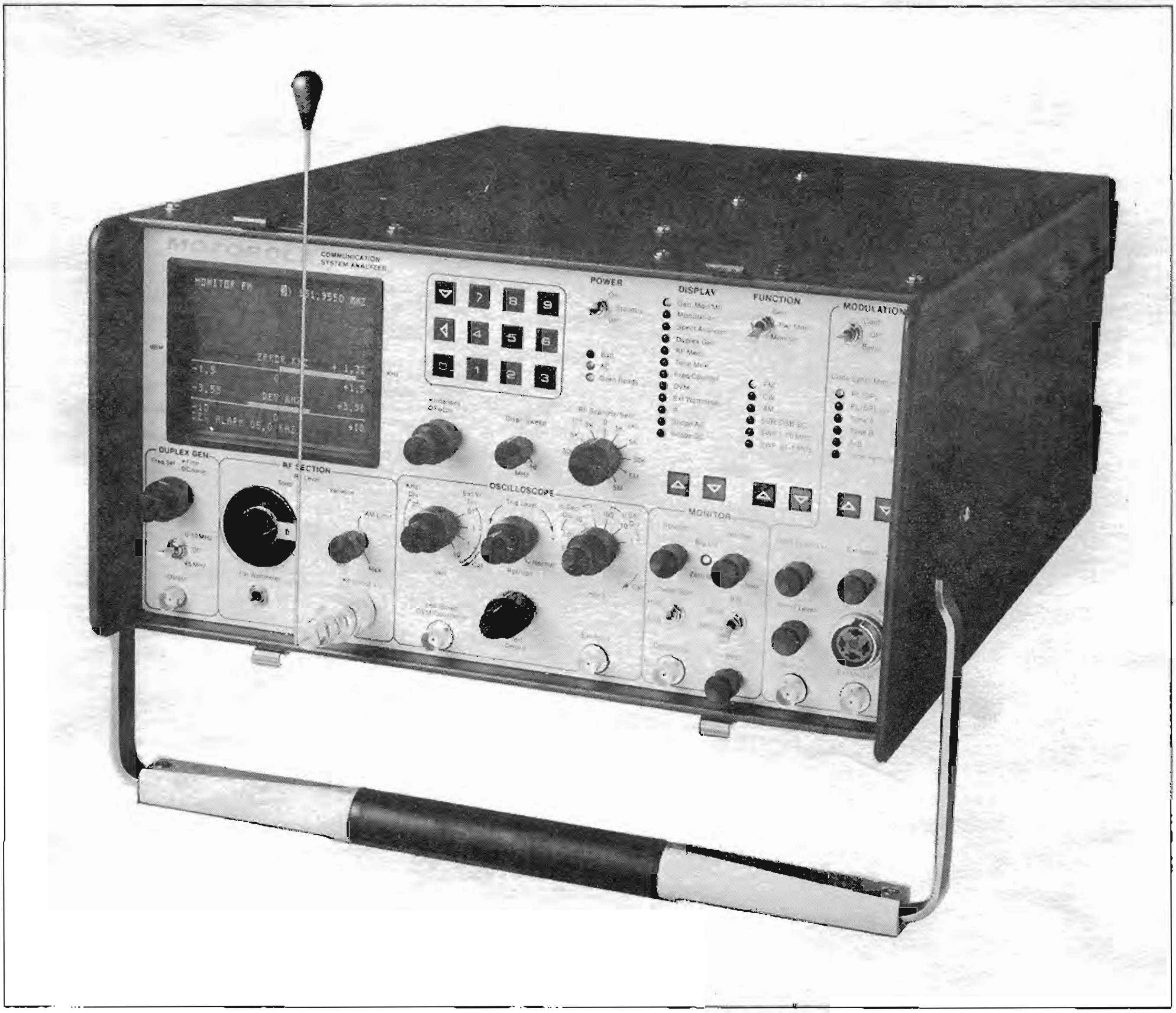
MOTOROLA INC.
Communications
Group

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



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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 R2001A is the standard Communications System Analyzer. The R2002A Analyzer, which contains the IEEE-488 Standard interface control bus, is also available. Programming for the R2002A is covered in Secton 22 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
- 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 failures 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 seven 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.

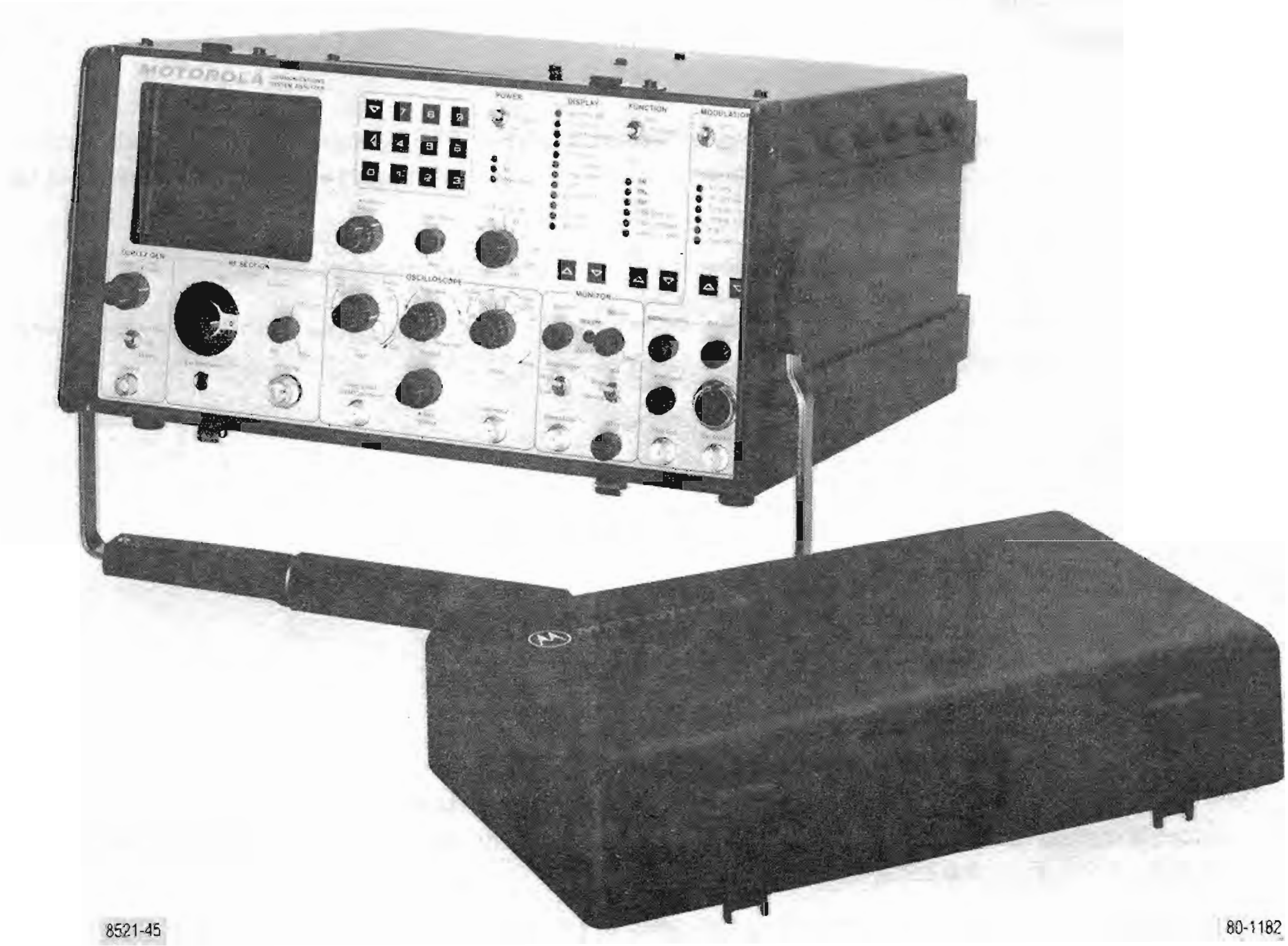

Figure 1-1. Communications System Analyzer

SECTION 1

1-1. INTRODUCTION

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

Table 1-1. Physical Characteristics

Characteristic	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

Characteristic	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:	0.1 µV 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 (Continued)

Characteristic	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)
External input:	Approximately 150 mV for 80%, BNC connector
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 Hz
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 MHz -10 dB at L.O. harmonics ±10.7 MHz
Deviation Measurement	
Range:	1, 10, 100 kHz full scale
Accuracy:	±5% of reading ±100 Hz 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 kHz to 99.9 kHz). Audible alarm indicates limit condition in all Monitor Modes.
AM modulation measurement	
Range:	0 to 100%
Accuracy:	±5% of full scale

Table 1-2. Electrical Characteristics (Continued)

Characteristic	Description
RF Wattmeter (Autoranging display)	
Frequency range:	1 MHz to 1000 MHz
Power range:	1.0 watts to 125 wattts
Accuracy:	±10%, 1 watt to 125 watts
Protection	Over temp indicator
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 x 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 μ s, 10 μ s, 0.1 ms, 1 ms, 0.01S, 0.1S (per division)
Sync	Automatic or normal triggering
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

Table 1-2. Electrical Characteristics (Continued)

Characteristic	Description
	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%
Signaling sequences	Four fixed 1. Tone only 2. Tone with battery saver 3. Tone and voice 4. Group call Four user programmable
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	10 Kohm nominal
Code synthesizer external output level	0-3 vrms into a 600 ohm load
	SINAD Meter
Input level range	0.5V to 10 Vrms
Sinad accuracy	±1 dB at 12 dB Sinad

Table 1-2. Electrical Characteristics (Continued)

Characteristic	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: ±1 x 10^{-6} per year Temp: ±1 x 10^{-6} maximum error over the 0° to 55°C temp. range
Optional ovenized high stability	Aging: ±1 x 10^{-6} per year Temp: ±5 x 10^{-8} maximum error over the 0° to 55°C temp range (warmup to ±5 x 10^{-7} of final frequency within 20 minutes)
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 operating; -40 to 85°C storage

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/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) • Sinad in: 0.5 to 10 Vrms in at 1 kHz

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

Characteristics	Description
	• DVM in: 1, 10, 100 and 300V full scale AC 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 mW. 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.
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 Vrms (-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
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 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 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. SINAD Metering. A comprehensive check of receiver performance can be made with a SINAD measurement. The analog line segment and digital representation of SINAD appear automatically whenever the unit is in the normal generate mode. The only hookups required are from the Communications System Analyzer to the RF input of the receiver under test, and from the audio output of the receiver to the instrument's multipurpose input. The measurement, and appropriate servicing, can then be accomplished without the need for a separate signal generator, SINAD meter or distortion analyzer.

2-12. Multi-Mode Code Synthesizer. The Communications System Analyzer generates Private Line tones (PL), Digital Private Line codes (DPL), two-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. Timing sequences are also stored in the Tone Memory to provide fast set-up and eliminate errors. User programmable timing sequences are also provided to allow the storage of non-standard or future time sequences.

2-13. Off-the-Air Monitor. The 1.5 μV 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 receiver 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 an audiable 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 generate 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. 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-4055A	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.
Blower	RTL-4054A	Provides additional cooling in high ambient temperature conditions

Table 2-2. Optional Equipment for Use with Analyzer (Cont)

Equipment	Motorola Part No.	Use
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 or Blower options.
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.

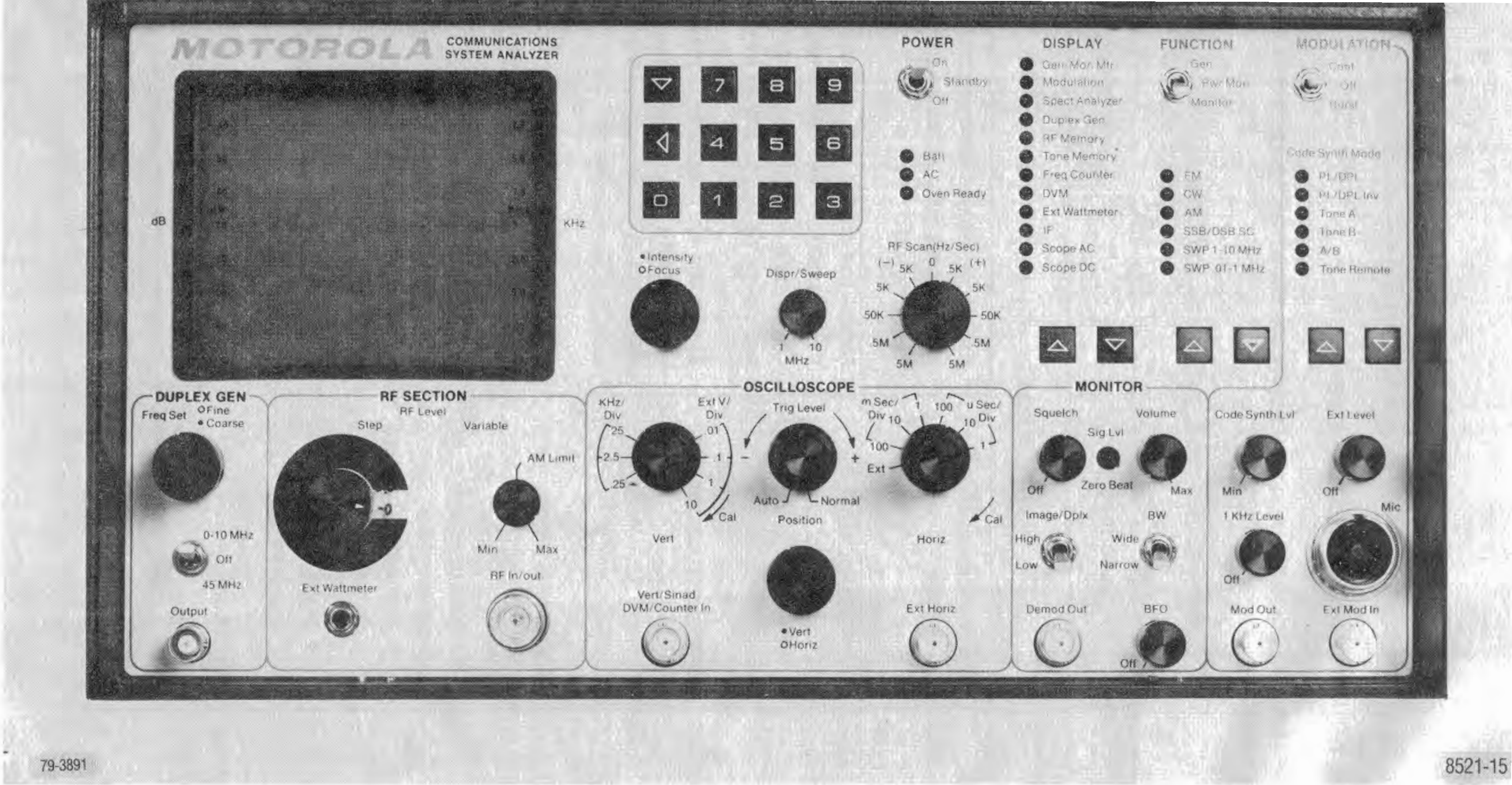

Figure 4-1. Controls, Indicators, and Connectors, Front Panel

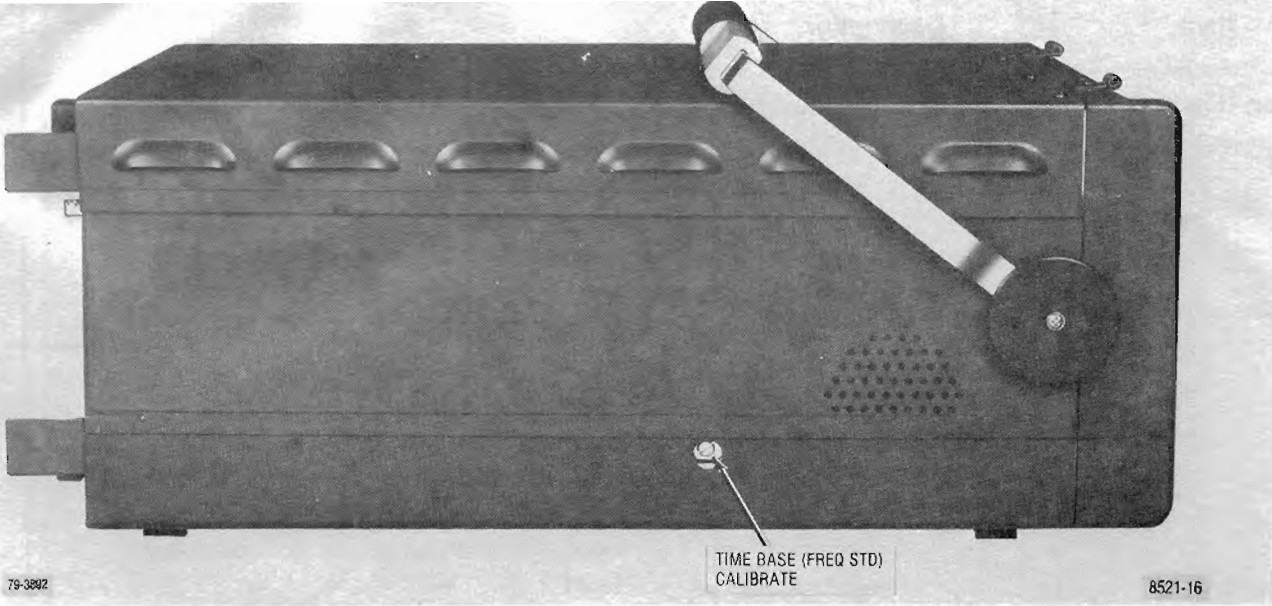

Figure 4-2. Controls, Indicators, and Connectors, Left Side Panel

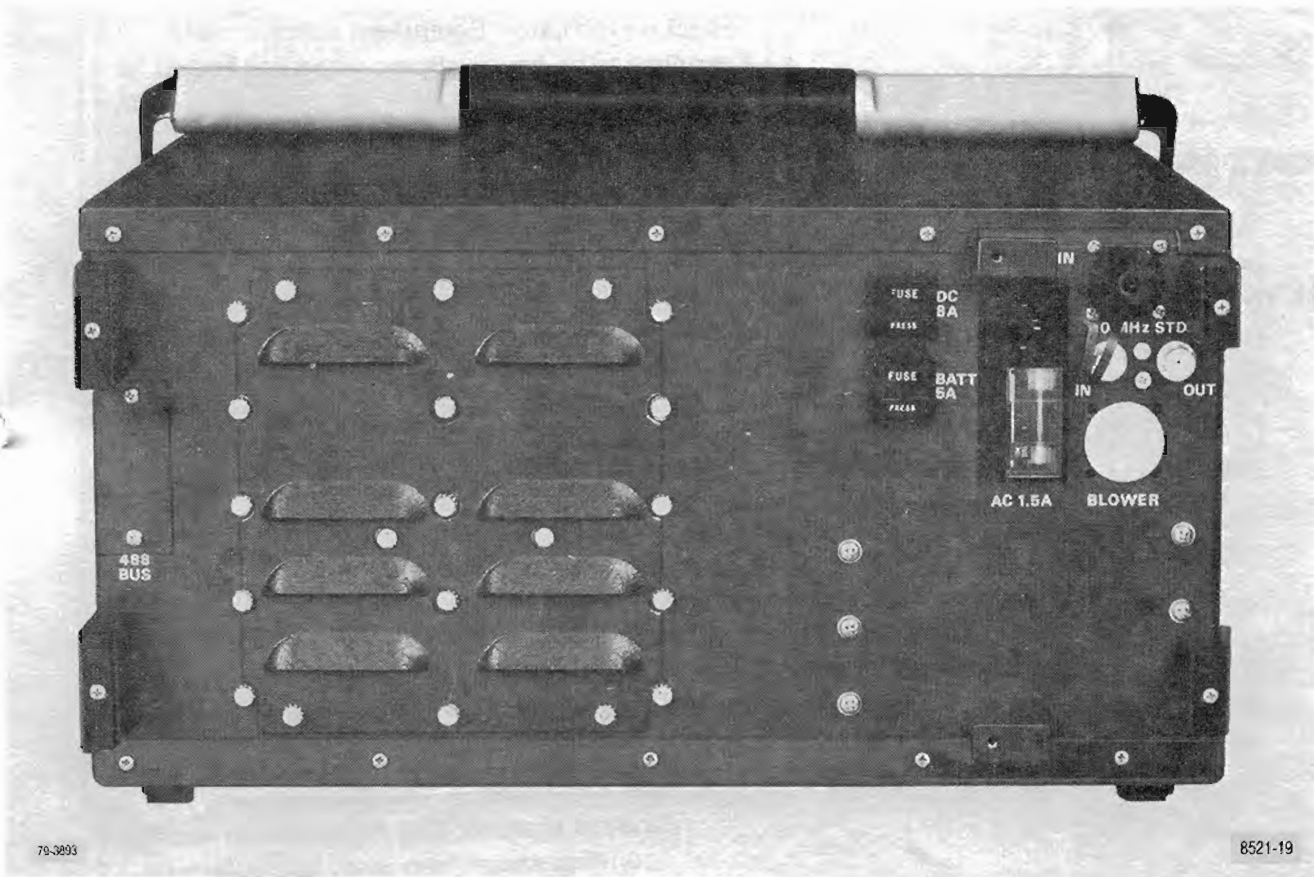

Figure 4-3. Controls, Indicators, and Connectors, Rear Panel

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

Item	Description	Function
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
		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. These include the tone A and B frequencies, the signaling sequence, and the programming for each of the eight sequences available. g. Freq Counter — The frequency of the signal input to the front panel frequency counter jack is displayed. h. DVM — The 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
		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.

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

Item	Description	Function
FRONT PANEL (fig. 4-1) (Cont)		
		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. 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 A/B 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

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

Item	Description	Function
		e. A/B indicator Indicates Tone A/Tone B signaling sequence will be output. See Tone Memory Table example, figure 4-9. f. Tone Remote indicator Indicates access sequence for Motorola Repeater will be output. 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.

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

Item	Description	Function
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.
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 counter-clockwise 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.

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

Item	Description	Function
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	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
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/ Counter In connector	BNC connector	Signal input to the equipment for the following operations: a. External vertical for oscilloscope operation b. SINAD Meter c. Frequency Counter d. Digital Voltmeter

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

Item	Description	Function
Type N connector	RF In/out connector	RF input in the power monitor or monitor mode, RF output in the generate mode.
Potentiometer	RF Level Variable control	Vernier control of RF output level. Exceeding the AM limit marking in AM generation mode may result in a distorted output.
14-position ganged atten and switch	RF Level Step 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 in-line 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.
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)		
BATT 5A	Line fuseholder (5 amp)	Battery charger output line fuseholder.
DC 8A	Line fuseholder (8 amp)	DC Input line fuseholder

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

Item	Description	Function
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.
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		Placement of Blower power connector, when Blower option is provided.

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 or 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.

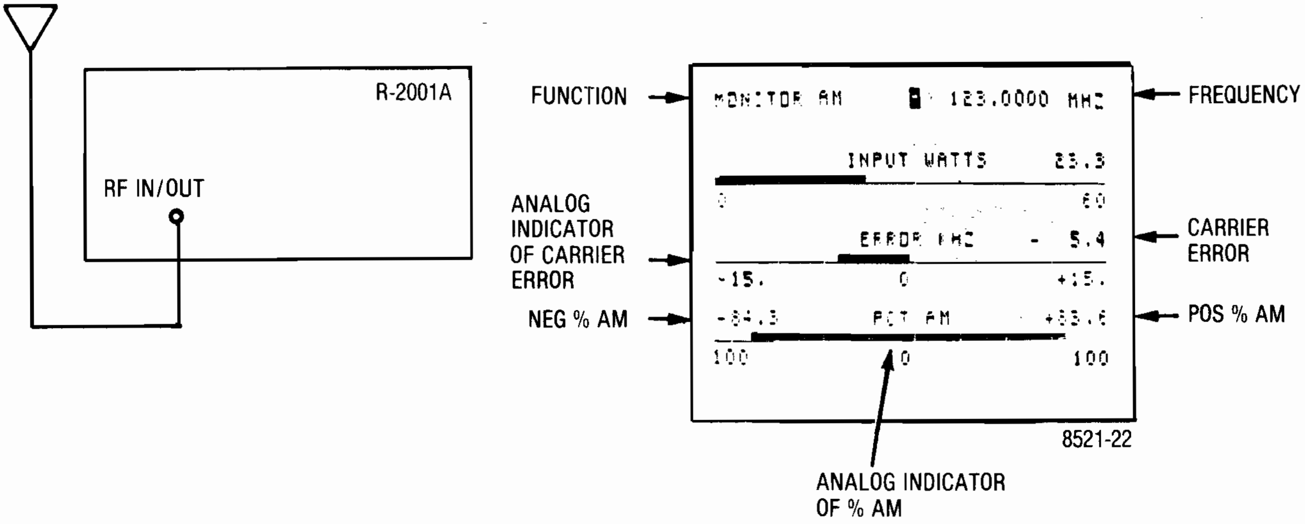

Figure 4-4. System Analyzer Time Base Calibrate Test Setup and CRT Display

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.

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 dBm 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.

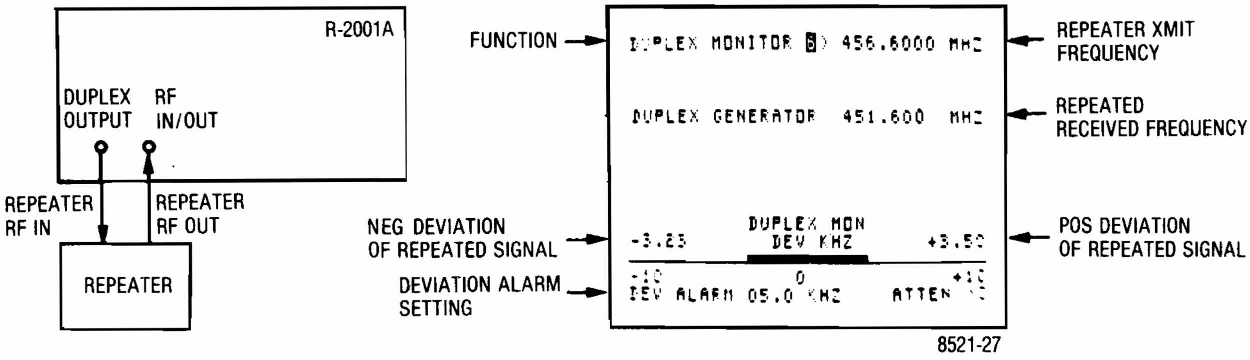

Figure 4-5. Duplex Generation Test Setup and CRT Display

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/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.

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.

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.

I. 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.)

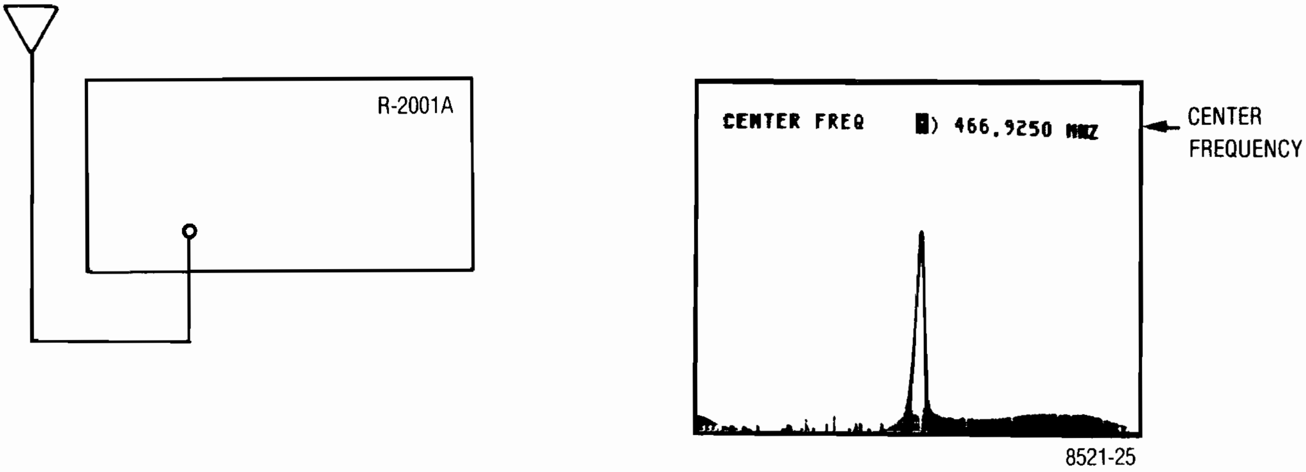

Figure 4-6. Spectrum Test Setup and CRT Display

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-4055A 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-4055A In-Line Wattmeter adaptor 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 adaptor and install element/adaptor assembly into transmission line.

NOTE

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

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

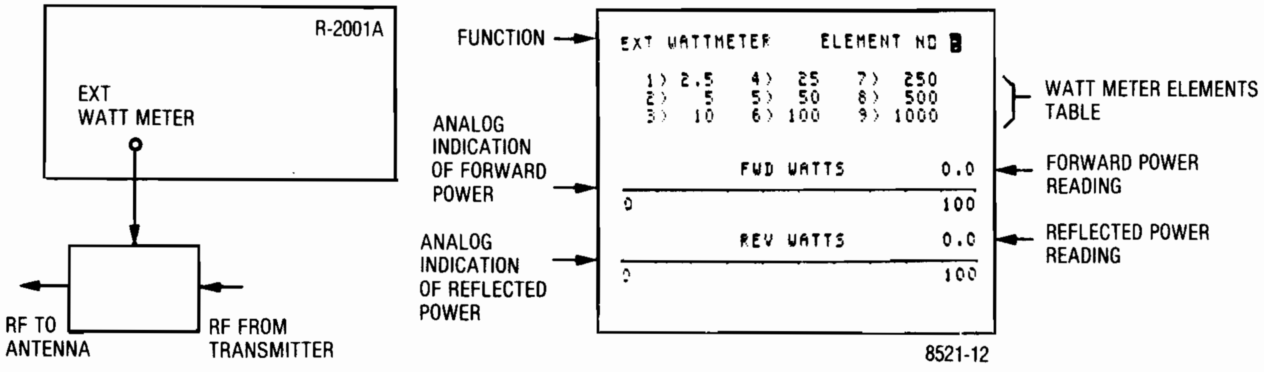

Figure 4-7. Wattmeter Test Setup and CRT Display

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.

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

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*Contact your Motorola Parts Source for ordering separately.

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.

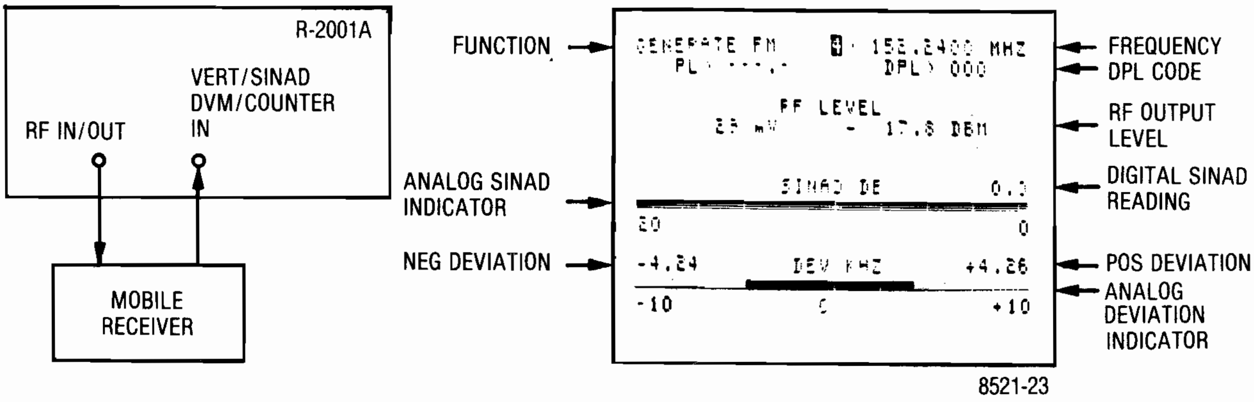


Figure 4-8. Test Setup for FM Receiver Sensitivity Using Generator and SINAD Meter with CRT Display

b. Test pager decode and alert function, and demonstrate simultaneous modulation.

1. Set FUNCTION switch to Gen and DISPLAY to Tone Mem.

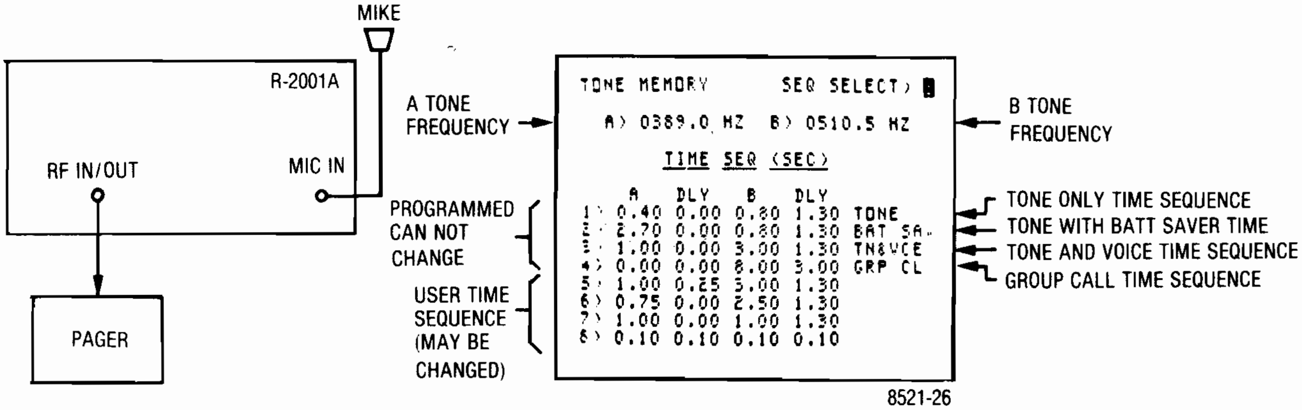
2. Select pager frequency from RF memory table or enter directly from keyboard.

3. Enter pager tone code frequencies and select desired time sequence in memory table.

4. Activate and adjust Code Synth. Lvl. for 3.3 kHz deviation on Gen/Mon Mtr. display. (5 kHz system)

NOTE

Timing sequences 1 through 4 are preset and can not be changed. Timing sequences 5 through 8 are keyboard programmable for testing other pager types, upper and lower timing limits, or future schemes.



```
TONE MEMORY          SEQ SELECT) █

  A) 0389.0 HZ  B) 0510.5 HZ

        TIME SEQ (SEC)

     A    DLY   B    DLY
1) 0.40 0.00 0.80 1.30 TONE
2) 2.70 0.00 0.80 1.30 BAT SA.
3) 1.00 0.00 3.00 1.30 TN&VCE
4) 0.00 0.00 8.00 3.00 GRP CL
5) 1.00 0.25 5.00 1.30
6) 0.75 0.00 2.50 1.30
7) 1.00 0.00 1.00 1.30
8) 0.10 0.10 0.10 0.10
```

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

c. Troubleshooting Receiver audio stages using “DVM and Signal Generate” function simultaneously.

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 DVM/Counter In” input. DC Voltage measurement points are also applied to this same input. The supplied XI 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.

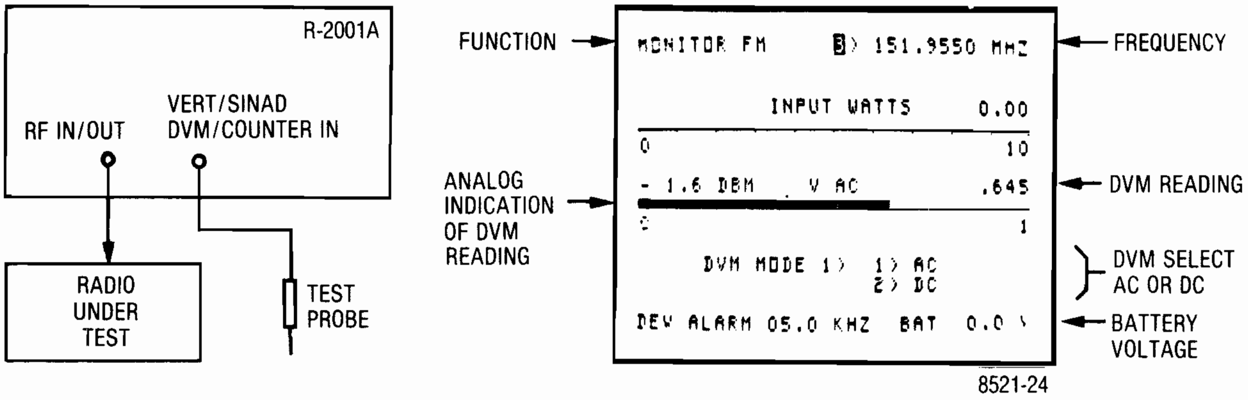


Figure 4-10. Test Setup for Using DVM and Signal Generate with CRT Display

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 repair 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 Except 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

5-14. MAJOR ASSEMBLIES

5-15. The Communication System Analyzer is designed for ease of maintenance. Most of the circuitry is on seven 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-P00422N001	RTP-1000A
A2	Scope Amplifier Module	01-P00413N001	RTC-4007A
A3	Scope/DVM Control Module	01-P00409N001	RTC-4008A
A4	Receiver Module	01-P00389N001	RTL-1002A
A5	Synthesizer Module	01-P00385N001	RTC-1001A
A5A*	Digital Synthesizer Card	01-P00358N001	RTC-4009A
A5B*	RF Synthesizer Card	01-P00386N001	RTC-4010A
A6	Audio Synthesizer Module	01-P00426N001	RTC-4011A
A7	Processor Input/Output Module	01-P00405N001	RTC-4012A
A8	IEEE Bus Module (Optional)	01-P00430N001	RTC-4013A
A9	Microprocessor/Character Generator Module	01-P00401N001	RTC-4014A
A10	High Voltage Power Supply Module	01-P00417N001	RTP-1001A
A11	RF Input Module	01-P00394N001	RTC-1002A
A11A1*	Protection/Power Meter Card	01-P00400N001	RTL-4061A
A11A2*	Converter/Wide Band Amplifier Card	01-P00398N001	RTC-4015A
A11A3*	Offset Generator Card	01-P00399N001	RTC-4016A
A12	Front Panel Interface Module	01-P00421N001	RTL-4045A
A13	Frequency Standard Module	01-P00368N001	RTL-1004A
A14	Front Panel Assembly	01-P00366N001	01-80304A42
	Motherboard Assembly	01-P00441N001	RTL-4060A

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

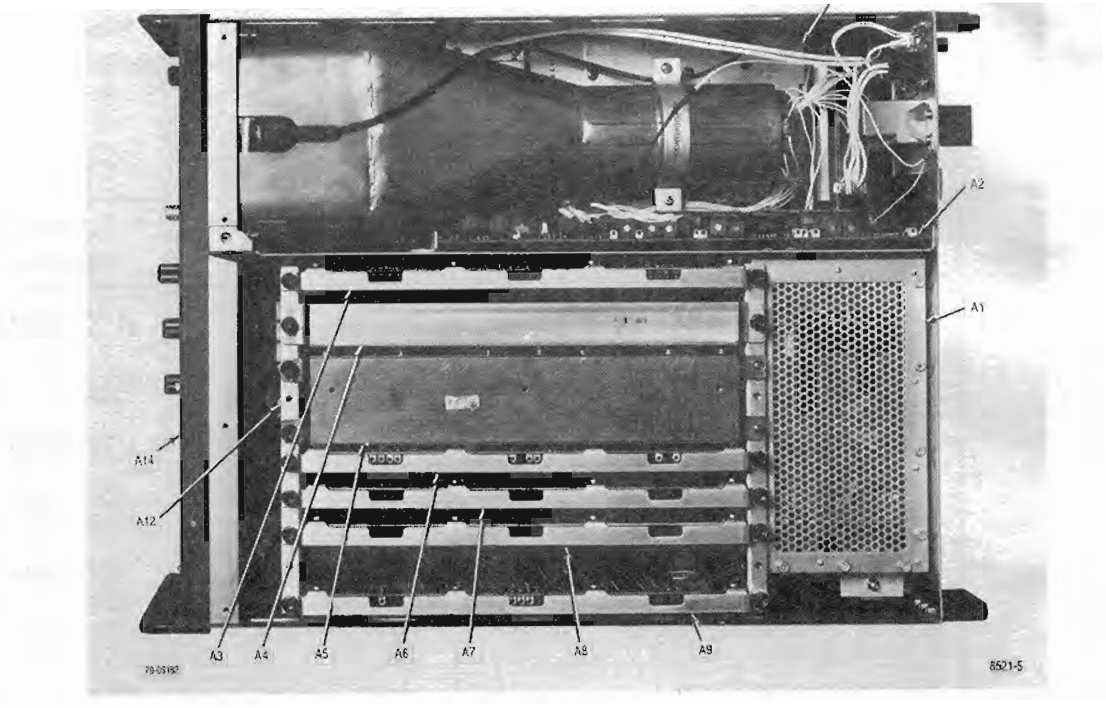


Figure 5-1. Communication System Analyzer, Top View Cover Removed

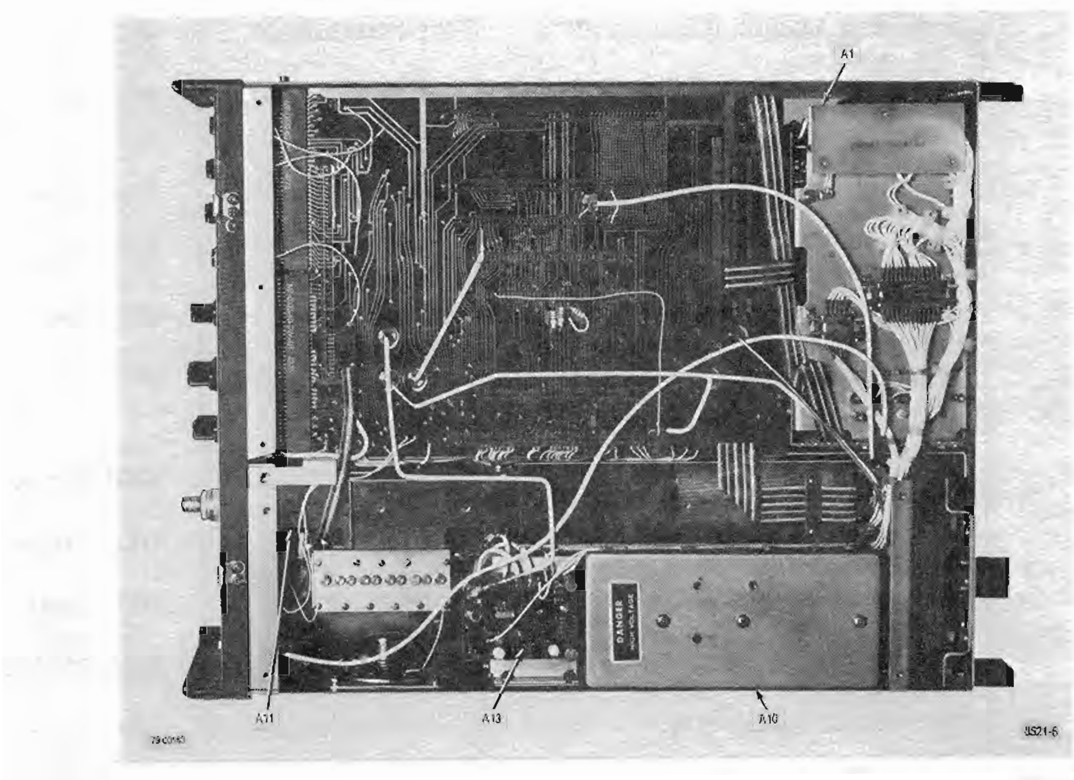


Figure 5-2. Communication System Analyzer, Bottom View Cover Removed

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 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 consits 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 22.

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.

Table 5-2. Control Buses and Functions

Data / ADRS	RF Bus				AF Bus #1				AF Bus #2				Data / ADRS
	D3	D2	D1	D0	D3	D2	D1	D0	D3	D2	D1	D0	
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				$\overline{\text{CSSG}}$ $\overline{\text{Cont}}$ Sw In	$\overline{\text{CSSG}}$ $\overline{\text{Burst}}$ 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		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	$\overline{\text{0.1V-}}$ $\overline{\text{10kHz}}$ DIV	$\overline{\text{0.01V-}}$ $\overline{\text{1kHz}}$ DIV	9
A	0.01-1000 Sel	500-700/ 700-1000 VCO Sel	LOOP INV/$\overline{\text{INV}}$ Sel	MOD Disable		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		.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 AC/DC Sel	Freq Cntr Range			E
F									Ctr/DVM Sel	Counter Input Sel IF/BFO	Offset	Ext	F

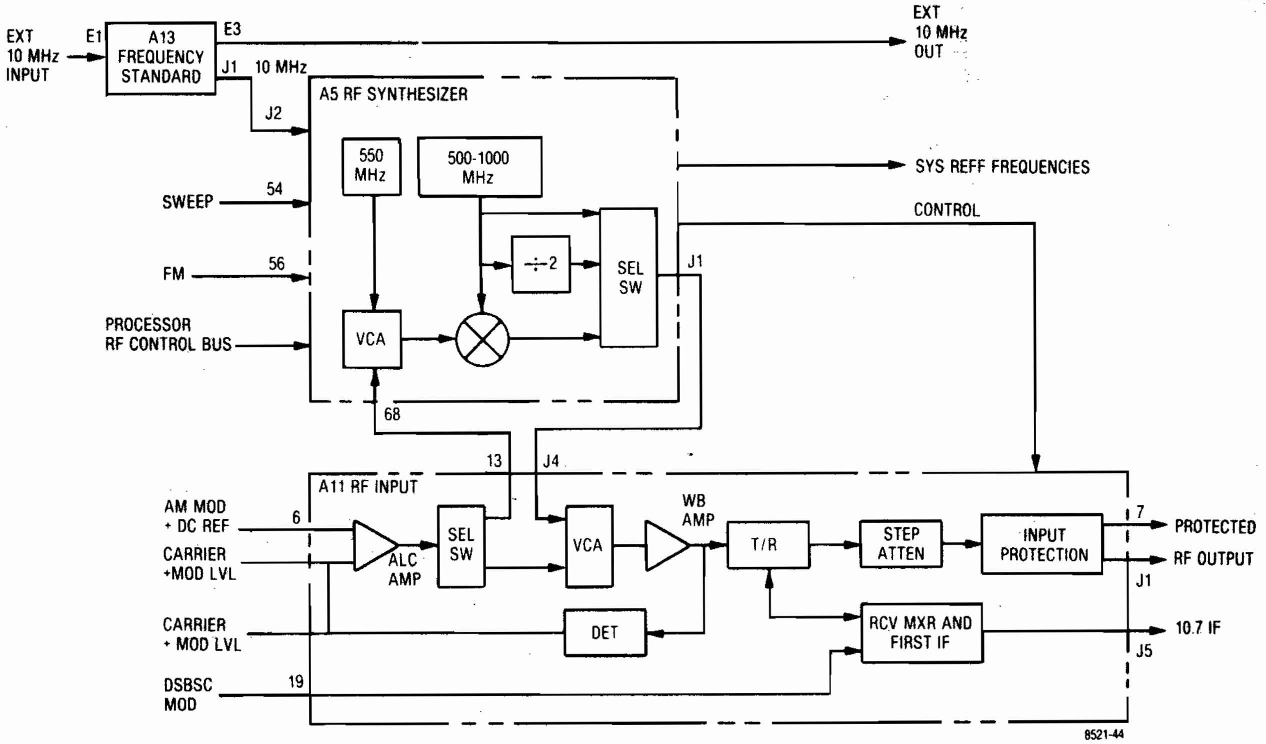


Figure 5-4. Generate Mode Block Diagram

5-27. 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.

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 suming 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 R2001A 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 22.)

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.

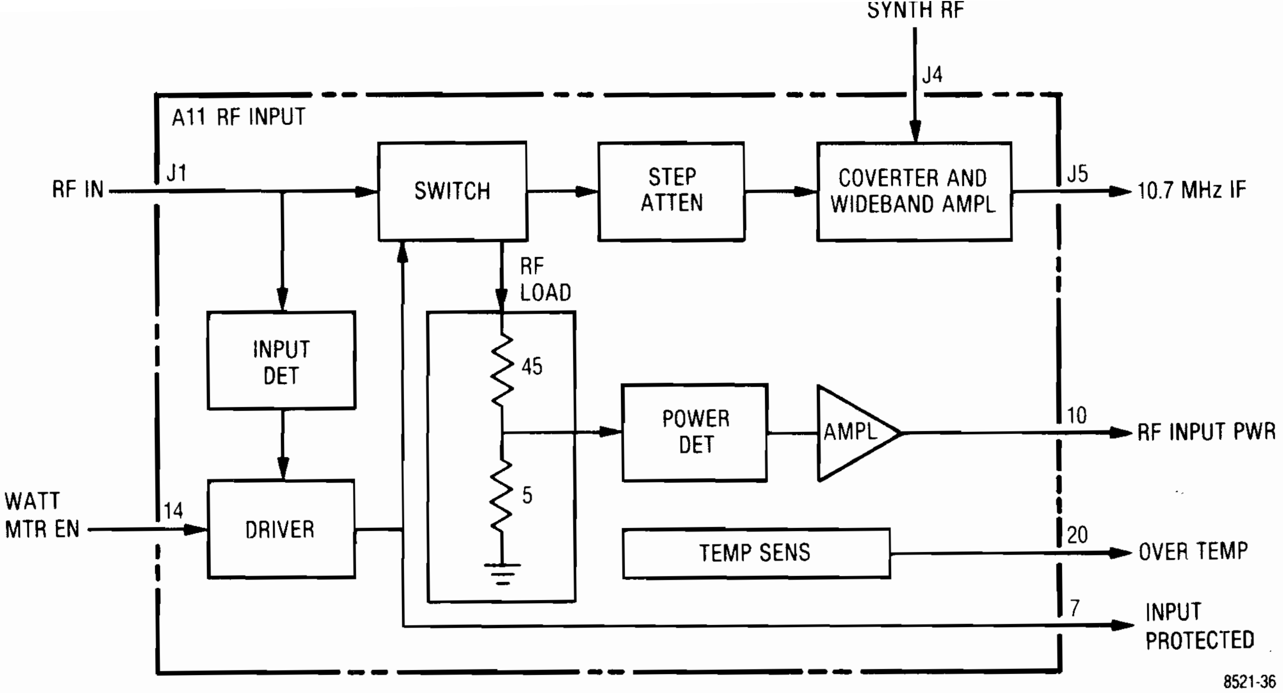


Figure 5-5. Power Meter Block Diagram

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.

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.

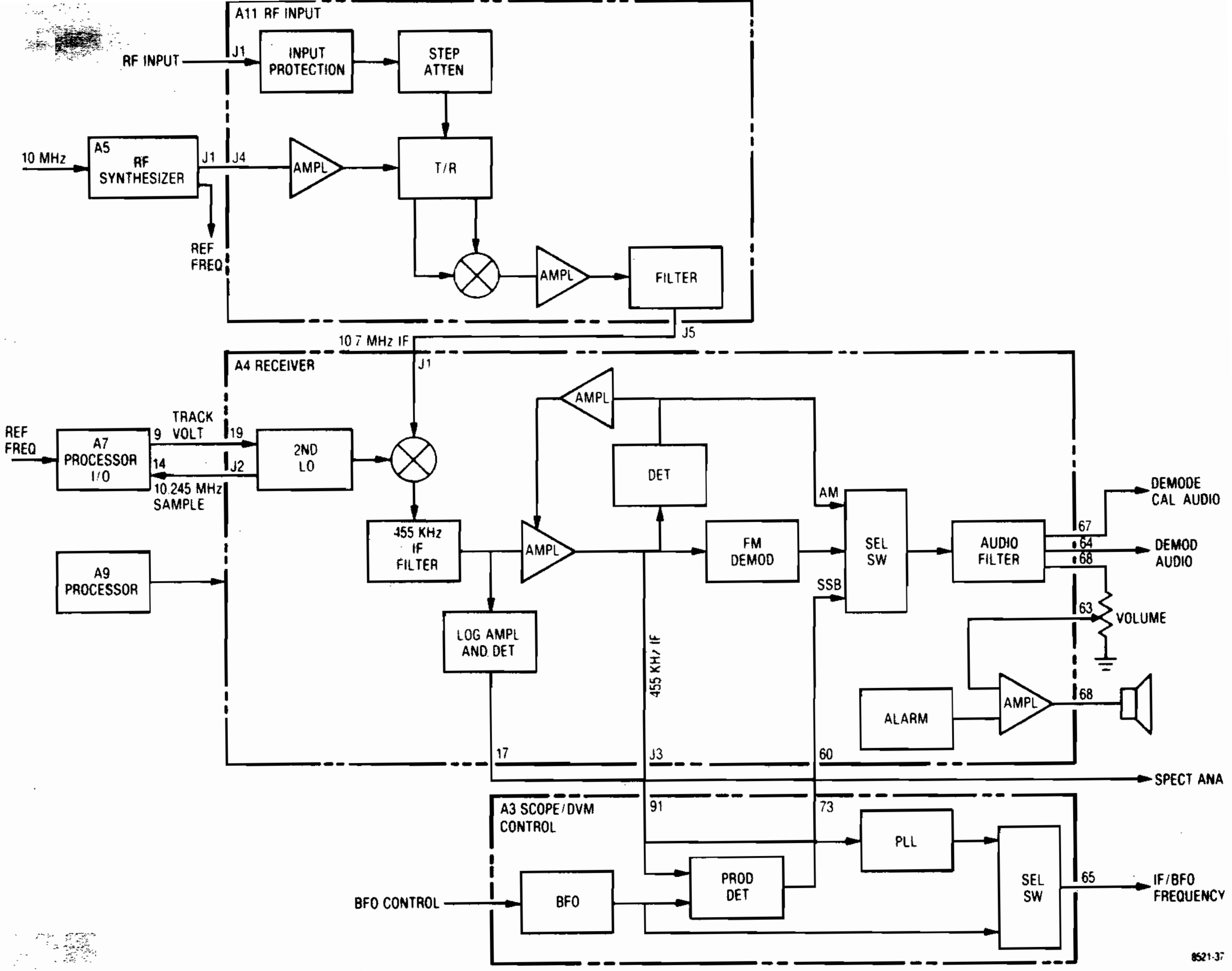


Figure 5-6. Monitor Mode Block Diagram

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 IF signal 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 Phase 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 -100 dBm to -20 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.

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. A OFFSET FREQUENCY output from the oscillator provides an input to the frequency counter for the determination of the duplex frequency.

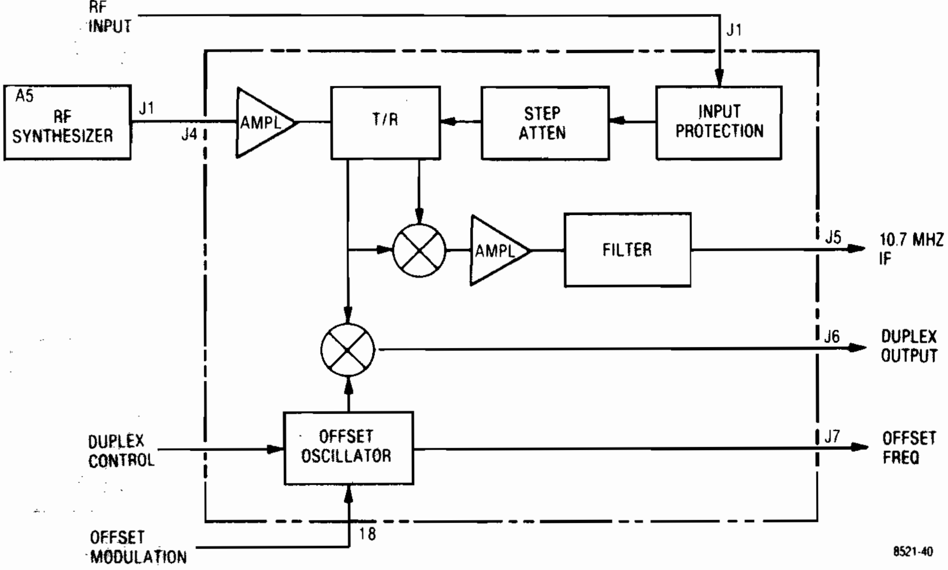


Figure 5-7. Duplex Generator Block Diagram

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 sumed 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 continuously 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.

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 controls set the modulation levels directly.

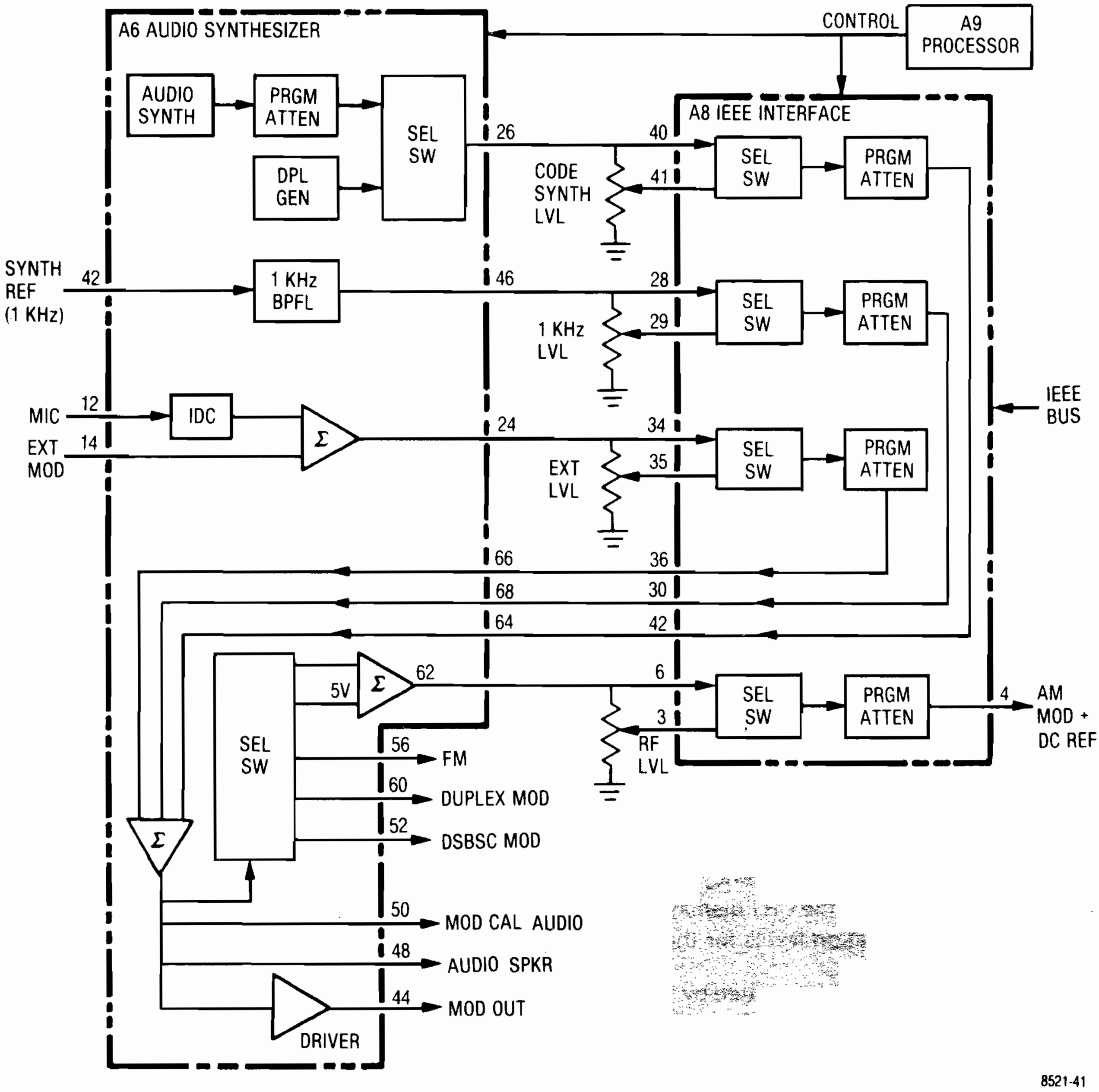


Figure 5-8. Code Synthesizer Block Diagram

5-63. The three modulation sources are sumed 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 sumed 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 an AM output. 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.

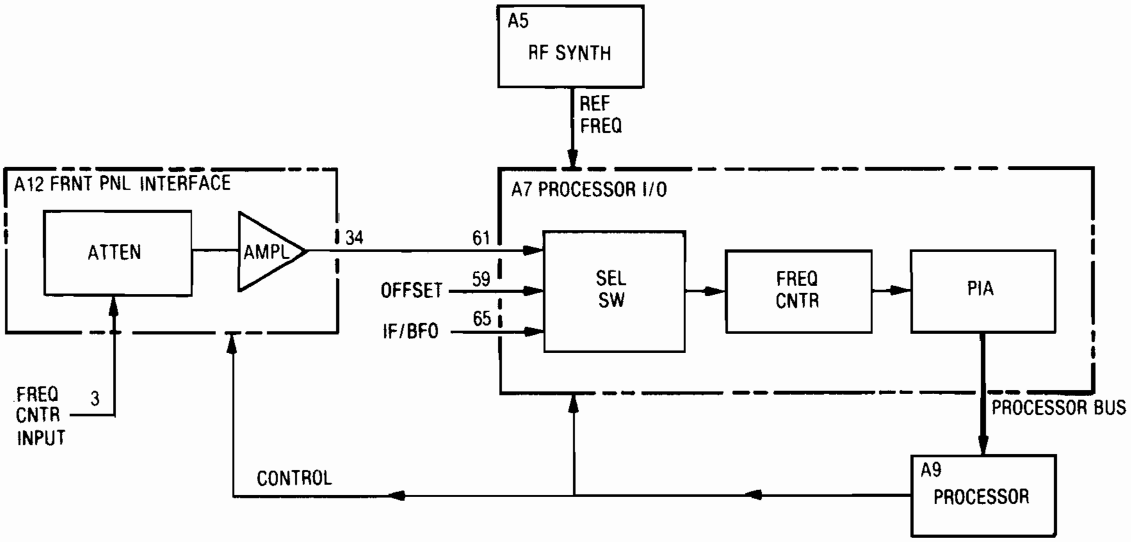


Figure 5-9. Frequency Counter Block Diagram 8521-39

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.

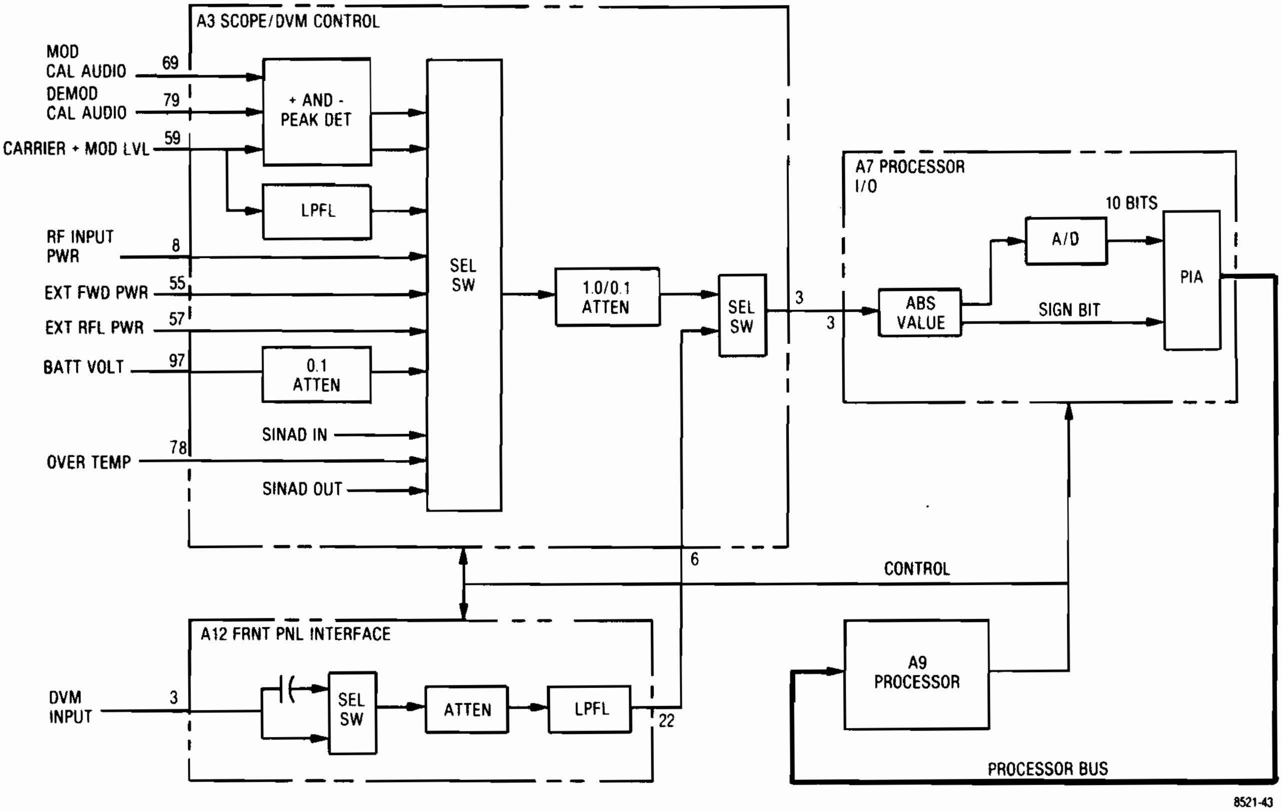


Figure 5-10. Digital Voltmeter (DVM) Block Diagram

5-73. Switching for the DVM input is contained on the Scope/DVM Control module (A3). One of ten internal measurement points may be selected for measurement. The switching action is controlled by the processor and is performed as required to obtain the information on the CRT. To keep the CRT information current, each of the required measurements are made in sequence at an approximate rate of thirty per second. The net effect is a multiplexing of the voltage information to the processor.

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 it's discharged state.

5-78. Sinad determination utilizes the two remaining inputs to the select switch. For a discussion on the sinad function see para 5-96.

5-79. The selected internal measurement signal is then passed through a range attenuator. Signals from the Select Switch have a 0 to +10 volt range while the DVM input has a 1 volt maximum input requirement. The processor automatically determines and sets the correct range on the attenuator so that the input level to the DVM is maintained at less than 1 volt. For levels from the select switch less than 1 volt, the attenuator is ranged to the unity gain position for maximum measurement resolution.

5-80. A select switch following the internal range attenuator gates either the internal measurement points or the external input to the DVM circuitry. External DVM inputs are applied through the front panel jack to the Front Panel Interface module (A12). On the Interface module, a processor controlled switch selects between a direct coupled or a capacitively coupled path for DC and AC measurements respectively. A range attenuator follows the AC/DC switch to provide processor controlled autoranging over a four decade range. Input voltages from 1 millivolt to 300 volt can be handled through the DVM Input.

5-81. For DC measurements a lowpass filter (LPFL) removes AC signal components. The filter provides approximately 25 dB rejection at 50 Hz so that accurate DC measurements can be made with superimposed AC line ripple. When the AC measurement mode is selected the LPFL is reprogrammed for less than 0.5 dB rejection at 10 kHz.

5-82. Positive and negative DVM input levels are full-wave rectified by the Absolute Value circuit on the Processor I/O module (A7). The outputs of the Absolute Value circuit provide a positive voltage level equal to the magnitude of the input voltage and a SIGN BIT indicating the polarity of the input signal. For AC measurements a lowpass filter is switched into the Absolute Value circuit to filter the rectified AC input for it's average level. The processor then multiplies by 1.11 to obtain the RMS value.

5-83. An analog to digital converter (A/D) converts the magnitude voltage level into a 10-bit digital word. This digital word when combined with the SIGN BIT is a binary representation of the input voltage level. The peripheral interface adapter transfers the information to the processor.

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.

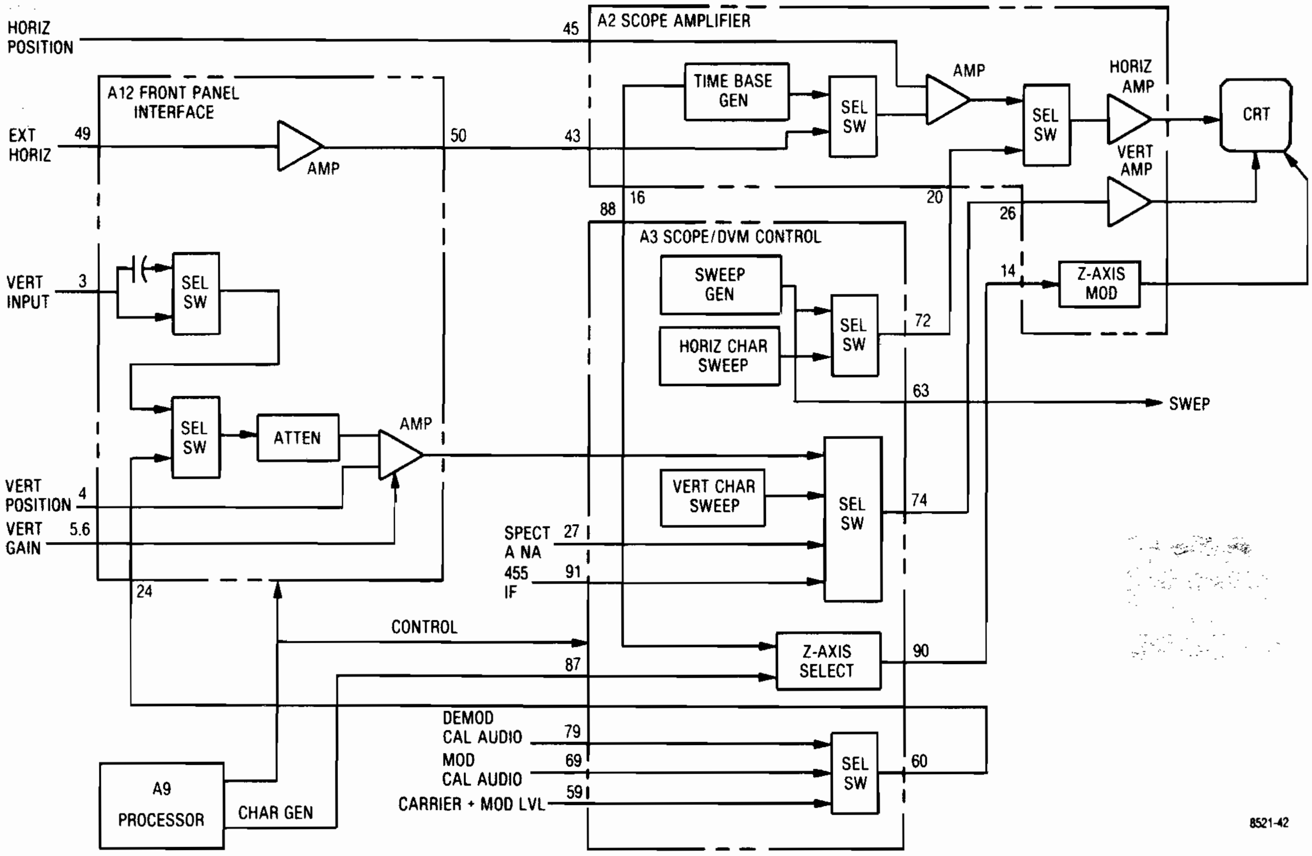


Figure 5-11. Oscilloscope Block Diagram

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 sumation amp where the HORIZONTAL POSITION signal from the front panel is added. The resulting DC offset positions the display horizontally on the CRT.

5-88. Six decade sweep ranges from 1μ sec 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 preceeded 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. Sinad Meter

5-97. Sinad, which is defined as the ratio of noise plus distortion to signal plus noise plus distortion, is a measurement of the audio quality at a receiver output. Measurement of the Sinad is implemented with a 1 kHz notch filter. For a receiver receiving a 1 kHz tone the audio output is applied to the 1 kHz notch filter. Sinad is then the ratio of the signal power at the output of the notch filter to the signal power at the input of the notch filter. A block diagram of the Sinad Meter is shown in figure 5-12.

5-98. The Sinad Input from the front panel is AC coupled to the range Attenuator on the Front Panel Interface module (A12). Processor control on the Attenuator allows a wide range of input levels to be automatically handled. The output of the Attenuator is routed to the 1 kHz Notch Filter on the Scope/DVM Control module (A3). Detectors, comprised of fullwave rectifiers and filters, on the input and output of the notch filter determine the respective power levels. The DC outputs of the detectors are read by processor through the DVM. The processor determies the ratio between the two readings and displays the Sinad.

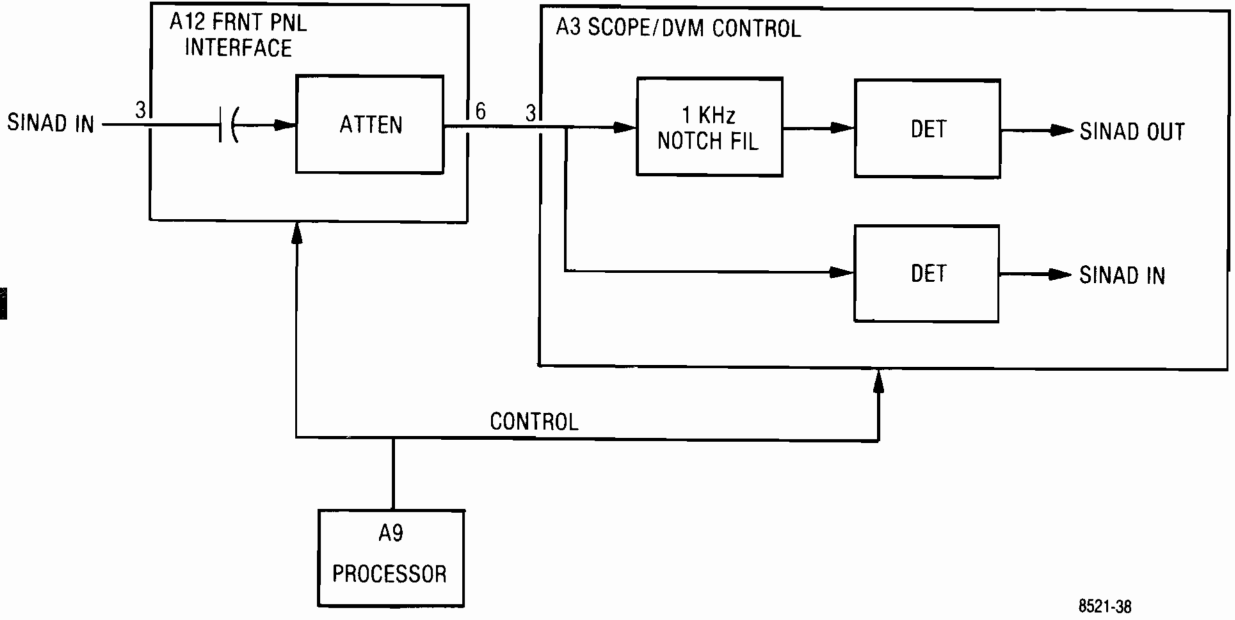


Figure 5-12. Sinad Meter Block Diagram

5-99. ALIGNMENT PROCEDURE

5-100. Introduction

5-101. This section provides a basic (para 5-105) and an extended (para 5-118) 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.

5-102. Test Equipment Required

5-103. 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 R1004A
Test Point Shorting Jumper	
Nonmetallic Alignment Tool	

*A R2001A is a suitable substitute

Table 5-4. Extended Test Equipment Required

Description	Model
*Oscilloscope	Motorola R1004A
*Digital Voltmeter	Motorola R1001A
*RF Signal Generator	Motorola R1201A
*Modulation Meter	Boonton 82AD
Receiver Test Cover	Motorola 15-P01324V001
Extender Card Set	Motorola 67-P01322V001

*A R2001A is suitable for use in place of these separate equipments.

5-104. 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.

5-105. Basic Alignment Procedure

5-106. CRT Astigmatism and Geometry

1. Select the Monitor Function and the Gen/Mon Mtr Display on the R2001A. 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 5-13) 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.

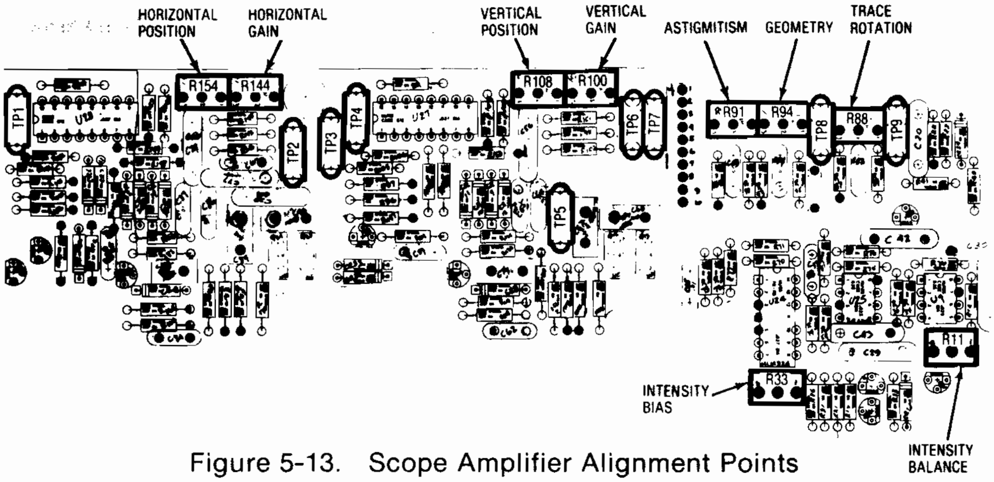


Figure 5-13. Scope Amplifier Alignment Points

5-107. 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 5-13) 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.

5-108. CRT Intensity Balance

1. Select the Scope DC Display and the 1 mSec/Div Horizontal Sweep rate on the R2001A. Set the Horizontal Timebase Veriner 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 5-13) for uniform intensity of the horizontal trace from left to right. The Balance potentiometer affects the intensity on the left side of the trace.

5-109. CRT Horizontal Centering

1. Select the Gen/Mon Mtr Display on the R2001A. Adjust the Intensity Control for a comfortable viewing brightness.
2. With the Test Point Shorting Jumper connect TP1 of the Scope Amplifier Board (Figure 5-13) to chassis ground.
3. Adjust the Horizontal Position Potentiometer (Figure 5-13) so that the vertical trace on the CRT screen passes through the graticule center point.
4. Remove the jumper from TP1.

5-110. CRT Vertical Centering

1. Select the Gen/Mon Mtr Display on the R2001A. Adjust the Intensity Control for comfortable viewing brightness.
2. With the Test Point Shorting Jumper connect TP4 of the Scope Amplifier Board (Figure 5-13) to chassis ground.
3. Adjust the Vertical Position Potentiometer (Figure 5-13) so that the horizontal trace on the CRT screen passes through the graticule center point.

5-111. CRT Trace Rotation

1. Select the Gen/Mon Mtr Display on the R2001A. Adjust the Intensity Control for a comfortable viewing brightness.
2. Adjust the Trace Rotation Potentiometer for a properly rotated CRT display.

5-112. CRT Horizontal Gain

1. Connect the Mod Out Jack to the Ext Horiz Jack on the R2001A front panel.
2. Set the R2001A 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 5-13).
4. Using the front panel Horizontal Vernier Control adjust for a 3 V p-p amplitude on the sinewave at TP1.
5. With 3V p-p at TP1 adjust the Horizontal Gain Potentiometer (Figure 5-13) 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).

5-113. CRT Vertical Gain

1. Connect the Mod Out Jack to the Vert Input Jack on the R2001A front panel.
2. Set the R2001A 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 5-13).
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 5-13) for a 6 cm p-p sinewave on the CRT. (use the front panel Position Controls to center the waveform on the CRT).

5-114. Vertical Input Gain

1. Set the R2001A for the Generate FM Function and the Scope DC Display. Set the Horiz Control for 1 m Sec/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.
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 6 V 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 R2001A.
5. Adjust the Input Vertical Gain Potentiometer on the Front Panel Interface Board (Figure 5-14) for a 6 cm p-p sinewave on the CRT. (Use the front panel Position Controls to center the waveform on the CRT.)

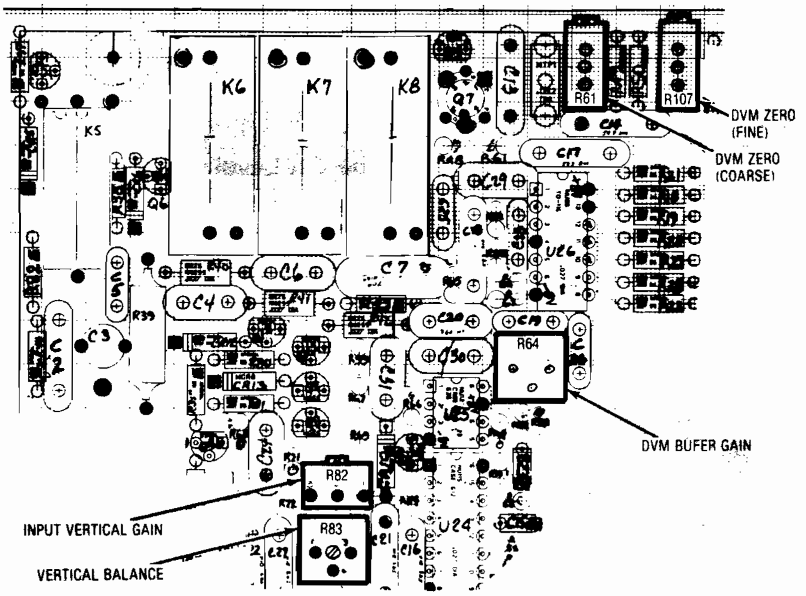


Figure 5-14. Front Panel Interface Alignment Points

5-115. DVM Zero

1. Select the DVM Display and the DC Mode on the R2001A.

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 5-14) for a zero reading on the DVM Display.

5-116. Spectrum Analyzer Centering

1. Select the Spect Analyzer Display on the R2001A. 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 5-15) so that the spectral line on the CRT is centered about the center graticule line.

5-117. Horizontal Time Base

1. Select the Tone Memory Display and the Generate FM Function on the R2001A. 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.

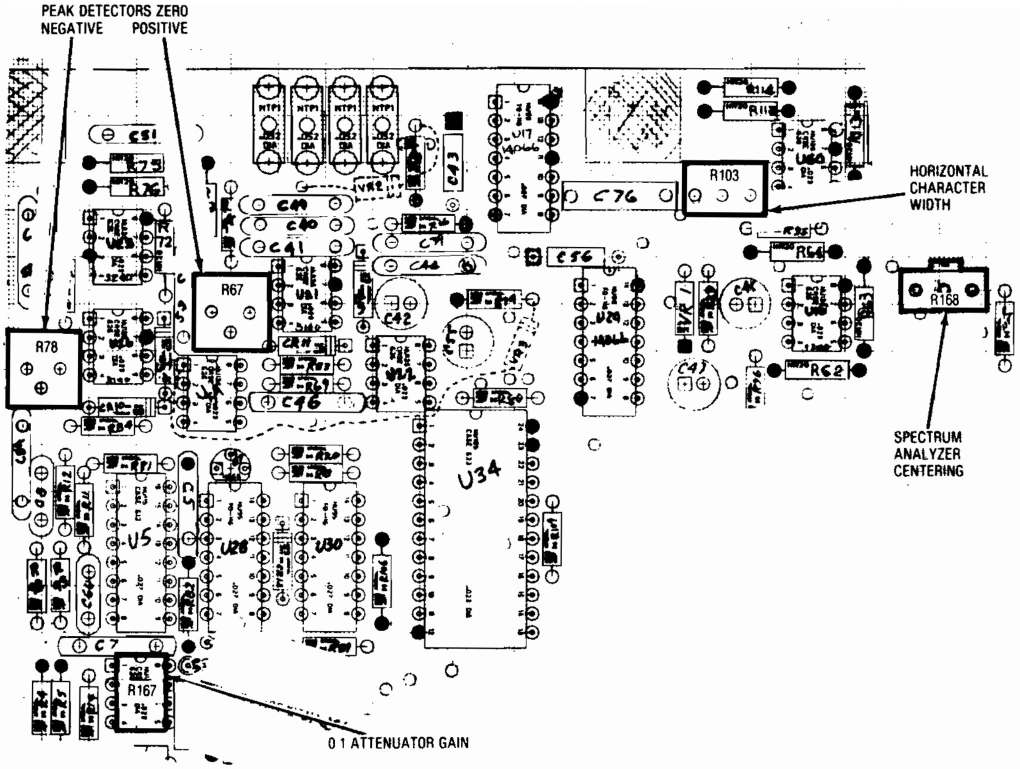


Figure 5-15. Scope/DVM Control Alignment Points

4. Adjust the Coarse Time Base Calibration Potentiometer on the Scope Amplifier Board (Figure 5-16) 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.

