PRICE $5.00

TWO-WAY RADIO SERVICING

with the FM-10C and FM-10CS communications service monitor

SINGER
INSTRUMENTATION

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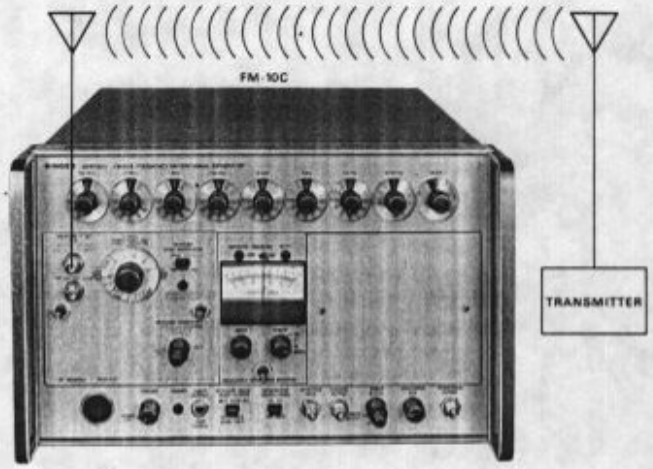
SECTION A
FM TRANSMITTER TESTS

No. A-1
ADJUSTMENT OF TRANSMITTER FREQUENCY



SUMMARY

Correct the frequency of a transmitter by using the FM-10C as a high accuracy (1 ppm) error frequency meter.

Make a comparison between the synthesized frequency of the FM-10C and the transmitter by means of the beat note presented by the loudspeaker. Adjust the transmitter until the beat note approaches zero frequency. Use the flashing beat light indicator for sub-audible beat frequencies to adjust the transmitter frequency to within a fraction of 1 Hz.

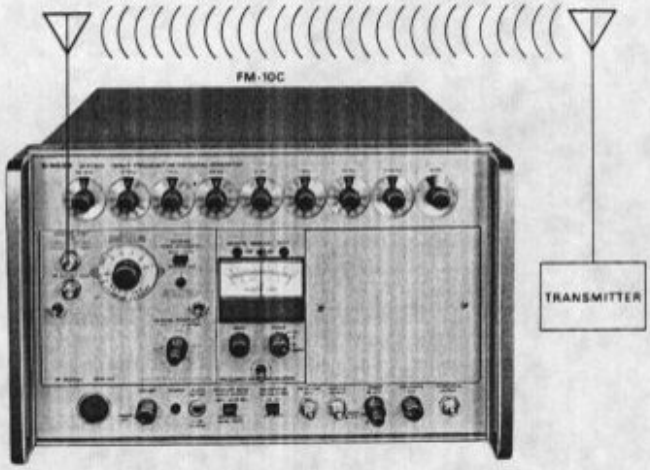
Modules Required: L.H.: Any RFM unit.
Cent.: FIM-1 or FIM-3
R.H.: Not required.

PROCEDURE:

1. FM-10C switch positions:
   - a. PWR: ON (volume as desired).
   - b. FREQUENCY DECADES: Desired frequency.
   - c. MODE: MEASURE.
   - d. MEASURE MODE AUDIO OUTPUT: IN/BEAT NOTE.
2. RFM-10/10A switch positions:
   - a. MEASURE MODE BANDWIDTH: OUT/WIDE or IN NARROW (*See note) antenna attached to RF input jack (do not exceed 0.5V).
   - b. MEASURE SENSITIVITY (RFM-10A): Desired sensitivity.
3. FIM-1/FIM-3 switch positions:
   - a. RANGE: Zero - rotate zero control to center meter on 0. Turn range switch to either 15, 5, or 1.5 kHz position. If measured frequency is off more than 1.5 kHz, switch to 5 kHz; if more than 5 kHz, switch to 15 kHz.
4. To measure a known assigned frequency:
   - a. Key the transmitter.
   - b. Adjust input level control until operate light comes on. (Note: If using ODM-1, adjust level for operate and do not increase to overload. If using MDM-1, level can be observed in limiter position.)
   - c. Read frequency error on FIM-1/3 meter. Exact frequency can be determined by adjusting decade knobs until meter is at "0", then reverting to beat indicator light. When light stops flashing or pulses at very slow rate, read decade numerals to determine frequency.
5. To adjust transmitter oscillator to assigned frequency:
   - a. Return decade knobs to assigned frequency.
   - b. Key transmitter.
   - c. Adjust transmitter oscillator with FIM-1/3 meter in 1.5 kHz position until meter reads "0". Revert to beat light and continue adjustment until beat light stops or beats at very slow rate.

*NOTE: The MEASURE MODE BANDWIDTH switch on RFM-10/RFM-10A should be in OUT/WIDE position for transmitters using over 5 kHz deviation. The IN/NARROW position is for 5 kHz or less systems and helps to eliminate adjacent channel interference. This is only important if measuring frequency and deviation simultaneously or if there is adjacent (off channel) interference.

No. A-2
MEASUREMENT OF UNKNOWN FREQUENCY



SUMMARY

The exact position of a transmitter in the frequency spectrum can be pin-pointed with the FM-10C, when its approximate frequency is known to within 1 MHz. The FM-10C is set to the approximate frequency of the transmitter and an interpolating oscillator with five search sweep ranges is temporarily switched into the circuit. The frequency of the

transmitter is determined by successively increasing the resolution of the search sweeps until the exact frequency is known to within a fraction of 1 Hz.

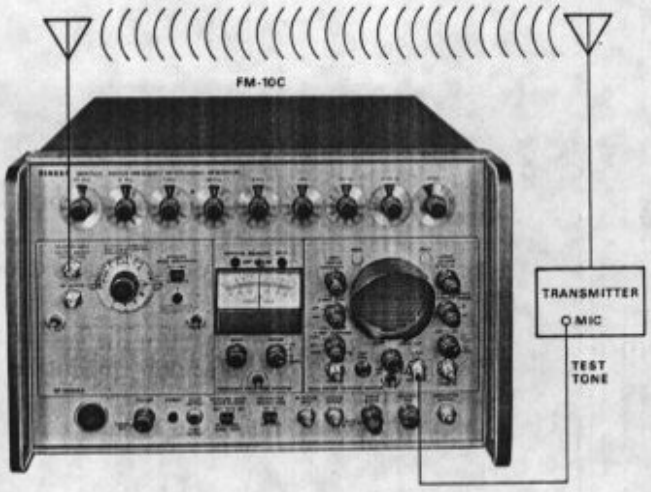
Modules Required: L.H.: Any RFM unit.
Cent.: FIM-1 or FIM-3.
R.H.: Not required.

PROCEDURE:

1. FM-10C switch positions:
   a. PWR: ON (volume as desired).
   b. FREQUENCY DECADES: Desired frequency.
   c. MODE: MEASURE.
   d. MEASURE MODE AUDIO OUTPUT: IN/BEAT NOTE.
2. RFM-10/RFM-10A switch positions:
   a. MEASURE MODE BANDWIDTH: OUT/WIDE or IN/NARROW (*See note 1) antenna attached to RF input jack (do not exceed 0.5V)
   b. MEASURE SENSITIVITY: Desired sensitivity.
3. FIM-1/FIM-3 switch positions:
   a. RANGE: Zero - rotate zero control to center meter on 0. Turn range switch to 15 kHz position.
4. Key transmitter:
   a. Set 100 kHz decade switch to "V" and tune 0-100 Hz dial to obtain "0" on FIM-3 meter. Set 100 kHz decade to lower significant digit indicated on 0-100 Hz dial.
   b. Set 10 kHz decade switch to "V" and repeat procedure 4a, setting the 10 kHz decade switch in the same manner.
   c. Put FIM-1/3 range switch on 5 kHz.
   d. Set 1 kHz decade switch to "V" and repeat procedure 4a, setting the 1 kHz decade switch in the same manner.
   e. Put FIM-1/3 range switch on 1.5 kHz.
   f. Set 100 Hz decade switch to "V" and tune 0-100 Hz dial for 0 on FIM-1/3 meter. Set 100 Hz decade switch to lower significant digit indicated on 0-100 Hz dial.
   g. Tune 0-100 Hz dial to obtain visual beat-note on BEAT indicator.
   h. Read the actual transmitter frequency from the decade switches with the 0-100 Hz dial being read to 1 Hz resolution (1/2 dial division).

NOTE 1: The MEASURE MODE BANDWIDTH switch on the RFM-10/RFM-10A should be in OUT/WIDE position for transmitter using over 5 kHz deviation. The IN/NARROW position is for 5 kHz or less systems and helps to eliminate adjacent channel interference. This is only important if measuring frequency and deviation simultaneously or if there is adjacent (off-channel) interference.

No. A-3
DEVIATION MEASUREMENT*, OSCILLOSCOPE INDICATION



SUMMARY

FM deviation can be measured and modulation problems can be quickly detected by means of the ODM-1 plug-in module. The oscilloscope affords quick detection of modulation distortion due to power supply problems, tone wave distortion, bad bias settings, incorrect limiter setting, or insufficient oscillator drive. Many other faults are also quickly analyzed. To measure deviation on the ODM-1 oscilloscope, couple the transmitter with the FM-10C and modulate the transmitter. The demodulated output is displayed on the ODM-1 screen and measured by use of the calibrated graticule.

Modules Required: L.H.: Any RFM unit.
Cent.: FIM-1 or FIM-3.
R.H.: ODM-1.

PROCEDURE:

1. Couple transmitter output to FM-10C MEAS INPUT with antenna provided or with RF input cable and appropriate attenuation.
2. FM-10C switch positions.
   a. PWR: ON (volume as desired).
   b. FREQUENCY DECADES: Desired frequency.
   c. MODE: MEASURE.
   d. MEASURE MODE AUDIO OUTPUT: OUT RECOVERED AUDIO.
3. RFM-10/RFM-10A switch positions:
   a. MEASURE SELECTIVITY: 15 kHz system, use OUT/WIDE, 5 kHz system, use IN/NARROW.
4. ODM-1 module switch positions:
   a. VERT CENTER, HORIZ CENTER, INTENSITY, and FOCUS: As required.
   b. SWEEP RANGE: LO.

c. VERT GAIN: CAL.
d. DEV RANGE: As required.
e. MOD MODE: INT.
f. INT MOD/AUDIO OUT: CCW.

5. Key transmitter.

6. If proper coupling to the FM-10C is obtained, the Operating Indicator (OPER) will light. If an overload condition exists, the OVLD indicator will light, so less coupling is required.

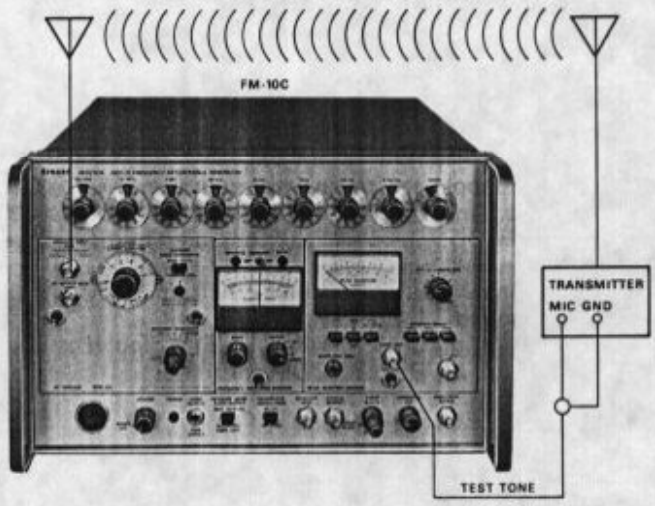
7. Modulate transmitter by tone.

8. Read modulation by using the left or right hand CRT scales as required.

Note: 1 kHz tone variable from 0-1Vrms is available at AUDIO OUT for precision modulation measurements.

*NOTE: Deviation and carrier frequency can be measured simultaneously.

No. A-4
DEVIATION MEASUREMENT, METER INDICATION



SUMMARY

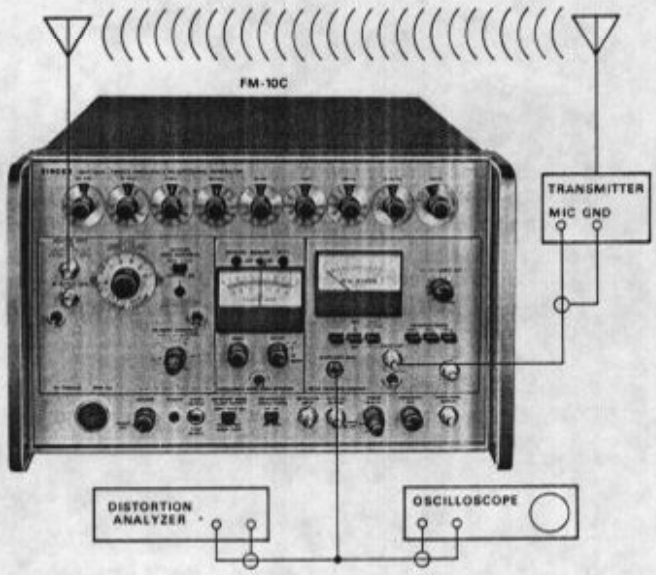
Measure deviation and check modulation symmetry using the Meter Deviation Monitor, Model MDM-1. Couple the FM-10C with the transmitter, modulate the transmitter and observe the recovered modulating signal on the meter scale.

Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: MDM-1.

PROCEDURE:

1. Connect the audio output of the MDM-1 to the microphone of transmitter.
2. Connect an antenna or "dummy" load to the antenna jack of the transmitter.
3. Connect the external antenna of the FM-10C to the MEASURE INPUT connector.
4. Set FM-10C frequency controls to transmitter frequency.
5. Turn on transmitter and allow warm-up.
6. Push MOD INT/COMB button to the OUT position.
7. Set MODE switch to MEASURE.
8. Push the MTR button to the LIM IN position.
9. Key the transmitter and observe the meter for an upscale reading (beyond red line). If the meter needle pegs, decrease the coupling between the transmitter and the FM-10C or adjust input level control on RFM-10.
10. Once the on-scale reading is obtained, push the MTR button to the DEV OUT position.
11. Push the appropriate deviation range button.
12. Note: Most transmitter checkouts call for a 1 kHz signal at 600 ohms set at a 1Vrms level. If this is the case, rotate the modulation control fully clockwise to the 1Vrms setting.
13. Adjust the transmitter modulation control to the proper level as read on the front panel meter.
14. Push the DEV "+" and "-" button IN and OUT to check modulation symmetry. Refer to the transmitter manual if problems exist.

No. A-5
AUDIO DISTORTION TEST (METER INDICATION)



SUMMARY

Couple the FM-10C with the transmitter and apply 1 kHz modulation to transmitter. Connect distortion analyzer to the MDM-1 distortion analyzer output and measure distortion on modulation signal.

Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: MDM-1.

Other Equipment: Distortion Analyzer.
Oscilloscope (optional)

PROCEDURE:

1. Connect the audio output of the FM-10C/MDM-1 to the microphone input of the transmitter.

2. Couple the transmitter output to the FM-10C.

3. Connect the distortion analyzer output of the MDM-1 to the distortion analyzer (and to oscilloscope if desired).

4. Push the MTR button to the LIM IN position.

5. Push the MOD INT/COMB button to the OUT position.

6. Dial the transmitter frequency into the FM-10C.

7. Apply power to the transmitter and allow for warm-up.

8. Key the transmitter.

9. Apply the 1 kHz signal from the MDM-1 at an output level to give 60% of rated system deviation as read on the meter, i.e., ±3 kHz for 5 kHz deviation.

10. Set the distortion analyzer to 100% scale.

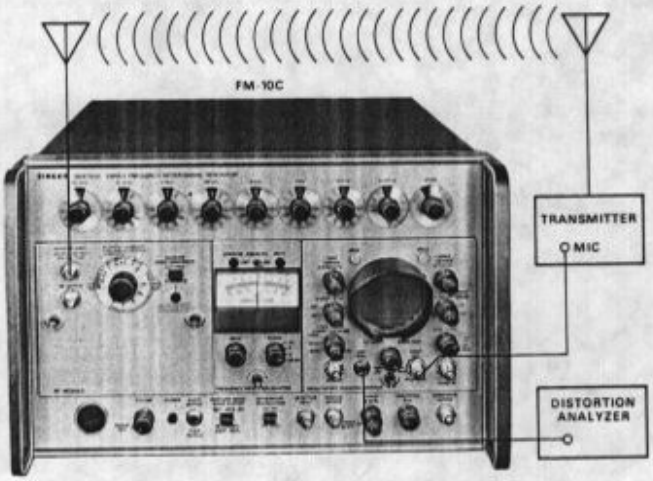
11. With the 1000 Hz filter out, adjust the level control for a 100% full scale deflection.

12. Set the 1000 Hz filter in, and tune for minimum reading (null) with the tuning controls.

13. Reduce the percentage control until the lowest meter reading is obtained and re-null.

14. Note the distortion level and compare with the manufacturer's specifications.

No. A-6
AUDIO DISTORTION TEST (OSCILLOSCOPE INDICATION)



SUMMARY

FM transmitter audio distortion can be measured by connecting a distortion analyzer to the output connector on the ODM-1 module provided specifically for this purpose.

Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: ODM-1.

Other Equipment: Distortion Analyzer.

PROCEDURE:

1. Connect audio output of the FM-10C/ODM-1 to microphone input of transmitter.

2. Couple output of transmitter to FM-10C MEAS INPUT connector with antenna provided or with RF input cable and appropriate attenuation.

3. Connect distortion analyzer output of ODM-1 to distortion analyzer.

4. Turn on transmitter and allow for warm-up.

5. FM-10C control positions:

a. PWR:	ON
b. Frequency controls:	To transmitter frequency
c. MODE:	MEASURE
d. MEASURE MODE AUDIO OUTPUT:	OUT RECOVERED AUDIO

6. ODM-1 control positions:

a. SWEEP RANGE:	LO
b. VERT GAIN:	CAL
c. DEV RANGE:	As required
d. MOD MODE:	INT
e. INT MOD/AUDIO OUT:	CCW

7. Key the transmitter.

8. Apply the 1 kHz signal from the MDM-1 at an output level to give 60% of rated system deviation as read on ODM-1 screen, i.e., ±3 kHz for 5 kHz deviation.

9. Set distortion analyzer to 100% scale.

10. Set 1000 Hz filter in, and tune for minimum reading (null).

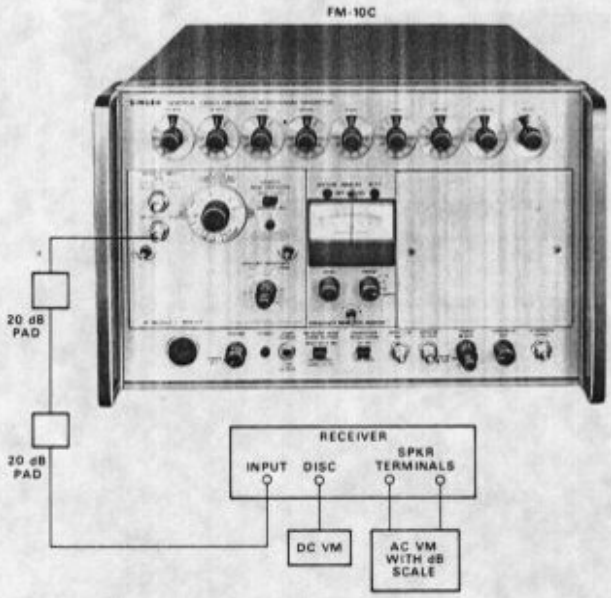
11. Reduce percentage control until lowest meter reading is obtained and re-null.

12. Note the distortion level and compare with the manufacturer's specifications.

SECTION B
FM RECEIVER TESTS

SECTION B
FM RECEIVER TESTS

No. B-1
20dB QUIETING SENSITIVITY MEASUREMENT



SUMMARY

The 20 dB quieting sensitivity of a receiver can be measured with the FM-10C since it provides a calibrated RF output.

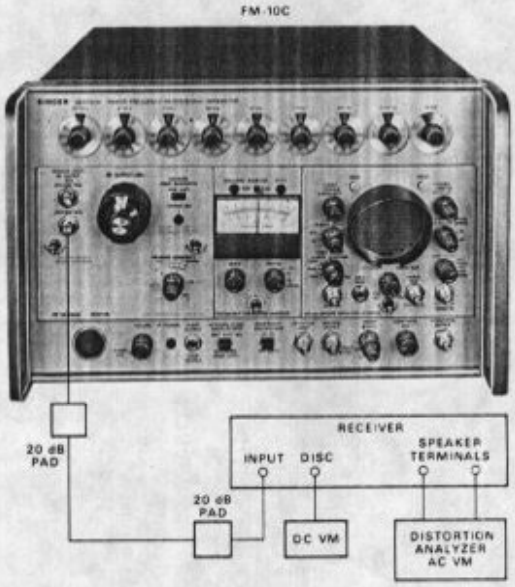
The FM-10C is set to supply an on-channel signal to the receiver which in turn is set for one quarter output power. The level of the input signal is increased until the output power has decreased 20 dB. The setting of the FM-10C output control is the 20 dB quieting sensitivity of the receiver.

Modules Required:	L.H.:	Any RFM unit.
	Cent.:	Not required.
	R.H.:	Not required.
Other Equipment:		AC Voltmeter (VTVM).
		DC Voltmeter.

PROCEDURE:

1. Connect the OUTPUT of the FM-10C through the two 20 dB pads to the input of the receiver.
2. If the receiver under test has a squelch circuit, set the squelch control for minimum squelch.
3. Turn on the receiver.
4. Connect the AC VTVM across the receiver's speaker.
5. Connect the DC voltmeter to the receiver's discriminator test jack.
6. Apply an unmodulated "on frequency" signal from the FM-10C while monitoring the discriminator on the DC voltmeter. Adjust receiver tuning for 0 volts at discriminator.
7. Set the FM-10C RF signal attenuation pad to minimum output so that no signal is fed to the receiver.
8. Adjust the receiver's volume control for one-quarter (¼) full rated power output. Do not touch the setting of the volume control once it has been set.
9. Set the controls of the AC voltmeter to an appropriate scale. Adjust the level control for a reference point.
10. Increase the FM-10C RF signal output until the reading on the AC voltmeter has decreased 20 dB.
11. In microvolts, read the setting of the FM-10C attenuator. This reading is the 20 dB quieting sensitivity of the receiver.

No. B-2
12 dB SINAD SENSITIVITY MEASUREMENT



SUMMARY

The 12 dB sinad sensitivity of a receiver can be measured with the FM-10C using it as a precision signal generator. The FM-10C is set to supply an on-channel signal to the receiver with 2/3 maximum deviation. The receiver's output is supplied to a distortion analyzer. Adjustment of the receiver's input is made until there is a 12 dB difference in the receiver output, with the filter in and out.

Modules Required:	L.H.:	Any RFM unit.
	Cent.:	Not required.
	R.H.:	ODM-1 or MDM-1.
Other Equipment:		Distortion Analyzer/AC Voltmeter.
		DC Voltmeter.

PROCEDURE:

1. Turn on the FM-10C.
2. Set the FM-10C for INTERNAL MODULATION. Reference: MDM-1 or ODM-1 Manual.
3. Connect the output of the FM-10C through the two 20 dB pads to the input of the receiver.
4. Turn on the receiver.
5. If the receiver under test has a squelch circuit, set the squelch control for minimum squelch.

6. Connect the receiver's speaker to the input of the distortion analyzer.

7. Connect the DC voltmeter to the receiver's discriminator jack test.

8. Apply a full output "on frequency" signal with 2/3 rated system deviation at 1000 Hz from the FM-10C to the receiver while monitoring the discriminator on the DC voltmeter. Adjust receiver tuning for 0 volts at discriminator.

9. Set the controls on the distortion analyzer for use as an AC voltmeter.

10. Adjust the receiver's volume control for full rated power output as read on the AC voltmeter. Once this has been set, do not re-adjust the volume control.

11. Adjust the distortion analyzer so that the signal will couple through the 1000 Hz filter.

12. Tune the 1000 Hz filter for a null (minimum reading) on the lowest possible meter scale (100%-30%, etc.).

13. Switch the 1000 Hz filter out of the circuit and adjust the level control for 0 dB reading. For best results, set this on a mid-range such as 30%.

14. Switch the 1000 Hz filter into the circuit. Notice that the meter deflection has moved to the left.

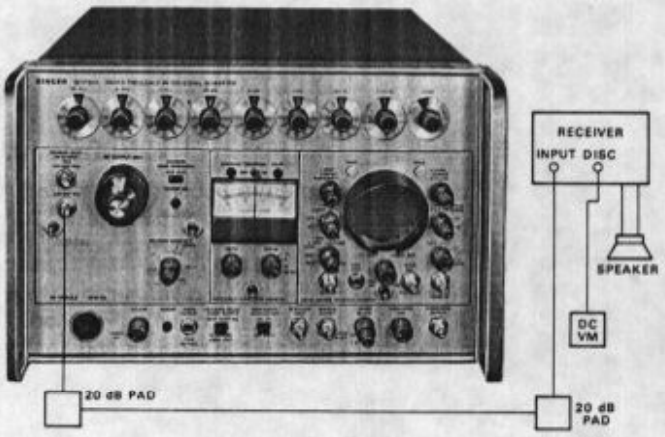
15. Decrease the output from the FM-10C, at the same time switching the distortion analyzer's 1000 Hz filter in and out. Continue reducing the RF signal output until a 12 dB difference reading appears on the distortion analyzer meter between the filter in and out positions.

16. Set the distortion analyzer's controls to read the output power from the receiver.

17. The reading on the distortion analyzer AC voltmeter should not be less than 50% of the receiver's full rated power.

18. The microvolt setting of the FM-10C is the 12 dB SINAD Sensitivity of the receiver.

No. B-3
SQUELCH SENSITIVITY MEASUREMENT



SUMMARY

Receiver squelch sensitivity can be measured using the FM-10C as a precision signal generator. A measured signal is supplied to the receiver and the audible output is squelched. The input is then increased until continuous audible noise is heard. The setting of the FM-10C output control gives the squelch sensitivity of the receiver.

Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: ODM-1 or MDM-1.

Other Equipment: DC Voltmeter.

