HP 8935 Series
E6381A TDMA Base Station Test Set
AMPS Base Station Tests

Application Guide

Firmware Version: A.01.00 and above

HP Part Number: E6381-90017

Revision A

Printed in U.S.A

June 1998

Notice

Information contained in this document is subject to change without notice.

Contents

In This Manual and Product Regulatory Information

What is Discussed This Manual

This manual explains how to use the Test Set to manually test an AMPS base station.

This document presents a step-by-step approach to AMPS base station testing using the Test Set, including what you need to know before you can start testing.

What is Not Discussed in this Manual

- General operation of the Test Set.

  Changing display screens and their associated controls is discussed in the Reference Guide (HP part number E6381-90019).

- Detailed operation of the Test Set's spectrum analyzer and oscilloscope.

  Although there are basic explanations in this manual, more detail is provided in the *Reference Guide* and the built-in HELP screens concerning the various control menus and fields available.

- How to control your base station, switch system, or any other software or hardware associated with your cell site equipment.

  Each manufacturer and cellular service provider has their own cell site control and base station configuration procedures that go beyond the scope of this documentation.

- How to perform IBASIC programming operations, such as writing, editing, copying, or cataloguing programs.

  Programming the Test Set is explained in the *Programming Manual* (HP part number E6381-90018), and the IBASIC language is explained in the *HP Instrument BASIC User's Handbook* (HP part number E2083-90005). HP-IB syntax are listed in the *HP-IB Syntax Reference Guide* (HP part number E6381-90014).

Conventions Used in This Manual

The following conventions are used throughout this manual to help clarify instructions and reduce unnecessary text:

Test Set refers to the HP 8935 Series E6381A TDMA Base Station Test Set.

Test Set keys are indicated like this: **Preset**

Test Set screen information, such as a measurement result or an error message, is shown like this: `TX Power 7.21 W`

Which Document is Required?

The following documents are part of the Test Set's document set. Use the table to help you decide which document you need.

Table 1 Document Navigation

Document	Part Number	Usage
AMPS Application Guide	E6381-90017	Use this manual for making AMPS base station measurements.
Programmer's Guide	E6380-90018	Use this manual to learn how to program the Test Set.
HP-IB Syntax Guide	E6381-90014	Use this listing of HP-IB syntax when writing control programs for the Test Set.
Assembly Level Repair Guide	E6381-90015	Use this manual to perform calibration on the Test Set and for general service information.
Reference Guide	E6381-90019	Use this manual for general information on accessing and changing settings, general Test Set operation, connector descriptions, and error messages. It also contains information on loading and running the various automated test routines (RF Tools) built in to the Test Set.
HELP Screens	(integral to Test Set)	Pressing the **Help** key accesses information on a variety of Test Set operations and tests.
CD-ROM	E6381-90020	All user documentation

Manufacturer's Declaration

This statement is provided to comply with the requirements of the German Sound Emission Directive, from 18 January 1991.

This product has a sound pressure emission (at the operator position) < 70 dB(A).

- Sound Pressure Lp < 70 dB(A)
- At Operator Position
- Normal Operation
- According to ISO 7779:1988/EN 27779:1991 (Type Test).

Herstellerbescheinigung

Diese Information steht im Zusammenhang mit den Anforderungen der Maschinenlärminformationsverordnung vom 18 January 1991.

- Schalldruckpegel Lp < 70 dB(A).
- Am Arbeitsplatz
- Normaler Betrieb.
- Nach ISO 7779:1988/EN 27779:1991 (Typprüfung).

Safety

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 1010, "Safety Requirements for Electronic Measuring Apparatus," 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 SYMBOLS

Indicates instrument 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 Instrument

WARNING

This product is a Safety Class I instrument (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.

Do not expose to or operate this instrument in outdoor atmospheric conditions such as direct rain, hail, sleet, snow, icing, sunshine or wind. Operate this instrument only within its specified temperature humidity conditions.

This instrument is equipped with internal ground fault circuit interrupter class A.

- **This device does not protect against electrical shock due to contact with both circuit conductors or a fault in supply wiring to product.**
- **Do not use extension cord to connect this product to power receptacle. Attention-ne pas utiliser de rallonge pour raccorder le detecteur-disjoncteur a la prise de courant.**
- **Replace cordset only with HP 8120 series. Attention - Remplacer uniquement par un cordon amovible numero 8120.**
- **Do not use in wet location. Ne pas utiliser dans un emplacement mouille.**

WARNING

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

If this instrument 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 instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

The power cord is connected to internal capacitors that my remain live for 5 seconds after disconnecting the plug from its power supply.

For Continued protection against fire hazard, replace the line fuse(s) only with 250 V fuse(s) or the same current rating and type (for example, normal blow or time delay). Do not use repaired fuses or short circuited fuseholders. FUSE: T 5.0A

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 personal injury and/or product damage.

This product is designed for use in Installation Category II and Pollution Degree 2 per IEC 1010 and IEC 664 respectively. For indoor use only.

This product has autoranging line voltage input, be sure the supply voltage is within the specified range.

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.

To prevent electrical shock, disconnect instrument 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.

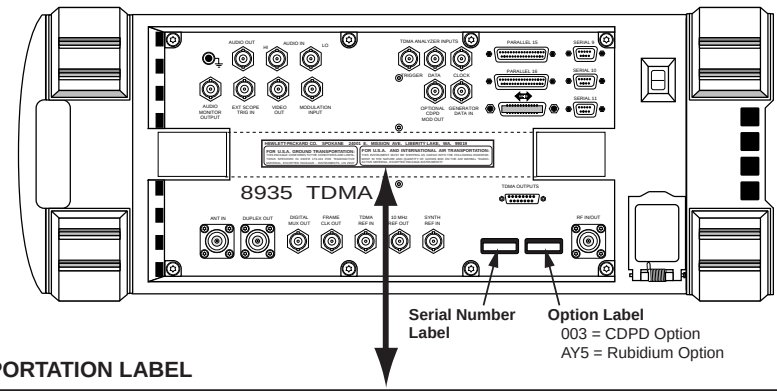
WARNING - RUBIDIUM REFERENCE ASSEMBLY (E6381A)

The optional Rubidium Reference assembly, A2A15, (OPTION AY5) of the HP 8935 Series E6381A TDMA Base Station Test Set contains the radioactive isotope Rubidium 87. DO NOT attempt to repair this assembly. This assembly contains no user serviceable parts. The Rubidium 87 is isolated inside a vacuum tube which is enclosed within a metal housing, and as a result, there is no measurable external radiation. The rubidium Reference assembly does not present any safety hazard. This assembly, for disposal purposes, is regulated as a hazardous waste and must be disposed of in accordance with local, state, and federal laws.

FOR GROUND TRANSPORTATION IN THE U.S.A:
This package conforms to the conditions and limitations specified in 49CFR 173.424 for radioactive material, excepted package – instruments, UN2910.

FOR AIR TRANSPORTATION IN THE U.S.A AND INTERNATIONAL:
This instrument must be shipped as cargo with the following endorsement in the nature and quantity of goods box on the air waybill, "Radioactive material, excepted package – instruments."

Figure 1 **Rubidium Transportation Labels**



TRANSPORTATION LABEL

HEWLETT-PACKARD CO. SPOKANE 24001 E. MISSION AVE. LIBERTY LAKE, WA. 99019

FOR U.S.A. GROUND TRANSPORTATION:
THIS PACKAGE CONFORMS TO THE CONDITIONS AND LIMITATIONS SPECIFIED IN 49CFR 173.424 FOR "RADIOACTIVE MATERIAL, EXCEPTED PACKAGE - INSTRUMENTS, UN 2910"

FOR U.S.A. AND INTERNATIONAL AIR TRANSPORTATION:
THIS INSTRUMENT MUST BE SHIPPING AS CARGO WITH THE FOLLOWING ENDORSEMENT IN THE NATURE AND QUANTITY OF GOODS BOX ON THE AIR WAYBILL "RADIOACTIVE MATERIAL, EXCEPTED PACKAGE-INSTRUMENTS"

WARNING

The optional Rubidium Reference assembly (OPTION AY5) contains the radioactive isotope Rubidium 87. For Test Sets with this option, there are strict transportation requirements. See transportation label on Test Set. Fines and penalties can results if the directions on the label are not followed.

If the Test Set is upgraded with this option, you must place the transportation label on the Test Set. Failure to do so can result in fines and penalties.

If the rubidium assembly is permanently removed from the Test Set, the transportation label must also be removed. Failure to remove the label when the rubidium assembly is removed can also result in fines and penalties.

labels.eps

Product Markings

CE - the CE mark is a registered trademark of the European Community. A CE mark accompanied by a year indicated the year the design was proven.

CSA - the CSA mark is a registered trademark of the Canadian Standards Association.

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory.
Hewlett-Packard 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.

Hewlett-Packard Warranty Statement for Commercial Products

HP 8935 Series
E6381A TDMA Base Station Test Set

Duration of Warranty: 1 Year

1. HP warrants HP hardware, accessories and supplies against defects in materials and workmanship for the period specified above. If HP receives notice of such defects during the warranty period, HP will, at its option, either repair or replace products which prove to be defective. Replacement products may be either new or like-new.
2. HP warrants that HP software will not fail to execute its programming instructions, for the period specified above, due to defects in material and workmanship when properly installed and used. If HP receives notice of such defects during the warranty period, HP will replace software media which does not execute its programming instructions due to such defects.
3. HP does not warrant that the operation of HP products will be uninterrupted or error free. If HP is unable, within a reasonable time, to repair or replace any product to a condition as warranted, customer will be entitled to a refund of the purchase price upon prompt return of the product.
4. HP products may contain remanufactured parts equivalent to new in performance or may have been subject to incidental use.
5. The warranty period begins on the date of delivery or on the date of installation if installed by HP. If customer schedules or delays HP installation more than 30 days after delivery, warranty begins on the 31st day from delivery.
6. Warranty does not apply to defects resulting from (a) improper or inadequate maintenance or calibration, (b) software, interfacing, parts or supplies not supplied by HP, (c) unauthorized modification or misuse, (d) operation outside of the published environmental specifications for the product, or (e) improper site preparation or maintenance.
7. TO THE EXTENT ALLOWED BY LOCAL LAW, THE ABOVE WARRANTIES ARE EXCLUSIVE AND NO OTHER WARRANTYOR CONDITION, WHETHER WRITTEN OR ORAL IS EXPRESSED OR IMPLIED AND HP SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTIES OR CONDITIONS OR MERCHANTABILITY, SATISFACTORY QUALITY, AND FITNESS FOR A PARTICULAR PURPOSE.

8. HP will be liable for damage to tangible property per incident up to the greater of $300,000 or the actual amount paid for the product that is the subject of the claim, and for damages for bodily injury or death, to the extent that all such damages are determined by a court of competent jurisdiction to have been directly caused by a defective HP product.
9. TO THE EXTENT ALLOWED BY LOCAL LAW, THE REMEDIES IN THIS WARRANTY STATEMENT ARE CUSTOMER'S SOLE AND EXCLUSIVE REMEDIES. EXCEPT AS INDICATED ABOVE, IN NO EVENT WILL HP OR ITS SUPPLIERS BE LIABLE FOR LOSS OF DATA OR FOR DIRECT, SPECIAL, INCIDENTAL, CONSEQUENTIAL (INCLUDING LOST PROFIT OR DATA), OR OTHER DAMAGE, WHETHER BASED IN CONTRACT, TORT, OR OTHERWISE.

   FOR CONSUMER TRANSACTIONS IN AUSTRALIA AND NEW ZEALAND: THE WARRANTY TERMS CONTAINED IN THIS STATEMENT, EXCEPT TO THE EXTENT LAWFULLY PERMITTED, DO NOT EXCLUDE RESTRICT OR MODIFY AND ARE IN ADDITION TO THE MANDATORY STATUTORY RIGHTS APPLICABLE TO THE SALE OF THIS PRODUCT TO YOU.

