



Agilent E7495A

Base Station Test Set



Measurement Guide

For firmware versions A.01.60 and higher



Agilent Technologies

Notices

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Contents

1 Getting Started

Introduction	12
Unpacking the E7495A Test Set	13
E7495A cables, connectors, and accessories	14
Test set options	16
Your First 15 Minutes with the E7495A	19
Get to know the layout of the E7495A	20
Install a battery	23
Practice using the three-way power button	24
Make your first measurement (two port insertion loss)	24
Using the Backpack	27
What goes where in the backpack	28
Contacting Agilent	29
More information from Agilent	29
E7495A product updates	29

2 Two Port Insertion Loss

Measuring Two Port Insertion Loss	32
Performing a basic two port insertion loss measurement	33
Measuring two port insertion loss for Spectrum Analyzer, Channel Scanner, CDMA Analyzer, and Signal Generator	34
Measuring insertion loss for Power Meter	36
Determining the lowest (worst) insertion loss and its frequency	38
Determining the highest (best) insertion loss and its frequency	38
Using the delta marker to measure a difference in insertion loss or frequency	38
Activating interference rejection	39
Optimizing dynamic range	39

3 One Port Insertion Loss

- Measuring One Port Insertion Loss 42
 - Performing a basic one port insertion loss measurement 42
 - Setting one port insertion loss interference rejection 44

4 Return Loss

- Measuring Return Loss 48
 - Performing a basic return loss measurement 48
 - Isolating a return loss signal using a single sweep 50
 - Setting return loss interference rejection 50

5 Distance to Fault

- Measuring Distance to Fault 54
 - Performing a basic distance to fault measurement (manual frequency range) 56
 - Performing a basic distance to fault measurement (automatic frequency range) 58
 - Viewing a single distance to fault sweep 59
 - Setting interference rejection for a distance to fault measurement 60
 - Displaying the top three faults 60

6 Spectrum Analyzer

- Using the Spectrum Analyzer 62
 - Performing a basic spectrum analyzer measurement 63
 - Entering the average and sweep 66
 - Changing the resolution bandwidth 66

7 Channel Scanner

- Using the Channel Scanner 70
 - Performing a basic channel scanner measurement 70
 - Displaying accurate peak power (recommended for pulsed signals) 74
 - Entering the channels with a list instead of a range 75
 - Entering the channel power measurement bandwidth and time 75
 - Setting the channel power average and sweep 76

Displaying frequency or power 77

8 Signal Generator

Using the Signal Generator 80

Performing a basic signal generator measurement 81

9 Power Meter

Making an Average Power Measurement 86

Making a basic average power measurement 87

Setting Power Meter resolution 90

Setting the Power Meter's high and low end-points 90

Setting the Power Meter's upper and lower limits 91

10 T1 Analyzer

Making T1 Measurements 94

Getting started with T1 testing 94

Selecting Hard Loop/End-End Full T1 94

Selecting Loopback CSU Full T1 BERT 102

Selecting the Monitor Test Mode 110

Selecting Emulate CSU/NIU 117

Selecting Delay 123

Patterns 127

Measurement Results 129

Alarm indicators 129

Results indicators 130

Status indicators 130

Measurement results fields 130

Testing and fault mitigation 134

More Information About T1 Testing 139

Detailed loop mode and auto configuration descriptions 139

Terminology 146

11 CDMA Analyzer

Using the CDMA Analyzer	150
Common CDMA TX Analyzer measurements	150
Performing a basic CDMA transmitter measurement	151
Optional CDMA TX Analyzer Measurement Settings	157
Setting the channel or frequency step	157
Setting the PN Increment	158
Setting the CDMA transmitter reference level	158
Setting the active channel threshold level and auto threshold level	159
Setting measurement time	160
Setting quick page channel	161
Metrics Provided by the CDMA TX Analyzer Measurement	162
Interpretation of CDMA TX Analyzer Measurement Results	165

12 CDMA Over Air

Using the CDMA Over Air Tool	170
Performing CDMA over air measurements	170
Performing a basic CDMA over air measurement	173
Displaying location information using GPS	175
Setting amplifier capacity metrics	176
Interpreting the display	177
Optional CDMA Over Air Measurement Settings	179
Setting the channel or frequency step	179
Setting the PN increment (PN Inc)	180
Setting the transmitter reference level	180
Setting the active channel threshold level and auto threshold level	181
Resetting amplifier capacity and traffic metrics	182
Setting measurement time	182
Setting quick page channel	183
Metrics Provided by CDMA Over Air Measurements	184

Interpretation of CDMA Over Air Measurement Results 189

13 Basic System Operations

System Reference Introduction 196

Setting System References 197

 Displaying GPS location data 197

 Selecting a frequency/timing reference 197

Printing Screens 198

 Selecting output media—PCMCIA card or CompactFlash card 198

 Setting up file naming 198

 Setting up automatic file naming 199

 Setting up user file naming 199

 Setting up asking for filename 200

Saving Data 201

 Selecting output media—PCMCIA card or CompactFlash card 201

 Setting up file naming 201

 Setting up automatic file naming 202

 Setting up user file naming 202

 Setting up asking for filename 203

Managing Media Types 204

 Formatting a PCMCIA or CompactFlash card 204

Configuring for Network Connectivity 205

 IP Administration using DHCP 205

 IP Administration without DHCP 206

Viewing System Statistics 208

 Viewing system release versions 208

 Viewing system memory 208

 Viewing battery statistics 209

Using the Option Manager 210

 Viewing installed options 210

Viewing installable options	210
Viewing installation information	211
Installing an option	211
Testing System Functions	212
Testing your display	212
Testing your keyboard	212

14 Working with Batteries

Installing Batteries	214
Viewing Battery Status	215
Battery LEDs	215
Front panel icons	215
System Statistics—Battery Screen	216
Built-in battery gauge	217
Charging Batteries	218
Internal charging	218
External charging	218
Reconditioning Batteries	220
Determining if a battery needs reconditioning	221
Internal reconditioning	221
Reconditioning with the external battery charger	223
Battery Care	224
Maximizing battery life	224
Lithium Ion battery disposal	226
Battery Specifications	228
Protection electronics	228
Test set operation: battery current drain in the off or standby mode	228
Battery and charger part numbers	230
Battery current drain	231

15 General Information

- Safety considerations 234
- Safety symbols 234
- Safety considerations for this test set 236
- Lifting and handling 238
- Electro-static discharge (ESD) precautions 239
- Product markings 240

Certification 241

Manufacturer's Declaration 242

Declaration of Conformity 243

Compliance Statements 244

- Compliance with German noise requirements 244

- Compliance with Canadian EMC requirements 244

- Disposal of batteries 244

Assistance 245

E7495A Base Station Test Set Specifications 246

16 Connector Care

Using, Inspecting, and Cleaning RF Connectors 258

- Repeatability 258

- RF cable and connector care 258

- Proper connector torque 259

- Connector wear and damage 260

- Cleaning procedure 260

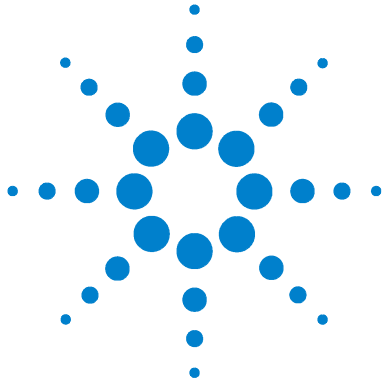
17 Returning the Test Set for Service

Adjustment, Maintenance, or Repair of the Base Station Test Set 264

Returning your Base Station Test Set for Service 265

- Warranty 265

- Preparing the test set for shipping 266



1 Getting Started

"Introduction" on page 12

"Unpacking the E7495A Test Set" on page 13

"Your First 15 Minutes with the E7495A" on page 19

"Using the Backpack" on page 27

"Contacting Agilent" on page 29



Introduction

The E7495A 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 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:

- CDMA Over Air
- CDMA Analyzer
- Channel Scanner
- T1
- Signal Generator
- Power Meter

In *Getting Started*, you will learn how to set up the E7495A, 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.

Unpacking the E7495A 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 includes:

- E7495A Base Station Test Set
- Shoulder strap
- Backpack
- One battery
- Two 10 dB pads
- 10-ft. cable
- Two 2-ft. cables
- AC/DC converter
- Two N-to-N barrels
- Two N-to-7/16" connectors
- Two attenuator 10dB coaxial connectors
- Load connector
- Open/Short connector
- GPS antenna
- High power attenuator
- 64 MB PCMCIA memory card
- Measurement Guide (this manual)
- CD ROM containing electronic (PDF) version of Measurement Guide and E7495A Quick Basics tutorial

E7495A cables, connectors, and accessories

Table 1 Cables, connectors and adapters

Part Number	Picture	Description
0950-4404		AC adapter
0950-4409		PCMCIA 64MB Flash memory card
0955-1458		High power attenuator (40 dB 100W)
0955-1458 Quantity 2		10 dB coaxial attenuator
1150-2085		GPS antenna

Table 1 Cables, connectors and adapters

Part Number	Picture	Description
1250-0777 Quantity 2		Barrel, N (f) - N(f)
1250-2810		Adapter, N (Female) to 7/16ths (Female)
1250-2810		Adapter, coax Str F-7 16ths N (f)
1420-0882		Battery
8120-8862 Quantity 2		Cable, 2 ft N (m) - N (m)
85032-60010		Load, N (m)

Table 1 Cables, connectors and adapters

Part Number	Picture	Description
85032-60011	A metal connector with two N-type ports. The top port is labeled 'OPEN' with a right-pointing arrow, and the bottom port is labeled 'SHORT' with a left-pointing arrow.	Open/Short connector, N (m)
08921-61010	A black, flexible coaxial cable with N-type connectors at both ends, coiled into a circle.	Cable, 10 ft (3.048m) N (m) - N (m)
E7495-80014	A yellow and black shoulder strap with a metal hook at the end. The Agilent Technologies logo is visible on the yellow part.	Shoulder strap
E7495-80014	A black and yellow backpack with a front pocket and a shoulder strap.	Backpack

Test set options

Test set part number	Description
E7495A, option 200	cdmaOne/cdma 2000 direct connect test

Test set part number	Description
E7495A, option 210	cdmaOne/cdma 2000 over-air test (requires option 200 and 810 or 811)
E7495A, option 220	GSM/TDMA/AMPS channel scanner
E7495A, option 240	UMTS
E7495A, option 500	CW signal generator
E7495A, option 510	CW and cdmaOne reverse link generator
E7495A, option 51B	Return to Agilent repair
E7495A, option 50C	Return to Agilent for calibration
E7495A, option 600	Power meter
E7495A, option 610	Power meter and power sensor head
E7495A, option 700	T-1 Test
E7495A, option 710	E-1 Test
E7495A, option 810	Cellular antenna and preselector filter for option 210
E7495A, option 811	PCS antenna and preselector filter for option 210
E7495A, option 812	Korean PCS antenna and preselector filter
E7495A, option 820	Battery Pack, AC external charger, DC car adapter
E7495A, option 840	Transit case
E7495A, option 900	UK power cord
E7495A, option 901	AUS/NZ/CH power cord
E7495A, option 902	Euro power cord
E7495A, option 903	US power cord
E7495A, option 906	Switz power cord
E7495A, option 912	Denmark power cord
E7495A, option 917	So Af/India power cord
E7495A, option 918	Japan power cord
E7495A, option 919	Israel power cord

1 Getting Started

Test set part number	Description
E7495A, option 920	Argentinean power cord
E7495A, option 921	Chilean power cord
E7495A, option 922	China power cord
E7495A, option 927	Thailand power cord

Your First 15 Minutes with the E7495A

Spend 15 minutes getting acquainted with the test set:

- “Get to know the layout of the E7495A” on page 20
- “Install a battery” on page 23
- “Practice using the three-way power button” on page 24
- “Make your first measurement (two port insertion loss)” on page 24

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



Number	Description
1	<p>Power button. Powers the test set on and off, and puts it into standby mode.</p> <ul style="list-style-type: none"> • 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 24. • To power off, press the button and hold down until you see both LEDs go out, approximately 5 seconds.
2	<ul style="list-style-type: none"> • 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	<p>Number keypad. Used for entry of values for many test parameters.</p>

-
- 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 215.
-
- 6** **Softkeys.** Allow you to select measurement modes and other settings for configuring and performing measurements, and for other E7495A 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 14](#), “Working with Batteries.”

Practice using the three-way power button

The E7495A 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 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):

Needed for normalization:

- Normalization jumper cable (2 ft.)

- Two 10 dB pads

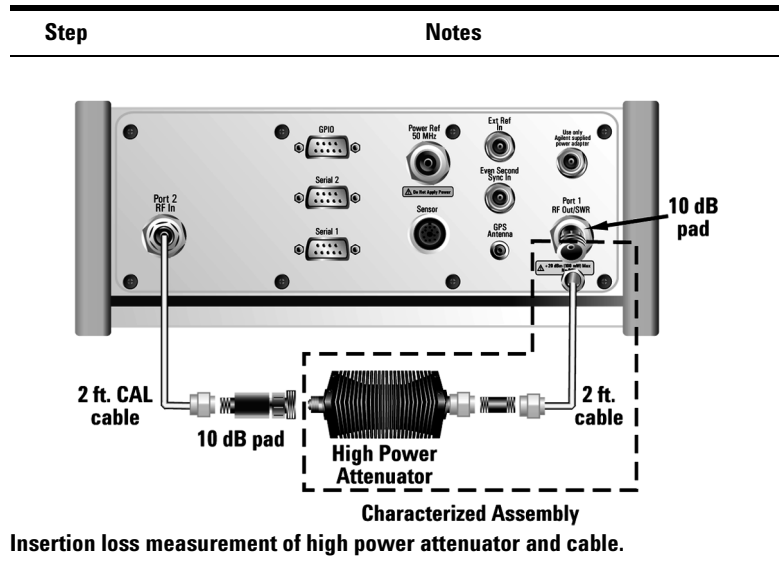
Devices whose insertion loss you measure:

- Test cable (2 ft.)
- Test cable (10 ft.)
- High power attenuator
- N-N barrel

To perform two port insertion loss:

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, softkeys 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 10dB pads.	

To perform two port insertion loss:



For more information, see [“Two Port Insertion Loss”](#) on page 31.

Using the Backpack

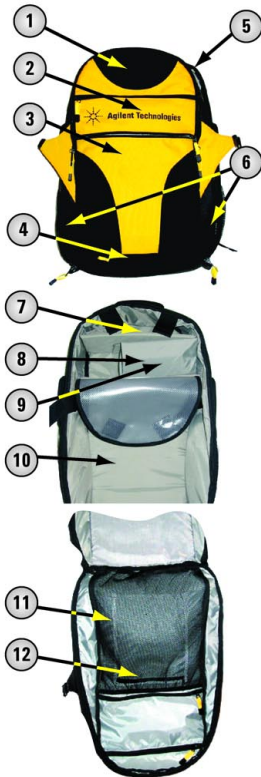
The E7495A backpack is ergonomically designed to hold the test set as well as its cables and accessories. The backpack allows you to carry all your gear up to a base station while keeping your hands free.

**WARNING**

To avoid overheating, always disconnect the test set from the AC adapter before storing the test set in the backpack.

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

What goes where in the backpack



Business card



Writing supplies



Fragile equipment,
such as antennas



Rain fly



Laptop



Food and water



Over-air filter and
other accessories



High power
attenuator



AC adapter



Base station test set



Cables



Batteries



CAUTION: A fully loaded backpack is heavy. Use caution when putting it on or taking it off.

Contacting Agilent

Contact your customer engineer through your local Agilent Technologies Service Center.

In the United States, call **1-800-452-4844**. For other countries, you can find up-to-date, country-specific contact information at:

<http://www.agilent.com/comms/contactus>

If you do not have access to the Internet, contact your local Agilent Technologies Sales and Service Office.

More information from Agilent

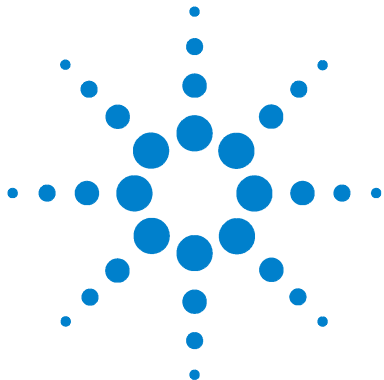
For more information about Agilent's solutions for the communications industry, visit the Agilent web site:
www.agilent.com

Find additional information about the test set:
www.agilent.com/find/basestations

E7495A product updates

Find information about E7495A updates:
www.agilent.com/cm/wireless/e7495a

1 Getting Started



2 Two Port Insertion Loss

"Measuring Two Port Insertion Loss" on page 32

"Performing a basic two port insertion loss measurement" on page 33

"Measuring two port insertion loss for Spectrum Analyzer, Channel Scanner, CDMA Analyzer, and Signal Generator" on page 34

"Measuring insertion loss for Power Meter" on page 36

"Determining the lowest (worst) insertion loss and its frequency" on page 38

"Determining the highest (best) insertion loss and its frequency" on page 38

"Using the delta marker to measure a difference in insertion loss or frequency" on page 38

"Activating interference rejection" on page 39



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—used to 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 RF Out (Port 1) and the receiver under test.
- Measuring the high power attenuator and 2 ft. normalization cable—used to provide 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 **normalize**—compensate for the loss associated with the connecting devices from the value the measurement will provide.

