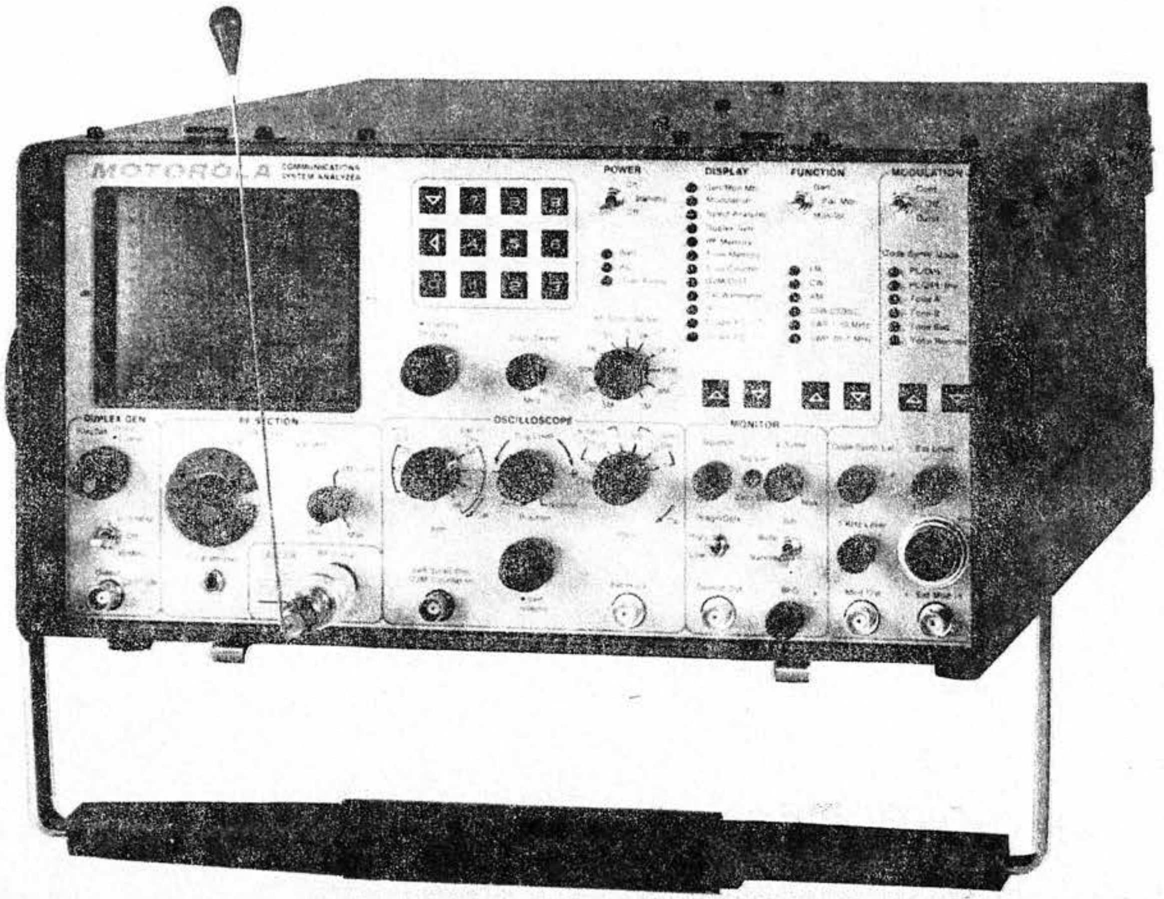
Communications Group

R-2001C/R-2002C COMMUNICATIONS SYSTEM ANALYZER



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1313 E. Algonquin Road, Schaumburg, Il. 60196

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FOREWORD

1. SCOPE OF MANUAL

This manual contains information for the installation, operation, and maintenance of the Communications System Analyzer.

2. PURPOSE AND USE

The Motorola Communications System Analyzer is a portable test instrument, designed specifically for the service and monitoring of communications equipment. Its functions supersede those of a Service Monitor, expanding the features and capabilities to the point wherein servicing is achieved with a single instrument, rather than a host of separate equipment.

The R2001C is the standard Communications System Analyzer. The R2002C Analyzer, which contains the IEEE-488 Standard interface control bus, is also available. Programming for the R2002C is covered in Section 21 of this manual.

The Analyzer improves a technician's efficiency and accuracy and reduces servicing time.

The Communications System Analyzer performs the functions of signal generation, signal monitoring and the tests normally associated with the devices listed below.

- Spectrum Analyzer
- Duplex Generator
- Modulation Oscilloscope
- Frequency Counter
- AC/DC Digital Voltmeter
- RF Wattmeter
- General Purpose Oscilloscope
- Multi-Mode Code Synthesizer
- Distortion/SINAD Meter
- Sweep Generator

The Analyzer meets the shock and vibration requirements of EIA test RS152B, the same specifications met by Motorola mobile radios. This minimizes failure when the instrument is used in a mobile service van, and means it is as tough as the radios it services.

The Communications System Analyzer is designed to be serviced quickly and easily, should a breakdown occur. The majority of the circuitry is on twelve modular plug-in circuit boards which have built-in test points that aid in isolating the problem to a specific board. Simple plug-in replacement gets the instrument back in service.

CAUTION

This equipment contains parts that are subject to damage by static electricity. Proper precautions should be taken during handling.

WARNING

Lithium Battery

The processor module within this system utilizes a lithium battery as a memory keep-alive voltage source. Do not mutilate or disassemble the battery cell. The lithium metal is a very active material that burns in the presence of water or high humidity. Do not put the battery in fire, attempt to charge, heat above 100°C, or solder directly to the cell. Do not overdischarge the cell to a reverse voltage greater than 3 volts. The battery may burst and burn or release hazardous materials. See section 5-143 of this manual for battery troubleshooting procedures and cautions.

CAUTION

Lithium Battery

Lithium batteries are classified as hazardous materials and must be disposed of accordingly. Do not dispose of the battery by placing it in with the everyday trash. Consult state and local codes for the appropriate disposal procedure. Motorola will dispose of the battery if the expended battery is returned in the replacement battery container and by the same method that the new battery came to you, send to: Motorola Inc., Return Goods Department, 1313 East Algonquin Road, Schaumburg, Ill. 60196.

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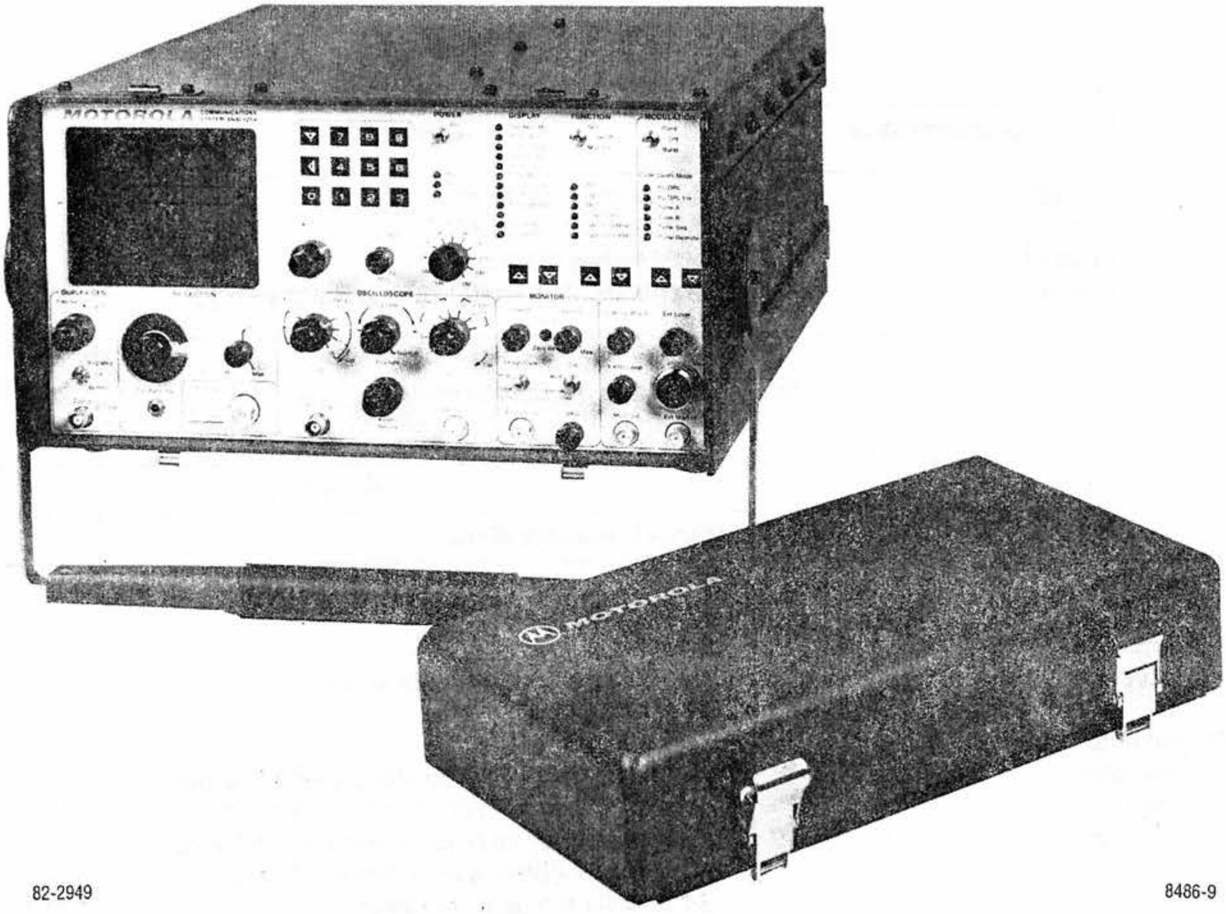

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Figure 1-1. Communications System Analyzer

SECTION 1

1-1. INTRODUCTION

1-2. This section lists the physical, electrical, and input/output characteristics of the Coummunications System Analyzer shown in figure 1-1.

Table 1-1. Physical Characteristics

Characteristics	Description
Length	20.75 inches (52.7 cm)
Width	15.75 inches (40.0 cm)
Height	8.25 inches (21.0 cm)
Weight	48 pounds (21.9 kg) (Excluding Battery Pack)

Table 1-2. Electrical Characteristics

Characteristics	Description
	Signal Generator Mode
Frequency	
Range:	10 kHz to 999,9999 MHz
Resolution:	100 Hz
Accuracy:	Equal to master oscillator time base
Output (into 50 ohms)	
Attenuator:	16 dB variable plus 10 dB steps over 13 ranges
Range:	0.1μV to 1 Vrms (−127 dBm to +13 dBm)
Accuracy:	±2 dB accuracy on 0 dB step attenuator range ±2 dB across other step attenuator ranges ±1 dB over temperature range
Spectral purity	
Spurious:	≦−40 dB
Harmonics:	≦−15 dB
Frequency modulation	
Range:	0 - 50 kHz peak
Accuracy:	±5% of full scale
FM residual noise:	100 Hz
External/internal frequency range:	5 Hz - 10 kHz (±1 dB)
External input:	Approximately 150 mV for 20 kHz deviation
Modes:	Internal, external, microphone or all simultaneously

Table 1-2. Electrical Characteristics (Cont)

Characteristics	Description
Amplitude modulation	
Range:	0 to 80% from 1 to 500 MHz
Accuracy:	±10% of full scale from 0% to 50% AM
External/internal frequency range:	5 Hz - 10 kHz (±1 dB)
Modes:	Internal, external, microphone or all simultaneously
Double sideband suppressed carrier	
Carrier suppression:	⩾25 dB (1 MHz - 500 MHz)
Monitor Mode	
Frequency	
Range:	1 MHz to 999.9999 MHz
Resolution:	100 MHz
Accuracy:	Equal to that of master oscillator time base
Frequency error indicator	Autoranging CRT display. ±10 Hz resolution for frequency error measurements on 1.5 kHz, 5 kHz and 15 kHz full scale ranges. ±1 Hz resolution on the 50 Hz full scale range.
Input sensitivity	1.5 μV for 10 dB EIA Sinad (narrow band ±6 kHz mod. acceptance) 7 μV for 10 dB EIA Sinad (wide band ±100 kHz mod. acceptance) 4 MHz to 1000 MHz. Useable to 1 MHz.
Spurious response	−40 dB typical 0 dB image at ±21.4 IMHz −10 dB at L.O. harmonics ±10.7 MHz
Deviation Measurement	
Range:	1, 10, 100 kHz full scale
Accuracy:	±5% of reading ± 100 kHz from 500 Hz to 50 kHz deviation; ±10% of reading from 50 kHz to 75 kHz deviation
Peak deviation limit alarm:	Set via keyboard to 100 Hz resolution (0.1 kHz to 99.9 kHz). Audible alarm indicates limit condition in all Monitor Modes. 00.0 setting disables the alarm.
AM modulation measurement	
Range;	0 to 100%
Accuracy:	±5% of full scale
RF Wattmeter (Autoranging display)	
Frequency range:	1 MHz to 1000 MHz
Power range:	1.0 watts to 125 watts
Accuracy:	±10%, 1 watt to 125 watts
Protection:	Over temp indicator

Table 1-2. Electrical Characteristics (Cont)

Characteristics	Description
General **Spectrum Analyzer**	
Dynamic range	⩾75 dB displayed, −105 dBm to −30 dBm input range with step attenuator
Frequency	
Range:	4 MHz to 1,000 MHz
Full scale frequency dispersion:	Adjustable between 1 MHz and 10 MHz
Duplex Generator	
Frequency offset	Adjustable from 0 to 10 MHz plus fixed offset of 45 MHz (high or low side)
Modulation level (FM only)	Adjustable from 0 to 20 kHz peak deviation
Oscilloscope	
Size	8 cm × 10 cm
Frequency response	DC to 0.5 MHz (3 dB point)
External vertical input range	10 mV, 100 mV, 1V, 10V (per division)
Sweep rates	1 μs, 10 μs, 0.1 ms, 1 ms 0.01S, 0.1S (per division)
Sync	Automatic, normal and delayed triggering. Delayed triggering is programmable to 10 seconds in 1 ms steps and works in conjunction with the code synthesizer. **See "CAUTION" note on page 4-19**
Frequency Counter	
Frequency range	10 Hz to 35 MHz
Readout:	5 digit, autoranging
Input sensitivity:	30 mV from 10 Hz to 1 MHz 50 mV from 1 MHz to 35 MHz
Digital Voltmeter	
Readout:	Auto ranging digital display, 1, 10, 100, 300 volts full scale. AC-dBm calibrated across 600 ohms.
DC accuracy:	±1% of full scale ±1 least significant digit
AC accuracy:	±5% of full scale
AC bandwidth:	50 Hz to 10 kHz
Modulation Source	
Code Synthesizer	
Frequency range:	5 Hz to 9.9999 kHz sinewave
Resolution:	0.1 Hz
Frequency accuracy:	±0.01%
Distortion:	⩽1%

Table 1-2. Electrical Characteristics (Cont)

Characteristics	Description
Signaling Sequences	
Two Tone A/B	Tone Only Sequence Tone and Voice Sequence Two user programmable (See figure 1-2 for sequence timing)
5/6 Tone	Digit Frequencies (See figure 1-3 for sequence timing) 0 - 600 Hz 1 - 741 Hz 2 - 882 Hz 3 - 1023 Hz 4 - 1164 Hz 5 - 1305 Hz 6 - 1446 Hz 7 - 1587 Hz 8 - 1728 Hz 9 - 1869 Hz R - 459 Hz X - 2010 Hz
Mobile Telephone	
IMTS	(See figure 1-4 for sequence timing)
MTS	(See figure 1-5 for sequence timing)
2805	(See figure 1-6 for sequence timing)
Select V	Tone length–70ms
ZVEI	Digit Frequencies 1 - 1060 Hz 2 - 1160 Hz 3 - 1270 Hz 4 - 1400 Hz 5 - 1530 Hz 6 - 1670 Hz 7 - 1830 Hz 8 - 2000 Hz 9 - 2200 Hz 0 - 2400 Hz R - 2600 Hz
Modified ZVEI	Tone length - 70 ms Digit Frequencies 1 - 970 Hz 2 - 1060 Hz 3 - 1160 Hz 4 - 1270 Hz 5 - 1400 Hz 6 - 1530 Hz 7 - 1670 Hz 8 - 1830 Hz 9 - 2000 Hz 0 - 2200 Hz R - 2400 Hz

Table 1-2. Electrical Characteristics (Cont)

Characteristics	Description
CCIR (100 ms)	Tone length - 100 ms Digit Frequencies 1 - 1124 Hz 2 - 1197 Hz 3 - 1275 Hz 4 - 1358 Hz 5 - 1446 Hz 6 - 1540 Hz 7 - 1640 Hz 8 - 1747 Hz 9 - 1860 Hz 0 - 1981 Hz R - 2110 Hz
CCIR (70 ms)	Tone length - 70 ms Digit Frequencies Same as CCIR (100 ms)
EEA	Tone length - 40 ms Digit Frequencies Same as CCIR
Tone remote access	Remote base access sequence as follows Tone A for 150 msec Tone B for 40 msec 10 dB below Tone A Tone A continuously 30 dB below the first Tone A burst
Digital private line (DPL)	Codes 000 to 777 and inverted
Fixed 1 kHz	
Accuracy:	Equal to master time base
Distortion:	⩽1%
External input	
Microphone:	Standard RTM 4000A microphone interface with IDC.
External Jack	
Frequency range:	5 Hz to 10 kHz
level:	7 vrms maximum
Impedance:	10K ohm nominal
Code synthesizer external output level	0-3 vrms into a 600 ohm load
	Distortion/SINAD Meter
Input Frequency:	1 kHz ± 1 Hz
Input level range:	0.5V to 10 Vrms
Sinad accuracy:	±1 dB at 12 dB Sinad
Distortion Accuracy:	±0.5% of Distortion for 1% ⩽ THD ⩽10% ±1% of Distortion for 10% ⩽THD ⩽20%

Table 1-2. Electrical Characteristics (Cont)

Characteristics	Description
	Manual Frequency Scan
Step size	Switch Selectable: 100 Hz, 1 kHz, 10 kHz, 100 kHz and 1 MHz (+ or −)
Step rate	5 steps/sec
	Time Base
Standard TCXO	Aging: $\pm 1 \times 10^{-6}$ per year Temp: $\pm 1 \times 10^{-6}$ maximum error over the 0° to 55°C temp range
Optional ovenized high stability	Aging: $\pm 1 \times 10^{-6}$ per year Temp: $\pm 5 \times 10^{-8}$ maximum error over the 0° to 55°C temp range (warmup to $\pm 5 \times 10^{-7}$ of final frequency within 20 minues)
	Power and Environmental
AC	100-130 VAC, 200-260 VAC 47-63 Hz
DC	+11.5 VDC to + 16 VDC
Optional battery	13.6V battery – provides 1 hour continuous operation
Temperature range	0° to 55°C operation; −40° to 85°C storage

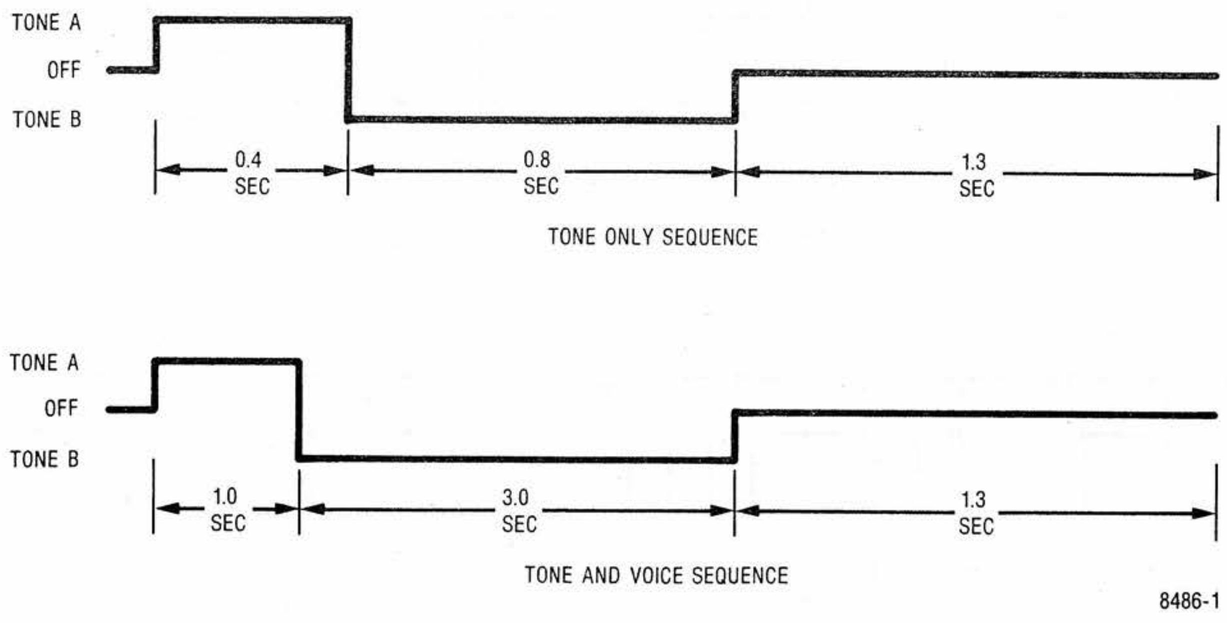

Figure 1-2. Two Tone (A/B) Sequence Timing

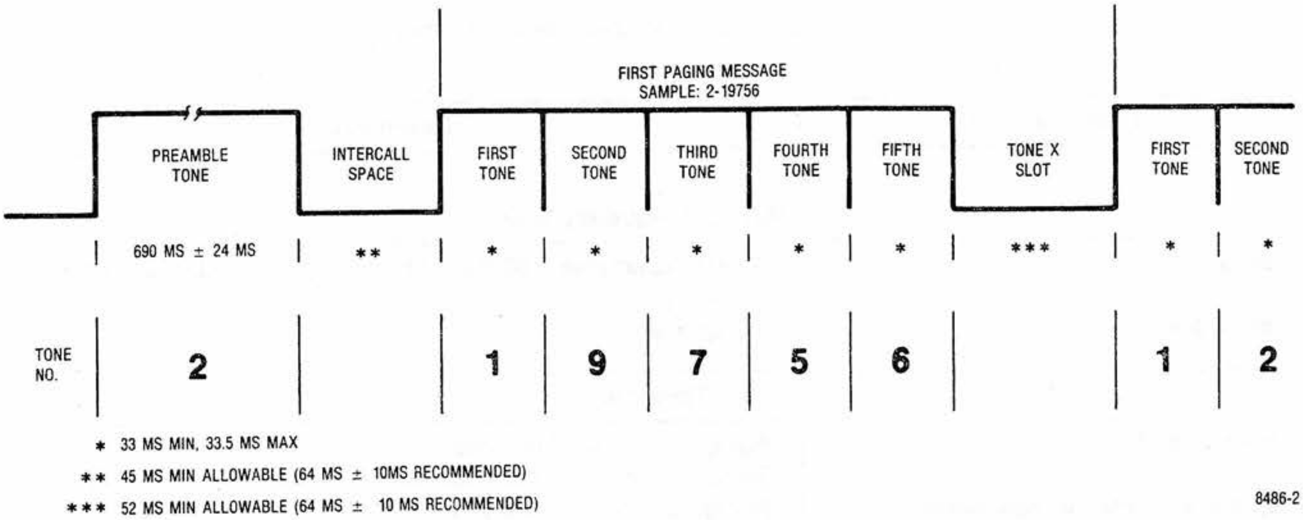

Figure 1-3. 5/6 Tone Squence Timing

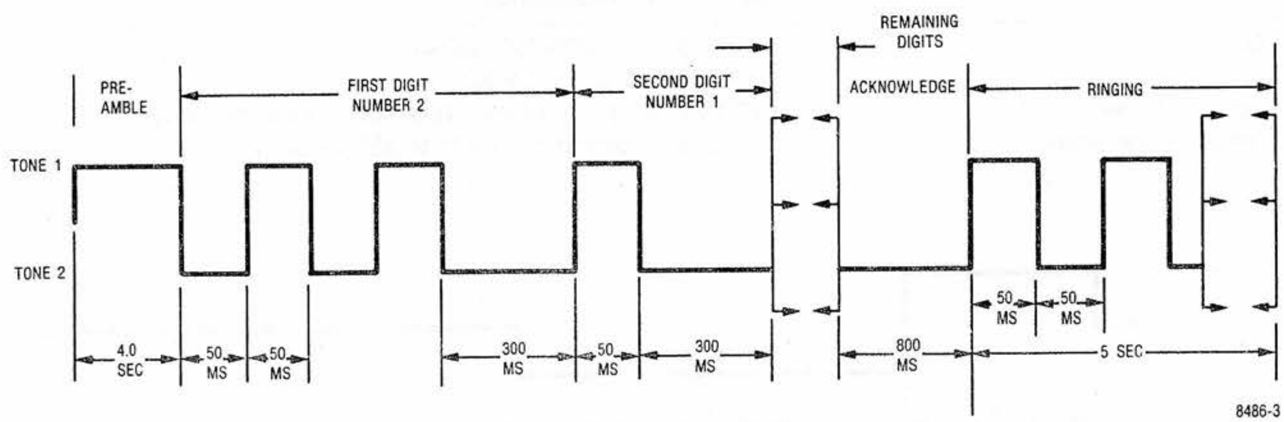

Figure 1-4. IMTS Sequence Timing

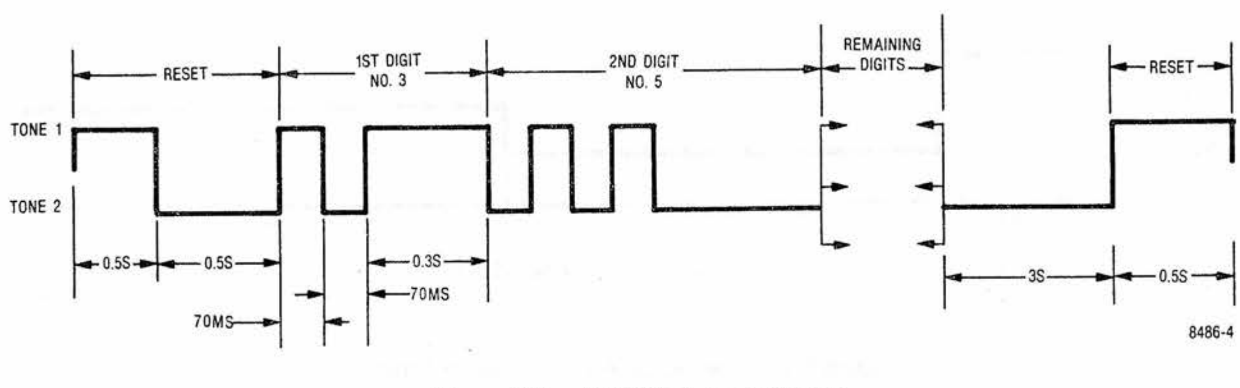

Figure 1-5. MTS Sequence Timing

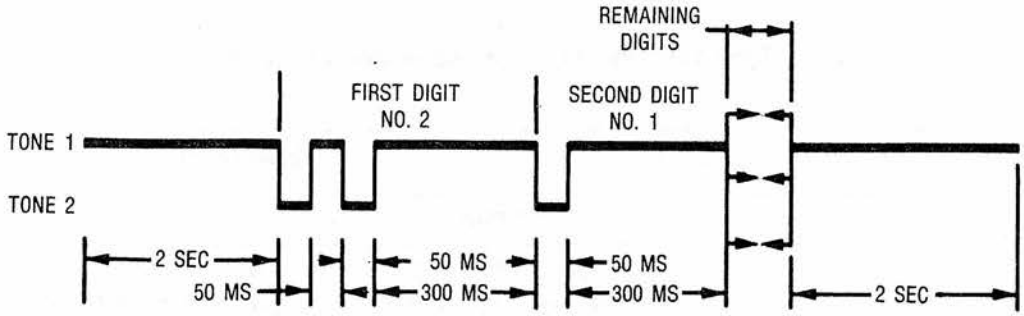

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Figure 1-6. 2805 Sequence Timing

Table 1-3. Input/Output Characteristics

Characteristic	Description
Input	
Ext Mod in	10K ohms nominal, 150 mV typical for 20 kHz dev. FM or 80% AM
Mic.	Mic input provides bias and IDC limiting suitable for Motorola RTM 9000A handset. PTT switches R2001 from monitor to generate.
Ext Horiz	1 volt minimum for full screen deflection. Maximum input 10 volts.
Vert/SINAD/Dist/DVM/Counter In	1 Meg ohm, 40 pf Nominal; ±300 volts DC max, 300 Vrms max at frequencies below 500 Hz, 10 Vrms max up to 35 MHz • Scope vert in: DC to 500 kHz or 50 Hz to 500 kHz AC mode (±3 dB) • Distortion/Sinad in: 0.5 to 10 Vrms in at 1 kHz • DVM in: 1, 10, 100 and 300V full scale AC (true RMS) or DC. AC bandwidth 50 Hz to 10 kHz for ±5% F.S. accuracy (AC dBm calibrated across 600 ohms) • Frequency counter in: 30 mV or greater required from 10 Hz to 1 MHz, 50 Mv or greater required from 1 MHz to 35 MHz
RF In/Out	50 ohms nominal, 125 watts max (1-1000 MHz) **CAUTION:** The RF In/Out Jack is protected against RF overload. However, to prevent undue stress on the protected circuits it is advisable to always switch the system to the power monitor mode before applying power in excess of 200 mV. Additional protection is also obtained by making it a practice not to leave the step attenuator in the 0 dB position.
Ext Wattmeter	Characteristics suitable for Motorola ST-1200 series Wattmeter Elements
10 MHz std in (rear panel)	70 to 350 mV rms input required at 10 MHz, impedance greater than 50 ohms.

