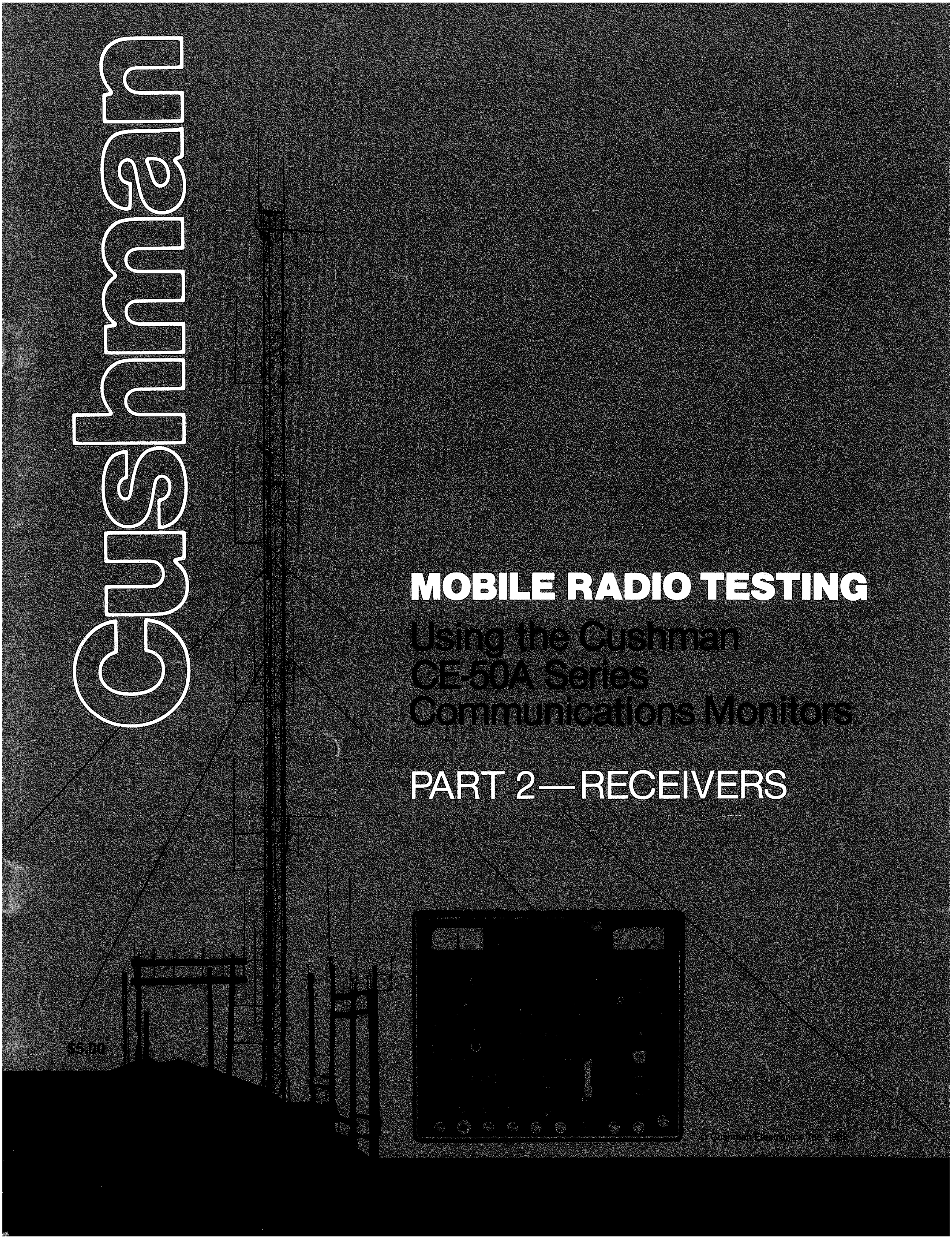


Cushman

MOBILE RADIO TESTING

Using the Cushman CE-50A Series Communications Monitors

PART 2—RECEIVERS

$5.00

Mobile Radio Testing

Using the Cushman CE-50A Series Communications Monitors

PART 2—RECEIVERS

TABLE OF CONTENTS

To the two-way radio service technician...

This booklet is one of a series designed for use as a training manual for the Cushman CE-50A Series Communications Monitors. The tests can also be used with any service monitor that has features like the CE-50A. It is important to note that becoming familiar with Part 1—TRANSMITTERS will help in the set up and performance of the intermediate level RECEIVER tests in this booklet.

In Part 2—RECEIVERS, the front panel controls have been drawn in the position that they should be adjusted to at the initial set-up of the test. Knowing what the controls do and how they control the input and output signals, or affect the CRT display for example, is one of the key elements in learning how to most effectively use the service monitor for easier and faster troubleshooting techniques.

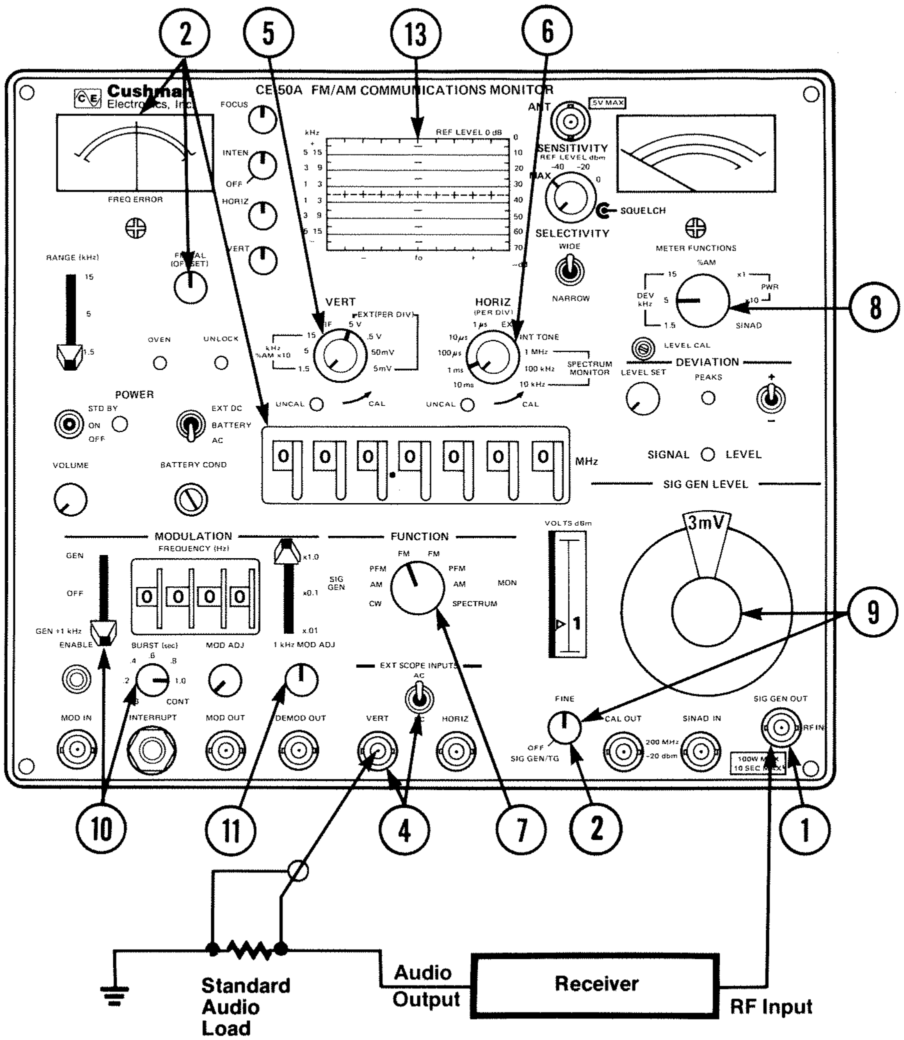
Many of the tests have been suggested by users of Cushman spectrum monitors. Our applications engineering staff has refined the tests to provide the clearest format possible. Suggestions for new tests are welcomed, since in servicing electronic equipment there is usually more than just one way to make the same measurement. Please note that even though two different tests reveal the same test results, they will often reveal something that the other test does not. Contact one of our applications engineers for any questions or new tests you may have at Cushman's Headquarters in San Jose, California, (408) 263-8100.

It is our sincere desire that each of these handbooks will help you to fully utilize the many capabilities of Cushman's service monitors, and in so doing improve your service effectiveness.

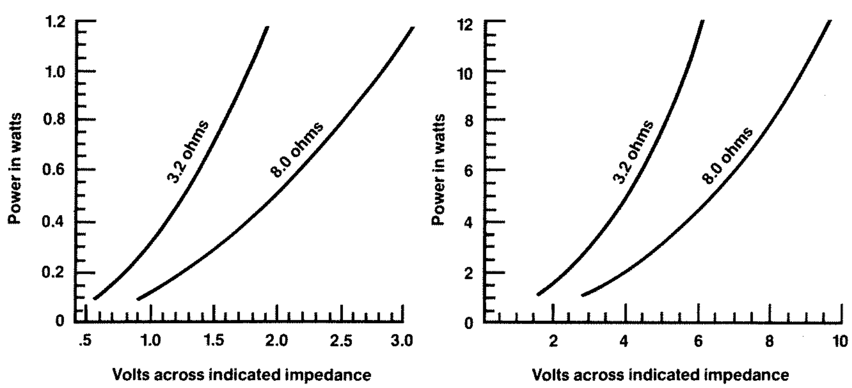
RECEIVER TEST RX-1

Recommended Test Equipment:
CE-50A Series
CE-45A, CE-46A
CE-5100 Series

Measuring Audio Power Output



If the receiver does not produce the rated audio output power, check to see if the detector output is normal. If the squelch is properly operating, then there is a probable loss of gain in the audio stages. Use the monitor oscilloscope and signal trace through the audio circuits to find the problem.



These two graphs will convert the power dissipated in the load to the RMS Voltage across the load for two common audio loads.