PROCEDURE:

1. Turn on equipment.

2. Set the FM-10C for internal or external 1000 Hz modulation.

3. Connect the output of the FM-10C through the two 20 dB pads to the input of the receiver.

4. Turn on the receiver.

5. Set the receiver's squelch control for minimum squelch.

6. Apply a full output "on frequency" signal with 2/3 rated system deviation at 1000 Hz from the FM-10C to the receiver while monitoring for zero discriminator on the DC voltmeter.

7. Adjust the RF attenuator on the FM-10C for minimum (no signal) output.

8. Adjust the volume control for normal listening level on noise.

Critical Squelch:

9. Adjust the receiver's squelch control so that the noise is just squelched.

10. Increase the FM-10C RF signal until the receiver produces a continuous audio output.

11. The setting of the FM-10C RF attenuator in microvolts is the squelch sensitivity of the receiver.

Maximum Squelch:

12. Set the RF attenuator to minimum.

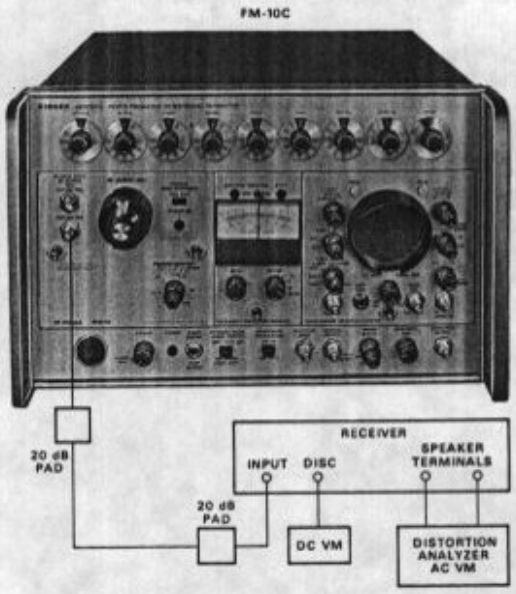
13. Remove one of the 20 dB pads.

14. Adjust the squelch control for maximum squelch.

15. Increase the FM-10C RF attenuator until the receiver produces a continuous audio output.

16. Multiply the setting of the FM-10C RF attenuator in microvolts by 10 and obtain the maximum squelch sensitivity of the receiver.

No. B-4
AUDIO DISTORTION MEASUREMENT



SUMMARY

Audio distortion of an FM receiver can be measured by using the FM-10C as a precision signal generator in conjunction with a distortion analyzer. Use the FM-10C to supply an input to the receiver and the distortion analyzer to measure the distortion in the output signal.

Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: ODM-1 or MDM-1.

Other Equipment: Distortion Analyzer/AC Voltmeter.
DC Voltmeter.

PROCEDURE:

1. Turn on the associated equipment and allow for warm-up.

   Note: The FM-10C does not require a warm-up period.

2. Set the FM-10C for INTERNAL MODULATION. Ref.: MDM-1 or ODM-1 Manual.

3. Connect the output of the FM-10C through the two 20 dB pads to the INPUT of the receiver.

4. If the receiver under test has a squelch circuit, set the squelch control for minimum squelch.

5. Turn on the receiver.

6. Adjust output of the FM-10C for FULL quieting of receiver.

7. Connect the distortion analyzer across the receiver's speaker terminal.

8. Connect the DC voltmeter to the receiver's discriminator test jack.

9. Apply the full output "on frequency" signal with 2/3 rated system deviation at 1000 Hz from the FM-10C to the receiver while monitoring for zero discriminator on the DC voltmeter. Adjust receiver oscillator for zero reading on discriminator.

10. Set the controls on the distortion analyzer for use as an AC voltmeter.

11. Adjust the receiver's volume control for full rated power output as indicated on the distortion analyzer. Once this has been set, do not re-adjust the volume control.

12. Set the distortion analyzer to the 100% position.

13. With the 1000 Hz filter OUT of the circuit, adjust the analyzer level control for a 100% full scale deflection.

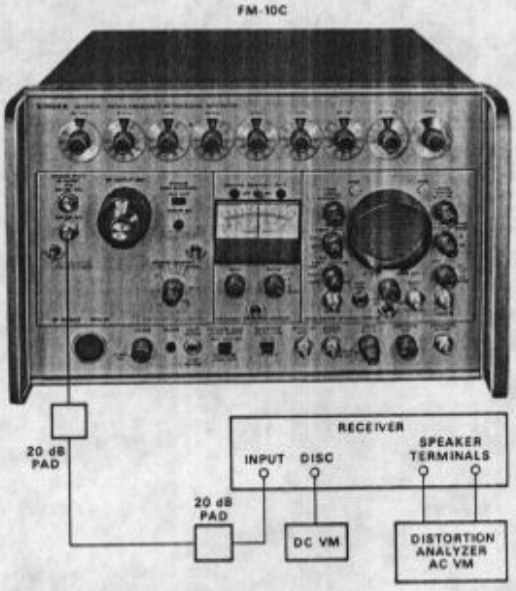
14. With the 1000 Hz filter IN the circuit, tune the distortion analyzer for a null or minimum reading with the tuning controls.

15. Reduce the percentage scale (100% to 30%) until the lowest meter reading is obtained.

16. Tune for a minimum reading with the tuning controls.

17. Note the percentage scale to which the distortion analyzer is set and read the percentage of distortion from the meter.

No. B-5
MODULATION ACCEPTANCE BANDWIDTH TEST FOR NARROW-BAND SYSTEMS



SUMMARY

A receiver's modulation acceptance bandwidth can be measured using the FM-10C as a signal source with FM modulation. Supply a modulated signal to the receiver and analyze the output with a distortion analyzer across the speaker terminals.

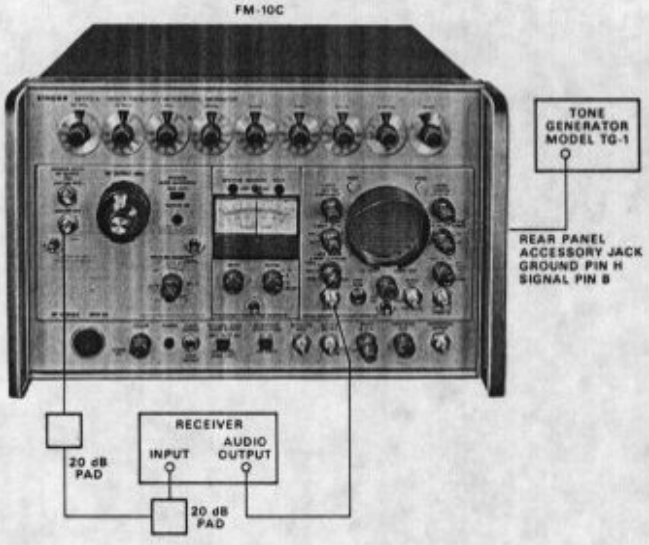
Modules Required: L.H.: Any RFM unit.
Cent: Not required.
R.H.: ODM-1 or MDM-1

Other Equipment: Distortion Analyzer/AC Voltmeter.
DC Voltmeter.

PROCEDURE (Preliminary set-up: Perform steps 1 thru 9 of Application Note B-2.):

1. Increase the output of the FM-10C RF signal 6 dB (twice the microvolt reading obtained for the 12 dB SINAD Sensitivity). See Application Note No. B-2.
2. Set the controls of the distortion analyzer so that the 1000 Hz filter is out of the circuit and adjust the level control for a 0 dB reading. For the best results, set this 0 dB reference on a mid-range such as 30%.
3. Switch the 1000 Hz filter into the circuit. Notice that the meter deflection has moved to the left.
4. Increase the deviation reading on the FM-10C, at the same time switching the distortion analyzer's 1000 Hz filter in and out. Continue increasing the deviation until there is a 12 dB difference reading on the distortion analyzer between the filter in and out positions.
5. The deviation reading on the FM-10C for the 12 dB difference is the modulation acceptance bandwidth of the receiver.

No. B-6
TONE CODED SQUELCH DECODER TEST



SUMMARY

A receiver's decoder circuitry can be tested using the FM-10C as a signal source with tone modulation derived from TG-1 tone generator.

Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: ODM-1.

Other Equipment: Tone Generator Model TG-1.

PROCEDURE:

1. Turn on equipment.
2. Set the FM-10C for IN/COMB MODULATION operation.
3. Connect output of the TG-1 to the accessory jack on rear panel. (Ground to Pin H, signal to Pin B.)
4. Connect the FM-10C RF output through the two 20 dB pads to the input of the receiver.
5. Connect the receiver audio output to the ODM-1 VERT IN connector.
6. Set the FM-10C output attenuator fully clockwise.
7. Set the TG-1 to the decoder frequency.
8. Advance the FM-10C internal modulation control and/or TG-1 level clockwise until a sine wave appears on the ODM-1 screen. If a sine wave does not appear, problems may be present in the decoder. Remove the decoder and check for 1000 Hz modulation tone.

No. B-7
MONITORING FREQUENCY MODULATION IN GENERATE MODE

Figure 1

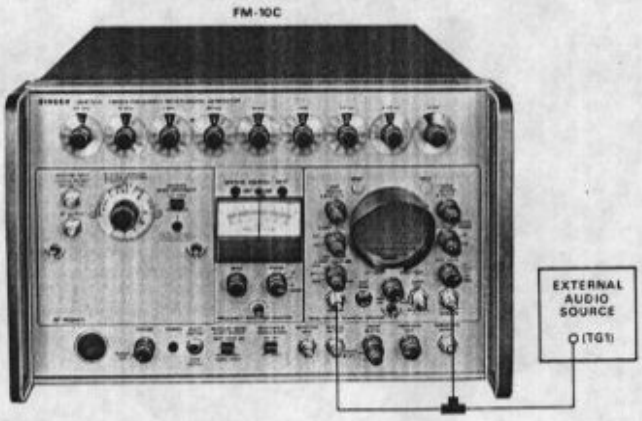


Figure 2

SUMMARY

For applications where it is necessary to vary the modulation while in the GEN mode, the need to repeatedly switch back to GEN MOD CAL to recalibrate modulation may be eliminated by monitoring the modulation indirectly while observing the amplitude of the modulating audio while in the GEN mode.

Modules Required: L.H.: Any RFM Unit.
Cent.: Not required.
R.H.: ODM-1.

Other Equipment: Audio Oscillator, e.g. TG-1.

PROCEDURE A (for internal modulation):

1. Connect a coax cable with BNC connectors from the AUDIO OUT connector to the VERT IN connector on the ODM-1 front panel as shown in Figure 1.

2. Set up normally for internally-modulated FM signal generation. (See ODM-1 Operating Instructions in FM-10C in Operator's Manual.)

3. Set VERT MODE switch to EXT to observe modulating audio signal on CRT.

4. Adjust the VERT GAIN to give the same vertical deflection previously obtained when calibrating in GEN MOD CAL mode (Step 2).

5. Set mainframe MODE switch to GEN and select desired frequency and output level in the normal manner. It is now possible to monitor peak deviation on the CRT while using the GEN mode, and to make any desired change in modulation by adjusting the INT MOD control without having to switch back to GEN MOD CAL to recalibrate.

PROCEDURE B (for external modulation):

1. Connect as shown in Figure 2 using a BNC T adapter to connect the external audio to both the EXT MOD and VERT IN connectors.

2. Set normally for externally-modulated FM signal generation. (See ODM-1 Operating Instructions in FM-10C Operator's Manual.)

3. Proceed with Steps 3 thru 5 as in Procedure A except that modulation is now controlled by adjusting the level of the external audio source. (The INT MOD control has no effect.)

NOTE: Since this technique indicates modulation indirectly the following precautions should be noted:

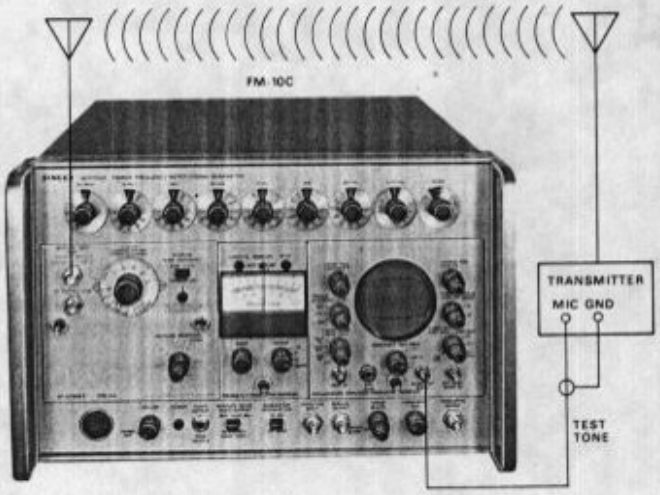
   a. The GEN MOD CAL method should still be used to calibrate before any measurement where accuracy is important, since it eliminates possible sources of error in modulator efficiency or audio gain fluctuations.
   b. Keep in mind that the indirect method could indicate frequency modulation when in fact there is none; for instance, if the GENERATOR MODULATION switch were changed to the OUT-OFF position.
   c. The indirect calibration holds true only on the DEV RANGE switch position in which calibration was performed; recalibrate against GEN MOD CAL each time range is switched.

SECTION C

AM TRANSMITTER TESTS

SECTION C
AM TRANSMITTER TESTS

No. C-1
MODULATION MEASUREMENT (OSCILLOSCOPE INDICATION)



SUMMARY

Couple the FM-10C to the transmitter, apply modulation and read out recovered modulation on calibrated OAM-1 screen.