Table 1-3. Input/Output Characteristics (Cont)

Characteristic	Description
Output	
Mod out	Up to 11 vpp into 600 ohms 10 Hz to 10 kHz
Demod out	Typically 3 vpp into 600 ohms for ±5 kHz deviation narrowband, 4 vpp for ±75 kHz deviation wideband. DC to 10 kHz response
RF in/out	1.0 Vrms (+13 dBm) to 0.1 μVrms (−127 dBm) 50 ohm nominal source impedance. 10 kHz to 1.0 GHz.
Duplex gen out	−30 dBm typical, 50 ohm nominal source impedance 2 MHz to 1 GHz
10 MHz std out (rear panel)	250 mV rms nominal output into 50 ohms

SECTION 2
DESCRIPTION

2-1. DESCRIPTION

2-2. The Communication System Analyzer is a portable test instrument designed for servicing and monitoring of portable, mobile, and land base communications equipment operating over the frequency range of 1 MHz to 1 GHz. The unit performs the functions of signal generation, frequency error and modulation measurement. It is also capable of a variety of tests normally associated with the following devices:

- Spectrum analyzer
- Duplex offset generator
- Modulation oscilloscope
- Frequency counter
- AC/DC digital-analog voltmeter
- RF wattmeter
- General purpose oscilloscope
- Multi-mode code synthesizer
- Distortion/SINAD meter
- Sweep generator

2-3 MICROPROCESSOR. A Motorola M-6800 series microprocessor permits keyboard entry of data, autoranging of displays, fast frequency access, and permanent storage of often-used frequencies and codes. Generate and monitor RF frequencies, tone codes, and timing sequences can be programmed into a nonvolatile memory, saving time and eliminating entry errors. When one particular type of equipment is continuously serviced, the unit can be programmed to select the mode of operation required when first turned on.

2-4. DISPLAY. All functions, generated or monitored, are presented on an 8 cm x 10 cm cathode ray tube (CRT) in both analog and digital format, with the name of the function being displayed. The CRT also displays control settings eliminating the need for operator search of different equipment panels. Digital readouts are visually aided by the use of the continuously autoranging analog line segments, which are similar to a bar graph. Each has a base line and calibration markers, in addition to the intensified segment showing the measurement. The user selectable displays are listed in a column beneath the DISPLAY heading on the front panel. Choosing a display is accomplished by pressing an arrow button below the column, for up or down movement, as required. When the appropriate arrow is pressed, the LED adjacent to the selected display illuminates. FUNCTION is selected in the same way, providing rapid, accurate changes in service capability at the touch of a button.

2-5. SYSTEM WARNINGS. To aid the technician in servicing, visual warnings will appear on the CRT when certain overload or caution conditions exist. Displays warn of low battery power, overheating of the RF load, or an improper attenuator setting for particular measurements. In addition, a continuous audible alarm sounds when a preset deviation limit is exceeded in monitor modes. This limit is entered by using the keyboard and may be programmed from 0.1 KHz to 99.9 kHz, with 100 Hz resolution.

2-6. FUNCTIONS. The following paragraphs briefly describe the major functions of the Communications System Analyzer.

2-7. AM, FM, CW, DSB Signal Generation. The built-in general purpose signal generator provides continuous coverage of the HF, VHF, and UHF land mobile spectrum for receiver testing. Many forms of external and internal modulation can be simultaneously impressed on the carrier signal for actual composite signals. The frequency range of the RF signal generator is from 10 kHz to 1000 MHz in 100 Hz steps. The output of up to 1 Volt rms provides sufficient amplitude to get through misaligned tuners and receivers, and is especially effective when changing a receiver's frequency. The high level, clean output is available over the entire frequency range of the Communications System Analyzer. The output frequency is referenced to an internal time base which can be calibrated to the WWV Standard. (See paragraph 4-7.)

2-8. Simultaneous Modulation. Modulation is simultaneously available from an internal 1 kHz tone generator, a multi-mode code synthesizer, and from external inputs. The external modulation can be voice from a standard Motorola mobile radio microphone (which plugs into the front panel of the instrument), as well as a signal applied to the external BNC input. Separate controls are provided for independently setting the levels of the 1 kHz tone, the code synthesizer, and the external modulation sources. The 1 kHz test tone is a convenient source of modulation for making SINAD (signal to noise and distortion) measurements. A MOD OUT connector provides external access to all of the modulation signals.

2-9. Modulation Display. The recovered audio waveform, or audio used to modulate the generator carrier can be viewed on the CRT. It is used to graphically measure deviation, and to aid in waveform analysis.

2-10. Sweep Generation. The sweep generator mode provides an RF output that is swept in frequency across a band centered at the programmed frequency. A synchronized horizontal sweep for the internal oscilloscope allows filter characteristics to be easily determined. This is ideal for in-depth troubleshooting of IF amplifiers and filters.

2-11. Distortion/SINAD Metering. A comprehensive check of receiver performance can be made with the Distortion/SINAD meter. An analog line segment and digital display of distortion and SINAD are automatically displayed on the CRT in the normal generate display or can be called up in the DVM display. The only hookups required are from the R2001C RF output to the RF input of the receiver under test, and from the receiver audio output to the R2001C SINAD input. The measurement and appropriate servicing can then be accomplished without the need for a separate signal generator, SINAD meter and distortion analyzer.

2-12. Multi-Mode Code Synthesizer. The Communications System Analyzer generates Private Line tones (PL), Digital Private Line codes (DPL), multi-tone sequential paging codes and tone-remote base signaling tones. All codes are available at the Mod Out jack, as well as being used internally to modulate the RF signal generator. This eliminates the necessity of using separate generators and oscillators for general servicing, setting transmitter deviation, or for checking tone-remote-base control lines. Time sequences are also stored in the Tone Memory to provide fast set-up and to eliminate errors. User programmable two-tone timing sequences are also provided to allow the storage of non-standard or future time sequences.

2-13. Off-the-Air Monitor. The 1.5μV sensitivity of the Communications System Analyzer receiver allows off-the-air-monitoring and measurement of transmitter frequency error and deviation to 1000 MHz. A variable squelch allows weak signals to be monitored, but can be set higher to ensure the proper signal-to-noise ratio for measurement accuracy. The off-the-air monitor function enables frequent parameter checks without leaving the shop, thus spotting system degradation early and keeping service costs down. Bandwidth can be set Wide for off-channel signal location or wide band FM; or Narrow for maximum sensitivity and selectivity.

2-14. IF Display. When the IF display mode is selected, the Communications System Analyzer's reciever IF envelope is shown on the CRT. This allows the technician to qualitatively and quantitatively assess the amplitude modulation envelope of a transmitter.

2-15. Spectrum Analyzer. In this mode of operation the CRT displays a window of the RF spectrum whose bandwidth (from 1 MHz to 10 MHz) is determined by the DISPERSION/SWEEP control. The center frequency of this window ranges from 4 MHz to 1,000 MHz, selectable by entering a specific center frequency with the keyboard. This center frequency is digitally displayed at the top of the CRT screen, eliminating the need for an external signal generator, and counter to provide markers. Once a signal is centered on the screen, positive identification is aided by switching the Analyzer to MONITOR AM or FM and listening to the demodulated output via the built-in audio amplifier and speaker. The spectrum analyzer's center frequency can be scanned up or down at rates varying from 0.5 kHz per second to 5 MHz per second, using the RF scan control. Slow rates are used to precisely determine a subject signal's frequency while faster rates are used for locating intermittent transmissions or viewing large areas of the spectrum in a short time. Uses of the Spectrum Analyzer are: Intermodulation interference identification, IF and RF signal tracing, transmitter harmonics measurements, transmitter spurious checks, and receiver local oscillator radiation.

2-16. RF Burnout Protection. At RF input levels above 200 mW, in any operating mode, the input automatically switches to the internal 125 watt RF load, thus protecting the attenuator and signal generator against damage from a keyed transmitter. If power above 200 mW is applied in any mode except the power monitor mode and audible alarm sounds and a visual warning on the CRT directs the operator to switch to the power monitor mode.

CAUTION

To prevent undue stress on the protected circuits it is advisable to always switch the system to the power monitor mode before applying power in excess of 200 mW. Additional protection is also obtained by making it a practice not to leave the step attenuator in the 0 dB position.

2-17. Terminated RF Power Measurement. RF power is automatically measured when the Communications System Analyzer is in the Power-Monitor mode. The built-in RF load dissipates up to 50 watts for three minutes and up to 125 watts for one minute. If a high power transmitter should be keyed into the unit for a time long enough to threaten overheating of the power measuring circuitry, the audible alarm sounds and the CRT display changes to read RF LOAD OVER-TEMP, thus warning the technician to un-key. This instrument function is further enhanced by the simultaneous indication of RF power output, carrier frequency error, and modulation, all on the same CRT display.

2-18. In-Line Power Measurement. Use of the Motorola ST-1200 series Wattmeter elements in conjunction with the analyzer's external wattmeter display provides measurement of forward and reflected antenna power on the CRT display. This capability eliminates the complex hook-ups and the additional instruments normally required for antenna measurements.

2-19. Duplex Generator. In this mode, the Communications System Analyzer simultaneously receives and generates the signals for duplex radio servicing, while generated and monitored frequencies are observed on the CRT. In the 0-10 MHz range, the 'Freq. Set' control tunes the proper offset frequency for the VHF and UHF bands. The 45 MHz mode provides a single offset for the 800 MHz range. A switch is also provided to select high or low side offset, as required. The Duplex Generator provides enhanced capability to service equipment such as repeaters, car telephones and Emergency Medical Telemetry portables.

2-20. 500-kHz Oscilloscope. This general purpose scope is ideal for waveform analysis in two-way communication servicing. Use it for viewing modulation signals (either internally or externally generated), detection of asymmetric modulation or audio distortion, and general purpose signal tracing and troubleshooting.

2-21. Frequency Counter. The frequency counter measures inputs in a range from 10 Hz to 35 MHz. Its 5 digit auto-ranging output is displayed on the CRT and allows precise measurement and setting of offset oscillators, 35 kHz and 455 kHz pager IF's, PL frequencies and other external input signals. This function will also operate simultaneously with the generator or monitor receiver modes of operation. Frequency measurement of transmitted carriers and other signals higher than 35 MHz is easily accomplished with the frequency error readout in the monitor modes.

2-22. AC/DC Voltmeter. Switching to the DVM mode provides a digital-analog voltage presentation on the CRT, along with the corresponding dBm value. The auto-ranging display provides full scale deflections of 1, 10, 100 and 300 Volts. AC or DC measurement is selected on the CRT. The meter's wide dynamic range and three digit display are ideal for setting power supply voltages, checking bias levels, and setting audio levels. Like the Frequency Counter, the DVM will operate simultaneously with generate or monitor operation.

2-23. Power Supply. The Communications System Analyzer may be powered by a variety of sources:

- AC at 110 or 220 Volts, 50, 60 Hz
- DC from an external 12 Volt source such as a service vehicle
- DC from an optional battery pack. Servicing can thus be accomplished wherever the equipment under test is located.

2-24. ACCESSORIES.

2-25. Figure 2-1 illustrates and Table 2-1 lists the accessories supplied with the Communication System Analyzer. Optional equipment available for use with the unit is listed in Table 2-2.

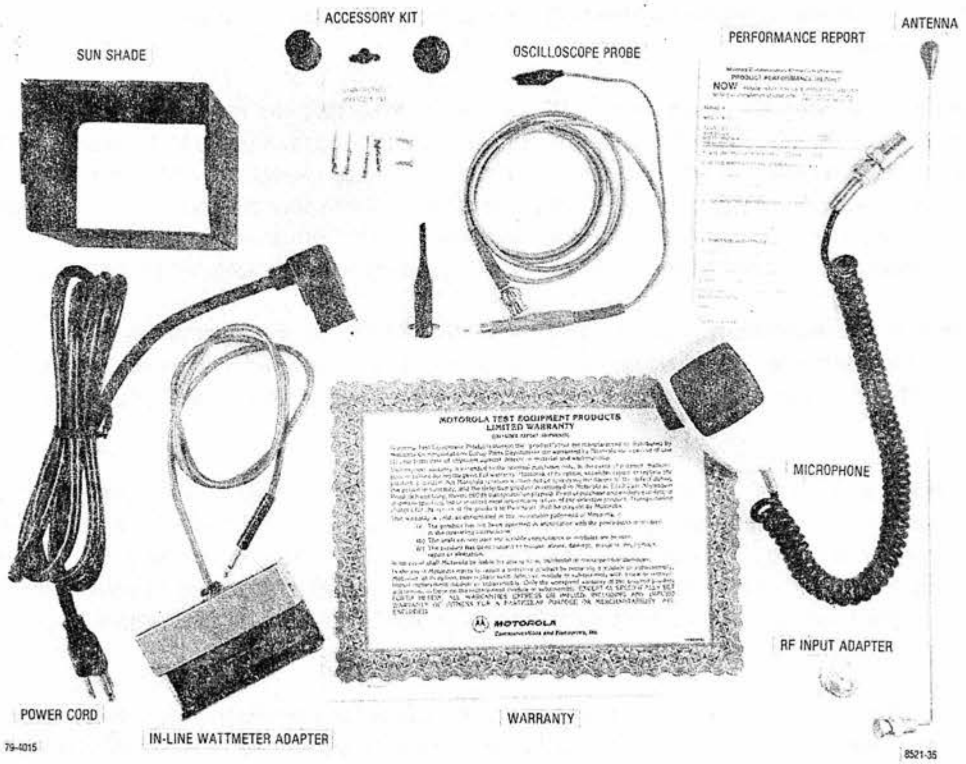

Figure 2-1. Accessories Supplied with Analyzer

Table 2-1. Accessories Supplied with the Communication Systems Analyzer

Equipment	Motorola Part No.	Use
Front cover	15-80335A70	Front panel and CRT protection, storage of cables, power cord, and other equipment for on-site servicing.
Sun shade	15-80335A55	Snap over CRT during use in bright sunlight.
Power cord	30-80336A36	Three conductor cord to supply AC power to unit. Also used when charging optional battery pack.
Oscilloscope probe	RTL-4058A	A X1 probe with attachments for general servicing.
In-line wattmeter adapter	RTL-4055B	Allows use of Motorola ST-1200 series in-line wattmeter elements for direct measurement and display of forward and reflected transmitted power.
Coax adapter	58-84300A98	Adapts front panel "N" connector to BNC female.
Antenna	TEKA-24A	Plugs into RF in/out connector on front panel, with N to BNC adapter. Used for off-the-air transmitter and receiver tests.
Test microphone	RTM-4000A	Used for voice modulation of signals.
Connector kit	RPX-4097A	Consists of connector shell, clamp, and four connector pins. Used to fabricate a mating plug for male dc power connector at back of analyzer. Enables user to make a dc power cable to interconnect separate power source to analyzer. Pins 1 and 2 are positive, pin 3 is the charging line, pin 4 is ground.

Table 2-2. Optional Equipment for Use with Analyzer

Equipment	Motorola Part No.	Use
IEEE-488 Standard interface bus option	Consult factory for retrofit information.	Enables fully automatic testing with the unit by external control from a computer or programmable controller.
Battery pack	RTP-1002A	13.6 volt battery and charger attaches to back of the unit. Provides one hour of continuous operation. Cannot be used with IEEE-488 option.
High-stability oscillator module	RTL-1007A	Improves stability of the time base as specified in electrical characteristics section.
Protective cover	RTL-4056A	Padded fabric type cover to protect unit from excessive field wear.

SECTION 4
OPERATION

4-1. GENERAL

4-2. This section contains information for the operation of the Communication System Analyzer.

4-3. CONTROLS, INDICATORS, AND CONNECTORS

4-4. The analyzer controls, indicators, and connectors are shown in Figures 4-1 through 4-3 and listed with their functions in Table 4-1.

Table 4-1. Controls, Indicators, and Connectors

Item	Description	Function
FRONT PANEL (fig. 4-1)		
Keyboard	Twelve-key pushbutton keyboard	Enters variables into memory/enters manual variables/ selects variables to be used from the memory.
▽	Line cursor key	Moves the cursor down to the next line that may be changed. Preset permanent entries are skipped. Cursor will move down only. When on last line, will return to top line with next entry.
◁	Horizontal cursor key	Moves the horizontal cursor left to the next entry position that may be changed. When in the last left position, the cursor will move to the far right with the next entry.
0 through 9	Numerical keys	Used to select from the memory a stored value to be used, or to enter directly a value to be used.
• Intensity • Focus	Stacked concentric potentiometers	
	• Intensity - center (small) knob	Controls the intensity of the scope presentation.
	• Focus - outside (large) knob	Controls the focus of the scope presentation.
Dispr/Sweep control	Potentiometer	Controls the frequency span (1-10 MHz) displayed on the CRT when unit is used as a spectrum analyzer. Provides sweep width control when either sweep function (SWP 0.01-1 MHz or SWP 1-10 MHz) is selected.

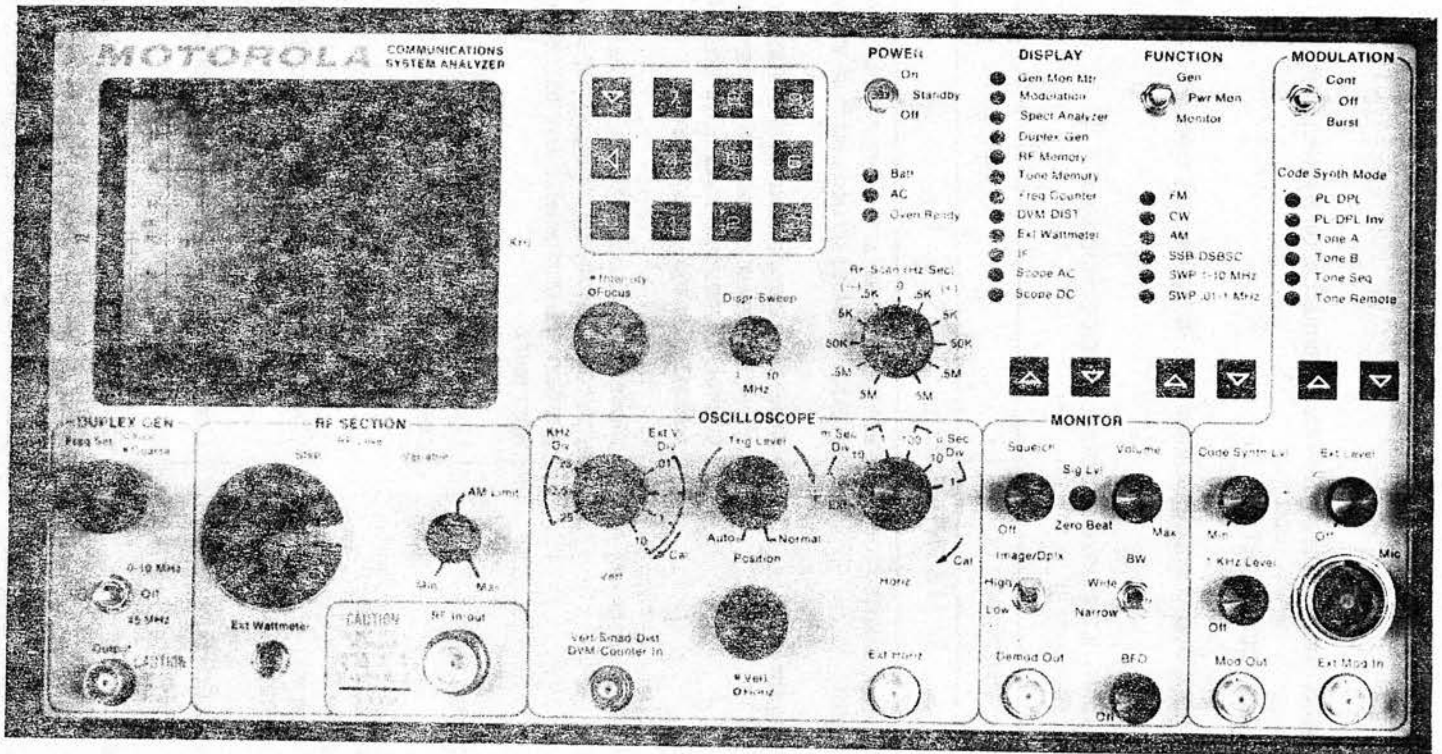

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Figure 4-1. Controls, Indicators, and Connectors, Front Panel

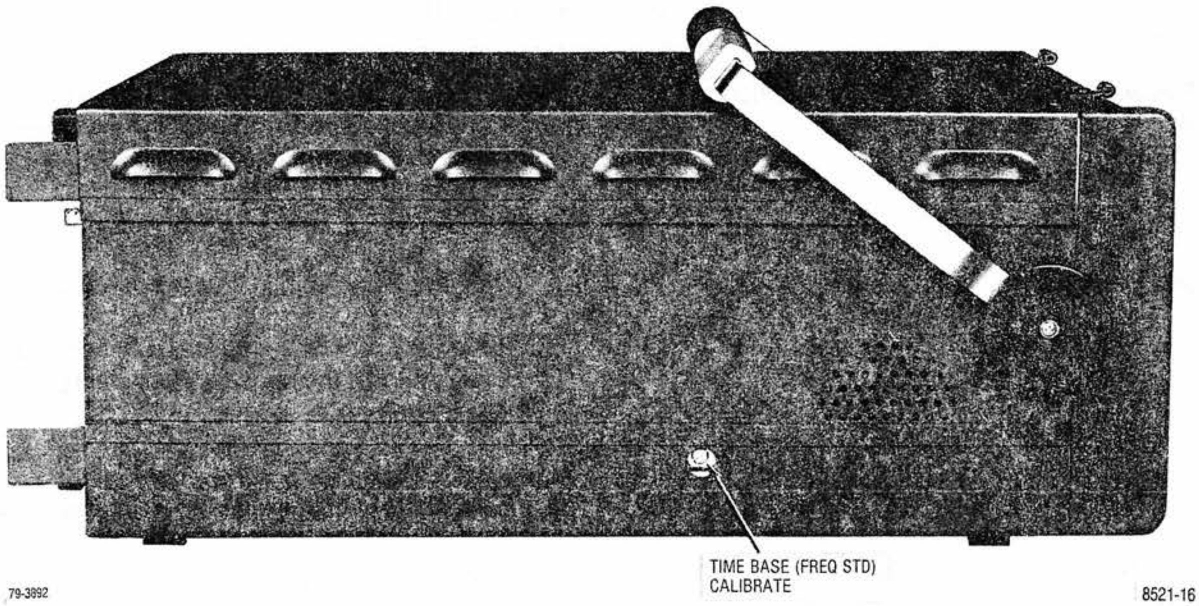


Figure 4-2. Controls, Indicators, and Connectors, Left Side Panel

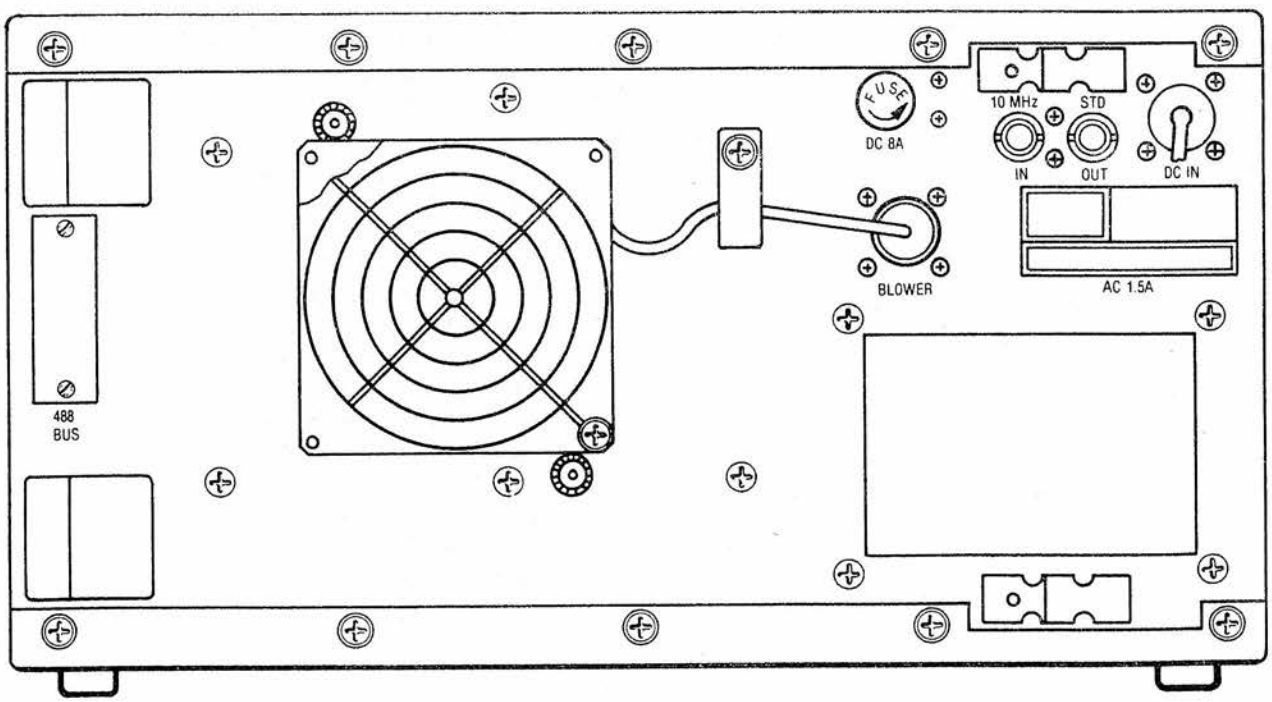


Figure 4-3. Controls, Indicators, and Connectors, Rear Panel

Table 4-1. Controls, Indicators, and Connectors (Cont)

Item	Description	Function
FRONT PANEL (fig. 4-1)		
RF Scan (Hz/Sec) switch	Eleven position switch	Allows automatic scan of the generated or the monitored frequency. The switch setting indicates rate of frequency change. The rate is 5 steps per second, with frequency steps of 100 Hz, 1 kHz, 10 kHz, 100 kHz and 1 MHz.
POWER switch	Three-position toggle switch.	a. Energizes all circuitry in the On position. b. At Standby position, removes DC from all circuitry except the frequency standard and battery charger. c. At Off, only the battery charging circuitry is operative if an ac power source is being used.
Batt indicator	LED (red)	Illuminates when equipment is using DC power.
AC indicator	LED (red)	Illuminates when equipment is connected to an ac power source. Position of POWER switch has no effect on indicator. Equipment automatically switches to ac power source when connected to ac line voltage.
Oven Ready indicator	LED (red)	Illuminates when optional frequency standard oven has stabilized. Continuously illuminated with the TCXO frequency standard.
DISPLAY indicators	Twelve LEDs (red)	Illuminate one at a time to indicate the function or type of operation the equipment is performing and the information displayed on the CRT. a. Gen/Mon Mtr — In the generate mode the center frequency, output power, and modulation depth of the RF output is displayed. In the monitor mode the center frequency, input power, frequency error, and modulation depth of the received carrier is displayed. b. Modulation — The modulation audio in the generate mode or the demodulated audio in the monitor mode is displayed. c. Spect Analyzer — The spectrum analyzer mode is enabled. The RF spectrum and the operating center frequency is displayed.

