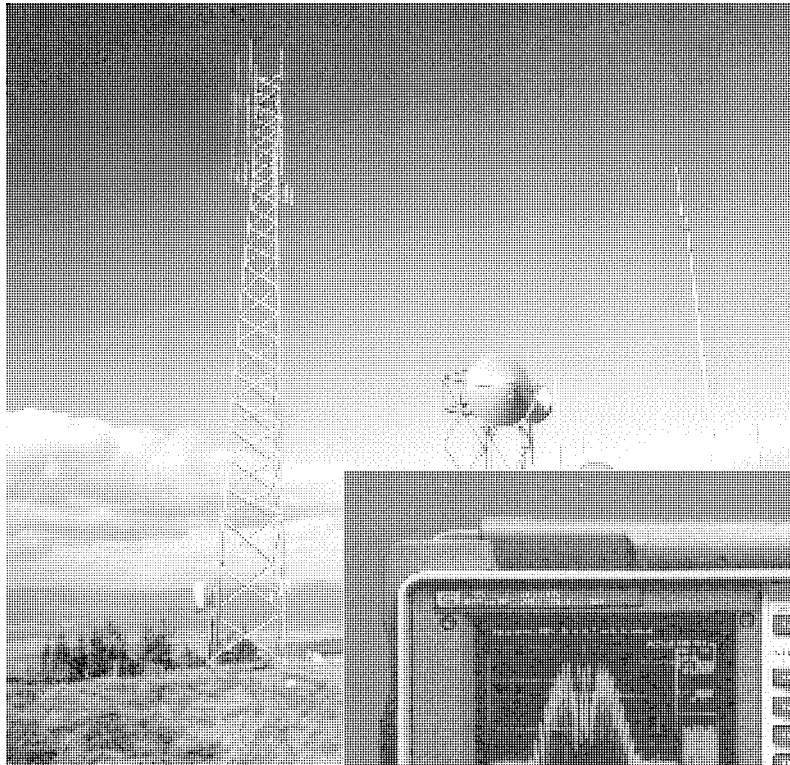
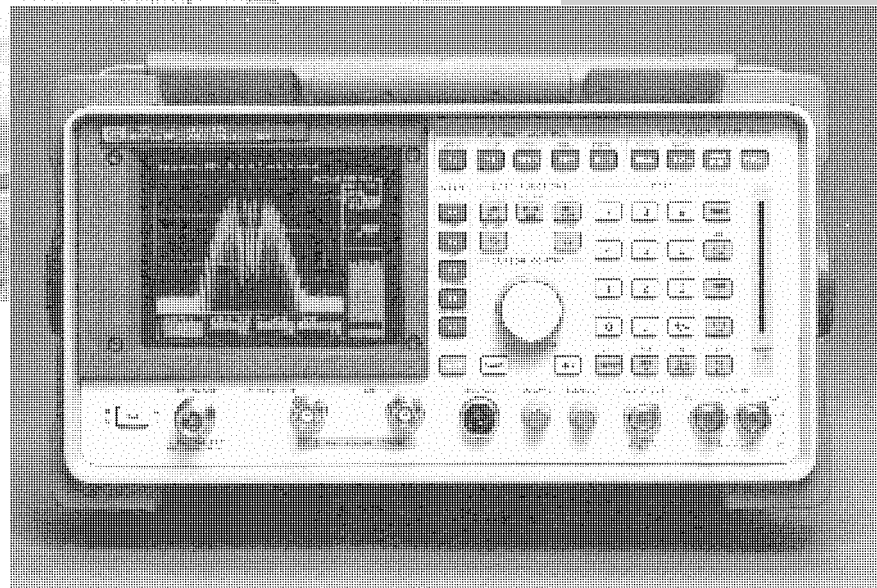


HP 8921A Cell Site Test Set

Product Note 8921-1



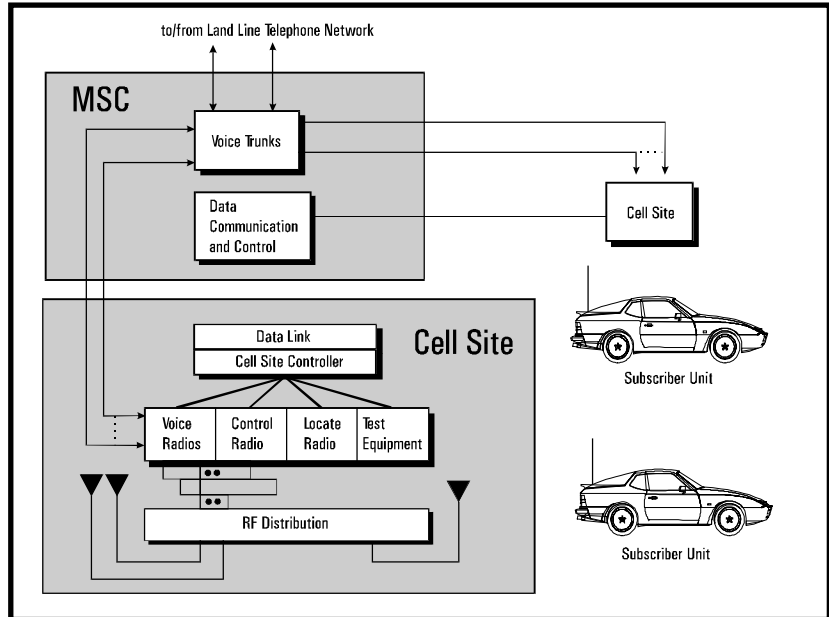
**AMPS
Base Station Testing**



AMPS Base Station Testing

This product note describes manual operation of the HP 8921A Cell Site Test Set (or HP 8920A RF Communications Test Set with options 001, 002, 003, 004, 005, 013, 014) for testing Advanced Mobile Phone System (AMPS) Cellular Base Station equipment. It will lead you through the steps required to set-up the instrument in the proper state to make particular measurements. Storing these instrument states in memory registers allows you to quickly recall them without having to go through the laborious task of creating them each time you want to make a measurement on your base station equipment.