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.	



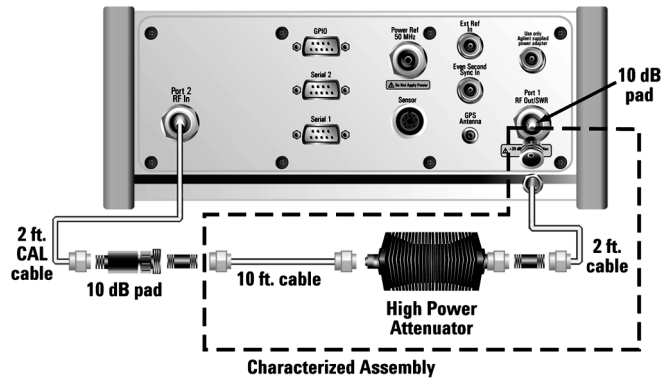
Figure 1 Two port insertion loss measurement results, after normalization.

Measuring two port insertion loss for Spectrum Analyzer, Channel Scanner, CDMA Analyzer, and Signal Generator

To prepare to perform spectrum analysis, CDMA analysis, and signal generator measurements, you must store RF in loss and RF out loss values.

Step	Notes
1	<p>Insert the cable or device.</p> <p>Insert 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.</p>

Step	Notes
------	-------



2	[Level]	<p>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.</p> <ul style="list-style-type: none"> • 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 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.

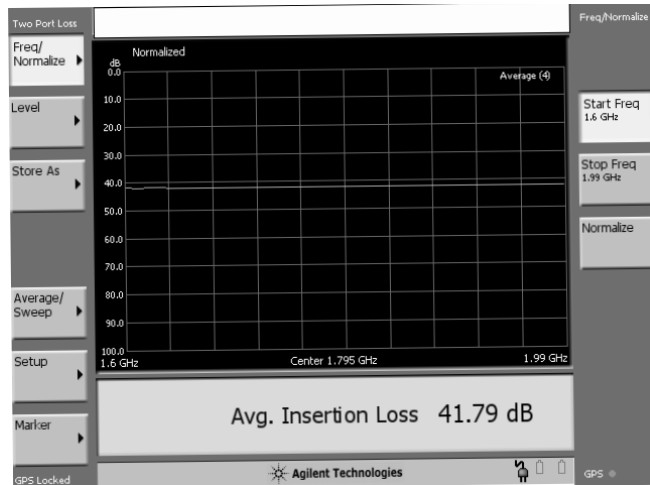
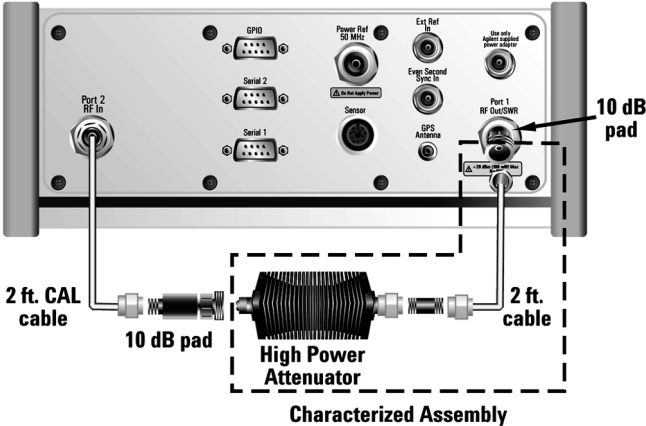


Figure 2 Two port insertion loss measurement results, including effects of 2 ft. cable, 10 ft. cable, and high power attenuator.

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	Insert the cable or device. Insert 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
 <p>The diagram shows a High Power Attenuator connected to a device under test (DUT). Two 2 ft. cables connect the attenuator to the DUT. A 10 dB pad is placed at the input of the DUT. The DUT has a 'Port 1 RF Out/SWR' and a 'Port 2 RF In'. A '10 dB pad' is also shown connected to the 'Port 1 RF Out/SWR'.</p>	
2 [Level]	<p>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.</p> <ul style="list-style-type: none"> • 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]	
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.

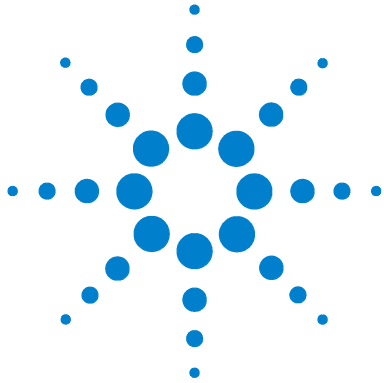
Optimizing dynamic range

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 30dB of dynamic range.

Step	Notes
1	[Setup]

2 Two Port Insertion Loss

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



3 One Port Insertion Loss

["Measuring One Port Insertion Loss"](#) on page 42

["Performing a basic one port insertion loss measurement"](#) on page 42

["Setting one port insertion loss interference rejection"](#) on page 44



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.

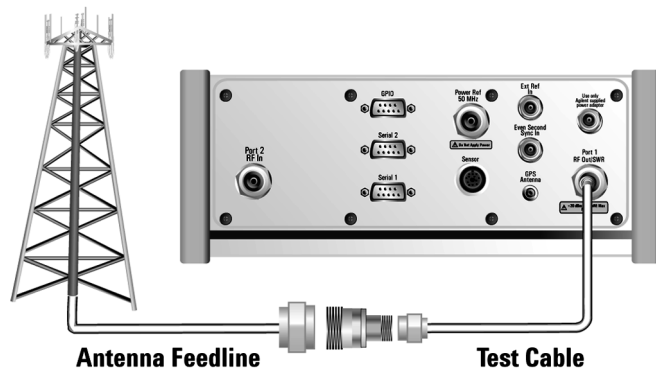
The calibration remains valid until you power off the test set or change the start or stop frequency.

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

Step	Notes
2 [Antenna/Cable]	
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	<p>Disconnect the feedline at the top of the tower, and connect a short connector to the feedline.</p>
13	<p>[Level]</p> <p>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.</p> <ul style="list-style-type: none"> • To choose Autoscale, press [Autoscale]. • To set the level manually, press [Ref Level], enter a value using the number keypad, then press [dB].

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 (while in a one port insertion loss measurement):

Step	Notes
1	[Setup]

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

3 One Port Insertion Loss



4 Return Loss

["Measuring Return Loss" on page 48](#)

["Performing a basic return loss measurement" on page 48](#)

["Isolating a return loss signal using a single sweep" on page 50](#)

["Isolating a return loss signal using a single sweep" on page 50](#)

["Setting return loss interference rejection" on page 50](#)



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.

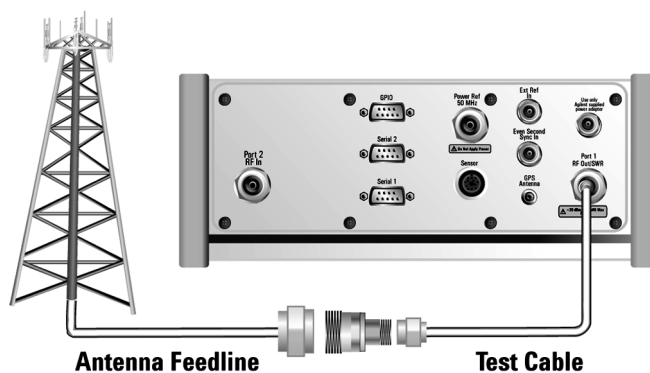
The calibration remains valid until you power off the test set or change the start or stop frequency.

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]

Step	Notes
3 [Return Loss]	The return 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 [Level]	<p>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.</p> <p>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.</p> <ul style="list-style-type: none"> To choose Autoscale, press [Autoscale]. To set the level manually, press [Ref Level], enter a value using the number keypad, then press [dB]. <p>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 53.</p>

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

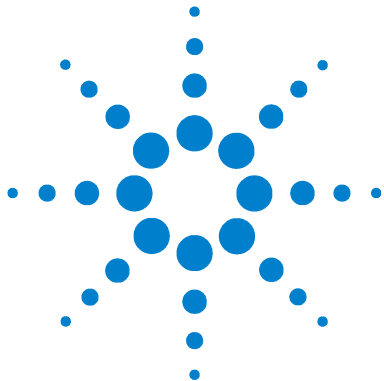
Other signals can interfere with return loss measurements. When making a return loss measurement in the presence of known or suspected interference, you can minimize the effect of the interference on the measurement by activating interference rejection in the test set.

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.

4 Return Loss



5 Distance to Fault

[“Measuring Distance to Fault” on page 54](#)

[“Performing a basic distance to fault measurement \(manual frequency range\)” on page 56](#)

[“Viewing a single distance to fault sweep” on page 59](#)

[“Setting interference rejection for a distance to fault measurement” on page 60](#)

[“Viewing a single distance to fault sweep” on page 59](#)

[“Setting interference rejection for a distance to fault measurement” on page 60](#)



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] softkey 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 cases, 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] softkey 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 lightning 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.

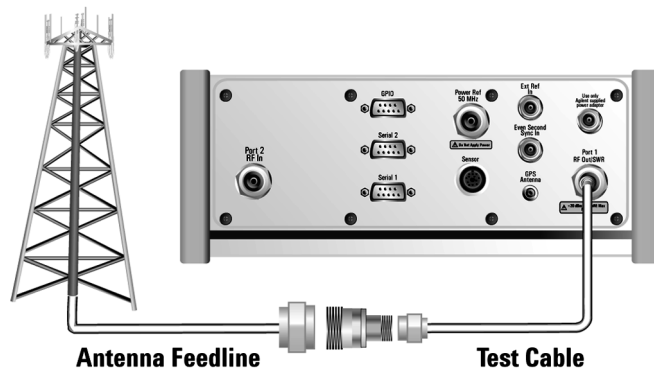
The distance to fault calibration for the **auto frequency range** is unique, however. It is not applicable to return loss or one port insertion loss, or even to the manual frequency range method for distance to fault.

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.
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]	

Step	Notes
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]
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.

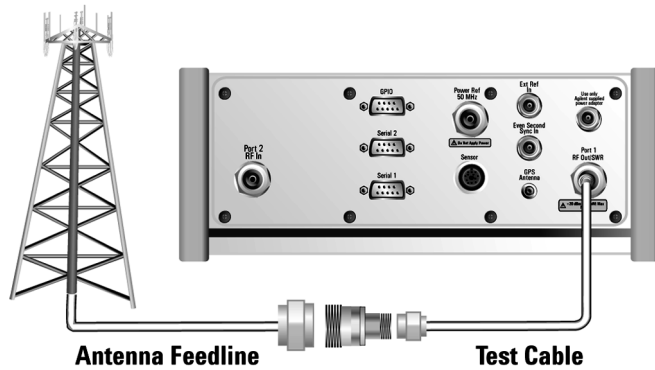


23	(Recommended) [Level] [Autoscale] If you prefer to set the level manually, after pressing [Level], press [Ref Level]. Then enter the value you want using the number keypad and press [dB].
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Performing a basic distance to fault measurement (automatic frequency range)

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

Step	Notes
15	Connect the antenna feedline and antenna. Connect the antenna feedline to the RF OUT/SWR port.



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].
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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.

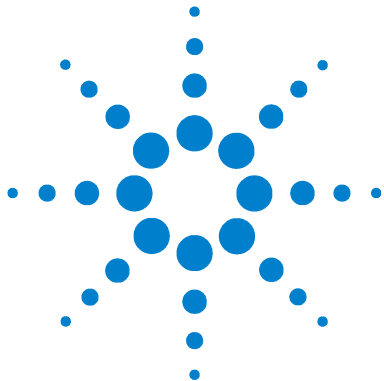
To activate interference rejection (while in a distance to fault measurement):

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.



6 Spectrum Analyzer

"Performing a basic spectrum analyzer measurement" on page 63

"Entering the average and sweep" on page 66

"Changing the resolution bandwidth" on page 66



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

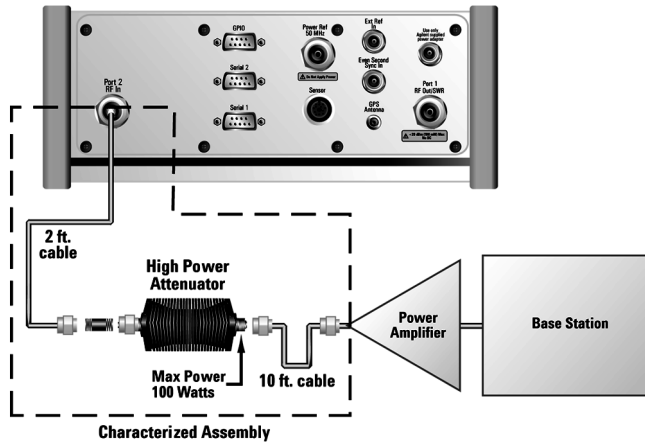
The maximum power for the RF In and RF Out port is 20 dBm (100 mW). The maximum power for the Power Sensor port is 24 dBm (300 mW). When directly coupled to a base station, the test set can be damaged by excessive power applied to any of these three ports.

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.

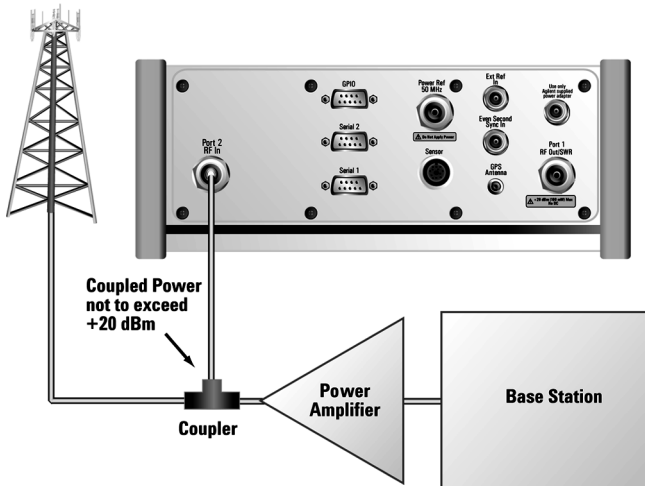
Performing a basic spectrum analyzer measurement

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

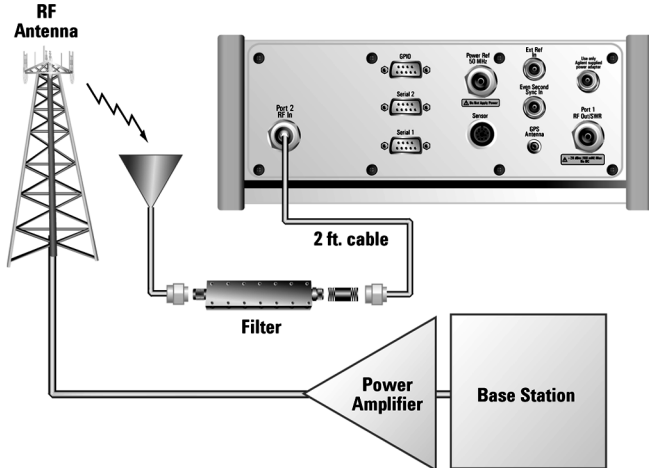
Step	Notes
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Out of service connection



In service connection

Step	Notes
	
<p>Over the air measurement connection</p>	
<p>6 Set the level to Autoscale.</p> <p>a [Level]</p> <p>b [Autoscale]</p>	
<p>7 (Recommended) Display a marker and set it to peak.</p> <p>a [Marker]</p> <p>b On [Type] select Normal.</p> <p>c [Marker to Peak]</p>	<p>The marker value appears in the upper right.</p>

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.

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.

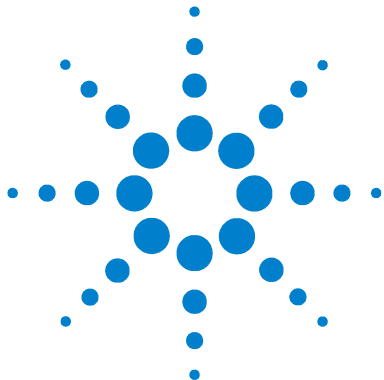
Entering the average and sweep

Step	Notes
1 [Average/Sweep]	
2 [Continuous] or [Single]	Continuous keeps sweeping until single sweep is selected. Single performs a single sweep and stops.
3 [Averaging]	Takes the average of trace cycles and displays the results every nth trace. Averaging applies to the data, not the trace.
4 [Average]	The number of trace cycles applied to the averaging algorithm.

Changing the resolution bandwidth

The default resolution bandwidth is .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.