Table 4-1. Controls, Indicators, and Connectors (Cont)

Item	Description	Function
FRONT PANEL (fig. 4-1)		
		d. Duplex Gen — The duplex generate and monitor frequencies are displayed. The depth of modulation on the generator output or on the received carrier is indicated for the generate and monitor modes respectively. For this display, the function switch only selects which modulation reading is displayed. e. RF Memory — The nine stored RF frequencies or DPL codes with their corresponding PL and the current frequency in use are displayed. f. Tone Memory — The user selectable parameters for the code synthesizer are displayed. g. Freq Counter — The frequency of the signal input to the front panel frequency counter jack is displayed. h. DVM/Dist — The true RMS AC or DC level of the signal at the front panel DVM jack is displayed. The AC or DC mode is selected with the display cursor and the keyboard. The battery voltage is also displayed. i. Ext Wattmeter — The external wattmeter element selected and the forward and reflected power being passed thru that element are displayed. The element select is changed by entering the appropriate range number with the keyboard. j. IF — The 455 kHz IF signal from the monitor receiver is displayed. k. Scope AC — The voltage waveform applied to the front panel vertical input is displayed. The vertical input is AC coupled. l. Scope DC — The voltage waveform applied to the front panel vertical input is displayed. The vertical input is DC coupled.
FUNCTION switch	Three-position toggle switch	Controls the function of the equipment. The mode is shown by the LEDs. a. Gen - equipment generates and outputs an RF signal.

Table 4-1. Controls, Indicators, and Connectors (Cont)

Item	Description	Function
FRONT PANEL (fig. 4-1)		
		b. Pwr Mon - equipment monitors input signals with the input terminated into the internal power meter. This position must be used for inputs of 0.2 watts and greater. c. Monitor - equipment monitors input signals with the input terminated into the receive mixer. This position is used for "off the air" monitoring.
FUNCTION indicators	Six LEDs (red)	Indicates the mode or type of signal the equipment is set up to monitor or generate: a. FM - equipment generates or monitors frequency modulated signals. b. CW - equipment generates an unmodulated RF signal. Monitor CW provides frequency error measurement only. c. AM - equipment generates or monitors amplitude modulated signals. d. SSB/DSBSC - equipment generates a double sideband suppressed carrier signal. NOTE: The level of the DSBSC signal generated is not calibrated, it is for use in relative measurements only. Monitor SSB mode receives SSB signals with the use of the BFO. e. SWP 1-10 MHz - equipment generates a swept RF signal having a sweep width of 1 to 10 MHz, controlled by the Dispr/Sweep control. Selection of Monitor Sweep has no effect, equipment remains in generate mode. f. SWP 0.01-1 MHz - equipment performs as in e. above except the sweep width limits are 0.01 MHz to 1 MHz.
MODULATION SWITCH	Three position toggle switch	Controls the Code Synthesizer modulation source. Code Synthesizer mode is shown by the LEDs. a. Cont - Continuous modulation signal output. b. Off - Turns off signal. When the mode is DPL or DPL Inv, returning the switch to Off from Cont produces a 133 Hz tone burst for a 120 ms duration.

Table 4-1. Controls, Indicators, and Connectors (Cont)

Item	Description	Function
FRONT PANEL (fig. 4-1)		
		c. Burst - For PL, tone A, and tone B modes the output is present for as long as the switch is held in the burst position. For the Tone Sequence mode the burst position causes a single signaling sequence to be output. For the DPL and DPL Inv modes the Burst position causes a 133 Hz tone to be output. For the Tone Remote mode either the Burst or the Cont position causes a tone remote access sequence to be output. The access sequence leaves tone A at a low level for transmit-type commands until the switch is returned to the Off position. This switch is spring loaded to return to the Off position from the Burst position.
CODE SYNTH Mode indicators	Six LEDs (red)	When illuminated, indicates the selected mode of the Code Synthesizer. a. PL/DPL Indicator PL - Selected Private Line frequency output to 1 kHz DPL - Selected Digital Private Line code output Maximum code number is 777. b. PL/DPL Inv indicator PL - Same as above DPL - Inverted output of selected Digital Private Line code. Maximum code number is 777. The Private Line frequency or the Digital Private Line code is selected from the RF memory display or entered from the keyboard on the Gen Mon Mtr display. c. Tone A indicator Indicates Tone A selected for output d. Tone B indicator Indicates Tone B selected for output e. Tone Sequence indicator Indicates a tone signaling sequence will be output. The sequence is selectable on the Tone Memory Display. See Tone Memory Table examples, Figures 4-9, 4-10, 4-11 and 4-12. f. Tone Remote indicator Indicates access sequence for Motorola Repeater will be output.

Table 4-1. Controls, Indicators, and Connectors (Cont)

Item	Description	Function
FRONT PANEL (fig. 4-1)		
		Tone A and B frequencies are entered from the keyboard on the Tone Memory Display.
DISPLAY select switches	Two-pushbutton switches	Selects the function to be displayed by the equipment, as indicated by the DISPLAY LEDs. a. △ - moves the selection up one step at a time b. ▽ - moves the selection down one step at a time
FUNCTION select switches	Two-pushbutton switches	Selects the type or mode of signal the equipment will generate or monitor as indicated by the FUNCTION LEDs. Operation is the same as for the DISPLAY select switches.
Code Synth Mode select switches	Two-pushbutton switches	Selects the Code Synthesizer output mode as indicated by the CODE SYNTH MODE LEDs. Operation is the same as for the DISPLAY select switches.
Code Synth Lvl control	Potentiometer	Controls the level of Code Synthesizer for modulation or MOD Output.
Ext Level control	Potentiometer/switch	Controls modulation level of external input (microphone and other external generators). Switch at full counterclockwise position disables external modulation inputs.
Mic connector	4-pin connector	Microphone input. Provides microphone bias and PUSH TO TALK (GENERATE) connection to equipment.
Ext Mod in connector	BNC connector	External modulation signal input.
1 kHz Level control	Potentiometer/switch	Internal 1 kHz tone modulation level control. Switch at full counterclockwise position disables 1 kHz modulation tone.
Mod Out connector	BNC connector	Output connector for all modulation signals (all signals combined).
Volume control	Potentiometer	Controls speaker output level.
BW switch	Two-position switch	In either Pwr Mon or Monitor modes selects IF bandwidth. NB is ±6 kHz mod acceptance bandwidth. WB is ±100 kHz mod acceptance bandwidth. In Gen FM mode selects modulation range. 0-25 kHz dev in NB mode or 0-100 kHz dev in WB mode.

Table 4-1. Controls, Indicators, and Connectors (Cont)

Item	Description	Function
FRONT PANEL (fig. 4-1)		
BFO control	Potentiometer/switch	BFO on/off and beat frequency control for sideband reception. Full Counterclockwise position is off. NOTE: To minimize interference the BFO should be turned off when not in use.
Sig Lvl/Zero Beat indicator	LED (red)	Flashes at a rate equal to the difference between the received carrier frequency and the programmed frequency. Also is used as a squelch indicator.
Squelch control	Potentiometer	Adjusts squelch threshold level, full counterclockwise position disables squelch. NOTE: Monitor sensitivity is greatly decreased (for high-level use) as the control is increased clockwise beyond the quieting point.
Image/Dplx switch	Two-position switch	In duplex generation mode, controls the duplex frequency output for above (High) or below (Low) the receive programmed frequency. In the monitor mode it selects the frequency of the local oscillator injection above or below the programmed monitor frequency to remove image interference.
Demod Out connector	BNC connector	Receiver audio output.
Oscilloscope Horiz switch	Seven-position rotary switch	When in the oscilloscope mode, selects the horizontal sweep rate or selects the external horizontal input.
Horiz Vernier control	Potentiometer	Horizontal sweep rate Vernier or external horizontal input gain Vernier. Calibrated position is fully clockwise.
Ext Horiz	BNC connector	Allows external horizontal inputs for oscilloscope.
Trig Level	Stacked concentric potentiometer and switch **See "CAUTION" note on page 4-19**	Selects oscilloscope trigger level and trigger mode. Center knob selects the level of trigger. Outside (largest) knob controls the trigger mode. In Auto position, continuous sweep with no vertical input signal, syncs on vertical input. Normal position, no sweep unless vertical input is present, syncs on vertical input.
Position controls	Stacked concentric controlled potentiometer	Controls the position of the CRT display, when in the oscilloscope mode.
• Vert	Center (small) control knob	Controls the vertical position of the CRT display
• Horiz	Outside (large) control knob	Controls the horizontal position of the CRT display

Table 4-1. Controls, Indicators, and Connectors (Cont)

Item	Description	Function
FRONT PANEL (fig. 4-1)		
Vert switch	Four-position rotary switch	Oscilloscope operation uses values marked to the right of the switch, indicating volts per division on the CRT. Values marked to the left of the switch are used during modulation display mode, indicating range for calibrated FM deviation. NOTE: Frequency Counter sensitivity is also controlled by this switch.
Vert Vernier control	Potentiometer	Vernier gain control for vertical inputs to the CRT when in the oscilloscope mode. Fully clockwise is the calibrated position.
Vert/Sinad/DVM/Dist/ Counter In Connector	BNC connector	Signal input to the equipment for the following operations: a. External vertical for oscilloscope operation b. Distortion/SINAD Meter c. Frequency Counter d. Digital Voltmeter
RF in/out connector	Type N connector	RF input in the power monitor or monitor mode, RF output in the generate mode.
RF Level Variable control	Potentiometer	Vernier control of RF output level. Exceeding the AM limit marking in AM generation mode may result in a distorted output.
RF Level Step Switch	14-position ganged atten and switch	Ten dB per step control of RF output level in generate mode. Also serves as RF input level step attenuator in monitor and spectrum analyzer modes.
Ext Wattmeter	Connector	Allows input from Motorola ST-1200 series inline wattmeter elements for measurement and CRT display of forward and reflected transmitted power.
Freq Set controls	Stacked concentric potentiometers	Controls the duplex generator output frequency in the Duplex Generation mode.
• Coarse	Inside (small) control knob	Coarse frequency control.
• Fine	Outside (large) control knob	Fine frequency control.

Table 4-1. Controls, Indicators, and Connectors

Item	Description	Function
FRONT PANEL (fig. 4-1)		
Frequency offset control (0-10 MHz/Off/45 MHz)	Three-position switch	Selects the offset of the transmitted frequency from the selected receive frequency (Image/Dplx switch determines side of selected frequency the offset will be). 0-10 MHz position allows frequency offset to be varied between 0-10 MHz. In the 45 MHz position the offset is variable over a small range around 45 MHz with the use of the Fine frequency control.
Output connector	BNC connector	Output connector for duplex generator output.
SIDE PANEL (fig. 4-2)		
Frequency Standard control	Potentiometer	Allows calibration of the time base frequency (freq std)
REAR PANEL (fig. 4-3)		
DC 8A	Line fuseholder (8 amp)	DC input line fuseholder
DC IN power connector	4-pin connector	Connects to DC prime power source
AC power connector	3-pin connector	Connects to AC prime power source. Internally patched to accommodate either 100-110 VAC, 110-130 VAC, 200-220 VAC or 220-260 VAC.
AC 1.5A	Line fuseholder	AC line fuseholder. Use a 1.5A fuse when input voltage is between 100-130 VAC and a 0.75A fuse when input voltage is between 200-260 VAC.
10 MHz std IN connector	BNC connector	Provides for external 10 MHz time base input. Equipment automatically switches to external time base with an input at this connector.
10 MHz std OUT connector	BNC connector	Provides an output of the internal or external 10 MHz time base for external use.
488 BUS connector		Placement of I/O connector when IEEE-488 Interface Bus option is provided.
Blower power connector	4-pin connector	Provides 110 VAC to the cooling fan.

4-5. OPERATION

4-6. The operator may use the CRT display to become familiar with the functions the Communication System Analyzer is capable of performing. The unit may be preset to any of the functions the unit performs. As a function and its parameters are selected they are displayed on the CRT.

The unit contains a nonvolatile memory that stores frequently used data for fast access, reducing setup time. As a function is selected, if data for that function is stored, the data is displayed on the CRT.

One of the stored parameters may be used or the user may manually select (keyboard entry) the parameters required for the function. Selection of stored data or keyboard entry of data is cursor controlled. As a control is changed the CRT display changes to reflect the new parameter being used for function being performed.

4-7. CALIBRATE. The Communication System Analyzer may be calibrated to WWV or other time/frequency standards (figure 4-4). To calibrate the unit's time base (frequency standard) proceed as follows:

a. Connect antenna to RF In/Out connector.

b. Set FUNCTION switch to Monitor and DISPLAY to Gen/Mon Mtr.

c. Enter frequency of time/frequency standards station directly from keyboard.

d. Select AM function.

e. Using a tuning tool, adjust time base frequency calibration control (on left side of housing) until CRT frequency error display indicates less than 5 Hz error. Frequency settability to 0.5 part per million can thus be achieved using a 10 MHz frequency standard station.

NOTE

The time base output is also available on the rear panel for external measurement or laboratory calibration to better than the 0.5 ppm achievable with the above method.

NOTE

An external time base input is also provided on the rear panel.

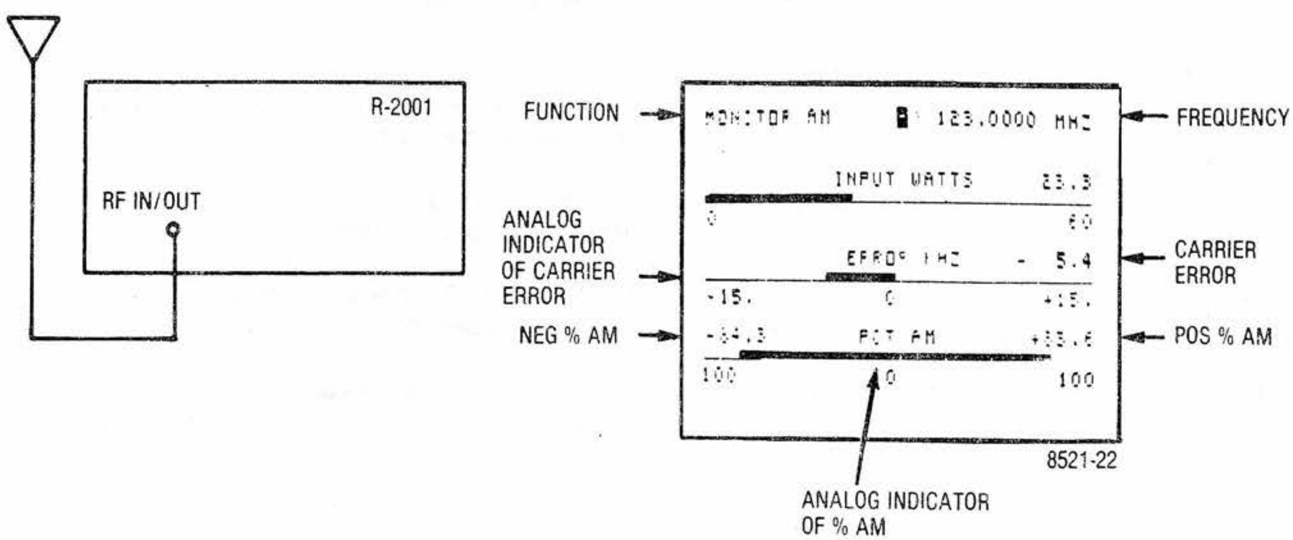


Figure 4-4. System Analyzer Time Base Calibrate Test Setup and CRT Display

4-8. GENERATOR OPERATION. The system generates RF frequencies for FM, AM, CW, SSB, and DSBSC types of transmission covering a range of 10 kHz to 1000 MHz. To generate a signal the FUNCTION switch is placed in the Gen. position.

NOTE

An RF protection circuit to protect against damage due to inadvertent application of RF power to the unit, when in a generate or sensitive monitor mode, is functional over the full monitor frequency range of the equipment (2 to 1000 MHz).

The type of signal is selected using the FUNCTION select LED indicator column. The unit can deliver an output of up to 1 volt into 50 Ohms. When in the AM generate mode the variable control (located in the RF SECTION on the front panel) should not be set above the AM limit mark. Exceeding this may cause distortion in the output.

NOTE

The RF protect circuit may trip if generator is run at full power output without having a 50-ohm load connected.

4-9. DUPLEX GENERATION. When operating in the duplex generate mode the offset frequency can be set to either 45 MHz or 0 to 10 MHz (adjustable). The Image/Dplx switch sets the offset frequency above (high) or below (low) the monitored frequency. When offset is in the 0 to 10 MHz range, the control range may include a foldback region. If the generator is operated in this foldback area erroneous frequency output indications can be given. Avoid areas where backward indication or a jittering display of the offset frequency are incurred. The following is an example of the duplex generator being used to setup repeater levels (Figure 4-5).

a. Connect DUPLEX GEN output to repeater receiver antenna input and repeater transmitter signal sample to RF In/Out connector. The Duplex Gen Output level is fixed at −30 dB nominal.

b. Set FUNCTION switch to Gen and DISPLAY to Duplex Gen.

c. Select Duplex Monitor frequency (repeater transmit frequency) from memory table or enter directly from keyboard.

d. Set DUPLEX GENERATOR frequency to repeater receiver frequency.

e. Adjust PL and test tone deviation to desired level on display.

f. Set FUNCTION switch to Monitor and measure the deviation of the repeated signal.

NOTE

Switch function to power monitor and connect repeater transmitter (under 125 watts) directly to the RF In/Out connector to read power and frequency error, as well.

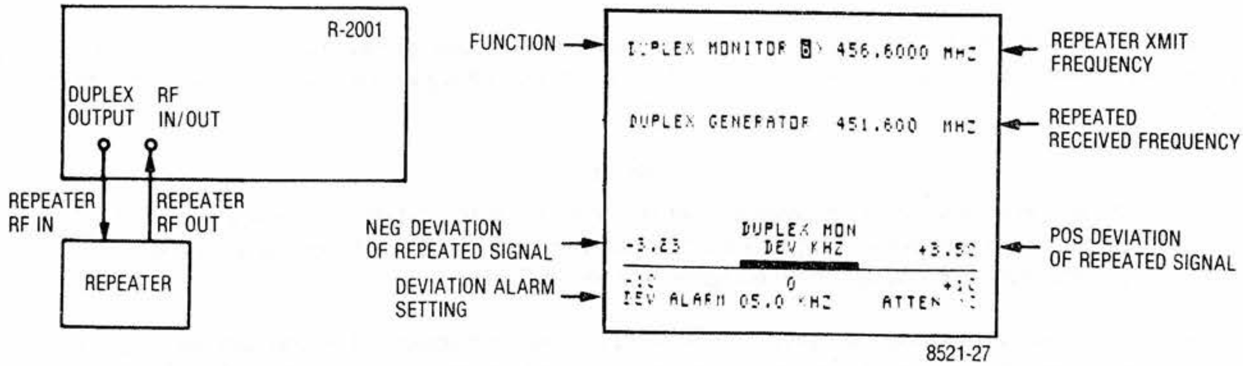


Figure 4-5. Duplex Generation Test Setup and CRT Display

4-10. FREQUENCY COUNTER. The frequency counter measures inputs in a range from 10 Hz to 35 MHz. The input to the frequency counter is through the Vert/Sinad/Dist/DVM/Counter in, BNC connector (located in the OSCILLOSCOPE section of the front panel). The counter sensitivity is controlled by the scope Vert switch. The following shows the minimum sensitivity for each switch setting.

Switch setting	Sensitivity
0.01	50 mV RMS
0.1	500 mV RMS
1.0	5V RMS
10.0	50V RMS

The autorange output of the counter is displayed on the CRT to a resolution of 0.1 Hz or 5 digits.

NOTE

Do not connect transmitter directly to the frequency counter input. Instead use the RF In/Out connector and the frequency error meter for transmitter frequency measurements.

To decode PL, run a cable from Demod Out to Counter In

4-11. SPECTRUM ANALYZER. Input to the spectrum analyzer is through the RF In/Out connector. Select the spectrum analyzer position on the DISPLAY column. Place the FUNCTION switch in the monitor position. Select the desired width of sweep by the Dispr/Sweep control. The center frequency is selected from the memory or entered directly from the keyboard, it is displayed at the top-right of the CRT. The following is an example of locating the frequency of an incoming signal with the spectrum analyzer (Figure 4-6).

a. Connect antenna to RF IN/OUT connector.

b. Set FUNCTION switch to Mon. and DISPLAY to Spect. Analyzer.

c. Select center frequency from memory table or enter directly from keyboard.

d. Adjust Disp/Sweep control for desired spectrum span.

e. Adjust Step attenuator if required to reduce sensitivity.

f. To determine whether a given displayed signal is valid or being internally generated, flip the Image/Dplx switch to the opposite position. If signal moves in frequency or disappears, it then/represents an internally generated spurious response or received image.

g. Use the RF Scan control to move desired signal to center of the screen. If the signal is located to the right of screen center line, move the RF Scan control clockwise into one of five positive stepping modes. If the signal is to the left of screen center line, turn the RF Scan control counter clockwise to one of five negative stepping modes.

h. Adjust Dispr/sweep control fully counterclockwise for 1 MHz spectrum span.

i. Again use RF Scan to recenter signal on screen.

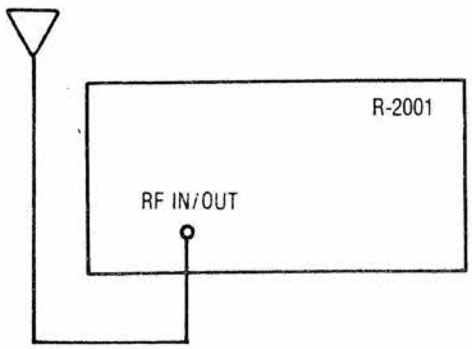
j. Set DISPLAY to Gen/Mon Mtr.

k. Now adjust the RF scan control to minimize any existing frequency error between the incoming signal and the Monitor frequency.

l. The frequency indicated at the top of the screen is now that of the desired incoming signal. It can also be monitored for call signs, etc.

NOTE

The spectrum analyzer is functional but uncalibrated for level measurements in Power Monitor mode for transmitter testing with the built-in 125 watt 50 ohm load. (Observe "RF LOAD OVERTEMP" warning for high power levels or extended periods of use.)



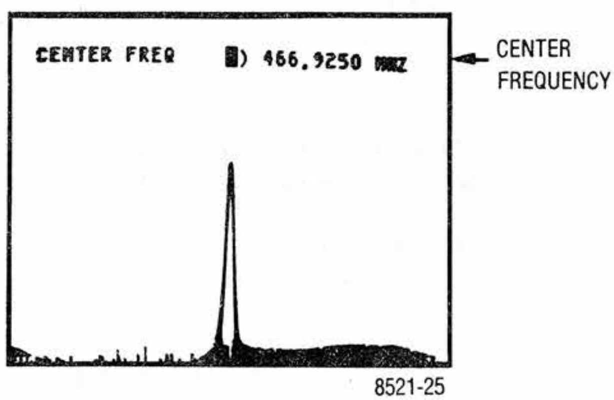


Figure 4-6. Spectrum Test Setup and CRT Display

4-12. MONITOR. The analyzer is capable of monitoring the same frequencies that it generates (para 4-9). Select Gen/Mon Mtr in the DISPLAY column and the modulation type in the FUNCTION column. Set the FUNCTION switch to the Monitor position for small signal samples or off the air monitoring. For high power signal monitoring (0.2w to 125w), set the FUNCTION switch to Pwr Mon.

CAUTION

To prevent undue stress on the protected circuits it is advisable to always switch the system to the power monitor mode before applying power in excess of 200 mw. Additional protection is also obtained by making it a practice not to leave the step attenuator in the 0 dB position.

NOTE

High-powered equipment in the 1-30 MHz range, which has unusually fast carrier rise times, may damage the system analyzer with repeated activation of the protect circuit. Ensure the FUNCTION switch is in the Pwr Mon position (this enables the protect circuit) before RF power is applied to the equipment.

In the monitor mode the CRT displays the type of signal being monitored, the selected frequency, power, error of the received frequency, and the modulation level.

4-13. EXT WATTMETER. When the analyzer DISPLAY is set to the Ext Wattmeter mode and the Motorola RTL-4055B in-line wattmeter adapter (supplied) is connected to the Ext Wattmeter jack the analyzer measures both forward and reflected power. The power rating of the wattmeter elements (Motorola ST-1200 series*), to be used, are displayed on the CRT. The following is an example of a test setup for external wattmeter operation. Figure 4-7 shows the test set connections and CRT display.

a. Select the EXT Wattmeter function by means of the arrow keys located below the DISPLAY column.

b. Plug the connector of the RTL-4055B In-Line Wattmeter adapter into the "Ext-Wattmeter" jack located on the RF SECTION of the front panel.

c. Using the keyboard; enter the single digit which corresponds to the full scale power rating of the ST-1200 series element you plan to use.

d. Place the ST-1200 element in the In-Line Wattmeter adapter and install element/adapter assembly into transmission line.

NOTE

Arrow on In-Line Wattmeter Adapter must point in the forward direction of the desired rf power flow through the adapter.

e. Key transmitter and observe magnitudes of forward and reflected power as displayed simultaneously on the 2 analog meter bars and corresponding digital readouts.

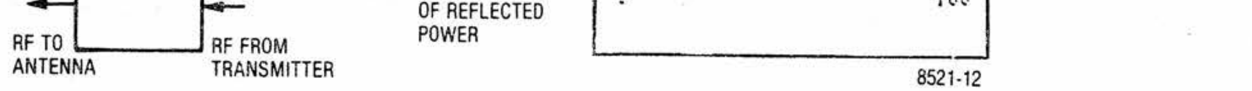


Figure 4-7. Wattmeter Test Setup and CRT Display

*Contact your Motorola Parts Source for ordering separately.