For automated base station testing, Hewlett-Packard offers HP 11807B Cell Site Test Software for use with the HP 8921A Cell Site Test Set. The HP 11807B software has options that cover the most widely used AMPS base stations. Each option uses test and adjustment procedures derived from the manufacturers maintenance manuals. For more information on this and other Hewlett-Packard products, contact your local Hewlett-Packard representative.



Cellular System Overview

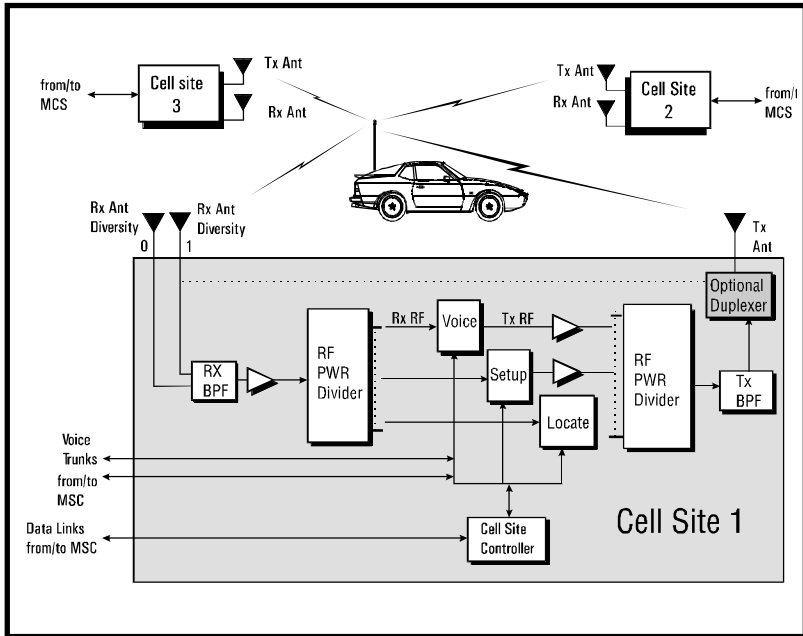
Cell Site Overview

A cell site contains three types of radios: control, voice, and locate. When a mobile originates a call or is paged, the cell site control radio sets up the call. This control radio communicates with the central switch (Electronic Mobile Exchange (EMX), Mobile Switching Center (MSC), and Mobile Telephone Switching Office (MTSO)) to connect the call to another mobile or landline phone. The mobile is then instructed by the cell site control channel to tune to a particular voice channel.

The conversation takes place on the voice radios with the voice signals traveling back to the MSC and routed to the other party.

The locate, or scanner, radio is used to monitor the signal levels of the channels and notifies the switch enabling it to make hand-off decisions. This radio is receive only and, like the voice and control radios, is controlled by distributed control functions between the MSC and local cell site controller. Communication of these control functions takes place via either a landline or microwave transmission data link.

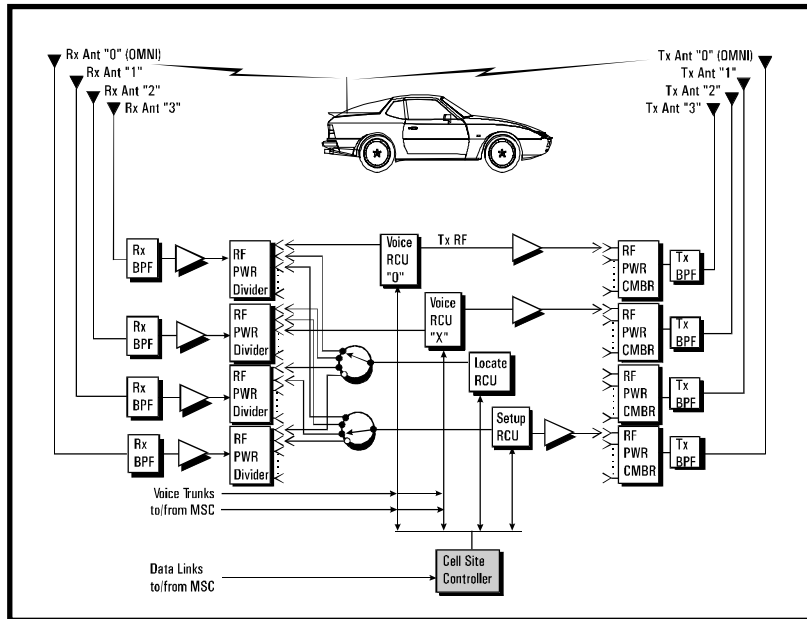
Cell sites are configured as omnidirectional, sectored, or some combination of the two. In general, an omni-directional cell will have two receive antennas and one transmit antenna.