TEST PROCEDURES:

1. Connect SIG GEN OUT to the receiver input connector.
2. Set FREQ SELECT switches to the receiver frequency; turn on the FINE RF control and set the FREQ ERROR meter to zero using the FM CAL (OFFSET) control.
3. Connect a standard load (R_L) to the receiver audio output.*
4. Connect EXT SCOPE VERT input across the audio load resistor. Set AC/DC switch to AC.
5. Set VERT switch to EXT 5 V/DIV.
6. Set HORIZ to 1 ms (PER DIV).
7. Set FUNCTION switch to SIG GEN: FM or AM.
8. Set METER FUNCTION switch to DEV kHz (FM) or (if AM modulation) % AM.
9. Set SIG GEN LEVEL to 1 mV.
10. Set GEN + 1 kHz switch to GEN + 1 kHz. Set BURST (sec) to the 1.0 position. This will turn the tone generator off.
11. Increase 1 kHz MOD ADJ until modulation meter reads 60% of maximum system deviation.
12. Use the graphs to convert the manufacturer's rated audio output power to an RMS voltage, and then multiply the RMS voltage by 2.828 to get the peak-to-peak voltage that should be obtained on the CRT. If the load resistance is not 3.2 Ω or 8 Ω, use the formula: $E = \sqrt{P \times R_L}$ to find the RMS voltage.
13. Increase the audio volume on the receiver until the P-P voltage, obtained in step 12, is displayed on the CRT.

*When making receiver tests, the audio output should be connected across a load resistor that can dissipate the power and not directed to the speaker. If you want to listen to the audio, connect a speaker across the load resistor. The resistance of the speaker should be at least 10 times higher than the load resistance.

VOLTAGE MULTIPLIERS
Full Power X1
50% Power X.7
25% Power X.5
P-P = RMS x 2.828

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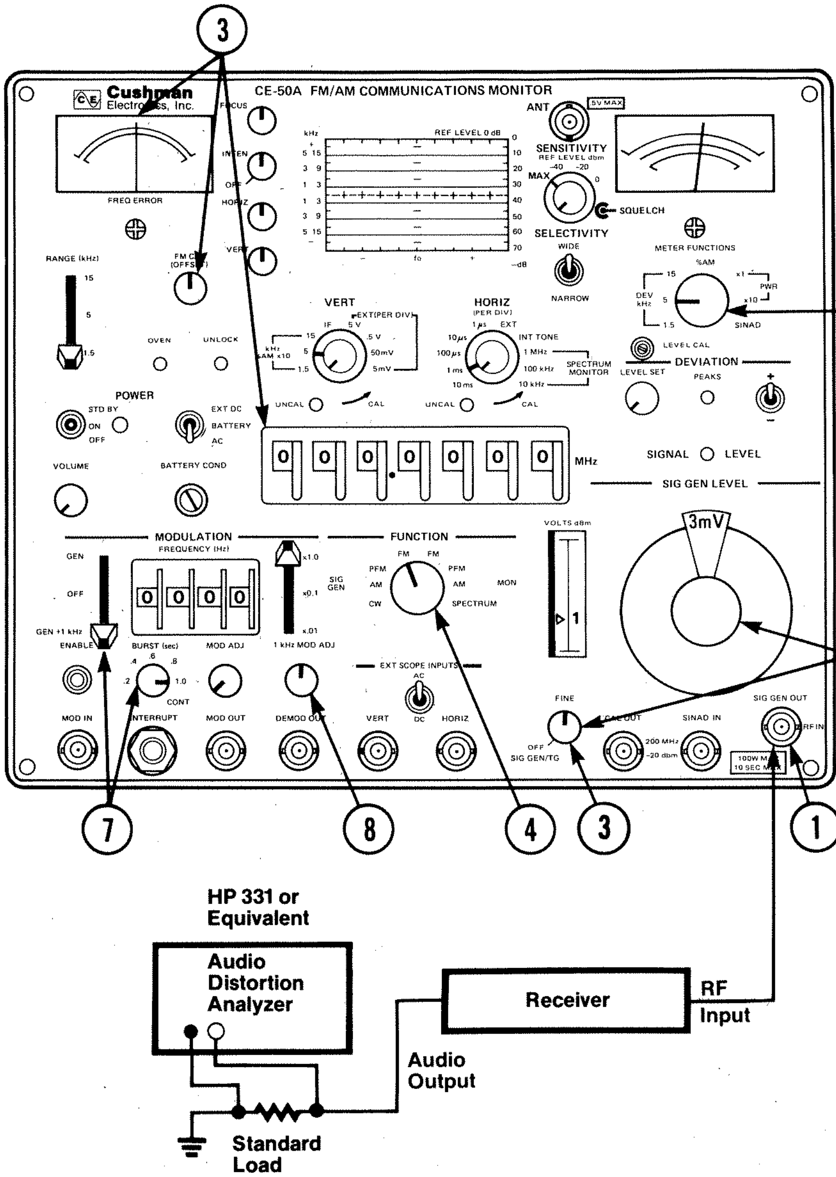
RECEIVER TEST RX-2

Recommended Test Equipment:
CE-50A Series
CE-45A, CE-46A
CE-5100 Series

Measuring Receiver Audio Distortion



TEST PROCEDURES:

1. Connect SIG GEN OUT to the receiver input.
2. Connect the receiver audio output to a standard audio load resistor and connect the audio distortion analyzer across the load resistor.
3. Set FREQ SELECT switches to the receiver frequency; turn on the FINE RF control and set the FREQ ERROR meter to zero using the FM CAL (OFFSET) control.
4. Set FUNCTION switch to SIG GEN-FM.
5. Set METER FUNCTION to 5 kHz DEV.
6. Set SIG GEN LEVEL to 1 mV.
7. Set Gen + 1 kHz switch to GEN + 1 kHz. Set BURST (sec) to the 1.0 position. This will turn the tone generator off.
8. Increase the 1 kHz MOD ADJ to 60% of maximum system deviation (typically 3.3 kHz).
9. Set the receiver volume to its rated audio output. (Ref to RX-1 to determine this value). Use the volt meter on the audio distortion analyzer to set this level.
10. Set the Audio distortion analyzer to 100% scale.
11. Set the filter to 1000 Hz and tune for a minimum reading.
12. Continue reducing the percentage control and re-nulling until the lowest meter reading is obtained.
13. Compare the distortion level measured to the manufacturer's specification.

If the receiver passes the audio distortion test then a number of circuits are working correctly. The detector is functioning properly, and the audio gain is normal since the receiver is putting out its rated audio output voltage. Passing the distortion test is important because the receiver won't pass the -12 dB SINAD test if the distortion is high. Remember that the receiver should be at full quieting since the RF level is at 1000 μv. If it's not, trouble-shoot the RF gain stages before performing the distortion test. A normal distortion measurement will be 3% to 10%. High level distortion can be traced with the monitor's oscilloscope while low level distortion can be detected with the distortion analyzer using an isolating probe or resistor to prevent circuit loading.

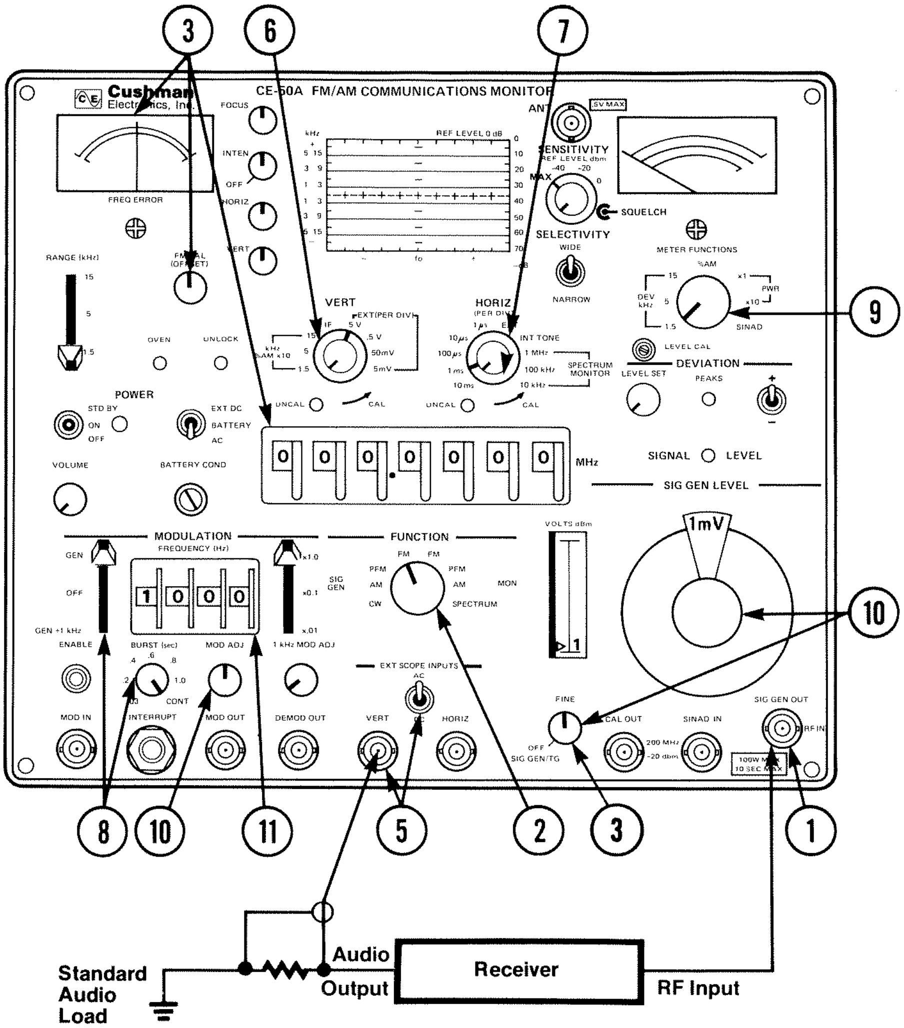
If you need to know the SINAD at 1 kHz for the distortion measured, use the formula:

$$\text{SINAD} = 20 \log \left(\frac{1}{D}\right)$$

RECEIVER TEST RX-3

Recommended Test Equipment:
CE-50A Series
CE-45A, CE-46A
CE-5100 Series

Measuring Audio Frequency Response



TEST PROCEDURES:

1. Connect SIG GEN OUT to the receiver input connector.
2. Set FUNCTION Switch to SIG GEN-FM.
3. Set FREQ SELECT switches to the receiver frequency; turn on the FINE RF control and set the FREQ ERROR meter to zero using the FM CAL (OFFSET) control.
4. Connect a standard audio load to the receiver audio output.
5. Connect EXT SCOPE AC VERT input across standard audio output load; set AC/DC switch to AC.
6. Set VERT switch to EXT 5 V/DIV.
7. Set HORIZ switch to 1 ms.
8. Set the GEN + 1 KHz to GEN. Set BURST (sec) to CONT.
9. Set METER FUNCTION switch to 1.5 kHz DEV.
10. Adjust SIG GEN LEVEL to 1 mV, deviation to 1 kHz with a 1 kHz modulation frequency, adjust receiver audio volume to read .707 of peak audio output voltage on CRT (50% of output power). (See RX-1 for measuring peak audio output power).
11. Vary the audio frequency over specified audio range and check frequency response by measuring peak audio voltage on CRT. The audio response should decrease at a 6 dB per octave de-emphasis.
12. Audio response should attenuate at 6 dB per octave rate past 3 kHz from 25 to 450 MHz and attenuate at 12 dB per octave rate from 450-470 MHz.