4-14. SIMULTANEOUS GENERATE AND MEASUREMENT OPERATIONS. The following test setups and CRT displays are examples of simultaneous generating and measurement operations.

a. FM Mobile radio setup for receiver sensitivity using Generator and SINAD meter (Figure 4-8).

1. Connect RF In/Out mobile radio antenna connector and multipurpose measurement (SINAD) input to receiver audio output.

2. Set FUNCTION switch to Gen. and DISPLAY switch to Gen/Mon Mtr.

3. Select frequency from RF memory table or enter directly from keyboard.

4. Adjust 1 kHz level for 3.0 kHz deviation and RF level for 12 dB SINAD indication. (The mobile radio audio output may be set to the desired level using the DVM AC mode.)

5. Read receiver SINAD sensitivity in microvolts or dBm.

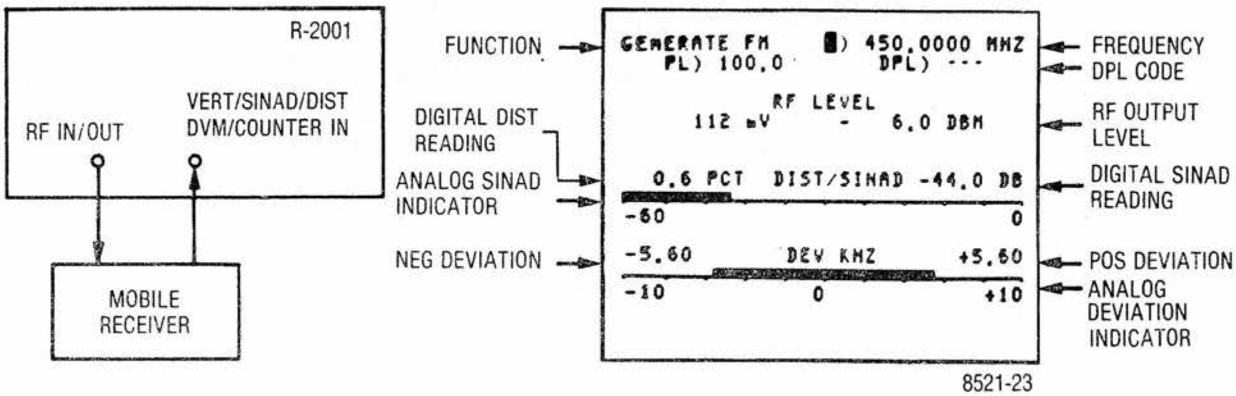


Figure 4-8. Test Setup for FM Receiver Sensitivity Using Generator and SINAD Meter with CRT Display

b. Test two-tone pager decode and alert function, and demonstrate simultaneous modulation (Figure 4-9).

1. Set FUNCTION switch to Gen and DISPLAY to Gen/Mon Mtr.

2. Select pager frequency from RF memory table or enter directly from keyboard.

3. Set the DISPLAY to Tone Memory and enter the A/B mode number in the mode select position from the keyboard. For an A/B sequence the mode number is 1. The stored information for the A/B sequence is then automatically displayed on the lower part of the display.

4. Enter the number of the desired two-tone sequence in the sequence select position from the keyboard.

NOTE

Timing sequences 1 and 2 are preset and cannot be changed. Sequences 3 and 4 are keyboard programmable for testing other pager types, upper and lower timing limits, or future schemes.

5. Enter the pager code Tone A and Tone B Frequencies from the keyboard.

6. Set the DISPLAY to Gen/Mon Mtr, the code synthesizer mode to tone A or tone B, and the MODULATION switch to Cont.

7. Adjust the Code Synth Lvl control for the desired level of modulation.

8. Set the Code Synth Mode to Signal Sequence and the MODULATION switch as desired to activate the pager under test.

9. The scope trigger delay setting at the bottom of the Tone Memory Display can be entered as necessary to delay the triggering of the oscilloscope horizontal sweep from the start of the tone sequence. This feature aids in troubleshooting tone decoders with the system oscilloscope.

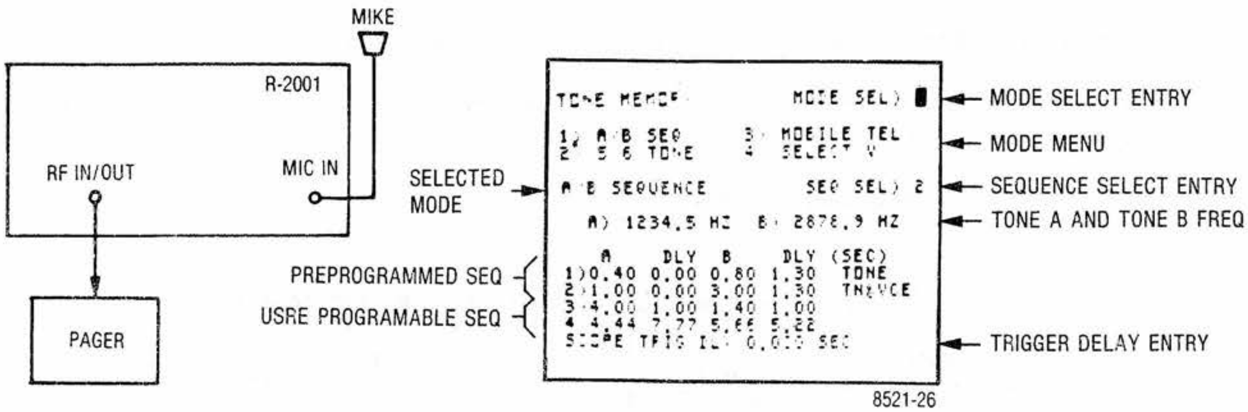


Figure 4-9. Test Setup for Two-Tone Pager and Alert Functions with CRT Display

c. Test 5/6 Tone Pager decode and alert function (Figure 4-10).

1. Set FUNCTION switch to Gen and DISPLAY to Gen/Mon Mtr.

2. Select pager frequency from RF memory table or enter directly from the keyboard.

3. Set the DISPLAY to Tone Memory and enter the 5/6 tone mode number in the mode select position from the keyboard. For a 5/6 tone sequence the mode number is 2. The stored information for the 5/6 tone sequence is then automatically displayed on the lower part of the display.

4. Select either a 5-tone or a 6-tone sequence by entering a 1 or 2 in the sequence select position from the keyboard.

5. Enter the desired CAP code from the keyboard.

6. Set the DISPLAY to Gen/Mon Mtr, the Code Synth Mode to Tone Seq, and the MODULATION switch to Cont.

7. Adjust the Code Synth Lvl control for the desired level of modulation.

8. Connect the pager as shown in Figure 4-10 and set the MODULATION switch as desired to activate the pager under test.

9. Enter the scope trigger delay setting at the bottom of the Tone Memory Display as necessary to delay the triggering of the horizontal sweep relative to the start of the tone sequence when troubleshooting the tone decoder with the oscilloscope.

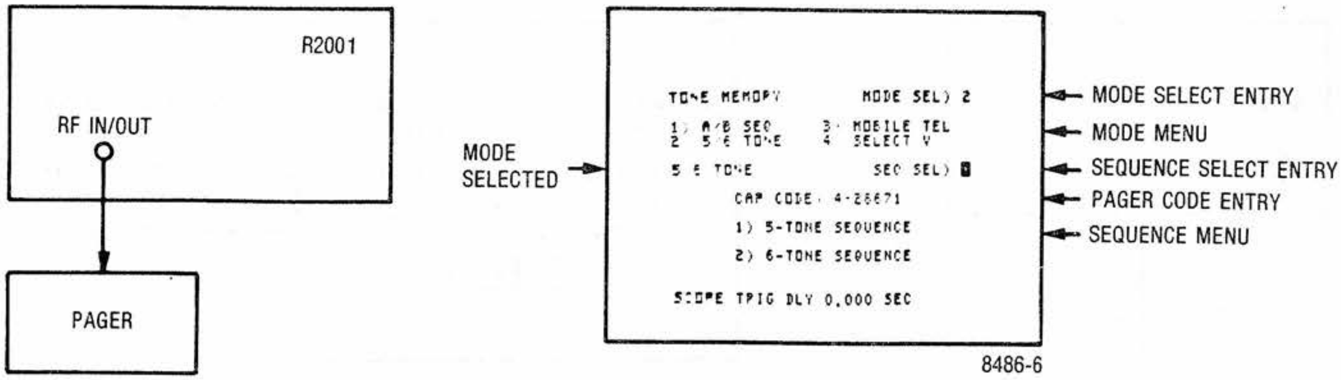


Figure 4-10. Test Setup for 5/6 Tone Pager with CRT Display

d. Test Mobile Telephone Receiver and Supervisory Decoder (Figure 4-11).

1. Set the FUNCTION switch to Gen and the DISPLAY to Tone Memory.

2. Select the Mobile Telephone mode by entering the number 3 in the mode select position from the keyboard. The stored information for the mobile telephone sequences will be automatically displayed on the lower part of the screen.

3. Select the desired mobile telephone sequence by entering the appropriate number in the sequence select position from the keyboard: 1-IMTS, 2-MTS, 3-2805.

4. With the keyboard enter the appropriate Tone 1 and Tone 2 frequencies on the display.

5. Enter the desired telephone number from the keyboard into the Telephone Number position onthe display.

6. Set the DISPLAY to Duplex Gen and set the DUPLEX GEN switch to the 0-10 MHz or 45 MHz position as applicable. Enter the desired receive frequency from the keyboard and then set the desired transmit frequency using the DUPLEX GEN frequency controls.

7. Set the MODULATION switch to the Cont position and adjust the Code Synth Lvl control for the desired level of modulation.

8. Set the FUNCTION to Pwr Mon and the DISPLAY to Gen/Mon Mtr.

9. Connect the system to be tested as shown in figure 4-11 and set the MODULATION switch as required to test the mobile telephone receiver and supervisory decoder.

10. Enter the scope trigger delay setting shown at the bottom of the Tone Memory display as necessary to aid in troubleshooting the decoder circuits.

CAUTION: The entry of a scope trigger delay will prevent normal operation of scope triggering as long as the unit is in the position "MODULATION", "Tone Seq."

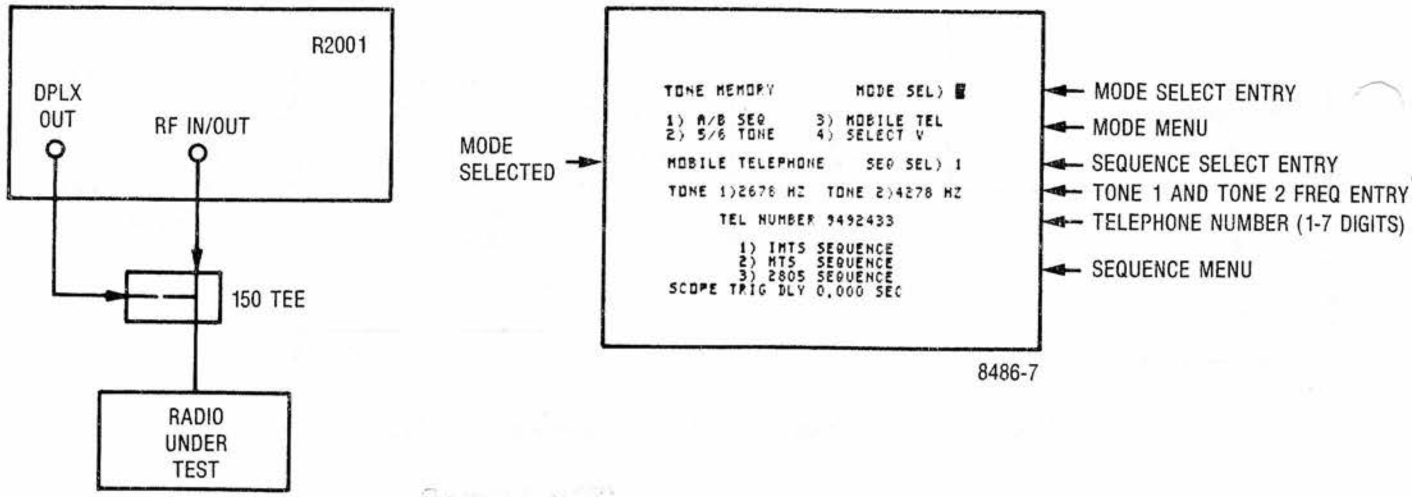


Figure 4-11. Test Setup for Mobile Telephone Test with CRT Display

e. Test Select V decode function (Figure 4-12).

1. Set the FUNCTION switch to Gen and the DISPLAY switch to Tone Memory.

2. Select the Select V mode by entering the number 4 in the mode select position from the keyboard. The stored information for the mobile telephone sequence will be automatically displayed on the lower part of the display.

3. Enter the number of the desired Select V sequence in the sequence select position on the display from the keyboard.

4. Enter the desired access number from the keyboard into the access code position on the display.

5. Set the DISPLAY to Gen/Mon Mtr., the Code Synth Mode to Tone Seq, and the MODULATION switch to Cont.

6. Adjust the Code Synth Lvl control for the desired level of modulation.

7. Connect the system to be tested as shown in figure 4-12 and set the MODULATION switch as desired to test the Select V decoder.

8. Enter the scope trigger delay setting shown at the bottom of the Tone Memory display as necessary to aid in troubleshooting the decoder circuits.

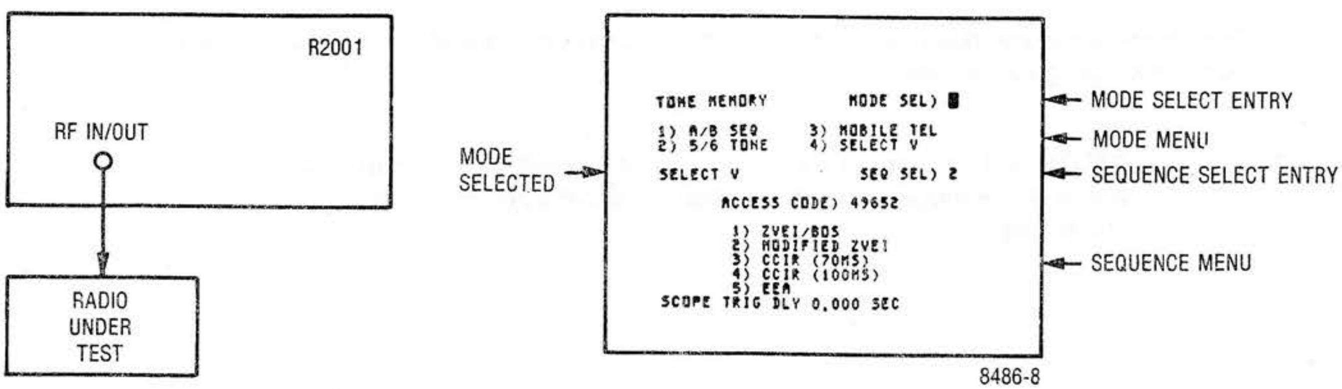


Figure 4-12. Test Setup for Select V Test with CRT Display

f. Troubleshooting Receiver audio stages using "DVM and Signal Generate" function simultaneously (Figure 4-13).

1. Select the DVM function by means of the arrow keys located below the DISPLAY column.

2. Using the keyboard "down" arrow position the CRT cursor adjacent to the "DVM Mode" graphics.

3. Enter a "1" via the keyboard to select AC voltage measurement or a "2" for DC voltage measurement selection.

4. Set up the desired on-channel RF signal to provide an input to the receiver.

5. Set FUNCTION switch to "Gen". Set appropriate RF output level (as indicated on the CRT screen).

6. Apply test signals from the receiver audio stages to the instrument's "Vert/Sinad/Dist/DVM/Counter In" input. DC Voltage measurement points are also applied to this same input. The supplied X1 test probe may be used.

7. Refer to the CRT screen for an auto-ranging and analog/digital indication of either DC voltage or AC voltage and corresponding dBm level.

NOTE

The AC DVM indication of dBm is referred to 600 ohms.

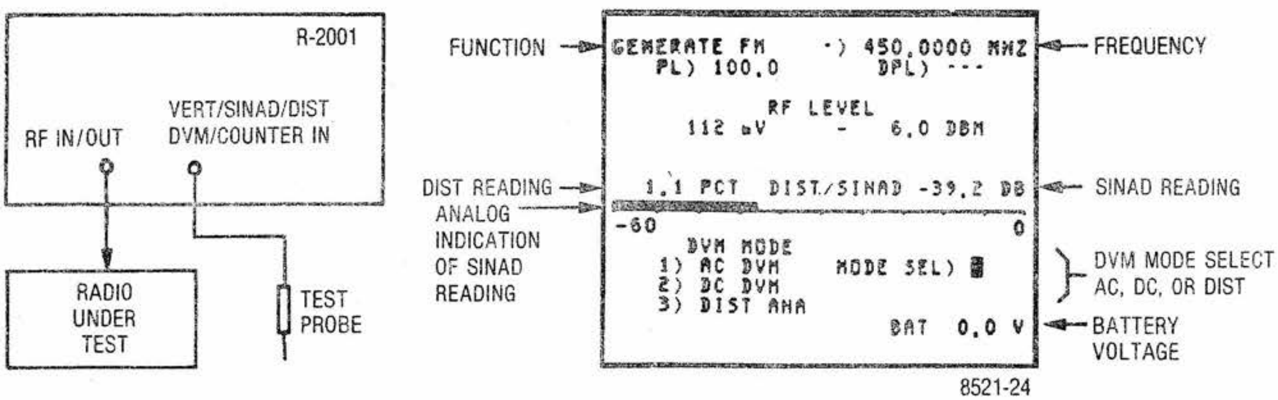


Figure 4-13. Test Setup for Using DVM and Signal Generate with CRT Display

MOTOROLA, INC.
COMMUNICATIONS SECTOR
TEST EQUIPMENT REPAIR CENTER
1313 EAST ALGONQUIN ROAD SCHAUMBURG, ILLINOIS 60196

TEST EQUIPMENT REPAIR REQUEST FORM

This completed form must accompany equipment returned for repair.

CUSTOMER'S PURCHASE ORDER NO.	DATE
MODEL NUMBER	SERIAL NUMBER
DESCRIPTION OF PROBLEM:	
REQUESTED REPAIRS:	
SHIP TO ADDRESS:	
SHIP VIA:	

Providing the information below will reduce the turnaround time on your Test Equipment Repair.

MOTOROLA CUSTOMER NUMBER	BILL TAG	SHIP TAG	INTERNAL MOTOROLA ACCOUNT NO.

SIGNED: ____________________

SECTION V
MAINTENANCE

5-1. SERVICE

5-2. The Motorola Test Equipment Repair Center is charged with the service responsibility for all test equipment supplied by the Motorola Communications Group. The center maintains a stock of original equipment replacement parts and a complete library of service information for all Motorola test equipment.

5-3. Most in-warranty repairs are performed at the center. Exceptions include repairs on some equipment not manufactured by Motorola which are performed by the original supplier under the direction of the Test Equipment Repair Center. Out-of-warranty service is performed on a time and materials basis at competitive rates and the maximum turn-around goal is less than ten working days. Customer satisfaction is continually surveyed by reply cards returned with repaired instruments.

5-4. The Test Equipment Repair Center also provides a convenient telephone troubleshooting service. Frequently, a user technician can troubleshoot a piece of equipment and isolate defective components under the direction of the Test Equipment Repair Center via telephone. Required replacement parts are then immediately shipped to the user thereby reducing shipping time and servicing costs. For telephone troubleshooting contact the Test Equipment Repair Center toll free at (800) 323-6967.

5-5. All other inquiries and requests for test equipment calibration and repairs should be directed to the Area Parts Office. They will contact the Test Equipment Repair Center, process the necessary paperwork and, if necessary, have the Center contact you to expedite the repair.

5-6. REPLACEMENT PARTS ORDERING

5-7. Motorola maintains a number of parts offices strategically located throughout the United States. These facilities are staffed to process parts orders, identify part numbers, and otherwise assist in the maintenance and repair of Motorola Communications products.

5-8. Orders for all replacement parts should be sent to the nearest area parts and service center listed below. When ordering replacement parts the complete identification number located on the equipment should be included.

5-9. ADDRESSES

5-10. General Offices

MOTOROLA INC.
Communications Division Parts Dept.
1313 E. Algonquin Rd.,
Schaumburg, Illinois 60196
Phone: 312-397-1000
Executive Offices: 1301 E. Algonquin Rd.,
Schaumburg, Illinois 60196

5-11. U.S. Orders

WESTERN AREA PARTS
1170 Chess Drive, Foster City,
San Mateo, California 94404
Phone: 415-349-3111
TWX: 910-375-3877

MID-ATLANTIC AREA PARTS
7230 Parkway Drive
Hanover, Maryland 21076
Phone: 301-796-8600
TWX: 710-862-1941

EASTERN AREA PARTS
85 Harristown Road
Glen Rock, New Jersey 07452
Phone: 201-447-4000
TWX: 710-988-5602

SOUTHWESTERN AREA PARTS
3320 Belt Line Road
Dallas, Texas 75234
Phone: 214-241-2151
TWX: 910-860-5505

GULF STATES AREA PARTS
8550 Katy Freeway
Houston, Texas 77024
Phone: 713-932-8955

MIDWEST AREA PARTS
1313 E. Algonquin Rd.
Schaumburg, Ill. 60196
Phone: 312-576-7322
TWX: 910-693-0869

EAST CENTRAL AREA PARTS
12995 Snow Road
Parma, Ohio 44130
Phone: 216-267-2210
TWX: 810-421-8845

PACIFIC SOUTHWESTERN AREA PARTS
9980 Carroll Canyon Road
San Diego, California 92131
Phone: 714-578-2222
TWX: 910-335-1634

SOUTHEASTERN AREA PARTS
5096 Panola
Industrial Blvd.,
Decatur, Georgia 30032
Phone: 504-981-9800
TWX: 810-766-0876

5-12. Canadian Orders

CANADIAN MOTOROLA ELECTRONICS COMPANY
Parts Department
3125 Steeles Avenue
East Willowdale, Ontario
Phone: 516-499-1441
TWX: 610-492-2713
Telex: 02-29944LD

5-13. All Countries Execpt U.S. and Canada

MOTOROLA INC., OR MOTOROLA AMERICAS, INC.
International Parts
1313 E. Algonquin Road,
Schaumburg, Illinois 60196 U.S.A.
Phone: 312-397-1000
TWX: 910-693-1592 or 1599
Telex: 722433 or 722424
Cable: MOTOL

CAUTION

This equipment contains parts that are subject to damage by static electricity. Proper precautions should be taken during handling.

WARNING

Lithium Battery

The processor module within this system utilizes a lithium battery as a memory keep-alive voltage source. Do not mutilate or disassemble the battery cell. The lithium metal is a very active material that burns in the presence of water or high humidity. Do not put the battery in fire, attempt to charge, heat above 100°C, or solder directly to the cell. Do not overdischarge the cell to a reverse voltage greater than 3 volts. The battery may burst and burn or release hazardous materials. See paragraph 5-143 of this manual for battery troubleshooting procedures and cautions.

CAUTION

Lithium Battery

Lithium batteries are classified as hazardous materials and must be disposed of accordingly. Do not dispose of the battery by placing it in with the everyday trash. Consult state and local codes for the appropriate disposal procedure. Motorola will dispose of the battery if the expended battery is returned in the replacement battery container and by the same method that the new battery came to you to: Motorola Inc., Return Goods Department, 1313 East Algonquin Road, Schaumburg, Ill. 60196.

5-14. MAJOR ASSEMBLIES

5-15. The Communication System Analyzer is designed for ease of maintenance. Most of the circuitry is on twelve plug-in circuit boards. A list of all subassemblies is given in table 5-1. The assembly locations are shown in figures 5-1 and 5-2.

Table 5-1. List of Subassemblies

Ref. Des.	Item	Part Number As Labeled	Replacement Order Part No.
A1	Low Voltage Power Supply Module	01-P07897V001	RTP-1005A
A1A1	Low Voltage Power Supply Switcher Module	01-P07891V001	RTP-4016A
A1A2	Low Voltage Power Supply Output Module	01-P07856V001	RTP-4013A
A1A3	Low Voltage Power Supply Control Module	01-P07853V001	RTP-4012A
A1A4	Lower Voltage Power Supply Relay Module	01-P07892V001	01-80305A68
A2	Scope Amplifier Module	01-P00413N002	RTC-4007B
A3	Scope/DVM Control Module	01-P24154A001	RTC-4024A
A4	Receiver Module	01-P00389N002	RTL-1002B
A5	Synthesizer Module	01-P00385N002	RTC-1001B
A5A*	Digital Synthesizer Card	01-P00358N002	RTC-4009B
A5B*	RF Synthesizer Card	01-P00386N002	RTC-4010B
A6	Audio Synthesizer Module	01-P00426N002	RTC-4011B

Table 5-1. List of Subassemblies (Cont)

Ref. Des.	Item	Part Number As Labeled	Replacement Order Part No.
A7	Processor Input/Output Module	01-P24158A001	RTC-4025A
A8	IEEE Bus Module (Optional)	01-P00203N002	RTC-4013B
A9	Microprocessor/Character Generator Module	01-P24162A001	RTC-4026A
A10	High Voltage Power Supply Module	01-P07896V001	RTP-1006A
A11	RF Input Module	01-P00394N003	RTC-1002B
A11A1*	Protection/Power Meter Card	01-P00400N002	RTL-4061B
A11A2*	Converter/Wide Band Amplifier Card	01-P00398N002	RTC-4015B
A11A3*	Offset Generator Card	01-P00399N002	RTC-4016B
A12	Front Panel Interface Module	01-P07846V001	RTL-4086A
A13	Frequency Standard Module	01-P07898V001	RTL-1011A
A14	Front Panel Assembly	01-P07860V001	01-80305A64
A14A1	Display Board Assembly	01-P07843V001	1-80305A63
	Motherboard Assembly	01-P07894V001	RTL-4089A

*These items are solder-in submodules listed for reference purposes. These cards are not normally repaired or replaced individually.

