ifr INC

FM/AM-1500
COMMUNICATIONS SERVICE MONITOR

OPERATOR'S GUIDE

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SECTION 1 — INTRODUCTION

1-1 GENERAL

The FM/AM-1500 is a microprocessor controlled, digitally synthesized communication service monitor, which integrates the functions of several different test instruments into a single, compact and portable unit. Utilizing such unique features as a keyboard entry system, an LCD display for frequency readout, processor controlled memory functions and a CRT capable of alphanumeric or waveform displays, the FM/AM-1500 incorporates the functions of the following test equipment:

1. Signal Generator (with a selectable offset for duplex testing)
2. Communication Receiver
3. Tracking Generator
4. Spectrum Analyzer
5. Sweep Generator
6. Oscilloscope
7. Two programmable Tone Generators
8. Power Meter
9. Frequency Error Meter
10. Modulation Meter
11. SINAD Meter
12. Audio Frequency Counter
13. Signal Strength Meter

These capabilities enable the FM/AM-1500 to be used for a wide range of communication test functions associated with most types of simplex and duplex transceiving equipment, including mobile telephone systems, AM/FM/SSB transceivers, CB and two-way radio systems, repeaters, etc.

1-2 SIGNAL GENERATOR/RECEIVER

The FM/AM-1500 Signal Generator is capable of generating modulated or unmodulated carrier signals within a range of 100 kHz to 999.9999 MHz (in 100 Hz steps), at an output level which is continuously variable from 0 to -128 dBm. The generated carrier signal may be AM or FM modulated by internal modulation signals originating from one or both of the FM/AM-1500 tone generators or by external sources applied through front panel modulation input connectors. The generator may also be voice-modulated and keyed through the front panel microphone input connector. All of the above described modulation sources, or any combination thereof, may be simultaneously applied to the carrier signal. During generator operation, signals being generated can be monitored by the FM/AM-1500 receiver and its associated monitoring devices.

The signal generator also features a selectable offset frequency function to permit testing of duplex equipment, which receives and transmits simultaneously on different frequencies. See paragraph 1-3 for additional information on this feature.

The FM/AM-1500 receiver is a quadruple conversion superheterodyne receiver, capable of monitoring communication signals within a range 300 kHz to 999.9999 MHz, in 100 Hz steps. Signals may be received "off-the-air" using an external antenna or by direct cable connection through the front panel TRANS/-40 dB

DUPLEX Connector. Associated receiver monitoring circuits include a frequency error meter, modulation meter, power meter, SINAD meter, signal strength meter, frequency error and demodulated audio counters, spectrum analyzer and oscilloscope.

1-3 SIMPLEX/DUPLEX CAPABILITIES

A prime feature of the FM/AM-1500 is the capability of testing both simplex and duplex communication equipment. Simplex operation applies to any equipment that communicates in only one direction at a time, including ordinary transmit-receive or press-to-talk operation, voice operated carrier and other forms of manual or automatic switching from transmit to receive. Duplex operation is characteristic of any equipment which transmits and receives simultaneously between two locations, such as mobile telephone systems and repeaters.

In simplex mode, the FM/AM-1500 will function either as a communication receiver or a signal generator, depending on which function is selected. In simplex receive, the FM/AM-1500 receiver monitors incoming signals received "off-the-air" or applied via direct cable connection through the front panel TRANS/-40 dB DUPLEX Connector. In this mode, the FM/AM-1500 signal generator is inactive. In simplex generate mode, the FM/AM-1500 is capable of generating modulated or unmodulated carrier signals, while the receiver circuits are simultaneously monitoring the generated output.

In the duplex mode, the FM/AM-1500 has the capability of generating and receiving signals simultaneously. While the receiver section of the FM/AM-1500 is monitoring incoming signals transmitted by the UUT, the FM/AM-1500 signal generator is simultaneously generating signals to stimulate the receiver section of the UUT. The frequency of the generated signal from the FM/AM-1500 can be offset up to ±50 MHz from the transmitting frequency of the UUT, in 10 kHz steps. Three methods of duplex testing are available to the FM/AM-1500 user, depending on the UUT and its associated systems:

1. Duplex Testing Using Separate Transmit/Receive Lines
2. Duplex Testing Using 1 Common Receive/Transmit Line
3. "Off-the-air" Duplex Testing

The methods of duplex testing are described in detail in paragraph 4-9 of SECTION 4.

1-4 DATA DISPLAY & CONTROL FEATURES

Operator interaction with the FM/AM-1500 is facilitated through the following primary data display and control features:

1. **Keyboard**
   The Keyboard provides a means of entering data into the FM/AM-1500 microprocessor, to control the operation of the signal generator, receiver and tone generator functions. The Keyboard is also used to address the FM/AM-1500 programmable menu functions which utilize the automatic storage, retrieval and execution capabilities of the set.

2. **LCD Display**
The LCD is used to display the current or "real time" operating frequencies associated with the FM/AM-1500 tone generators, signal generator and receiver functions.
3. **CRT Monitor**
The FM/AM-1500 CRT Monitor serves as a multimode CRT, capable of both alphanumeric or waveform displays, as selected by the front panel DISPLAY Switch. The CRT display modes associated with the waveform display capability include the oscilloscope, spectrum analyzer, tracking generator and sweep generator functions; alphanumeric displays include the RF and tone frequency menus, digital meter menu and operator assistance menus.

1-5 MENU FUNCTIONS

The FM/AM-1500 has an internal non-volatile memory capability which uses a menu display format to extend the monitoring and automatic testing capabilities of the set. All menus are accessed using the front panel Keyboard and are displayed on the CRT monitor. Available displays include several user-programmable RF and tone frequency menus, as well as several non-programmable utility menus, which are defined as follows:

RF Frequency Menus
Consisting of the RF MEMORY, RF SCAN and RF SWEEP menus, these menus enable the operating parameters of the RF signal generator and receiver functions to be programmed for use in automatic storage, scanning and sweeping operations. Also included within this group of menus is a CABLE FAULT Menu, used for computing cable fault distances. This menu is normally used in conjunction with the FM/AM-1500 Tracking Generator function.

Tone Frequency Menus
Associated with the FM/AM-1500 tone generator functions, these menus allow the generators to be programmed for automatic tone sequences, tone sweeping functions, DTMF (Dual Tone Multiple Frequency) testing and DCS (Digitally-Coded Squelch) Testing.

METER Menu
This menu provides an alphanumeric display of the monitored signal parameters measured by the FM/AM-1500 front panel analog meters. Parameters displayed on this menu include modulation, power, signal strength, frequency error, demodulated audio frequency and SINAD.

HELP Menus
These menus provide a display of FM/AM-1500 menu operating aids and programming codes for hardware self-test routines.

Detailed instructions for operating the FM/AM-1500 menu functions are contained in Section 5.

1-6 GENERATOR/RECEIVER SUPPORT FUNCTIONS

The FM/AM-1500 has the following additional operating functions which are primarily used to support the generate/receive capabilities of the set:

- Spectrum Analyzer
- Oscilloscope
- Tracking Generator
- Sweep Generator
- Programmable Tone Generators
- Front Panel Analog Meters

The use and application of these functions are described in detail in Sections 3 and 4 of this manual.

SECTION 2 — INSTALLATION

2-1 GENERAL

Preparing the FM/AM-1500 for operation is a simple procedure which consists of the following basic steps (reference Figures 2-1 and 2-2):

1. Set the FM/AM-1500 into a vertical or horizontal operating position, with cover removed.
2. Connect external antenna to FM/AM-1500 ANTENNA Connector, if "off-the-air" monitoring is desired.
3. Furnish electrical power to FM/AM-1500 as follows:

External AC Power

a) Connect furnished AC power cable between 115/230 VAC power source and AC POWER Input Connector on rear panel of FM/AM-1500.

b) Place PWR/OFF/BATT Switch to "PWR" position.

External DC Power

a) Connect furnished DC Power Cable between external 11 to 18 VDC power source and DC Power Input Connector on rear panel of FM/AM-1500.

b) Place PWR/OFF/BATT Switch to "PWR" position.

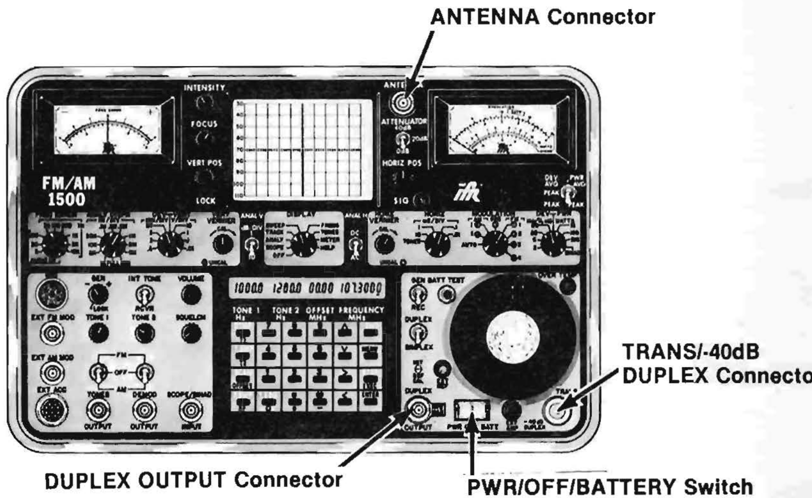


Figure 2-1 FM/AM-1500 Front Panel

Internal Battery Power

a) Place PWR/OFF/BATT Switch to "BATT" position, if optional battery is installed. (This is a push on/off switch.) When operating the test set on battery, an internal timer will interrupt power after approximately 10 minutes. Depress PWR/OFF/BATT Switch (13) to "BATT" position to restore power to test set.

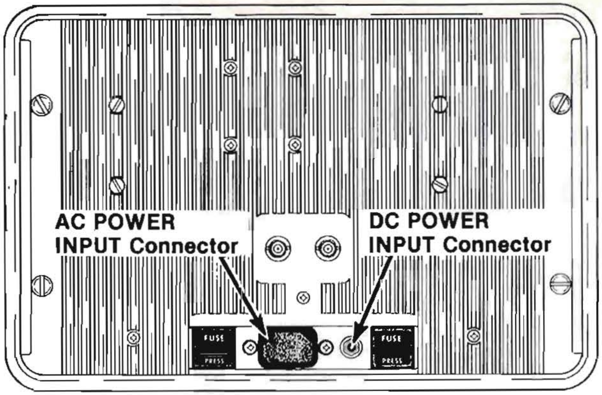


Figure 2-2 FM/AM-1500 Rear Panel

NOTE:

The oven oscillator is powered by the internal battery when the test set is switched to battery operation. However, there is no provision for preheating the oven oscillator. A 15 minute warm-up period is required, with the test set at room temperature, in order to stabilize the oven oscillator. The test set will turn on and operate immediately on battery operation, but the oven oscillator frequency will not be within specifications without the required 15 minute warm-up period. It is recommended the test set be connected to an AC or DC power source for the required 15 minute warm-up period.

2-2 INSTALLATION & OPERATION PRECAUTIONS

To prevent possible damage to the FM/AM-1500, the following power input and general operating precautions should be observed at all times (see Figure 2-1 for connector locations):

CAUTION:

ANTENNA CONNECTOR

DO NOT TRANSMIT INTO THIS CONNECTOR. MAXIMUM CONTINUOUS INPUT TO ANTENNA CONNECTOR MUST NOT EXCEED 0.25 WATTS, OR DAMAGE TO FM/AM-1500 MAY RESULT.

TRANS/-40 dB DUPLEX CONNECTOR

MAXIMUM CONTINUOUS INPUT TO TRANS/-40 dB DUPLEX CONNECTOR MUST NOT EXCEED 150 WATTS. IF OVERTEMP INDICATOR LAMP ILLUMINATES AT ANY TIME, WHEN POWER IS APPLIED TO THIS CONNECTOR, REMOVE POWER IMMEDIATELY. DO NOT REAPPLY POWER UNTIL OVER-TEMP INDICATOR LAMP EXTINGUISHES.

DUPLEX OUTPUT CONNECTOR

DO NOT TRANSMIT INTO THIS CONNECTOR. THIS CONNECTOR IS NOT PROTECTED FOR POWER INPUTS IN EXCESS OF 2.5 WATTS.

CRT INTENSITY

DO NOT OPERATE CRT DISPLAY WITH EXCESSIVE INTENSITY.

SCOPE/SINAD INPUT CONNECTOR

DO NOT APPLY MORE THAN 200 VOLTS PEAK-TO-PEAK TO THIS CONNECTOR.

POWER ON/OFF SWITCH

TO PROVIDE MAXIMUM PROTECTION OF NON-VOLATILE MEMORY CONTENTS, OBSERVE THE FOLLOWING STEPS:

1) Do not rapidly cycle power ON and OFF. Allow a minimum of one second between power ON/OFF cycle.
2) Ensure power is not shut off during data entry before ENTER Key is pressed, as the data being entered will be lost.

Do not apply any signals into the FM/AM-1500 other than those defined in the operating instructions. Other than the input power and operating restrictions described above, any combination of front panel control positions will not adversely affect the FM/AM-1500.

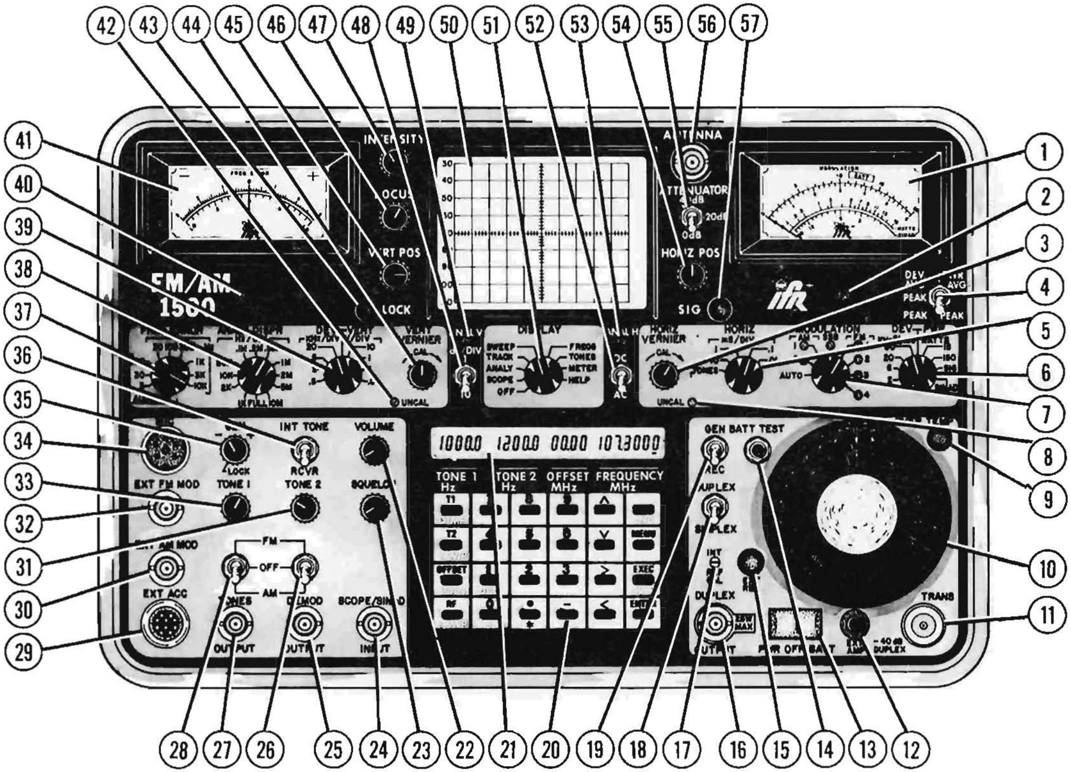


Figure 3-1 FM/AM-1500 Front Panel With Callouts

1. MODULATION Meter
2. MODULATION Meter Mechanical Zero Adjustment
3. HORIZ VERNIER Control
4. AVG PEAK/PEAK Switch
5. HORIZ Control
6. DEV/PWR Control
7. MODULATION Control
8. UNCAL Indicator (Horizontal)
9. OVERTEMP Indicator
10. RF Output Level Control
11. TRANS/-40 dB DUPLEX Connector
12. Optional Generate Amplifier Connector
13. PWR/OFF/BATT Switch
14. BATT TEST Button
15. EXT Reference Indicator
16. DUPLEX OUTPUT Connector
17. INT REF CAL Adjustment
18. DUPLEX/SIMPLEX Switch
19. GEN/REC Switch
20. KEYBOARD
21. LCD
22. VOLUME Control
23. SQUELCH Control
24. SCOPE/SINAD INPUT Connector
25. DEMOD/OUTPUT Connector
26. Tone 2 FM/OFF/AM Switch
27. TONES OUTPUT Connector
28. Tone 1 FM/OFF/AM Switch
29. EXT ACC Connector
30. EXT AM MOD Connector
31. TONE 2 Control
32. EXT FM MOD Connector
33. TONE 1 Control
34. MIC Connector
35. GEN/LOCK Control
36. INT TONE/RCVR Switch
37. FREQ ERROR Control
38. ANALY DISPR Control
39. DEV/VERT Control
40. FREQ ERROR Mechanical Zero Adjustment
41. FREQ ERROR Meter
42. UNCAL INDICATOR (Vertical)
43. Freq LOCK Indicator
44. VERT VERNIER Control
45. VERT POS Control
46. FOCUS Control
47. INTENSITY Control
48. dB/DIV Switch
49. Vertical Centering Adjustment (Analyzer)
50. CRT
51. DISPLAY Control
52. DC/AC Switch
53. Horizontal Centering Adjustment (Analyzer)
54. HORIZ POS Control
55. ATTENUATOR Switch (Antenna)
56. ANTENNA Connector
57. SIG Indicator

3-1 FRONT PANEL (Reference Figure 3-1, FM/AM-1500 Front Panel)

1. **MODULATION Meter**

   Provides visual display of modulation levels, power levels, relative signal strength, SINAD and Battery Voltage as determined by setting of DEV/PWR Control (6), MODULATION Control (7) and BATT TEST Button (14).

2. **MODULATION Meter Mechanical Zero Adjustment**
Adjustment screw used for mechanical zeroing of MODULATION Meter (1) when power to FM/AM-1500 is "OFF".

3. **HORIZ VERNIER Control**
Provides fine adjustment of oscilloscope horizontal sweep rate. When positioned fully clockwise, sweep is calibrated according to setting of HORIZ Control (5).

4. **AVG PEAK/PEAK Switch**
Controls power, % Modulation and deviation meter indication on MODULATION Meter (1) as follows:

MEASUREMENT	POSITION	INDICATION
FM Deviation	Peak	Meter indicates peak FM deviation. **NOTE:** Indication is the highest of the + or - peak deviation, whichever is greater.
	Avg Peak	Meter indicates average FM deviation calibrated to peak deviation for SINE WAVE modulation.
RF Power	Peak	Meter indicates peak RMS RF envelope power.
	Avg	Meter indicates average RMS RF envelope power.

Table 3-1 AVG PEAK/PEAK Switch Modulation Meter Indications

MEASUREMENT	POSITION	INDICATION
AM % Modulation	Peak	Indicates peak AM % modulation. **NOTE:** Indication is the highest of the + or - peak modulation, whichever is greater.
	Avg Peak	Meter indicates average AM % modulation calibrated for peak SINE WAVE modulation.

Table 3-1 AVG PEAK/PEAK Switch Modulation Meter Indications

5. **HORIZ Control**
Selects horizontal sweep rate of the oscilloscope as follows:

TONES POSITION — Horizontal sweep is driven by sinusoidal output of Tone Generator #1.

NUMBERED POSITIONS — Represent oscilloscope sweep rate in milliseconds per division, when HORIZ VERNIER Control (3) is in CAL position (fully clockwise) and UNCAL INDICATOR LAMP (8) is extinguished.

6. **DEV/PWR Control**
Selects range and input source for MODULATION METER (1) as follows:

DEV/PWR CONTROL POSITION	INPUT SOURCE	MODULATION METER RANGE	MODULATION METER SCALE
kHz/% x 10 (All positions)	FM/AM-1500 Demodulator	2 kHz DEV/20% AM full scale to 60 kHz DEV/600% AM full scale	First (top) and second
WATTS (15 and 150)	TRANS/-40 dB DUPLEX Connector	15 Watts full scale to 150 Watts full scale	Third
SIG	ANTENNA Connector	Relative Signal Strength. (Not calibrated)	None; observe relative deflection of meter needle.
SINAD	SCOPE/SINAD INPUT Connector	0 dB to 20 dB	Fourth (bottom)

Table 3-2 DEV/PWR Control Setting

7. **MODULATION Control**

Selects demodulation mode of FM/AM-1500 receiver for FM, AM, SSB and their associated pre- and post-detection bandwidths, as follows:

MODULATION CONTROL POSITION	DEMODULATION MODE	PRE-DETECTION BANDWIDTH	POST-DETECTION BANDWIDTH
AM_1 AM_2	AM AM	6 kHz 15 kHz	8 kHz 8 kHz
FM_1 FM_2 FM_3 FM_4	FM FM FM FM	15 kHz 200 kHz 200 kHz 200 kHz	8 kHz 8 kHz 20 kHz 80 kHz
SSB	SSB	6 kHz	8 kHz
AUTO	Demodulation mode and bandwidth selection is automatically made by FM/AM-1500 processor, according to demodulation parameters programmed into the appropriate menu functions.		

Table 3-3 Modulation Control Settings

8. **UNCAL Indicator**

Illuminates when HORIZ VERNIER Control (3) is not in the fully clockwise (CAL) position.

9. **OVERTEMP Indicator**

Illuminates when internal power attenuator becomes excessively hot. Transmitter power applied to TRANS/-40 dB DUPLEX Connector (11) must be removed when OVERTEMP Indicator is "ON". RF Power may be re-applied when indicator is extinguished.

CAUTION:

MAXIMUM CONTINUOUS INPUT TO TRANS/-40 dB DUPLEX CONNECTOR MUST NOT EXCEED 150 WATTS.

10. **RF Output Level Control**

Controls RF output level of the FM/AM-1500 signal generator (at DUPLEX OUTPUT Connector [16] and TRANS/-40 dB DUPLEX Connector [11]), per indicated dBm and uV SCALES as follows:

OUTPUT CONNECTOR	SIMPLEX MODE	DUPLEX MODE
TRANS/-40 dB DUPLEX (11)	As indicated on RF Output Level Control Scale.	40 dB below indication of RF Output Level Control
DUPLEX OUTPUT (16)	N/A	As indicated of RF Output Level Control

Table 3-4 RF Output Connector Levels

11. **TRANS/-40 dB DUPLEX Connector**

Functions as a generator/receiver I/O connector in both the simplex and duplex mode of operation. In simplex mode, generator output level at this connector is equal to setting of RF Output Level Control (10). In duplex mode, output level is 40 dB less than setting of RF Output Level Control (10). When external RF power is applied to this connector, internal switching enables this input as a high level spectrum analyzer input.

CAUTION:

MAXIMUM CONTINUOUS INPUT TO TRANS/-40 dB DUPLEX CONNECTOR MUST NOT EXCEED 150 WATTS. IF OVERTEMP INDICATOR (9) ILLUMINATES AT ANY TIME WHILE POWER IS APPLIED TO THIS CONNECTOR, REMOVE POWER IMMEDIATELY. DO NOT REAPPLY POWER UNTIL OVERTEMP INDICATOR EXTINGUISHES.

When using TRANS/-40dB DUPLEX Connector (11) in duplex mode, and there is no UUT connected to the DUPLEX OUTPUT Connector (16), terminate the DUPLEX OUTPUT Connector (16) to maintain level accuracy of the TRANS/-40dB DUPLEX Connector Output.

12. **Optional Generate Amplifier Connector**

Furnishes +12 VDC power to optional Generate Amplifier, when connected to this connector and to TRANS/-40 dB DUPLEX Connector (11). FM/AM-1500 must be in "generate" mode for this connector to be active.

13. **PWR/OFF/BATT Switch**
Applies/interrupts power to FM/AM-1500 as follows:

PWR POSITION — FM/AM-1500 is powered by external AC or DC power source.
OFF POSITION — FM/AM-1500 is "OFF".
BATT POSITION — FM/AM-1500 is powered by internal battery.

NOTE:
Internal FM/AM-1500 battery is continuously charged when external power is connected to set.

14. **BATT TEST Button**
When depressed, reflects internal battery voltage on top scale of MODULATION Meter (1), regardless of position of DEV/PWR Control (6).

15. **EXT Reference Indicator**
Illuminates when an external 10 MHz reference signal is applied to rear panel 10 MHz REF INPUT Connector (62) and is being accepted by the FM/AM-1500. When EXT Reference Indicator is not illuminated, the unit is referenced to the TCXO Master Oscillator. In this state, a 10 MHz Reference signal is present at the 10 MHz Reference Connector (62) which can be used to monitor the TCXO Master Oscillator frequency.

16. **DUPLEX OUTPUT Connector**
Output connector for a duplex receiver with a separate receive input. The FM/AM-1500 generator output level at this connector is equal to setting of RF Output Level Control (10), when in generate "DUPLEX" mode. This connector is not active in generate "SIMPLEX" mode.

CAUTION:
DO NOT TRANSMIT INTO THIS CONNECTOR. THIS CONNECTOR IS NOT PROTECTED FOR POWER INPUTS IN EXCESS OF 2.5 WATTS.

NOTE:
When using TRANS/-40dB DUPLEX Connector (11) in duplex mode, and there is no UUT connected to the DUPLEX OUTPUT Connector (16), terminate the DUPLEX OUTPUT Connector (16) to maintain level accuracy of the TRANS/-40dB DUPLEX Connector Output.

17. **INT REF CAL Adjustment**
10 MHz internal reference adjustment.

18. **DUPLEX/SIMPLEX Switch**
Controls transmit/receive capabilities of FM/AM-1500 as follows:

SIMPLEX Position — FM/AM-1500 functions as a receiver **or** signal generator, depending on position of GEN/REC Switch (19). In this mode, signals can be received through the TRANS/-40 dB DUPLEX Connector (11) or ANTENNA Connector (56) and generated out through the TRANS/-40 dB DUPLEX Connector.

DUPLEX Position — FM/AM-1500 functions as a receiver and signal generator simultaneously. In this mode, signals can be received and generated as follows, depending on UUT and its associated systems:

a. Simultaneous transmission and reception through TRANS/-40 dB DUPLEX Connector (11).
b. Reception through TRANS/-40 dB DUPLEX Connector (11) and transmission out through DUPLEX OUTPUT Connector (16).
c. Reception through ANTENNA Connector (56) and transmission out through DUPLEX OUTPUT Connector (16).

NOTE:

In "GENERATE SIMPLEX" mode, the RF output level at TRANS/-40 dB DUPLEX Connector (11) is equal to setting of RF Output Level Control (10).

In "GENERATE DUPLEX" mode, the RF output level at TRANS/-40 dB DUPLEX Connector (11) is 40 dB less than setting of RF Output Level Control (10).

In "GENERATE DUPLEX" mode, the RF output level at DUPLEX OUTPUT Connector (16) is equai to setting of RF Output Control (10).

19. **GEN/REC Switch**
Places the FM/AM-1500 into the generate or receive mode.

20. **KEYBOARD**
Used for data entry and control of FM/AM-1500 microprocessor.

21. **LCD**
Provides digital display of selected TONE 1, TONE 2, generator OFFSET and RF FREQUENCY, as entered through operator Keyboard (20).

22. **VOLUME Control**
Controls volume of FM/AM-1500 speaker.

23. **SQUELCH Control**
Controls receiver squelch threshold. Squelch disables audio output, freq error and modulation indicators when RF input at ANTENNA Connector (56) falls below squelch threshold.

24. **SCOPE/SINAD INPUT Connector**
Input connector for oscilloscope and SINAD measurements.

CAUTION:
DO NOT APPLY MORE THAN 200 VOLTS PEAK-TO-PEAK TO THIS CONNECTOR.

25. **DEMOD OUTPUT CONNECTOR**
Output connector for demodulated audio signals, as selected by MODULATION Control (7).

26. **Tone 2 FM/OFF/AM Switch**
Selects modulation mode of Tone Generator #2. (For manual tone functions only. Automated tone functions directly control level in addition to source.)

27. **TONES OUTPUT Connector**
Output connector which presents summation of Tone Generators #1 and #2. Mixing levels of output tones are controlled by TONE 1 Control (33) and TONE 2 Control (31) or by FM/AM-1500 processor, if a menu associated tone function is being executed.

28. **Tone 1 FM/OFF/AM Switch**
Selects modulation mode of Tone Generator #1. (For manually operated tone functions only. Automated tone functions directly control level in addition to source.)