Step	Notes
• [Setup]	
• 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.
• Enter the bandwidth using the number keypad.	
• [Hz] or [kHz]	



7 Channel Scanner

[“Performing a basic channel scanner measurement” on page 70](#)

[“Displaying accurate peak power \(recommended for pulsed signals\)” on page 74](#)

[“Entering the channels with a list instead of a range” on page 75](#)

[“Entering the channel power measurement bandwidth and time” on page 75](#)

[“Setting the channel power average and sweep” on page 76](#)

[“Displaying frequency or power” on page 77](#)



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

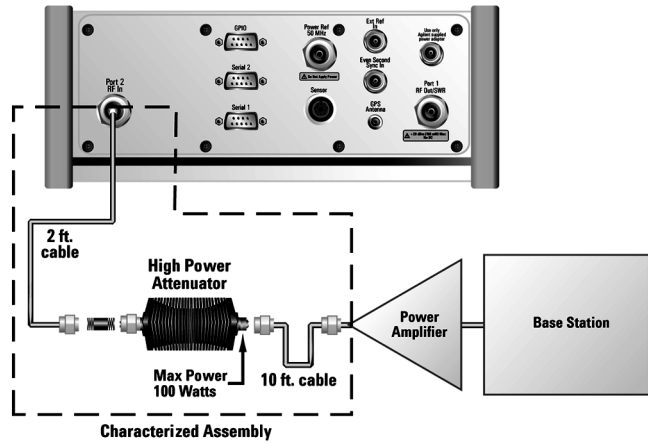
For complex modulation such as CDMA, the frequency error measurement is not accurate.

Performing a basic channel scanner measurement

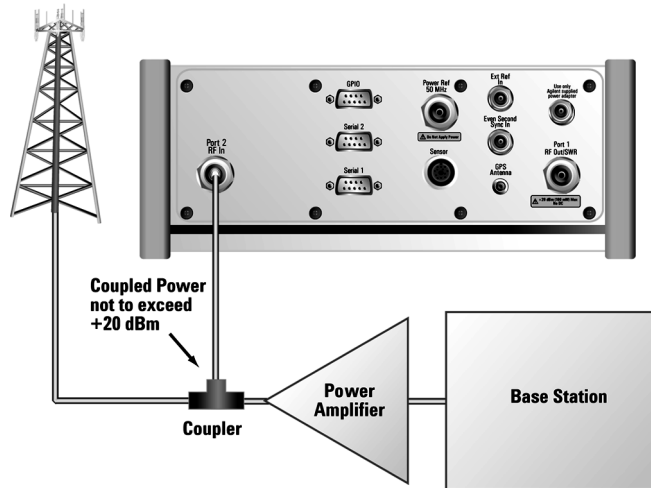
Step	Notes
1	Select Channel Scanner.
	<ul style="list-style-type: none"> a Mode b [Spectrum Analyzer/Tools] c [Channel Scanner]

Step	Notes
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]	
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.	

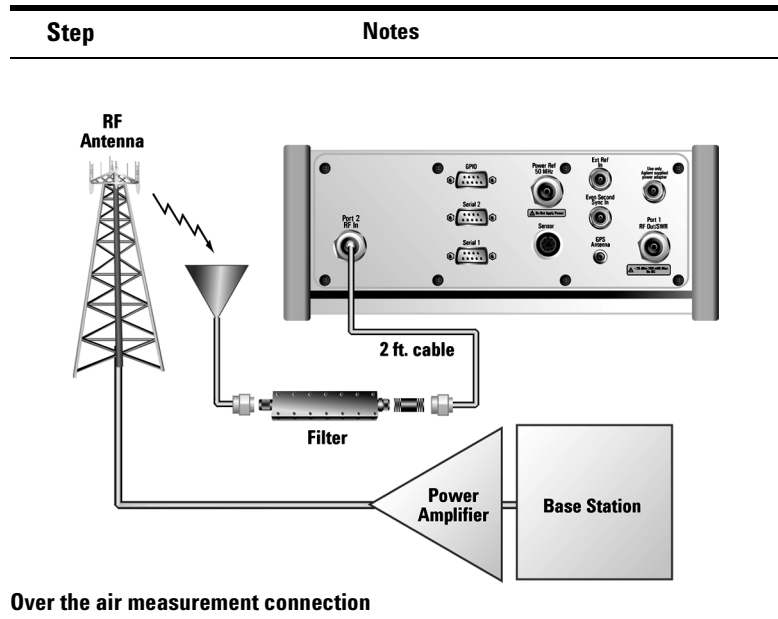
Step	Notes
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Out of service connection



In service connection

**NOTE**

The **autorangeing** 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] softkey is grayed out, the test set needs to be upgraded in order to measure pulsed signals. Contact the Agilent Service Center for upgrade information.

To display peak power (during a channel scanner measurement):

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 the channel power average and sweep

Step	Notes
1 [Average/Sweep]	
2 [Continuous] or [Single]	Continuous sweep continues to sweep until single sweep is selected. Single sweep performs a single sweep and then stops.
3 [Averaging]	Takes the average of trace cycles and displays the results every nth Trace. Averaging applies to the data, not the trace.
4 [Average]	The number of trace cycles applied to the averaging algorithm.

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 Signal Generator

["Using the Signal Generator" on page 80](#)

["Performing a basic signal generator measurement" on page 81](#)



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] softkey after beginning this measurement.

CAUTION

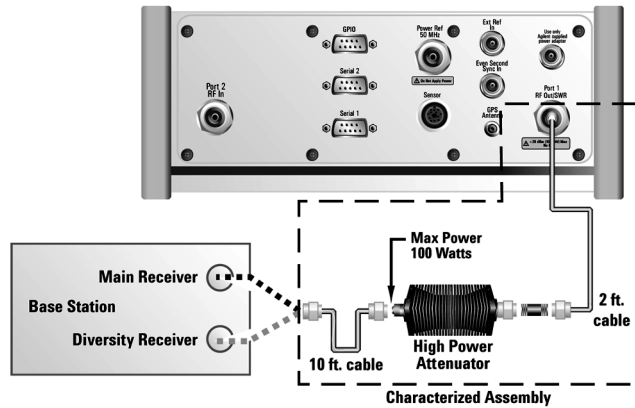
Maximum power is 100 watts at the high power attenuator input.

Performing a basic signal generator measurement

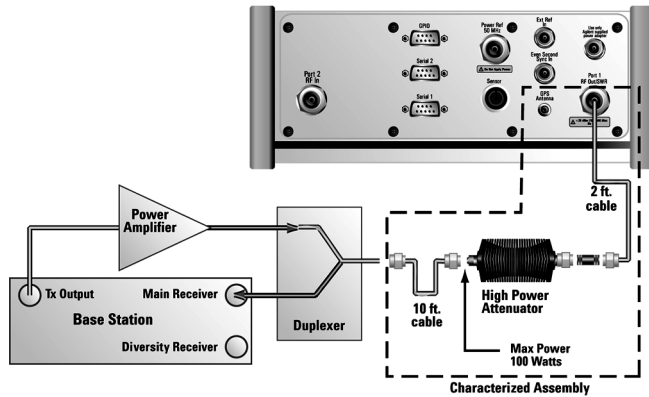
Step	Notes
1 Mode	
2 [Spectrum Analyzer/Tools]	
3 [Signal Generator]	
4 [Freq/Chan/Time Ref Freq Ref]	
5 [Chan Std]	
6 Select the channel standard from the list using the up and down arrow buttons.	
7 [Select]	
8 On [Units] select Chan.	Each time you press this softkey, the selected option changes. The 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 [Modulation] softkey is grayed out, your test set does not include the complex modulation option. You have only CW.
15 [Format]	

Step	Notes
<p>16 Select the modulation type from the list using the up and down arrow keys.</p>	<ul style="list-style-type: none"> • If you have CDMA Forward Link modulation types, select PN Offset. For other modulation types, you do not need to select PN Offset. • If you select cdma2000 modulation, which has fundamental channels, you also need to press [R/FCh Power].
<p>17 [Amplitude]</p>	<p>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].</p>
<p>18 If you have previously stored RF out loss from an insertion loss measurement, go to the next step.</p>	
<p>Or</p>	
<p>Press [RF OUT Loss] and enter the RF out loss value.</p>	
<p>19 Connect to the base station.</p>	

Step	Notes
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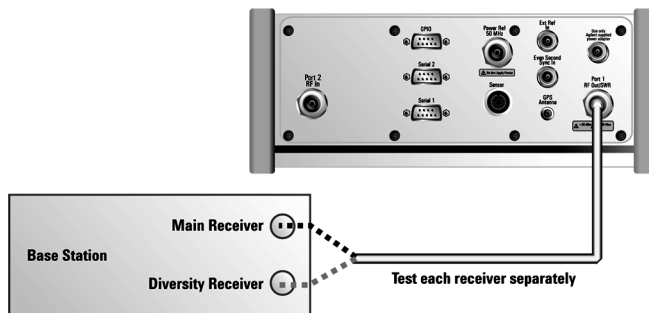


Low level non duplex connection



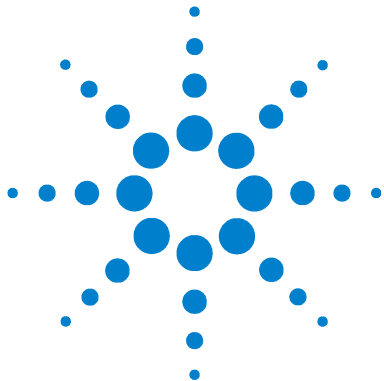
Low level duplex connection

Step	Notes
------	-------



High level non duplex connection

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



9 Power Meter

["Making an Average Power Measurement"](#) on page 86

["Making a basic average power measurement"](#) on page 87

["Making a basic average power measurement"](#) on page 87

["To make a basic average power measurement:"](#) on page 87

["Setting the Power Meter's high and low end-points"](#) on page 90

["Setting the Power Meter's upper and lower limits"](#) on page 91



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 31.

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, 10dB 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]	

Step	Notes
<p>9 Connect the power sensor to the Power Ref 50 MHz port.</p>	
<p>10 [Continue]</p>	
<p>11 [Cal Factor]</p>	
<p>12 Enter the cal factor using the number keypad.</p>	<p>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 2 on page 89 for an example of a power sensor calibration table. Using the example power sensor calibration table, if you were interested in 800 MHz, then:</p> <p>800 MHz has a Cal Factor percentage of ~98.2</p> <p>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.</p>
<p>13 [%]</p>	
<p>14 Connect the external attenuator.</p>	
<p>15 If you have previously stored PM loss from an insertion loss measurement, go to the next step.</p>	
<p>Or</p>	
<p>Press [PM Loss] and enter the PM loss value.</p>	

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.

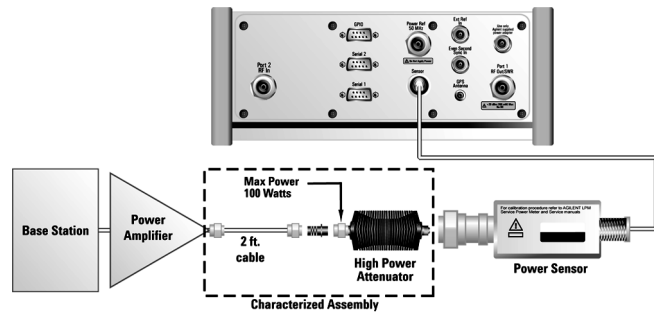


Table 2 Example of a sensor calibration table (Agilent 8482A)

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
2000	97.4
3000	98.1

Table 2 Example of a sensor calibration table (Agilent 8482A)

MHz	CF%
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. <ul style="list-style-type: none"> • [1] = 1 • [2] = 0.1 • [3] = 0.01 • [4] = 0.001

Setting the Power Meter's high and low end-points

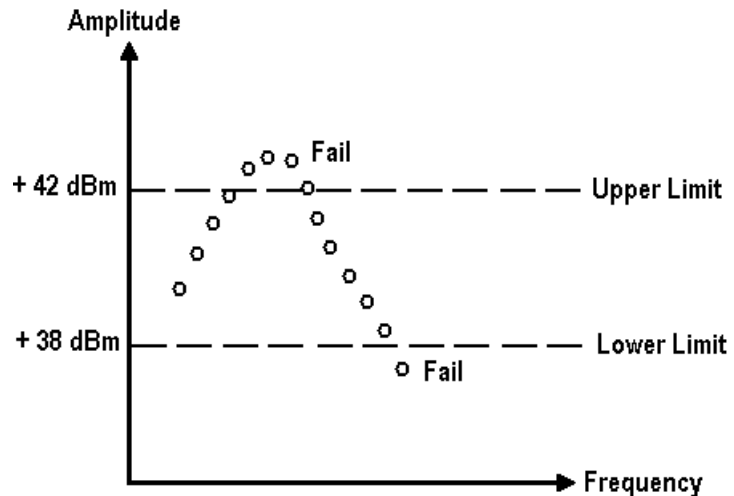
Changing the high and low end points changes the scale resolution, making it easier to view small changes in power. This does not change the range of the sensor.

Step	Notes
1 [Mode]	
2 [Power Meter]	
3 [Setup]	
4 [Low End]	

Step	Notes
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]

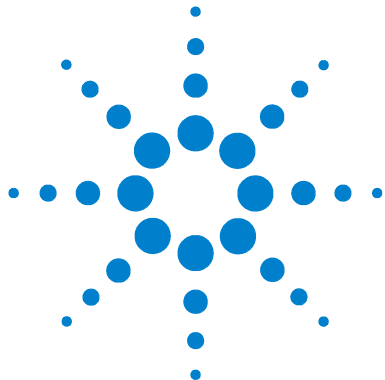
Setting the Power Meter's upper and lower limits

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



Step	Notes
1	[Mode]

Step	Notes
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]



10 T1 Analyzer

- "Making T1 Measurements" on page 94
- "Getting started with T1 testing" on page 94
- "Selecting Hard Loop/End-End Full T1" on page 94
- "Selecting Loopback CSU Full T1 BERT" on page 102
- "Selecting the Monitor Test Mode" on page 110
- "Multiple test sets monitoring BER along a T1 route" on page 117
- "Selecting Delay" on page 123
- "Patterns" on page 127
- "Measurement Results" on page 129



Making T1 Measurements

The E7495A provides 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 129.

Getting started with T1 testing

Step	Notes
1 [Mode]	
2 [Backhaul]	
3 [T1 Analyzer]	
4 [Get Started/ Test Mode]	<p>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. Do the following in this order:</p> <ul style="list-style-type: none"> • Select a test [Get Started/ Test Mode] • Select [Setup] • Select [Display] • Select [Control]

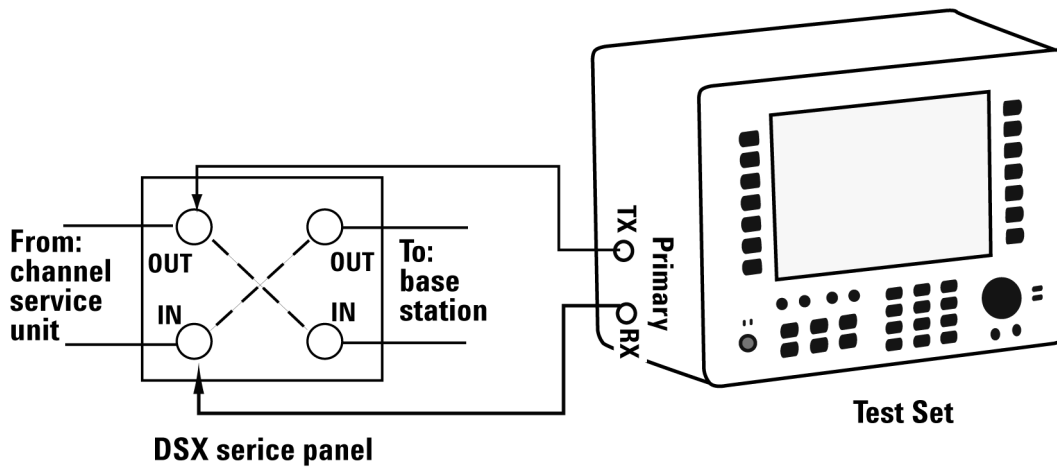
Selecting Hard Loop/End-End Full T1

Use this test mode to perform measurements such as BERT on a T1 circuit. 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.

End to end connection diagram



Step	Notes
1	[Mode]
2	[Backhaul]
3	[T1 Analyzer]
4	[Get Started/ Test Mode]
5	[Hard Loop/End-End]

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.

Step	Notes
6 [Full T1 BERT]	Select this to perform a BERT test on a full T1 Circuit.
7 [Auto Config]	Enables the Auto Configuration buttons.
8 [Primary Auto Config]	Causes the test set to analyze the incoming T1 signal and align the setup choices to the properties of that signal.
9 [Back]	Shifts focus back to the main mode selection buttons.
10 [Setup]	Select this to display a list of setup choices that pertain to this test mode.
11 [RX Input]	<p>Configures the RX Input properties on the test set. Select Terminate, Monitor, or Bridge. The Primary and Secondary inputs are both affected by this setting.</p> <ul style="list-style-type: none"> • Terminate sets the input impedance to 100 Ohms and should be selected when the T1 circuit is interrupted. • 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 a T1 circuit.
12 [Terminate]	This assumes the test set is connected into a jack that interrupts the T1 circuit.
13 [Line Code]	<p>Configures the test set to transmit and expect to receive a line code that is compatible with the circuit's provisioning.</p> <ul style="list-style-type: none"> • 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 patters by enhancing repeater synchronization by increasing pulse density thereby providing greater throughput.

Step	Notes
14 [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 data contains a string of 8 or more consecutive zeros.
15 [Framing]	Configures the test set to transmit and expect to receive a particular framing pattern that is compatible with the circuit's provisioning. <ul style="list-style-type: none"> • Unframed - The 193rd (framing) bit is set to 1. • 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
16 [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.
17 [Pattern]	Select a pattern.
18 [QRSS]	
19 [TX Clock]	Configures the test set to use one of the following methods to derive the transmit clock frequency. <ul style="list-style-type: none"> • 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.

