to the data, not the trace. You can select from the following types of averaging:

- **Off**: Disables averaging.
- **Running:** Computes the new result as the weighted sum of the last result and the new measurement. The last result is weighted by (n – 1)/n. The new result is weighted by 1/n. Each new measurement produces a new result.
- **Max Hold**: Is not an average, but on a point by point basis, displays the maximum amplitude for the given frequency or channel since Max Hold was turned on. It is updated when a new maximum occurs.
- **Group Average:** Makes the requested number of measurements, averages the measurement data, and displays the average as a single result trace. Measurement time will vary based on the requested number of averages and can take minutes for very large number of averages.
- **Group Max Hold:** Makes the requested number of measurements before returning a single trace result. This trace is the maximum

value seen at each trace point over the requested number of averages (measurements).

To set averaging:

	Step	Notes
1	Set the number of averages. a. [Average] b. Enter the number of averages using the number keypad. c. [Enter]	
2	Select the type of averaging you want to apply. a. [Average/Sweep] b. [Averaging] c. [Off], [Running Average], [Max Hold], [Group Average], or [Group Max Hold]	

NOTE These two steps can be performed in any order. However, if you turn averaging on and a large number of averages has previously been set, there may be a delay before you can change number of averages.

Setting Restart

When you have averaging turned on, you can restart the averaging by pressing the Restart menu key. This restarts the averaging for running average in either Continuous or Single sweep mode. It also resets the Interference Analysis Possibles List.

To restart averaging:

	Step	Notes
1	[Average/Sweep]	

	Step	Notes
2	[Restart]	

Changing the Resolution Bandwidth

The default resolution bandwidth is 0.1% of the span in Auto mode. By selecting Manual, you can define a narrower bandwidth and thereby see spurious signals that you might miss in Auto mode. However, the measurement will be slower.

NOTE The auto mode is appropriate for most measurements. When set to manual, you must remember to change the RBW whenever you change the span. Otherwise, the measurement may take longer then expected or will not have the expected accuracy and or resolution.

	Step	Notes
1	[Setup]	
2	On [Res BW] select **Manual**.	Each time you press this softkey, the selected option changes. In Auto mode, the resolution bandwidth is coupled to the span setting, Manual mode decouples the resolution bandwidth from the span.
3	Enter the bandwidth using the number keypad.	
4	[Hz] or [kHz]	

Adding a Marker

Markers can be used on traces to help you visually track up to four signals. Each marker has the following settings:

- **Type**: Provides three options, including:
  - **Off**
  - **Normal**, which places a diamond-shaped, colored marker, along with a number, 1-4, on the trace.

- **Delta**, is associated with a normal marker. Therefore, a normal marker must exist prior to creating the delta marker. The delta marker displays the difference between the normal marker position and the delta marker position. Only one delta marker can be associated with a given normal marker. The normal marker must be active when Delta is selected.

- **Marker to Peak**: Places the active marker on the current greatest value of the trace.
- **Marker to Next Peak**: Places the active marker on the current next greatest value of the trace.
- **Center Freq to Marker**: Changes the center frequency to locate the current marker in the center of the trace.
- **Ref Level to Marker**: Scrolls the trace to place the marker at the top of the screen. To reset the reference level, choose [Level/Location] [Autoscale].

To Add a Marker to a Trace:

	Step	Notes
1	[Marker]	
2	[Marker]	Press [Marker] repeatedly to select Marker 1, 2, 3, or 4.
4	[Type]	
5	[Normal] or [Delta]	
6	Locate the marker relative to the trace: • [Marker to Peak] • [Marker to Next Peak]	
7	Locate the trace relative to the marker: • [Center Freq to Marker] • [Ref Level to Marker]	

Using the Spectrogram View

The Spectrogram view requires Interference Analysis Option (Opt 270) is installed in your instrument and can be used with the Interference ID or the Occupied BW measurements and standard spectrum. Troubleshooting a transmitter system is often aided by examining the time evolution of the power distribution.

This view provides a history of the spectrum. You can use it to:

- locate intermittent signals
- track signal levels over time.

You may set the following parameters for this view:

- **Capture Interval**: Allows you to set the capture interval to 1 or more seconds. Or, you may set it to automatically determine the capture interval that provides the maximum data collection speed.

  A data sample is taken every n^{th} trace for display on the spectrogram. Increasing the capture time allows data capturing over a longer period of time in the spectrogram. However, it is a sampling technique that allows intermittent events, that occur between samplings, to be lost. Therefore, if you are searching for intermittent signals, consider using Group Max average type in conjunction with increasing the capture time.
- **Frame Skip**: Allows you to set the number of frames you would like to skip when capturing data. You may set this value from skip 0 to 2147,483,647 frames. Increasing the frame skip value causes the display to redraw the spectrum every n^{th} trace and a block of lines are shown at once instead of a single line at a time. Higher frame skip values are for use with fast measurements.
- **Palette**: Allows you to set the display to full color or grayscale.

To change the view to Spectrogram:

	Step	Notes
1	[Measurements]	
2	[Spectrogram]	
3	On [Spectrogram] select **On**.	

	Step	Notes
4	If you need to restart the data capture press [Reset Spectrogram]	
5	If desired set the capture interval: a. [Capture Interval] b. Enter the interval number using the number keypad. c. Select [sec] or [Max Speed].	[Max Speed] displays every trace captured.
6	If desired set the number of frames you want to skip: a. [Frame Skip] b. Enter the interval number using the number keypad. c. Select [frames].	
7	If desired set the display color: a. [Palette] b. Select [Full Color] or [Grayscale].	The color/grayscale top and bottom mappings are determined by the Ref Level and Scale/Div settings. To change the mapping, go to [Level/Location] and change [Ref Level] and [Scale/Div].

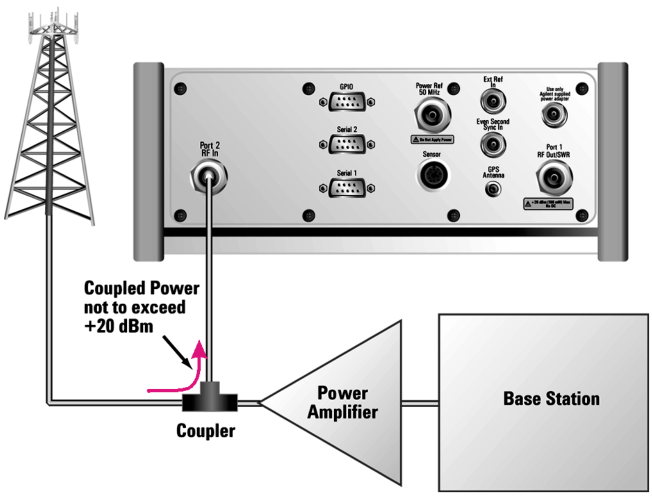
Using the Interference ID Measurement

Use the Interference ID measurement to find and identify interference signals over a designated spectrum. This measurement requires the Interference Analysis Option (Opt 270) be installed on your instrument. Interference ID provides you with a list of possible signal types for a designated signal. For example, a selected interference signal might be indicated as a possible CW or a CDMA signal. This measurement does not demodulate the signals. Therefore the list is not definitive. The list retains some history to help identify intermittent signals. The history can be reset with the [Average] [Restart] menu keys.

Performing a Basic Interference ID Measurement

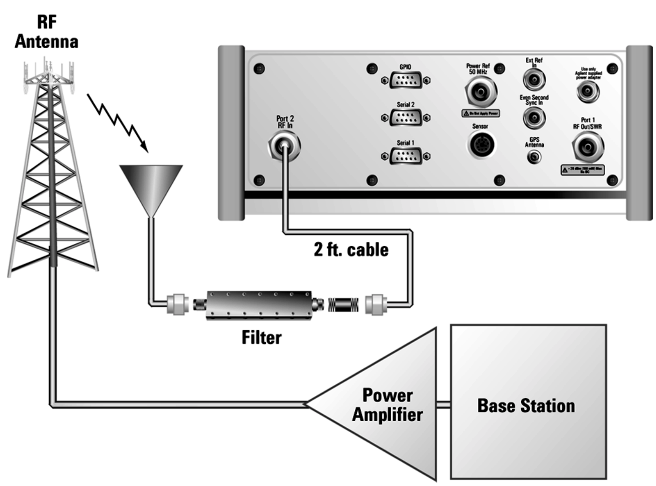
	Step	Notes
1	Select Spectrum Analyzer. a. **Mode** b. [Spectrum Analyzer/Tools] c. [Spectrum Analyzer]	
2	Enter the channel standard. a. [Chan Std] b. Select the standard using the up and down arrow buttons. c. [Select] d. On [Units] select **Chan**.	Each time you press the [Units] menu key, the selected option changes.
3	Enter the channel number. a. [Channel] b. Enter the channel number using the number keypad. c. Select [Fwd] or [Rev].	

	Step	Notes
4	Set the span. a. [Span] b. Enter the frequency using the number keypad. c. [Hz], [kHz], [MHz], or [GHz]	
5	Connect to the base station.	



Connect to the Antenna

	Step	Notes
6	For an over the air measurement, connect an antenna and an external filter to the RF input.	The external filter is necessary to eliminate out-of-band signals that would otherwise reduce the dynamic range of measurements in the band of interest. The effect of the out-of-band signals is to raise the noise floor, possibly hiding some or all of the signal of interest. However, the external filter is optional in this set up: • If you want to limit your search to a specific band of interest you should use it • If you want to search beyond a specific band then can leave the filter off.



Over the air measurement connection

	Step	Notes
7	Set the level to Autoscale. a. [Level] b. [Autoscale]	
8	Select the Interference ID Measurement. a. [Measurements] b. [Interference ID] c. On [Interference ID] select **On**.	A marker will appear on the trace at the left of the display. The Frequency and power level at the marker (Signal Pointer) is displayed in the data window below the trace display window. The types of signal that is causing the interference is indicated also.
9	You can set marker to a signal peak by: a. [Signal Pointer] b. Enter the frequency using the number keypad. c. Select [GHz], [MHz], [kHz], or [Hz]. OR by: a. [Pointer to Peak] b. Enter the frequency using the number keypad. c. Select [Pointer To Next Peak] to mark successively lower peaks.	The number displayed at the bottom of the Pointer to Peak button indicates the number of the marked peak and the total number of peaks. For example, 1/22 indicates the peak with the highest power on the display and a total of 22 peaks displayed. 2/22 would indicate the second highest peak, 3/22 the third highest, et cetera. Pointer to Peak always returns the marker to the highest peak.

	Step	Notes
10	You can set the threshold level to automatically set value or manual select a value by: a. On [Threshold] select **Auto** Or a. On [Threshold] select **Manual** b. Enter the threshold value using the number keypad. c. Select [dBm].	The threshold limit line is displayed on the graticule at the desired level. Ensure that the threshold value you enter is within the graticule range or the threshold limit line will be off of the display. The threshold is used to determine the “edges” of the signal. Manual adjustment may be required to correctly identify some signals, especially in crowded spectrums.
11	You can set center frequency of the display to the marker frequency by: a. [Zoom to Signal] b. [Zoom In]	The marker will track with the new center frequency at the center of the display. The Span will be decreased to enhance viewing of the designated interference signal.
12	Under [Zoom to Signal] you may also select [Zoom Out]	[Zoom Out] will back out the [Zoom In] series. If you Manually set the Frequency/Channel or Span, it will clear the [Zoom Out] history.

Using the Occupied BW Measurement

Occupied Bandwidth integrates the power of the displayed spectrum and puts markers at the frequencies between which a selected percentage of the power is contained. The measurement defaults to 99% of the occupied bandwidth power. The power-bandwidth routine first computes the combined power of all signal responses contained in the trace. For 99% occupied power bandwidth, markers are placed at the frequencies on either side of 99% of the power. 1% of the power is evenly distributed outside the markers. The frequency difference between the two markers is the displayed occupied bandwidth. The difference between the marker frequencies is the 99% power bandwidth and is the value displayed.

The Occupied BW result will correspond to span between the markers and will be a multiple of the span between two points. So, for a 10 MHz span, the OBW will come in multiples of 39.216 kHz (10 MHz divided by 255). Values will be 0, 39.216 kHz, 78.431 kHz, 117.647 kHz, etc. For narrow signals (TDMA, PDC, etc.) the user will need to zoom in on the signal to get a reasonably accurate Occupied BW result. For a 100 kHz span the OBW resolution will be 392 Hz (100 kHz divided by 255).

The occupied bandwidth measurement can be made in single or continuous sweep mode. The center frequency and reference level may be set by the user.

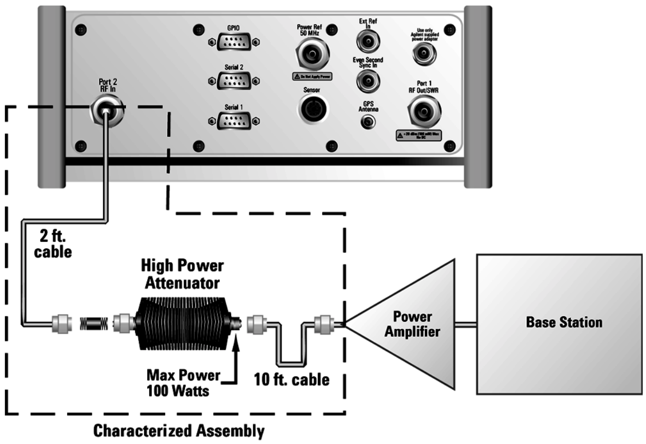
Performing a Basic Occupied BW Measurement

	Step	Notes
1	Select Spectrum Analyzer. a. **Mode** b. [Spectrum Analyzer/Tools] c. [Spectrum Analyzer]	

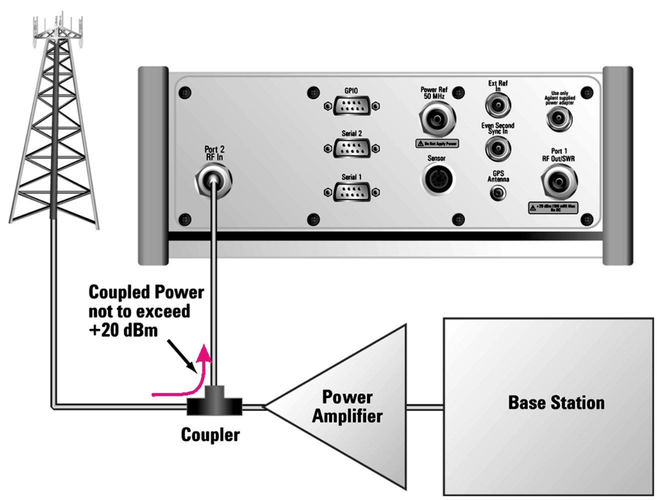
Spectrum Analyzer

	Step	Notes
2	Enter the channel standard. a. [Chan Std] b. Select the standard using the up and down arrow buttons. c. [Select] d. On [Units] select **Chan**.	Each time you press the [Units] menu key, the selected option changes.
3	Enter the channel number. a. [Channel] b. Enter the channel number using the number keypad. c. Select [Fwd] or [Rev].	
4	Set the span. a. [Span] b. Enter the frequency using the number keypad. c. [Hz], [kHz], [MHz], or [GHz]	
5	Connect to the base station.	

Step	Notes

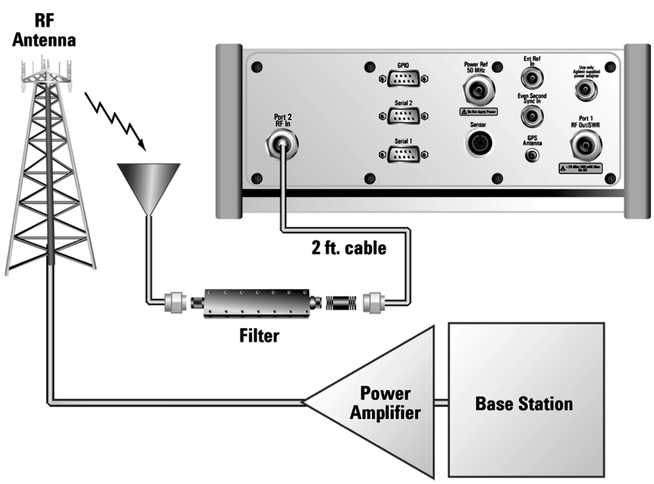


Out of service connection



In service connection

	Step	Notes
6	For an over the air measurement, connect an antenna and an external filter to the RF input.	The external filter is necessary to eliminate out-of-band signals that would otherwise reduce the dynamic range of measurements in the band of interest. The effect of the out-of-band signals is to raise the noise floor, possibly hiding some or all of the signal of interest. However, the external filter is optional in this set up: • If you want to limit your search to a specific band of interest you should use it • If you want to search beyond a specific band then can leave the filter off.



Over the air measurement connection

	Step	Notes
7	Set the level to Autoscale. a. [Level] b. [Autoscale]	
8	Select the Occupied BW Measurement. a. [Measurements] b. [Occupied BW] c. On [Occupied BW] select **On**.	A marker pair will appear on the trace and the occupied bandwidth value and the integrated power in the OBW are displayed in the data window below the trace graticule.
9	Set the percentage of power for calculating the Occupied BW. a. [Power] b. Enter the percentage number using the number keypad. c. Select [%].	.The default percentage is 99%.
10	If you are measuring a narrow signal such as TDMA or PDC, zoom in on the signal for a more accurate OBW results. a. [Freq/Chan/Span] b. [Span] c. Enter the frequency using the number keypad. d. [Hz], [kHz], [MHz], or [GHz]	

14 T1 Analyzer

Making T1 Measurements

The Agilent E7495A/B provide a simple solution for all your T1 testing needs from basic transmission testing, to BERT testing. For more information about T1 testing, refer to "Measurement Results" on page 265.

Steps for Performing a Basic T1 Analyzer Measurement

	Step	Notes
1.	[Mode]	
2.	[Backhaul]	
3.	[T1 Analyzer]	
4.	[Get Started/ Test Mode]	The tests are listed on the buttons on the right. Pressing a test mode button will provide you with information about the test and the test options available.
5.	[Setup]	Configure the T1 analyzer for the measurement.
6.	[Display]	Setup your view of the measurement results.
7.	[Control]	Modify the measurement setup and inject errors as you perform the measurement.

Making Selections from the Setup Button

- **Rx Input**: The Primary and Secondary inputs are both affected by this setting.
  - **Terminate -** Sets the input impedance to 100 Ohms. Can be performed only when the T1 circuit is interrupted (connected into a jack that interrupts the circuit).
  - **Monitor -** Sets the input impedance to 100 Ohms, inserts 20 dB

gain, and should be selected when connected to a 'Monitor' jack.

— **Bridge -** Sets the input impedance >1000 Ohms and should be selected when bridging on to an T1 circuit.

- **Line Code**: Configures the test set to transmit and expect to receive a line code that is compatible with the circuit's provisioning. There are type types of line coding used in T1 networks:

— **AMI -** Alternate Mark Inversion is a traditional line code.

— **B8ZS -** Bipolar 8 Zero Substitution replaces runs of 8 zeroes with a special code that is not compatible with AMI. It allows greater flexibility of data patterns by enhancing repeater synchronization by increasing pulse density, thereby providing greater throughput.

- **Framing**: Configures the test set to transmit and expect to receive a particular framing pattern that is compatible with the circuit's provisioning. It enables the test set to receive the T1 signal and to then synchronize, identify, and extract the individual channels.

— **Unframed -** The 193rd (framing) bit is set to 0 or 1, depending on the pattern.

— **D3/D4 -** A 12 frame structure accomplished by sending a unique pattern on the 193rd (framing) bit.

— **ESF -** A 24 frame structure accomplished by sending a unique pattern on the 193rd (framing) bit. In this mode the frame bits are used to transmit a CRC and carry information to accommodate alarms and control

- **Pattern:** Configures the test set to expect a particular test pattern. Many test patterns are available to 'stress' the circuit in a particular manner or to gain maximum insight into a particular problem.
- **Tx Pattern:** Allows you to select either Normal or Inverted patterns.
- **Tx Clock**: Configures the test set to use one of the following methods to derive the transmit clock frequency.

— **Internal -** The transmit clock is derived within the test set and is independent of the incoming signal. This is useful when the device or line under test is configured to synchronize on the incoming signal. In this case the return clock frequency of the return signal should match the transmit clock frequency of the test set.

— **Primary Rx -** The transmit clock frequency is derived from the signal received at the Primary Rx jack on the test set.

— **Secondary Rx -** The transmit clock frequency is derived from the signal received at the Secondary Rx jack on the test set.

- **Channel**: Applicable only in the Channel BERT mode. Sets the active channel to be tested for BERT.
- **Fill Data**: When performing Channel BERT testing this configures the source of data transmitted in the unused slots. For drop-and-insert testing this field is typically set to Secondary Rx.

— **All 1's -** Set this mode to maintain a sufficient 1's density on the unused channels during testing. All 1's are typically transmitted on unused channels in live T1 circuits.

— **Idle -** Set this mode to accommodate specific troubleshooting such as to exercise a circuit provisioned for B8ZS.

— **Primary Rx -** Fills the unused slots with Primary Rx data.

— **Secondary Rx -** Fills the unused slots with Secondary Rx data.

- **Loop Code**: Selects the format of the transmitted code when a loop-up or loop-down is requested.

— **ESF Datalink -** Loopback state change requests are sent to the far-end in the framing pattern in the ESF datalink channel. Note that this mode is possible when only ESF is selected for the framing pattern.

— **In-band -** Loopback state change requests are sent to the far-end by replacing the normal channel data with the loop code. Note that in this mode the code must persist for 5 seconds for the far-end to respond

- **Slip Reference:** Selects the reference for the frame slip measurement.

— **None -** This selection disables the frame slip measurement.

— **Internal -** In this mode the test set compares the framing of the incoming signal with the test set's internal clock. Three conditions are necessary when using this mode: The far end must be receiving a signal from this test set. The transmit clock on the far end must be configured to synchronize on the incoming signal. The Tx Clock on this test set must be set to internal.

Internal is the default selection after test set preset and covers the

T1 Analyzer

situation when a hard loop is configured at the far end. If a separate test set is utilized at each end, then the test set on one end should have the Tx Clock set to Primary Rx (Assuming the incoming signal is connected to this jack.) Another alternative is to use a second T1 circuit connected to the Secondary Rx jack to establish proper timing.

— **Second Rx -** In this mode the test set compares the frame clock timing of the received signal on the Primary Rx jack with the frame clock timing of the received signal on the Secondary Rx jack.

- **Tx Line Build Out [Tx LBO]:** Sets the Tx level and pulse shape to simulate the signal conditions that would be encountered at the end of a distant transmission cable. This is useful for testing equipment suspect of having trouble receiving signals found in typical applications.

  — 0 dB LBO = 0 dBdsx = 6 Vpp

  — -7.5 dB LBO = -7.5 dBdsx = 2.53 Vpp

  — -15 dB LBO = -15 dBdsx = 1.07 Vpp

- **Second Tx**: Selects the source of data of the signal available at the Secondary Tx jack.

  — AIS - The signal at the Secondary Rx jack is an unframed all ones aka AIS.

  — Second Rx - The Secondary Rx signal is buffered and looped back to the Secondary Tx jack.

  — Primary Rx - The signal at the Primary Rx jack is buffered and internally routed to the Secondary Tx jack.

Making Selections from the Display/Sound Buttons

Configure the following for the measurement you're doing:

- **Status**: Allows you to select which status panel is active.
- **Alarms**: Displays those errors occurring on either the primary or secondary channel, depending on your selection. Displays in the bottom-right of the screen.
- **Results**: You can choose an error and select results you want to drill down to; shows more metrics on error you select. Displays in bottom-right of screen.

- **Sound**: Works on single channels only and enables you to turn sound on and off. Use sound mostly to listen for drop outs and/or changes in the signal.
- **Volume**: Enables you to set the volume of speaker output.

Making Selections from the Control Button

On the Control button, the available buttons are unique to the test mode you select. Once you set up your display, you can change settings, such as patterns, alarm injections, etc., while you make the measurement.

- **Pattern:** Configures the test set to expect a particular test pattern. Many test patterns are available to 'stress' the circuit in a particular manner or to gain maximum insight into a particular problem.
- **Alarm/Error**: Enables a list of available alarms and conditions that can be transmitted on the Primary Tx channel. The alarm or condition is invoked by pressing the Inject button.

  To troubleshoot your T1 line, you can monitor for errors or alarms. Inject errors to see how the system responds.

  — **Loss of Signal Alarm -** The test set ceases to send a signal.

  — **Loss of Frame Alarm -** Forces the framing bit to always be set to 1.

  — **Yellow Alarm -** The test set sends a yellow alarm. In D3/D4 mode, the test set sets bit #2 of each timeslot to 0. In ESF mode, the datalink bits are configured to send a repetitive pattern of 8 ones, followed by 8 zeros.

  — **AIS Alarm -** The test set sends an AIS, or blue alarm, by sending an unframed, all 1s pattern (a constant contiguous stream of 1s).

  — **Idle Alarm -** The test set sends a framed, all zero pattern. Note that the far end will interpret this as a yellow alarm.

  — **BPV Error -** The test set forces a single, bipolar violation error with each press of the Inject button.

  — **Frame Error -** The test set forces a single frame error with each press of the Inject button.

  — The test set forces a CRC error with each press of the Inject button only when ESF mode is selected.

— The test set forces an error in the transmitted pattern with each press of the Inject button.

- **Fill Data**: When performing Channel BERT testing this configures the source of data transmitted in the unused slots. For drop-and-insert testing this field is typically set to Secondary Rx.

  — **All 1's -** Set this mode to maintain a sufficient 1's density on the unused channels during testing. All 1's are typically transmitted on unused channels in live T1 circuits.

  — **Idle -** Set this mode to accommodate specific troubleshooting such as to exercise a circuit provisioned for B8ZS.

  — **Primary Rx -** Fills the unused slots with Primary Rx data.

  — **Secondary Rx -** Fills the unused slots with Secondary Rx data.

- **Inject**: Causes the error or condition that is currently displayed on the button to occur. Some selections cause a single event to occur, while others maintain a constant state. The text on the button changes to reflect the appropriate action.

- **Loop Up/Loop Down**: Available in emulate mode, these buttons enable you to manually put the test set into either loop up or loop down mode.

- **Send Loop Up/Send Loop Down**: Available in emulate mode, the Send Loop Up button sends a loop up command to the far end. Send Loop Down sends a loop down command to the far end.

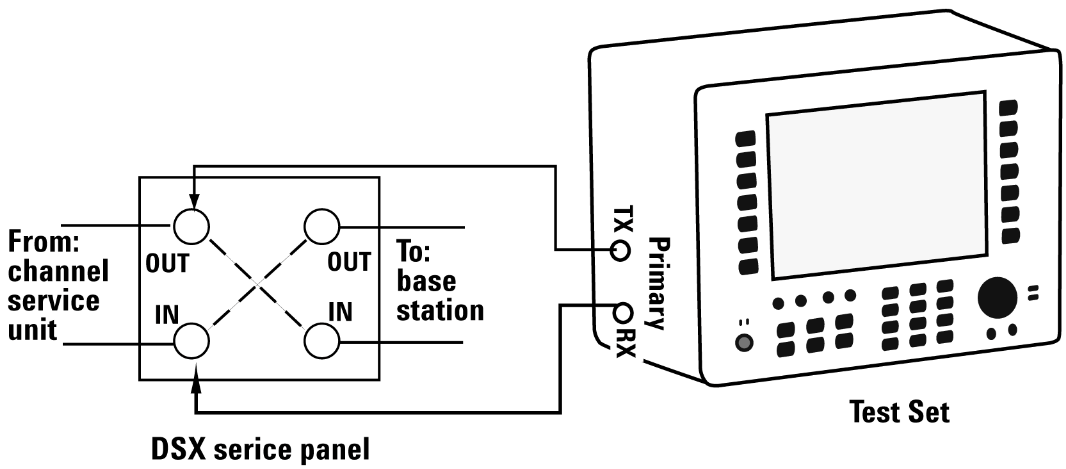
Sample Hard Loop/End-End Full T1 BERT Test

Use this test mode to perform measurements, such as BERT, on a known test pattern being sent from the far-end. The far-end signal can be generated by looping back the transmitted signal from this test set or by a second test set. To use this test, have someone at the far end manually loop-up the equipment or generate a known pattern with a far-end test set. Since a pattern is being sent on the T1 line, service on the T1 will be affected.

This example explains how to setup a hard-loop/end-end full T1 BERT test. A hard loop test requires one test set at one end and a hard loop at the other. An end-end test requires a test set at each end but enables the troubleshooter to identify the direction of the trouble. The T1 circuit is not available for service when using this test mode.

During the commissioning or startup phase of a T1 circuit a several day end-end or hard loop test is often performed. This type of test provides the most comprehensive level of information but does require the circuit to be taken out-of-service for the duration of the test. The test results provide more granular resolution on root cause problems than a monitor test.

Figure 14-1 Sample End to End Connection Diagram



	Step	Notes
1	Connect the BSTS to the DSX panel	Refer to Figure 14-1
2	[Mode]	
3	[Backhaul]	
4	[T1 Analyzer]	

	Step	Notes
5	Select a test mode. a. [Get Started/ Test Mode] b. [Hard Loop/End-End] c. [Full T1 BERT]	Use this test mode to perform measurements such as BERT on a T1 circuit. The far-end signal must be derived from either a hard loop or from a second test set. The T1 circuit is not available for service when using this test mode. Select this to perform a BERT test on a full T1 Circuit.
6	Setup auto configuration. a. [Auto Config] b. [Start Primary Auto Config]	Enables the Auto Configuration buttons and causes the test set to analyze the incoming T1 signal and align the setup choices to the properties of that signal.
7	[Back]	Shifts focus back to the main mode selection buttons.
8	[Setup]	Select this to display a list of setup choices that pertain to this test mode.
9	Setup the Rx input. a. [Rx Input] b. [Terminate]	This assumes the test set is connected into a jack that interrupts the T1 circuit.
10	Setup the line code. a. [Line Code] b. [B8ZS]	This assumes the circuit is provisioned for B8ZS (Bipolar 8 Zero Substitution). A T-carrier line code in which bipolar violations are deliberately inserted if user date contains a string of 8 or more consecutive zeros.
11	Setup the framing. a. [Framing] b. [ESF]	This assumes that the circuit has been provisioned for ESF. Extended Superframe Format utilizes the framing bit capacity for additional purposes. There number of frames per multiframe is expanded to 24 frames.

	Step	Notes
12	Setup the pattern. a. [Pattern] b. Use up and down buttons to select. c. [QRSS] d. [Select]	
13	Setup the Tx clock. a. [Tx Clock] b. [Internal]	Internal is the default selection after test set preset and covers the situation when a hard loop is configured at the far end. If a separate test set is utilized at each end, then the test set on one end should have the TX Clock set to Primary Rx (assuming the incoming signal is connected to this jack). Another alternative is to use a second T1 circuit connected to the Secondary Rx jack to establish proper timing.
14	Setup the Tx LBO. a. [Tx LBO] b. [0 dB]	This is a typical level found at the customer demarcation point.
15	Setup the slip reference. a. [Slip Ref] b. [None]	Disables the frame slip measurement.
16	Setup the second Tx. a. [Second Tx] b. [AIS]	Use the default condition.
17	Setup the display. a. [Display] b. [Status] c. [Pri]	Enables the [Display] options on the right-hand buttons. Activates only the Primary Status pane. The inactive channel should be deactivated to cease the display of invalid measurements.

	Step	Notes
18	Setup alarms. a. [Alarms] b. [Pri]	Use this selection to observe the Primary Results in the Alarm Panel.
19	Setup the results display. a. [Results] b. Use up and down buttons to select. c. [Select]	Enables a list of results information that can be displayed in the Results pane. Make a selection based on the need of the application.
20	Setup the results display. a. [Results] b. Use the up and down arrows to select. c. Make a selection. d. [Select]	Enables a list of results information that can be displayed in the Results pane. Make a selection based on the need of the application.
21	Setup the controls and select a pattern. a. [Control] b. [Pattern] c. Use the up and down buttons to select. d. QRSS e. [Select]	

	Step	Notes
22	Select the alarm. a. [Alarm/Error] b. Use the up and down buttons to select. c. Loss of Signal d. [Select]	
23	Inject an error. a. [Inject] b. [On]	Causes the error or condition that is currently displayed on the button to occur.