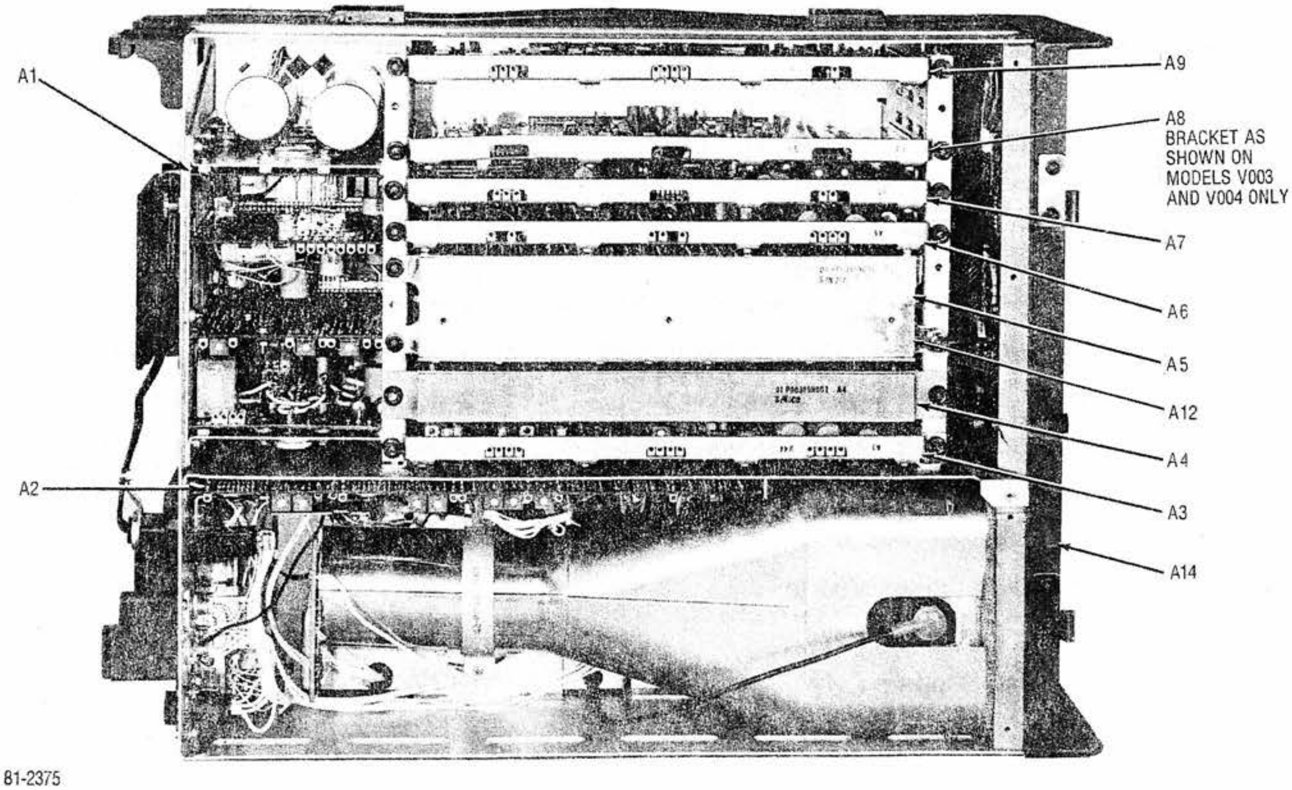


Figure 5-1. Communications System Analyzer, Top View, Cover Removed

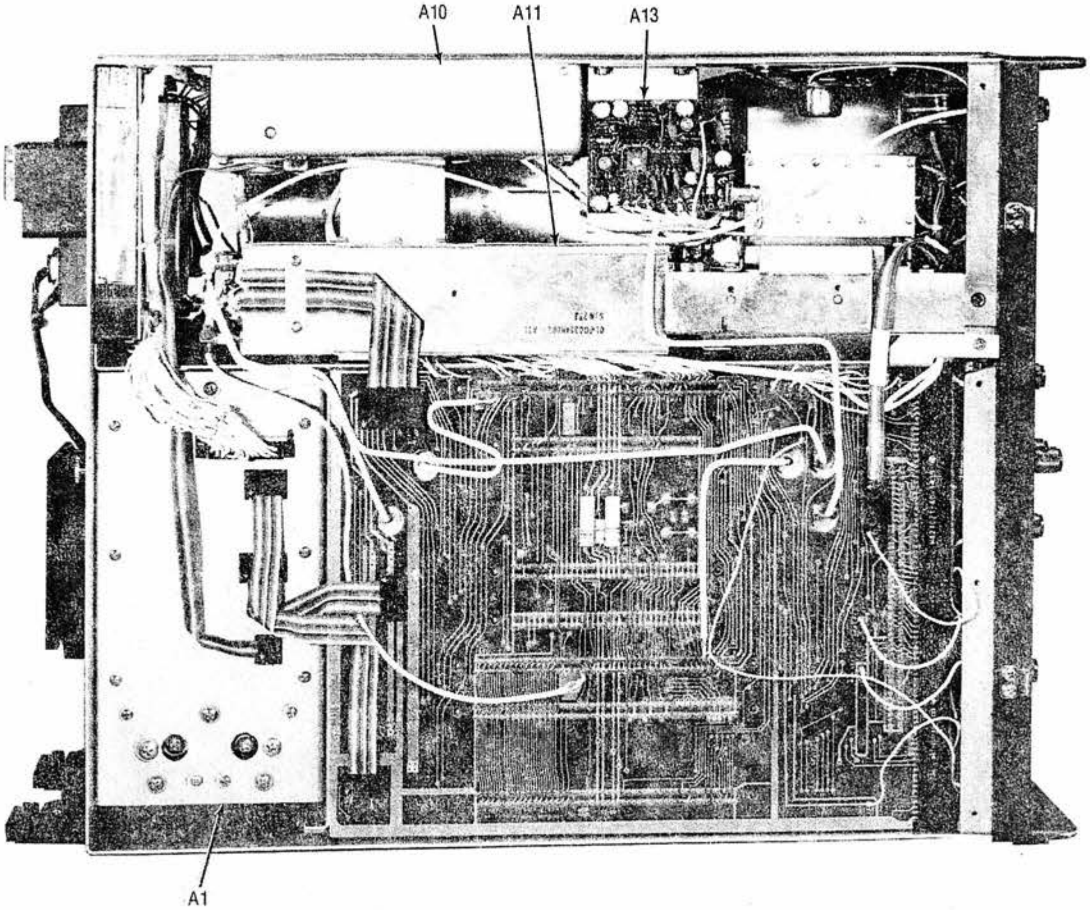


Figure 5-2. Communications System Analyzer, Bottom View, Cover Removed

5-16. THEORY OF OPERATION

5-17. General

5-18. The operation of the Communications System Analyzer can be divided into nine basic functions; Generate, Power Meter, Monitor, Duplex Generator, Code Synthesizer, Frequency Counter, Digital Voltmeter (DVM), Oscilloscope, and Distortion/SINAD Meter. The general operation of the unit will simultaneously incorporate the basic functions to provide the total capability of the system.

5-19. The following discussion will cover the block diagrams for each of the basic functions plus a discussion on the processor control of the system. A functional block diagram of the total system is shown in figure 5-3. Only the major signal paths between each of the modules are shown to clarify the total system configuration.

5-20. System Control

5-21. System Control is the primary responsibility of the internal microprocessor. Front panel control and system status inputs to the processor are manipulated by the processor to provide the control for the operating mode. From the front panel the processor monitors the keyboards, the function select switch, the modulation control switch, the RF scan switch, the image switch, the bandwidth switch, the horizontal and vertical range switches, and the step attenuator switch. This information plus internal status information causes the processor to display the appropriate information on the CRT to program the center frequency, to set up the generate or monitor mode, and to make the internal switching arrangements for the selected operating state.

5-22. The interface to and from the microprocessor is via the processor bus. This bus consists of a 16-bit address bus, an 8-bit data bus, and a 7-bit control bus. This bus interfaces the processor to its program memory (ROM), scratch pad memory (RAM), IEEE interface, and the peripheral interface adapters (PIA). The PIA is the mechanism by which the processor interfaces with the system. A PIA consists of a dual 8-bit latch which may be programmed as either an input or output for the microprocessor. System input and control information passes to and from the microprocessor via three system control buses attached to a PIA.

5-23. Each system control bus consists of a 4 bit address bus, a 4 bit data bus, and an enable line. The 4 address bits determine which of 16 possible latches the 4 bits of data is to be sent to or received from. The enable line triggers the actual transfer of data. The three control buses within the system are called the RF control bus and the AF control buses 1 and 2. The RF control bus is as described above while the AF control buses consist of a single 4-bit address and 4-bit data bus and two enable lines. The resulting total input/output capability for the system buses is 16 latches at 4-bits each times 3 buses or 192 bits. A tabulation of buses and the controlling or input function of each bit is shown in table 5-2.

5-24. Systems with the IEEE remote control option interface the IEEE bus to the processor bus through a general purpose interface bus adapter (GPIB) on the IEEE interface module. When enabled all control inputs to the system pass through the IEEE bus and front panel controls are ignored. For more information on IEEE control see section 21.

5-25. Generate Mode

5-26. The generate mode provides a variable level RF output that is phase locked to the internal 10 MHz standard. AM, FM, and Sideband Modulation are possible on the output signal. A block diagram of the generate mode is shown in figure 5-4.

5-27. The Frequency Standard module (A13) contains a 10 MHz standard oscillator with buffering and switching to provide a 10 MHz signal to the EXTERNAL 10 MHz OUTPUT and to the RF Synthesizer (A5). A provision is made for the application of an EXTERNAL 10 MHz INPUT which causes the internal standard to shut down and the EXTERNAL 10 MHz INPUT to be switched to the EXTERNAL 10 MHz OUT and to the RF Synthesizer.

5-28. The 10 MHz standard input to the RF synthesizer is digitally divided down to provide SYSTEM REFF FREQUENCIES for the frequency counter, the zero beat detector, the second local oscillator in the receiver, and the processor timing reference. Additionally reference frequencies are provided for a fixed 550 MHz locked loop and for a programmable 500 MHz-1000 MHz locked loop. The programming of the 500 MHz-1000 MHz locked loop is provided by the RF CONTROL BUS from the processor. The SELECT SWITCH selects one of three possible output points for the SYNTH RF output signal. The first is from the 500 MHz-1000 MHz loop directly. The second is from a divide by two on the output of the 500 MHz-1000 MHz loop which gives frequencies from 250 MHz to 500 MHz. For outputs below 250 MHz, the output of the 500 MHz- 1000 MHz loop is mixed with the fixed 550 MHz signal and the difference signal used for the output. For this output the processor programs the 500 MHz - 1000 MHz loop for frequencies between 550.01 MHz and 800 MHz to obtain outputs from 10 kHz to 250 MHz respectively.

5-29. FM and SWEEP Modulation is implemented within the 500 MHz-1000 MHz loop. FM capability is 200 kHz peak which when divided by two gives the 100 kHz peak requirement. Similarly the sweep capability is 10 MHz peak which provides the 5 MHz requirement for the sweep generator and spectrum analyzer requirements.

Table 5-2. Control Buses and Functions

ADRS \ Data	RF Bus D3	RF Bus D2	RF Bus D1	RF Bus D0	AF Bus #1 D3	AF Bus #1 D2	AF Bus #1 D1	AF Bus #1 D0	AF Bus #2 D3	AF Bus #2 D2	AF Bus #2 D1	AF Bus #2 D0	Data / ADRS
0	310-440 PLL A0				Audio Synth N0				Display Led's				0
1	310-440 PLL N0				Audio Synth N1				Function Led's				1
2	310-440 PLL N1				Audio Synth N2				Mode Led's				2
3	60 PLL N0				Audio Synth N3				Input Scope Atten 0.001	0.01	0.1	1.0	3
4	60 PLL N1				PL Sel	DPL CLK Enab	DPL Sel	AUDIO Synth N4			Atten Int/Ext Sel	Ext In AC/DC Sel	4
5	60 PLL N2				MOD To Spkr Enab	Audio Atten 30 dB	Aduio Atten 20 dB	Audio Atten 10 dB	RF Atten Position				5
6	60 PLL N3				DPLX MOD Enab	DSBSC MOD Enab	FM MOD Enab	AM MOD Enab	Scan Switch Position				6
7	310-440 PLL A1		60 PLL N4						IF Overl'd In	SIG Present In	RF Input <+20 dB In	WB/NB Sw In	7
8			500-1000 Out Enab	250-500 Out Enab	DVM MODE Select				$\overline{\text{CSSG}}$ Cont Sw In	$\overline{\text{CSSG}}$ Burst Sw In	Hi/Lo Image Sw In	Gen Sw In	8
9	WB MOD Enab	(MOD) x (2) Enab	MOD $\overline{\text{INV}}$/INV Sel	MOD FM/SWP Sel	Scope Trig Enable	Pk Det FM MOD Enab	Pk Det AM MOD Enab	Pk Det Demod Enab	Scope Vertical Switch Pos In $\overline{\text{10 V/}}$ DIV	$\overline{\text{1V-100kHz}}$ DIV	$\overline{\text{0.1V-}}$ 10kHz DIV	$\overline{\text{0.01V-}}$ 1kHz DIV	9
A	0.01-1000 Sel	500-700/700-1000 VCO Sel	LOOP INV/$\overline{\text{INV}}$ Sel	MOD Disable	Distor Notch Filter X1 X10 Gain	Int DVM x 0.1 Enab	WB/NB Sel	IF/BFO Freq Sel	$\overline{\text{Mon}}$ Sw In	Scope Horiz Switch Pos Sw In			A
B					Horiz Scope Mode Sel		Vert Scope Mode Sel						B
C					Pwr MTR Enab	(Mon + DSB)/ Gen Sel	Ext/Distortion Select	.01-1 /1-10 Swp Sel					C
D	SSB Demod Enab	FM Demod Enab	AM Demod Enab	Demod To Spkr Enab	Scope Time Base CTL SSC3	SSC2	SSC1	SSC0					D
E	WB/NB Sel	Demod INV/$\overline{\text{INV}}$ Sel	Alarm Enab	LIN IF/ Log IF Sel	Scope Time Base CTL SSC7	SSC6	SSC5	SSC4	DVM RMS/DIR Sel	Freq Cntr Range			E
F									Ctr/DVM Sel	Counter Input Sel IF/BFO	Offset	Ext	F

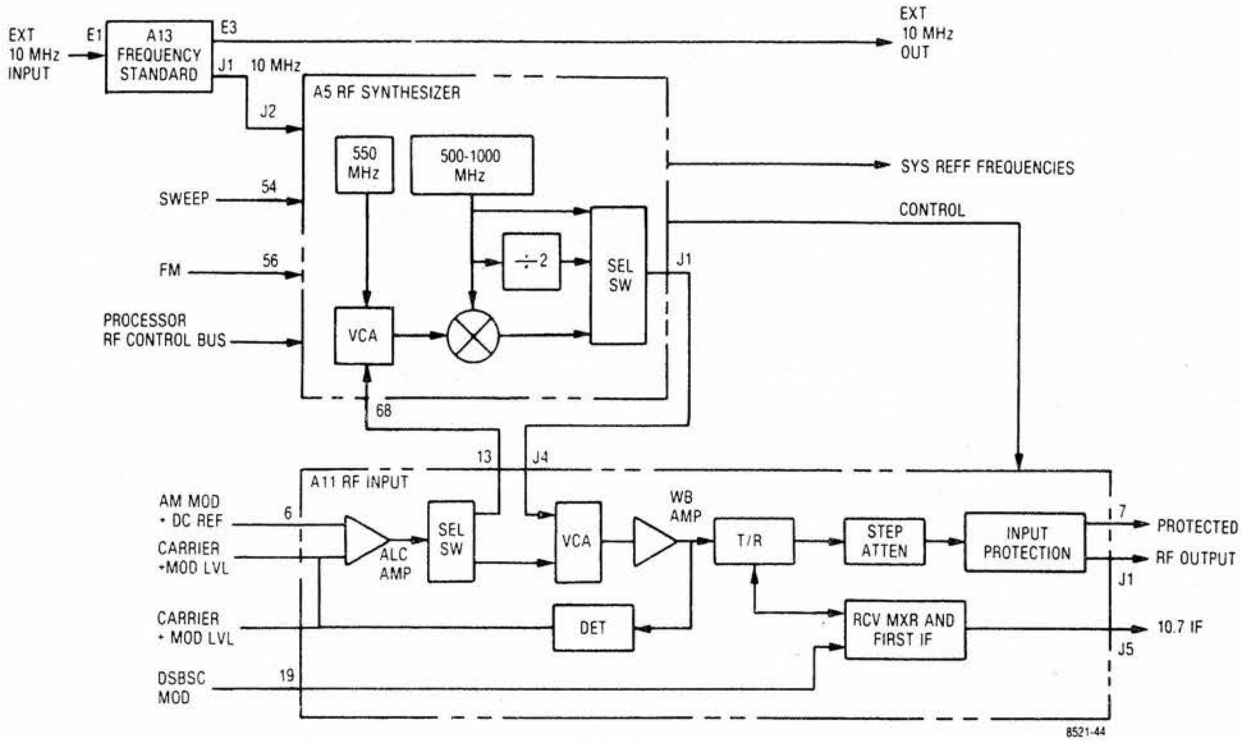


Figure 5-4. Generate Mode Block Diagram

5-30. The SYNTH RF signal is amplified and leveled in the RF input module (A11). The signal level at the output of the wideband amp is detected and compared to the AM MOD & DC REF signal from the front panel level control. If there is a difference between the two signal levels, the ALC amp provides an error voltage. The error voltage controls the attenuation of the Voltage Controlled Attenuator (VCA) in the direction that will make the detected RF output equal to the AM MOD & DC REF signal. There are two possible VCA's for the output leveling. The VCA within A11 is used for frequencies from 1 MHz to 1000 MHz. For frequencies below 1 MHz, the VCA on A11 is set to minimum attenuation and the VCA on the RF Synthesizer module is used for leveling. Amplitude modulation is incorporated by summing the modulation signal with the DC reference signal to force the leveling loop to vary the output level in proportion to the modulating signal. The signal from the RF level detector (CARRIER + MOD LVL) is used by the processor for the determination of RF output level and the percent AM. The leveled output range of the Wideband Amp is from −3 dBm to +13 dBm (0.16 to 1.0 Vrms).

5-31. The leveled output from the Wideband Amplifier is applied to the Generate/Monitor (T/R) switch. For AM, FM, and CW signals the switch connects the amplifier output to the Step Attenuator. For Double Sideband Suppressed Carrier (DSBSC) the T/R switch is in the "R" position where the amplifier output is connected to the local oscillator port on the receive mixer and the attenuator is connected to the RF port. The DSBSC MOD signal is then used to drive the IF port of the mixer giving a DSBSC signal at the RF port and thus at the Step Attenuator.

5-32. Coarse level control in 10 dB increments is provided by the Step Attenuator. The total range of the attenuator is from 0 dB to 130 dB attenuation. For the basic R2001C the Step Attenuator is controlled directly by a shaft to the front panel knob. With the IEEE control option the Step Attenuator is electrically programmable and controlled by the processor. The front panel knob in this case is connected only to a rotary switch which directs the processor in setting the attenuation level. Under IEEE control, commands via the IEEE bus determine the attenuator setting. (See section 21.)

5-33. The RF signal from the Step Attenuator passes through the input protection circuitry to the RF Output jack. A level detector on the RF Output jack monitors the power level at the jack. If power in excess of 200 mW is applied to the Output jack, the protection circuit will activate and switch the RF Output jack to the internal 50 ohm load. This action protects the Wideband Amp and Step Attenuator against burnout. A signal line from the protection network signals the processor that the system is in the protected mode. The processor in turn activates the CRT and alarm warnings.

5-34. Power Meter

5-35. Input power measurements are made with the RF input terminated into an internal 50 ohm load. This termination is the same one used for the protect mode when in the generate or monitor functions. A block diagram of the power meter is shown in figure 5-5.

5-36. For the power meter mode the processor sets the WATT METER ENABLE line to cause the RF input jack to be switched to the 50 ohm power termination. For modes other than the power meter, an input Detector on the RF input jack detects when the input power has exceeded 200 mW and then switches the input to the load.

5-37. The switch is a single pole double throw configuration so that when switched to the RF load the path to the Step Attenuator and Converter is open circuited. However, leakage across the open switch provides sufficient signal for operation of the normal monitor functions.

5-38. A sample of the RF voltage being applied to the RF Load is detected by the Power Detector to give a DC output proportional to the peak RF voltage. The amplifier following the detector buffers and gain adjusts the detected voltage to provide the RF INPUT POWER signal to the processor. The processor then determines and displays the RF input power.

5-39. A Temperature Sensor located near the flange of the RF Load alerts the processor when the load temperature exceeds 80°C. The processor reacts to the OVER TEMPERATURE signal by displaying a warning message on the CRT and by sounding the audible alarm.

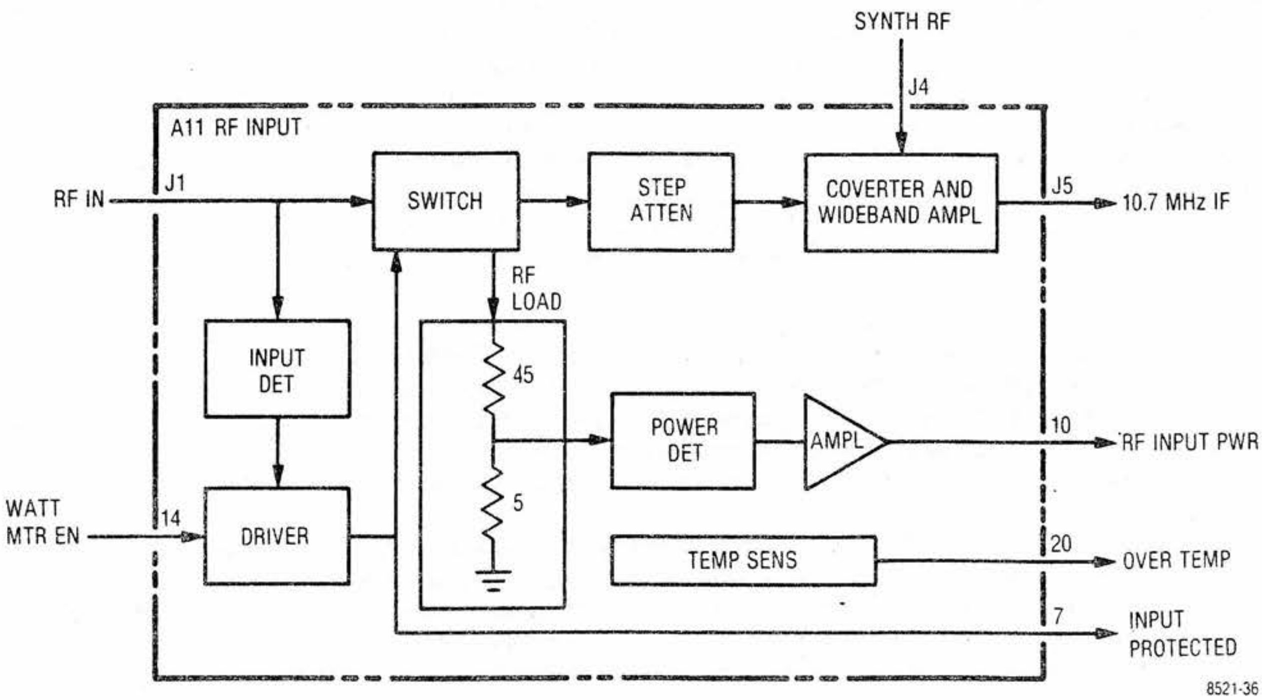


Figure 5-5. Power Meter Block Diagram

5-40. Monitor Mode

5-41. The monitor mode allows RF signals from an antenna or from a transmitter directly to be checked for frequency error, modulation level, and spectral content. AM, FM, and sideband modulations can be accommodated with this system. A block diagram of the monitor mode is shown in figure 5-6.

5-42. The RF signal to be monitored is applied to the RF Input jack on the RF Input module (A11). If the input level is less than 200 mW the input signal passes directly through the Input Protection circuitry to the Step Attenuator. For input levels greater than 200 mW the protection circuit switches the input to the internal load and signal the operator to switch to the Power Monitor mode. In this case, RF leakage (paragraph 5-37) through the protection circuits provides the input signal to the Step Attenuator.

5-43. For the monitor mode the T/R switch is set so that the RF input from the Step Attenuator is connected to the RF port on the receive mixer. The output from the wideband amp is switched to the local oscillator port on the receive mixer. The processor programs the RF Synthesizer for an output frequency that is offset from the frequency to be monitored by 10.7 MHz. The offset may be above or below the center frequency as selected by the front panel image switch.

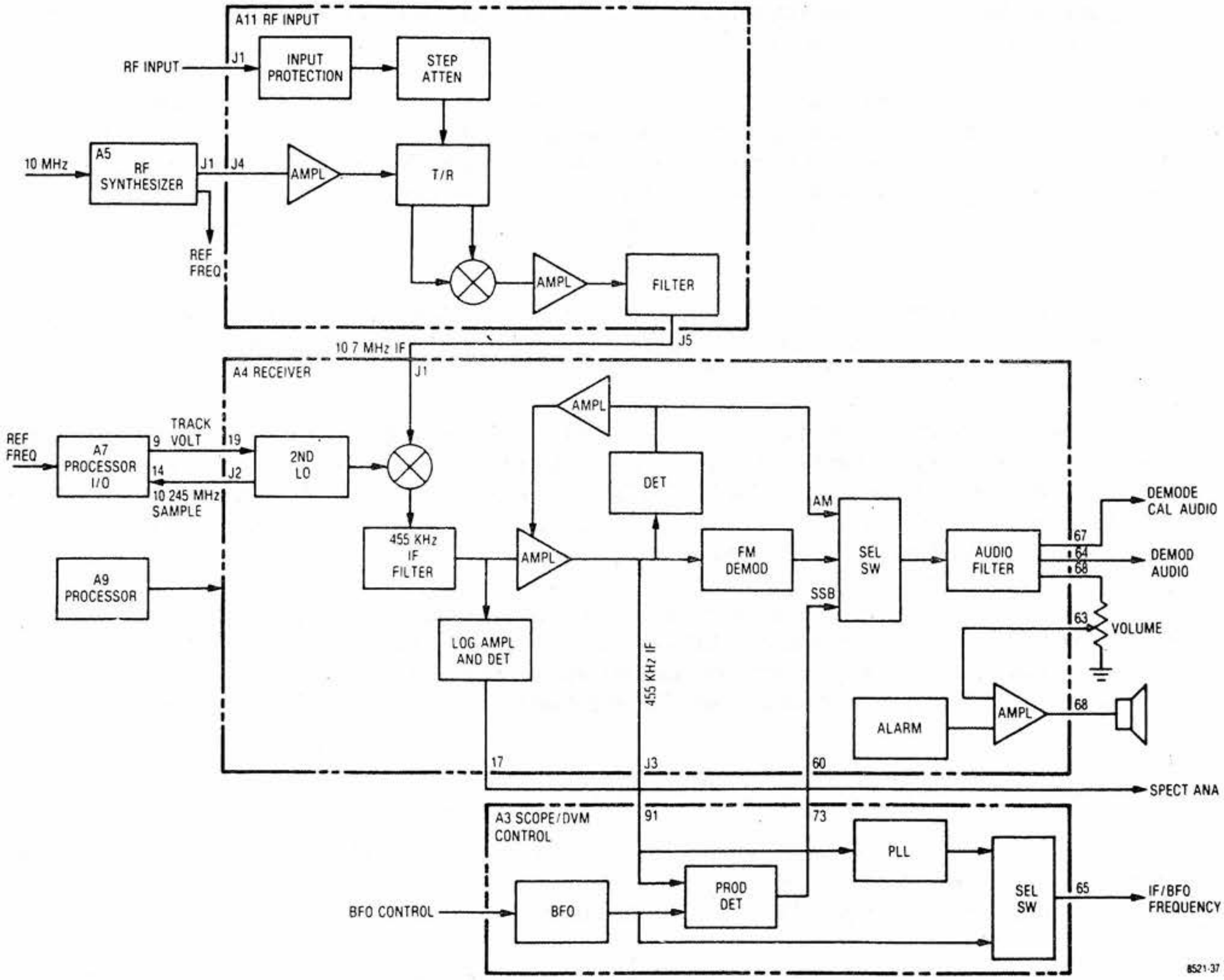


Figure 5-6. Monitor Mode Block Diagram

5-44. The 10.7 MHz difference signal at the IF port of the receive mixer is amplified and selected by the first IF Amplifier and Filter. The Amplifier provides sufficient gain so that the overall gain of the RF Input module is 10 ±2 dB. The IF filter provides a modulation acceptance bandwidth of ±100 kHz. The filter output is the 10.7 MHz IF signal to the Receiver module (A4).

5-45. A second mixer in the receiver module down converts the 10.7 MHz IFsignal to 455 kHz by mixing the input signal with a 10.245 MHz Second Local Oscillator. The Second Local Oscillator is phase locked to the 10 MHz system standard so that its frequency is as accurate as the standard. The phase locked loop for the Second Local Oscillator is split between two modules. A 10.245 MHz SAMPLE signal is compared with the REFERENCE FREQUENCIES from the RF Synthesizer on the Processor I/O module (A7). The comparison provides a TRACKING VOLTAGE error signal to the 10.245 MHz oscillator which corrects its frequency to hold it in lock.