Step	Notes
20 [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.
21 [TX LBO]	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. <ul style="list-style-type: none"> • 0dB LBO = 0 dBdsx = 6 Vpp • -7.5 dB LBO = -7.5 dBdsx = 2.53 Vpp • -15 dB LBO = -15 dBdsx = 1.07 Vpp
22 [0 dB]	This is a typical level found at the customer demarcation point.
23 [Channel]	This is applicable in only the Channel BERT mode. This sets the active channel to be tested for BERT.
24 [Not Applicable]	Not applicable in Full T1 BERT
25 [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. <ul style="list-style-type: none"> • 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 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.
26 [Not Applicable]	Not applicable in Full T1 BERT

Step	Notes
27 [ESF Loopback Code]	Not applicable in this mode
28 [Slip Ref]	<p>Selects the reference for the frame slip measurement.</p> <ul style="list-style-type: none"> • 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.
29 [None]	Disables the frame slip measurement.
30 [Second TX]	<p>Selects the source of data of the signal available at the Secondary TX jack.</p> <ul style="list-style-type: none"> • AIS - The signal at the Secondary RX jack is an unframed all ones a.k.a. AIS or Blue Alarm • 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.
31 [AIS]	Use the default condition.
32 [Display]	Enables the [Display] options on the right-hand buttons.

Step	Notes
33 [Status]	Selects the source of data of the signal available at the Secondary TX jack. <ul style="list-style-type: none"> • AIS - The signal at the Secondary RX jack is an unframed all ones a.k.a. AIS or Blue Alarm • 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.
34 [Pri]	Activates only the Primary Status pane. The inactive channel should be deactivated to cease the display of invalid measurements.
35 [Alarms]	This selection causes the Alarm pane to toggle between Primary and Secondary.
36 [Pri]	Use this selection to observe the Primary Results in the Alarm Panel.
37 [Results]	Enables a list of results information that can be displayed in the Results pane. Make a selection based on the need of the application.
38 [Control]	The selection enables several right-hand soft keys that control choices specific to each test mode.
39 [Pattern]	Select a pattern.

Step	Notes
40 [Alarm/Error]	<p>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.</p> <ul style="list-style-type: none"> • Loss of Signal Alarm - The test 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 zeroes. • AIS Alarm - The test set sends an AIS a.k.a Blue Alarm by sending an unframed all ones pattern. • Idle Alarm - The test set sends a framed all zero pattern. Note that the far end will also 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. Note that this is possible when only the ESF mode is selected. • The test set forces an error in the transmitted patten with each press of the Inject button.
41 [Loss of Signal]	<p>Causes the signal to be interrupted when the Inject button is pressed.</p>
42 [Inject]	<p>Causes the error or condition that is currently displayed on the 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.</p>

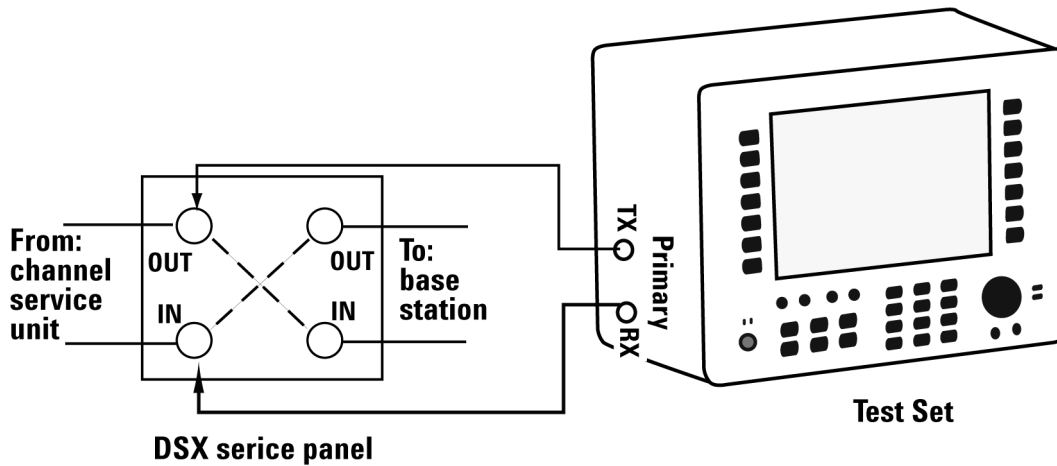
Selecting Loopback CSU Full T1 BERT

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.

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 methods 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 subject to 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.

CSU Full T1 BERT loopback connection diagram



Step	Notes	
1	[Mode]	
2	[Backhaul]	
3	[T1 Analyzer]	
4	[Get Started/ Test Mode]	
5	[Loopback CSU/NIU]	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.
6	[CSU Full T1 BERT]	Select this to perform a BERT test on a full T1 Circuit.
7	[Auto Config]	Auto Configuration is not available in this mode.

Step	Notes
8 [Setup]	Select this to display a list of setup choices that pertain to this test mode.
9 [RX Input]	<p>Configures the RX Input properties on the test set. Select Terminate, Monitor, or Bridge. The Primary and Secondary inputs are both affected by this setting.</p> <ul style="list-style-type: none"> • Terminate sets the input impedance to 100 Ohms and should be selected when the T1 circuit is interrupted. • 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 a T1 circuit.
10 [Terminate]	This assumes the test set is connected into a jack that interrupts the T1 circuit.
11 [Line Code]	<p>Configures the test set to transmit and expect to receive a line code that is compatible with the circuit's provisioning.</p> <ul style="list-style-type: none"> • 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 patters by enhancing repeater synchronization by increasing pulse density thereby providing greater throughput.
12 [B8ZS]	This assumes the circuit is provisioned for B8ZS.

Step	Notes
13 [Framing]	<p>Configures the test set to transmit and expect to receive a particular framing pattern that is compatible with the circuit's provisioning.</p> <ul style="list-style-type: none"> • Unframed - The 193rd (framing) bit is set to 1. • 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
14 [ESF]	This assumes that the circuit has been provisioned for ESF.
15 [Pattern]	Select a pattern.
16 [QRSS]	
17 [TX Clock]	<p>Configures the test set to use one of the following methods to derive the transmit clock frequency.</p> <ul style="list-style-type: none"> • 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.
18 [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.

Step	Notes
19 [TX LBO]	<p>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.</p> <ul style="list-style-type: none"> • 0dB LBO = 0 dBdsx = 6 Vpp • -7.5 dB LBO = -7.5 dBdsx = 2.53 Vpp • -15 dB LBO = -15 dBdsx = 1.07 Vpp
20 [0 dB]	<p>This is a typical level found at the customer demarcation point.</p>
21 [Channel]	<p>This is applicable in only the Channel BERT mode. This sets the active channel to be tested for BERT.</p>
22 [Not Applicable]	<p>Not applicable in Full T1 BERT</p>
23 [Fill Data]	<p>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.</p> <ul style="list-style-type: none"> • 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 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.

Step	Notes
24 [ESF Loopback Code]	Selects the format of the transmitted code when a loop-up or loop-down is requested. <ul style="list-style-type: none"> • 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.
25 [In-band]	Depends on the far-end CSU configuration.
26 [Slip Ref]	Selects the reference for the frame slip measurement. <ul style="list-style-type: none"> • 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.
27 [None]	Disables the frame slip measurement.
28 [Second TX]	Selects the source of data of the signal available at the Secondary TX jack. <ul style="list-style-type: none"> • AIS - The signal at the Secondary RX jack is an unframed all ones a.k.a. AIS or Blue Alarm • 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.
29 [AIS]	Use the default condition.

Step	Notes
30 [Display]	Enables the [Display] options on the right-hand buttons.
31 [Status]	<p>Selects the source of data of the signal available at the Secondary TX jack.</p> <ul style="list-style-type: none"> • AIS - The signal at the Secondary RX jack is an unframed all ones a.k.a. AIS or Blue Alarm • 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.
32 [Pri]	Activates only the Primary Status pane. The inactive channel should be deactivated to cease the display of invalid measurements.
33 [Alarms]	This selection causes the Alarm pane to toggle between Primary and Secondary.
34 [Pri]	Use this selection to observe the Primary Results in the Alarm Panel.
35 [Results]	Enables a list of results information that can be displayed in the Results pane. Make a selection based on the need of the application.
36 [Control]	The selection enables several right-hand soft keys that control choices specific to each test mode.
37 [Pattern]	Select a pattern.

Step	Notes
38 [Alarm/Error]	<p>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.</p> <ul style="list-style-type: none"> • Loss of Signal Alarm - The test 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 zeroes. • AIS Alarm - The test set sends an AIS a.k.a Blue Alarm by sending an unframed all ones pattern. • Idle Alarm - The test set sends a framed all zero pattern. Note that the far end will also 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. Note that this is possible when only the ESF mode is selected. • The test set forces an error in the transmitted patter with each press of the Inject button.
39 [Loss of Signal]	<p>Causes the signal to be interrupted when the Inject button is pressed.</p>
40 [Inject]	<p>Causes the error or condition that is currently displayed on the 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.</p>
41 [Send Loop Up]	<p>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)</p>

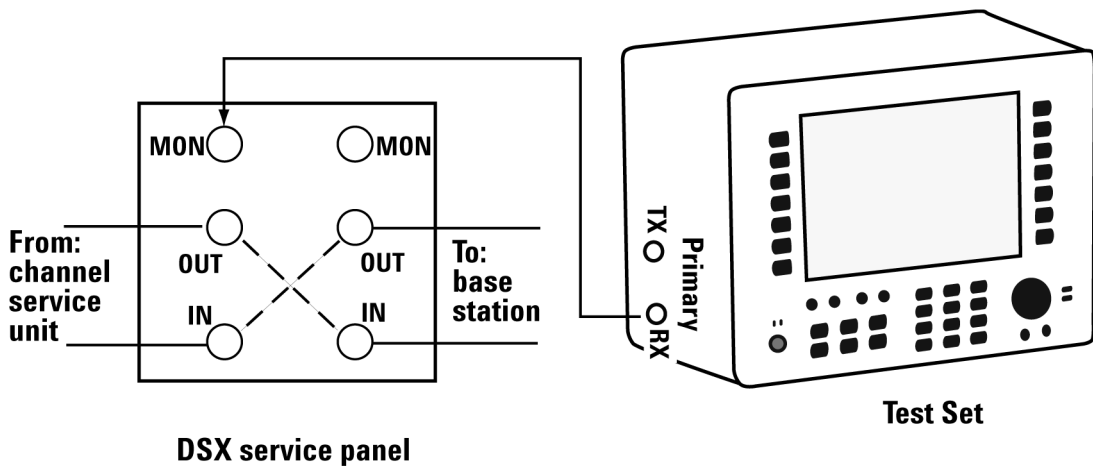
Step	Notes
42 [Send Loop Down]	Sends a loop down command to the far end and reports the loop state on the status line.

Selecting the Monitor Test Mode

Use this test mode to monitor performance without disrupting service on a T1 circuit. During this test the source of 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. (Editor's note show a diagram at the end of this section showing several test sets along a route monitoring BER.)

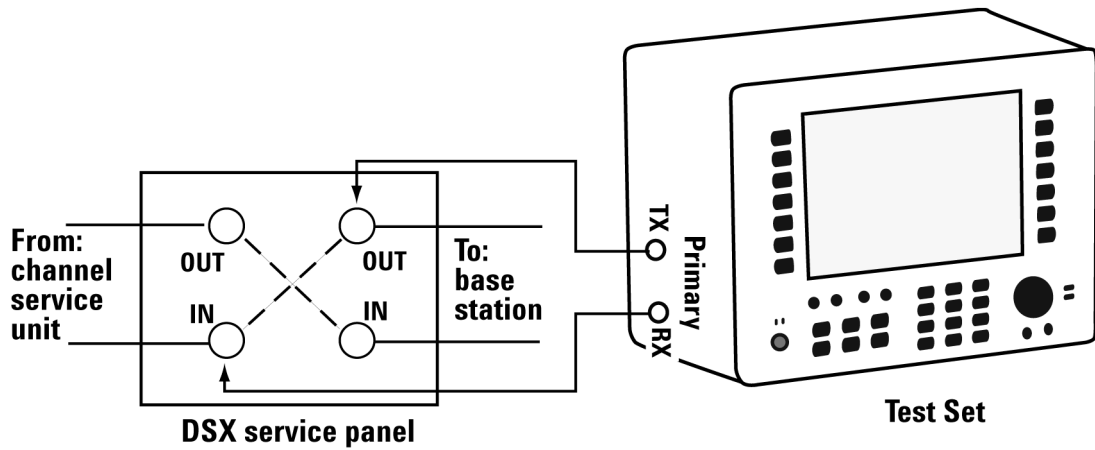
Typical Connection for monitoring a T1 circuit. Set Rx Input to monitor

Monitor Mode Connect Diagram



Typical Connection for terminating a T1 circuit. Set Rx Input to terminate

Termination mode connect diagram



Step	Notes
1	[Mode]
2	[Backhaul]
3	[T1 Analyzer]
4	[Get Started/ Test Mode]

Step	Notes
5 [Monitor]	Use this test mode to monitor performance without disrupting service on a T1 circuit. During this test the source of 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. (Editor's note show a diagram at the end of this section showing several test sets along a route monitoring BER.)
6 [Monitor Full T1]	Choose this to monitor performance of a full T1Circuit.
7 [Auto Config]	Enables the Auto Configuration buttons.
8 [Primary Auto Config]	Causes the test set to analyze the incoming T1 signal and align the setup choices to that signal.
9 [Back]	Shifts focus back to the main mode selection buttons.
10 [Setup]	Select this to display a list of setup choices that pertain to this test mode.
11 [RX Input]	<p>Configures the RX Input properties on the test set. Select Terminate, Monitor, or Bridge. The Primary and Secondary inputs are both affected by this setting.</p> <ul style="list-style-type: none"> • Terminate sets the input impedance to 100 Ohms and should be selected when the T1 circuit is interrupted. • 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 a T1 circuit.

Step	Notes
12 [Terminate]	This assumes the test set is connected into a jack that interrupts the T1 circuit.
13 [Line Code]	<p>Configures the test set to transmit and expect to receive a line code that is compatible with the circuit's provisioning.</p> <ul style="list-style-type: none"> • 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 patters by enhancing repeater synchronization by increasing pulse density thereby providing greater throughput.
14 [B8ZS]	This assumes the circuit is provisioned for B8ZS.
15 [Framing]	<p>Configures the test set to transmit and expect to receive a particular framing pattern that is compatible with the circuit's provisioning.</p> <ul style="list-style-type: none"> • Unframed - The 193rd (framing) bit is set to 1. • 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
16 [ESF]	This assumes that the circuit has been provisioned for ESF.
17 [Pattern]	Select a pattern.
18 [QRSS]	Set to the pattern sent by the far-end.
19 [TX Clock]	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
20 [Internal]	This is the default selection after test set preset.

Step	Notes
21 [TX LBO]	<p>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.</p> <ul style="list-style-type: none"> • 0dB LBO = 0 dBdsx = 6 Vpp • -7.5 dB LBO = -7.5 dBdsx = 2.53 Vpp • -15 dB LBO = -15 dBdsx = 1.07 Vpp
22 [0 dB]	This is a typical level found at the customer demarcation point.
23 [Channel]	This is applicable in only the Channel BERT mode. This sets the active channel to be tested for BERT.
24 [Not Applicable]	Not applicable in Monitor Full T1 mode.
25 [Fill Data]	<p>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.</p> <ul style="list-style-type: none"> • 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 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.
26 [Not Applicable]	Not applicable in monitor full T1 mode.
27 [ESF Loopback Code]	Not applicable in monitor test mode.
28 [In-band]	Depends on the far-end CSU configuration.

Step	Notes
29 [Slip Ref]	Selects the reference for the frame slip measurement. <ul style="list-style-type: none"> • 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.
30 [None]	Disables the frame slip measurement.
31 [Second TX]	Selects the source of data of the signal available at the Secondary TX jack. <ul style="list-style-type: none"> • AIS - The signal at the Secondary RX jack is an unframed all ones a.k.a. AIS or Blue Alarm • 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.
32 [AIS]	Use the default condition.
33 [Display]	Enables the [Display] options on the right-hand buttons.
34 [Status]	Selects the source of data of the signal available at the Secondary TX jack. <ul style="list-style-type: none"> • AIS - The signal at the Secondary RX jack is an unframed all ones a.k.a. AIS or Blue Alarm • 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.

Step	Notes
35 [Pri]	Activates only the Primary Status pane. The inactive channel should be deactivated to cease the display of invalid measurements.
36 [Alarms]	This selection causes the Alarm pane to toggle between Primary and Secondary.
37 [Pri]	Use this selection to observe the Primary Results in the Alarm Panel.
38 [Results]	Enables a list of results information that can be displayed in the Results pane. Make a selection based on the need of the application.
39 [Control]	The selection enables several right-hand soft keys that control choices specific to each test mode.
40 [Pattern]	Select a pattern.