ASSISTANCE

Maintenance Agreements

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

Regional Sales Offices

Table 2 Regional Sales and Service Offices

Eastern USA Sales Office Hewlett-Packard Company 2101 Gather Rd. Rockville, MD 20850 Tel: (301) 258-2000	Eastern USA Sales Office Hewlett-Packard Company 2101 Gather Rd. Rockville, MD 20850 Tel: (301) 258-2000	Midwestern USA Sales and Service Hewlett-Packard Company 5201 Tollview Drive Rolling Meadows, IL 60008 Tel: (708) 342-2000
Southern USA Sales and Service Hewlett-Packard Company 1995 North Park Place Atlanta, GA 30339 Sales Tel: (404) 955-1500 Fax: (404) 980-7292 Service Tel: (404) 850-2544 Fax: (404) 980-7292	Southern USA Service Center Hewlett-Packard Company 930 E. Campbell Road Richardson, TX 75081 Tel: (214) 699-4331	Western USA Service Center Hewlett-Packard Company 301 E. Evelyn Avenue Mountain View, CA 94041 Tel: (415) 694-2000 Fax: (415) 694-0601
Western USA Sales and Service Hewlett-Packard Company 24 Inverness Place East Englewood, CO 80112 Sales Tel: (303) 649-5000 Fax: (303) 649-5787 Service Tel: (303) 649-5512 Fax: (303) 649-5787	Western USA Sales and Service Hewlett-Packard Company 1421 South Manhattan Avenue Fullerton, CA 92631 Sales Tel: (714) 999-6700 Fax: (714) 778-3033 Service Tel: (714) 758-5490 Fax: (714) 778-3033	United States of America Customer Information Center Hewlett-Packard Company Tel: (800) 752-0900 6:00 am to 5:00 pm Pacific Time Parts Direct: 1-800-227-8164
South Eastern Europe Sales and Service Hewlett-Packard Ges. m.b.h. Liebigasse 1 P.O. Box 72 A-1222 Vienna, Austria Telephone: 43 222 2500 0 Telex: 13 4425	European Multicountry Region Sales and Service Hewlett-Packard S.A. P.O. Box 95 150, Route dv Nant_dl_AVRIL CH-1217 Meyrin 2 Geneva, Switzerland Telephone: (41/22) 780-8111 Fax: (41/22) 780-8542	Northern Europe Sales and Service Hewlett-Packard Nederland B.V. Startbaan 16 1187 XR Amstelveen, The Netherlands P.O. Box 667 Telephone: 31/20 5476911 X 6631 Fax: 31-20-6471825NL

Asia Sales and Service Hewlett-Packard Asia Ltd. 22-30/F Peregrine Tower Lippo Center 89 Queensway, Central Hong Kong G.P.O. Box 863 Hong Kong Telephone: 852-848-7777 Fax: 852-868-4997	Japan Sales and Service Yokogawa-Hewlett-Packard Ltd. 3-29-21, Takaido-Higashi Suginami-Ku, Tokyo 168 Telephone: 81 3 3331-6111 Fax: 81 3 3331-6631	International Sales Branch Headquarters Sales and Service Hewlett-Packard S.A. 39 Rue Veyrot P.O. Box 365 1217 Meyrin 1 Geneva, Switzerland Telephone: 41-22-780-4111 Fax: 41-22-780-4770
Australia, New Zealand Sales and Service Hewlett-Packard Ltd. P.O. Box 221 31-41 Joseph Street Blackburn, Victoria 3130 Telephone: (61/3) 895-2895 Fax: (61/3) 898-9257	Canada Sales and Service Hewlett-Packard (Canada) Ltd. 5150 Spectrum Way Mississauga, Ontario L4W 5G1 Canada Telephone: (416) 206-4725 Fax: (416) 206-4739	Canada Service Center Hewlett-Packard Company 17500 Transcanada Highway S. Serv Road Kirkland, Quebec H9J 2X8 Canada Telephone: (416) 206-3295
Canada Service Center Hewlett-Packard Ltd. 11120 178 Street Edmonton, Alberta T5S 1P2 Canada Telephone: (403) 486-6666 Fax: (403) 489-8764	Latin America Hewlett-Packard Company LAHQ Mexico City Col. Lomas de Virreyes 11000 Mexico D.F. Mexico Telephone: (52/5) 326-4000 Fax: (52/5) 202 7718	United Kingdom Sales and Service Hewlett-Packard Ltd. Cain Road Amen Corner Bracknell, Berkshire RG12 1HN United Kingdom Telephone: 44 344 360000

1 Getting Started with AMPS Test

This chapter introduces you to the HP 8935 Series E6381A TDMA Base Station Test Set and its AMPS functions. For information on other functions in the Test Set, see “Which Document is Required?” on page 18. To proceed immediately to the test procedures, see “AMPS Tests You Can Perform” on page 30.

About the Test Set

Product Description

This Test Set helps you install, commission, and maintain AMPS base stations. It also allows you to test TDMA base stations.

The Test Set contains an RF signal generator, RF analyzer, AF analyzer, and AF generator to test AMPS base stations. The following tools are also included:

Spectrum Analyzer

Power Meter

Oscilloscope

AC/DC Voltmeter

IBASIC controller

Batteries

There are two methods the Test Set uses to back up its RAM. One is a set of two AA batteries mounted inside the rear panel of the Test Set. You must periodically change these batteries. The second method of RAM backup is an internal battery. It is not user serviceable.

An error message is displayed at the top of the screen if either set of batteries is getting low on charge. Failure to take prompt action may result in loss of RAM data including IBASIC programs and SAVE/RECALL states stored in the RAM.

To change the AA batteries, use the following procedure:

1. Turn off power and unplug the Test Set.
2. Remove the six screws in the rear panel using a TX-15 TORX(R) screwdriver.
3. Remove the rear cover.
4. Replace the AA batteries. Do not use rechargeable batteries.
5. Replace the rear panel.
6. Dispose of the old batteries in an environmentally safe manner.

If the Test Set Fails to Power On

Connect a reliable power cord between the Test Set and an acceptable AC mains (line) power source, and set the Test Set's power switch in the on position. If the Test Set does not power on after a few seconds, either the Ground Fault Circuit Interrupter (GFCI) was tripped or the mains (line) power fuse is blown.

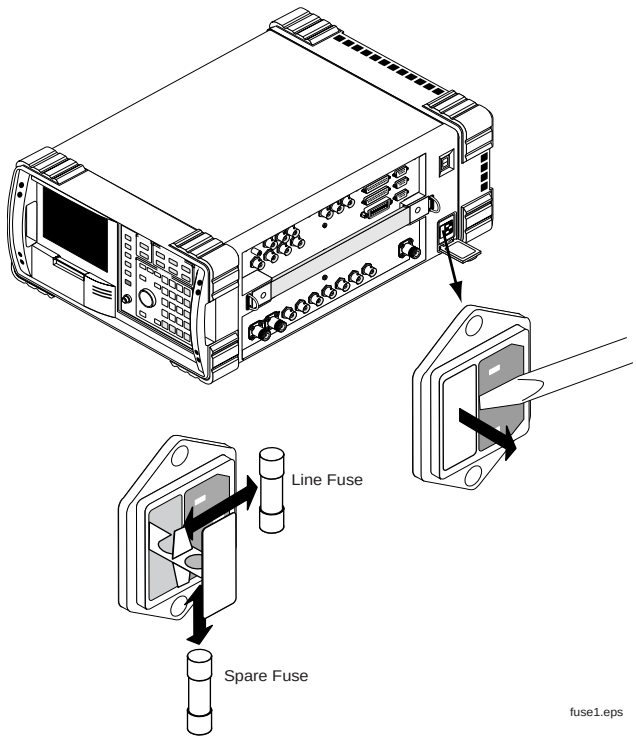
Checking the GFCI Circuit

The GFCI circuit prevents accidental electrical shock if the Test Set is damaged or is exposed to excessive amounts of water. A small door in the rear panel of the Test Set provides access to the **Test** (red) and **Reset** (black) buttons to test the operation of the circuit and reset it after being tripped. If the Test Set fails to power on, try pressing the **Reset** button to reset the GFCI.

Checking the Mains (Line) Fuse

The mains (line) fuse protects against fire and instrument damage caused by over-current operation inside the Test Set. The fuse is located in the power cord receptacle module. By removing the power cord from the receptacle and carefully prying out the small "door" in the receptacle, you can withdraw the inner fuse and see if it is damaged. If it is damaged, replace the fuse with another fuse of identical type, voltage, and current ratings (see warnings above the receptacle). A spare fuse is located immediately behind the fuse "door."

Figure 1-1 Accessing the Mains (Line) Fuse



Getting Help

If you have problems using this Test Set, and cannot find the solution in these documents or the help screens, please use one of the following contacts:

Your local or regional sales office (see "Regional Sales and Service Offices" on page 12)

- Application Support Helpline: 1-800-922-8920
- U.S. Call Center: 800 452-4844
- Korea HP Direct: (82/2) 769-0800
- Canada HP Direct: (800) 387-3154
- European Call center: +31 20 547-9990
- Test and Measurement Organization on the web: http://www.tmo.hp.com/

Manual and Automatic Operation Modes

You can operate the Test Set in either of two modes: manual or automatic. Controlling the Test Set with its knob and keypad is manual operation; the type of operation discussed in this manual. Controlling the Test Set with an IBASIC program is automatic operation, and is discussed in the software manuals for the manufacturer-specific software packages available from HP.

IBASIC Programs

You can obtain an IBASIC program in two ways: either write it yourself, or purchase a software package from Hewlett-Packard. To write programs yourself, refer to the *Programmer's Guide* included on the Test Set's documentation CD-ROM.

Many of HP's software packages are manufacturer-specific, providing automated testing of the manufacturer's base station to greatly reduce test times and provide test setup repeatability. Once configured, the software typically controls both the base station and the Test Set and prompts the user to make the required connections during testing. Test results can be printed and/or saved to a file for later use. Contact your local HP Sales Office to find out which software packages are currently available.

Maximizing the Accuracy of Your Measurements

This Test Set is designed to make highly accurate measurements. However, to ensure that you have the most accurate measurements available, you can perform the following tasks:

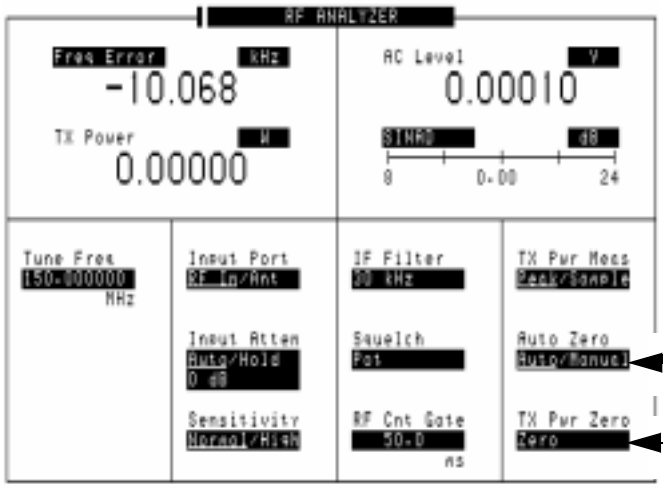
Calibration

You should calibrate the Test Set whenever you change or add an internal assembly. You may want to calibrate when you upgrade firmware. See the *Assembly Level Repair Manual* for calibration procedures.

TX Power Temperature Compensation

Power measurement calibration can be optimized for temperature changes using the `TX Pwr Zero` field on the RF ANALYZER screen. The new calibration factors are stored in RAM until the next time the routine is used.

To have the Test Set zero the TX Power measurement automatically when needed, set the `Auto Zero` field on the RF ANALYZER screen to `Auto`. During operation, the Test Set will temporarily halt the TX Power measurement as it is calibrated. This can happen during a measurement. If interrupting the measurement is a problem for your test setup, set the `Auto Zero` field to `Manual`, and select `TX Pwr Zero` whenever you want to manually calibrate the measurement.



"Auto" provides automatic periodic power calibration.

Select `Zero` to manually calibrate power measurements.

Display an FM Carrier Signal (Loopback Test)

The following procedure intended to make you feel more comfortable with using the Test Set. If you are familiar with using the Test Set, proceed to Chapter 2.

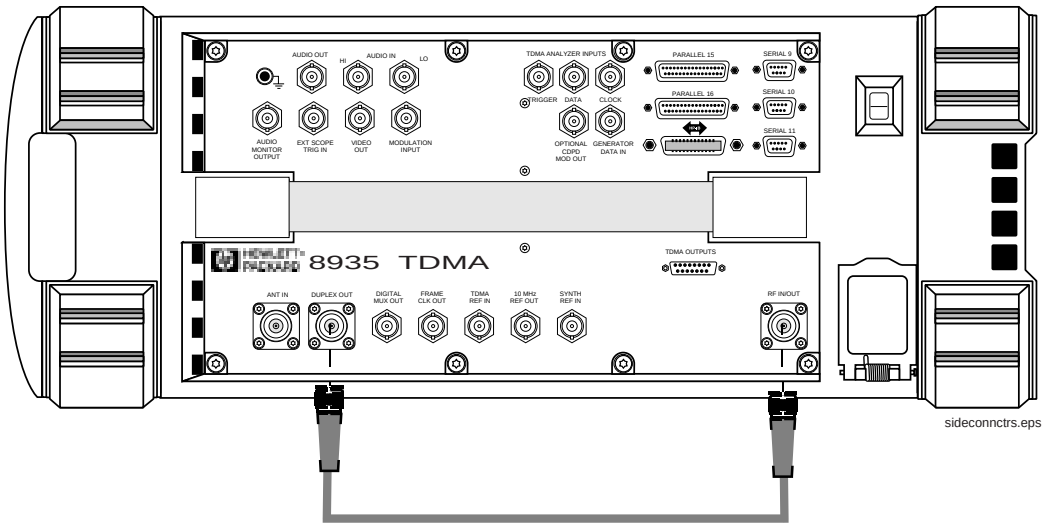
Since an AMPS base station is basically a continuous wave (CW) FM signal, this section will guide you through the process of generating and displaying an FM signal at a cellular band frequency.