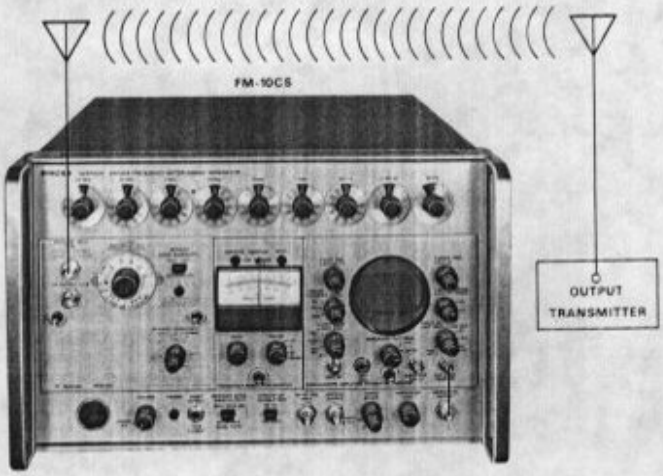
Modules Required:

L.H.:	Any RFM unit.
Cent.:	Not required.
R.H.:	OAM-1.

PROCEDURE:

1. Couple AM transmitter output to FM-10C MEAS INPUT, connecting via antenna provided or RF input cable with RFA-60 attenuator in the line.
2. Set FM-10C frequency controls to transmitter frequency.
3. Turn on transmitter and allow warm-up.
4. Set VERT MODE switch to VERT SET position.
5. Adjust VERT POS control to position oscilloscope trace on VERT SET line of graticule.
6. Set VERT MODE switch to CARR SET position.
7. Adjust transmitter coupling to FM-10C and/or CARRIER LEVEL control to position the trace at the CARRIER SET line of the graticule.
8. Set RANGE control for desired range (30% or 100% full scale.
9. Set VERT MODE switch to MEAS AM position and adjust transmitter modulation to desired percentage as indicated by scope calibration scale.

No. C-2
SWEEPING FOR SPURIOUS OUTPUTS OF TRANSMITTER



SUMMARY

The built-in sweep capability of the FM-10CS can be used to analyze the spectrum of a transmitter output or unwanted spurious signals. Spurious signals can be detected less than 20 dB down from carrier frequency level and up to approximately 1 MHz of bandwidth.

Modules Required:

Mainframe:	FM-10CS.
L.H.:	Any RFM unit.
Cent.:	Not required.
R.H.:	OAM-1.

PROCEDURE:

1. Set up FM-10CS controls to measure frequency. Use WIDE/OUT position.
2. Attach jumper cable from horizontal output on mainframe to horizontal input on OAM-1.
3. OAM-1 switch positions:
   a. Vertical mode switch: MEAS AM.
   b. MOD MODE switch: EXT HORIZ.
4. Couple transmitter output to FM-10CS via antenna or use transmitter power decoupler (do not exceed 0.5 volts).
5. Set FM-10CS frequency controls to transmitter frequency.
6. Put 100 kHz decade in "V" position.
7. Turn sweep on and adjust width for full sweep (fully clockwise). Keep sweep rate slow (counter clockwise).
8. Decrease MEASURE SENSITIVITY control for clean trace line.

9. Adjust VERTICAL POSITION control to position trace on vertical set line.

10. Key transmitter and adjust 0-100 Hz variable decade control to center carrier response on screen. Use MEASURE SENSITIVITY control and CARRIER LEVEL control to put peak of carrier response on CARRIER SET line. The HORIZONTAL SIZE control can be adjusted to give carrier response display desired. Keep width of bottom trace line to full display and use HORIZONTAL SIZE control to narrow blip. Spurious outputs up to approximately 500 kHz either side of carrier can now be observed if they are less than 20 dB down from carrier level.

NOTE: Turn off transmitter to identify spurious responses.

This method can also be used to monitor close-in spectrum of "off-the-air" signals to assist in detecting interference.

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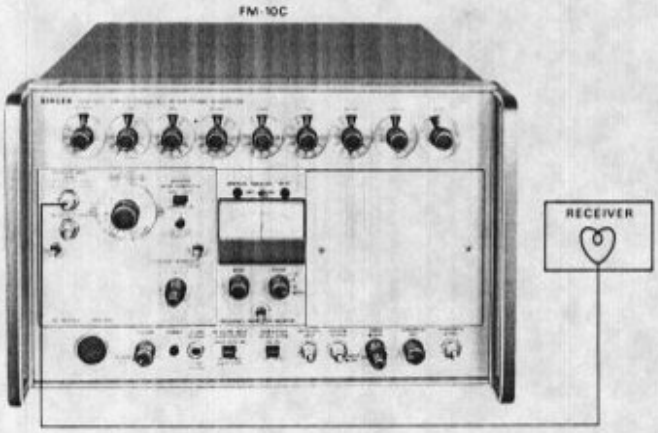
SECTION D
AM RECEIVER TESTS

SECTION D
AM RECEIVER TESTS

No. D-1
FIRST OSCILLATOR FREQUENCY MEASUREMENT



SUMMARY

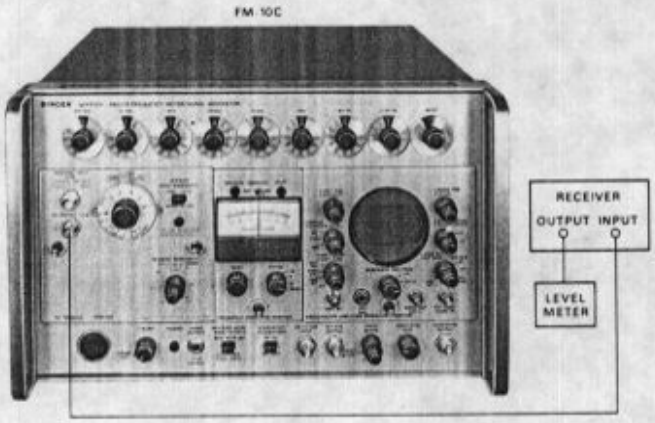
Prior to making any other receiver tests, it is advisable to check the frequency of the first oscillator. If first oscillator is on frequency, other tests such as sensitivity and bandwidth are more meaningful.

Modules Required:	Mainframe:	FM-10C.
	L.H.:	Any RFM unit.
	Cent.:	FIM-1.
	R.H.:	Not required.

PROCEDURE:

1. Connect an RF probe or shielded cable with small coupling loop on center conductor to MEASURE INPUT of FM-10C.
2. Place probe or coupling loop close to first oscillator tube or stage.
3. Set up FM-10C for frequency measurements.
4. The frequency measured at this point is the output of the first oscillator.

No. D-2
SENSITIVITY MEASUREMENT



SUMMARY

The sensitivity of an AM receiver can be measured with the FM-10C since it provides an accurate "on channel" signal with calibrated output. Perform Test D-5 "Squelch Threshold and Differential Test" before performing sensitivity measurement.

Modules Required:	L.H.:	RFM-10A, 10B, 10D or 11A.
	Cent.:	Not required.
	R.H.:	OAM-1.
Other Equipment:	Level Meter.	

PROCEDURE:

1. Connect the output of the FM-10C to the input jack of receiver (directly or through the furnished 20 dB pad if specified sensitivity is less than 0.7 microvolts).
2. Turn on receiver and allow for proper warm-up (FM-10C does not require warm-up other than CRT display).
3. If applicable to receiver under test, receiver controls shall be set as follows:

a. RF Gain.	Maximum (clockwise).
b. AF Gain.	Maximum (clockwise).
c. Audio Quieting.	Maximum (counter-clockwise).
d. Squelch Switch.	OFF.
e. AVC Switch.	ON.
f. Frequency Response Switch.	Narrow.
g. AVC Time Constant.	Communications.
h. Noise Limiter Switch.	ON.

   i. If receiver under test is tunable, tune for middle of band by injecting modulated "on frequency" signal and tune for maximum output.
4. Connect the output meter to the high level output of receiver.
5. Set the FM-10C attenuator for minimum output (off scale on RFM-10D).
6. Adjust FM-10C for 30% modulation at 400 Hz for VHF receivers or 1000 Hz for UHF receivers. See Operator's Manual for set up of modulation measurement.

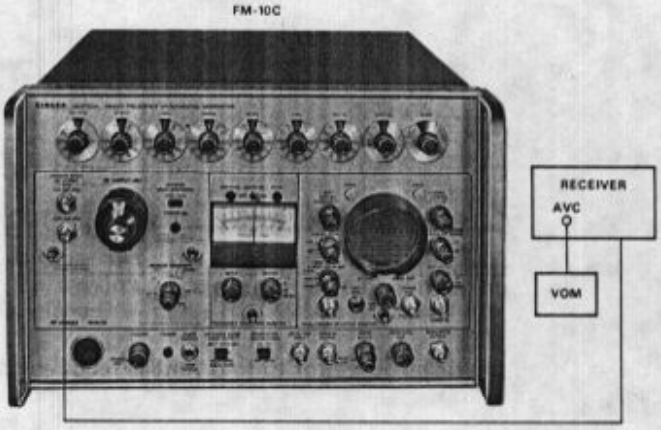
   Modulation can be turned on or off without affecting modulation level by using GENERATOR MODULATION switch on FM-10C mainframe.
7. Set FM-10C MODE switch to GEN.
8. With modulation ON, increase attenuator until receiver output caused by signal voltage exceeds noise level by at least 50 mW. Reduce AF gain control until 50 mW of output is indicated and adjust antenna trimmer for maximum receiver output.
9. Adjust attenuator for the standard test voltage input to receiver as specified for the receiver under test.
10. Reduce the AF gain control for a power output as specified under sensitivity requirements for the particular receiver under test. Refer to equipment instruction book.

11. Remove modulation from FM-10C by putting GENERATOR MODULATION switch in OUT position.

12. Without changing the AF gain control, vary FM-10C output until a power ratio of 10:1 (10 dB) is obtained when modulation is turned on and off.

13. The 20 dB quieting sensitivity of the receiver is the voltage (dBm) level required to obtain a signal plus noise (modulation on) to noise alone (modulation off) ratio of 10 to 1.

No. D-3
SELECTIVITY TESTS



SUMMARY

To measure selectivity, determine the frequencies at which 60 dB of attenuation occur above and below channel frequency. Subtract one frequency from the other.

Modules Required: L.H.: RFM-10D or -11A.
Cent.: Not required.
R.H.: Not required.

Other Equipment: VOM

PROCEDURE:

1. Dial in the FM-10C controls to receiver frequency. It should be determined that receiver oscillator is on frequency prior to test.

2. Determine the AVC voltage reference level. If the recommended level for the particular receiver type is not known, this may be set at a level 6 dB above quiescent noise.

3. With GENERATOR MODULATION switch OUT, adjust the output level of the FM-10C until reference level AVC is obtained at the AVC jack. Note and record the output level required.

4. Increase the output of the FM-10C from Step 3 by 6 dB.

   Example: If starting level of -95 dBm is required to obtain reference level at AVC jack, rotate attenuator knob +6 dBm to -89 dBm.

5. Tune frequency above and below the channel frequency until a reference level AVC is again obtained. Record both frequencies.

6. Compute the bandwidth at the 6 dB points by taking the difference of the two frequencies in Step 5.

7. Increase the output of FM-10C by 60 dB (refer to Step 3).

8. Tune frequency above the channel frequency by switching the 10 kHz control one division at a time. When searching for the reference level AVC, always use small frequency increments.

   Tune frequency below the channel frequency by switching the 100 kHz control one division down and increasing the 10 kHz control and the 1 kHz to the 9 position. From this point, decrease the frequency in small increments until the referenced level AVC is again obtained.

   If large frequency increments are used, it is possible to bypass the correct 60 dB point and measure the reference AVC level at an erroreous frequency.

9. Compute the bandwidth at the 60 dB points by taking the difference of the 2 frequencies in Step 7.

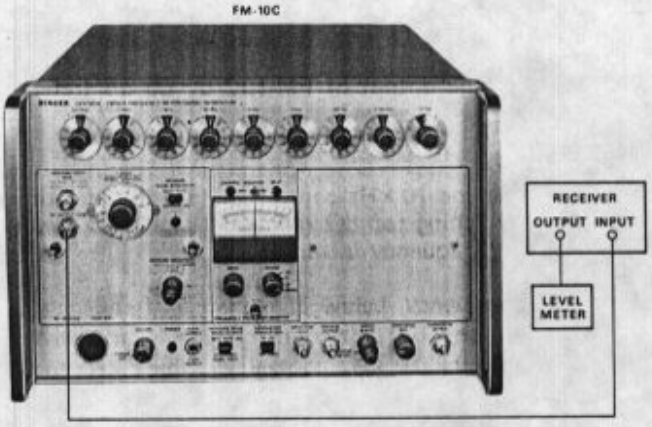
10. Compute the non-symmetry at the 60 dB points by taking the difference between channel frequency above and below the frequency at which 60 dB of attenuation occurs.

    Example: Channel frequency is 133.8 MHz. Frequency "above" at which 60 dB of attenuation occurs is 133.92 MHz. Subtract 133.8 MHz from 133.92 MHz. This gives an upper side frequency of 120 kHz. Frequency "below" at which 60 dB of attenuation occurs is 133.72 MHz. Subtract 133.72 MHz from 133.8 MHz. This gives a lower side frequency of 80 kHz. Even though total bandwidth is 200 kHz, the bandwidth is not symmetrical.