Step	Notes
1 [Mode]	
2 [Backhaul]	
3 [T1 Analyzer]	
4 [Get Started/ Test Mode]	
5 [Monitor]	Use this mode to monitor live data on the T1 line without affecting service.
6 [Setup]	
7 [Display]	
8 [Display]	
9 [Control]	
10 Connect the Test Set to the T1 Line	Connect the test to the Primary TX/RX connector on the left-side of the Test Set.

Multiple test sets monitoring BER along a T1 route



Selecting Emulate CSU/NIU

Use this 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.

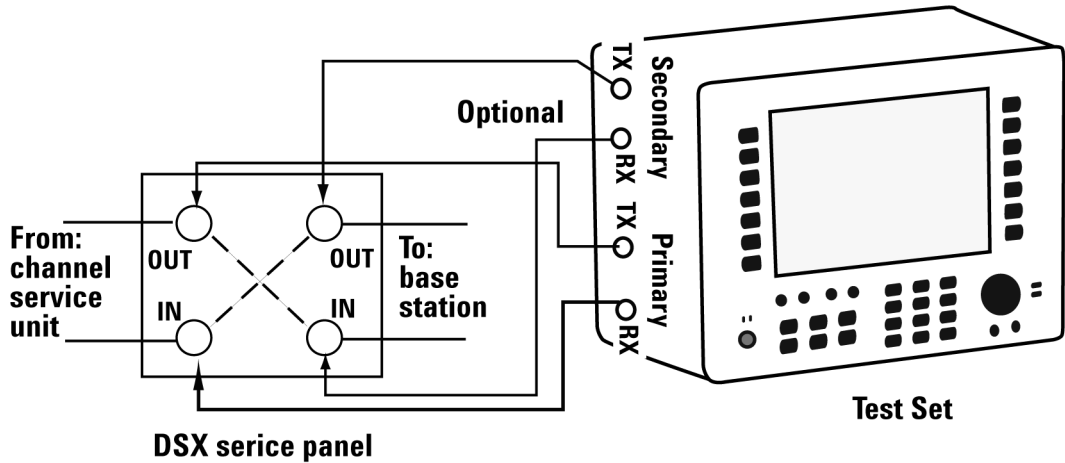


Table 3 Data source for Primary Tx and Secondary Tx during loop-up and loop-down states in emulate mode

Jack	Loop Up	Loop Down
Primary Tx	Primary Rx	<ul style="list-style-type: none"> • AIS when no signal present at Secondary Rx • Secondary Rx
Secondary Tx	Secondary Rx	<ul style="list-style-type: none"> • AIS

Step	Notes
1	[Mode]
2	[Backhaul]
3	[T1 Analyzer]

Step	Notes
4 [Get Started/ Test Mode]	
5 [Emulate CSU/NIU]	<p>Use this 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. Avoid having a hard loop in the Secondary channel as it will cause a constant loop condition to exist.</p>
6 [Emulate CSU]	Choose this to emulate a CSU.
7 [Auto Config]	Auto Configuration is not available in this mode.
8 [Setup]	Select this to display a list of setup choices that pertain to this test mode.
9 [RX Input]	<p>Configures the RX Input properties on the test set. Select Terminate, Monitor, or Bridge. The Primary and Secondary inputs are both affected by this setting.</p> <ul style="list-style-type: none"> • Terminate sets the input impedance to 100 Ohms and should be selected when the T1 circuit is interrupted. • 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 a T1 circuit.
10 [Terminate]	This assumes the test set is connected into a jack that interrupts the circuit.

Step	Notes
11 [Line Code]	<p>Configures the test set to transmit and expect to receive a line code that is compatible with the circuit's provisioning.</p> <ul style="list-style-type: none"> • 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 patters by enhancing repeater synchronization by increasing pulse density thereby providing greater throughput.
12 [B8ZS]	This assumes the circuit is provisioned for B8ZS.
13 [Framing]	<p>Configures the test set to transmit and expect to receive a particular framing pattern that is compatible with the circuit's provisioning.</p> <ul style="list-style-type: none"> • Unframed - The 193rd (framing) bit is set to 1. • 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
14 [ESF]	This assumes that the circuit has been provisioned for ESF.
15 [Pattern]	Select a pattern.
16 [QRSS]	
17 [TX Clock]	This selection is not applicable to Emulate Test Mode.
18 [Internal]	This is the default selection after test set preset.

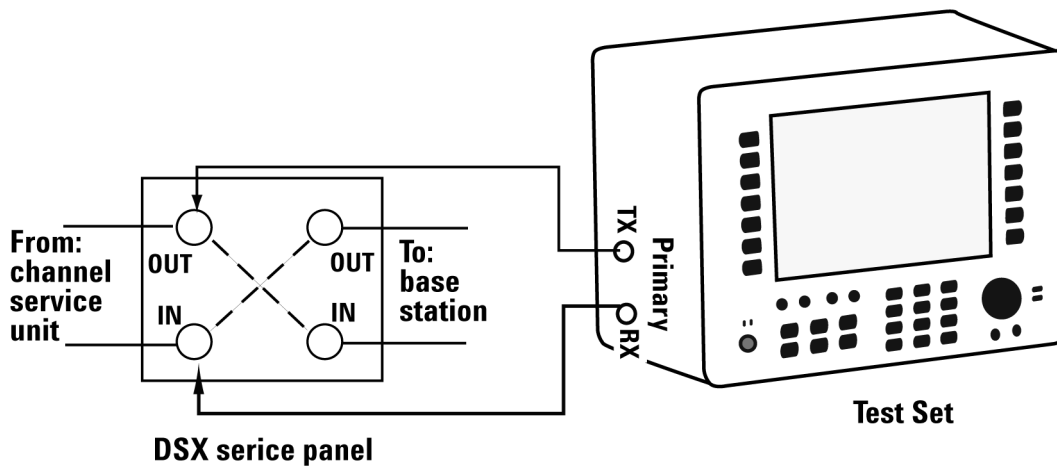
Step	Notes
19 [TX LBO]	<p>TX Line Build Out [TX LBO] sets the TX level and pulse shape to simulate the signal conditions that would be encountered at the end of a distant transmission cable. This is useful for testing equipment suspect of having trouble receiving signals found in typical applications.</p> <ul style="list-style-type: none"> • 0dB LBO = 0 dBdsx = 6 Vpp • -7.5 dB LBO = -7.5 dBdsx = 2.53 Vpp • -15 dB LBO = -15 dBdsx = 1.07 Vpp
20 [0 dB]	This is a typical level found at the customer demarcation point.
21 [Channel]	This selection is not applicable to Emulate Test Mode.
22 [Not Applicable]	This selection is not applicable to Emulate Test Mode.
23 [Fill Data]	<ul style="list-style-type: none"> • This selection is not applicable to Emulate Test Mode.
24 [ESF Loopback Code]	<ul style="list-style-type: none"> • Configures what type of loop code this test set will respond to.
25 [ESF Data Link]	Requires a Datalink loop code for this test set to enter loopback mode.
26 [Slip Ref]	<p>Selects the reference for the frame slip measurement.</p> <ul style="list-style-type: none"> • 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.

Step	Notes
27 [None]	Disables the frame slip measurement.
28 [Second TX]	Selects the source of data of the signal available at the Secondary TX jack. <ul style="list-style-type: none"> • AIS - The signal at the Secondary RX jack is an unframed all ones a.k.a. AIS or Blue Alarm • 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.
29 [AIS]	Use the default condition.
30 [Display]	Enables the [Display] options on the right-hand buttons.
31 [Status]	Allows the following display choices: <ul style="list-style-type: none"> • Pri - Activates the Primary Status pane. • Sec - Activates the Secondary Status Pane. • Both - Activates the Primary and Secondary Status panes.
32 [Pri]	Activates only the Primary Status pane. The inactive channel should be deactivated to cease the display of invalid measurements.
33 [Alarms]	This selection causes the Alarm pane to toggle between Primary and Secondary.
34 [Pri]	Use this selection to observe the Primary Results in the Alarm Panel.
35 [Results]	Enables a list of results information that can be displayed in the Results pane. Make a selection based on the need of the application.
36 [Control]	The selection enables several right-hand soft keys that control choices specific to each test mode.
37 [Pattern]	Select a pattern.
38 [Self Loop Up]	Forces the test set to enter loop-up state.
39 [Self Loop Down]	Forces the test set to enter loop-down state.

Selecting Delay

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.

Delay connection diagram



Step	Notes
1	[Mode]
2	[Backhaul]
3	[T1 Analyzer]

Step	Notes
4 [Get Started/ Test Mode]	
5 [Delay]	<p>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.</p>
6 [Delay]	<p>Choose this to perform a Delay test on a full T1 Circuit.</p>
7 [Full T1]	<p>Delay measurements require full T1 bandwidth</p>
8 [Setup]	<p>Select this to display a list of setup choices that pertain to this test mode.</p>
9 [RX Input]	<p>Configures the RX Input properties on the test set. Select Terminate, Monitor, or Bridge. The Primary and Secondary inputs are both affected by this setting.</p> <ul style="list-style-type: none"> • Terminate sets the input impedance to 100 Ohms and should be selected when the T1 circuit is interrupted. • 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 a T1 circuit.
10 [Terminate]	<p>This assumes the test set is connected into a jack that interrupts the circuit.</p>

Step	Notes
11 [Line Code]	Configures the test set to transmit and expect to receive a line code that is compatible with the circuit's provisioning. <ul style="list-style-type: none"> • 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 patters by enhancing repeater synchronization by increasing pulse density thereby providing greater throughput.
12 [B8ZS]	This assumes the circuit is provisioned for B8ZS.
13 [Framing]	Configures the test set to transmit and expect to receive a particular framing pattern that is compatible with the circuit's provisioning. <ul style="list-style-type: none"> • Unframed - The 193rd (framing) bit is set to 1. • 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
14 [ESF]	This assumes that the circuit has been provisioned for ESF.
15 [Pattern]	Allows the selection of the idle pattern.
16 [QRSS]	Not applicable in Delay mode.
17 [TX Clock]	Not applicable in Delay mode.
18 [Internal]	This is the default selection after test set preset.

Step	Notes
19 [TX LBO]	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. <ul style="list-style-type: none"> • 0dB LBO = 0 dBdsx = 6 Vpp • -7.5 dB LBO = -7.5 dBdsx = 2.53 Vpp • -15 dB LBO = -15 dBdsx = 1.07 Vpp
20 [0 dB]	This is a typical level found at the customer demarcation point.
21 [Channel]	Not applicable in Delay mode.
22 [Fill Data]	Not applicable in Delay mode.
23 [ESF Loopback Code]	Not applicable in Delay mode.
24 [ESF Data Link]	Not applicable in Delay mode.
25 [Slip Ref]	Not applicable in Delay mode.

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 as 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 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

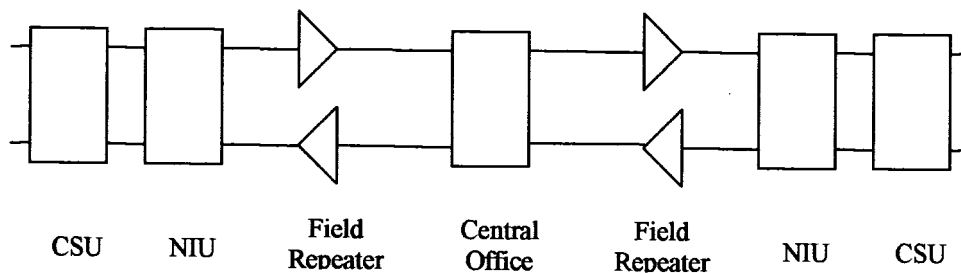
The complexity of T1 testing certainly parallels or possibly exceeds that of RF tests at a cell site. Shadowing efforts and customer expression have shown that most cell site technicians reduce the complexities of backhaul T1 testing down into a series of well-defined steps. These tests are often not 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 X shows a typical circuit layout.

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

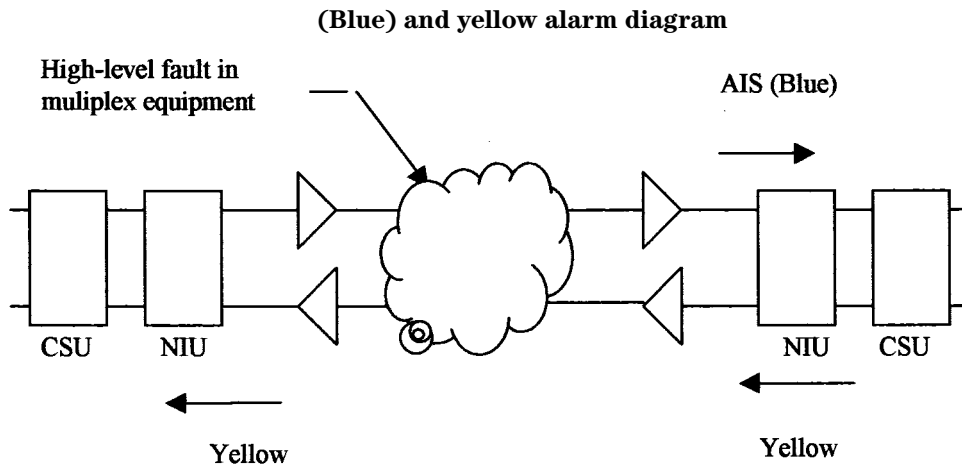
central office. The repeaters are powered from the central office. Typically 90 volts is provided between the center-taps of the transmit and receive transformers. A particular repeater can be looped back by applying a specific loop-back tone. Often a label affixed to the cabinet denotes the loop-back 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) a.k.a. 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. The following diagram applies:



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 4 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 5 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

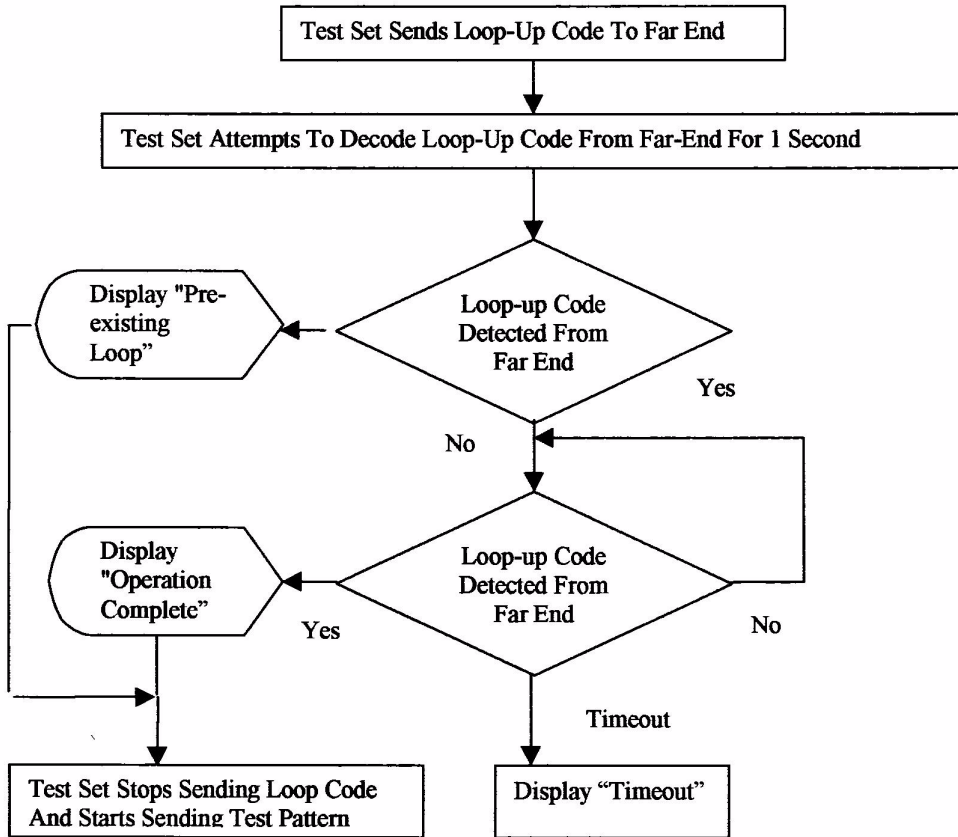
More Information About T1 Testing

Detailed loop mode and auto configuration descriptions

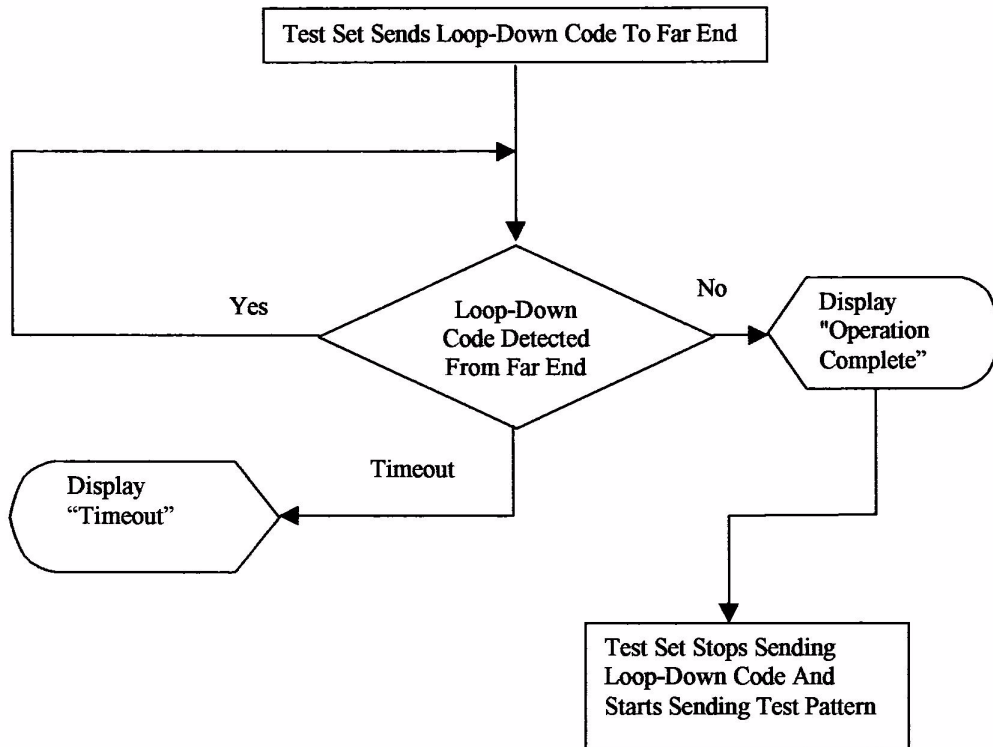
Remote CSU/NIU Loop Mode

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 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.