29. **EXT ACC Connector**
Output connector used for monitoring purposes and for supplying power to external devices.

30. **EXT AM MOD Connector**
Input connector for applying external AM modulation signals.

31. **TONE 2 Control**
Controls output level of Tone Generator #2. Clockwise rotation of control increases output level of tone generator, while counter-clockwise rotation decreases output level. (This control is used for manually operated tone functions only. Automated tone functions directly control output level.)

32. **EXT FM MOD Connector**
Input connector for applying external FM modulation signals.

33. **TONE 1 Control**
Controls output level of Tone Generator #1. Clockwise rotation of control increases output level of tone generator, while counter-clockwise rotation decreases output level. (This control is used for manually operated tone functions only. Automated tone functions directly control output level.)

34. **MIC Connector**

Input connector for external microphone. Allows the microphone to AM or FM modulate the RF output, as selected by MODULATION Control (7) and also permits keying of FM/AM-1500 signal generator. When keying the microphone, the FM/AM-1500 will automatically switch to the generate mode, regardless of the position of the GEN/REC Switch (19).

35. **GEN/LOCK Control**

Controls FM/AM-1500 generator frequency and phase lock. When control is fully ccw in detent position, generator will be phase locked to FM/AM-1500 internal 10 MHz reference. When control is out of detent, generator is not phase locked and generator output frequency may deviate above and below selected phase lock frequency.

36. **INT TONE/RCVR Switch**

Selects audio source for FM/AM-1500 speaker as follows:

INT TONE Position — Speaker audio is supplied by Tone Generators #1 and #2.
RCVR Position — Speaker audio is supplied by FM/AM-1500 demodulator.

37. **FREQ ERROR Control**

Selects full scale sensitivity of FREQ ERROR Meter (41) between RF and audio frequency ranges. The audio frequency error is referenced to Tone Generator #1 frequency.

38. **ANALY DISPR Control**

Selects spectrum analyzer dispersion, tracking generator and sweep generator sweep range as follows:

POSITION	DISPERSION	BANDWIDTH
1 k	1 kHz/Div.	300 Hz
2 k	2 kHz/Div.	300 Hz
10 k	10 kHz/Div.	3 kHz
20 k	20 kHz/Div.	3 kHz
.1 MHz	.1 MHz/Div.	30 kHz
.2 MHz	.2 MHz/Div.	30 kHz
.5 MHz	.5 MHz/Div.	30 kHz
1 MHz	1 MHz/Div.	30 kHz
2 MHz	2 MHz/Div.	650 kHz
5 MHz	5 MHz/Div.	650 kHz
10 MHz	10 MHz/Div.	650 kHz
FULL	(0 to 1000 MHz) (100 MHz/Div.)	650 kHz

Table 3-5 Dispersion Control Settings

NOTE:

Center frequency is phase locked in all positions except "FULL" scan position.

NOTE:

The Receiver and the Generator are not useable for dispersion of 2 MHz/DIV or wider.

39. **DEV/VERT Control**

Controls vertical input and vertical sensitivity of oscilloscope. In "kHz/DIV" positions, vertical input is applied from FM demodulator. In "V/DIV" positions, vertical input is applied through SCOPE/SINAD INPUT Connector (24). When DEV/VERT Control is in any "kHz/DIV" position and AM demodulation mode is selected by MODULATION Control (7), oscilloscope will display the AM IF envelope.

40. **FREQ ERROR Mechanical Zero Adjustment**

Mechanical zero adjustment for FREQ ERROR Meter (41), when power to FM/AM-1500 is "OFF".

41. **FREQ ERROR Meter**

Provides visual display of difference between received signal frequency and FM/AM-1500 receiver frequency, as displayed in RF data field of LCD (21). The audio frequency error is referenced to Tone Generator #1 frequency.

42. **UNCAL INDICATOR**

Illuminates when VERT VERNIER Control (43) is not in the fully clockwise (CAL) position.

43. **Freq LOCK Indicator**

Indicates RF synthesizer circuits are phase locked when indicator is "ON". When indicator blinks on and off, RF synthesizer circuits are out of phase lock. This indicator also blinks when GEN/LOCK Control (35) is out of the "LOCK" position.

NOTE:

LOCK indicator blinks on and off when ANALY DISPR Control (38) is in "FULL"scan position. This is a normal operating condition.

44. **VERT VERNIER Control**

Provides fine adjustment of oscilloscope vertical sensitivity. When control is fully clockwise in "CAL" position, vertical sensitivity is equal to setting of DEV/VERT Control (35).

45. **VERT POS Control**

Controls vertical position of CRT trace for both oscilloscope and sweep generator functions. Also adjusts reference level of spectrum analyzer over range of vertical axis, when dB/DIV Switch (48) is in "1" dB/DIV position.

46. **FOCUS Control**

Controls focus of CRT trace.

47. **INTENSITY Control**

Controls intensity of CRT trace. Clockwise rotation of control increases trace intensity, while counter-clockwise rotation of control decreases trace intensity.

CAUTION:

DO NOT OPERATE CRT DISPLAY WITH EXCESSIVE TRACE INTENSITY.

48. **dB/DIV Switch**

Controls scaling factor of spectrum analyzer graticule:

1 dB/DIV Position — Vertical calibration of CRT display is 1 dB per division.
10 dB/DIV Position — Vertical calibration of CRT display is 10 dB per division.

49. **Vertical Centering Adjustment**

Spectrum Analyzer adjustment for calibrating major vertical axis of graticule to a known reference level. (NOT A NORMAL OPERATING CONTROL.)

50. **CRT**

Multimode display screen for FM/AM-1500. Display mode is determined by setting of DISPLAY Control (51).

51. **DISPLAY Control**

Selects function of CRT display as follows:

POSITION	FUNCTION
OFF	Power to CRT display is OFF.
SCOPE	CRT functions as an oscilloscope.
ANALY	CRT functions as a spectrum analyzer.
TRACK	CRT functions as a spectrum analyzer. Tracking generator is active.
SWEEP	CRT functions as an oscilloscope. Sweep generator is active.
FREQS	CRT will display the following selection of RF Frequency menu displays: RF Memory Menu RF Scan Menu RF Sweep Menu Cable Fault Menu

Table 3-6 Display Control Settings

51. **Table 3-6** (Cont'd)

TONES	CRT will display the following selection of audio Frequency menu displays: Tone Sequence Menu DTMF Menu Tone Sweep Menu Digitally-Coded Squelch Menu
METER	CRT provides alphanumeric readout of power, deviation, % AM modulation, frequency error and demodulated audio frequency, SINAD and signal strength.
HELP	CRT provides alphanumeric FM/AM-1500 menu operating aids and programming codes for hardware self-test routines.

Table 3-6 Display Control Settings

52. **DC/AC Switch**
Selects AC or DC input coupling for oscilloscope function.

53. **Horizontal Centering Adjustment**
Spectrum analyzer adjustment for precise centering of analyzer center frequency over major vertical axis of graticule. (NOT A NORMAL OPERATING CONTROL.)

54. **HORIZ POS Control**
Controls horizontal position of scope trace in oscilloscope function.

55. **ATTENUATOR Switch**
Provides attenuation of signals applied to ANTENNA Connector (56), from 0 to 40 dB, in 20 dB steps.

56. **ANTENNA Connector**

External antenna input and low level spectrum analyzer input.

CAUTION:

MAXIMUM CONTINUOUS INPUT TO ANTENNA CONNECTOR MUST NOT EXCEED 0.25 WATTS.

57. **SIG Indicator**

When illuminated, indicates input level at ANTENNA CONNECTOR (56) is above squelch threshold of FM/AM-1500 receiver.

3-2 REAR PANEL

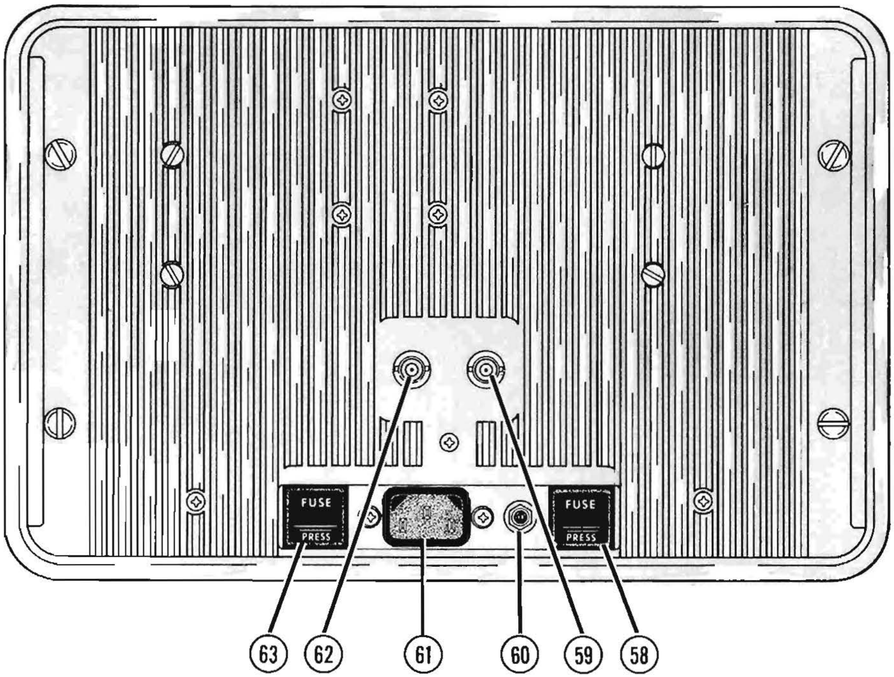


Figure 3-2 FM/AM-1500 Rear Panel With Callouts

58. **DC Fuse** (7.5 Amp)

59. **X Out Connector**
    Provides an output signal proportional to the FM/AM-1500 sweep signal when operating in the processor controlled sweep generator mode (RF Sweep or Tone Sweep Menus). The output amplitude at this connector is 0 to 10 volts, with 0 volts representing the start frequency and 10 volts representing the stop frequency.

60. **DC Power Input Connector**
    DC power input connector for 11 to 18 VDC supply.

61. **AC Power Input Connector**
    AC power input connector for 106 to 266 VAC supply at 50 to 400 Hz.

62. **10 MHz REF Connector**
    Input/output connector for 10 MHz reference signal.

63. **AC Line Fuse** (2.5 Amp)

3-3 KEYBOARD OPERATION

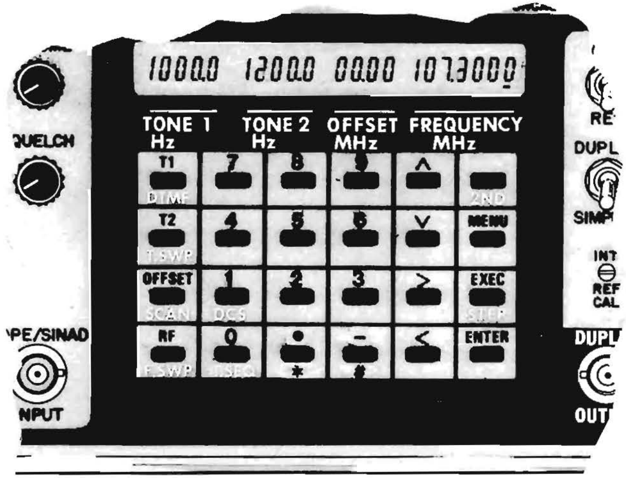


Figure 3-3 Keyboard Layout

The FM/AM-1500 keyboard provides a means of entering frequency data into the microprocessor to control the operation of signal generator, receiver and tone generator functions. Normal keyboard operation involves two basic types of key entry sequences:

1. "Manual" key entries that are immediately executed, without the use of the FM/AM-1500 memory capabilities, or
2. "Automatic" menu associated entries which utilize the storage, retrieval and automatic execution capabilities of the FM/AM-1500 processor.

The primary objective of this subsection is to familiarize the operator with the manual methods of making keyboard entries. Use of the keyboard's menu associated functions are described in detail in Section 5 of this manual.

The keyboard consists of 24 keys which are functionally grouped as shown in Figure 3-3 above and which function as described on the ensuing pages.

3-3-1 FUNCTION KEYS

These keys determine what FM/AM-1500 function is being addressed by the operator. These keys are dual :tion keys which will select either the 1st order functions (T1, T2, OFFSET and RF) or 2nd order functions MF, T.SWP, SCAN, F.SWP, T.SEQ and DCS) as determined by the operator.

1st Order Functions
These functions are used to set the operating frequencies of:

TONE GENERATOR #1 (T1)
TONE GENERATOR #2 (T2)
DUPLEX OFFSET GENERATOR (OFFSET)
RF SIGNAL GENERATOR or RECEIVER (RF)

Any keyboard entry involving a 1st order function is displayed in the appropriate data field of the LCD and is immediately executed by the processor.

NOTE:
The RF Function Key is also used to address the RF MEMORY MENU function contained in processor memory.

2nd Order Functions
These functions are used to address the following programmable menu functions contained in the FM/AM-1500 processor memory:

DUAL TONE MULTIPLE FREQUENCY Menu (DTMF)
TONE SWEEP Menu (T.SWP)
RF SCAN Menu (SCAN)
RF SWEEP Menu (F.SWP)
TONE SEQUENCE Menu (T.SEQ)
DIGITALLY-CODED SQUELCH Menu (DCS)

To display these menus on the CRT monitor, the front panel DISPLAY Control (51) must be positioned to the "TONES" position for DTMF, T.SWP, T.SEQ and DCS functions and to the "FREQ" position for SCAN, F.SWP and RF Memory functions. SEE SECTION 5 FOR KEYBOARD OPERATING INSTRUCTIONS ON MENU FUNCTIONS.

NOTE:
The DTMF Key is also used to select the manual DTMF operating mode, where the Keyboard will function as a touch tone synthesizer (see paragraph 4-4-3).

3-3-2 **INSTRUCTION KEYS**

These keys instruct the FM/AM-1500 processor to perform a specific operation or function to permit the execution of a key entry sequence. Specific key functions are as follows:

2ND KEY — Conditions the processor for a 2nd function entry; this key entry must precede the 2nd function entry.

MENU KEY — Menu associated instruction key for use in selecting and alternating menu pages.

STEP/EXEC KEY — 1st function EXEC instruction permits:

1. Execution of a menu associated self-test function.
2. Automatic execution of menu associated functions stored in processor memory.

2nd function STEP instruction permits a menu associated function to be manually stepped through, one item at a time.

ENTER KEY — Instructs processor that a key-in sequence has been completed.

3-3-3 **CURSOR CONTROL KEYS**

These keys are used to control the movement and positioning of the LCD and CRT cursor as follows:

LCD Cursor Control

The < and > keys will laterally move the cursor within the various LCD data fields for purposes of changing data values. To change a data value, the cursor must be positioned directly under the appropriate data field prior to making the value change. The ∧ and v keys are used to increment (∧) or decrement (v) any value positioned over the cursor and any adjacent values which are affected by "carry" and "borrow" operations.

CRT Cursor Control

All four cursor control keys are used to move the CRT cursor through the data fields of the various memory stored menu displays. The ∧ and v keys will move the cursor up (∧) and down (v), while the < and > keys will move the cursor left (<) and right (>).

Holding these keys in a depressed position, will allow a continuous movement of cursor or continuous increase/decrease of value.

3-3-4 DATA ENTRY KEYS

These keys include standard numerical value keys from 0 through 9, as well as two special symbol keys which are used to enter:

1. Decimal point and negative polarity indication (as 1st function entries).
2. # and * telephone associated symbols (as 2nd function entries); these symbols are used in conjunction with the DTMF function only.

3-3-5 MANUAL DATA ENTRY PROCEDURES

The following procedures describe the methods of making manual keyboard entries to control the operating frequencies of the FM/AM-1500 signal generator, receiver and tone generator functions.

TONE 1 or TONE 2 ENTRIES

Example #1: Set Tone Generator #1 frequency to 2900.0 Hz.

Step	Keys	Action	LCD
1.	T1	LCD cursor appears under leftmost character field of TONE 1 data field	0000.0
2.	2,9,0,0,.,0	2900.0 entry appears in TONE 1 data field	2900.0
3.	ENTER	2900.0 entry is stored by processor. Tone Generator #1 is generating an audio tone of 2900.0 Hz.	2900.0

Example #2: Change Tone Generator #1 frequency from 2900.0 Hz to 2780.2 Hz.

Step	Keys	Action	LCD
1.	T1	LCD cursor appears under leftmost character field of TONE 1 data field	2900.0
2.	>	LCD cursor moves one character field to right	2900.0
3.	v,v or v (hold)	Value 9 is decremented to 7	2700.0
4.	>	LCD cursor moves one character field to right	2700.0
5.	8	TONE 1 data entry is now:	2780.0
6.	>	LCD cursor moves one character field to right	2780.0
7.	2	TONE 1 data entry is now:	2780.2
8.	ENTER	2780.2 is stored by processor. Tone Generator #1 is generating an audio tone of 2780.2 Hz.	2780.2

Example #3: Change Tone Generator #1 frequency from 2780.2 Hz to 352.0 Hz.

Step	Keys	Action	LCD
1.	T1	LCD cursor appears under leftmost character field of TONE 1 data field	2780.2
2.	3	TONE 1 data entry changes to:	3780.2
3.	5	TONE 1 data entry changes to:	3580.2
4.	2	TONE 1 data entry changes to:	3520.2

Example #3 (Cont'd)

Step	Keys	Action	LCD
5.	•	TONE 1 data entry changes to:	0352.0
6.	ENTER	352.0 entry is stored by processor. Tone Generator #1 is generating an audio tone of 352.0 Hz.	0352.0

OFFSET & RF ENTRIES

The OFFSET data field is used to set the offset frequency of the RF signal generator, when using the FM/AM-1500 for testing duplex equipment. The RF data field is used for setting the generate frequency or receive frequency of the FM/AM-1500 generator and receiver functions.

The method of making keyboard entries into the OFFSET and RF data fields is the same as the procedures previously described for the TONE 1 and TONE 2 fields, with the following exceptions:

1. To enter the OFFSET field, the DUPLEX/SIMPLEX Switch (18) must be in DUPLEX position, and DISPLAY Control (51) must not be in TRACK or SWEEP position.
2. Instead of beginning a key entry sequence by pressing the T1 or T2 key, press OFFSET or RF, whichever is applicable.
3. Because the offset frequency to be entered may be above or below the RF Signal Generator frequency, an indication of positive or negative polarity is required. To enter a positive offset, enter the numerical data only in the usual manner; to enter a negative offset, the numerical entry must be preceded by a "-" sign which is obtained by the use of the #/- Key. Maximum data range for the OFFSET data field is +/-49.99. If a value larger than four is entered into the leftmost data position, a zero will be inserted whenever the ENTER Key is pressed.

Example: Change OFFSET entry from 3.00 MHz to -2.00 MHz.

Step	Keys	Action	LCD
1.	OFFSET	OFFSET data field is selected and LCD cursor appears under leftmost character field of OFFSET data field.	03.00
2.	-,2,.,0,0	-2.00 entry appears in OFFSET data field.	-02.00
3.	ENTER	-2.00 entry is stored by processor. The offset frequency being generated by the RF Signal Generator is -2.00 MHz.	-02.00

3-3-6 **OTHER OPERATIONS**

Other common keyboard operations and features which the operator will use during normal operation include:

ERROR CORRECTION

Correction of an entry error is a simple procedure which is performed as follows:

Example: Operator wishes to enter 125.0000 MHz into RF data field; instead, an entry of 126.000 MHz is erroneously made.

Step	Keys	Action	LCD
1.	RF, 1,2,6,.	Data entry into RF data field is as shown at right.	126.0000
2.	<	LCD cursor moves one character field to left	126.0000
3.	5	RF data field entry is corrected as shown	125.0000
4.	ENTER	Corrected entry is accepted by processor	125.0000

MANUAL FREQUENCY SLEWING

A useful feature of the FM/AM-1500 keyboard is the ability to manually slew a frequency up or down, in selectable increments (as determined by the position of the LCD cursor.) Any slewing sequence will affect the displayed values directly above and to the left of the cursor. This feature can be used for slewing frequencies in the TONE 1, TONE 2, OFFSET and RF data fields.

Example #1: The RF data field presently displays 050.0000 MHz. The operator wishes to slew this frequency up to 100.0000 MHz in 100 kHz increments.

Step	Keys	Action	LCD
1.	RF	RF data field is addressed. LCD cursor appears under leftmost character field of RF data field.	050.0000
2.	>>>	LCD cursor moves three character fields to right (under 100 kHz digit).	050.0000
3.	∧ (hold)	050.0000MHz entry slews up to 100 MHz in 100 kHz steps.	100.0000
4.	ENTER	100.0000MHz entry is stored by processor.	100.0000

NOTE:

Displayed entry will continue to slew up as long as ∧ key is held down.

Procedure for slewing down is same as in above procedure, except v key is used in place of ∧ key.

When slewing OFFSET data field, it is not possible to slew from a negative value to a positive value or vice versa. The most significant digit of the OFFSET data field can only be slewed up or down to 4. If slewed to a value greater than 4, a Ø is inserted whenever the Enter Key is pressed.

SECTION 4 — OPERATION

4-1 GENERAL

This section contains instructions for operating the following major functions of the FM/AM-1500 Communication Service Monitor:

GENERAL PURPOSE FUNCTIONS

SIMPLEX FUNCTIONS

DUPLEX FUNCTIONS

LIST OF ILLUSTRATIONS

LIST OF TABLES

4-2 OSCILLOSCOPE OPERATION

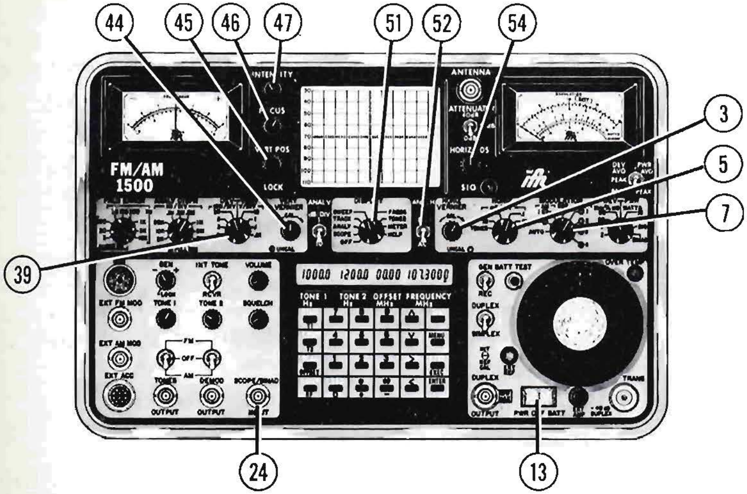


Figure 4-1 FM/AM-1500 Front Panel Controls Applicable to Oscilloscope Operation

FM/AM-1500 CONNECTORS AND INDICATORS APPLICABLE TO OSCILLOSCOPE OPERATION:

24 SCOPE/SINAD INPUT Connector

	CONTROL	SETTING	PARAMETER
3	HORIZ VERNIER Control	As req'd	Sweep Rate (Fine)
5	HORIZ Control	As req'd	Sweep Rate (Coarse)
7	MODULATION Control	As req'd	Modulation Monitoring Mode
13	PWR/OFF/BATT Switch	"PWR" or "BATT"	AC or DC Power
39	DEV/VERT Control	As req'd	Vertical Sensitivity
44	VERT VERNIER Control	As req'd	Vertical Sensitivity
45	VERT POS Control	As req'd	Vertical Trace Position
46	FOCUS Control	As req'd	Trace Focus
47	INTENSITY Control	As req'd	Trace Intensity
51	DISPLAY Control	"SCOPE"	CRT Mode
52	DC/AC Switch	As req'd	Coupling Mode
54	HORIZ POS Control	As req'd	Horizontal Trace Position

Table 4-1 FM/AM-1500 Controls Applicable to Oscilloscope Operation

4-2-1 **GENERAL**

Table 4-1 on the opposite page lists the front panel controls and connectors which are used in the oscilloscope function of the FM/AM-1500. All operating controls (with exception of the DISPLAY Control [51]) are similar to those found on most conventional oscilloscopes and are used to control such parameters as vertical sensitivity, sweep rate, external coupling, trace position, focus, etc. The DISPLAY Control (51) however, must be in the "SCOPE" position for the oscilloscope function to be active. Additional FM/AM-1500 scope functions not normally found on conventional oscilloscopes include:

1. **Tone Generator Input**

   The "TONES" position of the HORIZ Control (5) applies the output of Tone Generator #1 to the horizontal deflection circuits of the CRT. This function is useful for measuring the frequencies of externally applied audio signals, using the Lissajou method of frequency comparison.

2. **Modulation Display**

   The kHz/DIV positions of the DEV/VERT Control (39) enable the scope to be used for monitoring the instantaneous modulation characteristics of FM or AM modulated carriers. The type of modulation signal displayed is dependent on the position of the front panel Modulation Control (7). The oscilloscope will display the demodulated FM signal in the FM mode and the AM IF envelope in the AM mode, enabling the operator to check the signal for limiting and other forms of distortion.

4-2-2 **APPLICATIONS**

The FM/AM-1500 oscilloscope is a general purpose, (DC to 1 MHz Bandwidth) single trace oscilloscope which can be used for most troubleshooting applications. The internal horizontal triggering is AC coupled and in absence of a trigger signal, the scope will internally retrigger after a delay time of approximately 1.5 times the sweep trace time. Any external input to the scope must be applied at the front panel SCOPE/SINAD INPUT Connector (24).

4-3 SPECTRUM ANALYZER OPERATION

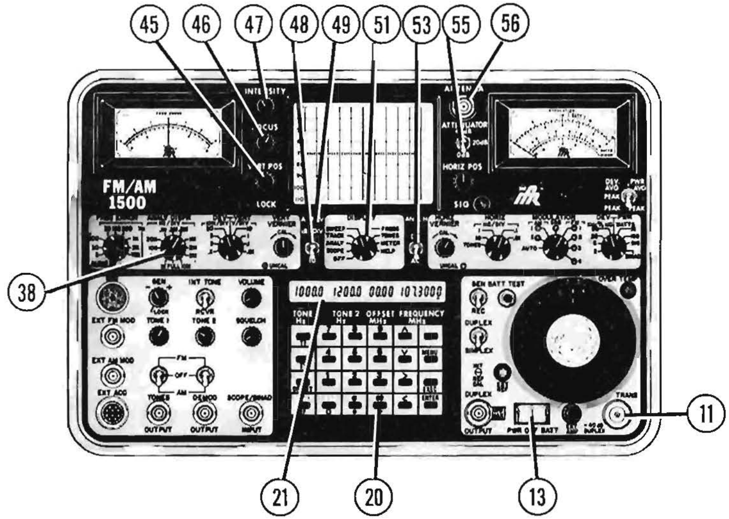


Figure 4-2 FM/AM-1500 Front Panel Controls Applicable to Spectrum Analyzer Operation

FM/AM-1500 CONNECTORS AND INDICATORS APPLICABLE TO SPECTRUM ANALYZER OPERATION:

11 TRANS/-40 dB DUPLEX Connector
21 LCD
56 ANTENNA Connector

	CONTROL	SETTING	PARAMETER
13	PWR/OFF/BATT Switch	"PWR" or "BATT"	AC or DC Power
20	KEYBOARD	As req'd	RF Frequency
38	ANALY DISPR Control	As req'd	Analyzer Dispersion
45	VERT POS Control	As req'd	Spectrum Reference Level
46	FOCUS Control	As req'd	Trace Focus
47	INTENSITY Control	As req'd	Trace Intensity
48	dB/DIV Switch	As req'd	CRT Graticule Scaling
49	Vertical Centering Adjustment	As req'd	Fine Reference Level Adjust
51	DISPLAY Control	"ANALY"	CRT Mode
53	Horizontal Centering Adjustment	As req'd	Fine Centering Level Adjust
55	ATTENUATOR Switch	As req'd	Input Attenuation

Table 4-2 FM/AM-1500 Controls Applicable to Spectrum Analyzer Operation

4-3-1 **GENERAL**

Table 4-2 on the opposite page lists the FM/AM-1500 front panel controls applicable to the spectrum analyzer function. The FM/AM-1500 has several notable operating features associated with the spectrum analyzer controls, which may differ from those (or may not exist) on conventional spectrum analyzers:

VERT POS Control (45)

With the dB/DIV Switch (48) in the 1 dB/DIV position, the VERT POS Control enables the operator to manually shift the reference level of the spectrum analyzer display over the range of the vertical axis on the graticule. This feature assures "on scale" viewing of spectrum displays for optimum resolution.

Horizontal & Vertical Centering Adjustments (53 & 49)

The Horizontal Centering Adjustment allows precise centering of the spectrum analyzer center frequency over center vertical graticule. The Vertical Centering Adjustment is used to calibrate the vertical axis of the analyzer to a known reference level. Both of these controls are not normal operating controls and their use is recommended only in special applications, where precise analyzer graticule alignment is necessary.