Sample Loopback CSU Full T1 BERT Test

Use this test mode to perform a measurement, such as BERT, on a known test pattern being sent from the far-end. The far-end signal will be generated by looping back the transmitted signal from this test set. You will use this test set to send a code to automatically loop-up either a CSU or NIU at the far-end. Since a pattern is being sent on the T1 line, service on the T1 will be affected.

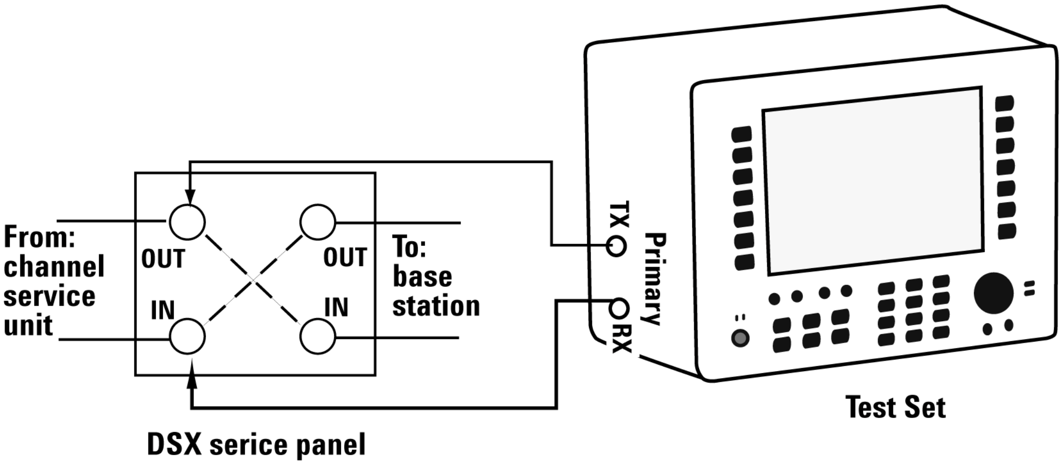
Once you have selected this test mode, you can send the loop-up or loop-down code using the buttons on the Control menu. If you are you are using ESF, configure the appropriate ESF Loop Code on the Setup menu.

The T1 circuit is not available for service when using this test mode. End-to-end loopback tests are normally limited to the CSU since NIU loop codes are normally suppressed at the central office.

When the far-end of a T1 circuit is in a remote location and trouble is suspected, it is possible to place the equipment at the far-end into loopback by sending a special code designated for this purpose. If the T1 circuit is leased, then the wireless technician is often limited to looping only the CSU, as NIU loop codes are usually blocked at the central office. The loop code can be sent either in-band or on the ESF datalink channel by the test set to the far-end equipment. The first method, in-band, replaces the bits in the T1 traffic channels with the unique loop code. The remote equipment must see this code for 5 seconds before it will respond in order to minimize the potential that patterns in live data will falsify this request. The downside of this technique is that all devices in the transmit path see this code and any may respond. This could lead to a confusing situation if a T1 route consists of multiple hops, each with its own CSU pair. If the far end has a hard loop then the loop code could come back to the near and inadvertently place that CSU into loopback. The test set does monitor for a pre-existing loop and will notify the user when remote loopback is attempted using an in-band loop code.

Another method is available if the circuit is provisioned for Extended Super Frame (ESF). This method, ESF datalink, sends the loop code on the ESF data link bits. This method is not prone to false information and, therefore, responds very rapidly. This is the default mode of the test set. For more information see the section detailing loopback operation.

Figure 14-2 CSU Full T1 BERT Loopback Connection Diagram



	Step	Notes
1	Connect the BSTS to the DSX panel	Refer to Figure 14-2
2	[Mode]	

	Step	Notes
3	[Backhaul]	
4	[T1 Analyzer]	
5	Select a test mode. a. [Get Started/ Test Mode] b. [Loopback CSU/NIU] c. [CSU Full T1 BERT]	Use this test mode to perform measurements such as BERT on a T1 circuit by placing the far-end CSU or NIU into a loopback state. The T1 circuit is not available for service when using this test mode. End-to-end loopback tests are normally limited to the CSU since NIU loop codes are normally suppressed at the central office. Select this to perform a BERT test on a full T1 Circuit.
6	[Setup]	Select this to display a list of setup choices that pertain to this test mode.
7	Setup Rx input. a. [Rx Input] b. [Terminate]	This assumes the test set is connected into a jack that interrupts the T1 circuit.
8	Setup line code. a. [Line Code] b. [B8ZS]	This assumes the circuit is provisioned for B8ZS.
9	Setup framing. a. [Framing] b. [ESF]	This assumes that the circuit has been provisioned for ESF.
10	Select a pattern. a. [Pattern] b. Use the up and down buttons to select. c. QRSS d. [Select]	

T1 Analyzer

	Step	Notes
11	Setup Tx clock. a. [Tx Clock] b. [Internal]	This is the default selection after test set preset and covers the situation when a hard loop is configured at the far end. If a separate test set is utilized at each end then the test set on one end should have the Tx Clock set to Primary Rx (Assuming the incoming signal is connected to this jack.) Another alternative is to use a second T1 circuit connected to the Secondary Rx jack to establish proper timing.
12	Setup the Tx LBO. a. [Tx LBO] b. [0 dB]	This is a typical level found at the customer demarcation point.
13	Setup the loop code. a. [Loop Code] b. [In-band]	Your choice depends on the far-end CSU configuration.
14	Setup the slip reference. a. [Slip Ref] b. [None]	Disables the frame slip measurement.
15	Setup the second Tx. a. [Second Tx] b. [AIS]	Use the default condition.
16	Setup the display. a. [Display] b. [Status] c. [Pri]	Enables the [Display] options on the right-hand buttons. Activates only the Primary Status pane. The inactive channel should be deactivated to cease the display of invalid measurements.
17	Setup the alarms. a. [Alarms] b. [Pri]	This selection causes the Alarm pane to toggle between Primary and Secondary. Use this selection to observe the Primary Results in the Alarm Panel.

	Step	Notes
18	Setup the results display. a. [Results] b. Use the up and down arrows to select. c. Make a selection. d. [Select]	Enables a list of results information that can be displayed in the Results pane. Make a selection based on the need of the application.
19	Setup the controls and select a pattern. a. [Control] b. [Pattern] c. Use the up and down buttons to select. d. QRSS e. [Select]	
20	Select the alarm. a. [Alarm/Error] b. Use the up and down buttons to select. c. Loss of Signal d. [Select]	
21	[Send Loop Up]	Sends a loop up command to the far-end and reports the loop state on the status line. If a pre-existing loop is detected at the far end then “Pre-existing loop” is displayed on the status line. (Only possible in In-band mode)
22	[Send Loop Down]	Sends a loop down command to the far end and reports the loop state on the status line.

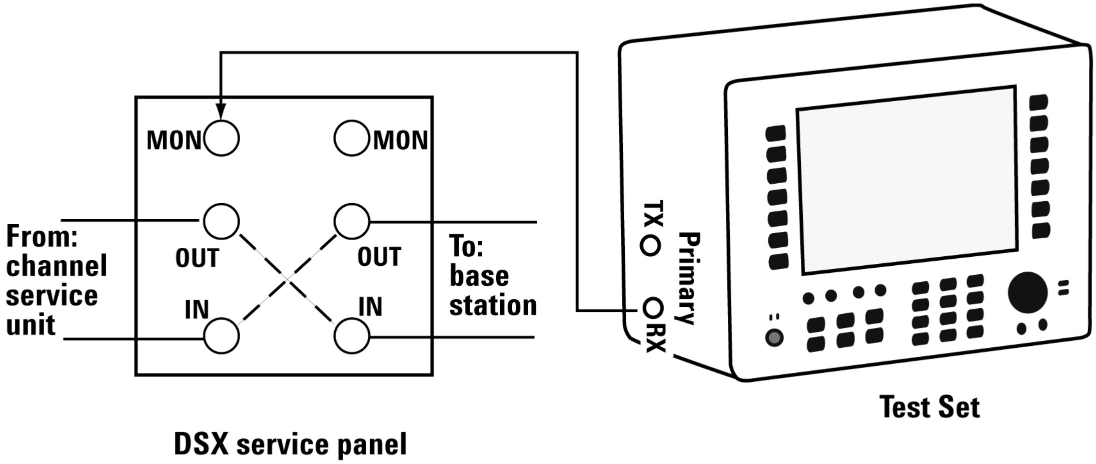
	Step	Notes
23	Inject an error. a. [Inject] b. [On]	Causes the error or condition that is currently displayed on the button to occur.

Sample Monitor Full T1 Test

Use this test mode to monitor live data on the T1 line without affecting service. The simplest hookup for monitoring does not require the test set Tx outputs to be connected. In some cases, you may connect the Tx outputs to the T1 circuit. For those cases, the Tx primary and secondary transmitted signals are regenerated from the received signal on the corresponding line.

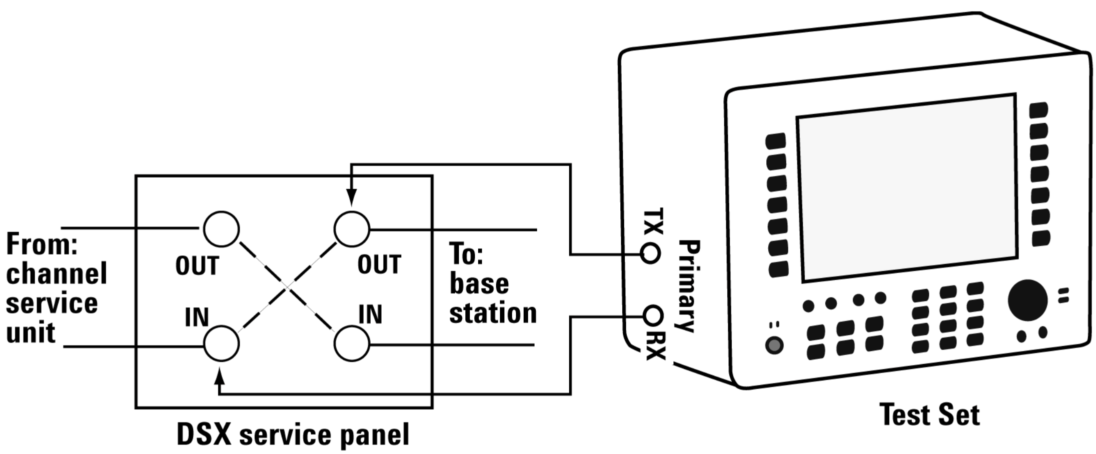
In this example, you use the monitor test mode to test performance without disrupting service on a T1 circuit. During this test, the source of the signal from far end can be either live data or pattern data from a second test set. This mode is very similar to End-to-End Hard Loop mode, with the exception that the signal present on the Primary Tx jack is a buffered replica of the signal present on the Primary Rx jack. When monitor jacks are not available, this feature allows the technician to break into a live T1 and pass that signal through the test set, thereby keeping the circuit in-service. This is useful for monitoring long-term statistics, of a T1 circuit.

Figure 14-3 Sample Monitor Mode With Monitor Port Connection.



When using the above sample connection for monitoring an T1 circuit with a monitor port, you should set Rx Input to monitor.

Figure 14-4 Sample Monitor Mode Without a Monitor Port Connection



When using the above sample connection for terminating an T1 circuit, set Rx Input to terminate.

	Step	Notes
1	Connect the BSTS to the DSX panel	For a DSX with a monitor port connection, refer to Figure 14-3 For a DSX without a monitor port connection, refer to Figure 14-4
2	[Mode]	
3	[Backhaul]	
4	[T1 Analyzer]	
5	[Get Started/ Test Mode]	
6	Setup monitoring. a. [Monitor] b. [Monitor Full T1]	Choose this to monitor performance of a full T1 Circuit.
7	Setup auto configuration. a. [Auto Config] b. [Primary Auto Config]	Causes the test set to analyze the incoming T1 signal and align the setup choices to that signal.
8	[Back]	Shifts focus back to the main mode selection buttons.
9	[Setup]	Select this to display a list of setup choices that pertain to this test mode.
10	Setup the Rx Input. a. [Setup] b. [Rx Input] c. [Terminate]	This assumes the test set is connected into a jack that interrupts the T1 circuit. Note: If you are connected to a monitor port, select [Monitor] instead of [Terminate].

	Step	Notes
11	Setup line code. a. [Line Code] b. [B8ZS]	This assumes the circuit is provisioned for B8ZS.
12	Setup framing. a. [Framing] b. [ESF]	This assumes that the circuit has been provisioned for ESF.
13	Select a pattern. a. [Pattern] b. Use the up and down buttons to select. c. QRSS d. [Select]	Set to the pattern sent by the far-end.
14	Setup Tx clock. a. [Tx Clock] b. [Internal]	This selection is not applicable in Monitor mode because the Primary Tx signal is a buffered replica of the signal applied to the Primary Rx jack and is not affected by this setting. This is the default selection after test set preset.
15	Setup the Tx LBO. a. [Tx LBO] b. [0 dB]	This is a typical level found at the customer demarcation point.
16	Setup the slip reference. a. [Slip Ref] b. [None]	Disables the frame slip measurement.
17	Setup the second Tx. a. [Second Tx] b. [AIS]	Use the default condition.

	Step	Notes
18	[Display]	Enables the [Display] options on the right-hand buttons.
19	Setup the display. a. [Display] b. [Status] c. [Pri]	Enables the [Display] options on the right-hand buttons. Activates only the Primary Status pane. The inactive channel should be deactivated to cease the display of invalid measurements.
20	Setup the alarms. a. [Alarms] b. [Pri]	This selection causes the Alarm pane to toggle between Primary and Secondary. Use this selection to observe the Primary Results in the Alarm Panel.
21	Setup the results display. a. [Results] b. Use the up and down arrows to select. c. Make a selection. d. [Select]	Make a selection based on the need of the application.
22	[Control]	The selection enables several right-hand soft keys that control choices specific to each test mode.
23	Select a pattern. a. [Pattern] b. Use the up and down buttons to select. c. QRSS d. [Select]	Select a pattern.

Sample Emulate CSU/NIU Test

The purpose of this test mode is to emulate a CSU or NIU. The test set will terminate the T1 line, and a loop-up code sent from the far-end will cause this test set to enter a loopback state. Conversely, a loop-down code sent from the far-end will cause this test set to exit the loopback state.

If you are using ESF, configure the appropriate ESF Loop Code on the Setup menu.

In this example, you use the emulate CSU/NSU test mode to have the test set emulate a CSU or NIU at the near-end. In this mode it is possible for the far-end to place this test set into loopback mode. The T1 circuit is not available for service during loopback. Loopback tests are normally limited to the CSU since NIU loop codes are normally suppressed at the central office. When the test set is in a loopback state AIS is present at the Secondary Tx jack. When not in loopback state the Primary Rx signal is routed to the Secondary Tx jack and the Secondary Rx signal is routed to the Primary Tx jack.

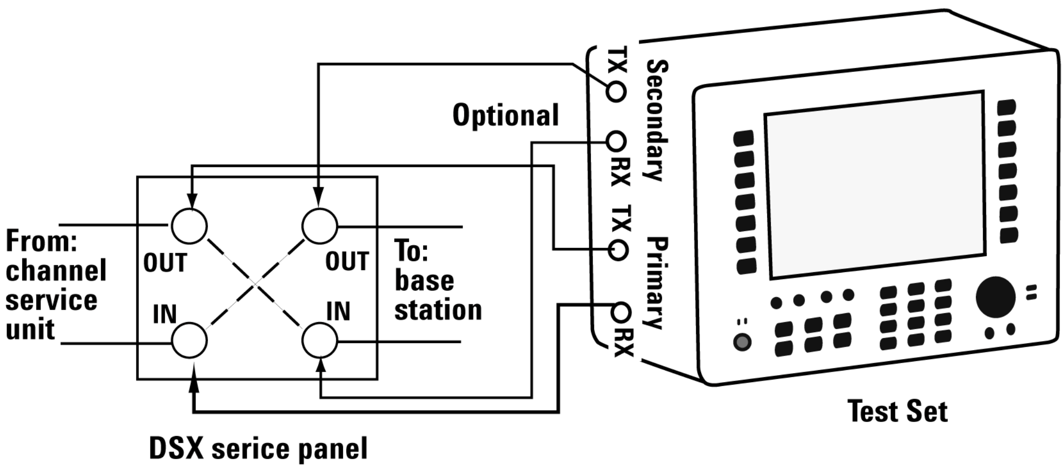
NOTE Avoid having a hard loop in the Secondary channel as it will cause a constant loop condition to exist.

It may be desirable to emulate the functionality of a CSU/NIU if trouble is suspected in that equipment. The wireless technician will often be interested in only the CSU mode. The functionality of a CSU is emulated in this mode and the test set will respond to loop codes received at the Primary Rx input.

The test set has the capability to emulate the functionality of a CSU/NIU.

The test set will respond only to the type of loop code selected on the setup screen. Be aware that when the test set is not in loopback mode that the source of data on the Primary Tx jack is the Secondary Rx jack and vice versa. If B8ZS is selected on the test set, then the signal (or no signal - which is decoded as all zeros) will be translated to B8ZS format.

Figure 14-5 Sample Emulate CSU/NIU Test Setup



The following table provides the data source for primary tx and secondary tx during loop-up and loop-down states in emulate mode

Table 14-1 Data Source in Emulate Mode

Jack	Loop Up	Loop Down
Primary Tx	Primary Rx	• AIS when no signal present at Secondary Rx • Secondary Rx
Secondary Tx	Secondary Rx	• AIS

Sample Emulated CSU/NIU Test:

	Step	Notes
1	Connect the BSTS to the DSX panel	Refer to Figure 14-5
2	[Mode]	
3	[Backhaul]	

	Step	Notes
4	[T1 Analyzer]	
5	Select a test mode. a. [Get Started/ Test Mode] b. [Emulate CSU/NIU] c. [Emulate CSU]	Choose this to emulate a CSU.
6	[Setup]	Select this to display a list of setup choices that pertain to this test mode.
7	Setup Rx input. a. [Rx Input] b. [Terminate]	This assumes the test set is connected into a jack that interrupts the circuit.
8	Setup line code. a. [Line Code] b. [B8ZS]	This assumes the circuit is provisioned for B8ZS.
9	Setup framing. a. [Framing] b. [ESF]	This assumes that the circuit has been provisioned for ESF.
10	Select a pattern. a. [Pattern] b. Use the up and down buttons to select. c. QRSS d. [Select]	
11	Setup Tx LBO. a. [Tx LBO] b. [0 dB]	This is a typical level found at the customer demarcation point.
12	[More 1 of 2]]	Displays the rest of the Setup options.

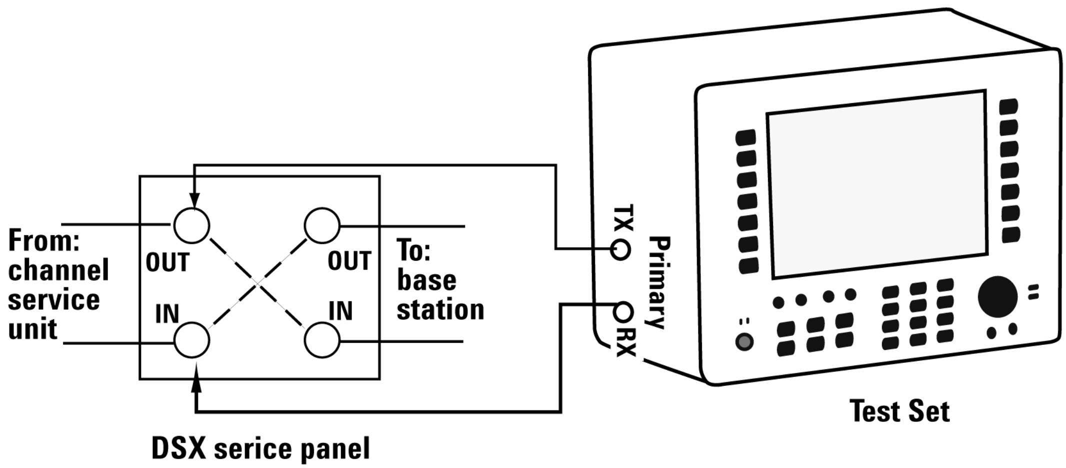
	Step	Notes
13	Setup the loop code. a. [Loop Code] b. [ESF Data Link]	Configures what type of loop code this test set will respond to. Requires a Datalink loop code for this test set to enter loopback mode.
14	[Display]	Enables the Display options on the right-hand buttons.
15	Setup the results display. a. [Results] b. Use the up and down arrows to select. c. Make a selection. d. [Select]	Enables a list of results information that can be displayed in the Results pane. Make a selection based on the need of the application.
16	[Control]	The selection enables several right-hand soft keys that control choices specific to each test mode.
17	[Pattern]	Select a pattern.
18	[Self Loop Up]	Forces the test set to enter loop-up state.
19	[Self Loop Down]	Forces the test set to enter loop-down state.

Sample Delay Test

Use this test mode to measure the delay between the primary Tx and Rx ports. This measured delay can be used to determine the approximate distance between near-end and far-end. The far-end of the line must be manually looped during this test. Since a signal is being sent on the T1 line, service on the T1 will be effected.

In this example, you can use this test mode to have the test set measure the round trip delay of a T1 circuit. It is necessary to have a loop condition at the far end during this test. The best accuracy is obtained when a hard loop exists at the far end. The far end CSU can be remotely looped up using the CSU/NIU Loopback mode, however, be aware that the loopback method in the remote device could add additional delay. During this mode a pattern consisting of a zero inserted into a string of ones is transmitted and analyzed to determine the delay in the path. The selected test pattern is sent as filler during the calculation interval.

Figure 14-6 Delay Connection Diagram



Sample Delay Test

	Step	Notes
1	Connect the BSTS to the DSX panel	Refer to Figure 14-6
2	[Mode]	
3	[Backhaul]	
4	[T1 Analyzer]	
5	Select a test mode. a. [Get Started/ Test Mode] b. [Delay] c. [Full T1]	Choose this to perform a Delay test on a full T1 Circuit. Delay measurements require full T1 bandwidth.

	Step	Notes
6	[Setup]	Select this to display a list of setup choices that pertain to this test mode.
7	Setup Rx input. a. [Rx Input] b. [Terminate]	This assumes the test set is connected into a jack that interrupts the circuit.
8	Setup line code. a. [Line Code] b. [B8ZS]	This assumes the circuit is provisioned for B8ZS.
9	Setup framing. a. [Framing] b. [ESF]	This assumes that the circuit has been provisioned for ESF.
10	Select a pattern. a. [Pattern] b. Use the up and down buttons to select. c. QRSS d. [Select]	
11	Setup Tx LBO. a. [Tx LBO] b. [0 dB]	This is a typical level found at the customer demarcation point.

Turning on sound

You can listen to a single channel at a time in channel test mode. Sound is disabled when you are in full T1 test mode.

	Step	Notes
1.	[Mode]	
2.	[Backhaul]	
3.	[T1 Analyzer]	
4.	[Get Started/Test Mode]	
5.	Select a measurement.	
6.	Select Channel mode.	
7.	[Display/Sound]	
8.	[Sound]	
9.	[On] or [Off]	Each time you press this softkey, the selected option changes.
10.	Set the volume. a. [Volume] b. Enter the volume level from 1 - 10. c. [Enter]	

Setting up T1 diagnostics

The diagnostic tests available for T1 include:

- **RAM -** During the RAM test, the memory on the T1 measurement module is tested. Memory hardware failures are detected.
- **ROM -** The ROM test verifies the integrity of the code by performing a checksum measurement.
- **Loop Back -** The loop back test is a functional test of the transmitting and receiving hardware. It attempts to send various signal patterns and levels and then to verify the measured values. It is important that this test be done using the short jumpers as even a 4-6 foot cable can cause a normally good board to fail.

If any of the above tests fail, contact your service center.

	Step	Notes
1.	[Mode]	
2.	[Backhaul]	
3.	[T1 Analyzer]	
4.	[Tests]	
5.	[Verification]	The “Connect the T1 Patch Plugs” diagram and explanation contain the information you need to set up the test.
6.	[Continue]	The test is performed and results are reported on the screen.

Patterns

Many test patterns are available to ’stress’ the circuit in a unique way or to gain maximum insight into a particular problem. Much has been written to guide the troubleshooter to select the proper pattern. Below is a summary of the qualities of the patterns available in the test set.

- **1:7 -** An eight-bit pattern that contains a single one. Used to test clock recovery.
- **2 in 8 -** An eight bit pattern with two ones and a maximum of four consecutive zeroes. B8ZS is never sent.
- **3 in 24 -** A twenty-four bit-pattern containing 3 ones with the longest length of consecutive zeroes constrained to fifteen. It has a ones density of 12.5% and is used to check clock recovery.
- **All 1’s -** A pattern that causes line drivers to consume the maximum amount of current. If framing is set to 'Unframed' the resulting pattern is equivalent to a 'Blue Alarm' or 'Alarm Indication Signal' or AIS.
- **All 0’s -** A pattern that is often selected to verify B8ZS provisioning.
- **QRSS -** A pseudorandom pattern that simulates live traffic on a circuit. It is a very common test pattern
- **T1-DALY -** A pattern that changes rapidly between high and low density. This pattern is used to stress ALBO, equalizer and timing recovery circuits.
- **55 Octet -** Similar to the T1-DALY pattern except that it contains runs of fifteen consecutive zeroes that violate ones density requirements if sent unframed.
- **2E15-1 -** A pseudorandom pattern based on a 15 bit shift register.
- **2E20-1 -** A pseudorandom pattern based on a 15 bit shift register.
- **2E23-1 -** A pseudorandom pattern based on a 15 bit shift register.
- **Alternating Ones and Zeroes -** A pattern that alternates between ones and zeroes.

Measurement Results

Alarm indicators

- **Signal Loss -** The test set encountered the absence of 192 or more consecutive pulses. A frame pulse may or may not be present
- **Frame Loss -** The test set encountered an unexpected frame pattern. The frame pattern did not match the one selected in 'Setup'
- **Excess Zeros -** The test set encountered the absence at least 16 consecutive pulses in AMI mode or the absence of at least 8 consecutive pulses in B8ZS mode.
- **All Ones -** The test set encountered an unframed, all 1s pattern (a constant contiguous stream of 1s). This pattern is also known as an Alarm Indication Signal (AIS), keep-alive signal, or blue alarm. Blue alarms are generated by faulty transmission equipment such a T3 to T1 multiplexer.
- **Yellow Alarm -** A Remote Alarm Indication (RAI) signal pattern was received. This is normally sent by the far end interface equipment (CSU) in response to receiving a blue alarm on its network side. In D4 framing mode a yellow alarm is created at the far end by setting bit 2 to 0 for 255 consecutive frames. In ESF, a pattern of eight 0s and eight 1s is repeated 16 times to indicate a yellow alarm.
- **Idle (CDI) -** A Customer Disconnect Indication signal was received from the far end interface unit indicating that the customer is no longer supplying a signal. A CDI signal is an in-band pattern 0001 0100. Eight ones followed by eight zeros interrupted each second for 100 ms with LAPD Idle code (01111110) will be sent in the ESF Facility Data Link (ESF FDL).

Results indicators

- **BPV -** A momentary indicator that responds when a bipolar violation occurs on the incoming signal applied to the Receive jack. B8ZS codes are not considered a BPV and will not activate this indicator when the test set is set to AMI mode.
- **Frame -** A momentary indicator that responds when the test set

T1 Analyzer

encountered a disruption of the incoming frame pattern.

- **Pattern -** A momentary indicator that responds to a disruption of the incoming pattern.
- **CRC -** A momentary indicator that respond to a disruption of the incoming CRC. This indicator is applicable in only ESF mode.

Status indicators

- **T1 Pulses -** The test set is receiving pulses at the receive jack. Frame pulses alone are not sufficient to activate this indicator. There must be pulses present in the payload field.
- **B8ZS -** A B8ZS pulse pattern was detected on the incoming signal at the receive jack. Note that only certain patterns transmit B8ZS pulse patterns. The pattern must contain at least 8 consecutive zeroes before a B8ZS pattern is sent. The QRSS pattern will generate B8ZS while an idle T1 circuit transmitting all 1's will not.
- **Frame Sync -** A frame sync pattern matches the one specified in the setup screen on the test set.
- **Pattern Sync -** The received pattern matches the one specified in the setup screen on the test set

Measurement results fields

Recv Level

The voltage level of the signal measured at the Rx jack. (0 dBdsx = 6 Vpp)

Frequency

The frequency of the signal measured at the Rx jack. The T1 Pulses indicator must be active for this measurement to be displayed.

Elapsed Time

Indicates the amount of elapsed time since the last measurement reset.

BPV Errors

A tally of the number of BPV errors since the last measurement reset.

BPV Error Rate

The percent ratio of BPV errors to total bits transmitted since the last measurement reset.

BPV Errd Secs

The number of one second intervals since the last measurement reset that contained BPV errors.

Frame Errors

A tally of the number of Frame errors since the last measurement reset.

Frame Error Rate

The percent ratio of frame errors to total bits transmitted since the last measurement reset.

Frame Errd Secs

A tally of the number of one-second intervals since the last measurement reset that contained frame errors.

Signal Loss

A tally of the number of one-second intervals since the last measurement reset that contained signal errors.

Frame Sync Loss

A tally of the number of one-second intervals since the last measurement reset that contained frame sync loss.

Excess Zeros

A tally of the number of one-second intervals since the last measurement reset that contained excess zeros.

All 1's

A tally of the number of one-second intervals since the last measurement reset that contained the AIS pattern.

Yellow Alarm

A tally of the number of one-second intervals since the last measurement reset that contained the yellow alarm pattern.

Error Free Seconds

A tally of the number of one-second intervals that were error free since the last measurement reset.

Errored Seconds

A tally of the number of one-second intervals since the last measurement reset that contained errors such as BPVs and frame errors.

Severe Errored Seconds

A tally of the number of one-second intervals since the last measurement reset that were severely errored.

Available Seconds

A tally of the number of one-second intervals since the last measurement reset that were available for service.

Unavailable Seconds

A tally of the number of one-second intervals since the last measurement reset that were unavailable for service.

Degraded Minutes

A tally of the number of one-second intervals since the last measurement reset that were degraded.

Slip Rate

The percent ratio of frames cycle slips of the incoming signal relative to the slip reference choice on the setup menu - since the last measurement reset.

Peak +Wander

The peak amount of positive wander, measured in bit intervals, since the last measurement reset. Each peak wander interval of 193 qualifies as a frame slip.

Peak -Wander

The peak amount of negative wander, measured in bit intervals, since the last measurement reset. Each peak wander interval of 193 qualifies as a frame slip.

+Frame Slips

A tally of the number of positive frame slips that occurred since the last measurement reset.

-Frame Slips

A tally of the number of positive frame slips that occurred since the last measurement reset.

Bit Errors

A tally of the number of bit errors that occurred since the last measurement reset.

Bit Error Rate

The percent ratio of bit errors to total bits transmitted since the last measurement reset.

Pattern Sync Loss

A tally of the number of times the pattern detector lost synchronization since the last measurement reset.

Test Data Rate

The measured data rate of the bit stream.