5-46. Immediately following the second mixer is the IF filter. The IF filter is selectable between a narrowband (±6 kHz mod acceptance) and a wideband (±100 kHz mod acceptance) bandwidth. The bandwidth is under the control of the processor and is selected by the bandwidth switch on the front panel.

5-47. The output signal from the IF filter has two possible paths. The path to the Log Amplifier and Detector provides the spectrum analyzer capability. The other path is the linear IF Amplifier for AM, FM, and SSB demodulation. The output level of the Amplifier is detected to give amplitude modulation and to provide the AGC control on the IF amplifier. The IF signal is applied to the FM Demodulator and is sent to the Scope/DVM Control module (A3) for SSB demodulation and for frequency error determination.

5-48. Demodulated audio from the selected demodulator is routed to the Audio Filter by the Select Switch under processor control. The Audio Filter provides post detection filtering for both wide and narrow band modes. The output of the Audio Filter is three signal lines. The Demod Calibration Audio line provides the calibrated audio levels for modulation level determination. A Demod Audio output provides a level adjusted signal to the front panel Demod Out jack. Speaker audio is level adjusted by the front panel volume control and then amplified by the Audio Amplifier on the Receiver module.

5-49. The Audio Amplifier sums the audio from the demodulator with the Alarm audio. The Audio Amplifier provides a 0.5 watt output capability to the system's internal speaker. The Alarm generator is under the control of the system processor.

5-50. SSB demodulation is implemented on the Scope/DVM Control module by multiplying the 455 kHz IF signal from the Receiver with a signal from the Beat Frequency Oscillator (BFO). The BFO is controlled from the front panel and typically has a frequency range of 455±3 kHz. The BFO signal is switched with the output of the 455 kHz IF Phased Locked Loop (PLL) to the frequency counter for frequency error determination. The 455 kHz PLL filters and shapes the IF signal to make it suitable for frequency counting.

5-51. When in the spectrum analyzer mode the linear IF Amplifier is shut down and the Log Amplifier is activated. The output of the Log Amplifier and Detector is a DC voltage that is proportional to the log of the 10.7 MHz IF input level. The log circuit has a dynamic range of approximately 80 dB, covering input levels from −110 dBm to −30 dBm. The SPECTRUM ANALYZER signal from the Log Amplifier is the vertical input to the scope for the spectrum analyzer display.

5-52 Duplex Generator

5-53. Simultaneous generate and monitor functions are available with the use of the Duplex Generator. The frequency spread between generate and monitor frequencies is limited to a range of 0 to 10 MHz and a fixed frequency of 45 MHz. A block diagram of the Duplex Generator function is shown in figure 5-7.

5-54. The Duplex Output signal is generated by mixing the local oscillator signal for the first receive mixer with a signal from the Offset Oscillator. The Offset Oscillator is at the frequency equal to the desired spread between generate and monitor frequencies less the 10.7 MHz IF offset. The monitor function is unaffected by the duplex mode and operates as described under paragraph 5-40.

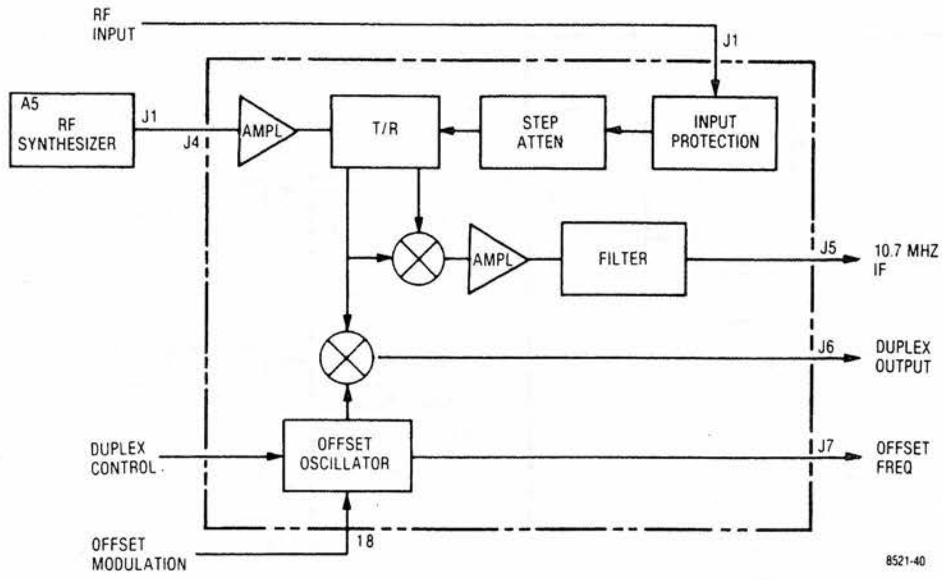


Figure 5-7. Duplex Generator Block Diagram

5-55. Frequency modulation of the duplex output is obtained by modulating the Offset Oscillator frequency via the OFFSET MOD signal line. Control of the Offset Oscillator is directly from the front panel of the system. An OFFSET FREQUENCY output from the oscillator provides an input to the frequency counter for the determination of the duplex frequency.

5-56. Code Synthesizer

5-57. Three simultaneous modulation sources are possible with the internal Code synthesizer. A private line (PL) or Digital Private Line (DPL) source, a fixed 1 kHz source, and external modulation sources are individually level controllable and summed together to give the composite modulation audio. The Code Synthesizer provides the modulation source for the system in the generate mode and can be used as an audio frequency source when in the monitor mode. For the IEEE option a provision is made to allow processor control of the modulation levels. A block diagram of the Code synthesizer is shown in figure 5-8.

5-58. The PL signaling sequence generator is an Audio Synthesizer with an output frequency range from 5 Hz to 10 kHz in 0.1 Hz steps. The frequency is programmed by the processor in response to the operator's request from the keyboard through the CRT display. The Programmable Attenuator following the synthesizer provides 10 dB and 30 dB attenuation levels for the tone remote access sequence.

5-59. DPL Code words are generated by the processor in response to the code entered by the operator. The 23-bit DPL word is stored in the DPL Generator and contunuously output when selected. Either PL or DPL signals are switched to the Code Synthesizer Level control on the front panel.

5-60. A 1 kHz reference signal from the RF Synthesizer is bandpass filtered to provide a low distortion 1 kHz sinewave to the front panel 1 kHz Level Control.

5-61. Two sources of external modulation are possible. A standard Motorola microphone interface jack on the front panel and a BNC front panel jack are provided. The microphone input is connected to an IDC circuit for peak limiting. The composite of the two external modulation sources is the signal to the External Level control on the front panel.

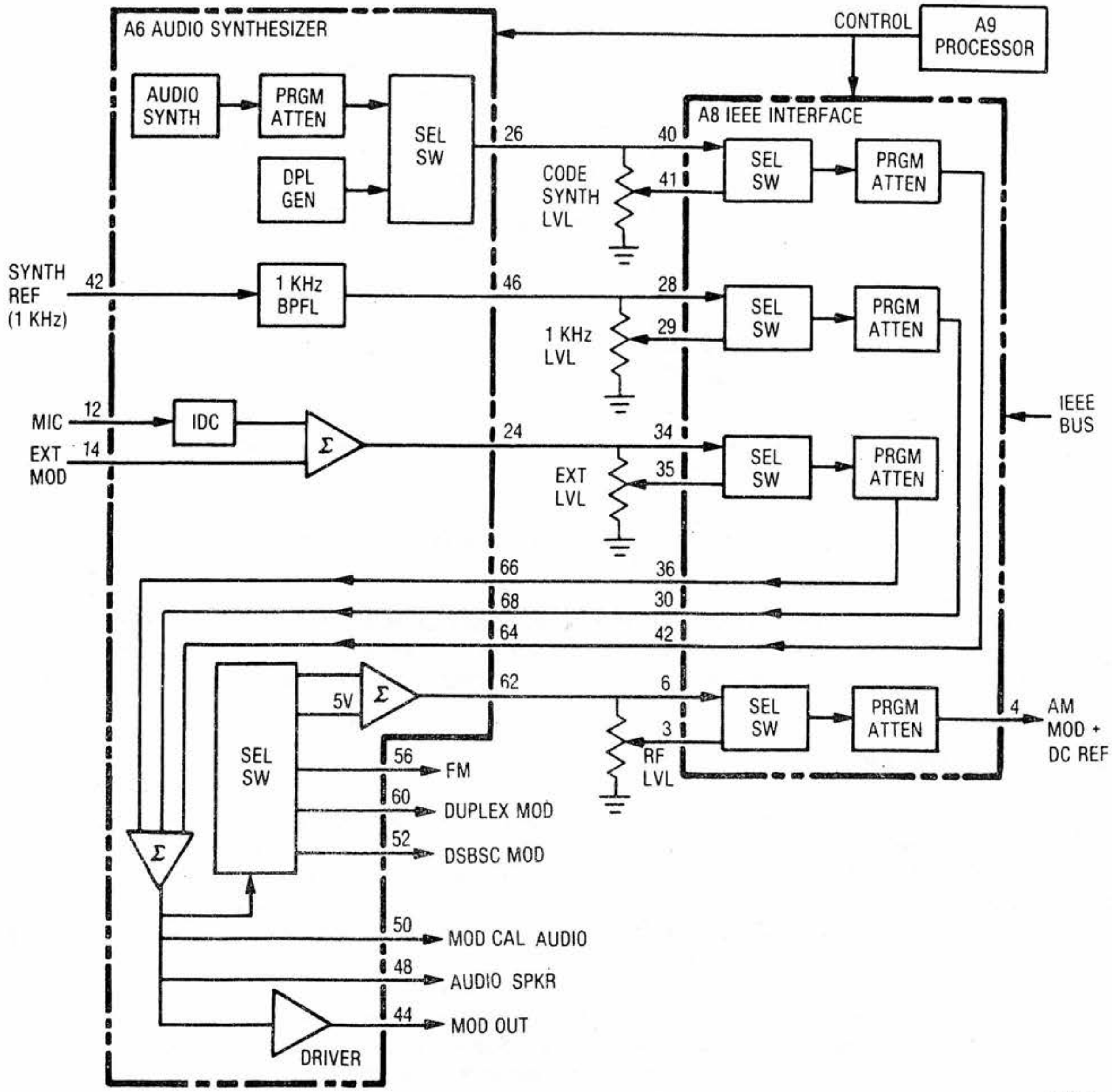


Figure 5-8. Code Synthesizer Block Diagram

5-62. Systems without the IEEE option will have the wipers of the level control pots jumpered to their respective inputs to the summation amp on the Audio Synthesizer module (A6). Those systems with the IEEE option will select on the IEEE Interface module (A8) either the tops of the level controls or their wipers to the Programmable Attenuators for remote or local control respectively. While in the IEEE Control mode the processor controlled Programmable Attenuator on the IEEE module provides the modulation level control. For the local mode the attenuators are programmed for zero attenuation so that the wipers of the level control set the modulation levels directly.

5-63. The three modulation sources are summed together on the Audio Synthesizer module after the level controls. The composite modulation signal is then switched to the appropriate modulator and applied to the modulation determination circuitry (MOD CAL AUDIO), the audio amplifier (SPKR AUDIO), and the Modulation Output jack (MOD OUT) on the front panel. The signal to the front panel jack is buffered by a Driver Amplifier to provide a low driving source impedance.

5-64. The AM modulation signal at the output of the Select Switch is summed with a +5 volt signal. This combination provides a DC level to control the average output power of the wideband amp in the RF Input module, and a superimposed modulation signal to give AM. The RF Level control on the front panel for local control or the Programmable Attenuator on the IEEE module provide local or remote RF level control by simultaneously attenuating the DC level and the modulating signal. The resulting signal is the AM MOD & DC REFERENCE signal to the RF Input module.

5-65 Frequency Counter

5-66. Three possible signal sources are made available to the frequency counter for frequency determination. Two of the inputs are from internal system points for the determinations of the offset frequency (OFFSET), and the monitored carrier error frequency (IF/BFO)). The third input is the external input (FREQ CNTR INPUT) on the front panel. A block diagram of the frequency counter function is shown in figure 5-9.

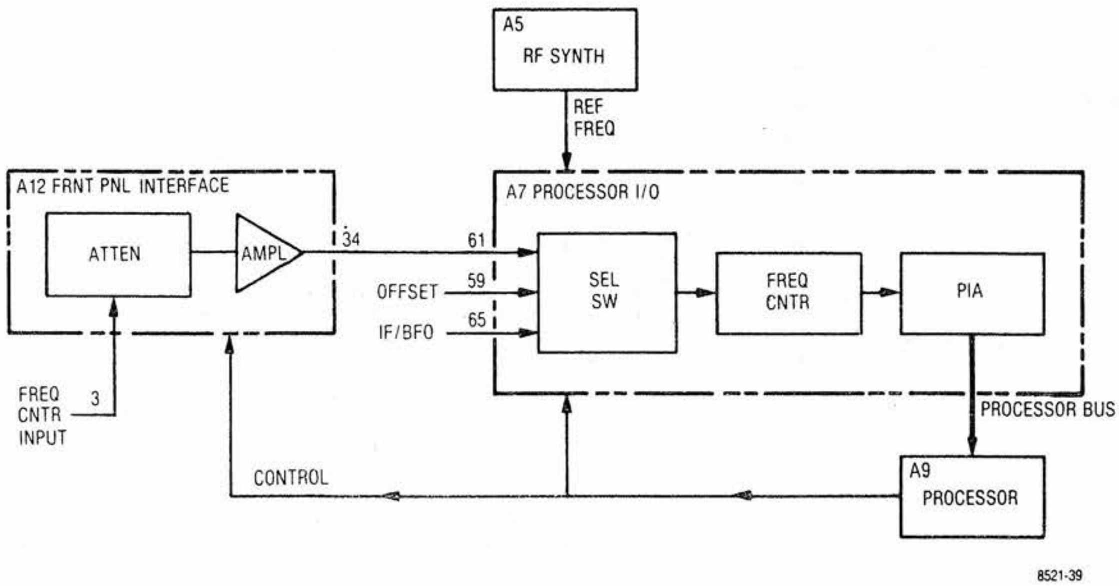


Figure 5-9. Frequency Counter Block Diagram

5-67. The external input signal is routed to the Front Panel Interface module (A12). A range Attenuator on the Interface module provides variable sensitivity settings according to the vertical range switch setting on the front panel. An Amplifier following the range Attenuator amplifies and limits the signal amplitude for the frequency counter input.

5-68. A Select Switch on the Processor I/O module (A7) routes the desired signal to the Frequency Counter circuitry. The signal selected is controlled by the processor and is determined by the operating mode of the system.

5-69. A 16-bit gated accumulator is used to determine the input frequency. Gate times from 1 msec to 10 sec are automatically selected by the processor to give the maximum possible resolution. The gate times are derived from the RF Synthesizer REFERENCE FREQUENCIES and thus are as accurate as the system time base.

5-70. The 16-bit Frequency Counter output is transferred directly to the processor bus through a Peripheral Interface Adapter (PIA). The processor in turn adjusts the data for the gate time used and then processes the information to obtain the required frequency display.

5-71. Digital Voltmeter (DVM)

5-72. The processor through the DVM circuitry has access to voltage information at a large number of points throughout the system. From this information the processor is able to determine and display parameters such as; output power level, modulation level, input power level and the like. In addition, an external voltage applied to the DVM input jack on the front panel can be measured and displayed for external voltage measurements. A block diagram of the DVM function is shown in figure 5-10.

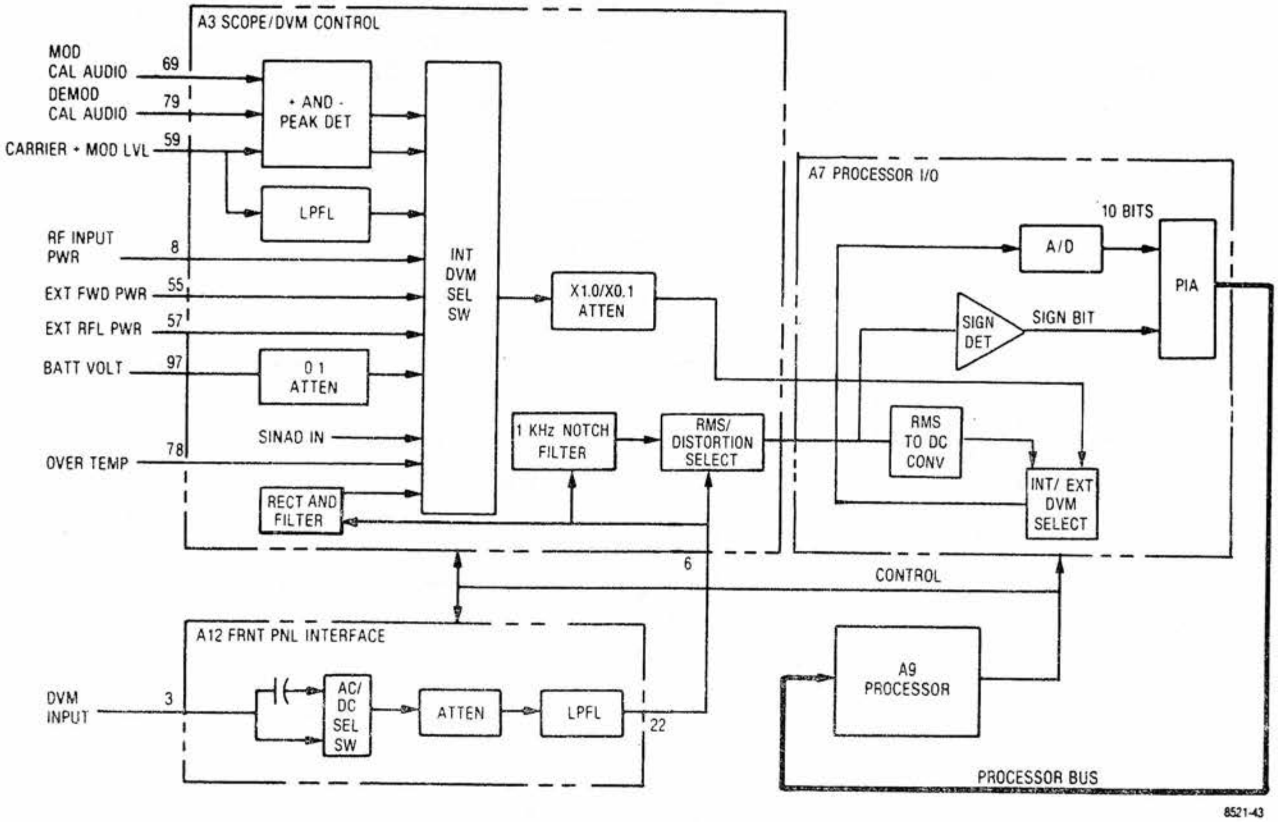


Figure 5-10. Block Diagram DVM/Distortion Analyzer

5-73. Internal voltage measurements are selected and ranged over two decades by the INT DVM SELECT SWITCH and the X1.0/X0.1 attenuator respectively on the Scope/DVM Control (A3) module. The resulting 0 to 1 VDC signal is routed to the INT/EXT DVM SELECT SWITCH on the Processor Interface (A7) module which applies the voltage to the A/D converter. The A/D converter converts the input voltage into a 10 bit digital word which is input to the processor. One of eight internal voltages may be selected for measurement as required by the processor to determine display data. Inputs to the A/D must be less than 1 VDC; therefore, with the decade X1/X.1 ranging attenuator the maximum input voltage to the internal DVM is 10 VDC. The X1 position of the attenuator is switched in for better voltage reading resolution on voltages less than 1 VDC. To keep CRT information current, each of the required measurements are made in sequence at an approximate rate of thirty per second.

5-74. Two modulation signals (MOD CAL AUDIO and CARRIER + MOD LVL) and a demodulated signal (DEMOD CAL AUDIO) are made available to the peak detectors. Positive and negative peak determination of the selected signal enables the processor to determine the level of modulation.

5-75. A Lowpass Filter (LPFL) removes the DC component from the CARRIER + MOD LVL signal so that the generate RF output level can be determined. Refer to paragraph 5-30.

5-76. The RF INPUT POWER and OVERTEMP signal lines from the RF Input module provide the processor inputs for the internal wattmeter. (Paragraph 5-38). External wattmeter element inputs (EXT FWD PWR and EXT RFL PWR) from the front panel jack provide the information for the external wattmeter display.

5-77. A signal line from the DC input jack on the rear panel (BATT VOLT) is brought to the processor for battery voltage determination. The voltage is attenuated by a factor of 10 to stay with the 10 volt maximum input to the select switch. The processor uses the battery voltage measurement to warn the operator when the battery is near its discharged state.

5-78. A rectified and filtered version of the input to the 1 kHz NOTCH FILTER is the last internal measurement point. This measurement is used as part of the distortion/SINAD reading. For further information on the distortion/SINAD meter see paragraph 5-82.

5-79. EXTERNAL DVM — In the external DVM mode, voltages applied to the Ext DVM Input Jack on the front panel are ranged by processor control over four decades in the Front Panel Interface (A12) module. The result is a 0 to 1 VRMS signal at the output of the attenuator for inputs of 0 to 300 VRMS. The signal is routed directly through the A3 module by the RMS/Distortion Select Switch to the RMS to DC Converter on the A7 module. The INT/EXT DVM Select Switch applied the output of the RMS to DC Converter to the A/D converter for input to the processor.

5-80. For external DC measurements the AC/DC Select Switch selects the DC coupled path from the Ext DVM Input Jack. A low pass filter (LPFL) in the A12 module removes ripple components. The rejection at 50 Hz is 25 dB in the low pass filter. The RMS to DC Converter reads the absolute value of the DC input, and the sign detector (SIGN DET) provides polarity information.

5-81. For AC voltage measurements the LPFL is reprogrammed for less than 0.5 dB attenuation out to 10 kHz. The AC/DC Select Switch selects the AC coupled path, and the RMS to DC Converter converts the AC input into a DC voltage equal to the RMS voltage of the input.

5-82. Distortion/SINAD Meter

5-83. The distortion of a signal with a 1 kHz fundamental frequency can be measured by the R2001C. The 1 kHz input enters the EXT DVM input jack through the AC coupled path and is ranged to between 0 and 1 volt RMS by the ranging attenuator. The signal is routed through the notch filter where the fundamental frequency is removed. The output of the notch filter is selected to the RMS to DC Converter input by the RMS/Distortion Select Switch where the RMS voltage of the distortion components (to 10 kHz) is measured. The input of the notch is rectified, filtered, and multiplied by 1.11 (the RMS to AVERAGE ratio for a sinusoid). The resulting DC voltage is measured by the internal DVM as described in paragraph 5-73. The processor divides the RMS output voltage of the notch filter by the RMS input voltage to the notch filter to obtain a distortion ratio. The distortion ratio is converted to dB by the processor for the SINAD display. The percent distortion display is obtained by multiplying the distortion ratio by 100.

5-84. Oscilloscope

5-85. Three basic functions are provided for by the system oscilloscope. The alphanumeric and modulation displays provide operating mode and control information for the system. The external oscilloscope feature augments the total system as a general purpose test instrument. A block diagram of the oscilloscope function is shown in figure 5-11.

5-86. Drive signals for the CRT are provided by circuits on the Scope Amplifier module (A2). Horizontal and vertical signals are amplified by their respective amplifiers from 0.5 volt/division input levels to the levels required on the deflection plates. A Z-Axis Modulator circuit controls the cathode to grid bias voltage on the CRT to effect intensity control.

5-87. The horizontal amplifier input is selected between external and internal scope functions. External functions, Time base Generator or external horizontal input, are switched to a summation amp where the HORIZONTAL POSITION signal from the front panel is added. The resulting DC offset positions the display horizontally on the CRT.

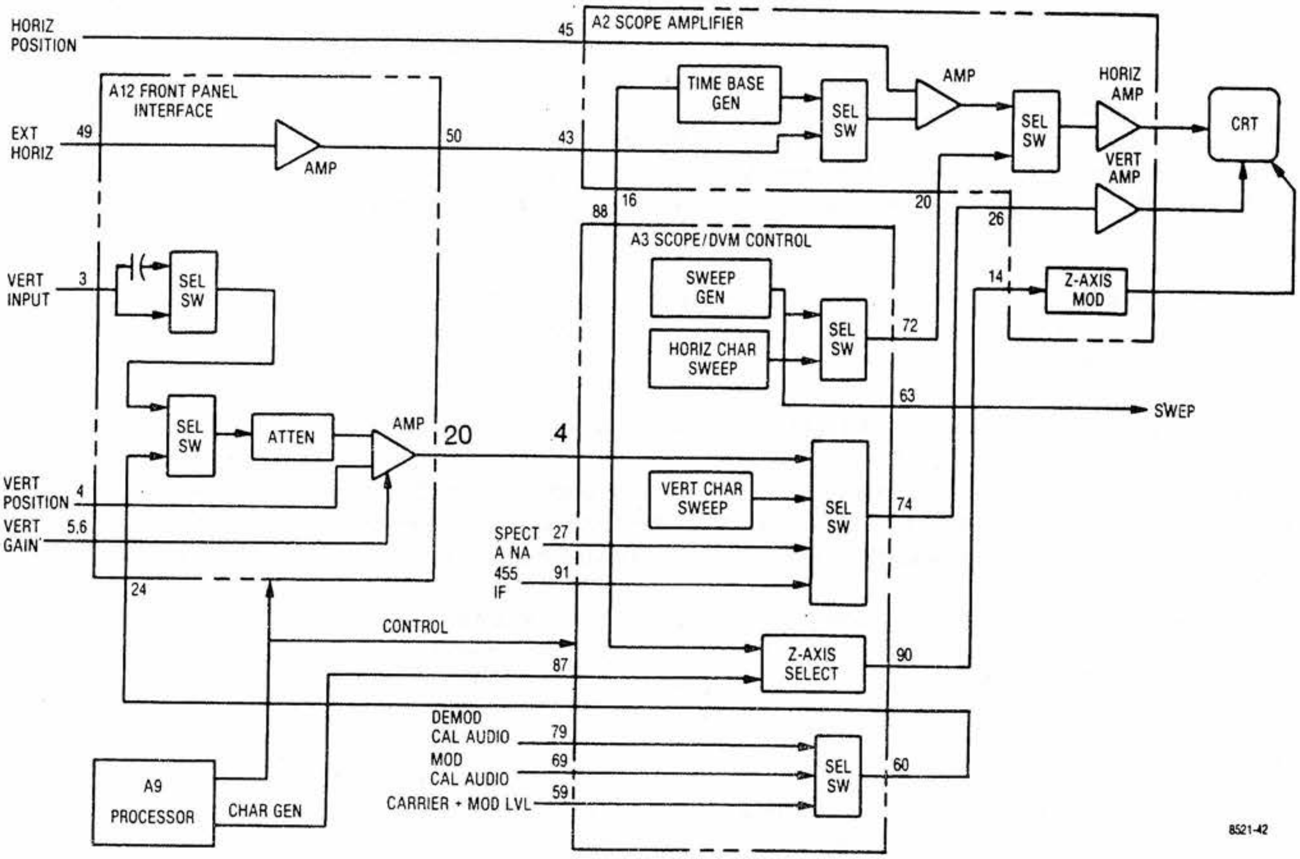


Figure 5-11. Oscilloscope Block Diagram

5-88. Six decade sweep ranges from 1 μsec to 100 msec per division are provided by the Time base Generator. Control of the Time base Generator is from the front panel horizontal switch through the processor.

5-89. Front panel external horizontal inputs are applied to the top of the horizontal vernier gain potentiometer. The wiper of the gain potentiometer is the EXTERNAL HORIZONTAL input signal to the preamp on the Front Panel Interface module (A12). The preamp provides the required horizontal input sensitivity and buffers the signal to the select switch on the Scope Amplifier module.