NOTE In the following operating example, you enter a common frequency for the RF generator and RF analyzer to create and view the Test Set's own signal. However, typical AMPS base station testing uses channel assignments with different transmit and receive frequencies. This is explained further in "Using Channel Numbers to Set Analyzer and Generator Frequencies" on page 69.

Connections for FM Carrier Loopback Test

Connect a cable to the Test Set as shown below.

Figure 1-2 FM Carrier Loopback Test Connections



Controlling the Test Set

The Test Set's controls are organized by display screens containing individual control fields. Here are some guidelines for selecting screens and control fields:

Use the knob to move the cursor around the screen. Reverse video boxes indicate fields that can be selected.

To select a field on the screen, push the knob or press the **Enter** key.

Use the **RF Gen**, **RF Anl**, and **Spec Anl** keys to access the RF GENERATOR, RF ANALYZER, and SPEC ANL screens.

Selecting the titlebar at the top of the screen displays a list of screens that can be immediately accessed when selected.

Preparing the Test Set

1. Plug in the Test Set.
2. Turn on the Test Set (or press **Preset** if it is already on). The SOFTWARE MENU screen is displayed.
3. Press the **Inst Config** key.
4. Position the cursor in front of the `RF Display` field and set the field to `Freq` (if not already set).
5. Verify your connections. See "Connections for FM Carrier Loopback Test" on page 23.

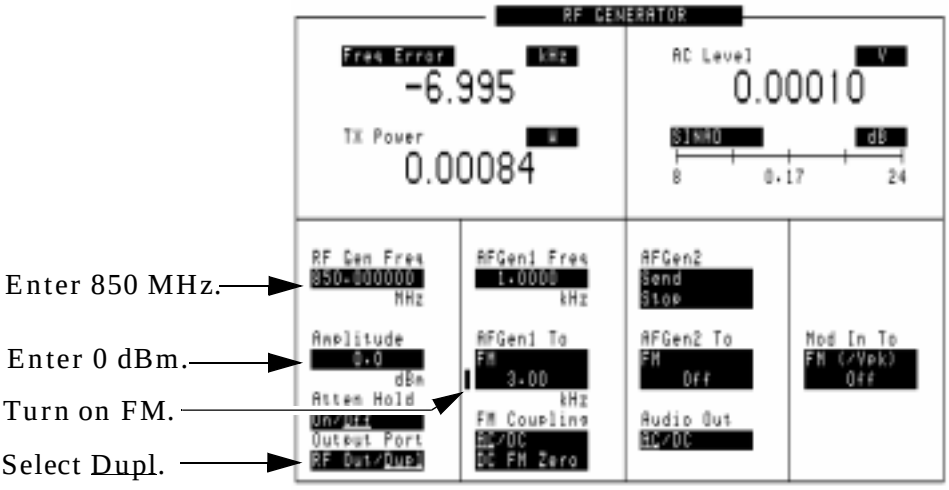
Generate an FM Carrier Signal

Refer to Figure 1-3.

1. Press **RF Gen** to go to the RF GENERATOR screen.
2. Select `RF Gen Freq` and use the keypad to set the frequency to 850.000 MHz.
3. Select `Output Port` and set it to `Dupl`.
4. Select `Amplitude` and set the amplitude to 0 dBm.
5 Turn on FM modulation by positioning the cursor in the lower half of the `AFGen1 To` field and pressing the **On/Off** key (see Figure 1-3 on page 25).

   The default FM deviation is 2.9 kHz. The default FM rate is 1.0 kHz.

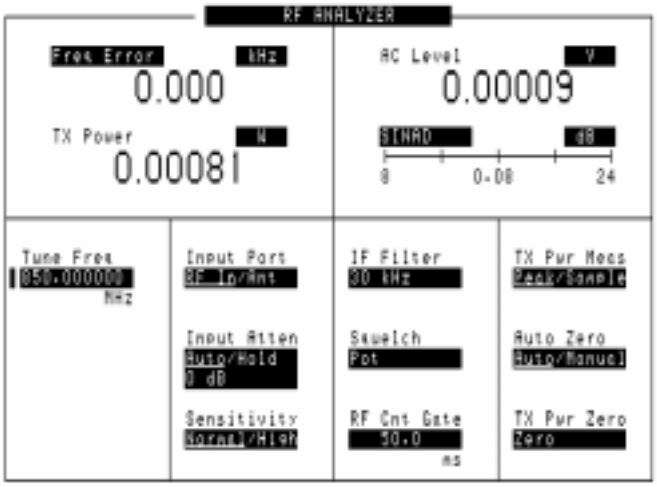
Figure 1-3 Setting Up the RF Generator



Analyzing an FM Carrier Signal

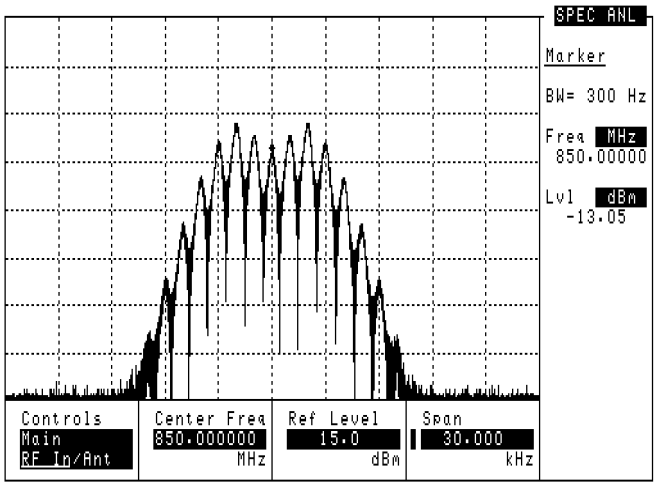
1. Press the **RF Anl** key to go to the RF ANALYZER screen.
2. Select `Tune Freq` and use the keypad to set the frequency to 850.000 MHz. The `Freq Error` and `TX Power` measurement for the RF Generator's signal are displayed. The `AC Level` and `SINAD` measurements are the default audio measurements, but are not relevant to the current measurement setup.

Figure 1-4 Default RF Analyzer Measurements



3. Press the **Spec Anl** key to go to the SPECTRUM ANALYZER screen.
4. The signal is displayed.
5. Select `Span` and set it to `30.000 kHz` to get a good view of the modulated signal. See Figure 1-5.

Figure 1-5 FM Carrier Signal



What to Do Next

Congratulations! You are now ready to begin testing your AMPS Base Station. Proceed to Chapter 2, “Testing AMPS Base Stations,” on page 29.

2 Testing AMPS Base Stations

Advanced Mobile Phone System (AMPS) base stations for cellular telephone systems are basically continuous wave (CW) FM voice transceivers with some control and data signals for system operation. This chapter explains how to use the Test Set to manually test the RF and AF performance of the transmitter and receiver portions of the base station.

AMPS Tests You Can Perform

The following tests are explained in this manual:

- "Transmitter Frequency Error/Offset and Power Test" on page 34.
- "Transmitter SAT Frequency and Deviation" on page 36.
- "Transmitter Data Deviation" on page 38.
- "Transmitter Maximum Voice Deviation" on page 40.
- "Receiver Sensitivity (SINAD)" on page 43.
- "Receiver Squelch Threshold" on page 47.

CAUTION

Transmitter power (`TX Power`) can only be measured through the Test Set's RF IN/OUT port. Verify that the signal connected to this port does not exceed the limits printed on the connector panel near the port.

If you hear a loud "warbling" sound from the Test Set, turn off your transmitter immediately! This is the over-power alarm, warning that instrument damage may occur. Turning the Test Set off at this point does not protect the internal circuitry. Also, removing the cable from the RF IN/OUT port without turning the transmitter off may damage your transmitter or power amplifier (due to an impedance mismatch).

The ANT IN port is used only for analyzing very low level signals (≤60 mW). Never attempt to measure a transmitter's power directly using the ANT IN port, because instrument damage may occur.

The DUPLEX OUT port is used only to provide RF signals to the base station's receive ports. It must not be connected to the base station's transmit port or damage may occur to the Test Set.

What You Need to Know to Begin

You need to know how to control the base station and the basic operation of the Test Set before you can test your base station.

Test Set operation includes how to change control settings, how to navigate between control screens, and how to change the units used for any measurement or setting. Test Set operation and feature descriptions are included in the *Reference Guide*.

Base station operation includes turning the transmitter on and off, turning the SAT tone and data signals on and off, and knowing where to connect test cables from the Test Set to your base station.

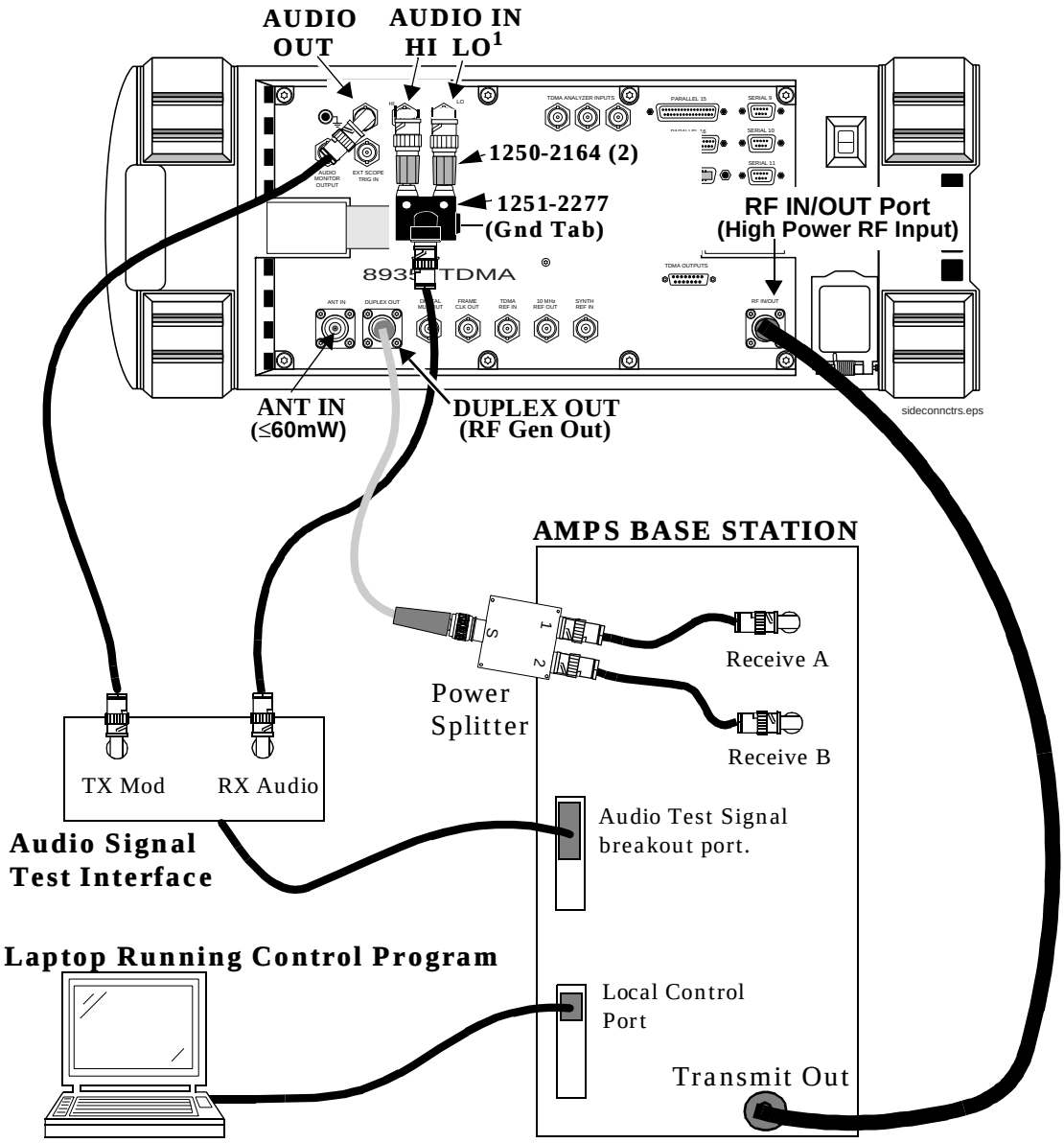
You also need to properly configure the Test Set for your test situation. The following sections describe operations needed to simplify Test Set operation and minimize measurement errors.

- Entering the known losses and/or gains in your test setup is explained in "Compensating for Signal Losses and Gains in the Test Setup" on page 33.
- Measuring the signal loss through cables and other devices is explained in "Measuring Insertion Losses" on page 53.
- Choosing to enter your base station's transmit and receive frequencies by channel number or by discrete frequencies is explained in "Using Channel Numbers to Set Analyzer and Generator Frequencies" on page 69.

Connecting the Test Set to Your Base Station

The connections shown in Figure 2-1 indicate a "generic" base station using a test interface for audio test signals and a laptop computer running a control program to control the base station. A power splitter is used for testing the receiver ports. Although this is a common setup for performing tests, audio and RF connections to base stations and the ways base stations are controlled vary among manufacturers.