The audio frequency response test checks how closely the audio output of the receiver follows a 6 dB per octave de-emphasis with frequency deviation being held constant over a frequency range of 300 to 3000 Hz. The receiver is connected to a standard load and the volume control is adjusted for 50% of full rated output power (.707 of peak voltage).

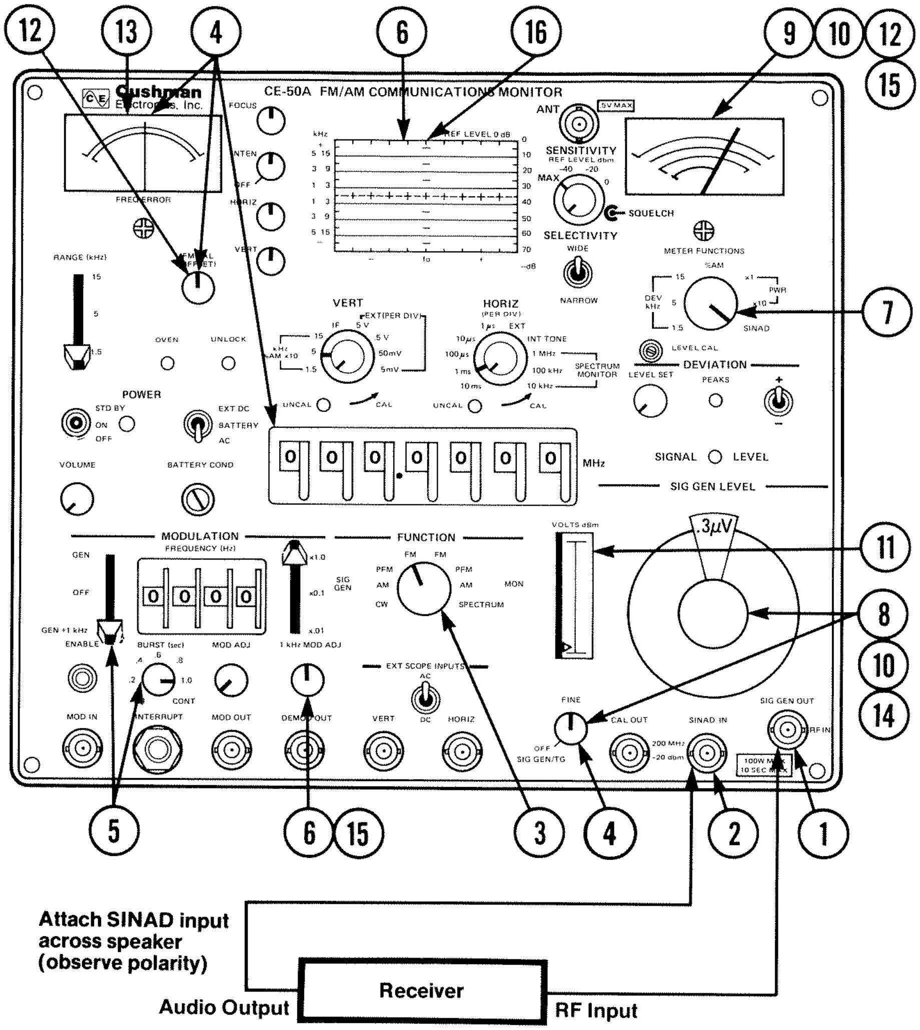
The modulation is reduced to 1/5th of the maximum rated system deviation with the deviation held constant at this value. For a receiver used with a loudspeaker then a minimum standard would be an audio response that varies less than +2 dB to -8 dB from a standard 6 dB per octave de-emphasis curve over a frequency range of 300 Hz to 3000 Hz using a reference frequency of 1000 Hz. For a receiver feeding a headphone or a line the audio response should not vary +1 to -3 dB from the 6 dB per octave de-emphasis curve over the frequency range of 300 to 3000 Hz.

These specifications are taken from the EIA standards for land mobile communication FM and PM receivers, 25-470 MHz.

RECEIVER TEST RX-4

Recommended Test Equipment:
CE-50A Series
CE-5100 Series

Measuring -12 dB SINAD Sensitivity, Receiver Center Frequency, and Modulation Acceptance Bandwidth



Meeting manufacturers specifications in this test will check the R.F. and I.F. gain, injection and mixer chain performance. It will also verify that the selectivity of the receiver is not too narrow or too wide. It is a valuable test because it checks a receiver's ability to respond to a weak signal. The SINAD measurement also checks the performance of the detector and audio stages. High audio distortion will make passing the test impossible. A normal reading for the modulation acceptance bandwidth test would be 6-9 kHz of deviation. The receiver center frequency test gives a quick check of receiver alignment. (For a more accurate test see test RX-6 for measuring Local Oscillator Frequency.)

SINAD is the voltage ratio $\dfrac{\text{signal + noise + distortion}}{\text{noise + distortion}}$ **expressed in decibels**

TEST PROCEDURES:

1. Connect SIG GEN OUT to receiver input connector.
2. Connect RECEIVER AUDIO OUTPUT to SINAD IN connector.
3. Set FUNCTION switch to: SIG GEN; FM or AM.
4. Set FREQ SELECT switches to the receiver frequency; turn on the FINE RF control and set the FREQ ERROR meter to zero using the FM CAL (OFFSET) control.
5. Set GEN + 1 kHz switch to GEN + 1 kHz: Set BURST (sec) to the 1.0 position, turning the tone generator off.
6. Set 1 kHz MOD ADJ to 3 kHz deviation on CRT.
7. Set METER FUNCTION switch to SINAD.
8. Set SIG GEN LEVEL to 0.3 µV step; FINE control OFF.
9. Adjust squelch control to fully open squelch on the receiver; turn receiver audio volume up until SINAD meter scale deflects full scale.
10. Turn SIG GEN LEVEL up until SINAD scale on FUNCTION meter reads -12 dB.
11. Read -12 dB SINAD sensitivity on VOLTS dBm meter.
12. Rotate FM CAL OFFSET knob about zero and observe SINAD meter. Frequency at which SINAD is minimum is receiver center frequency.
13. Read receiver center frequency on FREQ ERROR meter.
14. Increase SIG GEN LEVEL 6 dB (x2) above 12 dB SINAD sensitivity value used in step
15. Increase deviation of 1 kHz tone until SINAD meter again reads -12 dB.
16. Read deviation on meter or CRT. Deviation reading equals Modulation Acceptance Bandwidth.

If you need to know the percent distortion of the audio at 1 kHz use the formula:

$$\%D = \frac{1}{\log^{-1}\left(\dfrac{\text{SINAD}}{20}\right)} \times 100$$

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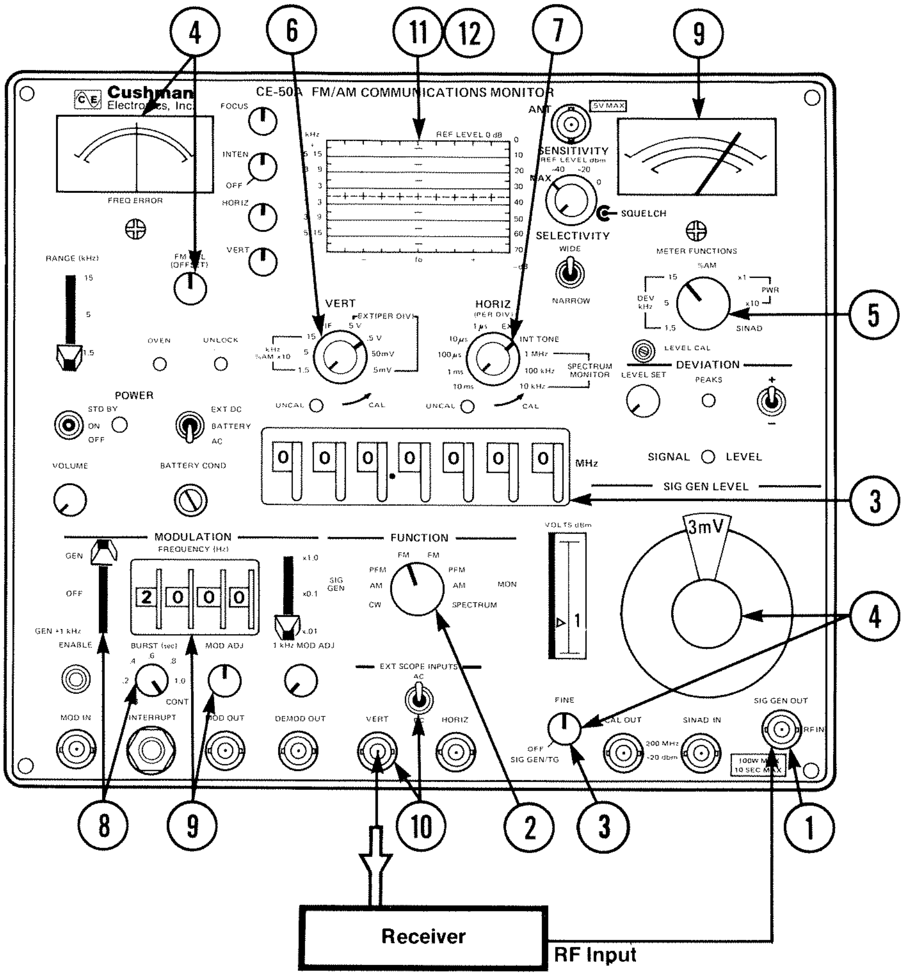
RECEIVER TEST RX-5

Recommended Test Equipment:
CE-50A Series
CE-46A
CE-5100 Series

Checking FM Discriminator Symmetry



Alignment of the tuned circuits of a receiver may be necessary for several reasons:

1. Frequency drift due to vibration, humidity, temperature or crystal aging.
2. Parts replacement may affect a frequency resonant circuit.
3. Receiver modification.
4. To correct the results of improper adjustments.