5-90. Internal horizontal signals, Sweep Generator and Character Sweep outputs, are selected on the Scope/DVM Control module (A3). The Sweep Generator provides a sawtooth waveform to the RF Synthesizer module for the sweep generator and spectrum analyzer functions. The sweep signal to the CRT horizontal input causes the scope sweep to be synchronous with the synthesizer sweep for the spectrum and swept filter response displays.

5-91. The Horizontal Character Sweep generator output is a sawtooth waveform that provides the horizontal sweep for the raster scan character display.

5-92. One of four possible vertical signal sources are switched to the Vertical Amplifier input by a Select Switch on the Scope/DVM Control module. The 455 kHz IF and SPECTRUM ANALYZER signals from the Receiver Module provide the IF envelope and spectrum analyzer displays respectively. The Vertical Character Sweep generator gives the vertical sweep for the raster scan character display. The remaining input is the path for external vertical or modulation scope vertical inputs from the Front Panel Interface module.

5-93. A vertical preamplifier on the Interface module gives a vertical sensitivity of 10 millivolt per division and provides positioning and vernier gain capability for its input. The amplifier is preceded by a four decade range attenuator which is controlled from the front panel vertical switch through the processor. The attenuator provides external vertical input sensitivities from 0.01 to 1.0 volt per division and modulation scope sensitivities from 0.25 to 25 kHz per division.

5-94. A Select Switch ahead of the Attenuator selects between the external vertical input or the modulation scope inputs. The External Vertical input path is further selected between AC and DC coupling before becoming the vertical input jack on the front panel. The modulation scope signal path is switched to one of three possible sources on the Scope/DVM Control module. Demodulation signals from the Receiver are selected via the DEMOD CAL AUDIO path, and frequency and amplitude modulation signals via the MOD CAL AUDIO and CARRIER + MOD LVL signal paths respectively. The Audio Synthesizer module provides the MOD CAL AUDIO signal while the RF Input module gives the CARRIER + MOD LVL signal.

5-95. A Z-Axis Select circuit on the Scope/DVM Control module gates either the CHARACTER GEN signal for character displays or the retrace blanking signal from the Time Base Generator for scope displays to the Z-Axis Modulator on the Scope Amplifier module.

5-96. ALIGNMENT PROCEDURE

5-97. Introduction

5-98. This section provides a basic (para 5-102) and an extended (para 5-115) alignment procedure. The basic procedure requires only the use of a calibrated oscilloscope. It is expected that the basic alignment be performed whenever service work is performed. The extended alignment procedure requires module extenders and a calibrated digital voltmeter in addition to the oscilloscope. The extended procedure should be performed as required after servicing the system. All adjustments not covered in this procedure are to be performed on suitable module test fixtures only.

5-99. Test Equipment Required

5-100. The test equipment or its equivalent listed in table 5-3 is required for the basic procedure. The additional equipment required for the extended procedure is listed in table 5-4.

Table 5-3. Basic Test Equipment Required

Description	Model
*Oscilloscope	Motorola R1029A
Test Point Shorting Jumper	
Nonmetallic Alignment Tool	

*An R2001 is a suitable substitute

Table 5-4. Extended Test Equipment Required

Description	Model
*Oscilloscope	Motorola R1029A
*Digital Voltmeter	Motorola R1024A
*RF Signal Generator	Motorola R1201A
*Modulation Meter	Boonton 82AD
Audio Generator	Motorola S1067
Receiver Test Cover	Motorola 15-80346A49
Extender Card Set	Motorola RPX-4150A

*An R2001 is suitable for use in place of these separate equipments.

5-101. Preparation for Alignment

1. All alignments to be performed at normal ambient temperature.

2. Remove the top cover of the unit to be aligned.

3. Apply power to the unit to be aligned and allow a warmup time of 15 minutes prior to alignment.

5-102. Basic Alignment Procedure

5-103. CRT Astigmatism and Geometry

1. Select the Monitor Function and the Gen/Mon Mtr Display on the R2001C. Set the Intensity Control for a medium intense display.

2. While using the Focus Control to maintain a focused display at the center of the CRT, adjust the Astigmatism and Geometry potentiometers (Figure 5-12) for the best focus at the outer edges of the CRT while minimizing the pincushion and barrel distortion of the display. The two adjustments are interactive so that repeated small adjustments alternated between the two potentiometers will be required to obtain the best display.

5-104. CRT Intensity Bias

1. Select the Scope DC Display and the Ext Horiz. Input mode. Set the Intensity Control fully counter clockwise.

CAUTION

Do not let a dot stay in one place on the CRT screen for more than 30 seconds as a permanent burn in the phosphor will occur.

2. Adjust the Intensity Bias potentiometer (Figure 5-12) until a dot appears on the screen. (The Vertical and Horizontal Position Control on the front panel may have to be used to bring the dot on to the screen.) Then back off the Intensity Bias potentiometer until the dot just disappears.

5-105. CRT Intensity Balance

1. Select the Scope DC Display and the 1 mSec/Div Horizontal Sweep rate on the R2001C. Set the Horizontal Timebase Vernier to the Cal position and adjust the Intensity Control for a barely visible horizontal line on the CRT.

2. Adjust the Intensity Balance potentiometer (Figure 5-12) for uniform intensity of the horizontal trace from left to right. The Balance potentiometer affects the intensity on the left side of the trace.

5-106. CRT Horizontal Centering

1. Select the Gen/Mon Mtr Display on the R2001C. Adjust the Intensity Control for a comfortable viewing brightness.

2. With the Test Point Shorting Jumper connect TP1 of the Scope Amplifier Board (Figure 5-12) to chassis ground.

3. Adjust the Horizontal Position Potentiometer (Figure 5-12) so that the vertical trace on the CRT screen passes through the graticule center point.

4. Remove the jumper from TP1.

5-107. CRT Vertical Centering

1. Select the Gen/Mon Mtr Display on the R2001C. Adjust the Intensity Control for comfortable viewing brightness.

2. With the Test Point Shorting Jumper connect TP4 of the Scope Amplifier Board (Figure 5-12) to chassis ground.

3. Adjust the Vertical Position Potentiometer (Figure 5-12) so that the horizontal trace on the CRT screen passes through the graticule center point.

4. Remove jumper from TP4.

5-108. CRT Trace Rotation

1. Select the Gen/Mon Mtr Display on the R2001C. Adjust the Intensity Control for a comfortable viewing brightness.

2. Adjust the Trace Rotation Potentiometer (Figure 5-12) for a properly rotated CRT display.

5-109. CRT Horizontal Gain

1. Connect the Mod Out Jack to the Ext Horiz Jack on the R2001C front panel.

2. Set the R2001C for the Generate FM Function and the Scope DC Display. Set the Horiz Control for Ext Horiz input. Turn the Code Synthesizer off, the Ext Level off, and the 1 kHz Level up about half way.

3. Connect an oscilloscope with a calibrated vertical input to TP1 on the Scope Amplifier Board. (Figure 5-12).

4. Using the front panel Horizontal Vernier Control adjust for a 3V p-p amplitude on the sinewave at TP1.

5. With 3V p-p at TP1 adjust the Horizontal Gain Potentiometer (Figure 5-12) for a horizontal trace 6 cm long on the CRT. (Use the front panel controls to position the trace at a convenient place near the center of the CRT).

5-110. CRT Vertical Gain

1. Connect the Mod Out Jack to the Vert Input Jack on the R2001C front panel.

2. Set the R2001C for the Generate FM Function and the Scope DC Display. Set the Horiz Control for 1 mSec/Div sweep rate and the Horizontal Vernier to the Cal position. Set the Vert Control for 1 V/Div input sensitivity and the Vertical Vernier to the Cal position.

3. Turn the Code Synthesizer off, the Ext Level off and the 1 kHz Level up about half way.

4. Connect an oscilloscope with a calibrated vertical input to TP4 on the Scope Amplifier Board. (Figure 5-12).

5. Using the front panel 1 kHz Level Control adjust for a 3V p-p amplitude on the sinewave at TP4.

6. With 3V p-p at TP4 adjust the Vertical Gain Potentiometer (Figure 5-12) for a 6 cm p-p sinewave on the CRT. (use the front panel Position Controls to center the waveform on the CRT).

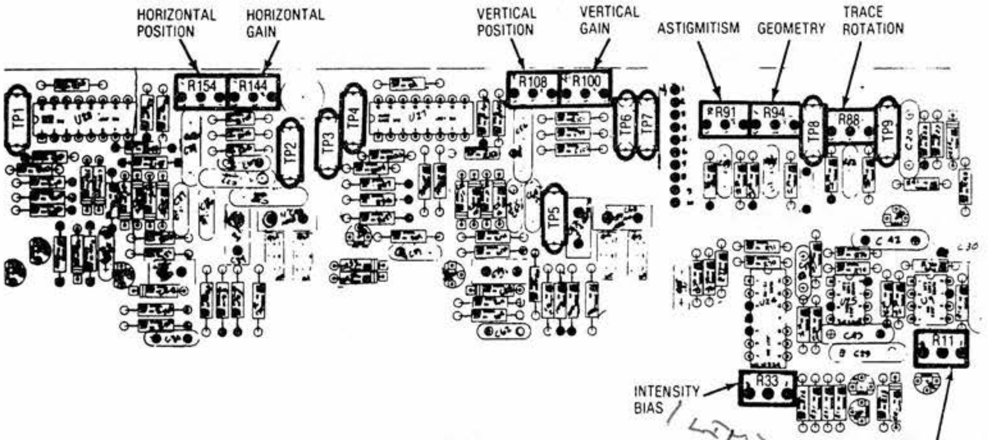


Figure 5-12. Scope Amplifier Alignment Points

5-111. Vertical Input Gain

1. Set the R2001C for the Generate FM Function and the Scope DC Display. Set the Horiz Control for 1m Sec/Div sweep rate and the Horizontal Vernier to the Cal position. Set the Vert Control for 1V/Div input sensitivity and the Vertical Vernier to the Cal position.
2. Connect an oscilloscope with a calibrated vertical input to the Mod Out Jack on the front panel.
3. Turn the Code Synthesizer off, the Ext Level off and adjust the 1 kHz Level Control for a 6V p-p sinewave on the attached oscilloscope.
4. Disconnect the oscilloscope from the Mod Out Jack and connect the Mod Out Jack to the Vert Input Jack on the R2001C.
5. Adjust the Input Vertical Gain Potentiometer on the Front Panel Interface Board (Figure 5-13) for a 6 cm p-p sinewave on the CRT. (Use the front panel Position Controls to center the waveform on the CRT.)

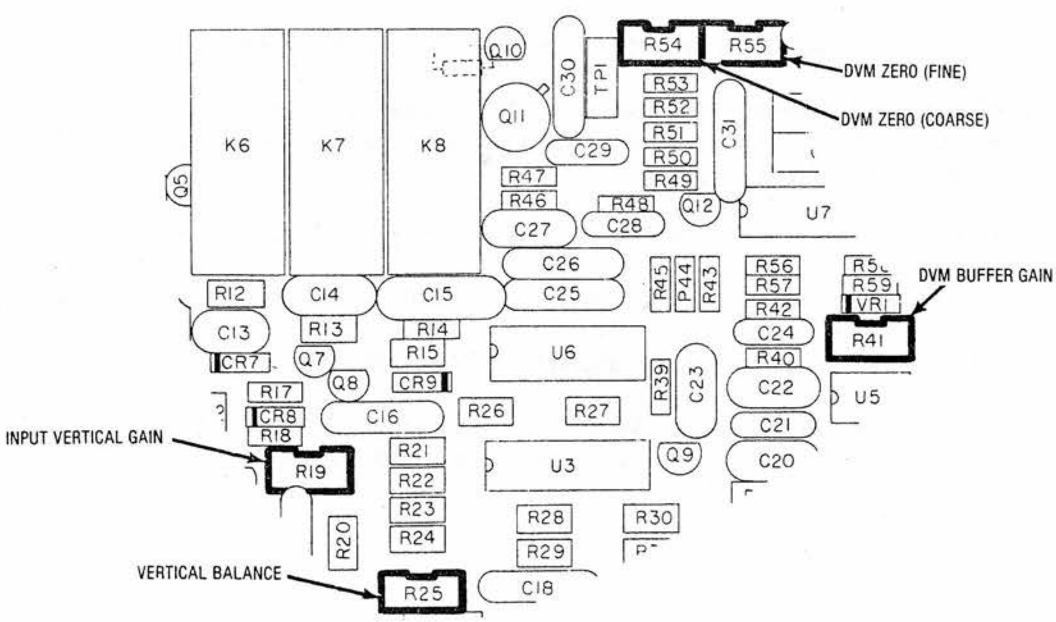


Figure 5-13. Front Panel Interface Alignment Points

5-112. DVM Zero

1. Select the DVM Display and the DC Mode on the R2001C.

2. Short the center conductor of the DVM Input Jack to ground.

3. Adjust the DVM Zero (Coarse) and the DVM Zero (Fine) Potentiometers on the Front Panel Interface Board (Figure 5-13) for a zero reading on the DVM Display.

5-113. Spectrum Analyzer Centering

1. Select the Spect Analyzer Display on the R2001C. Set the Dispersion Control on the front panel to the 1 MHz position. (full counter clockwise) Set the center frequency of the analyzer to 10.0 MHz.

2. Connect the 10 MHz Output on the rear panel to the RF Input on the front panel. Set the RF Step Attenuator to obtain a convenient spectral display.

3. Adjust the Spectrum Analyzer Centering Potentiometer on the Scope/DVM Control Board (Figure 5-14) so that the spectral line on the CRT is centered about the center graticule line.

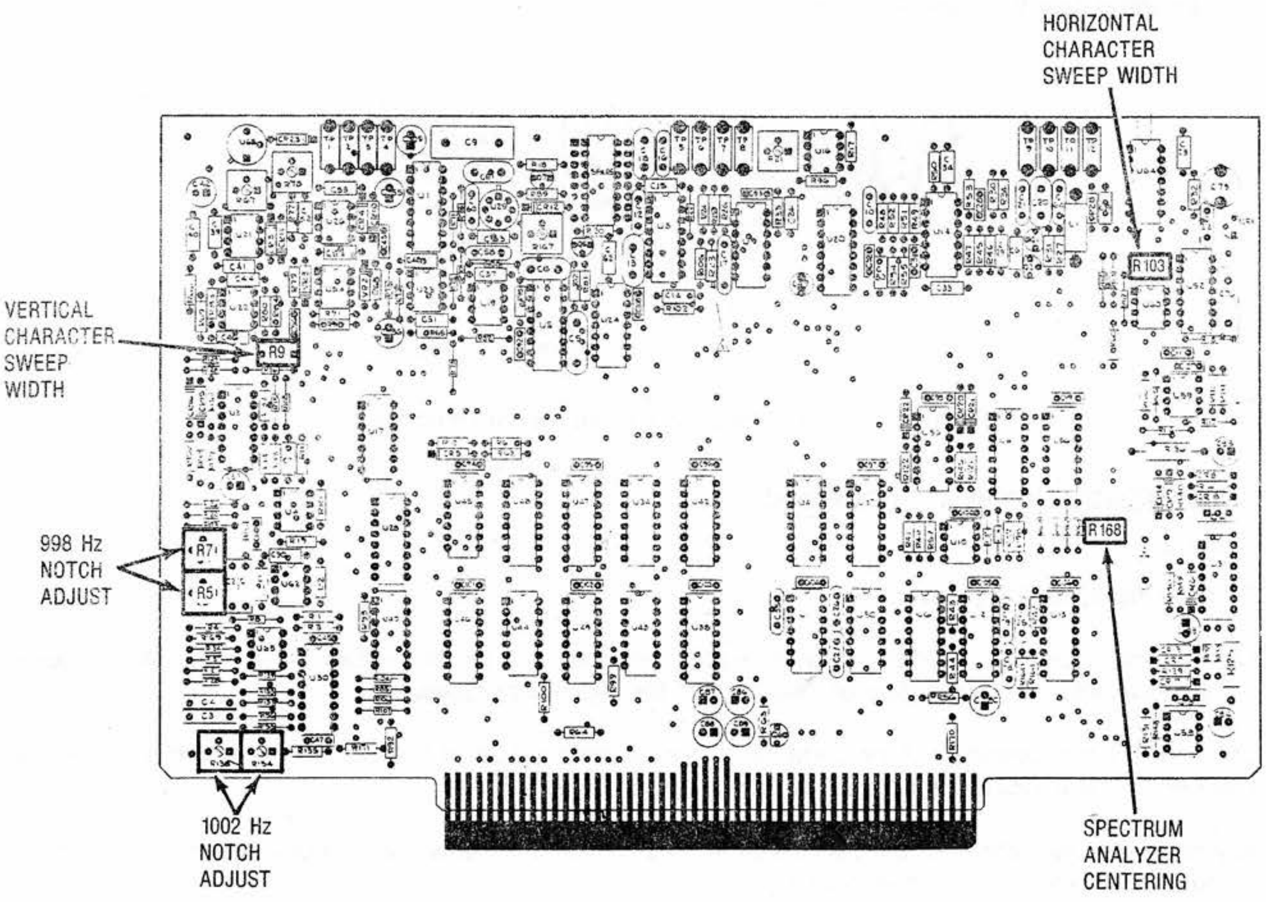


Figure 5-14. Scope/DVM Control Alignment Points

5-114. Horizontal Time Base

1. Select the Tone Memory Display and the Generate FM Function on the R2001C. Program tone A for 20.0 Hz and Tone B for 2000.0 Hz.

2. Select the Modulation Display. Set the Oscilloscope Controls for 2.5 kHz/Div vertical range, Auto Trigger, and 10 mSec/Div horizontal sweep range. Set the Horizontal and Vertical Vernier Controls to their Cal positions.

3. Set the Code Synthesizer for Continuous, Tone A, and turn up the Code Synth Level to obtain a nearly full scale sinusoidal waveform on the CRT. Turn the Ext Level and the 1 kHz Level Controls to the off position.

4. Adjust the Coarse Time Base Calibration Potentiometer on the Scope Amplifier Board (Figure 5-15) so that one cycle of the displayed waveform occurs in 5 cm along the horizontal axis. Use the Vertical and Horizontal Position controls to center and to move the waveform so that the 5 cm are measured in the middle of the screen to avoid nonlinearities near the edge of the CRT.

5. Set the Oscilloscope Horizontal Control for a 100 μSec/Div sweep rate and select the Tone B output on the Code Synthesizer.

6. Adjust the Fine Time Base Calibration Capacitor on the Scope Amplifier Board (Figure 5-15) so that one cycle of the displayed waveform occurs in 5 cm along the horizontal axis. Use the Vertical and Horizontal Position controls to center and to move the waveform so that the 5 cm are measured in the middle of the screen to avoid nonlinearities near the edge of the CRT.

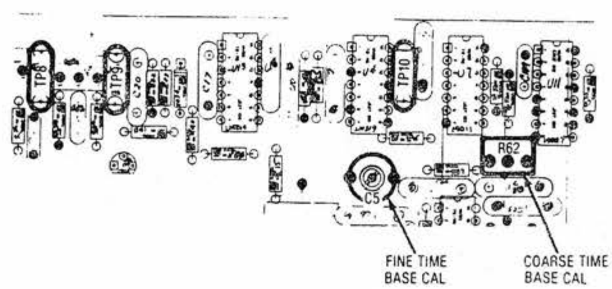


Figure 5-15. Horizontal Time Base Alignment Points

5-115. EXTENDED ALIGNMENT PROCEDURE

5-116. DVM

1. Remove the R2001C top cover.

2. Connect the R2001C to a primary power source, turn it on, and select the EXT DVM mode. Allow approximately 15 minutes warmup before proceeding with the alignment procedure.

3. Short the center conductor of the DVM input jack on the front panel to ground. Connect an external DVM between TP2 and TP9 of the Scope DVM Control Board (Figure 5-14).

4. Adjust the Coarse DVM Zero and the Fine DVM Zero on the Front Panel Interface Board (Figure 5-13) until the external DVM reads 0 $\pm$ 0.5 millivolts DC.

5. Remove the short circuit on the DVM input jack and apply approximately 0.900 volts DC from an external power supply. The voltage between TP2 and TP9 of the Scope/DVM Control Board should be within $\pm$1 mv of the voltage at the front panal DVM input jack. If the unit fails this test, adjust the DVM Buffer Gain on the Front Panel Interface Board (Figure 5-13) until the above two voltages are equal.

6. Select the generate FM narrowband mode and the Gen/Mon Metering display.

7. Short TP4 to TP9 on the Scope/DVM Control Board.

8. Adjust the A/D Offset on the Processor Interface Board (Figure 5-16) until the plus peak deviation reading on the CRT is just toggling between 0.00 and 0.01 kHz. Then slightly turn the adjustment just enough to make the reading 0.00 all the time. Note that if the offset adjustment is turned past this point the deviation reading is still 0.00 but the A/D converter is not aligned properly.

9. Remove the short circuit between TP4 and TP9, and connect the positive lead of the external DVM to TP4 of the Scope/DVM Control Board module. Place the negative lead on the ground plane or TP9 of the Scope/DVM Control Board.

10. Turn on the 1 kHz internal modulation and adjust the level until the voltage TP4 reads 0.900 volts.

11. Adjust the A/D Gain (Figure 5-16) until the reading on the positive deviation peak is 4.50 kHz.

12. Select the DC DVM mode.

13. With the center conductor of the front panel DVM input jack again shorted to ground, adjust the RMS Converter offset on the Processor Interface Board (Figure 5-16) for a reading of 0.000 volts on the CRT DVM display.

14. Adjust the sign detector offset (Figure 5-16) until the sign of the 0.000 volt reading is just flashing between plus and minus.

15. Remove the short and apply approximately 0.900 volts to the front panel. DVM input jack.

16. While monitoring the input voltage on an external DVM, adjust the RMS Converter Gain on the Processor Interface Board (Figure 5-16) until the CRT DVM reading is equal to the external voltage applied.

5-117. Character Generator

1. Perform the Basic Alignment Procedure of para 5-102.

2. Select the Monitor FM Function and the Gen/Mon Mtr Display.

3. Adjust the Horizontal Character Sweep Width Potentiometer on the Scope/DVM Control Board (Figure 5-14) so that the right-hand edge of the CRT character display is approximately 4.2 graticule divisions to the right of the graticule center line.

4. Adjust the Vertical Character Sweep Width Potentiometer on the Scope/DVM Control Board (Figure 5-14) so that the bottom edge of the CRT display is approximately 3.3 graticule divisions below the graticule center line.

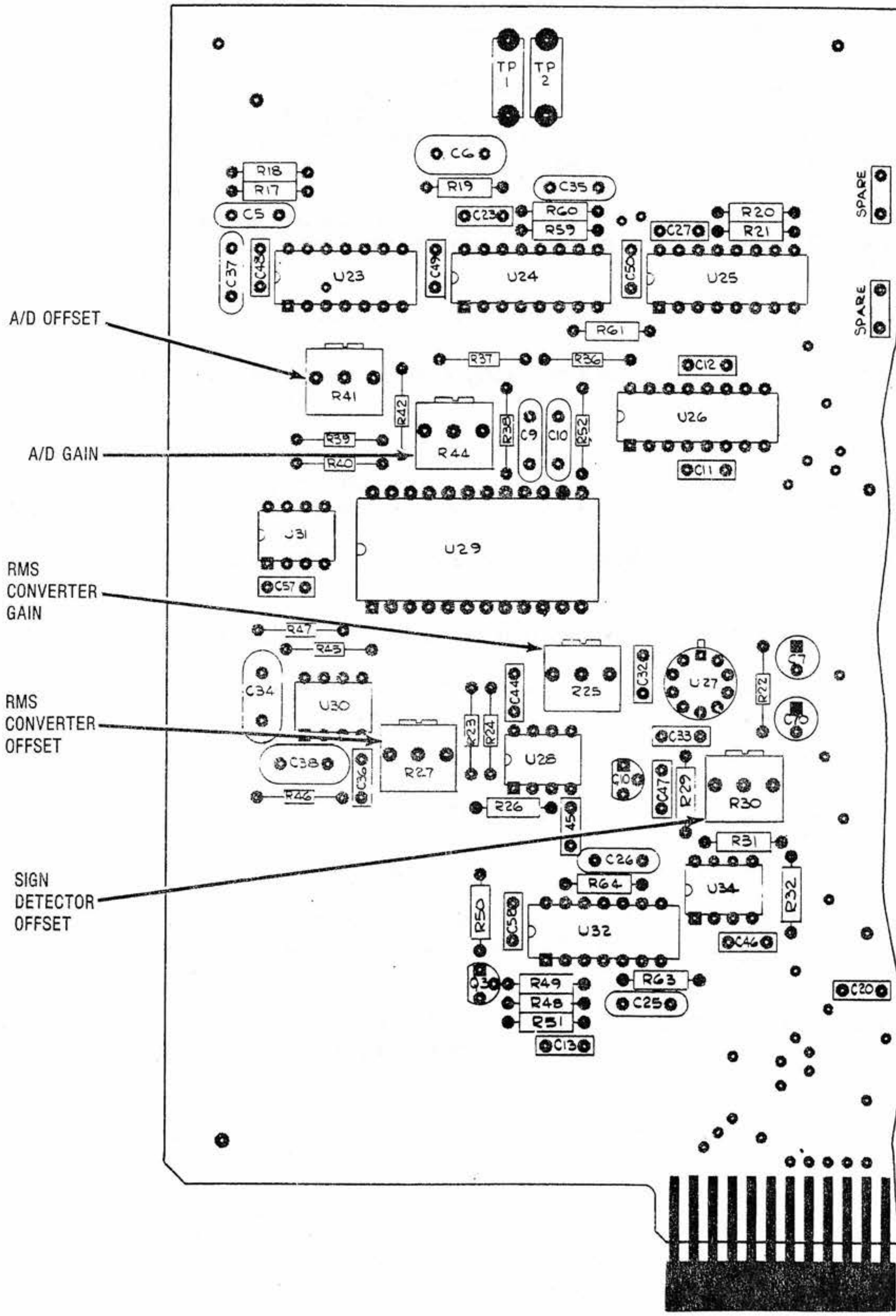


Figure 5-16. Processor I/O A/D Alignment Points

5-118. DISTORTION/SINAD ALIGNMENT

1. Enter the generate mode and the Gen/Mon Metering display. Using an audio generator with less than 0.1% distortion apply a 900 mVRMS 1 kHz ± 2 Hz signal to the Vert Sinad/DVM Dist/Counter In input on the front panel.
2. Verify that the distortion reading on the CRT is ⩽0.5%. If this test fails the notch filter should be aligned.
3. Turn the R2001C off and extend the Scope/DVM Control Board using the 100 pin extender card.
4. Turn the R2001C on and select the generate FM mode and the Gen/Mon Metering display.
5. Using the same low distortion generator as in article 1, apply a 998 ± 0.2 Hz sine wave to the Distortion input.
6. Alternately adjust the 998 Hz notch potentiometers on the Scope/DVM Control Board (Figure 5-14) to null the distortion reading on the CRT. A reading less than 0.5% should be obtained.
7. Change the audio generator input frequency to 1002 ± 0.2 Hz.
8. Alternately adjust the 1002 Hz notch potentiometers on the Scope/DVM Control Board (Figure 5-14) to again null the CRT distortion reading. A reading less than 0.5% should be obtained.
9. Turn the system power off and reinstall the Scope/DVM Control Board into the R2001C.

