CT SYSTEMS® INC.

OPERATION MANUAL

MODEL 2100

COMMUNICATIONS SERVICE MONITOR

WAVETEK

~~CT SYSTEMS®~~ INC. STREET ADDRESS ~~5245 Hornet Ave.~~ 5808 Churchman By Pass Indianapolis, IN 46203 Wavetek

P.O. ~~BOX 470~~

~~BEECH GROVE, IN 46107-0470~~

(U.S.A.)

(317) 787-5721

(TOLL FREE OUTSIDE OF INDIANA)

(800) 245-6356

Telex # 217124 C T SYS IND UD

FAX # 317-788-4197

8904

WARRANTY

CT Systems, Inc., warrants all instruments against defects in material and workmanship for a period of one year after shipment. CT Systems, Inc., agrees to repair or replace any assembly or component (except batteries, warranted for 90 days after shipment) found to be defective under normal use during this period. CT Systems, Inc.'s obligation under this warranty is limited solely to repairing any such instrument which, in CT Systems' sole opinion, proves to be defective within the scope of the warranty when returned to the factory or to an authorized service center. This warranty may, at CT Systems', sole discretion, be void if the instrument ownership is changed during the warranty period.

CT Systems, Inc., will assume all responsibility for UPS surface shipping charges for any warranty claims during the first thirty (30) days from shipment date. After the first thirty (30) days, CT Systems will assume responsibility for one-way shipping charges, UPS surface, F.O.B. customer's destination, during the warranty period. Should the customer desire an alternate method of shipping, he will be responsible for the difference between the UPS surface rate and the higher rate.

This warranty does not apply to any products repaired or altered by persons not authorized by CT Systems, Inc., or not in accordance with instructions furnished by CT Systems, Inc. If the instrument is defective as a result of misuse, improper repair, abnormal conditions or operations, repairs will be billed as per the CT Systems, Inc., non-warranty program.

CT Systems, Inc., assumes no responsibility for its products being used in a hazardous or dangerous manner, either alone or in conjunction with other equipment. CT Systems, Inc., assumes no liability for secondary charges or consequential damages and, in any event, CT Systems, Inc.'s liability for breach of warranty shall not exceed the purchase price of the specific instrument shipped and against which a claim is made.

This warranty is in lieu of all other warranties, express or implied, and no representative or person is authorized to represent or assume for CT Systems, Inc., any liability in connection with the sale of our products other than set forth herein.

CONTENTS

1.1 INTRODUCTION

The CT Systems Model 2100 is a bench-quality and field-portable, microprocessor-controlled Service Monitor. Designed to perform a variety of tests on FM tranceivers, the small size and straightforward, front-panel operation make it ideal for production and bench testing. A battery option makes it especially convenient to use in the field.

The Model 2100 generates and receives from 400 kHz to 999.9999 MHz in 100 Hz steps. The RF output level is continuously variable from 0.1 uVolts to 10 mVolts in five ranges.

L.E.D. annunciators and two front-panel L.C.D. displays indicate the instrument settings and measurement results.

The Model 2100 contains a 1 kHz modulation source, a 10 Hz to 10 kHz audio synthesizer and an external modulation input. The audio synthesizer output has a second independently variable output on the front-panel. Deviation markers at ±5 kHz or ±600 Hz may be superimposed on the demodulated output for viewing on an external oscilloscope.

The Model 2100 measures and displays SINAD in dB or % distortion, volts, FM deviation, signal strength, carrier frequency, demodulated audio frequency, error frequency and sub-tone.

When an RF load is attached to the antenna connector, power may be applied to the RF in/out connector to measure watts. Twenty memory registers are available for storing and recalling all front-panel keyboard settings. An optional RS-232 interface allows for its use in automated test systems.

1.2 2100 SPECIFICATIONS

Generate

Freq Range:	400 kHz to 999.9999 MHz
Resolution:	100 Hz
RF Output:	0.1uv to 10 mv in 5 ranges
Accuracy:	±2 dB
Spectral Purity:	<-35 dBc within ±300 kHz (within all land mobile bands)
FM Deviation:	0 to 10 kHz peak
Accuracy:	±5% of FS
Ext Mod:	All EIA tones, 10 Hz to 10 kHz
Internal Mod:	10 Hz to 10 kHz
Output Impedance:	50 ohms
Reverse Power Protection:	Auto switch to external load at inputs greater than approx. 200 mw, on the RF in/out connector

Receive

Freq Range:	400 kHz to 999.9999 MHz
Resolution:	100 Hz
Sensitivity:	2uv @ 10 dB SINAD, typical
Bandwidth:	10 kHz
Image Rejection:	-50 dB
RF Step Range:	100 Hz

Subtone Counter

Freq Range:	60 Hz to 270 Hz
Resolution:	0.1 Hz

Mod Measurements

FM Deviation:	0 to ±10 kHz
Accuracy:	±5% of FS @ 1 kHz from 0 to 7 kHz, ±10% of FS @ 1 kHz from 7 kHz to 10 kHz
FM Deviation Markers:	±600 Hz, ±5 kHz (optional markers available). Accuracy of markers ±5% @ 5 kHz deviation.

Freq Counter Modes

RF Freq:	30 MHz to 999.999 MHz
Resolution:	1 kHz
Freq Error:	10 Hz to 10 kHz @ >10uv rec. signal
Resolution:	10 Hz
Audio Freq:	10 Hz to 20 kHz
Resolution:	1 Hz

Power Meter

Range:	0 to 100 watts, auto ranging 10 and 100 watts FS
Accuracy:	±10% FS to 600 MHz, ±20% FS 600 MHz to 999.9999 MHz
Display:	LCD

NOTE:	No internal load. External 50 or 100 watt load must be connected at antenna connector. Use coax cables of minimum length. Power applied for 10 sec. after 2 min. cool-down time.

Internal Mod Sources

Freq Range:	10 Hz to 10 kHz
Resolution:	0.1 Hz, 10 Hz to 1999.9 Hz 1.0 Hz, 2 kHz to 10 kHz
Output:	0 to 1.0 VRMS
Fixed Freq:	1 kHz
Accuracy:	Time Base ±1 count

Signal Strength (Rec. Level)

Range:	60 dB (3uV to 3 mV)
Accuracy:	±3 dB at 10 uV
Display:	LCD

SINAD

Notch:	@1 kHz
Range:	0 to 30 dB
Resolution:	1 dB steps
Accuracy:	±1 dB at 12 dB (±3% @ 25%)
Impedance:	≃10k ohms
Measurement Units:	% Distortion or dB SINAD

RF Step Size:

100 Hz to 999.999 MHz steps

Memory

Stores all keyboard settings in each register for system storage.
Memory Size: 20 registers.

Voltmeter

Range:	±20V DC, 20 VAC peak, up to 50k Freq
Input Impedance:	≃100k ohms
Accuracy:	±5%

Time Base

Aging Rate:	±1 ppm/year
Temp (0 to 50 C):	±0.5 ppm

General

Op Temp Range:	0 to 50 C
Power Requirements:	
AC	100/110/220/240 VAC ±10%, 50-400 cycles
DC	10.5 to 15.2 VDC
Internal Rechargeable Battery:	>12 Volt lead acid with >1hr run time
Dimensions:	26.1 cm (10-3/8 in.) (including handle) wide 16.5 cm (6-1/2 in.) (including feet) high 43.2 cm (17 in.) (including rear feet) deep
Weight w/Battery:	<15 lbs.

Options
Service Manual

Model 300 Encoder/Decoder with trunking, MTS, IMTS, analog, digital, DCS and DTMF formats.

80 Additional Storage Registers
RS-232 Interface Bus
Rechargable Lead Acid Battery
Protective Soft Cover
Accessories Kit (Including Front Dust cover)

Standard Accessories
Operation Manual
Antenna
AC Power Cord

2.1 INTRODUCTION

The Model 2100 is a rugged test instrument designed for portability. Although it is commonly used as a bench instrument, it is also well suited for field use.

2.2 UNPACKING AND INSPECTION

When unpacking the instrument, inspect the shipping container and the instrument for shipping damage. Save the shipping carton and packing material for possible future use.

The instrument was inspected, given final operational and quality control tests, then carefully packaged for shipment, and should operate in accordance with Section 3 of this manual.

If the instrument received has been damaged in transit, notify the carrier and your CT Systems Customer Service representative. The representative will immediately arrange for either replacement or repair of your instrument without waiting for damage claim settlements.

CT SYSTEMS, INC.
5245 Hornet Avenue
P. O. Box 470
Beech Grove, IN 46107-0470

800-245-6356 (outside Indiana) or
(317) 787-5721 (in Indiana)
FAX (317) 788-4197
TELEX 217124

2.3 POWER REQUIREMENTS

The instrument operation is selectable for 100/120/220/240 VAC, 50/60 Hz primary power sources. The three conductor power cord provides a ground connection when it is connected to the proper outlet.

The instrument can also be operated from 10.5 VDC to 15.2 VDC.

The external DC source should be connected to the "EXT +12 V IN" jack on the rear panel. The plug (not supplied with the instrument) should be a 1/8" phone plug (Switchcraft #740 or equivalent) with the positive voltage on the tip of the plug and the negative voltage on the shield.

2.4 ENVIRONMENTAL CONSIDERATIONS

The instrument comes equipped with bottom and rear-panel feet (the rear-panel feet also serve as cord wraps).

The instrument's small size and light weight permit easy access to confined working spaces.

The instrument is designed to operate between 0 degrees C and 50 degrees C and should be used in an area where air flow around the instrument is not restricted.