NOTE: Particular combinations of receiver bandwidth and measurement frequency may present difficulty in reaching the reference level in Step 8 due to generator and/or receiver spurious responses. If this is suspected, the measurement may be facilitated by switching the 100 kHz decade switch to V and using the 0-100 Hz dial in a continuously variable "search" mode (spurious output is reduced when the 100 kHz decade is in the V position). Once the approximate tuning point has been found, successively move the V to the right until it is in the 100 Hz decade (see Operator's Manual).

If the 60 dB point still cannot be reached by tuning carefully down the steep skirt of the selectivity curve as described, then it may be necessary to perform the measurement at -50 dB or -40 dB and record it as such.

No. D-4
AVC ACTION TESTS



SUMMARY

Supply modulated carrier to receiver, increasing until AVC throttling action starts. Note receiver output levels at specified input levels. Determine ratio of maximum to minimum receiver output.

Modules Required: L.H.: RFM-10A, 10B, 10D or 11A.
Cent.: Not required.
R.H.: Not required.

Other Equipment: Level Meter.

PROCEDURE:

1. Dial in the FM-10C controls to receiver frequency. It should be determined that receiver oscillator is on frequency prior to test.

2. Rotate MODE switch to GEN MOD CAL, depress GEN MOD switch IN and set up 30% internal modulation as shown in the Operator's Manual.

3. Increase the FM-10C output while observing for the point at which AVC throttling action starts. This is the point where output ceases to increase in direct proportion to input level.

4. AVC threshold is the standard test voltage (dBm) at which threshold occurs.

5. Increase the FM-10C output to -67 dBm (100 microvolts).

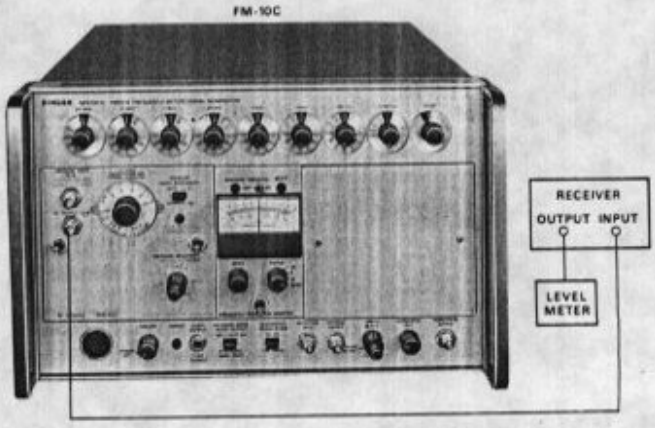
6. Reduce the AF gain control for receiver output of 50 milliwatts.

7. For VHF receivers readjust the FM-10C output to -87 dBm (10 microvolts), -47 dBm (100 microvolts), -27 dBm (10,000 microvolts) and 0 dBm (223 millivolts). For UHF receivers use outputs of -87 dBm (10 μV), -83 dBm (16 μV), -47 dBm (1000 μV), -27 dBm (10,000 μV) and -7 dBm (100,000 μV).

8. Note the corresponding receiver output level for each step.

9. Determine the ratio of maximum to minimum receiver output expressed in dB.

No. D-5
SQUELCH THRESHOLD AND DIFFERENTIAL TEST



SUMMARY

Use FM-10C as a signal generator to find voltage required to deactivate the receiver squelch. This is the squelch threshold. Reduce FM-10C output until squelch operates. The ratio of the two levels is the squelch differential.

Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: Not required.

Other Equipment: Level Meter.

PROCEDURE:

1. Connect FM-10CS RF output to input of receiver under test directly or through 20 dB pad if needed.

2. Set RF attenuator of FM-10CS to the blank position on the 10 dB scale. In this position there is zero output from the generator.

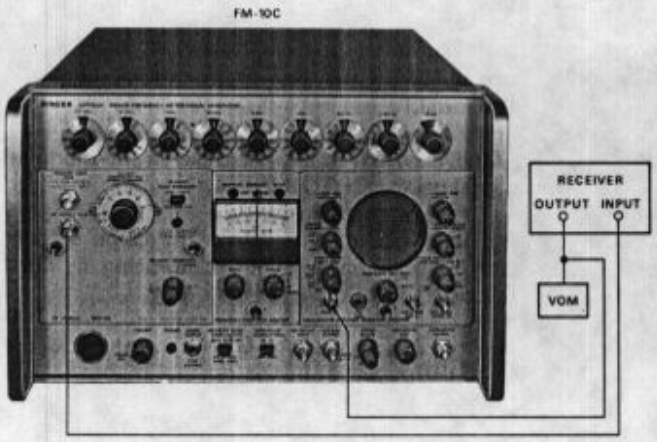
3. Turn squelch switch on and observe the noise output of the receiver. If squelch does not quiet receiver, reduce the RF gain control to the point at which it just operates.

4. Increase the signal generator output and note the standard test voltage (dBm) required to deactivate the squelch. This voltage is the squelch threshold.

   Note: With 20 dB pad in circuit add -20 dBm to readings. Example: -110 dBm (.7 μV) + -20 dBm = -130 dBm (.07 μV).

5. Reduce the signal generator output and note the standard test voltage (dBm) at which the squelch operates. The ratio of this voltage to voltage noted in Step 4 is the squelch differential.

No. D-6
MEASUREMENT OF MAXIMUM POWER OUTPUT



SUMMARY

Purpose is to determine if receiver is capable of delivering the maximum power output for which the receiver was designed.

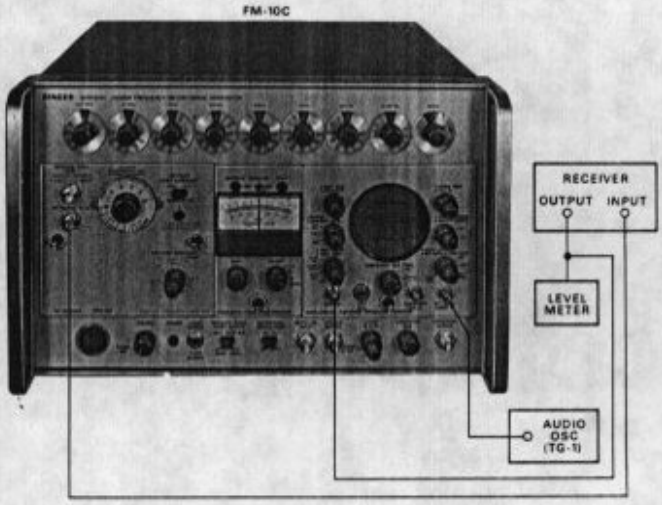
Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: OAM-1 or ODM-1.

Other Equipment: VOM.

PROCEDURE:

1. Dial in FM-10C controls to receiver frequency. (It should be determined that receiver oscillator is on frequency prior to this test.)
2. Rotate MODE switch to GEN MOD CAL, depress GEN MOD switch IN and set up 30% internal modulation as shown in the Operator's Manual.
3. Rotate mode switch to GEN.
4. Rotate VERT MODE switch to EXT.
5. Increase FM-10C output until maximum power, as read on dBm scale of VOM is obtained from receiver. Observe trace on OAM-1 for distortion or other audio problems.
6. Note maximum power reading on meter.

No. D-7
AUDIO FREQUENCY RESPONSE



SUMMARY

Use FM-10C as a signal generator to provide calibrated input to receiver. Use audio oscillator or TG-1 tone generator to provide modulation at varying frequencies over the audio range. Note receiver output at each frequency.

Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: OAM-1.

Other Equipment: Audio Oscillator and Level Meter.

PROCEDURE:

1. Dial in the FM-10C controls to receiver frequency. It should be determined that receiver oscillator is on frequency prior to test.
2. Rotate MODE switch to GEN MOD CAL, depress GENERATOR MODULATION switch IN, and refer to Operator's Manual to set up external modulation.
3. Adjust audio oscillator for 1000 Hz and adjust modulation for 30%.
4. Set output level of FM-10C to -67 dBm (100 μV).
5. Set receiver AF gain control for an output of 1 watt, as indicated on audio power level meter.
6. Adjust the audio oscillator from 100 Hz to 3000 Hz in 100 Hz steps and record reading of output meter for each step.
7. Switch VERT MODE switch to EXT and observe the audio trace on scope for distortion or audio problems.

No. D-8
MONITORING AMPLITUDE MODULATION IN GENERATE MODE

Figure 1

Figure 2

SUMMARY

For applications where it is necessary to vary the modulation while in the GEN mode, the need to repeatedly switch back to GEN MOD CAL to recalibrate modulation may be eliminated by monitoring the modulation indirectly, observing the amplitude of the modulating audio while in the GEN mode.

Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: OAM-1.

Other Equipment: Audio oscilloscope, e.g., TG-1.

PROCEDURE A (for internal modulation):

1. Connect a coax cable with BNC connectors from the AUDIO OUT connector to the VERT IN connector on the OAM-1 front panel as shown in Figure 1.

2. Set up normally for internally-modulated AM signal generation. (See OAM-1 Operating Instructions in FM-10C Operator's Manual.)

3. Set VERT MODE switch to EXT to observe the modulating audio signal on the CRT.

4. Adjust the VERT GAIN to obtain the same vertical deflection previously noted when calibrating in GEN MOD CAL mode (Step 2).

5. Set mainframe MODE switch to GEN and select desired frequency and output level in the normal manner. It is now possible to monitor percentage modulation on the CRT while using the GEN mode, and to make any desired change in modulation by adjusting the INT MOD control without having to switch back to GEN MOD CAL to recalibrate.

PROCEDURE B (for external modulation):

1. Connect as shown in Figure 2 using a BNC T adapter to connect the external audio to both the EXT MOD and VERT IN connectors.

2. Set normally for externally-modulated AM signal generation. (See OAM-1 Operating Instructions in FM-10C Operator's Manual.)

3. Proceed with Steps 3 thru 5 as in Procedure A except that modulation is now controlled by adjusting the level of the external audio source. (The INT MOD control has no effect.)

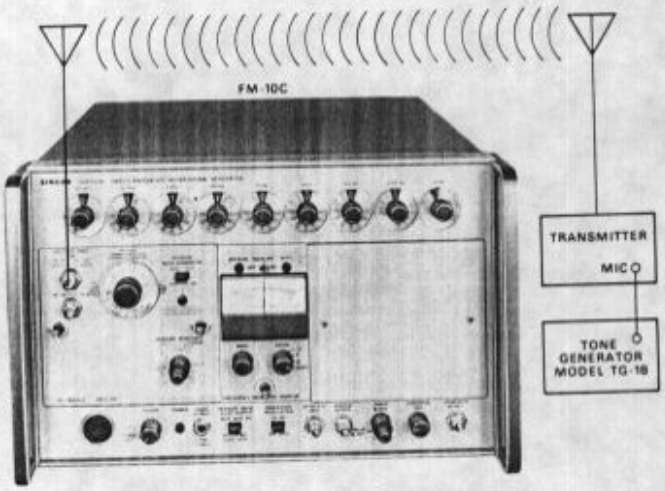
NOTE: Since this technique indicates modulation indirectly, the following precautions should be noted:

a. The GEN MOD CAL method should still be used to calibrate before any measurement where accuracy is important, since it eliminates possible sources of error in modulator efficiency or audio gain fluctuations.
b. Keep in mind that the indirect method could indicate amplitude modulation when in fact there is none; for instance, if the GENERATOR MODULATION switch were changed to the OUT-OFF position.

SECTION E
SINGLE SIDEBAND TESTS

SECTION E
SINGLE SIDEBAND TESTS

No. E-1
TRANSMITTER TESTS



SUMMARY

In testing the performance of an SSB transmitter, it is necessary to have a very accurate frequency determining device such as the FM-10C and a very stable and accurate source of dual audio tone such as supplied by the TG-1B Tone Generator.

Modules Required: L.H.: Any RFM unit.
Cent.: FIM-1 or FIM-3.
R.H.: Not required.

Other Equipment: Tone Generator Model TG-1B.

PROCEDURE:

1. Connect the output of the TB-1B to the microphone input of the transmitter and adjust to the recommended level. If the recommended level is not known, slowly increase the output level of the TG-1B while monitoring the final current until the final current no longer increases linearly or until rated PEP is obtained.

2. Couple the transmitter output to the MEASURE INPUT of the FM-10C via antenna or suitable attenuator and set the mode switch to MEASURE. Set the frequency decade switch to the transmitter frequency.

3. Modulate the transmitter with a single 1 kHz tone from the TG-1B and adjust level into FM-10C until OPERATE light on the frequency indication monitor is lit.

4. Adjust the decade switches until a beat indication is obtained. The actual transmitter frequency will be exactly 1 kHz below the frequency indicated on the decade switches if the transmitter is operating in the LSB mode. To adjust the transmitter frequency, set the decade switches 1 kHz above or below the channel frequency, as appropriate, and adjust the transmitter oscillator for a beat indication on the frequency indication monitor.

5. Most SSB transmitters require a certain test to be performed using an audio two-tone modulation signal. The equipment would be connected as described above and the TG-1B operated in the two-tone simultaneous mode. The 2 MHz IF output on the rear panel of the FM-10C can be used for spectrum analysis. (See application note No. F-3).