ATTENUATOR Switch (55)

Input attenuation is controlled by the Attenuator Switch in 20 dB steps from 0 dB to 40 dB. This switch alters the reference level of the applied input, so higher level signals may be monitored.

ANALY DISPR Control (38)

The spectrum analyzer bandwidth is automatically selected by the setting of the ANALY DISPR Control (38) (ref. Table 3-5). The spectrum analyzer center frequency is phase locked at all times, except in the "FULL SCAN" position.

NOTE:

The analyzer dispersion level rises when ANALY DISPR Control (38) is selected for 2 MHz/DIV or wider. This is a normal operating condition.

4-3-2 **ANALYZER OPERATION**

Basic analyzer operation is as follows:

1. Apply power to FM/AM-1500.
2. Place front panel DISPLAY Control (51) to "ANALY" position.

3. If monitoring external signals, apply signal to:
   a. ANTENNA Connector (56) for low level operation.
   b. TRANS/-40 dB DUPLEX Connector (11) for high level operation.
4. Using Keyboard, set FM/AM-1500 RF frequency to desired center frequency.
5. Adjust ANALY DISPR, ATTENUATOR, dB/DIV and VERT POS controls (38, 55, 48 and 45 respectively) for desired spectrum display.

4-3-3 **APPLICATIONS**

The FM/AM-1500 spectrum analyzer is a general purpose analyzer capable of monitoring high and low level signals within a range of 300 kHz to 999.9999 MHz. Low and high level operation are defined as follows:

LOW LEVEL OPERATION

Low level signals between a range of -100 dBm and +10 dBm must be applied through the front panel ANTENNA Connector.

CAUTION:

MAXIMUM CONTINUOUS INPUT TO ANTENNA CONNECTOR MUST NOT EXCEED 0.25 W (+24 dBm)!

When monitoring low level signals, the front panel ATTENUATOR Switch (55) can be used to alter the graticule reference level as follows:

ATTENUATOR Switch Position	Graticule Reference Level
0 dB	-30 dBm
20 dB	-10 dBm
40 dB	+10 dBm

HIGH LEVEL OPERATION

High level signals between a range of +20 dBm to +50 dBm must be applied through the front panel TRANS/-40 dB DUPLEX Connector (11). When using this input, the reference level of analyzer becomes +50 dBm.

CAUTION:

IF OVERTEMP INDICATOR (9) ILLUMINATES WHILE INPUT POWER IS APPLIED TO TRANS/-40 dB DUPLEX CONNECTOR (11), REMOVE INPUT POWER IMMEDIATELY! DO NOT RECONNECT POWER UNTIL OVERTEMP INDICATOR EXTINGUISHES.

NOTE:

When transmitter power is applied to TRANS/-40 dB DUPLEX Connector (11), the ANTENNA Connector (56) becomes attenuated. However, to prevent possible interference from high level signals being applied to the ANTENNA Connector, the antenna should be disconnected when monitoring transmitter signals directly.

4-3-4 **ANALYZER MONITOR MODE**

The monitor mode of the FM/AM-1500 spectrum analyzer is affected by the front panel SIMPLEX/DUPLEX and GEN/REC Switches as follows:

DUPLEX/SIMPLEX Switch (18)	GEN/REC Switch (19)	SPECTRUM ANALYZER MONITOR MODE
SIMPLEX	GEN	Spectrum Analyzer monitors internal FM/AM-1500 Signal Generator
SIMPLEX DUPLEX DUPLEX	REC GEN REC	Spectrum Analyzer monitors externally applied signals (At Antenna or TRANS/-40 dB DUPLEX Connectors)

4-4 TONE GENERATOR OPERATION

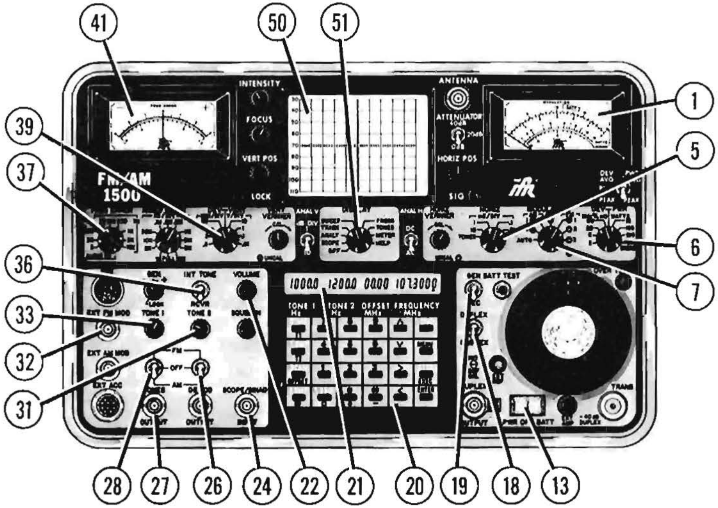


Figure 4-3 FM/AM-1500 Front Panel Controls Applicable to Tone Generator Operation

FM/AM-1500 CONNECTORS AND INDICATORS APPLICABLE TO TONE GENERATOR OPERATION:

1	MODULATION Meter
21	LCD
24	SCOPE/SINAD INPUT Connector
27	TONES OUTPUT Connector
32	EXT FM MOD Connector
41	FREQ ERROR Meter
50	CRT

	CONTROL	SETTING	PARAMETER
5	HORIZ Control	HORIZONTAL SWEEP TIME or "TONES"	Lissajous or Tone Output
6	DEV/PWR Control	As req'd	Deviation
7	MODULATION Control	As req'd	Demodulation Mode
13	PWR/OFF/BATT Switch	"PWR" or "BATT"	AC or DC Power
18	DUPLEX/SIMPLEX Switch	As req'd	Operating Mode
19	GEN/REC Switch	As req'd	Operating Mode
20	KEYBOARD	As req'd	Audio Frequency
22	VOLUME Control	As req'd	Speaker Audio Level
26	TONE 2 FM/OFF/AM Switch	As req'd	Modulation Mode

Table 4-3 FM/AM-1500 Controls Applicable to Tone Generator Operation

Table 4-3 (Cont'd)

	CONTROL	SETTING	PARAMETER
28	TONE 1 FM/OFF/AM Switch	As req'd	Modulation Mode
31	TONE 2 Control	As req'd	Modulation/Audio Level
33	TONE 1 Control	As req'd	Modulation/Audio Level
36	INT TONE/RCVR Switch	As req'd	Speaker Audio Routing
37	FREQ ERROR Control	As req'd	Frequency Error
39	DEV/VERT Control	As req'd	Modulation or Vertical Sensitivity
51	DISPLAY Control	"SCOPE", "TONES" or "METER"	CRT Mode

Table 4-3 FM/AM-1500 Controls Applicable to Tone Generator Operation

4-4-1 **GENERAL**

The FM/AM-1500 has two independently controlled variable tone generators which are capable of generating modulation signals within a range of 2 Hz to 30 kHz (in 0.1 Hz increments from 2 Hz to 9999.9 Hz and 1.0 Hz increments from 10 kHz to 30 kHz). The frequencies of both generators are keyboard selectable and are displayed in the TONE 1 and TONE 2 data fields of the front panel LCD (21). The output level and modulation mode of each tone generator can be individually controlled by the associated TONE 1 and TONE 2 controls listed in Table 4-3, while the modulation levels can be simultaneously monitored on the CRT (50) or Modulation Meter (1) (see Table 4-4).

NOTE:

If both Tone Generators are being used, the MODULATION Meter and CRT will display the composite modulation signal produced by both tone generators. To monitor either individual modulation signal, turn off opposite tone generator.

Monitoring Device	Control Position		Display
FM/AM-1500 CRT (50)	DISPLAY Control (51) to "SCOPE"	(Internal Scope Mode) kHz/DIV positions of DEV/VERT Control (39)	Displays AM% modulation or kHz deviation (per setting of MODULATION Control [7])
		(External Scope Mode) TONES OUT signal applied to SCOPE/SINAD INPUT Connector (24)	Displays amplitude & frequency characteristics of modulation signal
	DISPLAY Control (51) to "METER"		Provides alphanumeric readout of AM% modulation, kHz deviation and demod frequency
MODULATION METER (1)	DEV/PWR Control (6) to "kHz/%x10" DEV/PWR Control (6) to "kHz/%x10"		Displays AM% modulation or kHz deviation (per setting of MODULATION Control [7])

Table 4-4 Methods of Monitoring Modulation

4-4-2 BASIC TONE GENERATOR OPERATION

Basic operation of the FM/AM-1500 tone generators is as follows:

1. Apply power to FM/AM-1500.
2. Enter desired tone generator frequency into TONE 1 and/or TONE 2 data fields, using keyboard. (Additional operating steps will vary depending on application; see paragraph 4-4-3 for further instructions.)

4-4-3 APPLICATIONS

A. GENERATING TONES OF KNOWN AMPLITUDE

1. Perform "BASIC TONE GENERATOR OPERATION" steps described in paragraph 4-4-2.

2. Place DISPLAY Control (51) to "SCOPE" position.
3. Using "Tee" Connector and appropriate coax cables, connect TONES OUTPUT Connector (27) to SCOPE/SINAD INPUT Connector (24) and UUT audio injection point.
4. Adjust TONE 1 and/or TONE 2 Control(s) for desired peak-to-peak (pp) amplitude, as displayed on oscilloscope.

NOTE:

Amplitude in Volts (pp) = 2 x (Volts peak)
Volts (pp) = 2.828 x (VRMS)

B. USING TONE GENERATOR(S) AS A MODULATION SOURCE
1. Perform "BASIC TONE GENERATOR OPERATION" steps described in paragraph 4-4-2.
2. Select desired modulation mode for Tone Generator #1 and/or Tone Generator #2, using Tone 1 and/or Tone 2 FM/OFF/AM Switches (28 and 26).

NOTE:

If both tone generators are used, the modulation mode of one tone may be selected AM, while the other tone is simultaneously selected FM; or both may be selected the same.

When the FM/AM-1500 is operating under processor control (i.e. when using TONE SEQUENCE and/or DTMF Menu functions), Tone 1 and Tone 2 FM/OFF/AM Switches are disabled and modulation mode is automatically selected by processor. The processor selects the modulation as set on the MODULATION Control (7).

In the manual operating mode, the output levels of both generators are controlled by TONE 1 and TONE 2 Controls (33 and 31). Under processor control, TONE 1 and TONE 2 Controls are disabled and output levels programmed into menu functions are automatically selected.

3. Place GEN/REC Switch (19) to "GEN" position.

4. Place DUPLEX/SIMPLEX Switch (18) to "SIMPLEX" position.
5. Adjust TONE 1 and/or TONE 2 Control(s) (33 and/or 31) for desired modulation level, as indicated on top scales of MODULATION Meter (1) or on CRT METER Menu.

C. USING TONE GENERATOR(S) AS AN ACOUSTIC SOURCE

1. Perform "BASIC TONE GENERATOR OPERATION" steps described in paragraph 4-4-2.
2. Place INT TONE/RCVR Switch (36) to "INT TONE" position.
3. Adjust TONE 1 and/or TONE 2 Control(s) (33 and/or 31) and VOLUME Control (22) for a comfortable listening level.

NOTE:

Audio tone presently being monitored through FM/AM-1500 speaker, is also present at TONES OUTPUT Connector (27).

D. USING TONE GENERATOR DTMF FUNCTION AS A "TOUCH TONE" SYNTHESIZER

1. Apply power to FM/AM-1500.
2. Place DISPLAY Switch (51) to "TONES" position.
3. Using Keyboard (20), depress following keys in sequence given:
   a. MENU Key
   b. ∧ or ∨ Key, to scroll through "TONES" menu pages to display DTMF Menu on CRT.
   c. ENTER Key
   d. Ø Key
   e. ENTER Key (Selects the manual deviation field for entry.)
   f. Enter desired manual deviation for both tone generators using numeric and decimal point keys (e.g. 10.0, 25.5 etc.).

g. ENTER Key
h. 2nd Key
i. DTMF Key

4. The Keyboard will now function as a touch tone synthesizer (numbered and */# keys only).

NOTE:

The frequencies of the generated tones will be visible in the TONE 1 AND TONE 2 data fields, while keys are depressed.

To exit from DTMF Manual function, press ENTER Key.

E. MEASURING AUDIO FREQUENCIES BETWEEN 2 Hz and 30 kHz

1. Place GEN/REC Switch (19) to "GEN" position.
2. Place SIMPLEX/DUPLEX Switch (18) to "SIMPLEX" position.
3. Place DEV/PWR Control (6) to "60 kHz" position.
4. Using Table 4-5 below, set MODULATION Control (7) to appropriate setting, corresponding to modulation frequency and deviation of signal being measured. This will ensure that the pre- and post-detection bandwidth of the MODULATION Control (7) will accommodate the deviation and modulation characteristics of the signal under test.

MODULATION FREQUENCY	DEVIATION	FM/AM-1500 BANDWIDTH SETTING
20 Hz to 8 kHz	1 kHz to 80 kHz	FM 2
20 Hz to 30 kHz	1 kHz to 80 kHz	FM 4
20 Hz to 2 kHz	1 kHz to 5 kHz	FM 1

Table 4-5 FM/AM-1500 Controls Set to Signal Being Measured

NOTE:

If deviation exceeds 100 kHz, audio signal under test must be attenuated to bring deviation under 100 kHz.

5. Connect audio signal under test to EXT FM MOD Connector (32).
6. Place FREQ ERROR Control (37) to 3, 30 or 300 Hz AUDIO position.
7. Using Keyboard (20), slew TONE 1 frequency as close as possible to frequency of audio signal under test, until FREQ ERROR Meter (41) is zeroed.

NOTE:

3 Hz position of FREQ ERROR Control (37) will achieve .1 Hz resolution. With DISPLAY Control (51) in "METER" position, CRT (50) will provide an alphanumeric readout of audio signal under test, to 1 Hz resolution with 1 second gate time.

8. Frequency of audio signal under test is equal to frequency displayed in TONE 1 data field plus reading of FREQ ERROR Meter (41).

F. MEASURING FREQUENCIES ABOVE 30 kHz

1. Apply audio signal under test to SCOPE/SINAD Input Connector (24).
2. Place DISPLAY Control (51) to "SCOPE" position.
3. Place HORIZ Control (5) to "TONES" position.
4. Slew TONE 1 frequency appropriately using Keyboard (20), to obtain a 2nd, 3rd, 4th, or 5th order Lissajou figure on oscilloscope.
5. Frequency of unknown audio signal is equal to frequency displayed in TONE 1 data field, times the order number of the displayed Lissajou figure.

4-5 RECEIVER OPERATION (SIMPLEX)

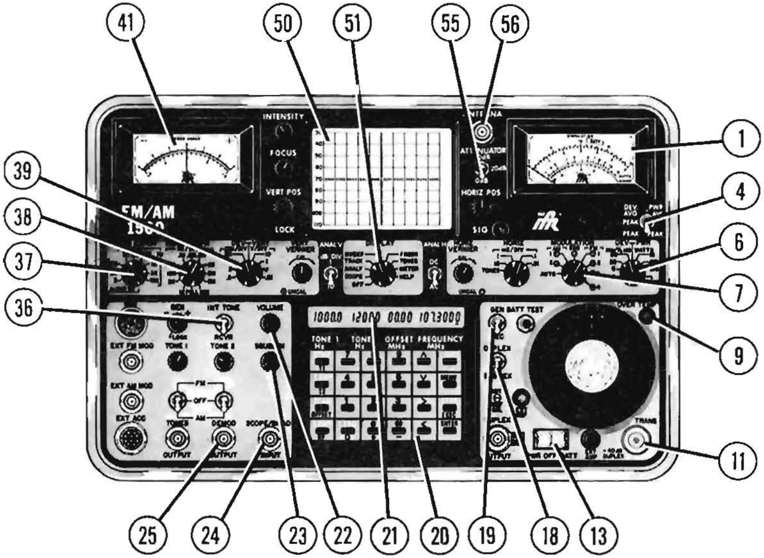


Figure 4-4 FM/AM-1500 Front Panel Controls Applicable to Receiver Operation

FM/AM-1500 CONNECTORS AND INDICATORS APPLICABLE TO RECEIVER OPERATION:

1	MODULATION Meter
9	OVERTEMP Indicator
11	TRANS/-40 dB DUPLEX Connector
21	LCD
24	SCOPE/SINAD INPUT Connector
25	DEMOD OUTPUT Connector
41	FREQ ERROR Meter
50	CRT
56	ANTENNA Connector

	CONTROL	SETTING	PARAMETER
4	AVG PEAK/PEAK Switch	As req'd	Peak/Average Power or Deviation Indication
6	DEV/PWR Control	As req'd	Meter Function/Range Selection
7	MODULATION Control	As req'd	Demodulation Mode
13	PWR/OFF/BATT Switch	"PWR" or "BATT"	AC or DC Power
18	DUPLEX/SIMPLEX Switch	"SIMPLEX"	RF Input/Output Configuration
19	GEN/REC Switch	"REC"	Operating Mode
20	KEYBOARD	As req'd	RF Frequency
22	VOLUME Control	As req'd	Volume

Table 4-6 FM/AM-1500 Controls Applicable to Receiver Operation

Table 4-6 (Cont'd)

	CONTROL	SETTING	PARAMETER
23	SQUELCH Control	As req'd	Squelch
36	INT TONE/RCVR Switch	"RCVR"	Speaker Audio Routing
37	FREQ ERROR Control	As req'd	Frequency Error Meter Scale
38	ANALY DISPR Control	1MHz/DIV or less	Analyzer Dispersion
51	DISPLAY Control	As req'd	CRT Mode
55	ATTENUATOR Switch	As req'd	Input Attenuation

Table 4-6 FM/AM-1500 Controls Applicable to Receiver Operation

4-5-1 **GENERAL**

The FM/AM-1500 contains a communications receiver capable of monitoring CW, AM, FM, and SSB signals within a range of 300 kHz and 999.9999 kHz. Signals may be monitored "off-the-air" using an external antenna or by direct cable connection to the front panel TRANS/-40 DUPLEX Connector (11). Table 4-7 defines the signal parameters which can be monitored using the receiver and associated monitoring functions.

SIGNAL CHARACTERISTIC(S):	MONITORING DEVICE(S):	CONTROLS:
AM% Modulation *	MODULATION Meter (1)	DEV/PWR Control (6) to "kHz/%x10". MODULATION Control (7) as req'd.
or	or	
kHz Deviation *	CRT (50) (Oscilloscope)	DISPLAY Control (51) to "SCOPE". DEV/VERT Control (39) to "kHz/DIV".
	CRT (50) (METER Menu)	DISPLAY Control (51) to "METER".
Instantaneous Modulation:		
AM IF Envelope or kHz Deviation *	CRT (50) (Oscilloscope)	DISPLAY Control (51) to "SCOPE". DEV/VERT Control (39) to "kHz/DIV". MODULATION Control (7) as req'd.

* When the received signal input level is below the FM/AM-1500 squelch threshold, these monitoring functions will be disabled.

Table 4-7 Receiver Monitoring Capabilities

Table 4-7 (Cont'd)

SIGNAL CHARACTERISTIC(S):	MONITORING DEVICE(S):	CONTROLS:
Frequency Error* and Demodulated Audio* Frequency	FREQ ERROR Meter (41) or CRT (50) (METER Menu)	FREQ ERROR Control (37) as req'd. DISPLAY Control (51) to "METER".
Signal Power (WATTS)	Power Meter Scale of MODULATION Meter (1) or CRT (50) (METER Menu)	DEV/PWR Control (6) to 15 or 150
Signal Power (dB)	CRT (50) (Spectrum Analyzer)	DISPLAY Control (51) to "ANALY".
SINAD (Distortion)	SINAD Scale of MODULATION METER (1) or CRT (50) (METER Menu)	DEV/PWR Control (6) to "SINAD".
Demodulated Audio*	FM/AM-1500 Speaker	VOLUME (22), SQUELCH (23) Controls as req'd.

* When the received signal input level is below the FM/AM-1500 squelch threshold, these monitoring functions will be disabled.

Table 4-7 Receiver Monitoring Capabilities

4-5-2 BASIC RECEIVER OPERATION (SIMPLEX MODE)

Basic operation of the FM/AM-1500 receiver is as follows:

1. Make sure all applicable FM/AM-1500 front panel controls are positioned as indicated in Table 4-6.
2. If signals are to be monitored "off-the-air", connect external antenna to ANTENNA Connector (56); if signals are to be received by direct cable connection, apply signal to TRANS/-40 dB DUPLEX Connector (11).

CAUTION:

MAXIMUM CONTINUOUS INPUT TO ANTENNA CONNECTOR (56) MUST NOT EXCEED 0.25 WATTS.

CAUTION:

MAXIMUM INPUT TO TRANS/-40 dB DUPLEX CONNECTOR MUST NOT EXCEED 150 WATTS. IF OVERTEMP INDICATOR (9) ILLUMINATES, REMOVE INPUT POWER IMMEDIATELY AND DO NOT REAPPLY UNTIL OVERTEMP INDICATOR EXTINGUISHES.

3. Using Keyboard (20), set FM/AM-1500 RF frequency to desired receive frequency.

(Additional operating steps will vary depending on the application; see paragraph 4-5-3 for further instructions.)

4-5-3 APPLICATIONS

A. RECEIVING AM or FM SIGNALS (OFF-THE-AIR)

1. Perform "BASIC RECEIVER OPERATION" steps described in paragraph 4-5-2.
2. Place MODULATION Control (7) to:
   a. AM1 or AM2 position, if receiving AM signals.
   b. FM1, FM2, FM3, or FM4 position, if receiving FM signals.

NOTE:

If receiver is being operated under processor controlled menu functions, place MODULATION Control (7) to "AUTO" position to select programmed demodulation method.

3. To aurally monitor received audio, adjust VOLUME Control (27) and SQUELCH Control (32) as required.
4. Use monitoring features outlined in Table 4-7 to monitor desired signal parameters.

B. RECEIVING SSB SIGNALS (OFF-THE-AIR)

1. Perform "BASIC RECEIVER OPERATION" steps described in paragraph 4-5-2.

2. Place MODULATION Control (7) to "SSB" position.

NOTE:

If receiver is being operated under processor controlled menu functions, place MODULATION Control (7) to "AUTO" position to select programmed demodulation method.

3. To aurally monitor audio, adjust VOLUME Control (27) and SQUELCH Control (32) as required.
4. If necessary, increment or decrement FM/AM-1500 RF frequency in 100 Hz steps to "clarify" signal.

C. RECEIVING WWV TIME STANDARD SIGNAL TO CALIBRATE FM/AM-1500 MASTER OSCILLATOR (OFF-THE-AIR)

1. Perform "BASIC RECEIVER OPERATION" steps described in paragraph 4-5-2.

NOTE:

Set FM/AM-1500 RF frequency to 10.0000 MHz.

2. Insert a 2 foot length of 24 gauge wire into center conductor of 10 MHz REF Connector (62) on rear of FM/AM-1500.
3. Place MODULATION Control (7) to "AM1" position.
4. Place DEV/PWR Control (6) to "SIG" position.
5. Adjust position of wire as necessary, to obtain a suitable beat note from FM/AM-1500 speaker.
6. Adjust INT REF CAL Adjustment (17) on FM/AM-1500 front panel as necessary, to obtain a zero beat.

NOTE:

Observation of AM envelope on oscilloscope and/or signal strength fluctuation on MODULATION Meter (1) may be helpful in obtaining a zero beat condition.

D. CALIBRATING FM/AM-1500 MASTER OSCILLATOR USING EXTERNAL FREQUENCY COUNTER

NOTE:

This procedure is recommended as an alternative for calibrating the FM/AM-1500 master oscillator, in the event a WWV 10 MHz "off-the-air" signal is not available.

1. Connect a calibrated frequency counter (with 1.0 or 0.1 Hz resolution) to 10 MHz REF Connector (62) on rear of FM/AM-1500.
2. Adjust INT CAL REF Adjustment (17) on FM/AM-1500 front panel, to obtain a 10 MHz (± .1 Hz) reading on frequency counter.

E. TESTING AM or FM TRANSMITTERS

1. Perform "BASIC RECEIVER OPERATION" steps described in paragraph 4-5-2.

NOTE:

Connect 50Ω coax cable between output of transmitter under test and FM/AM-1500 TRANS/-40 dB DUPLEX Connector (11).

2. Place MODULATION Control (7) to:
   a. AM1 or AM2 position if testing AM transmitters, or
   b. FM1, FM2, FM3, or FM4 position, if testing FM transmitters.

NOTE:

If transmitter is being tested under processor controlled menu functions, place MODULATION Control (7) to "AUTO" position to select programmed demodulation method.

3. Use monitoring features outlined in Table 4-7 to monitor desired signal parameters.

F. MEASURING AM or FM TRANSMITTER DISTORTION

1. Perform "BASIC RECEIVER OPERATION" steps described in paragraph 4-5-2.

NOTE:

Connect 50Ω coax cable between output of transmitter under test and FM/AM-1500 TRANS/-40 dB DUPLEX Connector (11).

CAUTION:

MAXIMUM CONTINUOUS INPUT TO TRANS/-40 dB DUPLEX CONNECTOR MUST NOT EXCEED 150 WATTS. IF OVERTEMP INDICATOR (9) ILLUMINATES, REMOVE INPUT POWER IMMEDIATELY AND DO NOT REAPPLY UNTIL OVERTEMP INDICATOR EXTINGUISHES.

2. Modulate transmitter under test with a 1 kHz tone.

NOTE:

FM/AM-1500 tone generator function may be used as a modulation source (see para. 4-4, "TONE GENERATOR OPERATION").

3. Place DEV/PWR Control (6) to SINAD position.
4. Connect coax cable between FM/AM-1500 DEMOD OUT Connector (25) and SCOPE/SINAD INPUT Connector (24).
5. Monitor SINAD level on bottom scale of Modulation Meter (1).

NOTE:

SINAD is typically better than 20 dB.

4-6 RF SIGNAL GENERATOR OPERATION (SIMPLEX)

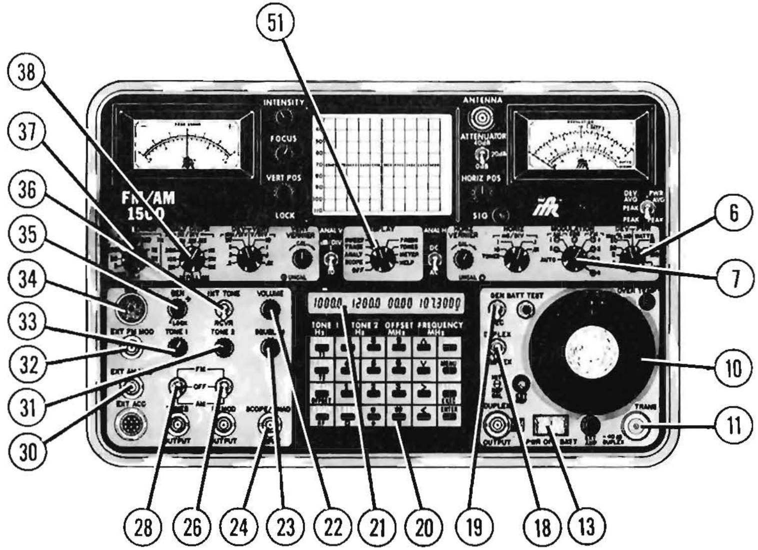


Figure 4-5 FM/AM-1500 Front Panel Controls Applicable to RF Signal Generator Operation

FM/AM-1500 CONNECTORS AND INDICATORS APPLICABLE TO RF SIGNAL GENERATOR OPERATION:

11 TRANS/-40 dB DUPLEX Connector
21 LCD
24 SCOPE/SINAD INPUT Connector
30 EXT AM MOD Connector
32 EXT FM MOD Connector
34 MIC Connector

	CONTROL	SETTING	PARAMETER
6	DEV/PWR Control	"kHz/%x10"	Modulation Meter Scaling Factor
7	MODULATION Control	As req'd	Modulation Monitoring Mode
10	RF Output Level Control	As req'd	Generator Output Level
13	PWR/OFF/BATT Switch	"PWR or BATT"	AC or DC Power
18	DUPLEX/SIMPLEX Switch	"SIMPLEX"	RF Input/Output Configuration
19	GEN/REC Switch	"GEN"	Operating Mode
20	KEYBOARD	As req'd	RF Frequency

Table 4-8 FM/AM-1500 Controls Applicable to RF Signal Generator Operation

Table 4-8 (Cont'd)

	CONTROL	SETTING	PARAMETER
22	VOLUME Control	As req'd	VOLUME
23	SQUELCH Control	Fully ccw	SQUELCH
26	Tone 2 FM/OFF/AM Switch	As req'd	Modulation Range
28	Tone 1 FM/OFF/AM Switch	As req'd	Modulation Range
31	TONE 2 Control	As req'd	Modulation Level
33	TONE 1 Control	As req'd	Modulation Level
35	GEN/LOCK Control	"LOCK"	DC Modulation
36	INT TONE/RCVR Switch	"RCVR"	Speaker Audio Routing
37	FREQ ERROR Control	As req'd	Freq ERROR Meter Scaling
38	ANALY DISPR Control	1MHz/DIV or less	Analyzer Dispersion
51	DISPLAY Control	As req'd	CRT Mode

Table 4-8 FM/AM-1500 Controls Applicable to RF Signal Generator Operation

4-6-1 **GENERAL**

The FM/AM-1500 RF signal generator is capable of generating calibrated amplitude signals within a range of 100 kHz of 999.9999 MHz, in 100 Hz steps. In the generate "SIMPLEX" mode, the signal generator can be used to stimulate external devices by generating modulated or unmodulated signals, while the FM/AM-1500 receiver circuits are simultaneously monitoring the generated output. Modulation signals for the generated carrier are available from the FM/AM-1500 internal tone generators or from external AM or FM sources. A microphone input connector is also available for applying voice modulation. All generated signals are transmitted out the front panel TRANS/-40 dB DUPLEX Connector (11), at an output level which is continuously variable from 0 to -128 dBm (using the RF Output Control [10]). An internal SINAD meter is active during generator operation, to enable testing of UUT receiver sensitivity. Table 4-9 outlines the parameters of the generated output, which can be monitored by the FM/AM-1500 receiver circuits during generator operation.

