MODEL FM-110

COMMUNICATIONS SERVICE MONITOR

INSTRUCTION MANUAL
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Welcome to the Measurements Corporations Model FM-110 Communications Service Monitor! With it one can evaluate the performance of all FM two-way radios in business bands from 30 to 512 MHz.

The following instructions are condensed to aid in initial set up. Complete information is on later pages.

GETTING STARTED

Before operating your FM-110, read the following directions carefully. Doing this will ensure maximum performance and enjoyment of your FM-110. We also recommend that you save all instructions for future reference.

1. Unpack the unit from the carton and check for damage. If the unit is damaged, contact the AIE Corporation immediately.
2. Check the contents of the box with the packing list. Report any shortages to the place of purchase.
3. Connect the FM-110 power cord to 115V AC receptacle.
4. Before turning on the unit, adjust the SQUELCH knob all the way CCW and throw generate/receive switch to receive position.
5. Now adjust the VOLUME knob approximately 1/3 of the way CW.
6. Throw power switch at lower right ON. Red lamp lights.
7. To obtain proper scanning action, SQUELCH must be set properly. Adjust the knob CW until the static just disappears. The Squelch knob past this point may result in poor reception of weaker channels. When scanning, however, the SQUELCH control may have to be adjusted slightly to eliminate false stopping.
8. Connect unit to be tested to its power source and its control panel.
9. Enter the frequency of unit to be tested on FM-110 as follows:
   9.1 Press MANUAL switch in FREQUENCY/FUNCTION section.
   9.2 Key in frequency digits, including decimal point.
   9.3 Press ENTER.

NOTE: Frequency setting while in SCAN or SEARCH modes is described in later pages.

TESTING TRANSMITTER PORTION

1. Set GENERATE/RECEIVE switch to RECEIVE.
2. Loosely couple (with antennas or RF load and attenuators) unit under test to RF IN jack of FM-110. CAUTION: DO NOT EXCEED 0.1 WATTS (0.2 Volts rms) TO RF IN JACK.*
3. Key transmitter.
4. Readjust VOLUME control for convenient sound.
5. Frequency error is shown on BAR GRAPH, in KHz (multiplied by lower switch position).
   NOTE: 30 to 50 MHz signals are shown in opposite polarity, i.e., if unit frequency is high BAR GRAPH reads low.

6. Modulation is displayed on scope. Full scale deviation in KHz is displayed by the setting of the DEVIATION (kHz) switch.
   NOTE: Deviation calibration procedure on next page is recommended for first time use or for precision deviation measurement.

7. CTCSS (Tone, PL) modulation is also displayed on the scope.

8. CTCSS frequency is measured by:
   8.1 Set SWEEP RANGE (ms) switch to F2.
   8.2 Set DEVIATION (kHz) switch to 1.5.
   8.3 Press MODULATION Key F2.
   8.4 Set F2 LEVEL Control to partly fill scope screen.
   8.5 Adjust F2 MODULATION frequency thumbwheel switch (including multiplier) to form Lissajous oval on scope. F2 MODULATION thumbwheel switch (including multiplier) now indicates CTCSS frequency.

TESTING RECEIVER PORTION

1. Connect RF OUT jack to input of receiver under test.
   CAUTION: DO NOT KEY TRANSMITTER OF UNIT UNDER TEST WHILE IN THIS MODE.

2. Set GENERATE/RECEIVE switch to GENERATE.

3. Reset frequency (as above) is necessary.

4. Preset OUTPUT LEVEL X10 switches off (down) and uV dial control fully counter-clockwise (zero RF output).

5. Connect receiver under test audio output to SINAD INPUT jack of FM-110. Adjust receiver under test volume until SINAD bargraph reads 0 dB.

6. Set DEVIATION (kHz) switch to 5.

7. Press F1 switch of MODULATION section.

8. Adjust F1 MODULATION control to produce ±3.3 kHz deviation on scope.
   NOTE: If receiver under test is CTCSS equipped, it will be necessary to DISABLE CTCSS (monitor the channel OR proceed to step 10.