NOTE

Exceeding the upper and lower temperature limits for extended periods may not result in damage to the instrument, but may cause degraded performance.

SECTION 3

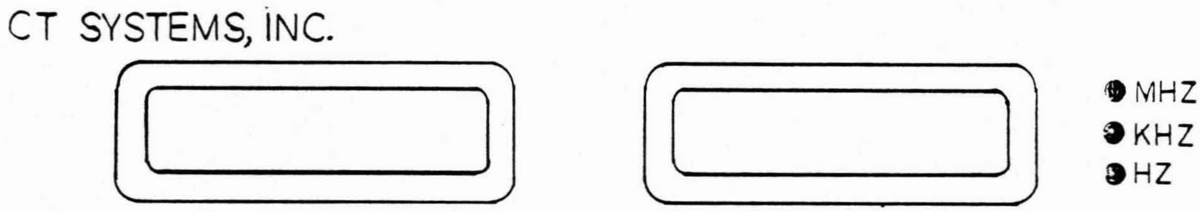
OPERATION

3.1 INTRODUCTION

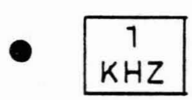
This section contains operating instructions for the Model 2100 Communications Service Monitor. Included are descriptions of the front- and rear-panels (refer to Figures 3-1 and 3-2), and notes on use of features.

3.2 FRONT-PANEL DESCRIPTION

LED annunciators light to indicate active functions or units. An audible error tone sounds if the user makes an invalid entry. In order to identify the instrument's functions and the corresponding keys, see the following descriptions:

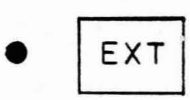


LEFT and RIGHT LCD displays indicate pertinent instrument settings and measurements. LED's on right annunciate proper units during frequency display.



Activates the 1 kHz modulation source in generate mode. Sounds error tone in receive.

Activates audio synthesizer at most recently set frequency and displays frequency on right LCD in Hz.



Turns on "Modulation in" port. Sounds error tone in receive.

±600Hz ●
±5KHz ●
DEV MARK

Activates markers at either ±600 Hz or ±5 kHz deviation and shuts markers off. Markers are superimposed on demod output for display on an external oscilloscope.

SINAD

Measures SINAD and displays reading on left LCD. The SINAD button toggles between dB and % distortion expressions each time it is pressed. Sounds an error tone in receive mode.

VOLTS

Activates either D.C. volts or A.C. volts. Measures voltage at SINAD/audio in connector. Displays mode and reading on left LCD.

WATTS

Measures RF power applied at RF IN/OUT port into a user-supplied 50 ohm load connected at the ANTENNA port and displays reading on left LCD. Sounds error tone in generate.

DEV

Measures FM deviation of the generated or received RF carrier and displays the reading on the left LCD in Hz.

1 2 3
4 5 6
7 8 9
• 0

DATA KEYS. Inputs data when preceded by AUDIO SYNTH, GEN, REC, STORE, RECALL, RF STEP or SHIFT key. Sounds an error tone when not preceded by one of the above keys.

ENTER

Terminates numerical data.

RF STEP

Displays RF step size on right LCD. Serves as a prefix for changing RF step size when followed by data and ENTER key.

↑ **↓**

Each of these keys perform two functions:

1) When preceded by the RF STEP KEY, the frequency is stepped up or down (respectively) by the preset step size and the new RF frequency is displayed on the right LCD.

2) When preceded by the RECALL key, the next front-panel stored setting up or down is implemented and the stored setting address is displayed on the right LCD for 1/2 second. The display then changes to show the stored settings.

SHIFT

Addresses second functions.

Shift 1 - toggles SINAD between 'dB' and '%' distortion expressions.

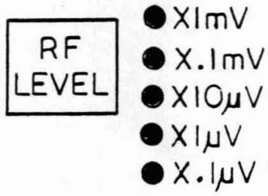
Shift 6 - identifies software version.

Shift 9 - verifies lock status of oscillators.

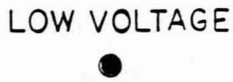
Shift . - loads storage RAM with preset data.

Shift REC - alternates the receiver L.O. frequency between high side and low side injection for frequencies above 16 MHz. The SHIFT function may be necessary for some readings if an L.O. spur interferes with the desired frequency.

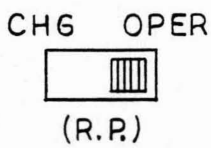
STORE	Prefix for storing front-panel keyboard settings in memory (should be followed by address code 1 through 20 and then the 'ENTER' key). Displays information on right LCD.
RE-CALL	Prefix for recalling front-panel keyboard settings from memory (should be followed by address code 0 through 20 and then the 'ENTER' key). Address 0 contains a non-alterable setting programmed at the factory.
SUB-TONE	Counts subtone in receive mode and displays on right LCD.
REC LEVEL	Measures signal strength in receive and displays on left LCD. Sounds error tone in generate.
GEN ● / REC ●	These two keys select the generate or receive mode. Only one mode is activated at a time. Each key responds by addressing the frequency mode and displaying the RF frequency on the right LCD. When the generator mode is selected, the LED is illuminated. In the receive mode the associated LED illuminates only when the squelch is broken by a received signal.
COUNT (● RF ● ERROR ● AF)	In the receive mode this selects the counter for RF, ERROR, AF or OFF. In generate the counter monitors the SINAD/AUDIO IN connector and the AF and OFF modes are selectable. The counter also works in the WATTS mode when sufficient power is keyed into the RF IN/OUT port. The count mode must be de-activated when reprogramming the RF frequency.



Selects one of five level ranges for RF generator. Sounds error tone in receive.



Lights to indicate low battery voltage.



Determines the function of the front-panel power switch.

operate - allows front panel power switch to activate the entire instrument.

charge - only allows the battery charging circuit to be activated when the front-panel power switch is on.

NOTE

When the front panel power switch is off, no circuitry in the Model 2100, other than the fuse, is active. This means that the battery charging circuit is off.