No. E-2
TWO-TONE TRANSMITTER TESTING

Modules Required: L.H.: Any RFM unit.
Cent.: FIM-1 or FIM-3
R.H.: OAM-1

A common method of verifying the performance of the linear final stage of a single sideband transmitter is known as the "two-tone test." This requires setting the exciter to generate two equal amplitude RF signals typically 1000 Hz apart in frequency. The sum of these two signals at the transmitter output, when viewed on a high frequency oscilloscope, will appear as in Figure 1a for a correctly adjusted linear final stage.

The Model OAM-1 in a Model FM-10C mainframe may be used without modification to display the demodulated envelope corresponding to the outline of one-half of the pattern of Figure 1a. This permits direct diagnosis of the transmitter performance in essentially the same manner as the RF display of Figure 1a would be interpreted, but avoids the need for a high frequency oscilloscope or special tuned circuitry for driving the deflection plates directly.

Figure 1b shows the display obtained on the OAM-1 under the same condition as Figure 1a, a correctly adjusted linear output stage with two-tone balanced RF signals.

The procedure is as described in the FM-10C Operator's Manual for measuring 100% AM. Sample the transmitter output at a level suitable for the MEASURE INPUT with the transmitter delivering rated power to a dummy load. Tune the frequency meter to midway between the two RF Signals. Then, after adjusting for VERTICAL SET and CARRIER SET, and switching to MEAS AM, the pattern should appear as in Figure 1b with the peak amplitude corresponding to approximately 78% AM.

The sharp negative-going peaks at the VERTICAL SET level on the graticule (0 volts DC baseline) indicate equal levels of the two RF signals just as this balance is indicated by the center zero axis crossovers in Figure 1a. Failure of the OAM-1 display to extend all the way down to the VERTICAL SET line indicates an imbalance in the two levels; one

of them should be adjusted in level to obtain exact balance. Then the waveform should appear as in Figure 1b for a correctly adjusted linear final stage.

Figures 1c and 1d show the RF display and the OAM-1 demodulated envelope display respectively, of a final stage which is improperly biased (beyond cutoff).

Figures 1e and 1f show the RF display and the OAM-1 demodulated envelope display respectively, of a final amplifier stage which is being overdriven, causing compression of the peaks at maximum amplitude.

TWO-TONE SINGLE SIDEBAND XMTR TESTING

High frequency oscilloscope display of combined RF signals.

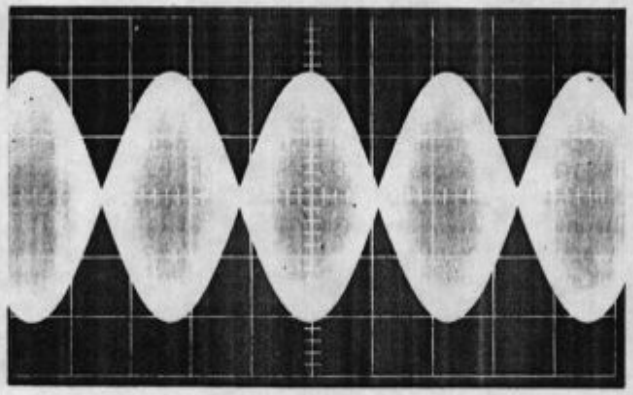


Figure 1a

Corresponding OAM-1 display of demodulated envelope.

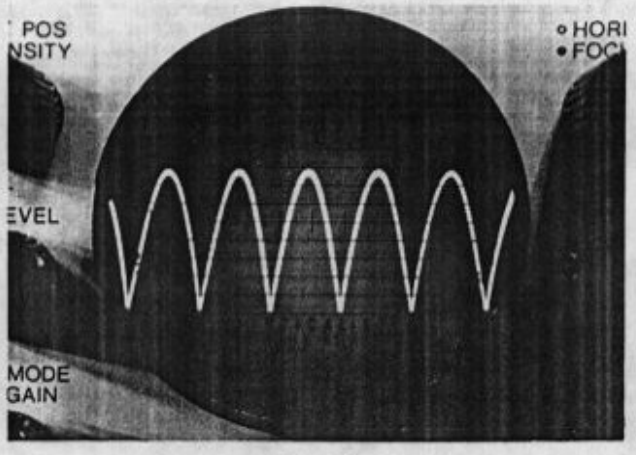


Figure 1b

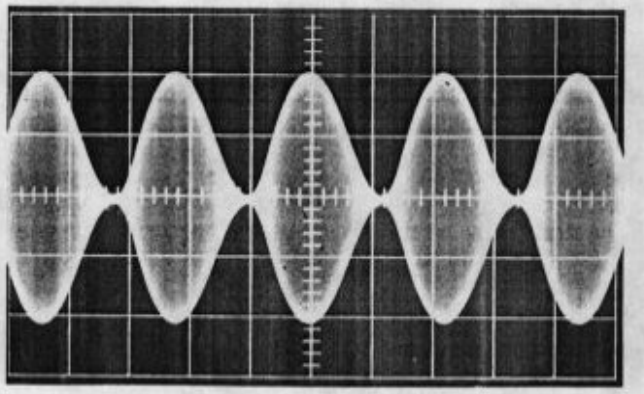


Figure 1c

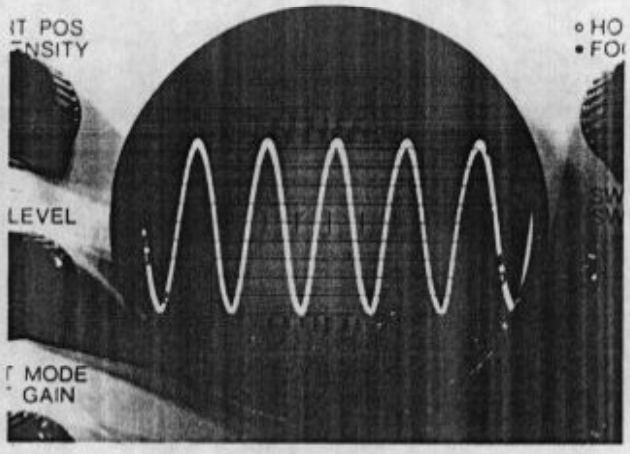


Figure 1d

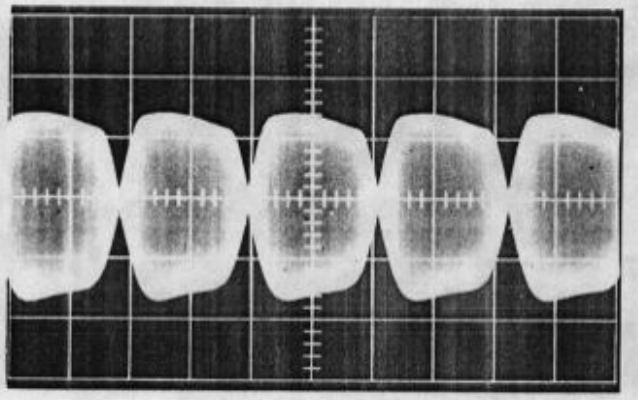


Figure 1e

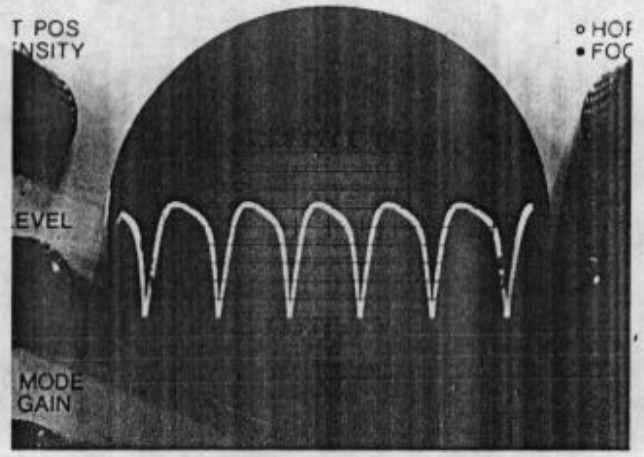
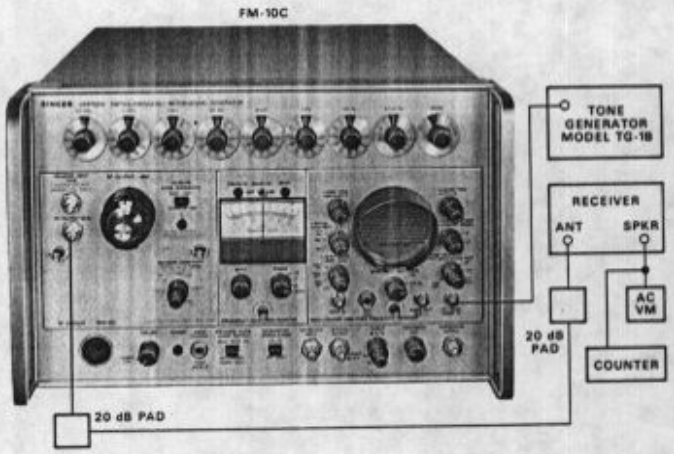


Figure 1f

No. E-3
SSB RECEIVER TESTS



SUMMARY

One of the major problems encountered when performing tests on single side band receivers is the frequency stability of the signal generator. Normal, continuously-variable signal generators will not maintain the stability required to properly translate the intelligence contained in the modulation. Having a highly stable synthesized output, the FM-10C is an ideal source of SSB signals.

Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: OAM-1 or AFM-2.

Other Equipment: Tone Generator Model TG-1B.
Frequency Counter.
DC Voltmeter.

PROCEDURE:

1. Turn on the FM-10C and set the mode switch to GEN.

2. Turn the decade switches to the actual channel frequency of the receiver under test. Add 1 kHz if the receiver is to be operated in the USB mode and subtract 1 kHz if the receiver is to be operated in the LSB mode.

3. Connect the output of the FM-10C to the antenna input of the receiver through the two 20 dB pads provided.

4. A 1 kHz tone should be heard in the speaker of the receiver.

5. The calibration dial on the FM-10C can be used to check the sensitivity of the receiver in the conventional manner by connecting an AC voltmeter across the speaker terminal and checking the S+N/N ratio.

6. The local oscillator (L.O.) in the receiver can be adjusted by connecting a counter across the speaker terminals and adjusting the L.O. frequency until the counter reads exactly 1 kHz. The receiver is now set to the accuracy of the FM-10C master oscillator.

7. A receiver two-tone signal may be simulated by using the FM-10C with either the OAM-1 or AFM-2 modulation plug-ins. Set the FM-10C frequency decades to the channel frequency and externally modulate the FM-10C by applying the output of the TG-1B to the EXT MOD jack on the plug-ins. Set f1 and f2 on the TB-1B to two frequencies in the audio bandwidth of the receiver, e.g., 1000 Hz and 1800 Hz. Set the output level of the TB-1B to give 30% modulation as monitored on OAM-1 or level specified for AFM-2. Operate the TG-1B in the two-tone simultaneous mode. The two tones will produce two RF sideband signals of equal amplitude in both the USB and LSB. The level of these tones will be approximately 10 dB below the indicated carrier level of the FM-10C and may be used to perform receiver two-tone and IM tests.

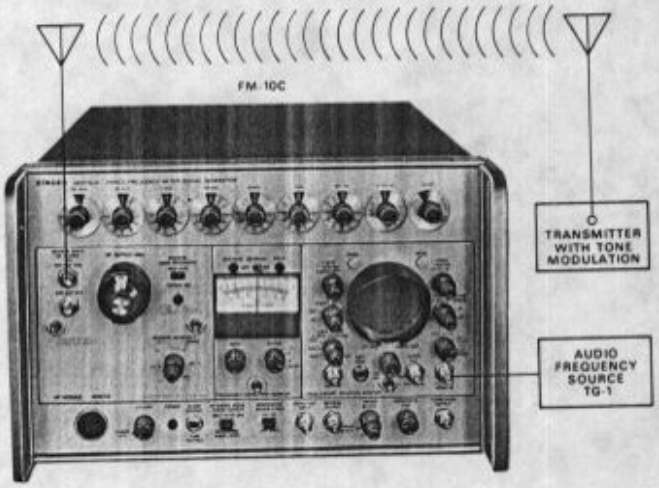
8. The FM-10C provides an ideal means of checking or plotting the bandwidth and opposite sideband rejection of a receiver. An output reference level is established with a 1 kHz tone in the proper sideband using an AC voltmeter across the speaker terminals as the monitor. The frequency of the FM-10C can not be varied with 1 Hz resolution and the relative output level plotted.

   Note: Assure that AGC action does not occur.

SECTION F
GENERAL

SECTION F
GENERAL

No. F-1
FREQUENCY MEASUREMENT OF SELECTIVE CALLING TONES



SUMMARY

Measurement of code tones used for selective calling can be accomplished with the FM-10C/ODM-1 in junction with an accurate Audio Frequency Source such as Singer Model TG-1 providing horizontal sweep to the ODM-1 to display Lissajous figures.