Testing and Fault Mitigation

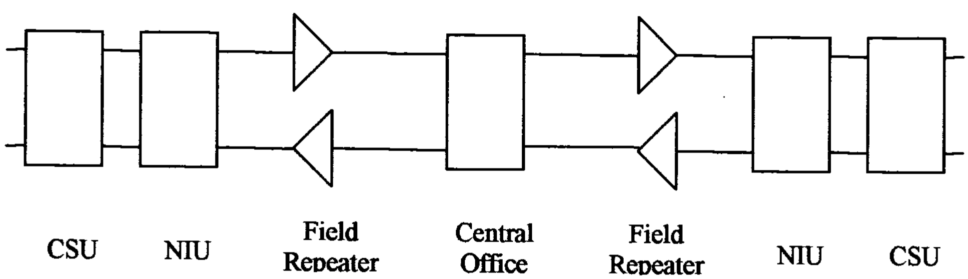
The complexity of T1 testing certainly parallels or possibly exceeds that of RF tests at a cell site. Shadowing efforts and customer expression have shown that most cell site technicians reduce the complexities of backhaul T1 testing down into a series of well-defined steps. These tests are often not comprehensive but are often sufficient to determine the continuity of a T1 circuit with a high degree of confidence. Often times the test sequence is developed by an experienced technician and is determined by finding the shortest path to an adequate measurement on a particular piece of readily available equipment. T1 testing often involves one technician on each end of a circuit. In the case of wireless, the technician at the switch end, very experienced at backhaul testing, is often working with a field technician that has a broader-based set of knowledge and is often less experienced in backhaul testing. The switch technician quickly develops a test procedure that involves the least amount of verbal instructions with the field technician.

T1 Facility Summary

This next section describes the elements in a typical T1 backhaul facility. Based on this information, typical fault conditions and what procedures are typically followed to restore service to the T1 span.

With almost no exception all circuits leased from the TELCO are routed through at least one central office facility. If this were not the case, planning and managing the repeaters needed for T1 transmission would be an onerous task. Repeater facilities are need to be spaced at a distance of 6000 feet and generally contain slots for multiple repeater units. Figure 14-7 shows a typical circuit layout.

Figure 14-7 Typical T1 Circuit Layout



The following definitions apply:

Central Office: This is usually located at the geographic center of a particular service area. It is normally a building that contains the switching equipment and cable cross-connect facilities. Although this diagrams shows a single central office, in actuality each end is often served by a separate central office. Facilities exist at the central office to accommodate remote testing and monitoring of T1 facilities.

Field Repeater: Repeaters are necessary when the customer is located beyond 6000 feet from the central office. Multiple repeaters are necessary when the span exceeds 12000 feet. Most commercial customers are located within 12000 feet of the central office. The repeaters are powered from the central office. Typically 90 volts is provided between the center-taps of the transmit and receive transformers. A particular repeater can be looped back by applying a specific loop-back tone. Often a label affixed to the cabinet denotes the loop-back tone. This may look like “FLTR A” or “FLTR B”.

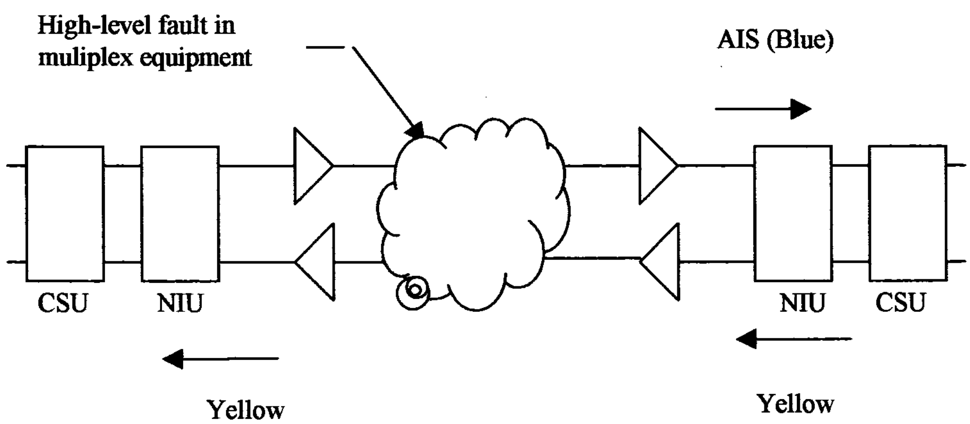
NIU: A device provided by the TELCO that contains the necessary equipment to provide the expected electrical levels to the customer. This device may be active and the serves as the customer demarcation (demark) point. When this device is active it can be looped back by applying the proper loop-back code. The customer is responsible for equipment beyond this point.

CSU: A customer provided unit that is required by the TELCO as part of the tariffed service agreement. This device may be looped back applying a specific loop-back code.

Isolating Faults with Alarm and Errors

Elements in a T1 facility are subject to failure. The most common failure is due to inadvertent cable dig-ups. Fault conditions cause errors and errors cause alarms. The alarms are often remotely monitored and can be observed by test equipment attached to the circuit. The most common alarm is the Alarm Indication Signal (AIS) aka a blue alarm. This alarm can be generated by a network element that not functioning or is receiving no signal. A CSU that is not receiving a signal (from the end-equipment) might generate an AIS depending on its configuration. When the CSU at the distant end sees AIS from the network it responds by sending a “Yellow Alarm” back to the network. Figure 14-8 shows a typical circuit layout.

Figure 14-8 (Blue) and Yellow Alarm Diagram



The CSU is a customer-supplied device. The Network Interface Unit (NIU) is provided by the network supplier. It may be a simple passive device with terminals or an advanced electronic package such as an optical to copper interface. Some NIU devices sense the presence or absence of the CSU and, if absent, send a Customer Disconnect Indication (CDI) toward the network.

Isolating Faults Using Test Equipment

Test equipment can be used to generate and monitor alarms and errors. Test equipment is connected to the T1 facility in a variety of ways. Bantam jacks are often available on the equipment. When the plug is inserted into the jack the circuit is interrupted. Sometimes a monitor jack is available. When a plug is inserted into the monitor jack the circuit is not interrupted and a -20 dB signal is available at the jack. When none of these is available the signal may be monitored at a connection block, sometimes referred to as a “punch-down block”. Table x describes the three typical access methods.

Table 14-2 T1 Facility Access Methods

Access method	Test set configuration	Notes
Test Jacks	Terminated	Circuit is broken when plug is inserted into jack. The test equipment is normally set to “Terminate” and provides 100 Ohm termination.
Monitor Jacks	Monitor	The circuit is not interrupted when the plug is inserted into the jack. The actual signal is available at a level 20 dB lower than the original. The test set normally set to “Monitor”, provides a 100 Ohm termination and expects the signal to be 20 dB down from what is usually expected.
Direct Connection to “Punch Down Block”.	Bridged	The circuit is not interrupted in this mode. The test set impedance is greater than 1000 Ohms so that the circuit is minimally affected. Test set is set to “Bridged”

WARNING **The following table describes the typical levels encountered in a T1 circuit. It is important to remember that 90 volts DC may exist between the transmit and receive pair. This voltage can be lethal!**

Table 14-3 Typical Levels Encountered in a T1 Circuit

0 dBdsx	6 Volts peak to peak
-7.5 dBdsx	2.53 Volts peak to peak
-15 dBdsx	1.07 Volts peak to peak

More Information About T1 Testing

Detailed Loop Mode and Auto Configuration Descriptions

Remote CSU/NIU Loop Mode

At each end of a T1 facility there is a Channel Service Unit (CSU) and possibly a Network Interface Unit (NIU). Both of these units have the ability to be remotely “looped up” by sending the proper loopback code. This can be done either by sending the expected loopback code in-band or out-of-band. When sent in-band a particular pattern is transmitted on every slot for 5 seconds. When the code is sent out-of-band the pattern is sent as part of the framing bit stream and is referred to as data-link. It is important to note that once a CSU or NIU is remotely placed into loopback it remains in that state. When a CSU or NIU is in a loopback state, that unit will loop the in-band loop code back to the near end. If the near end CSU sees the in-band loopback code repeated from the far end CSU then both CSU units can become locked in a loopback state. The test set is designed to minimize this possibility, however, the technician should take precautions to prevent this from happening and be observant of this potential situation. Some CSU/NIU units do not respond to in-band loop codes when they are configured for ESF. Generally NIU loop codes will be blocked at the central office.

Figure 14-9 Flow Diagram of In-band Loop-up Code Originating from the Test Set

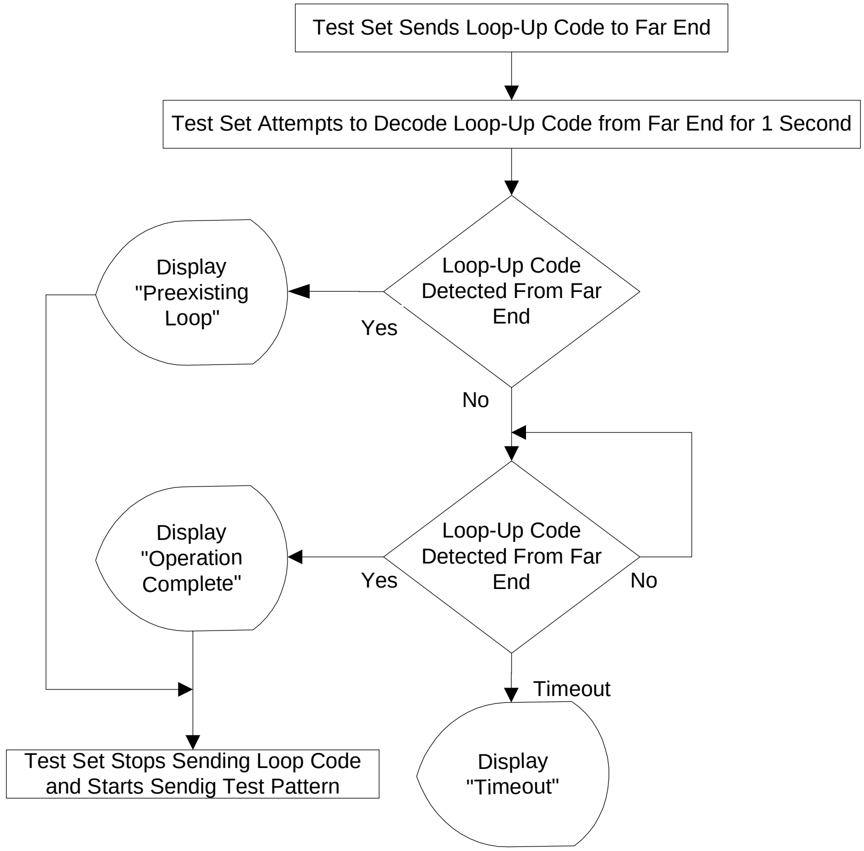
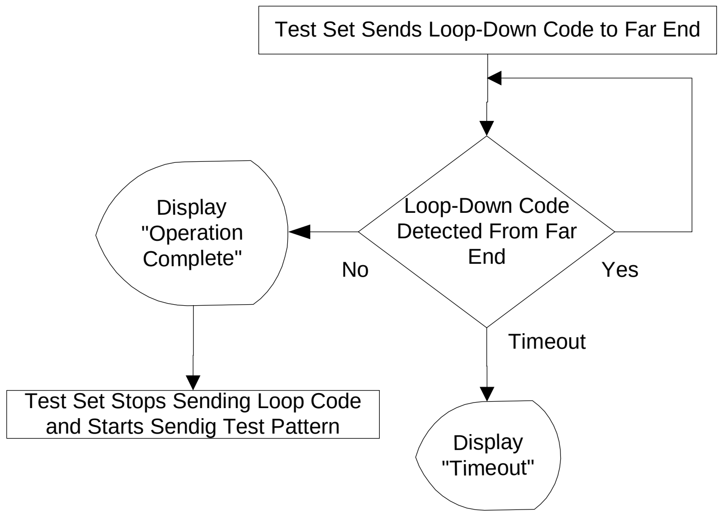
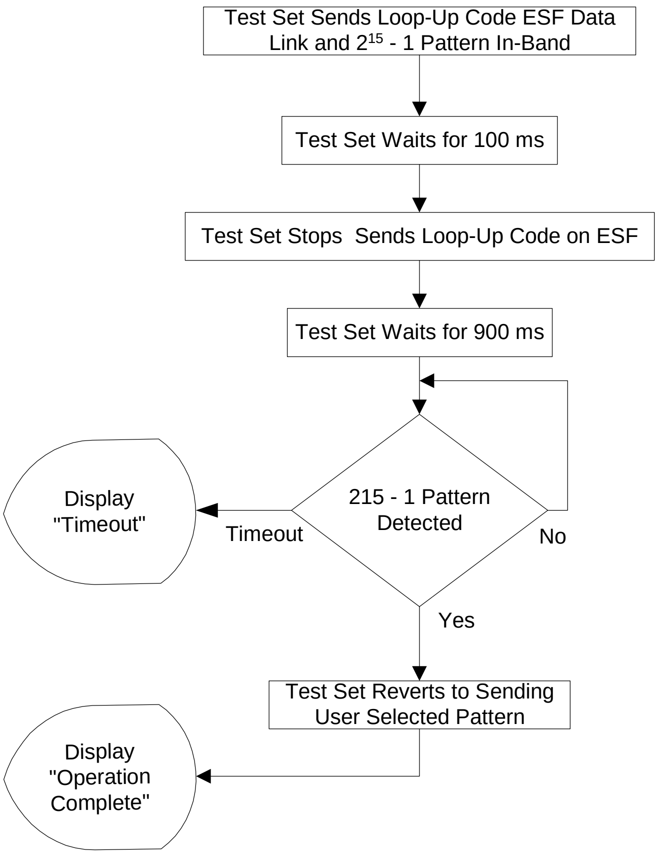


Figure 14-10 Flow Diagram of In-band Loop-down Code Originating from the Test Set



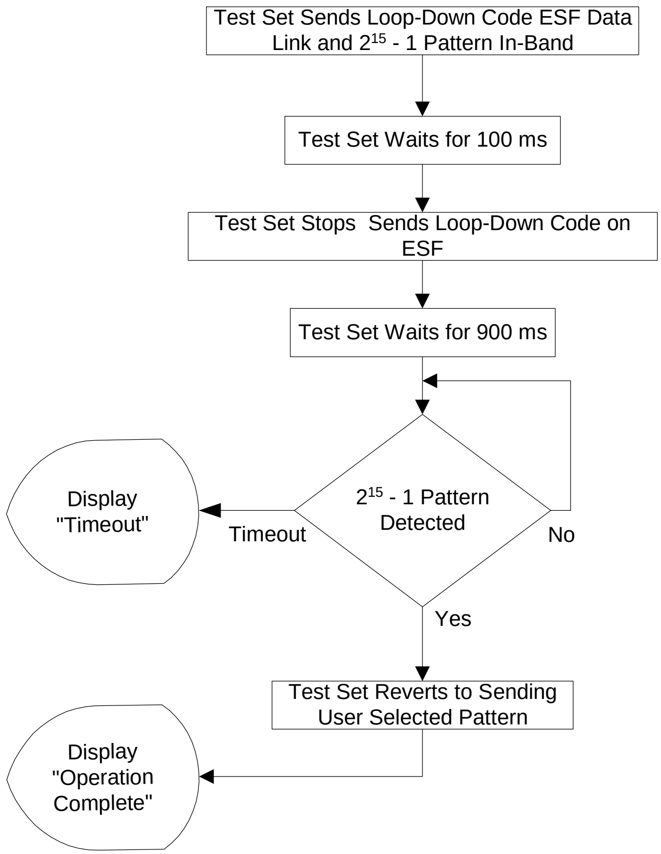
The flow of events differs when the out-of-band method of loopback is selected. In this case loopback can occur within 16 ms and therefore, it is not possible to determine if a pre-existing loop exists.

Figure 14-11 Flow Diagram of Out-of-band Loop-up Code Originating from the Test Set



Please note that 2^{15} -1 (2047) pattern is utilized because it is normally utilized for fractional T1 testing and has a low probability of being present on the full T1.

Figure 14-12 Flow Diagram of Out-of-band Loop-down Code Originating from the Test Set

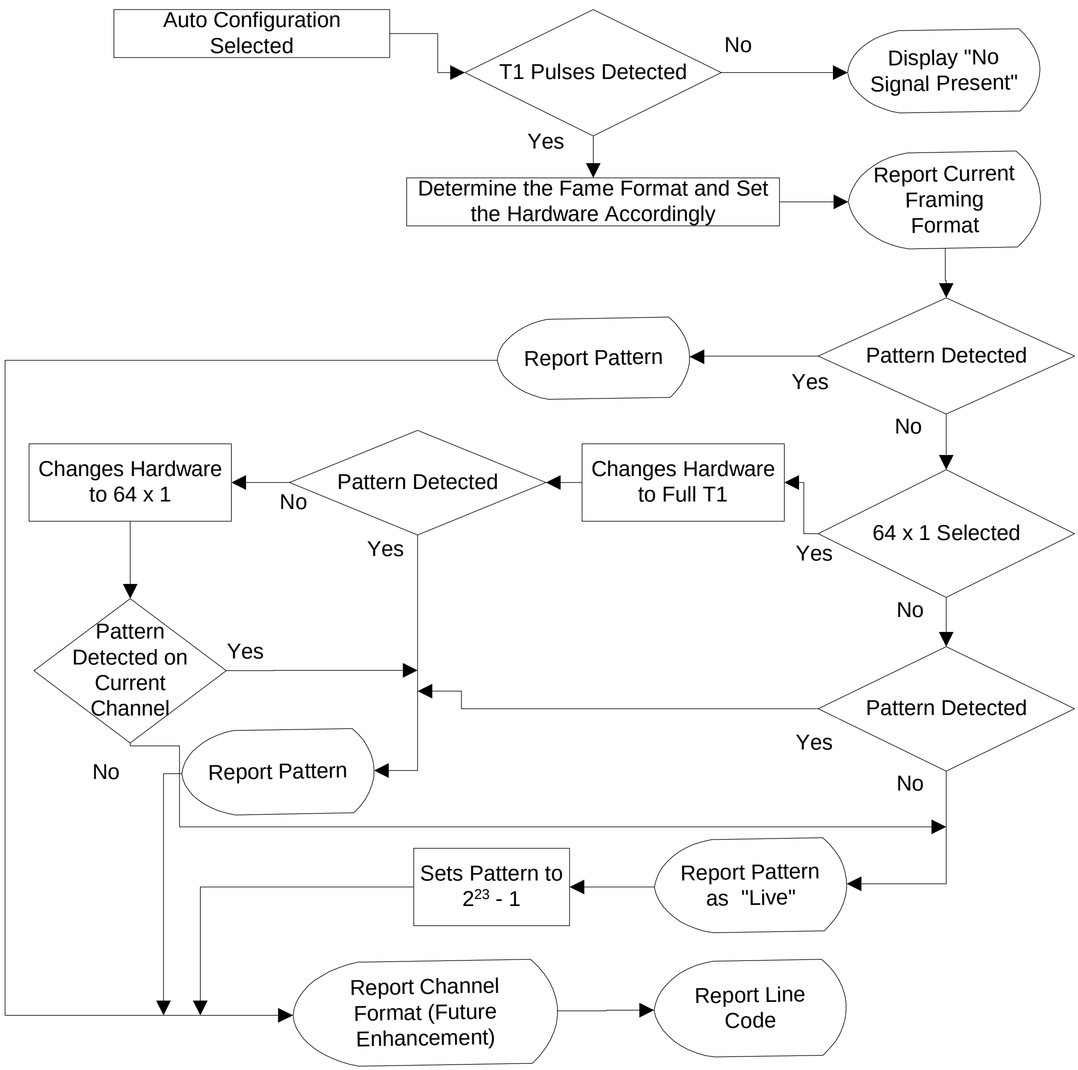


Please note that 2^{15} -1 (2047) pattern is utilized because it is normally utilized for fractional T1 testing and has a low probability of being present on the full T1.

Auto Configuration Flow Diagram

Selecting Auto Config causes the test set to analyze the incoming T1 signal and align the setup choices to that signal. If the incoming data pattern is not recognized then “NA Live Data” is displayed and the pattern selected on the setup screen will remain unchanged. If B8ZS codes are detected then this condition will be indicated and the line code parameter will be set accordingly. If setup was configured for B8ZS prior to selecting “Auto Config” and the pattern detected does not have sufficient zeros density to warrant B8ZS then “NA” will be displayed and the line code choice in the setup screen will remain unchanged. Finally, the framing format is detected, displayed and selection changed accordingly on the setup screen.

- **Flow Diagram for Auto Configuration**



Terminology

CRC

To an observer, the data on a live T1 Circuit appear to be random. Fortunately there is a way to perform limited testing when the circuit is provisioned for Extended Super Frame (ESF) format. A portion of the frame bits are reserved for a Cyclic Redundancy Checksum (CRC) sequence that can be monitored for performance. Simply stated, the CRC bits are calculated on the transmit end and inserted as a pattern on the frame bit. The CRC pattern depends on the pattern of other bits transmitted by the T1 Circuit. The receiving end also computes this pattern and compares it with the CRC that was computed and sent by the transmitting end. Since both ends use the same rules for computing the pattern, the CRC bits will be identical when all the bits involved in the computation agree. The CRC check provides good insight into the end-to-end integrity of the T1 Circuit and should be used in conjunction with other tests that can help determine what the cause of the CRC failure might be.

BPV

The electrical signals on a properly functioning T1 circuit conform to the specification set forth in the standards. The standards specify that the presence of a voltage indicates a data ’1’ and the absence of a voltage represents a data ’0’. Each occurrence of a data one produces a voltage for half a bit interval that is the opposite polarity of the previous bit, hence the name Alternate Mark Inversion (AMI). The alternating nature of the signal ensures that the average DC voltage is zero, allowing it be transformer coupled. Transformer coupling ensures a high degree of common mode rejection to the equipment that processes T1 signals.

Bipolar 8 Zero Substitution (B8ZS) is an exception to AMI that replaces runs of 8 consecutive zeroes with a special code that violates the AMI rules. It allows greater flexibility of data patterns by enhancing repeater synchronization by increasing pulse density thereby providing greater throughput.

When the electrical signal does not adhere to the alternating nature of the waveform specification a BiPolar Violation (BPV) has occurred. This can happen for a number of reasons, many of which are outside the control of the wireless technician. One cause may be from electrical noise radiating from florescent lamps, motors, or spark plug ignition circuits coupling into the copper lines that carry T1 signals. Shielded cable is often chosen for T1 circuits to minimize electrical interference. This shield must be grounded to be effective. When the cable is spliced or terminated the shield on both cables should be connected together. Often the transmit and receive signals are routed in separate cable bundles.

The receive signal is often much weaker that the transmit signal. Cross talk in the cable pairs can cause the transmit signal to appear on the receive pair and interfere with the low-level receive signal.

Frame

Pulses streaming in a T1 circuit would be meaningless if there were no way to organize them in a meaningful structure. In T1, bits are organized into 192 bit frames with an associated single frame bit for a total of 193 bits. The frame bit pattern has unique characteristics about it that allow the receiving end to recognize it synchronize to it. D3/D4 framing patterns have the ability to identify a super frame of 12 sub-frames. Extended Super Fame (ESF) has the ability to identify a super frame of 24 sub-frames and include a data link channel and Cyclic Redundancy Checksum (CRC) check bits.

15 W-CDMA (UMTS) Analyzer

Using the W-CDMA (UMTS) Analyzer

W-CDMA (UMTS) transmitter measurements verify proper transmitter performance of a UMTS Base Station (referred to as a Node B in UMTS world) and are typically made with the base station out-of-service under test conditions. Non-intrusive measurements can also be made on a live network if a monitor or test port is present. This is usually a coupled port, and power levels are –20 or –30 dB down from the main Tx output power RF path which can exceed 10 Watts. Important metrics are frequency error, error vector magnitude (EVM), peak code domain error (PCDE), channel power, carrier feedthrough, code domain noise floor, CPICH power, and the delta powers between CPICH and P-CCPCH, S-CCPCH, PICH, P-SCH and S-SCH. These latter measurements are all performed in the “Code Domain” and are sometimes referred to as Code Domain Power measurements.

One of the defining elements of a 3G system is high-speed data transmission. The 3GPP standard allows for multiple data rates depending on the application. This flexibility requires complex processing in both the transmitter and receiver to retain information quality and still transfer a variety of user information in the noisy spread spectrum environment. The code domain power (CDP) measurements allows us to quickly verify the operation of a 3GPP transmitter. In addition, it can give a high-level evaluation of modulation quality, channel power, and signal-to-noise in the code-domain.

Selecting a Reference

The E7495A/B supports three different types of frequency reference inputs for making frequency measurements, listed in the below.

Table 15-1 E7495A/B Reference Inputs

Reference	Type of reference provided	Notes
GPS Ref	Time and Frequency	Highly recommended- provides accurate and network-independent measurements

Table 15-1 E7495A/B Reference Inputs

Ext Ref	Frequency Only: 2.048 MHz, 10 MHz or 13 MHz	Recommended if no GPS signal is obtainable. Will only measure frequency and frequency error relative to BTS reference however
Int Ref	Frequency Only: Uses the test set's internal oscillator	Only recommended if no other reference signal is available. You must typically be within 750 Hz of the base station operating frequency when entering frequency or channel information in order for the test set to be able to lock to the Tx signal.

It highly recommended that you use the Global Positioning System (GPS) signal as the frequency reference for the W-CDMA (UMTS) Tx measurement because it provides an independent reference for measuring the operating frequency of the base station. A GPS antenna must be connected to the GPS input of the test set, and the antenna must have a clear view of the sky in order for the GPS to lock. If a GPS signal cannot be obtained, you can use the frequency reference provided by the base station to perform the measurement. The E7495A/B supports 10 MHz and 13 MHz external references.

If you use the frequency reference provided by the base station, keep in mind that the frequency error metric will only be measuring the error relative to the base station reference signal, and not relative to absolute frequency and time. You will not be able to determine if the base station frequency is aligned with the other base stations in the network. Since the GPS provides an independent reference, the frequency error metric can be used to determine if the base station frequency is offset from the rest of the network.

RF Connections

For the RF connection, you can connect the E7495A/B RF Input Port either directly to the Tx RF output of the base station, or to the coupled output port on the base station when you are making W-CDMA transmitter measurements. In this way, the base station can remain on-air (in-service) while Tx measurements are being made. If the RF Input port of the instrument is connected directly to the Tx RF output, then the base station (or at least that sector) must be taken out of service.

CAUTION The maximum power for the RF In and RF Out port is +20 dBm (100 mW). The maximum power for the Power Sensor port is +24 dBm (300 mW). When directly coupled to a base station, the test set can be damaged by excessive power applied to any of these three ports.

To prevent damage in most situations when you directly couple the test set to a base station, use the high power attenuator between the test set and the BTS.

NOTE Most base stations also provide a coupled output, a test port for testing. This output is usually a small RF connector on the front of the base station rack, located on or near the high power amplifier module, and is usually labeled “Test Out,” “Monitor Out,” or simply “Tx MON” or “TEST.” Be sure to check the specifications provided by the base station's manufacturer to determine the output power range of this test port prior to connecting the E7495A/B test set to avoid the possibility of damaging the test set.

Preparing to Make W-CDMA (UMTS) Tx Analyzer Measurements

The first step in measuring W-CDMA (UMTS) transmitter performance is to take the base station out of service. (In-service measurements are also possible if you use an external coupler or if a test port is available as described in the note above.) The next step is to choose the type of time reference available. The measurement configuration depends upon the type of time reference you choose to use. You can also use GPS to independently verify the frequency.

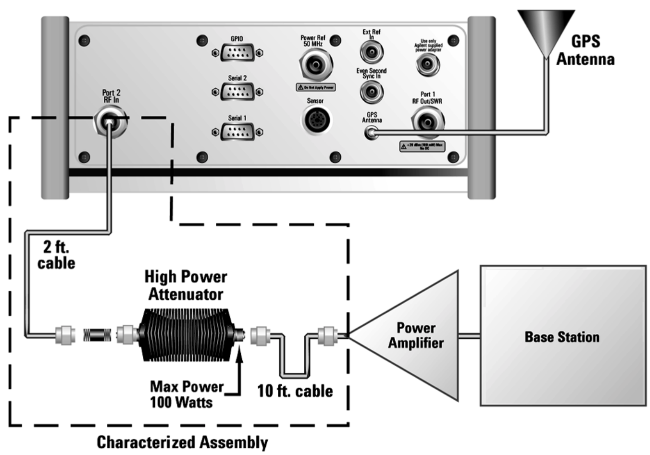
You must know the channel or carrier frequency of the transmitter to be analyzed. Additionally, each base station sector has a unique scrambling code that is transmitted to mobiles in that sector. These scrambling codes can be detected automatically by the test set or can be entered manually, if desired.

Performing a Basic W-CDMA (UMTS) Transmitter Measurement

Once you have taken the base station out of service, you can perform W-CDMA (UMTS) transmitter measurements.

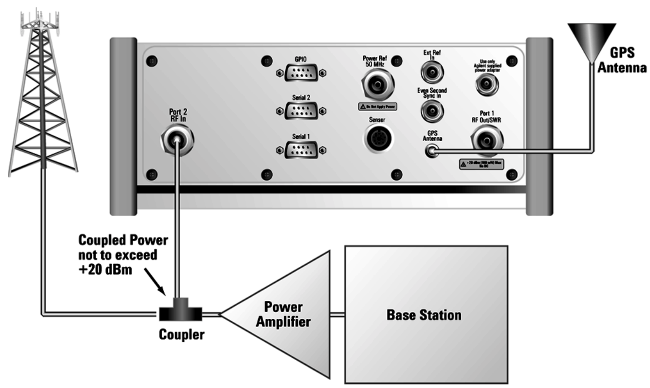
	Step	Notes
1.	**Mode**	
2.	[Tx Analyzer]	
3.	[W-CDMA (UMTS) Analyzer]	
4.	Setup the channel standard. a. [Chan Std] b. Highlight the channel standard you want using the up and down arrow buttons. c. [Select]	
5	On [Units] select **Freq** or **Chan**. Select Chan for this example.	Each time you press this softkey, the selected option changes.
6	Setup the channel. a. [Channel] b. Enter the channel using the number keypad. c. [Fwd] or [Rev]	
7	Setup the scrambling codes. a. [Scramble C...] b. [Auto] or [Manual]	Each time you press this softkey, the selected option changes. Auto takes the strongest code. Manual lets you specify the scrambling code.

	Step	Notes
8	Setup the frequency/time reference. a. [Fr/Time Ref] b. [GPS] or [Internal Reference] or [External 10 MHz] or [External 13 MHz]	GPS is the preferred frequency reference.
9	Connect to the base station.	



Connections for out of service W-CDMA (UMTS) measurements with GPS receiver as timing reference

Step	Notes



Connections for in service W-CDMA (UMTS) measurements with GPS receiver as timing reference

NOTE During a W-CDMA (UMTS) Analyzer measurement, a yellow triangle symbol may temporarily appear beside “GPS” in the lower right. The yellow triangle indicates that the test set is re-synching with the GPS pulse per second. Once the test set is synched, a green dot appears in place of the triangle. If the GPS is unavailable, a red X appears.

Multiple-View Display

The W-CDMA (UMTS) Tx analyzer multiple-view screen (shown in Figure 15-1 on page 291) is divided into 4 sections as follows:

- The top-left graph (Full View) shows the power in all 512 channels (OVSFs or spread codes). The light blue section on the bottom bar corresponds with the section displayed in zoom view (described below). The red line across the graph represents the active channel threshold. The traffic channel displays in orange color, the rest are in the color shown in the control view.
- The top-right graph (Control View) shows the power in the control channels (see Table 15-2).
- The lower-left graph (Zoom View) shows the power in the section of

the graph highlighted in light blue in the top-left graph, a section of 32, 64, or 128 codes.

- The bottom portion (Metrics View) displays the current measurement metrics.