By viewing the "S" curve an unsymmetrical or off-frequency IF can be immediately determined. It will also show if the passband (modulation acceptance bandwidth) is too wide or narrow.

In addition to viewing discriminator "S" curves, if the scope probe is connected to the output of the 455 kHz IF Filter the response of the filter will also be displayed on the CRT.

TEST PROCEDURES:

1. Connect SIG GEN OUT to the receiver input.
2. Set FUNCTION switch to SIG GEN-FM.
3. Set FREQ SELECT switches to the receiver frequency; turn on the FINE RF control and set the FREQ ERROR meter to zero using the FM CAL (OFFSET) control.
4. Set SIG GEN Level to 1 mV.
5. Set METER FUNCTION switch to 15 kHz DEV.
6. Set VERT switch to EXT .5 volts per DIV.
7. Set HORIZ switch to INT TONE.
8. Set GEN + 1 kHz switch to GEN; BURST to CONT.
9. Set MODULATION switches to 20 Hz and increase MOD ADJ to produce 12 kHz DEV on Meter.
10. Connect scope probe to VERT input and set AC/DC switch to AC.
11. Center the horizontal trace in the middle of the CRT using the scope controls.
12. Connect the scope probe to the output of the detector and view the "S" curve of the discriminator. The CRT should look like Photo #1.
13. Decrease the MOD ADJ to where just the "S" curve is visible as in Photo #2 and read the deviation on the meter. This is the modulation acceptance band width of the receiver.
14. If the "S" curve does not cut off evenly as in Photo #3, check the frequency of the LO or the center frequency of the IF filters.

The INT TONE position on horizontal switch enables the horizontal sweep of the scope to be triggered from the Tone Generator for quick and easy swept tuned displays.

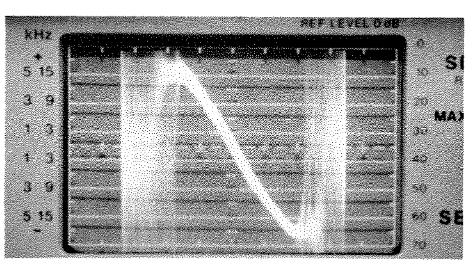


Photo 1

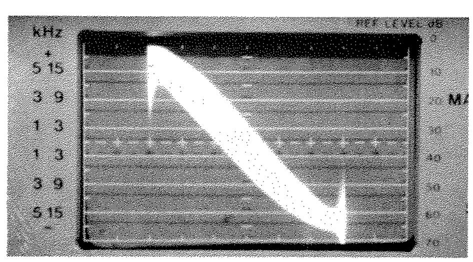


Photo 2

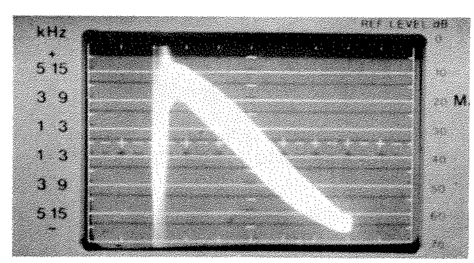
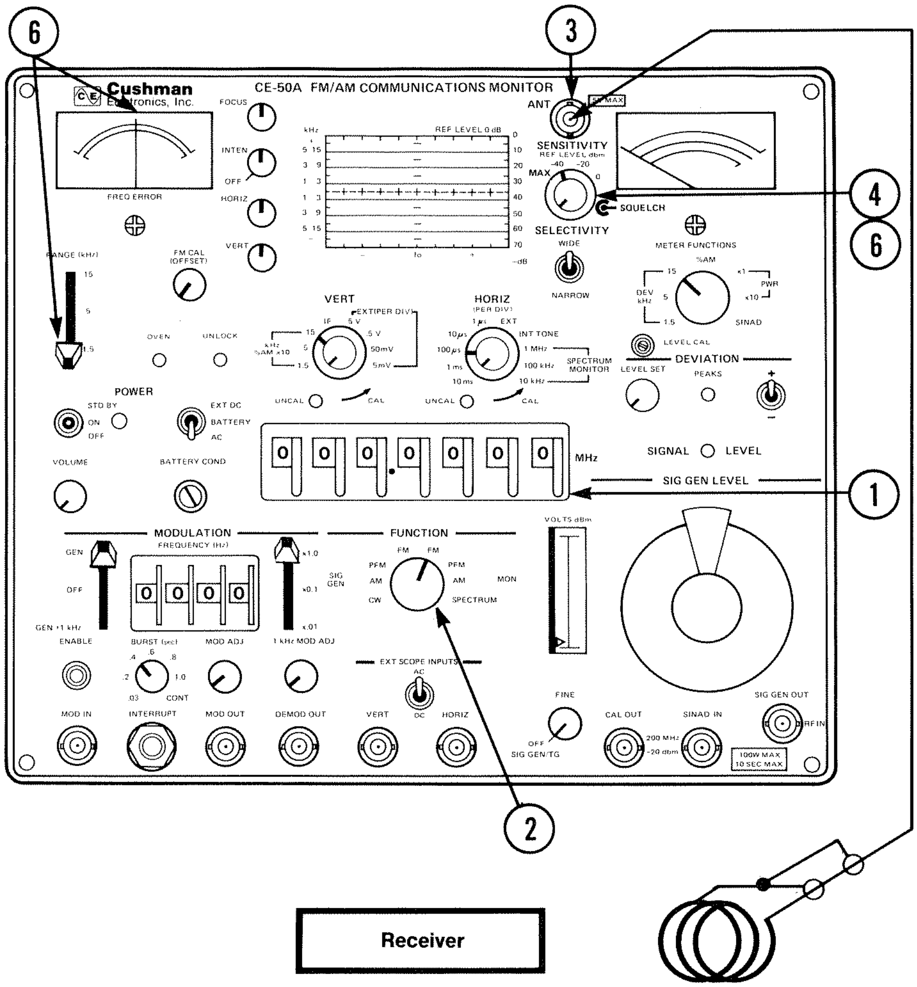


Photo 3

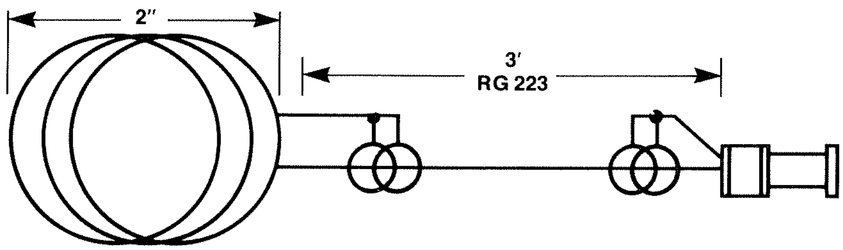
RECEIVER TEST RX-6

Recommended Test Equipment:
CE-50A Series
CE-45A, CE-46A
CE-5100 Series

Measuring Receiver LO Frequencies
Setting LO Frequencies



A sniffer probe is an important tool to have in your aresenal of test equipment. It's easy to make and comes in handy for LO measurements and in searching for RF leakage. All it takes to make one is 3 feet of double *shielded coax RG/U223,* a BNC connector, about 12" of #18 buss wire, and 12"of insulation to slip over the buss wire.



Connect the BNC to one coax end and three 2" loops of insulated buss wire to the other coax end as the above drawing shows.

TEST PROCEDURES:

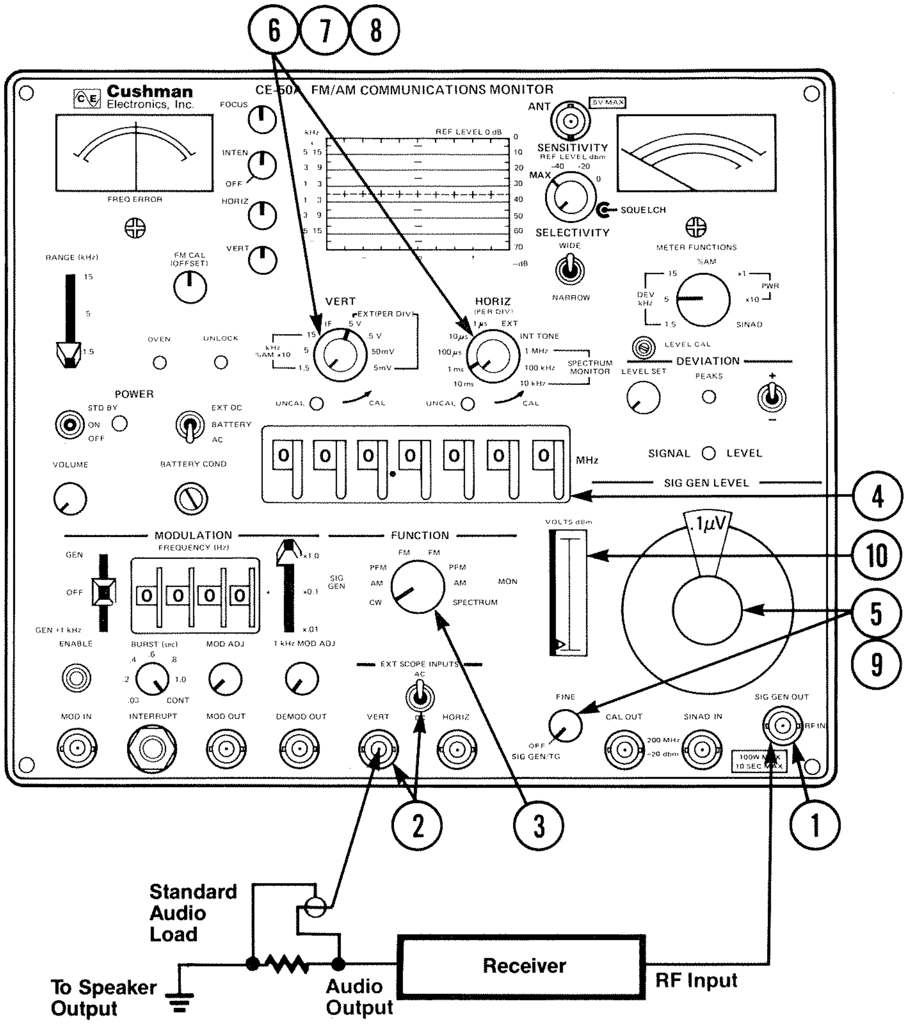
1. Set FREQUENCY SELECT switches to 1st local oscillator frequency. LO = 1st IF ± frequency of receiver divided by the multiplication factor of the local oscillator (see radio manual).
2. Set FUNCTION switch to MON: FM or AM.
3. Connect sniffer probe to the ANT IN connector.
4. Set SENSITIVITY to -40 dBm, adjust squelch as needed.
5. Position sniffer close to LO oscillator circuit.
6. Set RANGE (kHz) switch to 1.5 kHz and measure error of LO frequency on the FREQUENCY ERROR meter. Increase SENSITIVITY if needed.
7. Adjust 1st local oscillator for 0 error on FREQ ERROR meter.
8. Repeat procedure for 2nd or 3rd local oscillators.