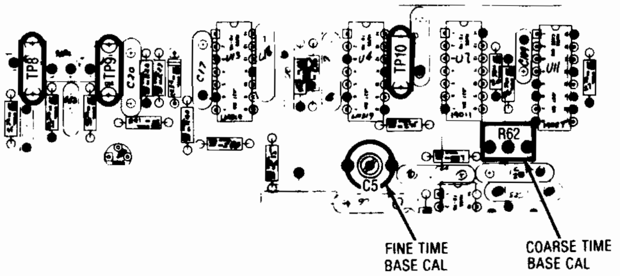


Figure 5-16. Horizontal Time Base Alignment Points

5. Set the Oscilloscope Horizontal Control for a 100 μ Sec/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 5-16) 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.

5-118. Extended Alignment Procedure

5-119. DVM

1. Remove the top and bottom covers of the R2001A.

2. Connect the R2001A to a primary power source and turn it on. Allow approximatly 15 minutes warm up 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 with a floating input between pin 1 and pin 6 of J3 on the bottom side of the motherboard.

4. Adjust the Coarse and Fine DVM Zero potentiometers on the Front Panel Interface board (Figure 5-17) for a reading of 0 ±0.5 mV on the external DVM.

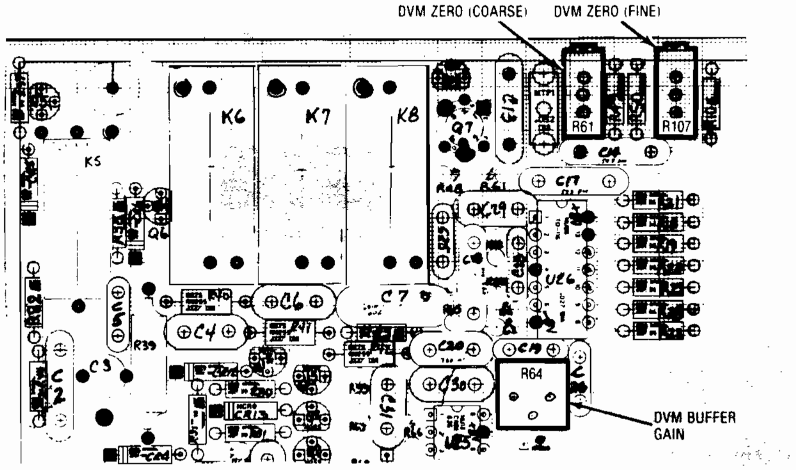


Figure 5-17. DVM Input Buffer Alignment Points

5. Remove the ground from the DVM Input and connect the DVM Input to TP 12 of the Scope/DVM Control Board. (Figure 5-18)

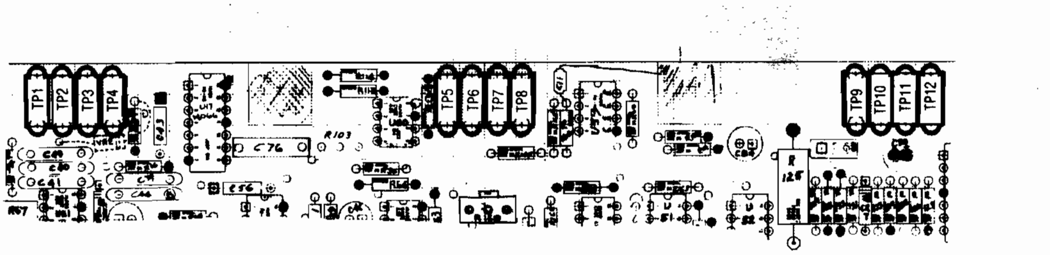


Figure 5-18. Scope/DVM Control Test Point Numbering

6. Disconnect the external DVM from pins 1 and 6 of J3 and connect it to TP 12 of the Scope/DVM Control Board and chassis ground. Note the DVM reading for TP 12.

7. Reconnect the external DVM between pin 1 and pin 6 of J3. The external DVM should show a reading equal to one-tenth the voltage at TP 12 noted in paragraph 5-119.6 plus or minus 10 mV. If the reading falls outside this range it will be necessary to physically disconnect the front panel from the chassis in order to adjust the DVM Input Gain Potentiometer on the Front Panel Interface Card (Figure 5-17). Adjust the DVM Input gain for a reading on the external DVM equal to one-tenth the voltage noted for paragraph 5-119.6. Reconnect the front panel to the chassis.

8. Repeat paragraphs 5-119.3 and 5-119.4.

9. Disconnect the external DVM. With the DVM input jack still shorted adjust the A/D Zero Potentiometer on the I/O Board (Figure 5-19) for a 0.0 VDC reading on the R2001A CRT display.

CAUTION

Do not use the card extender while aligning the Processor I/O board.

10. Remove the short from the DVM Input and connect the DVM Input to TP 12 of the Scope/DVM Control Board.

11. Adjust the A/D Gain Potentiometer on the Processor I/O Board (Figure 5-19) for a DVM reading on the CRT equal to the voltage measured at TP 12 with the external DVM for paragraph 5-119.6.

12. Connect the external DVM to TP11 of the Scope/DVM Control Board and chassis ground. Note the DVM reading for TP11.

13. Disconnect he external DVM from TP11 and connect the DVM Input Jack on the front panel to TP11 of the Scope/DVM Control Board.

14. Adjust the A/D Balance Potentiometer on the Processor I/O Board (Figure 5-19) for a DVM reading on the CRT equal to the voltage measured at TP11 with the external DVM in step 13.

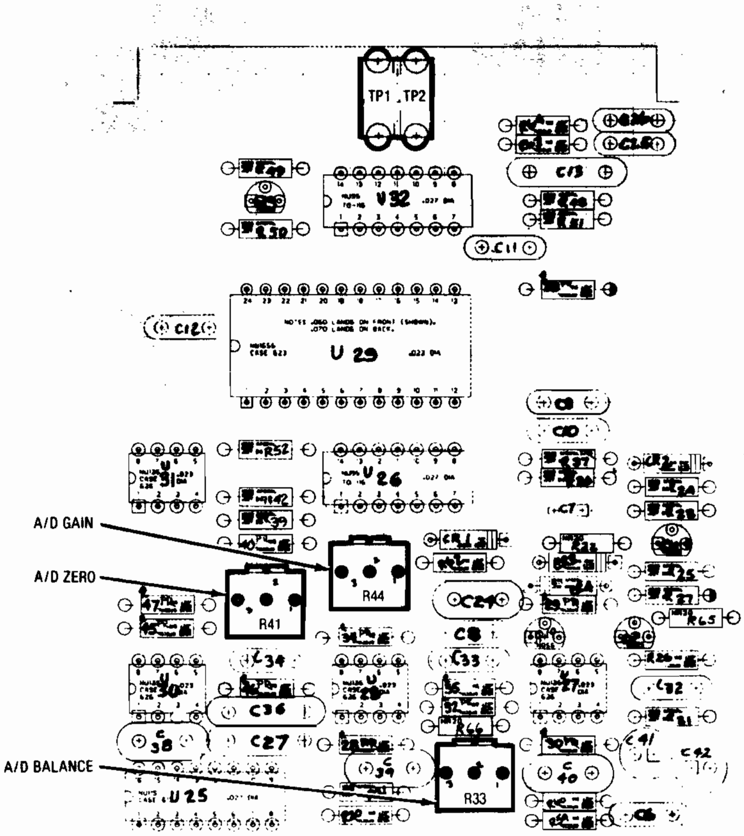


Figure 5-19. Processor I/O A/D Alignment Points

5-120. Character Generator

1. Perform the Basic Alignment Procedure of para 5-105.
2. Turn the R2001A off and extend the Scope/DVM Control Board using the 100 pin extender card.
3. Turn the R2001A on and select the Monitor FM Function and the Gen/Mon Mtr Display.
4. Adjust the Horizontal Character Sweep Width Potentiometer on the Scope/DVM Control Board (Figure 5-20) 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.

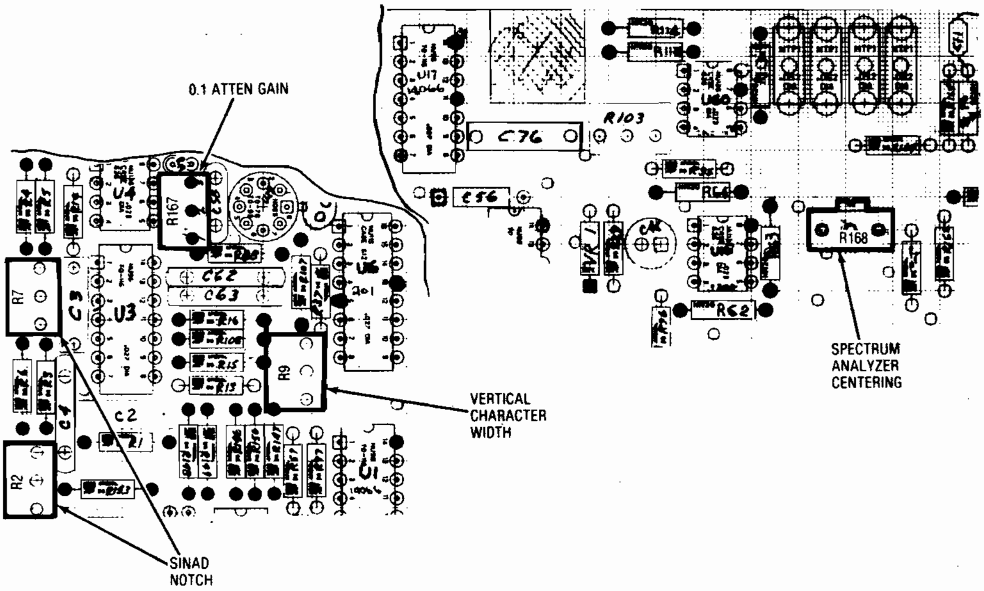


Figure 5-20. Scope/DVM Control Char Sweep and Sinad Alignment Points

5. Adjust the Vertical Character Sweep Width Potentiometer on the Scope/DVM Control Board (Figure 5-20) so that the bottom edge of the CRT display is approximately 3.3 graticule divisions below the graticule center line.
6. Turn the system power off and reinstall the Scope/DVM Control Board into the R2001A.

5-121. Sinad Notch Filter

1. Turn the R2001A off and extend the Scope/DVM Control Board using the 100 pin extender card.
2. Turn the R2001A on and select the Generate FM Function and the Gen/Mon Mtr Display.
3. Set the Modulation Switch and the Ext. Level Control to their off positions. Set the BW Switch to the Narrow position and adjust the 1 kHz Level Control for a 20 kHz deviation reading on the CRT display.
4. Connect the Mod Out Jack on the fron panel to the Vert/Sinad/DVM/Counter Input Jack on the front panel.

5. Alternately adjust the two SINAD Notch potentiometers on the Scope/DVM Control Board (Figure 5-20) for a maximum SINAD reading on the CRT display. A reading greater than 30 dB should be obtained.

6. Turn the system power off and reinstall the Scope/DVM Control Board into the R2001A.

5-122. Receiver

5-123. AM Detector

1. Perform the basic alignment procedure of para 5-105.

2. Turn the R2001A 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 R2001A 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 approximately -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.

5-124. 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 R2001A.

7. Connect the Demod Out Jack to the Vert/Sinad/DVM/Counter Input Jack on the front panel. Select the DVM Display and the DC DVM Mode on the R2001A.

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

5-125. Spectrum Analyzer

1. Select the Monitor Function and the Spectrum Analyzer Display on the R2001A. 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 5-125.4 and 5-125.5 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.

5-126. CHECKOUT PROCEDURE

5-127. Introduction

5-128. This section provides a system checkout procedure. This procedure will help isolate system failures when used with the troubleshooting information in para 5-146.

5-129. Test Equipment Required

5-130. 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 R2001A is suitable for use in place of these separate equipments.

5-131. Procedure

5-132. Power On

1. Check that the AC input power select card is in the 120 V postion. 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.

5-133. 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.

5-134. 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.

5-135. 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 Continuous 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.

5-136. 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.

5-137. DVM

1. Maintaining the same conditions as in paragraph 5-136.2, select the DVM Display and the AC Mode on the display. Verify a DVM reading of 0.707 vrms ±0.04 vrms.

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

5-138. 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 5-138.1, 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 the Auto mode.

5-139. 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 Continuous Mode and verify a SINAD reading 12 dB ±1 dB.

5-140. Scan Mode

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

5-141. 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 5-141.2 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 5-141.13.

5-142. 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.

5-143. 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 5-143.1 except for the AM Function.

3. Repeat paragraph 5-143.1 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 μ Vrms).

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.

5-144. Spectrum Analyzer

1. Set the UUT for the Monitor Function of 300 MHz the Spectrum Analyzer Display, and 0 dB input attenuation. Set at 300 MHz. 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.

5-145. 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.

5-146. System Troubleshooting

5-147. 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 5-126 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.

5-148. 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
5-132	No AC indication	1. Check AC linecord and line fuse. 2. If system powers up normally when on, Replace AC LED.
5-132	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
5-132	System won't turn on	1. Disconnect the high voltage supply from the low voltage supply at A10P1. Check for +7.9 VDC at pin 1 of J2 on the low voltage supply and for +12 VDC at pin 2. 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 at C15 on the high voltage supply. (C15 is a feedthru cap on the high voltage supply and can be reached from the top side just beyond the CRT socket.) **CAUTION** There is 110V on the rear panel connector even when the power switch is turned off. If 9 volts is not present replace the high voltage supply (A1). 3. If items 1 and 2 check okay replace the low voltage supply (A1).
5-132	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.
5-133	More than one key is inoperative or has the wrong effect	1. Replace the Processor Module (A9).
5-133	Only one key is inoperative	1. Replace the defective key switch.
5-134	Any part of the nonvolatile memory fails to remember	1. Replace the Processor module (A9).
5-135	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 presence of the jumpers on J8 for the standard unit.

Table 5-6. System Troubleshooting (Cont)

Test Paragraph	Fault	Troubleshooting Procedure
		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.
5-135	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. 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".
5-136	Frequency Counter inoperative	1. Check for presence of a 1 kHz signal 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.
5-137	DVM AC mode is inoperative	1. Check for DVM signal at pin 22 of Processor Interface module (A12). If not present replace the Front Panel Interface module. 2. Check for short bursts of the DVM AC signal at TP8 of the Scope/DVM Control module (A3).

Table 5-6. System Troubleshooting (Cont)

Test Paragraph	Fault	Troubleshooting Procedure
		NOTE The DVM AC signal from the external input is multiplexed with the other signals to be measured. Thus only short bursts of the input signal will be observed at TP8. If signal is not present at TP8 replace the Scope/DVM Control module. 3. If the signal is okay to TP8 of A3, replace the Processor I/O module (A7).
5-137	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 or if greater than 1 volt, replace the Front Panel Interface module. 2. If the signal is okay from A12, switch to the AC mode and apply an AC signal to the DVM input. Proceed from step 2 under DVM AC mode inoperative.
5-138	No horizontal sweep	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).
5-138	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.
5-138	No vertical sync	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.

Table 5-6. System Troubleshooting (Cont)

Test Paragraph	Fault	Troubleshooting Procedure.
		2. If sync pulse and the syn present lines are okay replace the Scope Amplifier module (A2).
5-139	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.
5-141	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.
5-141	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".
5-142	Internal wattmeter in error	1. Replace RF input module (A11).
5-143	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).
5-143	Monitor frequency error display is missing	1. Go to the troubleshooting list under "frequency counter inoperative".
5-143	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.

Table 5-6. System Troubleshooting (Cont)

Test Paragraph	Fault	Troubleshooting Procedure
5-144	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).
5-144	Spectrum display is in error	1. Replace the Receiver module (A4).
5-145	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.

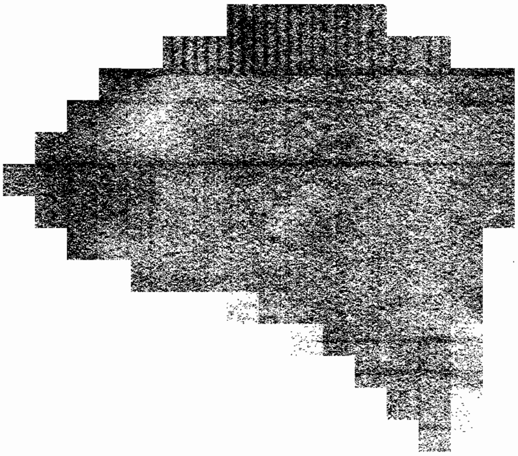
Module	Test Point No.	Signal Description
A2 Scope Amplifier	1	Horizontal Amp Input
	2	Horizontal Deflection Plate
	3	$\overline{\text{Horizontal Deflection Plate}}$
	4	Vertical Amp Input
	5	Focus Tracking Voltage
	6	Vertical Deflection Plate
	7	$\overline{\text{Vertical Deflection Plate}}$
	8	Z-Axis Modulator Output
	9	Intensity Tracking Voltage
	10	Time Base Output
A3 Scope/DVM Control	1	Vertical Character Sync
	2	Negative Peak Detector Output
	3	Gen Carrier Plus AM Level
	4	Positive Peak Detector Output
	5	Demodulated Calibrated Audio
	6	Not Used
	7	Ground
	8	Multiplexed A/D Signal
	9	Character Generator Reset
	10	Ground
	11	-8 VDC
	12	+8 VDC
A6 Audio Synthesizer	1	Synth/DPL Audio
	2	DPL Clock
	3	Unfiltered DPL

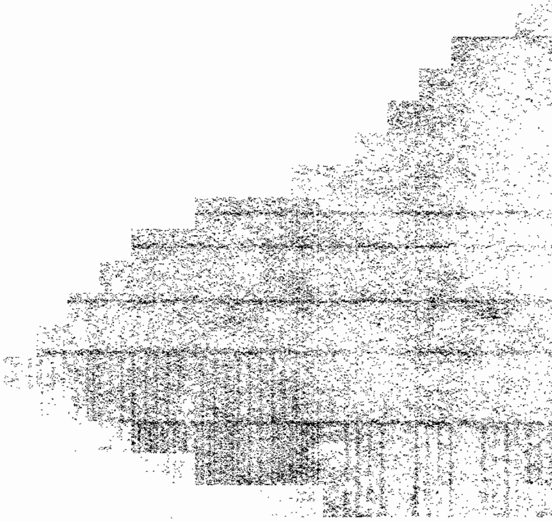
Table 5-7. Test Point Identification

Module	Test Point No.	Signal Description
	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 Processor I/O	1	A/D Input
	2	Unfiltered 10.245 MHz T.V.
	3	DVM/Freq. Counter Select
	4	Frequency Counter Input
	5	Not Used
A9 Processor	1	Ground
	2	Character Clock
	3	Character Row Clock
	4	Character Dot Clock
	5	Enable
	6	Character Line Clock
	7	R/W Select
	8	Char. Gen/Processor Select
A12 Front Panel Interface	1	Attenuator Buffer Output

SECTION 6

SYSTEM INTERCONNECT AND PARTS LISTS





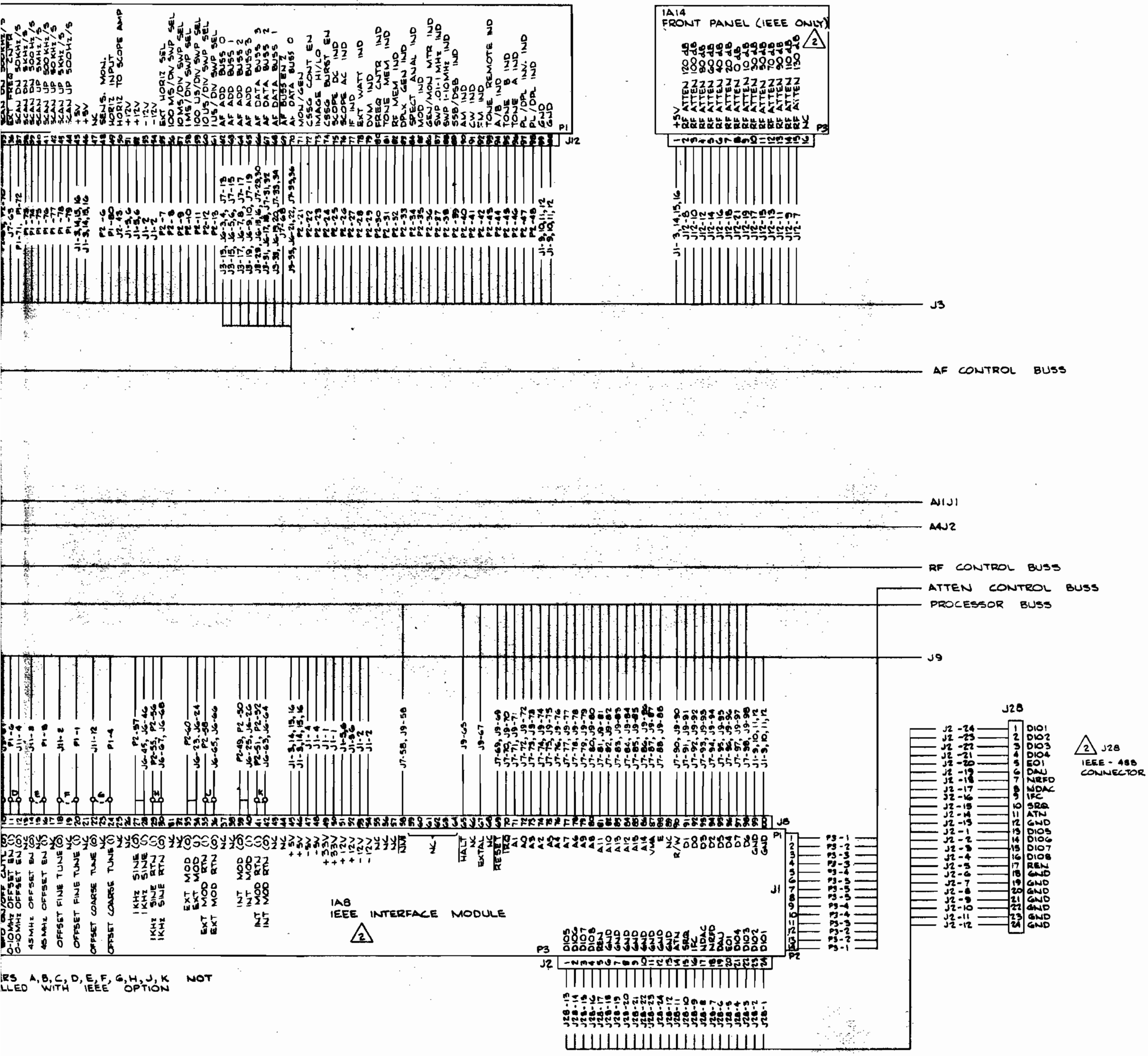
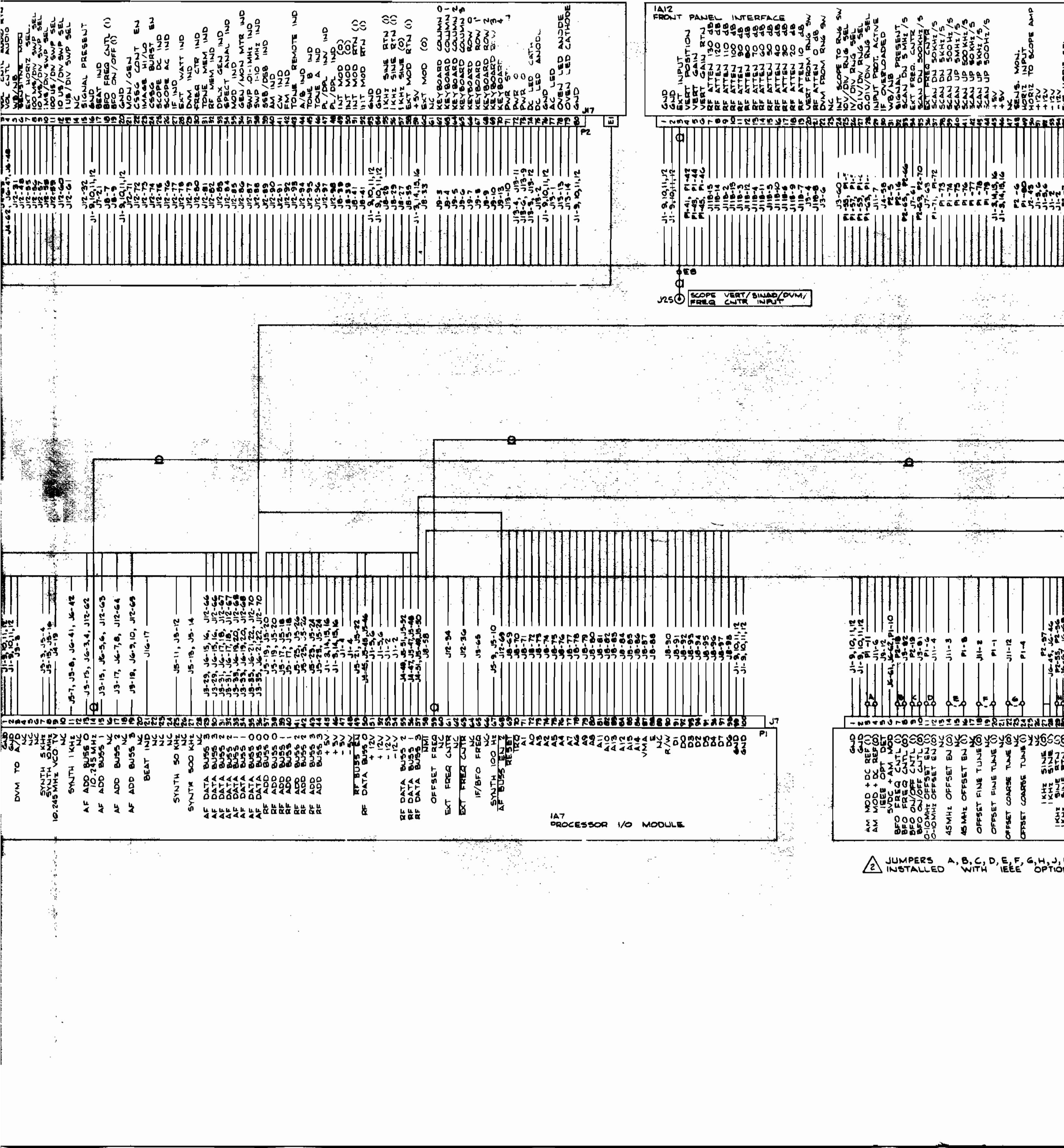
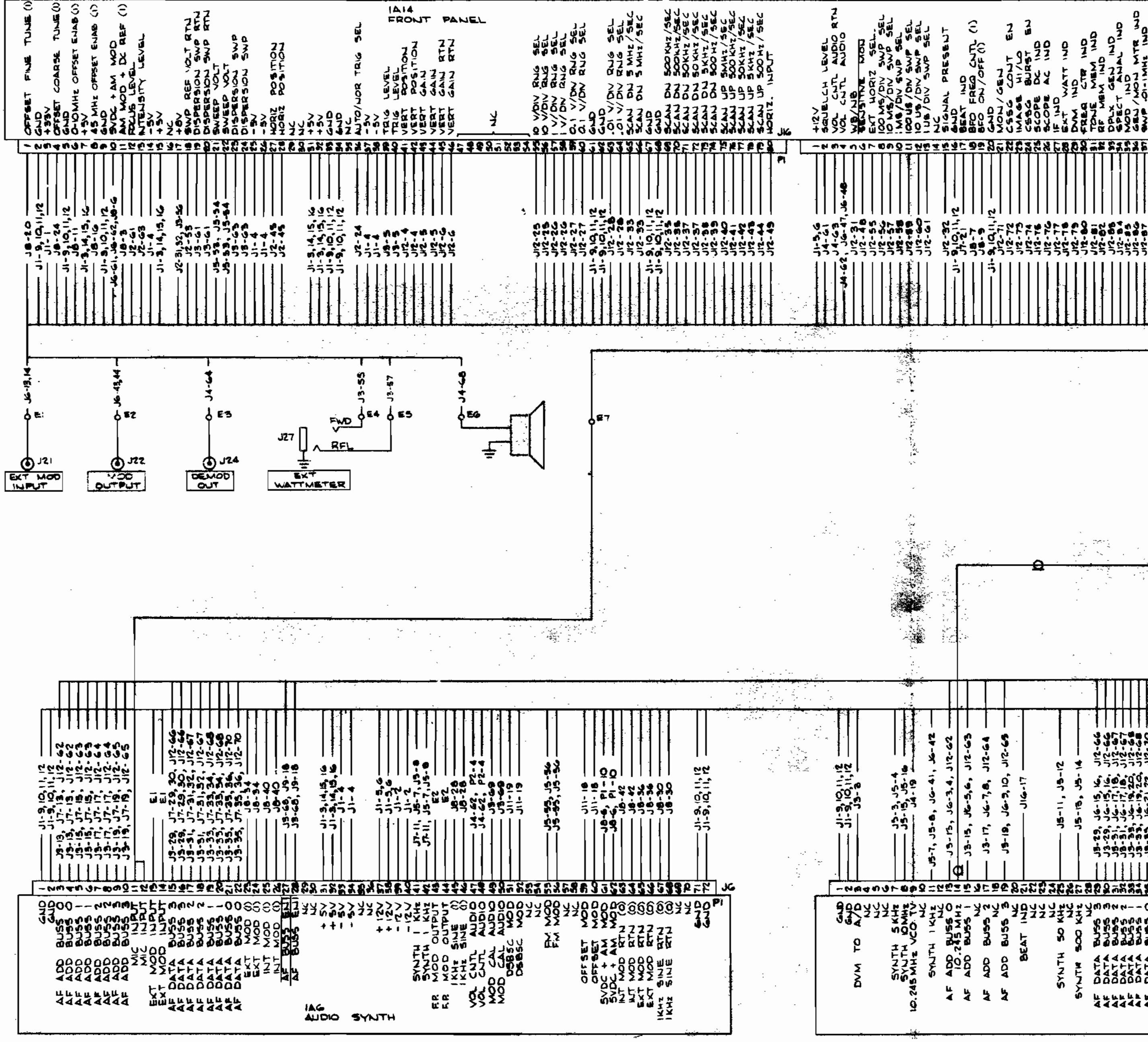


Figure 6-1. System Interconnect Diagram

(Sheet 2 of 2)



JUMPERS A, B, C, D, E, F, G, H, J,
INSTALLED WITH IEEE OPTIO


1A14
FRONT PANEL
J6
E1
E2
E3
E4
E5
E6
E7
J6-13,14
J6-43,44
J4-64
J3-55
J3-67
J4-68
J21
J22
J24
J27
FWD
RFL
EXT MOD INPUT
VCO OUTPUT
DEMOD OUT
EXT WATTMETER
OFFSET FINE TUNE (1)
OFFSET COARSE TUNE (1)
AM MOD + DC REF (1)
FOCUS LEVEL
INTENSITY LEVEL
SWP REF VOLT RTN
DISPERSION SWP RTN
SWEEP VOLT
HORIZ POSITION
VERT POSITION
AUTO/NOR TRIG SEL
TRIG LEVEL
VERT GAIN
NC
SCAN DN
SCAN UP
HORIZ. INPUT
SQUELCH LEVEL
VOL CNTL AUDIO RTN
VOL CNTL AUDIO
SIGNAL PRESENT
BEAT IND
BFO FREQ CNTL (1)
BFO ON/OFF (1)
MON/GEN
SCOPE DC IND
SCOPE AC IND
EXT WATT IND
DVM IND
FREQ CTR IND
RF MEM IND
1A6
AUDIO SYNTH
P1
J6
AF ADD BUSS
AF DATA BUSS
EXT MOD INPUT
EXT MOD
INT MOD
SYNTH 1 KHz
MOD OUTPUT
1KHz SINE
VOL CNTL AUDIO
MOD CAL AUDIO
DSBSC MOD
FM MOD
OFFSET MOD
5VDC + AM MOD
INT MOD RTN
EXT MOD RTN
1KHz SINE RTN
GND
DVM TO A/D
SYNTH 5 KHz
SYNTH 10MHz
10.245 MHz VCO TV
SYNTH 1 KHz
BEAT IND
SYNTH 50 KHz
SYNTH 500 KHz

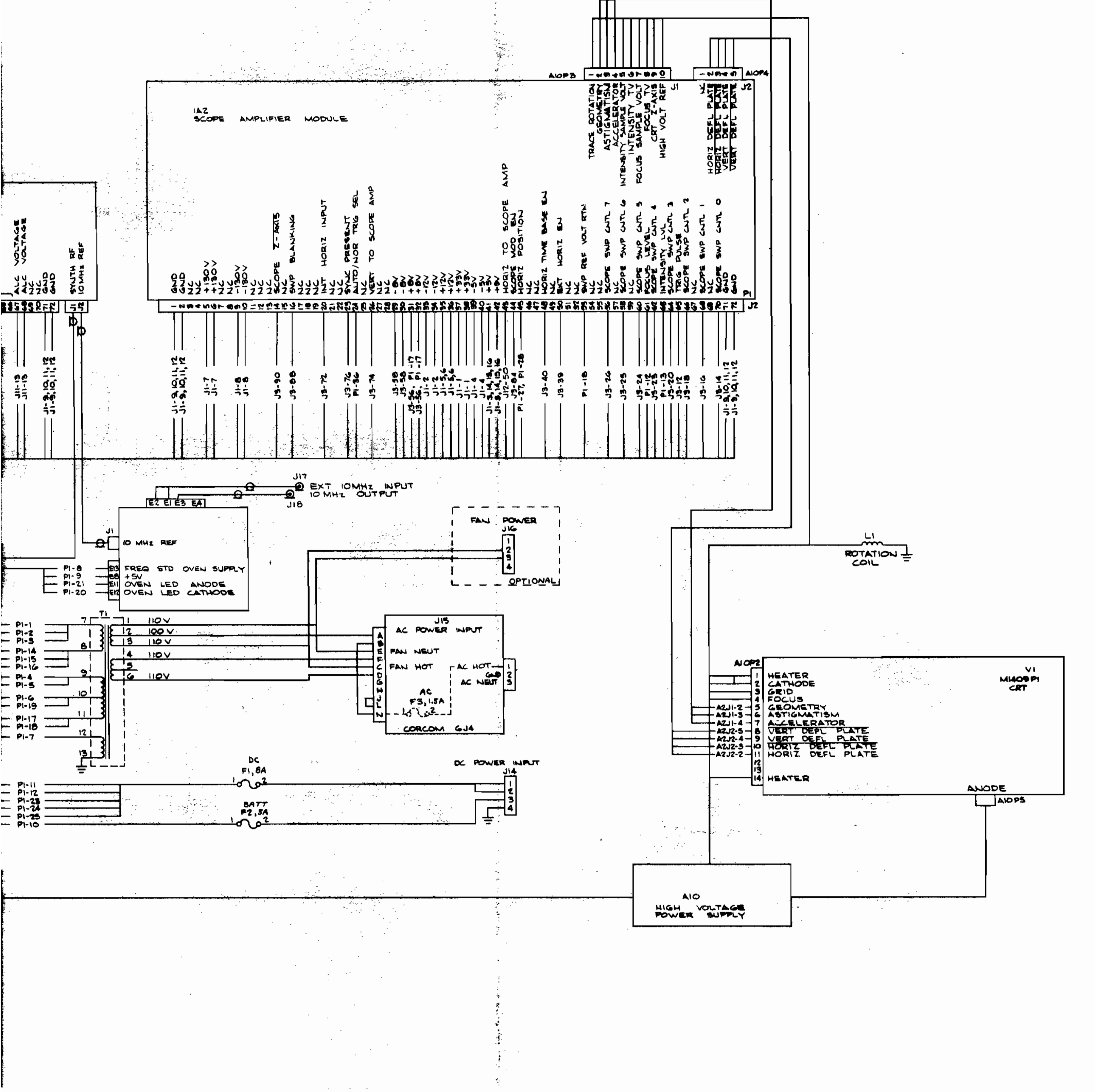
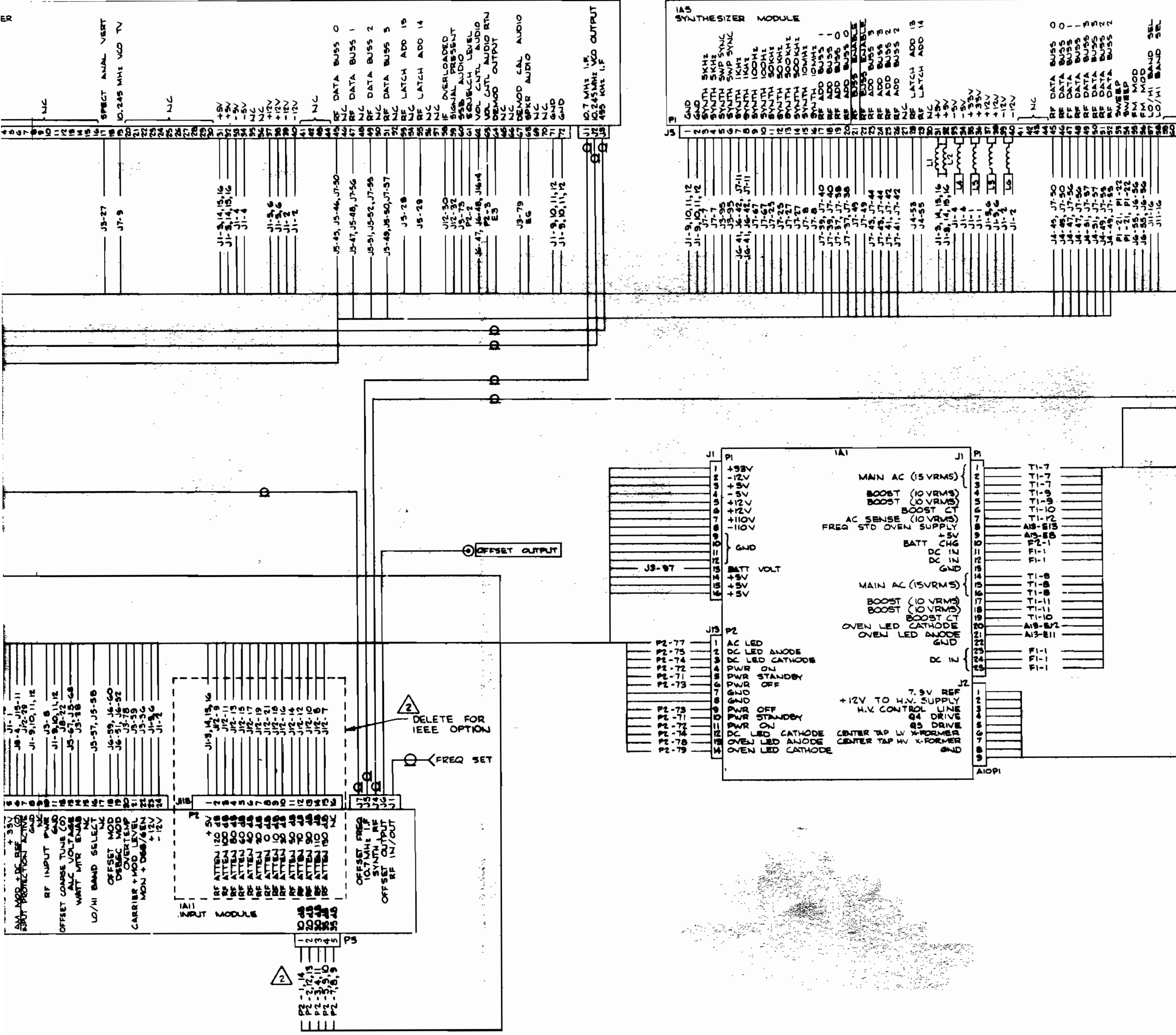


Figure 6-1. System Interconnect Diagram

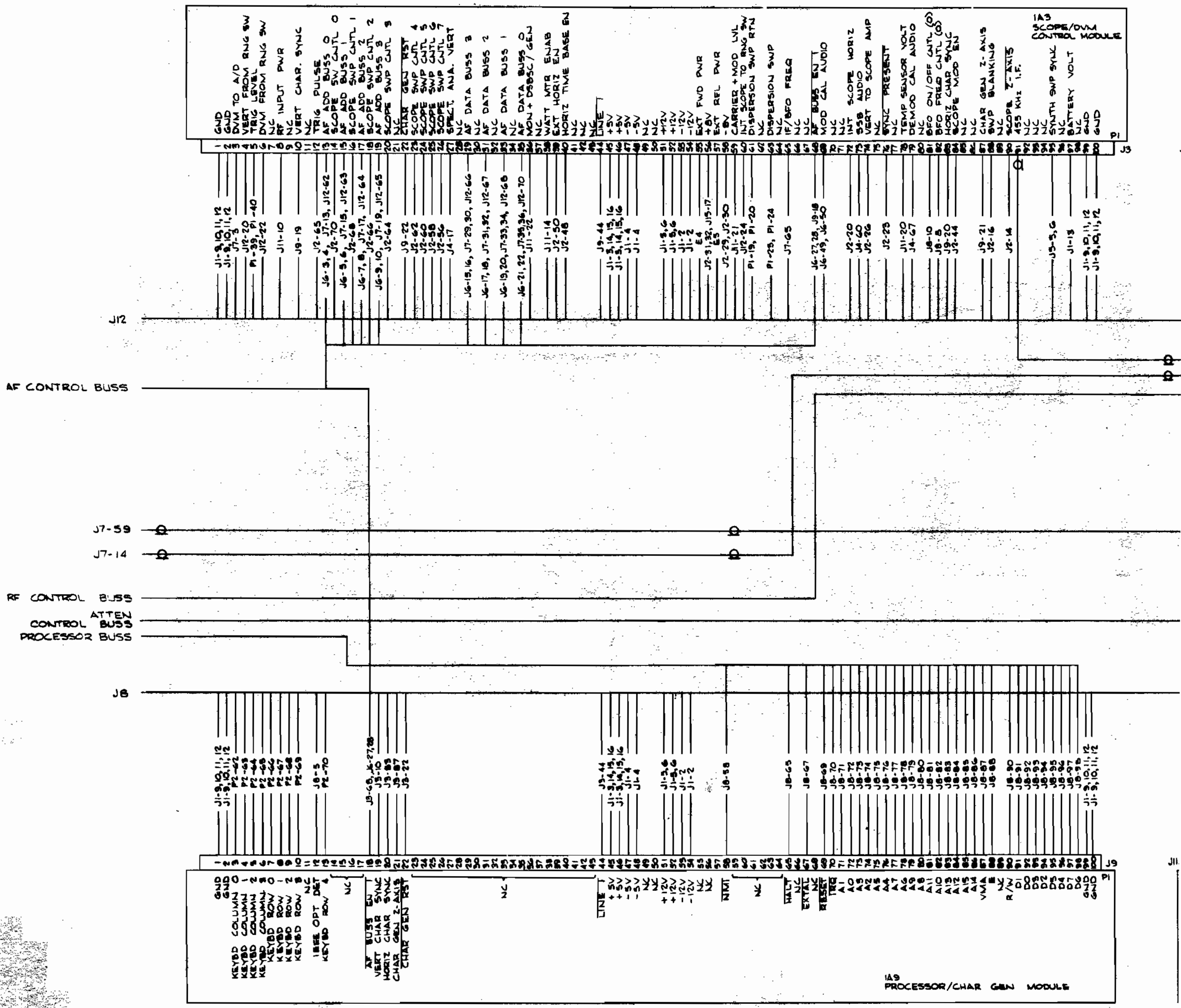
(Sheet 1 of 2)


1A5
SYNTHESIZER MODULE
1A1
1A11
INPUT MODULE
A10P1
OFFSET OUTPUT
FREQ SET
DELETE FOR IEEE OPTION
2
10.7 MHz I.F.
10.245 MHz VCO OUTPUT
455 KHz I.F.
SPECT ANAL VERT
10.245 MHz VCO TV
RF DATA BUSS 0
RF DATA BUSS 1
RF DATA BUSS 2
RF DATA BUSS 3
RF LATCH ADD 13
RF LATCH ADD 14
OVERLOADED
IF SIGNAL PRESENT
SSB AUDIO
SQUELCH LEVEL
VOL CNTL AUDIO RTN
VOL CNTL AUDIO
DEMOD OUTPUT
DEMOD CAL AUDIO
SPKR AUDIO
GND
NC
+5V
-5V
+12V
-12V
+35V
GND
SYNTH 5KHz
SYNTH SWP SYNC
SYNTH 1KHz
SYNTH 100Hz
SYNTH 100KHz
SYNTH 50KHz
SYNTH 500KHz
SYNTH 10MHz
RF ADD BUSS 0
RF ADD BUSS 1
RF ADD BUSS 2
RF BUSS ENABLE
RF ADD BUSS 3
RF DATA BUSS
SWEEP
FM MOD
LO/HI BAND SEL
L1
L2
L3
L4
L5
L6
P1
J5
J1
J13
J2
P2
P3
+33V
-12V
+5V
-5V
+12V
+110V
-110V
GND
BATT VOLT
+5V
MAIN AC (15 VRMS)
BOOST (10 VRMS)
BOOST CT
AC SENSE (10 VRMS)
FREQ STD OVEN SUPPLY
+5V
BATT CHG
DC IN
GND
MAIN AC (15VRMS)
BOOST (10 VRMS)
BOOST CT
OVEN LED CATHODE
OVEN LED ANODE
GND
DC IN
T1-7
T1-9
T1-10
T1-12
A13-E13
A13-E8
F2-1
F1-1
T1-8
T1-11
A13-E12
A13-E11
J3-97
AC LED
DC LED ANODE
DC LED CATHODE
PWR ON
PWR STANDBY
PWR OFF
GND
DC LED CATHODE
OVEN LED ANODE
OVEN LED CATHODE
P2-77
P2-75
P2-74
P2-72
P2-71
P2-73
P2-78
P2-79
7.9V REF
+12V TO H.V. SUPPLY
H.V. CONTROL LINE
Q4 DRIVE
Q5 DRIVE
CENTER TAP LV X-FORMER
CENTER TAP HV X-FORMER
GND
+33V
AM MOD + DC REF
INPUT PROTECTION ACTIVE
GND
RF INPUT PWR
GND
OFFSET COARSE TUNE (C)
ALC VOLTAGE
WATT MTR ENAB
NC
LO/HI BAND SELECT
OFFSET MOD
DSBSC MOD
OVERTEMP
CARRIER + MOD LEVEL
MON + DSB/GEN
+12V
-12V
+5V
RF ATTEN 120
RF ATTEN 10
RF ATTEN 20
RF ATTEN 40
RF ATTEN 80
RF ATTEN 1
RF ATTEN 2
RF ATTEN 4
RF ATTEN 8
RF ATTEN 110
RF ATTEN 130
OFFSET FREQ
10.7 MHz IF
SYNTH RF
OFFSET OUTPUT
RF IN/OUT
P2-1,14
P2-2,12,13
P2-3,4,11
P2-5,6,10
P2-7,8,9
J11B

NOTES:

1. THIS DIAGRAM APPLIES TO COMMUNICATION SYSTEM ANALYZER PART NUMBER 01-P00381N. FOR MATRIX OF CONFIGURATIONS SEE 00-P04134T

2. APPLIES TO UNITS WITH IEEE OPTION ONLY. FOR REFERENCE DRAWINGS SEE: 01-P00381N003 01-P00381N004



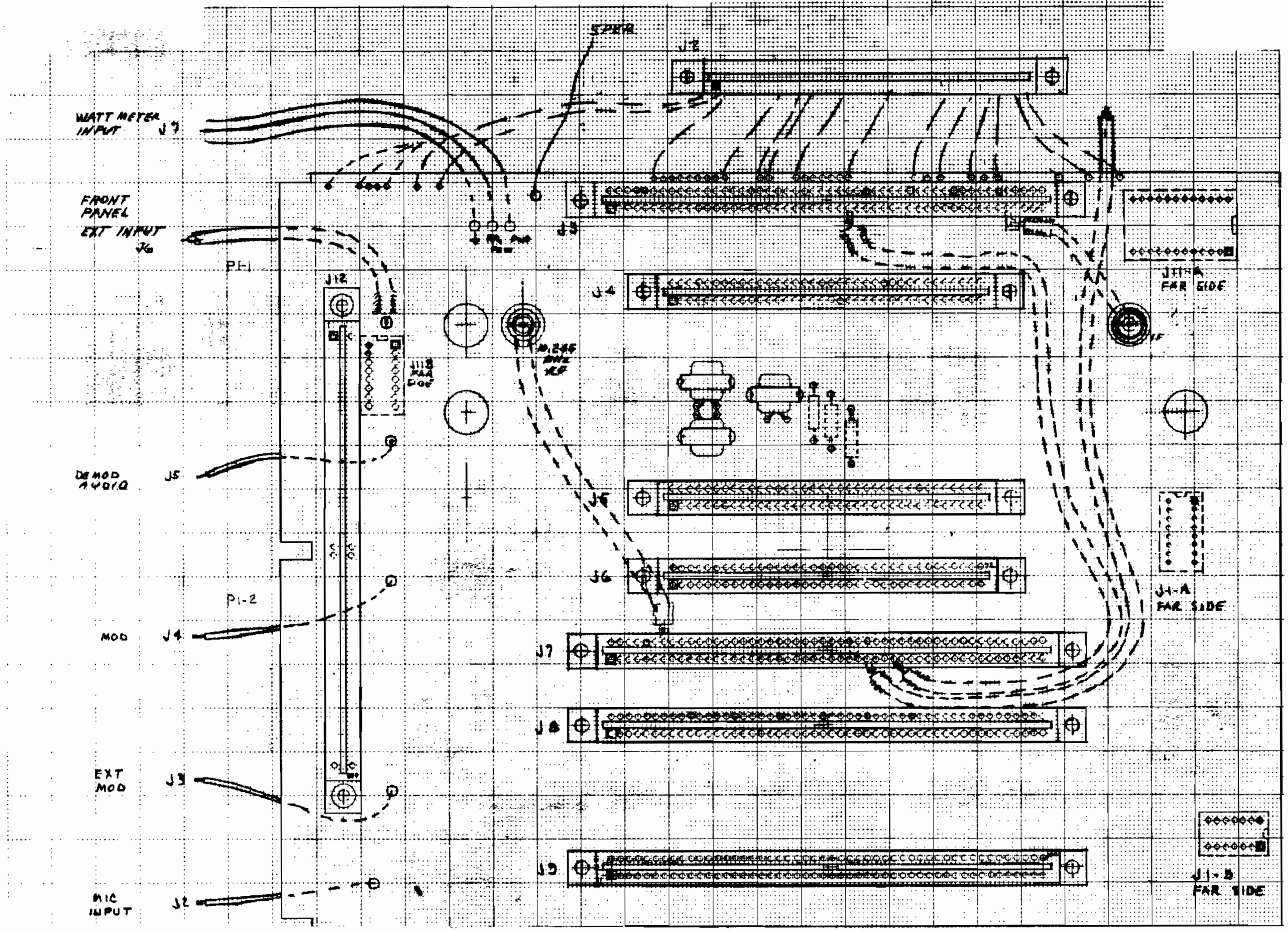
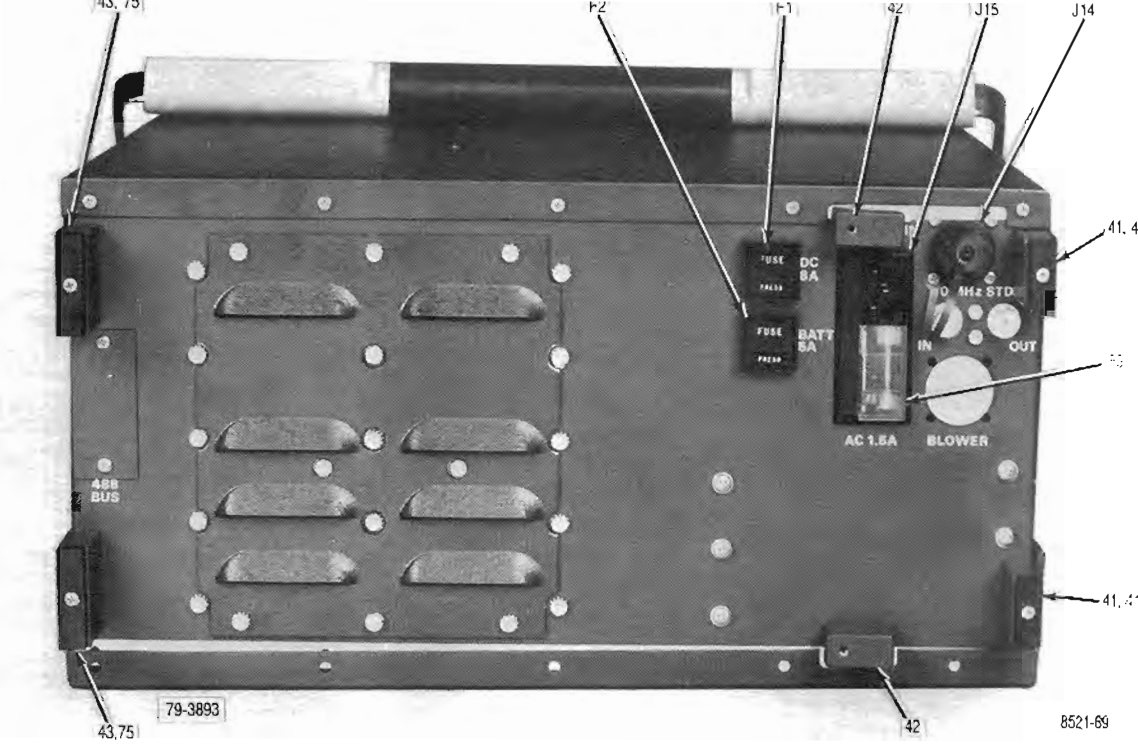


Figure 6-2. Motherboard Assembly Parts Locator

RTL-4060A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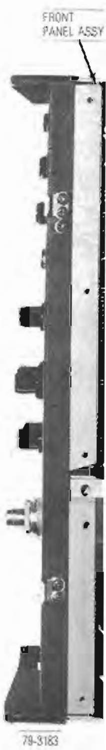
F2
F1
42
J15
J14
41, 4
FUSE
DC
8A
FUSE
BATT
8A
10 MHz STD
IN
OUT
AC 1.5A
BLOWER
488
BUS
41, 4
43,75
79-3893
42
8521-69

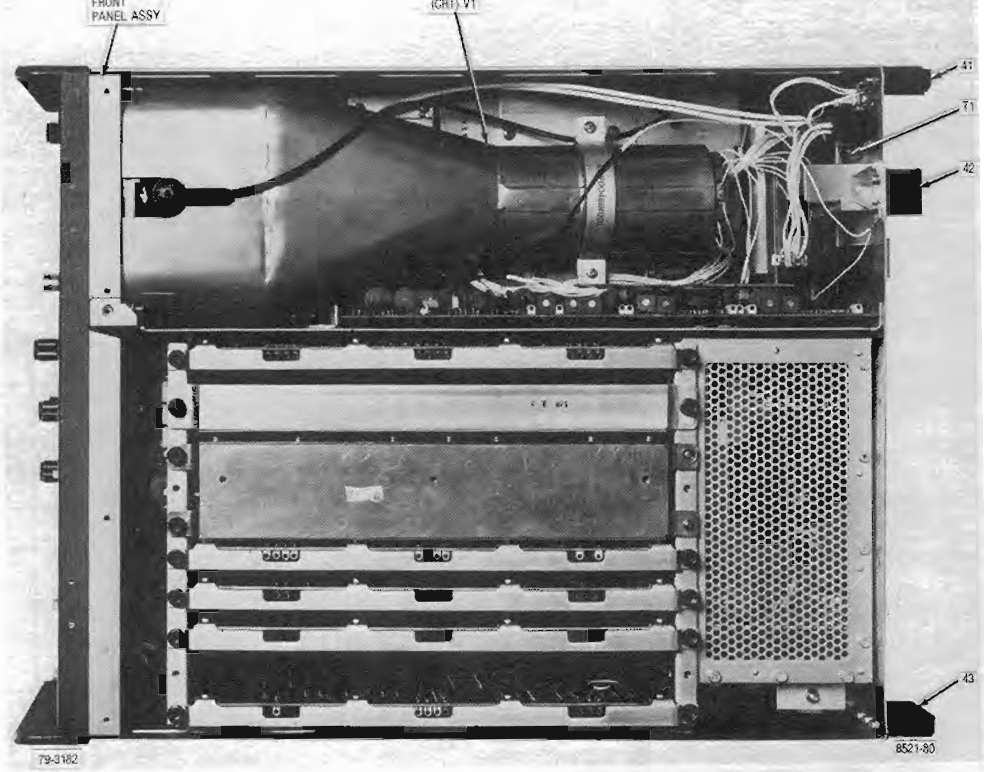

FRONT
PANEL ASSY
79-3183

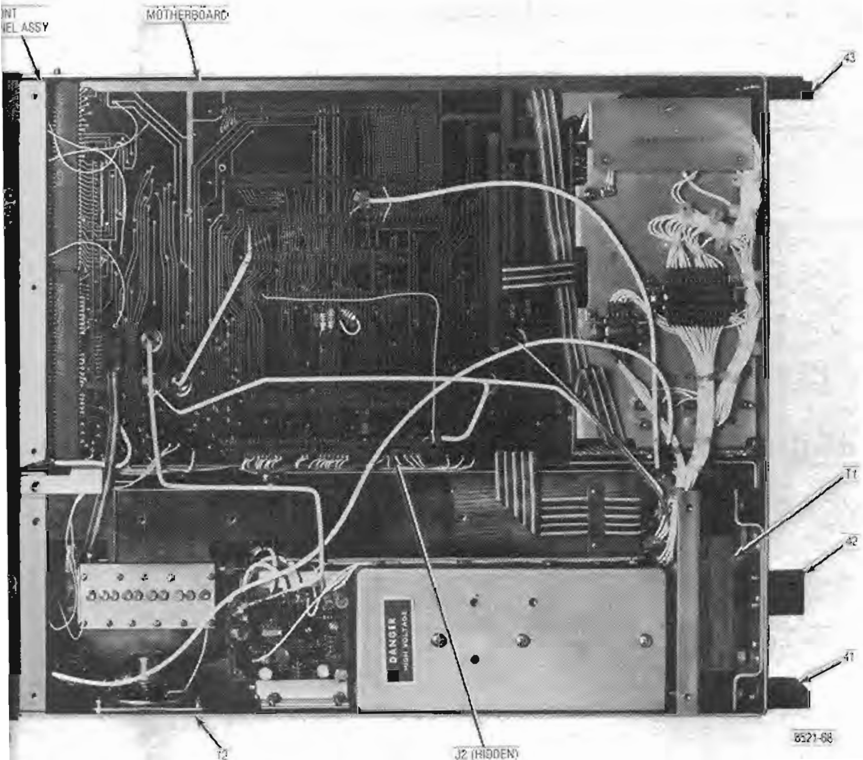
41, 44

F3

41, 44

69





Find No.	Qty. Req.	Part Number	Nomenclature	Part Value
	1	15-80335A44	COVER, SYSTEM,TOP	
	1	15-80335A69	COVER, SYSTEM	
	1	55-80335A58	HANDLE, BAIL	
	1	55-80335A73	HANDLE,BAIL	
	1	55-80335A72	HANDLE,MOLDED	
	1	33-14232A09	IDENTIFICATION PLATE	
	2	15-80335A59	COVER,HANDLE	
	1	01-P00249N002	FRONT COVER ASSY	
	2	55-80335A89	HINGE	
	10	MS35206-213	SCREW	4-40X1/4
	22	03-80335A97	SCREW,PH BLACK	6-32X.312
	4	MS51957-27	SCREW	6-32X5/16
	4	MS35338-136	WASHER	NO.6
	4	MS15795-806	WASHER	NO.6
	22	04-80335A99	WASHER,FLAT BLACK	NO.6
	22	MS35338-136B	WASHER,LOCK BLACK	NO.6
	2	55-847016	STRIKE,CATCH	
	2	MS24693-C49	SCREW	8-32X.438
	10	MS35338-40	WASHER,LOCK	NO.4
	10	NAS620C4L	WASHER,FLAT	NO.4
	1	58-84300A98	CONN,ADAPTER	N-BNC
		30-P04147T001	CABLE ASSEMBLY,IEEE	24 PIN
	AR		WIRE	26
	AR	11-14167A10	INK	WHITE
	AR	SN63WRP3	SOLDER	
	AR	11D84308A11	PAINT	SHADOW BRONZE
001	1	01-80304A57	FRONT PANEL ASSEMBLY	
002	1	27-80335A01	CHASSIS, SYSTEM	
003	1	64-P00260N001	PLATE MOUNTING; PWR S	A10/A11
004	5	MS35206-226	SCREW,PH	6-32X.250
005	4	66602-1	CONTACT,PIN	
006	26	MS35206-214	SCREW,PH	4-40X.312
007	60	MS27183-3	WASHER,FLAT	NO.4
008	60	MS35338-40	WASHER,LOCK	NO.4
009	12	MS24693-S24	SCREW,FLHD	6-32X1/4
010	AR		WIRE	22 WHT
011	AR	SN63WRMAP3	SOLDER	
012	1	50D83205B03	SPEAKER	
013	1	26-80335A54	SHIELD, CRT	
014	1	42-P00481N001	BRACKET,CRT SHIELD	
015	1	26-P06847R001	MAGNETIC SHIELD	
016	2	3-134169	SCREW,THD FORMING	
017	15	3-134185	SCREW,THD FORMING	6-32X.250
021	2	348-8-7-7	FUSEHOLDER	
028	2	42-14060A01	CLAMP ASSEMBLY, CONNE	MALE-SCREWLOCK
029	1	RTL-4060A	MOTHERBOARD ASSEMBLY	
034	2	206903-1	SEALING CAP	
035	1	36-80335A88	KNOB,SPECIAL	
040	1	75-80335A51	ISOLATOR, CRT,BOTTOM,	
041	2	07-80335A92	FOOT; REAR CHASSIS	
042	2	07-80335A93	FOOT,BATTERY HOLDER	
043	2	07-80335A94	FOOT,BATTERY HOLDER,L	
044	2	75-80335A60	FOOT,PLASTIC	
047	5	MS35206-228	SCREW	6-32X.375
048	3	MS51957-27B	SCREW,PH BLACK	6-32X.312
049	28	MS35206-215	SCREW	4-40X.375
050	12	MS27183-5	WASHER,FLAT	NO.6
051	3	MS15795-805B	WASHER,FLAT BLACK	NO.6
052	3	MS35338-136B	WASHER,LOCK BLACK	NO.6
053	12	MS35338-41	WASHER,LOCK	NO.6
054	10	MS35649-242	NUT,HEX	4-40
057	2	64-P00301N001	PLATE,THREADED	

Find No.	Qty. Req.	Part No.
058	1	30-P06804R00
059	1	30-P06805R00
060	1	30-P06806R00
061	1	30-P06807R001
062	1	30-P06808R001
063	1	30-P06809R001
066	2	29-15159A03
068	AR	
069	AR	SN63WRP3
070	AR	M23053/5-103-
071	AR	
072	AR	
073	AR	
074	AR	
075	2	75-80346A24
076	2	66601-2
077	1	MS35489-9
078	AR	
079	AR	
080	1	32-P04135T001
081	AR	
082	2	MS35206-213
083	2	MS35206-231
084	2	9224-A-140-10A
085	3	33-14232A09
086	1	14-P01317V001
A 001	1	RTP-1000A
A 002	1	RTL-4007A
A 003	1	RTC-4008A
A 004	1	RTL-1002A
A 005	1	RTC-1001A
A 006	1	RTC-4011A
A 007	1	RTC-4012A
A 008	1	RTC-4013A
A 009	1	RTC-4014 A
A 015	1	RTL-4054A
A 010	1	RTP-1001A
A 011	1	RTC-1003A
A 012	1	RTL-4045A
A 013	1	RTL-1004A
F 001	1	F03A250V8A
F 002	1	F02A250V5A
F 003	1	F02A250V1-1/2A
J 002	1	MP-0100-36-DW
J 011	1	DB-25S
J 014	1	206061-1
J 015	1	6J4
J 016	1	206430-1
T 001	1	24-P00243N001
V 001	1	95-80335A48

Nomenclature	Part Value
CABLE ASSEMBLY A11/A4	10.7 MHZ,IF
CABLE ASSEMBLY,SYNTH	A5/A11
CABLE ASSEMBLY,OFFSET	A11/MOTHERBOARD
CABLE ASSEMBLY 455KHZ	A4/MOTHERBOARD
CABLE ASSEMBLY 10.245	A4/MOTHERBOARD
CABLE ASSEMBLY 10MHZ	A13/A4
TERMINAL,LUG	
WIRE	16 WHT
SOLDER	
INSULATION SLEEVING	.093 WHT
WIRE	20 WHT
TAPE	NATURAL
WIRE	24 WHT
INSULATION TAPE,MYLAR	1IN YELLOW
FOOT,PLASTIC	
SOCKET	
GROMMET	
COMPOUND,THD LKG,BLUETYPE II,GR N,242	
ENCAPSULANT SILICONE	
PAD,CRT CLAMP	
WIRE	20
SCREW	4-40X.250
SCREW	6-32X.625
SPACER	.250DX.25L
IDENTIFICATION PLATE	HIGH VOLTAGE
INSULATOR	FP/INTERFACE BD
LOW VOLTAGE PWR SUPPL	A1
SCOPE HORZ/VERT AMP	
SCOPE/DVM CONTROL	
RECEIVER ASSY A4	
SYNTHESIZER A5	
AUDIO SYNTHESIZER A6	
PROCESSOR I/O A7	
IEEE INTERFACE(2002A SYSTEM ONLY)	
MICRO PROC CHAR GEN	
BLOWER ASSEMBLY	
HIGH VOLTAGE PWR SUPP	A10
RF FRONT END	A11
FRT PANEL INTRF ASSY	
FREQUENCY STANDARD	A13
FUSE	250V-8A
FUSE,CARTRIDGE	250V-5A
FUSE,CARTRIDGE	250V-1 1/2A
6H CONNECTOR	
CONNECTOR	25 PIN
CONNECTOR,BATTERY	4-PIN MALE
CONNECTOR	POWER INPUT
CONNECTOR,BLOWER	4 CONTACT
TRANSFORMER, LINE	
CATHODE RAY TUBE	

ASSEMBLY PARTS LIST

MOTHERBOARD ASSEMBLY
RTL-4060A

Find No.	Qty. Req.	Part No.	Nomenclature	Part Value
J 003	1	MP-0100-50-DW-6H	CONNECTOR	
J 004	1	MP-0100-36-DW-6H	CONNECTOR	
J 005	1	MP-0100-36-DW-6H	CONNECTOR	
J 006	1	MP-0100-36-DW-6H	CONNECTOR	
J 007	1	MP-0100-50-DW-6H	CONNECTOR	
J 008	1	MP-0100-50-DW-6H	CONNECTOR	
J 009	1	MP-0100-50-DW-6H	CONNECTOR	
J 010	1	MP-0100-50-DW-6H	CONNECTOR	
L 001	1	25-83127G01	CHOKE,AUDIO	
L 002	1	25-83127G01	CHOKE,AUDIO	
L 003	1	25-83127G01	CHOKE,AUDIO	
L 004	1	MS91189-33	COIL	47UH
L 005	1	MS90539-07	COIL	470UH
L 006	1	MS91189-37	COIL	100UH

ASSEMBLY PARTS LIST

System Top Level

SECTION 7

LOW VOLTAGE POWER SUPPLY (A1)

7-1. General. The low voltage power supply converts either an AC line input or a DC supply input to the DC operating voltages required by the system. Appropriate protection circuits are incorporated within the supply to protect both the supply and the system in vhe event of certain common malfunctions. A block diagram of the Low Voltage Supply module is shown in figure 7-1 with its schematic shown in figure 7-2.

7-2. Input Power Control. Whenever AC power is connected to the unit the DC BUS within the supply is supplied by the AC rectifier and filter circuitry. The AC sense circuit provides a control voltage whenever AC is present that isolates the DC input from the DC bus and drives the front panel AC indicator.

7-3. With power on the DC buss the power supply control circuitry determines the operating mode of the power supply. With the unit "OFF", the battery charger control circuit is turned on and the frequency standard control and chopper generator circuits are turned off. When the unit is in"STANDBY", the chopper generator is off and the frequency standard supply and battery charger are enabled. Finally with the unit "ON", the frequency standard supply and the chopper generator are enabled and the battery charger is off. Thus the battery is charged in off and standby modes, and the frequency standard operates in standby and on modes.

7-4. The voltage for the battery charger is boosted above the nominal DC bus voltage to 32 volts by the AC boost winding. This increase in voltage is necessary for proper charge operation.

7-5. For operation from a DC input, the AC power must be removed from the unit disabling the AC sense voltage. With the AC power removed and the unit off, no power is present on the DC bus. When the unit is switched to the standby mode, the DC relay closes, connecting the DC input to the DC bus and the supply voltage to the frequency standard is enabled. Then with the unit turned on the chopper generator is enabled and normal operation occurs.

7-6. DC Output Control. Regulation of the DC output voltages is accomplished by regulating only the +5V output. The transformer winding ratios determing the other output voltages with respect to the +5 volt output. The +5V output is compared with a stable reference voltage and the resultant control voltage is used to determine the on time of the pulse-width modulator, thus regulating the input voltage to the chopper circuits.

7-7. The chopper generator provides the 7.9 volt reference voltage, a 20 KHz square wave chopper drive signal, and a 20 KHz triangle waveform output for pulse-width modulator control. The pulse-width control comparator compares the triangle waveform with the control voltage. If the control voltage is equal to the mean DC voltage of the triangle wave the pulse modulator has a 50% duty cycle. For control voltages above and below the mean value the duty cycle is proportionally increased or decreased.

7-8. The filtered DC output from the pulse-width modulator is chopped through the primary of the output transformer at the 20 KHz rate. The DC output is alternately switched between the upper half and the lower half of the primary winding. The current through the primary center tap is detected by a current transformer and its output used for overcurrent protection.

7-9. Protection Circuitry. The power supply is protected against shorted outputs, high internal temperatures, and low or high DC buss voltages. In each case the protection circuit pulls the control voltage line to ground to open up the pulse-width modulator and shut down the supply.

7-10. Short circuit protection is implemented by monitoring the current in the primary winding of the output transformer. If a secondary output is shorted the primary current will increase significantly causing the overcurrent detector to pull the control line low shutting down the supply. However, with the supply shut down primary current will cease and the overcurrent detector will release the control line. With the control line released the supply will come back on. If the short is still present the cycle will repeat itself. Delay is provided in the overcurrent detector so that with a shorted output the supply cycles at about a 0.5 second rate.

7-11. Overtemperature protection is obtained by using a thermal switch mounted on the most heat critical capacitor. If the capacitors temperature exceeds the temperature setting of the thermal switch, the switch closes to ground shorting the control line and shutting down the supply. Normal operation of the supply will be resumed when the temperature returns to a safe operating level.

7-12. Protection for high or low DC and AC line inputs is provided by monitoring the voltage on the DC Bus. If the bus voltage exceeds 20 volts or if the voltage falls below 10 volts, the shutdown circuitry pulls the control line to ground shutting down the supply. When the bus voltage returns to normal limits, supply operation automatically resumes.

7-13. High Voltage Supply Control. A 12 volt regulator from the DC BUS provides the bias voltage for the High Voltage Power Supply (AI0). The primary power for the High Voltage Supply comes from the high voltage control circuitry. A control line from the high voltage supply regulates the input voltage to the high voltage transformer. The current used in the high voltage supply is the bias current for the pulse width modulator circuitry for improved power supply efficiency.