5-119. Receiver

5-120. AM Detector

1. Perform the basic alignment procedure of para 5-102.
2. Turn the R2001C off and remove the Receiver Module. Remove the Receiver Module cover and install the Receiver Test Cover on the module housing. Extend the Receiver module on the Receiver Extender Card.
3. Turn the R2001C on and select the Monitor AM Function and the Gen/Mon Mtr Display. Set the monitor frequency to 250 MHz, the RF Step Attenuator to the 0 dB position, and the BW Switch to the Narrow position.
4. Connect the external signal generator to the RF In/Out Jack on the front panel. Adjust the external generator for an output level of approxiamtely −60 dBm and a calibrated 30% AM.
5. Adjust R60 (Marked on the Receiver Test Cover) for a reading of 30% ±5% on the CRT AM display.

5-121. FM Detector

1. Select the Monitor FM Function and the Gen/Mon Mtr Display. Set the monitor frequency to 250 MHz, the RF Step Attenuator to the 0 dB position, and the BW Switch to the Wide position.
2. Connect the external signal generator to the RF In/Out Jack on the front panel. Adjust the external generator for a center frequency of 250 MHz at an output level of approximately −30 dBm and a calibrated 20 kHz FM.
3. Adjust R70 (Marked on the Receiver Test Cover) for a reading of 20 kHz ± 1 kHz on the CRT FM display.
4. Set the BW switch to the Narrow position and reset the FM on the external generator to 3 kHz deviation
5. Adjust R125 (Marked on the Receiver Test Cover) for a reading of 3 kHz ± 150 Hz on the CRT FM display.

6. Turn off the FM on the external generator so that a CW signal of a level of approximately −30 dBm is applied to the R2001C.

7. Connect the Demod Out Jack to the Vert/Sinad Dist/DVM/Counter Input Jack on the front panel. Select the DVM Display and the DC DVM Mode on the R2001C.

8. Adjust R68 (Marked on the Receiver Test Cover) for a 0.0 VDC ± 100 mVDC reading on the DVM Display.

5-122. Spectrum Analyzer

1. Select the Monitor Function and the Spectrum Analyzer Display on the R2001C. Set the monitor frequency to 250 MHz, and the RF Step Attenuator to the 40 dB position.

2. Connect the external signal generator to the RF In/Out Jack on the front panel. Adjust the external generator for a center frequency of 250 MHz and a calibrated output level of −30 dBm with no modulation.

3. Adjust in succession C2, C83, C88, and C96 (Marked on the Receiver Test Cover) to maximize the amplitude of the spectral line in the center of the CRT display.

4. Adjust R124, R91, and R100 (Marked on the Receiver Test Cover) to obtain a uniform change in the spectral amplitude per 10 dB change of the RF Step Attenuator. R124 affects the level of the spectral component when in the top quarter of the screen, R91 affects levels in the third quarter from the top, and R100 affects levels in the bottom quarter.

5. Adjust R119 for offset and R121 for gain so that with the step attenuator in the 0 dB Position the peak of the spectral line lies on the 30 dB line of the CRT and that successive step increases of the input attenuator move the spectral amplitude downward in 10 dB increments on the CRT. The accuracy required for any one step attenuator position is ±3 dB.

6. It will generally be necessary to repeat paragraphs 5-122.4 and 5-122.5 until the best possible accuracy is obtained.

7. Turn the power off and remove the Receiver Module and the Receiver Extender for the chassis. Remove the Test Cover from the Receiver Module and replace the module cover. Reinstall the Receiver Module into the system chassis.

5-123. CHECKOUT PROCEDURE

5-124. Introduction

5-125. This section provides a system checkout procedure. This procedure will help isolate system failures when used with the troubleshooting information in para 5-143.

5-126. Test Equipment Required

5-127. The test equipment listed in table 5-5 or its equivalent will be required to perform the checkout procedure.

Table 5-5. Test Equipment

*RF Signal Generator	Motorola R-1201A
*RF Power Meter	Motorola S-1339A
*SINAD Meter	Motorola R-1013A
*Modulation Meter	Boonton 82AD
RF Power Source	1 watt to 100 watts

*An R2001 is suitable for use in place of these separate equipments.

5-128. Procedure

5-129. Power On

1. Check that the AC input power select card is in the 120 V position. Connect the Unit Under Test (UUT) to a 120 VAC line source with the front panel power switch off. Verify the presence of an AC indication on the front panel.

2. Set the power switch to the Standby Position. Verify the oven ready indicator is on.

3. Set the power switch to the on position. Verify that after a warm-up period a display is visible on the CRT.

5-130. Keyboard Check

1. Verify that each key has the proper effect by observing the Gen/Mon Mtr Display and entering the frequency 123.4567 MHz and the PL frequency 890. Check for proper cursor key operation.

2. Verify that the up and down display keys perform properly and that the LED at each display illuminates.

3. Verify that the up and down function keys perform properly and that the LED at each function illuminates.

4. Verify that the up and down modulation keys perform properly and that the LED at each modulation mode illuminates.

5-131. Nonvolatile Memory

1. Select some random combination of Display, Function, and Modulation Modes. Simultaneously depress both cursor keys and after a five second delay turn the system power OFF. Turn the system power back ON and verify that the same Display, Function, and Modulation Modes are present.

5-132. Modulation capability

1. Set the UUT to the Generate FM Mode and select the Gen/Mon Mtr Display. On the Gen/Mon Mtr Display enter a DPL code of 111. Select the Oscilloscope Display and connect the Mod Out Jack to the Vert In Jack. Set the code synthesizer to the Cont PL/DPL Mode. On the scope verify the presence of a DPL waveform whose amplitude is variable with the code synthesizer level control.

2. Move the Modulation switch from CONT to OFF and verify that a short burst of 133 Hz is output before the output stops.

3. Move the Modulation Switch to the BURST position. Verify that a 133 Hz tone is output as long as the switch is held in the BURST position.

4. Select the Tone A Continous Mode. Verify a Tone A output on the scope and at the speaker.

5. Select the Tone Remote Mode. Verify that when the Modulation Switch is moved from OFF to BURST that a single Tone Remote Access Sequence is generated.

6. Connect a microphone to the Mic Jack. Turn up the Ext Level Control and verify that speaking into the mike causes a modulation signal to be output as observed on the scope display.

5-133. Frequency Counter

1. Set the UUT to the Gen CW Mode with an output frequency of 35 MHz at a level of 0 dBm as displayed on the Gen/Mon Mtr display. Connect the RF In/Out Jack to the Counter In Jack of the UUT. Select the Frequency Counter Display and verify a frequency reading of 35 MHz.

2. Set the UUT to the Generate FM Mode and select the Gen/Mon Mtr Display. Turn the Code Synthesizer and Ext Modulation sources OFF. Select the Narrow Band Mode and adjust the 1 kHz Level Control for a 5 kHz FM deviation reading. Connect the Mod Out Jack to the Counter Input Jack of UUT. Select the Frequency Counter Display and verify a nominal frequency reading of 1 kHz.

5-134. DVM

1. Maintaining the same conditions as in paragraph 5-133.2, select the DVM Display and the AC Mode on the display. Verify a DVM reading of 0.707 vrms $\pm$0.04 vrms.

2. Select the DC Mode and verify a near zero volt DC reading.

5-135. Scope Mode

1. Set the UUT to the Scope AC display mode and connect the scope vertical input jack to the Mod Out Jack. Enable the internal 1 kHz modulation source. Verify the operation of each position of the vertical input range switch and the vertical vernier gain control.

2. With the same connection as in paragraph 5-135.1, verify the operation of each position of the Horizontal Control and the Horizontal timebase vernier.

3. With the Horizontal Control set to the External Mode, connect the External Horizontal jack to the Mod Out Jack. Verify a horizontal line whole length is variable with the Horizontal vernier.

4. Connect the Vert In jack to the Mod Out jack on the UUT. Set the vert and horizontal controls for a convenient display. Verify that a steady sync is obtained in either the Norm or Auto modes and that the point of triggering is adjustable with the level control. Remove the input signal and verify no horizontal sweep in the Norm mode and the presence of a horizontal sweep in theAuto mode.

5-136. Distortion/SINAD Meter

1. Set the UUT for the Generate FM Function, Narrow Band Mode, and the Tone Memory Display. On the Tone Table set Tone A for 2000.0 Hz.

2. Select the Gen/Mon Mtr Display and the Tone A Cont Modulation Mode. Turn the Ext Level and the 1 kHz Level Controls Off. Adjust the Code Synth Lvl Control for an FM deviation of 1.88 kHz as read on the CRT display.

3. Without disturbing the Code Synth Lvl Control, turn the Code Synthesizer OFF. Turn ON the 1 kHz Level Control and adjust for an FM deviation of 7.5 kHz on the CRT display.

4. Connect the Mod Out Jack to the SINAD Input Jack on the UUT. Verify a SINAD reading greater than 25 dB.

5. Set the Code Synthesizer to the Continous Mode and verify a SINAD reading 12 dB ±1 dB.

5-137. Scan Mode

1. Set the UUT for the Gen/Mon Mtr display. Verify the proper operation of each of the RF Scan switch positions.

5-138. Generate Mode

1. Set the UUT for the Generate FM Mode at 200 MHz and select the Gen/Mon Mtr display. Verify an RF level output display on the CRT.

2. Connect the RF millivoltmeter with a 50 ohm termination to the RF In/Out Jack on the UUT. Set the RF step attenuator to the 0 dB position and adjust the Variable Level control to obtain a displayed output level of +13 dBm. Verify that the RF millivoltmeter reads +13 dBm ±2 dBm.

3. Repeat paragraph 5-138.2 except at a center frequency of 800 MHz.

4. Increase the RF Step Attenuator setting in 10 dB increments and verify that the displayed RF level decreases in 10 dB increments.

5. Set the Code Synthesizer Modulation switch and the Ext Level Control to their respective OFF positions. Select the Narrow Band mode and adjust the 1 kHz Level Control for a 5 kHz deviation reading on the CRT display. Verify a 1 kHz tone at the speaker output.

6. Connect the Modulation Meter to the RF In/Out Jack on the UUT. Set the Modulation Meter for a deviation display of 5 kHz ±250 Hz.

7. Select the Wide Band mode on the UUT and verify that the CRT displays a deviation of 20 kHz. Also verify that the Modulation Meter shows a peak deviation of 20 kHz ±1 kHz.

8. Select the Modulation Display on the UUT and verify a peak-to-peak modulation display of 40 kHz ±2 kHz.

9. Select the Generate CW Function and verify that no modulation is present on the CRT.

10. Set the UUT for the Generate AM Function, the Gen/Mon Mtr Display, and adjust for an RF output level of 0 dBm. Adjust the 1 kHz Level Control for a 50% AM reading on the CRT. Verify that the Modulation Meter reads 50% ±10% AM.

11. Select the Modulation Display and verify a low distortion 1 kHz sinewave.

12. Set the UUT for the Generate SSB/DSBSC Function and verify a low distortion 1 kHz sinewave on the CRT.

13. Set the UUT for the Generate SWP 1-10 MHz Function and the Scope DC Display. Verify a horizontal trace and a center frequency display on the CRT.

14. Set the UUT for the Generate SWP 0.01 - 1 MHz Function and verify the same results as paragraph 5-138.13.

5-139. Power Monitor Mode

1. Set the UUT to the Power Monitor Mode. Set the RF Step Attenuator to the 30 dB position, and select the Gen/Mon Mtr Display. Connect the RF power source to the RF In/Out Jack. Key the power source and verify a correct power reading on the CRT display. Unkey the power source.

2. Set the UUT to the Monitor Function and verify that the RF Step Attenuator is in the 30 dB position. Key the RF power source and verify the presence of an audible alarm and a warning display on the CRT. Unkey the power source.

5-140. Monitor Mode

1. Set the UUT to the Monitor FM Function. Set the Squelch Control to the OFF position and verify the presence of a Sig Lvl indication and noise at the speaker. Turn the Squelch Control full on and verify the absence of a Sig Lvl indication and noise at the speaker.

2. Repeat paragraph 5-140.1 except for the AM function.

3. Repeat paragraph 5-140.1 except for the SSB/DSBSC Function and enable the BFO. After the test turn the BFO off.

4. Select the Narrow Band FM Monitor Function at 300 MHz and set the RF Step Attenuator to the 0 dB position. Connect the RF Signal Generator to the RF In/Out Jack and the SINAD Meter to the Demod Out Jack. Set the RF Signal Generator for a center frequency of 300 MHz and for 3 kHz FM at a 1 kHz rate. Adjust the RF output level from the Signal Generator for a 10 dB reading on the SINAD Meter. Verify that the Signal Generator's level is less than −103 dBm (1.5 μVrms).

5. Calibrate the RF Signal generator for 3 kHz FM at 1 kHz rate using the Modulation Meter. Set the Generator for a nominal output level of −60 dBm and connect it to the RF In/Out Jack of the UUT. Select the Gen/Mon Mtr Display and verify a monitor deviation reading of 3 kHz ±150 Hz.

6. Calibrate the RF Signal Generator for 50 kHz FM at a 1 kHz rate. Select the Wide Band Mode on the UUT and verify a reading of 50 kHz ±2.5 kHz on the CRT deviation display.

7. Calibrate the RF Signal generator for 30 % AM at a 1 kHz rate. Set the Generator for a nominal output level of −60 dBm and connect it to the RF In/Out Jack of the UUT. Select the Monitor AM Function and the Narrow Band Mode. Verify a monitor AM reading of 30% ±5%.

8. Monitor the % AM Displayed on the CRT while increasing the RF level out of the Signal Generator. Verify that the IF Overload Warning occurs before the displayed AM exceeds a reading of 30% ±5%.

9. Select the Modulation Display on the UUT and verify the presence of the received modulation signal.

10. Select the Gen/Mon Mtr Display and the Wide Band Mode on the UUT. Vary the center frequency on either the UUT or the Signal Generator and verify that the Frequency Error Display properly represents the difference between the UUT's Center frequency and the Signal Generator's center frequency.

11. Select the IF Display on the UUT and verify the presence of an IF envelope on the CRT.

5-141. Spectrum Analyzer

1. Set the UUT for the Monitor Function at 300 MHz the Spectrum Analyzer Display, and 0 dB input attenuation. Connect the Signal Generator to the RF In/Out Jack on the UUT. Verify a spectral amplitude of −30 dBm ±5 dB on the CRT display. Increase the RF Step Attenuator in 10 dB increments verifying that the spectral amplitude decreases by 10 dB ±3 dB with each step.

2. Verify the operation of the Dispersion Control.

5-142. Duplex Generator

1. Select the Duplex Generator Display and the Monitor Function at a frequency of 100 MHz. Enable the 45 MHz offset frequency. For an Image Low switch position verify that a displayed duplex frequency of 55 MHz can be obtained. Set the Image Switch to the HIGH position and verify a duplex frequency display of 145 MHz.

2. Enable the 0 - 10 MHz offset frequency and verify that displayed duplex frequencies from 100 MHz to 110 MHz can be obtained.

3. Set the UUT to the Generate Function with the Duplex Generator Display. With the Code Synthesizer and the External Modulation sources OFF, adjust the 1 kHz Level Control for a 20 kHz FM deviation reading on the CRT. Select the Monitor Function and adjust the offset frequency for a duplex output of 100 MHz. Connect the Duplex Output Jack to the RF In/Out Jack and verify a 20 kHz ± 1 kHz FM deviation reading on the CRT.

5-143. System Troubleshooting

5-144. A troubleshooting procedure is outlined in Table 5-6. Because of the complexity of the system the table covers only the major failures and provides only a guide to the most probable failed module. When using the table it is important to use the checkout procedure at paragraph 5-123 to determine the fault. The troubleshooting table assumes that all tests prior to the failure point have been successfully completed and thus the applicable circuits are okay.

5-145. A list of the system test points and their functions are provided in Table 5-7. Test points are identified on the block diagrams for the Theory of Operation discussion of paragraph 5-16 and for the Module Descriptions to aid in troubleshooting.

Table 5-6. System Troubleshooting

Test Paragraph	Fault	Troubleshooting Procedure
5-129	No AC indication	1. Check AC linecord and line fuse. 2. If system powers up normally when on, Replace AC LED.
5-129	No Oven Ready indication	1. Check for approximately +15 VDC at E13 of the A13 module. If not present replace the Low Voltage Power Supply (A1). 2. Check E11 of A13 for +9 VDC and E12 for approximately +7.5 VDC. If E11 is okay and E12 is 0 VDC, replace the LED. If the +9 VDC is not present on E11 replace A13.

Table 5-6. System Troubleshooting (Cont)

Test Paragraph	Fault	Troubleshooting Procedure
5-129	System won't turn on	1. Disconnect the high voltage supply from the low voltage supply at A10P1. Check for nominal voltages of 15 VDC at pin 3 of U2 on the low voltage supply and for +12 VDC at pin 8. If either voltage is not present replace the low voltage supply (A1). 2. Reconnect the low voltage/high voltage interface and check for a nominal +9 VDC on the collectors of Q3 and Q4. (The actual signal on the collectors is a 0 VDC to +18 VDC square wave). If 9 volts is not present replace the high voltage supply (A10). 3. If items 1 and 2 check okay replace the low voltage supply (A1).
5-129	System turns on, but no display. on the CRT for any display mode	1. Check for presence of high voltage by disconnecting the CRT anode lead and arcing it to the chassis. If no arc, replace the high voltage supply. 2. If the high voltage supply is okay, replace the CRT.
5-130	More than one key is inoperative or has the wrong effect	1. Replace the Processor Module (A9).
5-130	Only one key is inoperative	1. Replace the defective key switch.
5-131	Any part of the nonvolatile memory fails to remember	**WARNING** Lithium Battery Do not mutilate or disassemble the battery cell. The lithium metal is a very active material that burns in the presence of water or high humidity. Do not put the battery in fire, attempt to charge, heat above 100°C, or solder directly to the cell. Do not overdischarge the cell to a reverse voltage greater than 3 volts. The battery may burst and burn or release hazardous materials. 1. Troubleshooting Instructions: A. Turn system power switch off and disconnect the unit from the primary power source. B. Remove the Processor Module (A9) from the system and place on a non-conductive surface. C. With a voltmeter measure the DC voltage across the lithium battery in the lower left corner of the board.

Table 5-6. System Troubleshooting (Cont)

Test Paragraph	Fault	Troubleshooting Procedure
		D. If the battery voltage is less than 2.4 volts, the cell is discharged and should be replaced. If the battery is okay, replace the entire Processor Module (A9). E. If a new battery is needed, obtain a new cell (P/N60-80396A0) from Motorola. Replace the battery using the procedure in Part 2. **CAUTION** Do not substitute another type lithium battery as a replacement. The specified battery was chosen with safety as a major consideration. Other lithium battery types may present a potential hazard when used in this system. 2. Replacement Instructions: A. Turn system power switch off and disconnect the unit from the primary power source. B. Remove the Processor Module (A9) from the system and place on a nonconductive surface. C. Cut each of the two wires connecting the battery to the circuit board near each battery end. D. Remove the battery from the hold-down clip. E. Remove the new battery from its shipping container and put the old battery into the shipping container. Dispose of the battery as per Part 3. F. With a 40-watt or lower watt soldering iron remove the old battery leads from the board. G. Using care not to short the battery leads to each other or to the battery case, install the battery into the hold-down clip with the negative lead nearest the left edge of the card (circuit board connector edge toward you). H. Solder the leads from the new battery into the printed wiring board at the points where the old leads were removed from. I. Trim the lead ends and reinstall the module into the system.

Table 5-6. System Troubleshooting (Cont)

Test Paragraph	Fault	Troubleshooting Procedure
		3. Disposal Instructions A. Do not dispose of the lithium battery by placing it in the everyday trash. Lithium batteries are classified as hazardous material and must be disposed of accordingly. B. Consult State and Local Codes for the appropriate procedure to be used for disposal. C. Motorola will dispose of the battery for you if you send it in the shipping container and by the same method that the new battery came to you to: Motorola, Inc. Return Goods Department 1313 East Algonquin Road Schaumburg, Ill 60196
5-132	No DPL (modulation) signal on CRT	1. Check TP1 of the Audio Synthesizer for the presence of the DPL signal. If not present replace the Audio Synthesizer module. 2. Check for the DPL signal on pin 64 of the Audio Synthesizer. If not present replace the IEEE interface module (A8), or check for the presènce of the jumpers on J8 for the standard unit. 3. Check for the DPL signal at TP6 of the Audio Synthesizer. If not present replace the Audio Synthesizer (A6). 4. Check for the DPL signal at TP4 of the Scope Amplifier module (A2). If not present replace the Scope/DVM control module (A3). 5. If signal switching is okay to the Scope Amplifier module proceed to the scope troubleshooting information.
5-132	No external modulation on the CRT	1. Check for modulation signal at TP7 of the Audio Synthesizer module (A6). If not present replace the Audio Synthesizer module.

Table 5-6. System Troubleshooting (Cont)

Test Paragraph	Fault	Troubleshooting Procedure
		2. Check for the modulation signal on pin 66 of the Audio Synthesizer. If not present replace the IEEE Interface module (A8), or check for the presence of the modulation jumpers on J8 for the standard unit. 3. Continue troubleshooting at step 3 of the "no DPL signal on the CRT".
5-133	Frequency Counter inoperative	1. Check for presence of a 1 kHz singal at TP9 of the Audio Synthesizer (A6). If not present check for the 10 MHz signal from the Frequency Standard module (A13) to the RF Synthesizer (A5). If present replace the RF Synthesizer. If not present replace the Frequency Standard module. 2. If the 1 kHz signal is present check for the presence of the signal to be counted at pins 61 and 63 of the processor I/O module (A7). If not present replace the Front Panel Interface Module (A12). 3. If signal is okay up to the Processor I/O module replace the Processor I/O module.
5-133	DVM AC mode is inoperative	1. Check for DVM signal at pin 22 of Front Panel Interface module (A12). If not present replace the Front Panel Interface module. 2. Check for short bursts of the DVM AC signal at TP2 of the Scope/DVM Control module (A3). If signal is not present at TP2 replace the Scope/DVM Control module. 3. If the signal is okay to TP2 of A3, replace the Processor I/O module (A7).
5-134	DVM DC mode is inoperative	1. Check for the DC input level attenuated by factors of 10 to less than 1 volt at pin 22 of the Front Panel Interface module (A12). If not present of if greater than 1 volt, replace the Front Panel Interface module. 2. Check for same voltage at TP2 of A3. If signal not present, replace A3. 3. If signal is present at TP2, replace Processor I/O module A7.

Table 5-6. System Troubleshooting (Cont)

Test Paragraph	Fault	Troubleshooting Procedure
5-135	No horizontal sweep **See "CAUTION" note on page 4-19**	1. Check for a voltage level between −2.0 VDC and +2.0 VDC at TP4 of the Scope Amplifier module (A2). If the voltage cannot be brought within range with either the vertical range attenuator or the vertical position control replace the Front Panel Interface module (A12). 2. If the voltage at TP4 is okay replace the Scope Amplifier module (A2).
5-135	No vertical display	1. Check for the input signal at TP4 of the Scope Amplifier Module (A2). If not present replace the Front Panel Interface Module (A12) 2. If signal is okay at TP4 replace the Scope Amplifier Module (A2).
5-135	No vertical snyc	1. Check for the presence of sync pulses at pin 12 of the Scope/DVM Control module (A3) and for a nominal zero volt sync present level at pin 76. If either signal is not present replace the Scope/DVM Control module. 2. If sync pulse and the syn present lines are okay replace the Scope Amplifier Module (A2).
5-136	Distortion/SINAD meter inoperative	1. If the DVM mode checks okay replace the Scope/ DVM Control module (A3). 2. If the DVM mode does not check okay go to the troubleshooting list for DVM AC inoperative.
5-138	No generate output	1. Remove the RF cable between the RF Synthesizer (A5) and the RF Input module (A11). Check for a nominal −10 dBm level at the Synthesizer output. If no output replace the RF Synthesizer. 2. If the Synthesizer output is okay replace the RF input module (A11).
5-138	No Frequency Modulation	1. Check for modulation signal at pin 56 of the RF Synthesizer (A5). If the signal is okay replace the RF Synthesizer. 2. If the modulation signal is not present proceed to the troubleshooting list under "no DPL (modulation) signal on CRT".

Table 5-6. System Troubleshooting (Cont)

Test Paragraph	Fault	Troubleshooting Procedure
5-139	Internal wattmeter in error	1. Replace RF input module (A11).
5-140	No monitor function	1. Apply a 10.7 MHz modulated carrier to the RF input. Check for normal receiver operation except reduced sensitivity. If receiver is not working replace the Receiver module (A4). 2. If the receiver checks okay and the generate function is okay, replace the RF Input module (A11).
5-140	Monitor frequency error display is missing	1. Go to the troubleshooting list under "frequency counter inoperative".
5-140	Monitor frequency error is in error	1. Check for presence of IF signal at pin 91 of the Scope/DVM Control module (A3). If not present replace the Receiver module (A4). 2. If the IF signal is present replace the Scope/DVM Control module.
5-141	No spectrum analyzer sweep	1. Check pin 6 of the RF Synthesizer module (A5) for a 50 Hz square wave. If not present replace the RF Synthesizer module. 2. If 50 Hz signal is present replace the Scope/DVM Control module (A3).
5-141	Spectrum display is in error	1. Replace the Receiver module (A4).
5-142	No duplex output	1. Replace the RF Input module (A11).

Table 5-7. Test Point Identification

All test points are located near the top edge of the card and counted from left to right when facing the component side of the card.

Module	Test Point No.	Signal Name
A1		
Low Voltage		
Power Supply		
A1A1	101	Pulse Width Mod Out
	102	Pulse Width Mod Dr
	103	HV Source Voltage
A1A2	201	Ground
	202	+5V FB
	203	−5V
	204	+12V
	205	−12V
	206	+33V
	207	+110V
	208	−110V
A1A3		
Control Board	301	+8V
	302	PWM Dr
	303	Error Voltage
	304	H.V. Bias Supply Voltage
	305	Sawtooth Voltage
	306	Chopper DR A
	307	Chopper DR B
A1A4		
Relay Assembly	401	Batt Chg
	402	Frequency Std Sup Voltage
	403	Relay +12V
	404	Dc Bus
A2	1	Int Horiz Input
Scope Amplifier	2	Horizontal Deflection Plate
	3	$\overline{\text{Horizontal Deflection Plate}}$
	4	Vertical Drive
	5	Focus TV
	6	Vertical Deflection Plate
	7	$\overline{\text{Vertical Deflection Plate}}$
	8	CRT Z-Axis

Table 5-7. Test Point Identification (Cont)

Module	Test Point No.	Signal Name
	9	Intensity TV
	10	Time Base Output
A3	1	Vertical Character Sync
Scope/DVM Control	2	Ext DVM to A/D
	3	+15V
	4	Positive Peak Detector
	5	Int. DVM to A/D
	6	Negative Peak Detector
	7	Carrier + MOD Level
	8	Character Gen. Reset
	9	GND
	10	GND
	11	+8V
	12	−8V
A6	1	Synth DPL Audio
Audio Synthesizer	2	DPL Clock
	3	Unfiltered DPL
	4	Synth. D/A Output
	5	Ground
	6	Composite Modulation Audio
	7	Composite External Mod. Audio
	8	Synthesizer Clock 104, 857.6 Hz
	9	1 kHz Modulation Source
A7	1	A/D Input
Processor I/O	2	Unfiltered 10.245 MHz T.V.
	3	DVM/Freq. Counter Select
	4	Frequency Counter Input
	5	Not Used
A9	1	Ground
Processor	2	Dot Clock
	3	Character Row Clock
	4	Character Clock
	5	Enable
	6	Character Line Clock
	7	R/W Select
	8	Char. Gen/Processor Select
A12	1	Attenuator Buffer Output
Front Panel		
Interface		