NOTE In W-CDMA (UMTS), the PSCH and SSCH are not assigned spread codes and therefore do not appear in the code domain power display (Full View). The E7495x features a control channel graph view (Control View) for these two Sync channels to measure power only, since there is no spread code associated with these channels. They have special non-orthogonal scrambling codes and are only actually “on” 10% of the time

Table 15-2 Control Channels Acronyms

Acronym	Full Name	Viewable in Which Display Area
CPICH	Common Pilot Channel	Visible in all views (red bar)
PCCPCH	Primary Common Control Physical Channel	Visible in all views (yellow bar)
SCCPCH	Secondary Common Control Physical Channel	Visible in all views (green bar)
PICH	Paging Indicator Channel	Visible in all views (light blue bar)
PSCH	Primary Sync Channel	Visible ONLY in the Control View (blue bar)
SSCH	Secondary Sync Channel	Visible ONLY in the Control View (purple bar)

Figure 15-1 The Multiple-View Zoom Display

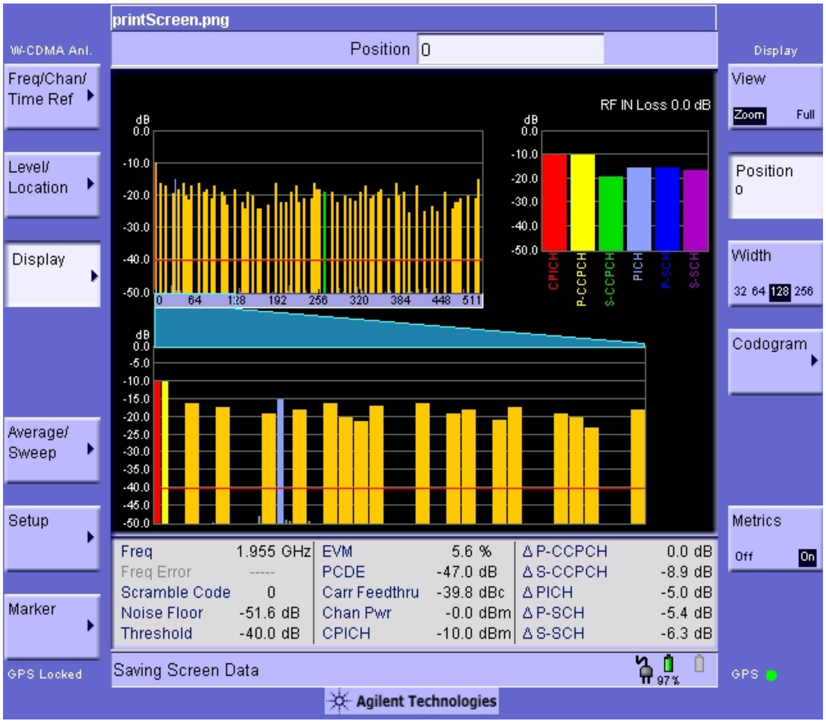


Figure 15-2 The Multiple-View Full Display

Setting the Display Options

The display options enable you to zoom in on portions of the graph, or to see the entire trace at once.

	Step	Notes
1.	[Display]	
2.	On [View] select [Zoom] or [Full].	If you are displaying Zoom view and select Full view, the display changes the top-left and bottom-left graphs to show the first 256 codes in the top graph, and the second 256 codes in the bottom graph. If you select Zoom, two more options are available.

	Step	Notes
3.	[Position]	When you are in Zoom view, this option changes the starting point (spread code) of the section of the full view (upper graph) that the Zoom view (lower graph) will expand for more detailed analysis.
4.	Enter the position using the number keypad.	
5.	[Enter]	
6.	On [Width] select [32], [64], or [128].	In Zoom view, smaller numbers selected with this option correspond to narrower zoom windows on the full view. If you select 32 for example, you will have the minimum window and maximum zoom. You will also see channel information displayed below each active channel. This information is the spreading factor used by that channel and its spread code or OVSF number.

Codogram Display

This view provides a history of the spectrum. You can use it to:

- see traffic channels as they come and go,
- track traffic channel call levels over time.

The W-CDMA (UMTS) Tx analyzer Codogram screen is divided into 3 sections in the Zoom view (default–Figure 15-3 on page 294) and 4 sections in the Full view (Figure 15-4 on page 295) as follows:

- **Zoom and Full views:** The lower-right graph (**Code Domain Trace view)** shows the power in all 512 OVSF (Orthogonal Variable rate Spread Factor) Code Channels. For display details, refer to.“Multiple-View Display” on page 289.
- **Zoom view:** The left graph (**Codogram view)** provides a display of data captured over time. The OVSF codes are shown on the x-axis and correspond to the light blue highlight on the Code Domain Trace view. You can change the time interval to allow longer spectrum history.

The color corresponds to the OVSF channel strength.

- **Full view:** The top-left graph (**Codogram view**) shows the power in the first half of the OVSF channels (SF512 channels 0 - 255). The lower-left graph shows the power in the other half of the channels (SF512 channels 256-511). Both graphs provide a display of data captured over time. You can change the time interval to allow longer spectrum history. The color corresponds to the OVSF channel strength.
- **Zoom and Full views:** The top-right graph (**Color Legend)** provides a color vs. power legend to help you interpret the power level in the Codogram.

The frequency indicator is at the bottom left corner of the screen, the time reference indicator at the bottom right. For each indicator the text indicates which reference you have chosen. A green LED indicates a locked condition. A red "X" indicates an unlocked condition.

Figure 15-3 The Codogram Zoom Display

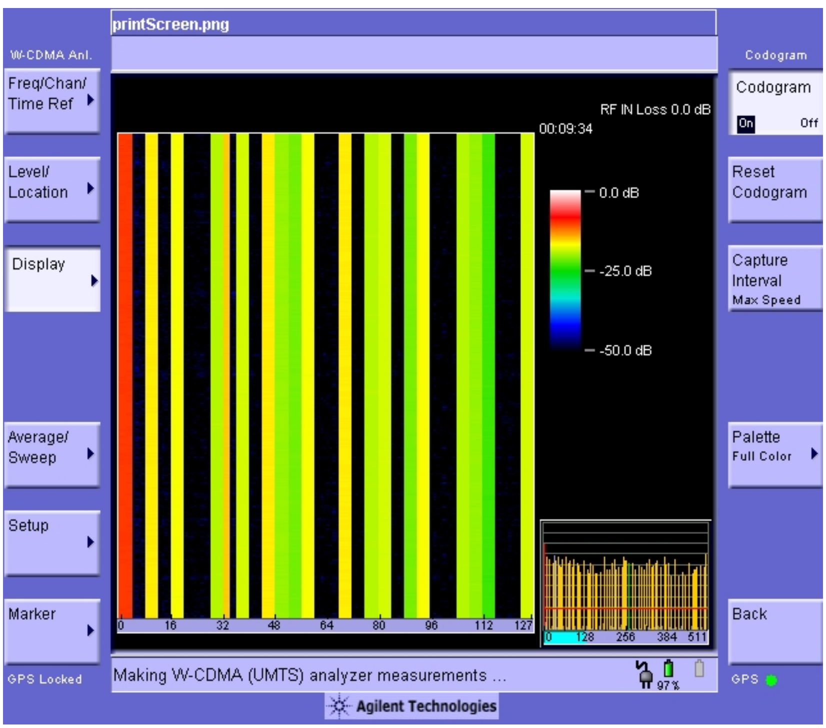
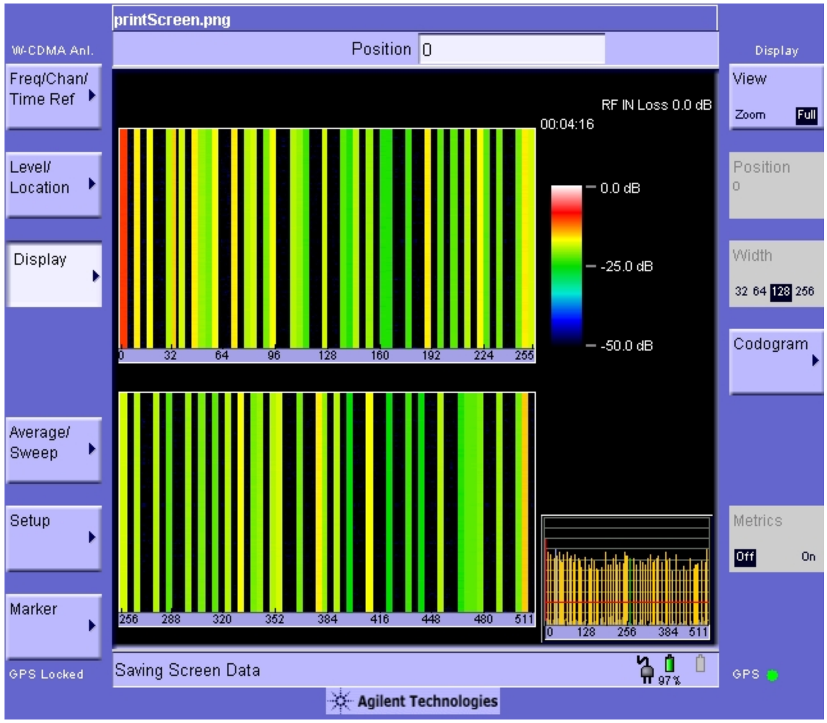


Figure 15-4 The Codogram Full Display



Setting Codogram Display Options

The display options enable you to zoom in on portions of the graph, or to see the entire trace at once.

	Step	Notes
1	[Display]	
2	[Codogram]	
3	On [Codogram] select **On** or **Off**.	When you set [Codogram] to On, [Reset Codogram], [Capture Interval] and [Palliate] become active.

	Step	Notes
4	[Reset Codogram]	This restarts the data capture for the Codogram. You may see the screen freeze for a few seconds before the display starts plotting data again.
5	If desired set the capture interval: a. [Capture Interval] b. Enter the interval number using the number keypad. c. Select [sec] or [Max Speed].	Allows you to set the capture interval to 1 or more seconds. Or, you may set it to automatically determine the capture interval that provides the maximum data collection speed. If you need to return to the automatically determine capture speed, you must press a keypad key to access [Max Speed}.
7	If desired set the display color: a. [Palette] b. Select [Full Color] or [Grayscale].	The color/grayscale top and bottom mappings are determined by the Ref Level and Scale/Div settings. To change the mapping, go to [Level/Location] and change [Ref Level] and [Scale/Div].

W-CDMA (UMTS) Analyzer Measurement Settings

Setting the Channel or Frequency Step

You can set the channel or frequency step so you can quickly increment to the next channel or frequency using the up and down arrow buttons.

	Step	Notes
1.	[Chan Step] or [Freq Step]	This choice depends on the [Units] mode you are using.
2.	Enter the desired channel or frequency step using the number keypad.	
3.	[Enter]	Notice (and verify) the number you entered below the Chan Step or Freq Step text on the corresponding button.

Setting the Scrambling Codes

The E7495 has two ways to identify the scrambling code being used by the transmitter under analysis: an automatic detection mode, Auto, and a manually-specified mode, Manual.

- In Auto mode, the test set automatically detects the scrambling code present in the signal.
- In Manual mode, the scrambling code can be entered by the user instead of being auto-detected by the instrument.

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, even if no P-SCH and S-SCH are present (a CPICH must be present, however). In normal operating conditions, these sync channels are available, so the P-SCH and S-SCH are used by the E7495A/B (and W-CDMA UMTS mobiles) to determine the correct sequence of scrambling codes required to demodulate the DPCH channels.

	Step	Notes
1.	[Freq/Chan/Time Ref]	
2.	[Scrambling C...]	
3.	[Auto] or [Manual]	Each time you press this softkey, the selected option changes. In Manual mode, you can enter a number using the keypad.

Setting the W-CDMA (UMTS) Tx Analysis Display Reference Level

You can set the W-CDMA (UMTS) Tx analysis display to show the power in each channel as either relative power (dB) or absolute power (dBm). The test set's default display mode is relative. In relative mode, the top horizontal line (top-most graticule) of the display represents the total power (channel power) in the 3.84 MHz bandwidth of that W-CDMA (UMTS) signal being broadcast by the transmitter. It is always 0 dB in this mode since it is a relative measurement. The power in each channel is shown as a vertical bar, with its height expressed in dB relative to the total channel power.

If you set the reference level mode to absolute, then the top graticule in the display still corresponds to total channel power in the 5 MHz bandwidth. However, the reference level and all the power values of the vertical bars showing the power in each channel are now indicated with actual absolute power in dBm.

To set the W-CDMA (UMTS) transmitter reference level (while in W-CDMA (UMTS) Analyzer mode):

	Step	Notes
1.	[Level/Location]	
2.	On [Reference] select **Abs** or **Rel**.	Each time you press this softkey, the selected option changes.

Compensating for the Loss of an External Cable and Attenuator

The insertion loss of the test cable and high power attenuator must be compensated for to obtain accurate W-CDMA (UMTS) power measurements, such as channel power. This process is called normalization and is described in "Measuring Two Port Insertion Loss" on page 48. The insertion loss of the test cable/attenuator combination is accounted for as the RF In Loss, which is an offset applied to the power measurements by the test set.

	Step	Notes
1.	[RF IN Loss]	
2.	Enter the RF in loss using the number keypad.	If you are using a cable and attenuator connected to the base station power amplifier, enter the combined cable and attenuator RF in loss here. The RF in loss can be obtained by measuring the Insertion loss. See "Two Port Insertion Loss" on page 47. **Note:** If data had been previously entered in [RF IN Loss], that data will be lost and replaced by the value you enter here.
3.	[dB]	

Setting Average, Sweep, and Restart

Setting the Sweep

You can select either continuous or single sweep. Continuous sweep provides repeated, ongoing measurements. Single sweep performs a single measurement that is repeated only when you push the Single button.

To set sweep:

	Step	Notes
1	[Average/Sweep]	
2	[Continuous] or [Single]	Each time you press this softkey, the selected option changes.

Setting Averaging

You can choose to have averaging on or off and set the number of averages you want to take. Averaging only applies to the data, not the trace. When turned on, the Agilent E7495A/B does a running average:

- A running average computes the new result as the weighted sum of the last result and the new measurement. The last result is weighted by (n – 1)/n. The new result is weighted by 1/n. Each new measurement produces a new result.

Averaging applies to the following measurement metrics and the control channel view only:

- Freq Error
- Noise Floor
- EVM
- PCDE
- Carrier Feedthrough
- Chan Pwr
- CPICH power

- all the delta powers
- Control Channel Graph

To set averaging:

	Step	Notes
1	Set the number of averages. a. [Average] b. Enter the number of averages using the number keypad. c. [Enter]	
2	Set averaging On or Off. a. [Average/Sweep] b. [Averaging] c. [Off] or [On]	

NOTE These two steps can be performed in any order. However, if you turn averaging on and a large number of averages has previously been set, there may be a delay before you can change number of averages.

Setting Restart

When you have averaging turned on, you can restart the averaging by pressing the Restart menu key. This restarts the averaging for running average in either Continuous or Single sweep mode. It also resets the Amplifier Capacity and Traffic metrics.

To restart averaging:

	Step	Notes
1	[Average/Sweep]	
2	[Restart]	

Setting the Active Channel Threshold Level and Auto Threshold Level

The active channel threshold level is an advanced setting that 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. The test set can set this level automatically, or you can manually enter a value.

In Auto mode the threshold level moves as the noise fluctuates. The threshold level is set by the test set at an optimal offset above the average noise floor. In Auto mode, you can alter the Auto Threshold Offset. The recommended and default setting is 0 dB. A negative value moves the threshold lower (closer to the noise floor) and is a more aggressive setting that increases the likelihood of interpreting an inactive channel as active. A positive value moves the threshold higher (away from the noise floor) and is a more conservative setting that increases the likelihood of interpreting an active channel as inactive.

In Manual mode the threshold level is fixed and does not move as the noise fluctuates.

To set the active channel threshold level (while in W-CDMA (UMTS) Analyzer mode)

	Step	Notes
1.	[Setup]	
2.	On [Threshold] select **Auto** or **Manual**.	Each time you press this softkey, the selected option changes. If you choose Manual, you must enter the threshold you want using the number keypad, then press [dB].
3.	[Auto Thres Offset]	The default value is 0 dB. Optionally, you can enter a negative (more aggressive) or positive (more conservative) value, then press [dB].

NOTE Knowing which inactive code channels are contributing the most noise to the overall W-CDMA channel may provide clues to the source of noise, such as a bad channel card in the base station.

Enabling PICH and S-CCPCH

In 3GPP W-CDMA (UMTS), two optional control channels are provided for: S-CCPCH and PICH. These can have different spreading codes and spreading factors. For this reason, the E7495A/B only identifies them as PICH and S-CCPCH channels when enabled by the user. The test set defaults to the disabled (off) state. In the default mode, the test set still shows the energy by assuming a spread factor of 512 in the Full view and Zoom view graphs. Either the actual spreading factor or spreading code must be entered manually before the test set will display the PICH and/or S-CCPCH parameters with their correct spread factors and OVSF codes.

To enable the PICH and S-CCPCH

	Step	Notes
1.	[Setup]	The same procedure is used for both settings. S-CCPCH is used in this example.
2.	[S-CCPCH]	Each time you press this softkey, the selected option changes.
3.	On [S-CCPCH Enable], select [Off] or [On]	
4.	[Spread Factor]	If you choose spread factor, you must press enter the spreading factor you want using the number keypad, then press [Enter].
5.	[Channel]	If you choose channel, you must press enter the channel you want using the number keypad, then press [Enter].

Adding a Marker

Markers can be used on traces to help you visually track up to four signals. Each marker has the following settings:

- **Type**: Provides three options, including:
  - **Off**
  - **Normal**, which places a diamond-shaped, colored marker, along

with a number, 1-4, on the trace.

— **Delta**, is associated with a normal marker. Therefore, a normal marker must exist prior to creating the delta marker. The delta marker displays the difference between the normal marker position and the delta marker position. Only one delta marker can be associated with a given normal marker. The normal marker must be active when Delta is selected.

- **Marker to Peak**: Places the active marker on the current greatest value of the trace.
- **Marker to Next Peak**: Places the active marker on the current second greatest value of the trace.

To add a marker to a trace

Step	Notes
1. [Marker]	
2. [Marker]	
3. [1], [2], [3], or [4]	
4. [Type]	
5. [Off], [Normal], or [Delta]	
6. Locate the marker relative to the trace: • [Marker to Peak] or • [Marker to Next Peak]	

Metrics Provided by the W-CDMA (UMTS) Analyzer Measurement

This section contains descriptions of the individual W-CDMA (UMTS) transmitter metrics in the Metrics view of the screen. The "Interpretation of W-CDMA (UMTS) Measurement Results" on page 307 section contains expected result values and possible causes of error if the expected results are not met.

Frequency

Frequency is the selected transmitter operating frequency entered by the user (or calculated from the channel number entered by the user).

Freq Error (Frequency Error)

Frequency error, as setup in Controls, is the frequency difference between your transmitter's actual center frequency and the frequency (or channel) you entered.

Scramble Code

The one being measured (manual or auto).

Noise Floor

Noise Floor is the average power level of all the inactive channels.

Threshold

Threshold is the active channel threshold level and is an advanced setting that can be set to indicate which code channels are considered active. (See "Setting the Active Channel Threshold Level and Auto Threshold Level" on page 302 for more information.)

EVM (Error Vector Magnitude)

EVM is the measure of signal quality specified as a percent of noise to pure signal. It is the difference between the measured waveform and the theoretical modulated waveform (the error vector). EVM metrics are used to measure the modulation quality of a transmitter. The 3GPP standard requires the EVM not to exceed 17.5%.

PCDE (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 W-CDMA (UMTS), specifically to address the possibility of uneven error power distribution, the EVM measurement has been supplemented with PCDE. The 3GPP standard requires the PCDE not to exceed -33 dB at a spreading factor of 256.

Carr Feedthru (Carrier Feedthrough)

Carrier Feedthrough is a result of the RF carrier signal feeding through the I/Q modulator and riding on the output circuitry without being modulated.

Chan Pwr (Channel Power)

Channel Power is the integrated power within a defined bandwidth. For W-CDMA (UMTS) the channel bandwidth is 3.84 MHz. Channel Power measures the power the base station is transmitting across the entire 3.84 MHz W-CDMA (UMTS) channel.

CPICH (Common Pilot Channel)

Common Pilot Channel (CPICH) is the channel that carries the scrambling code.

Control Channel Delta (Δ) Powers

The last column on the far right of the Metrics view shows the relative powers of the five control channels relative to the Common Pilot Channel. For example, P-CCPCH is the amplitude difference between the CPICH and the P-CCPCH. In W-CDMA UMTS systems, the transmit power of all the control channels can be set at different values relative to the CPICH. the five control channel Δ power metrics are:

- ΔP-CCPCH - primary common control physical channel
- ΔS-CCPCH - secondary common control physical channel
- ΔPICH - paging indicator channel
- ΔP-SCH - primary sync channel
- ΔS-SCH - secondary sync channel

Interpretation of W-CDMA (UMTS) Measurement Results

This section contains expected result values and possible causes of error if the expected results are not met.

Frequency

If you are in the channel mode, verify that the correct channelization and channel number are set.

Freq Error (Frequency Error)

The frequency error of the analyzer should be <1 kHz. If the frequency error is greater than this, there could be a possible malfunction in the base station equipment.

Before performing a procedure to check the base station equipment, check to ensure that the test set is performing a correct measurement. You can do this by reviewing the frequency reference settings for the test set (refer to "Selecting a Reference" on page 284). Ensure that these settings are correct, and that the test set shows reference lock. Lastly, make sure the test set has been powered on, and has been locked for at least 15 minutes.

If the error is still occurring after performing the above procedures, you will need to check the Base Station equipment for a source of the error. You can also verify that the base station is malfunctioning by turning off its modulation hardware and performing a frequency measurement on the Base Station carrier signal in the spectrum analyzer mode of the test set (refer to "Performing a Basic Spectrum Analyzer Measurement" on page 212).

Scramble Code

If the Scramble code is not as expected, it could be due to an incorrect Base Station setting or to incorrect positioning of the test set. Use of the "strongest pilot" display to position the test set. If the correct Scrambling code cannot be located, check the base station settings.

Noise Floor

An unexpectedly high noise floor could be due to interfering signals.

Threshold

If the **Threshold** is not as expected, check the following:

Check the Threshold settings to make sure they are correct. (See "Setting the Active Channel Threshold Level and Auto Threshold Level" on page 302 for more information.).

- If the Threshold setting is Auto with no offset, it is an indication that there is a poor signal to noise ratio.
- Check the Channel Power to ensure the level is as expected.
- If the power level is good, look for EVM and PCDE problems.

General Note:

For W-CDMA OA the Pilot Dominance and Multipath Power references are good, but for cabled up (W-CDMA Analyzer) they should be replaced with checks for transmitter's I/Q modulator and signal path. OA should also have references to them if Pilot Dominance and Multipath Power and Carrier Feedthrough are OK.

EVM (Error Vector Magnitude)

An unexpectedly high EVM could be due to interfering signals, carrier feedthrough, transmitter I/Q modulator, or signal path.

PCDE (Peak Code Domain Error)

An unexpectedly high PCDE could be due to interfering signals, carrier feedthrough, transmitter I/Q modulator, or signal path.

Carr Ft (Carrier Feedthrough)

A good Carrier Feedthrough level is less than -25 dB. The 3GPP standard does not specify Carrier Feedthrough; however, this measurement provides an additional tool to troubleshoot the base station's transmitter.

In the frequency domain, Carrier Feedthrough can show up as an energy spike that can be seen on the spectrum analyzer by closely spanning into the top of the W-CDMA signal. The effects of Carrier Feedthrough can also show up as higher noise levels on the Code Domain Power screen. Carrier Feedthrough can be caused by the lack of isolation across the mixer and cavity of the transmitter's I/Q modulator.

Chan Pwr (Channel Power)

If the Channel Power level is not as expected, check pilot dominance and the number of Scramble codes visible. All visible sectors will contribute to channel power. Also, check Amplifier Capacity and Utilization, they could have exceeded the maximum capacity. A high power data call could be indicated by a very wide and tall bar.

CPICH (Common Pilot Channel)

CPICH will vary with distance from the base station and clear line of sight to the antenna. If the CPICH is not as expected, check pilot dominance and base station settings (ratio to other control channels should be good).

Control Channel Delta (Δ) Powers

The Delta results should match the Base Station settings. If not, ensure the Base Station settings are as expected.

16 W-CDMA (UMTS) Over Air

Using the W-CDMA (UMTS) Over Air Tool

W-CDMA over air measurements provide a quick method of verifying W-CDMA transmitter performance. These transmitter measurements can be made on a base station from the convenience of your vehicle without taking the base station out of service. Over air measurements are especially useful in maintaining hard-to-access cell sites such as pole top base stations. The W-CDMA Over Air option may also be used to measure signals at a coupled port on the transmitter.

For out-of-service W-CDMA transmitter measurements, the W-CDMA Tx Analyzer option is recommended. For more information refer to "W-CDMA (UMTS) Analyzer" on page 283.

CAUTION To achieve valid over-the-air measurements, the test set must be stationary (not moving). An alternative is to make these measurements from a coupled port at the base station.

W-CDMA Over Air Measurements

Preparing to Make W-CDMA Over Air Measurements

An important consideration when making W-CDMA over air measurements is your location relative to the base station. There must be no obstructions between your location and the base station antennas. Also, the GPS antenna must be able to "see" the satellites to obtain lock. You must know the channel or frequency and the Channel Standard of the W-CDMA signal to be analyzed.

Performing a Basic W-CDMA Over Air Measurement

Once you have connected the proper antenna and filter to the test set, chosen a stationary location, and verified that you have a clear view of the base station antennas, you can perform W-CDMA over air measurements.

If this is the first W-CDMA over air measurement for this base station, you must find a location that meets the criteria for making a valid measurement. Your location must have a dominant pilot and very low multipath power. If you have made W-CDMA over air measurements at this location before and know it provides valid measurements, skip to

"Performing a Basic W-CDMA Over Air Measurement" on page 314.

Criteria for Making Valid W-CDMA Over Air Measurements

The first step in making valid W-CDMA over air measurements is to identify a target base station to measure. Then, for your measurements to be valid, you must find a location near the target base station with an unobstructed view of the base station antenna and a sufficiently strong W-CDMA signal. W-CDMA over air measurements will experience interference from other W-CDMA signals on the same RF channel and from multipath echoes. The code domain power view measures two key parameters to indicate these effects:

- Pilot dominance—Pilot Dominance - The ratio of energy between the strongest pilot and the other interfering pilots (expressed in dB). The maximum number of interfering pilots taken into account is five. Ideally, this value should be very large (> 16 dB)
- Multipath power—The ratio of total correlated power and the main correlation lobe power expressed in dB. Ideally all the signal power should be in the main lobe, and this value should be 0 dB. In the case of over the air measurements, multipath can disperse this energy outside the main lobe causing this metric to increase. A value < 0.1 dB should be obtained for good over the air measurements.

The table below shows the quality of the over air code domain measurements with respect to pilot dominance and multipath power.

Measurement Quality	Pilot Dominance	Multipath Power
Very good	> 16 dB	< 0.1 dB
Fair	> 10 dB	< 0.4 dB
Marginal	> 8 dB	< 0.7 dB

The default measurement limits for pilot dominance and multipath power are set to give "fair" measurement quality. If these limits are met, the pilot dominance and multipath power values will be displayed in green. When the pilot dominance and multipath power parameters are outside the acceptable limits, the parameters will turn red. If this occurs, you must move to a different location that meets the "fair" criteria defined above.

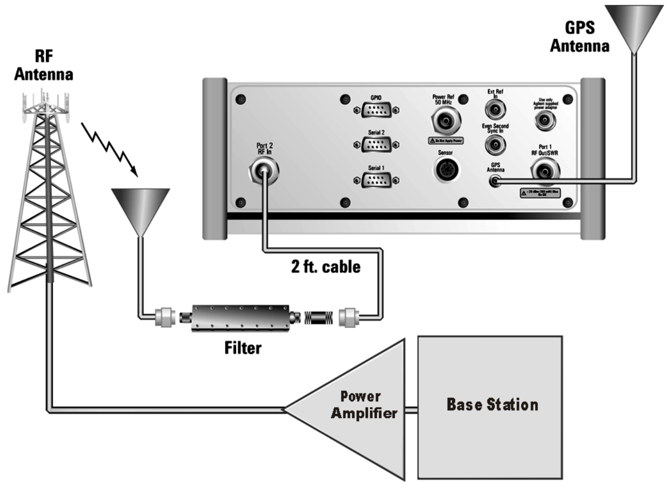
In general, you should always use a preselector filter for the band of interest to prevent strong signals from swamping out the signal of interest. Agilent offers the following preselector and antenna:

- Option 813—W-CDMA preselector filter and antenna for W-CDMA:

Performing a Basic W-CDMA Over Air Measurement

	Step	Notes
1	**Mode**	
2	[Over Air]	
3	[W-CDMA Over Air]	
4	[Chan Std]	
5	Select the channel standard you want using the up and down arrow buttons.	
6	[Select]	
7	On [Units] select **Chan** or **Freq**.	Each time you press this softkey, the selected option changes.
8	[Channel] or [Frequency]	• If you selected **Chan** in the previous step, select [Channel]. • If you selected **Freq**, select [Frequency].
9	Enter the channel or frequency using the number keypad.	
10	[Fwd]	Selects the forward W-CDMA channel.
11	Verify that on [Fr/Time Ref] **GPS** is selected. If not, press [Fr/Time Ref], then press [GPS].	This step is not require but it can improve the accuracy of the test set frequency reference.

	Step	Notes
12	On [Scramble Code] select **Auto** or **Manual**.	The test set defaults to Auto mode. • In Auto mode the test set finds the Scramble code of the strongest pilot signal and displays the value in the metrics display. • In Manual mode you must enter the Scramble code using the number keypad.
13	[Level/Location]	
14	On [Ref Level] select **Abs** or **Rel**.	Allows you to toggle the measurement reference value between **Abs** (absolute) and **Rel** (relative). • If set to **Abs**, the measurement is made in reference to absolute power and the results in the CDP chart are displayed in dBm. • If set to **Rel**, the measurement is made relative to a Channel Power and the results are displayed in dB.
15	[RF IN Loss]	
16	Enter the RF in loss using the number keypad.	If you are using a cable and additional devices connected to the antenna, enter the combined cable and device RF in loss here. The RF in loss can be obtained by measuring the Insertion loss. See “Two Port Insertion Loss” on page 47. **Note:** If data had been previously entered in [RF IN Loss], that data will be lost and replaced by the value you enter here.
17	[dB]	
18	Connect to the antenna.	

Step	Notes
	

NOTE The test set does not record data for post-processing. It provides a snapshot of W-CDMA base station transmit parameters at that location.

NOTE During a W-CDMA over air measurement, a yellow triangle symbol may temporarily appear beside "GPS" in the lower right. The yellow triangle indicates that the test set is re-synching with the GPS pulse per second signal. Once the test set is synched, a green dot appears in place of the triangle. If the GPS is unavailable, a red X appears.

Displaying Location Information Using GPS

If you are making W-CDMA over air measurements at a location you previously established as valid, Agilent recommends using GPS to verify that you are at the location from which you previously measured.

If you are making W-CDMA over air measurements from a new location, once you validate that the location provides a dominant pilot and low multipath power, Agilent recommends that you record the latitude and longitude coordinates of this location using GPS. Later measurements should be made from this precise location to provide performance trends.

To Display GPS Location Information:

	Step	Notes
1	[Level/Location]	
2	On [GPS Location] select **On**.	Displays GPS satellite location information. Uses the internal GPS to capture the location of a measurement. The GPS information can be used to return to the same location. The Time Ref (Freq/Chan/Time Ref mode) button must be set to Internal GPS for this function to be active. Information includes logitude, latitude, altitude (feet/meters), and number of satellites tracked. Each time you press this softkey, the selected option changes.
3	Highlight **On**	Toggle to **On** to display GPS satellite location information. Toggle to **Off** to remove the location information

NOTE If you prefer to have an electronic copy of the location information, see "Saving Data" on page 379.

Setting Amplifier Capacity Metrics

The Amplifier Capacity measurement is an estimate of the amount of power amplifier capacity that is being used, expressed in percent of maximum. Amplifier capacity properties must be properly set to make valid amplifier capacity measurements. Amplifier capacity metrics are amplifier capacity, peak amplifier capacity, and average amplifier capacity.

A W-CDMA base station is typically set up with a specified amount of power allocated to the CPICH, and specified power settings of the PCCPCH is defined relative to the CPICH. Occasionally, the PCCPCH power setting will also be specified in absolute power units (watts or dBm). Given the CPICH and PCCPCH setup values and the maximum power output of the amplifier, the percentage amplifier capacity setup parameters can be determined.