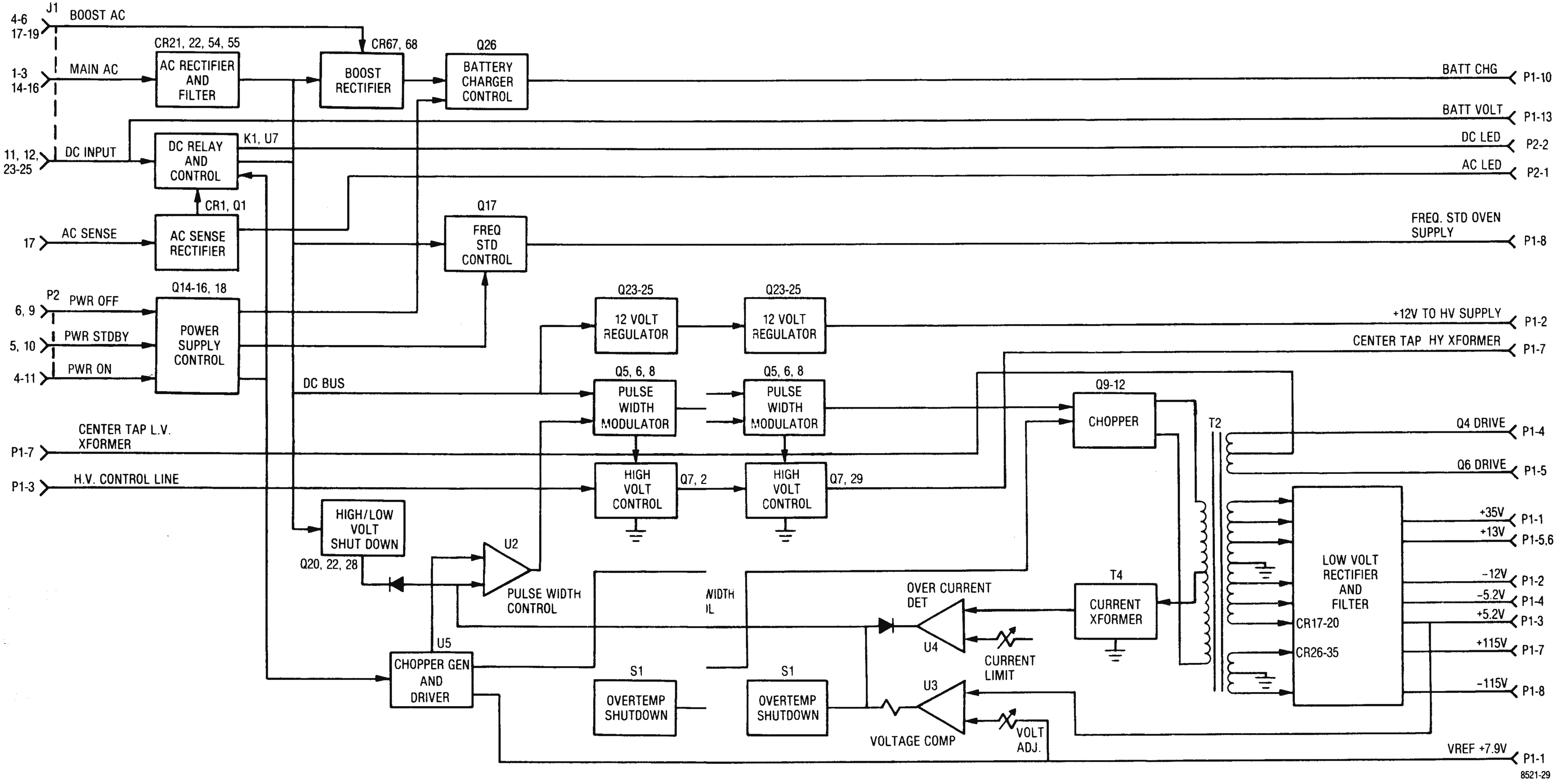
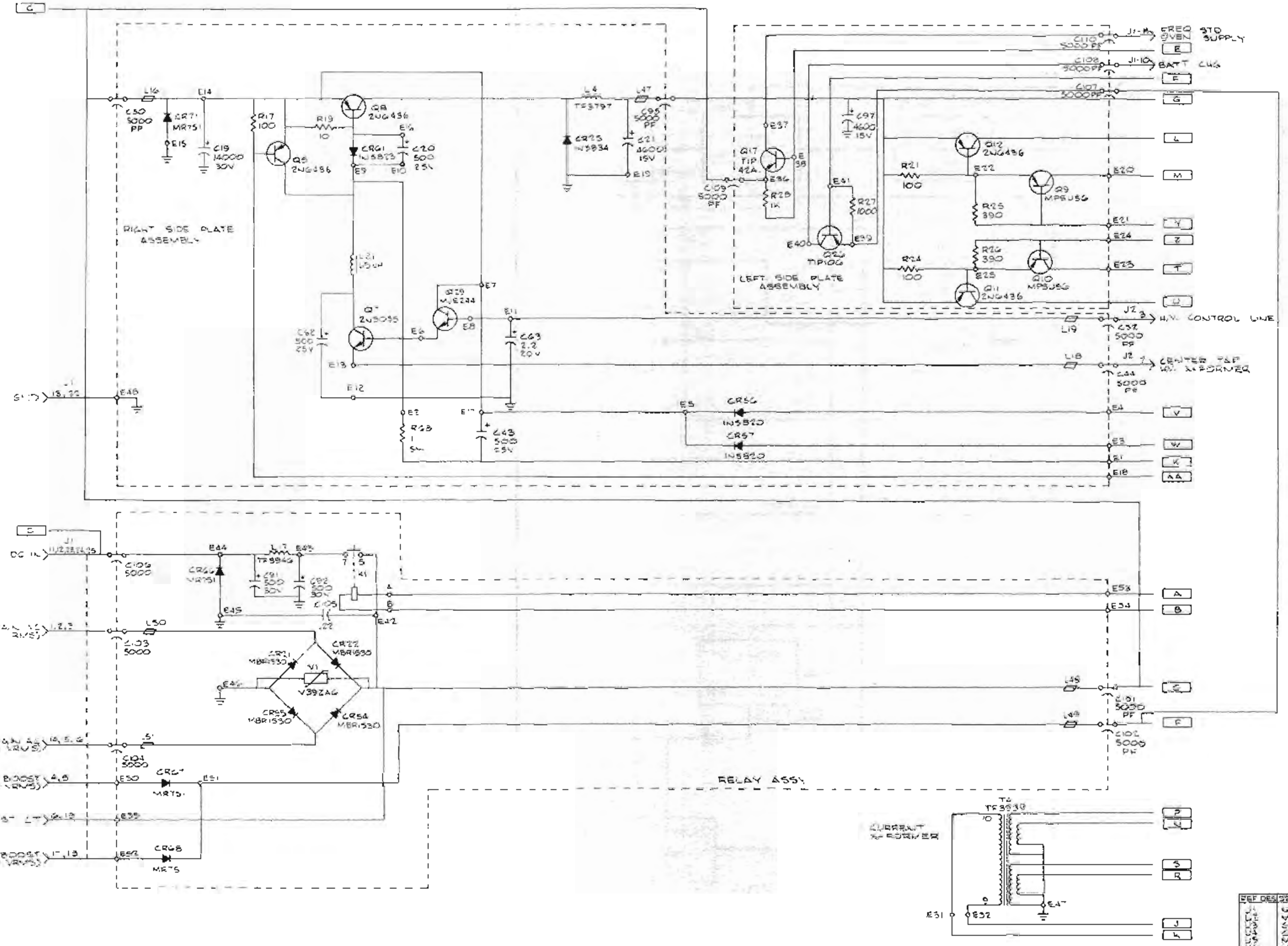


Figure 7-1. Low Voltage Power Supply A1 Block Diagram



NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH 1A1.
2. FOR REFERENCE DRAWINGS REFER TO: 01-P24427-.
3. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS ±5 PCT, 1/4 WATT. ALL CAPACITORS ARE IN UF. ALL INDUCTORS ARE AS MARKED ALL VOLTAGES ARE DC.
4. 9570 IS MOTOROLA 48-R00869570
5. SELECT IN TEST.
6. 9571 IS MOTOROLA 48-R00869571

REF DES	DEVICE TYPE	GND	NC CONN
U1	NOT USED		
U2	VLM37	1,4	5,6
U3	CA3140	4	1,5,8
U4	CA3140	4	1,5,8
U5	MC3576	6,15	3,4
U6	LM341P	3	
U7	MC7812		

Figure 7-2. Low Voltage Power Supply A1

Schematic Diagram (Sheet 1 of 2)

(RTP-1000A)

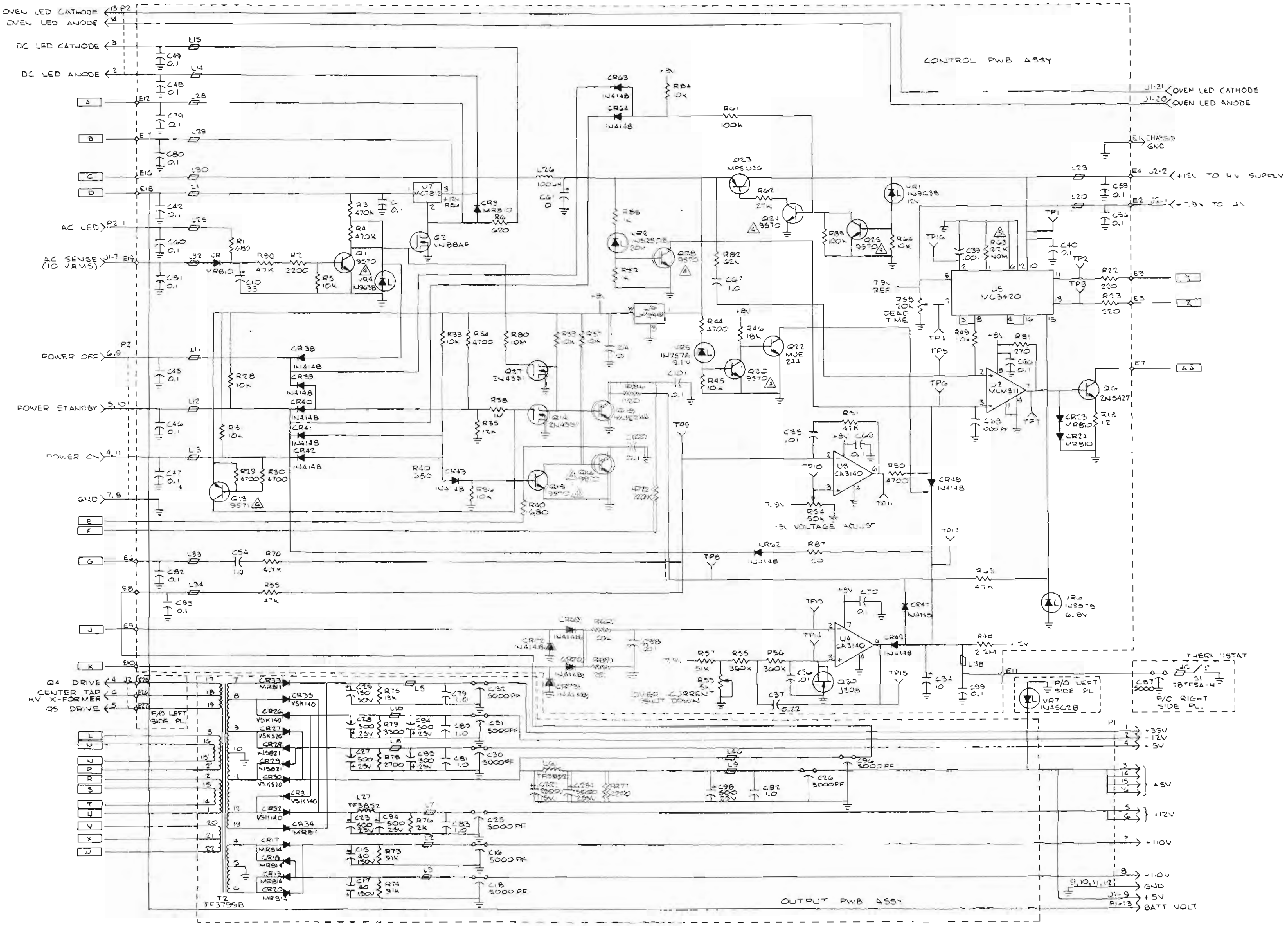
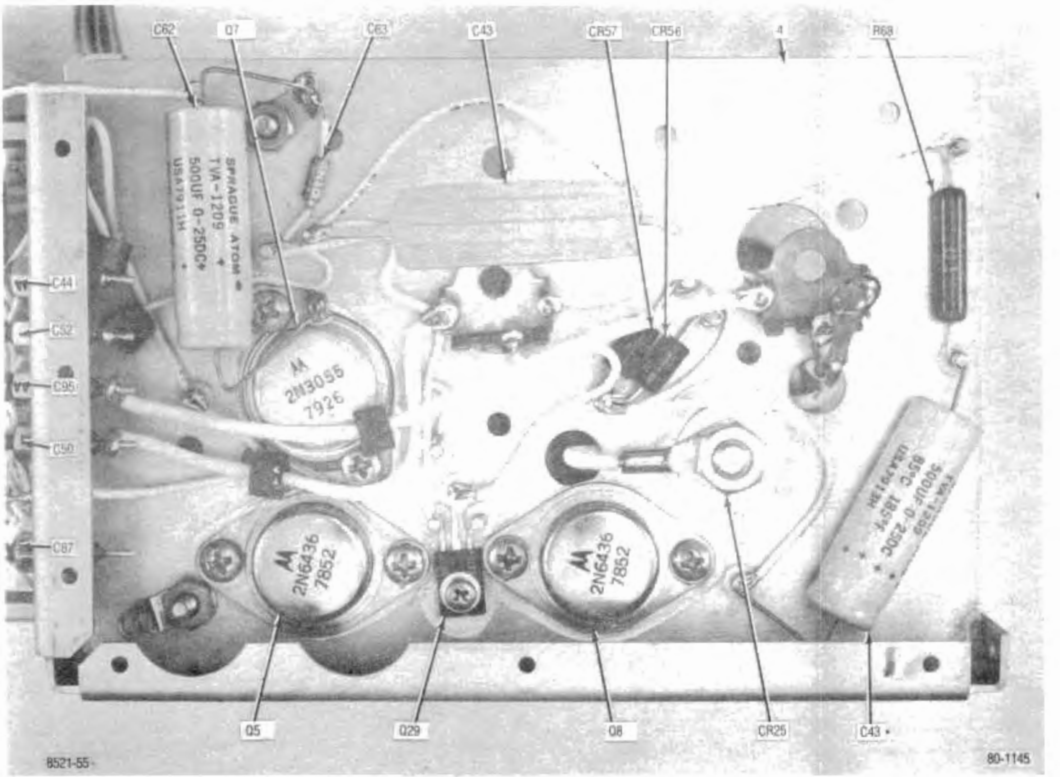
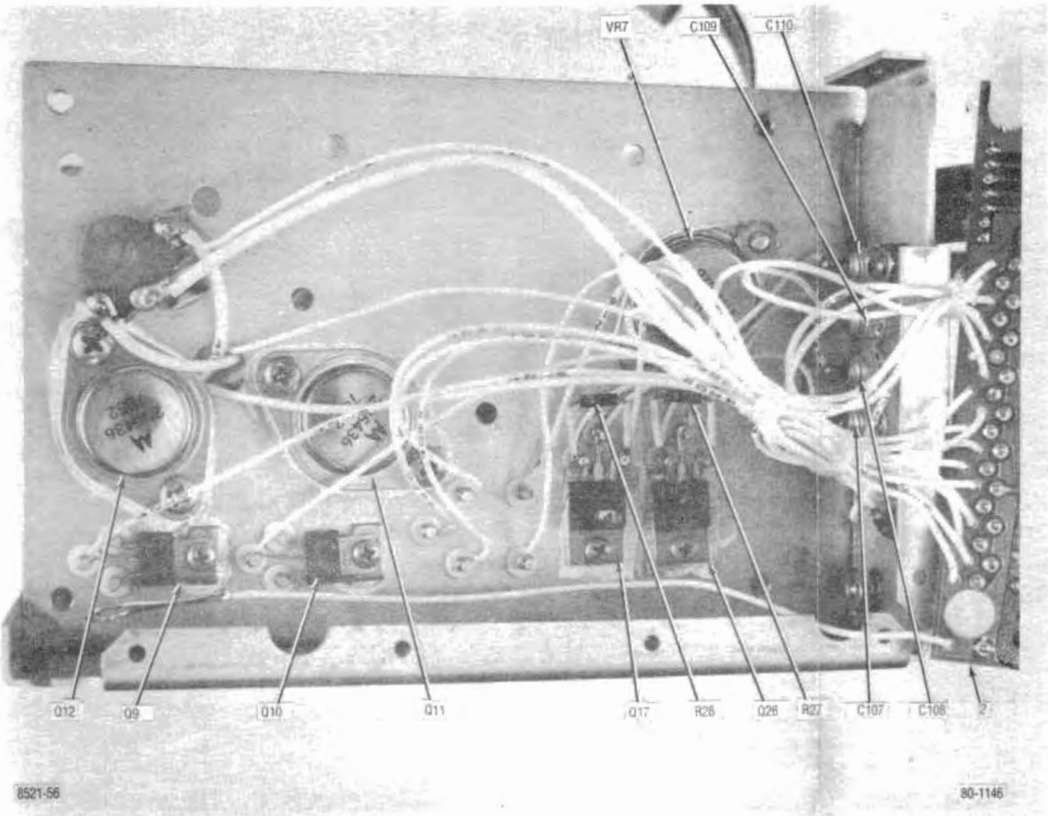
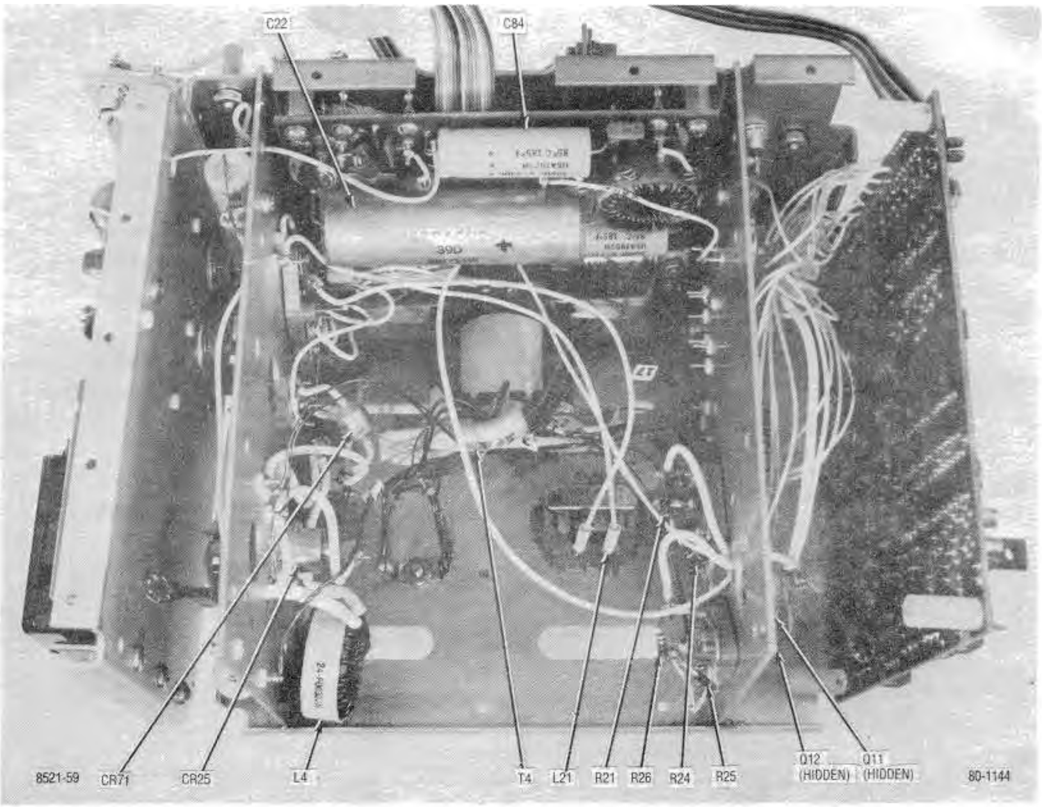
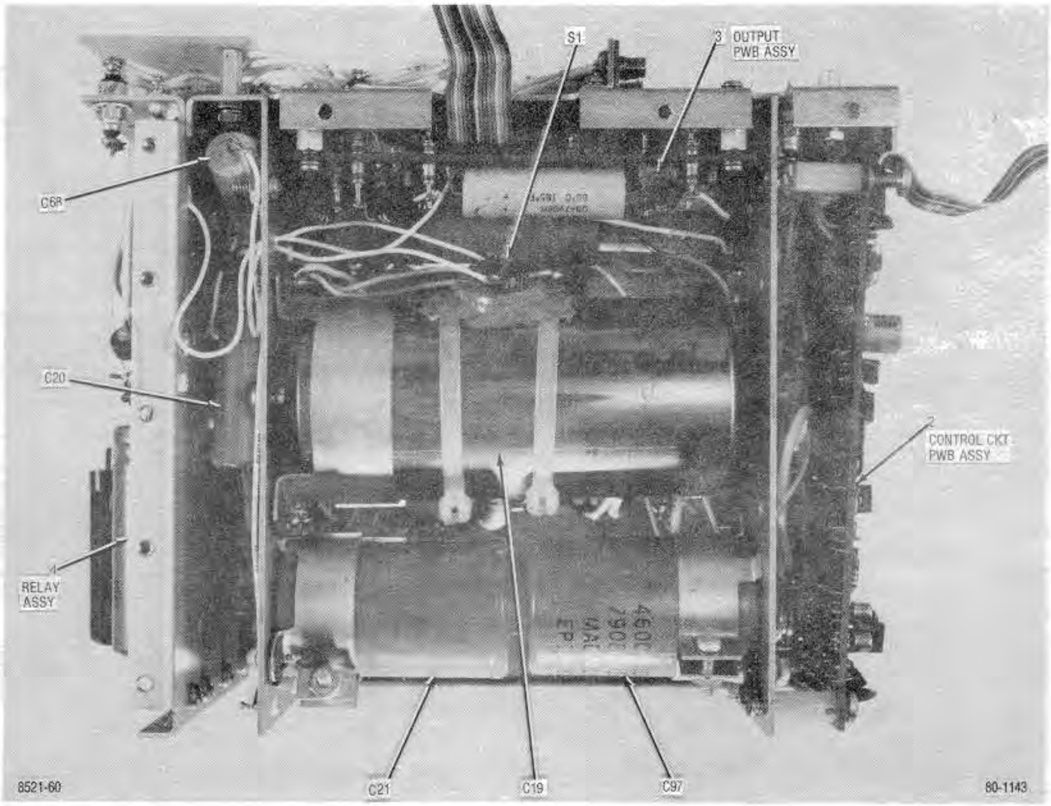


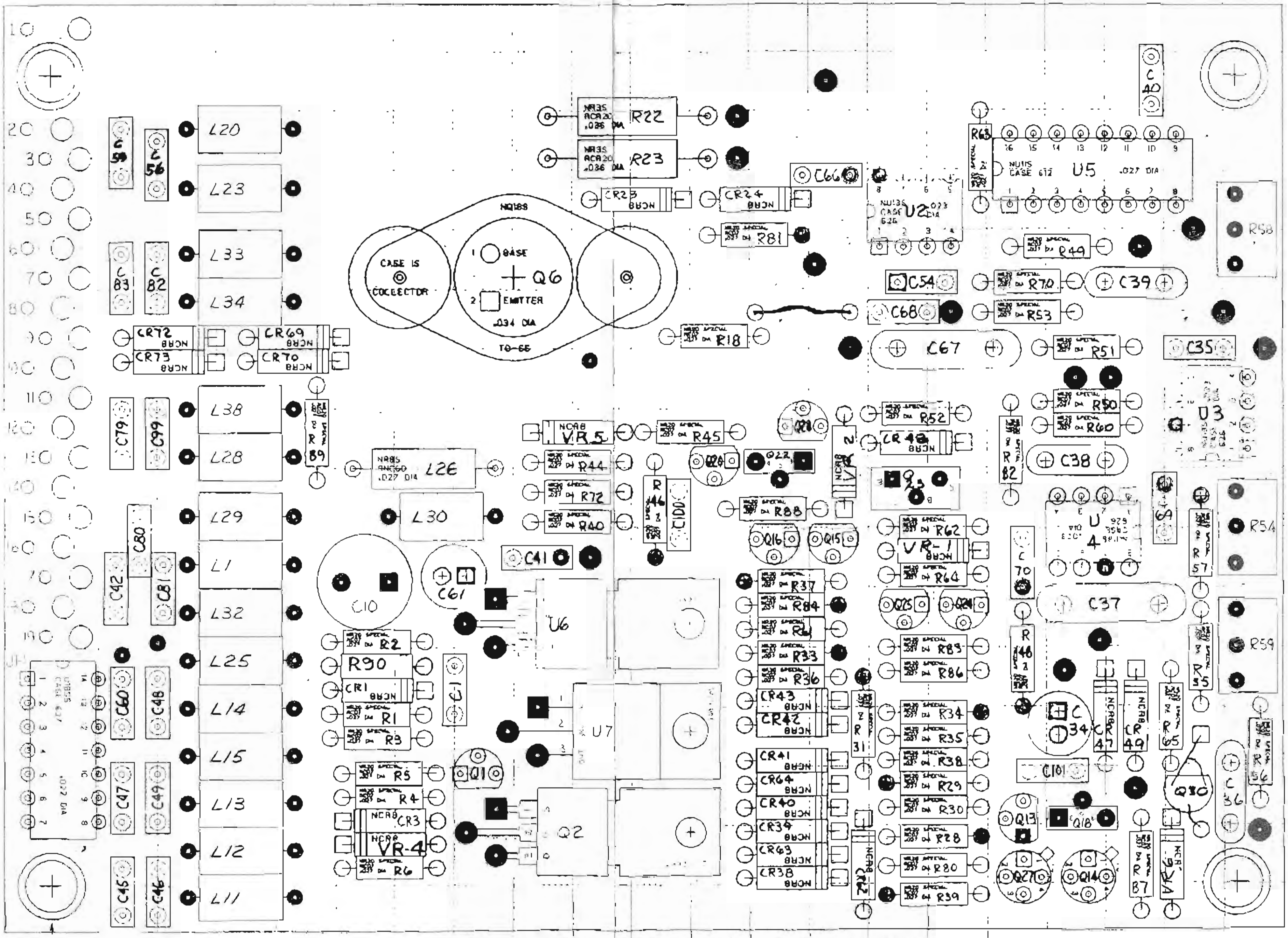
Figure 7-2. Low Voltage Power Supply A1 Schematic Diagram (Sheet 2 of 2) (RTP-1000A)


C62
Q7
C63
C43
CR57
CR56
4
R68
C44
C52
C95
C50
C87
Q5
Q29
Q8
CR25
C43
8521-55
80-1145


VR7
C109
C110
Q12
Q9
Q10
Q11
Q17
R26
Q26
R27
C107
C108
2
8521-56
80-1146


C22
C84
8521-59
CR71
CR25
L4
T4
L21
R21
R26
R24
R25
Q12 (HIDDEN)
Q11 (HIDDEN)
80-1144


S1
3 OUTPUT PWB ASSY
C68
C20
2 CONTROL CKT PWB ASSY
4 RELAY ASSY
8521-60
C21
C19
C97
80-1143


10
20
30
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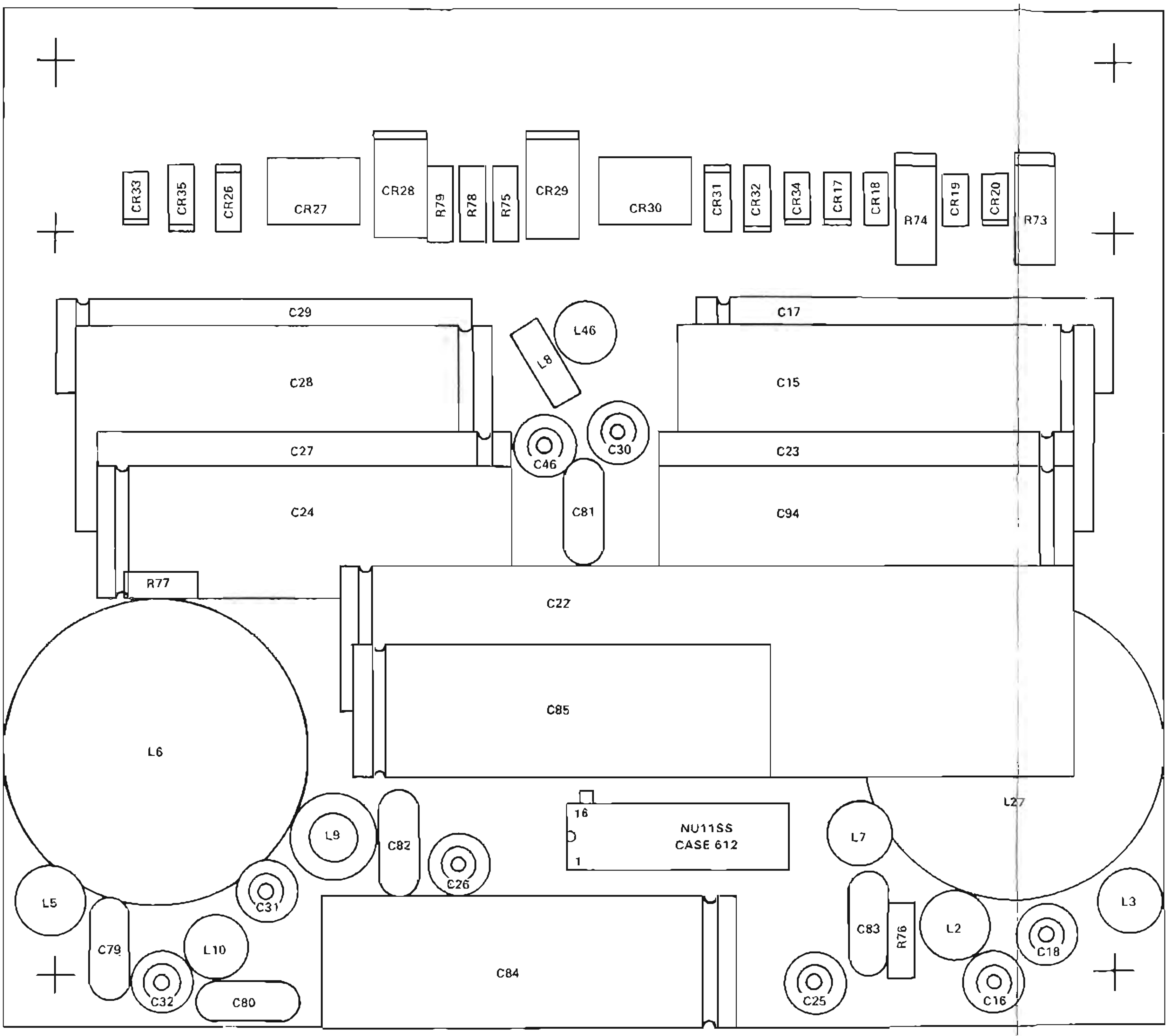
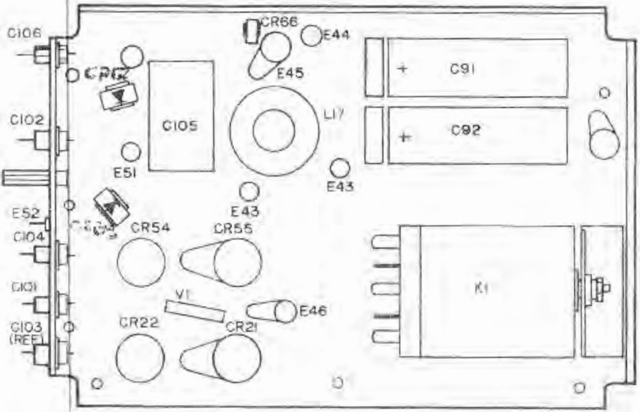
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
C59
C56
C83
C82
C79
C99
C80
C42
C81
C60
C48
C47
C49
C45
C46
L20
L23
L33
L34
L38
L28
L29
L1
L32
L25
L14
L15
L13
L12
L11
CR72
CR73
CR69
CR70
NCR8
R89
L26
NR85
.027 DIA
L30
C10
C61
C41
U6
U7
Q1
Q2
R2
R90
CR1
R1
R3
R5
R4
CR3
VR-4
R6
C11
U1
CASE 632
.027 DIA
R22
R23
NR35
RCR20
.036 DIA
NQ18S
CASE IS
COLLECTOR
BASE
EMITTER
Q6
.034 DIA
TO-66
CR23
CR24
R81
R18
C66
C68
C54
U2
NU13S
CASE 626
.023 DIA
U5
NU11S
CASE 612
.027 DIA
R63
C40
R58
R49
R70
C39
R53
C67
R51
C35
R50
R60
C38
U3
R82
R52
CR48
Q22
Q23
R45
VR5
R44
R72
R40
R146
C100
Q20
Q21
R88
Q16
Q15
R62
VR-1
R64
U4
C70
C69
R54
R57
C37
R59
R55
R37
R84
R33
R36
CR43
CR42
CR41
CR64
CR40
CR34
CR63
CR38
R31
CR62
Q25
Q24
R83
R86
R34
R35
R38
R29
R30
R28
R80
R39
R148
C34
CR47
CR49
R65
C101
Q13
Q18
Q30
C36
R56
Q27
Q14
R87
VR6


CR33
CR35
CR26
CR27
CR28
R79
R78
R75
CR29
CR30
CR31
CR32
CR34
CR17
CR18
R74
CR19
CR20
R73
C29
L46
C17
L8
C28
C15
C46
C30
C27
C23
C24
C81
C94
R77
C22
C85
L6
L27
16
NU11SS
CASE 612
1
L9
C82
C26
L7
L5
C31
C83
R76
L2
L3
C18
C79
L10
C32
C80
C84
C25
C16


C106
CR62
CR66
E44
E45
C91
C92
L17
C102
C105
E51
E43
E43
E52
CR54
CR55
C104
K1
V1
E46
C101
CR22
CR21
C103
(REF)
+
+

SECTION 8

SCOPE AMPLIFIER (A2)

8-1. General. The Scope Amplifier module contains the horizontal and vertical deflection amps, the horizontal timebase generator, focus and intensity control circuitry, and miscellaneous CRT bias adjustments. A block diagram of the Scope Amplifier module is shown in figure 8-1 with its schematic shown in figure 8-2.

8-2. Deflection Amplifiers. The vertical and horizontal deflection amplifiers are identical. The input signal is initially amplified and split into two signals 180° out of phase. Each of the two signals is then further amplified to become the CRT deflection plate signals. The amplifiers provide up to 200 volts peak-peak signal capability with a 1 MHz frequency bandwidth.

8-3. Horizontal Timebase Generator. The horizontal timebase generator provides calibrated sweep rates over a six decade range from 1μ sec to 100 msec per division. Sweep rate selection is from the processor via the SCOPE SWP CONT 0-7 signal lines. Veriner control over the sweep rate is via the SWP VERN VOLT input from the front panel. Sweep triggering is either the auto or normal mode as selected by the AUTO/NOR TRIG SEL line from the front panel. In the auto mode if the SYNC PRESENT input is high indicating no sync, the scope sweep is self triggered after a hold off time. If there is a sync present, the sweep will wait for a pulse on the TRIG PULSE line to start the sweep after the hold off time. For the normal trigger mode the sweep will always wait for a TRIG PULSE input.

8-4. A sweep cycle consists of two parts, the sweep and the hold off. During the sweep the CRT is unblanked via the SWP BLANKING line and the horizontal trace is made. At the end of the sweep the CRT is blanked and the hold off time begins. During the hold off time, which is equal to the sweep time, the sweep generator and trigger circuits are reset in preparation for the next sweep.

8-5. Horizontal Switching. The input to the horizontal deflection amp is selected between two sources. The INT HORIZ IN signal line provides the horizontal character sweep and the horizontal spectrum analyzer sweep. The other source is the scope mode signal path from the horizontal positioning suming amp. The scope mode signal is either the output of the Horizontal Timebase Generator or the EXT HORIZ INPUT from the front panel. Selection between internal horizontal and scope mode horizontal inputs is via the SCOPE MODE EN line from the processor. Selection between the two scope mode signals is via the EXT HORIZ EN line.

8-6. Intensity Control. A crossover network is used to provide CRT Z-axis modulation from DC to 1 MHz. The INTEN LVL signal from the front panel control is gated with the SCOPE Z-AXIS signal by the Intensity Level Gate. The gated signal is sumed with the HV REF and INTEN SMPL VOLT signals to provide the INTEN TV signal. The INTEN TV (Intensity Tracking Voltage) is the low frequency control path which drives the intensity optoisolator in the High Voltage Supply.

8-7. The high frequency modulation path is via the Z-Axis Modulator circuit. line. line. The resulting CRT Z-AXIS signal is capacitively coupled to the CRT grid.

8-8. Focus Control. The FOCUS TV (Focus Tracking Voltage) signal is obtained by comparing the FOCUS LEVEL control line to the FOCUS SAMPLE VOLT signal. The tracking voltage signal drives an optoisolator circuit in the High Voltage Supply which controls the CRT focus voltage.

8-9. Astigmatism, Geometry, and Trace Rotation. These three CRT alignment controls are obtained from the respective wipers of three potentiometers. Each potentiometer is connected between supply voltages equal to the adjustment range required.

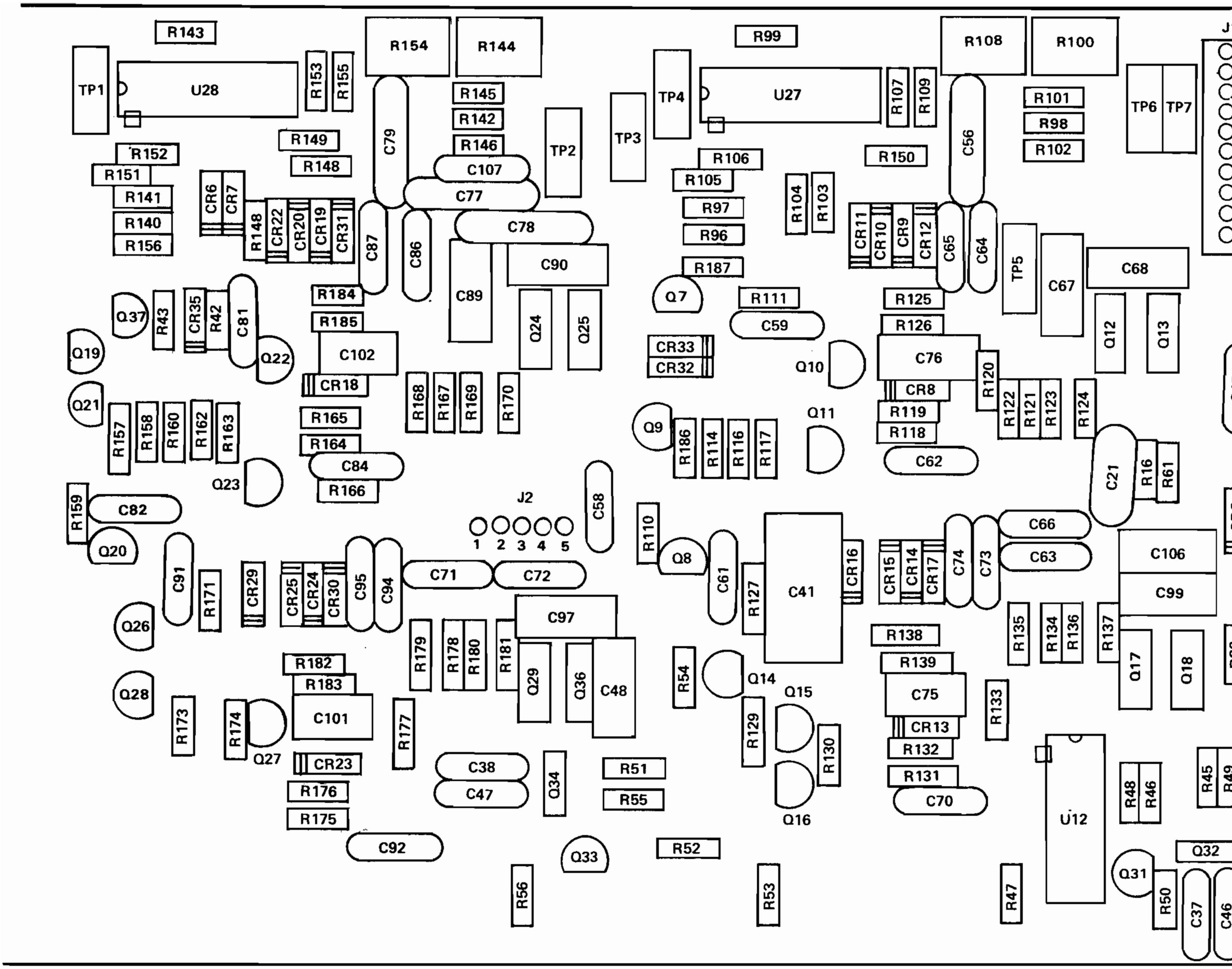
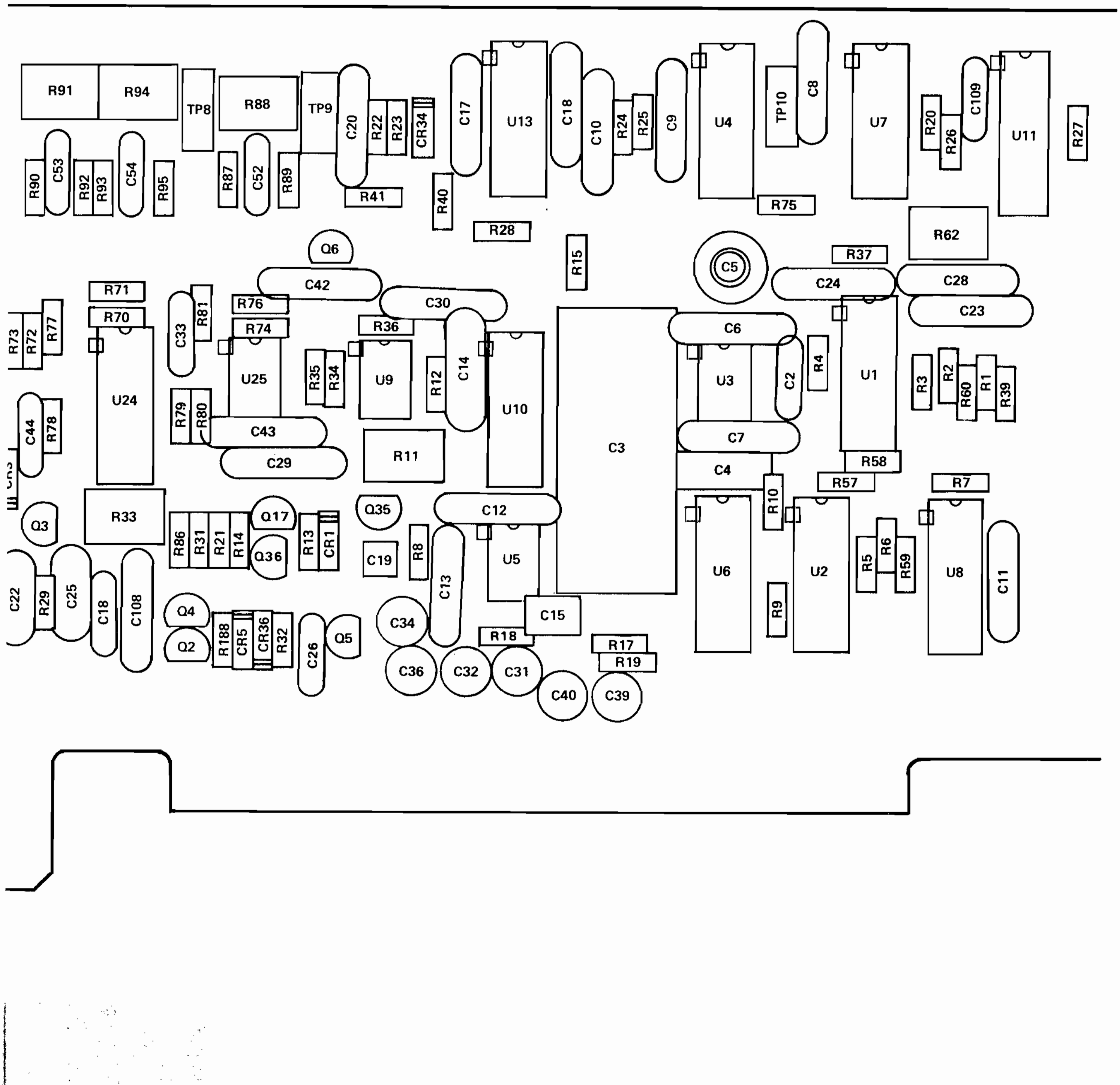


Figure 8-3. Scope Amplifier Parts Locator


R91
R94
TP8
R88
TP9
C20
R22
R23
CR34
C17
U13
C18
C10
R24
R25
C9
U4
TP10
C8
U7
R20
R26
C109
U11
R27
R90
C53
R92
R93
C54
R95
R87
C52
R89
R41
R40
R28
R75
R62
Q6
R15
C5
R37
C42
C24
C28
R71
R81
R76
C30
C23
R70
C6
R73
R72
R77
C33
R74
R36
U25
R35
R34
U9
R12
C14
U10
U3
C2
R4
U1
U24
R3
R2
R60
R1
R39
C44
R78
R79
R80
C43
C29
R11
C3
C7
R58
C4
R57
R7
R33
Q35
C12
R10
Q3
Q17
R86
R31
R21
R14
Q36
R13
CR1
C19
R8
U5
U6
U2
R5
R6
R59
U8
C11
C22
R29
C25
C18
C108
Q4
Q2
R188
CR5
CR36
R32
C26
Q5
C34
C13
C15
R9
R18
R17
R19
C36
C32
C31
C40
C39

SECTION 9

SCOPE/DVM CONTROL MODULE (A3)

9-1. General. A primary function of the Scope/DVM Control Module is to route the required measurement and viewing signals to the DVM and scope circuitry. A large portion of the displayed data is determined by the DVM measurements on internal signal points. Thus for a rapid update of several data displays it is necessary to time division multiplex several measurement points to the DVM. The DVM control circuitry and the system processor provide this function.

9-2. The scope control circuitry allows the system to display data information, internal modulation or demodulated signals, and external scope inputs as selected by the user. Provisions are also made for external horizontal inputs and a horizontal sweep that is coherent with the sweep generator for spectrum analyzer and filter alignment displays.

9-3. The control module also contains circuitry for single sideband demodulation and a IF phase locked loop for filtering and waveshaping the IF signal for frequency counting. A block diagram of the Scope/DVM Control module is shown in figure 9-1 with a schematic shown in figure 9-2.

9-4. Scope Vertical Control. The input to the scope vertical amplifier is switched between four different sources; the range switch (VERT FROM RNG SW), the vertical character sweep, the spectrum analyzer (SPECT ANA VERT), or the 455 kHz IF. Range switch inputs are from either the scope vertical input jack on the front panel or the internal modulation signals as selected by the modulation display control on this module. The vertical character sweep is a sawtooth waveform generated by the Vertical Character Sweep Generator and synced by the VERT CHAR SYNC signal from the character generator. The detected and amplified output of the receiver logarithimic IF is the vertical input for the spectrum analyzer. The remaining signal source is the second IF signal from the receiver for IF envelope observation.

9-5. For the spectrum analyzer and the scope sweep displays the Dual Display Control and Character Sweep Counter circuitry allow a single row of characters at the top of the CRT. This function is implemented with the Vertical Sweep Control by alternating the spectrum analyzer or the range switch signal with the vertical character sweep signal.

9-6. The dual display sequence of events starts with the Synthesizer Sweep Generator which is common to both display modes. When the synthesizer sweep is near its peak (scope horizontal sweep is at the edge of the screen) the Dual Display Control activates the CHAR GEN RST line and switches the scope vertical and horizontal inputs to their character generator sweeps. When the first character line has been traced, a transition on the $\overline{\text{LINE 1}}$ input from the character generator resets the character generator sweeps and the character generator, increments the Character Sweep Counter, and thus causes line 1 to be traced again. This process repeats until four traces,as counted by the Character Sweep Counter, have been completed. At that point the counter resets the scope inputs back to the spectrum analyzer or range switch input. During the character display time the synthesizer sweep generator is reset and held until a transition on the SYNTH SWP SYNC line restarts the sweep. The timing of the process allows for the four character traces to be completed before the sweep sync occurs.

9-7. SSB Detection. Single Sideband (SSB) modulation is recovered by multiplying the 455 KHz IF signal with a 455 KHz beat frequency oscillator (BFO) signal. The BFO is controlled directly from the front panel and is adjustable over a 6 KHz frequency range. SSB AUDIO from the multiplier is routed to the receiver for post detection filtering. A sample of the BFO signal is made available to the frequency counter on the IF/BFO FREQ line for sideband frequency error determination.

9-8. 455 KHz PLL. For monitor frequency error determination a 455 KHz Phase Locked Loop (PLL) is used to filter and to shape the IF signal. The cleaned up signal is switched with the BFO signal to the frequency counter.

9-9. Scope Horizontal Control. Switching for the scope horizontal input is divided between two modules. The time base generator and the external horizontal input are selected on the scope amplifier module. The Horizontal Character Sweep Generator and the Synthesizer Sweep Generator signals are selected on the Control Module to the INT SCOPE HORIZ signal line.

9-10. For the dual display modes (characters and synthesizer sweep) the Horizontal Switch Control switches the horizontal input between the synthesizer sweep and the character sweep. This switching occurs simultaneously with that occurring in the scope vertical control as described in paragraph 9-6. The Horizontal Switch Control also provides the SCOPE MODE EN line to the scope avplifier to enable the scope mode horizontal inputs.

9-11. Synthesizer Sweep Control. The sweep signal generated by the Synthesizer Sweep Generator is controlled in amplitude and in range across the front panel sweep width control. Attenuations of 1.0 or 0.1 are provided by the Sweep Width Select circuitry to the sweep signal at the DISPERSION SWP signal line to the top of the width control. The bottom side of the width control is returned to the Sweep Width Select circuitry via the DISPERSION SWP RTN line. A 10 to 1 resistor change is made in the return line simultaneously with the attenuator change to give sweep ranges of 1-10 MHz and 0.01-1 MHz.

9-12. Scope Z-Axis Control. The SCOPE Z-AXIS signal has three possible sources as selected by the Z-Axis Control circuit. For character displays the Z-Axis signal is the CHAR GEN Z-AXIS from the character generator. The SWP BLANKING signal from the horizontal timebase generator is switched to the scope Z-Axis for the scope modes. For the remaining modes, spectrum analyzer and scope sweep, a logic zero level is gated to the Z-Axis input.

9-13. Modulation Display Control. Internal modulation or demodulated signals are displayed on the scope by switching the desired signal source to the input ranging switch and then switching the ranging switch output to the scope vertical input. One of two modulation sources or a demodulation output can be switched to the INT SCOPE TO RNG SW signal line for display on the CRT. Each of the signals are gain adjusted prior to the selection switch for scope calibration.

9-14. The DEMOD CAL AUDIO signal from the receiver is either AM, FM, or SSB as determined by the operating mode. The peak signal level on this line is calibrated to 10 kHz/volt for FM and 10%/volt for AM. SSB signals are not calibrated.

9-15. For AM the CARRIER + MOD LVL input from the generator output detector provides a direct display of the modulation. This input is a DC level representative of the average output level plus an AC signal representative of the amplitude modulation on the output. For the scope modulation display the DC level is blocked so that only the AC component is observed. This input is uncalibrated for absolute AC levels, but the processor by determining the peak AC and average DC levels can determine the modulation depth.

9-16. For FM the MOD CAL AUDIO input from the audio synthesizer is calibrated to 5 kHz/volt for narrow band and to 20 kHz/volt for wide band. Correspondingly the display calibrating attenuator has two gain ranges to maintain the same display calibration for both narrow and wide band.

9-17. Peak Detector. Each of the modulation and demodulation inputs can be selected to the peak detecting circuitry for the determination of % AM or kHz deviation. The peak detector circuitry provides DC outputs equal to the negative and positive peak values of the input signal relative to the average DC level of the signal. These levels are then digitized by the DVM and input to the processor where the modulation level is determined.

9-18. DVM Control. Any one of ten internal or one external measurement point may be switched to the DVM for level digitization. Switching is controlled by the processor so that measurements are made to provide current display data. In general several measurement points must be input to obtain all the displayed data. Therefore the processor continuously cycles the switch through the required inputs stopping at each one long enough to digitize and input its level.

9-19. The Internal DVM Select switch is followed by a range attenuator. As the processor cycles through the inputs it sets the range attenuator according to the last cycle reading made at that input. Thus each internal input is auto ranged over two decades to give three digit accuracy up to a maximum input of 10 volts. The internal DVM inputs and their function are listed in table 9-1.

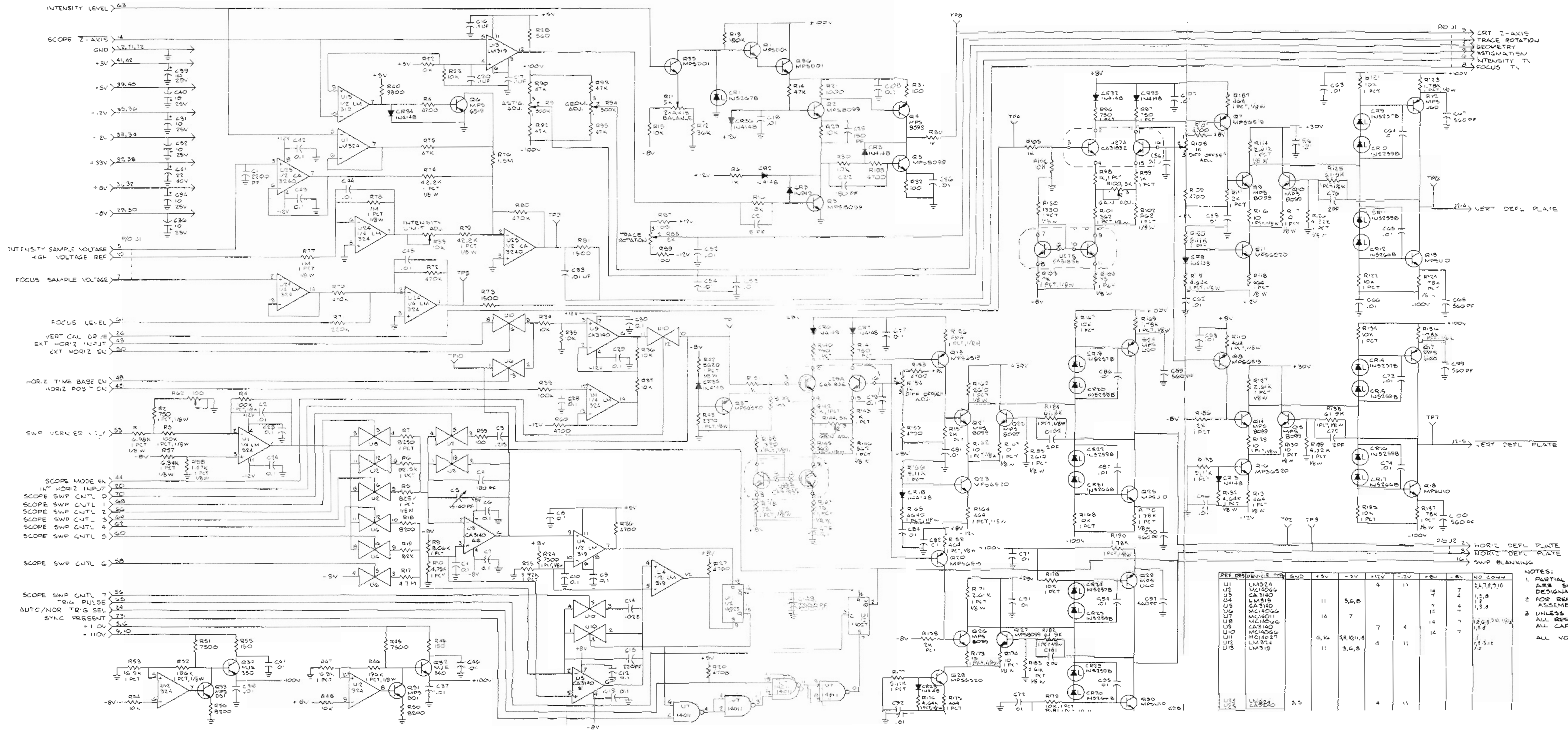
Table 9-1. Internal DVM Inputs

+ Peak Voltage	Positive modulation measurements
- Peak Voltage	Negative modulation measurements
Carrier Level	RF output level
RF INPUT PWR	Power level applied to the RF input/output port
EXT FWD PWR	Forward power level on external inline wattmeter element.
EXT RFL PWR	Reflected power level on external inline wattmeter element.
BATT VOLT	voltage level at DC input jack on the rear panel
TEMP SENS VOLT	+5V level signal the processor that the RF load temperature is too high.
SINAD OUT	DC level proportional to the signal power at the output of the SINAD notch filter.
SINAD IN	DC level proportional to the signal power at the input of the SINAD notch filter.

9-20. External DVM inputs to the front panel jack are ranged by the processor over a four decade range before being routed to the DVM switch. At the Internal/External DVM Select switch the external DVM FROM RNG SW signal or the internal signal from the x0.1 Attenuator is selected to the DVM to A/D signal line for digitization.

9-21. SINAD Detection. The SINAD of a signal on the DVM FROM RNG SW line is determined by taking the ratio of the input to the output signal power on the 1 kHz Notch Filter. Signal power is determined by Rectifier and Filter circuits whose outputs are DC levels proportional to the input signal levels. The DC levels, SINAD IN and SINAD OUT are digitized and input to the processor where the SINAD is calculated.

9-22. Module Control. Processor control of the Scope/DVM Control module is via the AF ADD BUS 0-3, the AF DATA BUS 0-3, and the AF BUS EN 1 signal lines. The four address bits are decoded by the Address Decode to determine which Control Latch the fours bits of data will be latched. The latching process is synchronized by the enable line. Control latches in addition to those necessary for controlling the module provide control for the Scope Amplifier module and part of the RF Input module.

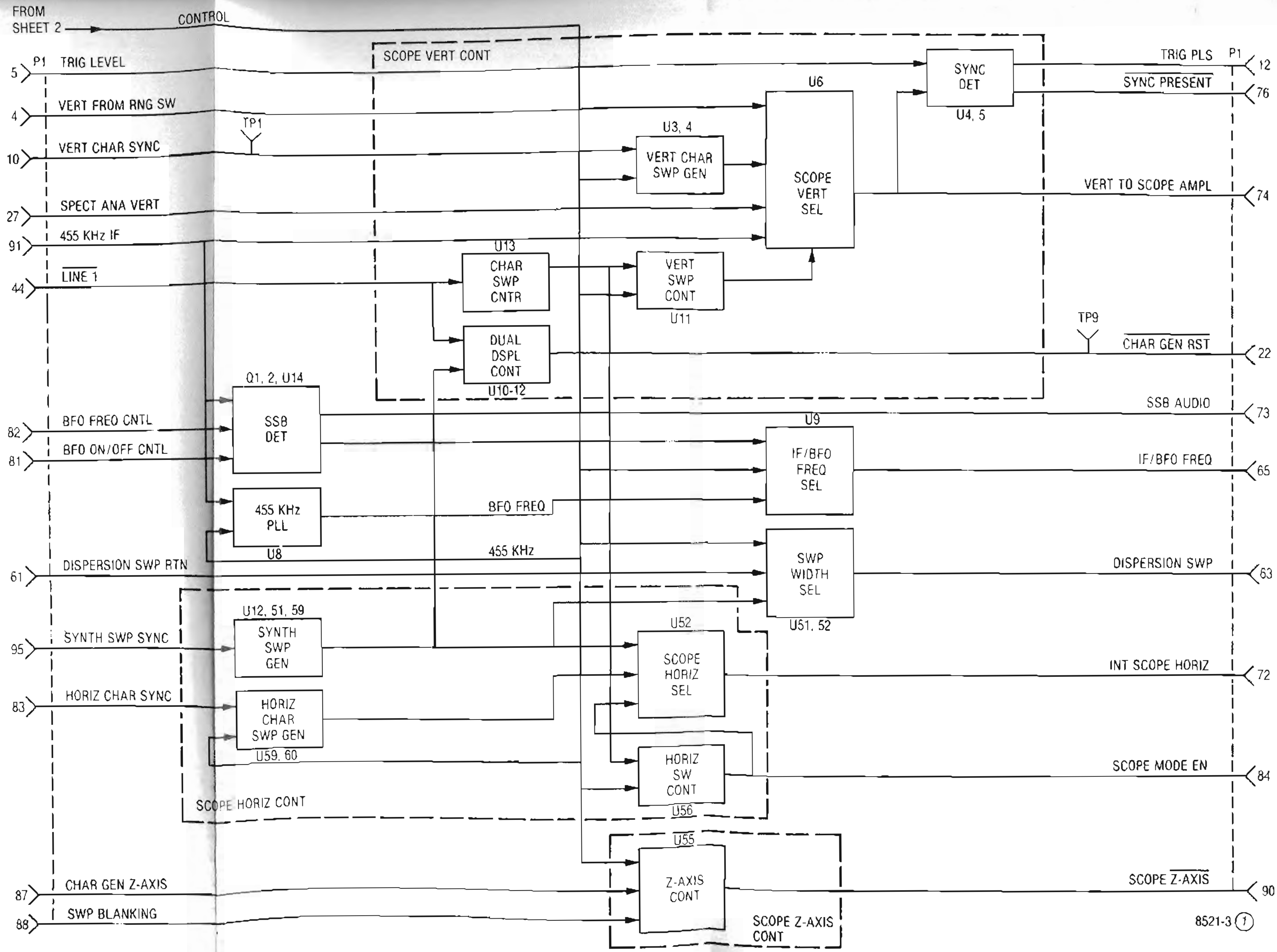


REF DES	DEVICE TYPE	GND	+5V	-5V	+12V	-12V	+8V	-8V	NO CONN
U1	LM324				4	11			5,6,7,8,9,10
U2	MC14066						14	7	
U3	CA3140						7	4	1,5,8
U4	LM319		11	3,6,8					1,2
U5	CA3140						7	4	1,5,8
U6	MC14066						14	7	
U7	MC14011		14	7					
U8	MC14066						14	7	1,2,6,8,9,10,11,12
U9	CA3140				7	4			1,5,8
U10	MC14066						14	7	
U11	MC14027		6,16	3,8,10,11,13					
U12	LM324				4	11			1,2,3,12
U13	LM319		11	3,6,8					1,2
U24 U25	LM324 CA3240	3,5			4	11			

NOTES:

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH 1A2
2. FOR REFERENCE DRAWINGS REFER ASSEMBLY 01-P00413N
3. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE IN OHMS 1.5 PCT 1/8W ALL CAPACITORS ARE IN UF

ALL VOLTAGES ARE IN DC


FROM SHEET 2
CONTROL
SCOPE VERT CONT
P1
5
TRIG LEVEL
4
VERT FROM RNG SW
TP1
10
VERT CHAR SYNC
27
SPECT ANA VERT
91
455 KHz IF
44
LINE 1
SYNC DET
U4, 5
U6
SCOPE VERT SEL
U3, 4
VERT CHAR SWP GEN
U13
CHAR SWP CNTR
VERT SWP CONT
U11
DUAL DSPL CONT
U10-12
TRIG PLS
P1
12
SYNC PRESENT
76
VERT TO SCOPE AMPL
74
TP9
CHAR GEN RST
22
Q1, 2, U14
SSB DET
82
BFO FREQ CNTL
81
BFO ON/OFF CNTL
455 KHz PLL
U8
BFO FREQ
455 KHz
U9
IF/BFO FREQ SEL
SSB AUDIO
73
IF/BFO FREQ
65
61
DISPERSION SWP RTN
SWP WIDTH SEL
U51, 52
DISPERSION SWP
63
U12, 51, 59
95
SYNTH SWP SYNC
SYNTH SWP GEN
83
HORIZ CHAR SYNC
HORIZ CHAR SWP GEN
U59, 60
U52
SCOPE HORIZ SEL
INT SCOPE HORIZ
72
HORIZ SW CONT
U56
SCOPE MODE EN
84
SCOPE HORIZ CONT
U55
Z-AXIS CONT
87
CHAR GEN Z-AXIS
88
SWP BLANKING
SCOPE Z-AXIS CONT
SCOPE Z-AXIS
90

8521-3 ①

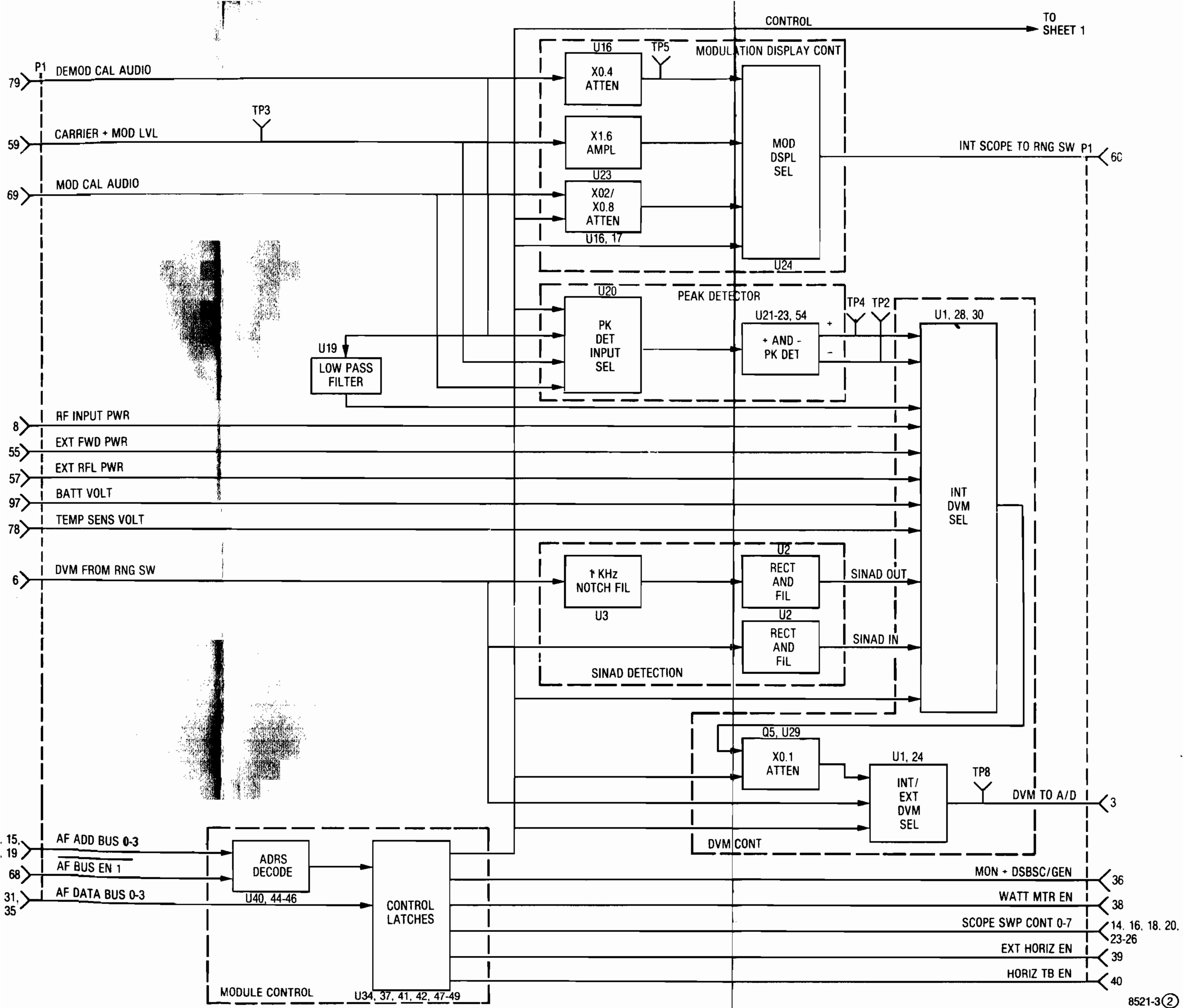


Figure 8-1. Scope/DVM Control Module A3

NOTES.

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH A3.
2. FOR REFERENCE DRAWINGS REFER TO: ASSY. NO. 01-P05400N
3. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS ±5 PCT, 1/4 WATT. ALL CAPACITORS ARE IN UF. ALL INDUCTORS ARE IN UH. ALL VOLTAGES AR DC.
4. TRANSISTOR Q1 P/N 48R00869570

REF DES	DEVICE TYPE	GND	+V	-V	NO CONN.
U1	MC14066		+12V/14	-5V/7	
U2	MC14001		+12V/4	-12V/11	
U3	MLM324		+12V/4	-12V/11	
U4	LM393		+5V/8	-5V/4	
U5	MC4528		+5V/16	-5V/8	
U6	DG-201	5	+12V/13	-12V/4	12
U8	MC14046		+5V/16	-5V/8	1,2,10,15
U9	MC1466	3	+5V/14	-5V/7	
U10	LM393		+5V/8	-5V/4	
U11	MC14011		+5V/14	-5V/7	
U12	MC14528		+5V/16	-5V/8	
U13	MC14017		+5V/12	-5V/8	1 THRU 7,9,11,12
U14	MC1496			-5V/7	7,9,11,13
U16	CA3240		+12V/8	-12V/4	
U17	MC14066	1,3,11	+12V/14	-5V/7	
U19	CA3140		+12V/7	-12V/4	
U20	DG-201	5	+12V/13	-12V/4	12
U21	CA3140		+12V/7	-12V/4	
U22	LM308		+12V/8	-12V/4	
U23	CA3240	3	+12V/8	-12V/4	
U24	MC14066		+5V/14	-5V/7	
U26	CA3140		+12V/7	-12V/4	
U29	MC14066		+12V/14	-5V/7	
U29	LM308		+5V/7	-5V/4	5
U30	MC14066		+12V/14	-5V/7	
U34	MC14514		+12V/24	-5V/12,23	14,15,16,19,20
U37	MC14042		+5V/16,6	-5V/8	9,10,11
U38	MC14555		+5V/16	-5V/8	
U39	MLM324	2,6,9,13	+12V/4	-5V/11	
U40	MLM324		+12V/4	-5V/11	
U41	MC14042		+5V/16,6	-5V/8	9,10
U42	MC14042		+5V/16,6	-5V/8	3,9,12,15
U43	MLM324		+5V/4	-5V/11	
U44	MLM324		+5V/4	-5V/11	
U45	MC14011		+5V/14	-5V/7	
U46	MC14028		+5V/16	-5V/8	4,5,9
U47	MC14042		+5V/16,6	-5V/8	3,9,12,15
U48	MC14042		+5V/16,6	-5V/8	3,9,12,13
U49	MC14042		+5V/16,6	-5V/8	3,9,12,15
U50	MC14001		+5V/14	-5V/7	
U51	MLM324		+12V/4	-12V/11	
U52	MC14066	9	+12V/14	-5V/7	
U54	LM393		+12V/7	-12V/4	
U55	74LS02	7	+5V/14		
U56	MC14001			-5V/7	
U57	MLM324	9	+12V/4	-12V/11	
U58	MC1403	3	+12V/1		
U59	LM393		+5V/8	-5V/4	
U60	CA3140		+12V/7	-12V/4	
U61	MC14049		+5V/1	-5V/8	

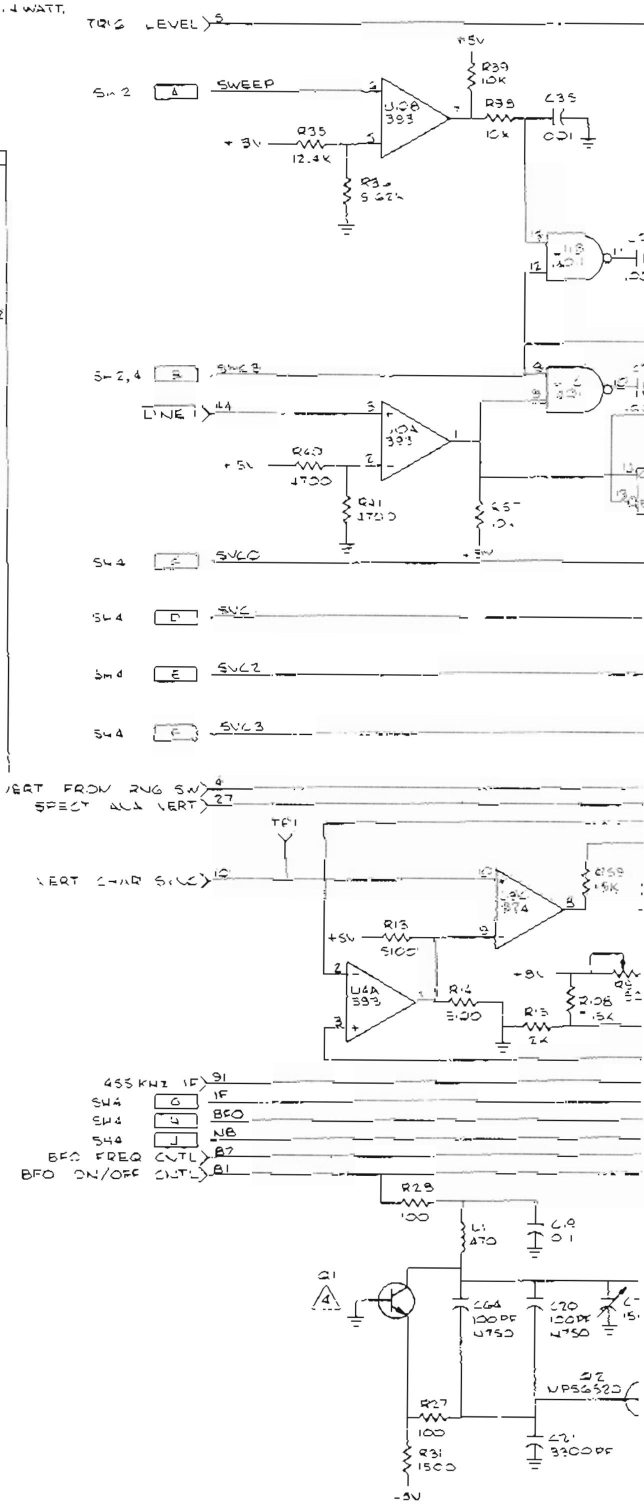
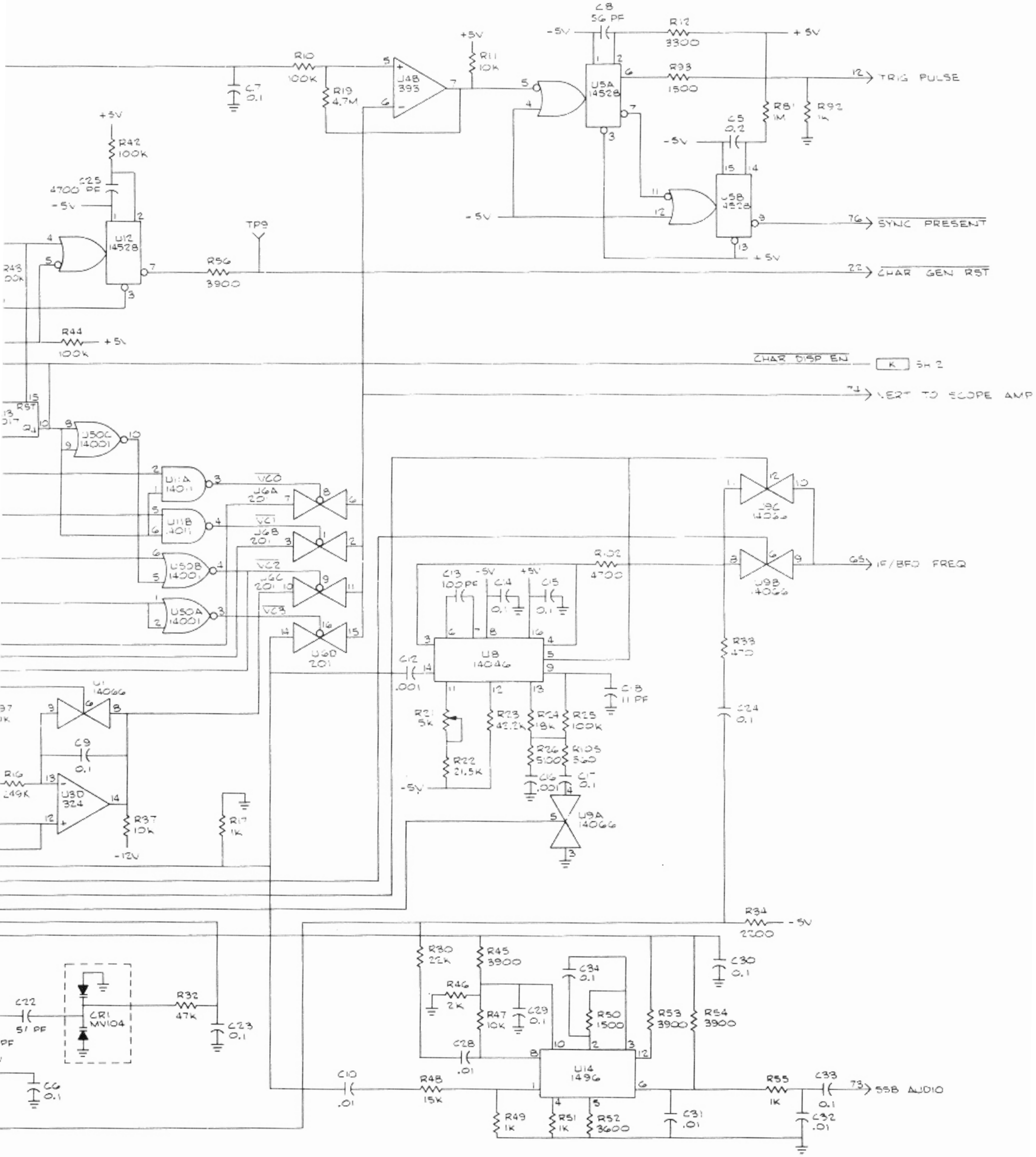
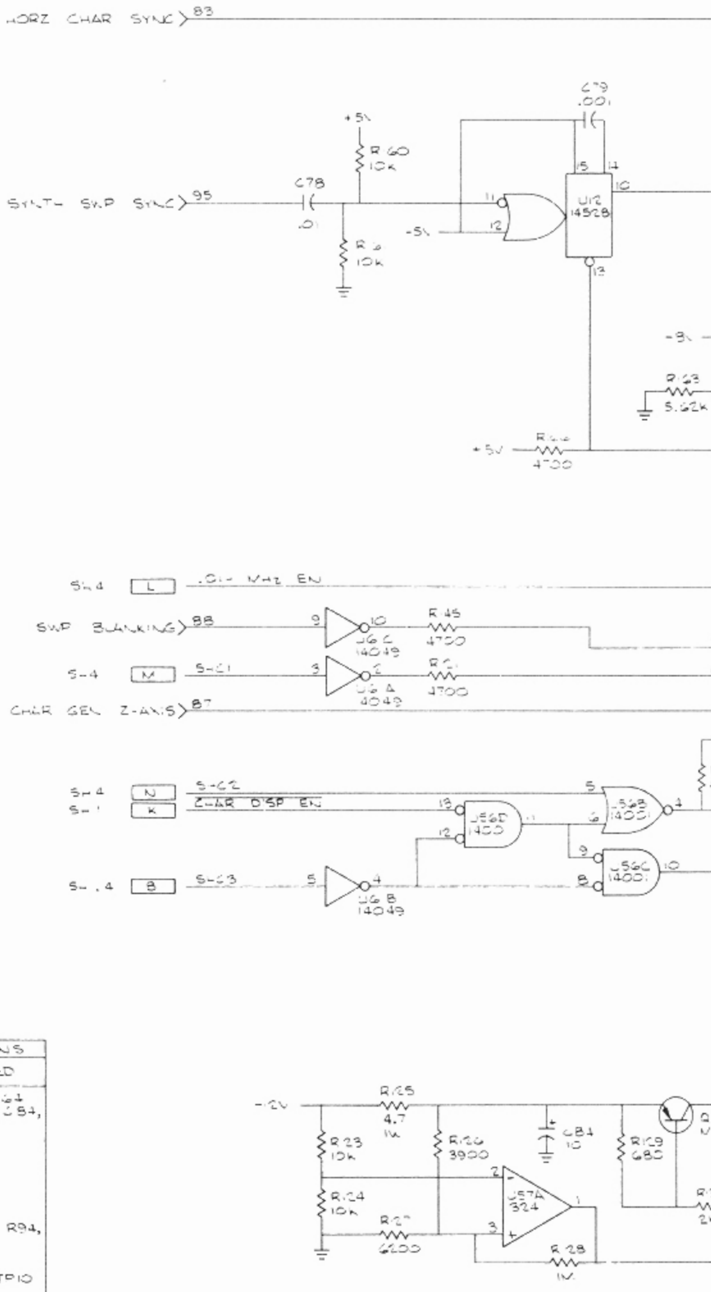


Figure 9-2. Scope/DVM Control Module A3 Schematic Diagram (Sheet 1 of 4) (RTC-4008A)


C8 56 PF
R12 3300
+5V
-5V
R10 100K
R19 4.7M
U4B 393
R11 10K
C7 0.1
U5A 14528
R93 1500
12 TRIG PULSE
R81 1M
R92 1K
C5 0.2
U5B 14528
76 SYNC PRESENT
22 CHAR GEN RST
R42 100K
C25 4700 PF
U12 14528
TP9
R56 3900
R43 100K
R44 100K
CHAR DISP EN
K SH 2
74 VERT TO SCOPE AMP
U13 4017
RST
U50C 14001
U11A 14011
U11B 14011
U50B 14001
U50A 14001
VC0
VC1
VC2
VC3
U6A 201
U6B 201
U6C 201
U6D 201
U9C 14066
U9B 14066
R102 4700
65 IF/BFO FREQ
C13 100 PF
C14 0.1
C15 0.1
U8 14046
C12 .001
C18 11 PF
R21 5K
R22 21.5K
R23 42.2K
R24 18K
R25 100K
R26 5100
R105 560
C16 .001
C17 0.1
U9A 14066
R33 470
C24 0.1
U1 14066
C9 0.1
R16 249K
U3D 324
R37 10K
-12V
R17 1K
R34 2200
R30 22K
R45 3900
R46 2K
R47 10K
C29 0.1
C34 0.1
R50 1500
R53 3900
R54 3900
C30 0.1
C28 .01
U14 1496
C10 .01
R48 15K
R49 1K
R51 1K
R52 3600
C31 .01
R55 1K
C33 0.1
C32 .01
73 SSB AUDIO
C22 51 PF
CR1 MV104
R32 47K
C23 0.1
C6 0.1



REF DESIGNATIONS	
HIGHEST USED	NOT USED
C89	C47, C50, C64 THRU C74, C84, C85
CR13	CR2
L1	
Q4	
R 45	R90 THRU R94, R103
TP12	TP6, TP7, TP10
U61	U15, U18, U25, U27, U31, U32, U33, U35, U36, U53
VR	

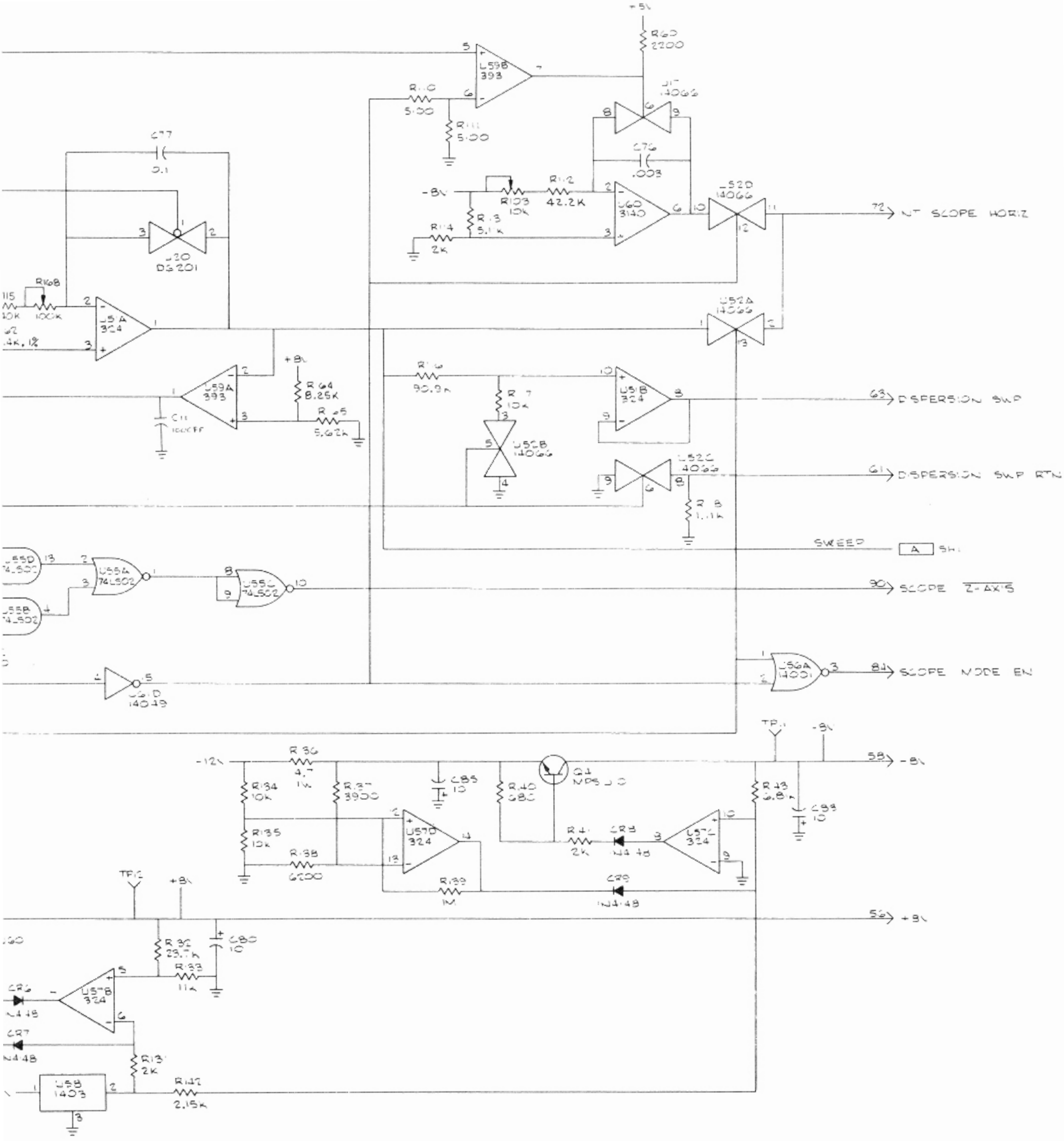


Figure 9-2. Scope/DVM Control Module A3
Schematic Diagram (Sheet 2 of 4)
(RTC-4008A)

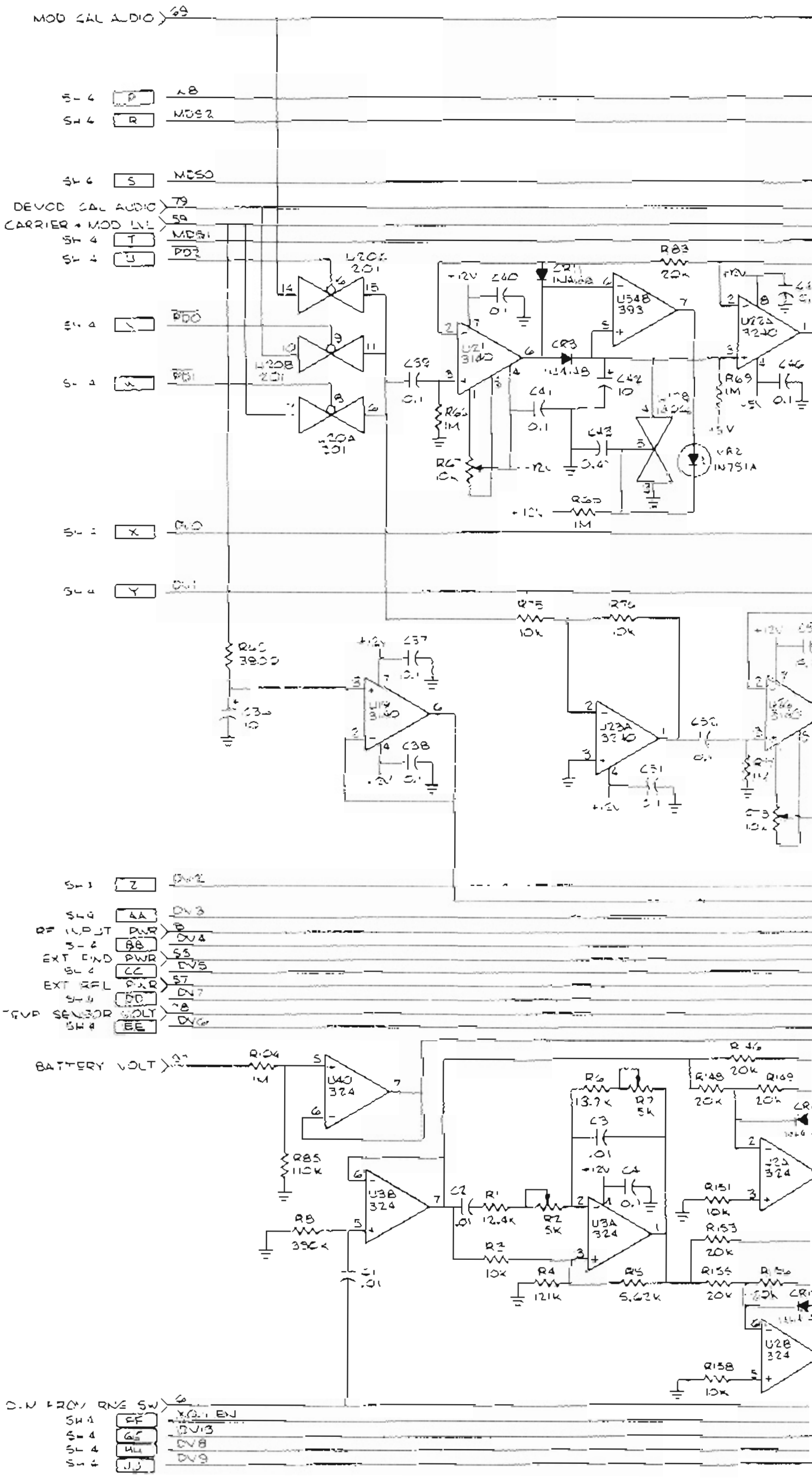
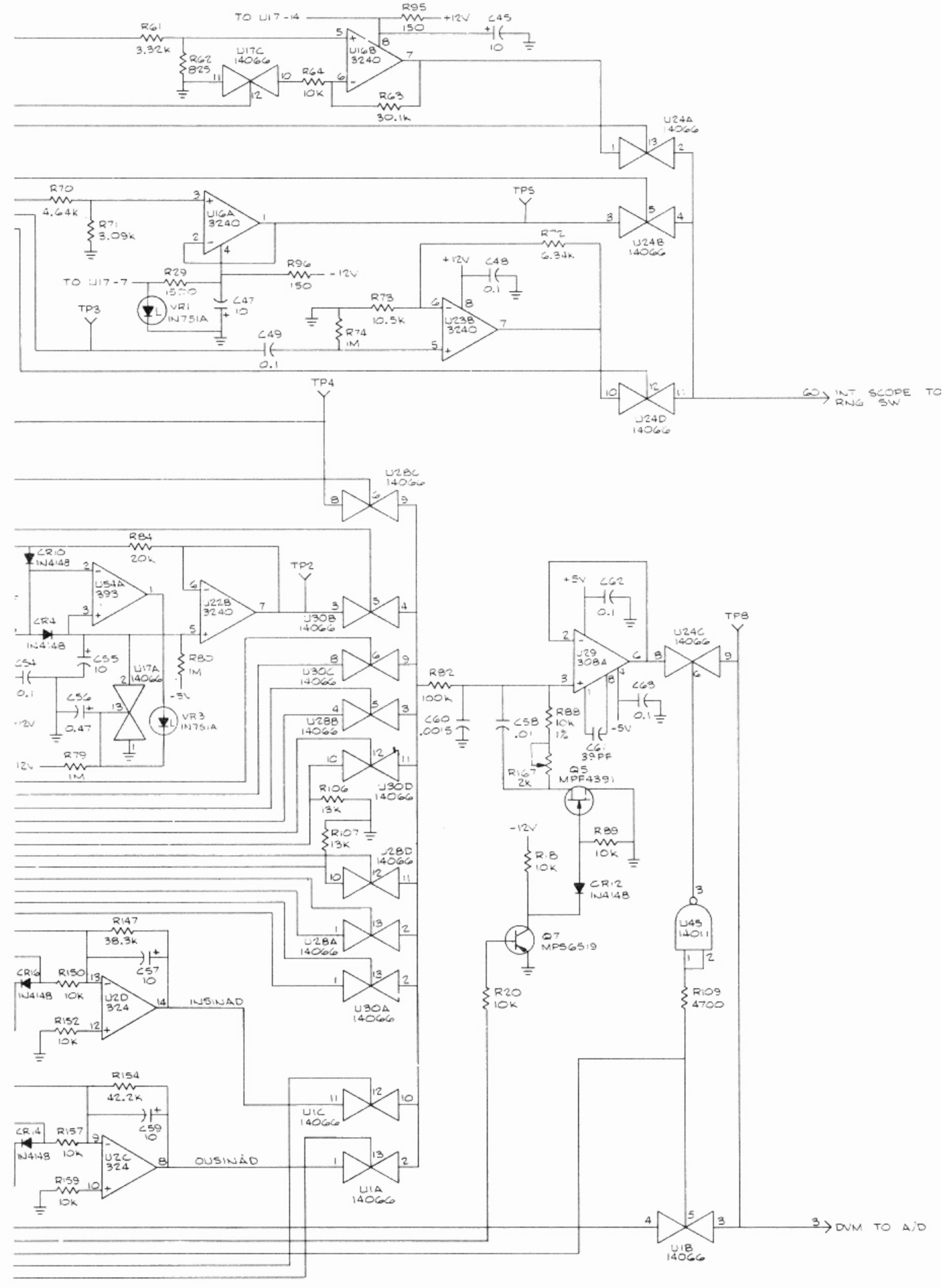


Figure 9-2. Scope/DVM Control Module A3
Schematic Diagram (Sheet 3 of 4)
(RTC-4008A)


TO U17-14
R95 150 +12V
C45 10
R61 3.32k
R62 825
U17C 14066
R64 10K
U16B 3240
R63 30.1k
U24A 14066
R70 4.64k
R71 3.09k
U16A 3240
TP5
U24B 14066
R72 6.34k
R96 150 -12V
+12V C48 0.1
TO U17-7
R29 1500
C47 10
VR1 IN751A
TP3
R73 10.5K
R74 1M
U23B 3240
C49 0.1
TP4
U24D 14066
GO INT SCOPE TO RNG SW
U28C 14066
R84 20k
CR10 IN4148
U54A 393
U22B 3240
TP2
U30B 14066
CR4 IN4148
C55 10
U17A 14066
R80 1M
-5V
C54 0.1
C56 0.47
VR3 IN751A
U30C 14066
R82 100k
C60 .0015
U28B 14066
R79 1M
12V
U30D 14066
R106 13K
R107 13K
U28D 14066
U28A 14066
R147 38.3k
C57 10
CR16 IN4148
R150 10K
U2D 324
R152 10K
INSINAD
U30A 14066
R154 42.2K
C59 10
CR14 IN4148
R157 10K
U2C 324
R159 10K
OUSINAD
U1C 14066
U1A 14066
+5V C62 0.1
U29 308A
C63 0.1
C58 .01
R88 10k 1%
C61 39PF
-5V
R167 2k
Q5 MPF4391
TP8
U24C 14066
-12V
R18 10K
R89 10K
CR12 IN4148
Q7 MPS6519
U45 14011
R20 10K
R109 4700
U1B 14066
3 DVM TO A/D

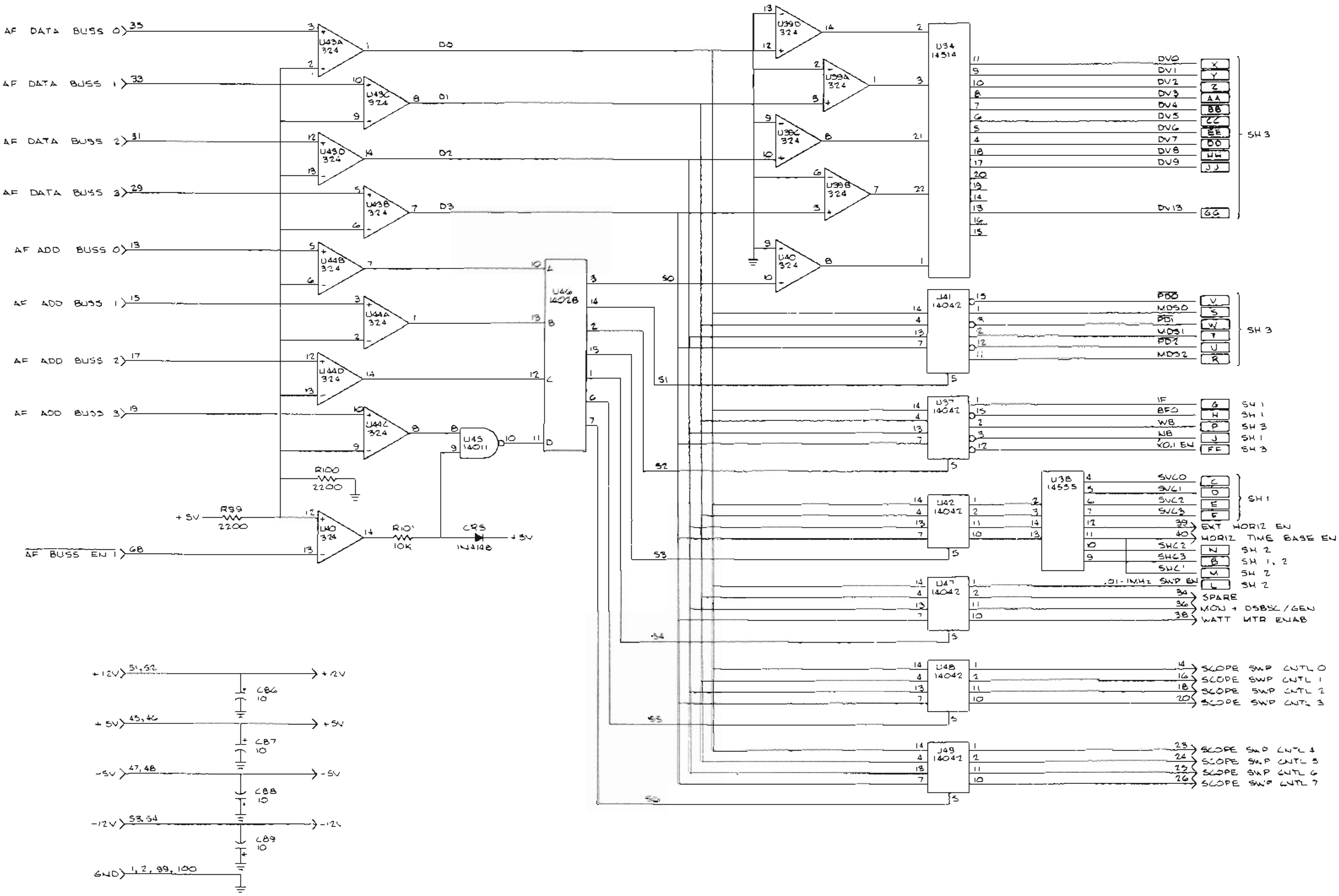


Figure 9-2. Scope/DVM Control Module A3
Schematic Diagram (Sheet 4 of 4)
(RTC-4008A)

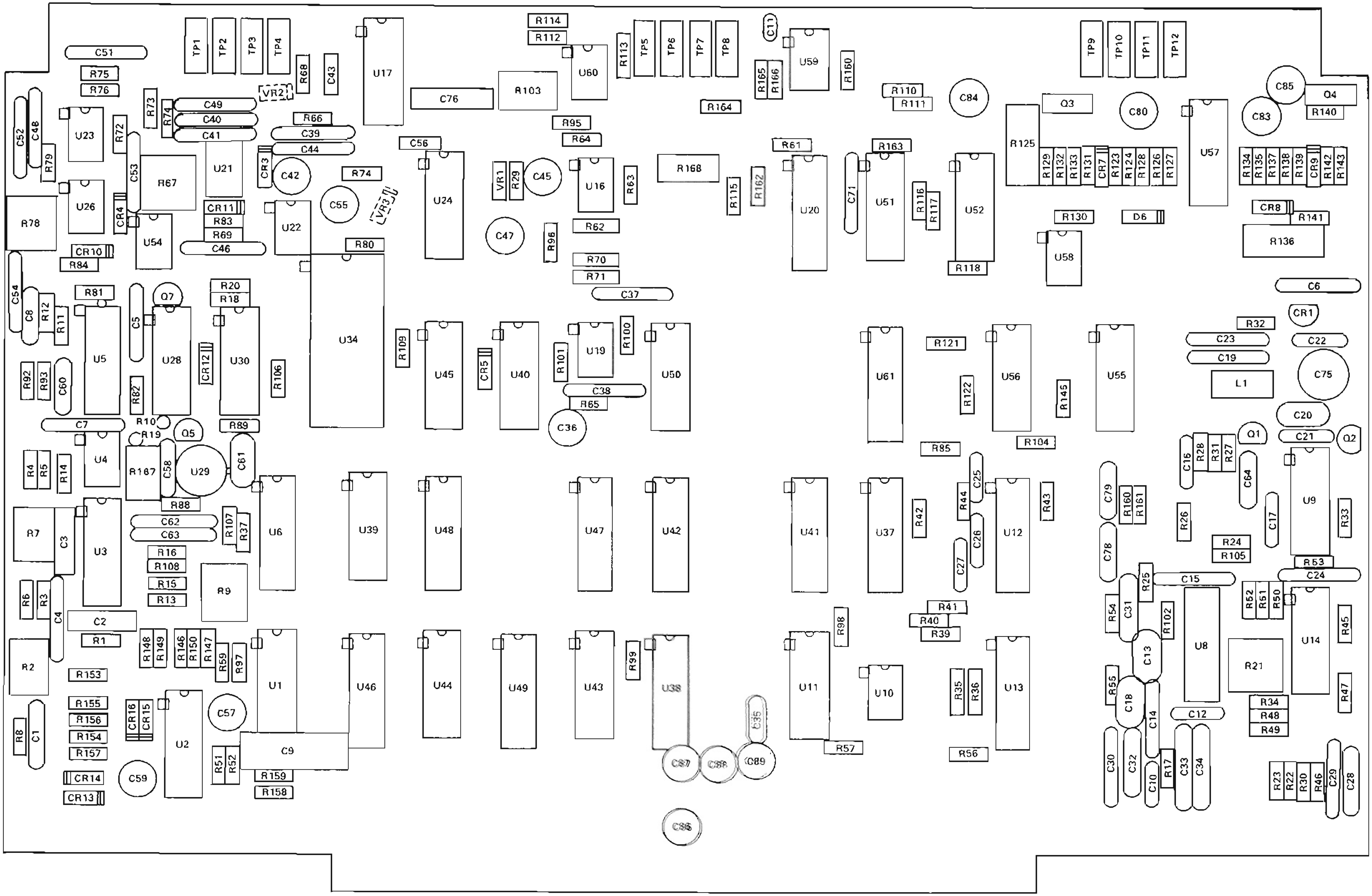


Figure 9-3. Scope/DVM Control Module Parts Locator

SECTION 10

RECEIVER (A4)

10-1. General. The Receiver down converts the 10.7 MHz first IF signal to 455 kHz. Following the down conversion a linear or a logarithimic IF amplifier provide the gain prior to AM and FM detectors or the spectrum analyzer detector respectively. Post detection filtering provides the wide or narrow band responses for the audio outputs. The audio amplifier for the speaker and the alarm generator are also contained on this module. A block diagram of the Receiver is shown in figure 10-1 and its schematic in figure 10-2.