NOTE: A second loop of wire can be wound around the first wire and connected to a coax stub with a BNC connector on the end. By connecting a calibrated RF signal generator to this coax stub, you can easily calibrate the loop. Once this is done, you have a "bench mark" against which to compare any stray radiation you may have. In addition, the loop can be used for security de-bugging. Loop size can be varied to meet the application, so experimentation to fit the need is advised.

RECEIVER TEST RX-7

Recommended Test Equipment:
CE-50A Series
CE-45A, CE-46A
CE-5100 Series

20 dB Quieting Sensitivity

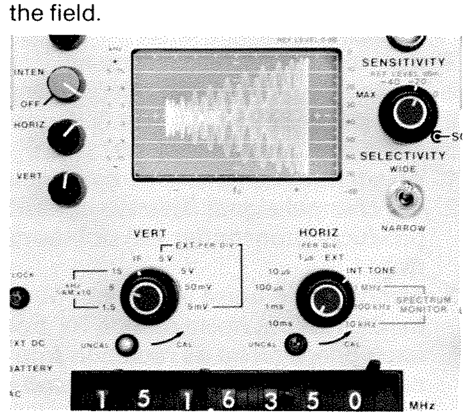


20 dB quieting is a good test for checking receiver gain. The quieting sensitivity of a receiver is the minimum amount of signal from an unmodulated standard input signal source that is required to produce 20 dB of noise quieting measured at the receiver audio output. It's a follow-up test to perform if the receiver fails the 12 dB SINAD test. Passing the 20 dB quieting sensitivity and failing 12 dB SINAD indicates trouble in the discriminator or audio stages because the 20 dB quieting test is performed with no modulation while the 12 dB SINAD is done with modulation.

TEST PROCEDURES:

1. Connect SIG GEN OUT to the receiver input connector.
2. Connect the receiver audio output to a standard audio load and attach SCOPE VERT IN connector across audio load; Set AC/DC switch to AC.
3. Set FUNCTION switch to SIG GEN-CW.
4. Set the FREQUENCY SELECT switches to the receiver frequency.
5. Set the SIG GEN LEVEL to 0.1 μV step; FINE control OFF.
6. Set VERT to EXT (PER DIV.); Set HORIZ to 1 ms.
7. Adjust receiver to critical squelch. (See RX-11). Turn receiver audio volume up to 25% of rated output and set reference level on CRT. Adjust VERT scale switch and uncalibrated knob for full deflection of noise on vertical display of the CRT.
8. Increase VERT sensitivity by 20 dB (x10).
9. Turn SIG GEN output ON and increase level until the vertical trace on CRT again is at full deflection.
10. SIG GEN METER reading is the 20 dB Quieting Sensitivity.

Built in scope with 5 mV/DIV to 5 V/DIV continuously adjustable between ranges makes a variety of AC waveform measurements possible. No need to carry another piece of test equipment into the field.



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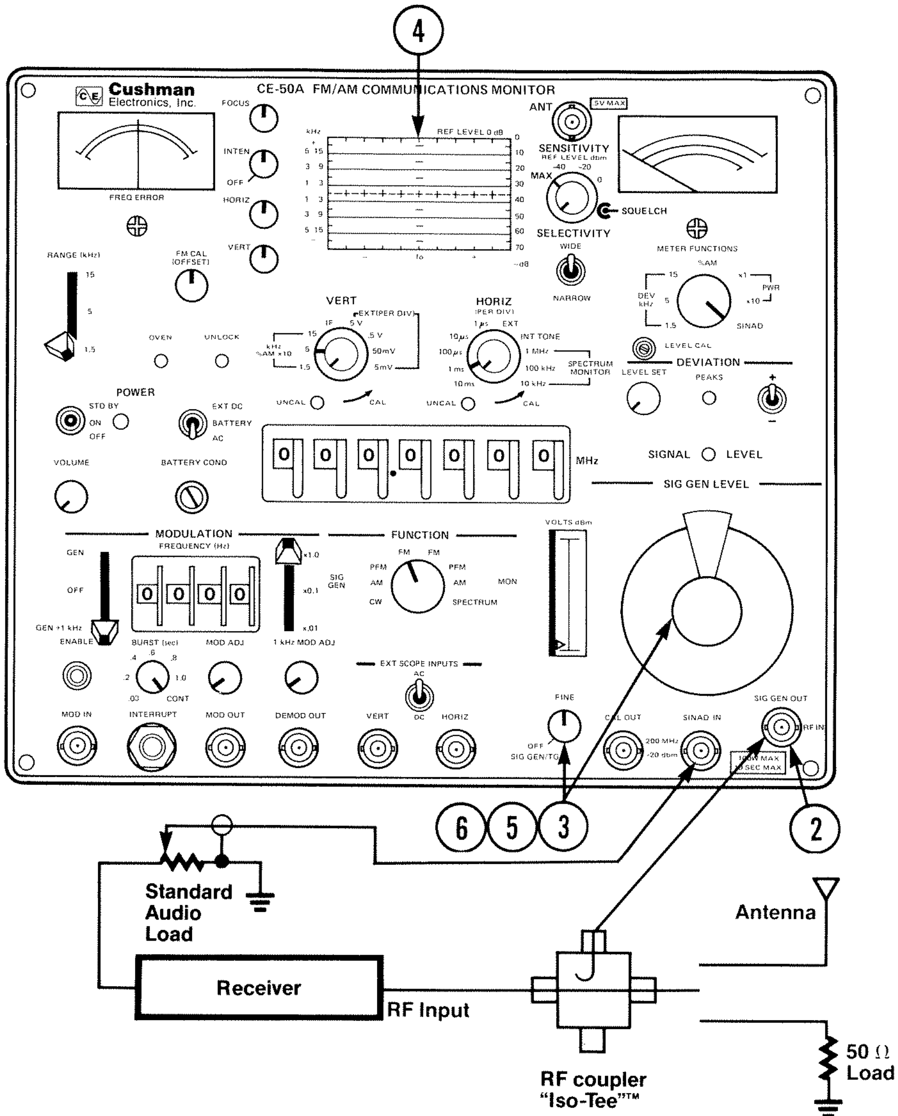
RECEIVER TEST RX-8

Recommended Test Equipment:
CE-50A Series
CE-45A, CE-46A
CE-5100 Series

Effective Sensitivity Testing



TEST PROCEDURES:

1 Perform the 12 dB SINAD sensitivity test on the receiver (basic sensitivity see RX-4). Record this level.

2 Connect the receiver to an RF coupler and SIG GEN OUT to the variable couple input connection on the RF coupler (see test set-up).

3 Increase the RF GENERATOR OUTPUT by 30 to 40 dB above the 12 dB SINAD sensitivity.

4 While viewing the SINAD meter, adjust the coupling trimmer on the RF coupler and/or the SIG GEN LEVEL until the SINAD sensitivity is again attained.

5 Connect the 50 Ω load to the RF coupler (see test set-up and increase the RF generator output to the SINAD sensitivity. The change should be approximately +6 dB. (This step accounts for the loss in the set-up). Record this level.

6 Now connect the antenna to the RF coupler in place of the 50 Ω load and again measure the SINAD sensitivity.

7 Subtract the reading in step 6 from step 5. This figure is the change in receiver sensitivity expressed in dB (see example).

8 If the effective sensitivity increases, then this is an indication that the antenna is open, its impedance is not 50 Ω, or standing waves are present on the transmission line (this test may not be effective when the transmission line is very long).

Example: SINAD sensitivity .5 μV
50 Ω load: SINAD measured = 80 dBm
Antenna: SINAD measured = 74 dBm

Antenna system degradation: 6 dB
Effective sensitivity of receiver equals 6 dB change from .5 μV to 1 μV.

NOTE: If the monitor does not have a SINAD meter use 20 dB quieting (See RX-7).