SIGNAL CHARACTERISTIC(S):	MONITORING DEVICE(S):	CONTROLS:
AM% Modulation or kHz Deviation	MODULATION Meter (1) or CRT (50) (Oscilloscope)	DEV/PWR Control (6) to "kHz/%x10". MODULATION Control (7) as req'd. DISPLAY Control (51) to "SCOPE". DEV/VERT Control (39) to "KHz/DIV".
Instantaneous Modulation: AM IF Envelope or kHz Deviation	CRT (50) (Oscilloscope)	DISPLAY Control (51) to "SCOPE". DEV/VERT Control (39) to "KHz/DIV". MODULATION Control (7) as req'd.
Modulated Audio Frequency	CRT (METER Menu)	DISPLAY Control (51) to "METER".

Table 4-9 Receiver Monitoring Capabilities

4-6-2 BASIC SIGNAL GENERATOR OPERATION (SIMPLEX MODE)

1. Make sure all applicable FM/AM-1500 front panel controls are positioned as indicated in Table 4-8.
2. Using Keyboard, set FM/AM-1500 RF frequency to desired generate frequency.
3. Adjust RF Output Level Control (10) for desired output level in uV or dBm, as indicated on control scale. FM/AM-1500 is now generating a carrier signal at selected frequency and output level.

NOTE:

If a signal greater than 100 mW is applied to the TRANS/-40 dB DUPLEX Connector while the FM/AM-1500 is generating, the set will automatically switch to the receive mode and will monitor only the signal(s) applied to this connector.

(Additional operating steps will vary depending on application; see paragraph 4-6-3 for further instructions.)

4-6-3 **APPLICATIONS**

A. GENERATING AM or FM MODULATED RF SIGNALS

1. Perform "BASIC SIGNAL GENERATOR OPERATION" steps described in paragraph 4-6-2.
2. Apply AM or FM modulation signal to carrier as follows:
   a. Using Keyboard (20), enter desired modulation frequency into TONE 1 and/or TONE 2 data fiel of LCD.
   b. Set Tone 1 and/or Tone 2 FM/AM/OFF Switch (28 or 26) to desired modulation mode.
   c. Adjust TONE 1 and/or TONE 2 Control (33 or 31) for desired modulation level, as displayed or MODULATION Meter (1) or CRT (50) (reference Table 4-7).

NOTE:

If both tone generators are used as modulation sources, the MODULATION Meter (1) and CRT (50) will display the composite modulation signal produced by both tone generators. To monitor either individual modulation signal, Tone Generator #1 or #2 must be turned off.

   d. The FM/AM-1500 is now generating a carrier signal with desired modulation characteristics Use monitoring features outlined in Table 4-7 to monitor desired signal parameters.

B. EXTERNALLY MODULATING RF SIGNAL GENERATOR

1. Perform "BASIC SIGNAL GENERATOR OPERATION" steps described in paragraph 4-6-2.
2. Apply external modulation signal to EXT AM MOD Connector (30) or EXT FM MOD Connector (32) whichever is applicable.
3. Adjust output of applied modulation signal to desired modulation level, as reflected on MODULA TION Meter (1).

NOTE:

To monitor output level of applied modulation signal on MODULATION Meter (1), DEV/PWR Control (6) must be in "kHz/%x10" positions and MODULATION Control (7) must be set to appropriate modulation mode (reference Table 4-7).

C. VOICE MODULATING RF SIGNAL GENERATOR

1. Perform "BASIC SIGNAL GENERATOR OPERATION" steps described in paragraph 4-6-2.
2. Connect external microphone to MIC Connector (34).
3. Press PTT (Press-to-Talk) Switch and talk into microphone. Use monitoring features outlined ir Table 4-7, to monitor voice modulation characteristics.

NOTE:

Diode speech limiting is incorporated for control of peak modulation. Limiter is set for 5 kHz deviation.

Whenever microphone is keyed, the FM/AM-1500 will automatically switch to the generate mode of operation, regardless of the position of the GEN/REC Switch (19).

D. DC MODULATING RF SIGNAL GENERATOR

1. Generate desired RF carrier frequency with desired modulation.
2. Offset generated carrier signal from center frequency by rotating GEN LOCK Control (35) out of detent position.
3. Monitor generator offset on FREQ ERROR Meter (41), spectrum analyzer or CRT METER Menu.

E. MEASURING UUT RECEIVER SINAD SENSITIVITY

1. Connect 50Ω coax cable between FM/AM-1500 TRANS/-40 dB DUPLEX Connector (11) and RF input of receiver under test.

NOTE:

For UUT SINAD measurements, the FM/AM-1500 internal tone generators should be used as a modulation source. A modulation frequency of 1000.0 Hz is required.

2. Connect audio output of receiver under test to SCOPE/SINAD INPUT Connector (24) and place DEV/PWR Control (6) to "SINAD" position.
3. Use FM/AM-1500 to generate a 1 kHz AM or FM modulated signal.
4. Adjust RF Level Output Control (10) for an output level of -40 dB.
5. Slowly decrease FM/AM-1500 RF output level until MODULATION Meter (1) displays applicable SINAD value (12 dB typical).
6. Setting of RF LEVEL OUTPUT Control (10) represents SINAD sensitivity of receiver under test.

4-7 SWEEP GENERATOR OPERATION

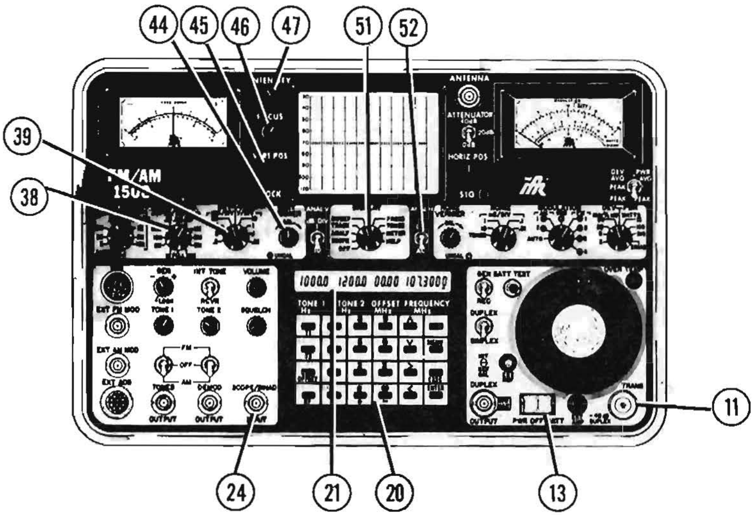


Figure 4-6 FM/AM-1500 Front Panel Controls Applicable to Sweep Generator

FM/AM-1500 CONNECTORS AND INDICATORS APPLICABLE TO SWEEP GENERATOR OPERATION:

11 TRANS/-40 dB DUPLEX Connector
21 LCD
24 SCOPE/SINAD INPUT Connector

	CONTROL	SETTING	PARAMETER
13	PWR/OFF/BATT Switch	"PWR or BATT"	AC or DC Power
20	KEYBOARD	As req'd	RF or IF Frequency
38	ANALY DISPR Control	As req'd	Sweep Span
39	DEV/VERT Control	"V/DIV"	Vertical Sensitivity
44	VERT VERNIER Control	As req'd	Vertical Sensitivity Fine Adjust
45	VERT POS Control	As req'd	Vertical Trace Position
46	FOCUS Control	As req'd	Trace Focus
47	INTENSITY Control	As req'd	Trace Intensity
51	DISPLAY Control	"SWEEP"	CRT Mode
52	AC/DC Switch	"DC"	Scope Coupling

Table 4-10 FM/AM-1500 Controls Applicable to Sweep Generator

4-7-1 GENERAL

The FM/AM-1500 sweep function can be used to sweep RF and IF systems up through the full range of 1 MHz to 1000 MHz, enabling the frequency response characteristics of the UUT to be displayed on the FM/AM-1500 oscilloscope. When sweeping RF or IF systems, the swept RF output available at the FM/AM-1500 TRANS/-40 dB DUPLEX Connector (11) is applied at the insertion point of the UUT, while the sampled output is fed through an appropriate RF detector to the SCOPE/SINAD Input Connector (24). The sweep generator function is also useful in aligning the amplifier IF and demodulator circuits of a UUT, by applying the swept RF output to the UUT injection point and applying the demodulated output to the FM/AM-1500 SCOPE/SINAD Input Connector (24).

4-7-2 BASIC SWEEP GENERATOR OPERATION

Basic sweep generator operation is as follows:

1. Set FM/AM-1500 sweep generator associated controls to positions indicated in Table 4-10.

NOTE:

ANALY DISPR Control (38) should be positioned to nearest desired sweep span.

2. Set appropriate FM/AM-1500 front panel controls for RF signal generator operation.

NOTE:

FM/AM-1500 RF frequency should be set to normal operating frequency present at UUT injection point.

3. Using appropriate coax cable(s), apply FM/AM-1500 generator output to UUT injection point.

4-7-3 APPLICATIONS

A. SWEEPING RF and IF SYSTEMS

1. Perform "BASIC SWEEP GENERATOR OPERATION" steps desired in paragraph 4-7-2.
2. Connect RF detector between FM/AM-1500 SCOPE/SINAD INPUT Connector (24) and sample point of UUT.
3. Adjust FM/AM-1500 RF output level as required, for proper UUT operation.

NOTE:

If testing the frequency response of an AM receiver, disable receiver AGC (in accordance with UUT manufacturer's recommendations) before proceeding with Step 4 below.

4. Adjust FM/AM-1500 DEV/VERT Control (39) as required for proper display of UUT characteristics on FM/AM-1500 oscilloscope. (See Figure 4-7.)

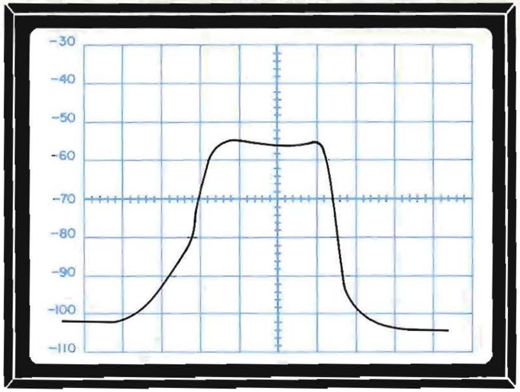


Figure 4-7 Typical Frequency Response Curve

B. SWEEPING A DEMODULATOR

1. Perform "BASIC SWEEP GENERATOR OPERATION" steps described in paragraph 4-7-2.
2. Monitor demodulated output at recommended UUT sample point in order to measure demodulation characteristics. (Connect demodulated sample to FM/AM-1500 SCOPE/SINAD Connector [24].)
3. Adjust FM/AM-1500 RF output level as required for proper UUT operation.

NOTE:

If testing the frequency response of an AM receiver, disable receiver AGC (in accordance with UUT manufacturer's recommendations) before proceeding with Step 4.

4. Adjust FM/AM-1500 DEV/VERT Control (39) as required for proper display of UUT characteristics on FM/AM-1500 oscilloscope. (See Figure 4-8 and Figure 4-9.)

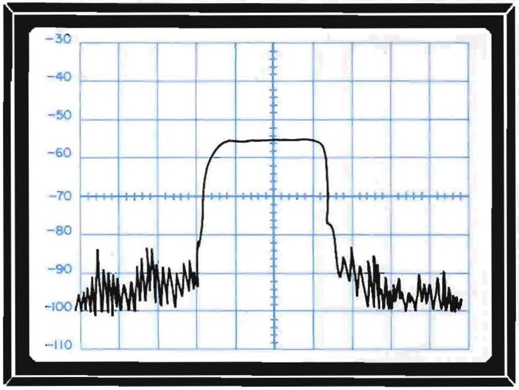


Figure 4-8 Typical Response Curve (AM)

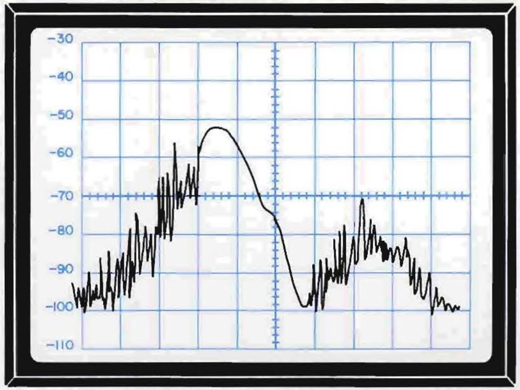


Figure 4-9 Typical Response Curve (FM)

4-8 TRACKING GENERATOR OPERATION

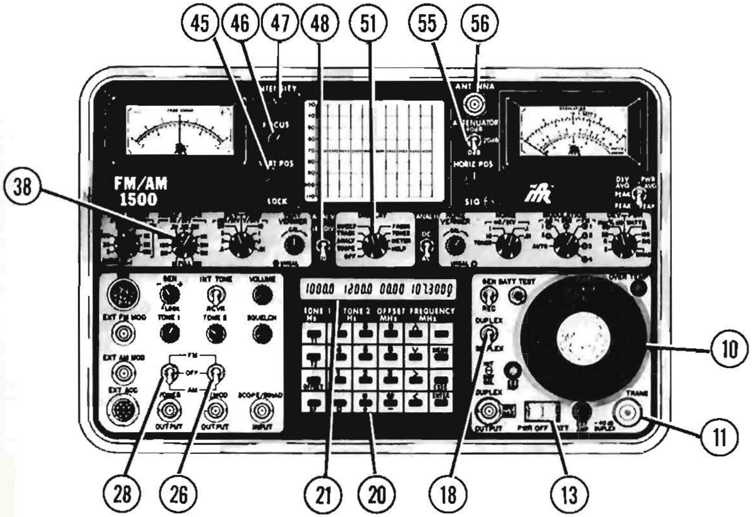


Figure 4-10 FM/AM-1500 Front Panel Controls Applicable to Tracking Generator Operation

FM/AM-1500 CONNECTORS AND INDICATORS APPLICABLE TO TRACKING GENERATOR OPERATION:

11 TRANS/-40 dB DUPLEX Connector
21 LCD
56 ANTENNA Connector

	CONTROL	SETTING	PARAMETER
10	RF Output Level Control	As req'd	Generator Output Level
13	PWR/OFF/BATT Switch	"PWR" or "BATT"	AC or DC Power
18	DUPLEX/SIMPLEX Switch	"SIMPLEX"	RF Input/Output Configuration
20	KEYBOARD	As req'd	RF Frequency
26	Tone 2 FM/OFF/AM Switch	"OFF"	n/a
28	Tone 1 FM/OFF/AM Switch	"OFF"	n/a
38	ANALY DISPR Control	As req'd	Sweep Span
45	VERT POS Control	As req'd	Vertical Trace Position (N/A with dB/DIV Switch in X10 dB position)
46	FOCUS Control	As req'd	Trace Focus

Table 4-11 FM/AM-1500 Controls Applicable to Tracking Generator Operation

Table 4-11 (Cont'd)

	CONTROL	SETTING	PARAMETER
47	INTENSITY Control	As req'd	Trace Intensity
48	dB/DIV Switch	"10"	CRT Graticule Scaling
51	DISPLAY Control	"TRACK"	CRT Mode
55	ATTENUATOR Switch	As req'd	Input Attenuation

Table 4-11 FM/AM-1500 Controls Applicable to Tracking Generator Operation

4-8-1 GENERAL

The FM/AM-1500 tracking generator combines the use of the RF signal generator and spectrum analyzer functions to measure the frequency response characteristics of such devices as filters, amplifiers, transmission lines, antenna systems etc. Another feature of the tracking generator is the capability of locating cable faults using the CABLE FAULT MENU function and associated RF "Tee" connectors. The FM/AM-1500 signal generator produces a calibrated RF sweep signal that automatically tracks the spectrum analyzer input frequency, up through the full range of 1 MHz to 1000 MHz. The device under test is connected between the swept RF output presented at the TRANS/-40 dB DUPLEX Connector (11) and the input to the spectrum analyzer at the ANTENNA Connector (56).

4-8-2 BASIC TRACKING GENERATOR OPERATION

Basic operation of the FM/AM-1500 tracking generator is as follows:

1. Make sure all applicable tracking generator controls on FM/AM-1500 front panel are positioned as indicated in Table 4-11.
2. Connect input of device under test to TRANS/-40 dB DUPLEX Connector (11).
3. Connect output of device under test to ANTENNA Connector (56).

CAUTION:

MAXIMUM CONTINUOUS RF INPUT TO ANTENNA CONNECTOR (56) MUST NOT EXCEED 0.25 WATTS.

CAUTION:

WHEN CONNECTING A DEVICE UNDER TEST TO ANTENNA CONNECTOR (56) WHICH HAS AN OUTPUT GREATER THAN + 10 dBM, ADDITIONAL INPUT ATTENUATION MUST BE APPLIED TO ANTENNA CONNECTOR (56) (USING ATTENUATOR SWITCH [55]), TO REDUCE INPUT POWER BELOW +10 dBm.

4. Using Keyboard (20), set FM/AM-1500 RF frequency to center frequency of desired sweep range.
5. Set ANALY DISPR Control (38) to desired frequency sweep span (frequency sweep span = setting of ANALY DISPR Control X 10).
6. Adjust RF Output Level Control (10) to obtain desired amplitude of frequency response curve on spectrum analyzer.
7. Place ATTENUATOR Switch (55) to appropriate position for desired analyzer input sensitivity.

NOTE:

ANTENNA Connector (56) has improved VSWR when ATTENUATOR Switch (55) is in 20 dB or 40 dB position.

8. For increased resolution of frequency response display on spectrum analyzer, place dB/DIV Switch (48) in "1" dB position.

NOTE:

With dB/DIV Switch (48) in "1" dB position, VERT POS Control (45) can be used to shift analyzer reference level between -30 and -100 dBm limits, as required.

9. Monitor desired response characteristics of device under test on analyzer display.

4-8-3 **APPLICATIONS**

A. CABLE FAULT TESTING

1. Make sure all applicable tracking generator controls on FM/AM-1500 front panel are positioned as indicated in Table 4-11.
2. Set RF Output Level Control (10) to -30 dBm or as desired.
3. Connect BNC "Tee" Connector to TRANS/-40 dB DUPLEX Connector (11).
4. Connect 50 Ω coax cable between one end of "Tee" connector and FM/AM-1500 ANTENNA Connector (56).
5. Connect cable to be tested to remaining end of "Tee" connector.
6. Using Keyboard (20), set FM/AM-1500 RF frequency to center frequency of 500 MHz.
7. Place ANALY DISPR Control (38) to "FULL SCAN" position.
8. Set or adjust RF Output Level Control (10), ATTENUATOR Switch (55), dB/DIV Switch (48) and VERT POS Control (45) as required for proper display of cable frequency response on spectrum analyzer.
9. While observing analyzer display, perform following steps (refer to sample display shown in Figure 4-11):

a. Randomly select a response curve dip on spectrum analyzer display.

NOTE:

If possible, select a lower frequency dip (deeper dip), to obtain best resolution for frequency measurement.

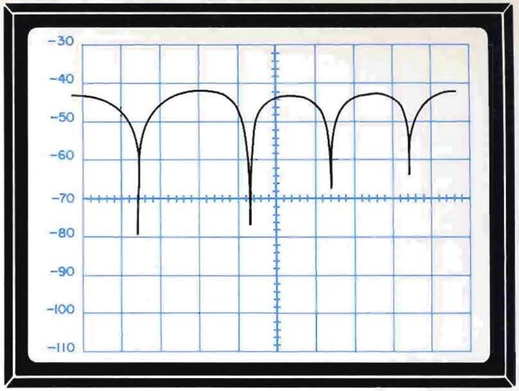


Figure 4-11 Sample Analyzer Display

b. Using Keyboard (20), slew FM/AM-1500 RF frequency as required, until selected dip is centered over major vertical axis.

NOTE:

For increased display resolution, use ANALY DISPR Control (38) to reduce scan width of the analyzer, while keeping selected dip in view.

c. Note and record frequency displayed in RF data field of LCD (21). This frequency is referenced as F_1.

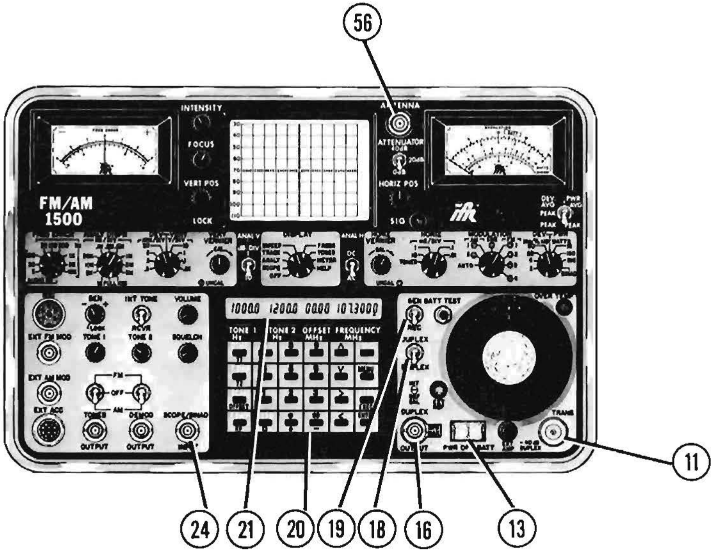
d. Select the next adjacent dip to right or left of dip previously selected.

e. Using Keyboard (20), slew FM/AM-1500 RF frequency as required, until selected dip is centered over major vertical axis.

f. Note and record frequency displayed in RF data field of LCD (21). This frequency is referenced as F_2.

g. Refer to SECTION 5, MENU OPERATION, for use of Cable Fault Menu; values F_1 and F_2 obtained in previous steps and cable velocity factor must be programmed into Cable Fault Menu to obtain location of cable fault.

4-9 DUPLEX OPERATION



FM/AM-1500 CONNECTORS AND INDICATORS APPLICABLE TO DUPLEX OPERATION:

11 TRANS/-40 dB DUPLEX Connector
16 DUPLEX OUTPUT Connector
21 LCD
24 SCOPE/SINAD INPUT Connector
56 ANTENNA Connector

Figure 4-1 FM/AM-1500 Front Panel Controls Applicable to Duplex Operation

	CONTROL	SETTING	PARAMETER
13	PWR/OFF/BATT Switch	"PWR or BATT"	AC or DC Power
18	DUPLEX/SIMPLEX Switch	"DUPLEX"	RF Input/Output Configuration
19	GEN/REC Switch	"GEN"	Operating Mode
20	KEYBOARD	As req'd	RF Frequency (Offset and Receive)

All controls associated with receiver, signal generator, tone generator, CRT Monitor, FREQ ERROR Meter and MODULATION Meter functions.

Table 4-12 FM/AM-1500 Controls Applicable to Duplex Operation

4-9-1 **GENERAL**

In the duplex mode of operation, the FM/AM-1500 has the capability of generating and receiving signals simultaneously, enabling the operator to check the performance of most duplex transceivers. While the FM/AM-1500 receiver is monitoring the power, modulation and frequency characteristics of the UUT transmitter, the FM/AM-1500 offset generator is simultaneously stimulating the UUT receiver with a calibrated signal -40 dB below the setting of the RF Output Level Control (10). This signal is not affected by the operation of the UUT transmitter. This simultaneous receive/transmit capability enables the operator to check the UUT transmitter/receiver interaction, typical under normal conditions.

NOTE:

A 50 Ω Termination to Duplex Output Connector (16) must be connected during duplex mode when connector is not in use. Failure to provide a Termination results in inaccurate output levels at TRANS/-40dB DUPLEX Connector (11).

Using the FM/AM-1500, three methods of duplex testing are possible:

1. **Duplex Testing Using Separate Transmit/Receive Lines**
In this mode, the UUT transmitter output is applied to the FM/AM-1500 at the TRANS/-40 dB DUPLEX Connector (11), where the signal is attenuated by 80 dB to the spectrum analyzer. The FM/AM-1500 offset generator output (available at the DUPLEX OUTPUT Connector (16) at an output level equal to setting of RF Output Level Control [10]) is applied to the RF input of the UUT receiver.

CAUTION:

DO NOT TRANSMIT INTO DUPLEX OUTPUT CONNECTOR (16), AS CONNECTOR IS NOT PROTECTED AGAINST RF INPUTS ABOVE 2.5 WATTS.

2. **Duplex Testing Using Common Transmit/Receive Line**
When testing a duplex transceiver with a single transmit/receive I/O port, a common receive/transmit line is connected between the UUT RF I/O port and the FM/AM-1500 TRANS/-40 dB DUPLEX Connector (11). The FM/AM-1500 will transmit and receive simultaneously over this single line.

NOTE:

The generator output level at the TRANS/-40 dB DUPLEX Connector (11) is 40 dB less than the indication of the RF Output Level Control (10).

3. **"Off-the-air" Duplex Testing**
In this mode, the output of the UUT transmitter is monitored "off-the-air" at the FM/AM-1500 ANTENNA Connector (56), while the FM/AM-1500 offset generator output (available at the TRANS/-40 dB DUPLEX Connector (11) or DUPLEX OUTPUT Connector [16]) is applied to the UUT receiver input.

NOTE:

The generator output level at the TRANS/-40 dB DUPLEX Connector (11) is 40 dB less than the indication on the RF Output Level Control (10); the generator output level at DUPLEX OUTPUT Connector (16) is equal to setting of RF Output Level Control.

CAUTION:

DO NOT TRANSMIT INTO DUPLEX OUTPUT CONNECTOR (16) AS CONNECTOR IS NOT PROTECTED AGAINST RF INPUTS ABOVE 2 WATTS.

DO NOT TRANSMIT INTO ANTENNA CONNECTOR (56); RF INPUTS IN EXCESS OF 0.25 WATTS MAY CAUSE DAMAGE TO FM/AM-1500.

4-9-2 BASIC DUPLEX OPERATION

Basic operation of the FM/AM-1500 RF signal generator and receiver functions for duplex testing is as follows:

1. Place GEN/REC Switch (19) in "GEN" position and DUPLEX/SIMPLEX Switch (18) in "SIMPLEX" position.
2. Set up FM/AM-1500 RF signal generator to produce an FM and/or AM modulated signal, (as required).

NOTE:

For UUT SINAD measurements, the FM/AM-1500 internal tone generators should be used as a modulation source. A modulation frequency of 1000.0 Hz is required.

3. Place DUPLEX/SIMPLEX Switch (18) to "DUPLEX" position.
4. Using Keyboard (20), enter UUT transmit frequency into RF data field of LCD (21).
5. Using Keyboard (20), enter offset generator frequency into OFFSET data field of LCD (21).

NOTE:

OFFSET FREQUENCY = (UUT RECEIVE FREQ) - (UUT TRANSMIT FREQ)

6. Connect UUT transmit/receive line to FM/AM-1500 according to desired method of duplex testing (reference paragraph 4-8-1).