To Set Amplifier Capacity Properties (While in W-CDMA Over Air Mode):

	Step	Notes
1	[Setup]	
2	[Amp Cap Settings]	
3	On [Amp Cap] select **On**.	
4	[CPICH Pwr]	
5	Enter the CPICH power in watts, using the number keypad.	The CPICH power is the total power in the dominant pilot signal, expressed in watts.
6	[W]	
7	[Max PA Pwr]	
8	Enter the maximum power amplifier power in watts, using the number keypad.	A base station power amplifier is specified to have a maximum power limit.
9	[W]	
10	[Delta PCCPCH Pwr]	
11	Enter the Delta PCCPCH Pwr in dB, using the number keypad.	The delta PCCPCH is the expected amplitude difference between the PCCPCH channel and CPICH channel, expressed in dB.
12	[dB]	

Multiple-View Display

The W-CDMA (UMTS) Tx analyzer multiple-view screen is divided into 4 sections in the Zoom view (default–Figure 16-1 on page 321) and 5 sections in the Full view (Figure 16-2 on page 322) as follows:

- **Zoom view**: The top-left graph (Code Domain Trace View) shows the power in all 512 OVSF (Orthogonal Variable rate Spread Factor) Code Channels. Code channels have variable width depending on the Spread Factor for the channel. SF512 has 512 code channels with each channel 1 unit in width. SF256 has 256 channels with each channel 2 units in width. The width continues to double for SF128, SF64, and et cetera. The Y-axis labels display the relative power (dB) or absolute power (dBm), threshold level, and dB/division. The X-axis labels display active channel numbers.

The light blue section on the bottom bar corresponds with the section displayed in zoom view (described below). The red line across the graph represents the active channel threshold. The control channels are in the color indicated in Table 16-1. Active code channels shown on the display include:

- Active Traffic Channels (orange)
- Unknown Channels (tan)
- Noise (light gray)

- **Full view**: The top-left graph (Code Domain Trace View) shows the power in the first half of the OVSF channels (SF512 channels 0 - 255). The lower-left graph shows the power in the other half of the channels (SF512 channels 256-511). The code channel appearance and colors are the same as described above.
- **Zoom view**: The lower-left graph (Zoom View) shows the power in the section of the graph highlighted in light blue in the top-left graph, a section of 32, 64, or 128 codes.
- **Zoom and Full views**: The top-right graph (Strongest Pilot View) contains the pilot dominance and multipath power parameters. This shows the strongest Scrambling Codes seen by the test set. The Scrambling Code of interest should be clearly dominate. The display is useful when positioning the test set to see what other base stations or sectors need to be avoided. Awareness of these two parameter values helps you be sure that you are making valid measurements on the sector of interest.
- **Full view**: The lower-right graph (Control View) shows the power in the control channels (see Table 16-1). The delta power (relative to CPICH) is shown in the middle of the control bars.
- **Zoom and Full views**: The bottom portion (Metrics View) displays 15 measurement parameters, for the current measurement, displayed in three columns and five rows—each with a value and units. For more information about the metric display, refer to “Metrics Provided by the W-CDMA (UMTS) Analyzer Measurement” on page 340.

The frequency indicator is at the bottom left corner of the screen, the time reference indicator at the bottom right. For each indicator the text indicates which reference you have chosen. A green LED indicates a locked condition. A red “X” indicates an unlocked condition.

NOTE In W-CDMA (UMTS), the PSCH and SSCH are not assigned OVSF codes and therefore do not appear in the code domain trace view. The E7495x features a control channel graph view (Control View) for these two Sync channels to measure power only, since there is no OVSF codes associated with these channels. They have special non-orthogonal codes and are only “on” 10% of the time

Table 16-1 Control Channels Acronyms

Acronym	Full Name	Viewable in Which Display Area
CPICH	Common Pilot Channel	Visible in all views (red bar)
PCCPCH	Primary Common Control Physical Channel	Visible in all views (yellow bar)
SCCPCH	Secondary Common Control Physical Channel	Visible in all views (green bar)
PICH	Paging Indicator Channel	Visible in all views (light blue bar)
PSCH	Primary Sync Channel	Visible ONLY in the Control View (blue bar)
SSCH	Secondary Sync Channel	Visible ONLY in the Control View (purple bar)

Figure 16-1 The Multiple-View Zoom Display

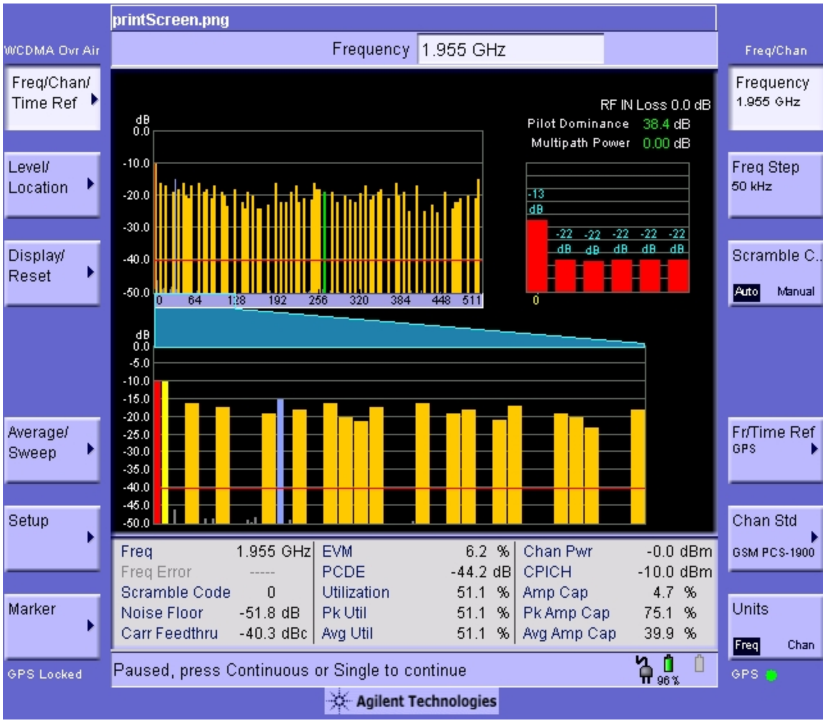
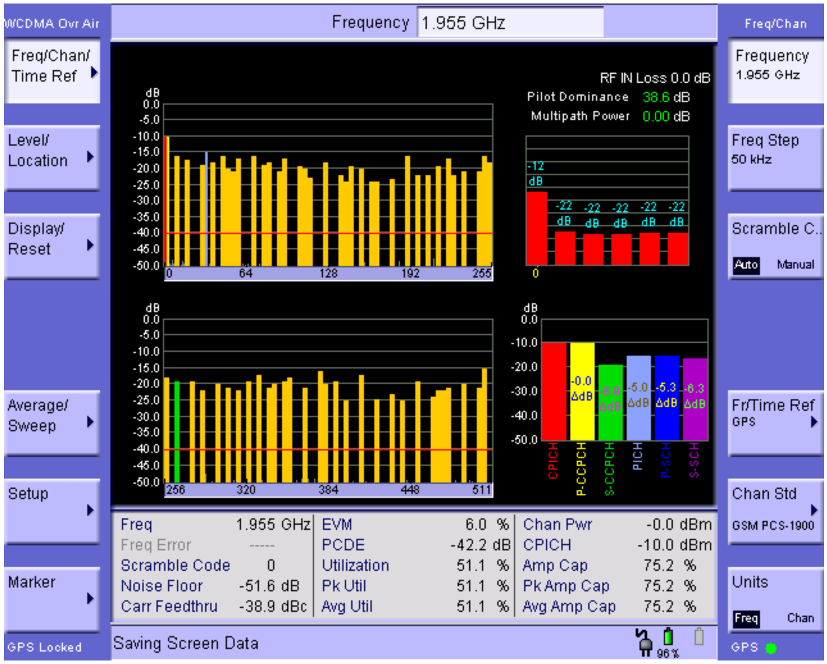


Figure 16-2 The Multiple-View Full Display



Setting Multiple-View Options

The display options enable you to zoom in on portions of the graph, or to see the entire trace at once.

	Step	Notes
1	[Display]	
2	On [View] select [Zoom] or [Full].	If you are displaying Zoom view and select Full view, the display changes the top-left and bottom-left graphs to show the first 256 codes in the top graph, and the second 256 codes in the bottom graph. If you select Zoom, two more options are available.

	Step	Notes
3	[Position]	When you are in Zoom view, this option changes the starting point (spread code) of the section of the full view (upper graph) that the Zoom view (lower graph) will expand for more detailed analysis.
4	Enter the position using the number keypad.	
5	[Enter]	
6	On [Width] select [32], [64], or [128].	In Zoom view, smaller numbers selected with this option correspond to narrower zoom windows on the full view. If you select 32 for example, you will have the minimum window and maximum zoom. You will also see channel information displayed below each active channel. This information is the spreading factor used by that channel and its spread code or OVSF number.

Codogram Display

This view provides a history of the spectrum. You can use it to:

- see traffic channels as they come and go,
- track traffic channel call levels over time.

The W-CDMA (UMTS) Tx analyzer Codogram screen is divided into 3 sections in the Zoom view (default–Figure 16-3 on page 324) and 4 sections in the Full view (Figure 16-4 on page 325) as follows:

- **Zoom and Full views:** The lower-right graph (**Code Domain Trace view)** shows the power in all 512 OVSF (Orthogonal Variable rate Spread Factor) Code Channels. For display details, refer to.“Multiple-View Display” on page 318.
- **Zoom view:** The left graph (**Codogram view)** provides a display of data captured over time. The OVSF codes are shown on the x-axis and correspond to the light blue highlight on the Code Domain Trace view. You can change the time interval to allow longer spectrum history.

The color corresponds to the OVSF channel strength.

- **Full view:** The top-left graph (**Codogram view**) shows the power in the first half of the OVSF channels (SF512 channels 0 - 255). The lower-left graph shows the power in the other half of the channels (SF512 channels 256-511). Both graphs provide a display of data captured over time. You can change the time interval to allow longer spectrum history. The color corresponds to the OVSF channel strength.
- **Zoom and Full views:** The top-right graph (**Color Legend)** provides a color vs. power legend to help you interpret the power level in the Codogram.

The frequency indicator is at the bottom left corner of the screen, the time reference indicator at the bottom right. For each indicator the text indicates which reference you have chosen. A green LED indicates a locked condition. A red “X” indicates an unlocked condition.

Figure 16-3 The Codogram Zoom Display

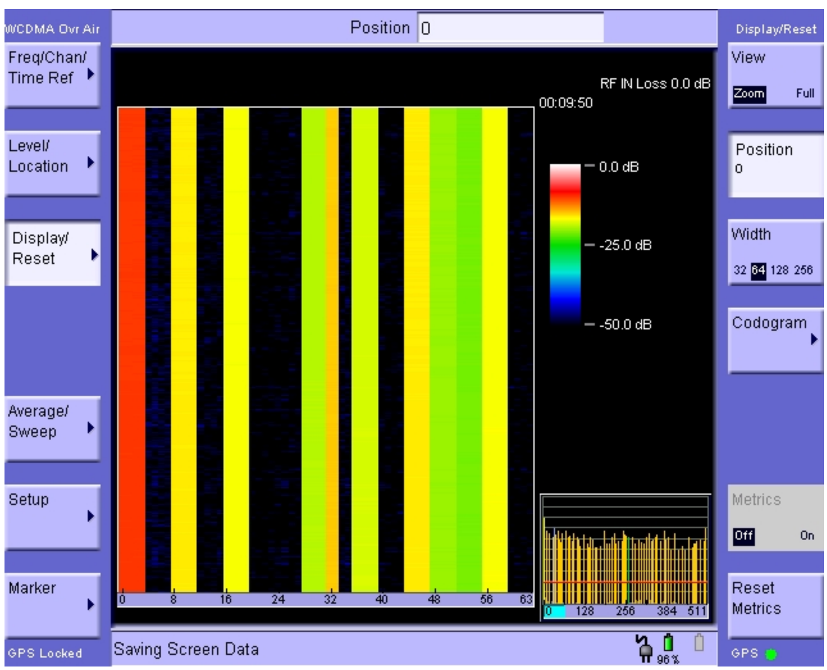
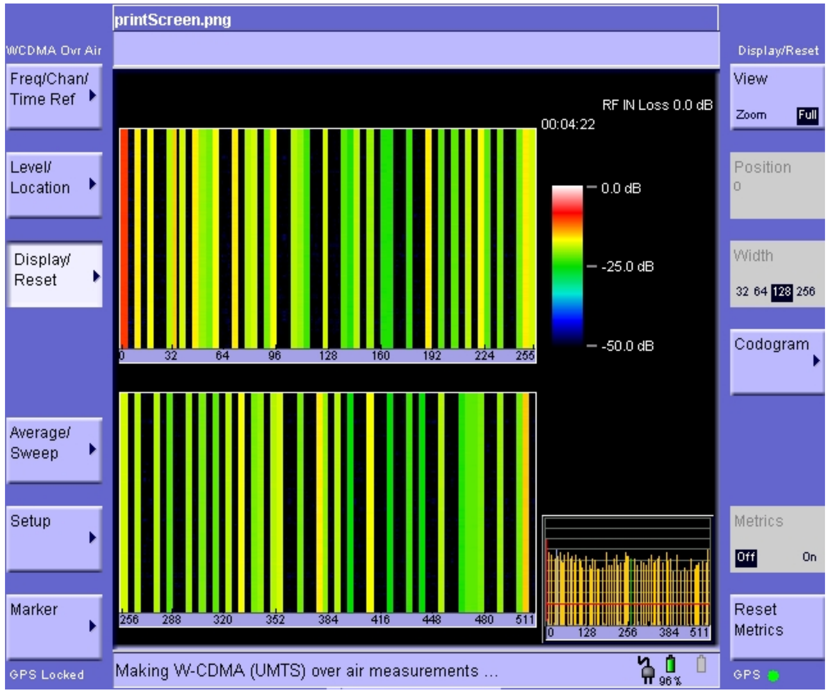


Figure 16-4 The Codogram Full Display



Setting Codogram Display Options

The codogram options let you turn the codogram on/off and control the update rate of the chart.

	Step	Notes
1	[Display]	
2	[Codogram]	
3	On [Codogram] select **On** or **Off**.	When you set [Codogram] to On, [Reset Codogram], [Capture Interval] and [Palliate] become active.
4	[Reset Codogram]	This restarts the data capture for the Codogram. You may see the screen freeze for a few seconds before the display starts plotting data again.

	Step	Notes
5	If desired set the capture interval: a. [Capture Interval] b. Enter the interval number using the number keypad. c. Select [sec] or [Max Speed].	Allows you to set the capture interval to 1 or more seconds. Or, you may set it to automatically determine the capture interval that provides the maximum data collection speed. If you need to return to the automatically determine capture speed, you must press a keypad key to access [Max Speed}.
7	If desired set the display color: a. [Palette] b. Select [Full Color] or [Grayscale].	The color/grayscale top and bottom mappings are determined by the Ref Level and Scale/Div settings. To change the mapping, go to [Level/Location] and change [Ref Level] and [Scale/Div].

Optional W-CDMA Over Air Measurement Settings

You can alter several optional measurement parameters in W-CDMA Over Air:

- "Setting the Channel or Frequency Step" on page 327
- "Setting the Scrambling Codes" on page 329
- "Setting the Transmitter Reference" on page 329
- "Compensating for the Loss of an External Cable and Attenuator" on page 330
- "Setting Average, Sweep, and Restart" on page 332
- "Setting the Active Channel Threshold Level and Auto Threshold Offset" on page 334
- "Resetting Amplifier Capacity and Traffic Metrics" on page 334
- "Setting Measurement Time" on page 335
- "Setting Valid Measurement Limits" on page 335
- "Setting the S-CCPCH Parameters" on page 336
- "Setting the PICH Parameters" on page 337
- "Adding a Marker" on page 338

Setting the Channel or Frequency Step

You can set the channel or frequency step so you can quickly increment to the next channel or frequency using the Up Arrow and Down Arrow buttons.

	Step	Notes
1	[Chan Step] or [Freq Step]	This choice depends on the [Units] mode you are using.

	Step	Notes
2	Enter the desired channel or frequency step using the number keypad.	
3	[Enter]	Notice (and verify) the number you entered below the Chan Step or Freq Step text on the corresponding button.

Setting the Scrambling Codes

The E7495 has two ways to identify the scrambling code being used by the transmitter under analysis: an automatic detection mode, Auto, and a manually-specified mode, Manual.

- In Auto mode, the test set automatically detects the scrambling code present in the signal.
- In Manual mode, the scrambling code can be entered by the user instead of being auto-detected by the instrument.

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, even if no P-SCH and S-SCH are present (a CPICH must be present, however). In normal operating conditions, these sync channels are available, so the P-SCH and S-SCH are used by the E7495A/B (and W-CDMA UMTS mobiles) to determine the correct sequence of scrambling codes required to demodulate the DPCH channels.

	Step	Notes
1	[Freq/Chan/Time Ref]	
2	[Scrambling C...]	
3	[Auto] or [Manual]	Each time you press this softkey, the selected option changes. In Manual mode, you can enter a number using the keypad.

Setting the Transmitter Reference

You can set the W-CDMA (UMTS) Tx analysis display to show the power in each channel as either relative power (dB) or absolute power (dBm). The test set's default display mode is relative. In relative mode, the top horizontal line (top-most graticule) of the display represents the total power (channel power) in the 3.84 MHz bandwidth of that W-CDMA (UMTS) signal being broadcast by the transmitter. It is always 0 dB in this mode since it is a relative measurement. The power in each channel is shown as a vertical bar, with its height expressed in dB relative to the total channel power.

If you set the reference level mode to absolute, then the top graticule in the display still corresponds to total channel power in the 3.84 MHz bandwidth. However, the reference level and all the power values of the vertical bars showing the power in each channel are now indicated with actual absolute power in dBm.

NOTE This setting only effects the CDP and Control Channel displays. The Metrics display is not effected.

To set the W-CDMA (UMTS) transmitter reference level:

	Step	Notes
1	[Level/Location]	
2	On [Reference] select **Abs** or **Rel**.	Each time you press this softkey, the selected option changes.

Compensating for the Loss of an External Cable and Attenuator

The insertion loss of the test cable and high power attenuator must be compensated for to obtain accurate W-CDMA (UMTS) power measurements, such as channel power. This process is called normalization and is described in “Measuring Two Port Insertion Loss” on page 48. The insertion loss of the test cable/attenuator combination is accounted for as the RF In Loss, which is an offset applied to the power measurements by the test set.

	Step	Notes
1	[RF IN Loss]	

2	Enter the RF in loss using the number keypad.	If you are using a cable and additional devices connected to the antenna, enter the combined cable and device RF in loss here. The RF in loss can be obtained by measuring the Insertion loss. See “Two Port Insertion Loss” on page 47. **Note:** If data had been previously entered in [RF IN Loss], that data will be lost and replaced by the value you enter here.
3	[dB]	

Setting Average, Sweep, and Restart

Setting the Sweep

You can select either continuous or single sweep. Continuous sweep provides repeated, ongoing measurements. Single sweep performs a single measurement that is repeated only when you push the Single button.

To set sweep:

	Step	Notes
1	[Average/Sweep]	
2	[Continuous] or [Single]	Each time you press this softkey, the selected option changes.

Setting Averaging

You can choose to have averaging on or off and set the number of averages you want to take. Averaging only applies to the data, not the trace. When turned on, the Agilent E7495A/B does a running average:

- A running average computes the new result as the weighted sum of the last result and the new measurement. The last result is weighted by (n – 1)/n. The new result is weighted by 1/n. Each new measurement produces a new result.

Averaging applies to the following measurement metrics and the control channel view only:

- Freq Error
- Noise Floor
- EVM
- PCDE
- Carrier Feedthrough
- Chan Pwr
- CPICH power

- all the delta powers
- Control Channel Graph

To set averaging:

	Step	Notes
1	Set the number of averages. a. [Average] b. Enter the number of averages using the number keypad. c. [Enter]	
2	Set averaging On or Off. a. [Average/Sweep] b. [Averaging] c. [Off] or [On]	

NOTE These two steps can be performed in any order. However, if you turn averaging on and a large number of averages has previously been set, there may be a delay before you can change number of averages.

Setting Restart

When you have averaging turned on, you can restart the averaging by pressing the Restart menu key. This restarts the averaging for running average in either Continuous or Single sweep mode. It also resets the Amplifier Capacity and Traffic metrics.

To restart averaging:

	Step	Notes
1	[Average/Sweep]	
2	[Restart]	

Setting the Active Channel Threshold Level and Auto Threshold Offset

The active channel threshold level is an advanced setting that 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 test set can set this level automatically, or you can manually enter a value.

In Auto mode the threshold level moves as the noise fluctuates. The threshold level is set by the test set at an optimal offset above the average noise floor. If you choose Auto mode, you can alter the auto threshold offset. The recommended and default setting is 0 dB. A negative value moves the threshold lower (closer to the noise floor) and is a more aggressive setting that increases the likelihood of interpreting an inactive channel as active. A positive value moves the threshold higher (away from the noise floor) and is a more conservative setting that increases the likelihood of interpreting an active channel as inactive.

In Manual mode the threshold level is fixed and does not move as the noise fluctuates.

To Set the Active Channel Threshold Level:

	Step	Notes
1	[Setup]	
2	On [Thresh Lvl] select **Auto** or **Manual**.	Each time you press this softkey, the selected option changes. If you choose Manual, you must enter the threshold you want using the number keypad, then press [dB].
3	[Auto Thres Offset]	The default value is 0 dB. Optionally, you can enter a negative (more aggressive) or positive (more conservative) value, then press [dB].

Resetting Amplifier Capacity and Traffic Metrics

The amplifier capacity metrics such as the peak and average amplifier capacity and peak and average utilization can be reset. If you prefer to reset these parameters manually, you may do so using the [Reset Metrics] menu key.

To Manually Reset the Amplifier Capacity Metrics:

	Step	Notes
1	[Display/Reset]	
2	[Reset Metrics]	

Setting Measurement Time

The Measurement Time setting allows you to alter the speed at which measurements are being made. Three choices exist: Slow, Normal, and Fast. The test set defaults to Normal. Slow measurement time provides a more accurate measurement at the expense of time. Fast measurement time provides a quicker measurement at the expense of accuracy. Normal measurement time strikes a balance between measurement speed and measurement accuracy.

	Step	Notes
1	[Setup]	
2	On [Meas Time] select **Slow**, **Normal**, or **Fast**.	Each time you press this softkey, the selected option changes.

Setting Valid Measurement Limits

The Valid Measurement Setting allows you to set the Multipath Power and Pilot Dominance limits. These settings control will help the test set to determine if valid over the air measurements are being made.

	Step	Notes
1	[Setup]	
2	[Valid Meas Settings]	

	Step	Notes
3	Set Multipath Power limit. a. [Mp Pwr <] b. Enter the power level using the number keypad. c. [dB]	
4	Set Pilot Dominance limit. a. [Plt Dom >] b. Enter the power level using the number keypad. c. [dB]	

Setting the S-CCPCH Parameters

The S-CCPCH Setting allows you enable S-CCPCH, set the spread factor, and designate the channel number. The S-CCPCH settings help the test set to determine which channel is the S-CCPCH channel. Once the test set has identified this channel, it can perform the delta power measurements for this channel and display them to the you.

	Step	Notes
1	[Setup]	
2	[S-CCPCH]	This key displays the current Spread Factor, selected channel, and Enable /Disable status.
3	On [S-CCPCH Enable] select **On** or **Off**.	Each time you press this softkey, the selected option changes.

	Step	Notes
4	Set the Spread Factor. a. [Spread Factor] b. [4], [8], [16], [32], [64], [128], or [256].	
5	Set the channel. a. [Channel] b. Enter the channel number using the number keypad. c. [Enter]	Always enter the channel number even if you have set Units to Freq.

Setting the PICH Parameters

The PICH Setting allows you enable PICH and designate the channel number. The PICH settings help the test set to determine which channel is the PICH channel. Once the test set has identified this channel, it can perform the delta power measurements for this channel and display them to you.

	Step	Notes
1	[Setup]	
2	[PICH]	This key displays the current Spread Factor, selected channel (in parenthesis), and Enable /Disable status.
3	On [PICH Enable] select **On** or **Off**.	Each time you press this softkey, the selected option changes. [Spread Factor] is grayed out and unavailable because the spread factor is fixed at 256.

	Step	Notes
4	Set the channel. a. [Channel] b. Enter the channel number using the number keypad. c. [Enter]	Always enter the channel number even if you have set Units to Freq.

Adding a Marker

Markers can be used on traces to help you visually track up to four signals. Each marker has the following settings:

- **Type**: Provides three options, including:
  - **Off**
  - **Normal**, which places a diamond-shaped, colored marker, along with a number, 1-4, on the trace.
  - **Δ (Delta)**, is associated with a normal marker. Therefore, a normal marker must exist prior to creating the delta marker. The delta marker displays the difference between the normal marker position and the delta marker position. Only one delta marker can be associated with a given normal marker. The normal marker must be active when Delta is selected.
- **Marker to Peak**: Places the active marker on the current greatest value of the trace.
- **Marker to Next Peak**: Places the active marker on the current second greatest value of the trace.

	Step	Notes
1	[Marker]	
2	[Marker]	
3	[1], [2], [3], or [4]	
4	[Type]	

	Step	Notes
5	[Off], [Normal], or [Delta]	
6	Locate the marker relative to the trace: • [Marker to Peak] or • [Marker to Next Peak]	

Metrics Provided by the W-CDMA (UMTS) Analyzer Measurement

This section contains descriptions of the individual W-CDMA (UMTS) transmitter metrics in the Metrics view of the screen. The "Interpretation of W-CDMA (UMTS) Measurement Results" on page 307 section contains expected result values and possible causes of error if the expected results are not met.

Frequency

Frequency is the selected transmitter operating frequency you have entered (or calculated from the channel number you have entered).

Freq Error (Frequency Error)

Frequency error is the frequency difference between your transmitter's actual center frequency and the frequency (or channel) you entered.

Scramble Code

The scramble code of the sector or BTS being measured.

Noise Floor

Noise Floor is the average power level of all the inactive channels.

Carr Ft (Carrier Feedthrough)

Carrier Feedthrough is a result of the RF carrier signal feeding through the I/Q modulator and riding on the output circuitry without being modulated.

EVM (Error Vector Magnitude)

EVM is the measure of signal quality specified as a percent of noise to pure signal. It is the difference between the measured waveform and the theoretical modulated waveform (the error vector). EVM metrics are used to measure the modulation quality of a transmitter. The 3GPP standard requires the EVM not to exceed 17.5%.

PCDE (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 W-CDMA (UMTS), specifically to address the possibility of uneven error power distribution, the EVM measurement has been supplemented with PCDE. The 3GPP standard requires the PCDE not to exceed -33 dB at a spreading factor of 256.

Utilization

Utilization is a ratio of the active OVSF codes to the total SF512 codes, expressed in percent. Even though active control channels such as the pilot are included in the utilization measurement, utilization is an indication of the traffic that is being carried by the base station.

For example, W-CDMA signal with CPICH, PCCPCH, SCCPCH using SF256, and PICH, would use 8 of 512 SF512 codes, giving a utilization of 1.6%.

Pk Util (Peak Utilization)

Peak Utilization is the peak level of all the valid Utilization measurements while on the same Scrambling code. In Scrambling code Auto mode this measurement is reset if the Scrambling code changes or the Reset Metrics button is used. In Scrambling code Manual mode this measurement is reset only if the Reset Metrics button is used.

Avg Util (Average Utilization)

Average Utilization is the average level of all the valid Utilization measurements while on the same Scrambling code. In Scrambling code Auto mode this measurement is reset if the Scrambling code changes or the Reset Metrics button is used. In Scrambling code Manual mode this measurement is reset only if the Reset Metrics button is used.

Chan Pwr (Channel Power)

Channel Power is the integrated power within a defined bandwidth. For W-CDMA (UMTS) the channel bandwidth is 3.84 MHz. Channel Power measures the power the base station is transmitting across the entire 3.84 MHz W-CDMA (UMTS) channel.

CPICH (Common Pilot Channel)

Common Pilot Channel (CPICH) is the channel that carries the scrambling code.

Amp Cap (Amplifier Capacity)

Assuming the Amplifier Capacity parameters are set properly, the Amplifier Capacity measurement is an estimate of the amount of power amplifier capacity that is being used, expressed in percent of maximum. When an amplifier is transmitting at maximum output power, it is said to be at 100% of its capacity. For example, an amplifier with a maximum output power of 12 watts would be at 50% of capacity when transmitting 6 watts and at 100% of capacity when transmitting at 12 watts.

The percentage of amplifier capacity generally increases as the number or level of the traffic channels increase.

Pk Cap (Peak Amplifier Capacity)

Peak Amplifier Capacity is the peak level of all the valid Amplifier Capacity measurements while on the same Scrambling code. In Scrambling code Auto mode this measurement is reset if the Scrambling code changes or the Reset Metrics button is used. In Scrambling code Manual mode this measurement is reset only if the Reset Metrics button is used.

Avg Cap (Average Amplifier Capacity)

Average Amplifier Capacity is the average level of all the valid Amplifier Capacity measurements while on the same Scrambling code. In Scrambling code Auto mode this measurement is reset if the Scrambling code changes or the Reset Metrics button is used. In Scrambling code Manual mode this measurement is reset only if the Reset Metrics button is used.

Control Channel Delta (Δ) Powers

The last column on the far right of the Metrics view shows the relative powers of the five control channels relative to the Common Pilot Channel. For example, P-CCPCH is the amplitude difference between the CPICH and the P-CCPCH. In W-CDMA UMTS systems, the transmit power of all the control channels can be set at different values relative to the CPICH. the five control channel Δ power metrics are:

- ΔP-CCPCH - primary common control physical channel
- ΔS-CCPCH - secondary common control physical channel

- ΔPICH - paging indicator channel
- ΔP-SCH - primary sync channel
- ΔS-SCH - secondary sync channel

Interpretation of W-CDMA Over Air Measurement Results

This section contains expected result values and possible causes of error if the expected results are not met.

Frequency

If you are in the channel mode, verify that the correct channelization and channel number are set.

Freq Error (Frequency Error)

The frequency error of the analyzer should be <1 kHz. If the frequency error is greater than this, there could be a possible malfunction in the base station equipment.

Before performing a procedure to check the base station equipment, check to ensure that the test set is performing a correct measurement. You can do this by reviewing the frequency reference settings for the test set (refer to "Setting the Transmitter Reference" on page 329). Ensure that these settings are correct, and that the test set shows reference lock. Lastly, make sure the test set has been powered on, and has been locked for at least 15 minutes.

If the error is still occurring after performing the above procedures, you will need to check the Base Station equipment for a source of the error. You can also verify that the base station is malfunctioning by turning off its modulation hardware and performing a frequency measurement on the Base Station carrier signal in the spectrum analyzer mode of the test set (refer to "Performing a Basic Spectrum Analyzer Measurement" on page 212).

Scramble Code

If the Scramble code is not as expected, it could be due to an incorrect Base Station setting or to incorrect positioning of the test set. Use of the "strongest pilot" display to position the test set. If the correct Scrambling code cannot be located, check the base station settings.

Noise Floor

An unexpectedly high noise floor could be due to interfering signals.

Carr Ft (Carrier Feedthrough)

A good Carrier Feedthrough level is less than -25 dB. The 3GPP standard does not specify Carrier Feedthrough; however, this measurement provides an additional tool to troubleshoot the base station's transmitter.

In the frequency domain, Carrier Feedthrough can show up as an energy spike that can be seen on the spectrum analyzer by closely spanning into the top of the W-CDMA signal. The effects of Carrier Feedthrough can also show up as higher noise levels on the Code Domain Power screen. Carrier Feedthrough can be caused by the lack of isolation across the mixer and cavity of the transmitter's I/Q modulator.

EVM (Error Vector Magnitude)

An unexpectedly high EVM could be due to interfering signals, carrier feedthrough, pilot dominance, or multipath power. If these are all correct, check for transmitter I/Q modulator or signal path problems.