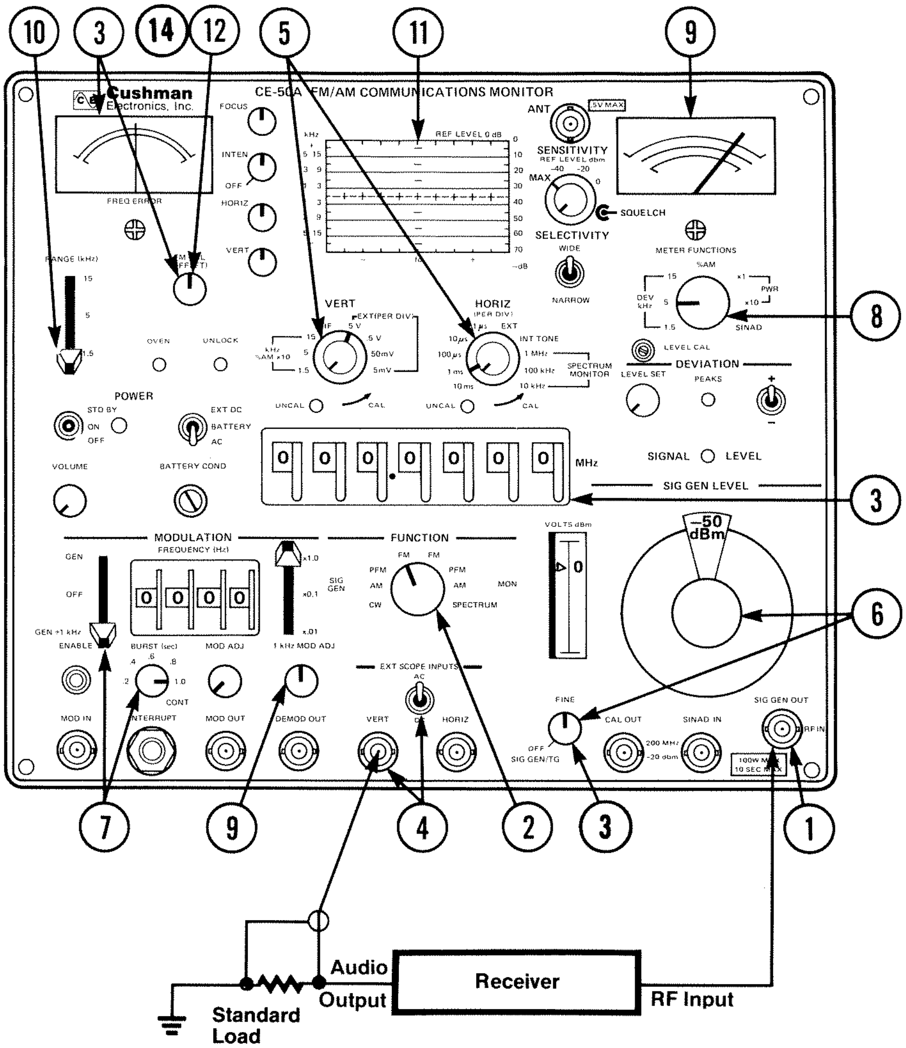
The ambient noise level of the environment in which the receiver is located determines the effective sensitivity of the receiver. When the sensitivity of the receiver is degraded it is usually caused by one of 4 problems. These are:

1. **Adjacent transmitter side band noise.**
2. **On channel signal desense caused by either external intermod products (transmitter IM) or internal intermod products (receiver IM).**
3. **Atmospheric noise which can be classified as natural or man-made. Natural noise can be RF from space and is caused by such phenomena as radiation from stars and solar flares or it can be atmospheric noise caused by lightning discharges and corona ionization. Man-made noise can be caused by such things as motors, generators, transformers, spark plugs, neon lights, or high power transmission lines.**
4. **Bad or mistuned transmission or antenna systems.**

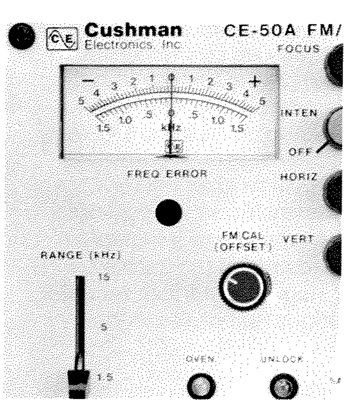
RECEIVER TEST RX-9

Recommended Test Equipment:
CE-50A Series
CE-45A, CE-46A
CE-5100 Series

Checking Receiver IF Bandwidth
Checking Receiver IF Symmetry



This test will check the I.F. filtering network which determines receiver selectivity. Varying the FM OFFSET on the monitor checks the bandwidth of the filter, and indicates if it is too narrow (causing audio distortion) or too wide (causing interference from adjacent channels). If the receiver uses crystal filters the symmetry test will indicate if the high and low cutoff crystals are working correctly. Audio distortion can be a problem if the bandpass of the filter is not symmetrical either side of the IF frequency.



The FM CAL OFFSET adjustment with 3 ranges (1.5, 5 and 15 kHz) takes the guesswork out of Receiver performance tests.

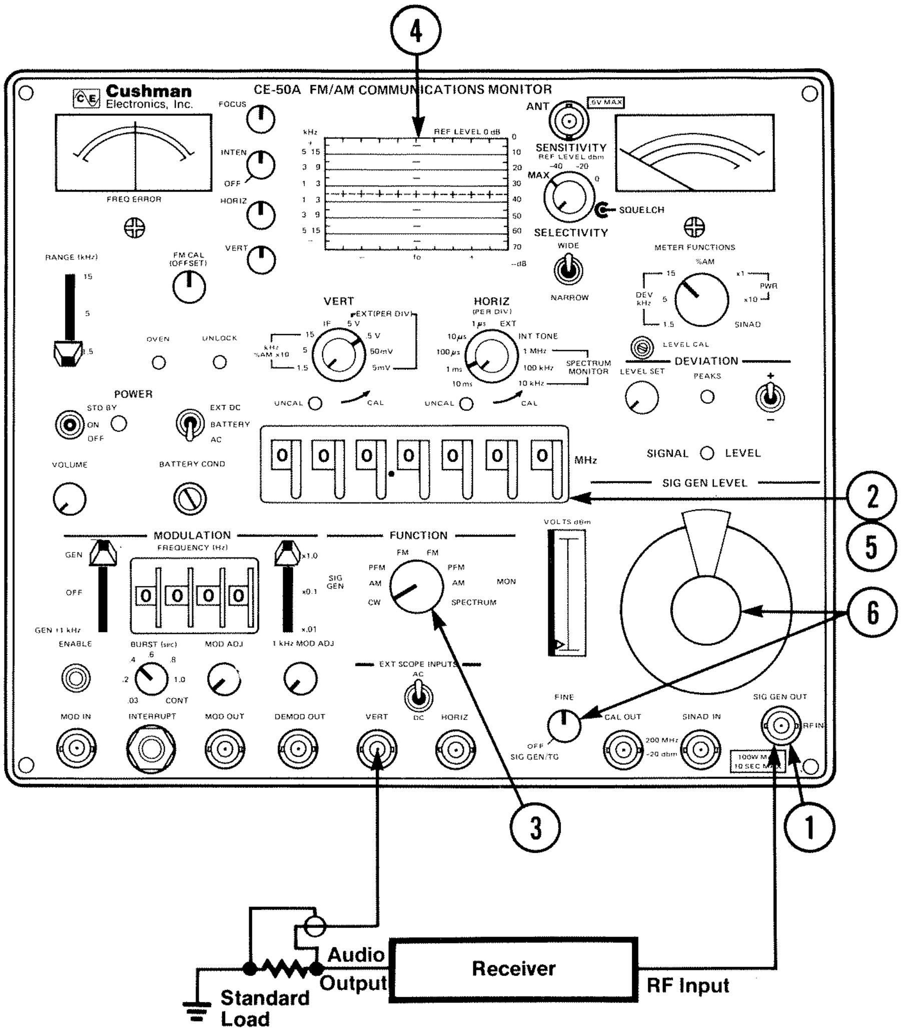
TEST PROCEDURES:

1. Connect SIG GEN OUT to the receiver input.
2. Set FUNCTION switch to SIG GEN-FM or AM.
3. Set FREQ SELECT switches to the receiver frequency; turn on the FINE RF control and set the FREQ ERROR meter to zero using the FM CAL (OFFSET) control.
4. Connect the receiver to a standard audio load and connect the VERT input across the load resistor; set AC/DC switch to AC.
5. Set VERT to EXT (PER DIV.) as needed; Set HORIZ to 1 ms.
6. Set SIG GEN LEVEL to -50 dB.
7. Set GEN + 1 kHz switch to GEN + 1 kHz: Set BURST (sec) to the 1.0 position.
8. Set METER FUNCTION switch to DEV 5 kHz.
9. Set 1 kHz tone to 4.5 kHz deviation on the deviation meter.
10. Set RANGE (kHz) switch to 15 kHz.
11. Adjust Squelch control to fully open the squelch on the receiver and adjust the audio output for display on the CRT.
12. Vary FM CAL (OFFSET) about zero to check IF bandwidth while listening to 1 kHz tone. On narrow band FM the tone should barely (if at all) be heard at ± 15 kHz off frequency.
13. The symmetry of the IF is good if the 1 kHz tone begins breaking up at the same frequency offset either side of zero.
14. Set SQUELCH control to critical squelch on receiver and repeat step 12. The receiver should squelch at approximately the same ± frequency offsets.

RECEIVER TEST RX-10

Recommended Test Equipment:
CE-50A Series
CE-45A, CE-46A
CE-5100 Series

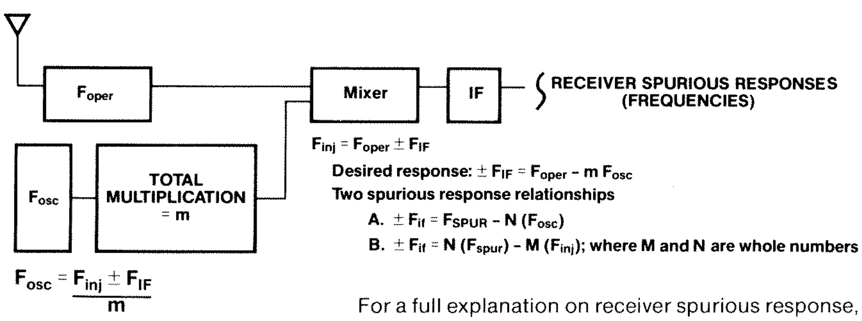
Measuring Spurious Response Attenuation



TEST PROCEDURES:

1. Connect SIG GEN OUT connector to the receiver input.
2. Select the receiver frequency on the FREQUENCY SELECT switches.
3. Set function switch to SIG GEN-CW.
4. Perform the 20 dB quieting test using an audio output level of 25% of maximum rated output as viewed on the CRT (see RX-7 for 20 dB quieting test and RX-1 for determining 25% of maximum rated output). Note this level.
5. Vary the signal generator from the lowest frequency amplified in the receiver to 1000 MHz. All responses should be noted. (*Exclude* harmonics of the signal generator and the frequencies between adjacent channels to the receiver frequency).
6. The ratio of the signal generator voltage required to produce 20 dB of noise quieting at any spurious response frequency to the signal generator voltage needed to produce 20 dB of noise quieting at the receive frequency is the receiver's spurious response attenuation. Use the spurious response which requires the least signal input to produce 20 dB of noise quieting as the receiver's spurious response attenuation.

The spurious response attenuation test measures a receiver's ability to discriminate between a desired signal to which it is resonant and an undesired signal at any other frequency to which it will respond. A minimum standard should be a spurious response attenuation of at least 85 dB on all bands for receivers operating below 400 MHz and at least 80 dB for receivers operating between 400 and 470 MHz.