4-9-3 APPLICATIONS

A. TESTING TRANSMITTER SECTION OF DUPLEX TRANSCEIVER

1. The following UUT transmitter characteristics can be monitored as follows:

UUT TRANSMITTER CHARACTERISTICS:	FM/AM-1500 MONITORING DEVICE(S):
Frequency	Reading of FREQ ERROR Meter (41) plus frequency displayed in RF data field of LCD (21) = UUT Transmitter Frequency.
Modulation (AM% or kHz Deviation)	MODULATION Meter (1) or CRT (50) (Oscilloscope)
Demodulated Audio Frequency	FREQ ERROR Meter (41) in audio function or on CRT METER Menu.
Power (Watts) *	Power Meter scale of MODULATION Meter (1)

*Can be monitored only when testing UUT by direct cable connection to the TRANS/-40 dB DUPLEX Connector (11).

Table 4-13 Transmitter Monitoring Function

B. TESTING RECEIVER SECTION OF DUPLEX TRANSCEIVER

1. Connect demodulated audio output from UUT to FM/AM-1500 SCOPE/SINAD INPUT Connector (24).
2. Place DEV/PWR Control (6) to "SINAD" position.
3. Adjust RF Output Level Control (10) appropriately until desired SINAD reading is present on SINAD scale of MODULATION Meter (1).
4. Setting of RF Output Level Control (10) represents SINAD Sensitivity of UUT receiver.
5. For detailed testing of UUT receiver bandwidth and center frequencies, refer to use of FM/AM-1500 Sweep and Tracking Generator functions (paragraphs 4-7 and 4-8).

NOTE:

When the DUPLEX/SIMPLEX Switch (18) is placed in the SIMPLEX position, a value of 00.00 MHz is set for DUPLEX OFFSET. When the DUPLEX/SIMPLEX Switch (18) is placed in the DUPLEX position, the previous DUPLEX OFFSET entry is restored.

When the DISPLAY Control (51) is placed in the TRACK or SWEEP position, the DUPLEX OFFSET is set to 00.00 MHz, the GEN/REC Switch (19) is over-ridden and set to receive and the DUPLEX/SIMPLEX Switch (18) is over-ridden and set to SIMPLEX. This is done as a convenience to the operator, as these conditions must be set when in TRACK or SWEEP Mode. The original settings of DUPLEX OFFSET, GEN/REC Switch (19) and DUPLEX/SIMPLEX Switch (18) are restored when the DISPLAY Control (51) is moved from the TRACK or SWEEP positions.

SECTION 5 — MENU OPERATION

5-1 GENERAL

This section contains three parts: a) using menus to display and set parameter functions; b) storing data; and c) retrieving data.

MENU FUNCTIONS

STORING DATA

RETRIEVING DATA & DATA EXECUTION

LIST OF ILLUSTRATIONS

LIST OF TABLES

5-2 MENU FUNCTIONS

Using menus, the operator can display, store, retrieve, and automatically execute test data according to the parameters displayed on selected menus. The FM/AM-1500 contains two basic types of Menus:

1. Programmable: RF and Tone Menus

   These menus can be programmed by the operator with variable test data to control the operation of the FM/AM-1500 Signal Generator, Receiver and Tone Generator functions.

2. Non-programmable: Utility and Informational Menus

   These menus are not changeable and can be selected for display only. These menus include the METER and HELP Menus.

A brief description of each menu and a detailed description of each data field in each menu is in Paragraphs 5-2-1 through 5-2-10. A quick reference to these menus is given in Paragraph 5-2-11.

5-2-1 RF MEMORY MENU

The RF MEMORY Menu is used for storing frequency, offset and modulation/demodulation data, associated with the receiver and signal generator functions of the FM/AM-1500. Using this menu, the operator can program the FM/AM-1500 to automatically receive or generate up to 30 frequencies, which can be stored and retrieved as required by the operator. The contents of this menu can only be executed one line at a time. When testing a UUT, the menu can be programmed to receive the UUT transmit frequency or to generate an offset frequency to be received by the UTT. (The FM/AM-1500 GEN/REC and DUPLEX/SIMPLEX Switches determine the operating mode of the FM/AM-1500.) The parameters of the RF MEMORY Menu are defined as follows (reference Figure 5-1):

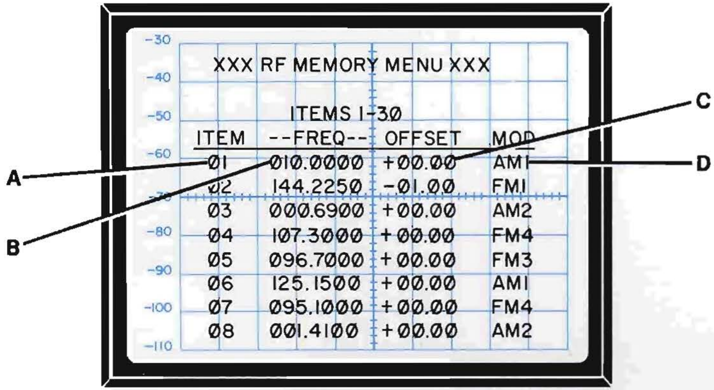


Figure 5-1 RF MEMORY Menu

A. **ITEM NUMBER**
Identifies each line entry by number. A total of 30 line entries are possible on this menu.

B. **FREQUENCY**
Programmable data field for entering receive or generate frequency of FM/AM-1500. Selectable frequency range is 000.0000 MHz to 999.9999 MHz.

C. **OFFSET**
Programmable data field for entering FM/AM-1500 duplex offset frequency. Selectable offset range is -49.99 MHz to +49.99 MHz.

D. **MODULATION/DEMODULATION**
Programmable data field for entering modulation/demodulation mode for FM/AM-1500. In the receive mode, demodulation mode can be programmed for AM1, AM2, FM1, FM2, FM3, FM4 or SSB. When executing an RF Memory Menu function, the front panel MODULATION Control (7) must be in "AUTO" position to enable automatic modulation control. In the generate mode, the modulation parameters must be manually entered using the front panel FM/AM Switches (26 & 28) and Tone Controls (31 & 33). Any generate modulation functions must be set with the FM/AM-1500 in the "SIMPLEX" mode of operation (as described in procedure "A. GENERATING AM or FM MODULATED RF SIGNALS" in para. 4-6-3).

5-2-2 **RF SCAN MENU**

The RF SCAN Menu allows the FM/AM-1500 receiver function to be used as a channel scanner, for monitoring "off-the-air" signals. This function enables the operator to program the FM/AM-1500 to automatically scan a sequence of up to 30 frequencies, with selectable demodulation and scan rate parameters. The parameters of the RF SCAN Menu are defined as follows (reference Figure 5-2):

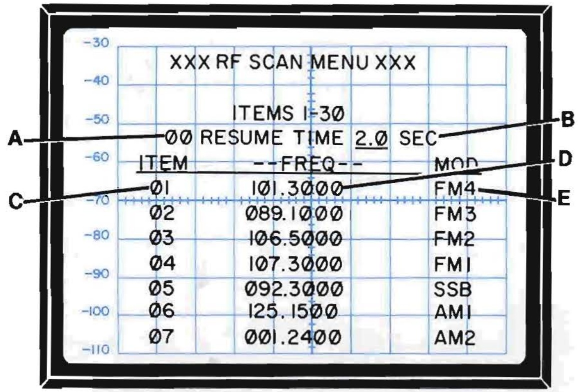


Figure 5-2 RF SCAN Menu

A. **00 ITEM NUMBER**
Identifies the line entry for the RESUME TIME.

B. **RESUME TIME**
Programmable data field for entering the "resume time" of the FM/AM-1500 scanning function. Resume time is defined as the amount of time the FM/AM-1500 receiver will stay on the active channel. The resume time can be programmed from 0.0 seconds to 9.9 seconds and this time applies to all scan frequencies entered in the RF SCAN Menu. If a channel goes inactive before the resume time has expired, the FM/AM-1500 will automatically continue the scan sequence.

C. **ITEM NUMBER**

Identifies each line entry by number. A total of 30 line entries are possible on this menu.

D. **FREQUENCY**

Programmable data field for entering the receive frequency of the FM/AM-1500. Selectable frequency range is 000.0000 MHz to 999.9999 MHz.

E. **MODULATION/DEMODULATION**

Programmable data field for entering modulation/demodulation mode for FM/AM-1500. In the receive mode, demodulation mode can be programmed for AM1, AM2, FM1, FM2, FM3, FM4 or SSB. When executing an RF SCAN Menu function, the front panel MODULATION Control (7) must be in "AUTO" position to enable automatic modulation control. In the generate mode, the modulation parameters must be manually entered using the front panel FM/OFF/AM Switches (26 & 28) and Tone Controls (31 & 33). Any generate modulation functions must be set with the FM/AM-1500 in the "SIMPLEX" mode of operation (as described in "GENERATING AM or FM MODULATED RF SIGNALS" in para. 4-6-3).

5-2-3 **RF SWEEP MENU**

The RF SWEEP Menu enables the operator to program the FM/AM-1500 to automatically sweep a selected RF frequency range, associated with the FM/AM-1500 receiver or generator functions. Programmable sweep parameters include sweep start and stop frequencies, increment step and increment rate. When an RF SWEEP Menu function is selected, the FM/AM-1500 will sweep from the START frequency to the STOP freqency in accordance with the preset step and rate parameters.

The RF SWEEP Menu consists of four menu subsets, each of which is preceded by an item number and which can be programmed with a separate set of sweep parameters. Only one menu subset can be executed at a given time. The parameters of the RF SWEEP Menu are defined as follows:

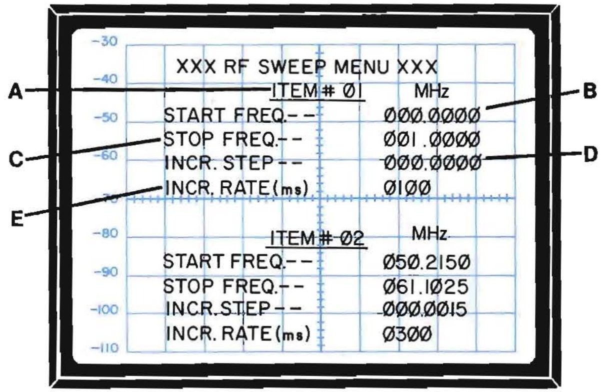


Figure 5-3 RF SWEEP Menu

A. **ITEM NUMBER**
Identifies each programmable menu subset.

B. **START FREQUENCY**
Programmable data field for entering sweep start frequency. Selectable START frequency range is 000.0000 MHz to 999.9999 MHz.

C. **STOP FREQUENCY**
Programmable data field for entering sweep stop frequency. Selectable STOP frequency range is 000.0000 MHz to 999.9999 MHz.

D. **INCR STEP**
Programmable data field for entering sweep step size. Minimum sweep step size is 0.0001 MHz (or 100 Hz) and maximum step size is 999.9999 MHz.

E. **INCR RATE**
Programmable data field for entering sweep increment rate. Selectable INCR RATE range is 1 mSec to 9999 mSec.

5-2-4 **TONE SEQUENCE MENU**

The TONE SEQUENCE Menu enables the operator to program the FM/AM-1500 tone generators to generate up to 99 successive single or dual tone sequences, with variable frequency, deviation and time parameters. The parameters of the TONE SEQUENCE Menu are defined as follows:

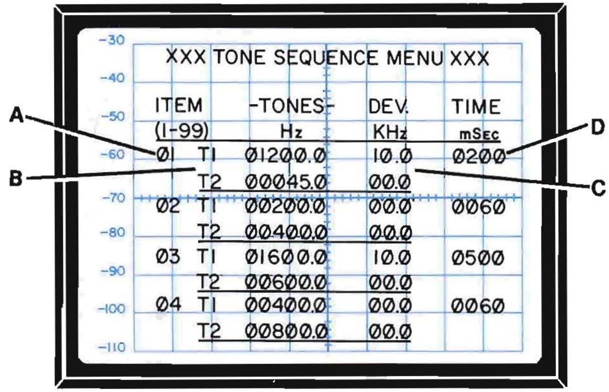


Figure 5-4 TONE SEQUENCE Menu

A. **ITEM NUMBER**
Non-programmable data field which identifies each line entry by number. A total of 99 line entries are possible on this menu.

B. **TONE 1 & TONE 2 FREQUENCY**
Programmable data fields for entering frequency of Tone Generator #1 (T1) and Tone Generator #2 (T2). Selectable frequency range for each tone generator is 00000.0 to 29999.9 Hz.

C. **TONE 1 & TONE 2 DEVIATION**
Programmable data fields for entering desired deviation and amplitude of Tone Generator #1 and Tone Generator #2. Selectable deviation range for each field is 00.0 kHz to 25.5 kHz. When AM is selected on MODULATION Control (7), the automatic modulation switches to AM. The level of AM is displayed as 10 kHz which equals 100% AM modulation.

D. **TONE 1 & TONE 2 TIME**

Programmable data field for entering the time interval that the generated tones will be active. Selectable time limits are 1 mSec to 9999 mSec.

5-2-5 DTMF MENU

The DTMF Menu is used for storing and synthesizing "touch-tone" telephone numbers. The parameters of the DTMF Menu are defined as follows:

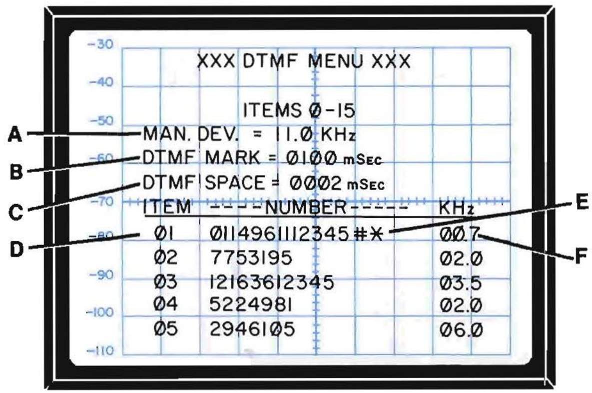


Figure 5-5 DTMF Menu

A. **MANUAL DEVIATION**

Programmable data field for entering deviation and amplitude parameters for Tone Generator #1 and Tone Generator #2. Selectable deviation range is from 0.0 kHz to 25.5 kHz. This field used only when the DTMF manual function is active (see para. 4-4-3, D. USING TONE GENERATOR DTMF MANUAL FUNCTION AS A "TOUCH-TONE" SYNTHESIZER). When AM is selected on MODULATION Control (7), the automatic modulation switches to AM. The level of AM is displayed as 10 kHz which equals 100% AM modulation.

B. **DTMF MARK**

Programmable data field for entering the time each digit of a telephone number is active. Selectable DTMF mark time range is 0001 mSec to 9999 mSec.

C. **DTMF SPACE**

Programmable data field for entering the "dead time" between each digit of the telephone number. Selectable DTMF space time range is 0001 mSec to 9999 mSec.

D. **ITEM NUMBER**

Identifies each line entry by number. A maximum of 15 line entries is possible on this menu.

E. **TELEPHONE NUMBER**

Programmable data field for entering DTMF telephone number. A maximum of 15 digits may be entered into this field. Usable keys include all numeric keys and #/* keys (2nd function accessible).

F. **DTMF DEVIATION**

Programmable data field for entering deviation and amplitude parameters for Tone Generator #1 and Tone Generator #2. Selectable deviation range is from 0.0 kHz to 25.5 kHz. When AM is selected on MODULATION Control (7), the automatic modulation switches to AM. The level of AM is displayed as 10 kHz which equals 100% AM modulation.

5-2-6 TONE SWEEP MENU

The TONE SWEEP Menu enables the operator to program the FM/AM-1500 Tone Generator #1 to automatically sweep a selected audio frequency range according to the preset sweep parameters. Programmable sweep parameters include start and stop frequencies, increment rate, increment step and sweep mode (linear vs. logarithmic). In the linear sweep mode, the FM/AM-1500 will sweep in a linear progression from the START frequency to the STOP frequency, in accordance with the preset INCR STEP and INCR RATE parameters. If STOP frequency is above the START frequency, the INCR STEP will be added to the current frequency; if STOP frequency is below the START frequency, the INCR step will be subtracted from the current frequency. In the logarithmic sweep mode, the FM/AM-1500 will sweep in a logarithmic progression according to the value of the INCR STEP multiplier. If the value of the INCR STEP multiplier is less than 1, the FM/AM-1500 will sweep to a value below the START frequency, which may be the STOP frequency (if less than the START frequency) or the minimum sweep limit of 1.0 Hz. Conversely, if the multiplier is greater than 1, the direction of sweep is to a value above the START frequency, which may be the STOP frequency (if greater than the START frequency) or the maximum sweep limit of 99,999.9 Hz. In the logarithmic sweep mode, each successive sweep step is obtained by multiplying the current frequency by the INCR STEP multiplier.

The TONE SWEEP Menu consists of four menu subsets, each of which is preceded by an item number and which can be programmed with a separate set of sweep parameters. The parameters of the TONE SWEEP Menu are defined as follows:

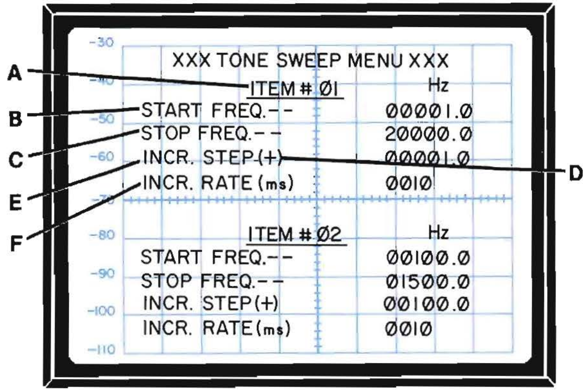


Figure 5-6 TONE SWEEP Menu

A. **ITEM NUMBER**
Identifies each programmable menu subset. A total of 4 menu subsets are available for programming.

B. **START FREQUENCY**
Programmable data field for entering sweep start frequency. Selectable frequency range for START FREQUENCY is 00000.0 Hz to 29999.9 Hz.

C. **STOP FREQUENCY**
Programmable data field for entering sweep stop frequency. Selectable frequency range for STOP FREQUENCY is 00000.0 Hz to 29999.9 Hz.

D. **SWEEP MODE**
Programmable data field for selecting the FM/AM-1500 sweep mode. A " + " in this field will produce a linear sweep, while an "x" will produce a logarithmic sweep.

E. **INCR STEP**

Programmable data field for entering sweep step size. The INCR STEP ranges are 00000.0 to 29999.9 for linear sweep and 0.00 to 2.00 for logarithmic sweep. (Although a higher value than 2 can be entered into the INCR STEP data field, the maximum permissible multiplier for the logarithmic sweep is 2.00.)

F. **INCR RATE**

Programmable data field for entering sweep increment rate. Selectable sweep INCR RATE is 1 mSec to 9999 mSec.

5-2-7 DCS MENU

The DCS (DIGITALLY-CODED SQUELCH) Menu allows the FM/AM-1500 to perform as a DCS generator and receiver. The DCS Menu allows data entry for generate item parameters and receive display locations for valid octal code numbers. Valid DCS octal code numbers are non-programmable data fields, which consist of a maximum of six octal code numbers decoded from a single DCS word. All valid DCS octal codes within the data word are displayed. The display of the received octal code numbers occurs whenever the DCS Menu is recalled, and will remain displayed until reception has stopped for one second or the DCS "STOP CODE" is received.

The DCS generate function is recalled in the same manner as other automatic functions (i.e. Tone Sequence, etc.) The DCS function begins when the ENTER Key is pressed, and will continue until the operator halts execution. (This differs from other automatic functions, as it must be halted manually by the operator.) The parameters of the DCS Menu are defined as follows:

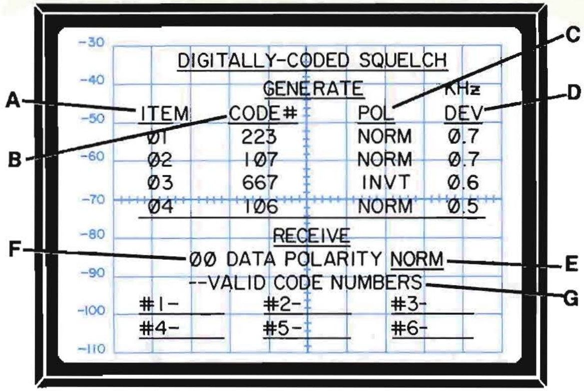


Figure 5-7 DIGITALLY-CODED SQUELCH (DCS) Menu

A. **ITEM NUMBER**

Identifies each line entry by number. A maximum of ten line entries are possible on this menu.

B. **CODE NUMBER**

Programmable data field used to display the DCS data number. Data is a three digit octal number from $000_{(8)}$ to $777_{(8)}$.

C. **POLARITY**

Programmable data field used to display the DCS data word polarity. Data is displayed as either NORM (Normal Polarity) or INVT (Inverted Polarity).

D. **DEVIATION**

Programmable data field used to display the DCS deviation. Selectable deviation range is from 0.0 kHz to 9.9 kHz.

E. **DATA POLARITY**

Programmable data field for selecting the received data polarity. Selections are NORM and INVERT by use of the ∧ or ∨ keys.

F. **00 ITEM NUMBER**

Identifies the line entry for the data polarity.

G. **VALID CODE NUMBERS**

Non-programmable data fields used to display all valid DCS codes contained in the received DCS word. Data fields are blank if no code is received or DCS "STOP" code is received. Data is a three digit octal number from $000_{(8)}$ to $777_{(8)}$.

5-2-8 CABLE FAULT MENU

The CABLE FAULT Menu is intended for use in conjunction with the FM/AM-1500 Tracking Generator function, in order to calculate cable fault distances. By performing the "CABLE FAULT TESTING" procedure in paragraph 4-8-3, the operator will obtain two frequency values (F_1 and F_2), which are associated with the frequency response of the cable under test. These values, along with the cable velocity factor (available from the cable manufacturer's specifications) can be entered into the CABLE FAULT Menu, to automatically compute the distance of the cable fault. The CABLE FAULT Menu consists of two identical menu subsets, which enable the operator to enter two sets of cable fault variables. The parameters of the CABLE FAULT Menu are defined as follows:

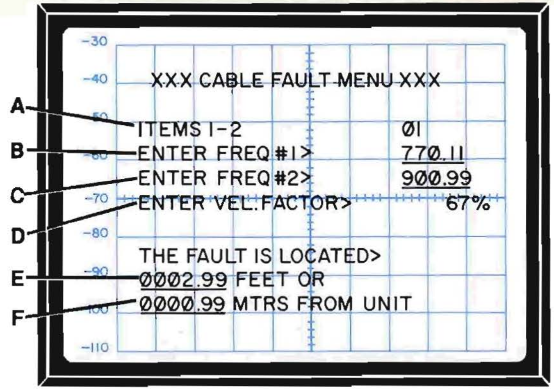


Figure 5-8 CABLE FAULT Menu

A. **ITEM NUMBER**

Programmable data field for selecting CABLE FAULT Menu subset 1 or 2.

B. **FREQ #1**

Programmable data field for entering frequency F_1 (as obtained in CABLE FAULT TESTING procedure in para. 4-10-3). Selectable frequency range for F_1 is 000.00 to 999.99 MHz.

C. **FREQ #2**

Programmable data field for entering frequency F_2 (as obtained in CABLE FAULT TESTING procedure in para. 4-10-3). Selectable frequency range for F_2 is 000.00 to 999.99 MHz.

D. **VEL FACTOR**

Programmable data field for entering cable velocity factor. Selectable range for this data field is 0 to 99%.

E. **CABLE FAULT DISTANCE (FEET)**

Non-programmable data field where the calculated cable fault distance (in feet) is displayed. Displayed result will be within a range of 000.0 ft to 999.9 ft.

F. **CABLE FAULT DISTANCE (METERS)**

Non-programmable data field where the calculated cable fault distance (in meters) is displayed. Displayed result will be within a range of 000.0 meters to 999.9 meters.

5-2-9 **METER MENU**

The FM/AM-1500 METER Menu is a non-programmable menu, which provides an alphanumeric display of signal parameters monitored by the FM/AM-1500 front panel meters. To display the METER Menu, place the DISPLAY Control (51) to the "METER" position. Displayed parameters include demodulated audio frequency, frequency error, deviation, % AM modulation, power, signal strength (%) and SINAD. A sample display of the METER Menu is shown in Figure 5-9. The top two data fields of the menu will always display the demodulated audio frequency and frequency error. The information displayed in the bottom data field will vary, depending on the positions of the front panel MODULATION Control (7) and DEV/PWR Control (6); (see Table 5-1).

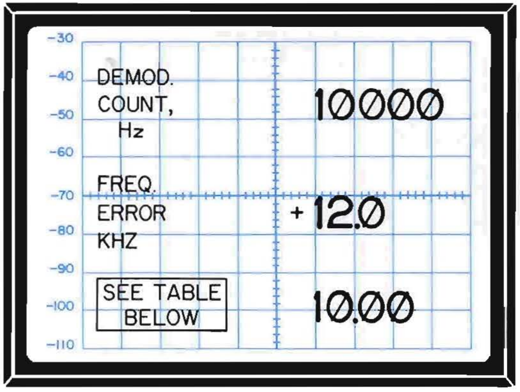


Figure 5-9 METER Menu

POSITION OF MODULATION CONTROL	POSITION OF DEV/PWR CONTROL	DATA DISPLAYED IN BOTTOM DATA FIELD OF METER MENU
AM1 AM2 OR SSB	kHz/DIV	MODULATION % AM
FM1 FM2 FM3 OR FM4	kHz/DEV	DEV, kHz
(IRRELEVANT)	POWER	POWER, WATTS
(IRRELEVANT)	SIG	SIGNAL, %
(IRRELEVANT)	SINAD	SINAD, -dB

Table 5-1 Meter Menu Variations

5-2-10 HELP MENUS

The FM/AM-1500 HELP Menus consist of the utility menus, shown on the following pages. Table 5-2 is the procedure to access HELP Menus.

STEP	ACTION
1.	Place front panel DISPLAY Control (51) to "HELP" position.
2.	Press MENU Key, followed by ∧ or ∨ Key, to scroll through the selection of available HELP menus previously described. Stop scrolling when desired menu is displayed. Press ENTER Key when desired menu is displayed.

Table 5-2 Displayng HELP Menu

1. **HELP Master Menu**
   Provides an index of available HELP Menus.

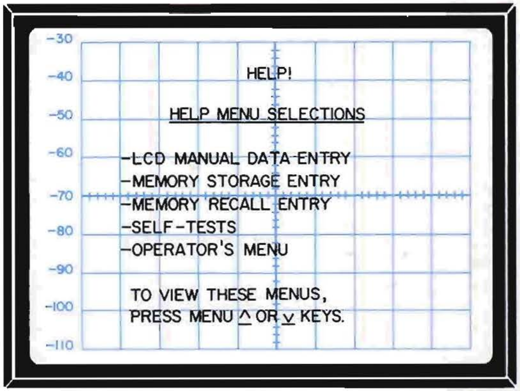


Figure 5-10 HELP Master Menu

2. **LCD Manual Data Entry Menu**
   Provides a quick reference on how to enter operating data into the FM/AM-1500 LCD, using the Keyboard (see para. 3-3).

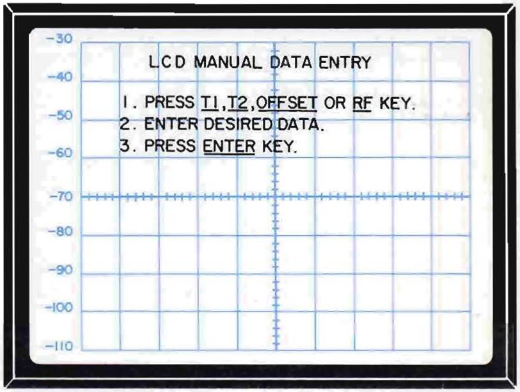


Figure 5-11 LCD MANUAL DATA ENTRY Menu

3. **Memory Recall Menu**
Provides a quick reference on how to automatically execute a selected menu test function or sequence (see para. 5-4).

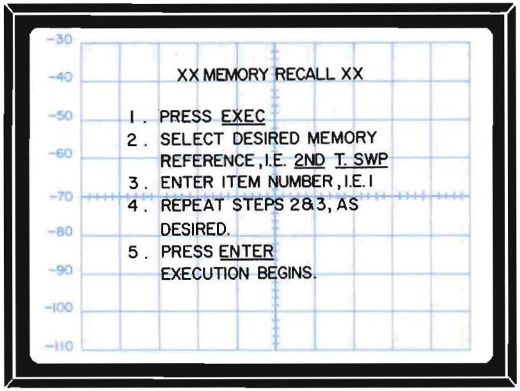


Figure 5-12 MEMORY RECALL Menu

4. **Memory Storage Entry Menu**
Provides a quick reference on how to store operating data within any of the programmable RF or TONE frequency menus (see paragraphs 5-2-1 through 5-2-8).