Flow diagram of in-band loop-up code originating from the test set

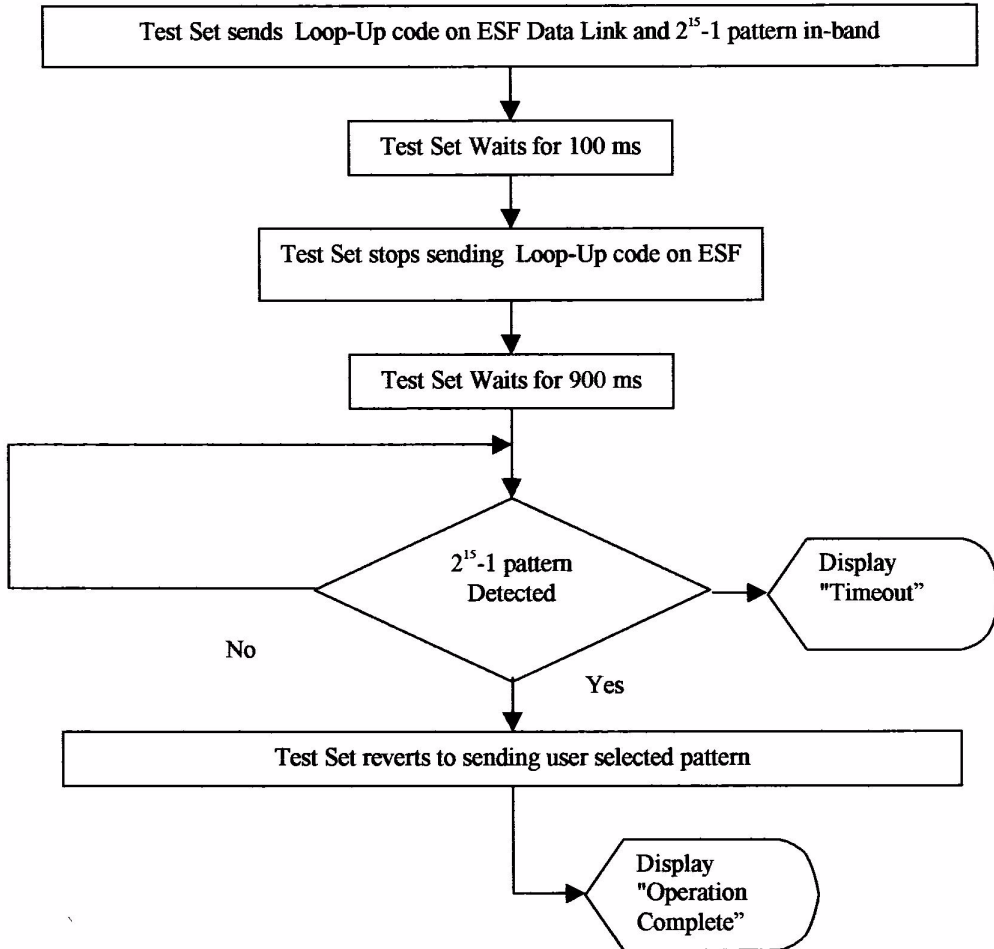


Flow diagram of in-band loop-down code originating from the test set



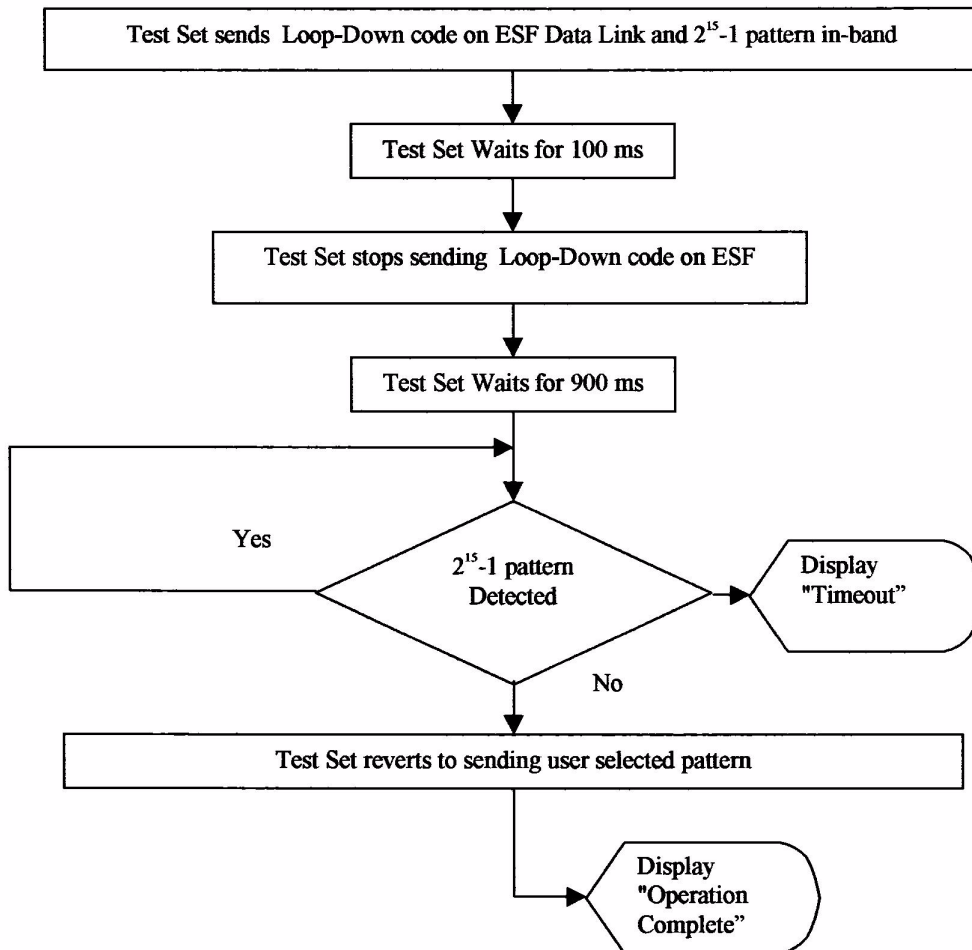
The flow of events differs when the out-of-band method of loopback is selected. In this case loopback can occur within 16 ms and therefore, it is not possible to determine if a pre-existing loop exists.

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.

Flow diagram of out-of-band loop-down code originating from the test set

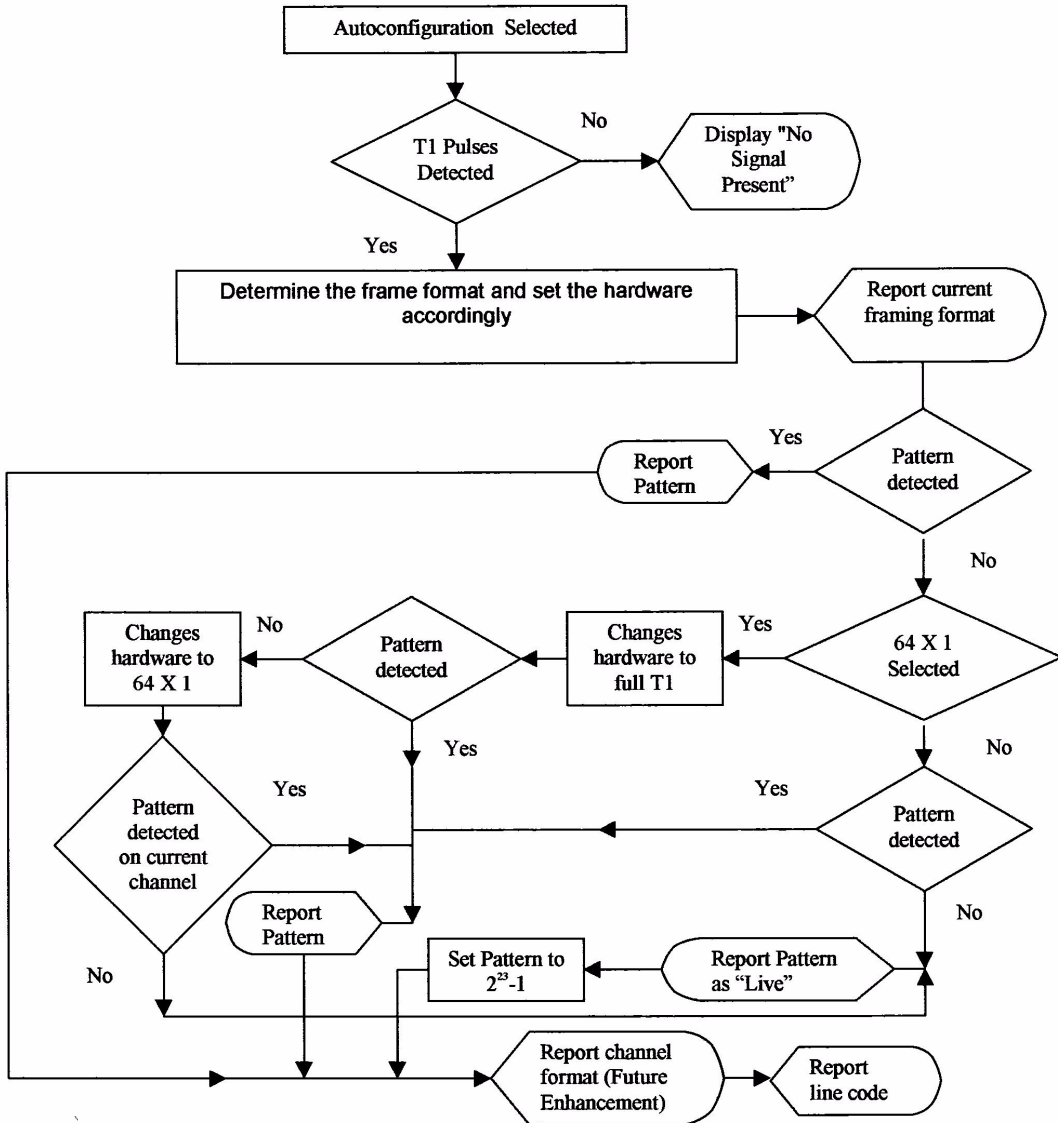


Please note that $2^{15}-1$ (2047) pattern is utilized because it is normally utilized for fractional T1 testing and has a low probability of being present on the full T1.

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 than 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 and synchronize to it. D3/D4 framing patterns have the ability to identify a super frame of 12 sub-frames. Extended Super Frame (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.



11 CDMA Analyzer

- ["Using the CDMA Analyzer" on page 150](#)
- ["Common CDMA TX Analyzer measurements" on page 150](#)
- ["Preparing to make CDMA TX Analyzer measurements" on page 150](#)
- ["Performing a basic CDMA transmitter measurement" on page 151](#)
- ["Interpreting the display" on page 155](#)
- ["Optional CDMA TX Analyzer Measurement Settings" on page 157](#)
- ["Setting the channel or frequency step" on page 157](#)
- ["Setting the PN Increment" on page 158](#)
- ["Setting the CDMA transmitter reference level" on page 158](#)
- ["Setting the active channel threshold level and auto threshold level" on page 159](#)
- ["Setting measurement time" on page 160](#)
- ["Setting quick page channel" on page 161](#)
- ["Metrics Provided by the CDMA TX Analyzer Measurement" on page 162](#)
- ["Interpretation of CDMA TX Analyzer Measurement Results" on page 165](#)



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, see [Chapter 12](#), “CDMA Over Air,” starting on page 169.

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 [“Metrics Provided by the CDMA TX Analyzer Measurement”](#) on page 162.

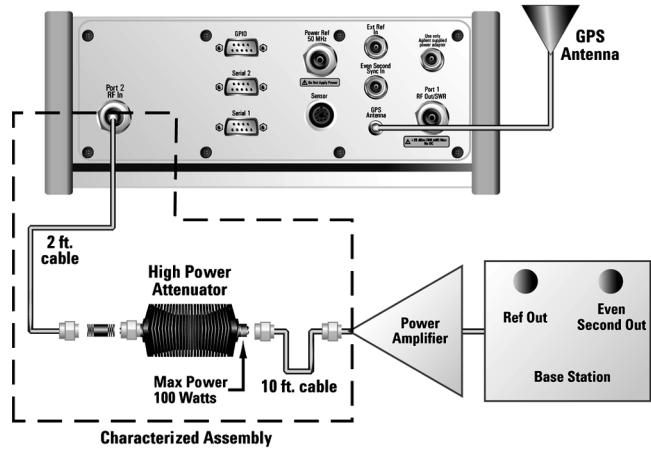
Performing a basic CDMA transmitter measurement

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

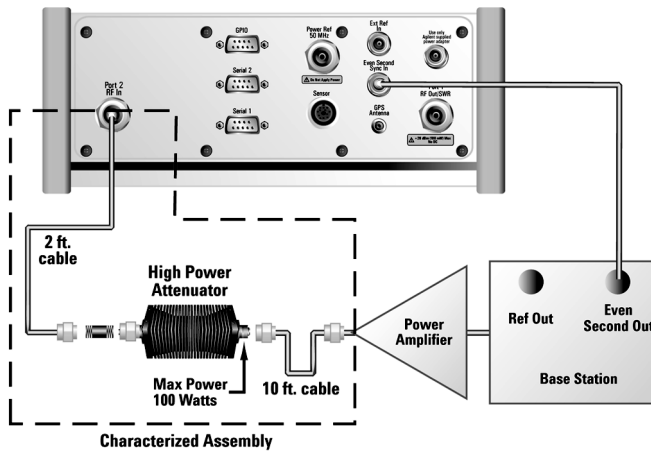
Step	Notes
1 Mode	
2 [TX Analyzer]	
3 [CDMA Analyzer]	
4 [Chan Std]	
5 Highlight the channel standard you want using the up and down arrow buttons.	
6 [Select]	
7 On [Units] select Chan or Freq.	Each time you press this softkey, the selected option changes.
8 Enter the channel or frequency using the 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. <ul style="list-style-type: none"><li data-bbox="791 354 1290 465">• 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.<li data-bbox="791 470 1290 562">• 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.	

Step	Notes
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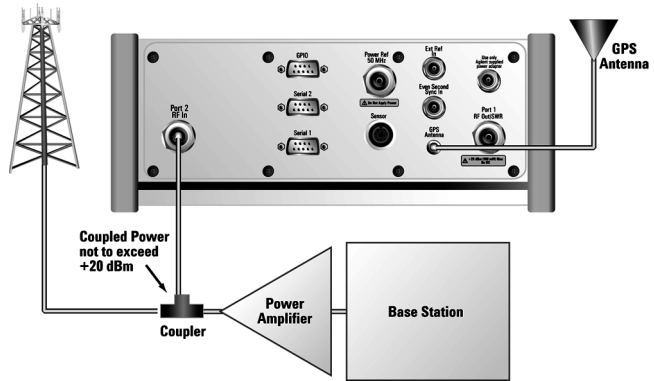


Connections for out of service CDMA measurements with GPS receiver as timing reference

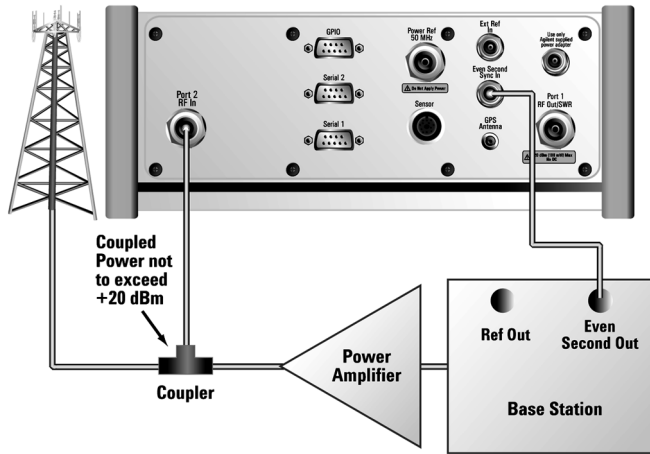


Connections for out of service CDMA measurements with base station even second as timing reference

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



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.

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 162.