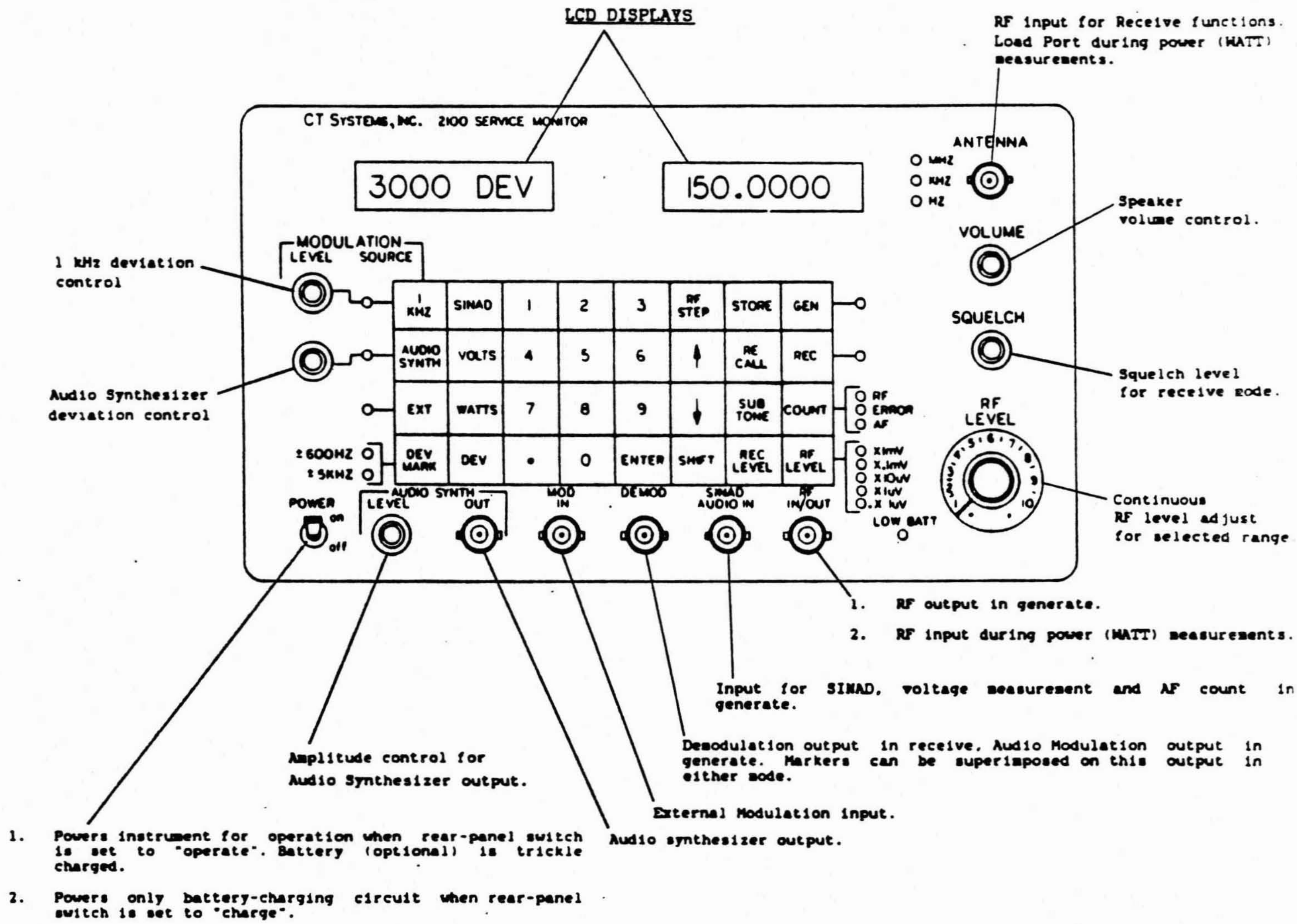


FIGURE 3-1. 2100 CONTROLS AND PORTS

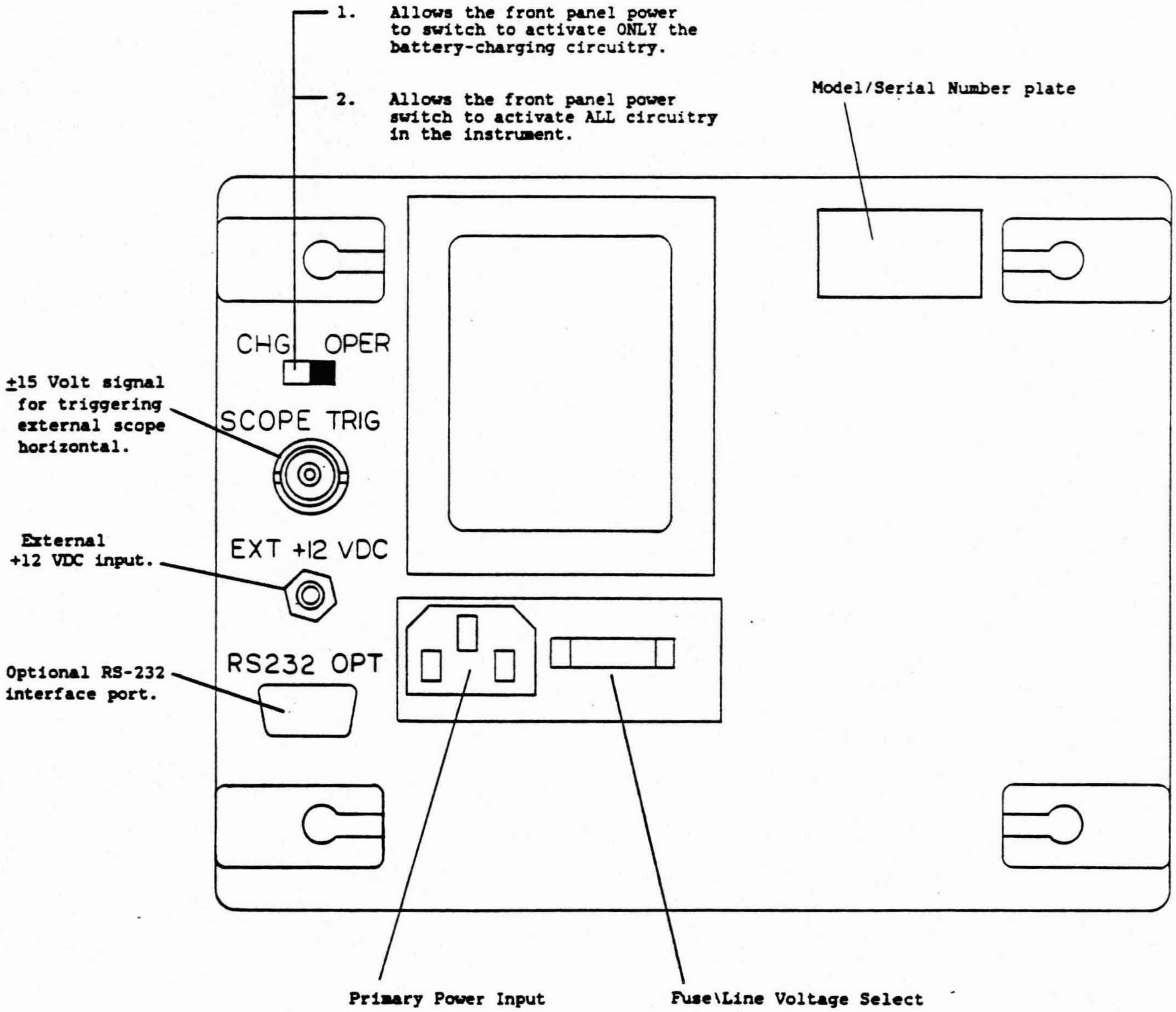


FIGURE 3-2. 2100 REAR PANEL

3.3 INTRODUCTION

This section outlines how to use the CT Systems Model 2100 in some commonly required applications. A brief overview of each test is followed by a description of the steps to take and their related controls.

RECEIVER MEASUREMENTS

TRANSMITTER MEASUREMENTS

SECTION 1

RECEIVER MEASUREMENTS

3.1.1 Receiver Audio Distortion Measurement

An important factor in proper receiver alignment is knowing the distortion of the processed recovered audio. If problems exist in the audio circuits causing high distortion, the 12 dB SINAD test will not be valid since SINAD combines the distortion factor with signal and noise in determining sensitivity.

NOTE: For % distortion lower than 1%, it is best to use a lab quality audio distortion analyzer with greater resolution.

Refer to Figure 3-3 for the following test procedure.

1) Cable the antenna port of the receiver under test to the "RF IN/OUT" port of the Model 2100.

2) Cable Audio output or speaker terminals of receiver to SINAD "AUDIO/IN".

3) Select GEN mode.

4) Select 1 kHz and adjust 1 kHz level control for 60% of max deviation, i.e., 3000 kHz if max allowable is 5 kHz.

5) Select VOLTS mode.

6) Adjust RF level control(s) to fully quiet receiver (1 mV).

7) Adjust receiver volume to full rated audio power, using Volt-meter Feature, and the formula:

$$\text{Audio Power} = \frac{V^2}{2r\ spk}$$

where V = speaker voltage and r spk = speaker impedance

8) Press SINAD once or twice (as required) to obtain a direct readout of distortion in %.

NOTE: the SINAD button toggles between dB and % expressions each time it is pressed.

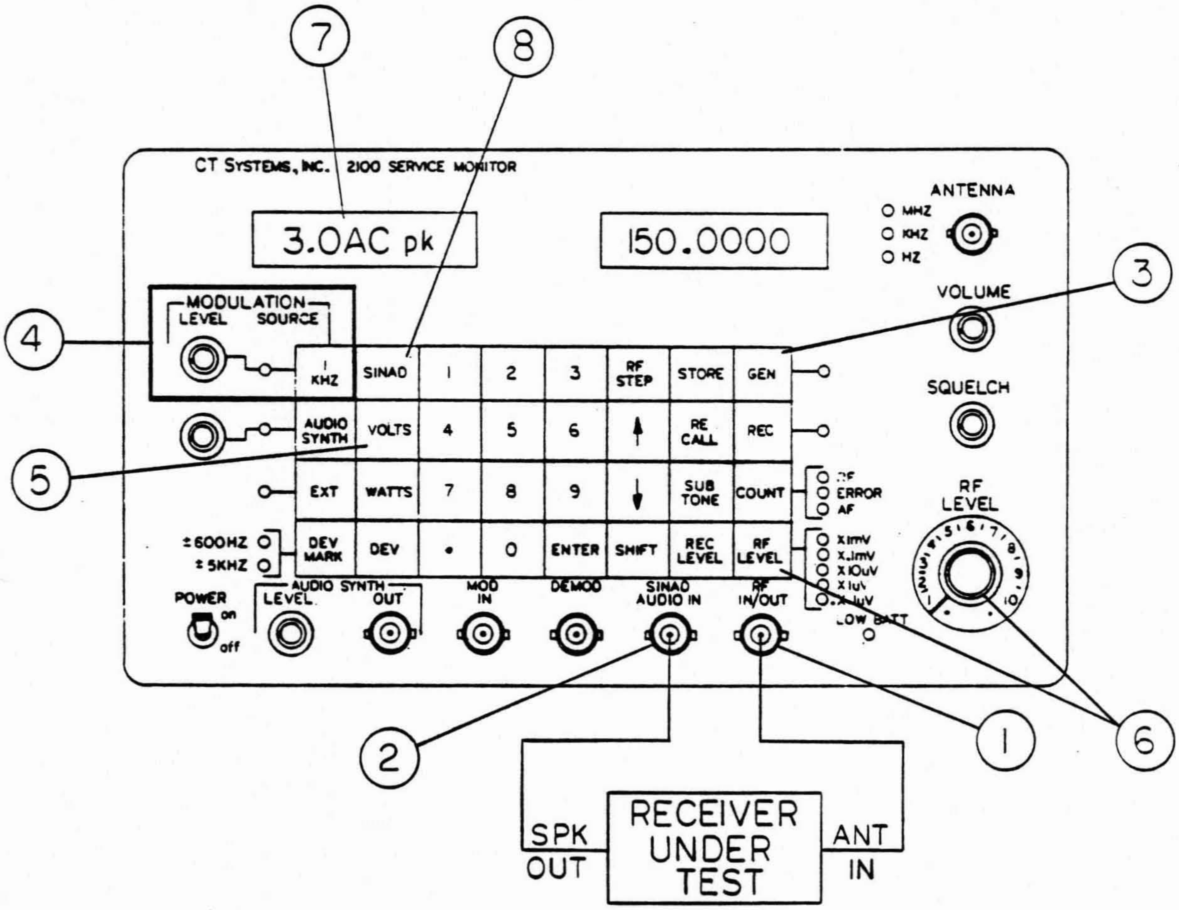


FIGURE 3-3. RECEIVER AUDIO DISTORTION MEASUREMENT

3.1.2 Sensitivity - 12 dB SINAD

Sensitivity measurements should reflect signal + noise and distortion if they are to be truly meaningful.