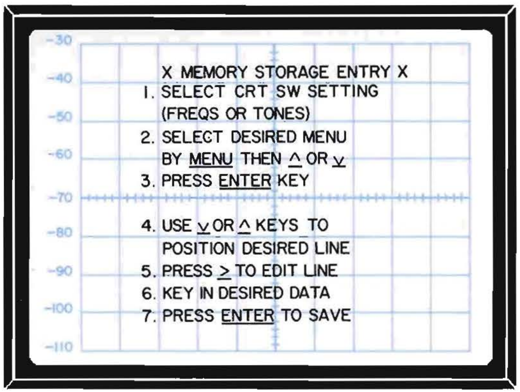


Figure 5-13 MEMORY STORAGE ENTRY Menu

5. **Self-Test**

Provides a quick reference on how to call-up a particular self-test function on the FM/AM-1500.

a. Code 1 MEMORY TEST (EXEC, 1, ENTER)

The MEMORY Test is initiated by entering: EXEC, 1, ENTER. The LCD displays the results of the test as shown below. This test will run until the operator depresses and holds down the ENTER Key through end of test cycle, restoring original field settings.

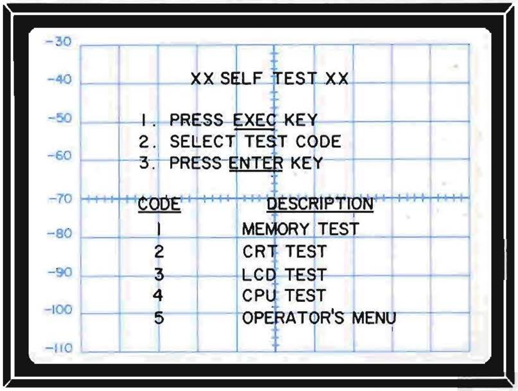
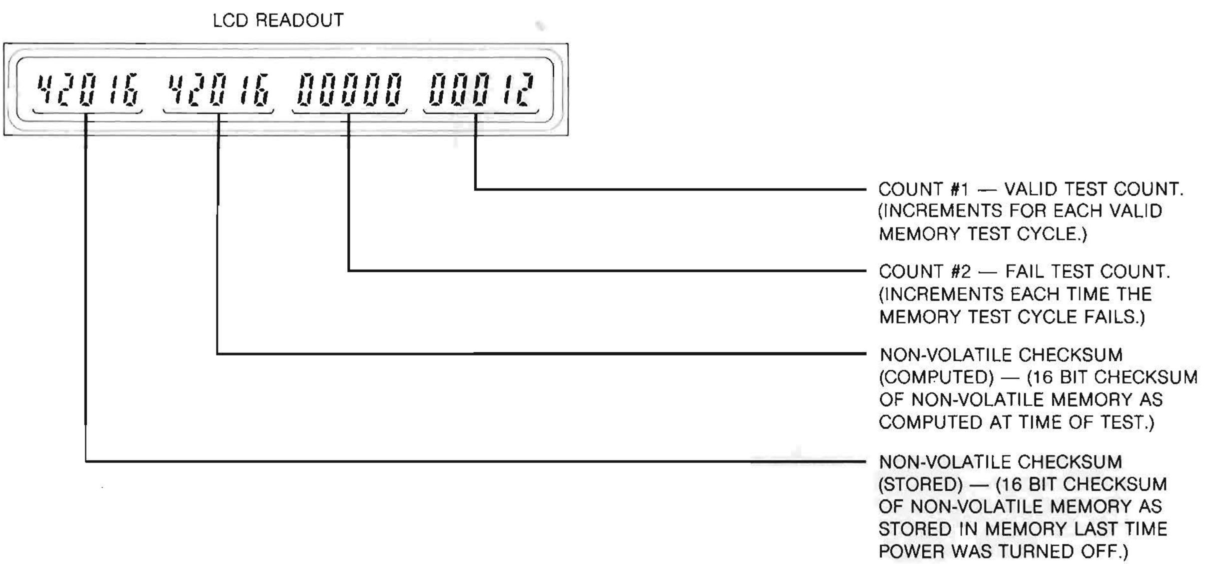


Figure 5-14 SELF TEST Menu



b. **Code 2** CRT TEST (EXEC, 2, ENTER)

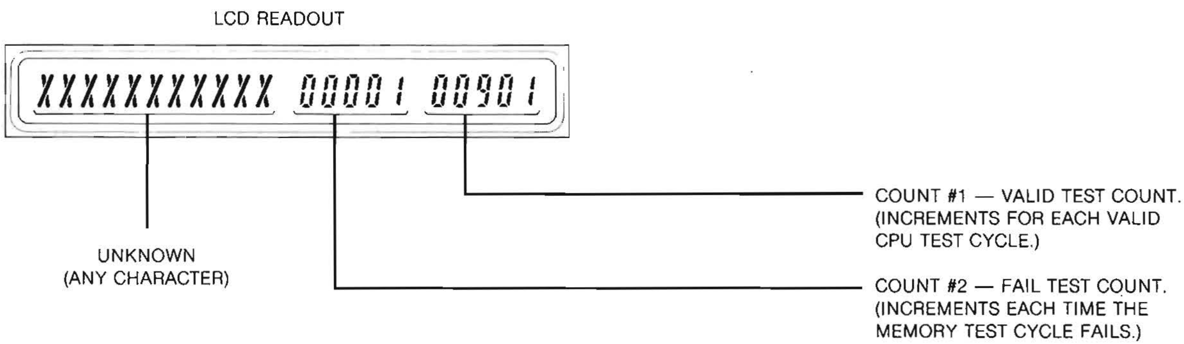
The CRT Test allows the operator to check each displayed character by using the ʌ or v keys. By depressing the ʌ Key, the next character code will be displayed; and by depressing the v Key, the previous character code will be displayed. The ENTER Key exits the CRT Test and returns the set to normal operation.

c. Code 3 LCD TEST (EXEC, 3, ENTER)

The LCD Test allows the operator to check each displayed character of the LCD. This test increments and shifts the characters from left to right, and will run continuously until the operator depresses and holds down the ENTER Key, restoring original field settings.

d. Code 4 CPU TEST (EXEC, 4, ENTER)

The CPU Test exercises all the CPU BUS lines within the internal bus connection. All data, address and control lines are checked for shorts, opens, etc. This test causes the LCD to flicker, internal relays to chatter and various LED's to blink, and will run in this mode until an error occurs, causing the LCD to display the following:



Depressing the ENTER Key after an error restarts the test. Depressing the ENTER Key during the test exits this test function, restoring original field settings.

e. Code 5 OPERATOR'S MENU (EXEC, 5, ENTER)
Provides a quick reference explanation on how to enter data into a user defined page on the CRT.

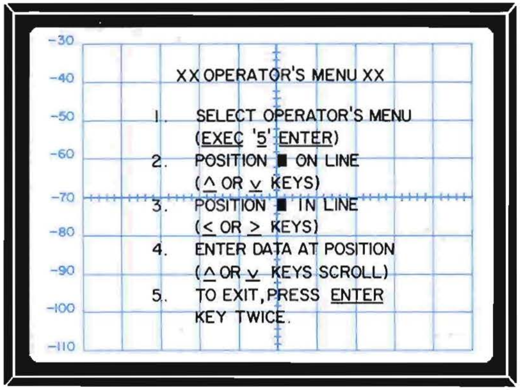


Figure 5-15 OPERATOR'S Menu

The OPERATOR'S Menu describes how to enter data, into a screen of data, which is stored for later recall by entering: EXEC, 5, ENTER. The last stored menu is recalled and screen editing is allowed. The cursor may be moved along the left edge of the screen by using the ∧ or v keys, to move up and down for line selection. When the desired line is selected, the > Key will move the cursor to the right, into the line, and the < Key will move the cursor backward (to the left). When the cursor is positioned over the character to be changed, the ∧ and v keys now slew the character to the next or previous ASCII character. After the desired ASCII character is found, the < or > Key may be used to select other characters.

When all editing is complete, depress the ENTER Key. This stores the screen in non-volatile memory. Depressing the ENTER Key again exits the OPERATOR Menu function and returns to the IFR LOGO start-up mode. Pressing any other key returns the test set to the operator's menu, with data saved.

5-2-11 SUMMARY OF MENU PARAMETERS

Table 5-3 provides a list of parameter boundaries for the "Freq" and "Tone" Menus in the FM/AM-1500:

MENU	DISPLAY SWITCH POSITION	ITEM NO.	FIELD	PARAMETER BOUNDARIES
RF Memory	FREQS	1 thru 30	Frequency Offset Mod	000.0000 to 999.9999 MHz -49.99 to +49.99 AM1, AM2, FM1, FM2, FM3, FM4, or SSB
RF Scan	FREQS	Resume Time 0 thru 30	0.0 to 9.9 seconds Frequency Mod	 000.0000 to 999.999 MHz AM1, AM2, FM1, FM2, FM3, FM4, or SSB
RF Sweep	FREQS	1 thru 4	Start Freq. Stop Freq. Incre. Step Incre. Rate	000.0000 to 999.9999 MHz 000.0000 to 999.9999 MHz 000.0001 to 999.9999 MHz 0.001 to 9.999 seconds
Tone Sequence	TONES	1 thru 99	Tone 1 Freq. Tone 1 Deviation Time Tone 2 Freq. Tone 2 Deviation	0000.0 to 29999.9 Hz 00.0 to 25.5 kHz 0.001 to 9.999 seconds 0000.0 to 29999.9 Hz 00.0 to 25.5 kHz
DTMF	TONES	0 thru 15	Manual Deviation DTMF Mark DTMF Space Telephone No. DTMF Deviation	00.0 to 25.5 kHz 0.001 to 9.999 seconds 0.001 to 9.999 seconds 15 digits consisting of 0,1, 2,3,4,5,6,7,8,9 * and # 00.0 to 25.5 kHz

Table 5-3 Summary of Menu Parameter Boundaries

MENU	DISPLAY SWITCH POSITION	ITEM NO.	FIELD	PARAMETER BOUNDARIES
Tone Sweep	TONES	1 thru 4	Start Freq. Stop Freq. Sweep Mode Incre. Step Incre. Rate	00000.0 to 29999.9 Hz 00000.0 to 29999.9 Hz Linear (+) or log (x) 00000.0 to 29999.9 Hz 0.001 to 9.999 seconds
DCS	TONES	0 thru 10	Code Number Polarity kHz Deviation 6 Receive Fields Receive Polarity	$000_{(8)}$ to $777_{(8)}$ Normal/Inverted 0.0 kHz to 9.9 kHz $000_{(8)}$ to $777_{(8)}$ Normal/Inverted
Cable Fault	FREQS	1 & 2	Freq. 1 Freq. 2 Vel Factor Cable Fault Distance (Feet) Cable Fault Distance (Meters)	000.0000 to 999.99 MHz 000.0000 to 999.99 MHz 0 to 99% 000.0 to 999.9 feet 000.0 to 999.9 meters

Table 5-3 Summary of Menu Parameter Boundaries (Cont'd)

5-3 DATA STORAGE

Data may be stored in the FM/AM-1500 by altering the data fields within the Programmable Menus. Table 5-3 lists the different programmable menus which can be classified as "TONES" or "FREQS" depending on the Display Switch Position required to access that menu. Perform the following steps to alter data:

1. Select appropriate menu.
2. Select item number to be programmed.
3. Program data field(s).
4. If desired, special character fields may be altered.

5-3-1 SELECTING APPROPRIATE MENU

Selecting the menu to be programmed is accomplished as follows:

STEP	ACTION
1A.	Place front panel DISPLAY Control (51) to "FREQS" position for RF MEMORY, RF SCAN, RF SWEEP or CABLE FAULT MENU.
or	
1B.	Place front panel DISPLAY Switch (51) to "TONES" position for TONE SEQUENCE, DTMF, TONE SWEEP or DCS MENU.
2.	If the menu of interest is now displayed, proceed directly to Paragraph 5-3-2, otherwise press MENU Key.
3.	Press ∧ or ∨ Key to scroll through menu pages, to display desired menu on CRT.
4.	Press ENTER Key. Desired menu is now selected and ready for programming.

Table 5-4 Selecting Desired Menu

5-3-2 SELECTING ITEM NUMBER

Selecting the item number to be programmed is accomplished as follows:

STEP	ACTION
1.	Press ∧ or ∨ Key to scroll through this menu's line numbers. Stop scrolling when desired line number is positioned on top line of item numbers. ------------------------------ Alternate Method ------------------------------ a. Enter desired line number using numbered keys. b. Press ENTER Key.

Table 5-5 Selecting Menu Item Number

5-3-3 **PROGRAMMING DATA FIELDS**

Programming data fields for each menu is accomplished as follows:

A. RF MEMORY MENU

STEP	ACTION
1.	Press > Key to position CRT cursor to FREQ data field.
2.	Enter desired frequency, using numeric and decimal point keys.
3.	Press > Key to position CRT cursor to OFFSET (Polarity) data field.
4.	Press ʌ or v Key to enter desired polarity.
5.	Press > Key to position CRT cursor to next character field of OFFSET data field.
6.	Enter desired offset frequency, using numeric and decimal point keys.
7.	Press > Key to position CRT cursor to MOD data field.
8.	Press ʌ or v Key to scroll through the selection of demodulation modes (AM1, AM2, SSB, FM1, FM2, FM3, FM4). Stop scrolling when desired demodulation mode appears in MOD data field.
	ERROR CORRECTION
	Before the FREQ, OFFSET & MOD parameters are entered into memory, any entry errors can be corrected as follows:
	Press < Key as necessary to return CRT cursor to data field where error is located in order to make error correction. If CRT cursor is returned under ITEM NO., the existing entry will be cancelled and will be replaced by previously stored data.
9.	Press ENTER Key to enter programmed data into user memory.

Table 5-6 Programming Frequency, Offset & Mod Data Fields Using RF MEMORY Menu

STEP	ACTION
10.	If additional lines in the RF MEMORY Menu are to be programmed, repeat step 1 in table 5-5.

Table 5-6 Programming Frequency, Offset & Mod Data Fields Using RF MEMORY Menu (Cont.)

B. RF SCAN MENU

STEP	ACTION
1.	Press > Key to position CRT cursor to FREQ data field.
2.	Enter desired frequency, using numeric and decimal point keys.
3.	Press > Key to position CRT cursor to MOD data field.
4.	Press ^ or v Key to scroll through the selection of demodulation modes (AM1, AM2, SSB, FM1, FM2, FM3, FM4). Stop scrolling when desired demodulation mode appears in MOD data field.
	ERROR CORRECTION
	Before the FREQ and MOD parameters are entered into memory, any entry errors can be corrected as follows:
	Press < Key as necessary to return CRT cursor to data field where error is located in order to make error correction. If CRT cursor is returned under ITEM NO., the existing entry will be cancelled and will be replaced by previously stored data.
5.	Press ENTER Key to enter programmed data into user memory.
6.	If additional lines in the RF SCAN Menu are to be programmed, repeat step 1 in table 5-5.

Table 5-7 Programming Frequency and Modulation Data Fields Using RF SCAN Menu

C. RF SWEEP MENU

STEP	ACTION
1.	Press > Key to position CRT cursor under to START FREQ data field.
2.	Enter desired start frequency, using numeric and decimal point keys.
3.	Press > Key to position CRT cursor to STOP FREQ data field.
4.	Enter desired stop frequency, using numeric and decimal point keys.
5.	Press > Key to position CRT cursor to INCR STEP data field.
6.	Enter desired increment step, using numeric keys and decimal point keys.
7.	Press > Key to position CRT cursor to INCR RATE data field.
8.	Enter desired increment rate, using numeric keys.
	ERROR CORRECTION
	Before the START FREQ, STOP FREQ, INCR STEP & INCR RATE parameters are entered into memory, any entry errors can be corrected as follows:
	Press < Key as necessary to return CRT cursor to data field where error is located in order to make error correction. If CRT cursor is returned under ITEM NO., the existing entry will be cancelled and will be replaced by previously stored data.
9.	Press ENTER Key to enter programmed data into user memory.
10.	If any additional menu subsets in the RF SWEEP Menu are to be programmed, repeat step 1 in table 5-5.

Table 5-8 Programming Start Freq, Stop Freq, Incr Step & Incr Rate Fields Using RF SWEEP Menu

D. CABLE FAULT MENU

STEP	ACTION
1.	Press > Key to position CRT cursor to FREQ #1 data field.
2.	Enter FREQ #1 frequency, using numeric and decimal point keys.
3.	Press > Key to position CRT cursor to FREQ #2 data field.
4.	Enter desired FREQ #2 frequency, using numeric and decimal point keys.
5.	Press > Key to position CRT cursor to VEL FACTOR data field.
6.	Enter cable velocity factor, using numeric keys.
	ERROR CORRECTION
	Before the FREQ #1, FREQ #2 & VEL FACTOR parameters are entered into memory, any entry errors can be corrected as follows:
	Press < Key as necessary to return CRT cursor to data field where error is located in order to make error correction.
7.	Press ENTER Key to display computed cable fault distances.

Table 5-9 Programming Freq 1, Freq 2 & VEL Factor Fields Using CABLE FAULT Menu

E. TONE SEQUENCE MENU

STEP	ACTION
1.	Press > Key to position CRT cursor to T1 TONES data field.
2.	Enter desired T1 frequency, using numeric and decimal point keys.
3.	Press > Key to position CRT cursor to T1 DEV data field.
4.	Enter desired T1 deviation, using numeric and decimal point keys.
5.	Press > Key to position CRT cursor to TIME data field.

Table 5-10 Programming Tones, Deviation & Time Data Fields Using TONE SEQUENCE Menu

STEP	ACTION
6.	Enter desired TIME, using numeric keys.
7.	Repeat steps 1 through 4 for T2 data fields.
	ERROR CORRECTION
	Before the T1 and T2 TONES, DEV & TIME parameters are entered into memory, any entry errors can be corrected as follows:
	Press < Key as necessary to return CRT cursor to data field where error is located in order to make error correction. If CRT cursor is returned under ITEM NO., the existing entry will be cancelled and will be replaced by previously stored data.
8.	Press ENTER Key to enter programmed data into user memory.
9.	If additional lines in the TONE SEQUENCE Menu are to be programmed, repeat step 1 in table 5-5.

Table 5-10 Programming Tones, Deviation & Time Data Fields Using TONE SEQUENCE Menu (Cont.)

F. DTMF MENU

STEP	ACTION
1.	Press > Key to position CRT cursor to TELEPHONE NUMBER data field.
2.	Enter desired telephone number, using numeric, 2ND/* and 2ND/# Keys.
3.	Press > Key to position CRT cursor to DEVIATION data field.
4.	Enter desired deviation using numeric and decimal point keys.
	ERROR CORRECTION
	Before the TELEPHONE NO. & DEVIATION parameters are entered into memory, any entry errors can be corrected as follows:

Table 5-11 Programming Telephone Number & Deviation Data Fields Using DTMF Menu

STEP	ACTION
	ERROR CORRECTION Press < Key as necessary to return CRT cursor to data field where error is located in order to make error correction. If CRT cursor is returned under ITEM NO., the existing entry will be cancelled and will be replaced by previously stored data.
5.	Press ENTER Key to enter programmed data into user memory.
6.	If additional lines in the DTMF Menu are to be programmed, repeat step 1 in table 5-5.

Table 5-11 Programming Telephone Number & Deviation Data Fields Using DTMF Menu (Cont.)

G. TONE SWEEP MENU

STEP	ACTION
1.	Press > Key to position CRT cursor to START FREQ data field.
2.	Enter desired start frequency, using numeric and decimal point keys.
3.	Press > Key to position CRT cursor to STOP FREQ data field.
4.	Enter desired stop frequency, using numeric and decimal point keys.
5.	Press > Key to position CRT cursor to MODE data field.
6.	Enter desired sweep mode (+ for linear, x for logarithmic) using ∧ or v Keys.
7.	Press > Key to position CRT cursor to INCR STEP data field
8.	Enter desired increment step, using numeric keys.
9.	Press > Key to position CRT cursor to INCR RATE data field.

Table 5-12 Programming Start Freq, Stop, Freq, Mode, Incr Step & Incr Rate Data Fields Using TONE SWEEP Menu

STEP	ACTION
	ERROR CORRECTION Before the START FREQ, STOP FREQ, MODE, INCR STEP & INCR RATE parameters are entered into memory, any entry errors can be corrected as follows: Press < Key as necessary to return CRT cursor to data field where error is located in order to make error correction. If CRT cursor is returned under ITEM NO., the existing entry will be cancelled and will be replaced by previously stored data.
11.	Press ENTER Key to enter programmed data into user memory.
12.	If any additional menu subsets in the TONE SWEEP Menu are to be programmed, repeat step 1 in table 5-5.

Table 5-12 Programming Start Freq, Stop, Freq, Mode, Incr Step & Incr Rate Data Fields Using TONE SWEEP Menu (Cont.)

H. DCS MENU

STEP	ACTION
1.	Press > Key to position CRT cursor to CODE NUMBER data field.
2.	Enter desired code number using numeric key 0 thru 7.
3.	Press > Key to position CRT cursor to POLARITY data field.
4.	Enter desired polarity (NORM for normal polarity and INVT for inverted polarity) using ∧ Key or v Key.
5.	Press > Key to position CRT cursor to kHz DEVIATION data field.
6.	Enter desired deviation using numeric and decimal keys.
7.	Press ENTER Key to enter PROGRAMMED DATA into user memory.

Table 5-13 Programming Code Number, Polarity & kHz Deviation Data Fields Using DCS Menu

5-3-4 **PROGRAMMING SPECIAL CHARACTER FIELDS**

The RF SCAN, DTMF and DCS Menus have special character fields. Once the menu is selected, these special character fields may be programmed as follows:

A. RF SCAN MENU SPECIAL CHARACTER FIELD

STEP	ACTION
1.	Press Ø Key, followed by ENTER Key.
2.	Enter desired resume time, using numeric and decimal point keys (0.0 to 9.9).
3.	Press ENTER Key to save data. RF SCAN Menu resume time is now programmed into memory. > Key will return to resume time field if further editing is required. Press ENTER Key again to return to Item #1.
	ERROR CORRECTION
	Before the RESUME TIME parameter is entered into memory, any entry errors can be corrected as follows:
	Press < Key to restore original data or press > Key to return CRT cursor to beginning of resume time field. Then re-enter correct data.
4.	Press ENTER Key to enter programmed data into user memory.

Table 5-14 Programming Resume Time Using RF SCAN Menu

B. DTMF MENU SPECIAL CHARACTER FIELDS

STEP	ACTION
1.	Press Ø Key, followed by ENTER Key.
2.	Press > Key to position CRT cursor to MANUAL DEV data field.
3.	Enter desired manual deviation, if required, using numeric and decimal point keys.

Table 5-15 Programming Manual Dev, DTMF Mark & DTMF Space Fields Using DTMF Menu

STEP	ACTION
4.	Press > Key to position CRT cursor to DTMF Mark data field.
5.	Enter desired mark time using numeric and decimal point keys.
6.	Press > Key to position CRT cursor to DTMF SPACE data field.
7.	Enter desired space time using numeric and decimal point keys.
8.	Press ENTER Key to save data. Press ENTER Key again to return to Item #1.
	ERROR CORRECTION
	Before the MANUAL DEV, DTMF Mark & DTMF Space parameters are entered into memory, any entry errors can be corrected as follows:
	Press < Key as necessary to return CRT cursor to data field where error is located in order to make error correction. If CRT cursor is returned under ITEM NO., the existing entry will be cancelled and will be replaced by previously stored data. > Key will return to Ø field editing if further changes are needed.

Table 5-15 Programming Manual Dev, DTMF Mark & DTMF Space Fields Using DTMF Menu (Cont.)

C. DCS MENU SPECIAL CHARACTER FIELD

STEP	ACTION
1.	Press Ø Key, followed by ENTER Key.
2.	Enter desired polarity (NORM for normal polarity and INVT for inverted polarity) using ∧ or v Keys.
3.	Press ENTER Key to save data. Press ENTER Key again to return to Item #1.

Table 5-16 Programming Data Polarity Using DCS Menu

STEP	ACTION
	ERROR CORRECTION Before the DATA POLARITY is entered into memory, any entry errors can be corrected as follows: Press < Key to restore original data or press > Key to return CRT cursor to beginning of resume time field. Then re-enter correct data.
4.	Press ENTER Key to enter programmed data into user memory.

Table 5-16 Programming Data Polarity Using DCS Menu (Cont.)

5-4 DATA RETRIEVAL & EXECUTION

Once the various FM/AM-1500 menu functions have been programmed with the desired operating parameters, the operator can retrieve or execute the programmed data using the automatic execution function. This function involves the use of EXECUTION STRINGS, in which a sequence of specific keystrokes are entered to allow the FM/AM-1500 to perform the selected operation(s), as defined in the execution string. Two types of execution strings can be entered into the FM/AM-1500.

1. **SIMPLE EXECUTION STRING**

   With this type of entry, the string is sequentially executed through the last item, at which time the execution is terminated.

2. **LOOPING EXECUTION STRING**

   A looping execution string will continuously execute the selected item(s) in a sequential manner until the operator intervenes to stop or alter the execution string.

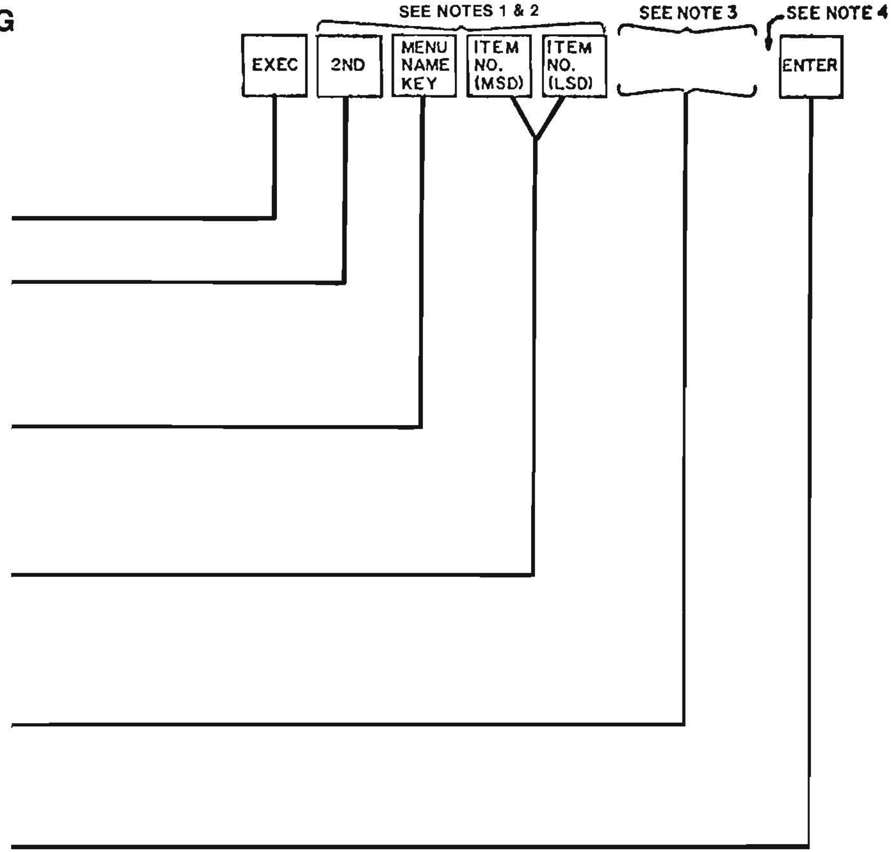
A maximum of 128 keystrokes may be used in any given execution string. The key entry sequence for both types of execution strings (as applicable to all menu functions) as follows:

5-4-1 **SIMPLE EXECUTION STRING**

Key entry sequence:

1. Press ENTER Key. Clears all previously entered data.
2. Press EXEC Key. This entry defines the beginning of an execution string.
3. Press 2ND Key (Except for RF MEMORY Menu).
4. Press desired menu name key. Choices are:

   RF DTMF DCS
   F. SWP SCAN (Ref Note 2)
   T. SWP T. SEQ. (Ref Note 2)
5. Key in desired menu item number (or line number) corresponding to desired operation. (MSD is most significant digit of item number, LSD is least significant digit.)
6. Additional menu names and item numbers to be included in execution string (if desired) may be inserted here.
7. Press ENTER Key to start execution of string.



NOTES:

1. This entry sequence sets the operating parameters of the FM/AM-1500 generator, receiver, or tone generator functions to the mode and/or values programmed into the selected menu.
2. A start and stop number separated by the "—" Key is required whenever entering menu item numbers for the RF SCAN or TSEQ menus. The FM/AM-1500 will execute item numbers sequentially from the start number to the stop number.