Figure 2-1 Connections Between the Test Set and the Base Station



[1]The AUDIO IN - LO connection is used to terminate the audio signal into 600Ω. See "Receiver Sensitivity (SINAD)" on page 43 and "Receiver Squelch Threshold" on page 47.

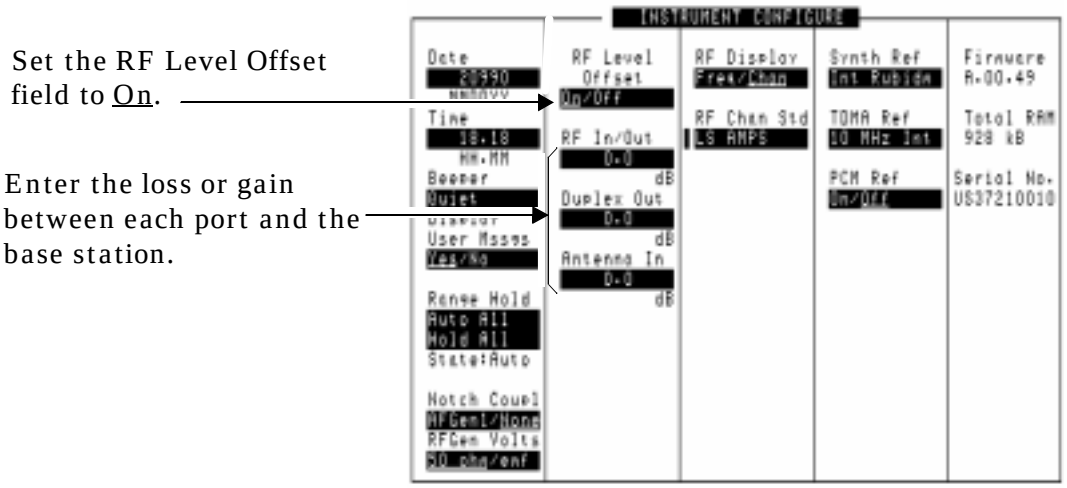
Compensating for Signal Losses and Gains in the Test Setup

Signal losses or gains through cables, splitters, combiners, connectors, amplifiers, or coaxial switches must be accounted for to ensure measurement accuracy. These values are entered in the INSTRUMENT CONFIGURE screen (press the **Inst Config** key).

Refer to "Measuring Insertion Losses" on page 53 for information about measuring cable/system losses.

- Total losses/gains between the transmitter's output and the Test Set's RF IN/OUT port are entered in the `RF In/Out` field. A negative number (indicating a loss) causes the displayed TX power measurement to be increased by the entered amount. A positive number (indicating a gain) causes the RF analyzer to decrease the displayed TX power measurement by the entered amount.
- Total losses between the Test Set's DUPLEX OUT port and the base station's receive port(s) are entered in the `Duplex Out` field as a negative number (such as –1.2). The RF Generator will automatically increase its level out of the DUPLEX OUT port by the value entered to compensate for the loss.

Figure 2-2 Entering Test System Losses and Gains



Transmitter Frequency Error/Offset and Power Test

This test compares the measured center frequency of the base station to the AMPS channel standard. The resulting difference is the frequency error (also called the frequency offset). The measurement can be displayed in frequency units (Hz, kHz, MHz) or in parts per million (ppm). Measurements are made with all modulation turned off.

The transmitter's power can be measured any time the transmitter is keyed, but may not be accurate unless all modulation is turned off. Transmitter power may be specified by the manufacturer in units of watts (W), milliwatts (mW), dBm, Volts (V), or millivolts (mV).

Prerequisites

The following conditions must be met before testing:

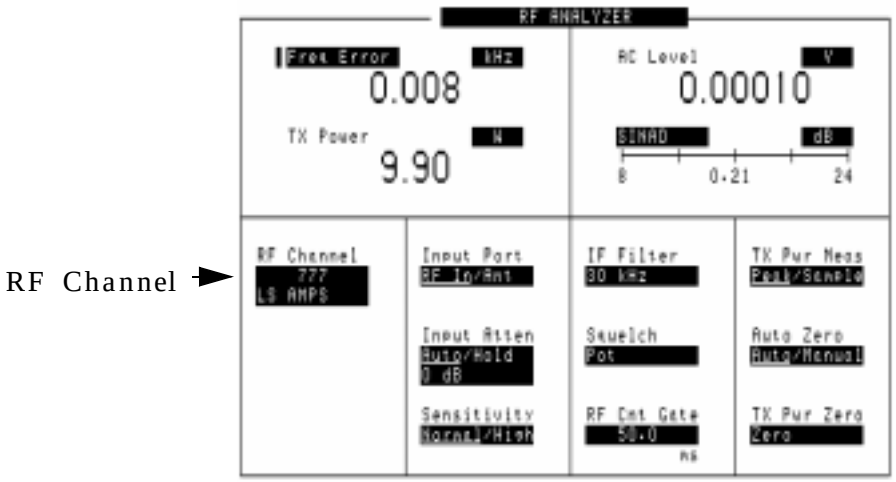
- ❒ The Test Set is turned on *and* **Preset** *was pressed to establish a known instrument state.*
- ❒ You have configured the Test Set for LS AMPS channel tuning (see "Using Channel Numbers to Set Analyzer and Generator Frequencies" on page 69).
- ❒ You have specified any gains or losses in your test system (see "Compensating for Signal Losses and Gains in the Test Setup" on page 33).

Begin Testing

1. *Turn off the base station's RF transmitter*. A transmitter can be damaged if it is not transmitting into a specified load, such as an antenna, power amplifier, duplexer, or power meter with a 50Ω input impedance.
2. Verify that the transmitter's rated RF power (or the level out of the power amplifier if applicable) does not exceed the level printed next to the Test Set's RF IN/OUT connector.
3. Connect the transmitter's TX output to the Test Set's RF IN/OUT port (see Figure 2-1 on page 32).
4. Turn off any modulation signals to the base station.
   - Turn off the SAT tone.
   - Turn off any data (digital) modulation signals.
   - Turn off any audio (voice) modulation signals.
5. Press the **RF Anl** key to access the RF ANALYZER screen.
6. Enter the transmitter's `RF Channel` number.
7. Turn on the transmitter. The `TX Freq Error` and `TX Power` measurements are displayed.

   Note: Disregard any values shown for `AC Level` and `SINAD` at this time.

Figure 2-3 Transmitter Frequency Error and Power Test Results



Transmitter SAT Frequency and Deviation

This test measures the transmitter's Supervisory Audio Tone (SAT) frequency and deviation in the absence of any other modulating signal.

Prerequisites

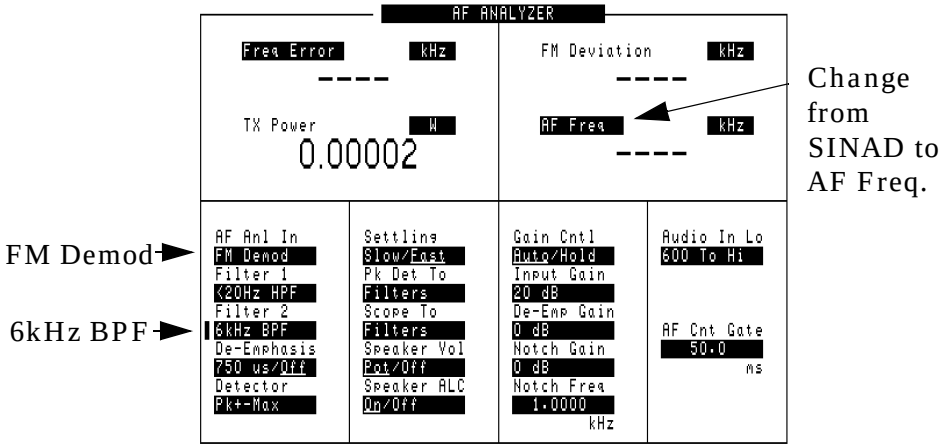
The following conditions must be met before testing:

- ❑ The Test Set is turned on *and* **Preset** *was pressed to establish a known instrument state.*
- ❒ You have configured the Test Set for LS AMPS channel tuning (see "Using Channel Numbers to Set Analyzer and Generator Frequencies" on page 69).
- ❒ You have specified any gains or losses in your test system (see "Compensating for Signal Losses and Gains in the Test Setup" on page 33).

Test Procedure

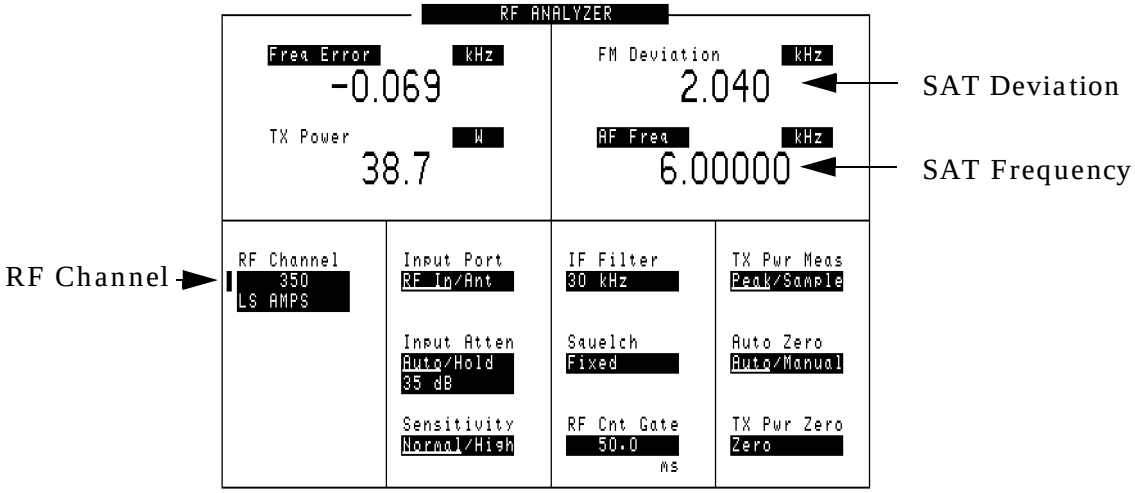
1. *Turn off the base station's RF transmitter*. A transmitter can be damaged if it is not transmitting into a specified load, such as an antenna, power amplifier, duplexer, or power meter with a 50Ω input impedance.
2. Verify that the transmitter's rated RF power (or the level out of the power amplifier if applicable) does not exceed the level printed next to the Test Set's RF IN/OUT connector.
3. Connect the transmitter's TX output to the Test Set's RF IN/OUT port (see Figure 2-1 on page 32).
4. Turn off the voice modulation to the transmitter.
5. Turn off data modulation to the transmitter.
6. Enable the transmitter's SAT transmission.

7. Press **AF Anl** to access the AF ANALYZER screen.
8. Set the `AF Anl In` field to `FM Demod`. This tells the Test Set to analyze the signal from its FM demodulator.
9. Set the `Filter 2` field to `6 kHz BPF`. This helps remove unwanted noise.
10. SINAD is one of the default audio measurements. To measure audio frequency instead, select the `SINAD` measurement and select `AF Freq` from the list of choices.



11. Press the **RF Anl** key to access the RF ANALYZER screen.
12. Enter the transmitter's `RF Channel` number.
13. Turn on the transmitter. The `FM Deviation` and `AF Freq` for the SAT are displayed (as well as the frequency error and TX power of the carrier).

Figure 2-4 SAT Frequency and Deviation Test Results



Transmitter Data Deviation

This test measures the transmitter's digital data deviation in the absence of any other modulating signal.

Prerequisites

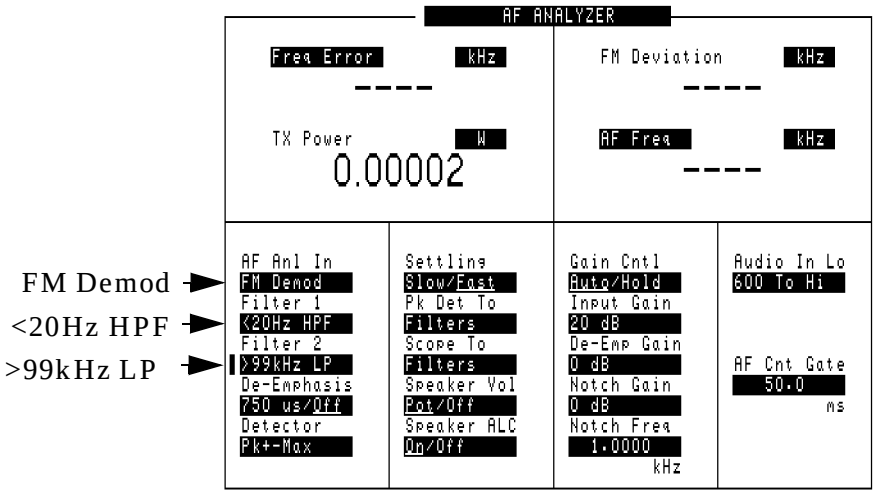
The following conditions must be met before testing:

- ❒ The Test Set is turned on *and* **Preset** *was pressed to establish a known instrument state.*
- ❒ You have configured the Test Set for LS AMPS channel tuning (see "Using Channel Numbers to Set Analyzer and Generator Frequencies" on page 69).
- ❒ You have specified any gains or losses in your test system (see "Compensating for Signal Losses and Gains in the Test Setup" on page 33).