9. Rotate OUTPUT LEVEL control clockwise until SINAD bargraph indicates -12 db. If necessary, turn on (up) one or more of the X10 switches. SINAD sensitivity is the product of the OUTPUT LEVEL dial reading times the number of X10 switches in UP position.

10. For CTCSS equipped receivers:
    10.1 Press MODULATION key F2.
10.2 Adjust F2 MODULATION frequency thumbwheel switch (including multiplier toggle) to CTCSS frequency.
10.3 Set DEVIATION (kHz) switch to 1.5.
10.4 Adjust F2 LEVEL switch to ±0.7 kHz on scope.
10.5 Press MODULATION switch F1 + F2.
10.6 Measure SINAD sensitivity as in Step 9 above.

DEVIA TION CALIBRATION

Calibration Frequency Deviation.
1. Set DEVIATION (kHz) to CAL, set F2 for 1000 Hz.
2. Adjust DEV CAL for full scale display.

USING THE SCOPE AS A SEPARATE DEVICE

1. Turn REAR PANEL switch to EXTERNAL.
2. Place a probe on REAR PANEL BNC jack.
3. Adjust SWEEP RANGE and SWEEP VARI controls for horizontal sweep speed.
4. Adjust DEVIATION (kHz) and DEV CAL controls for vertical gain.
5. Adjust POSITION controls as desired.

SETTING FREQUENCY/FUNCTION FOR SCAN AND SEARCH MODES

1. SCAN
   Press this button to start scanning action. All channels which are not locked out will be scanned.

2. MANUAL
   Press this button to advance channels from 1 to 10. Programming frequencies into channels is done in the MANUAL mode. (SEE PROGRAMMING)

3. LOCK
   Press this button to lock (omit) a channel. (Unit must be stopped on that channel to lock or unlock.) The locked channel will have an LCK in the display. The locked channel will be skipped during scanning. To unlock a channel, press LOCK.

4. SEARCH
   Use this button to set lower and upper search frequencies and for searching unknown frequencies within the set limits. (See PROGRAMMING SEARCH LIMITS and USING THE SEARCH FEATURE.) The display will show SRH during search.
PROGRAMMING

1. TEST
   Press to check processor operation. The display will show rolling 8’s (signaled by two beeps) and then the ten programmed frequencies one-by-one. Unit will always return to channel 1 in the MANUAL mode.

2. DIM
   Press to change display brilliance from bright to dim or dim to bright.

3. DISPLAY
   Press to display frequency (in MHz) of a given channel in SCAN or MANUAL mode. Press again to display channel number.

4. DELAY-HOLD
   Dual function key. DELAY effective in SCAN and SEARCH modes. Press to delay resumption of scan or search when stopped on a given channel. DLY will appear on display next to channel number. Press key again to remove delay. Use HOLD position of the key to remain on an active frequency in SEARCH mode. HLD will appear on display.

5. CLEAR
   Dual function key. Use to erase an incorrect frequency (ex., outside permitted range) prior to pressing enter. The decimal (.) on the key is for entering a decimal point.

6. 1-9
   Numerical keys for entering frequencies or selecting channel numbers.

7. 0/10
   Dual function key. 0 is used for entering frequencies; 10 is for channel 10.

8. ENTER
   Use this key to enter a frequency during programming.

PROMPTING MESSAGES

The following is an explanation of the prompts/indications that appear on the display during the course of operation.