Example: [EXEC] [2ND] [TSEQ] [2] [0] [—] [1] [2] [ENTER]

The above sequence will allow the FM/AM-1500 to execute item numbers sequentially from 20 to 12.

3. Additional operations on the same menu or on other menus may be entered into the string at this point, by keying in the appropriate menu name(s) and item number(s). (Maximum number of keystrokes allowable is 128.)

4. If an entry error is made prior to this point, the operator may use the < Key to backspace as necessary, for purposes of correcting errors (pressing the < Key once will delete the previous key entry.)

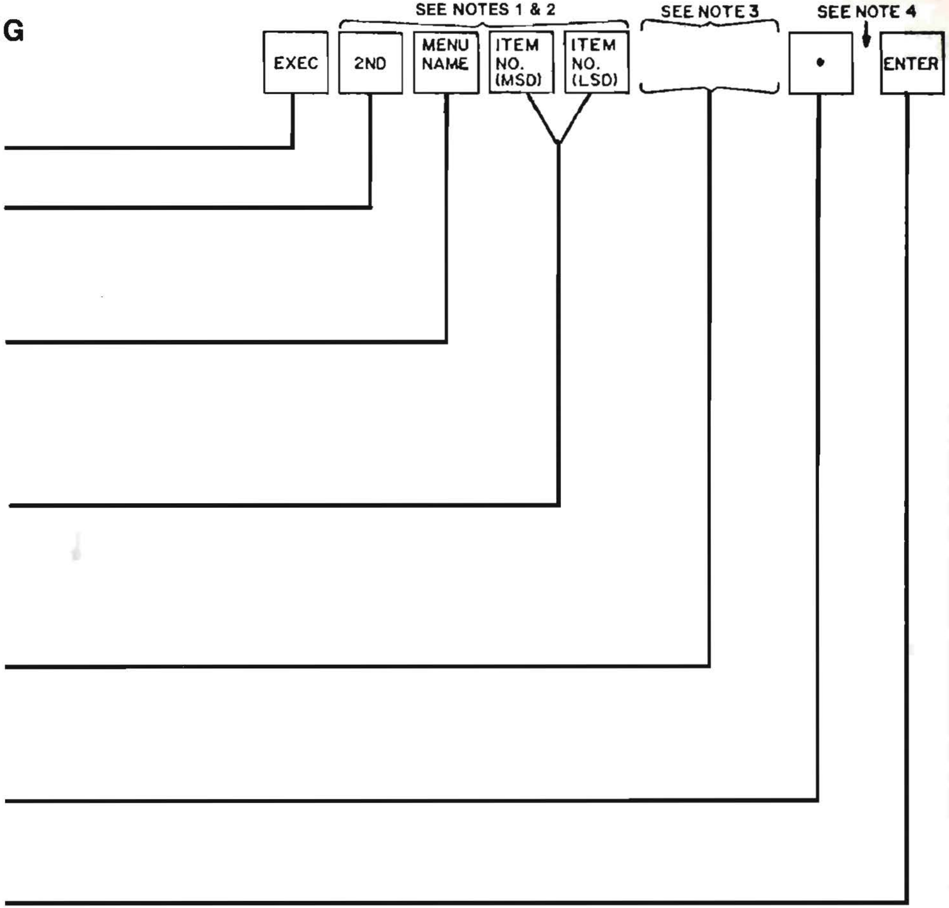
5. Timed execution (the time interval between updates by the microprocessor) items allows entry of time intervals from 1 mS to 9999 mSecs. The maximum rate the microprocessor can perform this task dictates the minimum time interval any given time execution can operate. If the microprocessor time interval limit is set too fast (less than 10 mSec), the rate of operation may not be correct. Complexity of operation and microprocessor tasks during execution determine this minimum rate. For instance, the minimum time interval required will increase (require a greater time interval for valid updates) if the oscilloscope is used to display CRT Menus.

5-4-2 **LOOPING EXECUTION STRING**

Key entry sequence:

1. Press EXEC Key. This entry defines the beginning of an execution string.
2. Press 2ND Key (Except for RF MEMORY Menu).
3. Press desired menu name key. Choices are:

   RF   DTMF   DCS
   F. SWP   SCAN (Ref Note 4)
   T. SWP   T. SEQ (Ref Note 4)
4. Key in desired menu item number (or line number) corresponding to desired operation. (MSD is most significant digit of item number, LSD is least significant digit.)
5. Additional menu names and item numbers to be included in execution string (if desired) may be inserted here.
6. Press decimal point key. This entry will allow the FM/AM-1500 to continuously repeat the execution string.
7. Press ENTER Key to begin execution.
8. To stop looping execution, press any Function Key (T1, T2 or RF), or enter another execution string.



SECTION 6 — GPIB OPERATION
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SECTION 6 — GPIB OPERATION

6-1 GENERAL

This Section is used if the GPIB option is installed in the FM/AM-1500. The technician should refer to Sections 3, 4 and 5 for general operating instructions and use this Section as a source of information on GPIB control.

The FM/AM-1500 GPIB is designed with partial local lockout capabilities. Therefore, a distinction must be made between those controls that are controlled by the GPIB and those that are not. Controls that are not controllable by GPIB must be set manually by the technician. It is good practice, when writing a software program for the FM/AM-1500, to include prompts in the software to tell the technician where or when to set the non-GPIB controls.

6-1-1 FRONT PANEL CONTROLS CONTROLLED BY GPIB

The front panel controls listed in Figure 6-1 are controlled by the GPIB and thus may be in any position at initial set-up, with the exception of the DISPLAY Control. The DISPLAY Control must be in "ANALY" whenever GPIB control is selected. This position allows "ANALY", "TRACK", "FREQS", "TONES" and "METER" functions to be controlled by the GPIB.

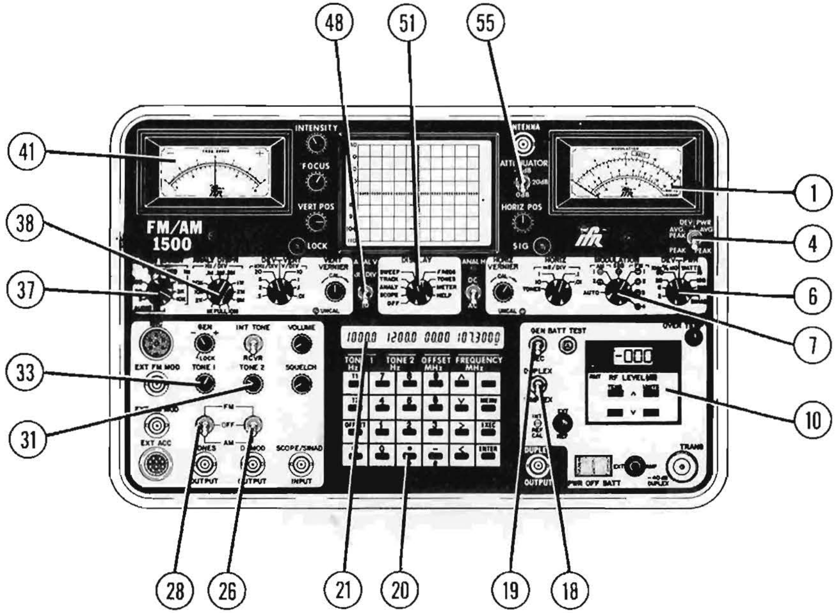
NOTE:

"OFF", "SCOPE", "SWEEP" and "HELP" positions of the DISPLAY Control must be manually selected.

6-1-2 FRONT PANEL CONTROLS NOT CONTROLLED BY GPIB

The front panel controls listed in Figure 6-2 are not controllable by the GPIB and therefore must be controlled manually by the technician, with the exception of the DISPLAY Control. The DISPLAY Control is manually selected for "OFF", "SCOPE", "SWEEP" and "HELP" positions, but must be in "ANALY" for GPIB control, as noted in Paragraph 6-1-1.

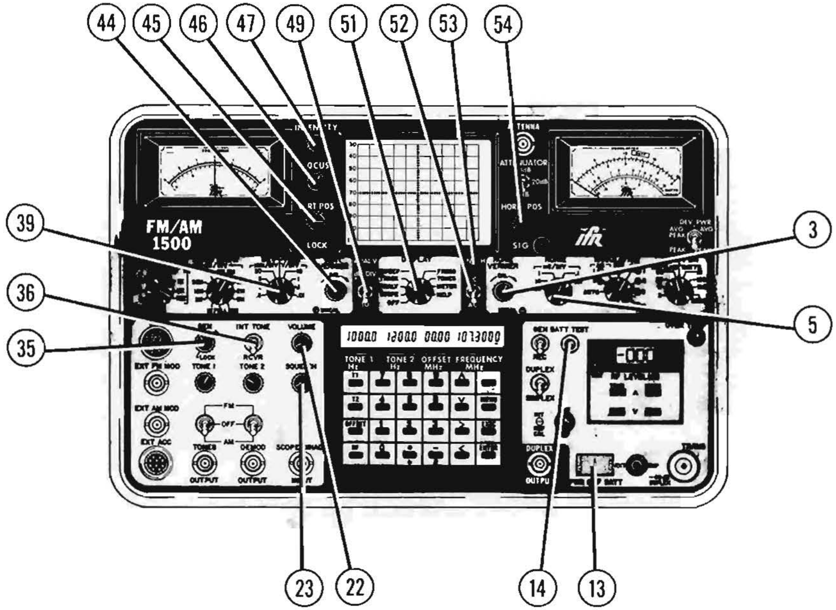
NOTE: Ref. Nos. correspond to Figure 3-1.



1. MODULATION Meter
4. AVG PEAK/PEAK Switch
6. DEV/PWR Control
7. MODULATION Control
10. RF Output Level Control
18. DUPLEX/SIMPLEX Switch
19. GEN/REC Switch
20. KEYBOARD
21. LCD
26. Tone 2 FM/OFF/AM Switch
28. Tone 1 FM/OFF/AM Switch
31. TONE 2 Control
33. TONE 1 Control
37. FREQ ERROR Control
38. ANALY DISPR Control
41. FREQ ERROR Meter
48. db/DIV Switch
51. DISPLAY Control (see text)
55. ATTENUATOR Switch

Figure 6-1 FM/AM-1500 Controls Controlled by GPIB

NOTE: Ref. Nos. correspond to Figure 3-1.



3. HORIZ VERNIER Control
5. HORIZ Control
13. PWR/OFF/BATT Switch
14. BATT TEST Button
22. VOLUME Control
23. SQUELCH Control
35. GEN/LOCK Control
36. INT TONE/RCVR Switch
39. DEV/VERT Control
44. VERT VERNIER Control
45. VERT POS Control
46. FOCUS Control
47. INTENSITY Control
49. Vertical Centering Adjustment (Analyzer)
51. DISPLAY Control (see text)
52. DC/AC Switch
53. Horizontal Centering Adjustment (Analyzer)
54. HORIZ POS Control

Figure 6-2 FM/AM-1500 Controls NOT Controlled by GPIB

6-1-3 REAR PANEL GPIB CONNECTIONS AND SWITCHES

1. **GPIB Connector**

   The GPIB Connector (J5902), on the Rear Panel of the FM/AM-1500, conforms to IEEE Standard 488-1978 configuration as shown in Figure 6-3.

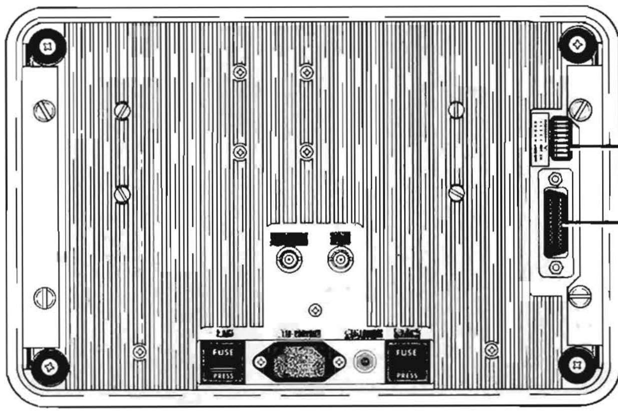
2. **GPIB Switch**

   The GPIB Switch (SW5901), on the Rear Panel of the FM/AM-1500, must be set in the desired configuration prior to powering up the FM/AM-1500. This is necessary since the microprocessor in the FM/AM-1500, once initialized, cannot read a change of a switch setting on the GPIB Switch until it is powered down and then powered back up again.

   Dip switches A1 thru A5 are used for the user-selected address of the FM/AM-1500. The DIP switches are coded in binary, with A1 being the least significant digit. For example, if the user desired the address of the FM/AM-1500 to be 9, switches A1 thru A5 would be configured as:

   A1 = ON = 1
   A2 = OFF = Ø
   A3 = OFF = Ø
   A4 = ON = 8
   A5 = OFF = Ø

   DIP Switch A8 on the GPIB Switch is the ENABLE/DISABLE Switch for GPIB operation. When A8 is ON, the GPIB control is operable. When A8 is OFF, the GPIB control is not operable.



GPIB Switch (SW5901)

A1	User-Selected Address
A2	User-Selected Address
A3	User-Selected Address
A4	User-Selected Address
A5	User-Selected Address
A6	Not Used
A7	Not Used
A8	ENABLE/DISABLE GPIB

GPIB Connector (J5902)

1. DIO 1
2. DIO 2
3. DIO 3
4. DIO 4
5. EOI
6. DAV
7. NRFD
8. NDAC
9. IFC
10. SRQ
11. ATN
12. GND
13. DIO 5
14. DIO 6
15. DIO 7
16. DIO 8
17. REN
18. GND
19. GND
20. GND
21. GND
22. GND
23. GND
24. GND

Figure 6-3 Rear Panel Connections and Switches for GPIB

6-2 REMOTE CONTROL (GPIB) OPERATIONS

Remote communication with the FM/AM-1500 is provided by use of the General Purpose Interface Bus (GPIB) which conforms to the latest IEEE Standard 488-1978. The test set will perform to the following IEEE 488-1978 Subsets: SH1, AH1, T2, TEØ, L2, LEØ, SR1, RL2, PPØ, DC1, DT1 and CØ. These subsets mean the FM/AM-1500 has the following capabilities using ASCII encoded character strings.

a. Complete Source and Acceptor Handshake
b. Talker with Serial Poll
c. Listener
d. Service Request
e. Remote/Local (Partial Local Lockout Capability)
f. Device Clear
g. Device Trigger

Communication with the FM/AM-1500 over the GPIB is implemented with ASCII encoded character strings. Invalid or improperly formatted characters are discarded and an error status flag will be set. The exceptions to this rule are the IEEE 488 bus messages defined in Table 6-1. Any of these messages will cause an immediate response within the FM/AM-1500. The coding for these messages is defined in Table 6-1. The ASCII String Commands are stored in a 128 Byte Buffer until receipt of a carriage return, line feed, null character or an "END", "IDY" or "GET" message. At this time, all commands will be executed and measurements made or initiated.

		1	2	3 BUS SIGNAL LINES AND CODING FOR TRUE VALUE OF MESSAGE								
MNEMONIC	FUNCTION	TYPE	CLASS	DATA ON DIO 1-8 (HEX)	DAV	NRFD	NDAC	ATN	EOI	SRQ	IFC	REN
ATN	ATTENTION	S	UC	N/A	X	X	X	1	X	X	X	X
DAB	DATA BYTE	M	DD	ØØ-FF	X	X	X	Ø	X	X	X	X
DAC	DATA ACCEPTED	S	HS	N/A	X	X	Ø	X	X	X	X	X
DAV	DATA VALID	S	HS	N/A	1	X	X	X	X	X	X	X
DCL	DEVICE CLEAR	M	UC	14	X	X	X	1	X	X	X	X
END	END	S	ST	N/A	X	X	X	Ø	1	X	X	X
GET	GROUP EXECUTE TRIGGER	M	AC	Ø8	X	X	X	1	X	X	X	X
GTL	GO TO LOCAL	M	AC	Ø1	X	X	X	1	X	X	X	X
IDY	IDENTIFY	S	UC	N/A	X	X	X	X	1	X	X	X
IFC	INTERFACE CLEAR	S	UC	N/A	X	X	X	X	X	X	1	X
LLO	LOCAL LOCK OUT	M	UC	NO RESPONSE TO THIS MESSAGE								
MLA	MY LISTEN ADDRESS	M	AD	2Ø-3F	X	X	X	1	X	X	X	X
MTA	MY TALK ADDRESS	M	AD	4Ø-5F	X	X	X	1	X	X	X	X
REN	REMOTE ENABLE	S	UC	N/A	X	X	X	X	X	X	X	1
RFD	READY FOR DATA	S	HS	N/A	X	Ø	X	X	X	X	X	X
SPD	SERIAL POLL DISABLE	M	UC	19	X	X	X	1	X	X	X	X
SPE	SERIAL POLL ENABLE	M	UC	18	X	X	X	1	X	X	X	X
SRQ	SERVICE REQUEST	S	ST	N/A	X	X	X	X	X	1	X	X
STB	STATUS BYTE	M	ST	ØØ-FF	X	X	X	Ø	X	X	X	X
UNL	UNLISTEN	M	AD	3F	X	X	X	1	X	X	X	X
UNT	UNTALK	M	AD	5F	X	X	X	1	X	X	X	X

NOTES:

1 TYPE: S = SINGLE LINE MESSAGE
M = MULTILINE MESSAGE

2 CLASS: AC = ADDRESSED COMMAND
AD = ADDRESS (TALK OR LISTEN)
DD = DEVICE DEPENDENT
HS = HANDSHAKE
UC = UNIVERSAL COMMAND
ST = STATUS

3 LEVEL: Ø = HIGH STATE SIGNAL LEVEL
1 = LOW STATE SIGNAL LEVEL

4 REFER TO IEEE STD. 488-1978 FOR FURTHER INFORMATION.

Table 6-1 Remote Message Coding

6-2-1 **FM/AM-1500 AND GPIB MESSAGE INTERFACE DEFINITIONS**

1. ATN — The FM/AM-1500 GPIB I/O device responds immediately to process the incoming GPIB Controller commands.
2. DAB — The FM/AM-1500 microprocessor responds by status testing of the GPIB I/O device to accept the data byte.
3. DAC — The FM/AM-1500 GPIB I/O device responds immediately to signal the talker that it has accepted the data byte.
4. DAV — The FM/AM-1500 GPIB I/O device responds immediately to signal the interceptor that it has put valid data on the bus.
5. DCL — The FM/AM-1500 processor responds to clear the input buffer and halt all command executions.
6. END — The FM/AM-1500 responds to terminate the command input from the source and begin processing the commands available up to the last valid delimiter.
7. GET — The FM/AM-1500 responds to terminate any further inputs and to execute the commands available up to the last available delimiter.
8. GTL — The FM/AM-1500 processor responds to remove itself from control over the FM/AM-1500, therefore returning control to the FM/AM-1500 front panel.
9. IDY — Same as "END".
10. IFC — The FM/AM-1500 processor responds by returning the GPIB to its quiescent state.
11. LLO — No response to this message.
12. MLA — The FM/AM-1500 GPIB I/O device responds immediately by comparing its address with the listen address given. If the two are the same, it instructs the processor to listen.

13. MTA The FM/AM-1500 GPIB I/O device compares its address with the talk address given. If the two are the same, it instructs the processor to talk.

14. REN The FM/AM-1500 processor responds from the interface to put the FM/AM-1500 into remote, which partially disables front panel operation and clears all status commands' buffers except "CG1?", "CG2?" and "CG3?".

15. RFD The FM/AM-1500 GPIB I/O device signals the source that it is ready for data to be transmitted on the bus.

16. SPD The FM/AM-1500 GPIB I/O device terminates the service request operation by disabling the Serial Poll.

17. SPE The FM/AM-1500 GPIB I/O device places the Status Byte on the bus addressed to talk.

18. SRQ The FM/AM-1500 processor instructs the interface to signal the Controller that servicing is desired. (This is done under FM/AM-1500 Software Control.)

19. STB The FM/AM-1500 GPIB I/O device responds immediately after the SPE and MTA messages by placing the Status Byte on the Bus.

20. UNL The FM/AM-1500 GPIB I/O device and the processor respond to unlisten the FM/AM-1500.

21. UNT The FM/AM-1500 GPIB I/O device and the processor respond to untalk the FM/AM-1500.

6-2-2 **GPIB TRANSACTIONS**

Two examples of GPIB transactions showing the ASCII Character String to be transmitted followed by the necessary BUS operations to complete the transactions are shown below. These examples were generated and executed using a GPIB Controller that uses an ANSI Standard Basic Interpreter with enhancements allowing direct communication over GPIB using special GPIB interface hardware. In the examples, the ASCII Character String to be transmitted is shown first and followed by the bus operations required to complete the transaction.

EXAMPLE No. 1

Instruct the FM/AM-1500 to set Generator/Receiver Frequency to 123.4567 MHz.

a. ASCII String: "RFF = 123.4567" (followed by Carriage Return and Line Feed.)

b. Bus Transaction: UNT, UNL, MLA, MTA, DAB"R", DAB"F", DAB"F", DAB" = ", DAB"1", "DAB"2", DAB"3", DAB".", DAB"4", DAB"5", DAB"6", DAB"7", DAB CR, DAB LF.

EXAMPLE No. 2

Instruct the FM/AM-1500 to return the Generator/Receiver Frequency. (123.4567 MHz)

a. ASCII String: "RFF?"

b. Bus Transactions:

1. Output Cycle — UNT, UNL, MLA, MTA, DAB"R", DAB"F", DAB"F", DAB"?", DAB CR, DAB LF.

2. Input Cycle — UNT, UNL, MLA, MTA, DAB"1", DAB"2", DAB"3", DAB".", DAB"4", DAB"5", DAB"6", DAB"7", DAB CR, DAB LF.

6-2-3 STATUS AND SERVICE REQUEST TRANSACTIONS

The FM/AM-1500 has the capability to trigger a service request, based on one to six trigger conditions which can be enabled by the user with the FM/AM-1500 "SRQ = " Command. After the FM/AM-1500 is placed in remote operation mode, it may be interrogated for the one byte status information. If an internal error or status condition becomes true and the matching trigger bit of the SRQ Trigger Byte (Bits Ø through 5) has been set, Bit 6 will also be set. Bit 6 is generally used as the service request bit, signaling a GPIB Controller that the FM/AM-1500 desires servicing.

NOTE:

Bit 7 of the Status Byte is not used.

6-3 COMMAND AND DATA STRUCTURE

All FM/AM-1500 Functional Commands and data information are transfered over the GPIB as Uppercase ASCII Alphanumeric Character Strings and are designed to replace the front panel controls.

6-3-1 ASCII OUTPUT COMMANDS TO FM/AM-1500

All output commands sent to the FM/AM-1500 are placed on an Internal Stack that will accommodate up to 128 bytes of data. Command Strings may be packed together, but the individual commands must be separated by delimiters. The delimiters are:

1. ASCII COLON ":"
2. ASCII PERIOD "."
3. ASCII QUESTION MARK "?"
4. ASCII SLASH "/"

NOTE:

The Question Mark ("?") will be accepted at any time and ignored unless it follows a command.

The Colon (":") and the Slash ("/") are general delimiters and may be used after the Period or Question Mark. Care must be exercised in using the Period or Question Mark at the end of a command as they may change the interpretation of that command.

The following ASCII Characters will terminate the output command or series of commands.

1. ASCII Carriage Return (ØD) — CR
2. ASCII Line Feed (ØA) — LF
3. NULL Character (Ø) — NL
4. GPIB EOI Command
5. Mnemonic GET Message

The FM/AM-1500 terminator may be selected by the command "TERM = n" to be CRLF, LFCR, CRCR, or LFLF. EOI will be asserted on the second ASCII character sent (i.e., CR or LF).

6-3-2 ASCII OUTPUT COMMAND DATA FORMAT

All spaces will be ignored. Below are some examples of commands which are valid:

"RFF = 123.4567:RFF?"
"AFF1 = 1ØØØØ.Ø/AFF1/"
"INIT.:RFF = 123.4567"
"AFF2?RF?RFL?:STAT?"

NOTE:
If no CR, LF, NL, GET or EOI is included, then the line may be continued and the commands will not be executed until one of the above is received.

Maximum command string length, including spaces and delimiters, is 128 characters. If the command string exceeds 128 characters, everything up to the most recent delimiter will be accepted and the rest ignored. The Error Status Condition "I/O OVERFLOW" will be set in this case.

EXAMPLE:

COMMAND: "INIT.RFF?TR?STAT?RID = ON:BLANK?"

RESPONSES: "Ø1Ø.ØØØØ:REC:OK:BLANK = ON"

NOTE:

Commands ending with an ASCII Question Mark ("?") would normally require the GPIB Controller to perform an ASCII String input command after issuing the output command.

The above commands set the Reply Identifier Flag which caused the command label following "RID = ON" to be attached to the response.

6-3-3 **RETURN DATA FORMAT**

The returned data format convention is similar to the Output Command Data Format in that all returns will be packed together and separated by ASCII Colon (":") delimiters. The number of responses returned is determined by the number of commands transferred in one block. If the number of responses required causes the internal response buffer to overflow by being larger than 128 bytes, then only the responses up to the most recent delimiter will be returned and the Error Status Condition "I/O OVERFLOW" will be set. For an example of a response, see paragraph 6-3-2.

Data inputs that are out of specific range will generally default to the minimum values or initial condition values.

6-3-4 **COMMAND GROUPS**

The command mnemonics used in the FM/AM-1500 are longer than normally seen in GPIB controlled equipment. This process is used to give the unfamiliar programmer a clear understanding of the functions he or she will be executing. Because the possibility exists that the long transmission time required for these commands could seriously impede overall ATE systems performance, three command group buffers and associated commands: "CGX = ", CGX?", and "CGX." have been included (X = 1, 2 or 3). These groups will allow the programmer to input up to 124 characters (128-"CGX = ") to one of three command buffers for later execution by the "CGX." command. The "CGX." commands may be stacked as long as not more than one "CGX." command is included at the end of another "CGX = " input. As soon as the command input interpreter sees the "CGX." command, it will immediately execute that command group buffer before proceeding with normal command interpretation and execution.

An example of the proper usage of command buffer stacking would be:

"CG1 = RID = ON:AFF1?"
"CG2 = RFF?CG1."
"CG3 = TR?CG2."

Executing a "CG3." command will return:

GEN:123.4567:AFF1 = 1ØØØØ.Ø"

6-3-5 **REPLY IDENTIFIER**

When the Reply Identifier is activated by the command "RID = ON", the returned information for data or status requests will be preceeded by the command mnemonic and an " = " character. This will continue until the command "RID = OFF".

6-4 FM/AM-1500 INSTRUCTION SET

The following paragraphs define the commands used to control the FM/AM-1500 under GPIB operation. The commands are grouped under paragraph headings according to the applicable function of each command.

Qualifiers for each command are used throughout the following paragraphs and are defined as follows:

a. An " = " represents a "set" operation for that command.
b. A "?" represents a "get" operation for that command.
c. A "." represents an "enable" operation for that command.

Symbols accompanying commands in the following paragraphs are defined as follows:

a. A ";" is a delimiter that separates fields of data from each other.
b. An "n" indicates a data item number.
c. An "s" indicates a sign (+, - or x).
d. An "x" indicates an alphanumeric character which is to be entered into a data field as explained in the description following each command.

6-4-1 **RF CONTROL GROUP**

REC.	Enables the FM/AM-1500 receiver mode. (Generator off, simplex mode.)
GEN.	Enables the FM/AM-1500 generator mode. (Receiver monitoring internal generator, simplex mode.)
DUP.	Enables the FM/AM-1500 duplex mode. (Receives selected frequency. Generates on selected frequency plus duplex offset value.)
TR?	Returns the transmit/receive mode status (i.e., REC, GEN, or DUP).
RFF = xxx.xxxx	Sets the FM/AM-1500 to the specified frequency: Range: Ø.1 to 999.9999 MHz Step: Ø.ØØØ1 MHz
RFF?	Returns the FM/AM-1500 frequency status.
DPX = sxx.xx	Sets the duplex offset value. Range: -49.99 to +49.99 MHz Step: Ø.Ø1 MHz
DPX?	Returns the duplex offset status.
RFL = xxx	Sets the RF output level in -dBm: Range: Ø to 127 (-dBm) Step: 1 (-dBm)
RFL?	Returns the status of the RF level.

6-4-2 **MODULATION AND BANDWIDTH CONTROL GROUP**

	DEMODULATION	PREDETECTION	POSTDETECTION
AM1.	AM	6 kHz	8 kHz
AM2.	AM	15 kHz	8 kHz
FM1.	FM	15 kHz	8 kHz
FM2.	FM	2ØØ kHz	8 kHz
FM3.	FM	2ØØ kHz	2Ø kHz
FM4.	FM	2ØØ kHz	8Ø kHz
SSB.	SSB	6 kHz	8 kHz

MAUTO. Selects the stored modulation associated with a menu execution item (i.e., RF SCAN or RF MEMORY).