10-2. Down Converter. The 10.7 MHz IF signal is converted to 455 kHz by mixing with a 10.245 MHz local oscillator. The local oscillator is phase locked to the system 10 MHz frequency standard. A sample of the 10.245 MHz VCO signal is output to the Processor I/O module. There the VCO signal is mixed with 10 MHz, the difference is divided by 49, and the result compared with a 5 kHz reference obtained from the 10 MHz. Any frequency difference causes a correction to be made to the VCO frequency via the 10.245 MHz VCO TV line through the Loop Filter.

10-3. The IF filter following the mixer provides the selectivity for the system. Two bandwidths, ±100 kHz wideband and ±13 kHz narrowband, are processor selectable to correspond the front panel bandwidth control.

10-4. Linear IF Amplifier and Detectors. The linear IF Amplifier amplifies the 455 kHz signal to the AM and FM detectors. The DC signal from the AM detector is fed to the AGC Amplifier and Squelch Detection circuitry. There it is compared to the AGC reference with the resulting AGC signal controlling the gain of the IF Amplifier. For signal present indication and squelch operation the SQUELCH LVL from the front panel is compared to the AGC voltage. When the AGC voltage fall below the squelch level, indicating a strong signal, the SIG PRESENT line is activated. With the SIG PRESENT active the audio is allowed through the select switch and the signal present light on the front panel is illuminated. To warn the operator when the IF input level is beyond the linear range of the IF amplifier, the AGC voltage is also compared to a fixed IF overload level. When this level is exceeded, the IF OVLD line is activated causing the processor to flash the warning on the CRT display.

10-5. The AC component from the AM detector is buffered by the Audio Buffer and then passed to the Audio Select switch. The lower 3 dB corner on the AM audio response is approximately 100 Hz.

10-6. Frequency modulation is recovered by a dual bandwidth phase locked loop discriminator. The bandwidth, wide or narrow. is selected coincident with the IF Filter bandwidth. Audio from the discriminator is applied to the Audio Select switch.

10-7. A 455 kHz Buffer amplifier provides an interface between the IF Amplifier output and the IF processing circuits on the Scope/DVM Control module.

10-8. Audio Switching and Filtering. The output of the AM or FM detector or the SSB AUDIO signal from the Scope/DVM Control module can be selected as the demodulated audio output. Selection is made by the processor depending on the operating mode and the presence of the active state on the SIG PRESENT line. If the SIG PRESENT line is not active, the Audio Select switch is opened squelching the audio signal.

10-9. The Audio Filter provides either wide or narrow band filtering on the recovered audio. For wideband a 0.5 dB bandwidth of 100 kHz is provided while narrowband has a 0.5 dB bandwidth of 3 kHz. The output of the filter is separately buffered to three signal lines. The DEMOD CAL AUD signal is used on the Scope/DVM

Control module for modulation determination, the DEMOD OUT signal goes to the front panel jack, and the VOL CNTL AUD provides the drive to the speaker audio amplifier.

10-10. Logarithmic Amplifier and Detector. For the spectrum analyzer function the logarithmic IF amplifier processes the input signal level over an 80 dB range. The Amplifier is composed of four 20 dB sections summed together. Amplitude detection at the output of the amplifier provides the SPECT ANA VERT signal to the Scope/DVM Control module.

10-11. Alarm Generator and Audio Amplifier. An astable multivibrator operating at 1.2 kHz is the Alarm Generator. The Alarm signal is controlled by the processor and is summed with the VOL CNTL AUD RTN signal at the input of the Audio Amplifier. The SPKR AUD output of the amplifier has 0.5 watt capability and is connected directly to the system speaker.

10-12. Module Control. Address decoding for the two control latches on this module is performed on the Synthesizer module. The two decoded lines, RF LCH ADD 13 and RF LCH ADD 14, determine which Control Latch the four bit data bus, RF DATA BUS 0-3, will be stored.

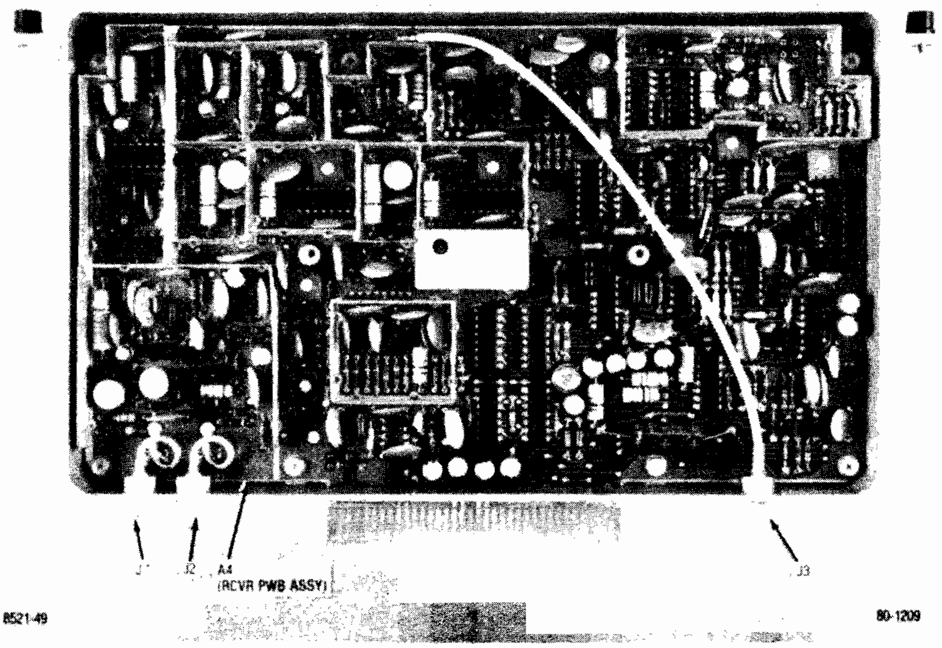


Figure 10-3. Receiver Parts Locator

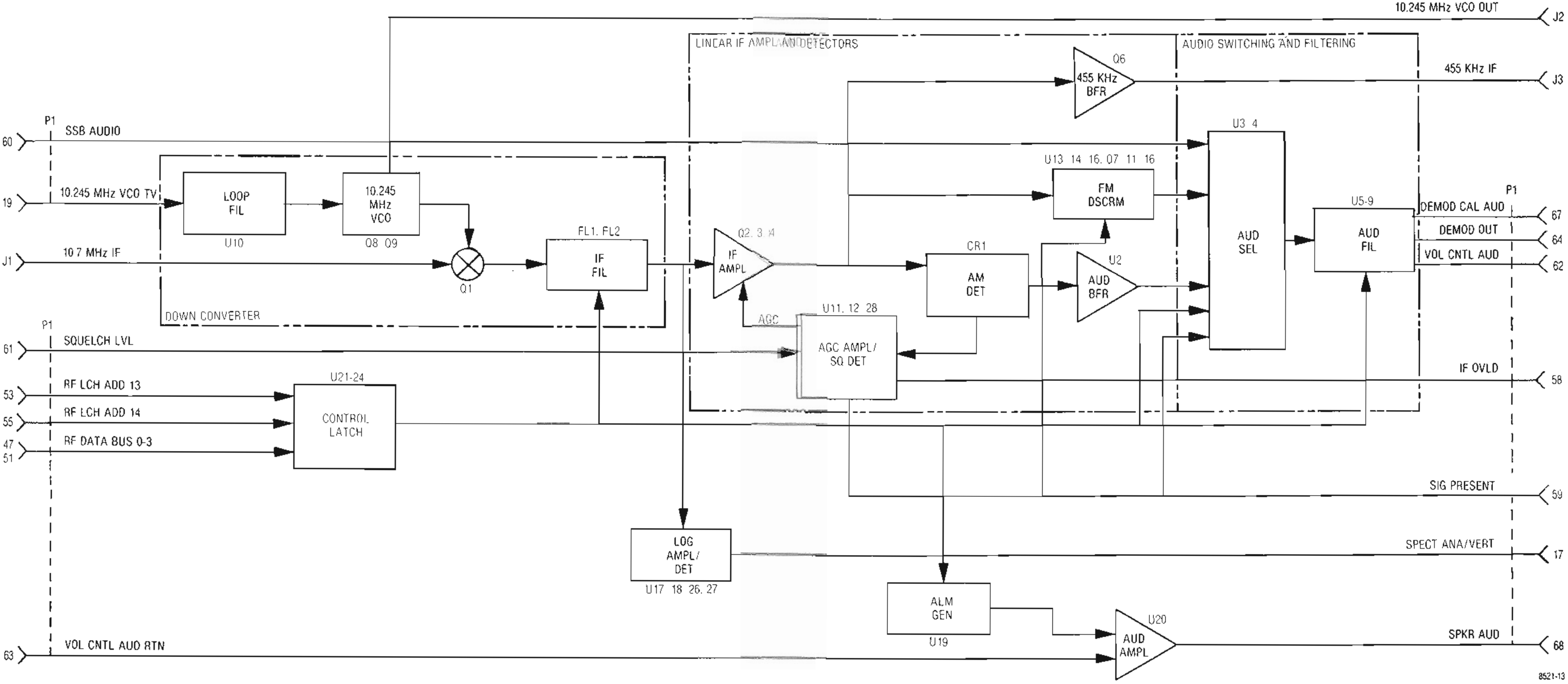


Figure 10-1. Receiver A4 Block Diagram

NOTES:

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH 1A4.
2. FOR REFERENCE DRAWINGS REFER TO: 01-P00389N
3. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS ±5PCT, 1/4 WATT.
   ALL CAPACITORS ARE IN UF.
   ALL INDUCTORS ARE IN UH.
   ALL VOLTAGES ARE DC.

⚠4 R123 IS SELECTED IN TEST NOMINAL VALUE IS ZERO OHMS (BUS WIRE). SOME UNITS MAY HAVE 1K-4, RN55D1001F.

⚠5 RESISTOR SELECTED IN TEST.

⚠6 DIODE IS P/N 48D84616A01

⚠7 VARACTORS CR4 AND CR7 ARE SELECTED IN TEST.

REF DES	DEVICE TYPE	GND	+V	-V	+VF	-VF	NO CONN
U1	MC14066						
U2	MC14066						
U3	MC14001				+5/14	-5/7	
U4	MC14066				+5/14	-5/7	
U5	MC14066	3			+5/14	-5/7	
U6	CA3240	3			+12/8	-12/4	
U7	MC14066	4, 8			+5/14	-5/7	
U8	MC14066						
U9	CA3240	3, 5			+12/8	-12/4	
U10	CA3160	4	+12/7				1, 5, 8
U11	LM393	4	+12/8				
U12	CA3240		+12/8	-5/4			
U13	MC14070						
U14	74LS74	7					
U15	MC14066	4			+5/14	-5/7	
U16	CA3240						
U17	MC1733						
U18	MC1733						
U19	MC14011				+5/14	-5/7	
U20	LM386	6		-12/4			1
U21	LM324						
U22	LM324						
U23	MC14042		+5/6,16	-5/8			
U24	MC14042		+5/6,16	-5/8			
U25							
U26	TL4410	13	+5/8				1, 3
U27	CA3240	3	+5/8	-5/4			5, 6, 7
U28	MC1403A	3	+5/1				

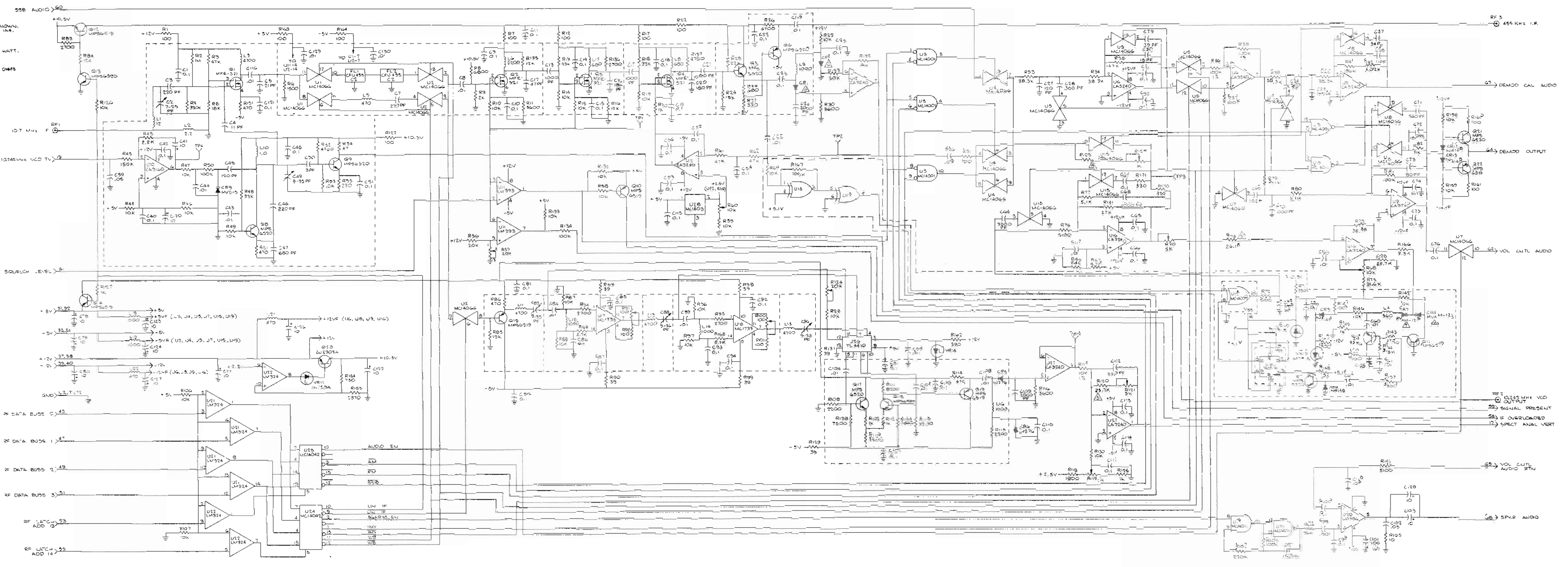


Figure 10-2. Receiver A4 Schematic Diagram (RTL-1002A)

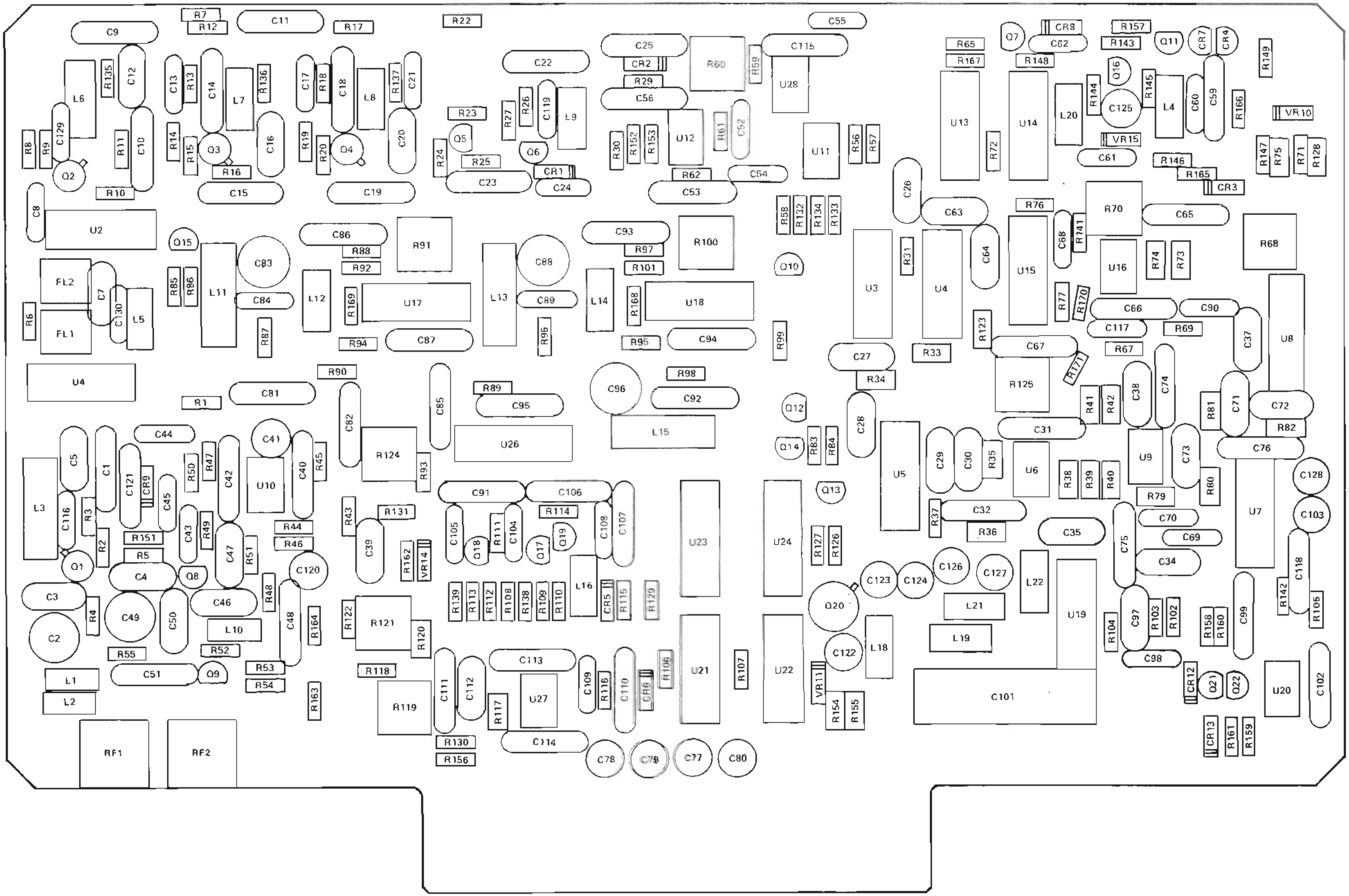


Figure 10-3. Receiver Parts Locator
(Sheet 1)

SECTION 11

RF SYNTHESIZER (A5)

11-1. General. The RF Synthesizer provides an RF signal source for the frequency range from 10 kHz to 1 GHz in 100 Hz steps. The output frequency is programmed by the processor through the RF control bus and is phase locked to the 10 MHz frequency standard. A reference divider in the module produces outputs of 500 kHz, 50 kHz, 5 kHz, 1 kHz, 100 Hz, and 50 Hz (SYNTH SWP SYNC) each having the same accuracy as the frequency standard. A block diagram of the RF Synthesizer is shown in figure 11-1 and its schematic is shown in figure 11-3.

11-2. Frequency Synthesis Scheme. Four phase locked loops are used to generate the output frequency; a 60.5 MHz loop, a 310-440 MHz loop, the 500 MHz-1000 MHz loop, and the 550 MHz loop. Two of these loops contain programmable dividers, controlled by the microprocessor for varying the frequency. The 310-440 MHz loop is controlled by the four most significant digits of the required frequency and operates in discrete 50 kHz increments. The 60.5 MHz loop is controlled by the three least significant digits of the required frequency and operates in discrete 50 Hz increments.

11-3. The output is derived from three sources, covering the ranges of 10 kHz to 250 MHz, 250 MHz to 500 MHz, and 500 MHz to 1000 MHz. In the first range, 10 kHz to 250 MHz, the output is derived by mixing the fixed 550 MHz signal with 500-1000 MHz signal programmed for frequencies from 550.01 MHz to 800 MHz. For the second range, 250 to 500 MHz, the output is a divide by two of the 500-1000 MHz signal. The final range is the 500-1000 MHz signal directly. The appropriate frequency source is switched to the SYNTH RF output by the Output Select switch.

11-4. A basic flow diagram for programming the RF Synthesizer is shown in figure 11-2. This diagram includes generate and monitor considerations, wideband amplifier control, and modulation control.

11-5. 310-440 MHz Phase Locked Loop. A single 310-440 MHz VCO is phase locked to the 100 kHz reference input using a straight forward loop. The VCO output is divided down to 50 kHz using a programmable two modulus prescaler and divider. Programming of the divider is controlled by the processor to give output frequencies from 310 to 440 MHz in 50 kHz steps.

11-6. 60.5 MHz Phase Locked Loop. The 60.5 MHz loop is programmable over a ±100 kHz range in 50 Hz increments. The 60.5 MHz VCO output is mixed with a 50 MHz signal from the 550 MHz loop. A programmable divider following the mixer divides the 10.5 MHz ± 100 kHz signal down to the 50 Hz reference frequency. A comparison between the divider output and the reference signal by the Phase/Frequency detector results in an error voltage to the VCO which maintains the phase lock.

11-7. 550 MHz Phase Locked Loop. A fixed frequency of 550 MHz is obtained by dividing the 550 MHz VCO by 55 to obtain 10 MHz. The 10 MHz from the divider is compared with the 10 MHz frequency standard in the Phase/Frequency Detector. The resulting error signal is filtered and used to correct the 550 MHz VCO to maintain it in lock.

11-8. A Voltage Controlled Attenuator (VCA) follows the 550 MHz output to level the generator output for frequencies below 1 MHz. The leveling loop in the RF Input module provides the ALC VOLT control signal to maintain the required output level at the front panel RF jack. See paragraph 5-31 for a further description of output leveling.

11-9. 500-1000 MHz Phase Locked Loop. The 500-1000 MHz output is locked to either the sum or the difference of the 310-440 MHz and 60.5 MHz loop output frequencies. In the locked condition, mixing the divide by two output of the 500-1000 MHz VCO's with the 310-440 MHz signal gives a difference frequency equal to the 60.5 MHz output. There are two frequencies at the divide by two output, the 310-440 MHz frequency plus or minus the 60.5 frequency, which will mix down to the correct frequency. However, the sense of the loop is inverted for one compared to the other. Thus the phase switch following the Phase/Frequency Detector determines at which frequency the loop will lock.

11-10. Modulation Control. Modulation of the tuning voltage for the 60.5 MHz VCO provides the frequency modulation of the RF output. Since the modulation sensitivity changes by a factor of two when the 250-500 MHz source is selected, the modulation control provides programmable gain control to maintain constant sensitivity at the FM MOD and SWEEP inputs. Additionally, the wideband modulation mode requires a gain of four beyond that for the narrowband mode. Thus under the control of the processor the Modulation Control selects between the SWEEP and FM MOD inputs, provides gains of 1, 2, 4, and 8 for the FM MOD input and gains of 1 and 2 for the SWEEP input. Input modulation sensitivites are 5 kHz/volt and 20 kHz/volt for narrow and wideband FM input and 2 MHz/volt for the sweep input.

11-11. Module Control. Control information is latched in four bit control latches which are loaded by the processor through the RF control bus. The four bit RF ADD BUS 0-3 is decoded by the Address Decoder to determine which Control Latch the four bit RF DATA BUS 0-3 is to be stored. Synchronization of the data transfer is the function of the RF BUS EN line. Two decoded address outputs, RF LATCH 13 and 14, select latches on the receiver module for receiver control. One control latch output, LO/HI BAND SEL, goes to the RF Input module to control the frequency range of the output amplifer.

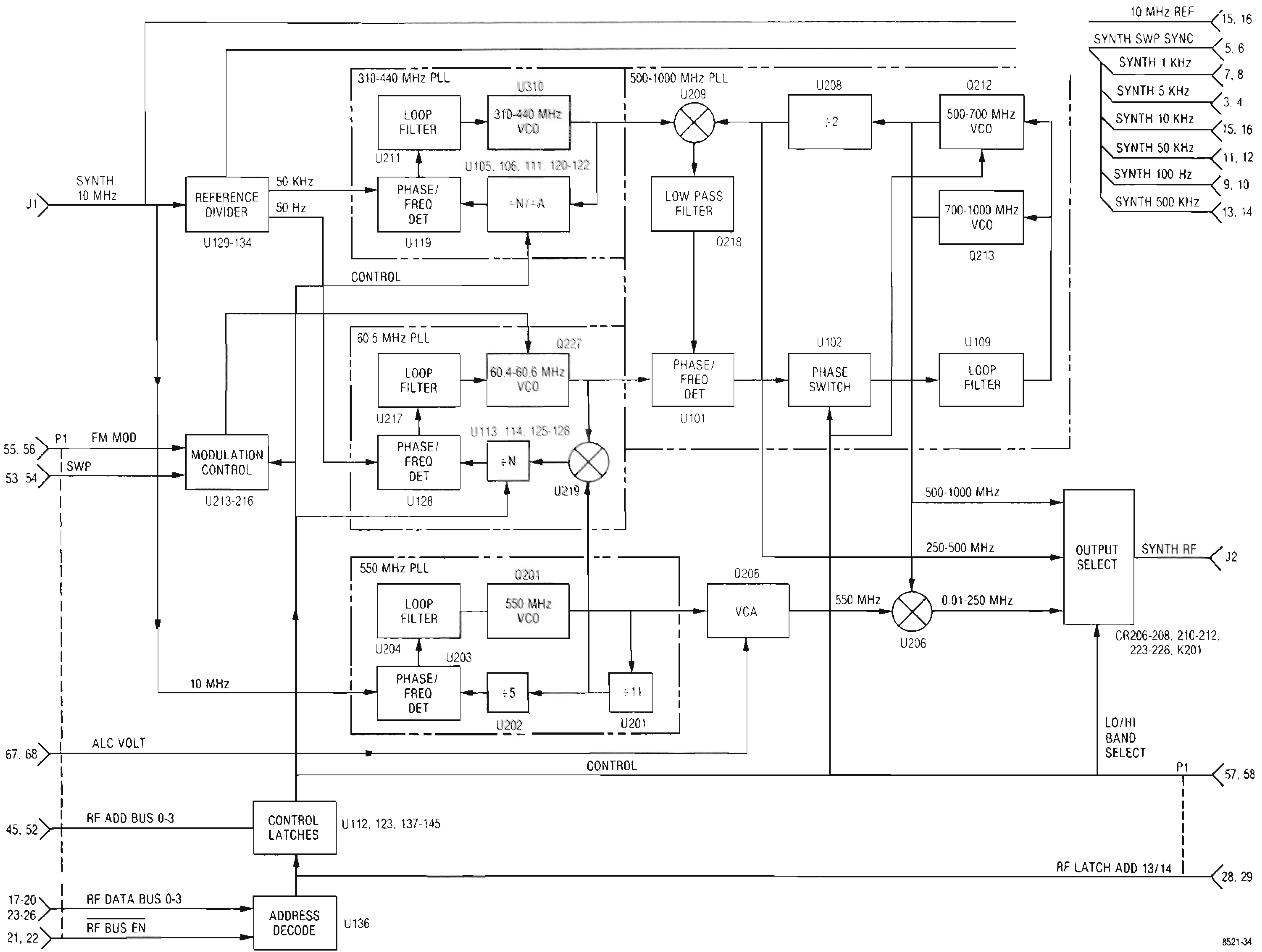


Figure 11-1. RF Synthesizer A5 Block Diagram

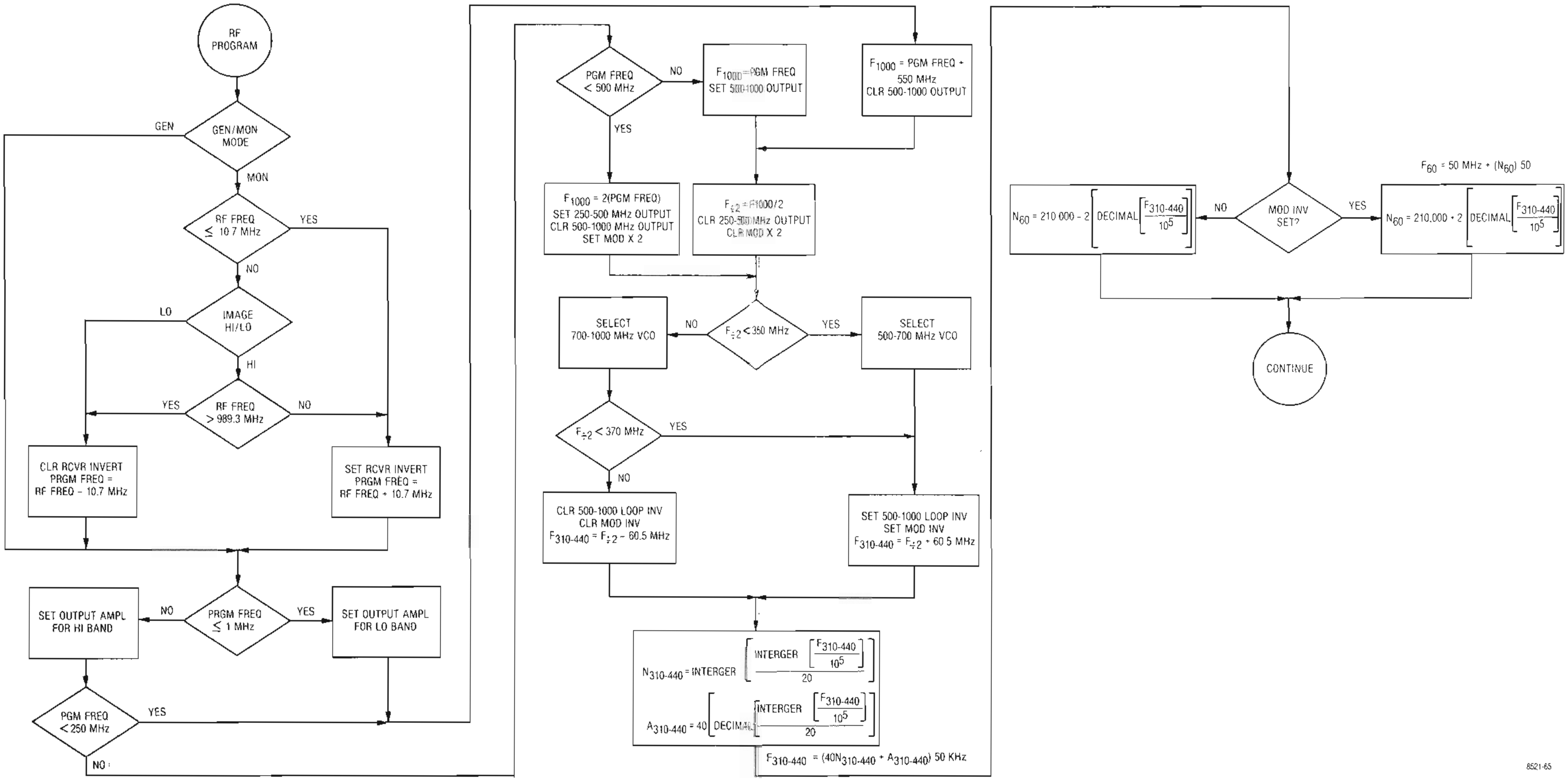
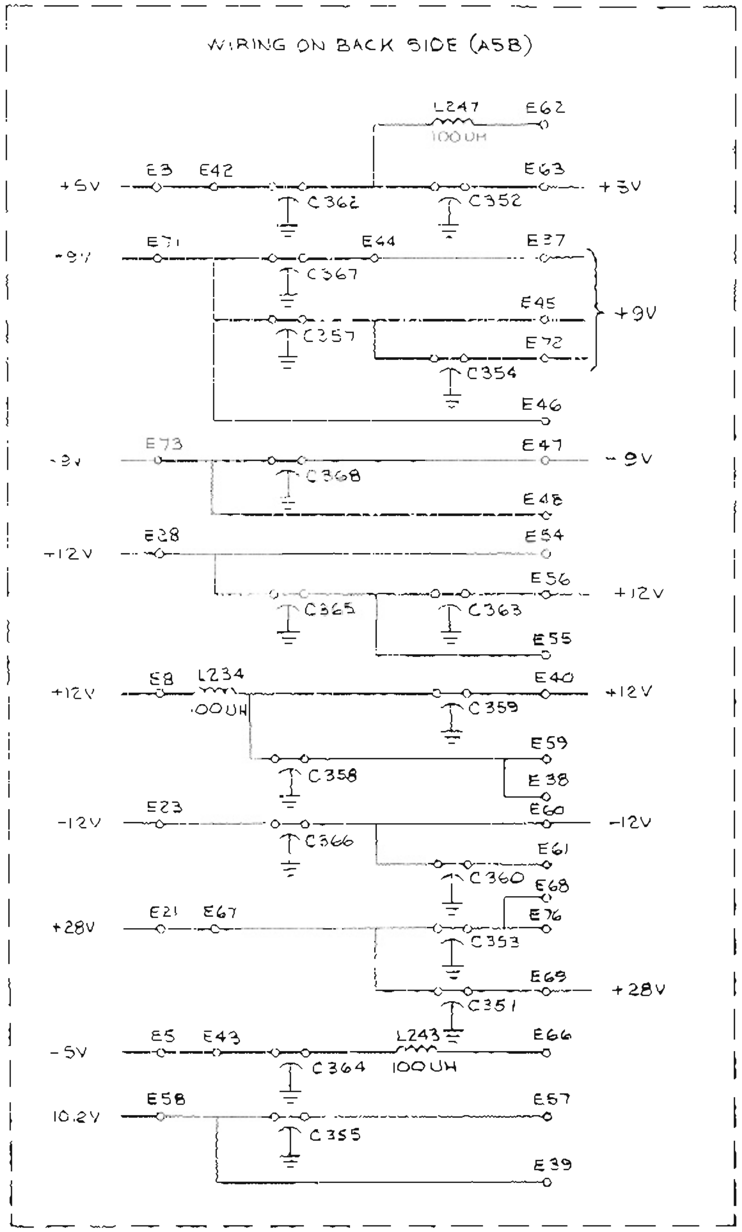


Figure 11-2. Frequency Programming Flow Diagram

NOTES:

1. ALL FEED THRU CAPACITORS ARE 5000 PF
2. FOR REFERENCE DRAWINGS REFER TO:
   01-P0038SN ASSEMBLY



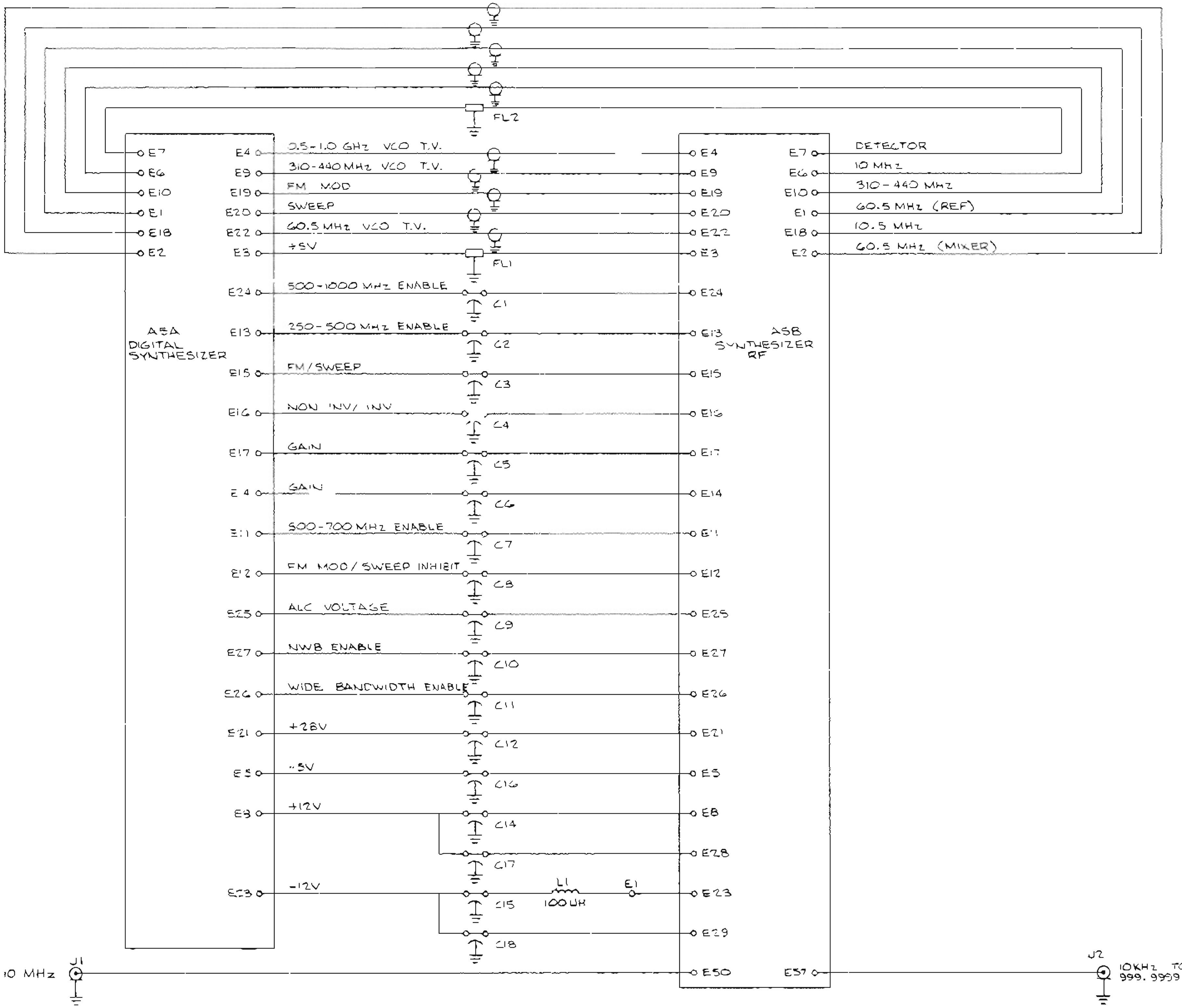


Figure 11-3. RF Synthesizer A5 Schematic Diagram (RTC-1001A)

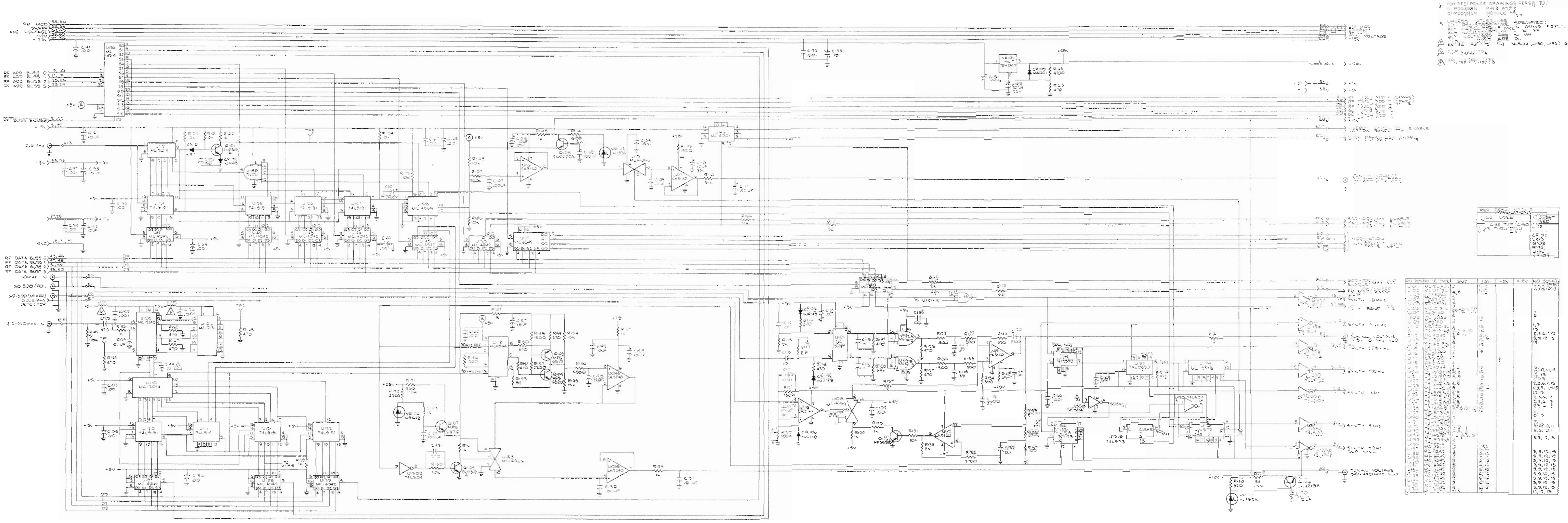
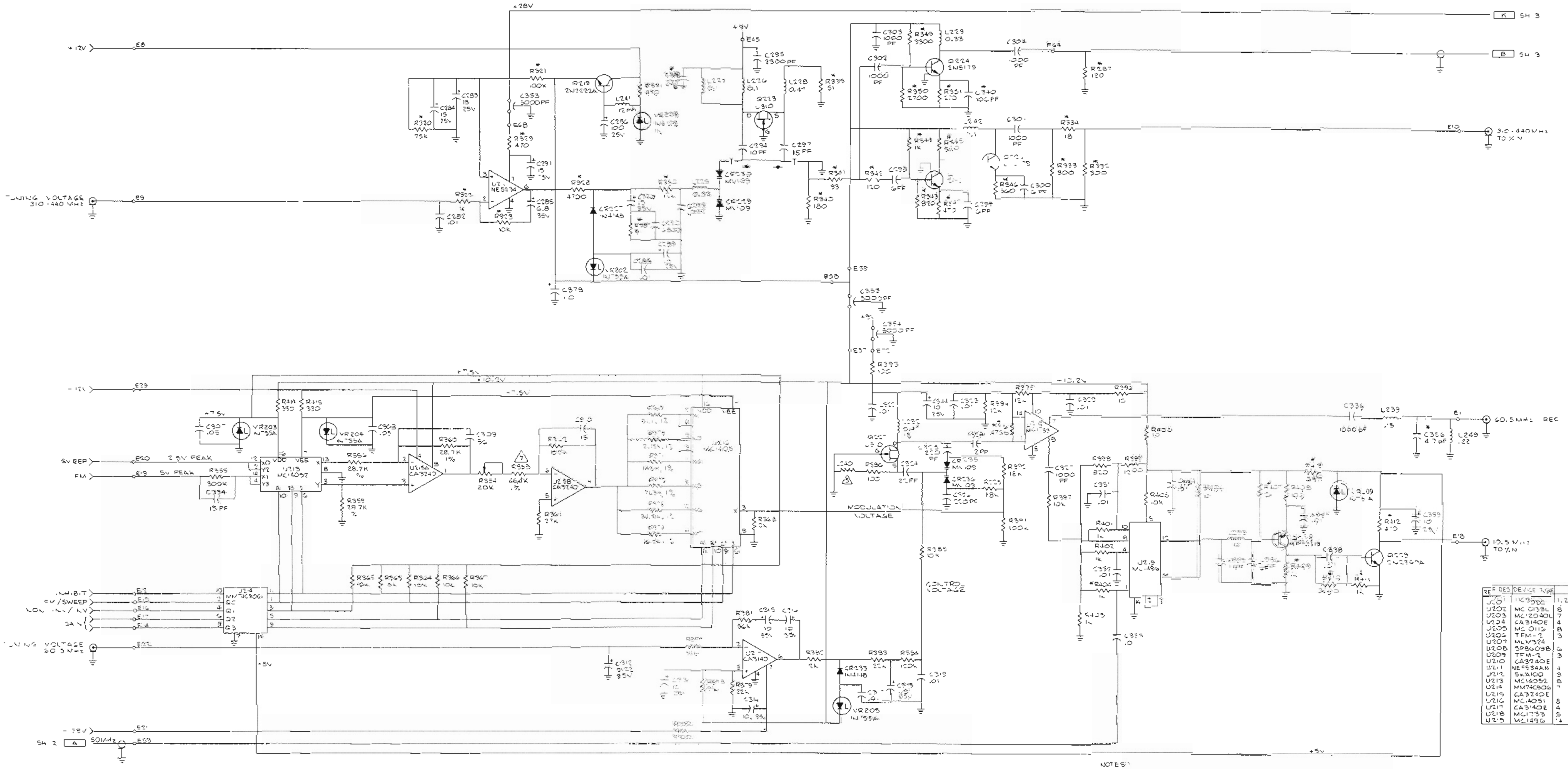


Figure 11-4. Digital Synthesizer Card A5A1 Schematic Diagram (RTC-4009A)



REF DESIGNATIONS	
NOT USED	HIGHEST USED
	C397
CR213,228,231,232, CR234,237 THRU 240	CR242
	FL201
	K201
L212 222	L249
	Q233
R226,280,316,317, R318 388, 306	R435
	T202
	U219
	VR210

REF DES	DEVICE TYPE	GND	+5V	-5V	+12V	-12V	NO CONNECTION
U201	[illegible]	1,2,3,12	4 5				2,7,10,11,13
U202	MC 0139L	8	16				4,5,6,9,10,11,12,13,14,15
U203	MC12040L	7	14				2,4,5,8,10,11,13
U204	CA3140E	4					1,5,8
U205	MC 0116	8	1,16				14,15
U206	TFM-2	3					
U207	MLM324		4	11			
U208	SP8609B	6					1,2,3,5,8,9,12,13
U209	TFM-2	3					
U210	CA3240E				8	4	
U211	NE5534AN	4					1,5,8
U212	SWA100	3					
U213	MC14052	8					1,5,11,15
U214	MM74C906	7	14				12,13
U215	CA3240E					4	
U216	MC14051	8					
U217	CA3140E	4					1,5,8
U218	MC1733	5					2,3,4,6,9,11,12,13
U219	MC1496	14					7,9,11,13

NOTES:

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATIONS PREFIX WITH A5A2.
2. FOR REFERENCE DRAWINGS REFER TO: 01-P00385N MODULE ASSY 01-P00386N PWB ASSY
3. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, 5 PCT [illegible] ALL CAPACITORS ARE IN UF. ALL INDUCTORS ARE IN UH. ALL VOLTAGES ARE DC.
4. * MEANS 1/8W [illegible]
⚠5 2N6689601
⚠6 SELECT IN TEST
⚠7 NOMINAL VALUE SHOWN SELECT IN TEST

Figure 11-5. RF Synthesizer Card A5A2 Schematic Diagram (Sheet 1 of 3) (RTC-4010A)

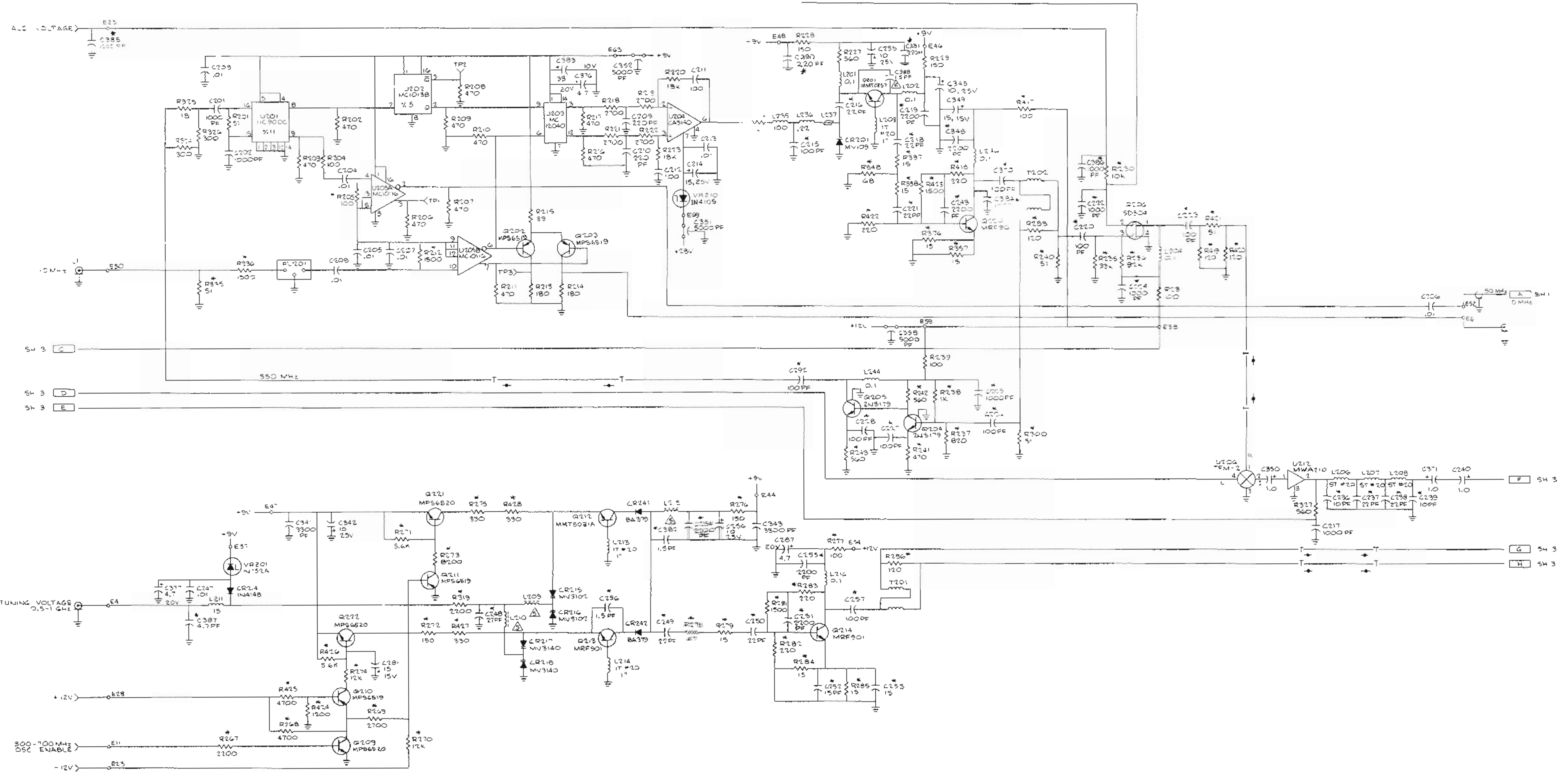


Figure 11-5. RF Synthesizer Card A5A2
Schematic Diagram (Sheet 2 of 3)
(RTC-4010A)

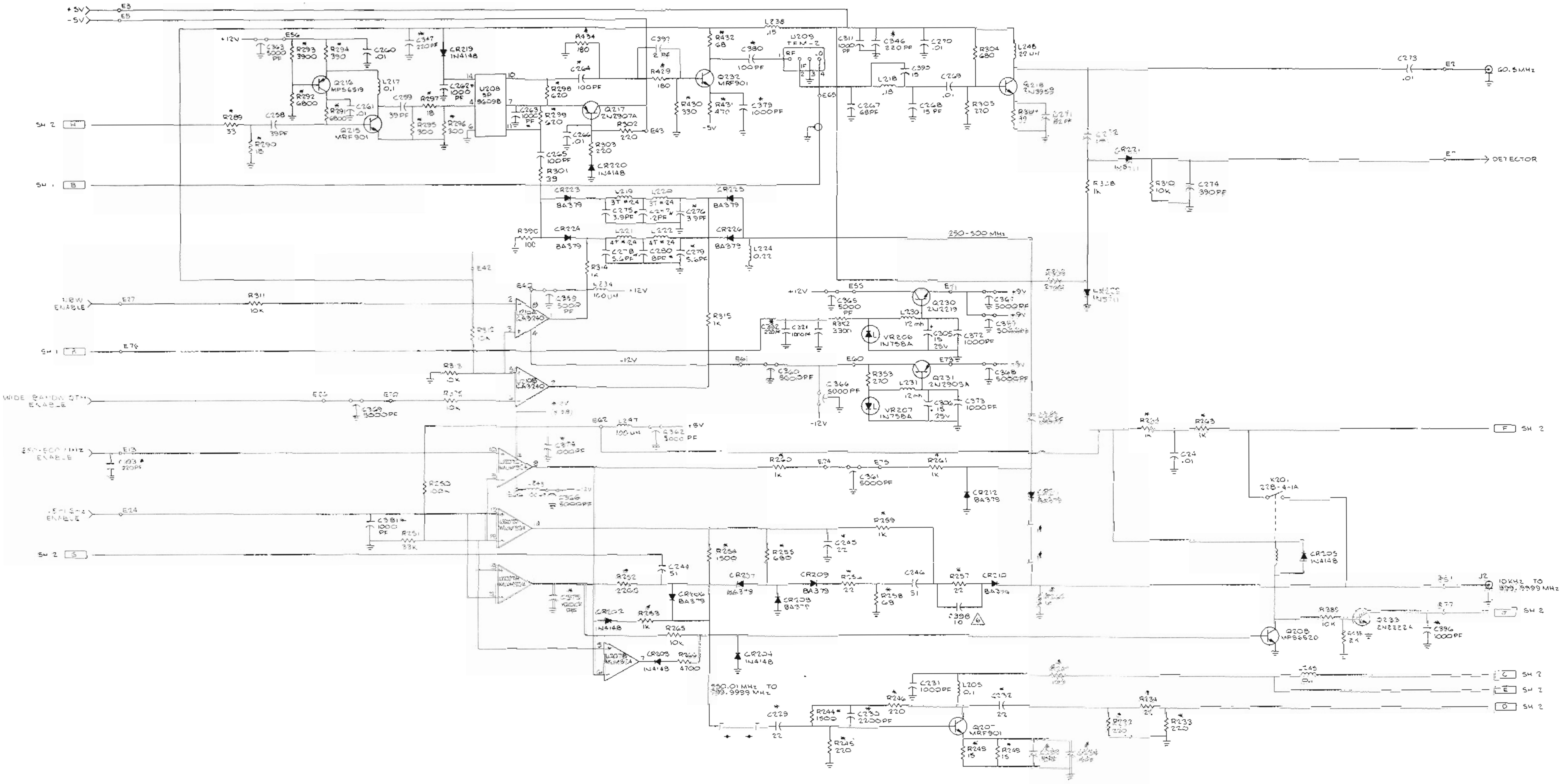


Figure 11-5. RF Synthesizer Card A5A2
Schematic Diagram (Sheet 3 of 3)
(RTC-4010A)

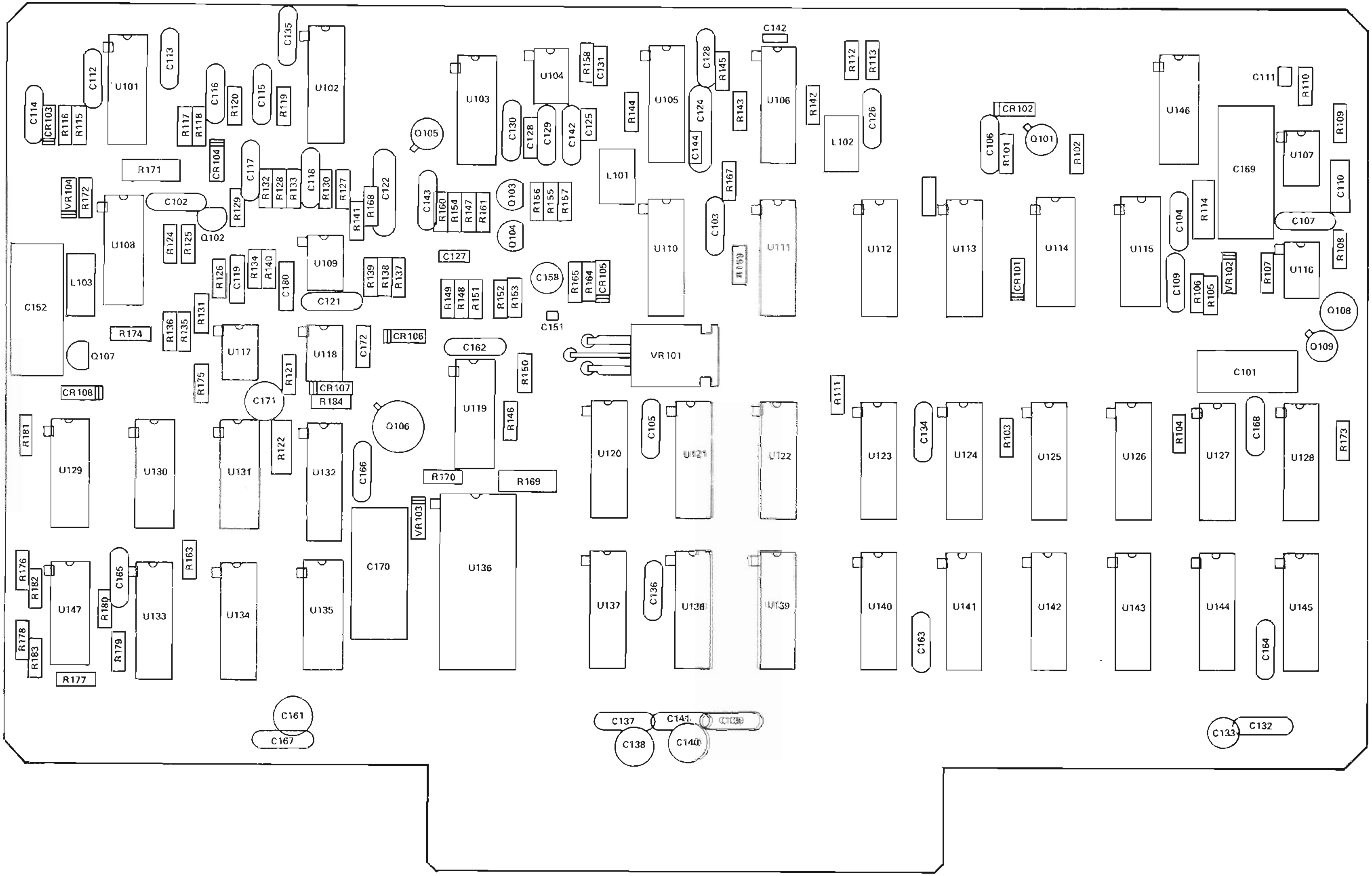


Figure 11-7. Digital Synthesizer A5A1
Parts Location

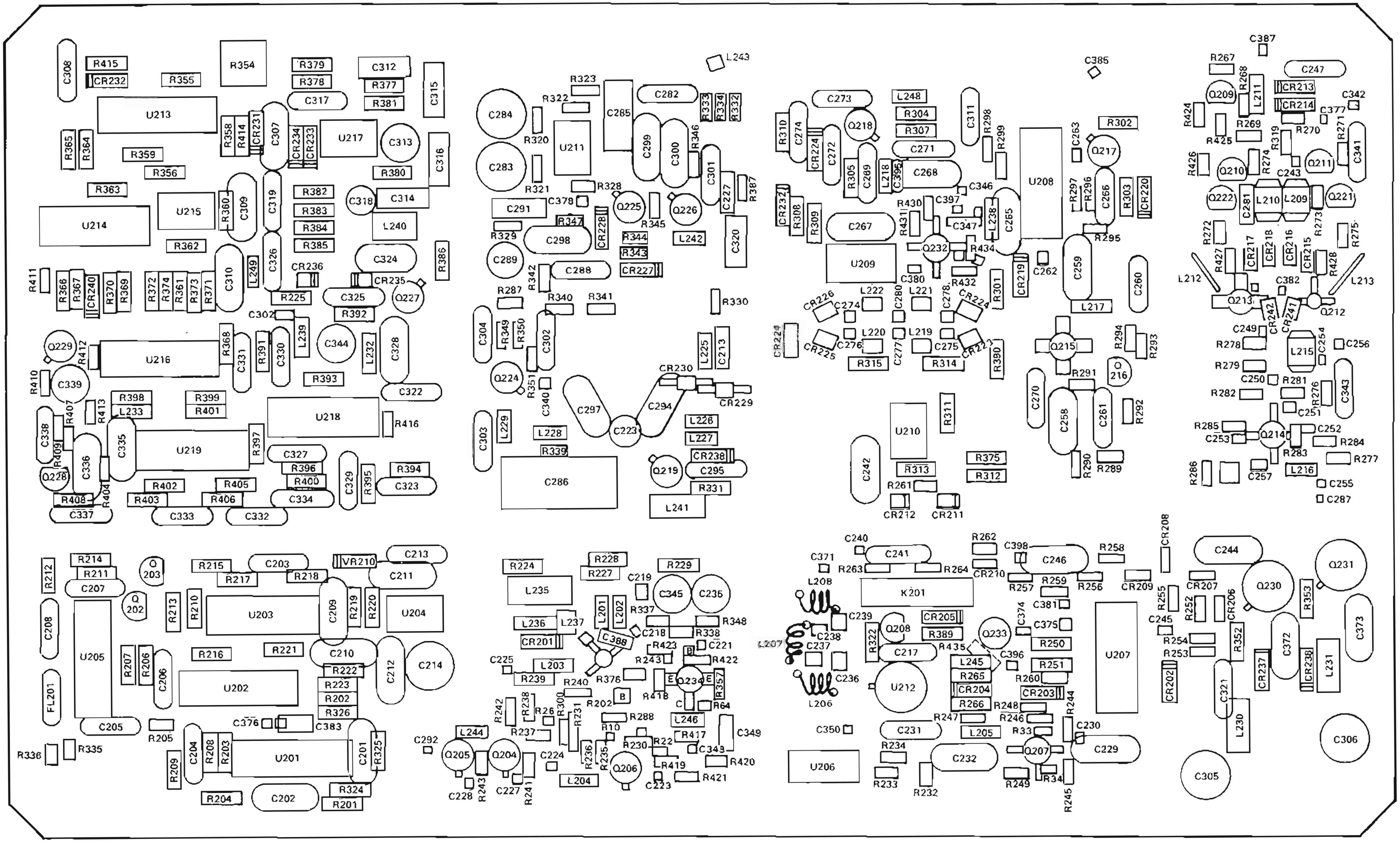
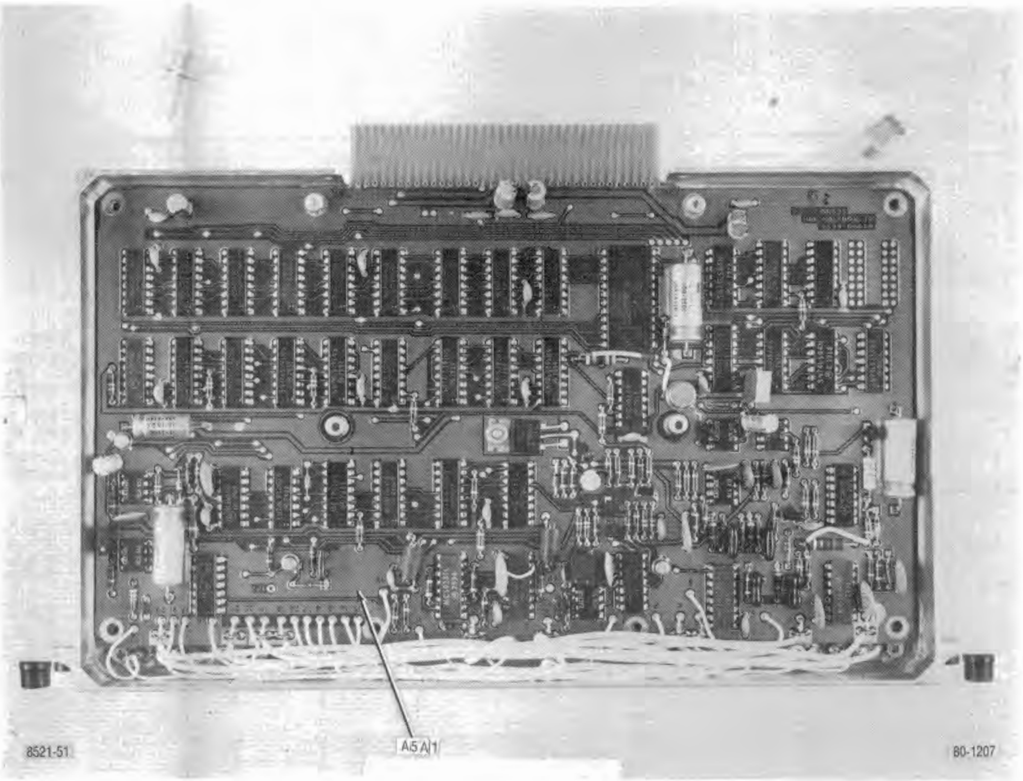
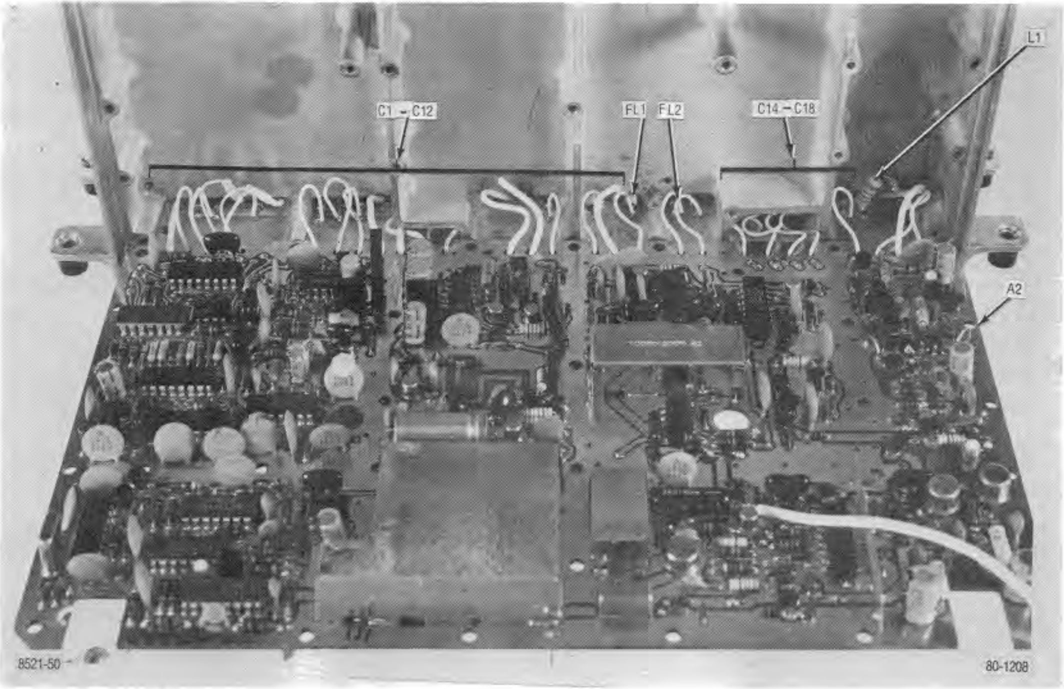


Figure 11-8. RF Synthesizer A5A2
Parts Location


A5A1
8521-51
80-1207


J1
J2
A5A2
8521-52
80-1206


C1 – C12
FL1
FL2
C14 – C18
L1
A2
8521-50
80-1208

SECTION 12

AUDIO SYNTHESIZER (A6)

12-1. General. Generation, processing, and control of modulation audio is the function of the Audio Synthesizer module. Three modulation signals, private line, digital private line, and a fixed 1 kHz, are generated on the board. Processing for external microphone and BNC jack audio inputs as well as sumation of all modulation sources to form a composite source is provided. Switching of the composite source to the appropriate modulator completes the function of the Audio Synthesizer. A block diagram of the Audio Synthesizer is shown in figure 12-1 with its schematic in figure 12-2.

12-2. Private Line Generator. Private line tones from 10 Hz to 10 kHz in 0.1 Hz increments are synthesized using a phase accumulative technique. Consider the 360 degrees in a cycle to be divided into 2^{20} pieces. A 20 bit digital accumulator incrementing at some fixed rate could then at any instant represent a fixed point in the 360 cycle. That is, if the accumulator was half full it would represent the 180° point and if totally full would represent the 360° point.

12-3. The number of times per second that the accumulator goes through its complete cycle determines the output frequency. If the increment rate is fixed, the time required to accumulate 2^{20} bits can be changed by changing the number of bits added at each increment time.

12-4. The PL synthesizer increments at a 104 857.6 Hz rate so that if only one bit were added each time, the time to complete one cycle would be 10 seconds. Processor loaded control latches determine the number of bits to be added at each increment time and thus the final output frequency. A 20 Bit Adder adds the control word to the current word in the 20 bit accumulator Latch. At the next increment time the Adder output is latched and becomes the next input to the Adder.

12-5. Conversion of the linear digital output of the 20-Bit Latch accumulator into a sinusoidal digital output is the function of the Decode ROM. A Digital to Analog (D/A) converter following the ROM converts the sinusoidal information into a quantized sinewave having a period equal to the cycle time of the 20-Bit Latch accumulator.

12-6. A bandpass filter with a 10 Hz to 10 kHz passband filters the quantized waveform to a sinewave having less than 1% distortion. The level of the sinewave is processor controllable by a programmable attenuator having 0, 10, 20, and 30 dB settings. The output of the PL generator is switched with the output of the DPL generator to give the INT MOD signal.

12-7. DPL Generator. The 23 bit Digital Private Line (DPL) word is generated by the processor from the 3-digit code. The 23-bit word is then transferred to a serial shift register and clocked out at a 133 Hz rate. Connecting the output of the shift register back to its input causes the 23-bit word to be continuously repeated.

12-8. A 133 Hz tone from the PL generator is the DPL clock input. For the DPL output mode the tone is gated to the clock input of the shift register by the Shift Register Control circuit. During the load mode the Shift Register Control gates a control latch to the shift register input. Twenty three data bits and clock pulses are then provided by the processor to load the DPL word. At the completion of the load mode, the Shift Register Control switches back to the output mode to cause the DPL word to be cycled through the shift register at the 133 Hz rate.

12-9. A bandpass filter following the shift register output removes the higher frequency components of the digital signal. The filtered DPL signal is then applied to the select switch. For the DPL off code (133 Hz tone), the processor switches the INT MOD line to the PL output so that a 133 Hz sinewave is output.

12-10. 1 kHz Tone. A filtered 1 kHz square wave provides the fixed 1 kHz modulation source. The SYNTH 1 kHz signal from the RF Synthesizer is filtered to less than 1% distortion by a bandpass filter. The filter output is the 1 kHz signal source.

12-11. External Modulation. A microphone and a front panel jack are the external modulation inputs. An Instaneous Deviation Control (IDC) circuit amplifies and limits the microphone signal (MIC IN) before sumation with the signal (EXT MOD IN) from the front panel jack. The sumation signal is the EXT MOD source.

12-12. Modulation Control. Level control of the three modulation sources is by either the front panel controls or the IEEE interface module. The level adjusted sources are then returned to the Audio Synthesizer module where they are summed together to form the composite modulation audio. The composite signal is then routed to the Scope/DVM Control module (MOD CAL AUDIO) for modulation determination, to a buffer amp which drives the front panel modulation output (MOD TO FP), and to a Modulation Select Switch which routes the signal to the desired modulator.

12-13. Modulation audio is switched to the speaker (VOL CNTL AUDIO) for any generate mode, to the DSBSC modulator (DSBSC MOD) for sideband modulation, to the RF Synthesizer for frequency modulation (FM MOD), to the offset oscillator for frequency modulation of the duplex output (OFFSET MOD), and to the RF output leveling loop for amplitude modulation. The signal for amplitude modulation is summed with a 5 VDC level and then routed to the variable RF level control on the front panel (5 VDC + AM MOD). At the RF level control the signal is attenuated according to the level setting to give the DC plus AM reference signal for the output leveling loop.

12-14. Module Control. Processor control of the Audio Synthesizer is via the AF control bus. The four bit address bus (AF ADD BUS 0-3) is decoded by the Address Decoder to determine which control latch is to be accessed. Control data is transferred to the accessed latch on the four bit data bus (AF DATA BUS 0-3). Synchronization of the data transfere is the function of the AF BUS EN1 signal line.