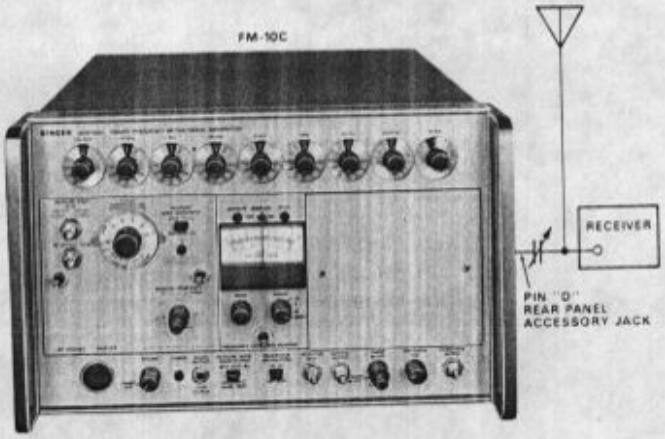
Modules Required: L.H.: Any RFM unit.
Cent.: FIM-1 or FIM-3.
R.H.: ODM-1

Other Equipment: Audio Frequency source such as TG-1 with a variable output load to approximately 1Vrms maximum.

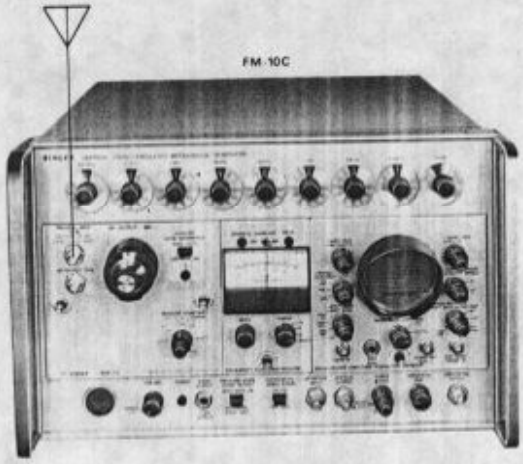
PROCEDURE:

1. Switch on power to FM-10C (and ODM-1).
2. Set FM-10C to carrier frequency. Adjust transmitter oscillator for zero on FIM-1 or FIM-3.
3. Set up the FM-10C for Peak Deviation Measurement on the 1.5 kHz range (as described in the Operator's Manual).
4. Connect the Audio Frequency Source to the HORIZ IN receptacle on the ODM-1.
5. Turn MOD MODE to EXT.
6. Adjust the output level of the Audio Frequency Source to obtain suitable horizontal display size.
7. Vary the frequency of the Audio Frequency Source to identify the modulation frequency by means of Lissajous figures.

No. F-2
CALIBRATING THE FM-10C MASTER OSCILLATOR TO WWV



Method A



Method B

METHOD A (Using a receiver):

Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: Not required.

Other Equipment: Receiver with S Meter.

PROCEDURE:

1. Tune receiver to WWV. This can be at 5 MHz, 10 MHz, 15 MHz, or 20 MHz. It is preferable to use higher frequencies for better accuracy.
2. Take internal 1 MHz output from FM-10C (rear panel accessory jack, pin D), and couple through a 5-25 $\mu\mu$f trimmer capacitor to antenna of receiver. Adjust trimmer to get maximum beat note on "S" meter.
3. A beat note will be heard and detected on "S" meter.
4. Remove seal plug from FM-10C TCXO and adjust trimmer for lowest observable beat note frequency on "S" meter.

METHOD B: (Direct reception in MEAS mode)

Modules Required: L.H.: RFM-10A, RFM-10B, RFM-10D or RFM-11A.
Cent.: FIM-1 or FIM-3.
R.H.: OAM-1 (optional).

Other Equipment: None.

PROCEDURE:

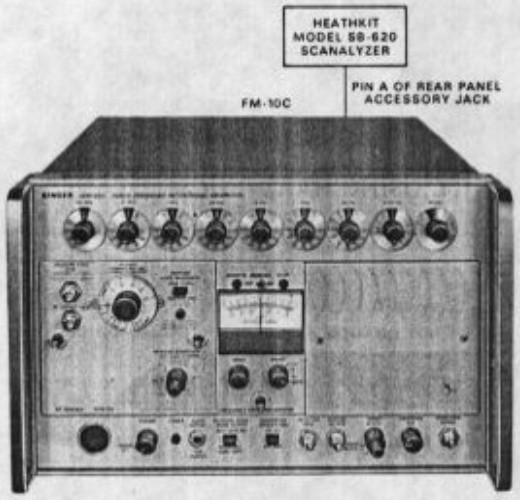
1. Set up according to the Operator's Manual for frequency measurement at a suitable WWV frequency.

2. If the signal is too weak to obtain reliable OPERATE light indication or if interference is excessive, it may be necessary to revert to Method A using a receiver.

3. Remove the seal plug from the FM-10C TCXO and adjust trimmer for lowest observable beat note frequency on the BEAT light of the FIM.

NOTE: In Methods A and B a beat note frequency of one Hertz (one beat per second, timed with a watch over a 1 minute period) indicates a comparative accuracy of 5 parts in 10^8 using a 20 MHz signal or 6.67 parts in 10^8 using 15 MHz.

No. F-3
SPECTRUM ANALYSIS USING THE FM-10C WITH HEATHKIT MODEL SB-620 SCANALYZER



SUMMARY

A high resolution spectrum analyzer for FM, AM and SSB tests can be made using the FM-10C and the Heathkit Model SB-620 Scanalyzer. Visual monitoring of the portion of the band which is centered around the frequency dialed into the FM-10C can be accomplished.

Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: Not required.

Other Equipment: Heath Model SB-620 Scanalyzer.

The Scanalyzer is operated as a monitor to:

1. Scan wide bands of frequencies.

2. Determine presence of signals.

3. Analyze interference or intermodulation problems.

The variable sweep mode of the Scanalyzer provides up to 500 kHz of bandwidth presentation. The 10 kHz and 50 kHz sweep widths permit slow speed, high resolution signal analysis.

4. See Section E for SSB applications. When assembling the Scanalyzer, use instructions applicable for 2075 kHz IF. It is recommended that the IF input jack be changed to the BNC type. Tune IF to 2 MHz using FM-10C as a signal generator. Connect IF input of the Scanalyzer to 2 MHz IF output of the FM-10C (pin A of accessory connector, rear panel; pin H is ground).

PROCEDURE:

FM-10C Settings:

1. Dial in desired center frequency on FM-10C.

2. MODE switch: MEAS.

3. PWR: ON.

4. MEASURE MODE BANDWIDTH: OUT/WIDE.

SB-620 Settings:

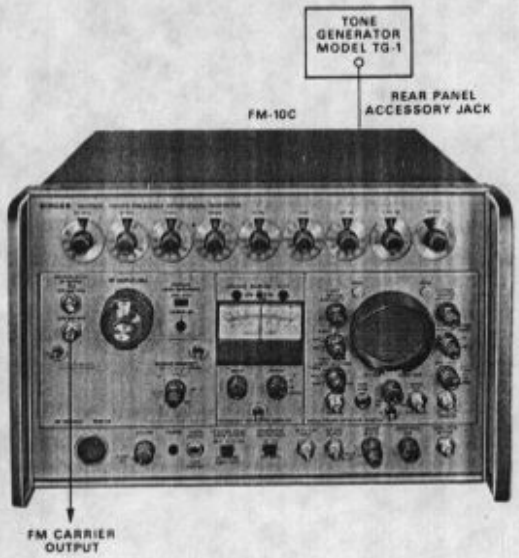
1. Front Panel Controls: As required.

2. Rear Panel Controls (HAMSCAN Position) Atten.: As required.

Signal is coupled into antenna or MEASURE INPUT jack through appropriate attenuator (see Note 1).

NOTE 1: Since AM-SSB is a function of carrier level, it is necessary to have constant signal. Use an RF attenuator such as RFA-60 or other appropriate attenuator (considering power) to couple into MEASURE INPUT jack. (Do not exceed .05V.)

No. F-4
USE OF EXTERNAL VCO INPUT ON FM-10C



SUMMARY

For low frequency tones (50 Hz to 300 Hz) when peak deviations of greater than 1.5 kHz are desired, it is recommended that the external VCO input on the rear panel be used.

The VCO input must also be used to obtain deviations in the range of 18 kHz to 60 kHz peak deviations.

The FM-10C uses a phase modulator to obtain frequency modulation. This technique allows the center frequency of a generated FM signal to maintain the stability of the FM-10C master oscillator. The phase modulator, however, has some limitations that a VCO does not. The modulation distortion increases at low modulation rates if the peak deviation is not limited.

The external VCO input has an input impedance of 600 ohms* and a bandwidth extending from below 50 Hz to 3 kHz and above.

The sensitivity of the external VCO input is scaled to whichever decade switch is in the "V" position and is approximately as follows:

100 kHz in "V":	80 mVrms per 10 kHz peak deviation.
10 kHz in "V":	80 mVrms per 1 kHz peak deviation.
1 kHz in "V":	80 mVrms per 100 Hz peak deviation.
100 Hz in "V":	80 mVrms per 10 Hz peak deviation.

Do not exceed 1.5 Vrms.

*Effective on S/N 301 and up. This procedure may be used with units with lower S/N's. However, the sensitivity will be slightly different. Furthermore, units below S/N 151 may not exhibit good modulation linearity.

Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: ODM-1 or MDM-1.

Other Equipment: Tone Generator Model TG-1.

PROCEDURE:

1. Set the FM-10C 0-100 Hz dial to "0".

2. On the ODM-1 or MDM-1 set:

VERT to INT:	(ODM-1 only).
VERT GAIN to CAL:	(ODM-1 only).
DEV RANGE:	As required.
MOD MODE to EXT:	
MTR to DEV-OUT:	(MDM-1 only).

3. Set the appropriate decade switch to the "V" position.
   For deviations greater than 5 kHz peak use 100 kHz decade.
   For deviations greater than 500 Hz, but less than 5 kHz, use 10 kHz.
   For deviations greater than 50 Hz, but less than 500 Hz, use 1 kHz.

4. Set FM-10C 0-100 Hz variable control to "0", not to OFF.

5. Set all decades except the one in the "V" position to "0".

6. Set FM-10C MODE switch to TONE GEN.

7. Connect the output of the TG-1 to the FM-10C rear panel "ACC" socket (signal to "B" and ground to "H") and set TG-1 to the desired frequency or frequencies and adjust the desired peak deviation on the scope or meter.

8. Set all decade switches, to the left of the one at "V" position, to the desired operating frequency and turn the variable 0-100 Hz control to the digit desired on the decade which is in the "V" position.

   i.e., If a signal at 151.53 MHz with 1 kHz peak deviation is desired:

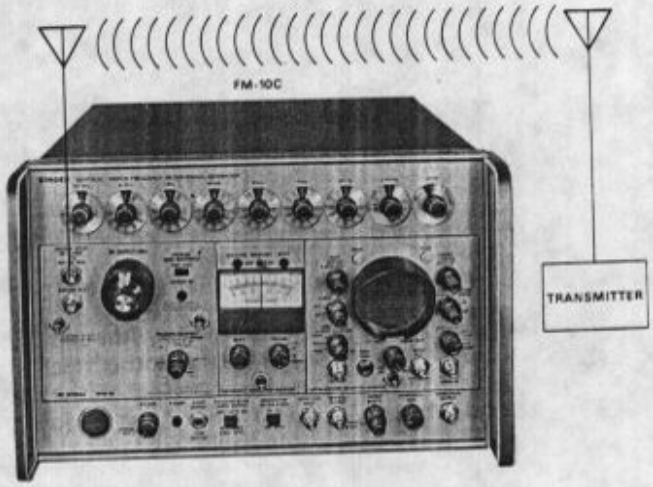
100 MHz decade:	1
10 MHz decade:	5
1 MHz decade:	1
100 kHz decade:	5
10 kHz decade:	"V"
1 kHz decade:	0†
100 Hz decade:	0†
0-100 Hz variable	3

†Decades to the right of a "V" are not active.

9. Set the MODE switch to GEN and the RF output level as appropriate. The FM-10C is now generating an FM carrier.

NOTE: The normal modulation circuit of the FM-10C is active at all times and any modulation applied in the proper manner to the ODM-1 or MDM-1 is combined with modulation applied to the Ext. VCO input. Also, it should be noted that it is possible to use the 1 kHz audio output from the front of the MDM-1 or ODM-1 to modulate the TG-1.

No. F-5
SIGNAL GENERATION AND MEASUREMENTS WITH FM-10C USING HARMONICS



SUMMARY

It is possible to use the FM-10C to generate and measure signals in the 512 MHz to 1.024 GHz band. The second harmonic of the synthesizer is used as a local oscillator injection signal or as the RF output signal.

Modules Required: L.H.: Any RFM unit.
Cent.: FIM-1 or FIM-3.
R.H.: ODM-1 or MDM-1.

PROCEDURE:

1. To generate a signal in the 512 MHz to 1.024 GHz band, simply set the FM-10C decade switches to one-half the desired frequency, i.e., with the decade switches set at 462.100.0 MHz, a signal at 924.200.0 MHz is also produced which is approximately 30 dB below the indicated output level.

   If the signal is frequency modulated, the rate of modulation will remain the same but the peak-to-peak deviation will be twice that indicated. If the signal is amplitude modulated, the rate of modulation remains constant but the percentage modulation may be incorrect and modulation distortion may occur due to the non-linearities which produced the harmonics.

2. To measure a signal in the 512 MHz to 1.024 GHz range requires a simple calculation. The measured frequency is equal to twice the frequency indicated on the decade switches plus 11 MHz, i.e., if a beat note is obtained with the decade switches at 401.1 MHz, the measured signal will be 2x(401.1 MHz) +11 MHz or 813.2 MHz. (See sensitivity spec.)