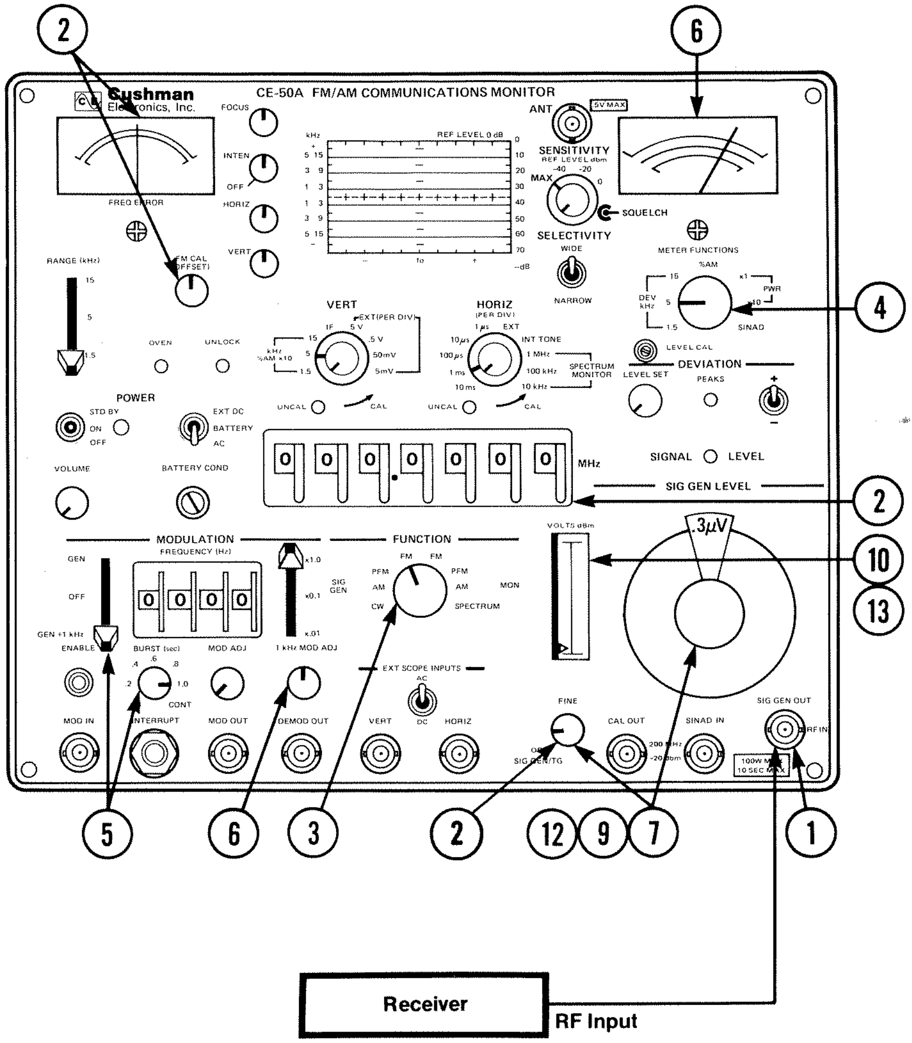
For a full explanation on receiver spurious response, read "If It Doesn't Belong, It's Spurious" by A. K. "Kenny" Guthrie in Communications Magazine, July 1975.

The block diagram shows how the frequencies which cause spurious responses in the receiver are directly related to two factors: (1) the injection frequency, and (2) the undesired output frequencies from the injection chain caused by leakage of the local oscillator and the multiplier stages. A strong signal entering the first mixer that is a ± IF frequency away from the oscillator frequency, a frequency of a multiplier stage, or a harmonic of the oscillator or multiplier stages have the potential to cause spurious responses in the receiver.

RECEIVER TEST RX-11

Recommended Test Equipment:
CE-50A Series
CE-45A, CE-46A
CE-5100 Series

Critical and Maximum Squelch Sensitivity



This test shows the level of signal needed to unsquelch a receiver that has the squelch control set to barely cut the noise off (critical squelch). Maximum squelch is the signal level needed to unsquelch the receiver when the control is fully rotated in the squelch position. When not specified, the critical squelch signal level will be about 8 dB less than the 20 dB Quieting Sensitivity and Maximum Squelch Sensitivity will be about 6 dB more than the 20 dB Quieting Sensitivity.

TEST PROCEDURES:

1. Connect the SIG GEN OUT to the receiver input.
2. Set FREQ SELECT switches to the receiver frequency; turn on the FINE RF control and set the FREQ ERROR meter to zero using the FM CAL (OFFSET) control.
3. Set the FUNCTION switch to SIG GEN-FM.
4. Set the METER FUNCTION switch to DEV -5 KHz.
5. Set the GEN + 1 kHz switch to GEN + 1 kHz; set BURST (sec) to 1.0 position.
6. Set 1 kHz MOD ADJ to ± 3 kHz deviation on meter.
7. Set SIG GEN LEVEL to 0.3 μV; FINE control CCW but *not* OFF.
8. Rotate receiver squelch control until receiver is barely squelched.
9. Increase SIG GEN output using the FINE control, until the receiver is barely unsquelched.
10. Read critical squelch sensitivity on the SIG GEN output level meter.
11. Rotate the receiver squelch control to maximum squelch.
12. Increase SIG GEN output until receiver is barely unsquelched.
13. Read Maximum Squelch Sensitivity on the SIG GEN output level meter. meter.

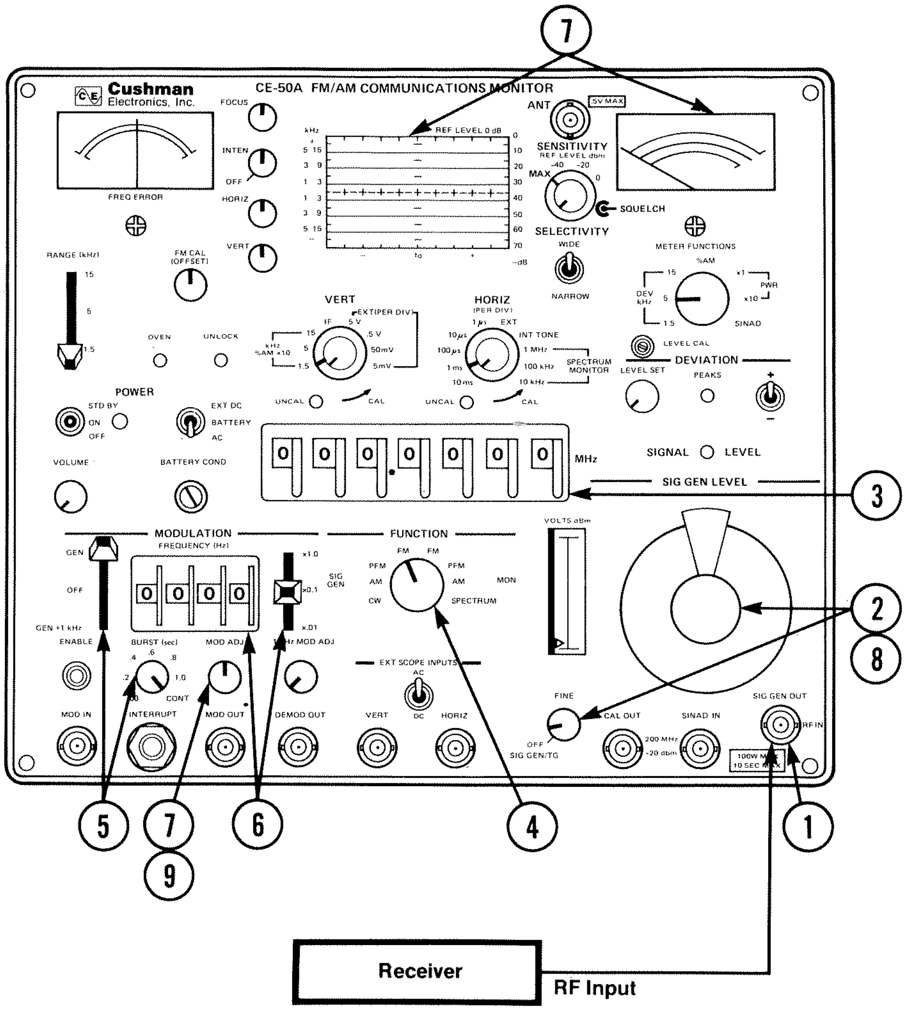
The CE-50 Series Monitor signal generators have an output level from 0.1 μV to 300 mV, continuous with an overall accuracy of ± 2 dB. Confident and accurate measurements of receiver sensitivity can be made in all land mobile bands.

Cushman

RECEIVER TEST RX-12

Recommended Test Equipment:
CE-50A Series
CE-45A, CE-46A
CE-5100 Series

Tone Coded Squelch Decoder Sensitivity and Bandwidth Measurement

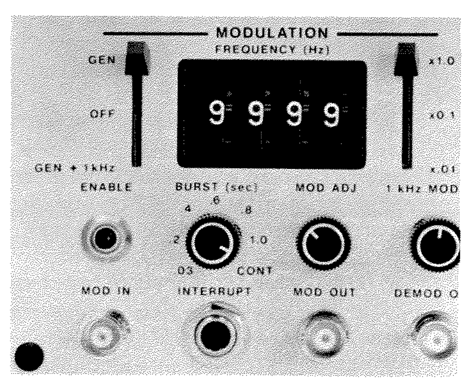


This test checks the signal level needed to unsquelch a tone coded squelched receiver (critical tone squelch). The test also checks how far off frequency the tone can drift before the decoding circuits will not detect the tone frequency (bandwidth). There are three basic decoder tests that should be performed. They are squelch sensitivity, bandwidth, and response time.