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:

- Channel or Frequency Step
- PN Increment
- Transmitter Reference Level
- Active Channel Threshold Level and Auto Threshold Offset
- 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 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 (while in CDMA TX Analyzer mode):

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	<p>Enter the RF in loss using the number keypad.</p> <p>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 31.</p> <p>Note: If data had been previously entered in [RF IN Loss], that data will be lost and replaced by the value you enter here.</p>
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 (while in CDMA TX Analyzer mode):

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 *burst 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.

Sweep (Continuous or Single)

Continuous sweep provides repeated, ongoing measurements. Single sweep provides a single measurement.

Averaging (# of averages)

Takes the average of trace cycles and displays the results every nth trace. Averaging applies to the data, not the trace.

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 μ s 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 μ s 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 signal to interference ratio (E_c/I_o) 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 burst 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 μ s). 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 31.

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.



12 CDMA Over Air

- [“Using the CDMA Over Air Tool” on page 170](#)
- [“Performing CDMA over air measurements” on page 170](#)
- [“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 184.” on page 170](#)
- [“Performing a basic CDMA over air measurement” on page 171](#)
- [“Criteria for making valid CDMA over air measurements” on page 171](#)
- [“Displaying location information using GPS” on page 175](#)
- [“Setting amplifier capacity metrics” on page 176](#)
- [“Optional CDMA Over Air Measurement Settings” on page 179](#)
- [“Interpreting the display” on page 177](#)
- [“Optional CDMA Over Air Measurement Settings” on page 179](#)
- [“Setting the channel or frequency step” on page 179](#)
- [“Setting the PN increment \(PN Inc\)” on page 180](#)
- [“Setting the transmitter reference level” on page 180](#)
- [“Setting the active channel threshold level and auto threshold level” on page 181](#)
- [“Resetting amplifier capacity and traffic metrics” on page 182](#)
- [“Metrics Provided by CDMA Over Air Measurements” on page 184](#)
- [“Setting measurement time” on page 182](#)
- [“Setting quick page channel” on page 183](#)
- [“Metrics Provided by CDMA Over Air Measurements” on page 184](#)
- [“Interpretation of CDMA Over Air Measurement Results” on page 189](#)
- [“Interpretation of CDMA Over Air Measurement Results” on page 189](#)



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 [Chapter 11](#), “CDMA Analyzer,” starting on page 149.

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.

Performing 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).

For CDMA over air transmitter measurements use the following connection diagram:

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 184.

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 173.

Criteria for making valid CDMA over air measurements

The first step in making valid CDMA over air measurements is to find a location near the base station that has a sufficiently strong CDMA signal from the base station you are measuring. 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

Measurement quality	Pilot dominance	Multipath power
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.

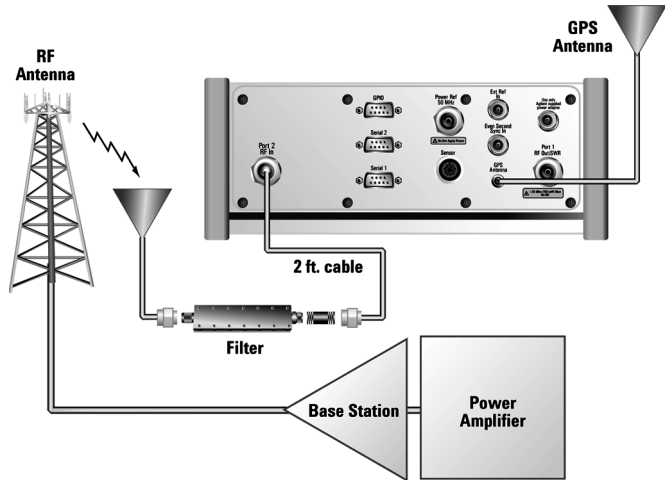
In general, you should always use a preselector filter for the band of interest to prevent strong signals from swamping out the signal of interest. Agilent offers these preselectors and antennas:

- 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]	<ul style="list-style-type: none"> • 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.
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 .	<p>The test set defaults to Auto mode.</p> <ul style="list-style-type: none"> • 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]	

Step	Notes
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.

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 longitude, 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 201.

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]	
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]	

Step	Notes	
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 184.

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] softkey. 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 *burst 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.

Sweep (Continuous or Single)

Continuous sweep provides repeated, ongoing measurements. Single sweep provides a single measurement.

Averaging (# of averages)

Takes the average of trace cycles and displays the results every nth Trace. Averaging applies to the data, not the trace.

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 189 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 $\pm 10 \mu\text{s}$ of its assigned value. Many base station manufactures specify that the timing must be within $\pm 3 \mu\text{s}$. 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 $\frac{1}{2}$ 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 (E_c/I_o) 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 of 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 μ s). 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 μ s if the receiving antenna is next to the base station, or
- Less than +/- 10 μ s + 1 μ s 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 171.

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 E_c/I_o

A high value of E_c/I_o means there is less interference from other base stations and noise and is an indicator of base station performance. When E_c/I_o 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

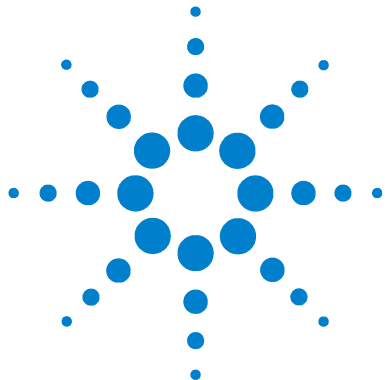
The Utilization metric provides an instantaneous reading of the percentage of the traffic channels currently being used. More meaningful information is provided by the Peak and Average Utilization metrics gathered over a 10 to 15 minute interval.

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.



13 Basic System Operations

["Setting System References"](#) on page 197

["Printing Screens"](#) on page 198

["Saving Data"](#) on page 201

["Managing Media Types"](#) on page 204

["Configuring for Network Connectivity"](#) on page 205

["Viewing System Statistics"](#) on page 208

["Viewing System Statistics"](#) on page 208

["Using the Option Manager"](#) on page 210

["Installing an option"](#) on page 211



System Reference Introduction

The E7495A Base Station Test Set provides a system utility that allows you to perform non-measurement activities and configure the box for:

- General operation
- System status updates
- Data manipulation
- Basic system functions testing.

Setting System References

The E7495A provides 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.

Selecting a frequency/timing reference

Perform this procedure to select a common frequency or timing reference to be used for all measurement tools (if applicable).

Step	Notes
1 [System]	
2 [Fr/Time Ref Location]	
3 [Fr/Time Ref]	Displays additional menu buttons. With Internal GPS and External Even Sec both frequency and time reference are active. This is used when measuring CDMA signals. This is required to get valid PN offsets. With the other three you get only frequency.

Printing Screens

The E7495A lets you save screen images to PNG files. You can save the image files to a PCMCIA card or CompactFlash card. You also can choose among three ways of naming each saved image file.

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.

Setting up file naming

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 [User Filename]	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. 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. Use the rotary knob to select the file and press Select . Press [Ok] to return to the previous screen.
5 [If File Exists]	
6 [Overwrite], [Prompt], [Auto Incr], or [Timestamp]	<ul style="list-style-type: none"> • 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. 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	[Print Screen Setup]
3	On [Filename] select Ask . Each time you press this softkey, the selected option changes.

Saving Data

The test set can save measurement data to a PCMCIA card or CompactFlash card. You have three options for naming the data files that you save.

Selecting output media—PCMCIA card or CompactFlash card

Step	Notes
1 [System]	
2 [Save Data Setup]	
3 On [File Location] select PCMCIA or CF .	Each time you press this softkey, the selected option changes.

Setting up file naming

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.
4 [User Filename]	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. 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. Use the rotary knob to select the file and press Select . Press [Ok] to return to the previous screen.
5 [If File Exists]	
6 [Overwrite], [Prompt], [Auto Incr], or [Timestamp]	<ul style="list-style-type: none"> • 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 Compact Flash 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 or CompactFlash card for storage. Erases existing data on the card.

Configuring for Network Connectivity

The E7495A is capable of existing as a device on any compatible network. Therefore, in order to be accessible on the network, certain information must exist 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 the 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 softkeys on the left.
10 [Ok]	
11 [Net Mask]	

Step	Notes
12 Enter the Net Mask using the rotary knob and the buttons on the left.	
13 [Ok]	
14 [Gateway]	
15 Enter the Gateway using the rotary knob and the buttons on the left.	
16 [Ok]	
17 [Save]	
18 [Ok]	Saves the current network configuration and restarts the test set.

Viewing System Statistics

The E7495A 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]	
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 216
5	As needed, [Page Up] or [Page Down] Use these softkeys if you need to scroll up or down to see all the information.

Using the Option Manager

The E7495A 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 all installable options and any options not installed.
5 [Page Up] or [Page Down]	Use as necessary to scroll to next screen

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]	View the conditions: <ul style="list-style-type: none"> • Model Number • Serial Number • Host ID

Installing an option

Step	Notes
1 [System]	
2 [More 1 of 2]	
3 [Option Manager]	
4 [Installing an Option]	Follow the on-screen instructions.

Testing System Functions

The E7495A 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.



14 Working with Batteries

["Installing Batteries"](#) on page 214

["Viewing Battery Status"](#) on page 215

["Charging Batteries"](#) on page 218

["Reconditioning Batteries"](#) on page 220

["Battery Care"](#) on page 224

["Battery Specifications"](#) on page 228



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 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
% 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 segments	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 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.

Step	Notes
<p>2 Fully discharge the battery.</p> <ul style="list-style-type: none"> 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). 	
<p>3 Charge the battery and verify a full charge.</p> <ul style="list-style-type: none"> 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. 	<p>On the System Statistics—Battery screen, the battery should show 100% charge rate and less than a 10% Fuel Gauge Error.</p>

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.

CAUTION

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 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 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 Base Station test set uses the Inspired Energy NI2040AG Smart Battery, which produces 10.8 volts DC at approximately 6000mA. 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.

External charging voltage is 18V to 24V DC.

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 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 70mA per hour, or 28% of a full battery charge in a 24-hour period. When in off mode, the test

set draws 45mA 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 24hrs.
- Single battery standby mode: 28.72% or 1.68 amps per 24hrs.

Battery and charger part numbers

Standard Supplied Accessories	
Description	Part Number
AC/DC Converter	0950-4404
NI2040AG Battery	1420-0882*(note 1)
Optional Accessories provided in E7495A Option 820	
Charger 12V AT 1A	0950-4276
AC/DC Converter	0950-4404
Auto Adapter F1455A	0950-4412
NI2040AG Battery	1420-0882

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:

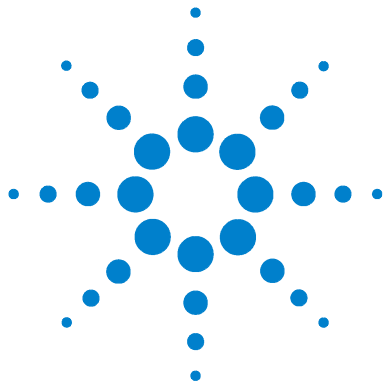
- Install the instrument so that the ON / OFF switch is readily identifiable and is easily reached by the operator. The ON / OFF switch or the detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. Alternatively, 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



15 General Information

["Safety considerations"](#) on page 234

["Safety symbols"](#) on page 234

["Safety considerations for this test set"](#) on page 236

["Lifting and handling"](#) on page 238

["Electro-static discharge \(ESD\) precautions"](#) on page 239

["E7495A Base Station Test Set Specifications"](#) on page 246



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.

CAUTION

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 product damage.

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

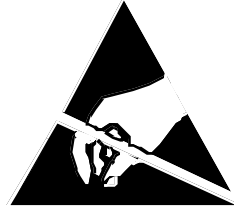
To avoid overheating, always disconnect the test set from the AC adapter before storing the test set in the backpack.

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

Lifting and handling

When lifting and handling the Agilent E7495A Base Station Test Set use ergonomically correct procedures. Lift and carry the test set by the its carrying strap.

Electro-static discharge (ESD) precautions



ATTENTION

Static Sensitive Devices

This test set was constructed in an ESD (electro-static 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.


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

DECLARATION OF CONFORMITY	
<small>According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014</small>	
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 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	
<u>Standard</u>	<u>Limit</u>
CISPR 11:1997 / EN 55011:1998/A-1999	Group 1, Class A
IEC 61000-4-2:1995+A1:1998 / 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.	

Compliance Statements

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 Maschinenlaermverordnung -3 GSGV Deutschland).

Table 6 Compliance with German Noise Requirements

Acoustic Noise Emission/ Geraeuschemission	
LpA <70 dB	LpA <70 dB
Operator Position	am Arbeitsplatz
Normal Position	normaler Betrieb
per ISO 7779	nach DIN 45635 t. 19

Compliance with Canadian EMC requirements

Table 7 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.

Assistance

Product maintenance agreements and other customer assistance agreements are available for Agilent Technologies products. For any assistance, contact your nearest Agilent Technologies Sales and Service Office.

Table 8 Regional Sales and Service Offices

<p>United States of America: Agilent Technologies Test and Measurement Call Center P.O. Box 4026 Englewood, CO 80155-4026</p> <p>(tel) 1 800 452 4844</p>	<p>Canada: Agilent Technologies Canada Inc. 5150 Spectrum Way Mississauga, Ontario L4W 5G1</p> <p>(tel) 1 877 894 4414</p>	<p>Europe: Agilent Technologies European Marketing Organization P.O. Box 999 1180 AZ Amstelveen The Netherlands</p> <p>(tel) (3120) 547 9999</p>
<p>Japan: Agilent Technologies Japan Ltd. Measurement Assistance Center 9-1 Takakura-Cho, Hachioji-Shi, Tokyo 192-8510, Japan</p> <p>(tel) (81) 456-56-7832 (fax) (81) 426-56-7840</p>	<p>Latin America: Agilent Technologies Latin America Region Headquarters 5200 Blue Lagoon Drive, Suite #950 Miami, Florida 33126 U.S. A.</p> <p>(tel) (305) 267 4245 (fax) (305) 267 4286</p>	<p>Australia/New Zealand: Agilent Technologies Australia Pty Ltd. 347 Burwood Highway Forest Hill, Victoria 3131</p> <p>(tel) 1 800 629 485 (Australia) (fax) (61 3) 9272 0749 (tel) 0 800 738 378 (New Zealand) (fax) (64 4) 802 6881</p>
<p>Asia Pacific: Agilent Technologies 24/F, Cityplaza One, 111 Kings Road, Taikoo Shing, Hong Kong</p> <p>(tel) (852) 3197 7777 (fax) (852) 2506 9233</p>		

E7495A 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 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 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. These characteristics are shown in italics or labeled as "typical," "usable to," or "nominal."

Table 9 E7495A Base Station Test Set specifications

Standard	
Frequency accuracy (time base)	± 1 ppm (warranted performance)
Internal frequency aging	± 1 ppm aging/year (warranted performance)
Spectrum/Signal Analyzer	
Input frequency range	10 MHz to 2500 MHz
Maximum input level	± 20 dBm (.1 W)
Maximum input power without damaging test set	100 W
RF channel power	± 1 dB
Adjacent channel power accuracy	± 0.75 dBc
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 - 2500MHz

Table 9 E7495A Base Station Test Set specifications

Return loss	Range > 30dB VSWR < 1.07
Distance to Fault	Range (m): 1 m to 300 m Resolution: $(1.5 \times 10^8) (V_f)/(F_2 - F_1 \text{ in Hz})$ in Hz where V_f is relative propagation velocity of cable (Typically 1% of measurement distance)
Insertion loss	Range >40 dB Accuracy: Average power with 5 averages: 0.1 dB in the mobile phone bands: <ul style="list-style-type: none"> • 824 - 960 MHz • 1710 - 2170 MHz
40 dB Attenuator	Frequency Range: 10 - 2500MHz Attenuation accuracy: ± 0.5 dB Max power: 100 Watts

Table 10 E7495A Base Station Test Set option specifications

Signal Generator (CW) Option 500	
Level accuracy:	± 1 dB between -25 to -80 dBm
Frequency range:	375 - 2500 MHz
Frequency accuracy (time base):	± 1 ppm (warranted performance)
Internal frequency aging:	± 1 ppm aging/year (warranted performance)
Phase error:	@ 30 KHz, offset 90 dBc
CDMA Reverse Link Signal Generator Option 510	
Same as signal generator except for:	
Output level:	-45 to -80
Level accuracy:	± 2 dB
Power Meter Option 600	

Table 10 E7495A Base Station Test Set option specifications

Power Meter 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
Power Reference	
Power output	1.00 mW (0.0 dBm). Factor set to $\pm 0.7\%$ traceable to the U.S. National Institute of Standards and Technology (NIST).
Accuracy	$\pm 1.2\%$ worst case ($\pm 0.9\%$ rss) for one year
SWR	<1.08
Power meter Option 600 with Agilent 8482A 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
Power linearity	+ 10 dBm to +20 dBm, +2, -4%
Maximum power	300 mW average. 1 W peak; 30 W- μ sec per pulse
T1 Analyzer Option 700	
Receive level (Line 1 and line 2)	+6 dB DSC to -36 dB DSX or 100mv peak-to-peak to 12V 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

Table 10 E7495A Base Station Test Set option specifications

Output	Conforms to TR-TSY-000499, CCITT Rec.G.703 AT&T Pubs CB113, 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 & ESF
Channel Formats	Full T1, 64x1
Test Patterns	ORSS, 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)
• Alarm rate	Single
cdmaOne, cdma2000 demodulation Option 200	
Waveform quality (rho)	
Estimated rho	
Pilot time alignment (tau):	$\pm 1 \mu\text{sec}$

15 General Information

Table 10 E7495A Base Station Test Set option specifications

Code domain power:	± 1.5 dB absolute, ± 0.5 dB relative
Typical performance is defined as 80% of the points over the specified range will meet or exceed the typical value. Nominal values are design center values and not normally tested.	