Basic Omni Cell Site Setup

The two receive antennas are physically separated to get better immunity to multipath fading conditions and are typically space diversity antennas. Other omni sites may have only two receive antennas to save money. In this case, one receive path is coupled to the same antenna as the transmit path. A tuned cavity duplexer (combined receive and transmit filter) is then used to keep the signal paths separated.

A directional, or sectored, cell splits the coverage into sectors which are served by different antennas. Typically, a directional cell will have three sectored receive antennas, one omni receive antenna, three sectored transmit antennas, and one omni transmit antenna. Voice radios are configured on one face of the cell for both transmit and receive and the locate radio accepts inputs from all of the receive antennas. The one omni-transmit antenna is used for control channel transmit. When testing base station equipment in directional cells, you will be working with radios



3 - Sector Directional Site

configured to different antennas. Gain/loss for each antenna path will have to be taken into consideration for power measurements and switching between receive antennas for testing receiver sensitivity may also be necessary.

AMPS Base Station Testing

Base Station Tests

Standard tests to make on base station equipment include receive, transmit, and system tests. This product note outlines the following tests for cell site transceivers:

Transmitter Tests

- Frequency Error/Offset
- Output Power
- SAT Frequency Error and Deviation
- Voice Deviation
- Data Deviation

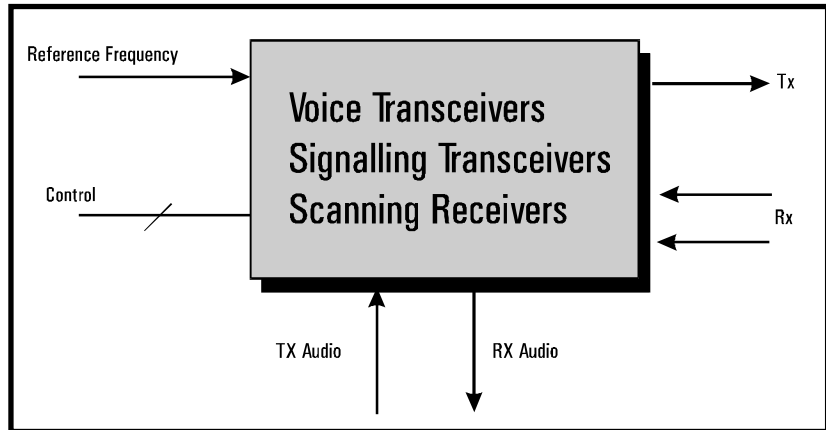
Receiver Tests

- Sensitivity (SINAD)
- Squelch Threshold

The following System Test procedures are NOT INCLUDED in this product note. However, you can find detailed procedures for these tests in the HP 8920A RF Communications Test Set Applications Handbook (Hewlett-Packard PN 08920-90126).

System Tests

- (not included)
- Antenna Return Loss (VSWR)
- Cable Fault Location
- Field Strength Measurements



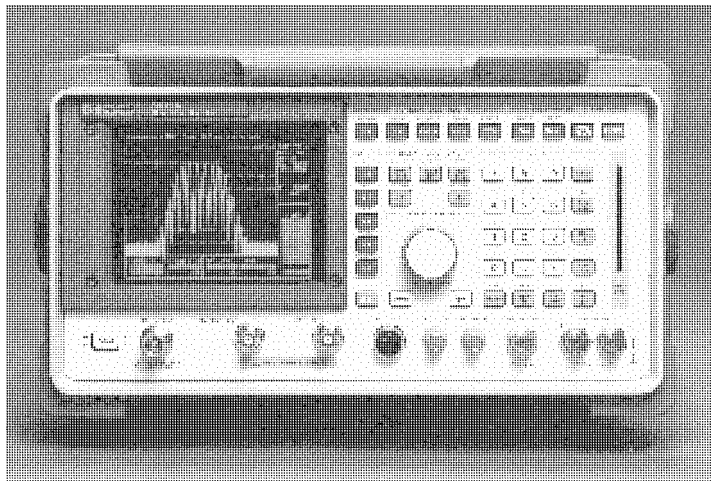
Cell Site Connections

The basic connections required for performing the manual tests in this application note include TX, RX, and audio. Because each manufacturer's base station equipment may connect to the HP 8921A Cell Site Test Set differently, it will be up to you to determine how best to connect your transceivers to the HP 8921A.

Test Set Operation

This product note assumes the user has some familiarity with the general use of the HP 8921A Cell Site Test Set (or HP 8920A RF Communications Test Set). If this is not the case, please refer to the HP 8921A Cell Site Test Set User's Guide and the HP 8920A RF Communications Test Set Applications Handbook for an overview of its functions, features, and capabilities.

This product note also assumes that the user is familiar with the operation of the Base Station under test. It is not the intent of this note to show the step-by-step setups required for setting up all base stations for particular measurements since many base stations have unique setups and control options. However, when a particular base station setup is required, it will be called out in the setup procedure.