SINAD is a unit of measure that is designed to take these factors into account. An accepted definition of sensitivity is "the amount of RF required to measure 12 dB SINAD from a receiver whose bandpass is "challenged" with 60% of the systems maximum deviation.

The RF level for this measurement is typically expressed in uV. SINAD is defined as the voltage ratio:

$$\frac{\text{Signal + Noise + Distortion}}{\text{Noise + Distortion}}$$

and is expressed in dB.

The Model 2100 quickly performs SINAD measurements and displays the results to the nearest dB. This allows the user to rapidly tune receivers for optimum performance.

Causes of distortion such as high noise or audio clipping may be analyzed by connecting an oscilloscope to the Model 2100's Demod output.

Refer to Figure 3-4 for the following test procedure.

1) Connect the RF input (antenna-port) of the receiver under test to the "RF IN/OUT" jack on the Model 2100.

2) Connect the "SINAD AUDIO IN" jack of the Model 2100 across the speaker of the receiver. If the external speaker jack is used and it disconnects the internal speaker, a load having the same impedance must be substituted.

3) Select the GEN mode.

4) Program the receiver frequency in MHz on the Model 2100 using the numerical keys followed by the ENTER key.

5) Select the 1 kHz modulation function and adjust it for 60% of the receivers maximum deviation using the 1kHz level control. For example, if the maximum deviation of the receiver is specified as 5 kHz then the test deviation would be:

   5 kHz X .6 = 3000 Hz

6) Select the AC pk volts mode on the Model 2100.

7) Open the squelch control on the receiver.

8) Adjust the receiver volume to achieve full rated audio power, as specified by the radio manufacturer. Use the internal voltmeter to determine audio power using the formula:

$$\frac{V_{pk}}{2r\ spk} = \frac{V^2_{(RMS)}}{r\ spk} \quad \text{for a sinewave} \quad = \text{Audio Power}$$

where V = speaker voltage and r spk = speaker impedance.

9) Select the SINAD function on the Model 2100 for a reading in dB.

10) Adjust the RF level range and vernier on the Model 2100 for a SINAD reading of 12 dB.

11) The sensitivity of the receiver may now be expressed as the uV setting on the Model 2100 RF level dial.

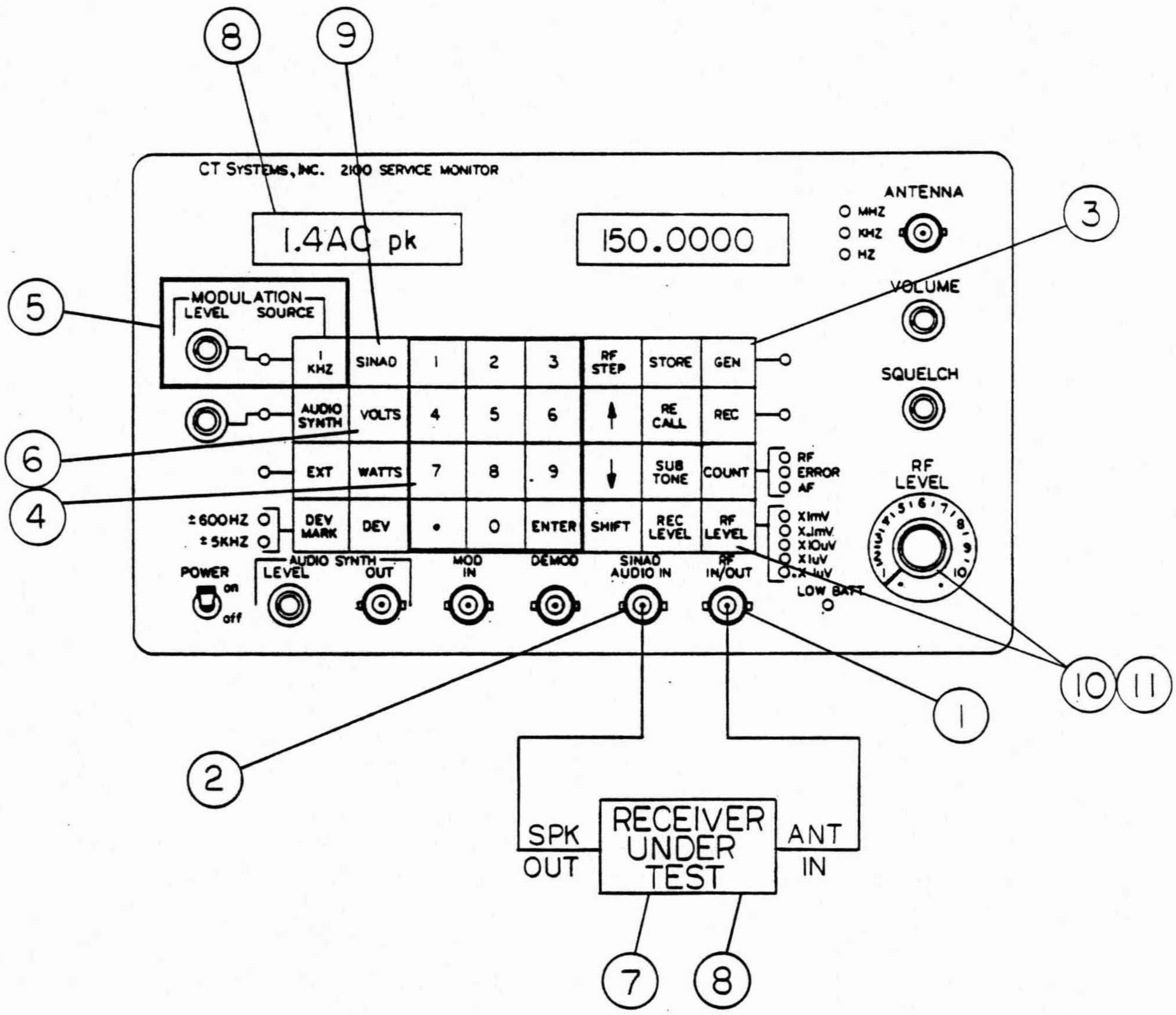


FIGURE 3-4. SENSITIVITY - 12 DB SINAD

3.1.3 Modulation Acceptance Bandwidth

In FM voice modulated receivers the maximum deviation accepted for a certain reduction in SINAD sensitivity is called Modulation Acceptance Bandwidth.

Since poor Modulation acceptance bandwidth results in degraded sensitivity with Modulation, this test becomes important to fully optimize receiver performance. This operating characteristic is also essential in maintaining a communications system since when the modulation acceptance bandwidth is poor, and exceeded, it will result in degraded Receiver sensitivity.

Refer to Figure 3-5 for the following test procedure.

1) Perform the 12 dB SINAD test described in the previous section.

2) Increase the Model 2100 RF level 6 dB over the 12 dB SINAD sensitivity point (a 6 dB increase is two times the uV setting on the 2100 RF output dial).

3) Increase the 1 kHz level setting until 12 dB SINAD is read again.

4) Activate the DEV mode on the Model 2100.

5) Multiply the increase in deviation by two to obtain the Modulation Acceptance Bandwidth as shown below:

   [New deviation - Previous deviation] X 2 = Modulation Acceptance Bandwidth

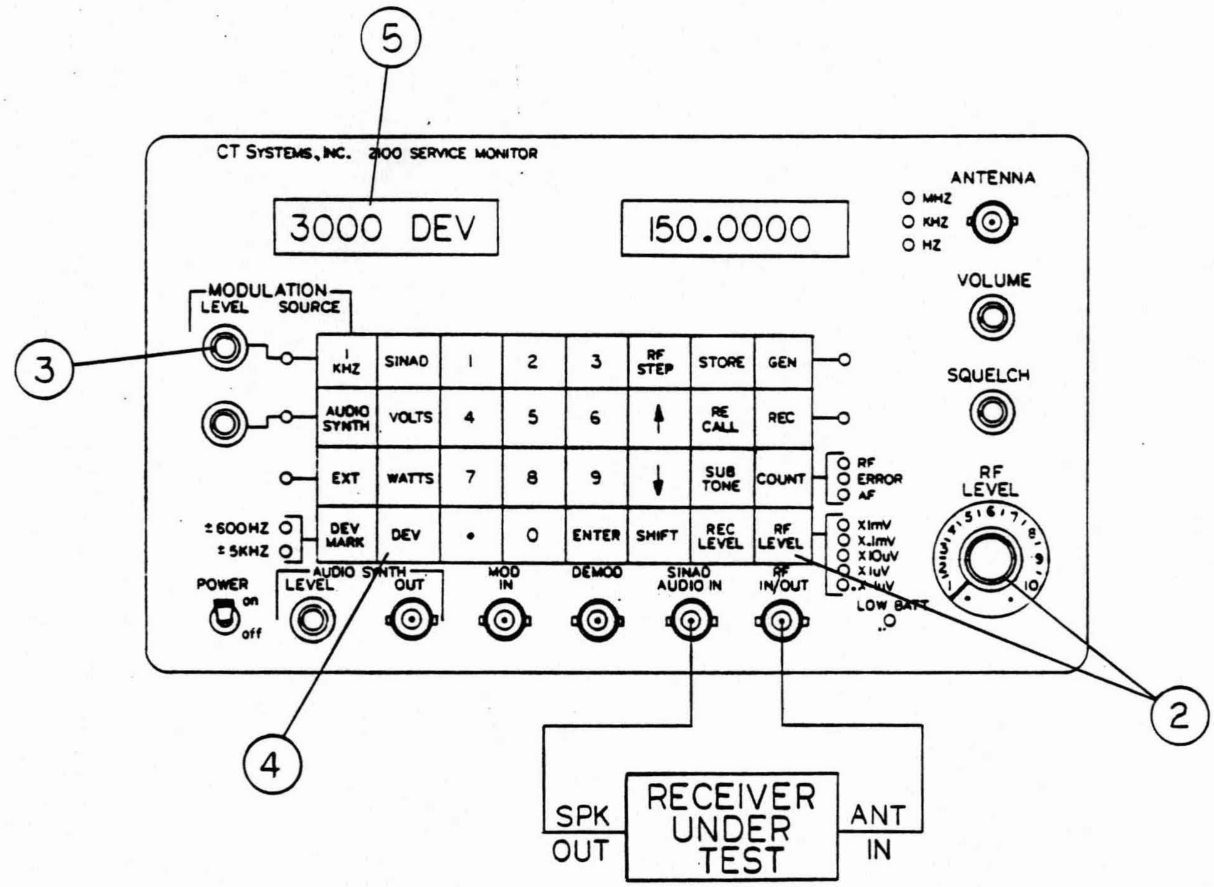


FIGURE 3-5. MODULATION ACCEPTANCE BANDWIDTH

3.1.4 Receiver IF Bandwidth and Symmetry

This test will determine the IF filter bandwidth and the symmetry (whether or not the high and low cutoff points are correct). Since a too narrow bandwidth will cause distortion, and a too wide bandwidth will cause noise, this test is a good troubleshooting aid in finding cause of high noise and distortion. If the Bandwidth of the IF filter is correct, but is offset, (i.e., high cutoff too low or low cutoff too low) the result will be distorted recovered audio in the form of positive peak clipping.

Refer to Figure 3-6 for the following test procedure.

1) Connect the "RF IN/OUT" jack of the Model 2100 to the RF input (antenna jack) of the receiver under test.

2) Select GEN mode.

3) Program the receiver frequency in MHz using the numerical keys followed by the ENTER key.

4) Connect receiver audio to "SINAD AUDIO IN".

5) Set RF LEVEL and vernier controls to 1 mV.

6) Select DEV , 1 kHz source, and adjust 1 kHz level control for 5 kHz deviation.

7) Select the AC pk VOLTS function.

8) Adjust receiver squelch to full open position.

9) Connect high resolution VOM (in DC mode) to AGC or limiter test point of Receiver.

10) Reduce RF output by 3 dB. Make note of AGC voltage. Increase RF output back to 1 mV.

11) Select RF step and program the Model 2100 for a 100 Hz (.0001MHz) step size using the numerical keys followed by the ENTER key.

12) Select GEN and use the UP arrow key to increase the RF frequency until the AGC voltage noted in Step 10 is obtained. Record this as the "high" frequency.

13) Use the down arrow key to return to the RF center frequency and then continue decreasing the RF frequency until the AGC voltage noted in Step 10 is obtained. Record the "low" frequency. The difference between the high frequency and the low frequency is the 3 dB bandwidth. The symmetry is good if the low frequency is off from the center the same amount as the high frequency.

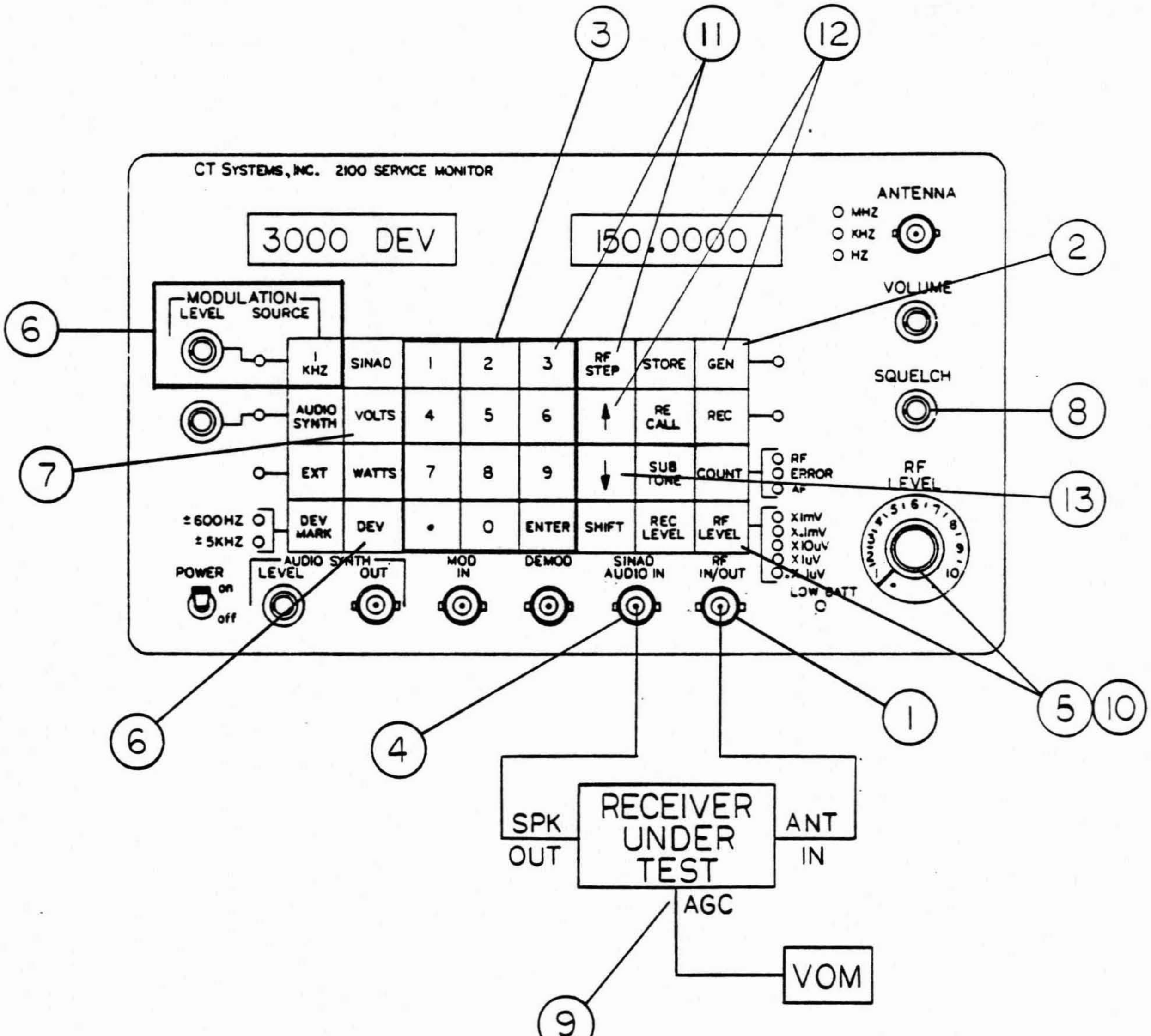


FIGURE 3-6. RECEIVER BANDWIDTH AND SYMMETRY

3.1.5 Receiver Sensitivity with CTCSS Decoder and Decoder Bandwidth Test

This test determines the amount of RF signal that is required to unsquelch a receiver that uses a CTCSS decoder. The Bandwidth part of the test determines the amount the encoder oscillator can drift from desired CTCSS frequency and still unsquelch the receiver. Too much decoder bandwidth can be a problem if wide enough to allow other transmitters with tone frequencies near the desired to operate the receiver.

This second test is sometimes called Tone Squelch Sensitivity.

Refer to Figure 3-7 for the following test procedure.

1) Connect the RF input (antenna port) of the receiver under test to the "RF IN/OUT" jack on the Model 2100.

2) Select GEN mode and set the RF Output level to.1 uV.

3) Select AUDIO SYNTH .

4) Set the Audio Synthesizer to the subtone frequency in Hz using the numerical keys followed by the ENTER key.

5) Put the receiver under test into Decode Mode and adjust its squelch for threshold.

6) Adjust the Audio Synthesizer level control to 600 Hz deviation, or to manufacturer's recommended deviation.

7) Turn off audio synthesizer by toggling the AUDIO SYNTH key.

8) Activate 1 kHz and adjust level to 3 kHz deviation.

9) Toggle AUDIO SYNTH back on.

10) Increase RF LEVEL vernier control until the receiver just becomes unsquelched (1 kHz tone is heard + noise). Read the Receiver sensitivity from the RF level dial.

11) Vary the AUDIO SYNTH frequency to either side of selected frequencies in 1 Hz increments using the numerical keys followed by the ENTER key. The difference between the frequencies at which the receiver unsquelched at the last RF level setting is the decoder bandwidth.