Test Procedure

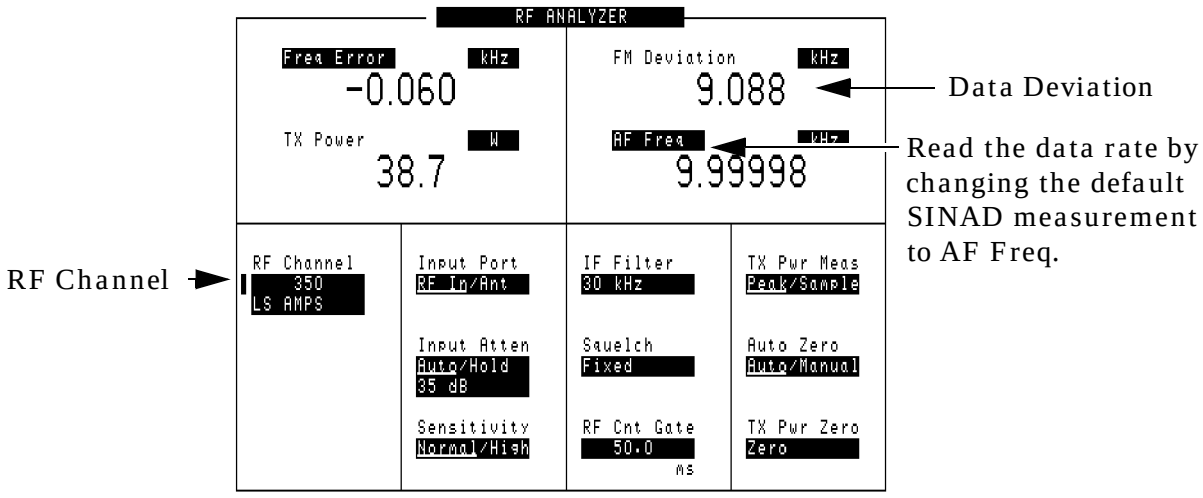
1. *Turn off the base station's RF transmitter.* A transmitter can be damaged if it is not transmitting into a specified load, such as an antenna, power amplifier, duplexer, or power meter with a 50Ω input impedance.
2. Verify that the transmitter's rated RF power (or the level out of the power amplifier if applicable) does not exceed the level indicated next to the Test Set's RF IN/OUT connector.
3. Connect the transmitter's TX output to the Test Set's RF IN/OUT connector (see Figure 2-1 on page 32).
4. Turn off voice modulation to the transmitter.
5. Turn off the SAT to the transmitter.
6. Turn on the data modulation to the transmitter.

7. Press **AF Anl** to access the AF ANALYZER screen.
8. Set the `AF Anl In` field to `FM Demod`. This tells the Test Set to analyze the signal from its FM demodulator.
9. Set `Filter 1` to `<20Hz HPF`.
10. Set `Filter 2` to `>99kHz LP`.



11. Press the **RF Anl** key to access the RF ANALYZER screen.
12. Enter the transmitter's `RF Channel` number.
13. Turn on the transmitter. The `FM Deviation` from the data is displayed. You can also read the data rate by changing the default SINAD measurement to AF Freq (as shown in Figure 2-5).

Figure 2-5 Data Deviation Test Results



Transmitter Maximum Voice Deviation

This test measures the transmitter's maximum FM Deviation by a voice signal in the absence of any other modulation signal.

Prerequisites

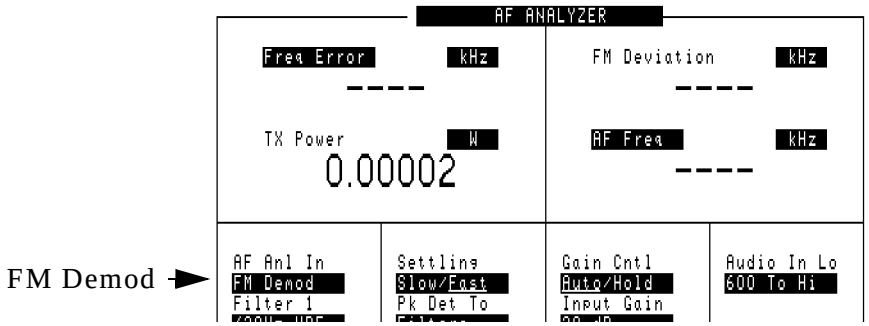
The following conditions must be met before testing:

- ❒ The Test Set is turned on *and* **Preset** *was pressed to establish a known instrument state.*
- ❒ You have configured the Test Set for LS AMPS channel tuning (see "Using Channel Numbers to Set Analyzer and Generator Frequencies" on page 69).
- ❒ You have specified any gains or losses in your test system (see "Compensating for Signal Losses and Gains in the Test Setup" on page 33).

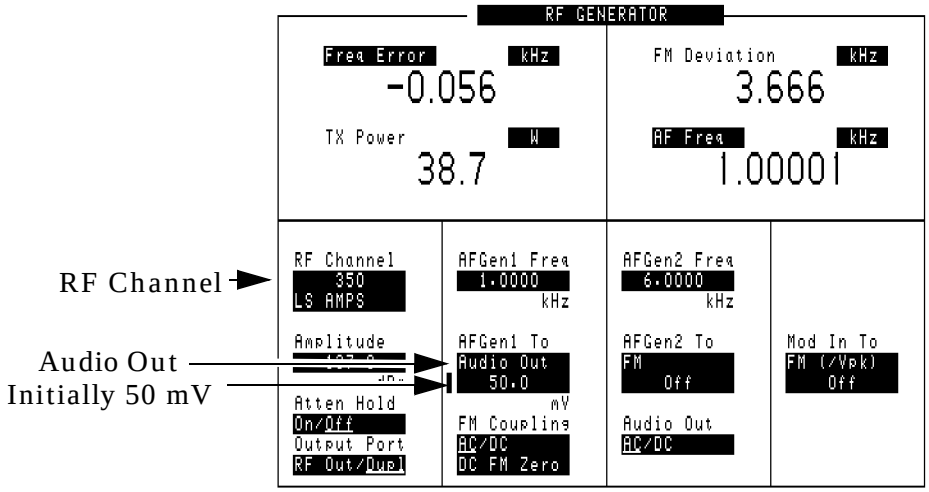
Test Procedure

1. *Turn off the base station's RF transmitter.* A transmitter can be damaged if it is not transmitting into a specified load, such as an antenna, power amplifier, duplexer, or power meter with a 50Ω input impedance.
2. Verify that the transmitter's rated RF power (or the level out of the power amplifier if applicable) does not exceed the level indicated next to the Test Set's RF IN/OUT connector.
3. Connect the transmitter's TX output to the Test Set's RF IN/OUT port (see Figure 2-1 on page 32).
4. Connect the transmitter's TX modulation (voice) input to the Test Set's AUDIO OUT port.
5. Enable the transmitter's audio (speech) modulation.
6. Turn off any modulation signals to the base station other than audio.

7. Press **AF Anl** to access the AF ANALZYER screen.
8. Select the `AF Anl In` field and change it to `FM Demod`.



9. Press the **RF Gen** key to access the RF GENERATOR screen.
10. Enter the transmitter's channel number in the `RF Channel` field.
11. Set the `AFGen1 To` field to `Audio Out`, and a level of 50 mV.

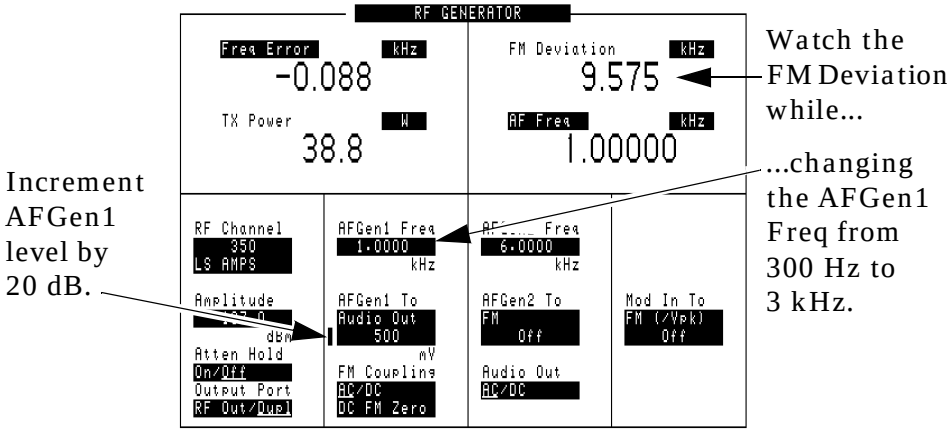


12. With the cursor still positioned in front of the level setting (50 mV), press the **Incr Set** key and enter `20 dB` using the keypad.
13. Turn on the transmitter.

14. With the cursor still positioned in front of the level setting (50 mV) press the up-arrow key once to increment the level by 20 dB.

15. Read the FM deviation.

16. Vary the `AFGen1 Freq` from 300 Hz to 3 kHz and observe the FM deviation at each frequency. Deviation must not exceed the rated system specification of ±12 kHz at any time.



17. Disconnect the cable to the transmitter's audio modulation input (connected in step 4) to reduce the chance of errors in your next transmitter test.

Receiver Sensitivity (SINAD)

This test measures the receiver's ability to demodulate voice signals from very low RF carrier levels.

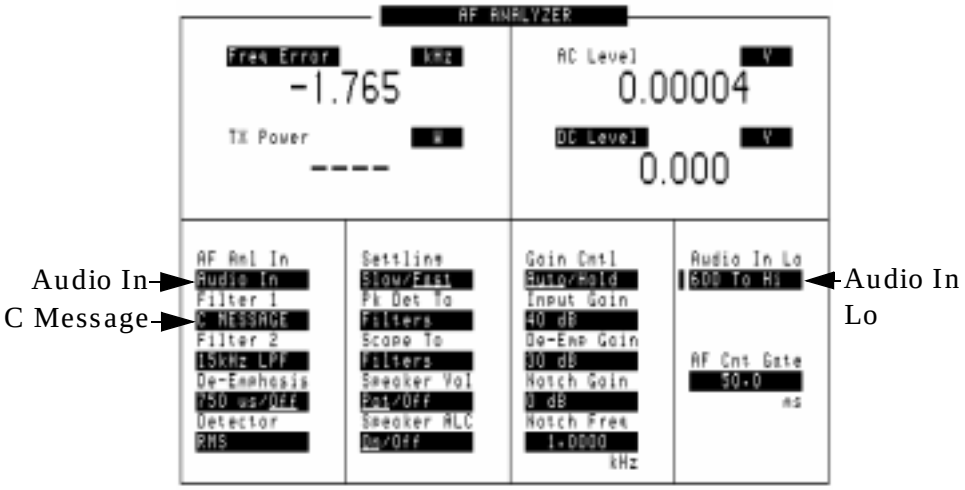
Prerequisites

The following conditions must be met before testing:

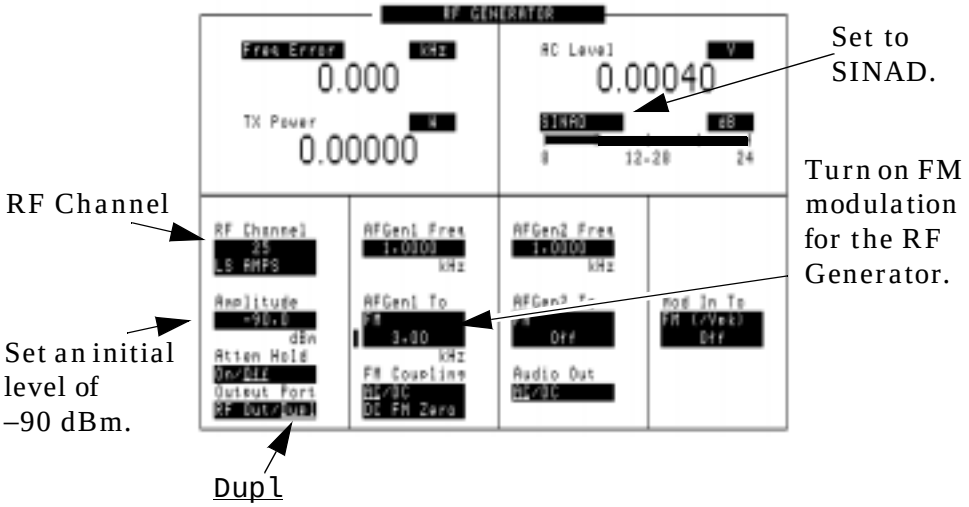
- ❒ The Test Set is turned on *and* **Preset** *was pressed to establish a known instrument state.*
- ❒ You have configured the Test Set for LS AMPS channel tuning (see "Using Channel Numbers to Set Analyzer and Generator Frequencies" on page 69).
- ❒ You have specified any gains or losses in your test system (see "Compensating for Signal Losses and Gains in the Test Setup" on page 33).