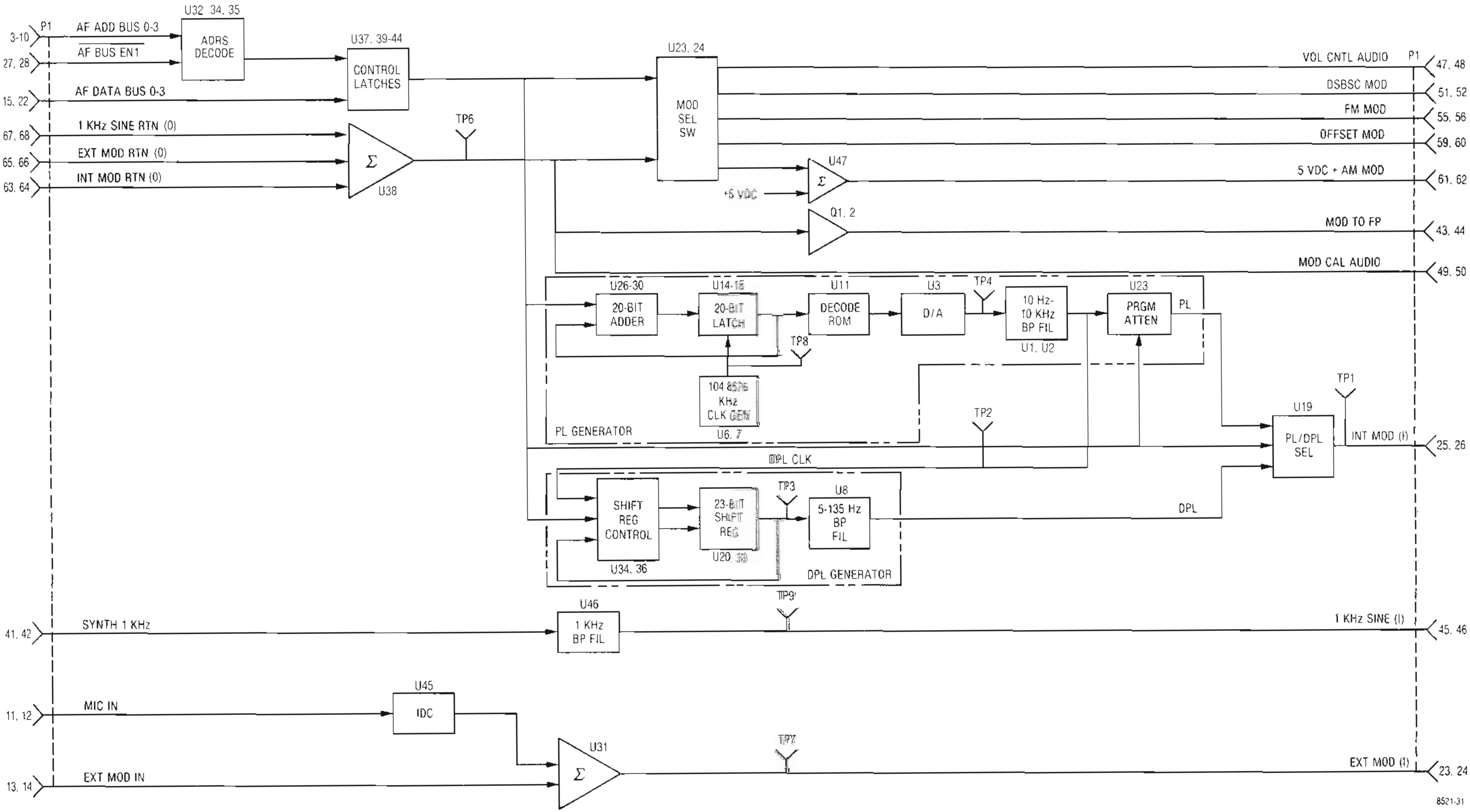
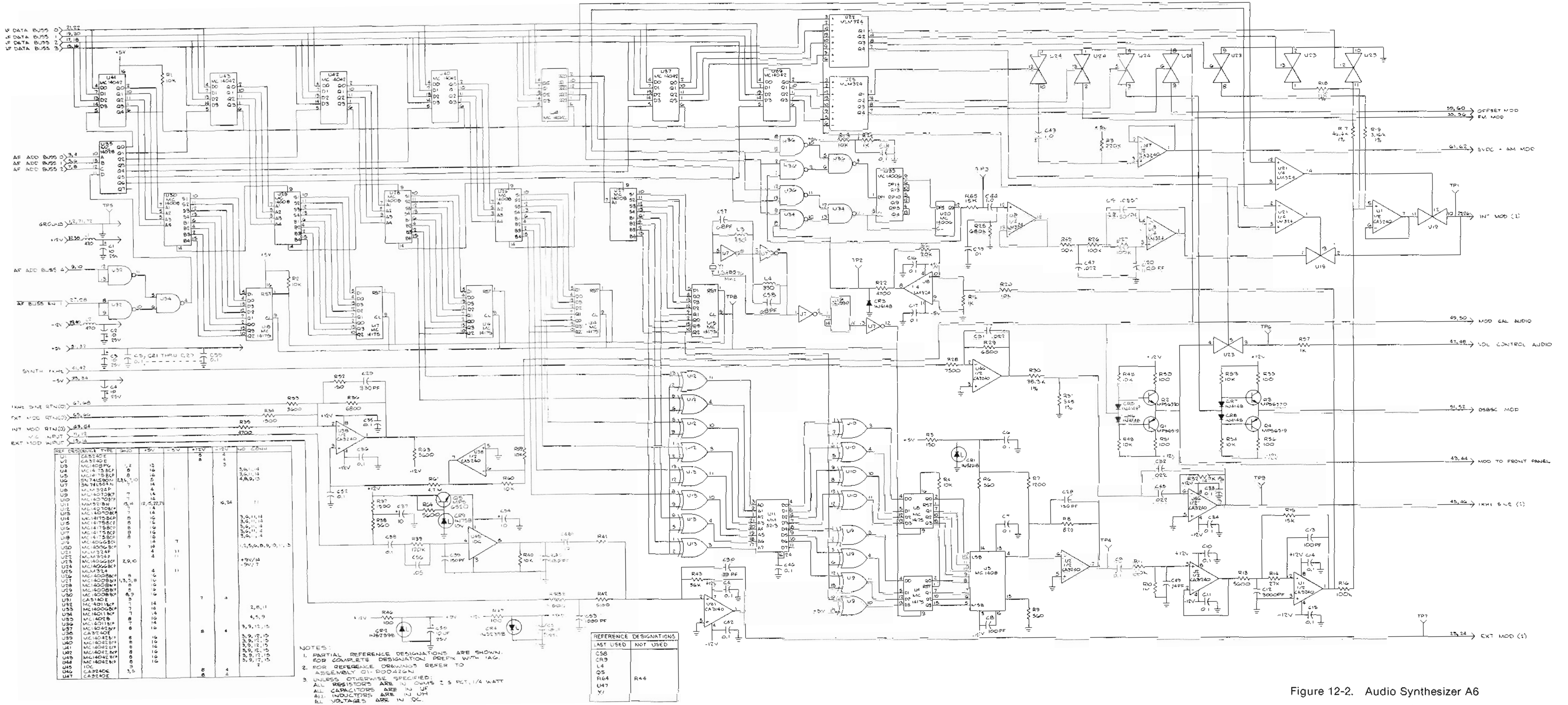


Figure 12-1. Audio Synthesizer A6 Block Diagram



REF DES	DEVICE TYPE	GND	+5V	-5V	+12V	-12V	NO CONN
U1	CA3240E				8	4	
U2	CA3240E				8	4	
U3	MC1408P6	1,2	13			3	
U4	MC14175BCP	8	16				3,6,11,14
U5	MC14175BCP	8	16				3,6,11,14
U6	SN74LS90N	2,3,6,7,10	5				4,8,9,13
U7	SN74LS04N	7	14				
U8	MLM324P		4	11			
U9	MC14070BCP	7	14				
U10	MC14070BCP	7	14				
U11	MM5218N	13,14	12,15,27,28			16,24	11
U12	MC14070BCP	7	14				
U13	MC14070BCP	7	14				
U14	MC14175BCP	8	16				3,6,11,14
U15	MC14175BCP	8	16				3,6,11,14
U16	MC14175BCP	8	16				3,6,11,14
U17	MC14175BCP	8	16				3,6,11,14
U18	MC14175BCP	8	16				3,6,11,14
U19	MC14066BCP		14	7			
U20	MC14006BCP	7	14				1,2,5,6,8,9,10,11,13
U21	MLM324P		4	11			
U22	MLM324P		4	11			
U23	MC14066BCP	2,9,10					+9V/14
U24	MC14066BCP						-9V/7
U25	MLM324		4	11			
U26	MC14008BCP	8	16				
U27	MC14008BCP	1,3,5,8	16				
U28	MC14008BCP	8	16				
U29	MC14008BCP	8	16				
U30	MC14008BCP	8,9	16				
U31	CA3140E	3			7	4	
U32	MC14011BCP	7	14				
U33	MC14006BCP	7	14				2,8,11
U34	MC14011BCP	7	14				
U35	MC14028	8	16				4,5,9
U36	MC14011BCP	7	14				
U37	MC14042BCP	8	16				3,9,12,15
U38	CA3240E				8	4	
U39	MC14042BCP	8	16				3,9,12,15
U40	MC14042BCP	8	16				3,9,12,15
U41	MC14042BCP	8	16				3,9,12,15
U42	MC14042BCP	8	16				3,9,12,15
U43	MC14042BCP	8	16				3,9,12,15
U44	MC14042BCP	8	16				3,9,12,15
U45	10C	3					2
U46	CA3240E	3,5			8	4	
U47	CA3240E				8	4	

NOTES:
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH 1A6.
2. FOR REFERENCE DRAWINGS REFER TO ASSEMBLY 01-P00426N
3. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS ± 5 PCT, 1/4 WATT
   ALL CAPACITORS ARE IN UF
   ALL INDUCTORS ARE IN UH
   ALL VOLTAGES ARE IN DC.

REFERENCE DESIGNATIONS	
LAST USED	NOT USED
C58	
CR9	
L4	
Q5	
R64	R44
U47	
Y1	

Figure 12-2. Audio Synthesizer A6
Schematic Diagram
(RTC-4011A)

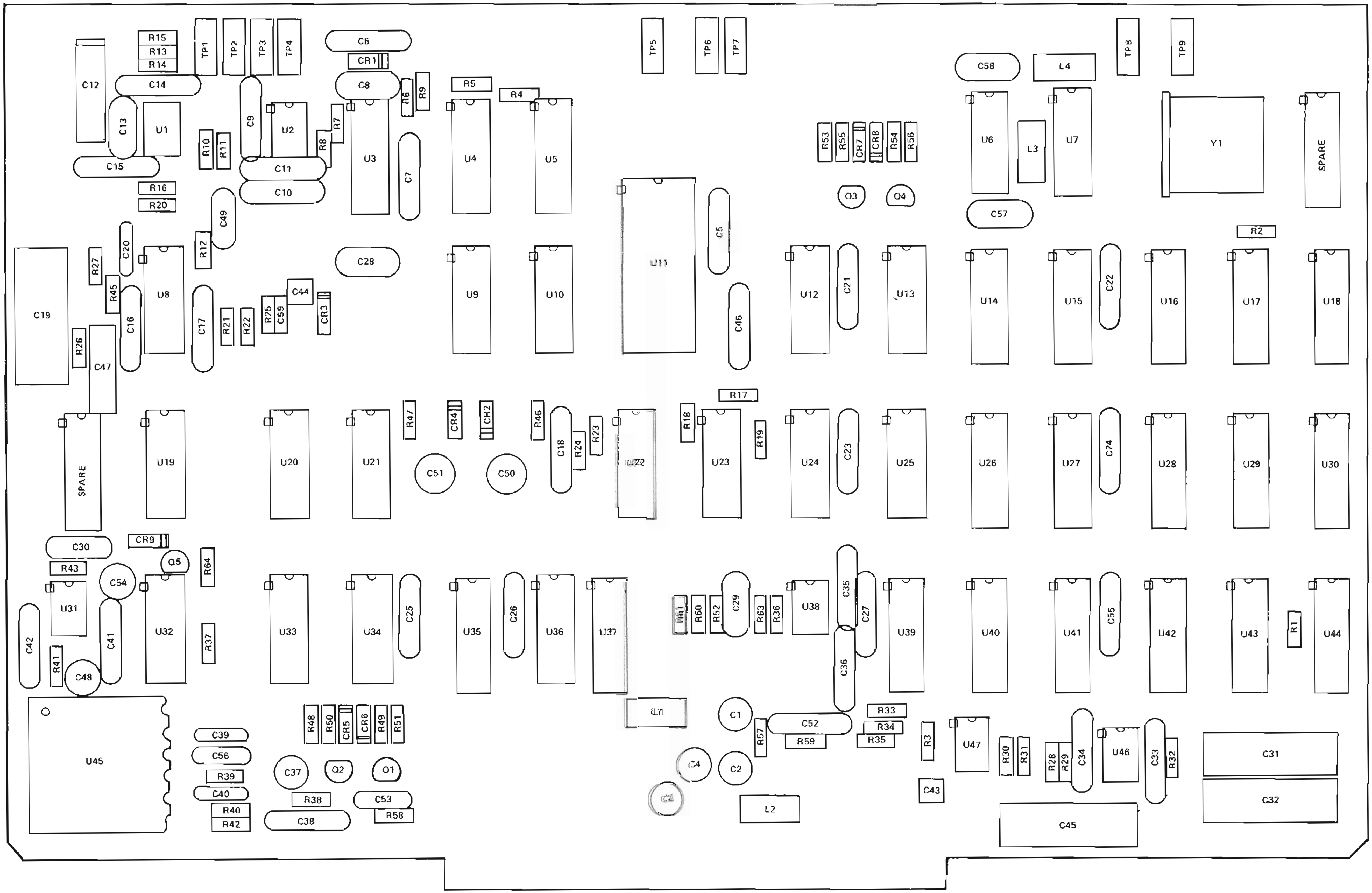


Figure 12-3. Audio Synthesizer Parts Locator

SECTION 13

PROCESSOR I/O MODULE (A7)

13-1. General. Frequency Counter and DVM functions with their processor interface as well as the processor interface for the two system control buses are contained on this module. Additionally, circuitry to complete the 10.245 MHz phase locked loop, and to zero beat the incoming carrier are also on this board. A block diagram of the processor I/O module is shown in figure 13-1 with its schematic shown in figure 13-2.

13-2. 10.245 MHz Phase Locked Loop. Only part of the circuitry for the second local oscillator loop is contained on this module. The 10.245 MHz VCO and the loop filter are on the received module. A sample of the 10.245 MHz second local oscillator is mixed with the SYNTH 10 MHz signal. A divide by fourty nine following the mixer divides the 245 kHz signal from the mixer to 5 kHz. A phase comparison between the 5 kHz from the divider and the SYNTH 5 kHz signal results in the 10.245 MHz VCO TV signal. The VCO TV signal is an error signal which is filtered by the loop filter on the receiver to correct the VCO frequency and maintain phase lock.

13-3. System Control Bus Interface. Interface between the processor buses and the system is through Peripheral Interface Adapters (PIA). The PIA is a single integrated circuit that provides 18 input/output latches which may either be read from or written into by the processor. Two additional inputs on the PIA provide for processor interrupt capability. The two system control buses utilize a single PIA.

13-4. Each system control bus consists of eight lines split into four data lines and four address lines. The address lines define the particular latch into which the data is to be stored, or the buffer from which data is to be obtained. One additional address line, the bus enable line, is required to enable the address decoding circuitry. Thus each control bus can have as many latches at one address as there are bus enable lines. The system utilizes one RF bus enable and two AF bus enables for a total control bus capability of 192 bits. The second bus enable for the AF control bus is on the processor card.

13-5. For internal timing on tone sequences, the processor is interrupted every 10 msec. When interrupted by the timing input the processor stops it current process, acknowledges the interrupt, increments its time counter and then combines as normal. The timing interrupt is the SYNTH 100 Hz input to the Bus PIA.

13-6. DVM. Inputs on the DVM to A/D signal line are digitized into a 10-bit digital word plus a sign bit and then input to the processor through the DVM PIA. An Absolute Value circuit converts the ±1 volt bipolar input signal to a 0-1 volt unipolar positive level with a separate digital output to indicate the sign of the input. An Analog to Digital Converter (A/D) converts the unipolar input into a 10-bit word under processor command. A pulse on the START line from the processor starts the A/D. When conversion is complete the A/D signals the processor on the END line. The processor in turn enables the output drivers on the A/D, sets the DVM/CNTR Buffer to the DVM mode, and inputs the 10bit word plus the signal bit.

13-7. For AC measurements a filter is switched on in the Absolute Value circuit so that its output is a DC level proportional to the average value of the input sinewave. Conversion to RMS is made in the processor by multiplying the average level by 1.11 to obtain the RMS level.

13-8. Frequency Counter. Three possible signal sources are available to the frequency counter for frequency determination. For external inputs the EXT FREQ CTR line from the Front Panel Interface module provides the input. Determination of the duplex frequency is accomplished by measuring the frequency of the offset oscillator on the OFFSET FREQ line. Monitor frequency error is determined from the IF/BFO FREQ line by comparing that frequency to 455 kHz. The desired signal is selected to the counter control by the Select Switch under processor control.

13-9. The Counter Control circuitry responds to a START pulse from the processor to gate the output of the Select Switch to the Accumulator for a time period determined by the Gate Time Generator. When the gate time has ended, or if the accumulator overflows, the Counter Control signals the processor on the END line that the count is complete. The processor in turn disables the A/D output drivers, switches the DVM/CNTR Buffer to the counter mode, and inputs the 16-bit accumulator information.

13-10. Gate times from 0.001 sec to 10 sec are generated by the Gate Time Generator. The SYNTH 1 kHz signal is the reference input for the generator. Selection of the gate time is by processor control to give a five digit or 0.1 Hz resolution frequency display.

13-11. Zero Beat. A zero beat with the incoming carrier is obtained by successively mixing the 455 kHz IF/BFO FREQ with 500 kHz, 50 kHz, and 5 kHz. The beat signal that results from the mixing drives the ground return circuit for the signal presence indicator.

13-12. Module Control. Control of this module is from the processor on the AF control bus. A four bit address (AF ADRS BUS 0-3) is decoded by the Address Decode circuitry to determine which Control Latch the control data is to be stored. The four data bits (AF DATA BUS 0-3) are then stored into the selected Control-Latch by a pulse on the AF BUS EN 2 signal line.

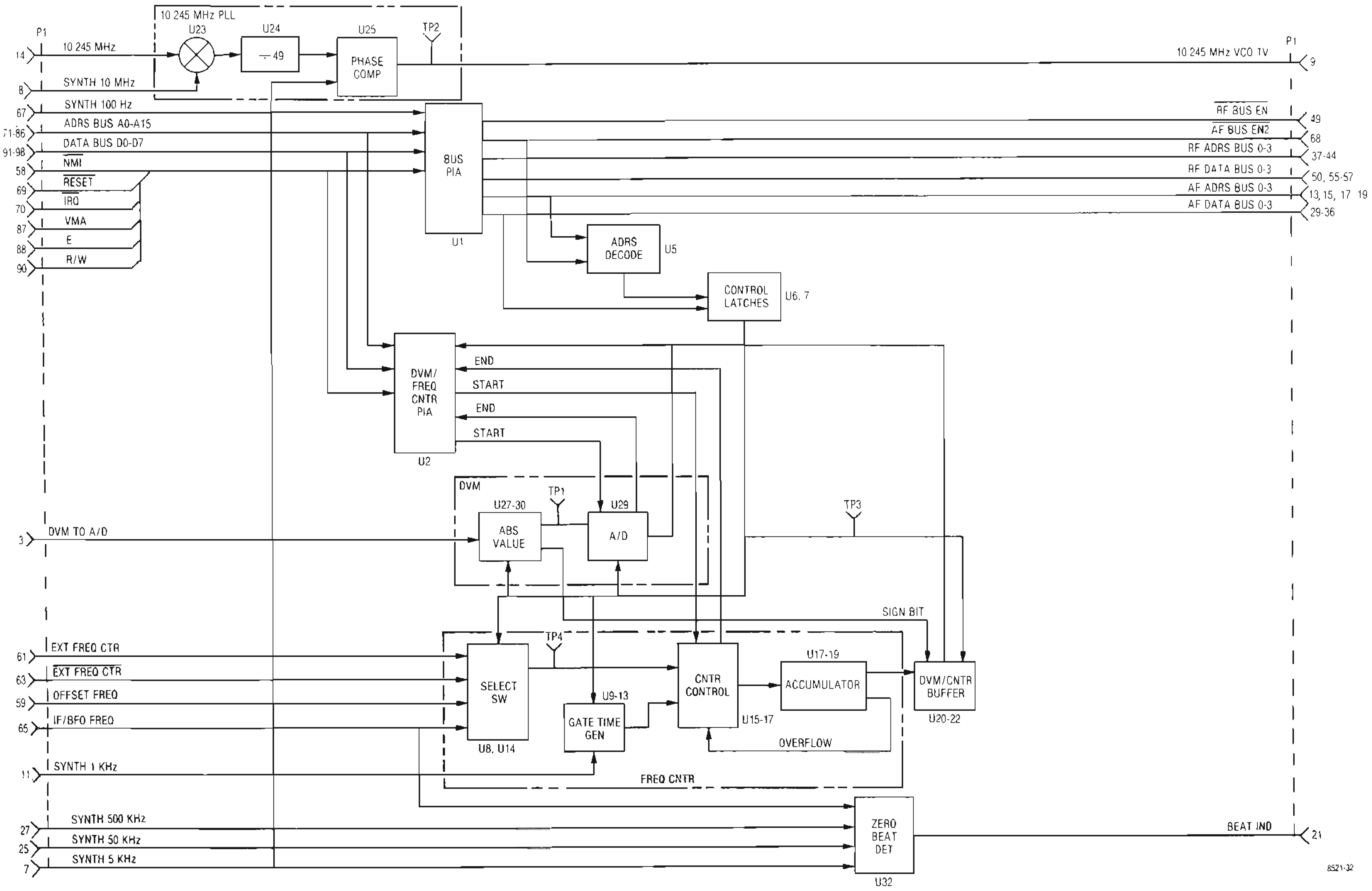


Figure 13-1. Processor I/O A7 Block Diagram

NOTES

1 PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH A7

2 FOR REFERENCE DRAWINGS REFER TO 01-P00103H ASSEMBLY

3 UNLESS OTHERWISE SPECIFIED
ALL RESISTORS ARE IN OHMS, ±5 PCT, 1/4 WATT
ALL CAPACITORS ARE IN UF
ALL VOLTAGES ARE DC

4 DEVICE TYPE AND CONNECTIONS NOT SHOWN ON SYMBOLS ARE LISTED IN TABLE 1.

TABLE 1

REF DES	DEVICE TYPE	GND	+5V	-5V	+12V	-12V	NO CONN
U1	MC6821	1	20				
U2	MC6821	1	20				
U3	MC10116	8	1,16				
U5	MC14073	7	14				
U6	MC14042	8	16				
U7	MC14042	8	16				
U8	74LS00	7	14				
U9	MC14518	8	16				
U10	MC14518	8	16				
U11	MC14081	7	14				
U12	MC14081	7	14				
U13	MC14512	8	16				
U14	74LS00	7	14				
U15	74LS74	7	14				
U16	MC14027	8	16				
U17	74LS12	7	14				
U18	74LS197	7	14				
U19	MC14040	8	16				
U20	MC14503	8	16				
U21	MC14503	8	16				
U22	MC14503	8	16				
U23	74LS86	7	14				
U24	MC14569	8	16				
U25	MC14046	8	16				
U26	MC14016		14	7			
U27	LM308A				7	4	5
U28	LM308A					4	5
U29	8704	20	19	10			1, 2
U30	LM308A				7	4	5
U31	MC3403						4 THRU 8
U32	MC14070	7	14				
U33	MC14069	7	14				

REFERENCE DESIGNATIONS	
HIGHEST NUMBER USED	NOT USED
C36	C1, C28 THRU C29
CR5	
Q9	
R66	R3, R43
U33	U4

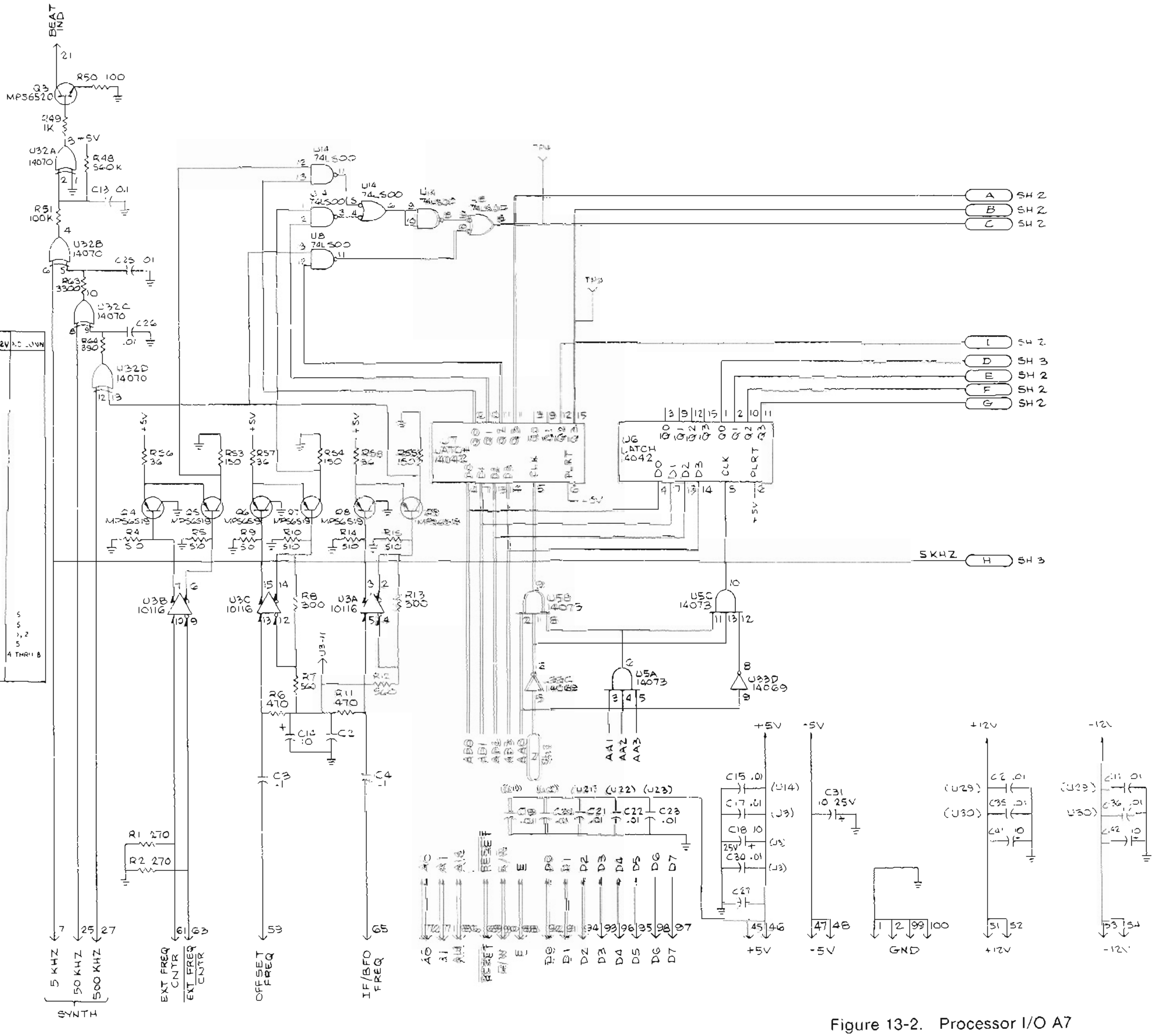


Figure 13-2. Processor I/O A7
Schematic Diagram (Sheet 1 of 3)
(RTC-4012A)

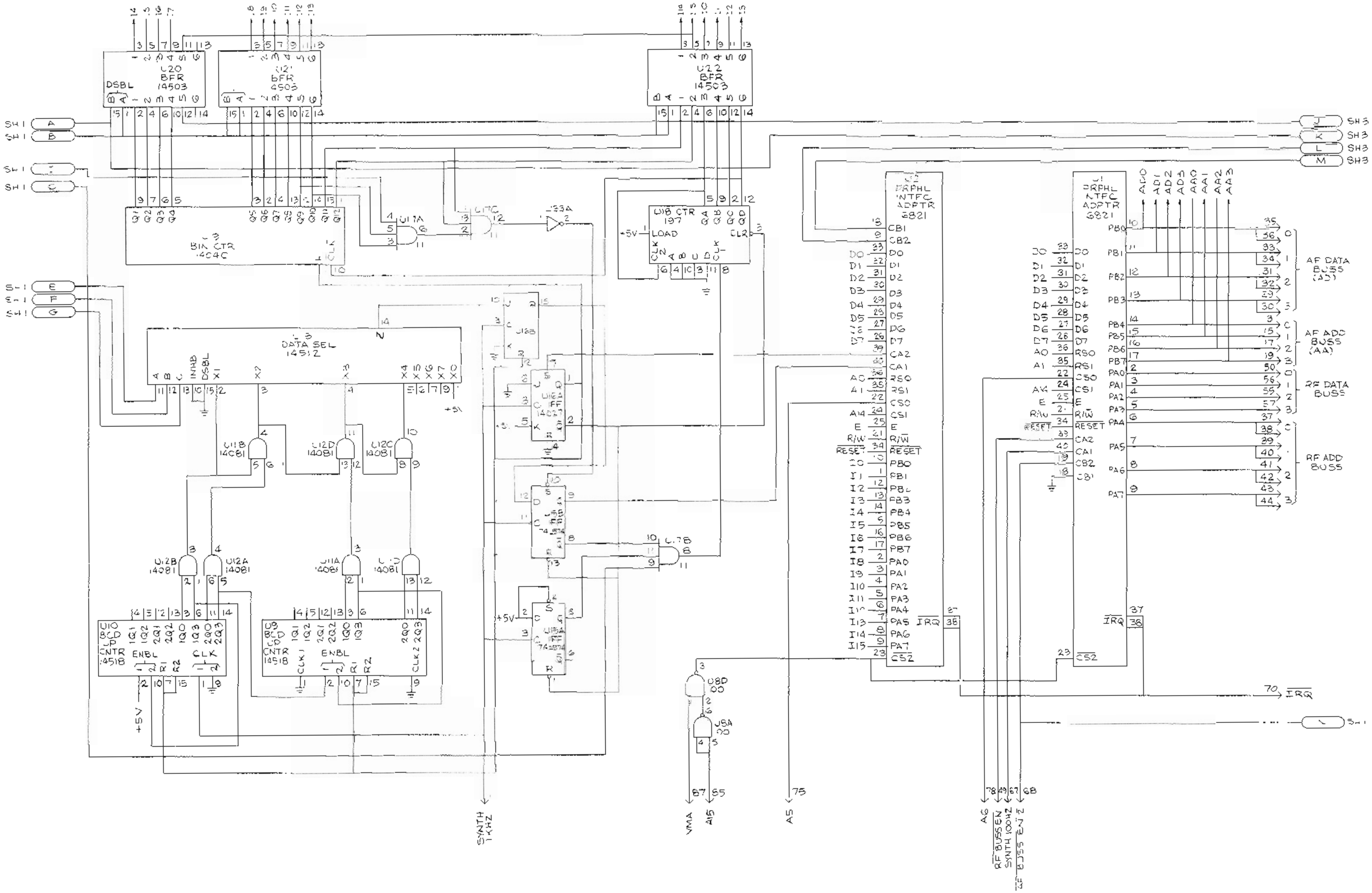


Figure 13-2. Processor I/O A7
Schematic Diagram (Sheet 2 of 3)
(RTC-4012A)

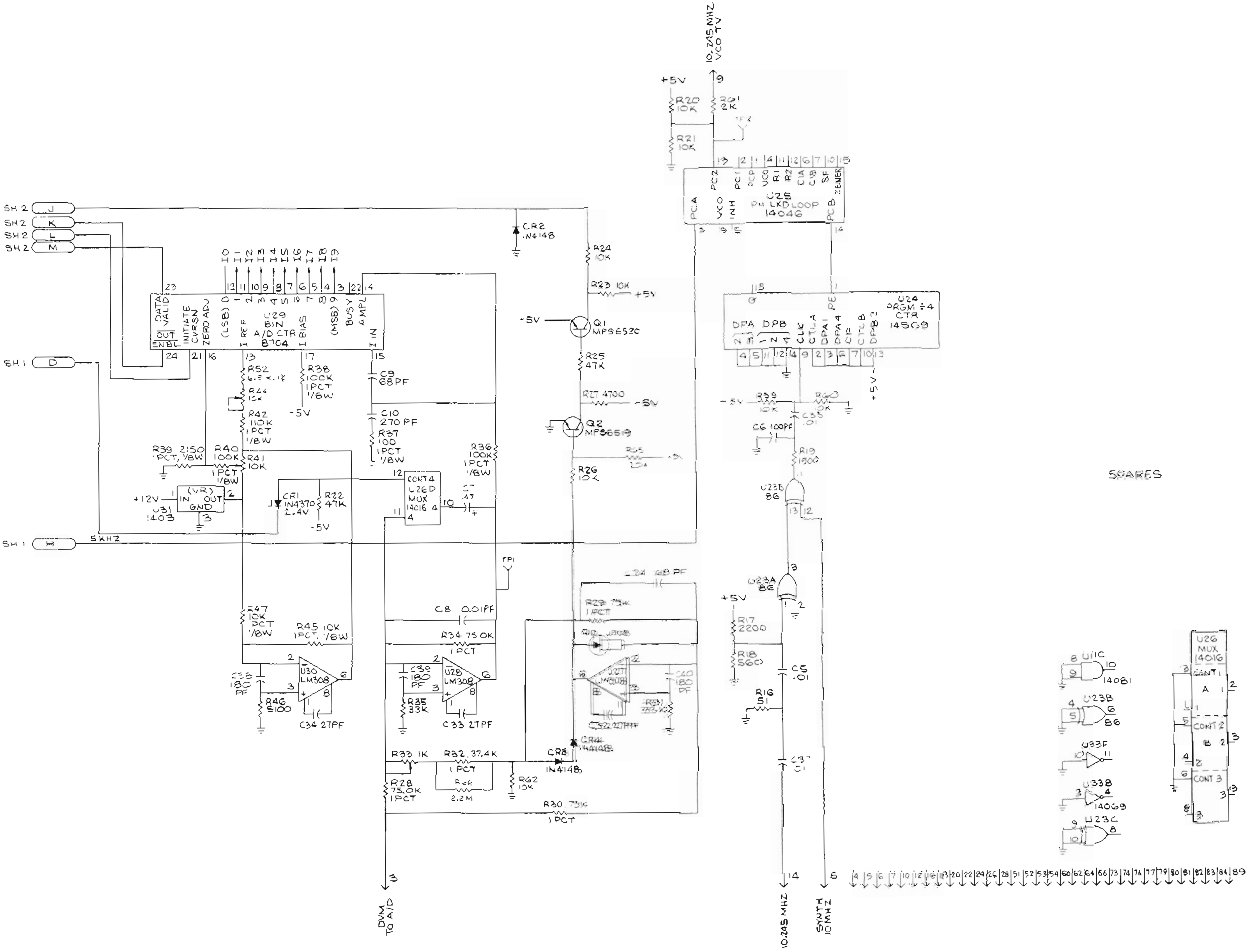


Figure 13-2. Processor I/O A7
Schematic Diagram (Sheet 3 of 3)
(RTC-4012A)

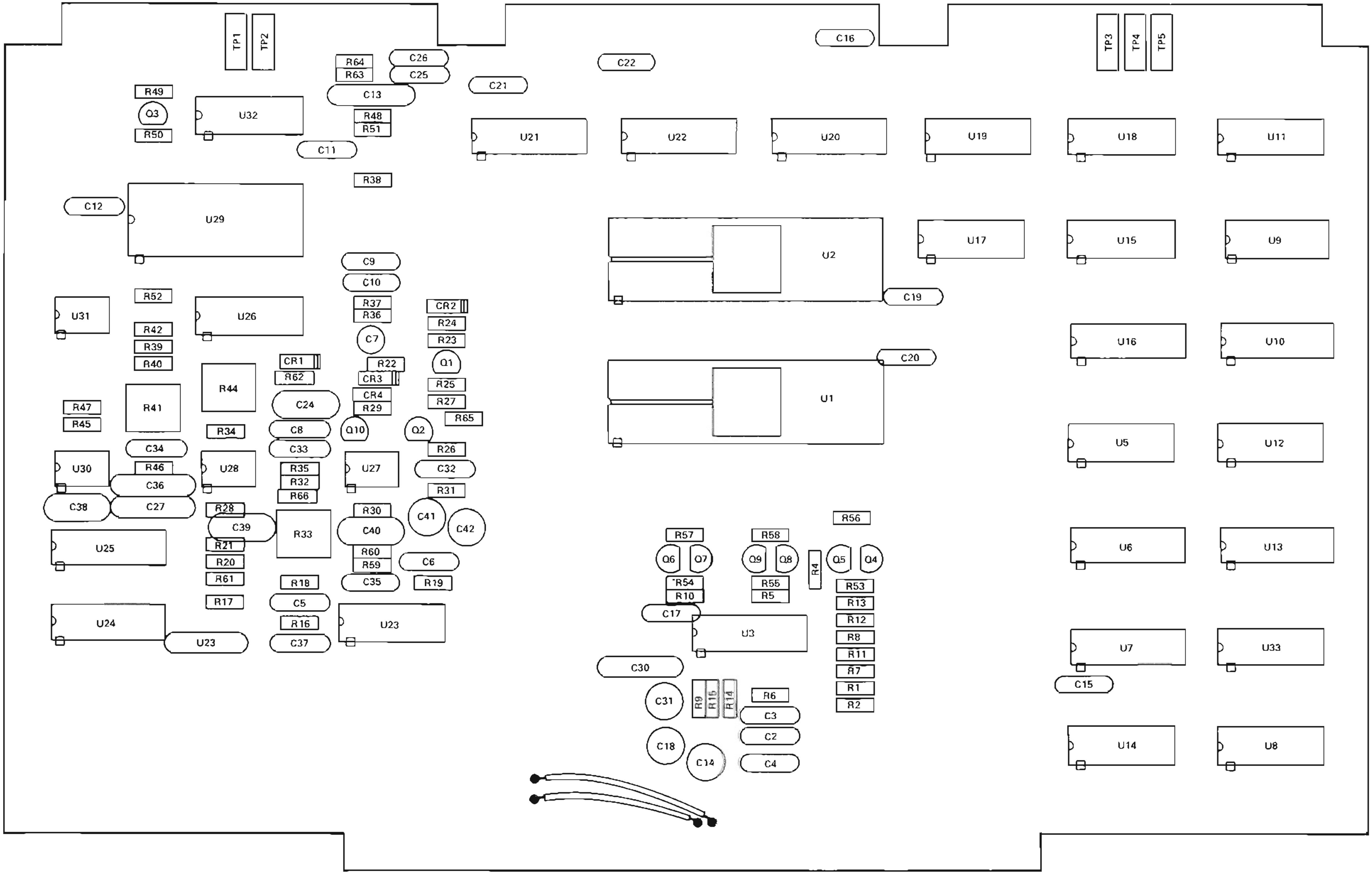


Figure 13-3. Processor I/O Parts Locator

SECTION 14

IEEE INTERFACE MODULE (A8)

14-1. General. Remote control of the system is possible using a IEEE-488 bus and the IEEE Interface Module. The Interface Module provides the interface for the 488 bus and provides for processor control of most of the functions normally controlled from the front panel. A block diagram of the IEEE Interface Module is shown in figure 14-1 with its schematic shown in figure 14-2. See section 22 for information on the use of the IEEE Bus for system control.

14-2. IEEE Bus Interface. Bus buffering and interface protocol as defined by the IEEE-488 specification is provided for by the IEEE Bus Interface circuit. The system processor accesses the interface directly through its address, data, and control buses for reading from or writing to the IEEE bus.

14-3. RF Level Control. The RF Level Control circuitry selects between the 5 VDC + AM MOD or the AM MOD + DC REF (I) input for remote or local control respectively. For remote control the 5 VDC + AM MOD input is electronically attenuated to provide the requested RF output level. For local control the attenuator is programmed for unity gain so that the AM MOD + DC REF (I) signal from the front panel RF level potentiometer controls the RF output level.

14-4. For the IEEE control option, a electronically programmable RF step attenuator is installed in the system. Control of the attenuator is then from the processor through the Address Decode and Control Latch circuitry on the Interface Module.

14-5. Modulation Control. Each of the three modulation sources are individually controllable by the IEEE Bus Interface module. For remote control the respective modulation input (INT MOD (I), EXT MOD (I), and 1 kHz SINE) is switched to a programmable attenuator. The system processor selects the level of attenuation necessary to provide the requested level of modulation. For local control the attenuators are programmed for unity gain and the respective modulation signal from the front panel level control (INT MOD RTN (I), EXT MOD RTN (I), and 1 kHz SINE RTN (I)) is selected to the attenuator to provide modulation level control.

14-6. Address Decode and Control Latches. The system processor has direct control over the programmable attenuators on the module with the Address Decode and Control Latch circuitry. Control data on the data bus (D0-D7) is latched at the Control Latch indicated by the address bus (A0-A15).

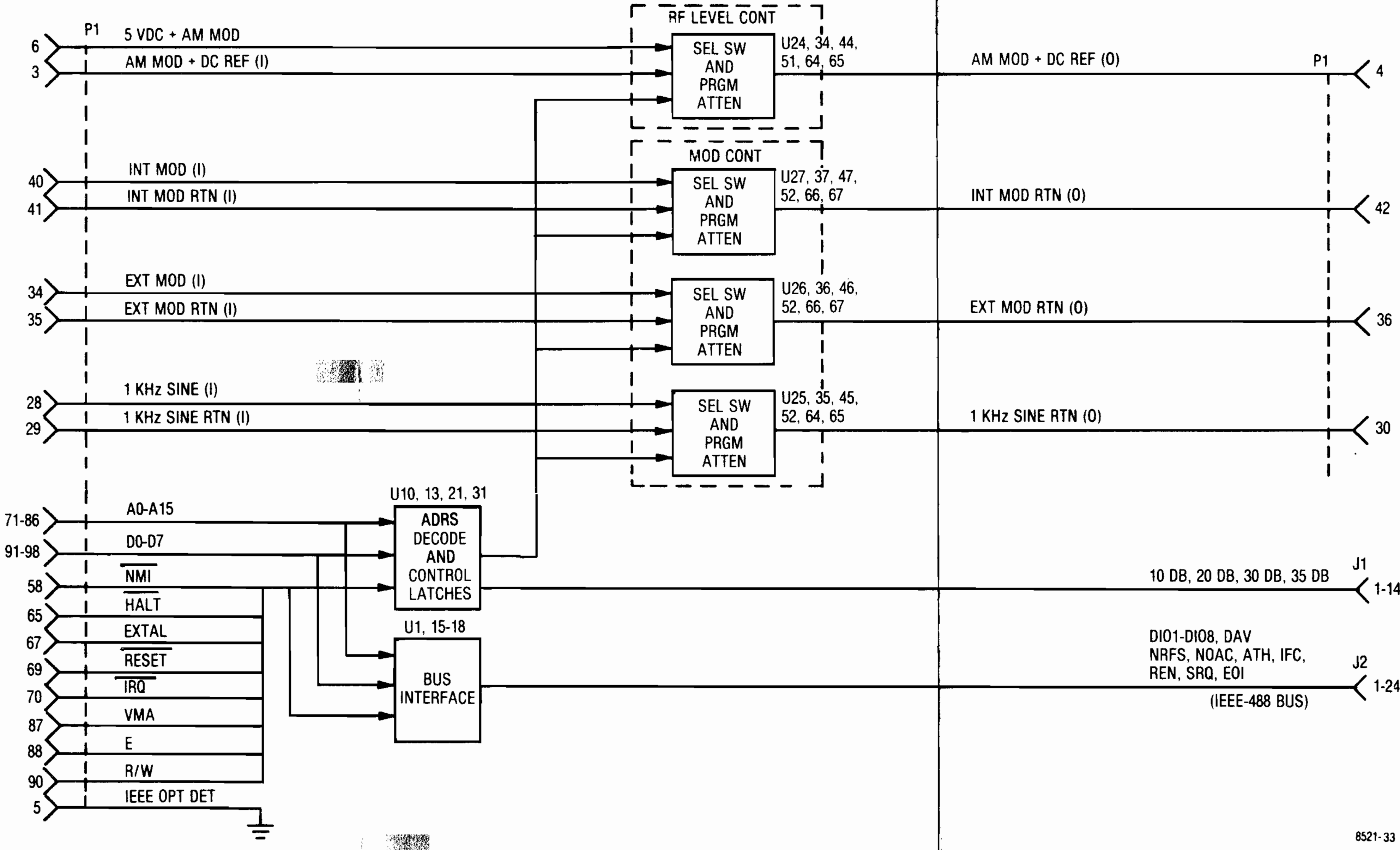


Figure 14-1. IEEE Interface Module A8 Block Diagram

NOTES:

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH A8
2. FOR REFERENCE DRAWINGS REFER TO 01- 00203N
3. UNLESS OTHERWISE SPECIFIED.
   A RESISTORS ARE IN OHMS, ±5 PCT, 1/4 WATT
   A CAPACITORS ARE IN UF.
   AL VOLTAGES ARE DC.

REF DES	TYPE	GND	+5V	-5V	+12V	-12V	+33V	NO CONN
U1	MC68488	1, 2, 40	19, 20					15, 24
U10	UDN6116A	1, 8			9			15, 16, 2
U11	74LS365	8	16					
U12	206-6		7 THRU 12					
U13	74LS138	8	6, 16					12, 13, 1, 9, 10, 11
U14	74LS138	5, 8	16					
U15	MC3448	4, 8, 12	16					
U16	MC3448	4, 8, 12	16					
U17	MC3448	4, 8, 12, 15	16					
U18	MC3448	1, 4, 7, 8, 12	9, 16					
U21	MC14174	8	1, 16					12, 13
U24	MC14174	8	1, 16					
U25	MC14174	8	1, 16					
U26	MC14174	8	1, 16					
U27	MC14174	8	1, 16					
U31	MC14174	8	1, 16					2, 10, 12, 5, 7
U34	MC14174	8	1, 16					
U35	MC14174	8	1, 16					
U36	MC14174	8	1, 16					
U37	MC14174	8	1, 16					
U44	AD7531	2, 3			16			
U45	AD7531	2, 3			16			
U46	AD7531	2, 3			16			
U47	AD7531	2, 3			16			
U48	74LS11	7	1, 14					3, 4, 5, 6
U49	74LS245	10	20					
U51	MC14053	6, 8	16	7				1, 2, 3, 4, 5, 15
U52	MC14053	6, 8	16	7				
U53	74LS04	7	14					1, 2, 3, 4, 5, 6, 12, 13
U54	74LS10	7	14					8, 9, 10, 11
U64	CA3240				8	4		
U65	CA3240				8	4		
U66	CA3240				8	4		
U67	CA3240				8	4		

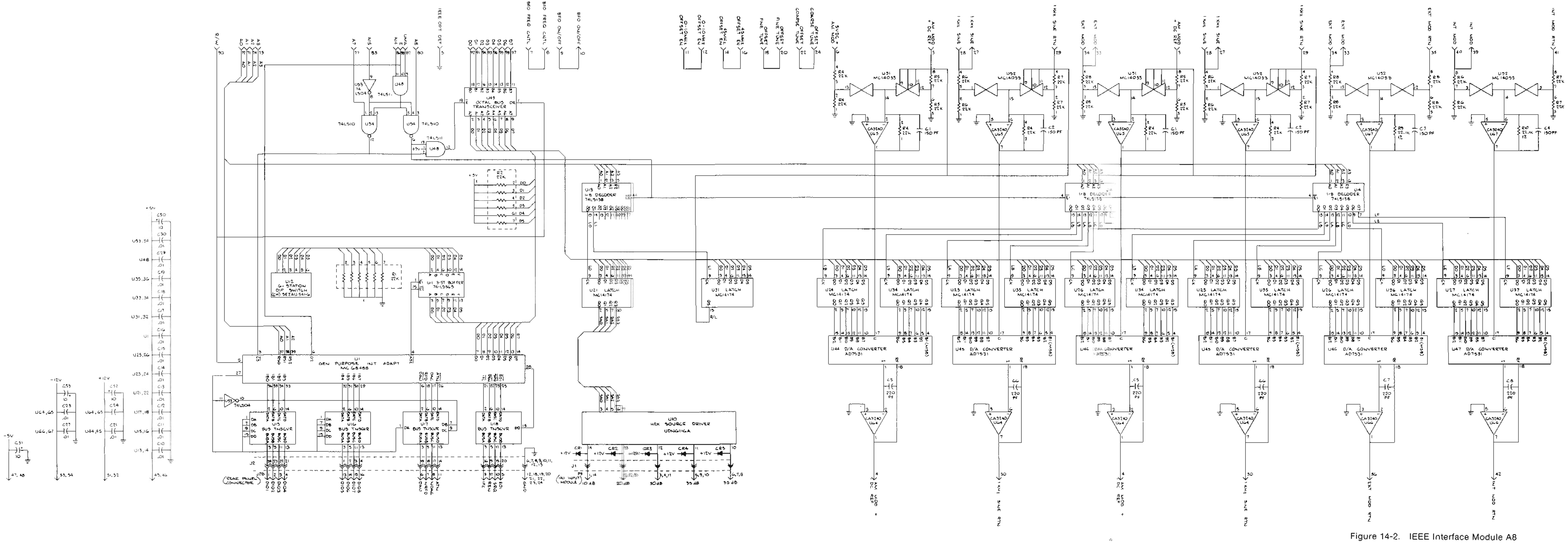
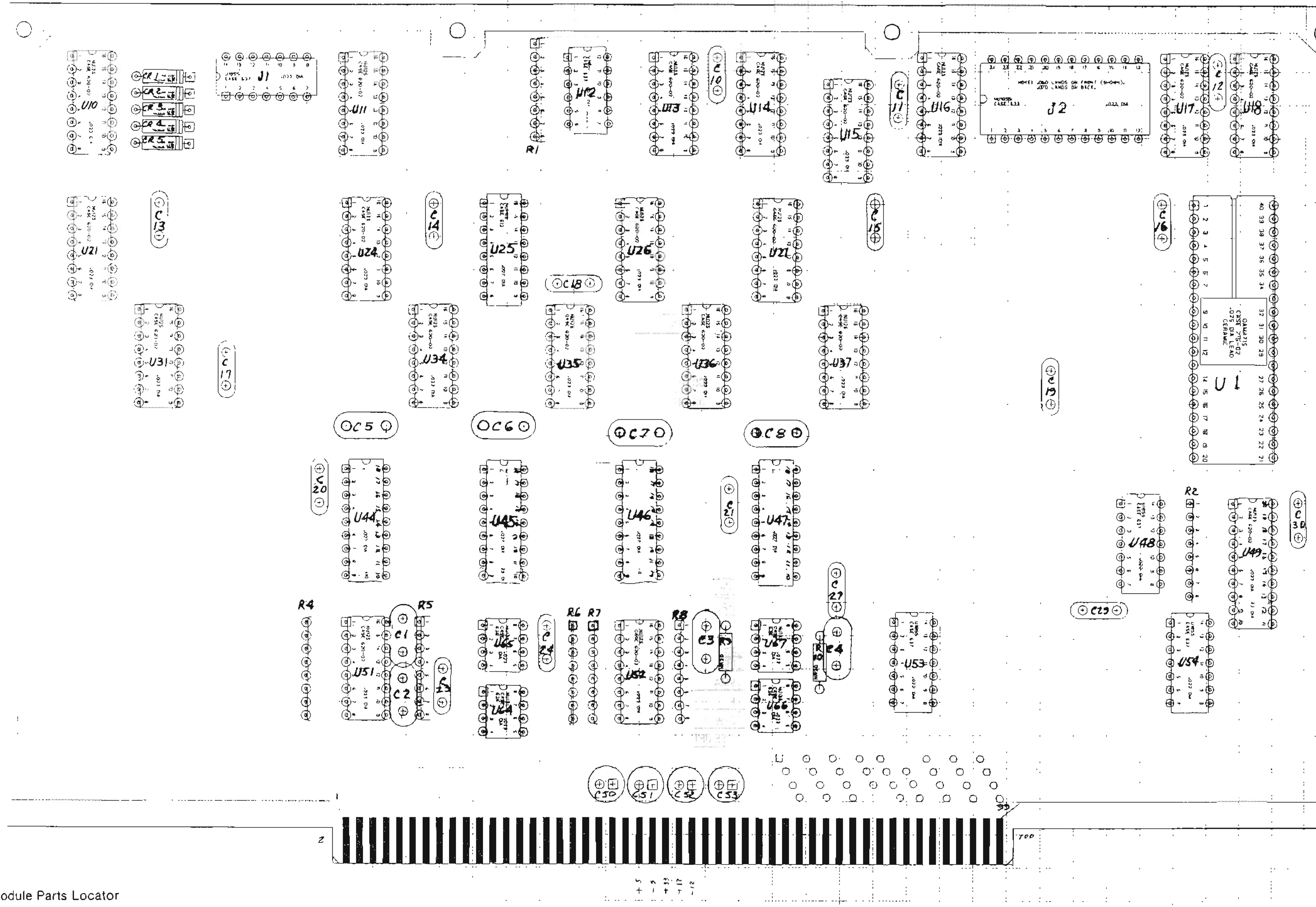


Figure 14-2. IEEE Interface Module A8 Schematic Diagram RTC-4013A)



Module Parts Locator

SECTION 15

PROCESSOR MODULE (A9)

15-1 General. Primary control and data manipulation requirements of the system are performed by the microprocessor on the Processor Module. Input and output information is carried along the processor's address, data, and control buses, or displayed on the CRT through the character generator circuits on the Processor Module. A block diagram of the Processor Module is shown in figure 15-1 with its schematic shown in figure 15-2.

15-2. Processor. A Motorola MC6802 microprocessor is the central part of the processor. The microprocessor then accesses and controls the rest of the processor via three signal buses. The sixteen bit address bus (A0-A15) determines which device on the bus the microprocessor will access. Data that will be read from or written to the accessed device is contained on the seven bit data bus (D0-D7). Synchronization of the data transfer and several specialized processor functions are provided by the control bus (HALT, NMI, RESET, IRQ, VMA, E, and R/W).

15-3. The series of commands that direct the microprocessor's actions (software) is contained in the 16 K x 8 ROM (Read Only Memory). A standard unit has 12K x 8 ROM for the main program. With the IEEE option an additional 4K x 8 ROM is added to provide the extra program required.

15-4. Temporary storage of microprocessor data is provided by 1 K x 8 RAM (Random Access Memory). RAM may be written into or read from by the microprocessor, and is used to store data generated by one part of the program for use in another part of the program. Half of the RAM is reserved for storage of the data to be displayed on the CRT.

15-5. A Peripheral Interface Adapter (PIA) on the microprocessor bus provides input and output latches for the front panel keyboard input (KYBD COL 0-3 and KYBD ROW 0-4), the IEEE option detector input (IEEE OPT DET), the AF BUS EN1 signal line, and the nonvolatile memory (NVM). Data that is to be held during power off is stored by the microprocessor in the NVM. Then when power is turned on the microprocessor reads the contents of the NVM to obtain its start up mode, the RF and tone memory presets, and the rest of the preset data. If the operator changes a preset, the microprocessor changes the data in the NVM so that the new preset will be remembered. The NVM has a 42 x 8 or fourty two eight bit words capability.

15-6. Character Generator. The Character Generator sequentially accesses that half of RAM where character information is stored and causes the respective characters to be displayed on the screen. Since both the character generator and the microprocessor share the same memory, the two must be synchronized so that they access that memory during alternate half cycles of the master clock. A 4 MHz oscillator is divided by four within the 6802 to give the 1 MHz (E) master timing signal. The E signal from the microprocessor is then used to synchronize the 2 MHz DOT CLOCK and input to the Character Clock Generator.

15-7. A raster scan technique is used to generate the character display. The CRT beam is scanned horizontally and vertically across the screen with the beam being modulated by a sequence of pulses. Each pulse is a dot on the screen whose position is determined by its time of occurrence from the horizontal and vertical sync pulses. During the horizontal sync the beam is reset to the left edge of the screen and during the vertical sync it is reset to the top of the screen. Each character field is eight dots wide and eight dots high. There are 32 character fields across the width of the CRT and 16 character field vertically. Since two horizontal character fields are used for horizontal sync blanking and one vertical field for vertical sync blanking the total display area is 30 by 15 characters or 450 characters.

15-8. Seven bit words representing one of 128 possible characters are stored in RAM for each character location on the CRT. The character generator sequentially accesses each RAM location in synchronization with the raster scan and creates a pulse modulation sequence in response to the character data that results in the character being displayed on the CRT. When the processor is not accessing RAM, the Address/Data Buffer from the processor is disabled and the Address Buffer from the character generator is enabled. The CHAR ADRS signal from the Character Clock Generator addresses the RAM location corresponding to the location being currently scanned on the CRT. The seven bits of data representing the character to be displayed are latched by the CHAR LATCH signal. A Character ROM decodes the seven bits plus a three bit ROW ADRS to determine the dot pattern for the current dot row scan position for the character to be displayed. The dot pattern is then parallel loaded into a Shift Register and clocked out serially to give the CHAR GEN Z-AXIS pulse modulation sequence. It should be noted that each character line on the CRT is scanned eight times, once for each dot row. Thus each character must be accessed eight times from RAM before the total character is displayed.

15-9. To maintain synchronization between the CHAR GEN Z-AXIS signal and the raster scan, the Clock Generator outputs horizontal and vertical character sync signals. These sync signals coordinated the sweep generators on the Scope/DVM Control module with the character generator. For the dual display mode, explained in paragraph 9-6, a $\overline{\text{LINE 1}}$ output and a CHAR GEN RST input is provided to the clock generator.

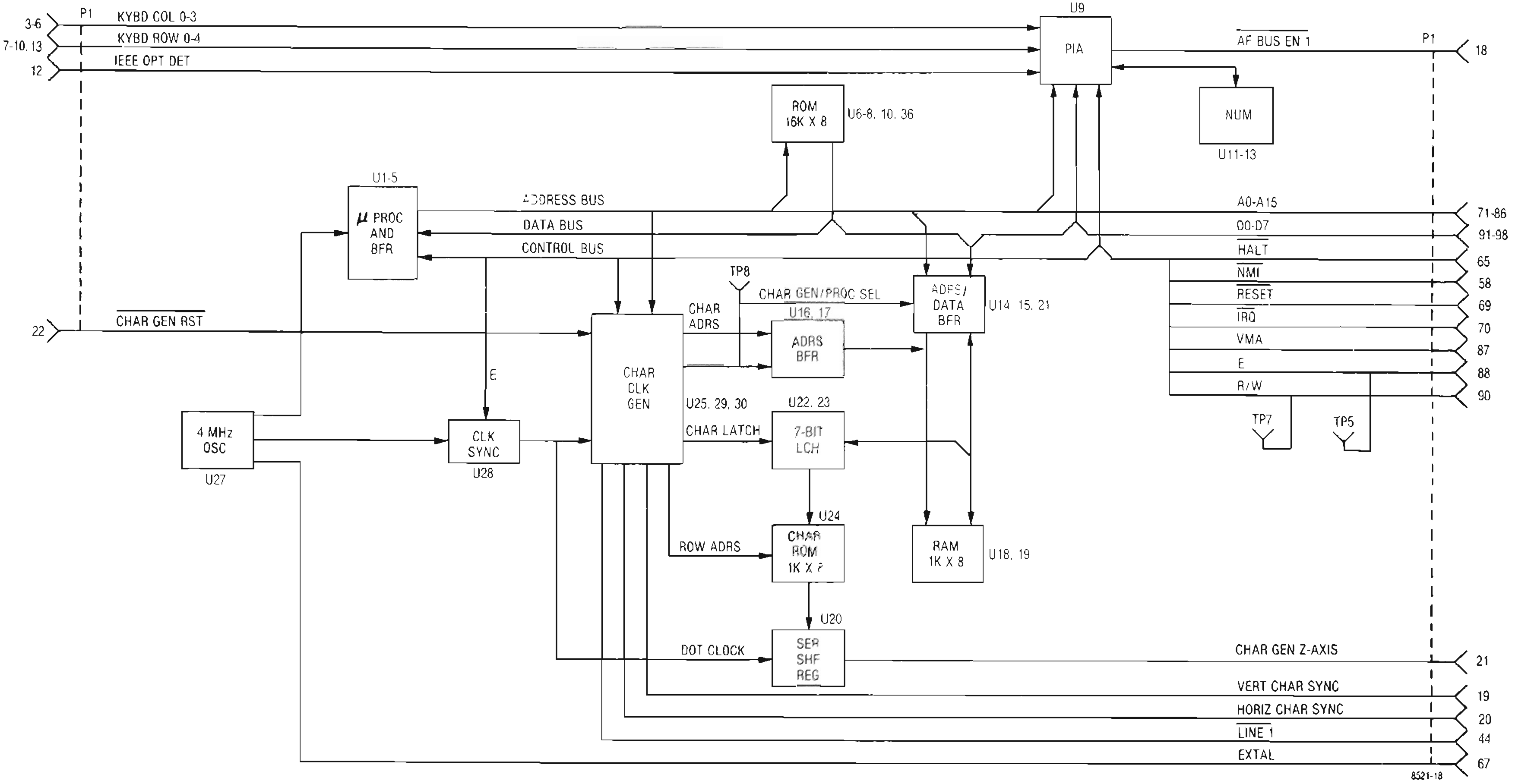


Figure 15-1. Microprocessor Module A9 Block Diagram

NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH A9

2. FOR REFERENCE DRAWINGS REFER TO 01-P0040LN ASSEMBLY.

3. UNLESS OTHERWISE SPECIFIED
ALL RESISTORS ARE IN OHMS, ±5 PCT, 1/4 WATT
ALL CAPACITORS ARE IN UF
ALL VOLTAGES ARE DC

4. DEVICE TYPE AND CONNECTIONS NOT SHOWN ON SYMBOLS ARE LISTED IN TABLE 1.

5. ALL DEVICES NOT BEARING A TYPE DESIGNATION ON THE FACE OF THE DRAWING ARE LISTED BELOW.

REF DES	P/N	TYPE
Q1	48AC0865571	MPS6519
Q2	48A0C665570	MPS6524
U6		9332B-0510 (MCM68A332O)
U7		9332B-05 (MCM68A332P)
U8		9332B 0512 (MCM68A332P)

6. U36 USED FOR IEEE CONFIGURATION ONLY. FOR REFERENCE DRAWING SEE 01-P0040IN002. E PROM TSM55L32 MUST BE PROGRAMMED WITH DATA PER IEEE PROGRAM 98 P0121GV.

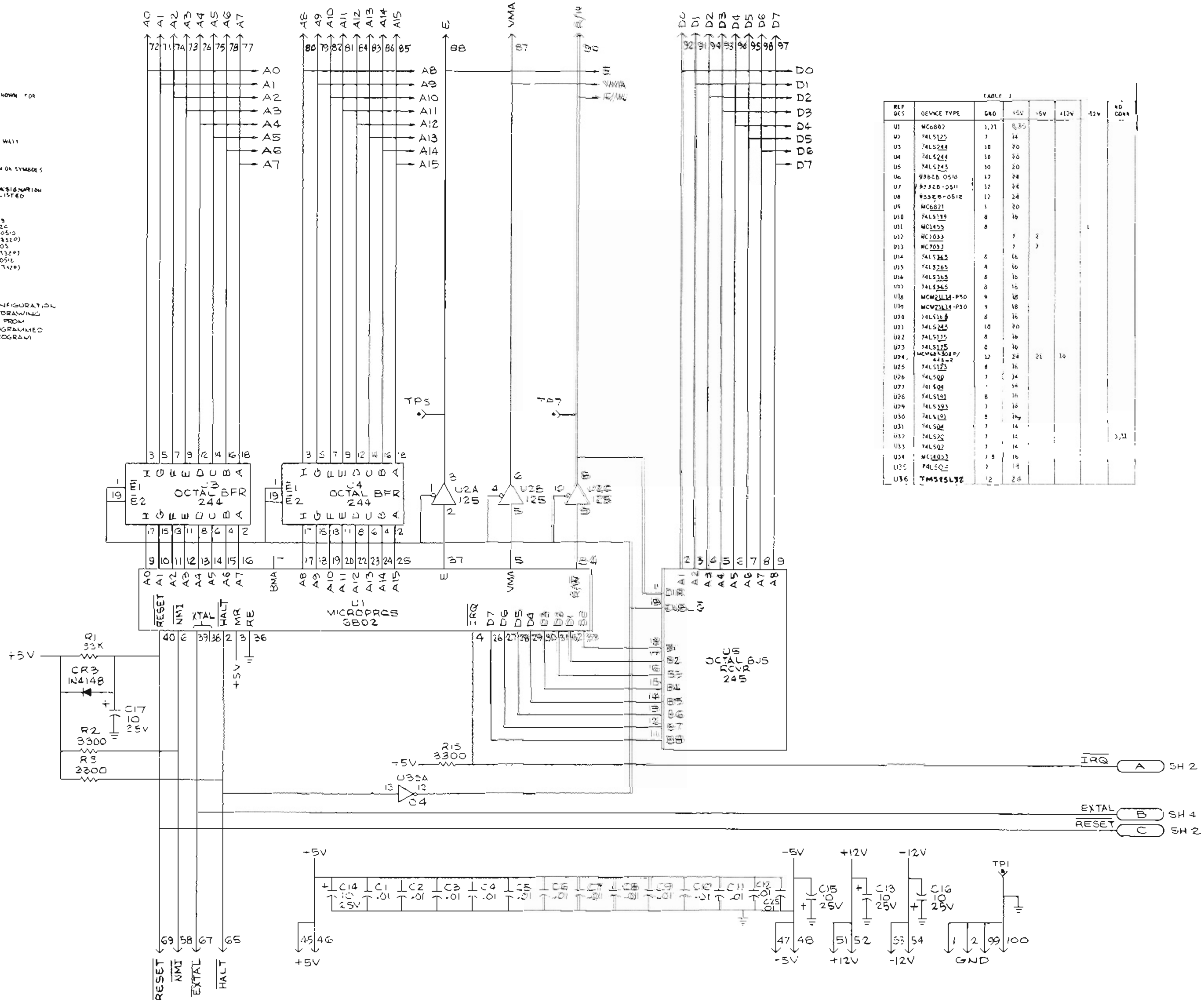


TABLE 1

REF DES	DEVICE TYPE	GND	+5V	-5V	+12V	-12V	NO CONN
U1	MC6802	1,21	8,35				
U2	74LS125	7	14				
U3	74LS244	10	20				
U4	74LS244	10	20				
U5	74LS245	10	20				
U6	9332B 0510	12	24				
U7	9332B-0511	12	24				
U8	9332B-0512	12	24				
U9	MC6821	1	20				
U10	74LS139	8	16				
U11	MC1455	8				1	
U12	MC3033		7	2			
U13	MC3033		7	3			
U14	74LS365	8	16				
U15	74LS365	8	16				
U16	74LS365	8	16				
U17	74LS365	8	16				
U18	MCM2114-P30	9	18				
U19	MCM2114-P30	9	18				
U20	74LS166	8	16				
U21	74LS245	10	20				
U22	74LS175	8	16				
U23	74LS175	8	16				
U24	MCM68A308P/4488R	12	24	21	19		
U25	74LS123	8	16				
U26	74LS00	7	14				
U27	74LS04	7	14				
U28	74LS191	8	16				
U29	74LS393	7	16				
U30	74LS191	8	16				
U31	74LS04	7	14				
U32	74LS20	7	14				1,11
U33	74LS02	7	14				
U34	MC14053	7,8	16				
U35	74LS05	7	14				
U36	TMS25L32	12	24				

REFERENCE DESIGNATIONS	
HIGHEST NUMBER USED	NOT USED
C27	
CR3	
E4 L2 Q2	
R17	R10, R11
TP8	
U36	
VR2	
Y1	

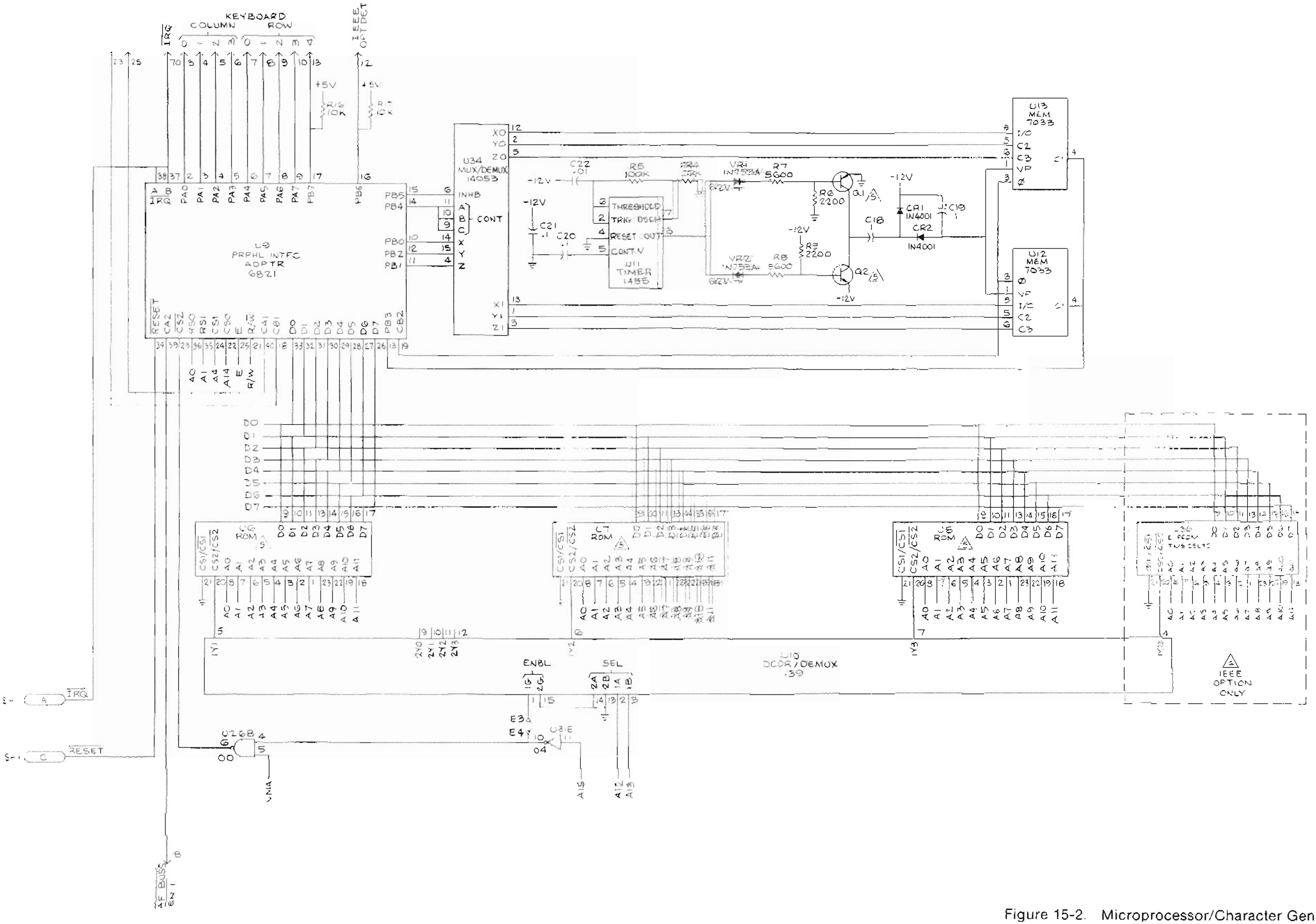


Figure 15-2. Microprocessor/Character Generator A9 Schematic Diagram (Sheet 2 of 4) (RTC-4014A)

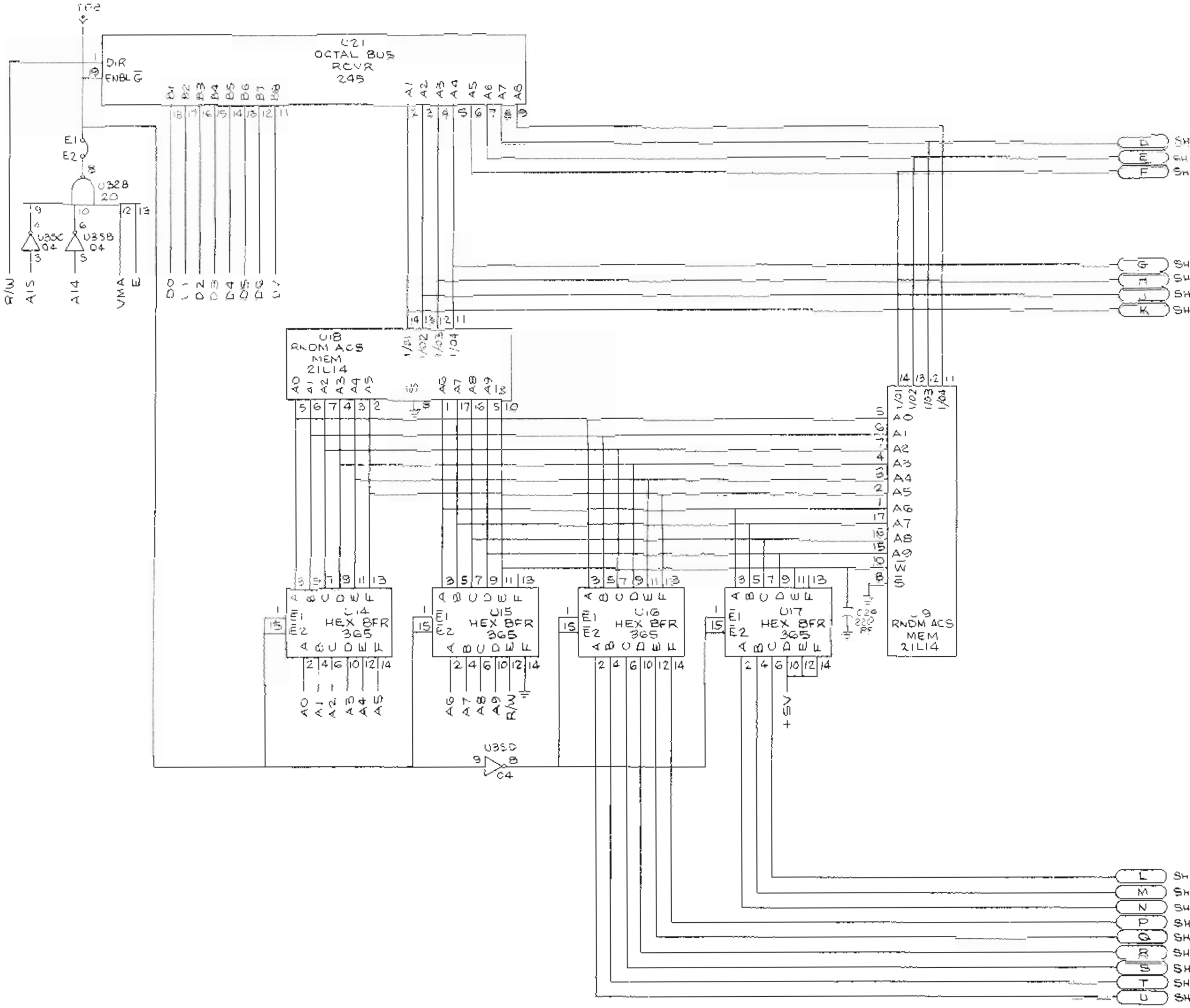


Figure 15-2. Microprocessor/Character Generator A9

Schematic Diagram (Sheet 3 of 4)
(RTC-4014A)

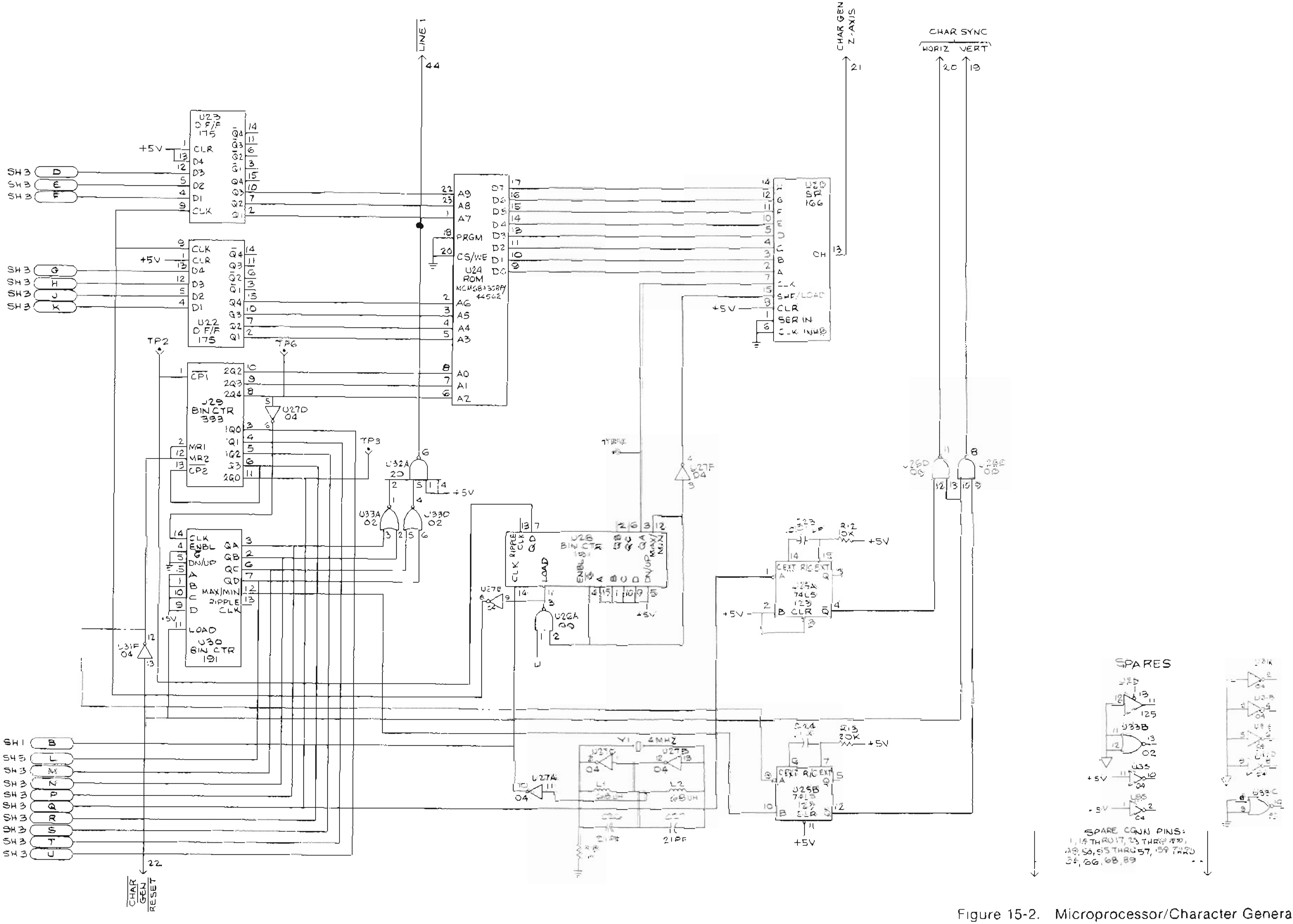


Figure 15-2. Microprocessor/Character Generator A9 Schematic Diagram (Sheet 4 of 4) (RTC-4014A)

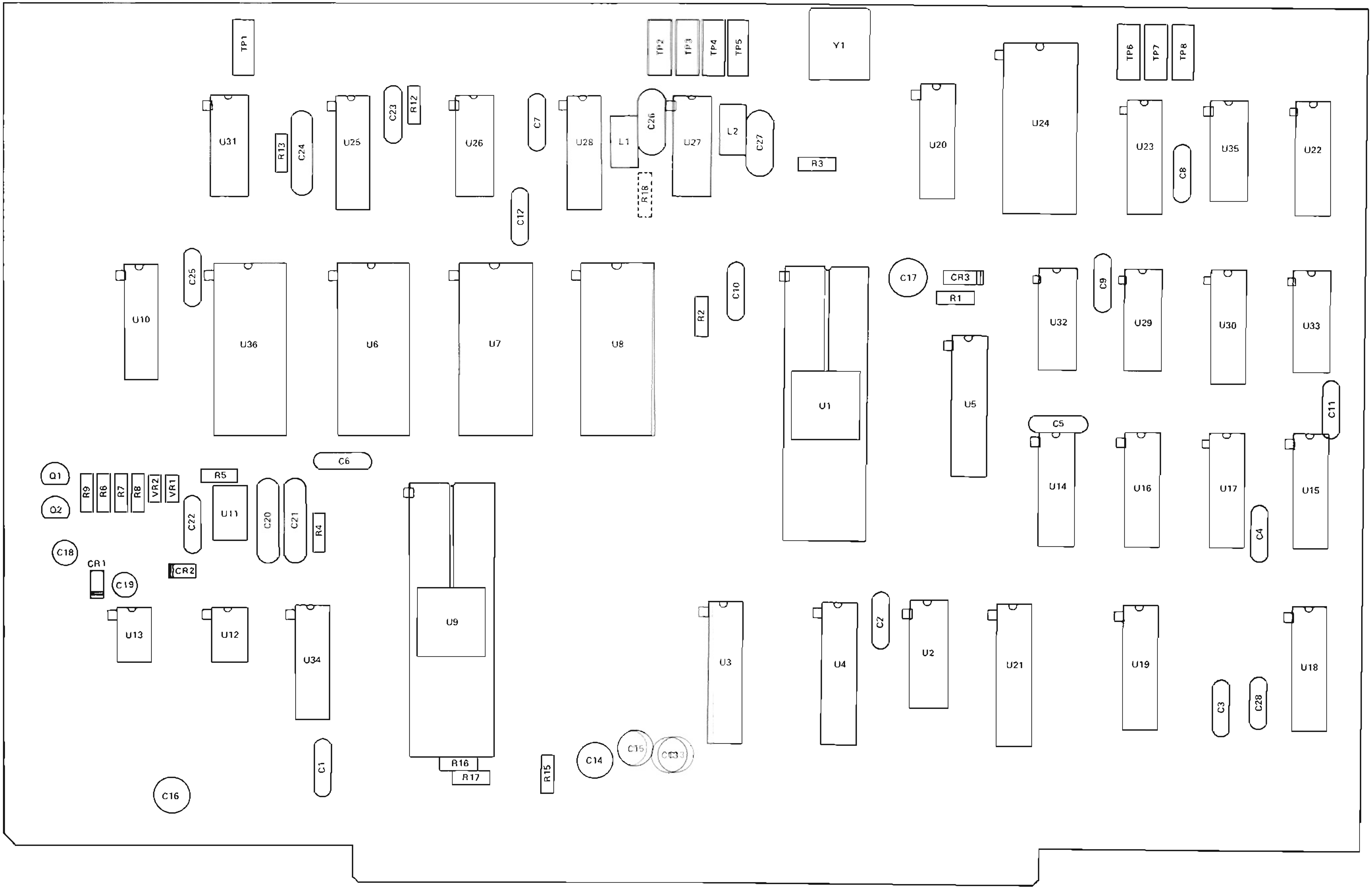


Figure 15-3. Processor Module Parts Locator

SECTION 16

HIGH VOLTAGE POWER SUPPLY (A10)

16-1. General. Bias and drive voltages for the CRT are supplied by the High Voltage Supply. The supply converts a nominal 8 VDC input level to output voltages of +4 kV and -2 kV. Circuits for low voltage control of the intensity and focus grids is also provided. A block diagram of the High Voltage Power Supply is shown in figure 16-1 and its schematic in figure 16-2.

16-2. High Voltage Supply. A nominal 8 VDC level at the center tap on the high voltage transformer is switched through the primary winding by the chopper at a 20 kHz rate. Q4/Q6 BASE DRIVE signals from the Low Voltage Supply drive the Chopper circuitry. The secondary of the transformer is a 1 KV winding that is quadrupled to a nominal +4 kV and is doubled to a nominal -2 kV. A separate 6.3 V winding provide the CRT heater drive.

16-3. The -2 kV is regulated by comparing a sample of that voltage to the 7.9 V REF signal. The resultant error signal (HV CONTROL) controls the level of the DC input to the high voltage transformer.

16-4. A Bias Divider circuit on the primary center tap provides the operating potential for the Q4/Q6 drive winding in the low voltage power supply.

16-5. Intensity and Focus Control. An 87V zener diode and resistive divider provide the intensity and focus voltages. The modulator circuits provide variable output voltages within their bias ranges under the control of the low voltage INTENSITY/FOCUS TV inputs.

16-6. DC control loops are utilized to stabilize the gird and focus voltages. For the intensity circuit the INTENSITY SAMPLE and HV REF signals are compared, on the Scope Amplifier Module, with the control input. The result of the comparison is the INTENSITY TV drive signal to the modulator. The focus voltage is controled in the same way, except the HV REF signal is not used in the comparison.