SRH    Unit is searching.
LCK    Locked channel. Appears in Manual only.
DLY    Delay effective in SCAN and SEARCH.
HLD    Hold. Effective in SEARCH only.
Fr Err Frequency is outside permitted range.
no ch  All channels are locked. Appears in SCAN only.
Pr Off Indicates that the microprocessor has been reset or that power has been lost for more than 24 hours.
PROGRAMMING SEARCH FREQUENCY LIMITS

In the SCAN mode, the unit can be programmed to search for frequencies between a lower (LO) and an upper (UP) limit. To set the LO and UP frequency limits, proceed as follows:

1. Press MANUAL and then SEARCH. The display will alternately flash LO and the current lower frequency limit. NOTE: SRH will appear on display in the SEARCH mode.

2. Press numeral keys corresponding to the desired lower frequency limit (Use CLEAR for decimal). Press ENTER.

3. Press ENTER again. The display will alternately flash UP and the current upper frequency limit.

4. Press numeral keys corresponding to the desired upper frequency limit (Use CLEAR/. for decimal). Press ENTER.
   NOTE: The new frequency limits may be reviewed (verified) by pressing ENTER.

USING THE SEARCH FEATURE

After the search limits have been programmed, press SCAN and then SEARCH. The unit will start to search and stop on an active frequency. This frequency can be assigned to any of the 10 channels by pressing ENTER and the channel number (EX.: to assign frequency to channel 5, press ENTER and then 5). The unit will resume search on the same channel frequency. To stop the search, press MANUAL. To resume the search after stopping, press SCAN and then SEARCH.
   NOTE: Activate the hold feature if you wish to stay on the first active channel.

ACCESSING CHANNELS DIRECTLY

Manual Mode: Press the numeral keys for the desired channel number, and then MANUAL again.

SCAN Mode: Press the numeral Keys for the desired channel number. The unit will now be in MANUAL for the desired channel.

SCANNING CHANNELS

Press SCAN. The unit will go through all unlocked channels and stop on an active channel. It will stay there until transmission ceases, and thereafter goes to the next active channel.
   NOTE: All locked channels will be skipped.
RESETTING MICROPROCESSOR

A momentary power line failure or a voltage drop may cause erratic display and/or keyboard operation. If this occurs, simply push SEARCH and SCAN buttons at the same time while the unit is turned on. The display will read "PR Off". NOTE: You must then reprogram the unit with all of your frequencies.

MEMORY

Your FM-110 is equipped with a permanent backup system, requiring no batteries. A memory capacitor retains stored frequencies for approximately 24 hours during a power outage.

NATIONAL WEATHER SERVICE

The National Oceanic and Atmospheric Administration (NOAA) broadcasts continuous (24 Hours) weather information throughout the US on the following frequencies (MHz):

| 162.400 | 162.500 |
| 162.425 | 162.525 |
| 162.450 | 162.550 |
| 162.475 |

(Canadian weather can be monitored on 161.650 MHz.)

If you are located within 25 to 30 miles of one of these cities, reception can usually be obtained with the telescopic antenna.

IMPORTANT: When set to automatic scan, the FM-110 will stop and remain on the weather channel because it broadcasts continuously. Thus, this channel should only be activated when you desire to hear the current weather report.

*We recommend the use of an RF Fuse (one is supplied with the FM-110 unit. Others may be purchased from AIE Corporation.
OPTION 8 -- Digital Squelch

1. To enable Digital Squelch, set the first digit of the F2 switch bank to 0.

2. Digital Squelch is now enabled and the next 3 digits of the F2 switch bank will be your digit code. For example: For a digital code of 123, your switches will read 0123.

3. In the event that inversion of the code is required, you may do this by switching the F2 range switch to X.1.

4. To set Deviation Squelch levels, adjust the F2 level control for the desired deviation level.
OPTION 9 -- 12V DC OPERATION

General Information

When it is desired to operate the FM-110 from a 12volt external source, replace the normal 110/220V power cord with the two conductor cable supplied with your unit.

It is necessary now only to connect the black wire to (−) ground and the white wire to (+) voltage. The unit will operate over a 12V DC to 16V DC range. It is essential that a source capable of supplying at least two (2) ampere is provided.