PCDE (Peak Code Domain Error)

An unexpectedly high PCDE could be due to interfering signals, carrier feedthrough, pilot dominance, or multipath power. If these are all correct, check for transmitter I/Q modulator or signal path problems.

Utilization

The Utilization metric provides an instantaneous reading of the percentage of the traffic channels currently being used. More meaningful information is provided by the Peak and Average Utilization metrics gathered over a 10 to 15 minute interval.

Pk Util (Peak Utilization)

If the Peak Utilization of this base station is greater than 65%, this is a warning that peak traffic rates at this base station are getting very high. It is possible that calls could be getting blocked or dropped. You should contact RF engineering as soon as possible.

Avg Util (Average Utilization)

If the Average Utilization of this base station is greater than 45%, the base station is carrying a great deal of traffic. It may be time to consider adding another carrier or another base station. You should contact RF engineering.

Chan Pwr (Channel Power)

If the Channel Power level is not as expected, check pilot dominance and the number of Scramble codes visible. All visible sectors will contribute to channel power. Also, check Amplifier Capacity and Utilization, they could have exceeded the maximum capacity. A high power data call could be indicated by a very wide and tall bar.

CPICH (Common Pilot Channel)

CPICH will vary with distance from the base station and clear line of sight to the antenna. If the CPICH is not as expected, check pilot dominance and base station settings (ratio to other control channels should be good).

Amp Cap (Amplifier Capacity)

The Amplifier Capacity metric provides an instantaneous reading of how much of the amplifier's capacity is currently being used. More meaningful information is provided by the Peak and Average Amplifier Capacity metrics gathered over a 10 to 15 minute interval.

Pk Amp Cap (Peak Amplifier Capacity)

If the Peak Amplifier Capacity is greater than 100%, the traffic at this base station has caused the base station amplifier to exceed its maximum power rating. This is not desirable, and you should contact your RF engineering department as soon as possible. This problem can result in system degradation or damage to the amplifier.

You can get an indication of how often the amplifier capacity is being exceeded by watching the Amplifier Capacity measurement. This is an instantaneous measurement of the amplifier capacity.

Avg Amp Cap (Average Amplifier Capacity)

If the Average Amplifier Capacity is greater than 85%, the base station power amplifier is close to its maximum power limit. Further increase in traffic on this base station could cause system performance problems or damage to the power amplifier. You should notify your RF Engineering Department as soon as possible.

17 GSM Analyzer

Using the GSM Analyzer

GSM transmitter measurements verify proper transmitter performance and can be made with the base station in service or out of service. Important metrics are frequency error, BSIC, peak channel power, RMS phase error, peak phase error, and IQ offset. The measurements conform to the following GSM standards GSM 450, GSM 480, GSM 850, GSM 900, DCS 1800, and PCS 1900 bands.

CAUTION The maximum power for the RF In and RF Out port is 20 dBm (100 mW). When directly coupled to a base station, the test set can be damaged by excessive power applied to either of these ports.

To prevent damage in most situations when you directly couple the test set to a base station, use the high power attenuator between the test set and the BTS.

NOTE To prevent unusual display information from being shown, ensure that you have selected a valid GSM Standard. It is possible for you to set a Chan Std that allows you to enter a lower Stop channel number than the current Start channel number resulting in unusual information in the display. This is because some of the channel standards have discontinuities and reversals in channel numbers.

Performing a Basic GSM Transmitter Measurement

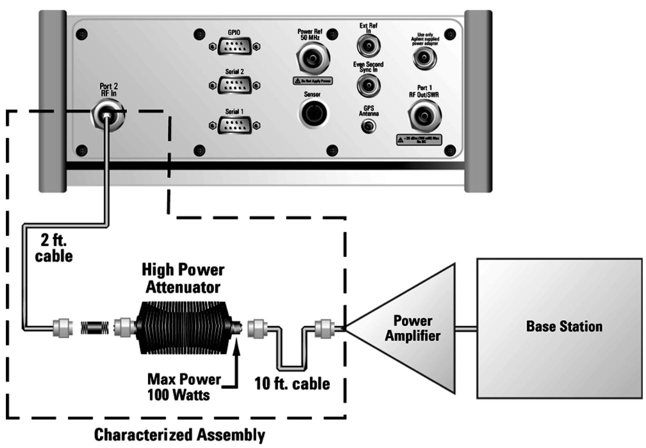
The first step in measuring GSM transmitter performance is to take the base station out of service or, for an inservice measurement, connect the test set to the coupled port. You must also know the channel or frequency of the GSM signal to be analyzed.

To Make GSM Tx Analyzer Measurement:

	Step	Notes
1	**Mode**	
2	[Tx Analyzer]	
3	[GSM Analyzer]	

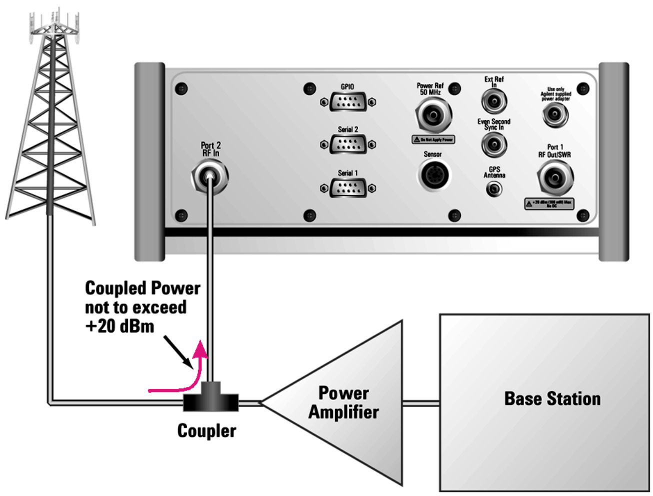
	Step	Notes
4	[Chan Std]	
5	Highlight the channel standard you want using the up and down arrow buttons.	
6	[Select]	
7	On [Scan Mode] select **Range**, **Auto**, or **List**. a. If you selected **Range** or **Auto**, go to step 8. b. If you selected **List**, go to step 9.	Each time you press this menu key, the selected option changes.
8	If you selected **Range** or **Auto**, you may set Start and Stop frequency/channel and the Step Size of the display range. a. On [Start Chan] enter the channel or frequency using the number keypad. b. On [Stop Chan] enter the channel or frequency using the number keypad c. On [Step Size] enter the channel or frequency step using the number keypad	Menu keys label will read Chan or Freq depending on the Units you have selected.

	Step	Notes
9	If you selected **List**, you may select and change any or all of the available Freqs/Chans on the List screen.	In addition, you may add Freqs/Chans to the list or delete Freqs/Chans from the list. Refer to “Adding or Deleting a List Item” on page 354.
	a. [List]	
	b. Highlight the list item you want using the up and down arrow buttons.	
	c. Enter a new Freqs/Chans.	
	d. Repeat steps b and c as necessary.	
	e. [OK]	
10	Connect to the base station.	



Out of service connection

Step	Notes



In service connection

11	[Level/Location]
12	[Autoscale]

Interpreting the Display

The GSM Tx Analyzer screen is divided into two sections:

- The trace display, the graphic bar chart taking up most of the screen
- The metrics display, a table of values at the bottom of the screen

The **trace display** contains a channel power display. In this display power of each selected channel is shown. The Y-axis labels display the absolute power (dBm), threshold level, and dB/division. The X-axis labels display the frequency or channel number. The selected Scan Mode provides different trace display data formats:

- **Range Mode**: All channels between the Start and Stop Freq/Channel are displayed. The channels are separated by the Freq/Channel Step value. Metrics are only computed for the single channel indicated by the vertical yellow line.

GSM Analyzer

- **Auto Mode**: All channels between the Start and Stop Freq/Channel are examined, but only the channels with the highest power are measured. Metrics are computed for all of the displayed channels, but are only displayed for the single channel indicated by the vertical yellow line. The maximum number of displayed channels is 20.
- **List Mode**: All channels in the list are measured. Metrics are computed for all of the displayed channels, but are only displayed for the single channel indicated by the vertical yellow line. The maximum number of list items is 40.

The *metrics display* shows measurement parameters displayed below the trace display in three columns and three rows—each with a value and units. (With the exception of BSIC. BSIC has no units.) For more information about the parameters in the metric display, refer to “Metrics Provided by the GSM Analyzer Measurement” on page 365.

The frequency indicator is at the bottom left, the time reference indicator at the bottom right. For each indicator the text indicates which reference you have chosen. A green LED indicates a locked condition, a red “X,” an unlocked condition.

Optional GSM Tx Analyzer Measurement Settings

You can change several optional measurement parameters in the GSM Tx Analyzer:

- "Setting the Channel or Frequency Step" on page 353
- "Adding or Deleting a List Item" on page 354
- "Setting the Display Reference Level" on page 355
- "Setting the Display Position" on page 355
- "Setting Auto Order" on page 356
- "Setting Bar Top and Units" on page 356
- "Setting Mid-Bar" on page 357
- "Setting Auto Mode Bar Count" on page 357
- "Setting the Pass/Fail Limits" on page 358
- "Compensating for the Loss of an External Cable and Attenuator" on page 359
- "Setting Average, Sweep, and Restart" on page 360

Setting the Channel or Frequency Step

The Channel or Frequency Step sets the distance between the measured channels. The GSM standard has a channel spacing of 200 kHz, but the signal is actually somewhat wider than that. Therefore service providers often space their channels 400 kHz apart. The entered step value must be a multiple of 200 kHz.

	Step	Notes
1	[Step Size]	This choice depends on the [Units] mode you are using.

	Step	Notes
2	Enter the desired channel or frequency step using the number keypad.	
3	[Enter] OR [Hz], [kHz], [MHz], or [GHz]	This choice depends on the [Units] mode you are using. Notice (and verify) the number you entered below the Chan Step or Freq Step text on the corresponding button.

Adding or Deleting a List Item

You may add and delete list items from the Scan Mode List for the specific channel/frequency ranges you want to measure.

	Step	Notes
1	Enter channels into the list. a. Use [Insert Row] to add a channel, then enter its number using the number keypad and [Fwd] or [Rev] to complete each entry. b. Use [Delete Row] to remove channels you do not want displayed. Select a channel you want to remove using the up and down arrow buttons. Then press [Delete Row] to remove the selected channel. c. [Ok]	The maximum number of list items is 40. If the number of channels displayed is 20 or less, a single bar graph is used to display them. If the number of channels displayed is greater than 20, two bar graphs are used to display them.

Setting the Display Reference Level

You can adjust the absolute amplitude represented by the top graticule line on the display (the reference level). Also, you can set the units per vertical graticule division on the display. When [Autoscale] is selected, [Ref Level] and [Scale/Div] are automatically calculated and any manually entered values will be reset.

To Set the Reference Level and Scale/Div:

	Step	Notes
1	[Level/Location]	
2	[Ref Level]	
3	Enter the reference level using the number keypad, up and down arrows, or knob.	
4	[dBm] or [W]	
5	[Scale/Div]	
6	Enter the graticule spacing value using the number keypad	
7	[dB]	

Setting the Display Position

You can set the location or position of the vertical yellow line (channel of interest indicator). This determines the channel used to calculate the measurement metrics displayed in the metrics portion of the display.

To Set the Display Position:

	Step	Notes
1	[Display]	
2	[Position]	

	Step	Notes
3	Enter the desired channel number of frequency using the number keypad, up and down arrows, or knob.	
4	If Frequency/Channel Units have been set to **Chan**, select [Fwd] or [Rev] If Frequency/Channel Units have been set to **Freq**, select [GHz], [MHz], [kHz], or [Hz]	If you use the up and down arrows or knob to change the channel number/frequency, the terminator units keys will not be displayed. However, the display will update to the entered number of bars after a few seconds.

Setting Auto Order

You can select the order that the channel bars are displayed. You can set them to be arranged in order of the relative power level or in order of the channel frequency. If you select **Pwr**, the bars are arranged in order of descending power. If you select **Freq**, the bars are arranged in order of ascending frequency.

To Set Auto Order:

	Step	Notes
1	[Display]	
2	On [Auto Order] select **Pwr** or **Freq**.	Each time you press this menu key, the selected option changes.

Setting Bar Top and Units

You can set the channel power to be displayed (in dBm or watts) at the top of the channel bars. This only effects the power displayed on the top of the bars. The vertical scale of the graph does not change.

To Set Bar Top:

	Step	Notes
1	[Display]	
2	On [Bar Top] select **Off** or **Pwr**.	Each time you press this menu key, the selected option changes.
2	On [Units] select **dBm** or **Watts**.	Each time you press this menu key, the selected option changes.

Setting Mid-Bar

You can set BSIC to be displayed at the middle of the channel bars.

To Set Mid-Bar:

	Step	Notes
1	[Display]	
2	On [Mid-Bar] select **Off** or **BSIC**.	Each time you press this menu key, the selected option changes.

Setting Auto Mode Bar Count

The measurement bar count setting allows you to alter the number of channel data bars displayed when you set the [Scan Mode] to auto. The channels that have the highest power will be displayed, up to the number of channels you have set.

To Set the Measurement Auto Mode Bar Count:

	Step	Notes
1	[Setup]	
2	[Auto Mode Bar Count]	
3	Enter the number of bars to display using the number keypad, up and down arrows, or knob.	The maximum number of bars displayed is 20.

	Step	Notes
4	[Enter]	If you use the up and down arrows or knob to change the bar count number, the Enter key will not be displayed. However, the display will update to the entered number of bars after a few seconds.

Setting the Pass/Fail Limits

The measurement limits setting allows you to alter the value of the upper and lower test limits. Limits are set in dBm and are absolute. The settings you choose define the location of the limit lines displayed on the screen. These settings affect the metrics color display: red is fail, green is pass.

To Set the Measurement Upper and Lower Limits:

	Step	Notes
1	[Setup]	
2	[Limits]	
3	[Power Limits]	
4	[On] or [Off]	
5	Set the upper limit. a. [High Limit] b. Enter the number on the number keypad. c. [dBm]	
6	Set the lower limit. a. [Low Limit] b. Enter the number on the number keypad. c. [dBm]	

Compensating for the Loss of an External Cable and Attenuator

The insertion loss of the test cable and high power attenuator must be compensated for to obtain accurate GSM power measurements. This process is called normalization and is described in "Measuring Two Port Insertion Loss" on page 48. The insertion loss of the test cable/attenuator combination is accounted for as the RF In Loss, which is an offset applied to the power measurements by the test set.

	Step	Notes
1	[Setup]	
2	[RF IN Loss]	
3	Enter the RF in loss using the number keypad.	If you are using a cable and additional devices connected to the antenna, enter the combined cable and device RF in loss here. The RF in loss can be obtained by measuring the Insertion loss. See "Two Port Insertion Loss" on page 47. **Note:** If data had been previously entered in [RF IN Loss], that data will be lost and replaced by the value you enter here.
4	[dB]	

GSM Analyzer

Setting Average, Sweep, and Restart

Setting the Sweep

You can select either continuous or single sweep. Continuous sweep provides repeated, ongoing measurements. Single sweep performs a single measurement that is repeated only when you push the Single button.

To set sweep:

	Step	Notes
1	[Average/Sweep]	
2	[Continuous] or [Single]	Each time you press this menu key, the selected option changes.

Setting Averaging

You can choose to have averaging on or off and set the number of averages you want to take. Averaging only applies to measuring of the channel power. GSM modulation metrics are not averaged. You can select from the following types of averaging:

- **Off**: Disables averaging.
- **Running:** Computes the new result as the weighted sum of the last result and the new measurement. The last result is weighted by (n – 1)/n. The new result is weighted by 1/n. Each new measurement produces a new result.
- **Max Hold**: Is not an average, but on a point by point basis, displays the maximum amplitude for the given frequency or channel since Max Hold was turned on. It is updated when a new maximum occurs.
- **Group Average:** Makes the requested number of measurements, averages the measurement data, and displays the average as a single result trace. Measurement time will vary based on the requested number of averages and can take minutes for very large number of averages.
- **Group Max Hold:** Makes the requested number of measurements

before returning a single trace result. This trace is the maximum value seen at each trace point over the requested number of averages (measurements).

To set averaging:

	Step	Notes
1	Set the number of averages. a. [Average] b. Enter the number of averages using the number keypad. c. [Enter]	
2	Select the type of averaging you want to apply. a. [Average/Sweep] b. [Averaging] c. [Off], [Running Average], [Max Hold], [Group Average], or [Group Max Hold]	

NOTE These two steps can be performed in any order. However, if you turn averaging on and a large number of averages has previously been set, there may be a delay before you can change number of averages.

Setting Restart

When you have averaging turned on, you can restart the averaging by pressing the Restart menu key. This restarts the averaging for running average in either Continuous or Single sweep mode.

To restart averaging:

	Step	Notes
1	[Average/Sweep]	

	Step	Notes
2	[Restart]	

GSM Band Data

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

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

DCS 1800 is an adaptation of GSM 900, created to allow for smaller cell sizes for higher system capacity. PCS 1900 is intended to be identical to DCS 1800 except for frequency allocation and power levels. The term GSM 1800 is sometimes used for DCS 1800, and the term GSM 1900 is sometimes used for PCS 1900. For specifics on the bands, refer to Table 17-1, “GSM Band Data,” on page 364.

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

Table 17-1 GSM Band Data

	GSM 850	P-GSM (GSM 900)	E-GSM (GSM 900)	R-GSM (GSM 900)	DCS 1800 (GSM 1800)	PCS 1900 (GSM 1900)
Uplink (MS Transmit)	890 to 915 MHz	880 to 915 MHz	876 to 915 MHz	1710 to 1785 MHz	1850 to 1910 MHz	824 to 849 MHz
Downlink (BTS Transmit)	935 to 960 MHz	925 to 960 MHz	921 to 960 MHz	1805 to 1880 MHz	1930 to 1990 MHz	869 to 894 MHz
Range (ARFCN)	1 to 124	0 to 124 and 975 to 1023	1 to 124 and 955 to 1023	512 to 885	512 to 810	128 to 251
TX/RX Spacing (Freq.)	45 MHz	45 MHz	45 MHz	95 MHz	80 MHz	45 MHz
TX/RX Spacing (Time)	3 timeslots	3 timeslots	3 timeslots	3 timeslots	3 timeslots	3 timeslots
Modulation Data Rate GMSK (kbits/s):	270.833	270.833	270.833	270.833	270.833	270.833
Frame Period	4.615 ms	4.615 ms	4.615 ms	4.615 ms	4.615 ms	4.615 ms
Timeslot Period	576.9 µs	576.9 µs	576.9 µs	576.9 µs	576.9 µs	576.9 µs
GSM Bit and Symbol Period	3.692 µs	3.692 µs	3.692 µs	3.692 µs	3.692 µs	3.692 µs
Modulation GSM	0.3 GMSK	0.3 GMSK	0.3 GMSK	0.3 GMSK	0.3 GMSK	0.3 GMSK
Channel Spacing	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz	200 kHz
TDMA Mux	8	8	8	8	8	8
Voice Coder Bit Rate	13 kbits/s	13 kbits/s, 5.6 kbits/s	13 kbits/s	13 kbits/s	13 kbits/s	13 kbits/s

Metrics Provided by the GSM Analyzer Measurement

This section contains descriptions of the individual GSM transmit parameters in the metric display of the screen. The “Interpretation of GSM Tx Analyzer Measurement Results” section contains expected result values and possible causes of error if the expected results are not met.

Frequency

Frequency of the channel indicated by the vertical yellow line on the display.

Frequency Error

Frequency error is the frequency difference between your transmitter's actual center frequency and the frequency (or channel) you entered.

BSIC (Base Station Identification Code)

A two digit number that identifies the base station for the indicated channel. It consists of the PLMN color code with a range from 0 to 7, and the S color code with a range from 0 to 7. The BSIC is shown in Decimal format (8 * NCC) + BCC. For example, if the NCC is 4, BCC is 3, the BSIC will be 35 (4*8+3 = 35). BSIC is transmitted on a synchronization channel and is used to identify a cell and to indicate the timing sequence being used.

Pk Ch Pwr (Peak Channel Power)

The maximum power in a channel. This is the absolute power level and displayed in both dBm and watts.

OBW (Occupied Bandwidth)

This is the 99% power bandwidth of the 500 kHz span centered at the channel frequency. In other words, the total power of 500 kHz span centered at the channel frequency is computed, then the bandwidth that contains 99% of the total power is returned as the occupied bandwidth.

RMS and Pk Phase Error

Phase error is the fundamental measure of modulation quality in GSM systems. Since GSM systems use relative phase to transmit information, the phase accuracy of the GSM transmission is critical to the systems performance and ultimately affective range.

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

RMS Phase Error: This is the RMS of the phase error (in degrees) between the measured phase and the ideal phase of a TCH timeslot. The GSM standard specifies the RMS phase error not to exceed 5 degrees during the useful part of the GSM burst.

Pk Phase Error: Peak phase error is the maximum phase error (in degrees) between the measured phase and the ideal phase of a TCH timeslot, at a single instant. The GSM standard specifies the peak phase error not to exceed 20 degrees during the useful part of the GSM burst.

IQ Offset

I/Q origin offset is a value in dB of the I and Q error (magnitude squared) offset from the origin. It indicates the magnitude of the carrier feedthrough signal. When there is no carrier feedthrough, I/Q Offset is zero(- infinity dB)

Interpretation of GSM Analyzer Measurement Results

This section contains expected result values and possible causes of error if the expected results are not met.

Frequency Error

The GSM standard specific very tight frequency error performance. In the GSM 900 band, the 0.05 ppm (parts-per-million) specification translates to only 45 Hz error.

Frequency error measurements indicate synthesizer/phase lock loop performance. This is especially important in a BTS with frequency hopping active. Poor frequency error measurements can show, for example, that a synthesizer is failing to settle quickly enough as it shifts frequency between transmissions. Poor frequency error can cause a multitude of problems, for example, the target receiver may be unable to gain lock, and the transmitter may cause interference with other users.

You will need to use an external reference or GPS (if available) in order to achieve ann accurate frequency error reading.

BSIC

If the BSIC can not be decoded, dashes will be displayed. If it is not as expected, check the base station settings against the plan.

Pk Ch Pwr (Peak Channel Power)

Peak Channel Power is the measure of in channel power for GSM Systems. The purpose of the Peak Channel Power measurement is to determine the power delivered to antenna system on the radio frequency/channel under test. The Peak Channel Power measurement verifies the accuracy of the transmitted RF carrier power.

If the peak channel power is lower than expected, verify you have a good connection to the RF output of the base station. Also, verify the cable you are using to connect to the base station is not faulty. A low channel power may also indicate a bad power amplifier.

Inaccurate channel power (high or low) may indicate an incorrect power setting at the base station.

Phase Error and IQ Offset

Phase error is the fundamental measure of modulation quality in GSM systems. Since GSM systems use relative phase to transmit information, the phase accuracy of the GSM transmission is critical to the systems performance and ultimately affective range.

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

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

18 Basic System Operations

System Reference Introduction

The Agilent E7495A/B Base Station Test Sets provide a system utility that allows you to perform non-measurement activities and to configure the test set for:

- General operations
- System status updates
- Data manipulation
- Basic system functions testing

Setting System References

The Agilent E7495A/B provide a utility to preconfigure the global settings for the box.

Displaying GPS Location Data

Perform this procedure to have the current GPS location data visible on the screen at all times.

	Step	Notes
1	[System]	
2	[Fr/Time Ref Location]	
3	On [Show GPS Location] select **On**.	Each time you press this softkey, the selected option changes.

NOTE A GPS locked or unlocked indicator is located in the bottom-left of the screen. It indicates whether or not the GPS is being applied.

Selecting a Frequency/Timing Reference

Perform this procedure to select a common frequency or timing reference to be used for all measurement tools (when applicable).

	Step	Notes
1	[System]	
2	[Fr/Time Ref Location]	

	Step	Notes
3	[Fr/Time Ref]	Displays additional menu buttons. With Internal GPS and External Even Sec, both frequency and time references are active. This is used when measuring CDMA signals to get valid PN offsets. With the other five options, you get only frequency.
4	Select the frequency/timing reference you want.	

NOTE

A frequency/time reference indicator in the lower-right of the screen shows both the selected reference and its status.

Reference indicators include: “GPS,” “Int Ref,” “Even Sec,” “Ext 10 MHz,” “Ext 13 MHz,” or “Ext 19.66 MHz.”

Status indicators include:

- Green dot to indicate that the reference is locked
- Yellow triangle to indicate that the reference is acquiring lock
- Red X to indicate that the reference is not locked

Setting up the DC Bias Option

The DC Bias Tee, option 300, provides power from the Agilent E7495B to the amplifier at the top of a base station tower, or the end of the cable run. The DC voltage (12 volts) is output on the center conductor of Port 1, RF Out. The option enables you to test with the amplifier powered on. DC bias defaults to off when you select a new measurement type which does not depend on either Port 1 or Port 2, and it must be turned on each time you want to use it. It stays on as long as you’re using measurements that use RF In or Out. DC Bias cannot be saved in the On position as a state and is turned off when the power is cycled, including the sleep state. If you do not have the option, it is grayed out on the screen.

NOTE The maximum current draw is 800 milliamps.

	Step	Notes
1	**System**	
2	[Fr/Time Ref Location]	
3	[DC Out] [On]	Each time you press this softkey, the selected option changes.

WARNING **If you have tripped the RPP or are over the current limit for the DC bias, a warning screen appears. However, if you have shorted the output, the short may not be detected, and the test set will shut off current to the DC Bias port.**

Printing a Screen to a File

The E7495A/B let you save screen images to PNG files. You can save the image files to a PCMCIA card or CompactFlash card.

Printing Screens

	Step	Notes
1	Display data on a measurement screen.	
2	Insert the PCMCIA or CompactFlash card.	
3	Select the card you want to use by selecting the output media (see “Selecting Output Media—PCMCIA Card or CompactFlash Card” on page 379).	This step must only be performed the first time you insert a new card type.
4	Select how you want to name the data file you’re saving (see “File Naming Options” on page 376).	This step must only be performed prior to the first time you save a file, or if you want to change the method you use.
5	[Print Screen]	
6	Enter a name for the file (or it is done automatically, depending on the file naming method you selected).	The name you provide is displayed on the top of the PNG screen image.

Selecting Output Media—PCMCIA Card or CompactFlash Card

	Step	Notes
1	[System]	
2	[Print Screen Setup]	
3	On [File Location] select **PCMCIA** or **CF**.	Each time you press this softkey, the selected option changes.

File Naming Options

You have three options for naming image files. You can

- Name each file automatically using this format: saveData_YYYYMMDD_HHMMSS.png
- Name each file individually, and enter the name you want. This is called User file naming.
- Have the test set ask you how you want to name each file for each file you save.

Setting Up Automatic File Naming

	Step	Notes
1	[System]	
2	[Print Screen Setup]	
3	On [Filename] select **Auto**.	Each time you press this softkey, the selected option changes.

Setting Up User File Naming

	Step	Notes
1	[System]	
2	[Print Screen Setup]	
3	On [Filename] select **User**.	Each time you press this softkey, the selected option changes.
4	Setup file naming. a. [User Filename] b. If the filename does not exist, use the rotary knob or up and down arrow buttons to select a letter and the buttons on the left to change cursor position c. For each character entered, press [Enter]. If the filename does exist, select [Choose File...] on the right to display a list of the current files on the selected media. d. Use the rotary knob to select the file and press **Select**. e. [Ok]	.
5	[If File Exists]	
6	[Overwrite], [Prompt], [Auto Incr], or [Timestamp]	• **Overwrite**—overwrites existing file data with new file data. • **Prompt**—prompts you to input a new file name. • **Auto Incr**—automatically increments the filename and retains the existing filename. • **Timestamp**—attaches a timestamp to the filename to distinguish it from the existing file.

Setting Up Asking For Filename

You can choose to have the test set ask you at the time you print a screen how you want to name the file. For every file you save, you can choose to specify automatic naming or to enter the filename you want.

	Step	Notes
1	[System]	
2	[Print Screen Setup]	
3	On [Filename] select **Ask**.	Each time you press this softkey, the selected option changes.

Saving Data

Saving data

	Step	Notes
1	Display data on a measurement view.	
2	Insert the PCMCIA or CompactFlash card.	
3	Select the card you want to use by selecting the output media (see "Selecting Output Media—PCMCIA Card or CompactFlash Card" on page 379).	This step must only be performed the first time you insert a new card type.
4	Select how you want to name the data file you're saving (see "File Naming Options" on page 376).	This step must only be performed prior to the first time you save a file, or if you want to change the method you use.
5	[Save Data]	
6	Enter a name for the file (or it is done automatically, depending on the file naming method you selected).	

Selecting Output Media—PCMCIA Card or CompactFlash Card

	Step	Notes
1	[System]	
2	[Save Data Setup]	

	Step	Notes
3	On [File Location] select **PCMCIA** or **CF**.	Each time you press this softkey, the selected option changes.

File Naming Options

You have three options for naming data files. You can:

- Name each file automatically using this format: saveData_YYYYMMDD_HHMMSS.xls
- Name each file individually, and enter the name you want. This is called User file naming.
- Have the test set ask you how you want to name each file at the time you save the data.

Setting Up Automatic File Naming

	Step	Notes
1	[System]	
2	[Save Data Setup]	
3	On [Filename] select **Auto**.	Each time you press this softkey, the selected option changes.

Setting Up User File Naming

	Step	Notes
1	[System]	
2	[Save Data Setup]	
3	On [Filename] select **User**.	Each time you press this softkey, the selected option changes.

	Step	Notes
4	Setup file naming. a. [User Filename] b. If the filename does not exist, use the rotary knob or up and down arrow buttons to select a letter and the buttons on the left to change cursor position c. For each character entered, press [Enter]. If the filename does exist, select [Choose File...] on the right to display a list of the current files on the selected media. d. Use the rotary knob to select the file and press Select. e. [Ok]	.
5	[If File Exists]	
6	[Overwrite], [Prompt], [Auto Incr], or [Timestamp]	• Overwrite—overwrites existing file data with new file data. • Prompt—prompts you to input a new file name. • Auto Incr—automatically increments the filename and retains the existing file name. • Timestamp—attaches a timestamp to the filename to distinguish it from the existing file.

Setting Up Asking For Filename

You can choose to have the test set ask you at the time you save a data file how you want to name the file. This option means that for every file you save, you will be able to specify automatic naming or enter the filename you want.

	Step	Notes
1	[System]	
2	[Save Data Setup]	
3	On [Filename] select **Ask**.	Each time you press this softkey, the selected option changes.

Managing Media Types

The E7495A is compatible with two media types for storing and retrieving data: PCMCIA card and CompactFlash card. The media type buttons are not active until a media card is inserted and recognized by the E7495. Upon proper recognition, the test set allows you to perform basic media tasks with each media type.

Formatting a PCMCIA or CompactFlash Card

You need to perform this procedure to prepare a new or existing PCMCIA or CompactFlash storage card for data storage.

	Step	Notes
1	Make sure the card you will format is inserted in its slot.	
2	[System]	
3	[Media Manager]	
4	[Format PCMCIA] or [Format CF]	Prepares a PCMCIA of CompactFlash card for storage. Erases existing data on the card.

Configuring for Network Connectivity

The E7495A/B can operate as a device on any compatible network. Therefore, in order to be accessible on the network, certain information must be entered so the test set can communicate with other devices. Configuring the test set for network activity is performed by using the IP administrator located in the system utilities.

IP Administration Using DHCP

Perform this procedure to allow your test set to be integrated into an existing network that uses DHCP to dynamically assign an IP address. This procedure requires that you have the System Name (available from your network administrator).

	Step	Notes
1	[System]	
2	[Controls]	
3	[IP Admin]	
4	[Sys Name]	
5	Enter the name of the test set.	This is automatically assigned by the network administrator.
6	[Ok]	
7	On [DHCP] select **On**.	An IP address and other network information will automatically be assigned if the Sys Name is recognized by the network.
8	[Save]	
9	[Ok]	Saves the current configuration and restarts the test set. DHCP will dynamically assign an IP address.