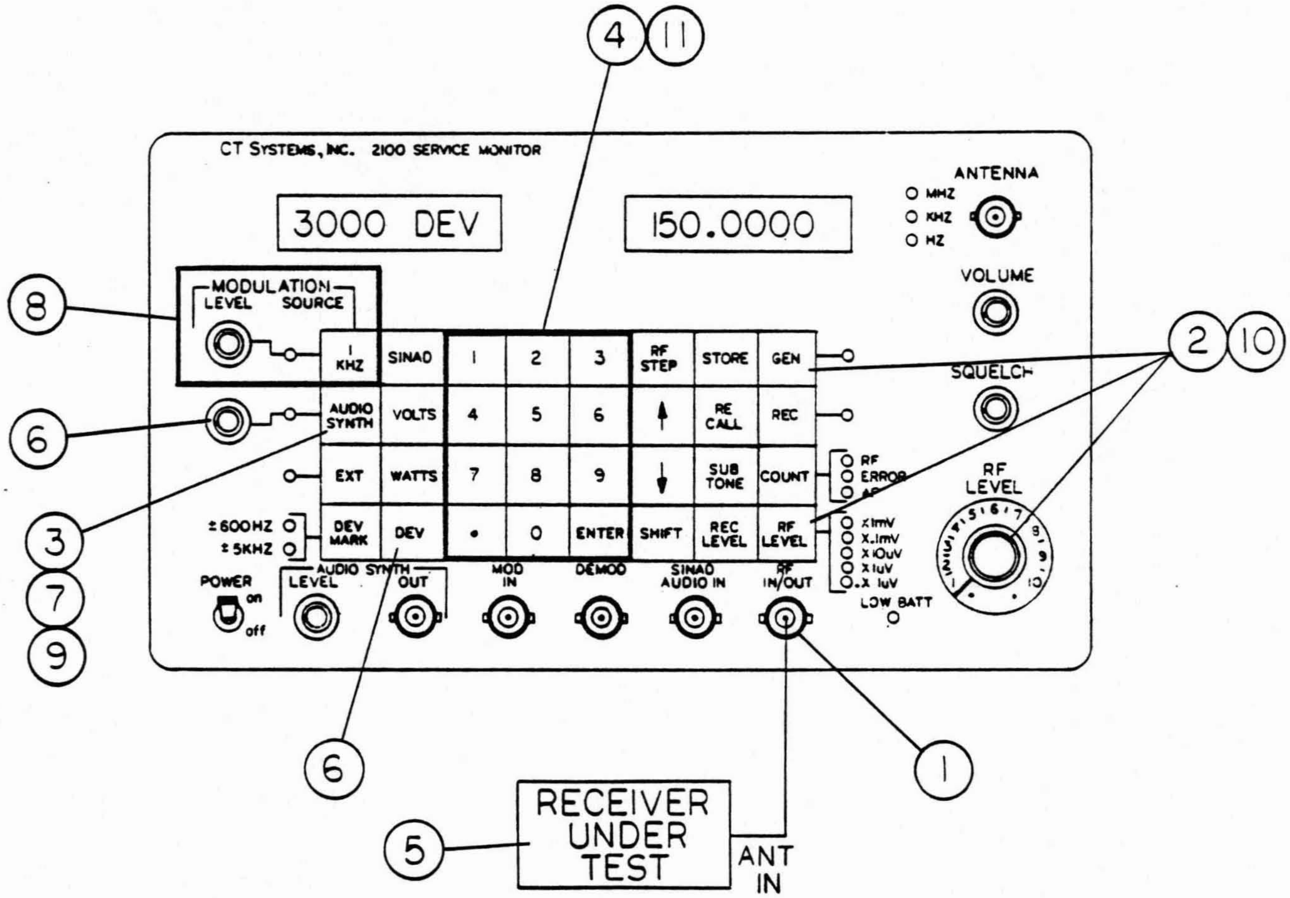


FIGURE 3-7. RECEIVER SENSITIVITY
WITH CTCSS DECODER AND DECODER BANDWIDTH TEST

3.1.6 CTCSS Decoder Sensitivity Test

This test determines the amount of subtone deviation that is required to unsquelch the CTCSS decoder of a receiver under test.

Refer to Figure 3-8 for the following test procedure.

1) Connect the RF input (antenna port) of the receiver under test to the "RF IN\OUT" jack on the Model 2100.

2) Select GEN mode and set the RF output level well above the receiver squelch threshold.

3) Select AUDIO SYNTH mode.

4) Set the audio synthesizer to the subtone frequency in Hz using the numerical keys followed by the Enter key.

5) Put the receiver under test into the decode mode and adjust its squelch for threshold.

6) Turn off the audio synthesizer by toggling the AUDIO SYNTH key.

7) Activate 1 kHz and adjust level to 3 kHz deviation.

8) Toggle AUDIO SYNTH back on.

9) Starting at minimum audio synthesizer deviation, slowly increase the synthesizer deviation until the decoder unsquelches the receiver.

10) The audio synthesizer deviation at this point is the decoder sensitivity.

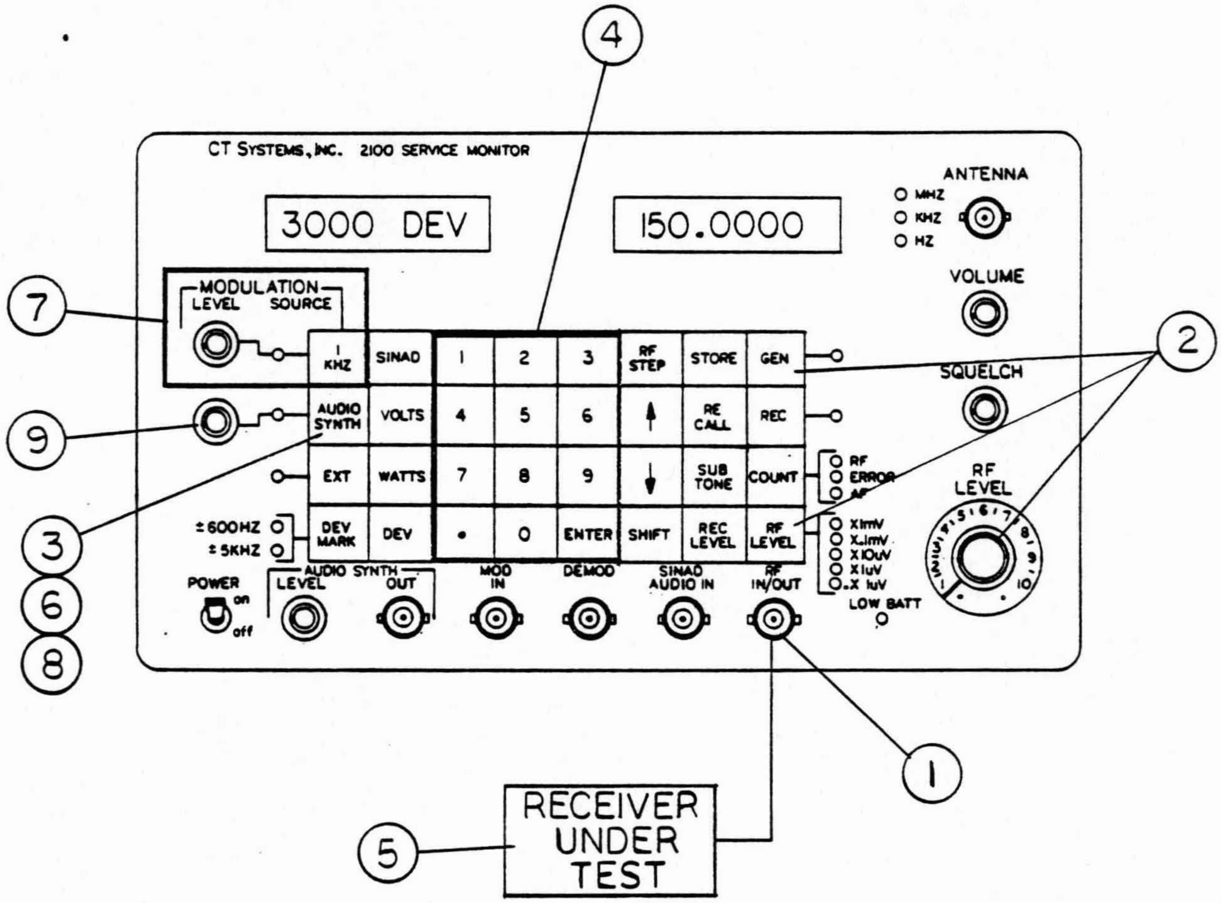


FIGURE 3-8. CTCSS DECODER SENSITIVITY TEST

TRANSMITTER MEASUREMENTS

3.2.1 Off the Air Monitoring

The 2100 receiver provides continuous frequency coverage from 400 kHz to 999.9999 MHz with good sensitivity and intermod rejection. Receiver sensitivity is typically 2 uV @ 10 dB for "off the air" monitoring.

Refer to Figure 3-9 for the following test procedure.

1) Attach antenna to antenna input.

2) Select REC mode.

3) Program the frequency to be monitored in MHz using the data entry keys followed by the ENTER key..

4) Adjust squelch control for sensitivity required.

5) Select COUNT RF to display the actual frequency of received RF signals above 100 mV.

   Select COUNT Error to display frequency error of the received signal.

   Select COUNT AF to display the frequency of the audio modulation on the carrier.

6) Select DEV to display the FM deviation on the carrier.

7) Select REC LEVEL to display the signal strength.

8) Select SUBTONE to display CTCSS tone on right LCD display.

9) Select DEV MARK and connect "DEMOD" connector to an external oscilloscope to calibrate demodulated audio to ±600 Hz or a ±5 kHz marker.