HP 8921A Cell Site Test Set

HP 8921A Cell Site Test Set Overview

The HP 8921A Cell Site Test Set is a single instrument that combines the features of 22 individual radio test instruments. The HP 8921A is designed to meet the communication needs of both service and manufacturing environments, and has the capability to test AMPS and TACS Base Stations, cellular phones, and various other communications systems.

Test and troubleshooting time is decreased by simplifying standard measurement tasks and providing the required measurement capability in a single instrument. Transmitters and receivers are characterized with single-key RX, TX, and duplex tests. Each of these tests displays a specialized screen that provides access to the necessary controls and measurement results. Measured results may be displayed as digital readouts and/or bar graphs. All settings and measurements are easily accessed and changed using the front panel knob and keys. If desired, all settings can be saved in nonvolatile save/recall registers for future access.

The various ports on the HP 8921A allow the receiver/transmitter being tested to be quickly connected. A receiver with 2 μV sensitivity (typically $<1 \mu\text{V}$) is available through the ANT IN port, for off-the-air monitoring of low-level signals. Transmitters of up to 60 W (100 W intermittently for 10 seconds/minute) can be connected to the RF IN/OUT port without the use of external attenuators.

Global Measurement Considerations

Saving and Recalling Instrument Setups

The **Save** and **Recall** functions allow you to store different instrument setups and retrieve them later eliminating the task of reconfiguring the HP 8921A each time you wish to make a measurement. You can name save registers anything you want provided the name does not exceed 9 characters. If there is a particular setup you would like the instrument to be in whenever you power it up, save the setup with the name **POWER ON**.

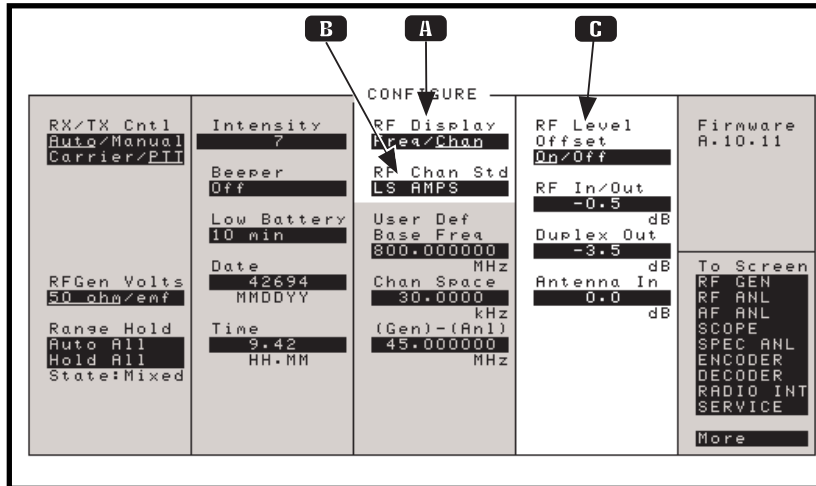
To save an instrument setup:

1. Make any changes to the instrument that you want to SAVE in a register.
2. Press, 'shift', **SAVE**.
3. Using the front panel knob, create a new name or choose an existing name from the 'SAVE' menu.
4. Scroll to the top of the 'SAVE' menu and choose 'DONE'. The current instrument state is now saved.

Configuring the HP 8921A for AMPS Base Station Testing

The **Configure** screen defines a number of general functions, such as date and time, screen intensity, and beeper volume. It is also used to define some RF signal parameters, such as RF Generator / Analyzer offset, channel standards and characteristics, and signal loss/gain compensation. Changes made to the "Configure" screen will be saved when you save instrument setups.

AMPS Base Station Testing



Screen Configuration

Explanations:

A The **RF Display** field selects the format for entering the **RF Analyzer** frequencies:

- * When **Freq.** is selected, you enter the RF Generator and RF Analyzer frequencies directly using the keypad or knob.

- * When **Chan** is selected, the **RF Gen Freq** and **Tune Freq** fields on all screens are replaced by the **RF Channel** field, and only the channel number is entered and displayed.

B The **RF Chan Std** field allows you to select the channel standard for the radio under test. The RF Generator and RF Analyzer frequencies will be automatically set to correspond to the channel number entered in the **RF Channel** field. This field also sets the correct TX/RX frequency offset (45 MHz for AMPS).

C The **RF Level Offset** field enables/disables the effects of the **RF In/Out**, **Duplex Out**, and **Antenna In** fields below it. These fields are used if you wish to take into account losses due to cables and/or splitters in your setup.

- * When set to 'Yes', the RF Generator amplitude and RF Analyzer power measurement are offset by the values entered in these fields.

- * When set to 'No', the values in these fields are ignored. The values can, however, be left in the three fields.

For example, enter "-3.5" into the **RF In/Out** field for the approximate total loss due to a 1 meter cable and 3 dB splitter.

From the front panel of the HP 8921A, enter the "Configure" screen. Set the **RF Display** and **RF Chan Std** as seen here and the **RF Level Offset** as desired.