IP Administration Without DHCP

Perform this procedure to allow your test set to be integrated into an existing network that uses a technique other than DHCP, such as DNS, as its IP address assignments. This procedure requires the following specific data from the network administrator:

- System name
- IP address
- Net mask
- Gateway

	Step	Notes
1	[System]	
2	[Controls]	
3	[IP Admin]	
4	[Sys Name]	
5	Enter the name of the test set.	This name is usually assigned by the network administrator.
6	[Ok]	
7	On [DHCP] select **Off**.	Each time you press this softkey, the selected option changes. Now you must specify relevant network information for the test set to be recognized. Contact your network administrator if you do not have this information.
8	[IP Address]	
9	Enter the IP address.	Use the rotary knob and menu keys on the left.
10	[Ok]	
11	[Net Mask]	
12	Enter the Net Mask.	Use the rotary knob and menu keys on the left.
13	[Ok]	
14	[Gateway]	
15	Enter the Gateway.	Use the rotary knob and menu keys on the left.

	Step	Notes
16	[Ok]	
17	[Save]	
18	[Ok]	Saves the current network configuration and restarts the test set.

Saving, Recalling, and Deleting Instrument States

You can save the current configuration of buttons and settings for recall at a later time. You can also save a customized power-up state, which the test set will use the each subsequent time it is powered on. This enables you to configure common usage and power-on states to speed up base station testing.

Saving the State

	Step	Notes
1	Configure all measurement settings you want to save.	Make sure you're viewing the screen you want to recall later.
2	[Save State]	
3	Enter the state name you want to use, for example, "Remote base station.	Each time you press this softkey, the selected option changes.
4	[Ok]	

Saving the Power-Up State

	Step	Notes
1	Configure all measurement settings you want to save.	Make sure you're viewing the screen you want to display at power up.
2	[Save State]	

	Step	Notes
3	Enter the state name, “Power up” (the test set is case-sensitive, so be sure to capitalize the “P”).	This is the name the test set uses to identify the power-up state.
4	[Ok]	

Recalling the State

	Step	Notes
1	[Recall State]	
2	Select from the list the state you want to recall.	Use the rotary knob or up and down arrow buttons to select the state you want to delete. All states, in addition to two supplied in the test set, are displayed: • Powerup - The default power-up state shipped with the test set, or the power-up state last saved with the test set. • Factory Defaults - The default power-up state shipped with the test set. You can always revert to it by selecting it in this procedure.
3	[Select]	

Returning the Power-Up State to Factory Defaults

	Step	Notes
1	[Recall State]	
2	Select Factory Defaults from the list.	f. Use the rotary knob or up and down arrow buttons to select the state you want to delete.

	Step	Notes
3	[Select]	
4	[Save State	
5	Enter the filename, “Powerup” (the test set is case-sensitive, so be sure to capitalize the “P”).	
6	[Ok]	

Deleting States

If you have saved a state you will no longer use, you can delete it.

	Step	Notes
1	[System]	
2	[Save/Recall]	
3	[Delete States]	
4	Select the state you want to delete or [All] to delete all saved states.	Use the rotary knob or up and down arrow buttons to select the state you want to delete.
5	[Select]	

NOTE Selecting [All] does not delete the Powerup or Factory Defaults states.

Viewing System Statistics

The E7495A/B provides a utility that allows you to:

- Check test set status
- Verify operational readiness
- Perform system configuration
- Check the system software version

Viewing System Release Versions

Perform this procedure to view the current version of software and firmware for enabled features.

	Step	Notes
1	[System]	
2	[More 1 of 2]	
3	[System Stats]	
4	[Rev Info]	View version information for system firmware.
5	[Page Up] or [Page Down]	Use to scroll to next screen.

Viewing System Memory

Perform this procedure to view current allocation and usage statistics of the memory available.

	Step	Notes
1	[System]	
2	[More 1 of 2]	
3	[System Stats]	

	Step	Notes
4	[Memory]	View status of total, used, and available memory.

Viewing Battery Statistics

Perform this procedure to view current status and battery usage.

	Step	Notes
1	[System]	
2	[More 1 of 2]	
3	[System Stats]	
4	[Battery]	View the status of battery conditions. For details, see “System Statistics—Battery Screen” on page 428
5	As needed, [Page Up] or [Page Down]	Use these menu keys if you need to scroll up or down to see all the information.

Using the Option Manager

The E7495A/B provides a utility that allows you to:

- View installed options
- View installable options (by user and by factory)
- View installation information
- Install an option

Viewing Installed Options

	Step	Notes
1	[System]	
2	[More 1 of 2]	
3	[Option Manager]	
4	[Installed Options]	Provides a list of all installed options.
5	[Page Up] or [Page Down]	Use as necessary to scroll to next screen.

Viewing Installable Options

Perform this procedure to view a list of all options that you can install for the test set. Two lists are displayed: options you can install yourself and options that must be installed at the factory.

	Step	Notes
1	[System]	
2	[More 1 of 2]	
3	[Option Manager]	

	Step	Notes
4	[Installable Options]	Provides a list of options that can be installed.
5	[Page Up] or [Page Down]	Use as necessary to scroll to next screen

Installing an Option

	Step	Notes
1	[System]	
2	[More 1 of 2]	
3	[Option Manager]	
4	[Installing an Option]	Follow the on-screen instructions.

Viewing Installation Information

Perform this procedure to view current manufacturing information about your test set that must be provided to Agilent to install a user-installable option.

	Step	Notes
1	[System]	
2	[More 1 of 2]	
3	[Option Manager]	
4	[Install Info]	When you call your Agilent sales representative to order an option, you will need to provide the information you see on this screen: • Model number • Serial number • Host ID

Testing System Functions

The E7495A/B provides two simple tests you can perform to test the basic system functionality: a display test and a keyboard test.

Testing Your Display

Perform this procedure to verify the correct operation of your display device.

	Step	Notes
1	[System]	
2	[More 1 of 2]	
3	[Service]	
4	[Verification]	
5	[Display Test]	Follow directions on screen.

Testing Your Keyboard

Perform this procedure to verify the correct operation of your keyboard device.

	Step	Notes
1	[System]	
2	[More 1 of 2]	
3	[Service]	
4	[Verification]	
5	[Keyboard Test]	Press the available buttons and view the results on the screen.

19 Safety and Regulatory Information and Specifications

Safety considerations

General

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product has been designed and tested in accordance with IEC Publication 61010-1+A1+A2:1992 Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use and has been supplied in a safe condition. This instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

Safety Earth Ground

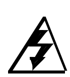
A uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set.

Chassis Ground Terminal

To prevent a potential shock hazard, always connect the rear-panel chassis ground terminal to earth ground when operating this test set from a dc power source.

Safety Symbols

Indicates test set damage can occur if indicated operating limits are exceeded. Refer to the instructions in this guide.



Indicates hazardous voltages.

Indicates earth (ground) terminal

WARNING **A WARNING note denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.**

CAUTION A CAUTION note denotes a hazard. It calls attention to an operation procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond an CAUTION note until the indicated conditions are fully understood and met.

Safety Considerations For This Test Set

WARNING **Whenever it is likely that the protection has been impaired, the test set must be made inoperative and be secured against any unintended operation.**

If this test set is to be energized via an autotransformer (for voltage reduction), make sure the common terminal is connected to the earth terminal of the power source.

If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.

No operator serviceable parts in this product. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.

Servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.

The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the product from all voltage sources while it is being opened.

Adjustments described in the manual are performed with power supplied to the test set while protective covers are removed. Energy available at many points may, if contacted, result in

personal injury.

For Continued protection against fire hazard, replace the line fuse(s) with T 250 V 5.0 A fuse(s) or the same current rating and type. Do not use repaired fuses or short circuited fuseholders.

WARNING **This product is a Safety Class I test set (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intentional interruption is prohibited.**

WARNING **Always use the three-prong ac power cord supplied with this product. Failure to ensure adequate earth grounding by not using this cord may cause personal injury and/or product damage.**

This product is designed for use in Installation Category II and Pollution Degree 3 per IEC 61010 and IEC 60664 respectively.

This product has autoranging line voltage input, be sure the supply voltage is within the specified range.

To prevent electrical shock, disconnect test set from mains (line) before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.

Ventilation Requirements: When installing the product in a cabinet, the convection into and out of the product must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the product by 4 ° C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, then forced convection must be used.

WARNING **If you are charging the batteries internally—even while the test set is powered off—the test set may become warm. Take care to provide proper ventilation.**

WARNING **Danger of explosion if battery is incorrectly replaced. Replace only with the same or equivalent type recommended. Discard used batteries according to manufacturer’s instructions.**

WARNING **To avoid overheating, always disconnect the test set from the AC adapter before storing the test set in the soft carrying case.**

If you prefer to leave the test set connected to the AC adapter while inside the soft carrying case, you can disconnect the AC adapter from its power source to prevent overheating.

Lifting and Handling

When lifting and handling the Agilent E7495A/B Base Station Test Set use ergonomically correct procedures. Lift and carry the test set by the carrying strap.

Electrostatic Discharge (ESD) Precautions

This test set was constructed in an ESD (electrostatic discharge) protected environment. This is because most of the semiconductor devices used in this test set are susceptible to damage by static discharge.

Depending on the magnitude of the charge, device substrates can be punctured or destroyed by contact or mere proximity of a static charge. The result can cause degradation of device performance, early failure, or immediate destruction.

These charges are generated in numerous ways such as simple contact, separation of materials, and normal motions of persons working with static sensitive devices.

When handling or servicing equipment containing static sensitive devices, adequate precautions must be taken to prevent device damage or destruction.

Only those who are thoroughly familiar with industry accepted techniques for handling static sensitive devices should attempt to service circuitry with these devices.

Product Markings

The CE mark shows that the product complies with all relevant European legal Directives (if accompanied by a year, it signifies when the design was proven).

The CSA mark is a registered trademark of the Canadian Standards Association.

The off symbol is used to mark a position of the instrument power line switch.

The on symbol is used to mark a position of the instrument power line switch.

The standby symbol is used to mark a position of the instrument power line switch.

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

Batteries: Safe Handling and Disposal

COBALT CELL MATERIAL SAFETY DATA SHEET Feb 14, 2003
FSSF00001AG - FOR CUSTOMER DISTRIBUTION

SECTION 1 - PRODUCT IDENTIFICATION AND USE	
Product: Molicel - Cobalt based Lithium-Ion cell (up to and including 2.4 Ah)	P.I.N.: Not Regulated
Use: High performance lithium-ion rechargeable battery system.	W.H.M.I.S.: exempt. manufactured article
Manufacturer: **E-One Moli Energy (Canada) Limited 20,000 Stewart Cres. Maple Ridge, BC, Canada V2X 9E7 (604) 466-6654** FAX: **(604) 466-6600**	24 HOUR EMERGENCY NUMBER (604) 466-6654 (MOLI)

SECTION 2 - HAZARDOUS INGREDIENTS

Hazardous Ingredients	%	CAS Number	LD_{50}(mg/kg) (oral-rat)	LC_{50} (mg/L)
Aluminium foil	0.1- 1 w/w	7429-90-5	N/AV	N/AV
Biphenyl (BP)	0-0.3 w/w	92-52-4	2400	N/AV
Copper foil	0.1- 1 w/w	7440-50-8	3.5 (ipr-mouse)	N/AV
Dioxathiolane 2,2-Dioxide (DTD)	0 – 3 w/w	1072-53-3	1600	N/AV
Linear and Cyclic Carbonate Solvents (See Other Information)	5- 17w/w	N/APP	~11000 (weighted avg)	N/AV
Graphite, powder	10- 30 w/w	7440-44-0	440 (ivn-mouse)	N/AV
Lithium Carbonate	0–0.3 w/w	554-13-2	525	N/APP
Lithium Cobaltite ($LiCoO_2$)	10- 30 w/w	12190-79-3	N/AV	N/AV
Lithium Hexaflurophosphate ($LiPF_6$)	1- 5 w/w	21324-40-3	1702	Rat: >20
Poly (vinylidene fluoride) (PVDF)	0.1- 1 w/w	24937-79-9	N/AV	N/AV
Propane Sultone (PS)	0 – 3 w/w	1120-71-4	100	N/AV
Steel, nickel and inert polymer	Balance	N/APP	N/APP	N/APP

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SECTION 3 - PHYSICAL DATA

Physical state:	Odour	Odour threshold:
Nickel plated metal canister under label	None	N/APP

Vapour pressure (mmHg)	Vapour Density (air =1)	Evaporation rate :	Boiling Point	Freezing point
N/APP	N/APP	N/APP	N/APP	N/APP
pH (10% in water): N/APP	Specific gravity: 1.5-2.0	Coeff. of water/oil distribution: N/APP	Water solubility: insoluble	Percent Volatiles: NONE

SECTION 4 - FIRE AND EXPLOSION DATA

Flammability	Conditions:
NO	Organic components will burn if cell incinerated. Combustion of cell contents will cause evolution of Hydrogen Fluoride.

Means of Extinction and Special Procedures:
Water spray, Carbon Dioxide, Dry chemical powder or appropriate foam. Use agent appropriate for surrounding materials.
Wear self-contained breathing apparatus and protective clothing to prevent contact with skin and eyes. Extremely corrosive Hydrogen Fluoride gas is produced upon combustion of cell contents.

Flashpoint:	Upper Flammable Limit:	Lower Flammable Limit:
NONE	NONE	NONE

Auto-ignition Temp:	Hazardous Combustion Products:
NONE	Hydrogen Fluoride, Phosphorus Oxides, Carbon oxides, Lithium Hydroxide, Cobalt Oxides, Aluminium Oxide, Sulphuric acid, Sulphur oxides, possible fluoro-compounds, Carbon soot
Impact sensitive: NO	Static Discharge Sensitive: NO, but cell may contain up to 4.2 volts.

SECTION 5 - REACTIVITY DATA

Stability:	
STABLE	Hazardous polymerization will not occur. Spontaneous decomposition at normal temperatures will not occur.

Incompatibilities:
Do not crush, puncture, incinerate, immerse in water or heat over 100 C. Steel casing slowly dissolves in strong mineral acids.

Reactivities:
None known

Hazardous Decomposition Products:
Hydrogen Fluoride, Phosphorus Oxides, Carbon oxides, Lithium Hydroxide, Cobalt Oxides, Aluminium Oxide, Sulphuric acid, Sulphur oxides, possible fluoro-compounds, Carbon soot

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SECTION 6 - TOXICOLOGICAL PROPERTIES

Routes of Entry:
Skin Contact: NO Skin Absorption NO Eye contact: NO Inhalation NO Ingestion NO

Acute Exposure

Skin:	No effect noticed in routine handling of product.
Eyes:	The bulk solid has no effect on the eye beyond blunt impact.
Inhalation:	Not applicable.
Ingestion:	Ingestion is not likely, given the physical size and state of the cell.

Chronic Exposure

Skin:	None anticipated.
Eyes:	Not applicable.
Inhalation:	Not applicable.
Ingestion:	Ingestion is not a likely exposure route.

Exposure Limits	Irritancy:	Sensitization:	Carcinogenicity
None listed	None	Not anticipated	Not anticipated

Teratogenicity:	Mutagenicity:
Not anticipated	Not anticipated.

Reproductive toxicity:	Synergistic Products:
Not anticipated	None expected

SECTION 7- PREVENTIVE MEASURES

Personal protective equipment:

Gloves:	Respirator:	Eyewear:
Not required for handling individual cells. Fabric gloves for warehouse container handling.	No respirator required for normal handling. SCBA required for fires.	Not required beyond employer policy.

Clothing:	Footwear:
Standard industrial clothing in normal use. Impervious suit in fires.	Wear steel-toed footwear if large containers of cells are being handled.

Engineering controls:
Keep away from heat and open flames. Store in a cool, dry place.

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COBALT CELL MATERIAL SAFETY DATA SHEET Feb 14, 2003
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Leak and spill procedure:
Evacuate area if fire present or likely. Wear SCBA for fire-related emergencies. Using gloves, pick up or sweep up fire-damaged cells, bag individually in plastic bags and place in closed metal containers. 205 Litre lined steel drums are appropriate. Cardboard boxes may be used for small quantities. Avoid raising dust while sweeping. Transport container outdoors. Hold burned cells and fire cleanup solids for disposal as potential hazardous waste. Unburned cells are not hazardous waste.
A fire with over 100 kg of cells burnt will likely require reporting to environment officials. Always consult and obey all international, federal and local environmental laws.

Waste disposal:
Always consult and obey all international, federal, provincial/state and local hazardous waste disposal laws. Some jurisdictions require recycling of this spent product.

Handling procedures and equipment:
Store in a cool, dry place away from sparks and flame. Keep below 125 C. Keep above -60 C. Charge between 0 C and 45 C. Use only approved charging equipment. Do not disassemble battery or battery pack. Do not puncture, crush or dispose of in fire.

Storage requirements:
Store at room temperature for best results.

Special Shipping Information:
Not regulated. This product is made from materials with no detectable mercury.
Equivalent lithium content
as per Section 38.3.2 of the UN Manual of Tests and Criteria (ST/SG/AC.10/11/27 Add. 2):
Equivalent grams of lithium is equal to 0.3 times the rated Amp-hour capacity of the individual cell, regardless of cell size.
1.8 Ah = 0.54 g 2.0 Ah = 0.60 g 2.2 Ah = 0.66g 2.4 Ah = 0.72 g

SECTION 8 - FIRST AID MEASURES

Skin:	Not a health hazard.
Eyes:	Not an eye hazard
Inhalation:	Not an inhalation hazard.
Ingestion:	If swallowed, seek emergency medical aid. If patient choking and can partially breathe, encourage patient to cough. Do not strike patient's back. This may lodge cell further in throat. If patient is not breathing, perform standing Heimlich manoeuvre until object is dislodged or patient becomes unconscious. An unconscious patient should be lowered gently to the floor on their back and abdominal thrusts performed continuously until cell is ejected from throat or medical aid arrives.

COBALT CELL MATERIAL SAFETY DATA SHEET Feb 14, 2003
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SECTION 9 - PREPARATION INFORMATION			
Prepared by: Martin RIDGWAY, B.Sc. Safety Co-ordinator	Phone: (604) 466-6654	Date Created: Mar 31, 1995	Revision Information: First Issue
		Date Last Revised: Jul 31, 1998	Revision Information: Assign document control number. Company name change.
		Date Last Revised: Jun 15, 2000	Revision Information: Company name change.
		Date Last Revised: Jan 23, 2001	Revision Information: Shipping: Contains no mercury.
		Date Last Revised: May 1, 2001	Revision Information: Incompatibilities – Do not heat over 100C (to match UL warning statement)
		Date Last Revised: Jan 28, 2003	Revision Information: Shipping Information – Added equivalent lithium content information
		Date Last Revised: Feb 4, 2003	Revision Information: Product – Up to and including 2.4 Ah Ingredients - Added PS, $LiCO_2$ and DTD Decomposition - Added sulphur compounds
Approval			

OTHER INFORMATION

The above information is believed to be correct but does not purport to be all-inclusive and shall be used only as a guide. Exact composition information is immediately available on a confidential basis to medical professionals treating exposure to cell components or combustion by-products.

HYDROFLUORIC ACID EXPOSURE DURING FIRE FIGHTING

This information is given for the use of professional fire fighters responding to a warehouse fire

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where fire from other materials may incinerate Molicels. This section is provided solely in case of exposure, during fire fighting, to the combustion by-products. Hydrofluoric acid is not present in the product. Contact with Molicels causes none of the following symptoms.

Hydrofluoric acid is extremely corrosive. Contact with hydrogen fluoride fumes is to be avoided. Permissible exposure limit is 3 ppm. In case of contact with hydrogen fluoride fumes, immediately leave the area and seek first aid **and** emergency medical attention. Symptoms may have delayed onset. Fluoride ions penetrate skin readily causing destruction of deep tissue layers and even bone. Fluoride interferes with nerve impulse conduction causing severe pain or absence of sensations. Immediately flush eyes or skin with water for at least 20 minutes to neutralize the acidity and remove some fluoride. Remove and destroy all contaminated clothing and permeable personal possessions. Before re-use, impermeable possessions should be soaked in benzalkonium chloride after water washing. Following flushing of the affected areas, an iced aqueous solution of benzalkonium chloride or 2.5 % calcium gluconate gel should be applied to react with the fluoride ion. Compresses and wraps may be used for areas where immersion is not practical. Medicated dressing should be changed every 2 minutes. Exposure to hydrofluoric acid fumes sufficient to cause pain requires immediate hospitalization for monitoring for pulmonary edema.

Certification and Compliance Statements

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

Manufacturer's Declaration

This product has been designed and tested in accordance with the standards listed on the Manufacturer's Declaration of Conformity, and has been supplied in a safe condition. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

Declaration of Conformity for Agilent E7495A

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

Manufacturer's Name: Agilent Technologies, Inc.

Manufacturer's Address: 1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799
USA

Declares that the products

Product Name: Base Station Test Set

Model Number: E7495A

Product Options: This declaration covers all options of the above products.

Conform to the following product standards:

EMC: IEC 61326:1997+A1:1998+A2:2000/ EN 61326:1997+A1:1998+A2:2001

Standard	Limit
CISPR 11:1997 / EN 55011:1998/A-1999	Group 1, Class A
IEC 61000-4-2:1995+A1998 / EN 61000-4-2:1995	4 kV CD, 8 kV AD
IEC 61000-4-3:1995 / EN 61000-4-3:1995	3 V/m, 80 - 1000 MHz
IEC 61000-4-4:1995 / EN 61000-4-4:1995	0.5 kV sig., 1 kV power
IEC 61000-4-5:1995 / EN 61000-4-5:1996	0.5 kV L-L, 1 kV L-G
IEC 61000-4-6:1996 / EN 61000-4-6:1998	3 V, 0.15 – 80 MHz
IEC 61000-4-11:1994 / EN 61000-4-11:1998	1 cycle, 100%

Safety: IEC 61010-1:1990 + A1:1992 + A2:1995 / EN 61010-1:1993 +A2:1995
CAN/CSA-C22.2 No. 1010.1-92

Supplementary Information:
The products herewith comply with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carry the CE-marking accordingly.

Santa Rosa, CA, USA 19 December, 2002

Greg Pfeiffer/Quality Engineering Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor.

Rev. A 12/19/2002

Declaration of Conformity for Agilent E7495B

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

Manufacturer's Name: Agilent Technologies, Inc.

Manufacturer's Address: 1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799
USA

Declares that the products

Product Name: Base Station Test Set

Model Number: E7495B

Product Options: This declaration covers all options of the above products.

Conform to the following product standards:

EMC: IEC 61326:1997+A1:1998+A2:2000/ EN 61326:1997+A1:1998+A2:2001

Standard	Limit
CISPR 11:1997 / EN 55011:1998/A-1999	Group 1, Class A
IEC 61000-4-2:1995+A1998 / EN 61000-4-2:1995	4 kV CD, 8 kV AD
IEC 61000-4-3:1995 / EN 61000-4-3:1995	3 V/m, 80 - 1000 MHz
IEC 61000-4-4:1995 / EN 61000-4-4:1995	0.5 kV sig., 1 kV power
IEC 61000-4-5:1995 / EN 61000-4-5:1996	0.5 kV L-L, 1 kV L-G
IEC 61000-4-6:1996 / EN 61000-4-6:1998	3 V, 0.15 – 80 MHz
IEC 61000-4-11:1994 / EN 61000-4-11:1998	1 cycle, 100%

Safety: IEC 61010-1:1990 + A1:1992 + A2:1995 / EN 61010-1:1993 +A2:1995
CAN/CSA-C22.2 No. 1010.1-92

Supplementary Information:
The products herewith comply with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carry the CE-marking accordingly.

Santa Rosa, CA, USA 26 September 2003

Paul Forrest/Quality Engineering Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor.

Rev. A

Compliance with German Noise Requirements

This is to declare that this test set is in conformance with the German Regulation on Noise Declaration for Machines (Laermangabe nach der Maschinenlaermrerordnung –3 GSGV Deutschland).

Acoustic Noise Emission/Geraeuschemission	
LpA <70 dB	LpA <70 dB
Operator Position	am Arbeitsplaz
Normal Position	normaler Betrieb
per ISO 7779	nach DIN 45635 t. 19

Compliance with Canadian EMC Requirements

This ISM device complies with Canadian ICES-001.
Cet appareil ISM est conforme a la norme NMB du Canada.

Disposal of Batteries

Do not throw batteries away but collect as small chemical waste.

E7495A/B Base Station Test Set Specifications

Specifications describe the test set's warranted performance and are valid over the entire operating/environmental range unless otherwise noted.

The E7495A/B Base Station Test Set has been tested to the specifications of IEC 529 "Degrees of Protection Provided by Enclosures (IP Code)." Using this standard, the E7495A/B is rated IPX4.

Supplemental Characteristics are intended to provide additional information useful in applying the test set by giving typical, but non-warranted performance parameters.

Characteristics and specifications are shown as follows:

- **Bold type** indicates a warranted, hard specification.
- Normal type indicates a nominal value. Nominal values are design center values and not normally tested during manufacturing.
- *Italics type* indicates a typical value. Typical performance is defined as 80% of the points over the specified range will meet or exceed the typical value.

Table 1 E7495A/B Base Station Test Set General Specifications

Unless otherwise noted, the following specifications apply to all measurements/tools using Port 2.	
Frequency accuracy:	
Using internal time base:	**≤ ± 1 ppm**
Internal frequency aging	**± 1 ppm aging/year**
With GPS lock for > 15 minutes:	≤ ± 0.03 ppm
Input frequency range:	500 kHz to 2700 MHz (Refer to individual measurement tools below for applicable frequency ranges.)
Maximum input level:	+ 20 dBm (.1 W), + 50 dBm with supplied attenuator
Maximum input power without damaging instrument:	100 W (without external attenuator)

Table 1 E7495A/B Base Station Test Set General Specifications

Frequency and time reference:	
Can use internal timebase or external signal:	
GPS (external antenna supplied) EVEN SECOND; PULSE	
1.000 MHz:	≥ 0 dBm (E7495B only)
2.048 MHz:	≥ 0 dBm (E7495B only)
4.950 MHz:	≥ 0 dBm (E7495B only)
10.000 MHz:	≥ 0 dBm
13.000 MHz:	≥ 0 dBm (E7495B only)
15.000 MHz:	≥ 0 dBm (E7495B only)
19.6608 MHz:	≥ 0 dBm
Display:	
Scale:	1 to 20 dB / div. Settable in 1 dB increments.
Number of points:	256
Number of divisions:	10
40 dB Attenuator:	
Frequency range:	10 to 2500 MHz
Attenuation accuracy:	±0.5 dB
Max power:	50 dBm (100 W)

Spectrum Analyzer / Tools	
Input frequency range:	10 mHz to 2700 MHz (usable to 500 kHz)
Reference level range:	–150 to +100 dBm
Dynamic range:	+50 dBm to –150 dBm (with supplied external 40 dB attenuator) (30 Hz RBW)
Input attenuation:	0 to 30 dB automatically selected. 10 dB controllable manually.
Amplitude accuracy:	*±1 dB (100 MHz – 2500 MHz at 25 °C)*
Resolution bandwidth:	10 Hz to 1 MHz, settable to 1 Hz precision

Table 1 E7495A/B Base Station Test Set General Specifications

Span:	1 kHz to 2.6995 GHz
Trace update:	
Span:	*2.6995 GHz (autocouple) = 5.1 seconds*
	60 MHz (autocouple) = 400 ms
	1 MHz (100 Hz RBW) = 1.2 seconds
Simultaneous dynamic range:	*> 90 dB (CW signals at 300 kHz separation, span 500 kHz, 30 Hz RBW*
SSB phase noise:	*≤ –85 dBc (30 kHz offset)*
Spurious responses:	
Range control set to auto, high sensitivity mode internally generated.	
50 ohm load on input:	*< 115 dBm*
Crossing spurs:	*≤ 50 dBc*
Displayed average noise level:	*–150 dBm (30 Hz RBW, 375 MHz to 1.5 GHz)*
Port 2 VSWR:	*< 2:1*

Antenna/Cable Tester

For each of the following measurements, a short self-calibration procedure must be run prior to making the measurement.

Frequency range:	375 to 2500 MHz
Frequency resolution:	< 500 Hz
Immunity to interfering signals:	*+20 dBm (with interference rejection turned on)*
Measurement speed:	
Full span:	*< 17 ms/point*
60 MHz span:	*< 7 ms/point*

Table 1 E7495A/B Base Station Test Set General Specifications

Return loss (Port 1): With ≥ 4 averages and 375 MHz to 2200 MHz	
Range:	E7495B > *40 dB*, E7495BA> *30 dB*
VSWR:	E7495B < *1.02*, E7495A < *1.07*
Resolution:	0.1 dB
Display range:	–5 to +150 dB
SWR range:	1 to 500
Distance to Fault (Port 1):	
Range (m):	1 m to 300 m
Resolution:	(1.5×10^8) (Vf)/(f2 - f1) Hz where Vf is relative propagating velocity of the cable. Typically 1% of measurement distance
VSWR:	1 to 500
Insertion loss (Port 1 to Port 2):	
Measurement uses supplied 10 dB pads.	
Usable range:	*> 100 dB wide range mode*
Accuracy:	± 1 dB (over 0 to 60 dB, ≥ 16 averages)
Readout resolution:	± 0.1 dB
Average insertion loss (readout) accuracy: ± 0.1 dB for	± 0.1 dB; for Range – 0 to 40 dB, Frequency (mobile phone bands) – 824 to 960 MHz, 1710 to 2170 MHz

Table 2 E7495A/B Base Station Test Set Option Specifications

cdmaOne / cdma2000 Tx Analyzer Option 200	
Waveform quality accuracy (rho):	*± 0.005 for 0.9 < p < 1.0* *(min. power at RF input > –85 dBc*
Pilot time alignment (tau):	*± 500 nSec*
Code domain power accuracy:	*± 1.5 dBm absolute, ± 0.5 dB relative (> –20 dB)*
Pilot power:	*± 1.5 dB*

Table 2 E7495A/B Base Station Test Set Option Specifications

RF Channel Scanner Option 220 (includes adjacent channel power)	
Measurement range	*+20 dBm to –125 dBm > 375 MHz, 10 kHz RBW (up to +50 dBm with external attenuator)*
Frequency readout accuracy:	*Timebase accuracy +3 Hz + 1 / (measurement time X duty cycle)*
Frequency range:	10 MHz to 2700 MHz
RF channel power:	*± 1 dB (100 to 2500 MHz)*
Adjacent channel power accuracy:	*± 0.75 dBc*
GSM Analyzer Option 230	
Measurement range	*+20 dBm to –125 dBm > 375 MHz, 10 kHz RBW (up to +50 dBm with external attenuator)*
Frequency readout accuracy:	*Timebase accuracy +3 Hz + 1 / (measurement time X duty cycle)*
Frequency range:	*10 MHz to 2500 MHz*
RF channel power:	*± 1 dB (100 to 2500 MHz)*
Phase error:	*± 1 degree RMS, ± 3 degree peak*
W-CDMA (UMTS) Option 240	
Error Vector Magnitude (EVM): Conditions:	Resolution 0.1%; residual error <6% Min power at RF input > –65 dBm, 3GPP test model 4
Code Domain Power Accuracy:	*±0.5 dB (for code channel power > –25 dB relative to total power, using test model 1 (with 16 DPCH, 32 DPCH, and 64 DPCH), test model 2 and test model 3 (with 16 DPCH and 32 DPCH))*
Scrambling Code Determination	*1 second (in auto mode)*

Table 2 E7495A/B Base Station Test Set Option Specifications

DC Bias Option 300 (Port 1) E7495B only	
DC Voltage:	*+12.7 VDC maximum*
DC Current:	*800 mA maximum*
Volt-Amps:	*9.84 VA maximum*
Signal Generator (CW) Option 500 (Port 1)	
Frequency range:	375 to 2500 MHz
Output level:	*–23 to –95 dBm*
Level accuracy:	*± 1 dB between –25 to –85 dBm*
Phase error:	*At 30 KHz offset –90 dBc/Hz*
cdmaOne / cdma2000 Reverse Link Signal Generator Option 510 (port 1)	
Frequency range:	375 to 2500 MHz
Output level (E7495A):	*–50 to –95 dBm*
Output level (E7495B):	*–28 to –95 dBm*
Level accuracy:	*± 1.5 dB (–50 dBm to –90 dBm)* *± 2 dB (> –50 dBm)*
Power Meter Option 600	
Display	
Range:	–100 dBm to +100 dBm
Limits:	± –100 dBm
Resolution:	Settable 1.0, 0.1, 0.01, 0.001 in logarithmic mode or 1, 2, 3, or 4 significant digits in learner mode.