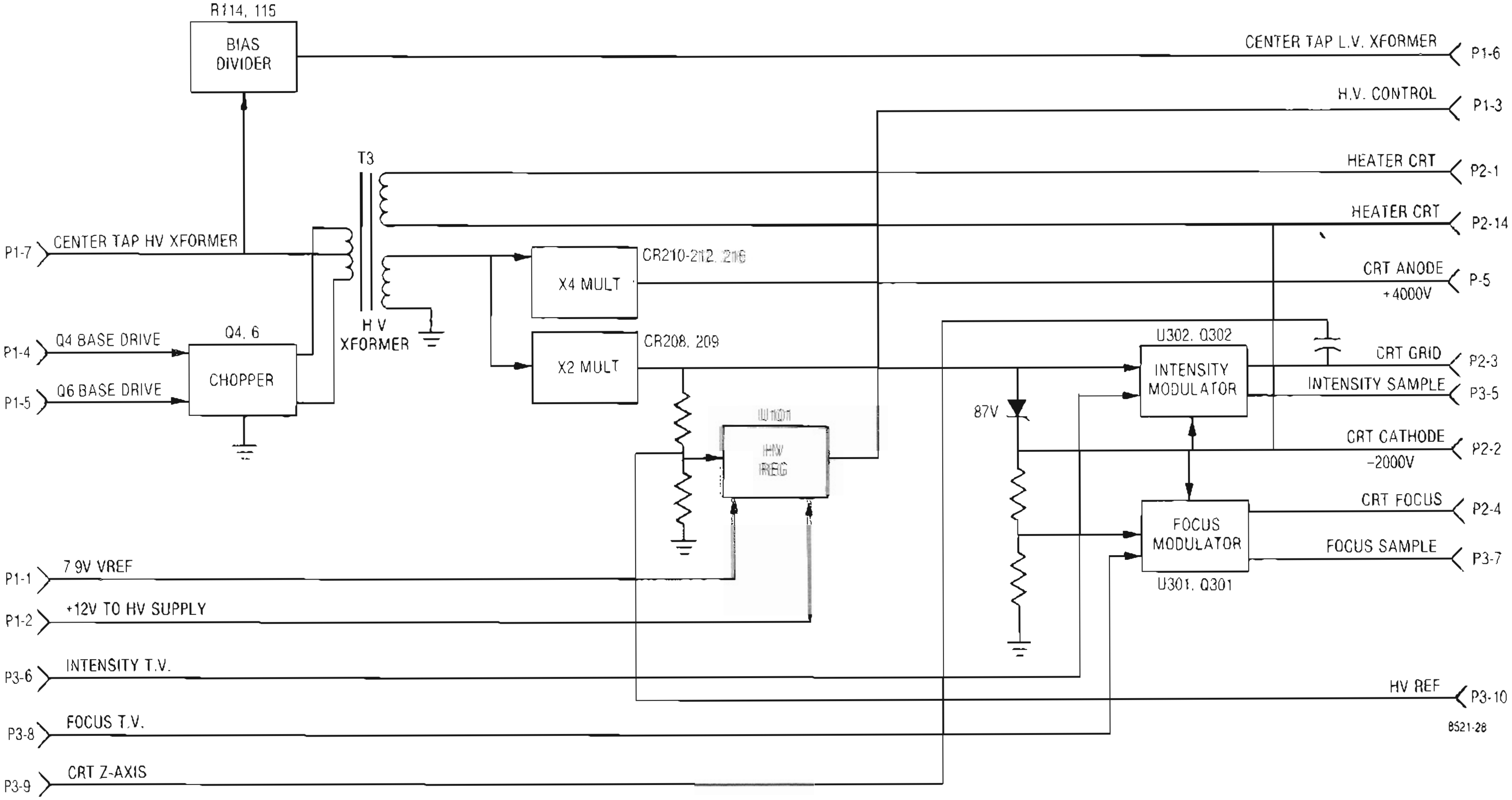
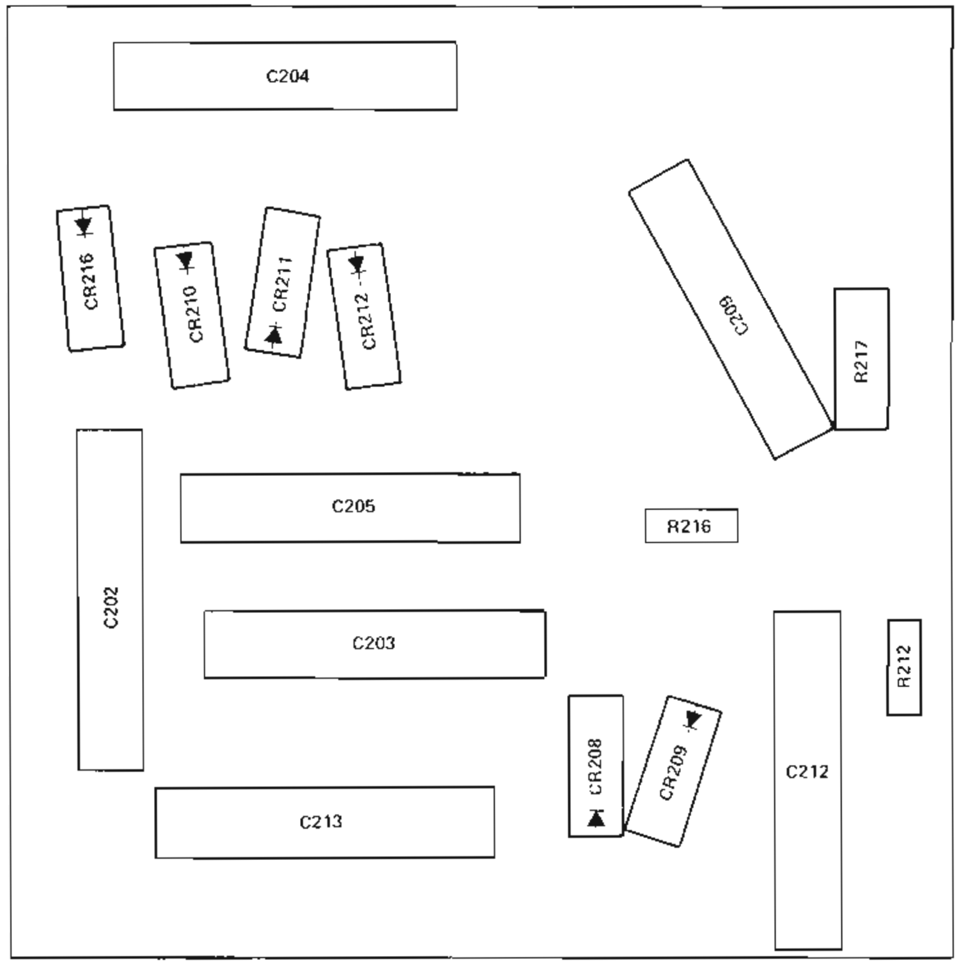
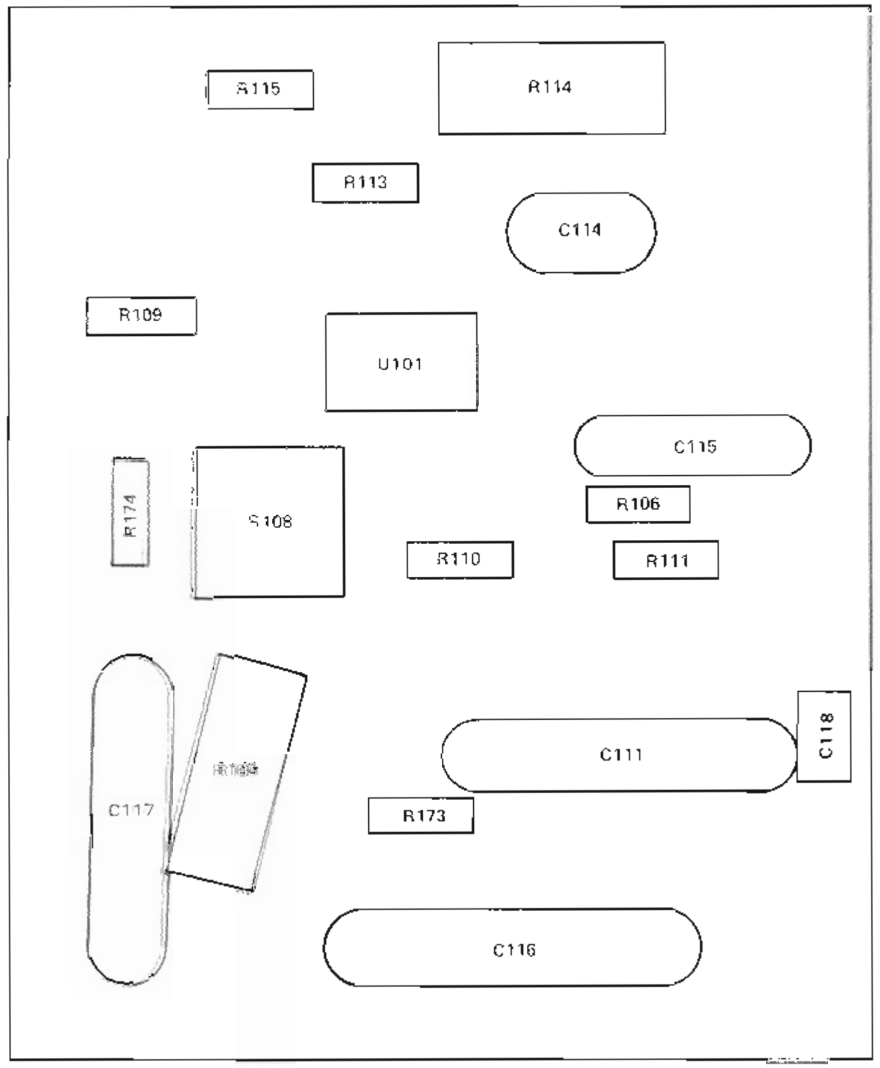


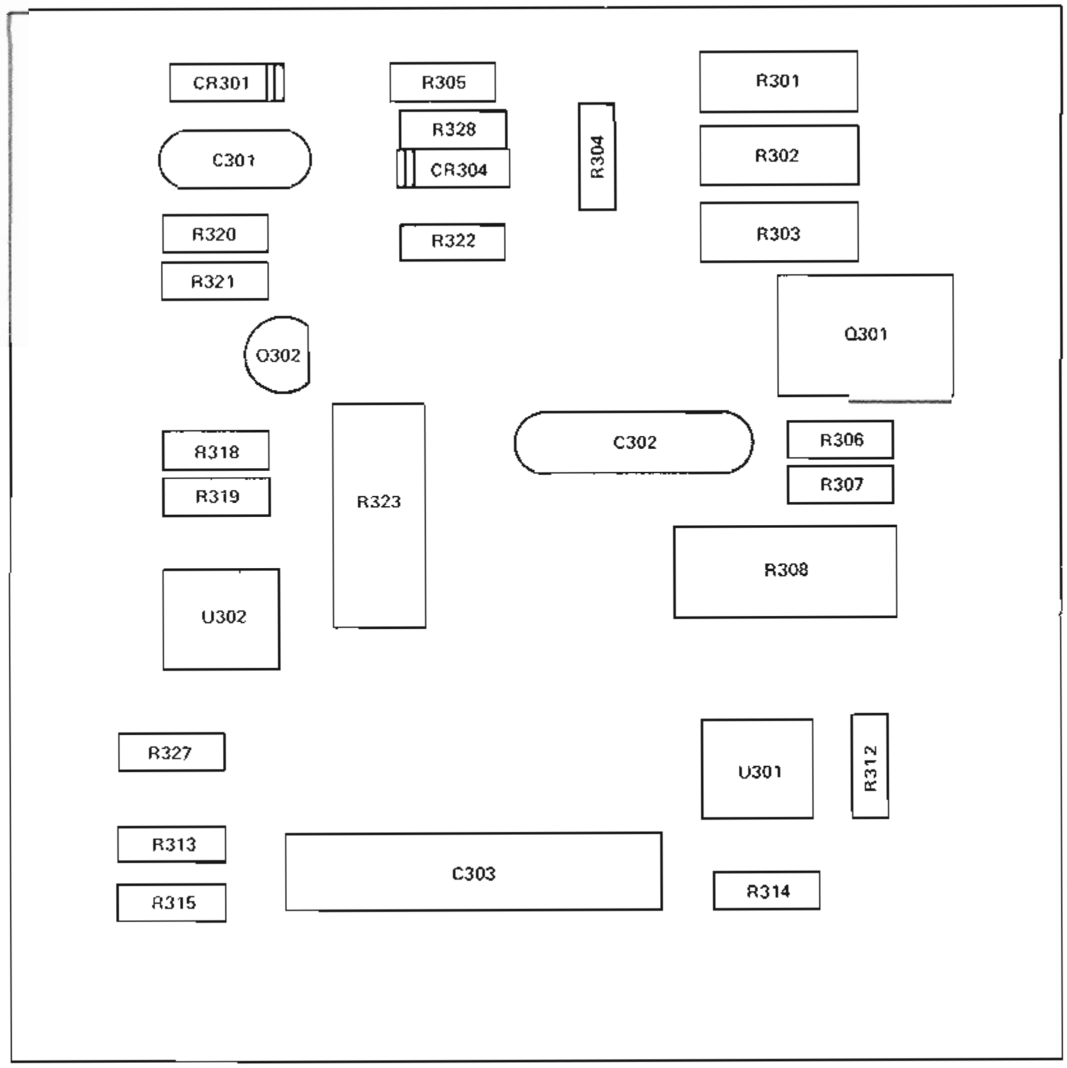
Figure 16-1. High Voltage Power Supply A10 Block Diagram



High Voltage Power & Regulator A10A1

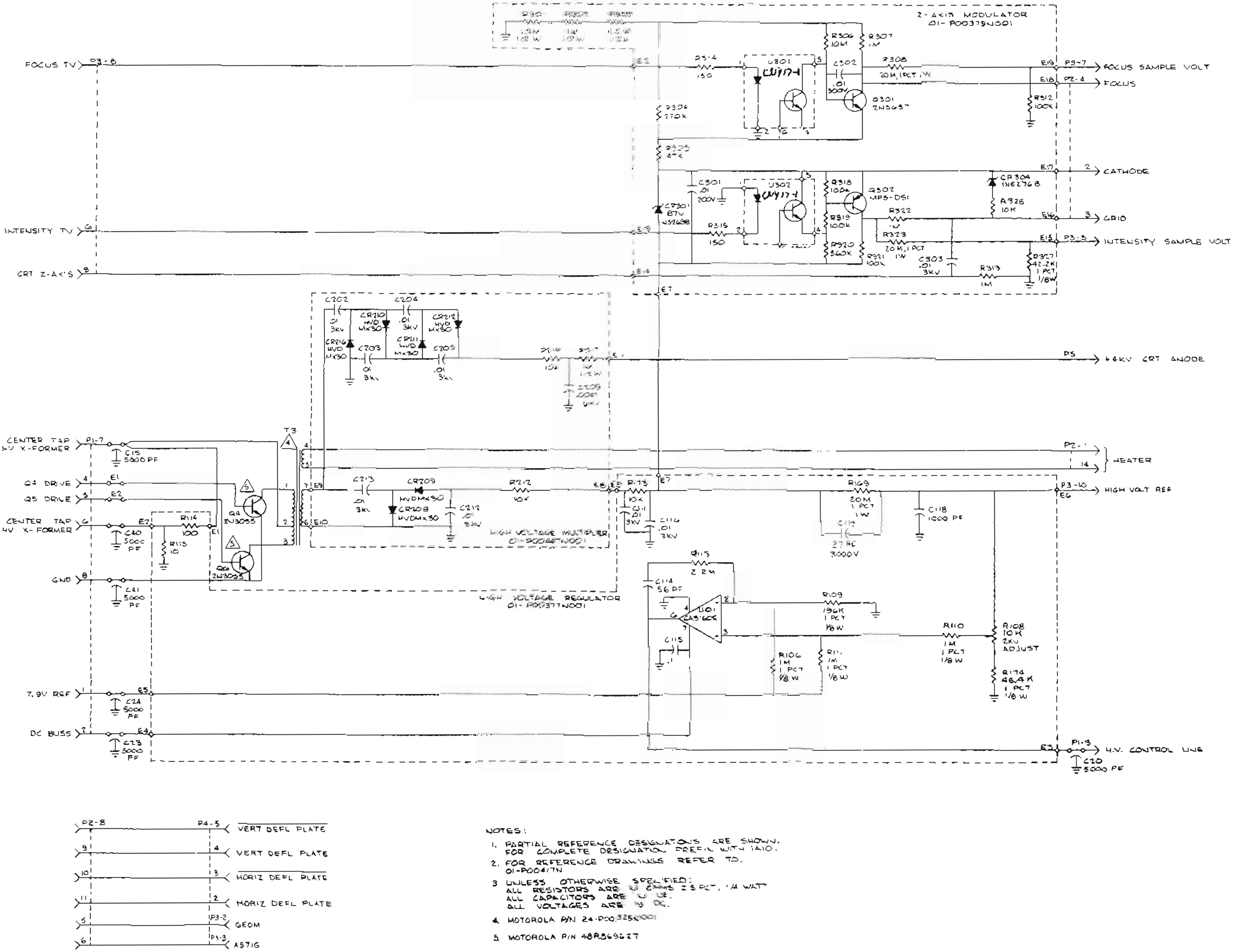


High Voltage Regulator A10A2



SCOPE-ZAxis/Focus/Int Control A10A3

High Voltage Power Supply A10
Parts Location



NOTES:

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH 1A10.
2. FOR REFERENCE DRAWINGS REFER TO. 01-P00417N
3. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS ±5 PCT, 1/4 WATT
   ALL CAPACITORS ARE IN UF.
   ALL VOLTAGES ARE IN DC.
4. MOTOROLA P/N 24-P00325N001
5. MOTOROLA P/N 48R869627

Figure 16-2. High Voltage Power Supply A10 Schematic Diagram (RTP-1001A)

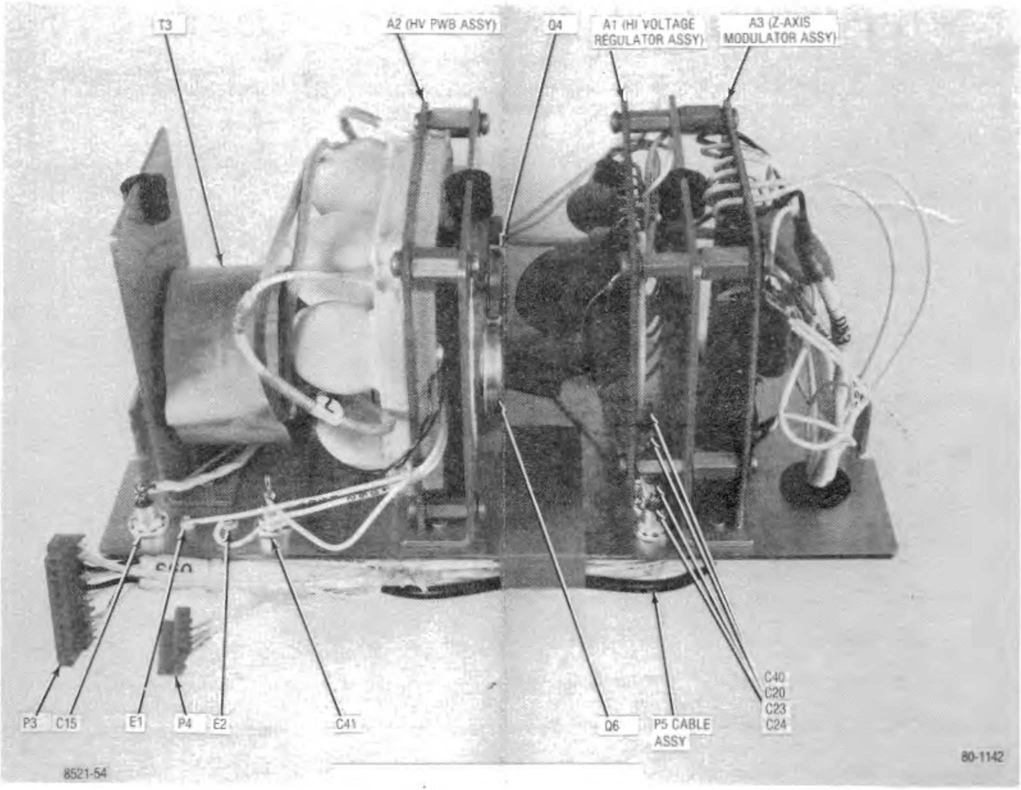


Figure 15-3. High Voltage Power Supply Parts Locator

SECTION 17

RF INPUT MODULE (A11)

17-1. General. The RF Input Module is subdivided into three isolate circuits; input protection and power meter, wideband amplifier and frequency converter and duplex generator. A block diagram of the RF Input Module is shown in figure 17-1 with its schematic shown in figure 17-2.

17-2. Input Protection and Power Meter. RF power to and from the system pass through this section to a common input/output RF connector (RF In/Out) attached to the module. In the generate or monitor operating modes the input protection relay is switched so that a low-loss 50-ohm path exists through the module. When the power monitor mode is selected, the WATT MTR EN line switches the relay so that the input is connected to a 50 ohm power termination. A detector across a portion of the load provides a DC level proportional to the input RF level. This level is amplified and made available to the system processor for the determination of input power. A thermal sensor monitors the load temperature and signals the processor when safe operating limits are exceeded. The processor in turn warns the operator that the RF input to the unit must be removed to prevent permanent damage.

17-3. If power in excess of 200 mW is applied to the system while operating in the 50 ohm load, protecting the system. A signal line (INPUT PROTECT ACT) to the processor results in an audiable and visual warning to the operator that the unit is in a protected mode. The warning ceases and normal operation resumes if the RF input is removed or if the power monitor mode is selected.

17-4. Wideband Amplifier and Frequency Converter. The wideband amplifier provides a leveled RF output from -3dBm to +13dBm in the generate mode and a +7dBm LO drive in the monitor modes over the 10 KHz to l GHz frequency range. Primary components of the leveling loop are; the input VCA (Voltage Controlled Attenuator), the output level detector, and the level comparator. A level control voltage, proportional to the desired output level, is compared to the actual output level as determined by the level detector. The result of the comparison steers the VCA maintaining the detected output level equal to the requested output level. In the generate mode the control voltage is obtained from the front panel RF level control (AM Mod + DC REF). For generate AM, the modulation signal is summed with the DC control level, causing the RF output level to follow the modulation signal. Also, in the generate mode the signal from the output level detector(CARRIER + MOD LVL) is made available for the determination of RF output power and percent of AM. A fixed reference voltage is switched to the level control input in the monitor modes giving a leveled +7dBm local oscillator drive.

17-5. The VCA on the wideband amplifier board covers the frequency range from 1 MHz to 1 GHz. For frequencies below 1 MHz, the VCA select circuit clamps the VCA in the minimum attenuation position and enables a low frequency VCA in the RF Synthesizer. Coincident with the enabling of the low frequency VCA, the time constant of the output RF level detector is increased assuring proper operation down to 10 kHz.

17-6. The wideband amplifier output is relay switched between the local oscillator port of the input mixer for the monitor and generate DSBSC modes, and the RF attenuator for the generate mode. An RF sample from the mixer local oscillator output terminal, at a nominal level of -20dBm, is provided to the duplex generator.

17-7. The frequency converter section consists of the input mixer, the first IF amplifier, and IF filters. In the monitor mode the desired signal is converted to 10.7 MHz by the input mixer. A two-pole input filter, IF amplifier, and a four-pole output filter select the 10.7 MHz component at the mixer output. The 10.7 MHz IF output of the converter is applied to the receiver module.

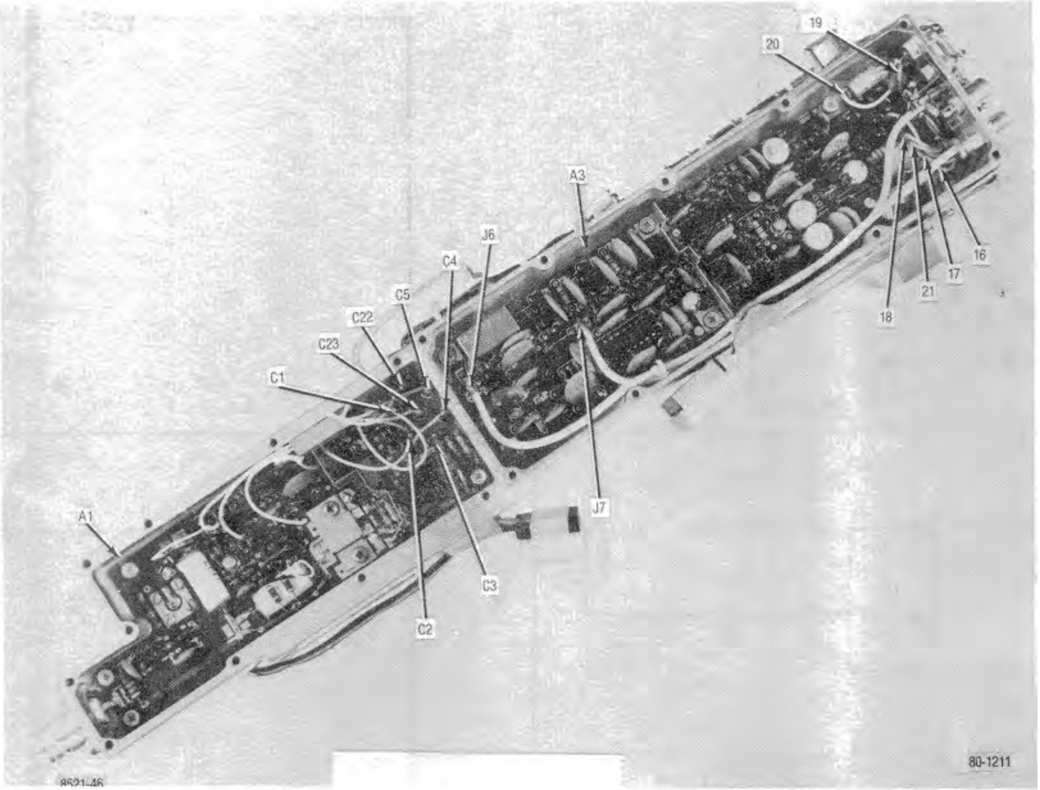
17-8. For DSBSC generation the modulation audio is applied to the IF port of the input mixer through an isolation network. With the output of the wideband amplifier switched to the local oscillator port, a DSBSC signal is present at the RF port. Switching the Step Attenuator to the RF output port makes the DSBSC signal available at the RF output.

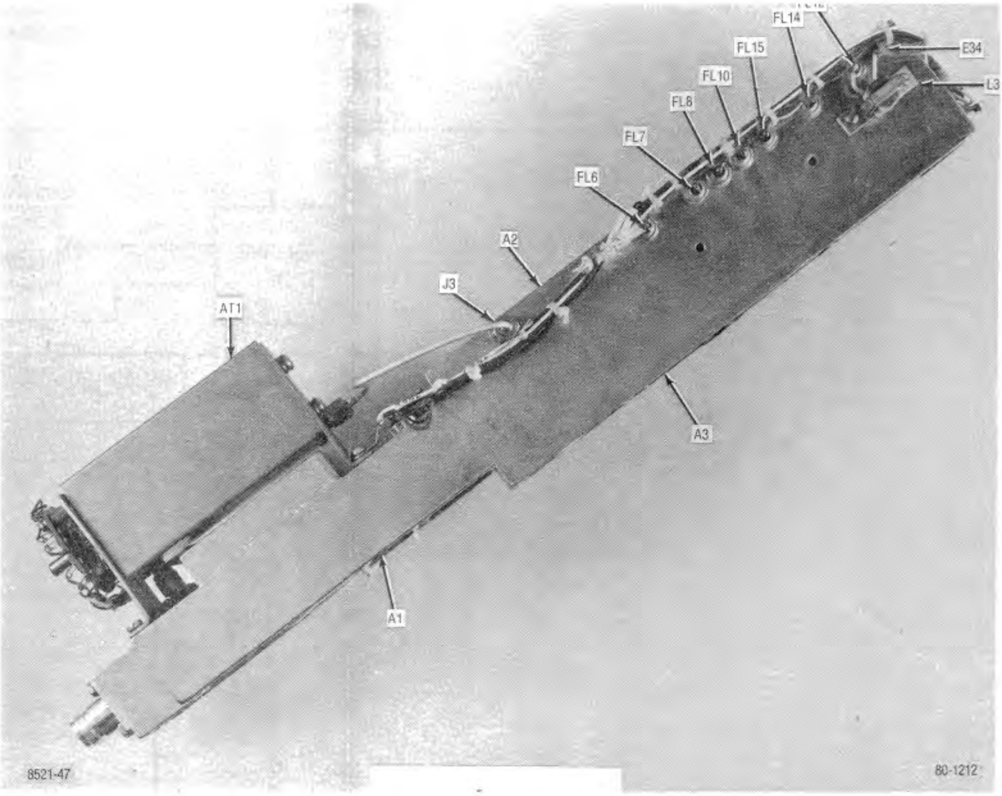
17-9. Duplex Generator. The Duplex Generator output is a frequency component that is offset from the system monitor frequency by 0 to 10 MHz or by 45 MHz. The offset is obtained by mixing the -20dBm local oscillator signal from the wideband amp, which is already offset by 10.7 MHz, with a signal frequency from 10.7 MHz to 0.7 MHz or 34.3 MHz.

17-10. For the 34.3 MHz mixing signal, a single VCO is used. Tuning of the VCO is with the OFFSET FINE TUNE line from the front panel. Frequency modulation of the VCO is implemented by suming the OFFSET MOD signal with the tuning voltage.

17-11. For the 0.7 MHz to 10.7 MHz mixing signal a VCO with a frequency range from 35 MHz to 45 MHz is mixed with the 34.3 MHz VCO. The 35-45 MHz VCO is tuned by the OFFSET COARSE TUNE line from the front panel.

17-12. A sample of the offset frequency is made available to the frequency counter on the OFFSET FREQ line. The processor uses the frequency information to calculate and display the actual duplex frequency.


19
20
A3
J6
C4
C5
C22
C23
C1
A1
C2
C3
J7
16
17
21
18
80-1211
8521-46



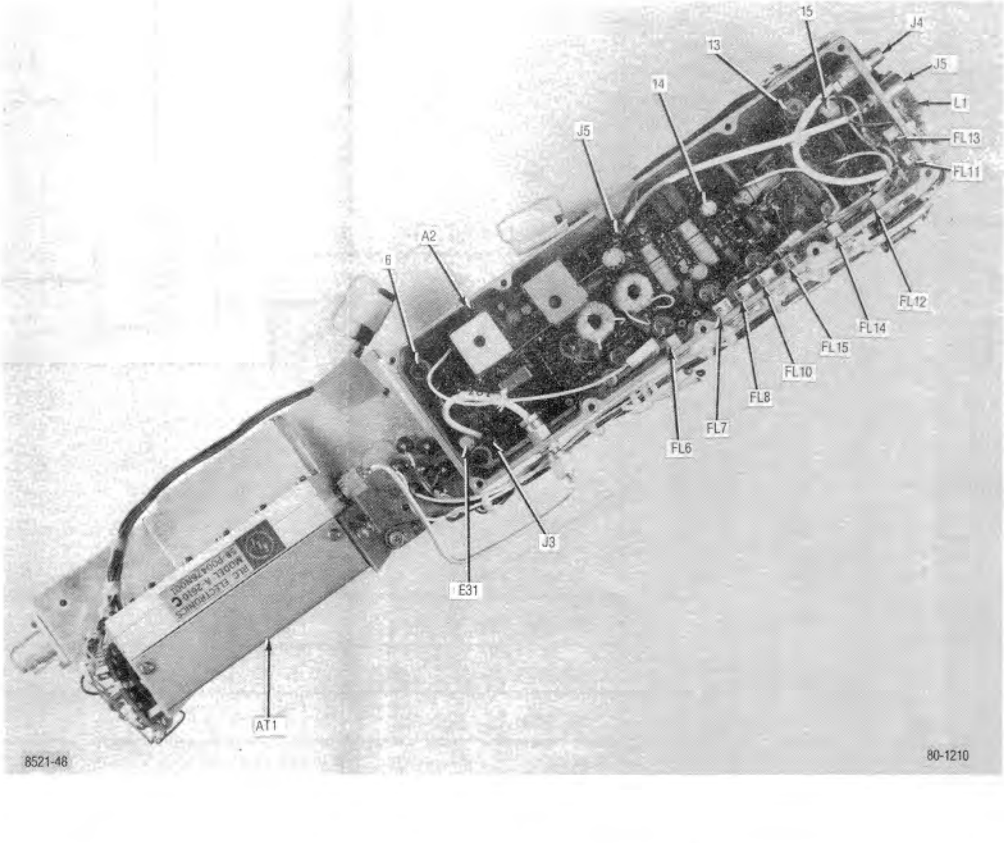


Figure 17-3. RF Input Module Parts Locator

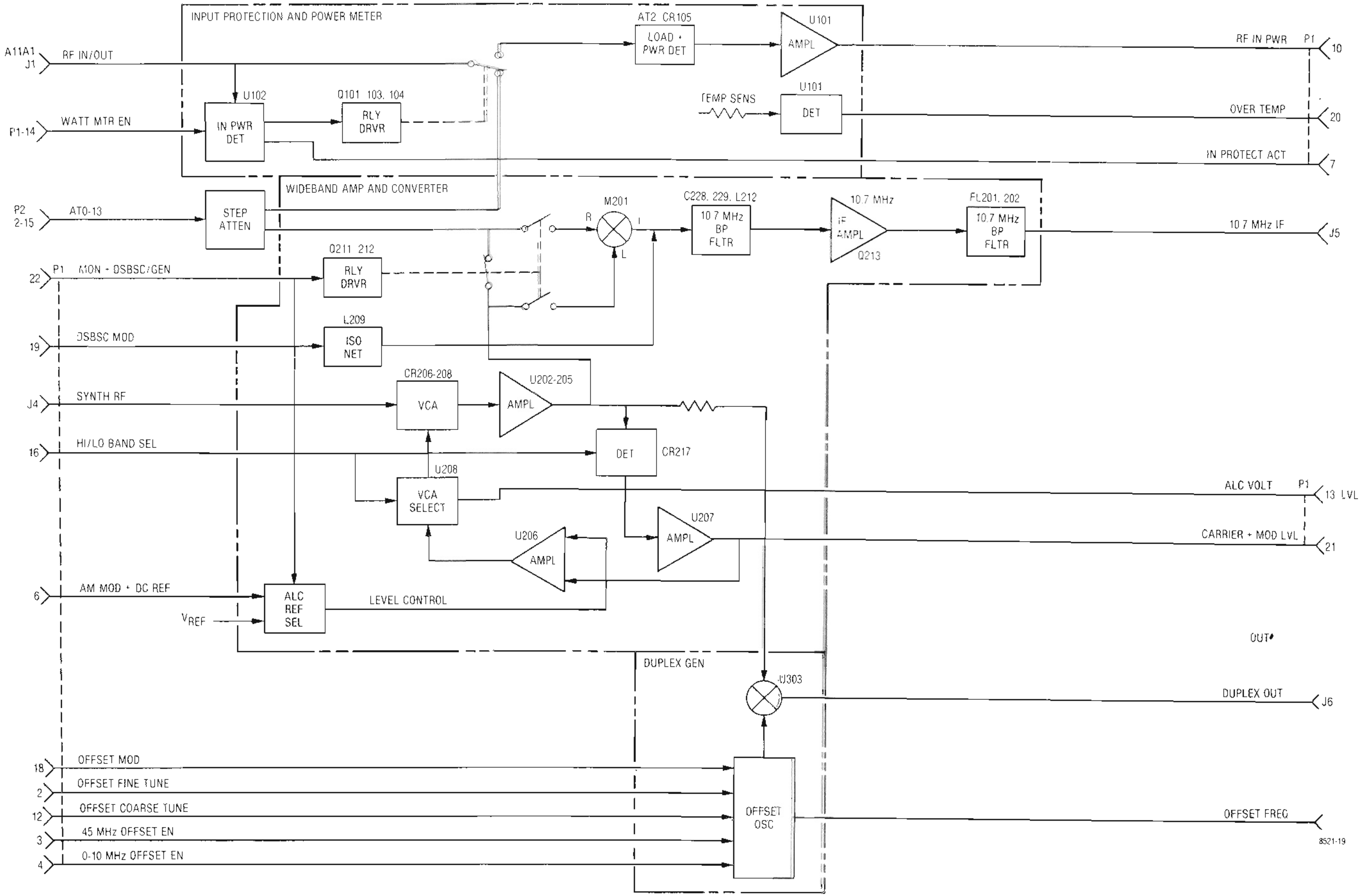
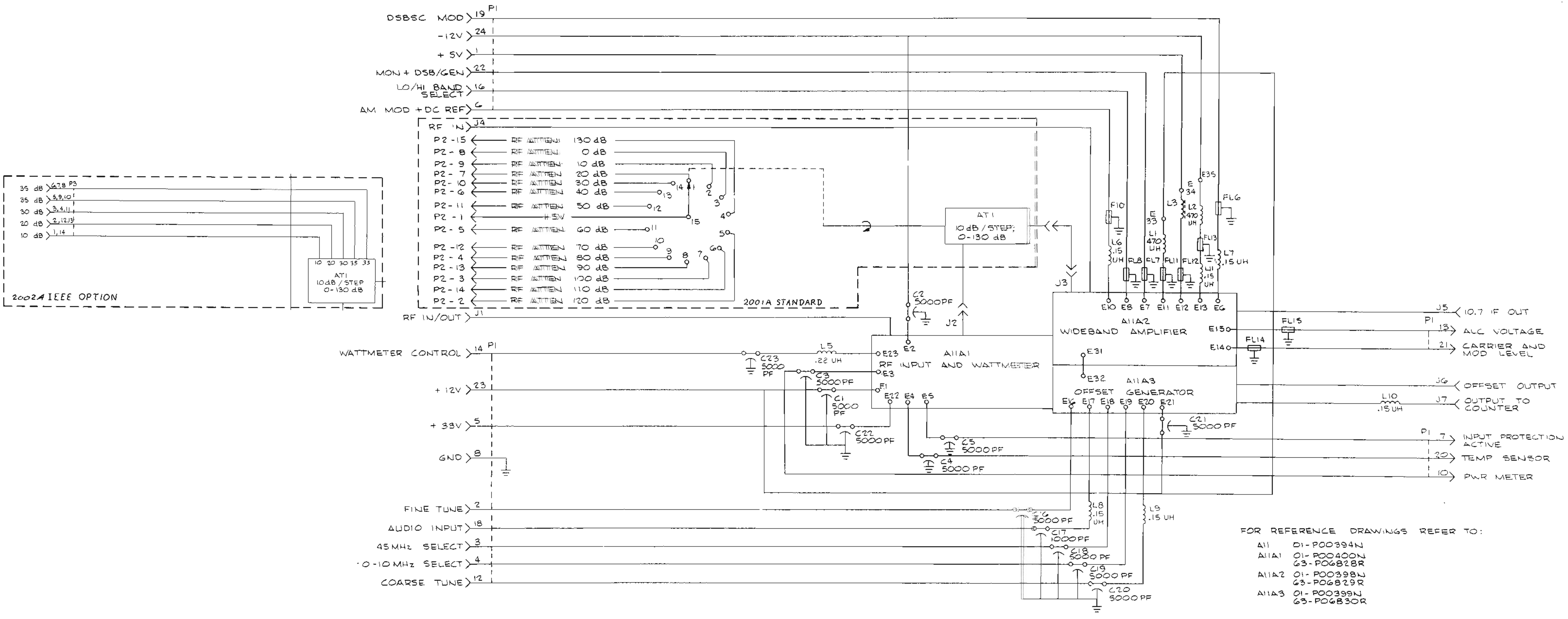


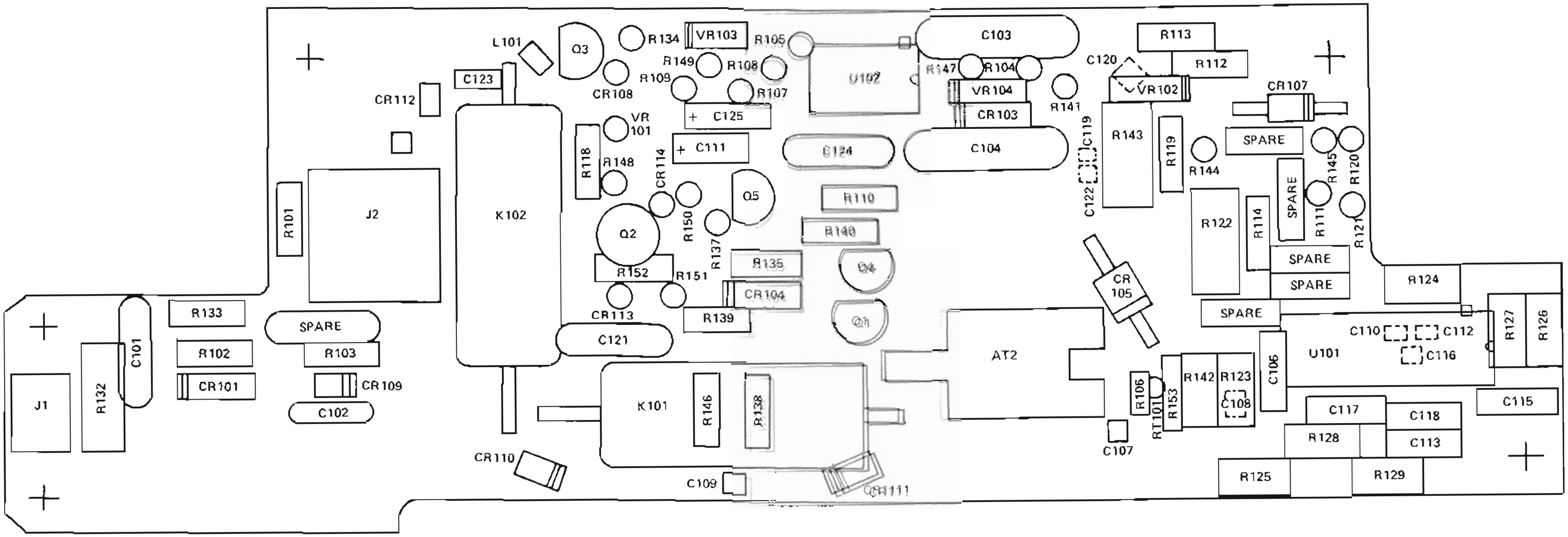
Figure 17-1. RF Input Module A11 Block Diagram



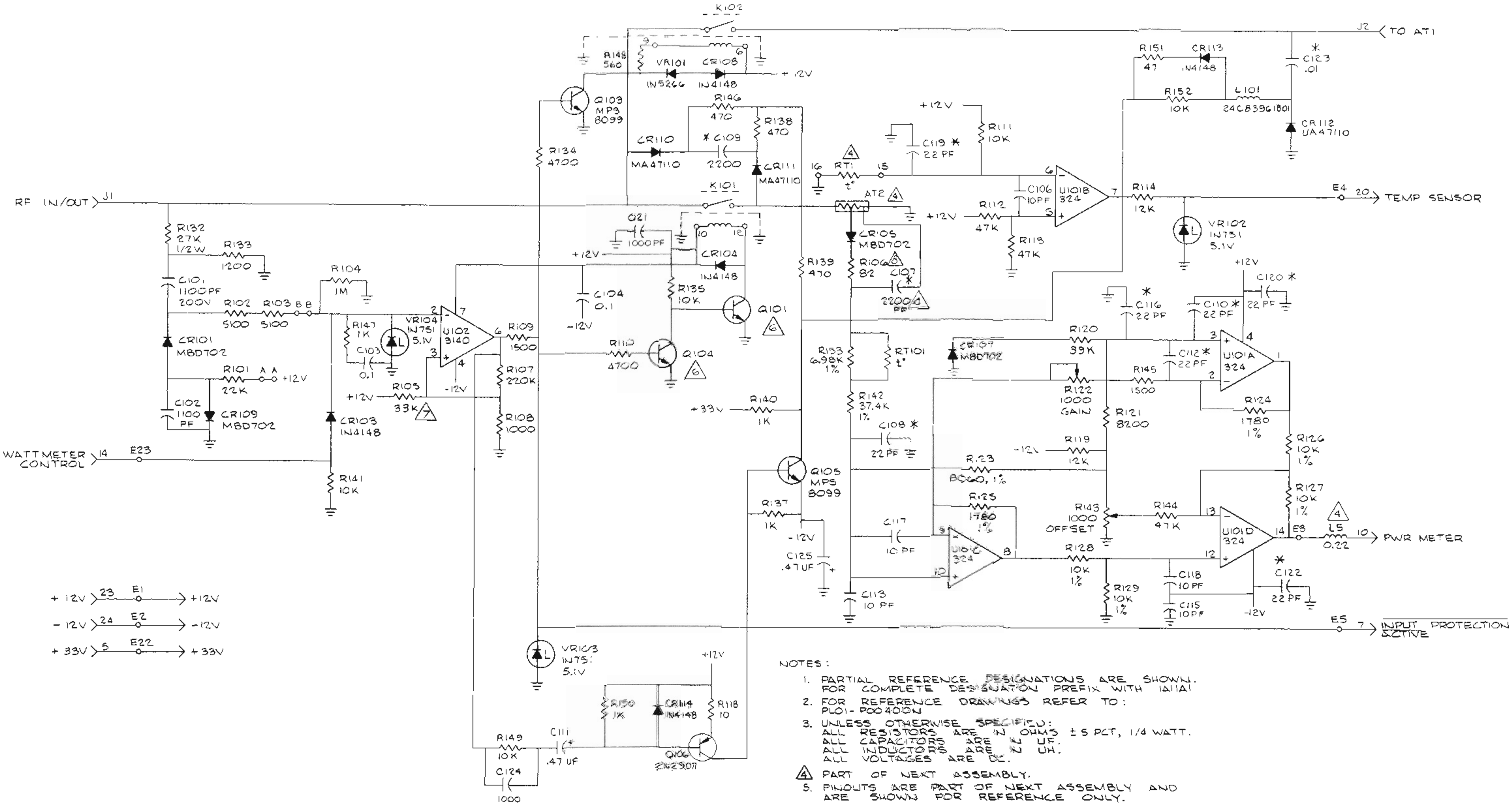
FOR REFERENCE DRAWINGS REFER TO:

A11	01-P00394N
A11A1	01-P00400N 63-P06828R
A11A2	01-P00398N 63-P06829R
A11A3	01-P00399N 63-P06830R

Figure 17-2. RF Input Module A11 Schematic Diagram (RTC-1003A)



Power Meter Protection A11A1



NOTES:

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH 1A11A1
2. FOR REFERENCE DRAWINGS REFER TO: PL01-P00400N
3. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS ±5 PCT, 1/4 WATT.
   ALL CAPACITORS ARE IN UF.
   ALL INDUCTORS ARE IN UH.
   ALL VOLTAGES ARE DC.

△4 PART OF NEXT ASSEMBLY.

5. PINOUTS ARE PART OF NEXT ASSEMBLY AND ARE SHOWN FOR REFERENCE ONLY.

△6 MOTOROLA PART NUMBER 48R00869570 (MPS6520).

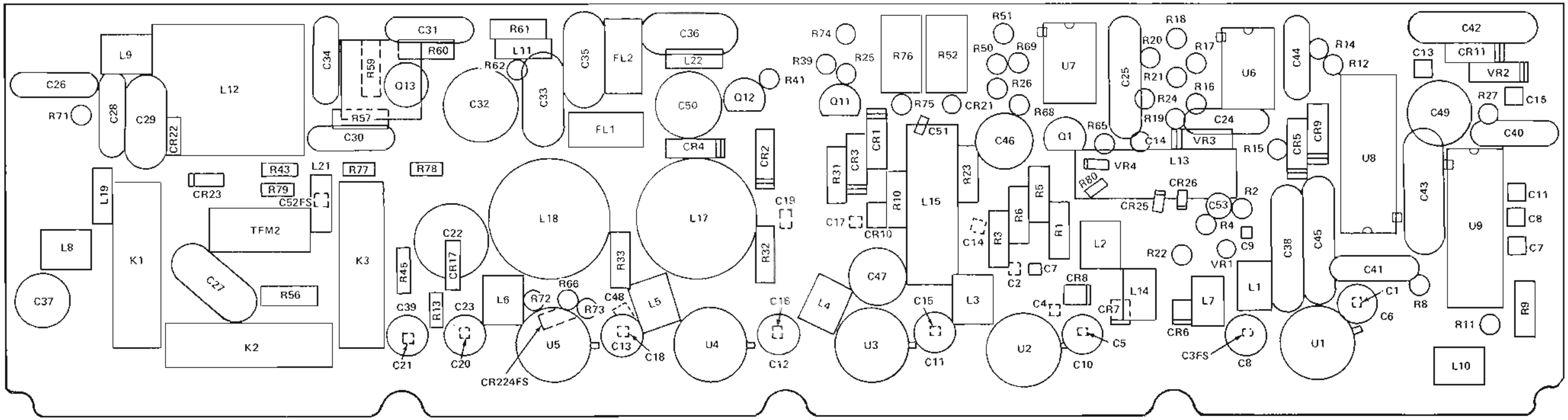
△7 R105 MAY BE SELECTED FROM: 27K, 33K NOM, OR 39K.

△8 R106 MAY BE SELECTED FROM: 68, 75, 82 NOM, 91, OR 100Ω.

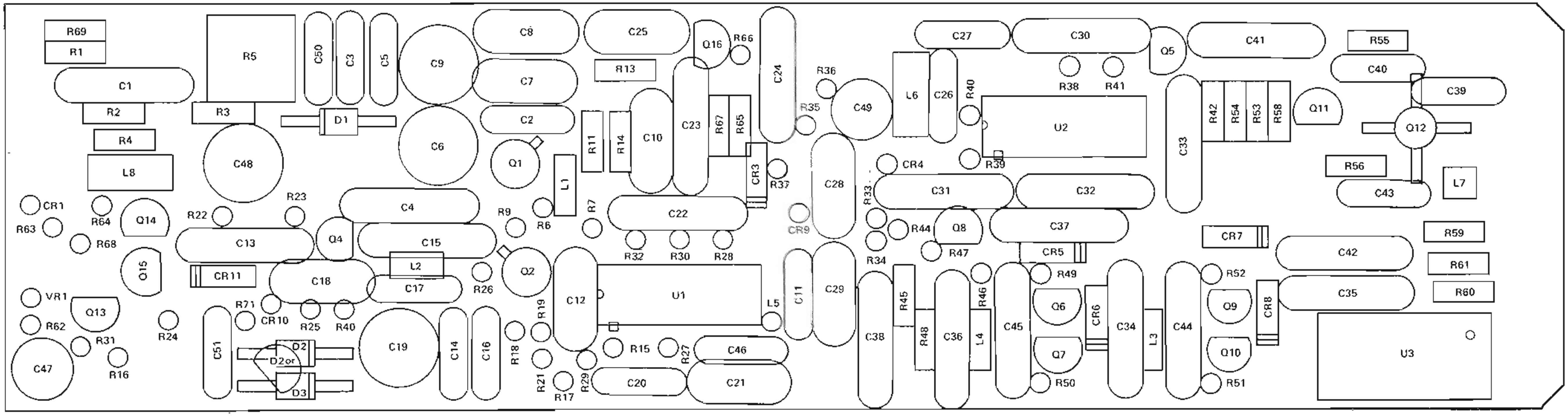
9. * MEANS CHIP CAP.

REF DES	DEVICE TYPE	+12V	-12V	NO CONN
U101	MLM324	4	11	
U102	CA3140	7	4	1, 5, 8

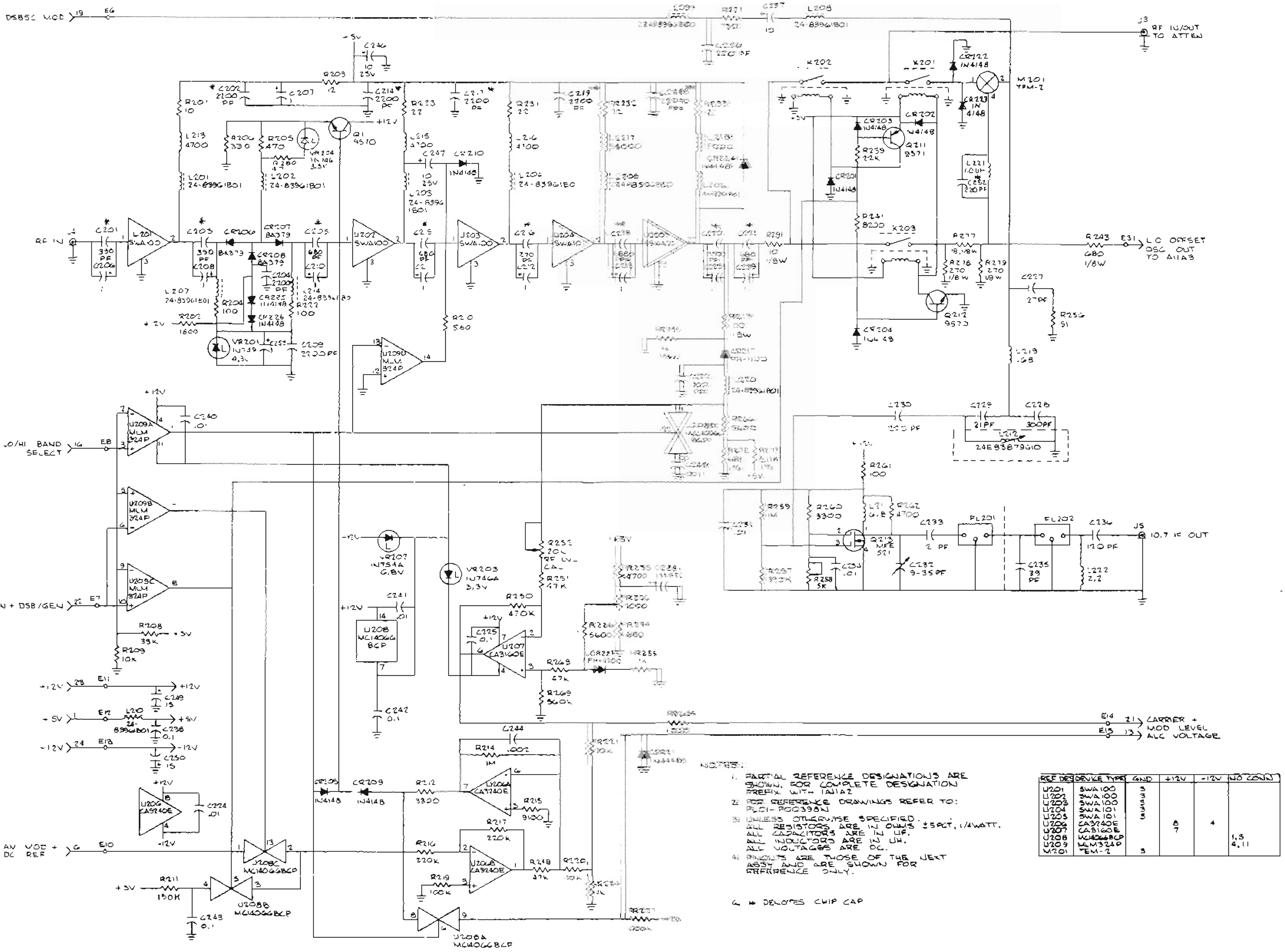
Figure 17-3. RF Input/Wattmeter Card A11A1 Schematic Diagram (RTC-4061A)



Wideband Amplifier A11A2



Offset Generator A11A3



NOTES:

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH 1A11A2
2. FOR REFERENCE DRAWINGS REFER TO: PL01-P00398N
3. UNLESS OTHERWISE SPECIFIED. ALL RESISTORS ARE IN OHMS ±5PCT, 1/4WATT. ALL CAPACITORS ARE IN UF. ALL INDUCTORS ARE IN UH. ALL VOLTAGES ARE DC.
4. PINOUTS ARE THOSE OF THE NEXT ASSY AND ARE SHOWN FOR REFERENCE ONLY.

* DENOTES CHIP CAP

REF DES	DEVICE TYPE	GND	+12V	-12V	NO CONN
U201	SWA100	3			
U202	SWA100	3			
U203	SWA100	3			
U204	SWA101	3			
U205	SWA101	3			
U206	CA3240E		8	4	
U207	CA3160E		7		
U208	MC14066BCP				1,3
U209	MLM324P				4,11
M201	TFM-2	3			

Figure 17.4 Wideband Amp Card A11A2

NOTES.

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN, FOR COMPLETE DESIGNATION PREFIX WITH 1A11A3
2. FOR REFERENCE DRAWINGS REFER TO: ASSY 01-P00399N
3. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS ± 5 PCT, 1/4 WATT.
   ALL CAPACITORS ARE IN UF
   ALL INDUCTORS ARE IN UH
   ALL VOLTAGES ARE IN DC.
4. PINOUTS ARE A PART OF THE NEXT ASSEMBLY AND ARE SHOWN FOR REFERENCE ONLY.

⚠3 C318 MAY BE SELECTED IN TEST FROM 68, 100 OR 120 PF.

REF DES	DEVICE TYPE	GND	NO CONN
U301	MC1496P	14	7, 9, 11, 13
U302	MC1733P		2, 3, 4, 6, 9, 11, 12
U303	SRA-2	2, 5, 6, 7	

REF DESIGNATIONS	
HIGHEST USED	NOT USED
C351	C302
CR311	CR302
D303	
L308	
Q316	Q303
R371	R312, 320, 331, 345, 357
U303	R358, 310
VR301	

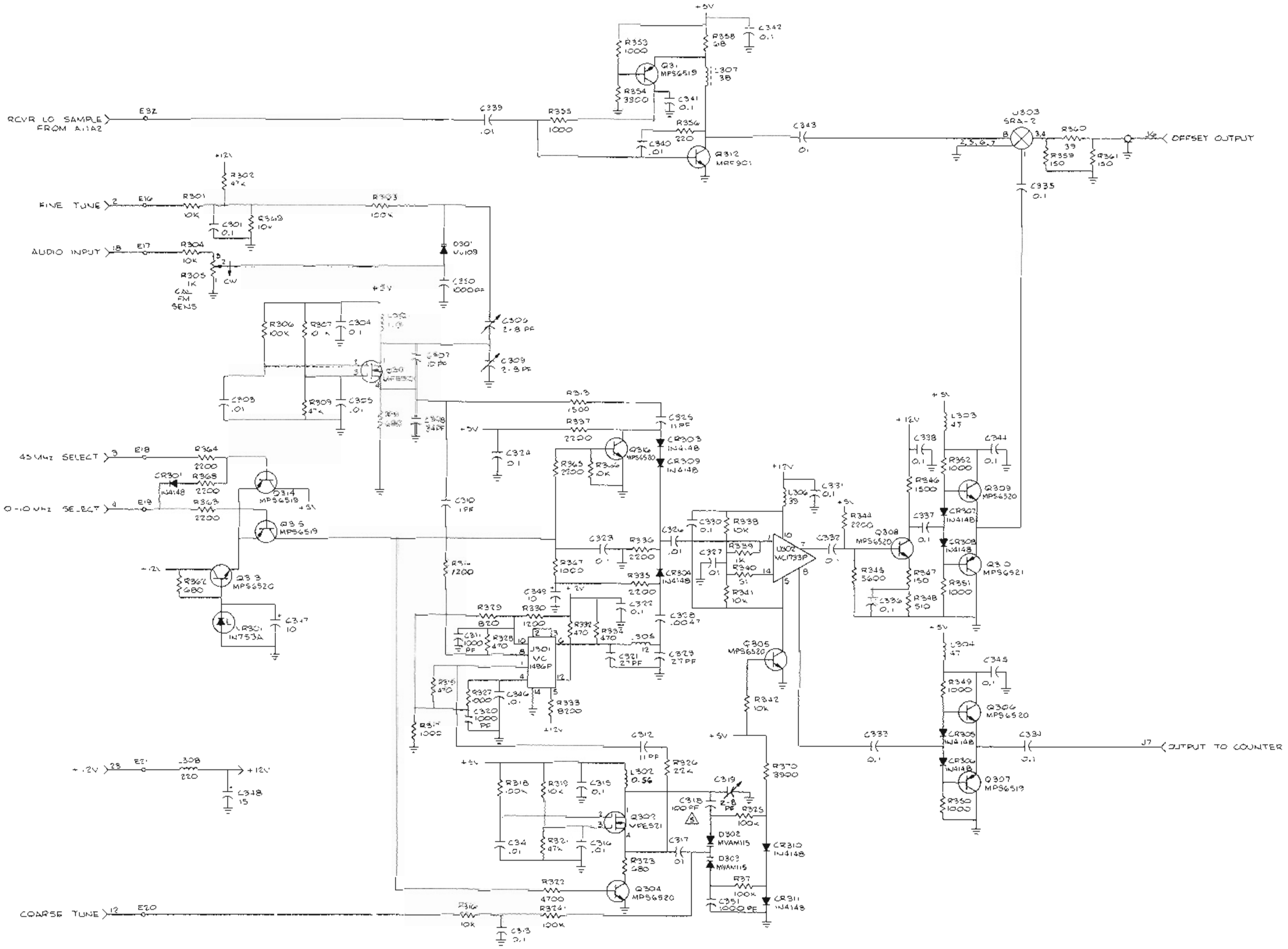


Figure 17-5. Offset Generator Card A11A3 Schematic Diagram (RTC-4016A)

SECTION 18

FRONT PANEL INTERFACE MODULE (A12)

18-1. General. Input buffers and output latches for front panel control and display interface to the processor are contained on the Front Panel Interface Module. Buffering and ranging circuits for the external scope vertical, SINAD, DVM, Frequency Counter, and external scope horizontal inputs is also contained on this module. A block diagram of the Front Panel Interface Module is shown in figure 18-1 with its schematic shown in figure 18-2.

18-2. Input Coupling and Ranging. Scope inputs to the Range Attenuator are from the front panel jack (EXT IN) or from the internal modulation sources (INT SCOPE TO RNG SW). An INT/EXT relay selects the input path. The external path may be AC or DC coupled and is also the path for external DVM, Frequency Counter, and SINAD inputs.

18-3. Four decades of attenuation from 1.0 to 0.001 are provided by the Range Attenuator. The input impedance of the attenuator is 1.0 megohm compensated for a bandwidth of 1 MHz. A unity gain buffer amp following the attenuator provides the drive for the DVM, Frequency Counter, and Scope Vertical Preamp circuits.

18-4. DVM Buffer. For DC measurements the DVM Buffer provides a 2-pole low pass filter with a minimum of 30 dB attenuation at 50 Hz. For AC measurements the bandwidth of the buffer is switched so that the attenuation at 10 kHz is less than 0.5 dB.

18-5. Frequency Counter Preamp. The Frequency Counter Preamp has sufficient gain for 30 mV rms sensitivity and provides hystersis for noise immunity.

18-6. Scope Vertical Preamp. A calibrated gain of 50 or a variable gain from 5 to 50 is provided by the Vertical Preamp. The gain is controlled from the front panel. For vertical scope positioning the DC bias point of the preamp is controlled by the front panel position control. Deflection sensitivity at the VERT FROM RNG SW output is 0.5 volt per division.

18-7. Scope Horizontal Preamp. A fixed gain of 5 in the Horizontal Preamp gives a horizontal input sensitivity of 0.1 volt per division. Horizontal vernier gain is implemented on the front panel, and horizontal positioning on the Scope Amplifier module. Deflection sensitivity at the HORIZ TO SCOPE AMPL is 0.5 volt per division.

18-8. Control and Display Interface. Front panel control information is input to the processor in 4-bit groups through the AF control bus. Priority encoders convert the multiposition switches, scope horizontal, frequency scan, and RF step attenuator, to 4-bit codes. The processor sequentially addresses (AF ADRS BUS 0-3) each input buffer through the Address Decoder. Data in the selected buffer is then transfered to the processor on the AF DATA BUS 0-3 lines while the AF BUS EN 2 signal is low.

18-9. A three or four bit code for each LED display group is transfered from the processor to the display latch. The latched data is decoded and the indicated LED driver is enabled.

18-10. Two additional latches provide the processor control interface for the Range Attenuator, input switching, and DVM Buffer control.

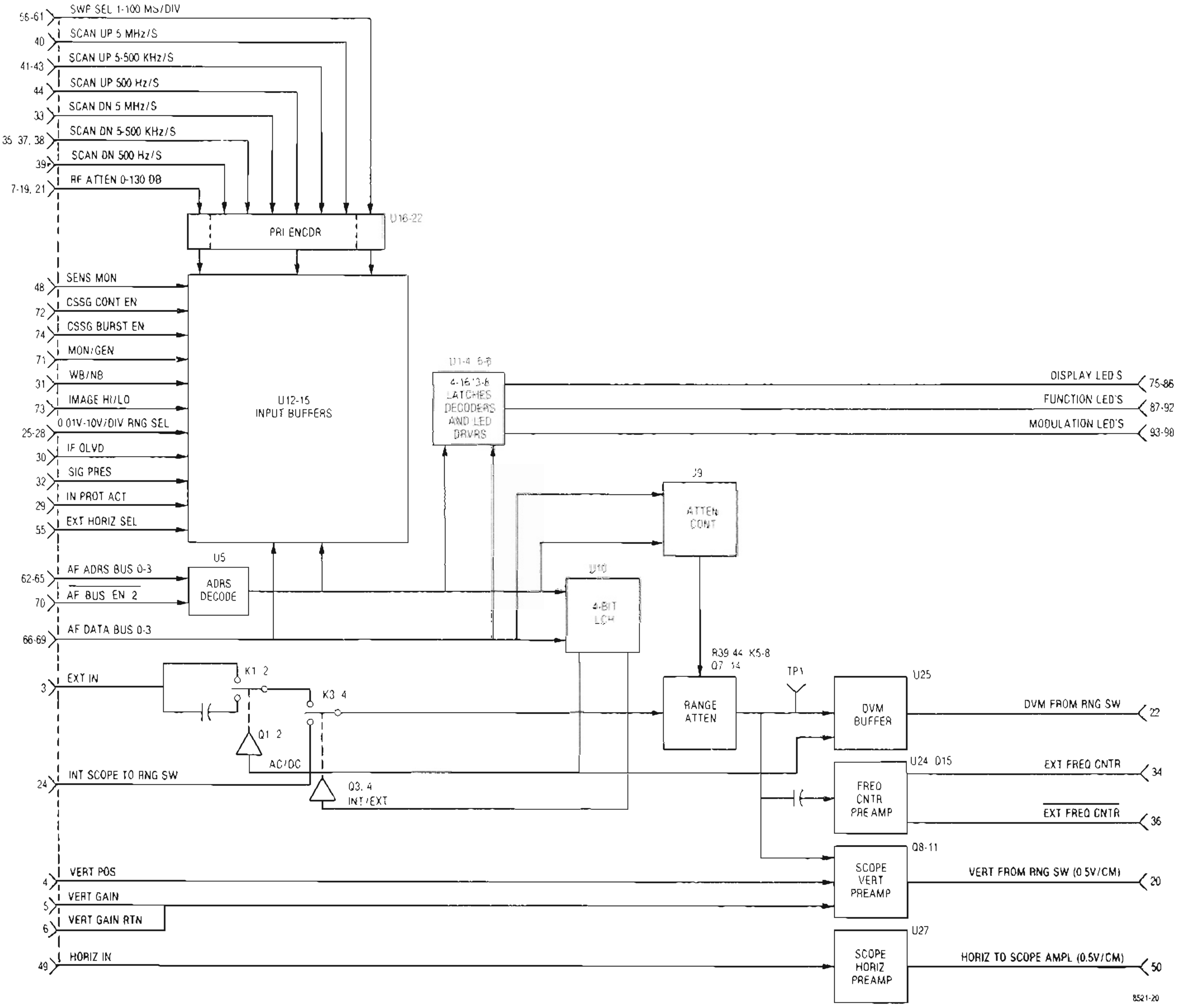
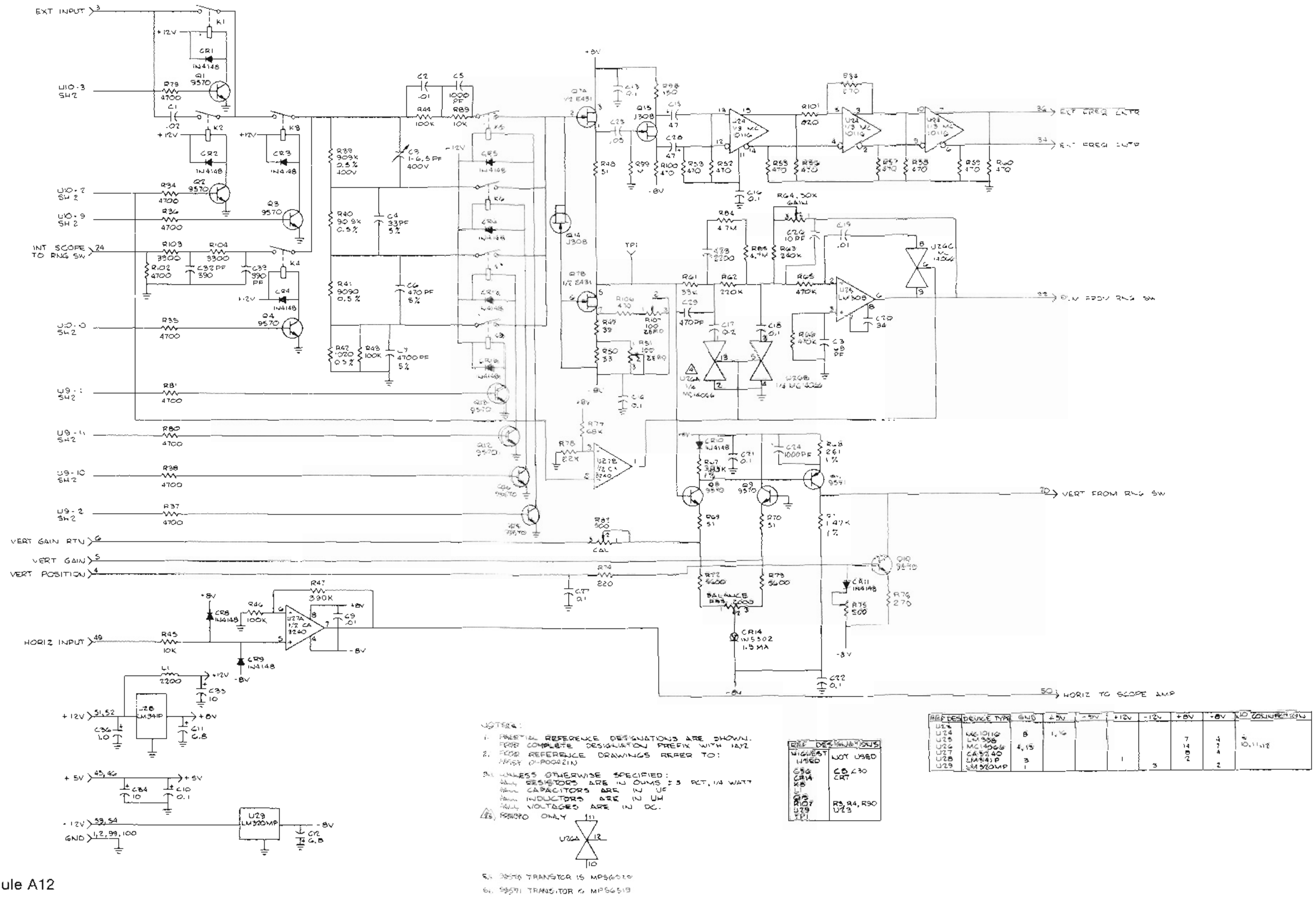


Figure 18-1. Front Panel Interface Module A12 Block Diagram



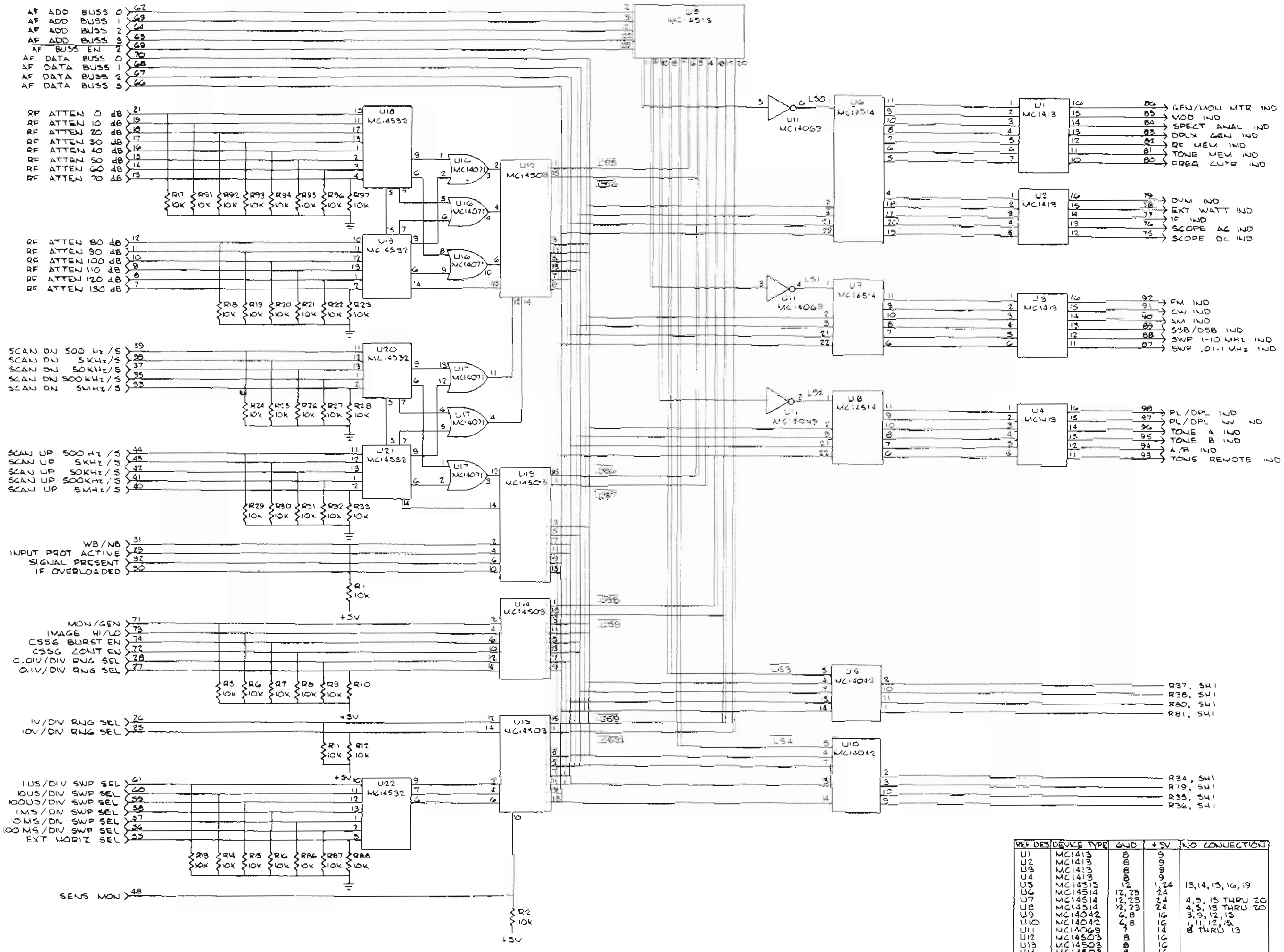
NOTES:

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH 1A12
2. FOR REFERENCE DRAWINGS REFER TO: ASSY 01-P00421N
3. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS ±5 PCT, 1/4 WATT
   ALL CAPACITORS ARE IN UF
   ALL INDUCTORS ARE IN UH
   ALL VOLTAGES ARE IN DC.
4. R6070 ONLY
5. 9570 TRANSISTOR IS MPS6520
6. 9571 TRANSISTOR IS MPS6519

REF DESIGNATIONS	
HIGHEST USED	NOT USED
C36	C8, C30
CR14	CR7
K5	
L1	
Q15	
R107	R3, R4, R90
U29	U23
TP1	

REF DES	DEVICE TYPE	GND	+5V	-5V	+12V	-12V	+8V	-8V	NO CONNECTION
U23									
U24	MC10116	8	1, 16						
U25	LM358						7	4	5
U26	MC14066	4, 15					14	7	10, 11, 12
U27	CA3240						8	4	
U28	LM341P	3			1		2		
U29	LM320MP	1				3		2	

Figure 18-2. Front Panel Interface Module A12 Schematic Diagram (Sheet 1 of 2) (RTL-4045A)



REF DES	DEVICE TYPE	GND	+5V	NO CONNECTION
U1	MC1413	8	9	
U2	MC1413	8	9	
U3	MC1413	8	9	
U4	MC1413	8	9	
U5	MC14515	12	1, 24	13, 14, 15, 16, 19
U6	MC14514	12, 23	24	
U7	MC14514	12, 23	24	4, 5, 13 THRU 20
U8	MC14514	12, 23	24	4, 5, 13 THRU 20
U9	MC14042	6, 8	16	3, 9, 12, 15
U10	MC14042	6, 8	16	1, 11, 12, 15
U11	MC14069	7	14	8 THRU 13
U12	MC14503	8	16	
U13	MC14503	8	16	
U14	MC14503	8	16	
U15	MC14503	8	16	
U16	MC14071	7	14	11, 12, 13
U17	MC14071	7	14	8, 9, 10
U18	MC14532	8	16	14, 15
U19	MC14532	3, 4, 8	5, 16	
U20	MC14532	3, 4, 8, 10	16	14, 15
U21	MC14532	3, 4, 8, 10	5, 16	
U22	MC14532	4, 8	3, 14, 16	15

Figure 18-2. Front Panel Interface Module A12 Schematic Diagram (Sheet 2 of 2) (RTL-4045A)

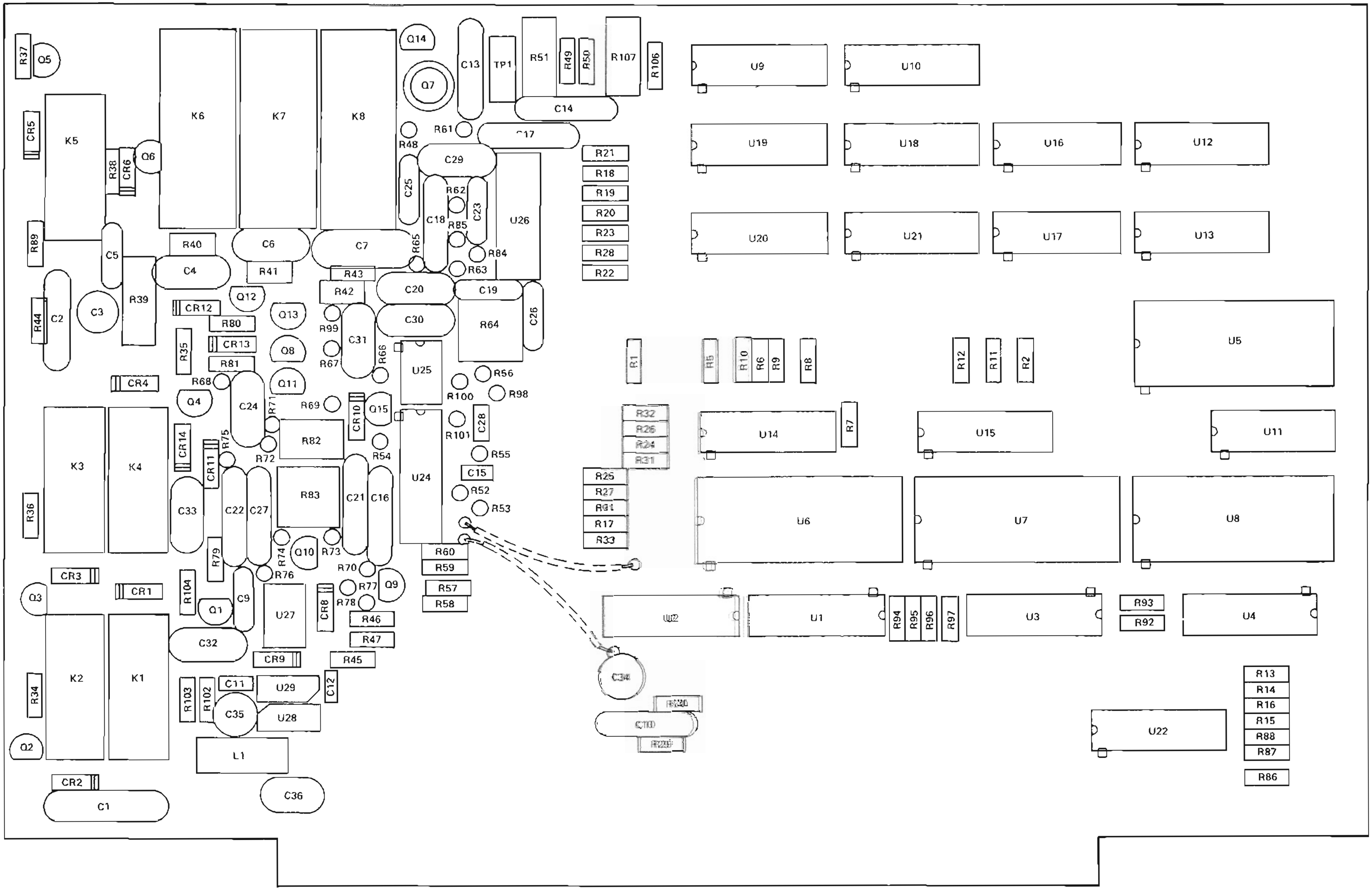


Figure 18-3. Front Panel Interface Module Parts Locator

SECTION 19

10 MHz FREQUENCY STANDARD MODULE (A13)

19-1. General. The frequency Standard Module provides a stable 10 MHz source and the interface for an external 10 MHz input. A block diagram of the Frequency Standard Module is shown in figure 19-1 with its schematic shown in figure 19-2.

19-2. 10 MHz Oscillator and Control. The internal 10 MHz source is either a temperature compensated crystal oscillator (TCXO) or an optional ovenized crystal oscillator (OVXO). A voltage regulator on the module supplies the voltage to the oscillator and monitors the supply current. For the ovenized option, at power on the oven draws high current. As the oven warms up the current decreases, reaching some low valve when the operating temperature has been reached. A current detector illuminates the oven ready indicator when the current has decreased to the stabilized valve. The indicator is continuously illuminated with the TCXO.

19-3. Internal/External Switchover. With no signal at the external 10 MHz input jack, the internal oscillator is gated to the SYNTH 10 MHz and the external 10 MHz OUT signal paths. When an external 10 MHz input is applied the switchover circuitry detects its presence, removes the power from the internal oscillator, and gates the external input to the SYNTH 10 MHz and external 10 MHz OUT signal paths. The oven ready indicator is extinguished when the system is operating from an external standard.