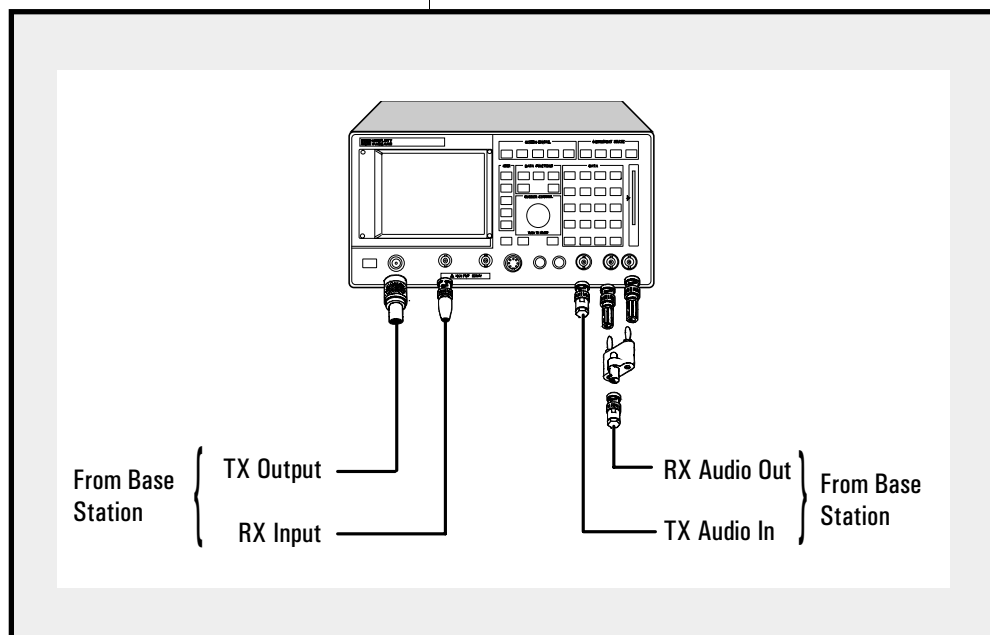
Performing Measurements

The following measurement procedures assume the HP 8921A **Configure** screen is setup as described in the previous section. If the instrument has been preset since then, you will need to re-configure that screen.

Transmitter Tests

Transmitter Frequency Error/Offset and Power . . .	page 8
Transmitter SAT Frequency and Deviation	page 9
Transmitter Maximum Voice Deviation	page 10
Transmitter Data Deviation	page 11

Connect the Base Station to the HP 8921A according to the following diagram.



Transmitter Frequency Error/Offset and Power

Base Station Setup



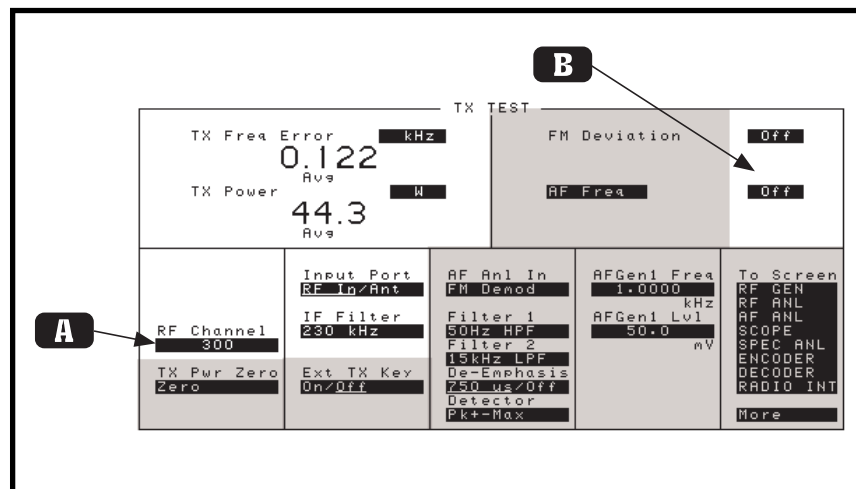
Channel: As desired
TX Power Level: As desired
TX Power: On
SAT: Off
Data: Off

HP 8921A Cell Site Test Set Setup



Step 1:

Press the **TX** key on the HP 8921A to enter the transmitter test screen.



Step 2:

Change the settings in the TX screen as seen in the highlighted areas.

Key instrument considerations

- A** With the front panel keys, enter the same **RF Channel** as set on the base station.
- B** Disable the **FM Deviation** and **AF Freq** measurements by scrolling to their units fields and pressing the **On/Off** key.

Step 3:

The transmitter frequency error and power should now be displayed in the appropriate result fields. For **TX Output Power** in units other than Watts, scroll to and highlight the **TX Power** units field and press the appropriate units key.

Step 4:

Save this measurement setup as **FREQ**.

Transmitter SAT Frequency and Deviation

Base Station Setup



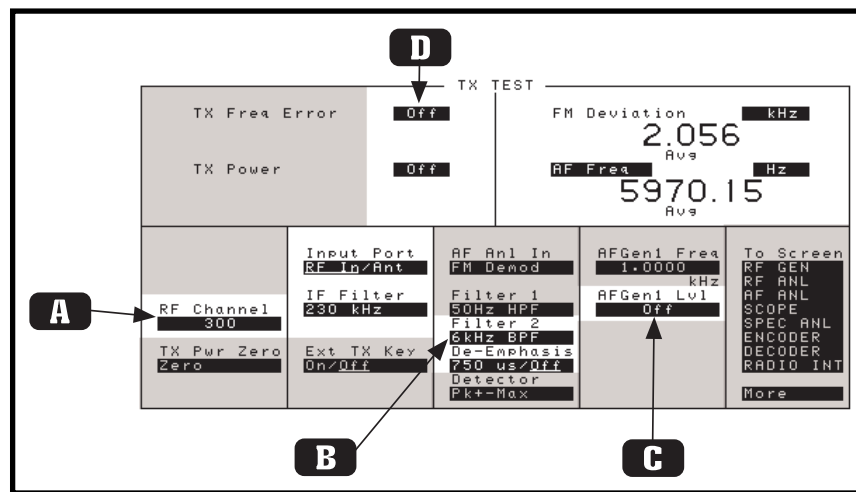
Channel: As desired
TX Power Level: As desired
TX Power: On
SAT: On
Data: Off