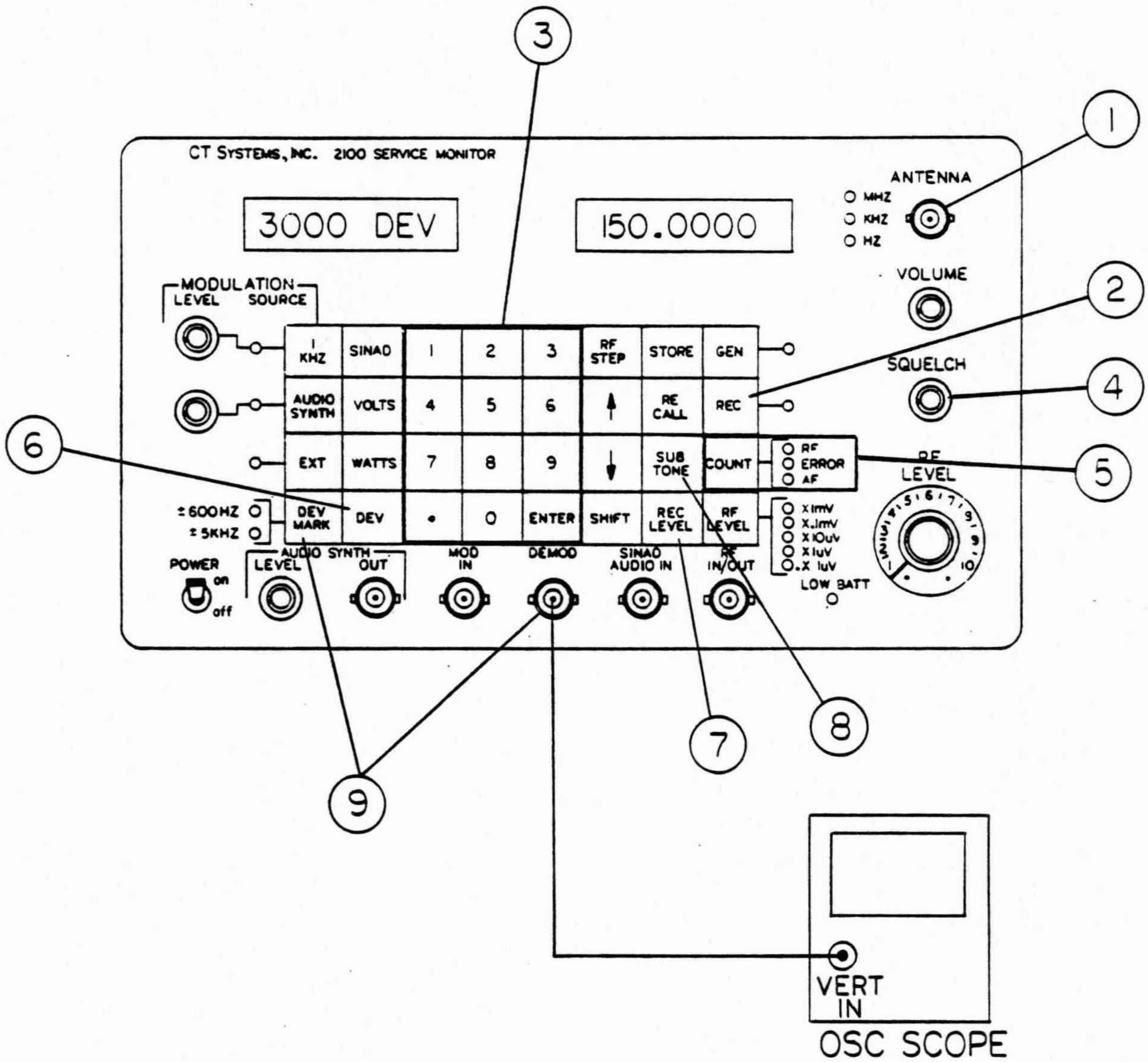


FIGURE 3-9. OFF AIR MONITORING

3.2.1a Relative Signal Strength Measurements

Refer to Figure 3-10 for the following test procedure.

1) Attach antenna to antenna input. For measuring remote sites, connect to an outside antenna.

2) Select RCV mode.

3) Program frequency to be monitored in MHz using the numerical keys followed by the ENTER key.

4) Open Squench control.

5) Select REC LEVEL .

6) Compare signal strength reading with last "known good" indication, or use to compare two transmitters of the same output power, and approximate location.

   NOTE: Several comparisons using the instrument should be made to determine what a "correct" reading for a local transmitter should be. This may also require taking the test readings at the same time of day as the sample reading due to changing atmospheric conditions.

7) Signal strength meter compression begins when received signals exceed 3 mV or more. Relative signal strength can be meausred above this level by inserting an external pad in line with the antenna or by reducing the gain of the antenna.

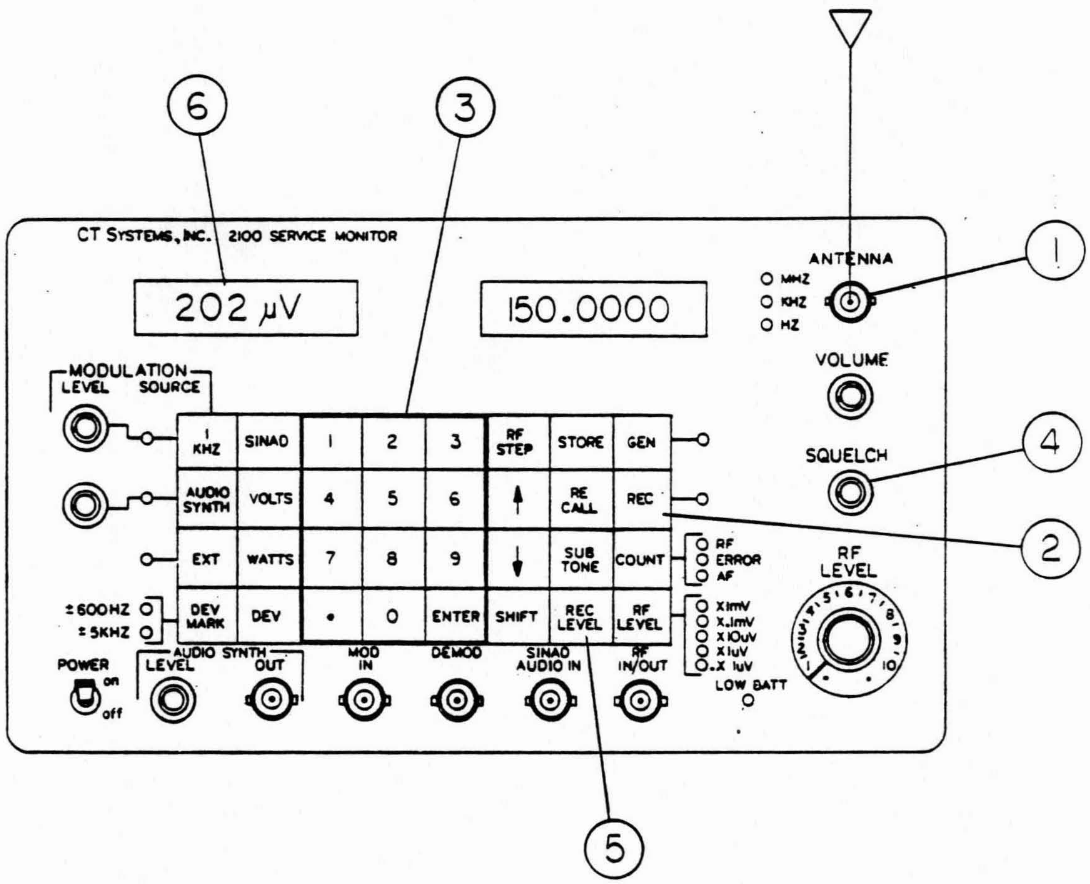


FIGURE 3-10. RELATIVE SIGNAL STRENGTH MEASUREMENTS

3.2.2 Measuring Transmitter Power and Frequency Error

The built-in 100 watt power meter automatically switches the Model 2100 into a monitor mode if approximately 200 mW or greater is keyed into the RF In/Out connector. This not only protects against circuit damage from accidental keying, it also provides for "hands off" switching into monitor mode for simultaneous display of transmitter power and some other selectable parameter, i.e., frequency error.

NOTE

The Model 2100 is designed to take transmitter measurements based on what is presented at the RF IN/OUT port under the assumption that the ANTENNA port is terminated into a purely resistive 50 ohm load. The user must take into consideration the potential inaccuracies introduced by the cables used to hook up the system under test. To reduce cable-related errors, use only good quality 50 ohm coax cables of the minimum length required.

Refer to Figure 3-11 for the following test procedure.

1) **CAUTION:** Connect a 50 ohm 100 watt RF load to the Model 2100 ANTENNA port.

2) Connect RF output of the transmitter to "RF IN/OUT" of Model 2100.

3) Select REC mode. (If in GEN mode, unit will automatically switch to REC when power is keyed into unit.)

4) Program transmitter frequency on monitor in MHz using numerical keys followed by ENTER key.

5) To prevent overheating the instrument, see the specifications for applying power to the wattmeter.

6) Key the transmitter. The 2100 will display power in watts (up to 100 watts) on the left LCD.

7) Select COUNT Error" and read frequency error on the right LCD.

   NOTE: The Model 2100 switches to the watts mode when power is initially keyed in. In order to read frequency error, the COUNT Error mode must therefore be selected after the power is keyed in.