TEST PROCEDURES:

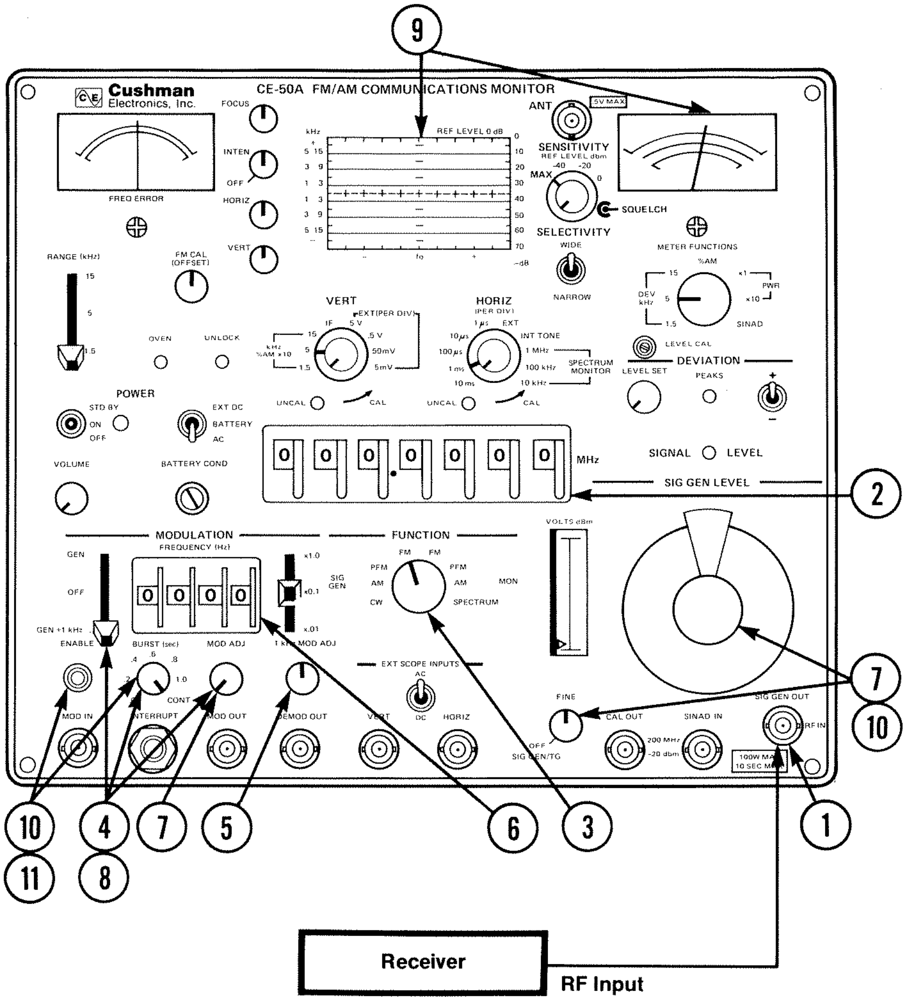
1. Connect SIG GEN OUT to the receiver input connector.
2. Set the SIG GEN LEVEL to -120 dBm. (SIG GEN LEVEL-FINE control ccw but *not* OFF.)
3. Set the FREQUENCY SELECT switches to the receiver frequency.
4. Set the FUNCTION switch to SIG GEN: FM.
5. Set the GEN + 1 kHz switch to GEN; set the BURST (sec) to CONT.
6. Set the Tone Generator thumb wheel switches and X1.0, X0.1, X.01 switch to tone decoder frequency.
7. Increase the MOD ADJ until the proper tone deviation is read on the CRT or meter (remember the amount of deviation of tone will affect the sensitivity of the receiver so check the radio manual for the manufacturer's specification).
8. Increase the RF signal until the receiver becomes unsquelched and read tone decoder squelch sensitivity on VOLTS/dBm meter.
9. Vary the tone generator to either side of the squelch tone frequency in 1 Hz increments. The difference between the frequencies at which the receiver squelches is the bandwidth of the tone decoder. (Consult the manual of the radio for the proper bandwidth and sensitivity).

Built in tone generator from 10 Hz to 9999 Hz and an accuracy of .005% ± 20 PPM/year makes tone coded squelch circuit trouble shooting easy and fast whether in the shop, in a service vehicle or at a repeater site.

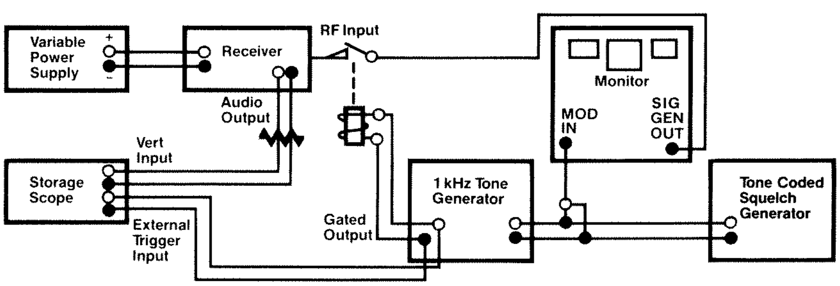


Recommended Test Equipment:
CE-50A Series
CE-46A
CE-5100 Series

Tone Coded Squelch Decoder Minimum Deviation and Receiver Response Time



The response time measurement in this test should be used as a quick test. Fig. #1 shows a more accurate analysis that can be made with a triggered scope (preferably a storage scope). The scope probe is connected to the audio output of the receiver. The RF signal is modulated with a 1 kHz tone at 4.25 kHz deviation and squelch tone set to the manufacturer's specified deviation. The output of the RF generator is keyed on through a good coaxial relay by a tone generator equipped with a gated output. The same time the gated output closes the relay, it also triggers the scope and the response time is displayed on the CRT. Response time is measured at the point where the audio output reaches 75% of the maximum output voltage. Normally the time should not exceed 250 ms.



TEST PROCEDURES:

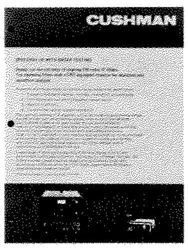
1. Connect the SIG GEN OUT to the receiver input connector.
2. Set the FREQUENCY SELECT switches to the receiver frequency.
3. Set the FUNCTION switch to SIG GEN-FM.
4. Set the GEN + 1 kHz switch to GEN + 1 kHz; set BURST (sec) to CONT.; turn MOD ADJ control fully CCW.
5. Adj 1 kHz MOD ADJ up to give 4.25 kHz deviation on the CRT.
6. Set the thumb wheel switches on the MODULATION generator to the frequency of the tone decoder.
7. Adjust SIG GEN LEVEL to -12 dB SINAD sensitivity and increase the deviation of the tone (MOD ADJ) until receiver unsquelches and the 1 kHz tone is heard on receiver speaker.
8. Set GEN + 1 kHz switch to GEN.
9. Read deviation of squelch tone on meter or CRT.
10. Decrease the SIG GEN output to the level that the receiver squelches up. This should be below the -12 dB SINAD of the receiver.
11. Set BURST (sec) to .03 sec.
12. Slowly increase burst duration while alternately pressing on and releasing ENABLE. The position where the 1 kHz tone is heard is the response time of the receiver. Accuracy of reading is ± 50 ms.

Product Application Notes

The following applications notes are available upon request.

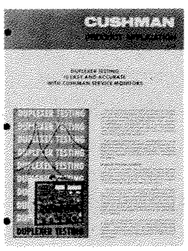
A Portable Test Set for Microwave Radio Installation and Maintenance
Shows how to utilize the combination of test instruments in the Cushman Communications Monitor to maintain and verify the proper operation of microwave radio systems to 1000 MHz.

Application Note 1



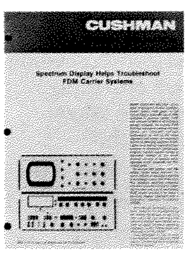
Speeding Up With Sweep Testing
Describes how to use swept frequency tuning techniques with a Communications Monitor having a CRT display to easily and quickly align receiver IFs and other tuned circuits.

Application Note 2



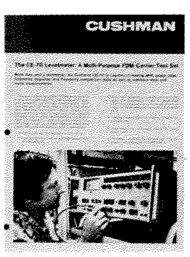
Duplexer Testing is Easy and Accurate With All Cushman Service Monitors
The test set-up and methods of testing transceiver duplexers using the Cushman Communications Monitor.

Application Note 5



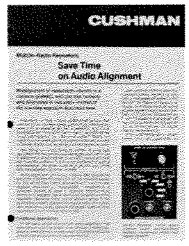
Spectrum Display Helps Troubleshoot FDM Carrier Systems
Rapidly changing conditions on a carrier system are impossible to follow using only a Frequency Select Levelmeter (FSLM). This Product Application shows how to utilize a suitable spectrum display system to track these conditions in FDM systems.

Application Note 6



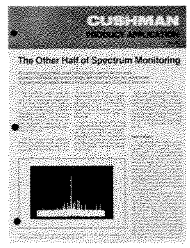
The CE-70 Levelmeter: A Multi-Purpose FDM Carrier Test Set
Explains the procedures for using the CE-70 Frequency Select Levelmeter to make NPR, phase jitter, frequency response and frequency comparison tests as well as standard level and noise measurements.

Application Note 7



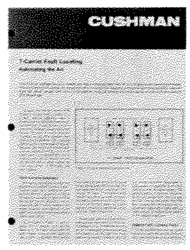
Mobile-Radio Repeaters: Save Time on Audio Alignment
Describes a method of diagnosing misalignment of modulation circuits in one step instead of the normal two-step approach, and then aligning them for a total elapsed on-site time of five minutes or less.

Application Note 10



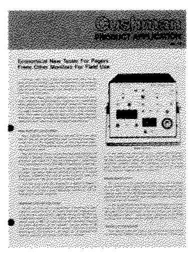
The Other Half of Spectrum Monitoring
Tells how tracking generators (TG) work, and their use with a spectrum monitor as an exceptionally useful troubleshooting aid for frequency-sensitive circuit elements such as duplexers, receiver RF and IF circuits, transmitter output filters and combiners.

Application Note 11



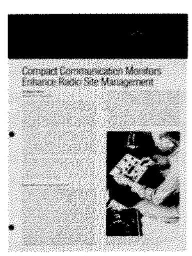
T-Carrier Fault Locating: Automating the Art
To understand why the fault-locating scheme has remained virtually unchanged through 17 years of system hardware evolution, and to find out what can be done to improve the situation.

Application Note 12



Economical New Tester for Pagers Frees Other Monitors for Field Use
Shows a simplified test set-up for pager repair and describes how to use the CE-31A FM Radio Test Set to measure basic pager parameters.

Application Note 13



Using the Synthesized Offset Generator to Save Time On Audio Alignment
Misalignment of modulation circuits is a common problem, and one that formerly was diagnosed in two steps instead of the one-step approach using the CE-5110 Communications Monitor.

Application Note 14

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