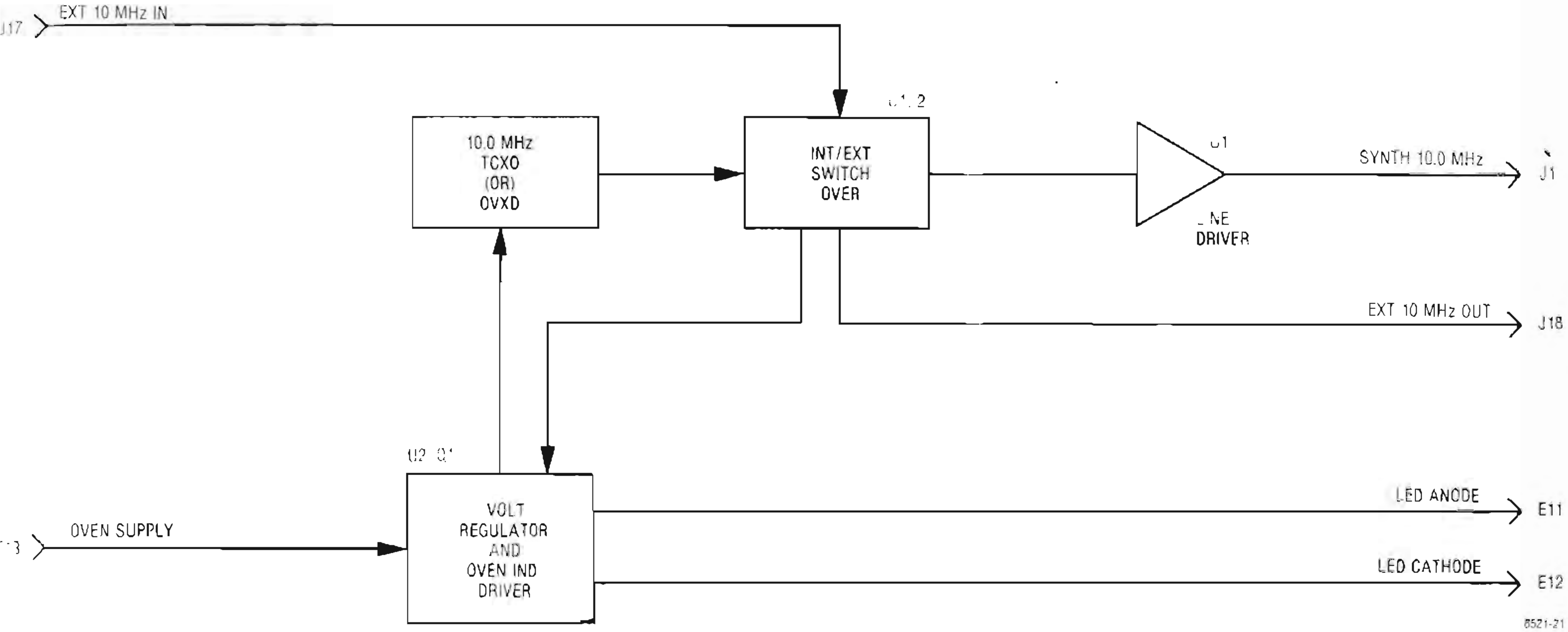


Figure 19-1. Frequency Standard Modu
Block Diagram

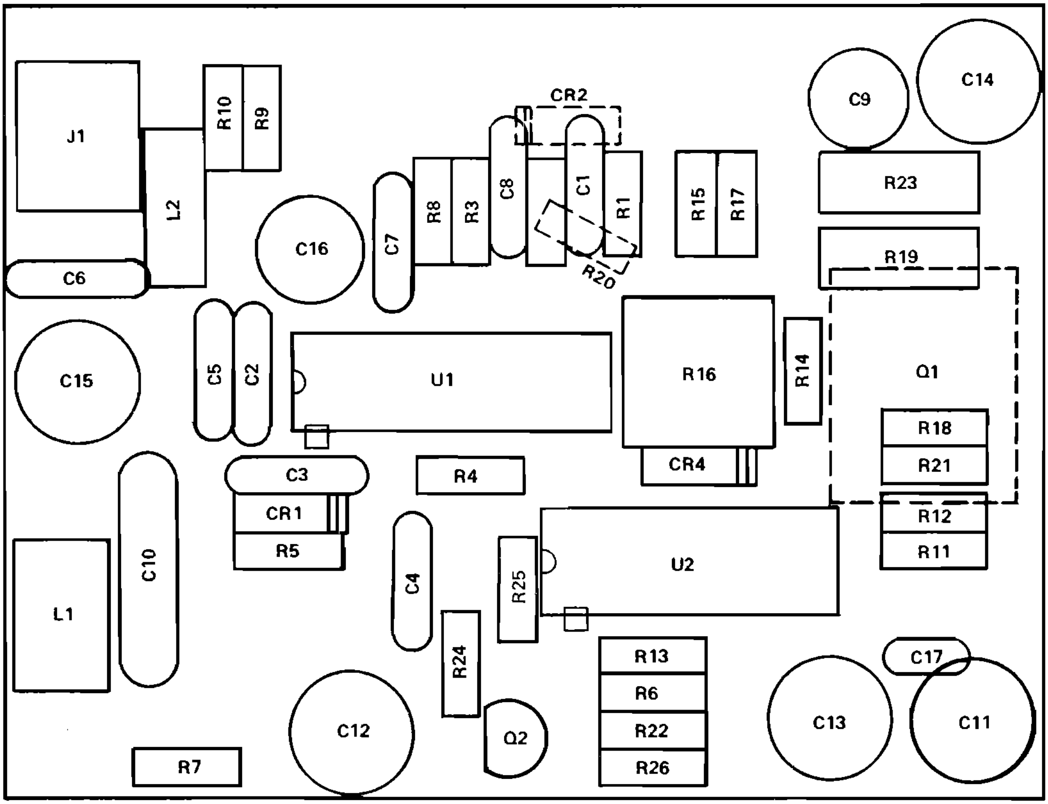
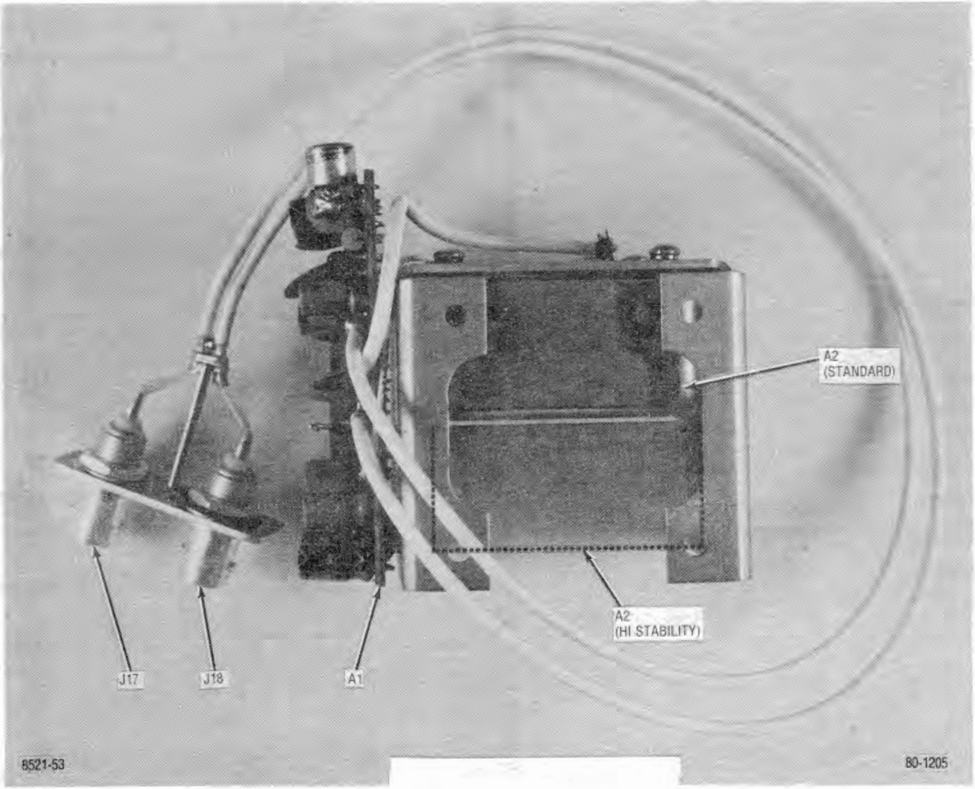


Figure 19-3. Frequency Standard Module Parts Locator


A2
(STANDARD)
A2
(HI STABILITY)
J17
J18
A1
8521-53
80-1205

NOTES

1. TOP ASSY A13 01-P00368N
   PWB ASSY A13A1 01-P00375N
   A13A2 OCXO 58-P00355N
   A13A2 TCXO 58-P00354N

⚠2 9570 IS 48-00869570

3. CAPACITORS ARE IN UF UNLESS NOTED
4. RESISTORS ARE 1/4 W UNLESS NOTED

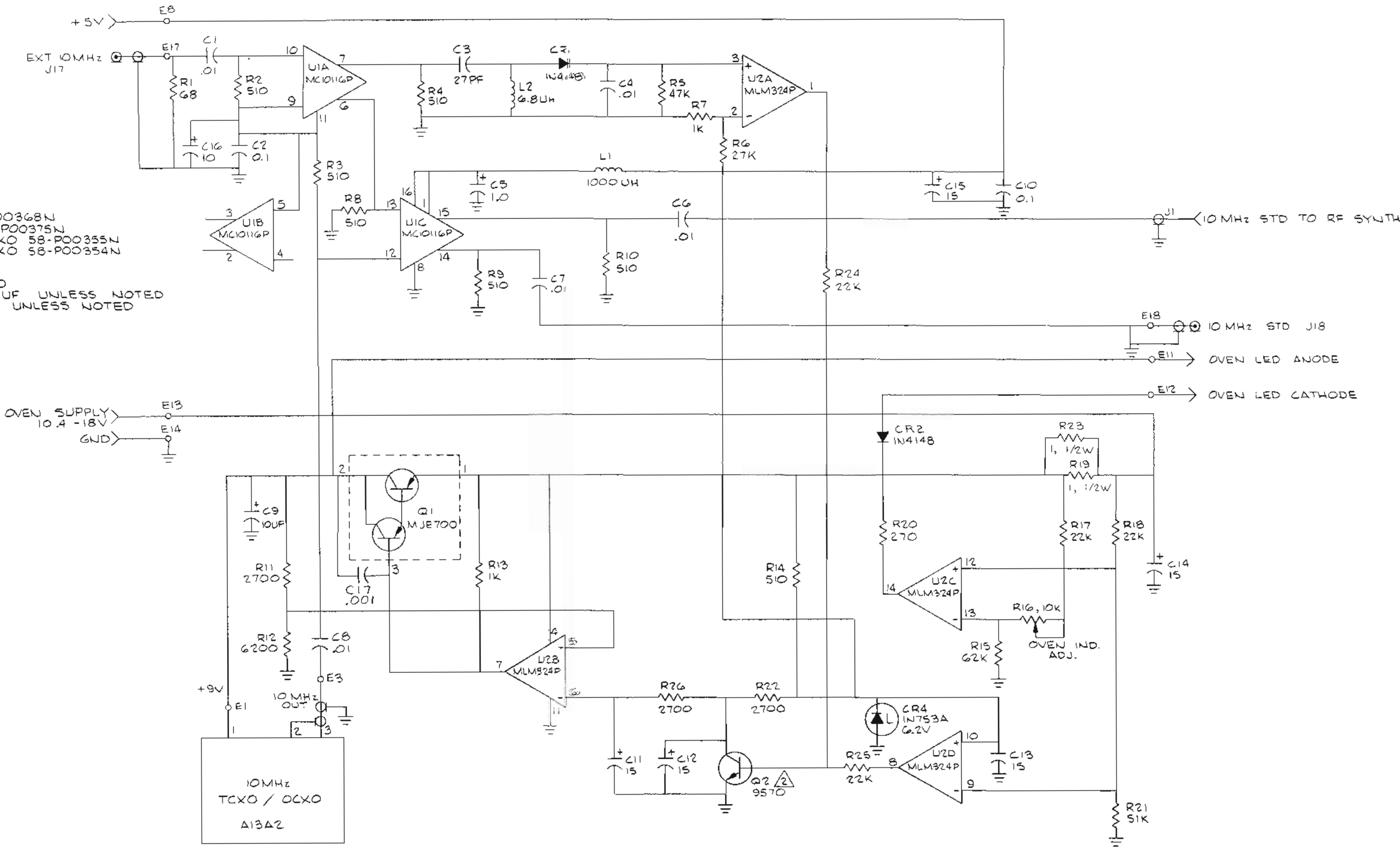
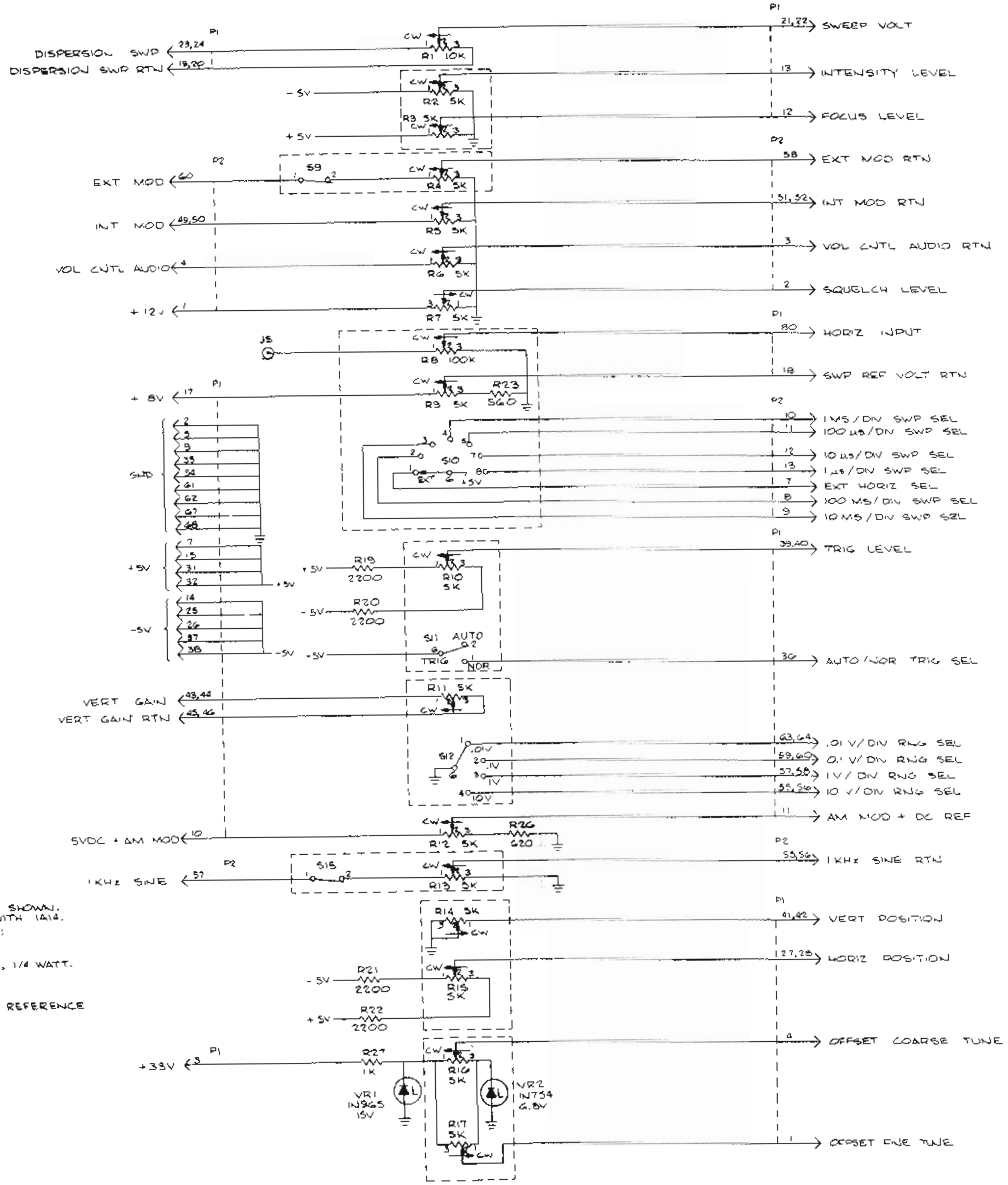


Figure 19-2. Frequency Standard Module A13 Schematic Diagram.
(RTL-1004A)



NOTES:

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH 1A14.
2. FOR REFERENCE DRAWINGS REFER TO: ASSY DRAWING 01-P00366N
3. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS ± 5 PCT, 1/4 WATT.
   ALL CAPACITORS ARE IN UF.
   ALL VOLTAGES ARE IN DC.

△4 APPLIES TO IEEE OPTION ONLY. FOR REFERENCE DRAWING SEE 01-P00366N002.

Figure 20-1. Front Panel A14
Schematic Diagram (Sheet 1 of 3)
(01-80304A42)

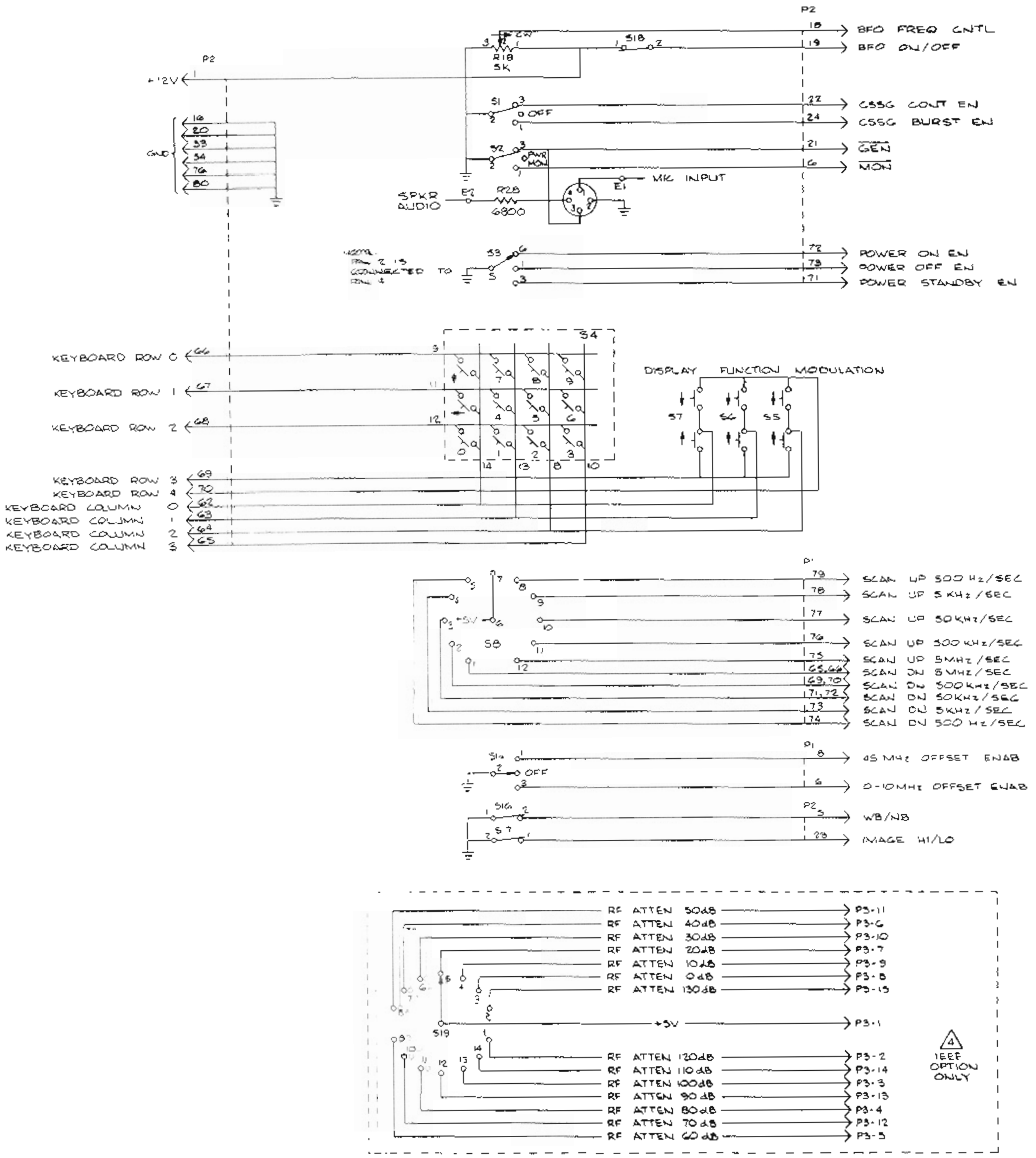


Figure 20-1. Front Panel A14
Schematic Diagram (Sheet 2 of 3)
(01-80304A42)

NOTES:
1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH 'A14A1
2. FOR REFERENCE DRAWINGS REFER TO: ASSEMBLY 01-P00206N
3. UNLESS OTHERWISE SPECIFIED.
ALL RESISTORS ARE IN UF
ALL VOLTAGES ARE IN DC.

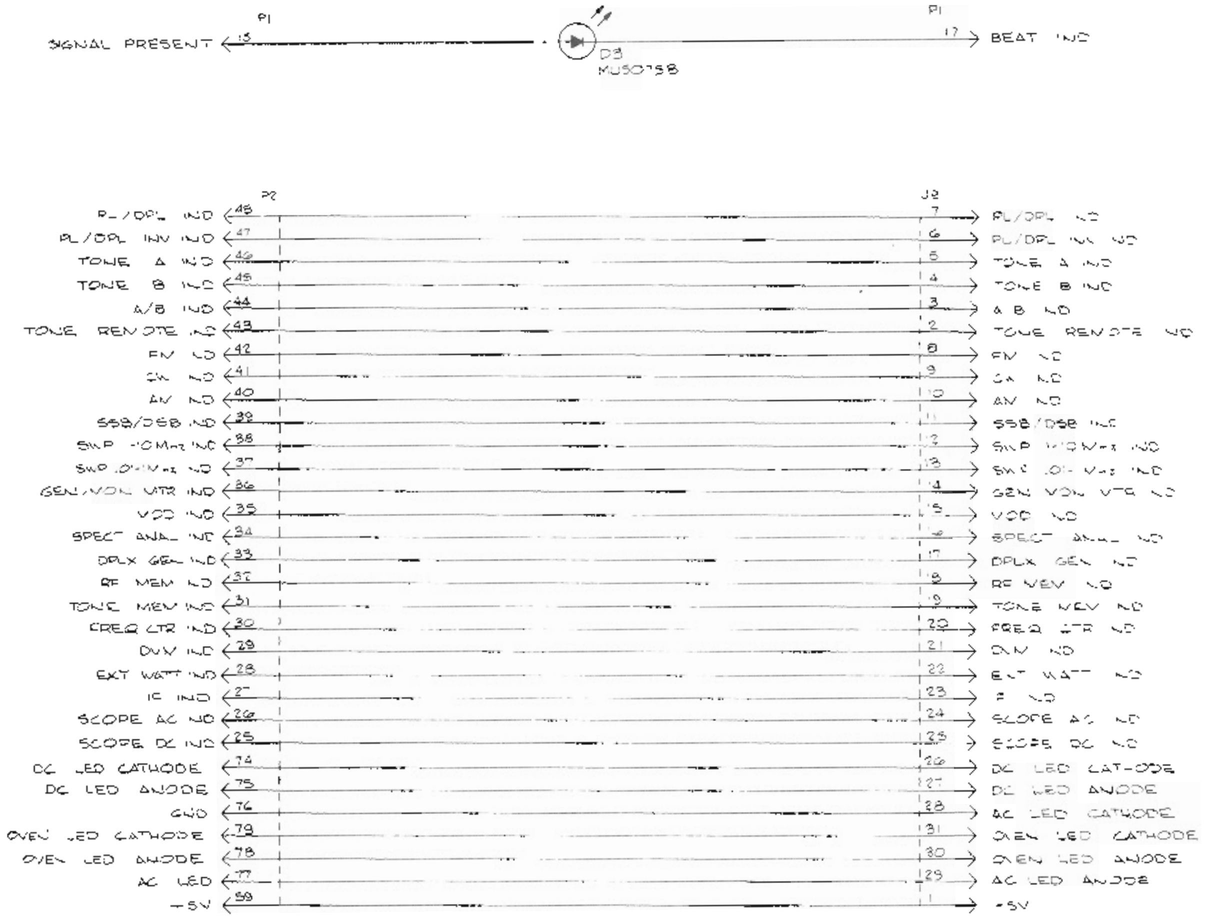


Figure 20-1. Front Panel A14
Schematic Diagram (Sheet 3 of 3)
(01-80304A42)

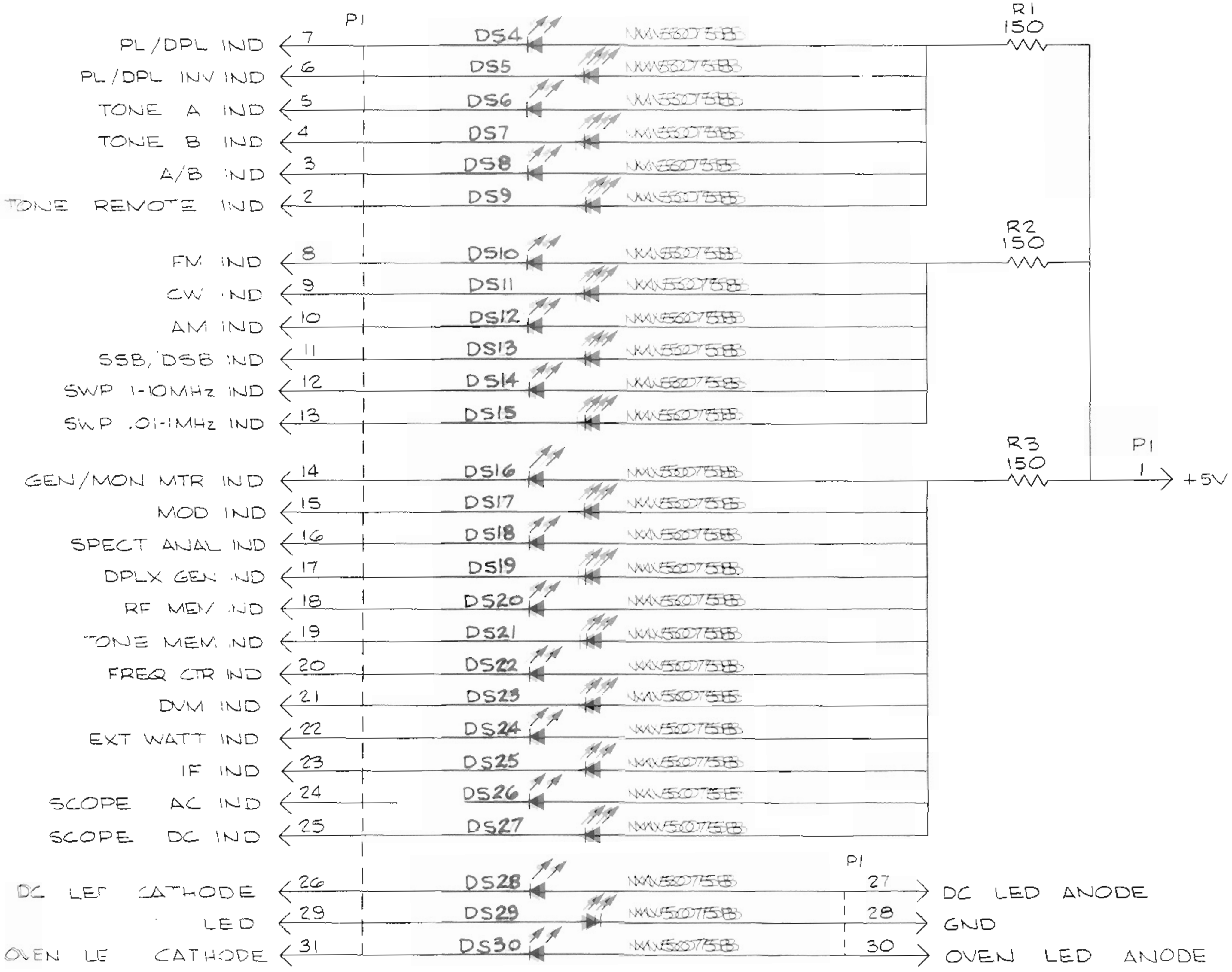


Figure 20-2. Display Board A14A1
Schematic Diagram
(01-80304A43)

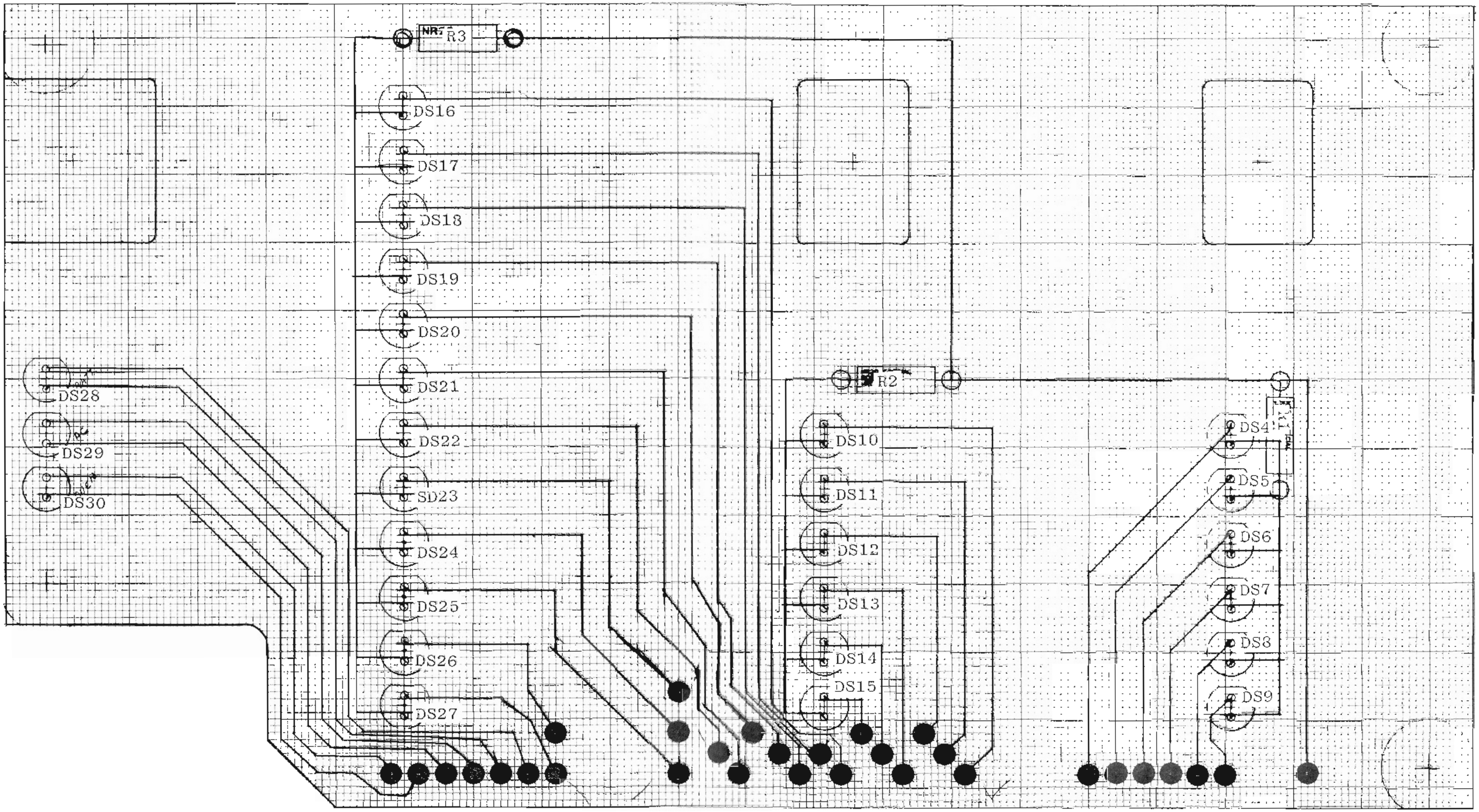
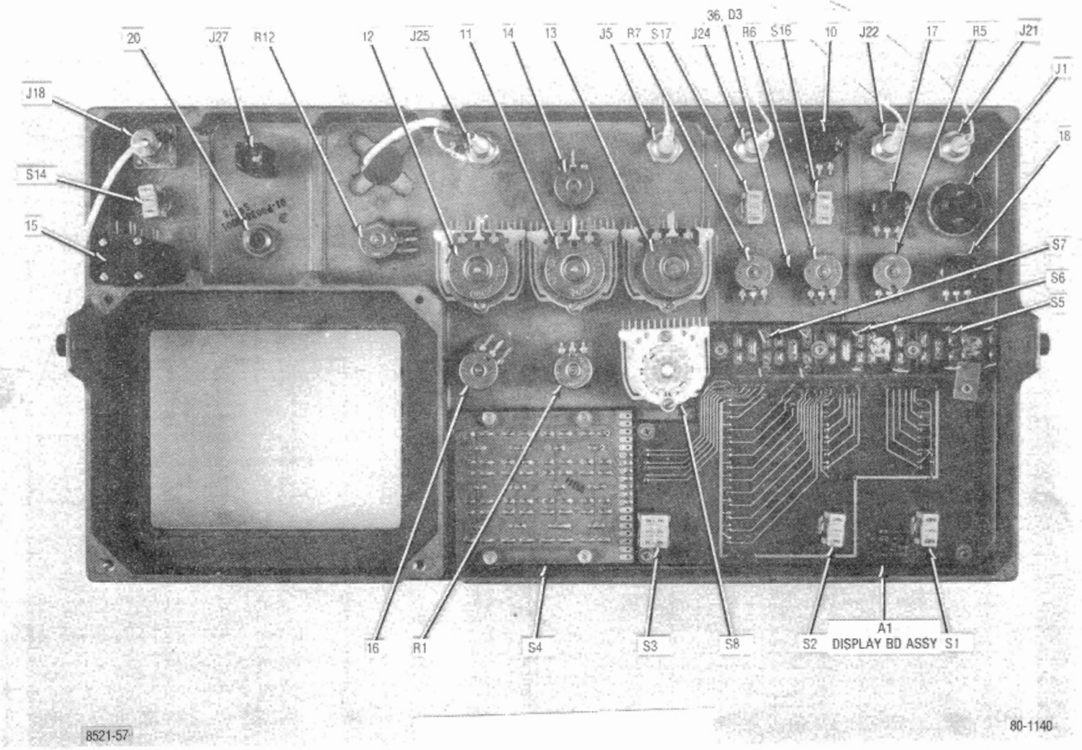
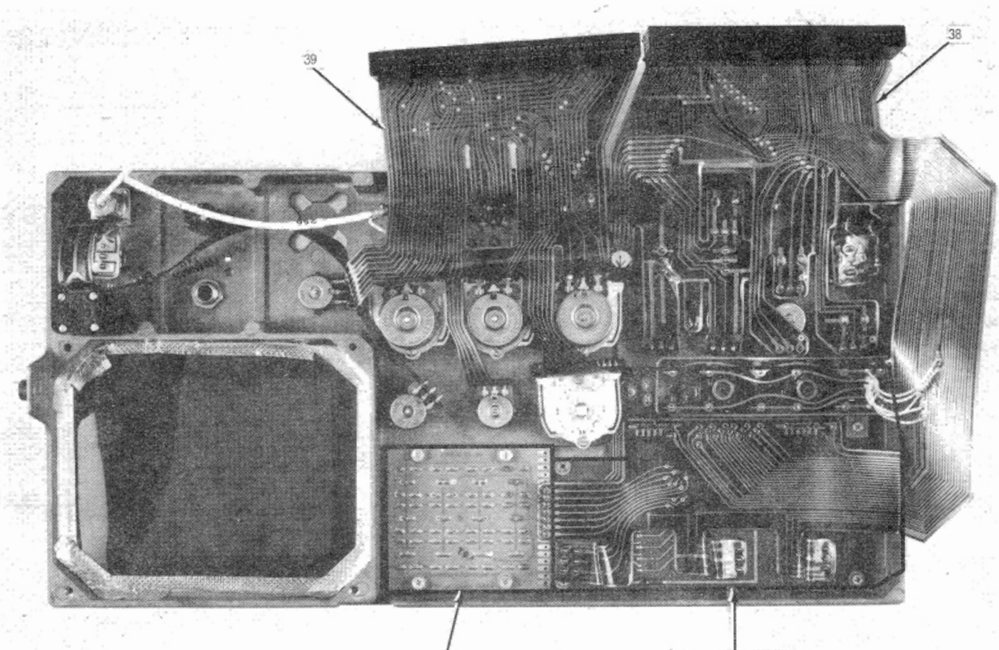
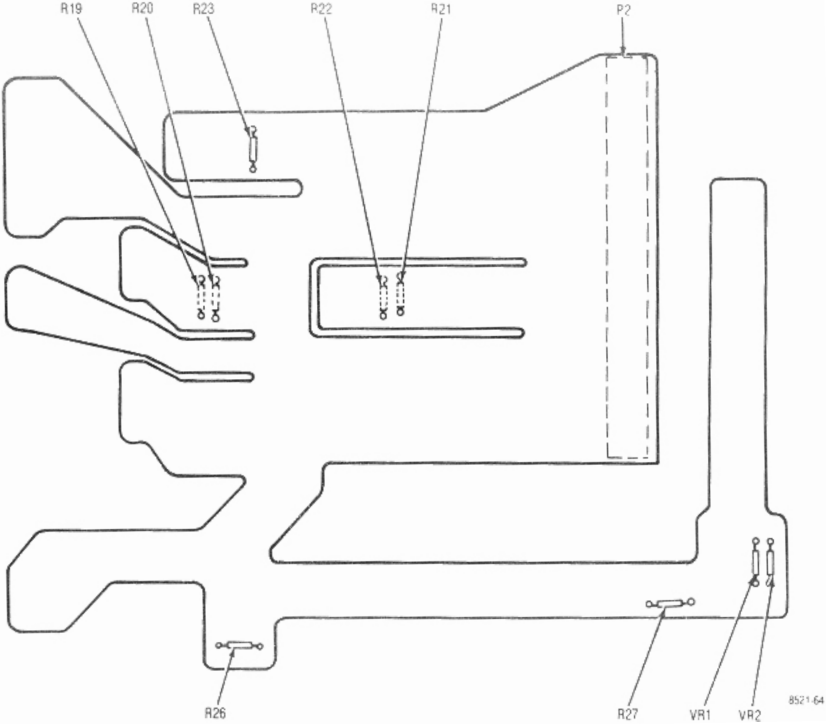


Figure 20-2. Display Board A14A1
Schematic Diagram
(01-80304A43)


20
J27
R12
12
J25
11
14
13
J5
R7
S17
J24
36, D3
R6
S16
10
J22
17
R5
J21
J1
18
J18
S14
15
S7
S6
S5
16
R1
S4
S3
S8
S2
A1
DISPLAY BD ASSY
S1
8521-57
80-1140

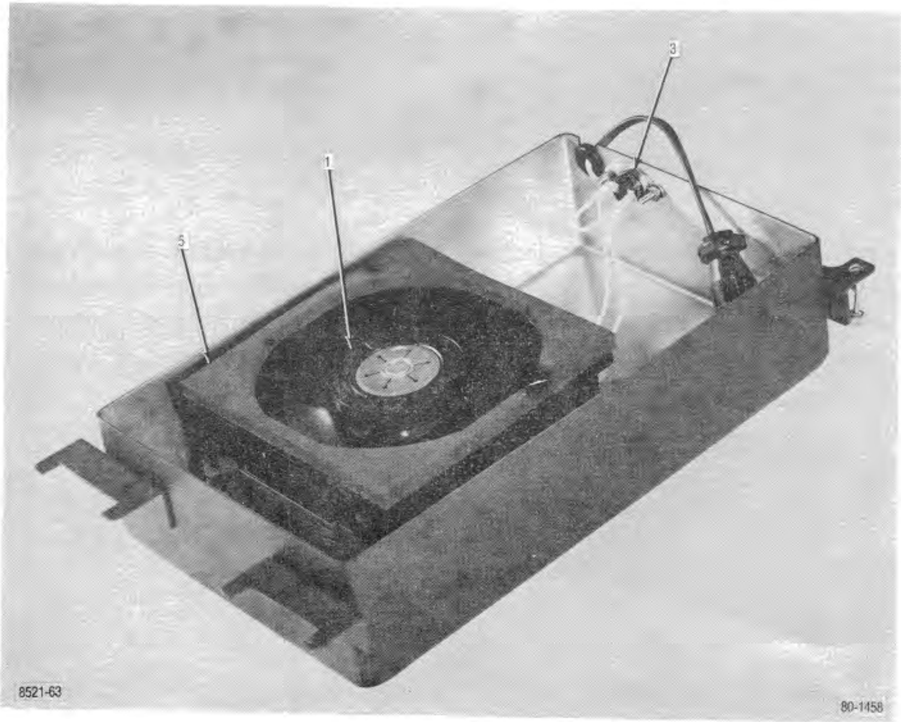

39
38
S4
A1 DISPLAY BOARD

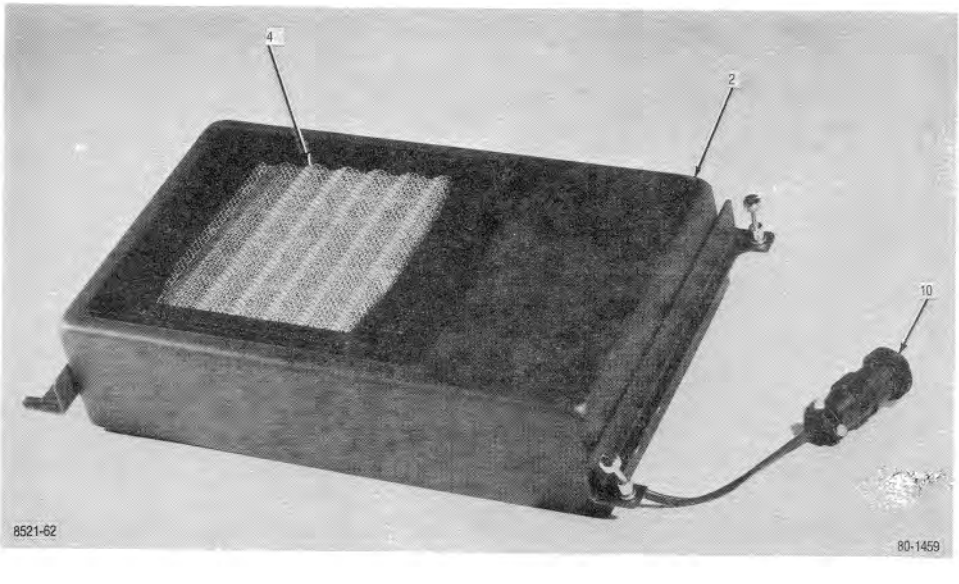

R19
R20
R23
R22
R21
P2
R26
R27
VR1
VR2
8521-64

SECTION 21

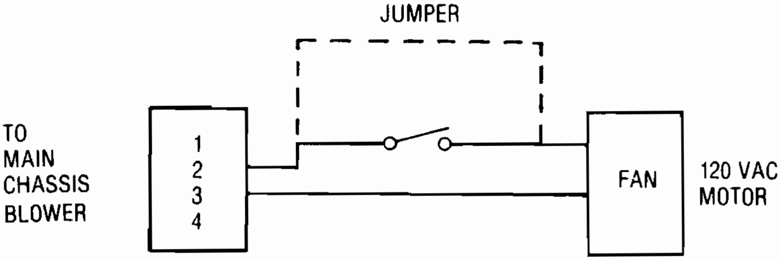
BLOWER ASSEMBLY (A15)

21-1. For continuous high ambient temperature operation or with the IEEE control option, the blower option provides additional cooling for the system. The blower as received from the factory will run whenever the unit is connected to the AC line. However, a jumper shorting out a thermostat in the blower assembly may be removed so that the fan only operates when high temperature conditions exist. A schematic of the Blower Assembly is shown in figure 21-1.


3
1
5
8521-63
80-1458


4
2
10
8521-62
80-1459

Find No.	Qty. Req.	Part Number	Nomenclature	Part Value
001	1	MU2A1	FAN	
002	1	15-P00257N001	CASE, HOUSING	
003	1	3450-87-239	THERMOSTAT	
004	1	477712	FILTER ASSY	
005	1	32-P06859R001	GASKET, BLOWER	
010	1	206429-1	CONNECTOR	



SECTION 22

IEEE — 488 BUS CONTROL

22-1. INTRODUCTION

22.2. The IEEE Interface Option enables the use of the Communications System Analyzer as a programmable measurement instrument. When combined with a suitable programmable controller and applications software, the major functions of the analyzer can be controlled or monitored via an IEEE-488 standard digital interface. Thus, repetitive test routines can be performed and the data recorded quickly and accurately with little operator interaction.

22-3. The interface characteristics conform to the specifications of the IEEE Standard Digital Interface for Programmable Instrumentation (IEEE Standard 488) which defines both the electrical and the mechanical interface. Control protocol is also defined by the specification. Control commands which are unique to the analyzer are described in detail in the following paragraphs of this section.

22-4. The controller for this application should be capable of reading and writing ASCII and control characters from and to the bus in accordance with the 488 specification. Application software is the user's responsibility as dictated by the controller selected, although interface and application assistance is available from Motorola.

22-5. The IEEE option package consists of an IEEE Interface module (A8) with a rear panel connector, an electrically programmable RF attenuator in place of the step attenuator on the RF Input Module (A11), a fourteen position rotary switch on the front panel in place of the step attenuator shaft, and one additional ROM memory IC on the Processor module (A9).

22-6. While in the local mode the IEEE-488 equiped system operates and performs the same as a standard system, except the maximum RF output level is reduced to +11 dBm from +13 dBm. However, when the Remote Enable (REN) line on the IEEE Bus is activated many of the front panel controls are disabled and their functions placed under bus control. Refer to table 22-1 for a listing of those functions which can be controlled or monitored via the 488 Bus.

Table 22-1. IEEE-488 Interface Controllable Functions

Control/Measurement	Comment
Function Switch	Generate/Power Monitor/ Monitor
Modulation Control	Continuous/OFF/BURST
Wideband/Narrowband Switch	
Image High/Low Switch	
Duplex Oscillator Switch	0-10 MHz/OFF/45 MHz
Keyboard	Numeric Entries 0-9. Can be transmitted to the bus.
Display Mode	Generate/Monitor Metering (Note: 1) Modulation Spectrum Analyzer Duplex Generator RF Memory Tone Memory Frequency Counter DVM External Wattmeter IF Scope AC Scope DC Remote Terminal Mode Unit can also display a subset of ASCII characters (numerals 0-9, upper case alpha letters A-Z, plus other symbols—ASCII characters 20 thru 5F Hexadecimal) enables display of operator messages on CRT display in a transparent terminal mode.
Function Mode	FM (Note: 1) CW AM SSB/DSB SWP 1-10 MHz SWP 0.01-1 MHz
Code Synthesizer Mode	PL/DPL PL/DPL Invert Tone A Tone B A/B Tone Remote

Control/Measurement	Comment
RF Frequency	Frequency entry to be supplied by program. Frequencies not available from memory table.
PL Frequency	
DPL Code	
Tone A Frequency	
Tone B Frequency	
Time Sequence Select	Sequences 1 through 5 only (Note: 2)
Wattmeter Element Select	
External Modulation	Modulation settable to any measurable level
Code Synthesizer Modulation	(0-20 KHz deviation in 10 Hz steps) (Note: 3) (0-90% AM in 0.1% steps)
RF level	RF level settable to any displayable level (-140 to +11 dBm in 0.1 dBm steps (Note: 3) (Note: 4)
Offset Oscillator Adjust	Duplex Generator Frequency Settable from f_0 to f_0 ±10 MHz in 1 KHz steps (Switch) placed in 0-10 MHz position) (Note: 3)
Scope Vertical Step Attenuator	0.01, 0.1, 1, 10 volts
Horizontal Scope Sweep	1, 10, 100 milliseconds 1, 10, 100 microseconds External
Input Power Meter	Reading returned as displayed on screen (Note: 3)
Frequency Error	
Deviation + or -	
% AM + or -	
SINAD	
External DVM (AC or DC)	
External Frequency Count	
External Power Meter FWD/REV	

Notes: (1) May be affected by other controls (see below).
(2) Sequence 5 timing is programmable under IEEE bus control.
(3) As reading is displayed, LED corresponding to appropriate display and function mode will illuminate.
(4) The IEEE-Bus option, due to a change in the RF step attenuator, restricts the maximum RF output to +11 dBm.

NON-CONTROLLABLE FUNCTIONS

Since control and monitor functions of the interface are implemented to obtain remote measurement capability, certain front panel controls are not implemented in the interface due to their local operator orientation. A list of these operator oriented controls are as follows:

- Power On/Off
- Power Mode Indicators
- Display Focus
- Display Intensity
- Dispersion/Sweep
- Scope/DVM Vertical Vernier
- Scope Trigger Level
- Scope Trigger Slope
- Scope Horizontal Sweep Vernier
- Scope Vertical Position
- Scope Horizontal Position
- Receiver Squelch
- Receiver Volume
- Zero Beat Indicator
- RF Scan
- RF Memory Table
- Tone Sequences, 6, 7, and 8 Entries
- Deviation Limit
- Battery Voltage Reading
- Deviation Limit Alarm (Disabled Under Remote Control)
- Attenuator 0 Indicator
- Battery Below Limit Warning
- BFO Frequency Adjust

8521-66

22-7. IEEE-488 BUS STRUCTURE

22-8. The following discussion briefly describes the 488 Bus operation. It is not a complete definition of the total bus structure or capability. For complete information a copy of IEEE Standard 488 should be obtained.

22-9. Bus Signals. The IEEE-488 Bus consists of 16 parallel lines. The lines are divided into three groups. Lines DI01-DI08, Data Input Output, form the 8-bit data bus for the bidirectional transfer of control and ASC II characters. Three handshake lines, Data Valid (DAV), Not Ready for Data (NRFD), and Not Data Accepted (NDAC), control the transfer of data on the data bus. The remaining five lines can be termed the bus management lines with functions as follows:

Attention (ATN) — When true the data bus carries an address or a comand when false it carries data.
Interface Clear (IFC) — When true all devices on the bus are placed in a known quiescent state.
Service Request (SRQ) — Indicates a device on the bus needs service.
Remote Enable (REN) — Enables the remote control feature of the devices on the bus.
End or Indentify (EOI) — Indicates the end of a multiple byte transfire.

22-10. Data Transfer. Each byte of data that is transferred across the data bus is synchronized with a handshaking procedure. This procedure allows devices with different data transfer rates to share the same bus. The handshake cycle starts when the source device which has data to transfer checks for a false condition on the NRFD line. When NRFD is false, all devices on the bus are ready to accept data. The source then puts the data onto the data bus and sets the DAV to its true state. The acceptor devices input the data, set the NRFD line to its true state, and when ready sets the NDAC line to its false state. Because the NRFD and NDAC lines are wire-ORed the line will not go to the false state until all devices on the bus have released the line. Thus the slowest device on the bus determines the transfer rate. When the NDAC line goes false the source devices sets the DAV false which in turn causes the acceptor devices to set the NDAC line true. When the acceptor devices have completed processing the data byte just received they allow the NRFD line to go to the false state completing the handshake. As the data transfer continues the cycle repeats for each data byte.

22-11. Bus Address. Each device on the bus is assigned a four bit address by the programer. The address assigned to the device is set by an address switch within the device. On the analyzer the address switch is on the IEEE Interface Module. Only the top four switches are used to set the address. The fifth switch is unused. To set the address use the binary equivalent of the address number and set the switches to the ON position for a logic 1. The least significant bit is the top switch.

22-12. Programing

22-13. Programing the system analyzer consists of first addressing the unit as a listener, transferring the control commands to the unit, and then sending a command termination sequence. To obtain data from the system, the pertinent control commands are first transferred to the unit and then the unit is addressed as a talker. As a talker the system outputs onto the bus the data requested by the control commands.

22-14. The bus controller is the central part of the automatic system. The program, consisting of sequences of analyzer control commands and sequences of controller instructions for handling the return data, is contained within the controller. The user must initially write the program so that the desired test sequences and data outputs will be obtained. The following paragraphs define the instruction set and data formats that can be used to control or will be returned from the system analyzer. The user must insure that the controller is compatible with the IEEE-488 Standard bus and that its program is correct for the instruments on the bus.

Table 22-3 Programming Commands

Prefix	Data	Units	Type	Function	Changes To Display	Changes To Function	Changes To Mode
AUDIO GENERATOR							
AA	0-9999.9	HZ	D	Tone A Frequency			
AB	0-9999.9	HZ	D	Tone B Frequency			
AP	0-999.9	HZ	D	PL Frequency			
AD	0-777	—	D	DPL Code			
AS	0-5	—	D	Audio Sequence Select			
AW	0-9.99	SEC	D	A ON, User Seq (AS=5)			
AX	0-9.99	SEC	D	A OFF, User Seq (AS=5)			
AY	0-9.99	SEC	D	B ON, User Seq. (AS=5)			
AZ	0-9.99	SEC	D	B OFF, User Seq. (AS=5)			
CONTROL							
CD	0-12	—	C	Display Select 0 Gen-Mon Mtr 1 Modulation 2 Spect Analyzer 3 Duplex Gen 4 RF Mem 5 Tone Mem 6 Freq Counter 7 DVM 8 Ext Wattmeter 9 IF 10 Scope AC 11 Scope DC 12 Terminal	1		
CF	0-5	—	C	Function Select 0 FM 1 CW 2 AM 3 SSB/DSBSC 4 SWP 1-10 MHz 5 SWP 0 01-1 MHz		1	
CG	—	—	C	Generate Mode			GEN
CM	—	—	C	Monitor Mode			MON
CP	—	—	C	Power Monitor Mode			PWR MON
FREQUENCY COUNTER							
FC	0-35000	kHz	O	External freq count	2		
GENERATE/MONITOR							
GF	0-999.9999	MHz	D	Generate/Monitor Frequency			
GL	-130.0 to +13 0	DBM	C	Generate RF Level			GEN
KEYBOARD							
K1	0-127	—	D	Display Up Key Data			
K2	0-127	—	D	Display Down Key Data			
K3	0-127	—	D	Function Up Key Data			
K4	0-127	—	D	Function Down Key Data			

Table 22-3. Programming Commands (Cont)

Prefix	Data	Units	Type	Function	Changes To Display	Changes To Function	Changes To Mode
K5	0-127	—	D	Mode Up Key Data			
K6	0-127	—	D	Mode Down Key Data			
MODULATION							
MB	—	—	C	Modulation Burst			
MC	—	—	C	Modulation Continuous			
MO	—	—	C	Modulation Off			
MM	0-5	—	C	Modulation Mode 0 PL/DPL 1 PL/DPL div 2 Tone A 3 Tone B 4 A/B 5 Tone Remote			
ME	0-99.9	kHz (FM) % (AM)	C	External Mod Level		3	GEN
MK	0-99.9	kHz (FM) % (AM)	C	1 kHz Mod Level		3	GEN
MS	0-99 9	kHz (FM) % (AM)	C	Code Synthesizer Mod Level	—	3	GEN
OSCILLOSCOPE							
OH	0-6	—	C	Horizontal Sweep Select 0 1 micro sec/div 1 10 micro sec/div 2 100 micro sec/div 3 1 milli sec/div 4 10 milli sec/div 5 100 milli sec/div 6 External			
OV	0-3	—	C	Vertical Gain Select 0 10 V/div 1 1 V/div 2 0.1 V/div 3 0 01 V/div			
RECEIVER							
RH	—	—	C	High Image			
RL	—	—	C	Low Image			
RN	—	—	C	Narrow band			
RW	—	—	C	Wide band			
RA	0-13	10's dB	C	Receive Mode Step Attenuator Setting 0 0 dB 1 10 dB 1 10 dB 1 10 dB 13 130 dB			
RE	0-100	—	O	Receive frequency error	4		MON

Table 22-3 Programming Commands (Cont)

Prefix	Data	Units	Type	Function	Changes To Display	Changes To Function	Changes To Mode
RP	0-1	—	O	Signal Presence Indication 0 No signal 1 Signal present			MON
R-	0-99 99	kHz	O	Minus Deviation	4	FM	MON
R+	0-99 99	kHz	O	Plus Deviation	4	FM	MON
R	0-99 99	%	O	Minus % AM	4	AM	MON
R	0-99 99	%	O	Plus % AM	4	AM	MON
VOLTMETER							
VA	0-300	VOLTS	O	DVM AC	5		
VD	0-300	VOLTS	O	DVM DC	5		
VS	0-40 0	dB	O	Sinad Reading	4	6	GEN
WATTMETER							
WE	1-9	—	D	Wattmeter element number 1 2 5 W 2 5 W 3 10 W 4 25 W 5 50 W 6 100 W 7 250 W 8 500 W 9 1000 W			
WI	0-132 0	WATTS	O	Internal Wattmeter reading	4		PWR MON
WF	0-1000	WATTS	O	Forward External Wattmeter Reading	7		
WR	0-1000	WATTS	O	Reverse External Wattmeter Reading	7		

Notes
1. Display is defined by the data
2. External Frequency Counter Display
3. FM if not AM
4. Gen/Mon Mtr Display
5. DVM Display
6. FM if in DSBSC or SWEEP
7. External Wattmeter Display

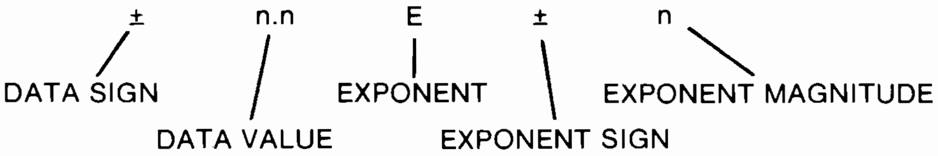
22-15. Command Structure. Each command consists of a two letter definition prefix followed by a numeric data field. The data field will vary in length and structure according to the definition prefix as shown in table 22-3. Spaces may be inserted anywhere in the command but are not required. Each letter or number of a command is transferred from the bus controller to the analyzer in ASCII format. ASCII defines a 7-bit digital code for each letter, number, and symbol commonly used in computer programming.

22-16. The first letter of the two letter prefix identifies a command category with the second letter identifying a particular command within that category. A listing of the command categories and the corresponding first letter is provided in table 22-2. A complete list of commands is shown in table 22-3.

Table 22-2. Command Categories

A	Audio Synthesizer
C	Control
F	Frequency Counter
G	Generate/Monitor Control
K	Keyboard
M	Modulation
O	Oscilliscope
R	Receiver
V	Voltmeter
W	Wattmeter

22-17. The data field is comprised of five sub-fields as shown:



Data limits and accompanying units are given in table 22-3. The data field is optional or not allowed for certain commands.

22-18. Data Sign. The data sign is a single '+' or '–' character indicating the sign of the data value. The sign may be omitted for positive value data.

22-19. Data Value. The data value field is restricted to the numbers '0' through '9' and '.'. A maximum of five digits to the right and to the left of the decimal point are allowed. The decimal point can be omitted for integer values. If the value field is omitted, it is assumed to be zero.

22-20. Exponent. The presence of the "E" character in the exponent field indicates that the data value is to be multiplied by 10 raised to the power following the "E" character. If the "E" is omitted the exponent is assumed to be 10^0 or 1.

22-21. Exponent Sign. The exponent sign is a single + or – character and can be omitted for positive exponent values.

22-22. Exponent Magnitude. The exponent magnitude is a single character 0 through 9. If the exponent magnitude is omitted, it is assumed to be zero.

22-23. The following are examples of correct data fields for the value 12.34:

0.1234 E+2	+0.1234 E2	1234 E-2	1234. E-2
+12.34	12.34 E	+1234 E-2	12.34 E0

22-24. Command Strings. A command string consists of either a single command or multiple commands in succession with or without embedded spaces. A command string must be terminated with a carriage return and a line feed character.

22-25. Command Types. Each command is one of three basic types, control selects (C), data entry (D), and output requests (O). Type information for each command is listed in table 22-3.

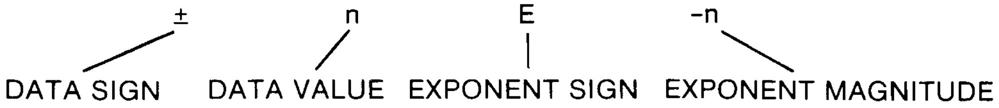
22-26. Control Selects. Control select commands select front panel switch settings. Some of these commands do not require accompanying data, such as toggle switch commands.

22-27. Data Entry. Data entry commands replace manual entry of data through the keyboard. All of these commands require data in the data field.

22-28. Output Requests. Output request commands allow data that is normally displayed on the CRT to be transferred to the controller. Accompanying data is not required with output requests. The data limits and units listed in table 22-3 for these commands refer to the return data. Output request commands cause the analyzer to go to the proper display, function, and mode to acquire the designated reading. These states are listed in table 22-3. The measurement however, is not made until a trigger command 'T' has been sent from the controller. The trigger command causes the measurement to be made and the data held for transmission to the controller. Then when the controller addresses the analyzer as a talker the data is output to the controller. A reading can be retaken for any number of triggers without repeating the output request. The request is lost however, when any command changing the display, function, or mode is sent.

22-29. Trigger Command. The trigger command is the exception to the two character command prefix. This command is simply the letter 'T' usually sent immediately following the output request command. If no output request is pending, the trigger command is ignored.

22-30. Return Data. The data returned from the analyzer is formatted similar to the control data as shown:



The data is always returned in this format with a single exception. Data for the "RP", signal present, command is returned as a single digit having a value of "0" or "1".

22-31. Data Sign. A + or - character indicates the sign of the return data.

22-32. Data Value. The data value is 1 to 5 digits in length with leading zero supression and no decimal point.

22-33. Exponent and Exponent Sign. The letter 'E' followed by a '-' character is always transmitted with return data.

22-34. Exponent Magnitude. The exponent magnitude is a single digit with a value from 0 to 9. The digit indicates the negative power of ten that is to be multiplied with the data value to obtain the units listed in table 22-3.

22-35. Programming Commands. Table 22-3 lists the programming commands available for the system analyzer. The table identifies the category and type of command, the data limits and units, the command function, and any display, function, or mode change that would occur.

22-36. Terminal Mode. When the command 'CD12' is used, the system terminal mode is enabled. The terminal mode allows the analyzer's CRT display and keyboard to perform as a limited function I/O terminal. Possible uses for the terminal mode would be to provide test instructions to a test operator at an auto test station.

22-37. Display Format. Once the 'CD12' command has been sent the terminal mode has been entered. All further ASCII valid characters sent from the controller will appear on the CRT display. The total display area on the CRT is 15 lines of 30 characters each. Character entry on the CRT is on the bottom line. Each line feed character causes the bottom line to move up one place. If more than 30 lines are entered, the top lines are lost off the top of the display. A list of valid ASCII characters for the display is provided in table 22-4. All invalid characters are ignored in the terminal mode.

22-38. Keyboard Entry. In the terminal mode the keyboards on the analyzer may be used to input data to the bus controller. The ten numeric keys and the left cursor key have predefined ASC II characters. The character corresponds to the number on the key for the numeric keys. For the left cursor key, carriage return and line feed characters are sent. The down cursor key causes a bus service request to be generated regardless of the operating mode. Thus this key could be used to halt an automatic test sequence.

22-39. The remaining pushbuttons are defined, prior to entering the terminal mode, with the use of the keyboard control commands listed in table 22-3. Each key is assigned an ASCII character by following the Kn command prefix with the decimal equivalent of the binary ASCII code for that character. A list of valid ASCII characters and their binary and decimal equivalents are listed in table 22-4.

22-40. Data that is entered from the keyboard is stored in a 9 character buffer until addressed by the bus controller. If more than 9 keypresses occur before the controller accesses the analyzer, the excess inputs are lost. Once the controller has addressed the analyzer, the analyzer transmits the character data to the controller. The analyzer will continue to transmit, or hold up the bus handshake if no keys have been pressed, until the left cursor key is pressed. Thus every data string entry from the keyboard must terminate with the left cursor key. As the data is transmitted to the controller it is also entered onto the CRT display.

22-41. Terminal Mode Exit. An ASCII end of transmission character (EOT) sent from the controller will terminate the terminal mode. When the mode is terminated the analyzer returns to the Gen/Mon Mtr display, and is ready to accept new command inputs.

22-42. Error Messages. Error messages are generated by the analyzer to help the programmer troubleshoot his program. As control commands are received by the analyzer, they are decoded to determine the command sent. If the analyzer is unable to decode the command it generates an error message and ignores all succeeding commands. To clear the error condition the bus controller must address the analyzer as a talker so that the error message will be transferred to the controller.

Table 22-4. Terminal Mode ASC II Characters
Printable Characters

	Equivalent				Equivalent		
ASCII Char.	Binary	Hex	Dec	ASCII Char.	Binary	Hex	Dec
SP	00100000	20	32	@	01000000	40	64
!	00100001	21	33	A	01000001	41	65
"	00100010	22	34	B	01000010	42	66
#	00100011	23	35	C	01000011	43	67
$	00100100	24	36	D	01000100	44	68
%	00100101	25	37	E	01000101	45	69
&	00100110	26	38	F	01000110	46	70
'	00100111	27	39	G	01000111	47	71
(	00101000	28	40	H	01001000	48	72
)	00101001	29	41	I	01001001	49	73
*	00101010	2A	42	J	01001010	4A	74
+	00101011	2B	43	K	01001011	4B	75
,	00101100	2C	44	L	01001100	4C	76
-	00101101	2D	45	M	01001101	4D	77
.	00101110	2E	46	N	01001110	4E	78
/	00101111	2F	47	O	01001111	4F	79
0	00110000	30	48	P	01010000	50	80
1	00110001	31	49	Q	01010001	51	81
2	00110010	32	50	R	01010010	52	82
3	00110011	33	51	S	01010011	53	83
4	00110100	34	52	T	01010100	54	84
5	00110101	35	53	U	01010101	55	85
6	00110110	36	54	V	01010110	56	86
7	00110111	37	55	W	01010111	57	87
8	00111000	38	56	X	01011000	58	88
9	00111001	39	57	Y	01011001	59	89
:	00111010	3A	58	Z	01011010	5A	90
;	00111011	3B	59	[	01011011	5B	91
[illegible]	00111100	3C	60		01011100	5C	92
=	00111101	3D	61	]	01011101	5D	93
	00111110	3E	62		01011110	5E	94
?	00111111	3F	63	-	01011111	5F	95

NON-PRINTING CHARACTERS

	Equivalent		
ASCII Char.	Binary	Hex	Dec
EOT*	00000100	04	4
BELL	00000111	07	7
BSP	00001000	08	8
LF	00001010	0A	10
CR	00001101	0D	13

*causes exit from terminal mode

22-43. The format of the error message is:

ERROR nn (CR)(LF)

The two digit number nn defines the error condition as listed in table 22-5. The carriage return (CR) and line feed (LF) characters are the termination sequence used by analyzer whenever it transmitts information. All characters are ASC II coded.

Table 22-5. Error Messages

Error Code	Condition
00	Data requested without trigger
01	Involid mnemonic prefix
02	One character mnemonic (not T)
03	Invalid mnemonic suffix
04	Exponent overflow
05	Data underflow
06	Data overflow
07	Data transmitted, not allowed
08	Invalid data
09	RF input power exceeded
10	Level or mod control error

22-44. To effectively utilize the error message capability of the analyzer it is necessary to address the unit as a talker after the transmission of each command string. The bus controller must then be programmed to recognize the error message and to decode the error number. A successful data transmission will send back an error code 00 when addressed as a talker. The controller should be programmed to ignore error 00 and to display any other error to the operator. Of course if a valid output command followed by the trigger command was sent, the talker address will result in the requested data being output to the controller.

22-45. Service Requests. There are only two conditions that will cause the analyzer to generate a service request (SRQ) on the bus. If a SRQ is generated it must be cleared by a serial poll of the analyzer. The serial poll is a bus command which results in a data byte being sent to the controller from the analyzer. The data byte indicates the cause of the SRQ. Table 22-6 lists the SRQ causes and the corresponding serial poll data.

Table 22-6. SRQ Data

	Return Data		
Condition	Binary	HEX	DEC
Depressing Cursor Down Key	01000001	41	65
RF load over Temperature	01000010	42	66

22-46. Programming Considerations. The flexibility of the IEEE-488 option is reflected in the number of programming commands. To use these effectively and efficiently, certain programming practices should be followed. The following paragraphs present the major considerations for effective programming.

22-47. Generate Mode. For accurate level control it is best to specify the generate frequency prior to the RF output level. For example, the command string:

```
CGGFIOOGL5
```

sets the generate mode, a frequency of 100 MHz and an output level of +5 dBm.

22-48. Code Synthesizer. Before enabling the output of the code synthesizer with an MS, ME, or MK command, all the necessary parameters must first be defined. Table 22-7 lists the modes and their controlled parameters that need to be defined. It should be noted that these parameters do not need to be defined each time a mode is selected, only when they are to be changed for that mode.

Table 22-7. Code Synthesizer Programming Considerations

Output	Command String	Effect
DPL Code	CF0AD131MM0MS3	FM, DPL Code 131, 3 kHz FM
DPL Inverted Code	CFAD313MM1MS5	FM, DPL Code 313, 5 kHz FM
PL Code	CF2AP60.5MMMS30	AM, PL-60.5 Hz, 30% AM
Tone A	CFAA2E3MM2MS3	FM, 2000 Hz, 3 kHz FM
Tone B	CFAB2000MM3MS3	FM, 2000 Hz, 3 kHz FM
Tone Remote	CFAA1.5E3AB300MM5MS3	FM, A = 1500 Hz, B = 300 Hz, 3 kHz FM
A/B Standard Sequence	CFAS4AA1E3AB2E3MM4MS3	FM, Sequence 4, A = 1 kHz, B = 2 kHz, 3 kHz FM
A/B User Sequence	CFAS5AA1E3AB2E3AW1 AX1AY1AZ1MM4MS3	FM, Sequence 5, A = 1 kHz, B = 2 kHz 1 sec on/off times, 3 kHz FM

22-49. Modulation. The system analyzer is capable of modulating with three simultaneous sources. The commands ME, MK, and MS only affect their individual portion of the total output. Thus to avoid inadvertently having an unwanted modulation source enabled it is recommended that all three source values be defined together. For example;

```
CFMKMSME20
```

selects the FM mode, disables the 1 kHz and code synthesizer modulation, and set 20 kHz deviation from the external input. The external input must be applied to the analyzer prior to sending this command.

22-50. For the generate AM mode the frequency and output level must be defined prior to selecting the modulation level. The following command string is of the proper sequence to obtain 30% AM at 100 Mz with a level of -100 dBm:

```
CGGF100GL-100MEMSMK30
```

22-51. The bandwidth control commands, RN and RW, range the generate FM modulator sensitivity. For greater resolution and faster set up time for deviations less than 20 kHz use the narrowband 'RN' command. Above 20 kHz deviation the wideband 'RW' command must be used.

22-52. Measurements. To obtain correct monitor mode data it is necessary to first set the frequency, bandwidth, and image prior to making the reading. Thus, it is a good practice to always place the request for a reading as the last command in the string. For example the command string:

```
CMRNRHGF95.5RET
```

selects the monitor mode, narrowband, high image, and 95.5 MHz center frequency. The 'RET' command asks for a frequency error reading and triggers the analyzer so that the reading will be made.

22-53. General. Overall, programming the analyzer involves the same steps as are involved when using it manually. A program can be fairly easily obtained by first performing the desired test sequence manually noting each time a setting is changed and a reading made. The program is then simply a duplication of the manual steps with control commands substituted.

22-54. R2002A Analyzer Configuration

The R2002A analyzer differs in configuration from the standard R2001A in the following manner:

A11 Module: The manual attenuator AT1 is replaced with a programmable version (P/N RTL-4064A). A new ribbon cable assembly connected to the A8 module provides control signals for the attenuator. The module is reidentified for ordering purposes as RTC-1003A.

A9 Module: Additional memory for the IEEE program is added by adding U36 (E-PROM TMS 25L32).

Front Panel Assembly A14: Rotary switch S19 is added for control of the RF Input/Output level. The switch P/N is 40-P04127T001.

Module A8 is added to the analyzer (see Section 14 for details). Ribbon cable assembly 30-P04147T001 is added from the A8 module to the rear panel of the analyzer to provide I/O signals.

The R2002A also contains blower assembly A15 for additional cooling (see Section 21).

MOTOROLA INC.
Communications
Group

MOTOROLA BATTERY PACK

MODEL RTP-1002A

1. DESCRIPTION

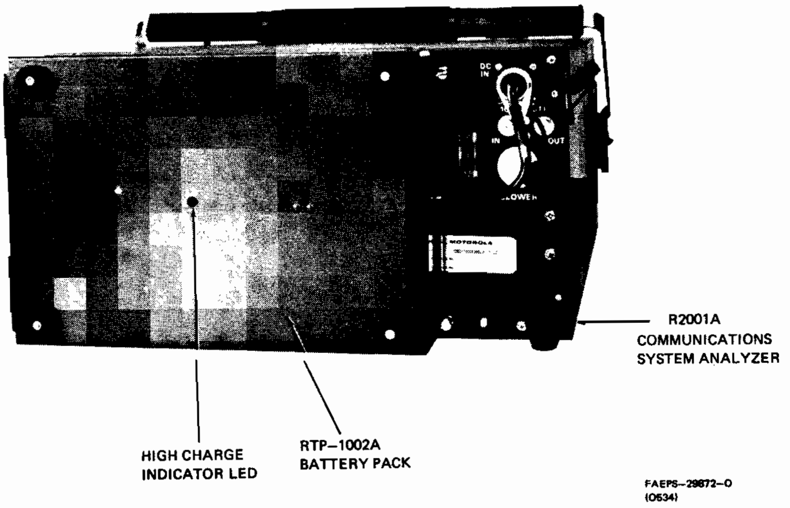
The RTP-1002A is a battery pack and charger designed to be mounted to the back of the R-2001A Communications System Analyzer. The unit contains battery capacity to operate the R-2001A for approximately one hour. A constant current charging system is capable of recharging the batteries in 16 hours.

2. OPERATION

2.1 The RTP-1002A Battery Pack is automatically engaged when no ac power is present, and the power switch is either in the ON or STANDBY positions. When ac power is applied, the R-2001A automatically switches the RTP-1002A Battery Pack out of the circuit and draws its power from the ac power source.

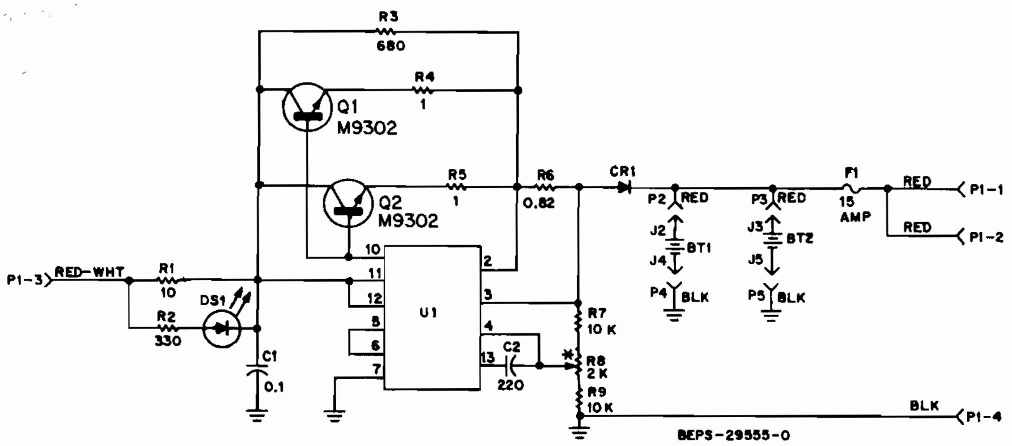
2.2 When the power switch is in the OFF or STANDBY position and ac power is applied to the R-2001A, the RTP-1002A Battery Pack draws dc current from the R-2001A to activate the charging circuit. The charging circuit delivers approximately 750 mA of current until the battery voltage reaches 14 volts. As the battery voltage reaches 14 volts, the current drops to approximately 25 mA and the high-charge indicator LED extinguishes.

2.3 When the R-2001A systems analyzer is used with the RTP-1002A Battery Pack, it is recommended to keep the power switch in the STANDBY position whenever possible. This extends the time the battery is able to operate the R-2001A Communications System Analyzer. The low trickle charge rate enables the batteries to be left on charge indefinitely without damage due to overcharging.

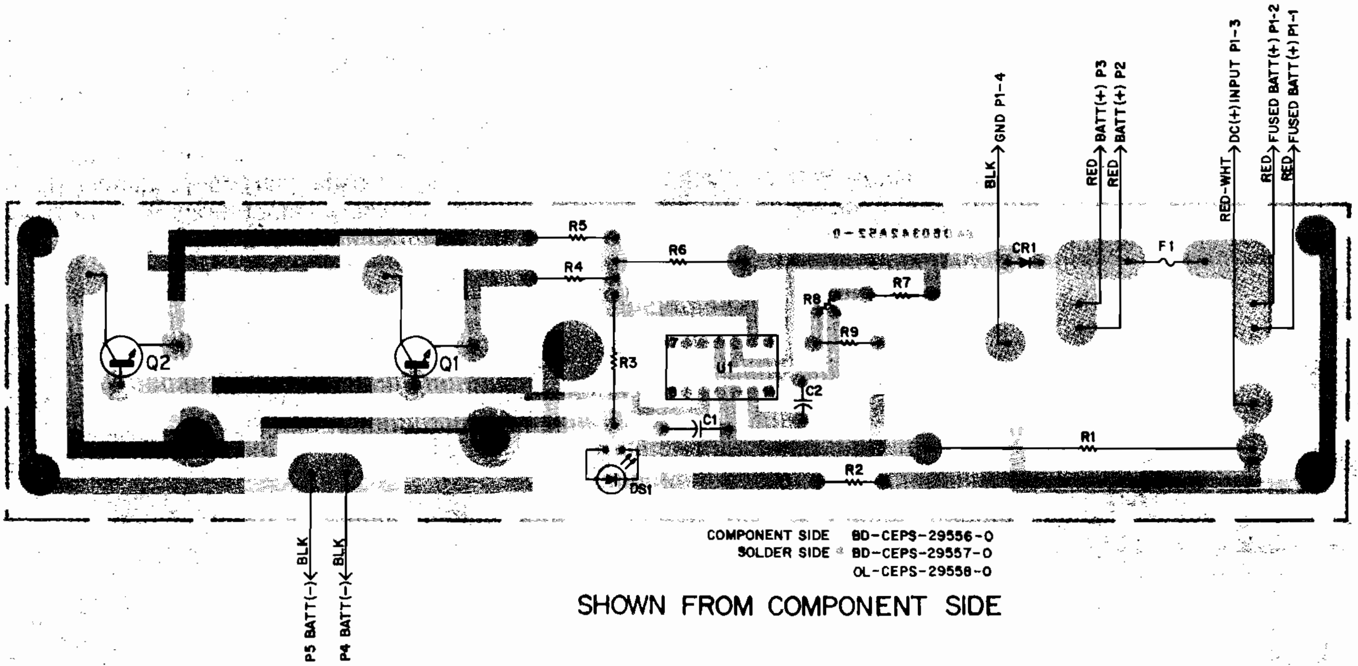


RTP-1002A Battery Pack Mounting Detail

technical writing services
1301 E. Algonquin Road, Schaumburg, Il. 60196



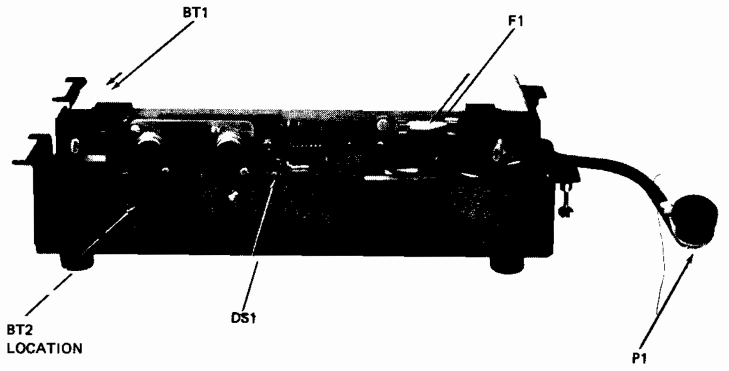
* WITH THE BATTERIES REMOVED (BT1 AND BT2) AND A 30–OHM; 10 WATT RESISTOR IN PLACE OF THE BATTERIES, SET R8 FOR 14.1 V USING A DIGITAL VOLTMETER ACROSS THE BATTERY TERMINALS.



COMPONENT SIDE BD-CEPS-29556-0
SOLDER SIDE BD-CEPS-29557-0
OL-CEPS-29558-0

SHOWN FROM COMPONENT SIDE

RTP-1002A Battery Pack
Schematic Diagram, Circuit Board Detail,
Parts Location Detail, and Parts List
Motorola No. ***PEPS-29554-O***
(Sheet 1 of 2)
3/24/80-SK



FAEPS–29873–O
(R534)

RTP-1002A Battery Pack Parts Location Detail

parts list

RTP-1002A Battery Pack PL-6816-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		battery, 12 V:
BT1, 2	60-80340A88	6-cell
		capacitor, fixed:
C1	8-82096J18	.1 uF ± 10%; 250 V
C2	21-83596E10	220 pF ± 20%; 500 V
		diode: (see note)
CR1	48-82525G01	silicon
		light emitting diode:
DS1	48-82019L05	LED
		fuse:
F1	65-804906	15A slow blow
		transistor: (see note)
Q1, 2	48-869302	NPN; type M9302
		resistor, fixed: ± 10%; 1/4 W: unless otherwise stated
R1	17-80344A60	10; 10 W
R2	6-124C37	330
R3	6-126C45	680; 1 W
R4, 5	6-125B70	1 ± 5%; 1/2 W
R6	17-80344A70	0.82; 2 W
R7	6-124A73	10k ± 5%
R8	18-80342A10	variable: 2k ± 20%; 1/2 W
R9	6-124A73	10k ± 5%
		integrated circuit: (see note)
U1	51-84320A42	MC1723CL

note: For optimum performance, replacement diodes, transistors and integrated circuits must be ordered by Motorola part numbers.

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		non-referenced items
	1-80304A71	BATTERY CASE includes:
	27-80335A41	CASE, battery
	3-80340A89	SCREW, captive: 6-32 x 21/32"; 2 used
	41-80342A53	SPRING, clip
	15-80340A92	COVER, battery case
	1-80304A72	CIRCUIT BOARD ASSEMBLY includes:
	42-82690A01	CLIP, fuseholder: 2 used
	43-865080	STANDOFF, threaded: 4 used
	1-80304A73	LEAD ASSEMBLY, battery (red) includes:
	30-10310A26	WIRE, No. 16 stranded: 4-1/2" used
	29-859118	CONTACT, receptacle
	1-80304A74	LEAD ASSEMBLY, battery (black) includes:
	10-134301	WIRE, No. 16 stranded: 4-1/2" used
	29-859118	CONTACT, receptacle
	3-120938	SCREW, machine: 4-40 x 5/16"; 4 used
	4-7667	WASHER, lcok: No. 4 external tooth; 4 used
	64-80342A54	PLATE, heatsink
	1-80303A91	CABLE ASSEMBLY includes:
	15-10811A08	HOUSING, connector: 4-pin
	9-83741F01	CONTACT, receptacle: 4 used
	42-80340A90	CLAMP, cable
	2-2888	NUT, hex: 5/8-24
	2-7005	NUT, hex: 6-32; 4 used
	4-7666	WASHER, lock: No. 6 external tooth; 4 used
	14-80340A91	INSULATOR BOARD
	75-82566B01	FOOT, rubber: 4 used
	3-80342A46	SCREW, machine: 6-32 x 1/2"; 4 used
	3-136774	SCREW, machine: 4-40 x 1/4"; 5 used
	3-132840	SCREW, machine: 8-32 x 5/8"; 2 used
	4-7667	WASHER, lock: No. 4 external tooth; 5 used
	42-850925	CLAMP

RTP-1002A Battery Pack
Schematic Diagram, Circuit Board Detail,
Parts Location Detail, and Parts List
Motorola No. PEPS-29554-O
(Sheet 2 of 2)
3/24/80-SK

Attention ROBERT

Regards, Jane [illegible]

SECTION 3.
ALIGNMENT PROCEDURE

3.1 INTRODUCTION

This section provides a basic (paragraph 3.2) and an extended (paragraph 3.3) alignment procedure. The basic procedure, which should accompany any service work, requires only a calibrated oscilloscope. The extended procedure, which should be performed at nominal [illegible] intervals, requires the oscillo[illegible] [illegible], a calibrated digital voltme[illegible] [illegible] as listed in Table 3-2. All adjustmen[illegible] [illegible]d in this procedure should be performe[illegible] [illegible] module test fixtures only.

3.1.1 TES[illegible] REQUIRED

Th[illegible] the test equipment liste[illegible] The a[illegible] equipment required [illegible] [illegible] listed in Table 3-2.

[illegible] Equipment Required

[illegible]	Model
[illegible]	Motorola ~~[illegible]~~ R1029B

*An R2001 is [illegible] substitute.

Table 3-2. Extended Test Equipment Required

Description	Model R1029B
*Oscilloscope	Motorola ~~[illegible]~~
*Digital Voltmeter	Motorola R1039A
*RF Signal Generator	Motorola R1040A
*Modulation Meter MARCONI	Boonton 82AD
[illegible] R102	Motorola S1067
[illegible] Test Cover	Motorola
Extender Card Set	Motorola

*An R2001 is a suitable substitute for these separate equipments.

3.1.2 PREPARATION FOR ALIGNMENT

1. Perform all alignments at normal ambient temperature.
2. Remove the top cover of the unit to be aligned.
3. Turn on the unit to be aligned, allowing a warmup time of 15 minutes before starting alignment.

3.2 BASIC ALIGNMENT PROCEDURE

3.2.1 CRT INTENSITY BIAS

1. Select Scope DC display and Ext Horiz input mode on the System Analyzer. 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 because it will leave a permanent burn in the phosphor.

2. Adjust the Intensity Bias potentiometer on the Scope Amplifier board (Figure 3-1) until a dot appears on the screen. You may have to use the Vertical and Horizontal position control (Vert, Horiz) on the front panel to bring the dot onto the screen. Then back off the Intensity Bias potentiometer until the dot just disappears.

3.2.2 CRT INTENSITY BALANCE

3.2.2 CRT INTENSITY BALANCE

1. Select Scope DC display and a horizontal sweep rate of 1 mSec/Div on the System Analyzer. Set the horizontal timebase vernier to calibrate (Cal) and adjust the Intensity control for a barely visible horizontal line on the CRT.
2. Adjust the Intensity Balance potentiometer (Figure 3-1) for uniform intensity of the horizontal trace from left to right. The Balance potentiometer affects the intensity on the left side of the trace.