Test Procedure

1. Turn off the base station's transmitter.
2. Turn the base station's radio squelch, data, and SAT off.
3. Connect the base station's receiver inputs to the Test Set's DUPLEX OUT port (see Figure 2-1 on page 32).
4. Connect the receiver's audio output to the Test Set's AUDIO IN ports. To terminate the audio into a 600Ω load, or to terminate a floating output amplifier, you must connect to the center pins of the AUDIO IN HI and LO ports. If the audio amplifier is ground referenced, you can use just the AUDIO IN HI connector if desired.
5. Press **AFAnl** to access the AF ANALYZER screen.
6. Set the `Audio In Lo` field to match the audio output of your receiver.
   - `600 To Hi` is used to establish a 600Ω impedance between the center pins of the AUDIO IN HI and LO ports. This is the most common setting for this test.
   - `Gnd` is used when the audio amplifier's output is referenced to chassis ground of the receiver.
   - `Float` is used with double-ended (floating) output audio amplifiers.
7. Set the `AF Anl In` field to `Audio In` (if not already set).
8. Set the `Filter 1` field to `C Message`.



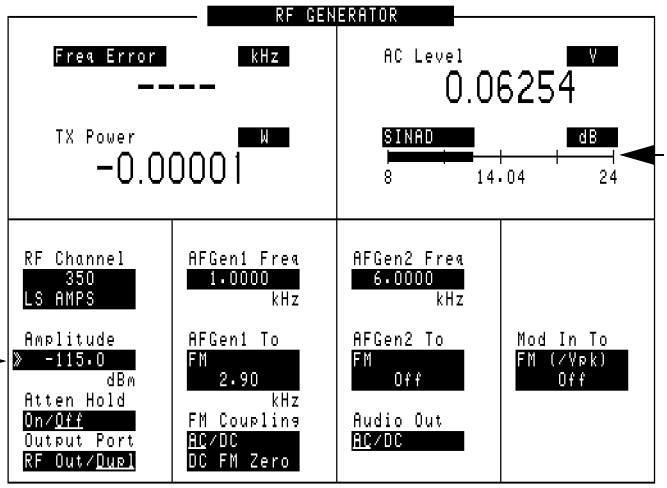
9. Press the **RF Gen** key to access the RF GENERATOR screen.
10. If it is not already displayed, change the lower audio measurement to SINAD. This is done by selecting the existing measurement and choosing SINAD from a list of choices.
11. Set the AFGen1 To field to FM and turn it on (3.00 kHz) using the **Yes On/Off** key.
12. Enter the transmitter's channel number in the RF Channel field.
13. Set the Output Port field to Dupl.
14. Set an initial RF generator level in the Amplitude field. This value depends on the sensitivity of the receiver; but –90 dBm should be a good starting point. At this point you should be able to turn the Test Set's Volume knob clockwise and hear a 1 kHz tone from the Test Set's speaker.



15. Set the Amplitude field to increment in 1 dB units. To do this, position the cursor in front of the Amplitude field, press the **Incr Set** key, and enter 1 dB using the keypad.

16. With the cursor front of the field, turn the knob to decrease the Amplitude setting until the desired SINAD measurement is displayed (commonly 12 dB). You should hear the 1 kHz tone get noisy as you approach the 12 dB SINAD reading.

Figure 2-6 SINAD Test Results



As you decrease the RF generator amplitude into your receiver....

...the SINAD reading goes down and the signal through the Test Set's speaker gets noisy.

Receiver Squelch Threshold

This test determines the RF Signal level where the receiver squelches (switches off) the audio output.

Prerequisites

The following conditions must be met before testing:

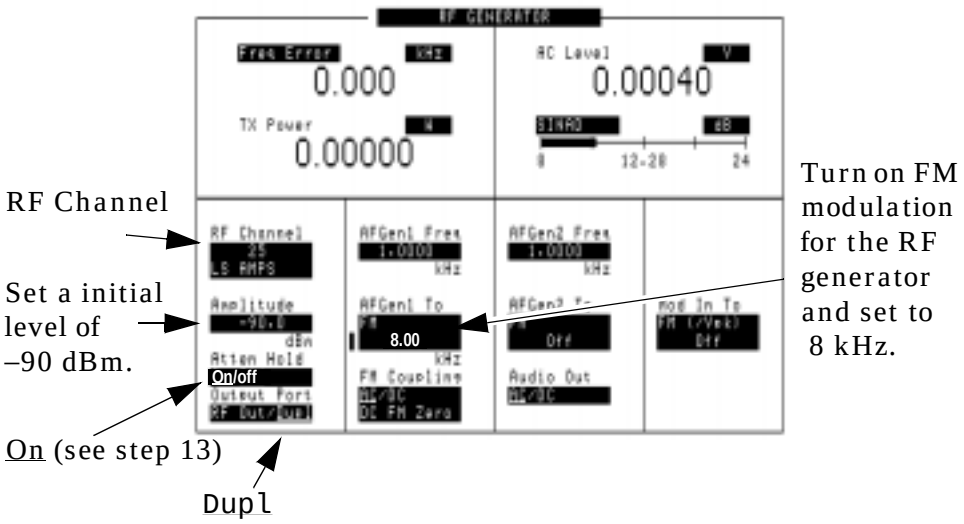
- ❒ The Test Set is turned on *and* **Preset** *was pressed to establish a known instrument state.*
- ❒ You have configured the Test Set for channel LS AMPS tuning (see "Using Channel Numbers to Set Analyzer and Generator Frequencies" on page 69).
- ❒ You have specified any gains or losses in your test system (see "Compensating for Signal Losses and Gains in the Test Setup" on page 33).

Test Procedure

1. Turn off the base station's transmitter.
2. Turn the base station's data and SAT off.
3. Connect the base station's receiver inputs to the Test Set's DUPLEX OUT port (see Figure 2-1 on page 32).
4. Connect the receiver's audio output to the Test Set's AUDIO IN ports. To terminate the audio into a 600Ω load, or to terminate a floating output amplifier, you must connect to the center pins of the AUDIO IN HI and LO ports. If the audio amplifier is ground referenced, you can use just the AUDIO IN HI connector if desired.
5. Press **AFAnl** to access the AF ANALYZER screen.
6. Set the `Audio In Lo` field to match the audio output of your receiver.
   - `600 To Hi` is used to establish a 600Ω impedance between the center pins of the AUDIO IN HI and LO ports. This is the most common setting for this test.
   - `Gnd` is used when the audio amplifier's output is referenced to chassis ground of the receiver.
   - `Float` is used with double-ended (floating) output audio amplifiers.
7. Set the `AF Anl In` field to `Audio In` (if not already set).

8. Press the **RF Gen** key to access the RF GENERATOR screen.
9. Set the `AFGen1 To` field to FM and set it to 8 kHz deviation.
10. Enter the transmitter's channel number in the `RF Channel` field.
11. Set the `Output Port` to `Dupl`.

12. Set an initial RF generator level in the Amplitude field. This value depends on the sensitivity of the receiver; but –90 dBm should be a good starting point. At this point you should be able to turn the Test Set's Volume knob clockwise and hear a 1 kHz tone from the Test Set's speaker.



13. Set the Amplitude field to increment in 1 dB units. To do this, position the cursor in front of the Amplitude field, press the **Incr Set** key, and enter 1 dB using the keypad.

14. With the cursor in front of the Amplitude field, turn the knob counterclockwise to decrease the Amplitude setting until the received audio is no longer heard on the Test Set's speaker (or until the AC Level reading drops suddenly). The RF Generator amplitude at which the receiver's audio output is no longer output is the squelch threshold.

NOTE

If the receiver's squelch threshold level is very close to a level where the Test Set's RF output step attenuator switches, you could get a false reading caused by a momentary signal dropout from the Test Set. To prevent this, adjust the RF Generator amplitude until the audio signal is squelched, then lock the attenuator at its current setting by turning the Atten Hold field On. Increase the amplitude until the received audio is present and then reduce the level until the audio is squelched again. This should be the true squelch threshold amplitude.

3 Utility Procedures

This chapter contains procedures and instructions that will help you make the most efficient use of your Test Set.

Beeper

The beeper notifies you when a message is displayed. Since a message may be removed from the screen before you notice it, it is better to leave the beeper on to alert you to errors during operation. Messages can be viewed by pressing **Shift**, **Help** (Error Messages).

The beeper's volume setting is retained when the instrument is turned off.

Beeper Control

1. Press the **Inst Config** key to go to the INSTRUMENT CONFIGURE screen.
2. Select `Beeper`.
3. Choose from `Off`, `Quiet`, or `Loud`.

Measuring Insertion Losses

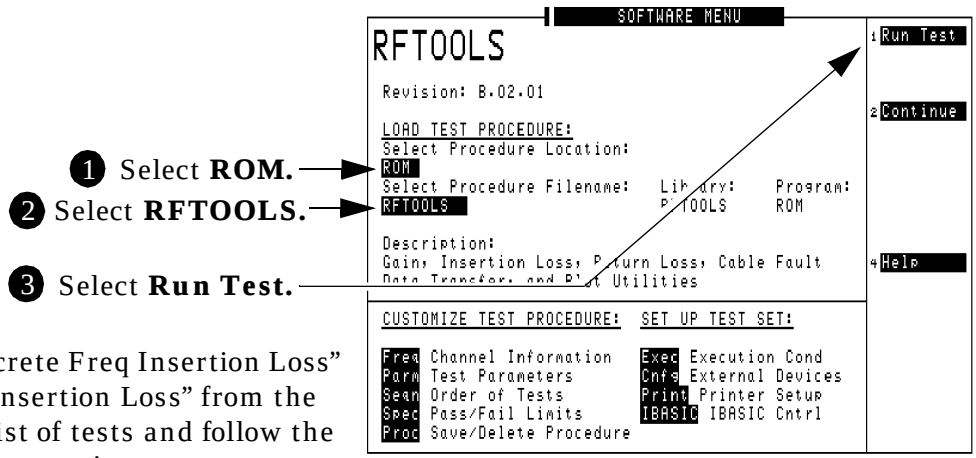
To make accurate power and receiver measurements, the signal loss through the cables or other devices used in your test setup must be known and entered into the Test Set's INSTRUMENT CONFIGURE screen to compensate for these losses.

Signal losses are measured using a built-in automated routine that runs on the Test Set's IBASIC controller. Losses can be calibrated at a discrete (single) frequency or over a frequency range. This is one routine included in a set of utility procedures called the RF TOOLS.

During the test, a calibrated signal goes through two 6-dB attentuators/pads (such as Mini-Circuits model NAT-6-60) and a short type-N male-to-male cable to establish a known reference point. (The pads and cable are not part of the standard equipment shipped with the Test Set.) The Test Set then prompts you to connect the device under test to measure the additional loss through that device.

Figure 3-1 shows how to load and run the RFTOOLS routines. Refer to the *Reference Guide* for more information on running this test.

Figure 3-1 Loading and Running the RF Tools Program



4 Select "Discrete Freq Insertion Loss" or "Swept Insertion Loss" from the displayed list of tests and follow the on-screen instructions.

Memory Cards

The slot on the front of the Test Set is used for PC (memory) cards. The slot is used for the following operations:

- Storing save/recall registers
- Loading of software (either HP or self-written)
- Collecting data (only when using software)
- Upgrading firmware or software

Memory Cards and Intialization

There are several types of PC cards available, and the following cards are used with the Test Set:

- SRAM: used for save/recall and data storage
- Flash ROM: used when upgrading firmware
- OTP (One-Time Programmable): used for HP software

Flash ROM cannot be used for collecting data and save/recall.

Data cannot be loaded on Flash RAM and OTP cards with the Test Set's memory card slot.

SRAM can be initialized with the Test Set.

Initializing SRAM Cards for Save/Recall and Data Collection

1. Insert the SRAM card into the slot. If the card is uninitialized, a message will appear at the top of the display.
2. Press **Shift**, then **Inst Config** (I/O Config) to display the I/O CONFIGURE screen.
3. Using the knob, locate the FORMAT CARD field.
4. Select the FORMAT CARD field. A prompt will appear at the top of the display. Pressing **Yes** will erase and initialize the card.