Table 11 E7495A Base Station Test Set general specifications

Display	
Display	Transflective VGA and color LCD
Power	
AC Adapter Voltage Input	100 - 240VAC 50/60 Hz 50 W
DC to DC Adapter Input	9 - 18 Vdc 50 W
Battery Life:	>1.5 hours per battery
Interface Ports	Two RS 232 Two USB 1.1 One LAN Port 10 Base T Built-in Speaker and Microphone PC Card Slot Compact Flash Memory Stereo Headphone Jack Agilent Power Sensor Jack General Purpose Input/Output - TTL Level
Dimensions	Height: 11.6", 295 mm Width: 14.5", 368 mm Depth: 5.3", 135 mm Weight: 20 lbs, 9.1 kg
Inputs	RF In: 50 ohm, type N Frequency Reference: 50 ohm BNC Even Second: High impedance BNC GPS Antenna
Outputs	RF Out/SWR: 50 ohm type N Power Reference: 50 ohm type N; SWR < 1.06; 1 mWatt @ 50 MHz
Operating temperature:	Specified Temperature range: -10° to 50 °C; 14 ° to 122 °F
Storage temperature	-40 ° to 70 °C
Calibration	Cycle: 1 year



Product Safety Data Sheet

PRODUCT NAME: Inspired Energy Rechargeable Battery Pack Model: NI2040AG Rev1
 ALTERNATE NAME: 1420-0882
 TRADE NAME: NI2040AG Rev 1 Volts: 10.8
 CHEMICAL SYSTEM: Lithium Ion Approximate Weight: 484 g
 Date Prepared: November 13th 2002

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: NI2020AG Rev 1 Cell MSDS.pdf

SECTION III – OPERATING PARAMETERS

Maximum Charge Voltage:	12.0 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
 US toll free: 1-888-5-INSPIRE (1-888-546-7747) Tel: 386 462 3676 Fax: 386 462 6765
www.inspired-energy.com

15 General Information

COBALT CELL MATERIAL SAFETY DATA SHEET Jan 23, 2001
 FSSF00001AD - FOR CUSTOMER DISTRIBUTION

SECTION 1 - PRODUCT IDENTIFICATION AND USE				
Product:	MoliceL - Cobalt based Lithium-Ion cell	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)	0.1-0.3 w/v	92-52-4	2400	N/AV
Copper foil	0.1- 1 w/w	7440-50-8	3.5 (ipr-mouse)	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 Cobaltite (LiCoO ₂)	10- 30 w/w	12190-79-3	N/AV	N/AV
Lithium Hexafluorophosphate (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
Steel, nickel and inert polymer	Balance	N/APP	N/APP	N/APP

COBALT CELL MATERIAL SAFETY DATA SHEET Jan 23, 2001
 FSSF00001AD - FOR CUSTOMER DISTRIBUTION

SECTION 3 - PHYSICAL DATA				
Physical state: Nickel plated metal cannister under label		Odour None		Odour threshold: N/APP
Vapour pressure (mmHg): N/APP	Vapour Density (air =1) N/APP	Evaporation rate : N/APP	Boiling Point N/APP	Freezing point 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 NO	Conditions: 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: NONE		Upper Flammable Limit: NONE	Lower Flammable Limit: NONE	
Auto-ignition Temp: NONE	Hazardous Combustion Products: Hydrogen Fluoride, Phosphorus Oxides, Carbon Monoxide, Carbon Dioxide, Lithium Hydroxide, Cobalt Oxides, Aluminum Oxide, 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 125°C. Steel casing slowly dissolves in strong mineral acids.				
Reactivities: None known				
Hazardous Decomposition Products:				

COBALT CELL

MATERIAL SAFETY DATA SHEET
 FSSF00001AD - FOR CUSTOMER DISTRIBUTION

Jan 23, 2001

Hydrogen Fluoride, Boron Oxide, Carbon Monoxide, Carbon Dioxide, Lithium Hydroxide, Cobalt Oxides, Aluminum Oxide, possible fluoro-compounds, Carbon soot			
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.			
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 None listed	Irritancy: None	Sensitization: Not anticipated	Carcinogenicity Not anticipated
Teratogenicity: Not anticipated		Mutagenicity: Not anticipated.	
Reproductive toxicity: Not anticipated	Synergistic Products: None expected		
SECTION 7 - PREVENTIVE MEASURES			
Personal protective equipment:			
Gloves: Not required for handling individual cells. Fabric gloves for warehouse container handling.	Respirator: No respirator required for normal handling. SCBA required for fires.		Eyewear: Not required beyond employer policy.
Clothing: Standard industrial clothing in normal use. Impervious suit in fires.		Footwear: Wear steel-toed footwear if large containers of cells are being handled.	

COBALT CELL MATERIAL SAFETY DATA SHEET Jan 23, 2001
 FSSF00001AD - FOR CUSTOMER DISTRIBUTION

Engineering controls: Keep away from heat and open flames. Store in a cool, dry place.			
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.			
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.	
SECTION 9 - PREPARATION INFORMATION			
Prepared by: Martin RIDGWAY, B.Sc.	Phone:	Date Created:	Revision Information:

15 General Information

COBALT CELL MATERIAL SAFETY DATA SHEET Jan 23, 2001
FSSF00001AD - FOR CUSTOMER DISTRIBUTION

Safety Co-ordinator	(604) 466-6654	Mar 31, 1995	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.
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 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.



16 Connector Care

["Using, Inspecting, and Cleaning RF Connectors"](#) on page 258

["Repeatability"](#) on page 258

["RF cable and connector care"](#) on page 258

["Proper connector torque"](#) on page 259

["Connector wear and damage"](#) on page 260

["Cleaning procedure"](#) on page 260



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 12](#). Do not overtighten the connector.

CAUTION

Never exceed the recommended torque when attaching cables.

Table 12 *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	8720-1765
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. You can order this aerosol from Agilent Technologies (see [Table 13](#)).
- 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

Table 13 Cleaning supplies available from Agilent Technologies

Product	Part number
Ultrajet	9310-6395
Alcohol wipes:	92193N
Lint-Free cloths:	9310-4242
Small foam swabs:	9300-1270
Large foam swabs	9300-0468

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.



17 Returning the Test Set for Service

"Adjustment, Maintenance, or Repair of the Base Station Test Set" on page 264

"Returning your Base Station Test Set for Service" on page 265

"Preparing the test set for shipping" on page 266



Adjustment, Maintenance, or Repair of the Base Station Test Set

Any adjustment, maintenance, or repair of the E7495A Base Station Test Set must be performed by qualified personnel. Contact your customer engineer through your local Agilent Technologies Service Center.

In the United States, call **1-800-452-4844**. For other countries, you can find up-to-date, country-specific contact information at:

<http://www.agilent.com/comms/contactus>

If you do not have access to the Internet, contact your local Agilent Technologies Sales and Service Office.

NOTE

For specific test set packing instructions, refer to "Returning your Base Station Test Set for Service" on page 265.

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 test set for shipping”](#) on page 266) 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 test set 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
<p>1 Write a complete description of the failure and attach it to the system.</p>	<p>Include any specific performance details related to the problem. The following information should be returned with the system:</p> <ul style="list-style-type: none"> • Type of service required • Date system was returned for repair • Description of the problem: <ul style="list-style-type: none"> • 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
<p>2 Caution: Cover all front and rear panel connectors that were originally covered when you first received the system.</p>	
<p>3 Pack the system in the original shipping containers. Original materials are available through Agilent Technologies office. See step 4 for more information.</p>	

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.	

17 Returning the Test Set for Service

Index

A

adjustment, maintenance, or repair of test set, [264](#)
Agilent customer assistance, [245](#)
Agilent sales offices, [245](#)
Agilent, contacting, [29](#)
assistance from Agilent, [245](#)

B

backpack
 using, [27](#)
 what goes where, [28](#)
batteries
 built-in battery gauge, [217](#)
 caring for, [224](#)
 charging, [218](#)
 current drain, [231](#)
 disposal, [226](#)
 front panel icons, [215](#)
 installing, [23](#), [214](#)
 LEDs, [215](#)
 maximizing battery life, [224](#)
 part numbers, [230](#)
 precautions, [224](#)
 reconditioning/recalibrating, [220](#)
 specifications, [228](#)
 status, [215](#)
 System Statistics - Battery Screen, [216](#)
battery charger part numbers, [230](#)
battery statistics, [209](#)
buttons on front panel, [20](#)

C

cable and connector care, [258](#)
cables, connectors, and accessories, [14](#)
Canadian EMC requirements, [244](#)
CDMA analyzer
 basic measurement, [151](#)
 carrier feedthrough, [163](#), [167](#)
 channel power, [162](#), [166](#)
 common measurements, [150](#)

- delta page power, [163](#), [168](#)
- delta quick page channel power, [164](#), [168](#)
- delta sync power, [163](#), [168](#)
- estimated Rho, [163](#), [167](#)
- frequency error, [162](#), [165](#)
- interpretation of measurement results, [165](#)
- interpreting the display, [155](#)
- metrics, [162](#)
- noise floor, [163](#), [168](#)
- optional measurement settings, [157](#)
- pilot power, [163](#), [168](#)
- PN offset, [162](#), [165](#)
- setting active channel threshold and auto threshold levels, [159](#)
- setting CDMA transmitter reference level, [158](#)
- setting channel or frequency step, [157](#)
- setting measurement time, [160](#)
- setting PN increment, [158](#)
- setting quick page channel, [161](#)
- sweep (continuous or single), [161](#)
- time offset, [166](#)
- uses, [150](#)

CDMA over air

- amplifier capacity, [187](#), [193](#)
- average amplifier capacity, [187](#), [193](#)
- average utilization, [188](#), [194](#)
- basic measurement, [173](#)
- carrier feedthrough, [185](#), [191](#)
- channel power, [185](#), [191](#)
- criteria for making valid measurements, [171](#)
- delay, [184](#), [189](#)
- delta page power, [186](#), [192](#)
- delta quick page channel power, [186](#), [192](#)
- delta sync power, [186](#), [192](#)
- displaying location information using GPS, [175](#)
- estimated Rho, [185](#), [190](#)
- frequency error, [189](#)
- interpretation of measurement results, [189](#)
- metrics, [184](#)
- noise floor, [185](#), [191](#)
- optional measurement settings, [179](#)
- peak amplifier capacity, [187](#), [193](#)
- pilot E_c/I_o , [186](#), [192](#)
- pilot power, [186](#), [192](#)
- PN offset, [184](#), [189](#)
- resetting amplifier capacity and traffic metrics, [182](#)
- setting active channel threshold and auto threshold levels, [181](#)
- setting amplifier capacity metrics, [176](#)
- setting channel or frequency step, [179](#)
- setting measurement time, [182](#)

- setting PN increment, [180](#)
- setting quick page channel, [183](#)
- setting transmitter reference level, [180](#)
- sweep (continuous or single), [183](#)
 - utilization, [188](#)
- certification, [241](#)
- channel scanner
 - autoranging, [73](#)
 - basic measurement, [70](#)
 - displaying accurate peak power for pulsed signals, [74](#)
 - displaying frequency or power, [77](#)
 - entering channels with list instead of range, [75](#)
 - entering measurement bandwidth and time, [75](#)
 - setting channel power average and sweep, [76](#)
- charging batteries, [218](#)
- cleaning RF connectors, [258](#)
- cleaning supplies, connector, [261](#)
- CompactFlash cards, [204](#)
- compliance statements, [244](#)
- configuring for network connectivity, [205](#)
- connector care, [258](#)
- connectors
 - cleaning, [260](#)
 - inspecting for wear, [260](#)
 - ordering cleaning supplies, [261](#)
 - torque specifications, [260](#)
- contacting Agilent, [29](#)

D

- declaration of conformity, [243](#)
- DHCP, [205](#)
- distance to fault
 - basic measurement (automatic frequency range), [58](#)
 - basic measurement (manual frequency range), [56](#)
 - interference rejection, [60](#)
 - manual vs. automatic frequency range, [54](#)
 - viewing a single sweep, [59](#)

E

- E7495A options, [16](#)
- E7495A specifications, [246](#)
- electro-static discharge (ESD) precautions, [239](#)

F

formatting a PCMCIA or CompactFlash card, [204](#)
frequency/timing reference, [197](#)
functionality in the test set, [12](#)

G

German noise compliance, [244](#)
GPS location data, [197](#)

I

inspecting RF connectors, [258](#)
installing a battery, [23](#), [214](#)
introduction to the test set, [12](#)
IP administration using DHCP, [205](#)
IP administration without DHCP, [206](#)

L

layout of front panel, [20](#)
lifting and handling the test set, [238](#)

M

managing media types, [204](#)
manufacturer's declaration, [243](#)
measurements, optional, [12](#)

N

network connectivity, [205](#)
noise compliance, German, [244](#)

O

one port insertion loss
 basic measurement, [42](#)
 interference rejection, [44](#)
 measuring, [42](#)

option manager, 210
optional measurements, 12
options for test set, 16

P

PCMCIA cards, 204
power button, 21, 24
power meter

- basic average power measurement, 87
- making an average power measurement, 86
- setting high and low end-points, 90
- setting resolution, 90
- setting upper and lower limits, 91

printing screens, 198
product markings, 240

R

reconditioning/recalibrating batteries, 220
release versions, 208
return loss

- basic measurement, 48
- interference rejection, 50
- isolating a return loss signal using a single sweep, 50

returning the test set for service, 265
RF cable and connector care, 258
RF connectors, using and caring for, 258

S

safety considerations, 234
safety symbols, 234
sales and service offices, 245
saving data, 201
service

- returning the test set, 265
- shipping the test set, 266

service offices, 245
shipping the test set, 266
signal generator

- basic measurement, 81
- selecting a channel, time and frequency reference, 81
- uses, 80

specifications for test set, 246
spectrum analyzer

- basic measurement, 63
- uses, 62
- system memory, 208
- system operations
 - configuring for network connectivity, 205
 - displaying GPS location data, 197
 - formatting a PCMCIA or CompactFlash card, 204
 - IP administration using DHCP, 205
 - IP administration without DHCP, 206
 - managing media types, 204
 - printing screens, 198
 - saving data, 201
 - selecting a timing reference, 197
 - setting system references, 197
 - using the option manager, 210
 - viewing battery statistics, 209
 - viewing system memory, 208
 - viewing system release versions, 208
 - viewing system statistics, 208
- system release versions, 208
- system statistics, 208

T

T1

- alarm indicators, 129
- all 1's, 132
- available seconds, 133
- bit error rate, 134
- bit errors, 134
- BPV, 146
- BPV errd secs, 131
- BPV error rate, 131
- BPV errors, 131
- CRC, 146
- degraded minutes, 133
- detailed loop mode and auto configuration descriptions, 139
- error free seconds, 132
- errored seconds, 132
- excess zeros, 132
- facility summary, 135
- frame errd secs, 131
- frame error rate, 131
- frame errors, 131
- Frame Slips, 133
- frame sync loss, 132
- getting started with T1 testing, 94
- isolating faults using test equipment, 137

- isolating faults with alarm and errors, [136](#)
- making T1 measurements, [94](#)
- measurement results, [129](#)
- measurement results fields, [130](#)
- multiple test sets monitoring BER along a T1 route, [117](#)
- pattern sync loss, [134](#)
- patterns, [127](#)
- peak - wander, [133](#)
- peak +wander, [133](#)
- remote CSU/NIU loop mode, [139](#)
- results indicators, [130](#)
- selecting delay, [123](#)
- selecting emulate CSU/NIU, [117](#)
- selecting hard loop/end-end full T1, [94](#)
- selecting loopback CSU full T1 BERT, [102](#)
- selecting monitor test mode, [110](#)
- severe errored seconds, [132](#)
- signal loss, [132](#)
- slip rate, [133](#)
- status indicators, [130](#)
- terminology, [146](#)
- test data rate, [134](#)
- testing and fault mitigation, [134](#)
- unavailable seconds, [133](#)
- test set functionality, [12](#)
- test set options, [16](#)
- test set specifications, [246](#)
- two port insertion loss
 - as your first measurement, [24](#)
 - basic measurement, [33](#)
 - determining the highest insertion loss and its frequency, [38](#)
 - determining the lowest insertion loss and its frequency, [38](#)
 - for power meter, [36](#)
 - for spectrum analyzer, channel scanner, CDMA analyzer, and signal generator, [34](#)
 - measuring, [32](#)
 - uses, [32](#)

U

- unpacking the test set, [13](#)
- updates to the test set, [29](#)

V

- versions, system release, [208](#)
- viewing battery statistics, [209](#)
- viewing system memory, [208](#)

viewing system release versions, [208](#)
viewing system statistics, [208](#)

W

warranty, [265](#)