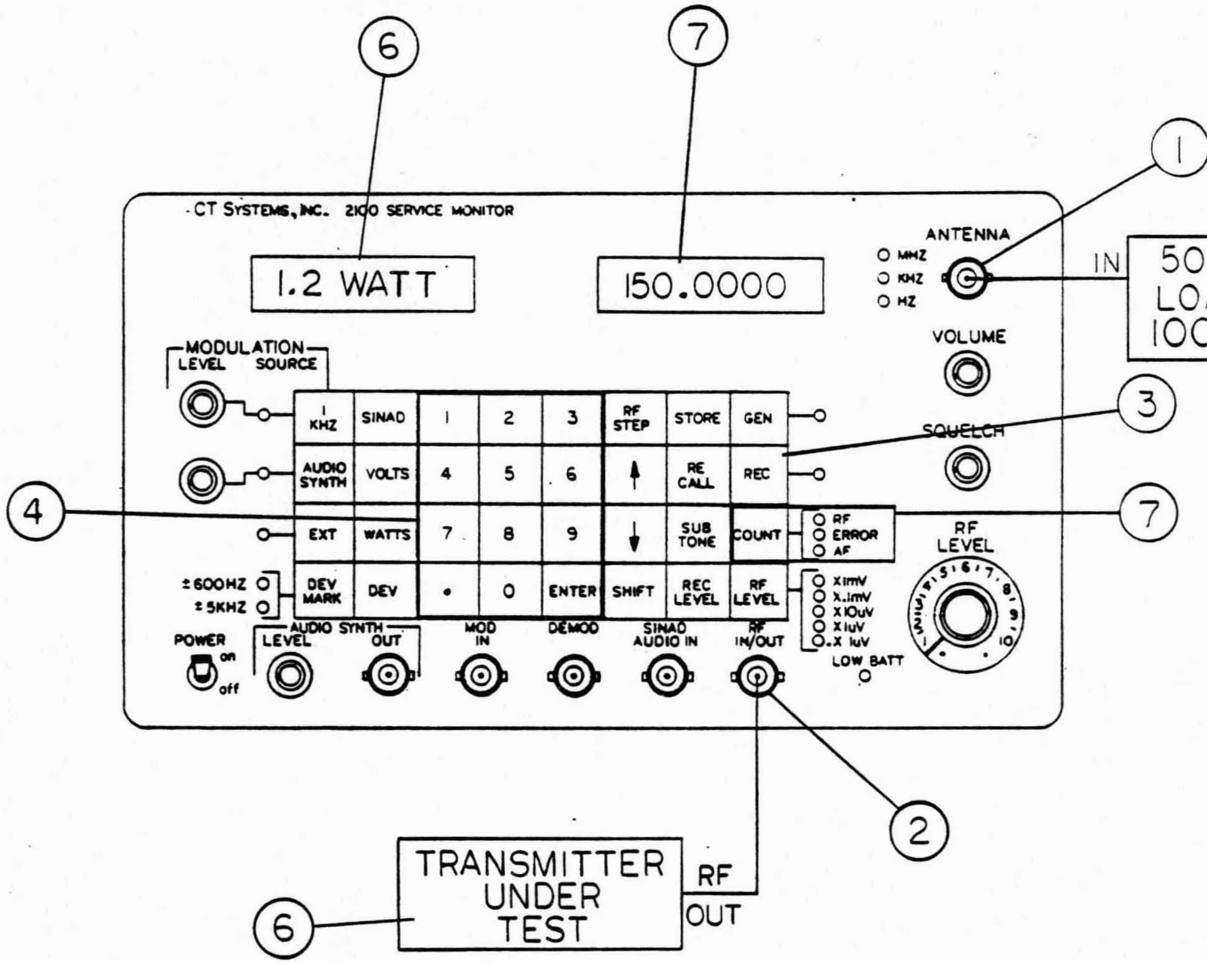


FIGURE 3-11. MEASURING TRANSMITTER POWER AND FREQUENCY ERROR

3.2.3 Tuning Sub-Audible Transmitter Tones

CTCSS tones may be identified using the SUBTONE function as described in Section 3.2.1 (Off Air Monitoring). This task may also be more rapidly performed by using an oscilloscope to create a lissajous pattern during tuning.

NOTE

The Model 2100 is designed to take transmitter measurements based on what is presented at the RF IN/OUT port under the assumption that the ANTENNA port is terminated into a purely resistive 50 ohm load. The user must take into consideration the potential inaccuracies introduced by the <u>cables</u> used to hook up the system under test. To reduce cable-related errors, use only good quality 50 ohm coax cables of the minimum length required.

Refer to Figure 3-12 for the following test procedure.

1) CAUTION: Connect a 50 ohm 100 watt RF load to the Model 2100 ANTENNA port.

2) Select REC mode.

3) Set frequency for transmitter frequency in MHz using numerical keys followed by ENTER key.

4) Select AUDIO SYNTH .

5) Use the numerical keys to program the desired subtone in Hz and terminate the data with the ENTER key.

6) Cable the Antenna Port of the transmitter under test to the "RF IN/OUT" port of the Model 2100.

7) Cable the demod out of the Model 2100 to the oscilloscope vertical input.

8) Cable the audio synthesizer output to the oscilloscope horizontal input.

9) To prevent overheating the instrument, see the specifications for applying power to the wattmeter.

10) Key the transmitter.

11) Adjust the audio synthesizer level control for a lissajous pattern on the oscilloscope.

12) Adjust the transmitter subtone frequency for a stable lissajous pattern.

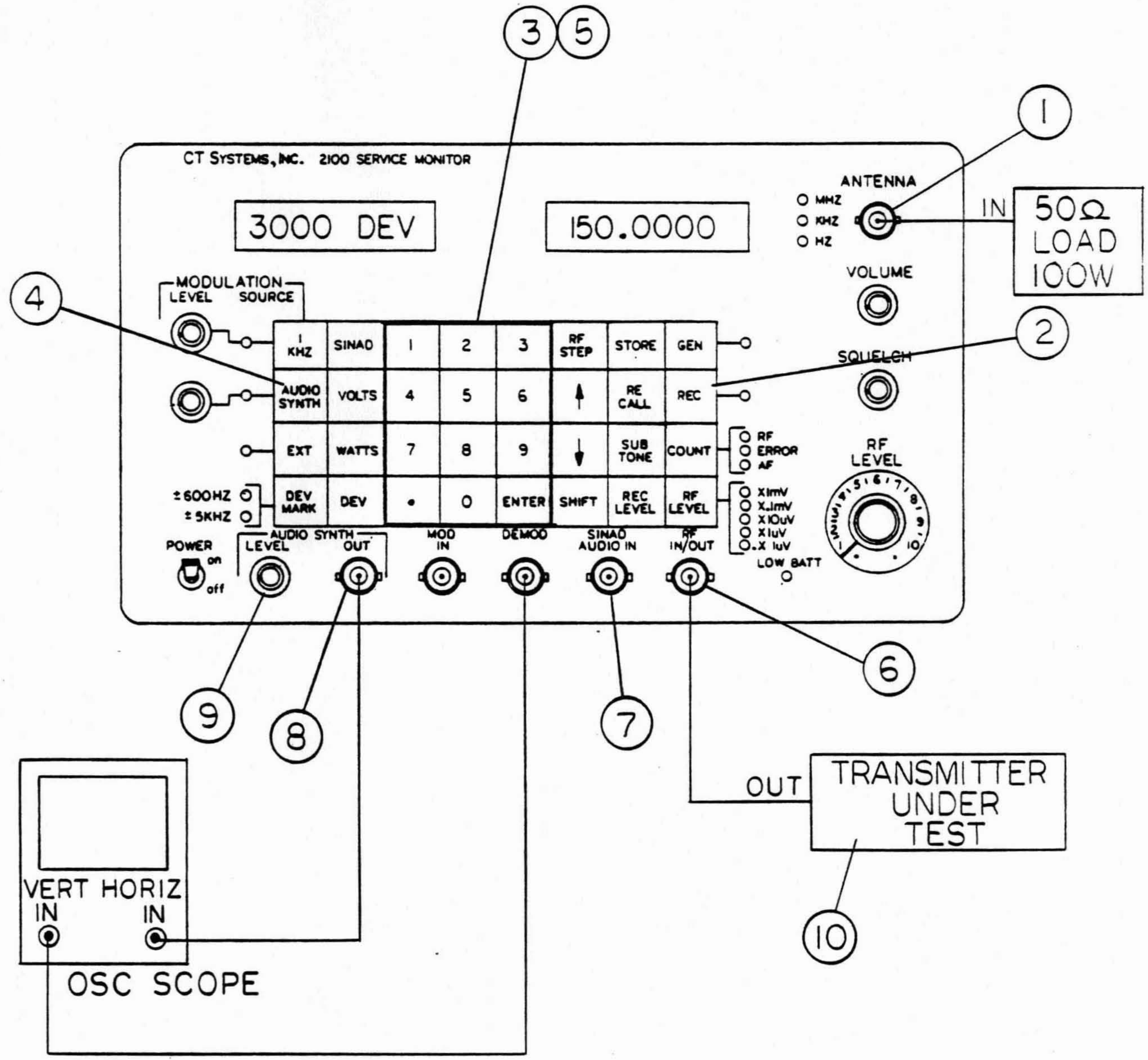


FIGURE 3-12. TUNING SUB-AUDIBLE TRANSMITTER TONES

3.2.4 Miscellaneous Keyboard Programming

RF Step Size Programming

RF step size can be tailored to suit the users specific application by using the RF STEP key as shown below.

1) Select RF STEP.

2) Enter the desired step size in MHz and press ENTER.

3) Use the up or down arrow keys to step the RF frequency.

Memory and Recall Operation

Twenty storage registers (1 - 20) are available for retaining desired front panel keyboard settings. To store a setup in memory:

1) Select STORE.

2) Enter a memory location from 1 to 20 using the data keys.

3) Select ENTER to terminate.

To recall a memory register:

1) Select the RECALL key.

2) Select the desired memory register (from 1 to 20) using the data keys.

3) Recall (activate) the register by pressing ENTER.

4) The operator may scroll thru the stored settings by pressing RECALL followed by the up or down arrow keys.