Modulation is measured in the normal manner.

No. F-6
OBTAINING HIGH LEVEL OUTPUT FROM FM-10C PLUG-INS RFM-10A AND RFM-10B

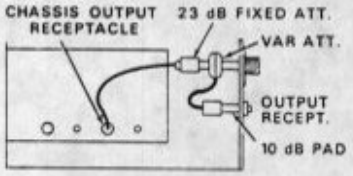


Figure 1
Normal Output Hookup

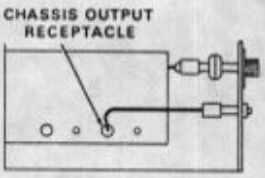


Figure 2
Special Hookup for 70 mV Output

SUMMARY

The maximum output capability of RFM-10A and RFM-10B is normally 2.5 mV (-39 dBm) as specified.

If high level is required for an unusual test where attenuator adjustment is not needed, a level of 70 mV (-10 dBm) may be obtained by a simple rearrangement of coax cables to bypass the variable attenuator and 23 dB fixed internal attenuator.

Modules Required: L.H.: RFM-10A S/N 501 or above or RFM-10B S/N 126 or above.
Cent.: Not required.
R.H.: Not required.

PROCEDURE:

1. Turn off mainframe power switch.

2. Remove RFM unit from mainframe by releasing the two holding screws. Remove cover from RFM unit by removing 5 screws at rear.

3. Locate the coax cable connected between the fixed attenuator at the rear of the variable attenuator and the chassis output receptacle. Disconnect both ends and remove this cable.

4. Disconnect the cable at the bottom of the variable attenuator and connect it to the chassis output receptacle vacated in Step 2.

5. Replace cover and install RFM unit into mainframe compartment. Unit is now ready to use.

6. Restore to original condition when finished.

NOTE: On RFM-10A it is possible to obtain approximately 220 mV (0 dBm) by using the internal measure input cable to connect to the chassis output receptacle (disregard Step 4) and connect the external output cable to the MEASURE INPUT receptacle, thus avoiding the 10 dB pad at the RF OUTPUT receptacle.

CAUTION: Bypassing the built-in attenuators in this manner reduces the output circuitry protection against destructive overloads. Special care should be taken to prevent accidental keying of transmitters, etc.

No. F-7
SPECTRUM ANALYSIS USING THE FM-10CS

SUMMARY

Model FM-10CS is similar to FM-10C with the addition of built-in sweep generator capability. An FM-10CS with an RF module and an OAM-1 includes everything needed to perform as a spectrum analyzer capable of displaying signals across swept portions of the spectrum up to 1 MHz wide. The entire received spectrum may be searched by operation of the synthesizer dials. The frequency of any unknown signal observed may be read out directly on the dials. Relative signal strength may be measured as amplitude on the CRT display.

A spectrum analyzer is a very versatile instrument with numerous applications, including the following:

a. A monitor to examine channel activity in a communications band.

b. A service instrument to check out transmitters for spurious emissions.
c. A design tool in developing new circuitry.
d. A diagnostic aid in developing communications systems.

The FM-10CS used as a spectrum analyzer performs as follows:

Sweep Rate:	10 Hz to 100 Hz.
Sweep Width:	Adjustable up to 0.5 to 1.0 MHz (maximum capability depends upon the setting of the 0-100 Hz variable dial, being greatest around 5 at the center of the control).
Bandwidth:	Narrow: 32 kHz. Wide: 200 kHz.
Frequency Range:	See RFM specifications.
Sensitivity:	Typically signals may be observed down to 5 times below the rated RFM sensitivity; e.g., to 0.4 uV (-115 dBm) with RFM-10B or RFM-10D.

Equipment Required:	Mainframe:	FM-10CS.
	L.H.:	RFM-10A, 10B, 10D or 11A.
	Cent.:	Not required.
	R.H.:	OAM-1.

PROCEDURE:

1. Turn on power switches (FM-10CS mainframe and OAM-1).

2. Connect a coax cable between the HORIZ IN receptacle on the OAM-1 and the HORIZONTAL OUTPUT receptacle immediately below the mainframe.

3. The input signals may be connected by coax cable or picked up by an antenna at the MEASURE INPUT receptacle of the RFM unit.

4. Push MEASURE MODE BANDWIDTH switch to NARROW (IN) unless wide bandwidth is needed.

5. On OAM-1 set VERT MODE to VERT SET and set MOD MODE to EXT HORIZ.

6. On mainframe turn SWEEP on and set to desired RATE (usually just increase RATE sufficiently to eliminate trace flicker). Turn SWEEP WIDTH to maximum (clockwise).

7. Adjust HORIZ SIZE (on mainframe), VERT POS, INTENSITY HORIZ POS, and FOCUS (on OAM-1), to obtain a trace 10 divisions wide on the CRT graticule, positioned on the VERTICAL SET line.

8. Switch VERT MODE to MEAS AM, set CARRIER LEVEL control to maximum (clockwise) and switch RANGE to 30%.

9. Set frequency dials to low end of band of interest, with a V dialed in the appropriate decade (usually 100 kHz) for suitable sweep range on the 0-100 Hz dial.

10. Adjust MEASURE SENSITIVITY on RFM as required to give desired display amplitude. The CARRIER LEVEL control on the OAM-1 may be used for additional attenuation.

11. Use decade frequency dials (to the left of the decade set to V), 0-100 Hz dial and SWEEP WIDTH control to adjust display to desired center frequency and sweep width, or to search and examine any part of the received spectrum.

12. It is useful to establish a reference position indicating "center frequency" on the horizontal scale of the graticule. This may be located by turning the sweep off (SWEEP RATE control) and noting the spot position. (Avoid excessive spot intensity.) The unit is now in the normal MEASURE mode and may be used to listen to AM signals on the speaker by turning up the VOLUME control and tuning accurately with the 0-100 Hz dial. (The CRT may be used as a tuning indicator in this mode.)

13. By simply turning the sweep on again (SWEEP RATE control), the signal which was tuned in accurately (Step 12) may now be observed at the "center frequency" position on the swept spectrum display, with its frequency indicated on the synthesizer dials. Now, when the center frequency is varied as in Step 11, the frequency of each signal is displayed on the dials as it crosses the "center frequency" position on the graticule.

NOTE: The FM-10CS and RFM MEASURE system front end is essentially a super-heterodyne receiver with a broadband input and a first conversion IF of 11 MHz. Image responses will be seen from signals 22 MHz above the swept range selected. Also, as indicated in FM-10 series operating manuals, measurement sensitivity may be reduced at certain frequencies due to spurious outputs from the synthesizer; in the spectrum analyzer mode these "spurs" will be visible, and may be identified as such by removing external signals to see if they disappear (internal "spurs" will remain visible).

No. F-8
SWEEP GENERATOR TESTING WITH THE FM-10C USING EXTERNAL SWEEP SOURCE

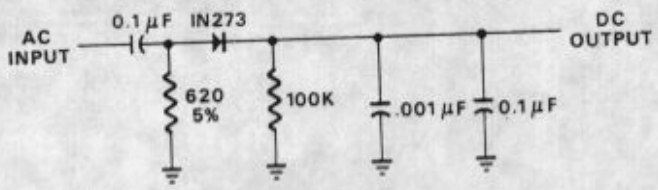


Figure 1
RF Detector

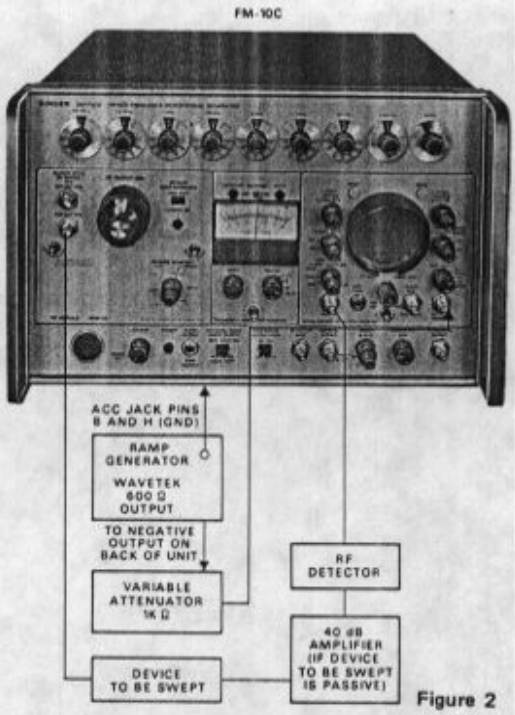


Figure 2

SUMMARY

The FM-10C may be swept up to 1 MHz in width and from 10 Hz to 100 Hz in sweep speed as in the following procedure. A 40 dB amplifier may be required between the device under test and the RF detector if the device under test has no gain.

Modules Required: L.H.: Any RFM unit.
Cent.: Not required.
R.H.: OAM-1 or ODM-1

Other Equipment: Ramp Generator - Wavetek, Model 116 or equal.
RF Detector - See figure 1.
1kΩ Potentiometer.

PROCEDURE:

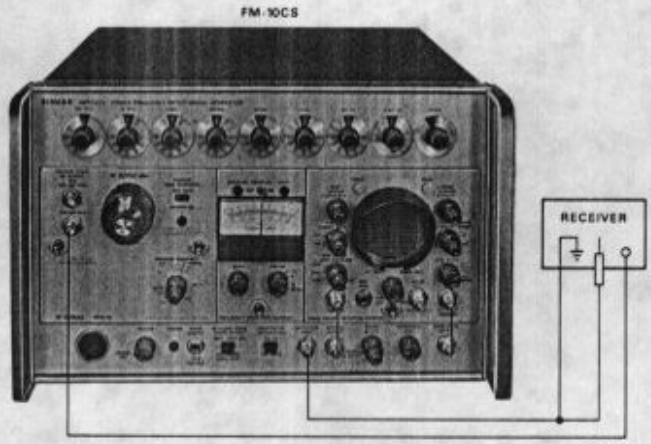
Example: Test device has a center frequency of 1.5 MHz.

a. Set up the equipment as in figure 2.
b. Set the FM-10C controls as follows:

100 kHz decade switch:	V
1 MHz decade switch:	1
MODE:	GEN.
RF OUTPUT:	As required.
VERT IN:	EXT.
MOD MODE:	EXT HORIZ.
0-1 Hz:	0 (not OUT).

c. Adjust the ramp generator to approximately 14V negative ramp.
d. Adjust ODM-1 or OAM-1 vertical controls to set the trace on the top graticule line.
e. Adjust the external 1 k potentiometer and the horizontal centering control so that the trace deflects full scale.
f. To spread out the bandpass representation, reduce the ramp generator level and vary the 0-100 Hz control as required. Readjust the VERT GAIN control as necessary.

No. F-9
SWEEPING IF's AND CRYSTAL FILTERS



SUMMARY

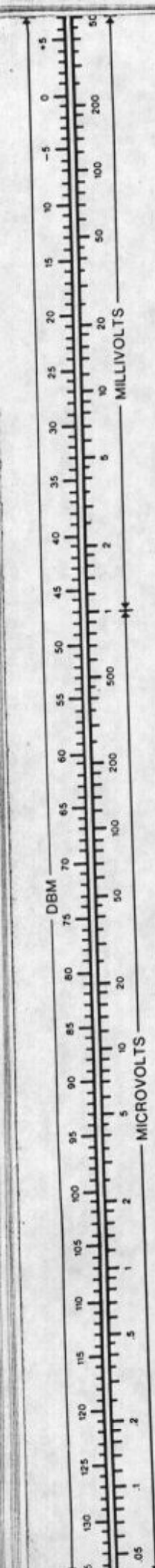
Sweep is primarily intended to determine proper tuning of IF stages and proper operation of crystal filters. Approximations of 6 dB bandwidth points and symmetry can be made using built-in sweep of the FM-10CS.

Exact bandwidth and symmetry checks should be made as outlined in application note number D-3.

Modules Required: Mainframe: FM-10CS.
L.H.: Any RFM unit.
Cent.: Not required.
R.H.: OAM-1 or ODM-1.

PROCEDURE:

1. Set up FM-10CS to generate an unmodulated signal at receiver frequency.
2. Connect jumper cables from vertical output to vertical input and horizontal output to horizontal input.
3. Connect RF cable from FM-10CS RF output to input of receiver. Connect probe from detector input to output of IF or crystal filter stage. CAUTION: If tube type equipment use grid of following stage keeping high voltage off probe.
4. Put OAM-1 or ODM-1 vertical and horizontal mode switches to EXT and EXT HORIZ position.
5. Turn on sweep and keep at slow rate (counterclockwise). Adjust SWEEP WIDTH and HORIZONTAL SIZE for approximately 12 o'clock position.
6. Turn on FM-10CS and inject an on frequency signal into receiver at a high level.
7. Rotate 10 kHz decade to "V" position and use 0-100 Hz variable decade to center trace. Use vertical centering control to position trace to VERTICAL SET line.
8. Amplitude of trace can be adjusted as desired by using vertical gain control and/or attenuator on FM-10CS.
9. Observe pattern for flatness, symmetry and roll-off. With the 10 kHz decade in the "V" position, sweep width is up to 100 kHz.



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15M E-3