In the 12 volt mode of operation, the oscilloscope is inoperative. Deviation can be measured or set by viewing the bar graph and switching the Normal/Deviation switch to Deviation. Calibration for the bar graph is internal. Error and SINAD measurements can be made by switching bands to NORMAL.

An internal fuse is installed for protection of the 12 volt circuits. In the event that the unit will operate from an AC source, but will not operate from a 12 volt DC source, it is probable that this fuse is blown. To replace, remove the top cover and you will observe the fuse on the upright panel.
After following the GETTING STARTED procedure, if the scope trace appears skewed, proceed as follows:

1. Set function switch to GENERATE.
2. Set MODULATION switch to EXT with no input to EXT jack.
3. Observe unmodulated scope trace.

NOTE: Make sure to observe the trace from directly in front of the center of the scope, otherwise parallax error may cause apparent skew.

4. If skew needs readjustment (from shipping jolts) continue below:
5. Remove from rear panel 6 black Phillips screws, all within 3/4" of edge. Do not remove 4 screws around speaker opening.
6. Gently lay back rear panel. Speaker wires are still connected.
7. Locate 1/16" x 3/8" slot in plate behind scope tube. Loosen slightly, but do not remove, 2 screws near arrows 1 1/4" from each end of slot.
8. Insert large, flat blade screwdriver into slot and turn carefully until trace is horizontal as viewed from directly in front of scope.
9. Retighten screws at ends of slot.
10. Replace rear panel and its 6 screws.

CAUTION: During panel replacement, make certain that speaker wires are not pinched between panel and case.
FM 110                        ADDENDUM 2
Applies to serial numbers 0124 and higher

NOTE: If serial number is 0123 or lower, see ADDENDUM 1

A. SCOPE TRACE ALIGNMENT

After following the GETTING STARTED procedure, if the scope trace appears skewed, proceed as follows:

1. Set function switch to GENERATE.
2. Set MODULATION switch to EXT with no input to EXT jack.
3. Observe unmodulated scope trace.
   NOTE: Make sure to observe the trace from directly in front of the center of the scope, otherwise parallax error may cause apparent skew.
4. If skew needs readjustment (from shipping jolts) continue below:
5. Locate 3 holes in rear panel behind scope tube socket. Center hole is larger than 2 outer holes.
6. Using Phillips screwdriver, loosen slightly, but do not remove, both outer screws.
7. Using a large flat-blade screwdriver in larger center hole, rotate axis of scope until trace is horizontal as observed from directly in front of unit.
8. Retighten both adjacent Phillips screws loosened above.

B. R-F INPUT FUSE

1. If in RECEIVE mode, unit seems insensitive to incoming signals, check r-f input fuse as follows:
2. At lower left corner of front panel, unscrew BNC connector labelled RF IN.
3. Check fuse. If open, replace with 1/8 Amp Picofuse. Cut axial leads to 3/16" on both ends. Reinstall BNC connector.
4. Probable cause of fuse failure was excessive r-f power input.
1. **Simplex Operation.** Generating OR receiving on the same frequency, according to the GEN/REC switch:
   1.1 Place switch in GEN OR REC position.
   1.2 Key in frequency (See manual). Press ENTER.
   1.3 Unit now generates OR receives according to GEN/REC switch.

2. **Duplex Operation.** Simultaneously generating AND receiving on different frequencies.
   2.1 Place switch in GEN OR REC position.
   2.2 Press MANUAL, then key in generate frequency.
   2.3 Press ENTER. Make a note of generate frequency because generate frequency will no longer be displayed.
   2.4 Place switch in GEN + REC position.
   2.5 Press MANUAL, then key in receive frequency.
   2.6 Press ENTER. Display now reads receive frequency only. Generate frequency cannot be displayed.
   2.7 Unit now generates previously entered generate frequency (undisplayed) and also receives displayed frequency.
   2.8 Use the GEN/REC switch as follows:
   2.8.1 GEN position: Scope displays generated waveform and SINAD bargraph operates. Speaker is muted.
   2.8.2 REC position: Scope displays received waveform and bargraph indicates received frequency error.