HP 8921A Cell Site Test Set Setup



Step 1:

Press the **TX** key on the HP 8921A to enter the transmitter test screen.



Step 2:

Change the settings in the TX screen as seen in the highlighted areas.

Key instrument considerations

- A** Enter the same **RF Channel** as set on the base station.
- B** If you are using an HP 8920A RF Communications Test Set, you must have Option 014 (6 kHz BPF) in order to choose this filter. If not, you can use the 15 kHz LPF. The 6 kHz BPF is standard on the HP 8921A.
- C** **AFGen1 Lvl** must be "OFF" or it may interfere with the SAT measurement.
- D** Disable the **TX Freq Error** and **TX Power** measurements by scrolling to their units fields and pressing the **On/Off** key.

Step 3:

The SAT frequency and deviation should now be displayed in the appropriate result fields. For **AF Freq** in units other than Hz, scroll to and highlight the **AF Freq** units field and press the appropriate units key.

Step 4:

Save this measurement setup as **SAT**.

Transmitter Maximum Voice Deviation

Base Station Setup



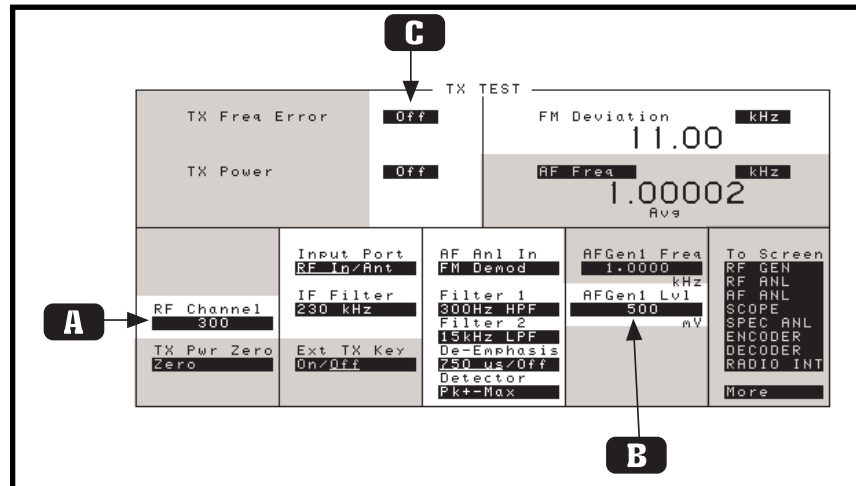
Channel: As desired
TX Power Level: As desired
TX Power: On
SAT: Off
Data: Off

HP 8921A Cell Site Test Set Setup



Step 1:

Press the **TX** key on the HP 8921A to enter the transmitter test screen.



Step 2:

Change the settings in the TX screen as seen in the highlighted areas.

Key instrument considerations

- A** Enter the same **RF Channel** as set on the base station.
- B** For **AFGEN1 Lvl**, enter an initial value of 50 mV and set an increment for this field of 20 dB.
- C** Disable the **TX Freq Error** and **TX Power** by scrolling to their units fields and pressing the **On/Off** key.

Step 3:

Scroll to the **AFGen1 Lvl** field and depress the **Up-Arrow** key once. This will increment the **AFgen1 Lvl** by 20 dB (as set above).

Step 4:

The maximum voice deviation should now be displayed in the **FM Deviation** result field.

Step 5:

Save this setup as **MAX_VOICE**.

Transmitter Data Deviation

Base Station Setup



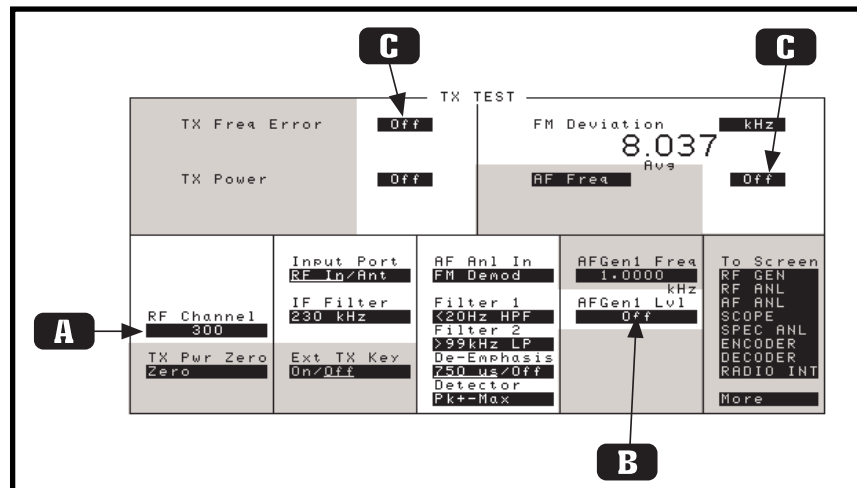
Channel: As desired
TX Power Level: As desired
TX Power: On
SAT: Off
Data: On

HP 8921A Cell Site Test Set Setup



Step 1:

Press the **TX** key on the HP 8921A to enter the transmitter test screen.