Oscilloscope

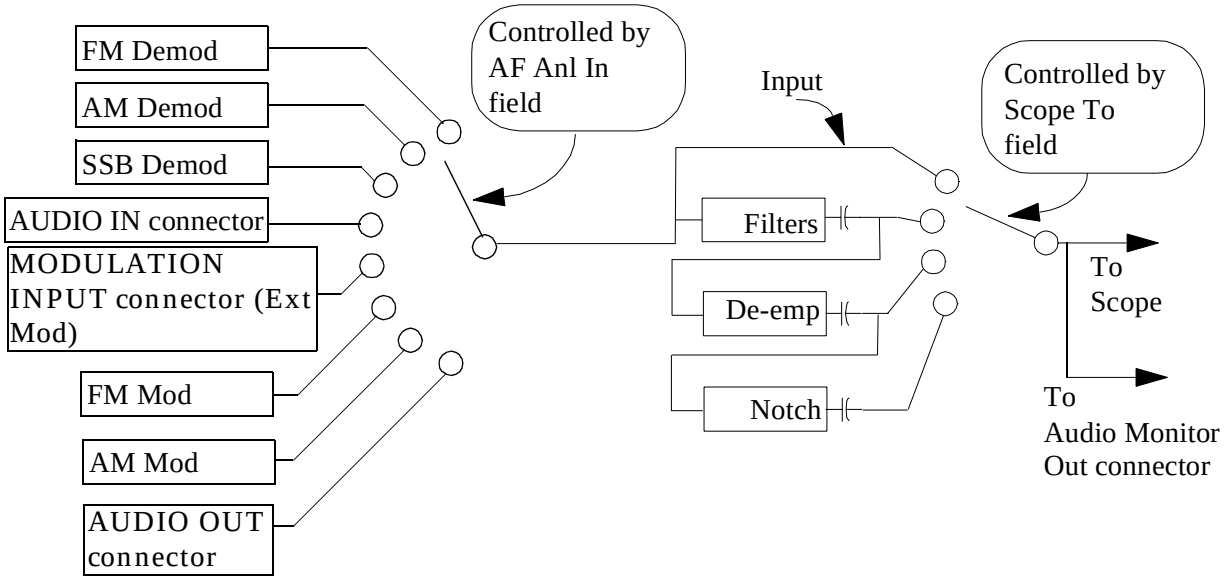
The built-in 50 kHz oscilloscope provides

- multiple triggering formats (internal and external)
- single-shot and pre-trigger viewing for single events
- full marker capability with automatic level and time readout

Time/division, volts/division and vertical offset are displayed and can be changed using the front-panel knob.

Input to the oscilloscope (SCOPE) is provided from various sources including direct inputs to the AUDIO IN and MODULATION INPUT connectors. Oscilloscope functions are accessed from the AF ANALYZER and SCOPE screens.

Figure 3-2 Inputs and Filters for the Oscilloscope



Selecting the Oscilloscope's Input

1. Press the **AF Anl** key to select the AF ANALYZER screen.
2. Select the `AF Anl Input` field. A list of choices appears.
3. Select the desired input to the scope:
   - `FM Demod` for FM demodulated audio from input signals connected to the RF IN/OUT or ANT IN connectors.
   - `AM Demod` for AM demodulated audio from input signals connected to the RF IN/OUT or ANT IN connectors.
   - `SSB Demod` for SSB demodulated audio from input signals connected to the RF IN/OUT or ANT IN connectors.
   - `Audio In` for a signal connected to the AUDIO IN connector.
   - `Ext Mod` for a signal connected to the MODULATION IN connector.
   - `FM Mod` for the FM modulation audio from the RF generator section.
   - `AM Mod` for the AM modulation audio from the RF generator section.
   - `Audio Out` for the signal present at the AUDIO OUT connector.

The input to the oscilloscope is displayed in the lower left corner of the SCOPE screen.

Selecting the Oscilloscope's Filters

1. Press the **AF Anl** key to select the AF ANALYZER screen.
2. Select the `Scope To` field. A list of choices should appear.
3. Select the desired filtering for the signal:
   - `Input` if you want no filtering (dc coupled).
   - `Filters` to route the audio to the oscilloscope after passing through filters 1 and 2 (ac coupled).
   - `De-emp` to route the audio to the oscilloscope after passing through filters 1 and 2, and the de-emphasis circuitry (ac coupled).
   - `Notch` to route the audio to the oscilloscope after passing through Filters 1 and 2, the de-emphasis circuitry, and notch filter circuitry (ac coupled).

Triggering the Oscilloscope

You can control following triggering features of the oscilloscope:

- Trigger: external or internal
- Automated or normal triggering
- Continuous or single shot triggering
- Trigger level
- Trigger delay

The oscilloscope trigger is specified using the SCOPE screen's `Trigger` menu. Select this menu with the following procedure:

1. Press the **Scope** key to go to the SCOPE screen.
2. Select the `Controls` field, then choose `Trigger` from the list of choices.

Using the Marker

The marker is used to help you make measurements with the oscilloscope. By repositioning the marker, you can measure the level and time.

The marker is controlled using the SCOPE screen's `Marker` menu. Select this menu with the following procedure:

1. Press the **Scope** key to go to the SCOPE screen.
2. Select the `Controls` field, the choose `Marker` from the list of choices.

Online Help

The Test Set contains help screens which briefly identify the most commonly used features of the Test Set.

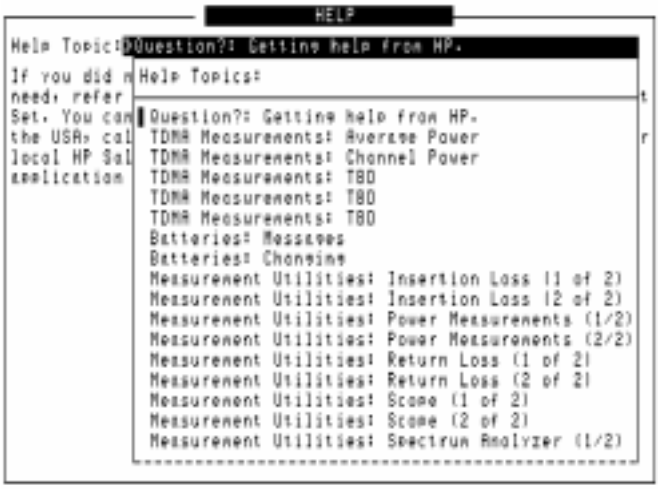
Access the help screens by pressing the **Help** key. Use the knob to select the help topic of interest.

Pressing the **Prev** key allows you to switch between the HELP screen and the previous screen you had accessed. This is particularly useful when you are following a procedure described in the HELP screen.

After selecting a topic, the up arrow (⇑) and down arrow (⇓) keys can be used to scroll through the topic's pages.

Help Screen Display

Figure 3-3 Help Screen Display



Ports: HP-IB, Serial and Parallel

There are three types of data ports on the Test Set: HP-IB, Serial, and Parallel. They each have specific purposes.

HP-IB Port

This port is provided on the Test Set for IEEE 488.2 communications. It is used to control the Test Set with an external IBASIC controller, or to control other HP-IB equipped devices.

This port can be used with an external programming device when writing programs, although it is also common to program the Test Set using a serial port.

The default address of the HP-IB port is 14. This is commonly used in IBASIC programs. An example command providing output to the port is **OUTPUT 714;"*RST"**, which presets the Test Set.

It has two modes, which correspond to modes useful when programming the Test Set. `Talk&Listn` is the normal mode. Use `Control` only when you need to control HP-IB instruments external to the Test Set.

Controlling the HP-IB Port

1. Press **Shift**, then the **Inst Config** (I/O Config) key to display the I/O CONFIGURE screen.
2. Set the address of the HP-IB port with the `HP-IB Adrs` field.
3. Use the `Mode` field to set the mode to either `Talk&Listn` or `Control`.

Serial Ports

Three external serial ports are available on the Test Set. SERIAL 9 is used for printing, IBASIC control, and data communications. Serial ports 10 and 11 are used only for data communications from IBASIC to a base station, external modem, or other device in the test system.

An internal serial port, SERIAL 9, is used to communicate with specialized modules within the Test Set under IBASIC control. Do not change the settings for this port.

Configuring Serial Ports

All serial ports are configured via the I/O CONFIGURE screen. Baud Rate, Parity, Data Length, Stop Length and Flow Control are all configured in this screen. Additionally, SERIAL 9 can be configured for IBASIC control in this screen.

1. Press **Shift**, then **Inst Config** (I/O Config) to go to the I/O CONFIGURE screen.
2. Select `Serial Port` to choose the port you w ant to configure.
3. Change the settings for the port as desired.

NOTE

Do not set flow control (`Flow Cntl`) to “Hardware” in the I/O CONFIGURE screen until you have a device attached to the port that can respond to hardware flow control communications.

Example: You have a printer attached to the Serial 9 port. Power is off to the printer. Before you start to run any IBASIC software (for example, the RFTOOLS program), you must make sure that the printer is attached and its power is on.

Using Serial Ports for Printing

SERIAL 9 is the only serial port that can be used for printing. See “Printing” on page 62.

1. If you want to change the serial port configuration, see “Configuring the SERIAL 9 Port for IBASIC Communications” . It is not necessary to change the `Serial_9 In` field.
2. Press **Shift**, then **Print** (Printer Config) to display the PRINTER CONFIGURE screen.
3. Select `Printer Port`. Choose `Serial 9` to direct the output to Serial Port 9.
4. Press **Print** to print the currently displayed screen.

Configuring the SERIAL 9 Port for IBASIC Communications

The internal connection to the SERIAL 9 port is controlled on the I/O CONFIGURE screen. The port has two purposes with IBASIC:

- `Inst`: SERIAL 9 port is connected to a terminal (for example, a PC running Windows Terminal program). IBASIC commands are input from the terminal and are used to control the Test Set.
- `IBASIC`: SERIAL 9 port is connected to a device that can communicate with an IBASIC program already running inside the Test Set. Typically used for input/output to a PC or other device.

1. Press **Shift**, then **Inst Config** (I/O Config) to go to the I/O CONFIGURE screen.
2. Select `Serial_9 In` to toggle between `Inst` and `IBASIC`.

Configuring Serial Ports 10 and 11

Serial ports 10 and 11 are only configured via IBASIC commands. See the *Syntax Guide* for commands that control these ports.

Parallel Ports

There are two parallel ports on the Test Set.

PARALLET 15 is the only parallel port that can be used for printing. It can be selected in the PRINTER CONFIGURATION screen (press **Shift**, then **Print** (Printer Config)).

Both parallel ports (PARALLEL 15 and 16) may be used for controlling a base station. The port can be configured in an input or an output mode. The data is then written or read under IBASIC control. When in either of these modes, the printing function on the PARALLEL 15 port is disabled.

Printing

You can print from the Test Set via the PARALLEL 15 port, SERIAL 9 port, or the HP-IB port.

Note that data collection, saving test results to some media, is not the same as printing. Data collection can only be done from a software program.

Configuring the Test Set for Printing

1. Press **Shift**, then **Print** (Printer Config) to display the PRINTER CONFIGURE screen.
2. Select the `Model` field and choose the printer that most closely matches your printer.
3. Select the `Printer Port` field and choose the port you will connect the printer to. If necessary, use the I/O CONFIGURE screen to set up addresses and communication modes.
   a. SERIAL 9: This is the uppermost serial port. Configuration defaults are 9600, none, 8, 1, Xon/Xoff.
   b. HP-IB: The HP-IB address (`HP-IB Adrs`) is set to printer address 701. Enter this number as 01. Set `Mode` to `CONTROL`. (The default address, 14, is reserved for an external controller.)
   c. PARALLEL PORT: There are two ports available. PARALLEL 15 (the printer port) is the uppermost port.
4. Connect the proper cable to the connector you selected.
   - SERIAL PORT: standard NULL MODEM cable.
   - HP-IB: HP-IB cable (such as HP 10833B)
   - PARALLEL PORT: parallel cable
5. Change the `FF` (form feed) and `Lines/Page` as needed.

Printing a Screen

1. Configure the Test Set for printing.
2. Go to the screen you want to print.
3. Press the **Hold** key if you want to temporarily stop the measurement. (Optional).
4. Press the **Print** key. Data will be sent to the printer.
5. To cancel the print, go to the PRINTER CONFIGURE screen and select `Abort Print`.

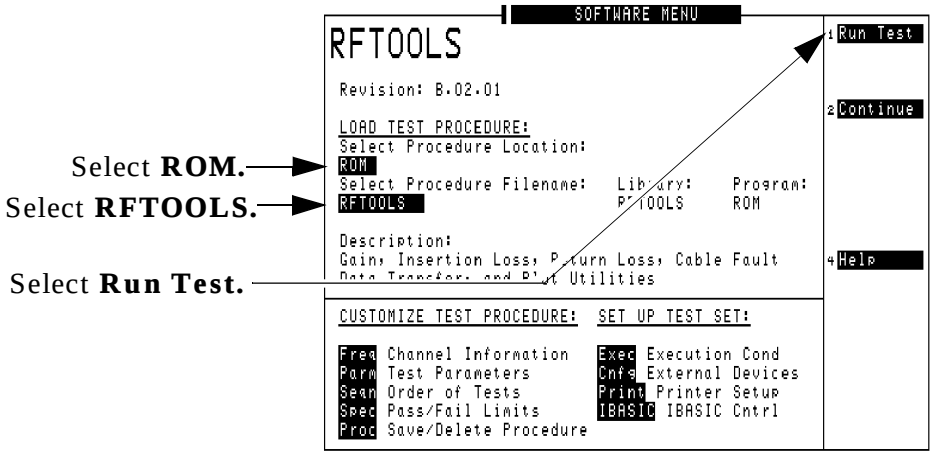
Measuring Swept Return Loss

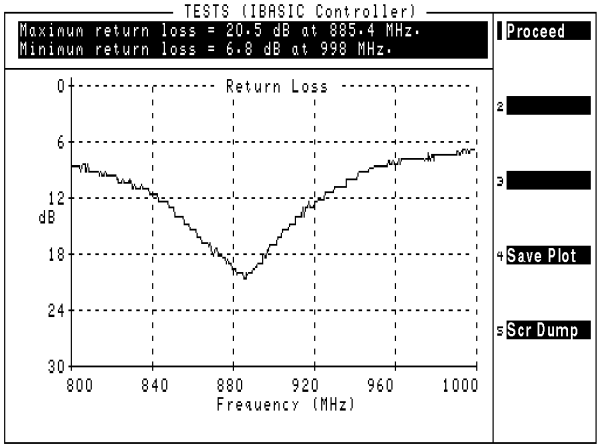
This procedure measures the return loss (VSWR) of an antenna using an IBASIC program that is in the Test Set's memory. An external directional bridge must be provided (such as an Eagle RLB 150X5 Option N5A or equivalent).