3. **Once in Duplex mode, then what?**
   3.1 To revert from Duplex to Simplex: Place switch in GEN OR REC position, press ENTER. Unit now generates OR receives on displayed frequency, depending upon position of GEN/REC switch. Change frequency if desired. (Press MANUAL, key in frequency, then press ENTER).
   3.2 To reenter Duplex operation again, go back to Step 2.
   **NOTE:** If input power to the FM-110 is lost by ON/OFF or any reason, it is necessary to reset Duplex mode by step 2.

**EXAMPLE**

To analyze a repeater station whose receive input frequency is 452.1 MHz and transmit output frequency is 457.1 MHz:
1. Connect cable from FM-110 RF-OUT to repeater receiver input.
2. Connect (not directly, but via attenuators or loosely coupled antennas) from repeater transmit output to to FM-110 RF-IN. Maximum input to FM-110 is 3.5 V rms (.25 Watts).
3. Place FM-110 in GEN OR REC and GEN positions.
4. Key in: MANUAL-4-5-2-.1-ENTER. Display shows 452.100.
5. Place switch in GEN + REC position.
6. Key in: MANUAL-4-5-7-.1-ENTER. Display shows 457.100.
7. In GEN position, adjust f1 and/or f2 modulation using scope. Connect repeater audio output to FM-110 SINAD INPUT to measure SINAD sensitivity on bargraph.
8. Place switch in REC position. Scope now displays the modulation from the repeater's transmitter. Bargraph shows its frequency error.
ADDENDUM 4
Rev. A

Level Control of External Modulation

When applying external modulation to EXT input jack, press Modulation Function switch to EXT. External modulation level is now adjustable by F1 control as observed on scope. Internal F1 1000Hz is disabled.

NOTE: EXT switch is push ON-push OFF type, not returned to OFF when F1, F2 or F1+F2 is pressed.

Combining Internal and External Modulation

1. Place unit in GEN position.
2. Apply external modulation to EXT jack.
3. Press Function Switch EXT (in=ON).
4. Release Function Switches F1, F2 and F1+F2 to OFF (out).
5. Use F1 control to set external modulation as observed on scope.
6. Press Function Switch EXT to release (out=OFF).
7. Press Function Switch F2 to ON.
8. Adjust internal modulation frequency with F2 Frequency Switch.
9. Adjust F2 level with F2 control as observed on scope.
10. Combine EXT with F2 by pressing F1+F2 switch and EXT switch to ON.
Addendum 5

A 1/8 amp Fuse has been added in the RF Out Line. This fuse is necessary to protect the output attenuator from accidental reverse power. DO NOT OPERATE the equipment without the proper rated fuse.

To replace this fuse, remove the (3) three #6 screws along the bottom of the front panel. Turn the unit upside down and remove the front part of the bottom. To do this it is necessary to remove the (5) #6 screws and the (11) #4 screws.

You will note the RF fuse is soldered directly to the connector. Replace with an identical rated part in the same manner.
NOTES:
1. ALL RESISTOR VALUES ARE IN OHMS, 1/4 WATT, UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITOR VALUES ARE IN PICO-FARADS, UNLESS OTHERWISE SPECIFIED.
3. LAST COMPONENT USED R239, C235, L204, CR203, Q205, AND U204.
UNSCREW REC BNC TO REPLACE

IN 1/8 A

RF

OUT 1/8 A MOUNTED AT BNC. REMOVE FRONT SECTION OF BOTTOM COVER TO REPLACE

X10 X10 X10 X10

+5V

10K

1.3 K

.001

+10V GEN

TO X10 ON RF DECK

TO RF OUT ON RF DECK

TO C50/L16 ON RF DECK

* USE ONLY 1/8 A TO PROTECT ATTENUATORS