Step 2:

Change the settings in the TX screen as seen in the highlighted areas.

Key instrument considerations

- A** Enter the same **RF Channel** as set on the base station.
- B** **AFGen1 Lvl** must be "OFF" or it may interfere with the DATA measurement.
- C** Disable the **TX Freq Error**, **TX Power**, and **AF Freq** measurements by scrolling to their units fields and pressing the **On/Off** key.

Step 3:

The Data Deviation should now be displayed in the **FM Deviation** result field.

Step 4:

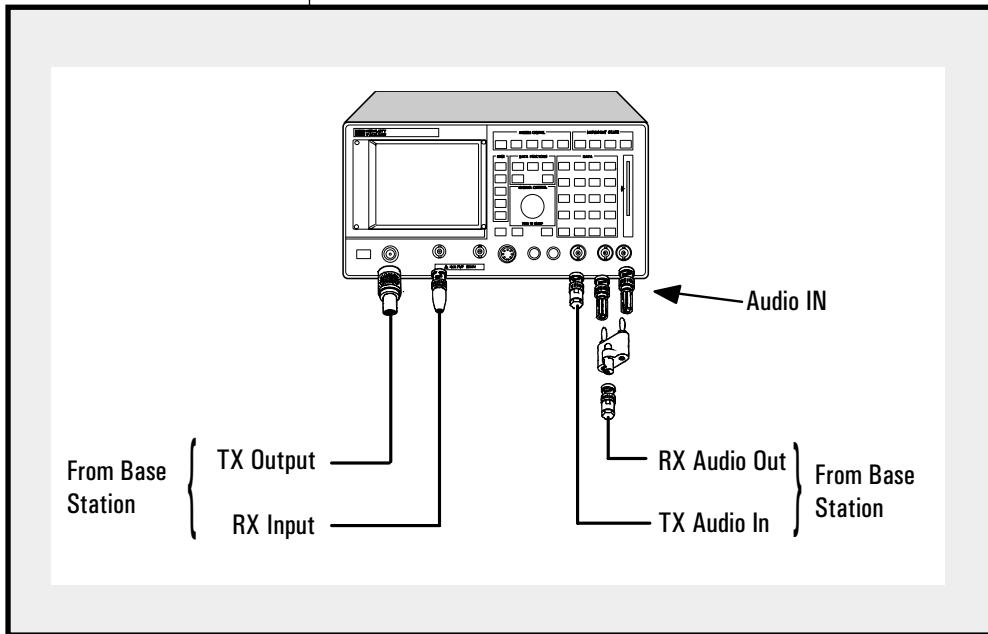
Save this measurement setup as **DATA**.

Receiver Measurements

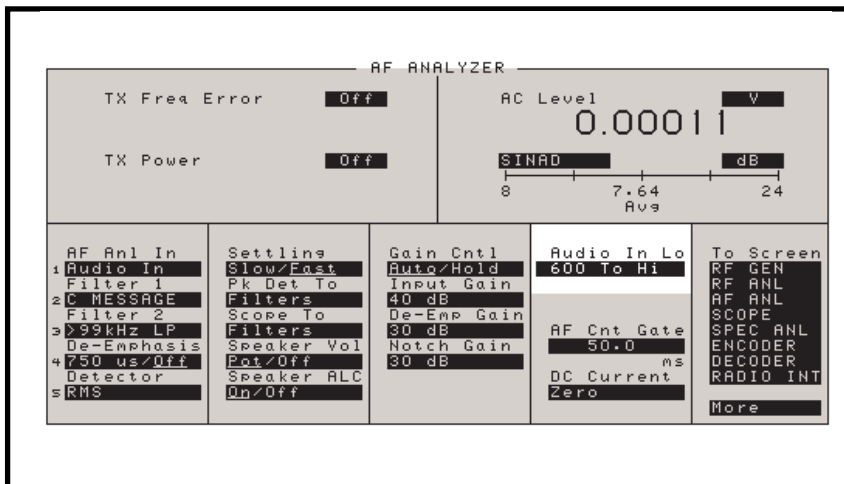
Receiver Sensitivity (SINAD) page 13

Receiver Squelch Threshold page 14

Connect the Base Station to the HP 8921A according to the following diagram. Note the Audio In connection. This must be connected properly for accurate receiver audio measurements



Using the front-panel knob, scroll to and select the **AF ANL** screen, and select **600 TO HI** in the **Audio IN LO** field. **600 TO HI** establishes a 600 Ω impedance between the center pins of the Audio IN LO and Audio IN HI connectors.