Press the **Menu** key to access the SOFTWARE MENU screen, and follow the instructions illustrated on the following pages.

Figure 3-4 shows how to load and run the RFTOOLS routines, and shows an example of a swept return loss measurement. Refer to the *Reference Guide* for more information on running this test.

Figure 3-4 Loading and Running the RF Tools Program





This plot is for a cellular band antenna, swept from 800 MHz to 999 MHz. The plot (and the text above it) indicates that the maximum return loss is at 885.4 MHz. This is the point where the antenna is radiating the maximum amount of signal being fed into it from the return loss bridge, and therefore the Test Set is receiving the least amount of reflected (returned) energy back.

Tracking Generator

The tracking generator is typically used for measuring return loss and insertion loss. It also allows for quick and accurate characterization of filters, duplexers, combiners, and RF to IF conversions. Broadband RF devices can be characterized with single sweeps due to the full-span sweep capability to 1 GHz. The tracking generator also includes amplitude and frequency offset. The tracking generator's output can be routed to either the RF IN/OUT or DUPLEX OUT connector.

Using the Tracking Generator

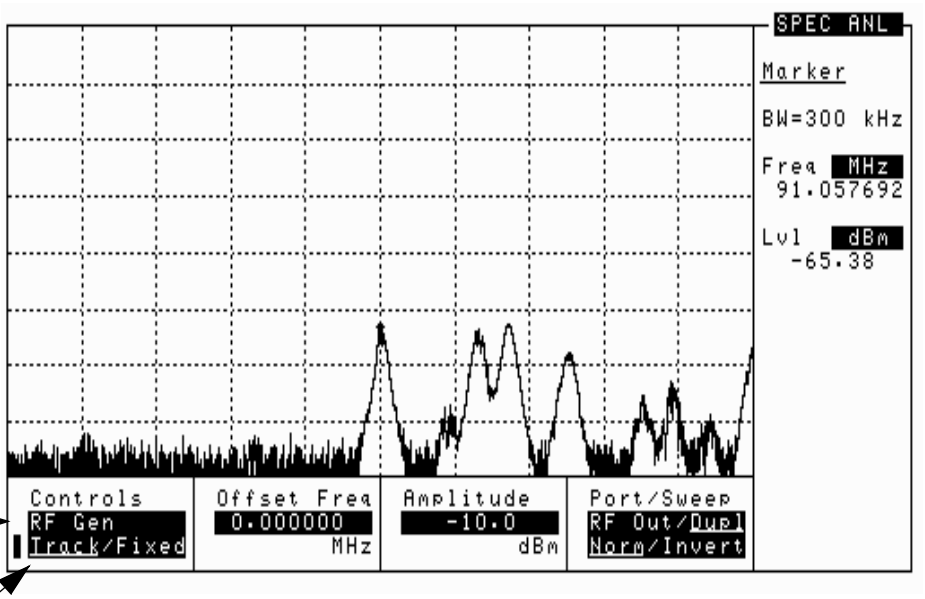
To measure return loss, see "Measuring Swept Return Loss" on page 63.
To measure insertion loss, see "Measuring Insertion Losses" on page 53.

Features of the tracking generator (`RF Gen` menu) are listed below.

- `Track/Fixed`: causes the RF Generator to either synchronize its sweep with the spectrum analyzer's sweep (track) or generate a signal that is totally independent of the spectrum analyzer (fixed).
- `Sweep`: the start and stop frequencies of the sweep are determined by the spectrum analyzer's `Main` menu. The `Span` determines the band, and `Center Freq` (or `RF Channel`) defines the midpoint of the sweep.
- `Offset Freq`: sets the difference between the instantaneous frequency of the tracking generator and the center frequency of the spectrum analyzer. This value can be positive or negative.
- `Amplitude`: sets the amplitude of the signal.
- `Norm/Invert`: With `Norm`, the tracking generator sweeps from low to high frequencies. With `Invert`, it sweeps from high to low frequencies.

NOTE The offset function is useful when looking at frequency translating devices, or anytime you need to sweep around a frequency while analyzing another. During normal operation, offset should be 0.00.

Figure 3-5 Spectrum Analyzer with Tracking Generator Controls Displayed



Tracking Generator Controls

Set to Track to synchronize the RF Generator and Spectrum Analyzer sweeps.

User Keys

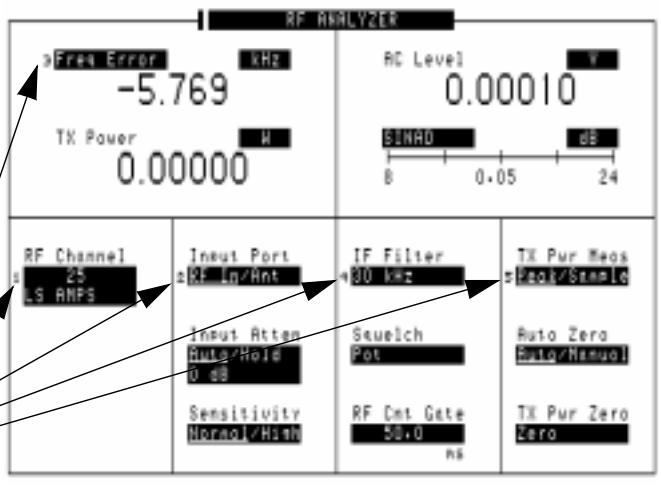
User keys instantly access instrument settings without using the knob. You can use user keys to move quickly between fields on the same screen, and to access field settings that are not normally available on the screen you are using. When the user key is pressed, the cursor instantly moves to, and selects, the assigned field.

Global user keys are used to access settings that are not available on the current screen. Three global user keys are available: k1', k2', and k3'. (To use one of these keys, press **Shift**, then **k1**, **k2**, or **k3**.)

Local user keys are used to move between settings on the screen that is currently displayed. Five local user keys are available for each screen: **k1**, **k2**, **k3**, **k4**, and **k5**. You can assign these keys yourself, or use the factory preset assignments.

Displaying the Pre-assigned Local User Keys

1. Press the **Shift** key.
2. Press the **k4** (Assign) key.
3. Press **Enter**. Now the factory preset keys are displayed.



Examples of local USER key assignments.

Assigning a Local User Key

1. Move the cursor to the field you want to assign to a user key.
2. Press the **Shift** key.
3. Press the **k4** (Assign) key.
4. Press the user key you want to assign to the field you chose. The number of the user key will appear beside the field when you move the cursor.

Assigning a Global User Key

1. Move the cursor to the field you want to assign to a user key.
2. Press the **Shift** key.
3. Press the **k4** (Assign) key.
4. Press the **Shift** key.
5. Press the user key you want to assign to the field you chose (**k1**, **k2**, or **k3**). Global user keys are indicated as k1', k2', and k3' on the front panel to indicate that they are shifted functions. The number of the user key does not appear beside the field when using global user keys.

To Release a User Key Assignment

Perform the same procedure for assigning a key, but instead of pressing the **k4** (Assign) key, press the **k5** (Release) key.

Using Channel Numbers to Set Analyzer and Generator Frequencies

RF analyzer and RF generator frequencies can be entered by channel number or by discrete frequencies (in MHz). The RF Display field on the INSTRUMENT CONFIGURE screen controls which way frequencies are entered. This screen is accessed by pressing the **Inst Config** key.

If the RF Display field is set to Chan for channel tuning, you also need to set the RF Chan Std field to LS AMPS to tell the Test Set you are testing Land (base) Station AMPS radios. This automatically sets the correct 45 MHz frequency offset needed to generate reverse channel signals and analyze forward channel signals for an AMPS base station.

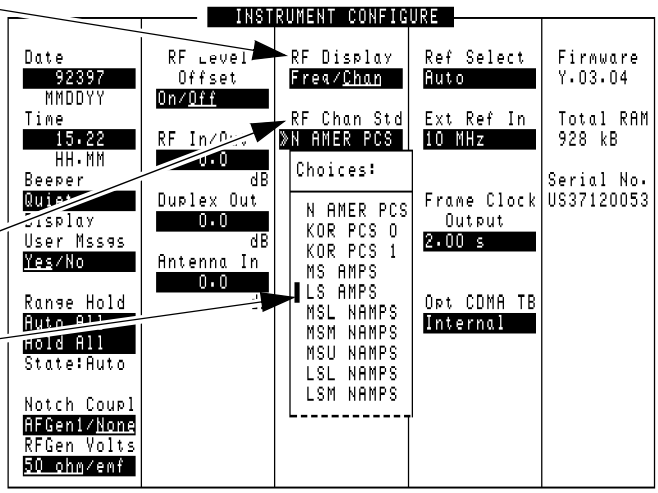
If you do not know the channel number of your base station, but know the transmit and receive frequencies, set the RF Display field to Freq. You can then enter these frequencies directly for the RF generator and RF analyzer as the RF Gen Freq and the Tune Freq, respectively.

Figure 3-6 Configuration to Use Channel Numbers for RF Generator and Analyzer Settings

Set the **RF Display** field to **Chan** to turn on channel tuning.

Select the **RF Chan Std** field to display a list of system types.....

..and then select **LS AMPS** for testing AMPS base stations.



RF Chan and Tune Freq Fields

NOTE All of the test procedures in this document use channel tuning. If you are using frequency tuning, enter the frequency in the appropriate field(s).

When you use **channel tuning**, the RF ANALYZER and RF GENERATOR screens display an `RF Channel` field for entering the channel to tune to or generate.

When you use **frequency tuning**, the RF ANALYZER screen replaces the `RF Channel` field with the `Tune Freq` field for direct frequency entry. The RF GENERATOR screen replaces the `RF Channel` field with the `RF Gen Freq` field. The SPEC ANL screen replaces the `RF Channel` field with the `Center Freq` field.

For AMPS Base Station tests, remember that there is a 45 MHz separation between the transmit and receive frequencies (transmit frequency is 45 MHz greater than the receive frequency).

Voltmeter

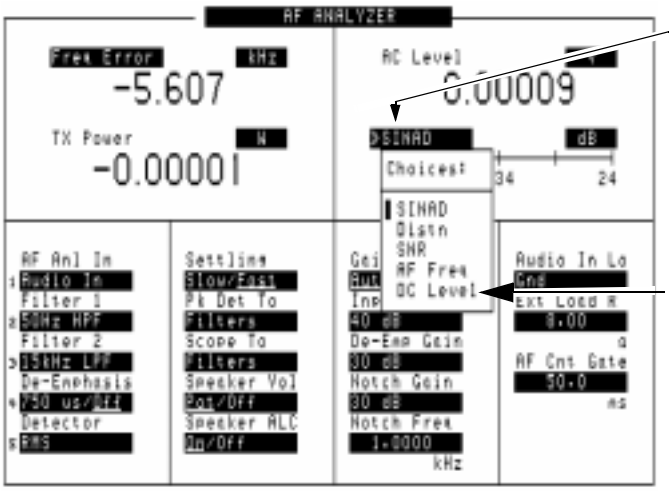
A voltmeter is available in the Test Set, and can measure low level dc or ac voltages. The input to the voltmeter is controlled by the AF Anl In field in the AF ANALYZER screen.

CAUTION Do not exceed the rated input to the Test Set for the DC Level and AC Level measurements.

The connector best suited to making ac level and dc level measurements is the AUDIO IN port.

Measuring AC Level and DC Level

1. Press the **AF Anl** key to go to the AF ANALYZER screen.
2. Select AF Anl In and choose Audio In.
3. Select Audio In Lo and choose Gnd. This sets the AUDIO IN LO port to ground, which allows you to measure voltage at the AUDIO IN HI port.
4. Attach a probe (for example a 1:1 oscilloscope probe) to the AUDIO IN HI connector.
5. AC Level is displayed. To measure DC Level, select the default SINAD measurement and choose DC Level from the displayed list of choices.



Selecting the default SINAD measurement displays a list of measurement choices.

Choose DC Level to measure dc voltage.

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