Table 2 E7495A/B Base Station Test Set Option Specifications

Instrumentation Accuracy:	
Absolute:	**± 0.02 dB (log) or ± 0.5% (linear)** Add the corresponding power sensor linearity percentage.
Relative:	**± 0.04 dB (log) or ± 1.0% (linear)** Add the corresponding power sensor linearity percentage.
Zero set accuracy:	**Zero set is the digital zero with an 8482A sensor ± 50 nW**
Power reference accuracy:	
Power output:	**1.00 mW (0.0 dBm)** traceable to the U.S. National Institute of Standards and Technology (NIST).
Accuracy:	**± 1.2% worst case (± 0.9% rss) for one year**
VSWR:	< **1.08**
External attenuator:	
Max power:	100 watts
Attenuation:	40 dB ± 0.5 dB

Power meter Option 600 with Agilent 8482A power sensor (also supports Agilent 8481A power sensor)	
Frequency Range:	100 kHz to 4.2 GHz
VSWR	
100 kHz to 1 MHz:	< **1.60**
0.3 MHz to 1 MHz:	< **1.20**
1 MHz to 2 GHz:	< **1.10**
2 GHz to 4.2 GHz:	< **1.3**
Power linearity:	**+ 10 dBm to +20 dBm; ± 3%**
Maximum power:	**300 mW average. 1 W peak, 30 W - µsec per pulse**
Measurement noise:	< 93.5 nW (0.85 + 110 nW)
Average filtering:	Fixed at 32 in normal mode
Zero drift:	< ± 10 nW

Table 2 E7495A/B Base Station Test Set Option Specifications

T1 Analyzer Option 700	
Receive level (line 1 and line 2):	+6 dB DSC to –36 dB DSX or 100 mv peak-to-peak to 12 V peak-to-peak Receive frequency (line 1 and line 2) display receive frequency (5 ppm) “Loopback” control send CSU or NIU loop codes CSU/NIU emulation respond to CSU or NIU loop codes
Electrical interface:	
Connectors, Rx, Tx:	Primary and secondary ports
Output:	Conforms to TR-TSY-000499, CCITT Rec.G.703 AT&T Pubs CB113, CB119, CB132, CB143 PUB62508 and PUB62411 pulse shape specifications when terminated in 100 ohms and 0 dB line build-out is selected
Line build out	0 dB, –7.5, –15 dB
Input:	
Terminate:	DSX +6 dB to DSX –36 dB, 100 ohms
Monitor:	DSX –14 dB to DSX –40 dB, 100 ohms
Bridge	DSX + 6 dB to DSX –36 dB, > 1000 ohms
Clock:	1.544 MHz
Internal:	± 5 ppm
External:	± 300 ppm
Recovered:	± 300 ppm
Transmitter and receiver:	
Framing: Unframed:	D3 / D4 and ESF
Channel formats:	Full T1, 64 X 1
Test patterns:	QRSS, all Os, 1:7, 2 in 8, 3 in 24, all 1s, T-1-Daly, 55 OCTET
Error injection type:	BPV, frame, CRC, pattern (logic)
Error rate:	Single
Alarm inject type:	LOS, LOF, yellow, AIS, idle (CDI)

Table 2 E7495A/B Base Station Test Set Option Specifications

E1 Analyzer Option 710	
Error detect:	Code (BPV), FAS, MFAS, CRC-4, Far End Block (FEBE), Pattern, Fame Slip
Error rate calculation:	Bit-Error-Rate, Error Free Seconds, Errored seconds
Alarm detect:	AIS, TS-16 AIS, FAST DISTANT, MFAS DISTANT
Clock and frame slips:	Clock Slips, Frame slips, Peak Wander, Clock slip rate
Auto configuration:	Automatically detect line code, framing and test pattern
Receive level (line 1 and line 2):	+6 dB DSX to –36 dB DSX or 100 mv p-to-p to 12 v p-to-p
Receive frequency (line 1):	Display receive frequency (± 5 ppm)
Channel access:	Output audio to system
Delay measurement:	Measure delay in unit intervals for “looped-back” signal
Electrical Interface:	
Connectors, Rx, Tx:	Primary and secondary ports
Output:	Conforms to ITU-T Rec.G.703
Line code: Impedance:	AMI, HDB3 Terminate: 75 ohms ± 5% Bridge: > 1000 ohms
Input: Bridge:	Terminate: DSX +6 dB to DSX –36 dB DSX +6 dB to DSX –36 dB
Clock:	2.048 MHz
Internal: External: Recovered:	± 5 ppm ± 300 ppm ± 300 ppm
Transmitter and receiver	
Framing:	Unframed, PCM-30, PCM-30 with CRC, PCM-31, PCM-31 with CRC
Channel Formats:	Full E1, 64x1

Table 2 E7495A/B Base Station Test Set Option Specifications

Test Patterns:	(True or Inverse, ITU Rec) 2^6–1 (Q6&Q5), 2^9–1 (V.52), 2^{11}–1 (0.152), 2^{15}–1 (0.151) 2^{20}–1 (V.57), QRSS, 2^{23}–1(0.151), All 0's, 1:7, 1:3, 1:1, All 1's
Error injection	
Type:	Code (BPV), FAS, MFAS, CRC-4, Far End Block (FEBE), Pattern
Error rate:	Single
	Alarm generation AIS, TS-16 AIS, FAS DISTANT, MFAS DISTANT, Loss of signal, Loss of Frame

Table 3 E7495A/B Base Station Test Set General Specifications

Display:	Transflective VGA and color LCD
Dimensions	
Height:	11.6”, 295 mm
Width:	14.5”, 368 mm
Depth:	5.3”, 135 mm
Weight (without batteries):	20 lbs, 9.1 kg
Power supply:	
Internal:	*Lithium Ion battery: 10.8 volts, 6.0 Ah* (1 NI2040AG shipped standard, will accept 2 batteries)
External:	DC Input +9 V to +25 V dc (55 Watts)
Battery life:	*Approximately 1.5 hour per battery (time varies depending upon instrument mode)*

Table 3 E7495A/B Base Station Test Set General Specifications

Interface Ports:	Two RS 232 (DB-9) (reserved for future use)
	Two USB 1.1 (reserved for future use)
	One LAN Port 10 Base T
	Built-in speaker
	PCMCIA Card slot
	CompactFlash memory (type 1 & 2)
	Stereo headphone jack
	General purpose input/output - TTL level (reserved for future use)
Inputs	
Port 2 RF in:	50 ohm type N
External DC input:	+9 V to + 25 V DC (55 Watts)
Frequency reference:	
Input power:	*–10 to + 10 dBm*
Connector:	*50 ohm BNC*
Even second:	
Connector:	*High impedance BNC*
Level:	*TTL compatible*
GPS antenna:	
Connector:	SMA
Output:	5 V at 50 mA
Outputs:	
Port 1 RF Out/SWR Connector:	*50 ohm type N*
Power reference:	*50 ohm type N; SWR < 1.06*

Table 3 E7495A/B Base Station Test Set General Specifications

Optional Connectors:	
Option 600 power meter:	
Outputs:	50 ohm type N power reference
Inputs:	Sensor input for 8480 series sensors
Option 700 T1 analyzer:	
Out puts:	(2) Bantum outputs; Tx primary and secondary
Inputs:	(2) Bantum inputs; Rx primary and secondary
Option 710 E1 analyzer:	
Outputs:	(2) 75 ohm BNC outputs; Tx primary and secondary
Inputs:	(2) 75 ohm BNC inputs; Rx primary and secondary
Operating temperature specified range:	*–10 ° to 50 °C; 14 ° to 122 °F*
Storage temperature:	*–40 ° to 70 °C; –40 ° to 158 °F*
Calibration Cycle:	1 year
Warranty Duration:	1 year

Battery Pack Specifications

INSPIRED ENERGY™
SOLUTIONS FOR PORTABLE POWER

Product Safety Data Sheet

PRODUCT NAME: Inspired Energy Rechargeable Battery Pack	Model: NI2040AG Rev2
ALTERNATE NAME: 1420-0883	
TRADE NAME: NI2040AG Rev 2 / NI2040AG2	Volts: 10.8
CHEMICAL SYSTEM: Lithium Ion	Approximate Weight: 484 g
Date Prepared: November 13thth 2002	Updated April 7th 2003

SECTION I – MANUFACTURER INFORMATION

Inspired Energy, Inc.
12705 N US Hwy 441
Alachua, FL 32615
Telephone: (888) 5-INSPIRE (888-546-7747)

SECTION II – HAZARDOUS INGREDIENTS

Important Note:

The battery should not be opened or burned. Exposure to the ingredients contained within or their combustion products could be harmful

Please refer to the attached cell Material Safety Data Sheet Filename: MSDS Moli 18650 up to 2400mAh.pdf

SECTION III – OPERATING PARAMETERS

Maximum Charge Voltage:	12.6 V
Minimum Charge Voltage:	7.5 V
Maximum Charge Current:	3.0 A
Maximum Discharge Current:	6.0 A

Recommended Charging Method: Use an Agilent approved charger to provide a 3.0 A current limited constant voltage of 12.6 V. The charging cycle will terminate when the average current falls below 150mA.

The information contained within is provided for your information only. This battery is an article pursuant to 29 CFR 1910.1200 and, as such, is not subject to the OSHA Hazard Communication standard requirement for preparation of a material safety data sheet. The information and recommendations set forth herein are made in good faith and are believed to be accurate as of the date of preparation. However, INSPIRED ENERGY, INC. MAKES NO WARRANTY, EITHER EXPRESSED OR IMPLIED, WITH RESPECT TO THIS INFORMATION AND DISCLAIMS ALL LIABILITY FROM RELIANCE ON IT.

Inspired Energy, Inc. 12705 US Hwy 441 N, Alachua, FL 32615
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www.inspired-energy.com

20 Working with Batteries

Installing Batteries

	Step	Notes
1.	Open the battery door.	Turn the latch counterclockwise several times until loose. Then pull the battery door open.
2.	Insert the battery.	Insert one or two batteries.
3.	Close the battery door.	Turn the latch clockwise until tight to secure the battery door.

Viewing Battery Status

You can view information about battery status in four ways:

- Two battery LEDs embedded in the E7495A/B enclosure
- Icons in the lower right of the front panel screen
- System Statistics—Battery screen, available from the System menu
- LCD gauge built into each battery

Battery LEDs

LED	Charge remaining
Green	Greater than or equal to 25% charge capacity remaining
Blinking green	Battery charging
Green and red (may appear yellow or orange)	Greater than or equal to 10% and less than 25% charge capacity remaining
Red	Less than 10% charge capacity remaining

Note: The battery status LEDs will function only when the test set is on, in standby mode, or connected to external power.

Front Panel Icons

Icon	Status
Plug icon	Connected to external power through AC adapter converter or car adapter
2 solid batteries	2 batteries installed
1 solid battery	1 battery installed

Icon	Status
% displayed beneath battery	Amount of charge capacity remaining for battery

System Statistics—Battery Screen

Step	Notes
1. **System**	
2. [More 1 of 2]	
3. [Battery]	

The Battery screen displays several kinds of information:

- **Temperature**—the internal temperature of each battery as measured by a sensor embedded in each battery
- **Voltage**—for each battery cell stack as measured by each battery's sensor
- **Run Time to Empty**—while using external power, External DC Power is displayed; while using battery power, the predicted remaining battery run time is displayed in minutes at the present rate of discharge. If two batteries are installed, the second battery will have Not in Use displayed. The instrument mode you select affects the discharge rate, which determines the run time to empty. Antenna/Cable, Spectrum Analyzer, CDMA Tx Analyzer, and CDMA Over Air modes use the most power. Backhaul and Power Meter modes use the least power.
- **Fuel Gauge Error**—the present accuracy of each battery's fuel gauge or remaining charge capacity. If the error exceeds 10%, you should condition the battery.
- **Percent Charged**—the predicted charge capacity of each battery in percent.
- **Battery Status**—For Battery 1 and Battery 2, Present or Missing tells you whether a battery is installed.

Built-In Battery Gauge

Each Lithium Ion battery has a five-segment LCD gauge that displays its charge status. Each segment represents 20% of the charge capacity. The gauge is active unless the battery is in shutdown mode. You can view the gauge with the door open.

Gauge	Charge Remaining
5 segments	81-100%
4 segments	61-80%
3 segments	41-60%
2 segment	21-40%
1 segment	1-20%
0 segment	Less than 1%

Charging Batteries

You can charge batteries internally or using the external battery charger (Option #820). The external charger provides much faster charging time.

CAUTION Charge batteries internally or with the appropriate charger—a SMBus charger of level II or higher.

Never use a non-SMBus charger because the battery issues commands over the SMBus to the charger to control the charge rate and voltage.

Never use a modified or damaged charger.

Internal Charging

You can use the E7495A/B to recharge while the test set is operating or shut down. For a fully depleted battery, charging time is approximately 4 hours if the test set is shut down, 8 hours if the test set is operating.

If two batteries are installed, the test set fully charges Battery 1 before charging Battery 2. During internal charging, the charge indicator blinks to indicate which battery is being charged.

To charge a battery internally, simply attach the car adapter or AC adapter and turn on external power.

External Charging

The external battery charger (available as part of Option 820) lets you charge two batteries simultaneously. Each fully depleted battery takes up to 4 hours to recharge.

You have the option of charging batteries before they become fully depleted. Doing this does not shorten battery life. But repeatedly charging a battery before it's fully discharged will impair the accuracy of its internal charge-remaining indicator. When the fuel gauge error is greater than 10%, the battery should be reconditioned.

External Battery Charger LED	Charging Status
Green on	Fully charged
Green flashing	Fast charging
Yellow flashing	Reconditioning—the accuracy of the battery's internal LCD charge gauge is being renewed. See "Reconditioning Batteries."
Yellow/green	Battery is reconditioned
Red flashing	Error
Yellow on	Standby

Reconditioning Batteries

Each battery contains a microchip that monitors battery usage and tracks how much capacity is available. This function can become less accurate because of temperature fluctuations, aging, self-discharge, repeated partial charging, and other factors. This inaccuracy is displayed on the System Statistics—Battery screen as Fuel Gauge Error.

To ensure the accuracy of the battery’s internal capacity tracking system, occasionally you need to recalibrate the battery. Reconditioning—also known as recalibrating—is done by fully charging the battery, fully discharging it, recharging it again, and then verifying that the error has been corrected.

You can recondition a battery internally or with the external charger. The charger makes the process simpler.

Determining if a Battery Needs Reconditioning

	Step	Notes
1.	**System**	
2.	[More 1 of 2]	
3.	[Battery]	On the Battery screen, if the error percentage for the battery is greater than 10%, the battery needs to be reconditioned.

NOTE After reconditioning, if the battery is not fully charged or still shows more than a 10% Fuel Gauge Error reading, repeat the reconditioning procedure. If the second reconditioning does not restore a full charge and an error reading of 10% or less, the battery needs replacement. This error will affect all of the displayed battery charge indicators.

Internal Reconditioning

If you don’t have the external battery charger, you can use the test set to recondition a battery. The process takes longer and requires shutting down the test set.

	Step	Notes
1	Fully charge the battery. a. Power off the test set. b. Install the battery needing reconditioning into the test set. If you have a second battery installed, remove the second battery. c. Connect the car adapter or AC adapter to the test set, and plug the other end of the adapter in the appropriate power source.	To fully charge the battery, leave the test set power off for approximately 4 hours.
2	Fully discharge the battery. a. Disconnect the external power adapter, then power on the test set. b. Confirm that the battery now has 100% of its charge by checking the Battery 1 or Battery 2 status icon in the lower right of the display or the System Statistics—Battery screen. c. Run the test set without external power until you fully deplete the battery (approximately 1.5 hours).	
3	Charge the battery and verify a full charge. a. Power off the test set again. b. Reconnect the external power adapter and charge the battery again for approximately 4 hours. c. Power on the test set. d. Confirm that the battery is fully charged and reconditioned by checking the System Statistics—Battery screen.	On the System Statistics—Battery screen, the battery should show 100% charge rate and less than a 10% Fuel Gauge Error.

Reconditioning with the External Battery Charger

	Step	Notes
1	Insert a battery into the left bay of the external battery charger.	
2	Press the blue button labeled **Push to Recalibrate Left Battery Bay**.	The charger will charge the battery fully, discharge it completely, then recharge it fully again. The entire process can take up to 10 hours.
3	Install the battery into the test set.	
4	On the System Statistics—Battery screen, verify that the battery is fully charged and reconditioned.	

WARNING **If you are charging the batteries internally—even while the test set is powered off—the test set may become warm. Take care to provide proper ventilation.**

Battery Care

WARNING

Lithium Ion and lithium polymer cells and battery packs may get hot, explode, or ignite and cause serious injury if exposed to abuse conditions. Be sure to follow these safety warnings:

- **Do not install the battery backward, so the polarity is reversed.**
- **Do not connect the positive terminal and negative terminal of the battery to each other with any metal object (such as wire).**
- **Do not carry or store the battery with necklaces, hairpins, or other metal objects.**
- **Do not pierce the battery with nails, strike the battery with a hammer, step on the battery, or otherwise subject it to strong impacts or shocks.**
- **Do not solder directly onto the battery.**
- **Do not expose the battery to water or salt water, or allow the battery to get wet.**
- **Do not disassemble or modify the battery. The battery contains safety and protection devices, which, if damaged, may cause the battery to generate heat, explode, or ignite.**
- **Do not place the battery in or near fire, on stoves, or in other high temperature locations. Do not place the battery in direct sunlight, or use or store the battery inside cars in hot weather. Doing so may cause the battery to generate heat, explode, or ignite. Using the battery in this manner may also result in a loss of performance and a shortened life expectancy.**
- **Danger of explosion if battery is incorrectly replaced. Replace only with the same or equivalent type recommended. Discard used batteries according to manufacturer's instructions.**

WARNING **Do not discharge the battery using any device except the specified device. When the battery is used in devices other than the specified device, it may damage the battery or reduce its life expectancy. If the device causes an abnormal current to flow, it may cause the battery to become hot, explode, or ignite and cause serious injury.**

Maximizing Battery Life

The Lithium Ion battery used in the E7495A/B has a life span of approximately 300 charge cycles at room temperature, with normal charge and discharge rates. You can maximize the number of charge cycles with reasonable battery care:

- Clean the battery contacts occasionally, using a pencil eraser or alcohol and a cotton swab. Make sure no residue from the eraser or cotton swab is left on the contact points.
- Cycle each battery through a full charge and full discharge on a regular basis, preferably monthly. Even if you use external power most of the time, you will lengthen battery life by occasionally cycling through a full discharge/recharge cycle.
- Do not leave a battery unused for an extended period. Batteries that sit idle eventually lose their ability to hold a charge.
- Unplug the external battery charger (Option #820) when you're not using the test set.
- Store batteries in a cool, dry location, away from metal objects and corrosive gases. Extended exposure to high humidity or temperatures above 45 degrees Celsius (113 degrees Fahrenheit) can impair battery performance and shorten battery life. Storage limits are –20 °C to 60 °C 80% RH.
- Allow a battery to warm to room temperature before charging it. Temperature shock can damage the battery chemistry and in some cases cause a short circuit.
- Always charge batteries at temperatures between 0 and 45 degrees Celsius (32 to 113 degrees Fahrenheit).
- Operate the test set on battery power between the temperatures of -10 and +50 degrees Celsius (–14 to +122 degrees Fahrenheit). Using

the batteries at lower or higher temperatures can damage the batteries and reduce operating life. Cold temperatures affect battery chemistry, reducing charge capacity, especially below 0 degrees Celsius (32 degrees Fahrenheit).

- Batteries are shipped with a minimum of 20% charge capacity to provide at least a 6-month shelf life at room temperature, before the battery electronics go into shutdown mode. When a battery has discharged down to a 7.1 volts, it goes into shutdown mode. When this occurs, the battery electronics self-disconnect, removing their electronic load from the cells. This provides approximately 1 year of room temperature storage before the cells self-discharge to the point beyond which they should not be recharged. Once a battery has reached shutdown mode the battery will undergo a self-test immediately upon being put into charge. The charger will then attempt to pre-charge the battery at a very low initial charge rate. If the voltage does not recover, the battery pack has been allowed to discharge beyond the point of safe recovery. The charge cycle will be terminated, and the battery pack needs to be replaced.

  If the battery does recover from a shutdown mode, the fuel gauge accuracy will be reduced. Complete a battery recalibration as soon as possible to calibrate the fuel gauge.

Initial Charge Cycle

New batteries must be rapid-charged (typically to 80%), then trickle-charged (slowly charged to 100%) for 24 hours, before their first use and for the first two or three uses.

Because the batteries you receive with the E7495A/B are new, they have a minimal charge when you receive them. All batteries require a “break-in” period, so don't be alarmed if a battery doesn't hold a full charge right away. A new battery commonly will show a false full charge (voltage) as indicated on the test set or charger, and may not power up the test set upon first use. Before using a new battery, leave it charging for 24 hours.

Lithium Ion Battery Disposal

When you notice a large decrease in charge capacity after proper recharging, it’s probably time to replace the battery.

Li-Ion batteries need to be disposed of properly. Contact your local waste management facility for information regarding environmentally sound collection, recycling, and disposal of the batteries. Do not throw batteries away but collect as small chemical waste.

Battery Specifications

The E7495A/B Base Station test set uses the Inspired Energy NI2040AG Smart Battery, which produces 10.8 volts DC at approximately 6000 mA. The NI2040AG is a Lithium Ion battery pack, which uses the System Management Bus (SMBus) interface to communicate with the test set and charger. To charge the batteries, use only the Agilent approved SMBus charger of Level II or higher or the E7495A/B.

External charging voltage is 18 V to 24 VDC.

The battery is designed for approximately 300 full charge/discharge cycles at room temperature and under normal rates of discharge.

The NI2040 uses electronically programmable read-only memory (EPROM) to store key data regarding the battery cells and charge capacity.

Protection Electronics

The NI2040AG SMBus battery uses several protection devices to prevent damage to the battery and test set. The battery is internally protected against excessive current draws and reduced loads (shorts), excessive voltage and temperatures.

During charging and discharging, the battery will monitor and report its voltage, current, and temperature. If any of these monitored conditions exceeded their safety limits, the battery will terminate any further charge or discharge until the error condition is corrected.

Test Set Operation: Battery Current Drain in the Off or Standby Mode

The E7495A/B provides two “powered down” modes: off and standby.

When the test set is operating from battery power, it continues to draw current in both off and standby modes. When in standby mode the test set draws 70 mA per hour, or 28% of a full battery charge in a 24-hour period. When in off mode, the test set draws 45 mA per hour, or 18% of a full battery charge in a 24-hour period. Agilent recommends that if the test set is not going to be used for an extended period of time, you periodically check and maintain the batteries’ charge, or remove the batteries from your test set. This will ensure you have sufficient battery capacity if you intend to operate the test set from battery power.

Battery Drain when in Off and Standby Modes

- Single battery off mode: 18.46% or 1.08 amps per 24 hrs.
- Single battery standby mode: 28.72% or 1.68 amps per 24 hrs.

Battery and Charger Part Numbers

Table 20-1

Standard Supplied Accessories	
Description	**Part Number**
AC/DC Converter	0950-4404
NI2040AG Battery	1420-0883*
Optional Accessories provided in E7495A/B Option 820	
Charger 12 V at 1 A	0950-4276
AC/DC Converter	0950-4404
Auto Adapter F1455A	0950-4412
NI2040AG Battery	
E7495A	1420-0882
E7495B	1420-0883

NOTE Replace only with NI2040AG or equivalent, Agilent-approved battery.

Additional batteries are also available directly from Inspired Energy, Inc. To purchase additional or replacement batteries, visit www.inspired-energy.com, or call toll free USA 1-888-5-INSPIRE (546-7747).

NOTE

Regarding the battery charger and conditioner:

- Install the instrument so that the ON / OFF switch is readily identifiable and is easily reached by the operator. The ON / OFF switch or the detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. Alternatively, an externally installed switch or circuit breaker (which is readily identifiable and is easily reached by the operator) may be used as a disconnecting device.
- Install the instrument so that the detachable power cord is readily identifiable and is easily reached by the operator. The detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. The front panel switch is only a standby switch and is not a LINE switch. Alternatively, an externally installed switch or circuit breaker (which is readily identifiable and is easily reached by the operator) may be used as a disconnecting device.

Battery Current Drain

When in the Off mode the test set draws ~45 mA of current when the batteries) are left installed, and ~70 mA when in Standby mode.

The test set with a single battery loses ~18% of its battery charge per day in Off mode and ~28% per day in Standby mode. The following table shows how long a test set can be in Standby or Off modes until the battery is providing enough current to operate the test set.

Number of Batteries	Battery Capacity in Standby Mode	Battery Capacity in Off Mode
1	3.5 days	5.4 days
2	6.9 days	10.8 days

21 Connector Care

Using, Inspecting, and Cleaning RF Connectors

Taking proper care of cables and connectors will protect your test set's ability to make accurate measurements. Inaccurate measurements often result from improperly made connections or dirty or damaged connectors.

Worn, out-of-tolerance, or dirty connectors degrade the accuracy and repeatability of measurements. For more information on connector care, refer to the documentation that came with your calibration kit.

Repeatability

If you make two identical measurements with your test set, the differences should be so small that they do not affect the value of the measurement. Repeatability (the amount of similarity from one measurement to another of the same type) can be affected by:

- Dirty or damaged connectors
- Connections that have been made without using proper torque techniques (this applies primarily when connectors in the test set have been disconnected, then reconnected)

CAUTION This test set contains test sets and devices that are static-sensitive. Always take proper electrostatic precautions before touching the center conductor of any connector, or the center conductor of any cable that is connected to the test set.

RF Cable and Connector Care

Connectors are the most critical link in a precision measurement. These devices are manufactured to extremely precise tolerances and must be used and maintained with care to protect the measurement accuracy and repeatability of your test set.

To Extend the Life of Your Cables or Connectors:

- Avoid repeated bending of cables—a single sharp bend can ruin a cable instantly.

- Avoid repeated connection and disconnection of cable connectors.
- Inspect the connectors before connection; look for dirt, nicks, and other signs of damage or wear. A bad connector can ruin the good connector instantly.
- Clean dirty connectors. Dirt and foreign matter can cause poor electrical connections and may damage the connector.
- Minimize the number of times you bend cables.
- Never bend a cable at a sharp angle.
- Do not bend cables near the connectors.
- If any of the cables will be flexed repeatedly, buy a back-up cable. This will allow immediate replacement and will minimize your test set's down time.

Before Connecting the Cables to Any Device:

- Check all connectors for wear or dirt.
- When making the connection, torque the connector to the proper value.

Proper Connector Torque

- Provides more accurate measurements
- Keeps moisture out the connectors
- Eliminates radio frequency interference (RFI) from affecting your measurements

The torque required depends on the type of connector. Refer to Table 21-1. Do not overtighten the connector.

CAUTION Never exceed the recommended torque when attaching cables.

Table 21-1 Proper Connector Torque

Connector	Torque cm-kg	Torque N-cm	Torque in-lbs	Wrench part number
Type-N	52	508	45	8710-1935
3.5 mm	9.2	90	8	8710-1765
SMA	5.7	56	5	8710-1582

Connector Wear and Damage

Look for metal particles from the connector threads and other signs of wear (such as discoloration or roughness). Visible wear can affect measurement accuracy and repeatability. Discard or repair any device with a damaged connector. A bad connector can ruin a good connector on the first mating. A magnifying glass or jeweler's loupe is useful during inspection.

Cleaning Procedure

1. Blow particulate matter from connectors using an environmentally-safe aerosol such as Ultrajet. This product is recommended by the United States Environmental Protection Agency and contains chlorodifluoromethane.
2. Use an alcohol wipe to wipe connector surfaces. Wet a small swab with alcohol (from the alcohol wipe) and clean the connector with the swab.
3. Allow the alcohol to evaporate off the connector before making connections

CAUTION Do not allow excessive alcohol to run into the connector. Excessive alcohol entering the connector collects in pockets in the connector's internal parts. The liquid will cause random changes in the connector's electrical performance. If excessive alcohol gets into a connector, lay it aside to allow the alcohol to evaporate. This may take up to three days. If you attach that connector to another device it can take much longer for trapped alcohol to evaporate.

22 Returning the Test Set for Service

Adjustment, Maintenance, or Repair of the Base Station Test Set

Any adjustment, maintenance, or repair of the E7495A/B Base Station Test Set must be performed by qualified personnel. Contact your customer engineer through your local Agilent Technologies Service Center. You may contact Agilent through the Internet or by telephone. For contact information refer to "Contacting Agilent Technologies" on page 37.

NOTE For specific test set packing instructions, refer to "Returning your Base Station Test Set for Service" on page 449.

Returning your Base Station Test Set for Service

The instructions in this section explain how to properly package the system for return to Agilent Technologies.

NOTE Please notify Agilent Technologies before returning your system for service. Any special arrangements for the system can be discussed at this time. This will help Agilent Technologies repair and return your system as quickly as possible.

Warranty

If the system is still under warranty or is covered by an Agilent Technologies maintenance contract, it will be repaired under the terms of the warranty or contract. If the system is no longer under warranty or is not covered by an Agilent Technologies maintenance plan, Agilent Technologies will notify you of the cost of the repair after examining the unit.

When a system is returned to Agilent Technologies for servicing, it must be adequately packaged (see "Preparing the Agilent E7495A/B for Shipping" on page 449) and have a complete description of the failure symptoms attached.

When describing the failure, please be as specific as possible about the nature of the problem. Include copies of additional failure information (such as receiver or computer failure settings, data related to system failure, and error messages) along with the system being returned.

Preparing the Agilent E7495A/B for Shipping

CAUTION Cover electrical connectors to protect sensitive components from electrostatic damage. Test set damage can result from using packaging materials other than the original materials. Never use styrene pellets as packaging material. They do not adequately cushion the system or prevent it from shifting in the carton. They may also cause system damage by generating static electricity.

	Step	Notes

1	Write a complete description of the failure and attach it to the system.	Include any specific performance details related to the problem. The following information should be returned with the system:
		
		• Type of service required
		• Date system was returned for repair
		• Description of the problem:
		    • Whether problem is constant or intermittent
		    • Whether system is temperature-sensitive
		    • Whether system is vibration sensitive
		    • System settings required to reproduce the problem
		    • Error Code
		    • Performance data
		• Company Name and return address
		• Name and phone number of technical contact person
		• Model number of returned system
		• Full serial number of returned system
		• List of any accessories returned with the system

2	**Caution:** Cover all front and rear panel connectors that were originally covered when you first received the system.	
3	Pack the system in the original shipping containers. Original materials are available through Agilent Technologies office. See step 4 for more information.	

	Step	Notes
4	Wrap the system in anti-static plastic to reduce the possibility of damage caused by electrostatic discharge.	For systems weighing less than 54 kg (120 lbs.), use a double-walled, corrugated cardboard carton of 159 kg (350 lbs.) test strength. The carton must be large enough to allow 3 to 4 inches on all sides of the system for packing material, and strong enough to accommodate the weight of the system. Surround the equipment with 3 to 4 inches of packing material, to protect the system and prevent it from moving in the carton. If packing foam is not available, the best alternative is S.D-240 Air Cap™ from Sealed Air Corporation (Commerce, California 90001). Air Cap looks like a plastic sheet filled with air bubbles. Use the pink (anti-static) Air Cap to reduce static electrical damage. Wrapping the system several times in this material will protect the system and prevent it from moving in the carton.
5	Seal the carton with strong nylon adhesive tape and mark it “FRAGILE, HANDLE WITH CARE”.	
6	Retain copies of all shipping papers.	

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