Receiver Sensitivity (SINAD)

Base Station Setup



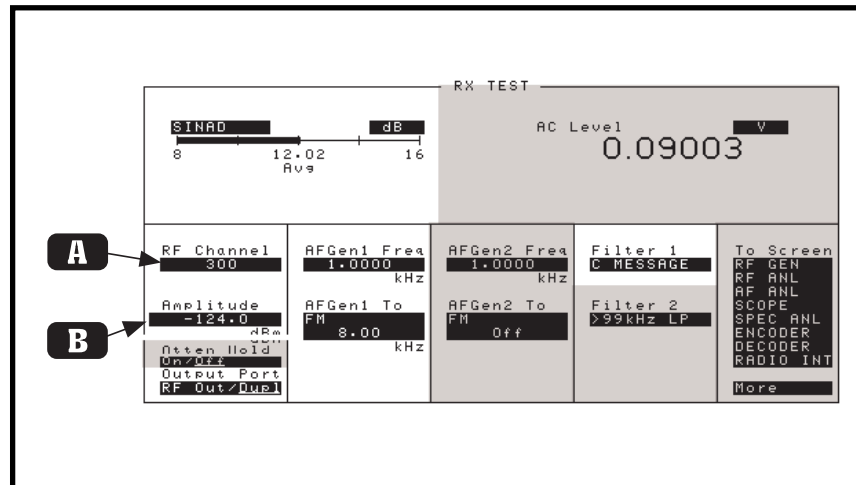
Channel: As desired
TX Power Level: As desired
TX Power: Off
SAT: Off
Data: Off
Squelch: Off

HP 8921A Cell Site Test Set Setup



Step 1:

Press the **RX** key on the HP 8921A to enter the receiver test screen.



Step 2:

Change the settings in the RX screen as seen in the highlighted areas.

Key instrument considerations

- A** Enter the same **RF Channel** as set on the base station.
- B** Enter an initial value in the amplitude field. This value will depend on the sensitivity of the receiver you are testing.

Step 3:

Using the front-panel knob, adjust the **Amplitude** until the desired SINAD is measured. To adjust the resolution of the amplitude adjustment, use the **INCR SET**, **INCR ÷10**, or **INCR ×10** keys.

Step 4:

Save this measurement setup as **SINAD**.

Receiver Squelch Threshold

Base Station Setup



Channel: As desired
TX Power Level: As desired
TX Power: Off
SAT: Off
Data: Off
Squelch: On

HP 8921A Cell Site Test Set Setup



Step 1:

Press the **RX** key on the HP 8921A to enter the receiver test screen.

The image displays two screenshots of the HP 8921A RX TEST screen. The top screenshot shows the initial state with SINAD at 8.32 dB and AC Level at 0.00011 V. The bottom screenshot shows the screen after adjustments, with SINAD at 36.29 Avg dB and AC Level at 0.1625 V. Callouts A, B, and C indicate the changes made to the RF Channel, Amplitude, and Atten Hold settings.

Step 2:

Change the settings in the RX screen as seen in the highlighted areas.

Key instrument considerations

- A** Enter the same **RF Channel** as set on the base station.
- B** Enter a starting amplitude. This initial amplitude value will depend on the squelch sensitivity of your receiver.
- C** It is important to activate the **Atten Hold** function of the HP 8921A for this test. If this is not done, the RF signal to the receiver may drop out momentarily as you adjust its amplitude and an attenuator change is required. This will activate the squelch on the receiver and make it difficult to measure the squelch sensitivity.

Step 3:

Adjust the volume on the HP 8921A to verify audio output. If no audio is heard, the base station may be in a squelched condition. In this case, increase the amplitude until the squelch de-activates and an audio signal is heard.

With the amplitude field highlighted, slowly decrease the amplitude of the RF signal and note the point at which the squelch activates and the audio signal is muted. To adjust the resolution of the amplitude adjustment, use the **INCR SET**, **INCR ÷10**, or **INCR ×10** keys.

For **squelch hysteresis** testing, slowly increase the RF level until the squelch de-activates and an audio signal is present. Note the RF level at which this occurs. The **squelch hysteresis** is the difference between this level and the level at which the squelch activates.

Step 4:

Save this measurement setup as **SQUELCH**.

Appendix A

Typical AMPS System Specifications

Parameter	Specification
TX Frequency Error	±1.5 ppm
TX Sat	
Frequency	± 1 Hz
Deviation	2 kHz ±10%
TX Voice	
Nominal Deviation	8 kHz ±10%
Maximum Deviation	12 kHz
TX Wideband Data	
Deviation	8 kHz ±10%
RX Sensitivity (SINAD)	< -116 dBm @ 12 dB SINAD

For more information on Hewlett-Packard Test & Measurement products, applications or services please call your local Hewlett-Packard sales offices. A current listing is available via Web through

<http://www.hp.com/go/tmdir>

If you do not have access to the internet please contact one of the HP centers listed below and they will direct you to your nearest HP representative.

United States:

Hewlett-Packard Company
Test and Measurement Organization
5301 Stevens Creek Blvd.
Bldg. 51L-SC
Santa Clara, CA 95052-8059
1 800 452 4844

Canada:

Hewlett-Packard Canada Ltd.
5150 Spectrum Way
Mississauga, Ontario
L4W 5G1
(905) 206 4725

Europe:

Hewlett-Packard
European Marketing Center
P.O. Box 999
1180 AZ Amstelveen
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Hewlett-Packard Japan Ltd.
Measurement Assistance Center
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Hong Kong
Fax: (852) 2506 9285