MBW? Returns the status of the modulation and bandwidth (i.e., AM1, FM2, etc.).

6-4-3 **TONE GENERATOR CONTROL GROUP**

AFF1 = xxxxx.x Sets audio tone generator number one to the specified frequency.

Range: ØØØØ.1 to 29,999 Hz
Step: ØØØØ.1 to 9999 Hz - ØØØØ.1 Hz
1Ø,ØØØ to 29,999 Hz - ØØØØ1 Hz

AFF2 = xxxxx.x Sets audio tone generator number two to the specified frequency.

Range: ØØØØ.1 to 29,999 Hz
Step: ØØØØ.1 to 9999.9 Hz - ØØØØ.1 Hz
1Ø,ØØØ to 29,999 Hz - ØØØØ1 Hz

AFF1? — Returns the status of the AFF1 setting.

AFF2? — Returns the status of the AFF2 setting.

AM%1 = xxx — Sets the percentage of AM specified for tone generator #1.

Range: ØØØ to 127%
Step: ØØ1%

AM%2=xxx — Sets the percentage of AM specified for tone generator #2.

Range: ØØØ% to 127%
Step: ØØ1%

AM%1? — Returns the status of tone generator #1's percentage of AM or "OFF" if #1 has been routed to FM.

AM%2? — Returns the status of tone generator #2's percentage of AM or "OFF" if #2 has been routed to FM.

DEV1=xx.x — Sets the FM deviation specified using tone generator #1.

Range: ØØ.Ø to 25.5 kHz
Step: ØØ.1 kHz

DEV2=xx.x — Sets the FM deviation specified using tone generator #2.

Range: ØØ.Ø to 25.5 kHz
Step: ØØ.1 kHz

DEV1? — Returns the FM deviation specified with tone generator #1 or "OFF" if #1 has been routed to AM.

DEV2? — Returns the FM deviation specified with tone generator #2 or "OFF" if #2 has been routed to AM.

6-4-4 DISPLAY CONTROL GROUP

BLANK = ON	Blanks Alphanumeric menu displays.
BLANK = OFF	Enables display of alphanumeric menu displays.
BLANK?	Returns Blank status (ON/OFF).
DAL.	Selects the Spectrum Analyzer display mode.
DTK.	Selects the Tracking Generator display mode.
DMT.	Displays the digital meter readout of power, deviation, or demod audio.
DSP?	Returns the status of the display control switch.
AL1K.	Selects the 1 kHz/Division scale on the Spectrum Analyzer.
AL2K.	Selects the 2 kHz/Division scale on the Spectrum Analyzer.
AL1ØK.	Selects the 1Ø kHz/Division scale on the Spectrum Analyzer.
AL2ØK.	Selects the 2Ø kHz/Division scale on the Spectrum Analyzer.
AL1ØØK.	Selects the 1ØØ kHz/Division scale on the Spectrum Analyzer.
AL2ØØK.	Selects the 2ØØ kHz/Division scale on the Spectrum Analyzer.
AL5ØØK.	Selects the 5ØØ kHz/Division scale on the Spectrum Analyzer.
AL1M.	Selects the 1 MHz/Division scale on the Spectrum Analyzer.
AL2M.	Selects the 2 MHz/Division scale on the Spectrum Analyzer.

AL5M.	Selects the 5 MHz/Division scale on the Spectrum Analyzer.
AL10M.	Selects the 1∅ MHz/Division scale on the Spectrum Analyzer.
ALFULL.	Selects the FULL SCAN (∅-1∅∅∅ MHz) scale on the Spectrum Analyzer.
AL?	Returns the status of the Spectrum Analyzer dispersion range setting.
ADB1.	Selects 1 dB per division on the Spectrum Analyzer.
ADB10.	Selects 1∅ dB per division on the Spectrum Analyzer.
ADBS?	Returns the 1 dB/1∅ dB status.
DIGTZ.	Digitizes one Spectrum Analyzer frame.
DIGTZ(X)?	Returns one 100-byte segment of ASCII data of the digitized spectrum data in hexadecimal code. "X" range is 1 through 10 (1000 bytes total).
DGPEAK?	Returns six hexadecimal characters of ASCII data in the format xx:xxx. The first character pair is the maximum digitized data point value. The second and third character pairs represent the horizontal position of the peak point (000-01F3).

6-4-5 **RF SIGNAL FUNCTIONS GROUP**

RFE1.	Enables the RF frequency error measurement in range #1.
RFE2.	Enables the RF frequency error measurement in range #2.
RFE3.	Enables the RF frequency error measurement in range #3.
AFE1.	Enables the AF frequency error measurement in range #1.
AFE2.	Enables the AF frequency error measurement in range #2.
AFE3.	Enables the AF frequency error measurement in range #3.

ERRM? Returns the status of the frequency error counter's mode (i.e., RFE1, RFE2, RFE3, AFE1, AFE2, or AFE3).

ERR? Returns the frequency error measurement, either the error from the RF center frequency or the difference between the demodulated audio signal and the tone generator #1 value, depending upon whether an RFE or an AFE mode is selected.

	FULL SCALE	UNIT		FULL SCALE	UNIT
RFE1	+127/-126	Hz	AFE1	+12.7/-12.6	Hz
RFE2	+1.27/-1.26	kHz	AFE2	+127/-126	Hz
RFE3	+12.7/-12.6	kHz	AFE3	+1.27/-1.26	kHz

If signal is not present (squelched), "NOSIG" is returned. If frequency error is out of range, an "UNDER" or "OVER" indication will be returned.

R2. Enables the modulation meter to measure modulation on the 2 kHz or 2Ø% scale, depending upon the mode of modulation (FM or AM).

R6. Enables the modulation meter to measure modulation on the 6 kHz or 6Ø% scale, depending upon the mode of modulation (FM or AM).

R2Ø. Enables the modulation meter to measure modulation on the 2Ø kHz or 2ØØ% scale, depending upon the mode of modulation (FM or AM).

R6Ø. Enables the modulation meter to measure modulation on the 6Ø kHz or 6ØØ% scale, depending upon the mode of modulation (FM or AM).

R15. Enables the modulation meter to measure power on the 15 Watt scale.

R15Ø. Enables the modulation meter to measure power on the 15Ø Watt scale.

RSIG.	Enables the modulation meter to measure signal strength in a relative value from ∅ to 1∅∅, where ∅ represents an **APPROXIMATE** value of -1∅∅ dBm and 1∅∅ represents an **APPROXIMATE** value of -3∅ dBm.
RSID.	Enables the modulation meter to measure SINAD in -dB. (∅-24.∅ dB, .1 dB resolution; 25-56 dB, 1 dB resolution).
RNG?	Returns the modulation meter range status (R2, R6, R2∅, R15∅, RSIG, RSID).
MTR?	Returns the selected modulation meter function value and label:

RNG	VALUE	LABEL
R2	xxx.xx	kHz/%
R6	xxx.xx	kHz/%
R2∅	xxx.xx	kHz/%
R6∅	xxx.xx	kHz/%
R15	xx.xx	WAT
R15∅	xxx.x	WAT
RSIG	xxx.x	SIG
RSID	xx.x	-dB

If signal is not present (squelched), "NOSIG" is returned. If range value is out of limits, "OVER" or "UNDER" will be returned.

AVG.	Selects the DEV., % AM and power meters to "AVERAGE" mode.
PEAK.	Selects the DEV., % AM and power meters to "PEAK" mode.
PKAV?	Returns the Peak/Average meter-select status (AVG or PEAK).

DMOD? Returns the value of the demodulated audio signal.

Range: 1Ø Hz through 2Ø kHz
Resolution: 1 Hz

If no signal is present (squelched), "NO SIG" is returned.

DBØ. Selects the Ø dB antenna attenuator switch position.

DB2Ø. Selects the 2Ø dB antenna attenuator switch position.

DB4Ø. Selects the 4Ø dB antenna attenuator switch position.

DBS? Returns the antenna attenuator switch status.

6-4-6 STORED CONTROL FUNCTIONS GROUP

DTMFZ = xx.x;xxxx;xxxx

Field 3 sets the space time (Ø to 9999 mS).
Field 2 sets the mark time (Ø to 9999 mS).
Field 1 sets the DTMF item Ø manual deviation (Ø to 25.5 kHz).

DTMFZ? Returns the status of DTMFZ.

DTMF(nn) = xxxxxxxxxxxxxxx;xx.x

Field 2 sets the deviation (Ø to 25.5 kHz).
Field 1 sets the 15 digit DTMF code (Ø to 9 and # or * characters).
Sets the DTMF item number (1 to 15).

DTMF(nn)? Returns the status of the DTMF item number requested.

DTMF(nn). Executes DTMF item number nn.

FSWP(n) = xxx.xxxx;xxx.xxxx;xxx.xxxx;xxxx

Field 4 sets the increment rate (ØØØØ to 9999 mS).
Field 3 sets the step frequency (Ø.ØØØØ to 999.9999 MHz).
Field 2 sets the stop frequency (Ø.ØØØØ to 999.9999 MHz).
Field 1 sets the start sweep frequency (Ø.ØØØØ to 999.9999 MHz).
Sets the RF sweep item number (1 to 4).

FSWP(n)? Returns the sweep status for the item number selected.

FSWP(n). Executes frequency sweep item number (n).

RFM(nn) = xxx.xxxx;s;xx.xx;xxx

Field 4 sets the type of modulation and bandwidth (AM1, AM2, FM1, FM2, FM3, FM4, or SSB).
Field 3 sets the offset (Ø to 49.99 MHz).
Field 2 sets the sign for offset (either + or -).
Field 1 sets the RF frequency (Ø to 999.9999 MHz).
Sets the RF memory data item number (1 to 3Ø).

RFM(nn)? Returns the status of the RF memory item selected.

RFM(nn). Executes the RF memory item number nn.

SCANZ = x.x Sets the RF scan's resume time (Ø to 9.9 seconds).

SCANZ? Returns the status of the RF scan resume time.

SCAN(nn) = xxx.xxxx;xxx

Field 2 sets the type of modulation and bandwidth (AM1, AM2, FM1, FM2, FM3, FM4, or SSB).

Field 1 sets the RF frequency (Ø to 999.9999 MHz).

Sets the RF scan item number (1 to 3Ø).

SCAN(nn)?	Returns the status of the RF scan item number nn, (1 to 3Ø).
SCAN(nn).	Executes RF scan item number nn.
SCAN(nn-nn).	Executes RF scan items nn through nn.

TSEQ(nn) = xxxxx.x;xx.x;xxxx;xxxxx.x;xx.x

Field 5 sets Tone 2 modulation level (Ø to 25.5 kHz deviation).

Field 4 sets Tone 2 frequency (Ø to 29,999.9 Hz).

Field 3 sets interval (ØØØØ to 9999 mS).

Field 2 sets Tone 1 modulation level (Ø to 25.5 kHz).

Field 1 sets Tone 1 frequency (Ø to 29,9999.9 Hz.)

Sets the tone sequence memory data item number (1 to 99).

TSEQ(nn)?	Returns the status of the tone sequence item number selected.
TSEQ(nn).	Executes tone sequence item number nn.
TSEQ(nn-nn).	Executes tone sequence items nn through nn.

TSWP(n) = xxxxx.x;xxxxx.x;s;xxxxx.x;xxxx

Field 5 sets the increment rate (Ø to 9999 mS).

Field 4 sets the increment step either < + > Ø to 29,999.9 Hz or < x > Ø to 2.ØØ).

Field 3 sets the sign for increment step (either + or x).

Field 2 sets the stop frequency (Ø to 29,999.9 Hz).

Field 1 sets the start frequency (Ø to 29,999.9 Hz).

Sets the tone sweep memory data item number (1 to 4).

TSWP(n)?	Returns the status of the tone sweep item selected.
TSWP(n).	Executes tone sweep item number n.
DCSZ = NORM	Sets the digital coded squelch (DCS) received data polarity field to NORM (normal).
DCSZ = INVT	Sets the digital coded squelch (DCS) received data polarity field to INVT (inverted).
DCSZ?	Returns the status of the DCS received data polarity field.
DCSR?	Returns the status of the DCS received data codes. Data is up to six (6) three-digit ASCII octal numbers, or if none are received, "NO CODE" is returned.

DCS(nn) = xxx;xxxx;x.x

Field 3 sets deviation (Ø.Ø to 9.9 kHz).
Field 2 sets data polarity (NORM or INVT).
Field 1 sets the three digit octal code (ØØØ$_8$ to 777_8).
Sets the DCS memory item number (1 to 1Ø).

DCS(nn)? — Returns the status of the DCS item number selected.

DCS(nn). — Executes the DCS memory item selected.

EXEC = x....x — Sets the stored functions (x....x) into a string of commands to be executed sequentially and stored for later recall. Items allowed include "DTMF(nn).", "FSWP(n).", "RFM(nn).", SCAN(nn-nn).", "TSEQ(nn-nn).", "TSWP(n).", and "DCS(nn).". Any or all may be used in any order, up to a maximum of 123 (128-"EXEC = ") total characters. The "LOOP." command may be appended to the end of the string to allow continuous execution (looping) of the command string. Execution of loop commands begins at reception of last command.

EXEC? — Returns status of stored execution command buffer contents.

EXEC. — Executes the stored execution command buffer contents. Any "AFF1 = ", "AFF2 = ", "DUP = " or "RFF = " commands following the "EXEC." command in the same input string will disable this function.

6-4-7 MISCELLANEOUS COMMANDS GROUP

LOOP. — This command is used at the end of an "EXEC." command statement to create an internal continual re-execution of the command string until another command string is sent.

CG1 = xxxx...xxx — This command allows a 124 character command string to be stored internally for execution by the "CG1." command.

CG1?	Returns the status of command group 1.
CG1.	Executes command group 1.
CG2 = xxxx...xxx	This command allows a 124 character command string to be stored internally for execution by the "CG2." command.
CG2?	Returns the status of command group 2.
CG2.	Executes command group 2.
CG3 = xxxx...xxx	This command allows a 124 character command string to be stored internally for execution by the "CG3." command.
CG3?	Returns the status of command group 3.
CG3.	Executes command group 3.
INIT.	Reinitializes the FM/AM-1500 to the cold start condition.
LOC.	Commands the FM/AM-1500 to return to local mode of operation. This command will erase all internally stored status conditions except "CG1?", "CG2?", and "CG3?".
RID = ON or RID = OFF	Controls the reply identifier switch (ON or OFF), which, when ON, will add the command name followed by " = " as a prefix to a command's response.
RID?	Returns reply identifier switch status.
TERM = n	This command allows the operator to specify the desired terminator for the end of string output of the FM/AM-1500. Selections for terminator are as follows (default is n = 1):

n	Hexidecimal Value	ASCII
1	ØAØA	CRLF
2	ØAØD	LFCR
3	ØDØD	CRCR
4	ØAØA	LFLF

TERM? — Returns the status of the Terminator setting.

SRQ = xxxxxx — Sets one (1) to six (6) bits of an SRQ interrupt service mask to trigger a serial poll of the FM/AM-1500.

BIT POSITION	**CONDITION**
xxxxx1	Command entry/execute error
xxxx1x	Self-test error
xxx1xx	System operation error
xx1xxx	GPIB interface error
x1xxxx	Not defined
1xxxxx	Not defined

SRQ? — Returns the status of the SRQ mask.

STAT? — Returns command error status. Returns up to 128 characters which describe all errors that have occurred since last "STAT?" command. Multiple status messages will be appended until the buffer overflows unless this command is periodically executed. Returned responses include:

RELATED SRQ BIT	**RESPONSE**	**DESCRIPTION**
N/A	FM/AM-1500 CSM VER.X.X, MM/DD/YY, NO ERRORS DETECTED	Power-up response. Gives firmware version, date and self-test results.
N/A	OK	No errors detected on last command(s) executed.
Ø	SYNTAX ERROR	Improper command format.
Ø	DATA FIELD ERROR	Invalid data used on last command.

RELATED SRQ BIT	RESPONSE	DESCRIPTION
Ø	ITEM FIELD ERROR	Invalid item number.
Ø	FUNCTION ERROR	Invalid execution item.
Ø	I/O OVERFLOW	Input or output buffer exceeds 128 characters.
1	SYSTEM RAM ERROR	ROM failure.
1	N.V. RAM CHECKSUM ERROR	Non-volatile memory failure.
1	I/O BUS ERROR	Interface device failure.
2	OVER POWER	Too much power is being applied to FM/AM-1500.
2	NO PHASE LOCK	Synthesizer in FM/AM-1500 is out of phase lock.
3	GPIB INTERFACE ERROR	GPIB I/O device failure.

APPENDIX A — FM/AM-1500 SPECIFICATIONS

A-1 RF SIGNAL GENERATOR

Frequency Range:	100 kHz to 999.9999 MHz in 100 Hz increments.
Frequency Accuracy:	(See TCXO Master Oscillator)
Residual FM:	< 50 Hz (typical 30 Hz RMS) (Post detection 50-300 Hz)
RF Output Power:	0 dBm to -128 dBm continuously adjustable into 50 Ω. (No range changing)
Accuracy:	± 2 dB, -10 to -80 dBm ± 2.5 dB, -80 to 128 dBm (-80 to -120 on IEEE version)
Attenuator Dial:	One continuous dial with uV and dBm.
Modulation:	FM: 2 Hz to 30 kHz rate at 0 to ± 25 kHz deviation. For external inputs DC to 30 kHz rate. (DC, if generated lock control is in the variable position). Flat to ± 2 dB DC to 30 kHz 6 Vp-p ± 2 Vp-p produce ± 15 kHz deviation AM: 10 Hz to 5 kHz rate at 0-90% 6 kHz to 30 kHz rate at 0-30% 3 Vp-p ± 1 Vp-p produces 90% modulation External Mod impedance 600 Ω

NOTE:

FM_1, FM_2, FM_3 and FM_4 are all FM modulation. SSB, AM_1, and AM_2 are AM modulation. SSB has no function other than AM in the generator mode.

Freq. Shift with Modulation:	When the generator is in the "lock" position, the center frequency is phase-locked to the system clock.
Modulation Distortion:	The FM modulation distortion plus noise at ± 25 kHz deviation is less than 2% from 200 Hz to 20 kHz.
Generator Freq. Control:	When in the "locked" position, the generator is phase-locked to the master clock. When switched off from the "locked" position, the generator may be varied ± 10 kHz. The FM modulation input is DC coupled for this unlocked function. (Internal or external modulation.)
Microphone Input:	Generator can be switched on by an external microphone. It has internal preamp with adjustable level.
SSB Noise:	90 dBc/Hz at ± 20 kHz from carrier.
Deviation Accuracy of Processor controlled audio levels:	$\pm 5\%$ from 20 Hz to 5 kHz and $\pm 10\%$ from 5 kHz to 20 kHz.
Generator Spurious:	
Harmonics:	>25 dBc
Non Harmonics:	>40 dBc
Typically:	>60 dBc
In-Band, typically:	>70 dBc

A-2 DUPLEX GENERATOR

Freq Range:	±49.99 MHz from receive frequency (as indicated on front panel (LCD) in 10 kHz increments.)
Freq Accuracy:	See TXCO Master Oscillator.
Output Level:	
DUPLEX Connector:	0 dBm to -128 dBm continuously adjustable into 50Ω. (No range changing.)
TRANS Connector:	40 dB (±3 dB) below Attenuator settings from -10 to -80 dBm. 40 dB (±3.5 dB) below Attenuator settings from -80 to -128 dBm.

A-3 RECEIVER/MONITOR

Frequency Range:	300 kHz to 999.9999 MHz.
Resolution:	100 Hz
10 dB Sinad Sensitivity (typical):	2 uV (1 MHz to 1 GHz). Sensitivity reduced below 1 MHz (for 15 kHz RF bandwidth and 8 kHz post detection bandwidth)
Selectivity: (3 dB):	6 kHz; SSB and AM_1 15 kHz; AM_2 and FM_1, 200 kHz; FM_2, FM_3 and FM_4 FM_1 and FM_2 has post demodulation bandwidth of 8 kHz. FM_3 has a post demodulation bandwidth of 20 kHz. FM_4 has a post demodulation bandwidth of 80 kHz. FM_4 has a demodulation flatness of ±2 dB referenced to 1 kHz from 10 Hz to 20 kHz.

	AM_1 and SSB have an RF bandwidth of 6 kHz and post detection bandwidth of 8 kHz. AM_2 has an RF bandwidth of 15 kHz and a post detection bandwidth of 8 kHz.
Antenna Attenuator:	Selectable 0, -20 dB, and -40 dB (± 2dB each)
Quieting:	Deviation measurements can be made down to 0.1 kHz in post detection bandwidth of 8 kHz.
Adjacent Channel Rejection:	> 25 dB at ± 25 kHz (when on 15 kHz RF bandwidth) > 40 dB at ± 50 kHz (when on 15 kHz RF bandwidth)
Beat Frequency Oscillator (BFO):	Fixed at center frequency.
Demodulation Output Level: (600 Ω Load)	AM: 100% = 0.5 Vp-p nominal (selectable by modulation switch) FM: ± 10 kHz deviation = 1.0 Vp-p nominal
Demodulation Output Level Impedance:	600 ohms
Receiver Antenna Input Protection:	0.25 Watts maximum level without damage
FM Demodulation Noise + Distortion:	Less than 2% at ± 25 kHz deviation for modulation frequencies from 200 Hz to 20 kHz with a receiver input level of -50 dBm. (RF bandwidth = 200 kHz, post detection bandwidth = 80 kHz)
Image Rejection:	+ 1.4 MHz, 50 dB + 21.4 MHz, 50 dB + 238.6 MHz, 50 dB + 2500 MHz ± 10 MHz, 5 dB

A-3 RECEIVER/MONITOR (Cont'd)

Deviation Monitor Meter: (max peak either polarity)	Scales: 2 kHz, 6 kHz, 20 kHz, 60 kHz Accuracy ±5% full scale for modulation frequencies of 30 Hz to 10 kHz at a signal level of -50 dBm.
AM Modulation Digital Display: (max peak, positive or negative	0.1% resolution on 20% and 60% ranges, 1% on 200% and 600% ranges. Accuracy 5% reading ±20 counts at received signal of -50 dBm for modulation frequency of 1 kHz. (10% to 90% depth)
Digital Deviation Display (CRT):	Range is 0.00 to 60.0 kHz Accuracy is ±3% at these two points: 1. 6 kHz rate at ±2 kHz with 8 kHz post detection BW. 2. 10 kHz rate at ±8 kHz with 20 kHz post detection BW.
AM Modulation Monitor Meter:	Scales 0-20%, 0-60%, 0-200% Accuracy ± 7% of reading, ± 5% full scale.

A-4 SPECTRUM ANALYZER

Inputs:	Transmitter:	Transmitter under test when power exceeds 0.1 watt. A 100 watt signal produces a top graticule reading. (marked -30 dBm)
	Antenna Jack:	The log scale is marked for dBm for this input when the antenna attenuator is set for "0". The signal can be attenuated by 20 dB or 40 dB by the antenna attenuator switch.
Log Scale:	Within ±2 dB linearity from -30 dBm to -90 dBm indication. Switchable between 1 dB/DIV and 10 dB/DIV.	
Dynamic Range:	70 dB, additional 40 dB selectable by input attentuator.	

A-4 SPECTRUM ANALYZER (Cont'd)

Modes:	Full Scan:	1 MHz to 1000 MHz; 650 kHz bandwidth
	10 MHz/DIV:	Center frequency as selected; 650 kHz bandwidth
	5 MHz/DIV:	Center frequency as selected; 650 kHz bandwidth
	2 MHz/DIV:	Center frequency as selected; 650 kHz bandwidth
	*1 MHz/DIV:	Center frequency as selected; 30 kHz bandwidth
	*0.5 MHz/DIV:	Center frequency as selected; 30 kHz bandwidth
	*0.2 MHz/DIV:	Center frequency as selected; 30 kHz bandwidth
	*0.1 MHz/DIV:	Center frequency as selected; 30 kHz bandwidth
	*20 kHz/DIV:	Center frequency as selected; 3 kHz bandwidth
	*10 kHz/DIV:	Center frequency as selected; 3 kHz bandwidth
	*2 kHz/DIV:	Center frequency as selected; 300 Hz bandwidth
	*1 kHz/DIV:	Center frequency as selected; 300 Hz bandwidth

* The receiver is fixed on the center frequency for monitoring while the analyzer scans as specified. On wider scans, the receiver and monitor portion are not usable.

A-5 TRACKING GENERATOR

Frequency Range:	1.0 MHz to 1000 MHz as selected by the frequency control.
Output Level:	Same as RF generator; 0 dBm to -128 dBm.
Sweep Mode:	The oscilloscope is switchable to external vertical input when in the tracking generate mode.

A-6 OSCILLOSCOPE

Display Size:	2″ x 2½″
Vertical Bandwidth:	DC to 1 MHz (at 3 dB bandwidth)
External Vertical Input Ranges:	10 mV, 100 mV, 1 V, 10 V per division
Horizontal Sweep Rate:	10 mSec, 1 mSec, 100 uSec, 10 uSec per division

A-7 AUDIO GENERATORS

Operating Modes:	Internal: Variable frequency generators, one or both. External plus Internal: Any external tone(s) plus either or both internal tones simultaneously.
Frequency Range:	Variable from 2 Hz to 30 kHz.
Accuracy:	0.01%
Resolution:	0.1 Hz; 2 Hz to 9999.9 Hz; 1 Hz, 10.000 kHz to 30 kHz.
Output Level:	Variable from 0 to 2.5 VRMS minimum either tone into 150Ω.
Distortion:	< 2% (10 Hz to 100 Hz) < 0.7% typical 100 Hz to 30 kHz Some frequencies have a measured distortion of less than 1.5% as measured on a typical null type distortion analyzer.
Output Distribution:	Each tone selectable OFF or into either AM or FM modulator when not under processor sequence control. Each tone level variable through "Tones Out" jack regardless of selection of "FM", "AM" or "OFF" by the manual switches.
Speaker:	Selectable from receiver or same signal as "Tone Out" jack.

A-8 FREQUENCY ERROR METER MEASUREMENT CAPABILITY

RF Signals

Sensitivity:	Typically 1.5 uV above 1 MHz (sensitivity is reduced below 1 MHz)
Ranges:	±30 Hz, ±100 Hz, ±300 Hz, ±1 kHz, ±3 kHz, ±10 kHz
Resolution:	±1 Hz on the ±30 Hz and ±100 Hz ranges

Demodulated Audio Signals

Ranges:	±3 Hz, ±30 Hz, ±300 Hz as referenced to frequency of Tone Generator #1.
Resolution:	±0.1 Hz on ±3 Hz scale
Frequency Range:	20 Hz to 10 kHz

A-9 DEMODULATED AUDIO FREQUENCY COUNTER

Range:	10 Hz to 20 kHz
Resolution:	1 Hz
Accuracy:	±2 counts

A-10 INTERNAL SINAD METER

Input:	0.5 to 10 VRMS
Frequency:	1 kHz
Range:	0 to 20 dB
Accuracy:	±1.5 dB at 12 dB reading

A-11 POWER MONITOR

Frequency Range:	1 MHz to 1000.00 MHz (wideband detector circuit)

Power Ranges:	0 to 15 and 0 to 150 Watts
Accuracy:	1 to 600 MHz, ±7% of reading ±3% of full scale.
	600 to 1000 MHz ±17% of reading ± 3% of full scale
	821 MHz to 896 MHz ±7% reading, ±3% of full scale
Input Power:	50 watts continuous 150 watts until "over temp" lamp illuminates

Changeover from generate to monitor mode occurs at nominally 100 mW input level to the TRANS/-40 dB DUPLEX Connector.

A-12 TCXO MASTER OSCILLATOR

Accuracy:	5×10^{-7} = 0.0000 5% (typically 2×10^{-7}). Greater accuracy is attainable with front panel adjustment.
Aging Stability:	2 to 3 PPM during first year . . . 1 PPM per year thereafter.
EXT. Clock:	BNC Connector for EXT 10 MHz STD.

A-13 PHYSICAL CHARACTERISTICS

Dimensions:	12.5″ wide, 9″ high, 19.5″ deep (31.8 cm W, 22.9 cm H, 49.5 cm D)
Weight:	46 lbs. (20.9 kg)
Temperature Range:	0° to 50° C

A-14 POWER

Conveniently portable. Self-contained battery automatically recharges when AC line is connected. Operates on 106 to 266 VAC without switching, 50-400 Hz, 85 watts, or 11 to 18 VDC. Typical DC currents 6.0 A at 12 V.