3.2.3 CRT ASTIGMATISM AND GEOMETRY

1. Select Monitor function and Gen/Mon Mtr display on the System Analyzer. 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 3-1) for the best focus at the outer edges of the CRT with minimum pincushion and barrel distortion of the display. The two adjustments are interactive; to get the best display, alternate repeated small adjustments between the two

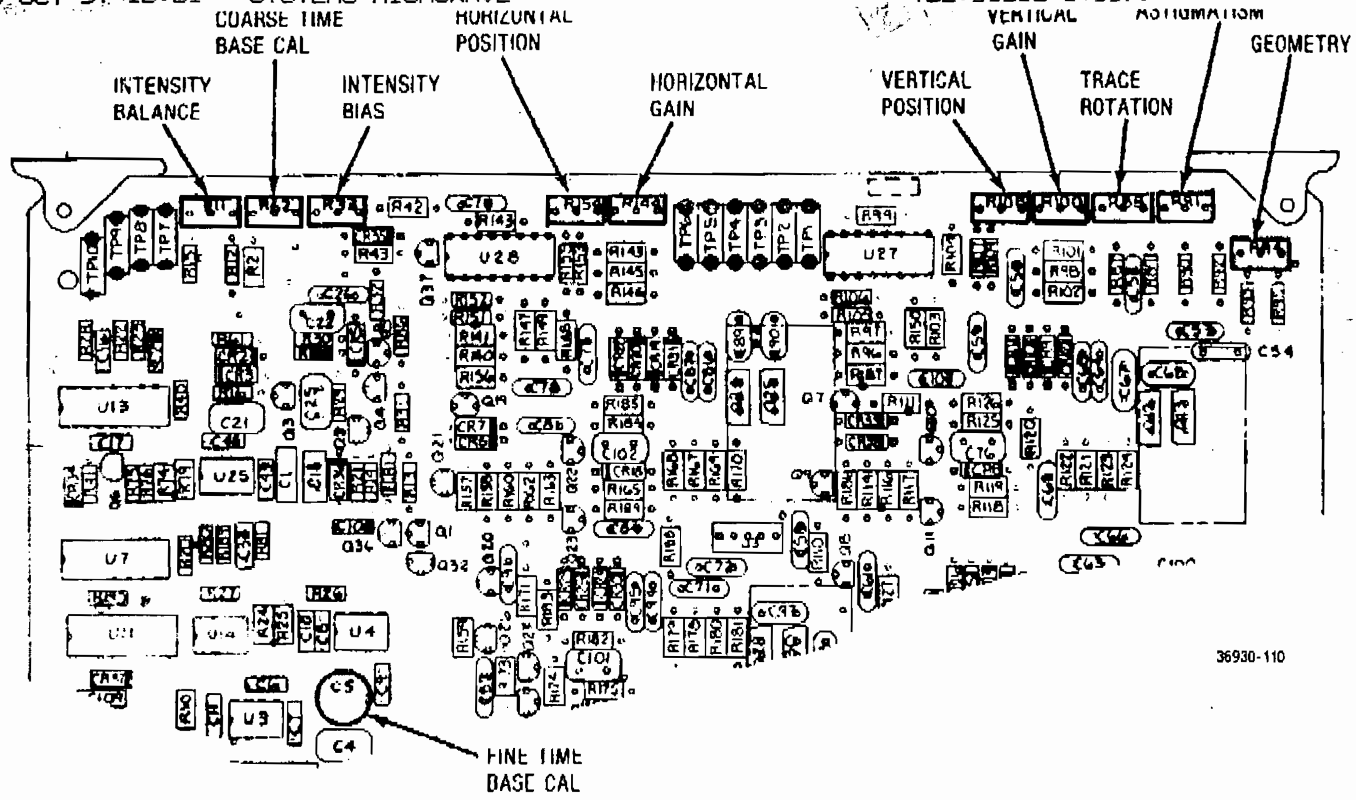


Figure 3-1. Scope Amplifier Board (A2) - Alignment Points

VERTICAL CENTERING AND TRACE ROTATION

1. Select Gen/Mon Mtr display. Adjust the Intensity control for a comfortable viewing brightness.
2. With the Test-Point Shorting Jumper, connect TP1 of the Scope Amplifier board (Figure 3-1) to chassis ground.
3. Adjust the Trace Rotation potentiometer (Figure 3-1) to make the horizontal trace on the CRT perpendicular to the graticule center line.
4. Adjust the Vertical Position potentiometer (Figure 3-1) so that the horizontal trace on the CRT passes through the graticule center point.
5. Adjust the Trace Rotation potentiometer (Figure 3-1) to align the horizontal trace on the CRT behind the horizontal graticule line.
6. Remove the jumper from TP1.

3.2.5 CRT HORIZONTAL CENTERING

1. Select Gen/Mon Mtr display. Adjust the Intensity control for a comfortable viewing brightness.
2. With the Test-Point Shorting Jumper, connect TP6 of the Scope Amplifier board (Figure 3-1) to chassis ground.
3. Adjust the Horizontal Position potentiometer (Figure 3-1) so that the vertical trace on the CRT passes through the graticule center point.
4. Remove the jumper from TP6.

3.2.6 CRT HORIZONTAL GAIN

1. Connect the Mod Out port to the Ext Horiz port on the System Analyzer's front panel.
2. Select Generate FM function and Scope DC display. Set the Horiz control for external horizontal input (Ext). Turn the Code Synthesizer and the Ext Level control OFF, and the 1 KHz Level control up about half way.
3. Connect an oscilloscope with a calibrated vertical input to TP6 on the Scope Amplifier board (Figure 3-1).
4. Using the front panel's horizontal vernier control, adjust for a 3 Vp-p amplitude on the sinewave at TP6.
5. With 3 Vp-p at TP6, adjust the Horizontal Gain potentiometer (Figure 3-1) for a CRT horizontal trace of 6 cm. (Use the front panel controls to position the trace at a convenient place near the center of the CRT.)

3.2.7 CRT VERTICAL GAIN

1. Connect the Mod Out port to the vertical input port (Vert In) on the System Analyzer's front panel.
2. Select Generate FM function and Scope DC display. Set the Horiz control for a sweep rate of 1 mSec/Div and the horizontal vernier to Cal. Set the Vert control for an input sensitivity of 1V/Div and the vertical vernier to Cal.
3. Turn the Code Synthesizer and the Ext Level control OFF, and the 1 KHz Level control up about half way.
4. Connect an oscilloscope with a calibrated vertical

3.2.8 VERTICAL INPUT GAIN

1. Select Generate FM function and Scope DC display. Set the Horiz control for a sweep rate of 1 mSec/Div and the horizontal vernier to Cal. Set the Vert control for an input sensitivity of 1V/Div, and the vertical vernier to Cal.
2. Connect an oscilloscope with a calibrated vertical input to the Mod Out port on the front panel.
3. Turn the Code Synthesizer and the Ext Level control OFF and adjust the 1 KHz Level control for a 6 Vp-p sinewave on the attached oscilloscope.
4. Disconnect the oscilloscope from the Mod Out port and connect the Mod Out port to the Vert input port

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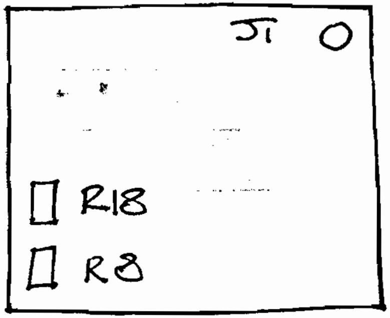
MOTOROLA (EDDIE AMOFA): 01256- 484657
SYSTEMS MICROWAVE (DAVE RAISIN): 01252- 376396

TxCO CONTROL BOARD



J1 10 MHz O/P
R18 O/P LEVEL (1·2 V pp)
R8 OVEN SENSITIVITY.

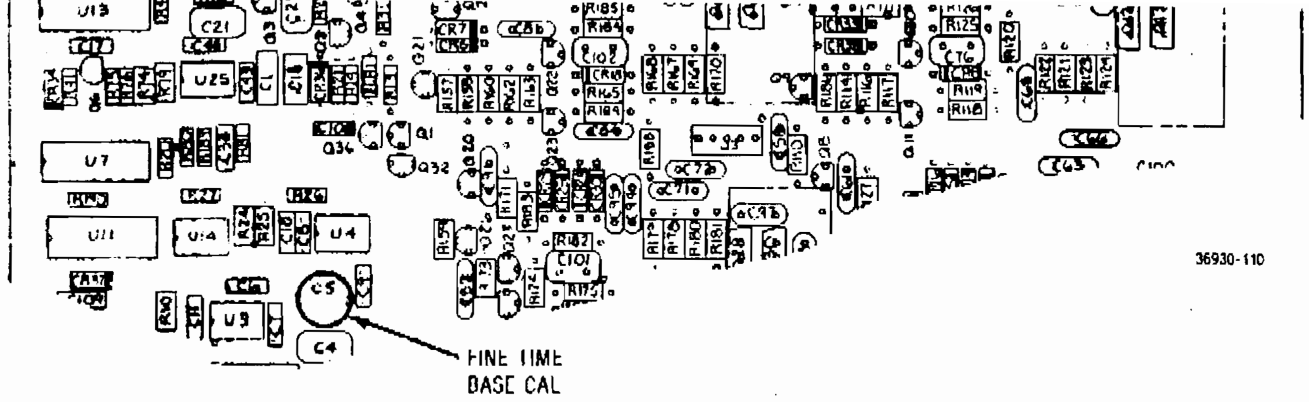


Figure 3-1. Scope Amplifier Board (A2) – Alignment Points

VERTICAL CENTERING AND TRACE ROTATION

1. Select Gen/Mon Mtr display. Adjust the Intensity control [illegible] comfortable viewing brightness.
2. With [illegible] Point Shorting Jumper, connect TP1 on the Scope Amplifier board (Figure 3-1) to chassis ground.
3. Adjust the Trace Rotation potentiometer (Figure 3-1) to make the horizontal trace on the CRT perpendicular to the graticule center line.
4. Adjust the Vertical Position potentiometer (Figure 3-1) so that the horizontal trace on the CRT passes through the graticule [illegible] point.
5. [illegible] the Trace R[illegible] potentiometer (Figure [illegible] to align the horizontal trace on the CRT behind the horizontal graticule line.
6. Remove the jumper from TP1.

3.2.5 CRT HORIZONTAL CENTERING

1. Select Gen/Mon Mtr display. Adjust the Intensity control for a comfort[illegible] viewing brightness.
2. With the Test-Point Shorting Jumper, connect TP6 of the Scope Amplifier board (Figure 3-1) to chassis ground.
3. Adjust the Horizontal Position potentiometer (Figure 3-1) so that the vertical trace on the CRT passes through the graticule center point.
4. Remove the jumper from TP6.

3.2.6 CRT HORIZONTAL GAIN

1. Connect the Mod Out port to the Ext Horiz port on the System Analyzer's front panel.
2. Select Generate FM function and Scope DC display. Set the Horiz control for external horizontal input (Ext). Turn the Code Synthesizer and the Ext Level control OFF, and the 1 KHz Level control up about half way.
3. Connect an oscilloscope with a calibrated vertical input to TP6 on the Scope Amplifier board (Figure 3-1).
4. Using the front panel's horizontal vernier control, adjust for a 3 Vp-p amplitude on the sinewave at TP6.
5. With 3 Vp-p at TP6, adjust the Horizontal Gain potentiometer (Figure 3-1) for a CRT horizontal trace of 6 cm. (Use the front panel controls to position the trace at a convenient place near the center of the CRT.)

3.2.7 CRT VERTICAL GAIN

1. Connect the Mod Out port to the vertical input port (Vert In) on the System Analyzer's front panel.
2. Select Generate FM function and Scope DC display. Set the Horiz control for a sweep rate of 1 mSec/Div and the horizontal vernier to Cal. Set the Vert control for an input sensitivity of 1V/Div and the vertical vernier to Cal.
3. Turn the Code Synthesizer and the Ext Level control OFF, and the 1 KHz Level control up about half way.
4. Connect an oscilloscope with a calibrated vertical input to TP1 on the Scope Amplifier board (Figure 3-1).
5. Using the 1 KHz Level control on the front panel, adjust for a 3 Vp-p amplitude on the sinewave at TP1.
6. With 3 Vp-p at TP1, adjust the Vertical Gain potentiometer (Figure 3-1) for a 6-cm p-p sinewave on the CRT. (Use the front panel's Horiz and Vert position controls to center the waveform on the CRT.)

3.2.8 VERTICAL INPUT GAIN

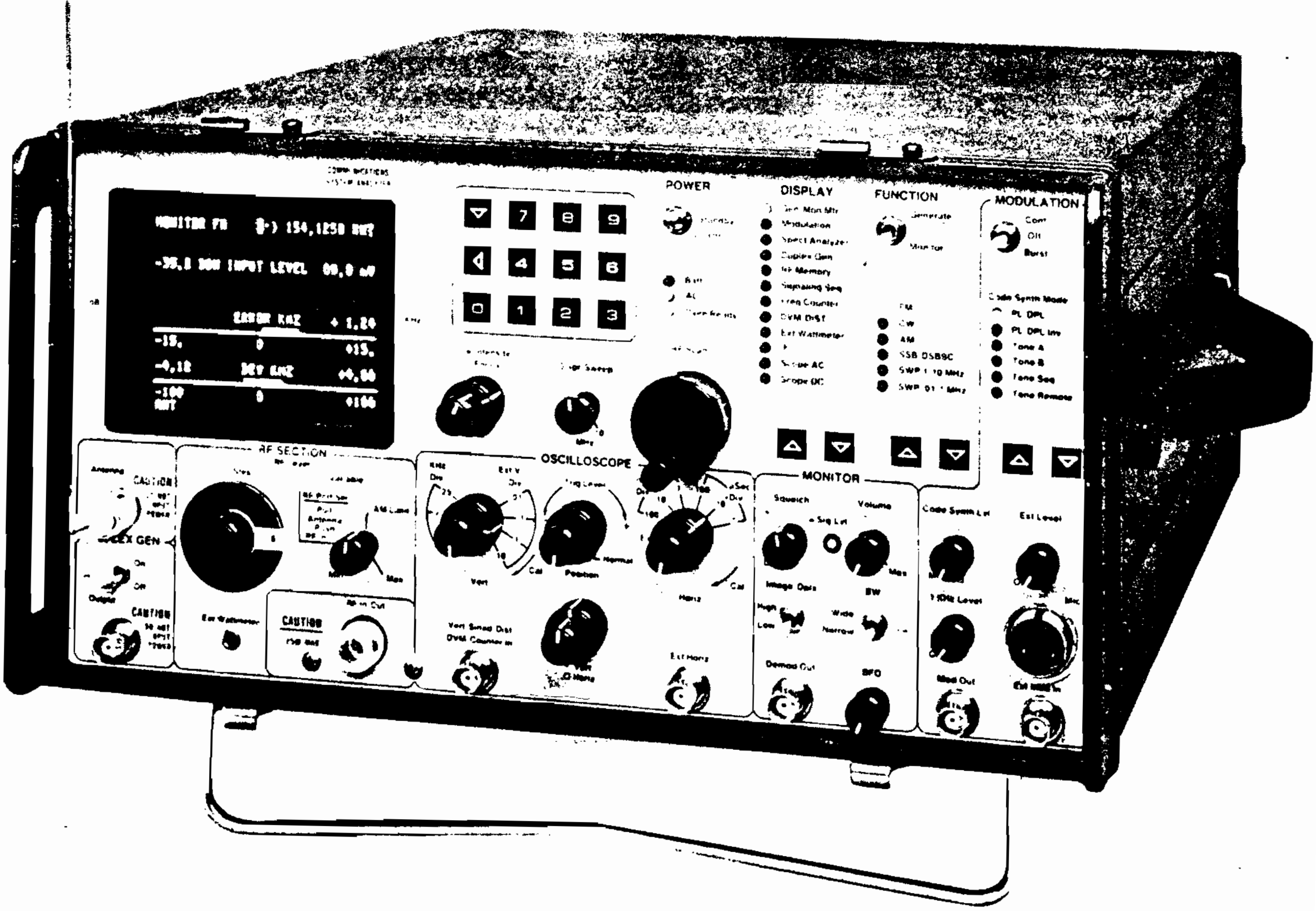
1. Select Generate FM function and Scope DC display. Set the Horiz control for a sweep rate of 1 mSec/Div and the horizontal vernier to Cal. Set the Vert control for an input sensitivity of 1V/Div, and the vertical vernier to Cal.
2. Connect an oscilloscope with a calibrated vertical input to the Mod Out port on the front panel.
3. Turn the Code Synthesizer and the Ext Level control OFF and adjust the 1 KHz Level control for a 6 Vp-p sinewave on the attached oscilloscope.
4. Disconnect the oscilloscope from the Mod Out port and connect the Mod Out port to the Vert input port.
5. Adjust the Input Vertical Gain potentiometer on the Front Panel Interface board (Figure 3-2) for a 6-cm p-p sinewave on the CRT. (Use the front panel's Horiz and Vert position controls to center the waveform on the CRT.)

3.2.9 DVM ZERO

1. Select DVM display and DC mode.

MOTOROLA INC.

Communications
Sector



COMMUNICATIONS SYSTEM ANALYZER
R2008D/R2010D

Motorola Test
Equipment Products

1313 E. Algonquin Rd.
Schaumburg, IL 60196

68P81069A62-0
7/8/85-PHI

R2008D/R2010D OPERATOR'S MANUAL

TABLE OF CONTENTS

5.0 APPLICATION NOTES

APPENDICES

1.0 INTRODUCTION

The R2008D/R2010D is an expansion of the R2001D which extends its testing capability to include the unique requirements of cellular radio systems. Any existing R2001D communications system analyzer can be modified to an R2008D/R2010D. With the modification, all of the capability of the R2001D is retained with the cellular test sequences being added as an extension of the tone memory display.

Cellular test capability in the R2008D/R2010D includes performance verification for both the digital signaling and the RF transceiver aspects of the cellular radio. In the cellular test mode, the analyzer simulates the basic aspects of the central cell site. It provides all of the signaling required to allow both call origination and call reception testing on the cellular transceiver. In addition, once the voice path is established, the R2008D/R2010D can then be used to simulate cell site to cell site handoffs, to control the transmitter power level, and to execute performance tests normally associated with a transceiver.

A fully automatic test sequence is provided which sequences through an operator selectable number of the 666 cellular channels and measures the transmitter output power, frequency error, and modulation limiting for each channel. Provision has been made for attachment of a serial printer RS-232, (1200 baud) to provide hardcopy output of AUTOTEST MODE results. The printer can also print the contents of the CRT display in all modes except MODULATION, SPECTRUM ANALYZER, IF, AND SCOPE, by pressing both the left cursor key and the "0" key together.

To complete the package, the R2008D/R2010D also provides the interface to manually control the transceivers that are compatible with the Advanced Mobile Phone Service Cellular Mobile Telephone Equipment Specification, July 1983. This separate interface bypasses the normal RF signaling interface and allows direct control over transceiver functions such as channel selection, transmitter key, transmitter audio, and receiver audio. Also available through this interface is access to the number assignment module (NAM) and the nonvolatile memory (NVM). A total of 43 commands are available for the purpose of setting up, checking out, and troubleshooting the cellular radio.

This manual is written as a supplement to the R2001D Operator's Manual (68P81069A66); refer to the R2001D Operator's Manual for the operating instructions in non-cellular testing.

U.K. Cellular Test Capability. The United Kingdom (U.K.) Cellular System Analyzer (R2010D) is the basic R2008D analyzer with modifications to permit testing of U.K. "TACS" System Cellular Mobile Transceivers. A description of differences between the U.S. cellular system and the "TACS" system is found in appendix "H".

2.0 THE CELLULAR CONCEPT

Conventional VHF mobile telephone systems us
single transmitter site to cover a given service area
cellular mobile telephone system, on the other ha
divides the service area into smaller coverage ar
called cells. A cellular system consists of a c
tinuous pattern of these hexagon-shaped cells, e
having a 5 to 10 mile radius. Within each cell is a c
tralized based station which contains transceivers a
related control equipment for the channels assig
to that cell. All of the cells within a system are t
connected either by dedicated land lines, microw
links, or a combination of both to a central cont
site. The central control site, or controller, is resp
sible for the overall control of the system and the
terface to the land line network.

A cellular radio-telephone in the cell system is un
the indirect control of the central controller. A se
of control channels over which only digital signal
is allowed and voice channels which allow both au
and signaling are used for control and data trans
as well as for conversation once the call is est
lished. The control channels are divided into th
groups: Forward control, paging, and access ch
nels. The control channel generally provides so
basic information about the particular cellu
system such as the system identification number a
the range of channels to scan to find the paging a
access channels. Paging channels are the norr
holding place for the idle cellular radio. When a c
is received at the central controller for a cellu
radio, the paging signaling will occur on a pag
channel. In responding to a page or when originat
a call, the radio telephone will use an access chan
where two way data transfer occurs to determine
initial voice channel. In many systems all three c
trol channel functions will be served by the sa
channel for a particular cell. The R2008D/R201
operates in this single data control channel mo
Only in the very high density areas will multiple ch
nels be required.

Voice channels are primarily used for conversati
with signaling being employed as necessary to eff
cell to cell handoffs, output power control on
cellular radio and special local control features. D
from the cell site, forward data, and data from
mobile, reverse data, is sent at a 10 kilobit/seco
rate utilizing direct frequency modulation. The d
is formatted into groups of words with a disti
binary preamble that allows the receiver to synch
nize to the incoming data.

In addition to the digital signaling there are two t
signaling mechanisms employed in the cell syste
The supervisory is one of three frequencies aroun
kilohertz. It is generated by the cell site, checked
frequency by the cellular radio, and then tra
ponded back to the cell site on the reverse chan
The cellular radio uses the SAT to verify that it tu
to the correct channel after a new voice channel c
mand. When the central controller signals the mol

3.0 TESTING CELLULAR RADIOS

To ensure satisfactory operation of the cellular radio, the proper operation of the digital and analog signaling functions, the transceiver function, the transceiver control function, and the information contained in the Number Assignment Module (NAM) must be verified. Since the transceiver is generally only controllable through an on-board controller, the first item to be checked must be that controller. For AMPS compatible radios and for most radios in general, a basic self check of the controller system is performed when the radio is first turned on. If the self test is successfully completed the handset indicators are activated. If the controller is not working the indicators will either not activate or will activate in an abnormal manner. Generally, a failed controller will prevent further testing and troubleshooting until it is either replaced or repaired.

Once past the self test, the cellular radio will then attempt to locate a forward control channel (FOCC). At this point the R2008D/R2010D can be used to supply the FOCC signal modulated with the appropriate forward control messages. A cradle 'no service' indicator will extinguish when the radio has successfully tuned to, decoded, and responded to the FOCC signal.

A failure at this portion of the sequence would most likely indicate that the receiver or the receiver/controller interface circuitry has failed.

The manual test mode of the R2008D/R2010D which allows separate control and monitoring of the receiver, transmitter, and controller status can be used to isolate the source of the failure.

With the cellular radio in service either the call origination or the call reception capability of the radio can be checked. With the R2008D/R2010D the signaling exchange necessary to execute both sequences can be generated with the proper responses automatically checked for accuracy. Error messages are provided in the event that the radio does not respond properly. These messages and the manual test capability can then be used to isolate the cause of the failure.

Failure at this point would most likely be in the transmitter or data generating circuitry as the receiving circuitry had to be working to get an 'in service' indication.

A successful call origination or call reception test will end with the radio on a voice channel. On the voice channel the radio detects and checks for the correct SAT frequency, and then transponds the SAT signal on the reverse voice channel. It is necessary to verify that the radio correctly identifies the SAT frequency and that it correctly transponds the signal. The R2008D/R2010D again handles this verification automatically with error messages being provided in the event of a failure.

Other functions to be checked on the voice channel are transmitter power output and control, transmit frequency error, and modulation limiting. Each of these functions is easily checked with the R2008D/R2010D with the data readouts provided on the cellular control display. Power, frequency error, and modulation checks on other channels is implemented with the use of the channel handoff capability. From the cellular control display, the signaling necessary to cause the radio to move to any cellular channel can be initiated. For the handoff, the R2008D/R2010D verifies the response from the radio, and once on the new channel, verifies the correct SAT response. Again, error messages are generated in the event of a failure and with the manual test mode can be used to isolate the cause of the failure.

Finally, the R2008D/R2010D can verify the termination sequence again with appropriate error messages in the event of a failure. User unique information such as home system identification number, telephone number, and control head lock code can be read from the NAM using the manual mode. This information will be required when servicing any cellular radio.

4.0 THE R2008D/R2010D TEST CAPABILITIES

Cellular testing capability has been made possible in the R2008D/R2010D by the addition of one new module over the R2001D system analyzer (see note). A new cellular option board is added that performs the RF and manual interfacing to the cellular telephone transceiver unit. It controls the modulation of digital messages, audio and SAT tones by using the microprocessor to command the cellular radio.

The cellular option board also decodes the digital messages returned by the cellular telephone. This includes synchronizing on the dotting sequence and the word sync sequences at the start of these messages and decoding the Manchester encoded data in the message stream. The recovered digital information is then sent to the microprocessor board for processing. The cellular board also detects the presence of the 10 KHz tone sent by the cellular telephone, and can measure its duration. It does the necessary routing of SAT tones and audio.

Although the R2008D/R2010D can transmit only one frequency at a time, it can switch frequencies at a relatively fast rate, making it ideal for multiple frequency checks necessary for more complete cellular testing. Once the desired channel numbers are selected in the initial parameters screen, the R2008D/R2010D automatically switches its transmit and receive frequencies to simulate transition from a forward control channel to a forward voice channel, or from one voice channel to another, to simulate a cell handoff.

The digital messages are modulated onto the duplex generator automatically by the R2008D/R2010D Digital responses are decoded and analyzed to verify that the correct message has been sent back by the cellular telephone. Necessary data is extracted for verification, processing and display.

The required SAT frequency is produced by the R2008D/R2010D and the transponded SAT is checked. There are three possible SAT frequencies, they are 5970, 6000 and 6030 Hz.

The 10 KHz signaling tone sent by the cellular telephone is measured by the R2008D/R2010D to confirm successful handoffs, alert and release.

While in the voice channel, the frequency error, the output power and the peak modulation of the cellular telephone's carrier is constantly updated and displayed on the screen of the R2008D/R2010D.

Extensive software has been written to exercise the cellular telephone in a variety of ways. Motorola's approach to cellular testing has been to keep testing as simple and comprehendable as possible without sacrificing capability. In keeping with this ideal, a thermometer style display is used that 'fills in' as the test progresses. Help messages can be shown that spell out the definition of each square in the thermometer display. If a problem is encountered, warning and error message numbers are displayed. Temporary exits are allowed so that the power of the other R2008D/R2010D modes can be utilized.

The software version numbers for the 9 files that comprise the R2008D/R2010D software can be seen if a zero key is held down while the R2008D/R2010D is turned on. This version number display will stay on the screen for 10 seconds; then normal operation ensues.

A manual test mode allows the operator to command the cellular telephone with any one of the 43 commands defined by the Advanced Mobile Phone Ser ice (AMPS) specification of May, 1983.

The following sections describe how to physically s up a test, using the RF interconnect or the manu test interconnect. Then, operator instructions on ho to use the cell initiated test, the mobile initiated tes and the manual test are detailed. A list of possib warnings and errors is included in Appendix E.

4.1 Setup Instructions

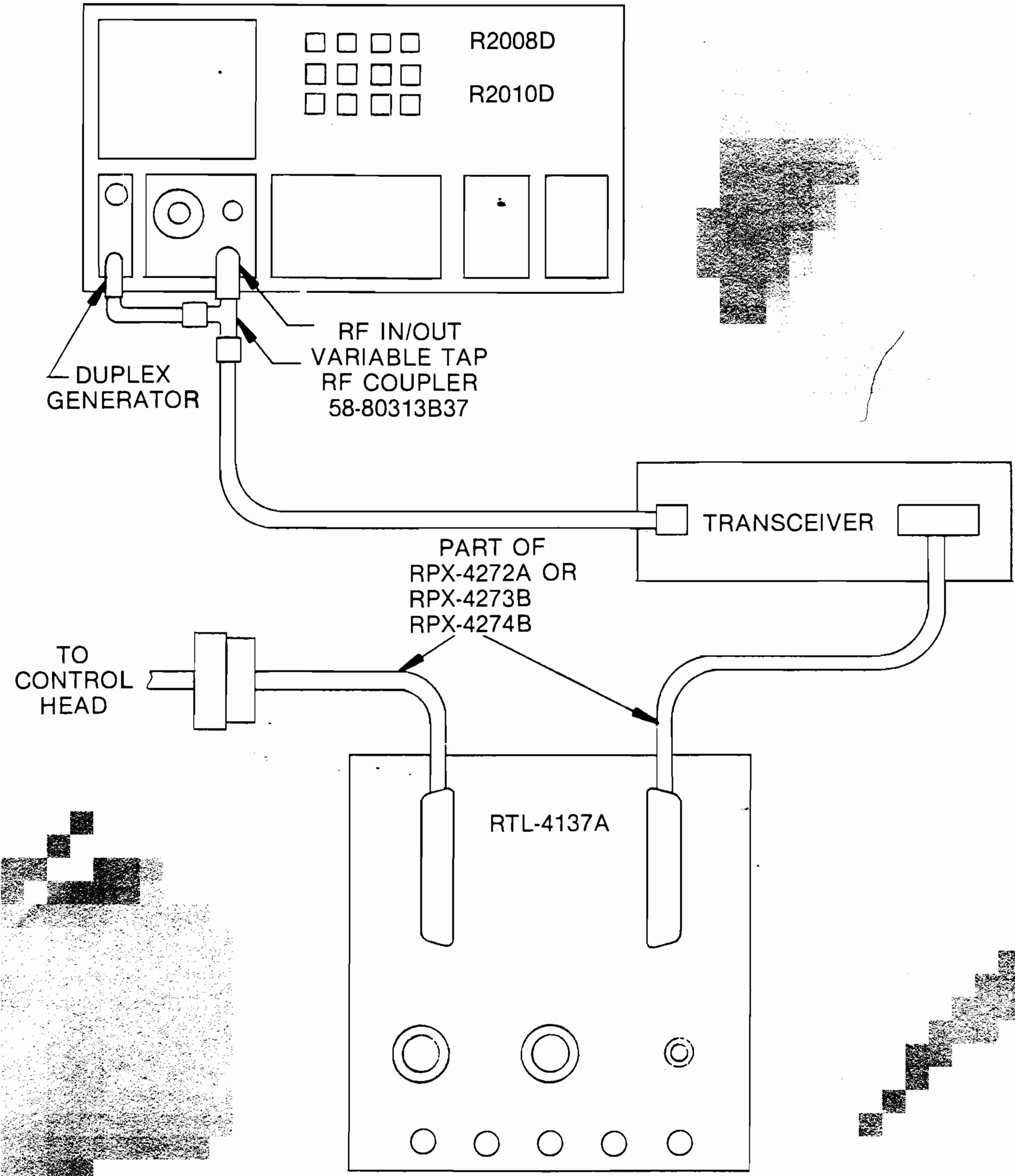
Connection from the R2008D/R2010D to the mobil unit require accessories included in separate kits.

RPX-4350A -	Variable RF coupler (58-80313B37) Junction box (RTL-4137A) Printer/junction box cable (01-80356A73) TNC-BNC adapter (58-80313B33) Self Test Enable Adapter (RTL-4148A)
RPX-4272A -	Adapter cables for junction box t AMPS type radios
RPX-4273B -	Adapter cables for junction box t Motorola DYNA-TAC mode T19ATA8822AE radios.
RPX-4274B -	Adapter cables for junction bo Motorola CT and ET series mobil radios.

SIGNALING SEQUENCE TEST CONNECTION

The signaling sequence test mode requires an RF connection be made from the R2008D/R2010D to th mobile unit. To couple the output from the duple generator to the main RF in/out connector, variable tap RF coupler 58-80313B37, is used. Connect the male N connector on the coupler to th R2008D/R2010D RF in/out port. Connect th variable tap to the duplex generator output with short length of BNC to BNC coax 01-80352A02 Connect the female N connector on the coupler to th mobile unit antenna connector. A TNC and BN adapter, 58-80313B33, may be required to connect t the mobile unit. See figure 2.

It is sometimes useful to access some test points o the control head to transceiver interface during th signaling test mode. This is accomplished by usin the cellular junction box RTL-4137A and the adapte cables included in either RPX-4272A, RPX-4273B or RPX-4274B.



SIGNALING CONNECTION
FROM R2008D/R2010D TO CELLULAR TRANSCEIVER

FIGURE 2.

4.2 Operating Instructions

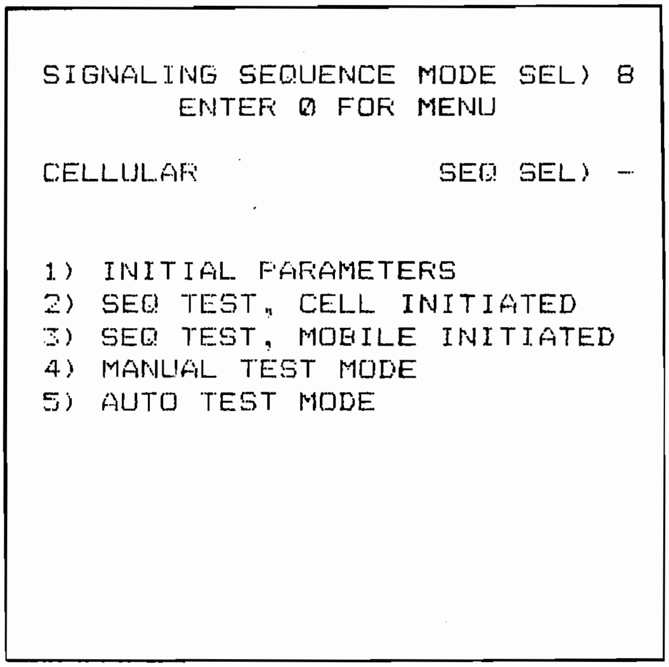
Front panel selections for cellular testing

Before initiating cellular testing, make the following adjustments and switch selections on the R2008D/R2010D front panel. They are . . .

1. Enter a 45 MHZ offset in the DUPLEX GEN screen.
2. Set the RF step attenuator to 50 dB.
3. Set the DISPLAY led to Signaling Sequence.
4. Set the FUNCTION switch to Monitor.
5. Set the MODULATION Cont/Off/Burst switch to Off.
6. Use the FM FUNCTION state.
7. Set the BW (BandWidth) switch to Wide.
8. Set the Image/Dplx switch to High.
9. Adjust the Squelch level to near threshold. (Turn counter-clockwise until the squelch light comes on, then back off a small amount).
10. Set the variable RF tap between 1/4 to 1/2 inch from maximum coupling.

THE CELLULAR TEST SCREENS

The cellular test is accessed via the Signaling Sequence display. Enter '8' in the 'mode sel' position to access the cellular test screens. See figure 3. There are now 5 sub-selections possible. Move the cursor down to the 'seq sel' position. The 5 selections possible are described in the following paragraphs.

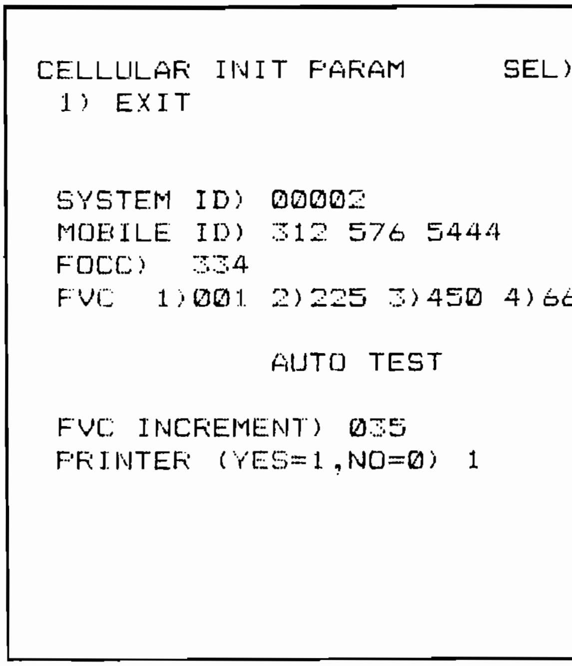


```
SIGNALING SEQUENCE MODE SEL) 8
      ENTER 0 FOR MENU

CELLULAR              SEQ SEL) -


1) INITIAL PARAMETERS
2) SEQ TEST, CELL INITIATED
3) SEQ TEST, MOBILE INITIATED
4) MANUAL TEST MODE
5) AUTO TEST MODE
```

FIGURE 3.
SIGNALING SEQUENCE MODE DISPLAY

1) INITIAL PARAMETERS

This screen allows for the entry of basic paramet
concerning the cellular telephone under test a
selections the operator desires. See figure 4. Entr
must be made here in order to use any of the cellu
signaling sequence tests. Selections are stored in n
volatile memory and are saved even if the analyze
powered down.



```
CELLULAR INIT PARAM      SEL)
 1) EXIT


 SYSTEM ID) 00002
 MOBILE ID) 312 576 5444
 FOCC) 334
 FVC  1)001 2)225 3)450 4)6

           AUTO TEST

 FVC INCREMENT) 035
 PRINTER (YES=1,NO=0) 1
```

FIGURE 4. INITIAL PARAMETERS DISPLA

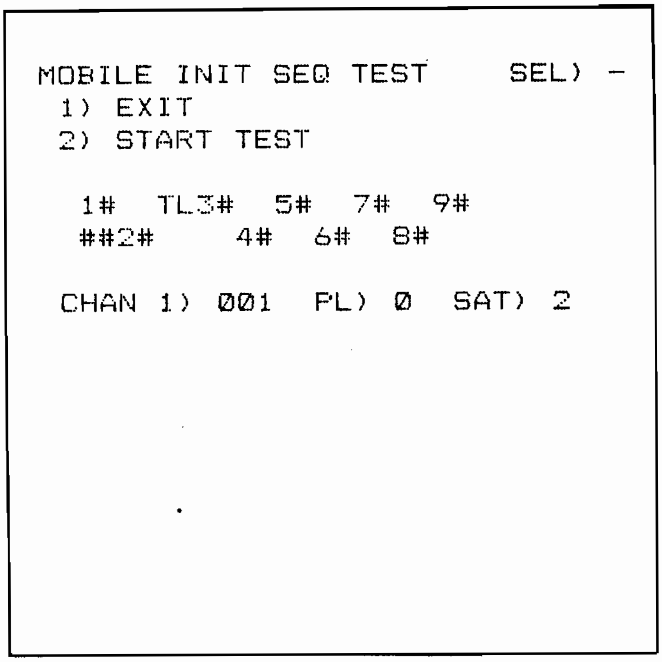
SYSTEM ID: Enter the system ID of the cell
telephone under test. Entering a SID that does
match the one of the cellular telephones under
will force the telephone to go into the ROAM st
The SID is a 15 bit binary number entered in decin

MOBILE ID: Enter the telephone number of
cellular telephone under test. Entering the MIN t
does not match that of the radio under test will p
vent the cellular telephone from being called in
cell initiated test. The mobile initiated test will upc
this field.

FOCC: Enter the number of the desired con
channel. Cellular radios scan channels 313 to 3
Those units configured for operation in a non-w
line carrier system consider channels in the range
to 333 as home data channels. Those units configu
for operation in a wireline carrier system consider
range 334 to 354 as home channels. However, for
purposes, any channel from 1 to 666 may be ente
A channel selection of 334 will result in the tra
mitted frequency of 835.02 MHZ from the R200
R2010D. This is derived from the equation be
. . . (825.00 + .03 X (channel number) MHZ).

3) SEQUENCE TEST, MOBILE INITIATED

The mobile initiated sequence test is similar to the cell initiated test except the cellular telephone is placing the call. This screen is accessed through the main Signaling Sequence screen. See figure 7.



```
MOBILE  INIT  SEQ  TEST      SEL)  -
 1)  EXIT
 2)  START  TEST

  1#   TL3#   5#   7#   9#
  ##2#      4#   6#   8#

 CHAN  1)  001   PL)  0   SAT)  2
```

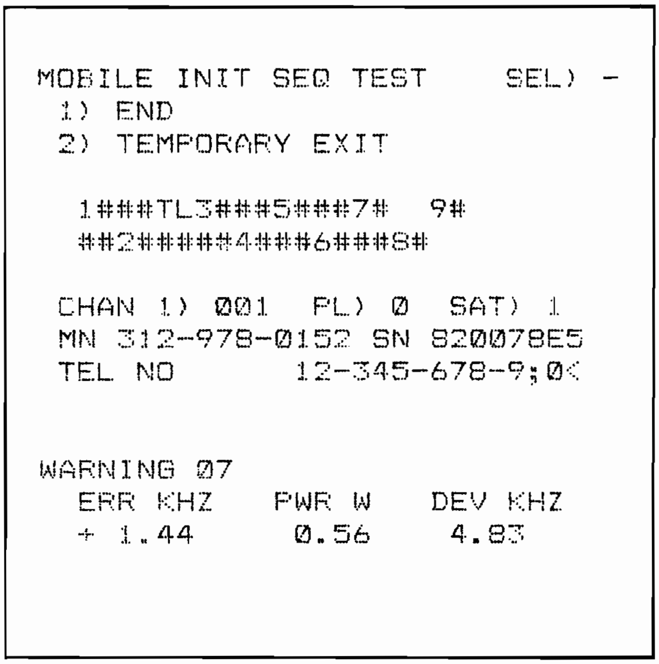
FIGURE 7.
MOBILE INITIATED SEQUENCE TEST DISPLAY

The selections possible are 1) EXIT, and 2) START TEST. These selections are possible if the cursor is in the home position at the top of the screen. A '1' will return the screen back to the tone memory screen. A '2' will start the test.

Help messages describing the blocks of the thermometer sequence can be accessed by moving the cursor to the line underneath the squares and advancing to the right by keying any number 1 to 9. The squares on the top row of the thermometer display indicate actions that will be taken by the R2008D/R2010D during the test. The squares on the next line indicate actions that the mobile takes are perceived by the R2008D/R2010D. Note that the first square is filled in since the R2008D/R2010D commences a FOCC data stream upon entry into the mobile initiated sequence test screen. The cellular telephone should 'lock up' onto the data stream and the 'no svc' light should go out. If a foreign system ID was entered, the 'roam' light will light.

The test can be started at any time. Once commenced, the R2008D/R2010D will wait for a service request from the car phone. Enter the number that is to be called into the cellular telephone. Allow the 'NO SVC' light to go out, then depress the 'SEND' key the R2008D/R2010D will receive this service request message and display the called address on the CRT screen. Verify that the called address matches the one sent. The mobile ID and serial number are also extracted from this message and displayed on the CRT screen. The mobile ID is also used to update the Initial Parameters data. The R2008D/R2010D now sends an initial voice channel designation message. The R2008D/R2010D and the cellular telephone will switch to the first FVC and RVC channel respectively. See Figure 8. Just as in the cell initiated test, voice communications can be verified, temporary exists are allowed to analyze the signal, handoffs are allowed to any one of the four pre-selected forward voice channel be changed to force a telephone drop out. And, as in the cell initiated test, the call can be terminated either by pressing the 'END' key or by entering a '1' (End) on the top line of the display.

For a detailed description of the mobile initiated sequence test steps, see appendix B and D.



```
MOBILE  INIT  SEQ  TEST      SEL)  -
 1)  END
 2)  TEMPORARY  EXIT

  1###TL3###5###7#   9#
  ##2######4###6###8#

 CHAN  1)  001   PL)  0   SAT)  1
 MN  312-978-0152  SN  820078E5
 TEL  NO         12-345-678-9;0<


WARNING  07
  ERR  KHZ    PWR  W    DEV  KHZ
  + 1.44       0.56      4.83
```

FIGURE 8.
MOBILE INITIATED TEST RESULTS SCREEN

4) MANUAL TEST

The manual test mode is accessed by a '4' entry in the 'SEQ SEL' of the Signaling Sequence screen. See figure 10. This mode allows the operator to enter and send any one of the 43 commands to the transceiver unit of the cellular telephone as defined by the AMPS SPEC•of May, 1983.

A '3' entry in the Cellular Manual Test Mode accesses the Cellular Manual Test display, which provides test set up information (accessory cable kit part numbers) for the various types of cellular units. See figure 11.

MANUAL TEST MODE CONNECTION.

The manual test mode requires that the R2008D
R2010D seize control of the transceiver unit by ma
ing connection directly to the control port on t
mobile unit. The printer/junction box cable is co
nected to the 37 pin "D" connector on the rear panel
the R2008D/R2010D, and to the 50 pin "D" connect
on the cellular junction box. The junction box is the
connected to the mobile with an adapter cable fro
either the RPX-4272A, RPX-4273B or RPX-4274
accessory kit. The antenna connector on the mobi
can be connected either to an external antenna f
monitoring purposes, or to the R2008D/R2010
directly into the RF in/out port or via the variable R
tap for duplex measurements. See figure 9.

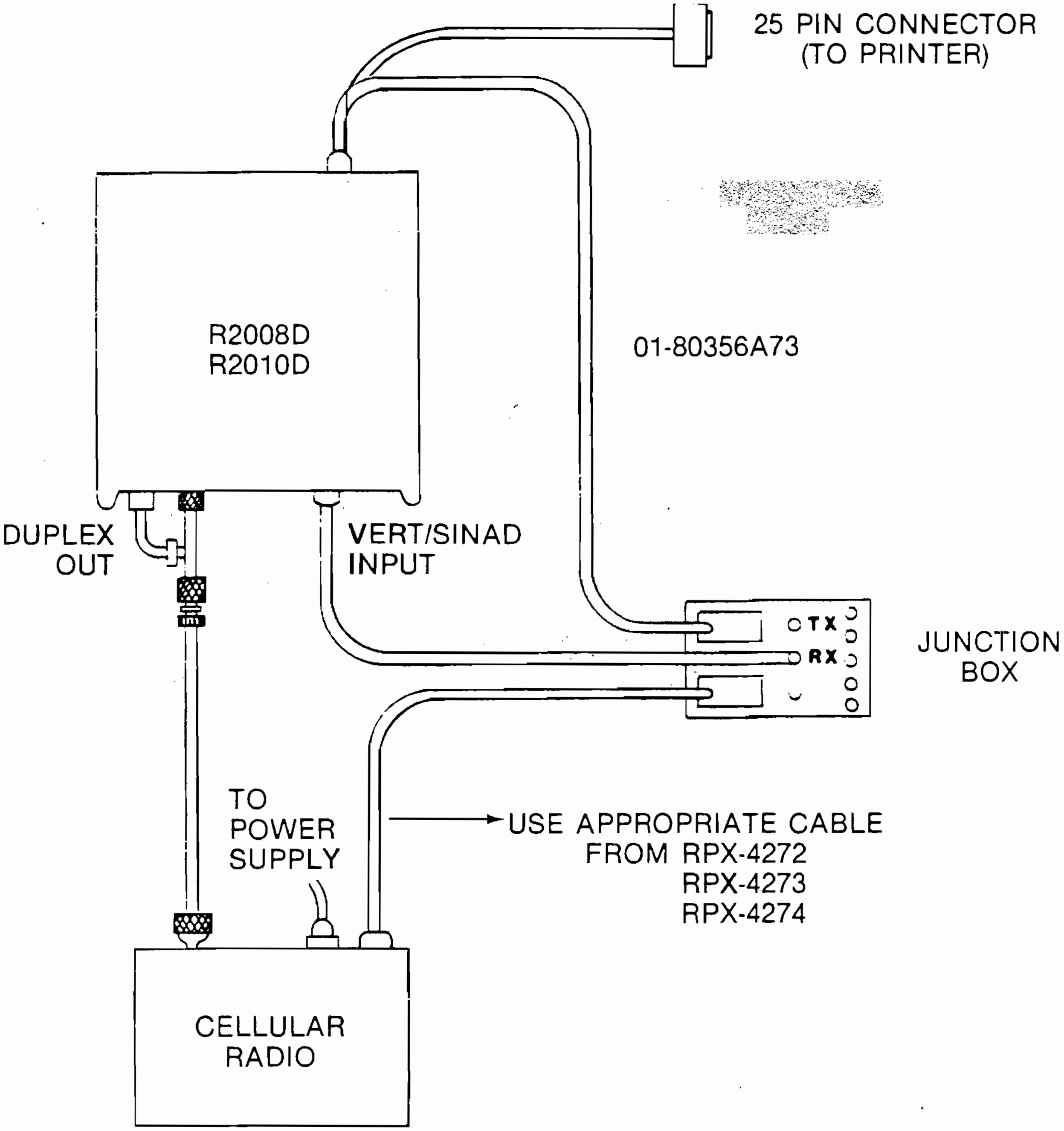
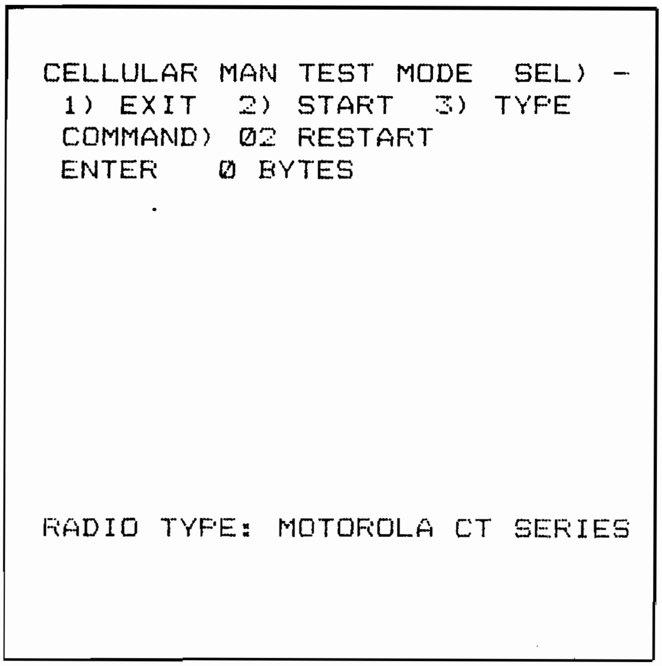
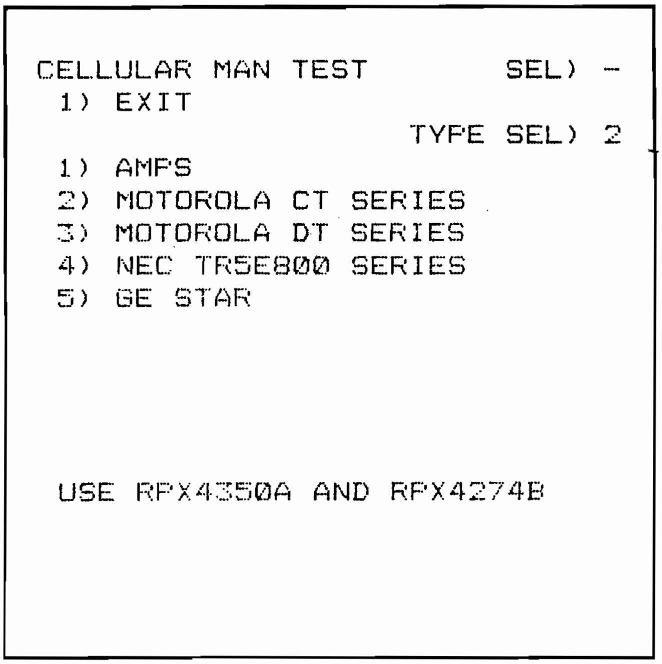


FIGURE 9. MANUAL TEST SETUP



```
CELLULAR MAN TEST MODE  SEL) -
 1) EXIT  2) START  3) TYPE
 COMMAND) 02 RESTART
 ENTER   0 BYTES




RADIO TYPE: MOTOROLA CT SERIES
```

**FIGURE 10.
MANUAL TEST MODE DISPLAY**



```
CELLULAR MAN TEST         SEL) -
 1) EXIT
                      TYPE SEL) 2
 1) AMPS
 2) MOTOROLA CT SERIES
 3) MOTOROLA DT SERIES
 4) NEC TR5E800 SERIES
 5) GE STAR



 USE RPX4350A AND RPX4274B
```

FIGURE 11. MANUAL TEST DISPLAY

Move the cursor down to the command line. Enter the desired command. The R2008D/R2010D will echo back a mnemonic describing the command. If the particular command requested requires additional bytes, dashed lines indicate where they should be entered on the screen. See figure 10. If this is the case, move the cursor over to the dashed lines and make the necessary entries. If hexadecimal data is required, use the normal 0-9 keys, but in addition, use the 'up/down' keys, of DISPLAY, FUNCTION and MODULATION to obtain A-F. The 'up/down' keys of DISPLAY are used for A and B. The 'up/down' keys of FUNCTION are used for C and D. The 'up/down' keys of MODULATION are used for E and F.

To send the command to the transceiver unit, return the cursor to the home position and enter a '2'. The command will then be sent along with any additional bytes required. The operator is now free to send additional commands or to exit the screen and measure parameters using the other R2008D/R2010D test modes.

If the command sent requires that the cellular telephone return information, the R2008D/R2010D will display the returned data automatically.

If failures occur in this handshaking procedure, an error message is displayed on the bottom of the screen.

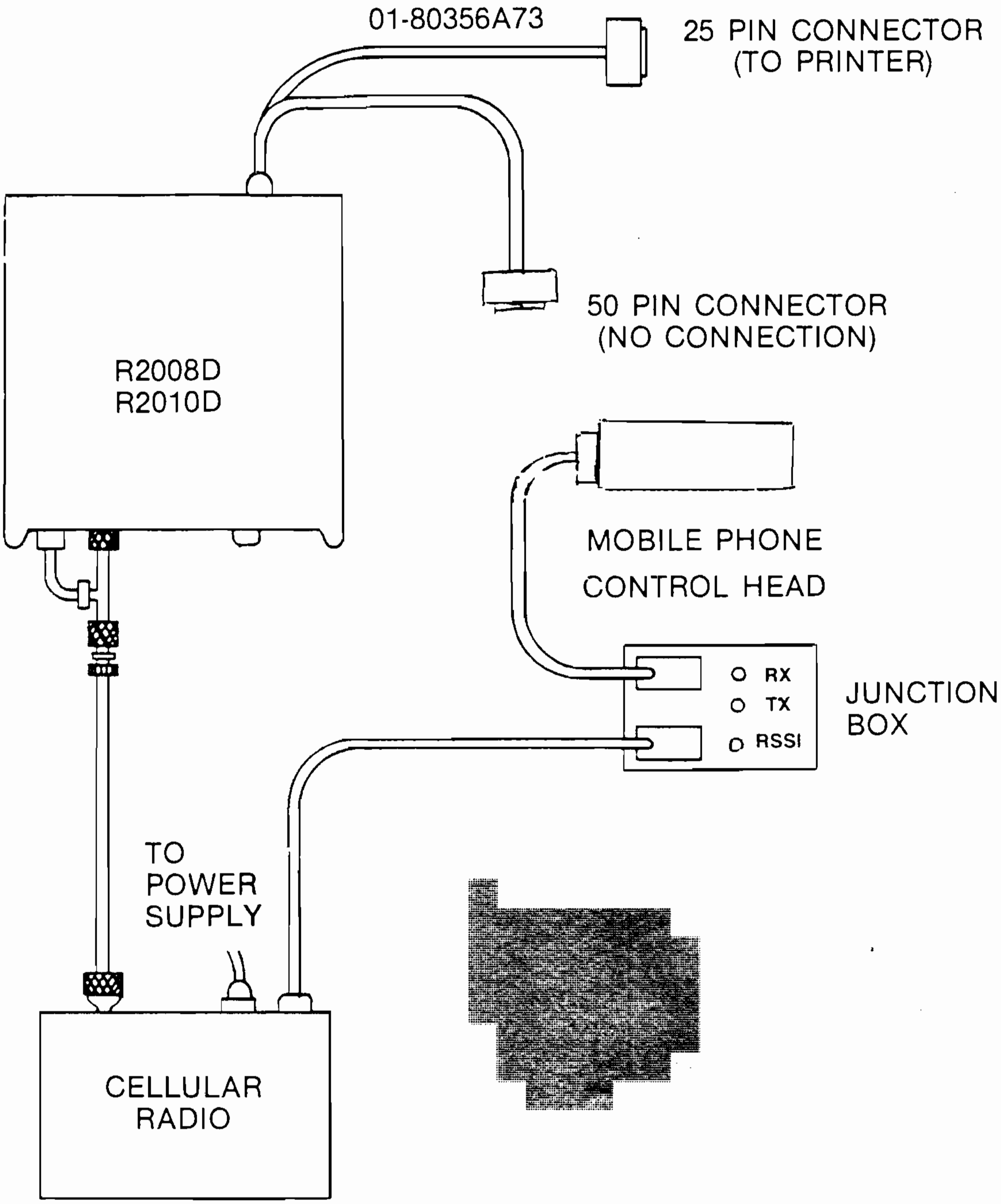
Normally, the first command entered is an 01 command (SUSPEND) to set the transceiver into the test mode so that the other commands can be utilized. Otherwise, only STATUS, TURNAROUND, RESET, RESTART and SUSPEND will function.

Repeats of the same command can be made by multiple entries of '2' while the cursor is in the home position.

For a list of the 43 possible commands, see appendix F.

5) AUTO TEST

The Auto Test Mode enables a technician to test a cellular radio on as many channels as desired. The R2008D/R2010D signals the radio under test as in the sequence tests. Measured values of frequency error, output power and modulation deviation are d played for each channel tested, and recorded on optional printer. The following sections describe h to set up and operate the R2008D/R2010D in t Auto Test Mode. See figure 12.



AUTO TEST SETUP

FIGURE 12.

A. INITIAL PARAMETERS

Select the INITIAL PARAMETERS screen by keying a 1 in the main Signaling Sequence screen.

SID Enter the System ID that the mobile expects. If incorrect, or if not known, the mobile will still function but the mobile will give a ROAM indication.

FOCC Enter the FOCC (data channel) desired. The mobile will scan the channels 313-354 as their home system range. Mobiles configured for non-wireline carriers consider channels 313-333 as their home system range.

FVC 1) This channel is the first in the series of channels to be tested. The other three FVC selections are used only in the cell and mobile initiated sequences.

FVC increment This parameter specifies the channel spacing for the automatic handoffs. So if this is 100, then every 100th channel will be checked.

PRINTER (1 = YES, 0 = NO) Select a 1 if a printer is desired, and select 0 if not. The printer is required to have RS232, 1200 baud capability. See Appendix G. for instructions on setting up the optional Epson RX-80 printer, Motorola part no. RT-RX80/8148.

B. AUTO TEST OPERATION

Connect the R2008D/R2010D Mod Out jack to the Tx Audio jack on the junction box.

On the main Signaling Sequence screen, key in selection 5 to access the auto test mode. The screen will instruct the operator to adjust the 1 kHz level too a 2.0 to 2.5 volt output. The purpose of this is to input sufficient signal so the transceiver will begin to go into deviation limiting on each channel tested.

Key in a 2 to begin the test.

A WAIT message will be displayed as the R2008D/R2010D adjusts the 45 MHz offset. At this point, the R2008D/R2010D is sending out an overhead message stream on the FOCC, as a cell would.

This portion of the sequence is very similar to the MOBILE INITIATED test described earlier. The R2008D/R2010D is waiting for a service request message from the mobile under test. The R2008D/R2010D now will display a SEND TEL # WHEN IN SVC message. When the NO SVC indicator on the car phone goes out, start a call from the mobile.

The R2008D/R2010D will now display SAT deviation (not from the 1kHz Mod Out), output power and frequency deviation of the mobile on FVC #1). The R2008D/R2010D will wait for the data to stabilize, and then print it out if a printer was selected. Then, the R2008D/R2010D will issue a release order to the mobile, and resume transmission of overhead data on the FOCC.

After a short delay, to allow the mobile to firmly lock onto the data stream, the R2008D/R2010D will page the mobile using the Mobile ID number sent by the mobile in the earlier part of the test. When the mobile begins to ring, the operator has 10 seconds to answer before the 10 kHz signaling tone interferes with the SAT and deviation measurements.

The R2008D/R2010D will now display frequency error, power output and 1 kHz modulation deviation from the mobile under test.

After a short delay, to allow the data to stabilize, the R2008D/R2010D will execute handoff orders to step the mobile through the FVC range up to channel 666. The R2008D/R2010D will display and send the measured data to the printer for each channel tested.

By looking at trends in the data over the range of channels, a troubleshooter will be able to narrow down the faulty functional blocks in the mobile under test, as well as provide an historical record of the mobile for customer assurance.

5.0 APPLICATION NOTES

A. RECEIVER AUDIO LEVEL TESTING

1) Connect R2008D to transceiver unit via junction box. (Refer to Fig. 13)
2) Disconnect duplex generator output if connected.
3) Select generator function and execute the following manual mode commands:
   01 Suspend
   09 Load synthesizer (enter desired channel)
   12 RX unmute
4) Set R2008D to desired channel (870 MHz plus .03 X channel #) ex. 879.99 MHz equals channel 333.
5) Connect RX audio BNC connector on junction box to Vert/Sinad input on R2008D.
6) Select GEN function on R2010D. Adjust the output level to -50 dBm to simulate a strong signal. Adjust 1 KHz modulation level to 2.9 KHz deviation.
7) With junction box compandor switch in NORMAL mode, adjust radio for 100 mV RX audio while in DVM/DIST display on R2008D. Refer to radio maintenance manual.
8) Increase 1 KHz deviation to 8 KHz, read distortion in either DVM/DIST or GEN/MON display.
9) Data distortion: Using DVM/DIST display, and with modulation still 1 KHz at 8 KHz deviation, measure level at discriminator test point (junction box test point for AMPS bus compliant radios, internal radio test point for others). Using Signaling Sequence display, input 9999.9 Hz for tone A. Turn 1 KHz modulation off. Adjust code synth output for 8 KHz deviation using tone A and note level at radio discriminator. Difference in level from that noted with 1 KHz modulation should be less than 3 dB.
10) Audio frequency response: Bypass the transceiver compandor. Use the Signaling Sequence display to set tone A to 300 Hz, and tone B to 3000 Hz. Using a constant deviation level of 2.9 KHz check the level at the RX audio jack. Typical output levels are:

300 Hz	331 mV
1000 Hz	110 mV (REF)
3000 Hz	33 mV

AUDIO RESPONSE IS -6 dB/OCTAVE DEEMPHASIS

B. TRANSMITTER DEVIATION

1) Connect R2008D to transceiver unit via the ju
tion box, as in manual test mode connecti
(Refer to Fig. 13.)
2) Select power monitor mode and execute the f
lowing manual mode commands:
   01 Suspend
   09 Load synthesizer, enter desired channel
   07 Carrier on
   14 TX unmute
3) To check deviation, connect mod out jack to
audio connector on junction box. Set eithe
KHz level or code synth level using modulat
display and observe deviation on GEN/M
display. Use Signaling Sequence display to v
frequency of tone A or tone B to check deviat
on frequencies other than 1 KHz. Send man
mode command 13 TX mute to mute transmit
audio for further tests.
4) Signaling tone deviation can be set by sending
manual mode command 16, Signaling Tone
to the transceiver unit. Set deviation to 8 K
measured on GEN/MON display. Manual m
command 17, Signaling Tone Off, will deacti
the transceiver signaling tone generator.
5) DTMF deviation can be set by executing man
mode command 42, DTMF On, and input
desired digit such as 06. Adjust the transcei
for approximately 8.5-9 KHz deviation (roug
equal to 9 radians peak phase deviation).
6) SAT deviation can be set by executing man
mode command 32, SATON, and entering
Set SAT deviation to 2 KHz.

C. RECEIVER SENSITIVITY

1) Connect R2008D to transceiver unit via the j
tion box. (Refer to Fig. 13.)
2) Execute the following manual commands:
   01 Suspend
   09 Load synthesizer (to desired chan
   12 Receiver unmute
3) Connect RX audio (on junction box) to R20
sinad input.
4) Set R2008D to generate on desired freque
(870 + channel # X 0.03 MHz), with 1
modulation at 8 KHz deviation.
5) Bypass the compandor on the transceiver u
6) Adjust the RF output level on the R2008D f
12 dB sinad reading in GEN/MON display.

NOTE: One can expect to see a difference of ab
dB of RF level between a C-mes
weighted sinad measurement and a
weighted sinad measurement on
R2008D, i.e. -115dBm on the R2008D
responds approximately with -116
C-message weighted.

D. POWER LEVEL SETTING

1) Connect R2008D to transceiver unit through the junction box. (Refer to Fig. 13.)
2) Set R2008D to Power Monitor. Through the manual test mode execute the following commands:
   01 Suspend
   09 Load synthesizer (enter desired channel)
   07 Carrier on
   10 Set attenuator (set to 0 highest power)
   NOTE: Power levels are as follows:

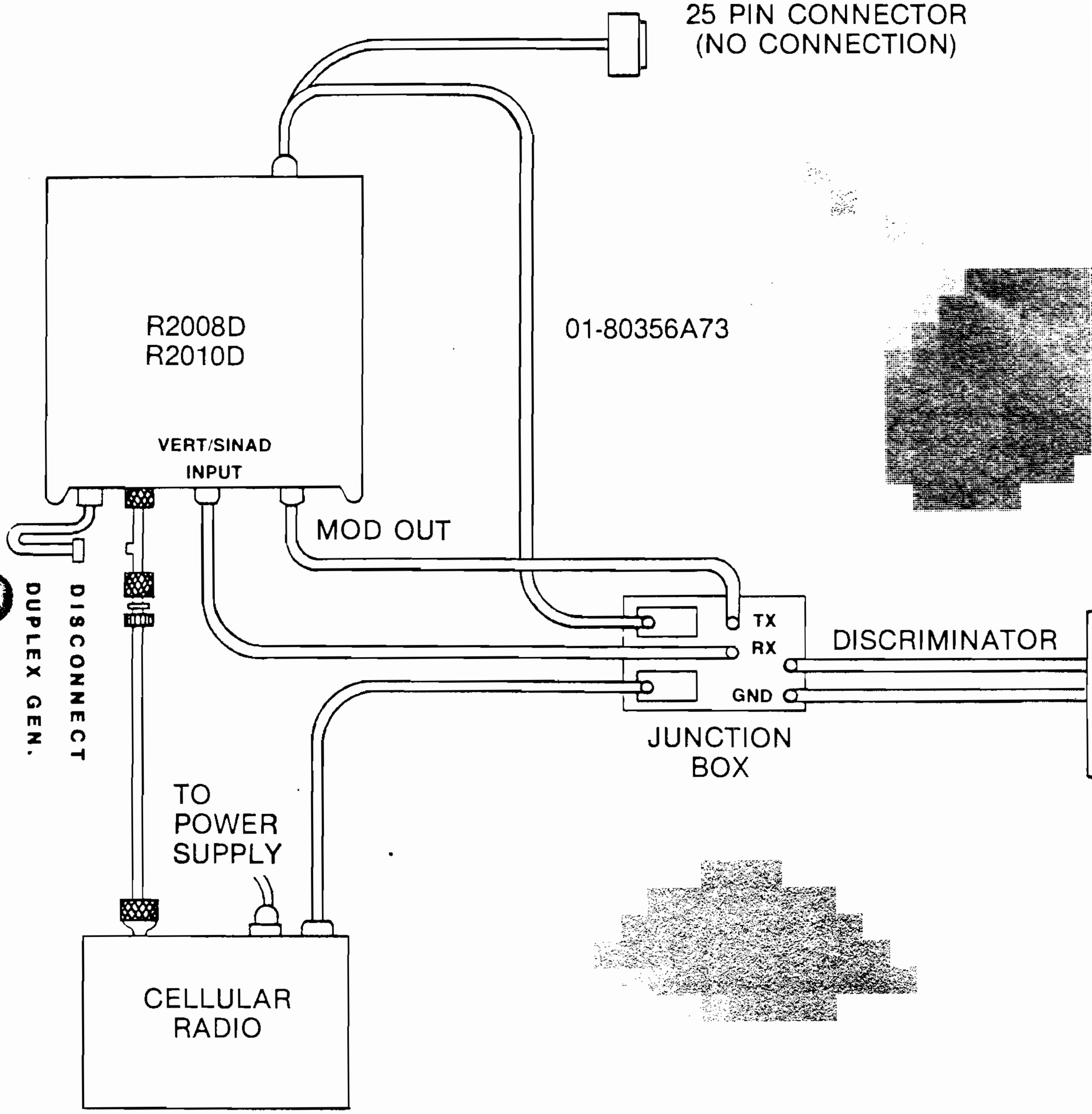
ATTENUATOR	WATTS	dBm
0	3.0	34.8
1	1.2	30.8
2	.48	26.8
3	.19	22.8
4	76mW	18.8
5	30mW	14.8
6	12mW	10.8
7	4.8mW	6.8

3) Note power level in GEN MON display. For the lower power levels, use the R2008D spectrum analyzer.
4) Select the spectrum analyzer display and note the relative power level in dB.
5) In the Signaling Sequence display, execute manual mode command 10, Set Attenuator (select desired attenuation).
6) Determine power level by using the spectrum analyzer display. Note the relative power level in dB. Power output should decrease in 4 dB steps as transceiver attenuator setting is increased through the manual test mode commands.

E. TESTING SIGNALLING AT THRESHOLD LEVEL

It is sometimes desirable to verify the operation of the mobile under weak signal conditions. This can be done by using the following procedure.

1) Connect the R2008D to the transceiver unit via the junction box as in Fig. 13.
2) Turn off the Duplex Generator and disconnect the output from the RF tee.
3) Select the Generator function and execute the following manual mode commands:
   01 Suspend
   09 Load synthesizer (enter the desired channel)
4) Set the R2008D to generate on the desired frequency (870 MHz + 0.03 X channel #), ex. 879.99 MHz = channel 333.
5) Select the DVM display on the R2008D and use a scope or meter probe to access the RSSI test point on the junction box.
6) Set the output level on the R2008D to the desired signaling level. A -108 dBm level is the accepted signaling threshold level. Note the voltage at the RSSI test point.
7) Connect the R2008D to the transceiver unit via the variable RF tee as in the Cell and Mobile Initiated Sequence tests. Reconnect the control head to the transceiver unit.
8) Insert a 60 dB attenuator (part no. 58-80314B21) in series with the Duplex Generator output. Set the variable tap on the RF tee to fully in (maximum coupling).
9) On the Initial Parameters screen, select one of the Forward Voice Channels (FVC) to be the same as the desired FOCC (data channel).
10) Select either the Cell or Mobile Initiated Sequences. Executed the test and handoff to the FVC loaded with the FOCC channel above.
11) Using a temporary exit from the Signaling Sequence screen, select the DVM display. Monitor the RSSI voltage and adjust the tap on the RF tee for the same RSSI voltage noted earlier. The signal being fed to the transceiver unit is now at the desired threshold level.
12) Continue with any of the Cell Initiated, Mobile Initiated or Auto Test sequences to test the performance of the mobile under threshold signaling conditions.

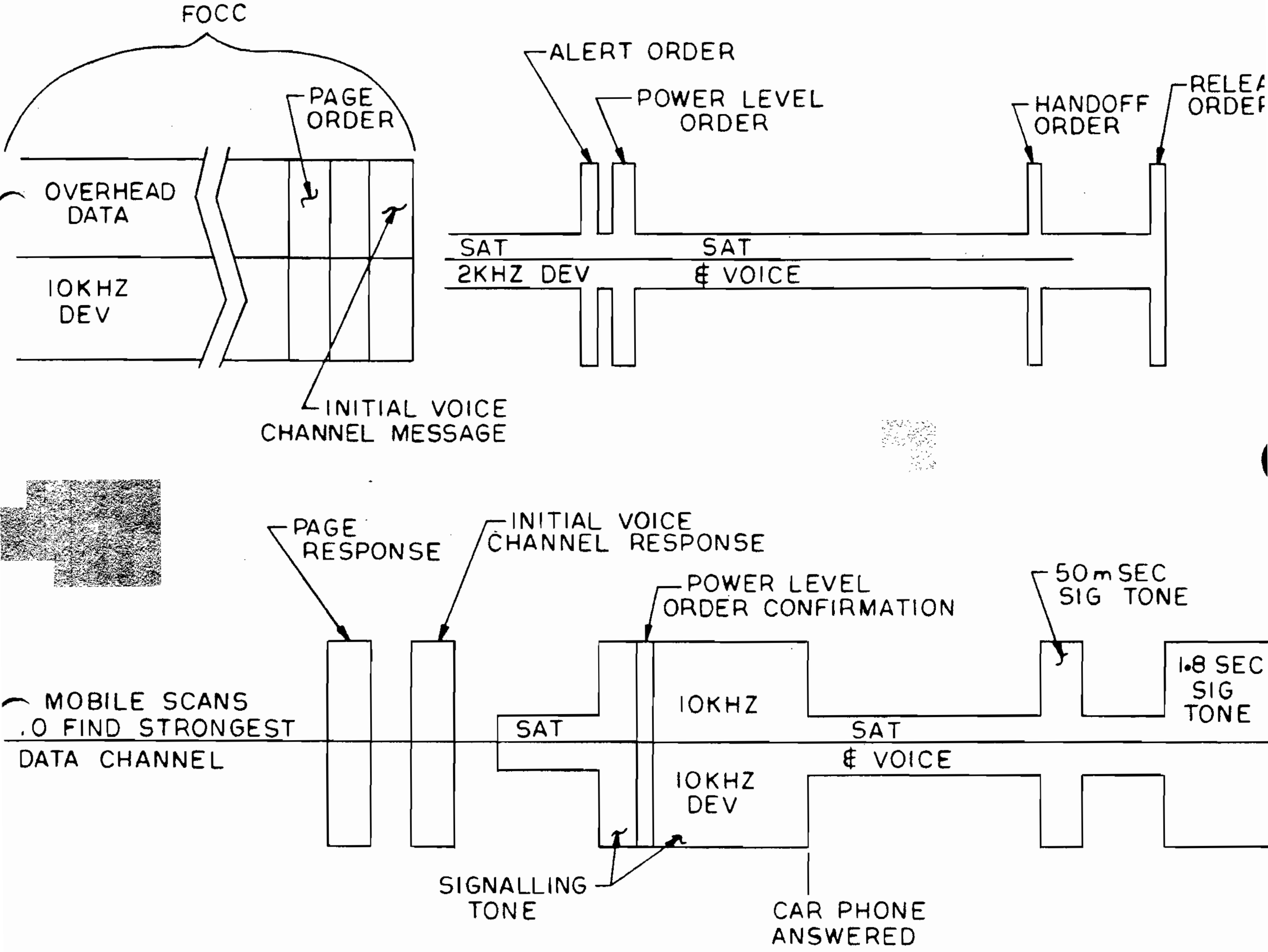


MANUAL MODE, TRANSCEIVER TESTS

FIGURE 13.

APPENDIX A
CELL INITIATED TEST STEP DEFINITION

The following illustration, figure 18, shows the major events in the Cell Initiated Sequence Test. The top line represents the forward, or from the base, data and SAT sequences. The lower line represents the reverse, or from the mobile, data and SAT exchange. The horizontal time axis is not to scale, this illustration is a conceptual overview of the handshaking that takes place in a cellular system.



CELL INITIATED TEST STEP DIAGRAM

FIGURE 18.

The following list corresponds to the step rectangles seen on the cell initiated sequence test screen, figure 5. The first sentence following each number is the help message that will be seen if the cursor is positioned under that test square on the R2008D/R2010D display.

R2008D/R2010D ACTIVATED

1. FOCC-system parameter overhead messages sent. The R2008D/R2010D sends a continuous stream of system parameter overhead messages to the mobile unit under test.

2. FOCC-paging message sent. The R2008D/R2010D sends a paging message to the mobile unit under test. The paging message contains the mobile telephone number entered in the initial parameters screen.

4. Voice channel designation message sent. The R2008D/R2010D sends a message to command the mobile to a forward voice channel.

6. Alert order sent. The R2008D/R2010D sends out an alert order to command the mobile to start ringing.

8. Power level command sent. A high power level command is sent by the R2008D/R2010D to the mobile.

10. Power level and handoff testing normal conversation mode. The R2008D/R2010D allows for manual power level testing of the other power levels possible from the mobile. Handoffs to the four possible forward voice channels can be made. A SAT drop test can be performed.

12. TEST COMPLETED.

MOBILE ACTIVATED

3. Page response accepted. The R2008D/R2010D perceives a valid page response from the mobile.

5. Sat accepted. The mobile and R2008D/R2010D are now on FVC #1. The R2008D/R2010D measures the SAT returned by the mobile to verify that it is the correct SAT.

7. Signaling tone accepted. The R2008D/R2010D detects a valid signaling tone from the mobile verifying that the mobile has been alerted.

9. Power level order confirmation accepted. The R2008D/R2010D has received an order confirmation from the mobile.

11. Release signaling tone accepted. The R2008D/R2010D has received a termination signaling tone.

APPENDIX B
MOBILE INITIATED TEST STEP DEFINITION

The following corresponds to the test step rectangles seen on the mobile initiated sequence test screen, Figure 7. The first sentence following each number is the help message that will be seen if the cursor is positioned under that test square on the R2008D/R2010D CRT screen.

CELL ACTIVATED	MOBILE ACTIVATED
1. FOCC-system parameter overhead messages sent. The R2008D/R2010D sends a continuous stream of system parameter overhead messages to the mobile under test.	
	2. Service request accepted with called address. The R2008D/R2010D accepts the service request message, displays the telephone number, the mobile and serial number from the mobile.
TL- Display called address.	
3. Voice channel designation message sent. The R2008D/R2010D sends a message to the mobile, instructing it to tune to a forward voice channel.	
	4. SAT accepted. The R2008D/R2010D measures the SAT returned by the mobile and verifies that it is correct.
5. Power level command sent. A high power level command is sent by the R2008D/R2010D to the mobile.	
	6. Power level order confirmation accepted. The R2008D/R2010D has received an order confirmation from the mobile.
7. Power level and handoff testing, normal conversation mode. The R2008D/R2010D allows for manual power level testing of the other power levels possible from the mobile. Handoffs to the four possible forward voice channels can be made. A SAT drop test can be performed.	
	8. Mobile terminates RVC. The R2008D/R2010D has received a termination tone from the unit under test.
9. TEST COMPLETED.	

APPENDIX C
DETAILED CELL INITIATED TEST ACTIONS

The following describes in more detail what goes on in a typical cell initiated sequence test. It includes internal functions to the cellular telephone. This is only a brief summary. Refer to the AMPS specification for a more detailed description and to find the definitions of various acronyms used.

R2008D/R2010D	MOBILE
Enter initial parameters through the initial parameters screen of the tone memory mode. SYSTEM ID MOBILE ID FOCC FVC #1 TO #4 FVC INCREMENT (AUTO TEST) PRINTER (YES/NO)	
	Power up mobile. Mobile performs DC power up task.
Enter cell initiated sequence test screen. The R2008D/R2010D starts to send a continuous stream of system parameter overhead messages.	
	Mobile performs initialization task. A. Scan control channels B. Tune to R2008D/R2010D FOCC. C. Acquire word sync. D. Receive overhead messages. E. Update overhead information.
	Perform paging channel selection task. A. Scan paging channels. B. Tune to R2008D/R2010D FOCC. C. Acquire word sync. D. Receive overhead message. E. Perform overhead message processing task.
	Enter idle task examine data for: A. Paging match. B. User request. C. Order. D. Overhead message.
	Receive paging message. Perform page response task. A. Scan access channels. B. Tune to R2008D/R2010D FOCC. C. Acquire word sync. D. Retrieve internal access parameters. E. Wait random delay. F. Seize RECC. G. Perform service request subtask. H. Enter await message subtask.
Accept page response. Extract mobile number and serial number and display on R2008D/R2010D.	
Send initial voice channel designation message.	
Tune to FVC.	

Perform initial voice channel confirmation subtask.
A. Tune receiver to R2008D/R2010D FVC.
B. Adjust transmit frequency to RVC.
C. Adjust rf power to VMAC.
D. Turn on SAT.
E. Set DSCMM to SCC.

Accept transponded SAT as an indication of mobile confirmation.

Enter waiting for order task.

Send alert order.

Receive alert order.
A. Turn on 10 KHZ signaling tone.
B. Generate "ring".

Accept signaling tone (10KHZ) as confirmation of alert order.

Enter waiting for answer task. A Maximum of 65 seconds allowed for answer.

Off hook (mobile is answered). Signaling tone is turned off.

Enter conversation task.
A. Set audio mode to conversation.
B. Two way audio conversation now in progress.

Send power level command. High power.

Adjust power level to that requested and send order confirmation.

Accept order confirmation. Manual power level testing permitted. Select power levels 0-7.

Adjust power level to that requested and send order confirmation.

Verify order confirmation.

Handoff testing permitted. Select FVC.

Send a 50 msec signaling tone as a confirmation. Change to the new RVC.

Confirm 50 msec signaling tone time for the handoff.

Switch to the new FVC.

SAT drop testing permitted. Select a new SAT frequency (1-3).

If a new SAT selected, the mobile should stop transmitting after 5 seconds.

Repeat power level and/or handoffs above as described.

Temporary exists allowed to analyze signals using the other R2008D/R2010D modes.

On - hook (mobile hangs up). Enter release task.
A. Set audio mode to idle.
B. Send signaling tone (10KHZ) for 1.8 seconds.

Receive termination signaling tone. Check for proper duration.

End of cell initiated sequence test.

APPENDIX E
WARNING AND ERROR MESSAGES

The warnings and errors possible in cellular testing are outlined in the following table.

SUMMARY OF WARNING AND ERROR MESSAGES

WARNINGS

1 Power level order confirmation not accepted.
3 Handoff signaling tone out of limits.
4 Termination signaling tone out of limits.
5 Invalid DTMF keycode. (Manual Test only)
7 Incorrect SAT returned.

ERRORS

4 Channel out of 1-666 limit
11 Page response not valid
12 Page response not received
13 Alert signaling tone not accepted
14 Handoff signaling tone not accepted
18 Service request message sent by mobile in error
19 SAT not returned
20 Too many bytes in free format command
21 Bell command not in 1-43 range
22 Transceiver does not acknowledge command
23 Transceiver's DCL has not gone high
24 Transceiver has not set TCL low
25 Transceiver has not set TCL line high
26 Transceiver not powered up
27 Transceiver did not accept all commands words
28 Transceiver did not send all response words
29 Too many bits in response word
30 Too few bits in response word
31 Transceiver timed out in idle state
32 Transceiver timed out in data state
33 Opcode error
34 No response from transceiver

WARNING 1

Power level order confirmation not accepted. The R2008D/R2010D has sent the cellular telephone a power level command. The telephone's confirmation has not been received or it has been detected as incorrect. Possible causes are low cellular telephone sensitivity, excessive loss in the RF test connections or an attenuation setting that is too high on the R2008D/R2010D.

WARNING 3

Handoff signaling tone out of limits. The R2008D/R2010D has detected that a 10Khz signalling tone sent by the cellular telephone the cellular telephone in response to a handoff message is out of limits. The typical duration is 50 msec. This warning is displayed if the duration is outside a 40-60 msec window.

WARNING 4

Termination signaling tone out of limits. The R2008D/R2010D has detected that the duration of the termination 10 kHz signaling tone is out of limits. The typical duration is 1.8 seconds. This warning is displayed if the duration is outside a 1.7 to 1.9 second window.

WARNING 7

Incorrect SAT returned. The R2008D/R2010D has detected that the SAT transponded back by the cellular telephone is out of limits. The three SAT tones are 5970, 6000 and 6030 Hz. The R2008D/R2010D allows a window of ± 10 Hz around the proper SAT. This warning can be induced if a large amount of background noise is present while initiating a sequence test, while doing handoffs or while performing an auto test sequence.

ERROR 4

Channel out of 001-(1)000 limit. A channel number entered in the initial parameters screen, is outside the 001-(1)000 limit allowed as valid FOCC and FVC's.

ERROR 11

Page response not valid. The page response sent by the cellular telephone is not valid. This error can be induced if the squelch control is set too close to 'breaking' or if the signal from the cellular telephone is attenuated too much due to a problem with the RF cable hookup, the R2008D/R2010D has too much attenuation dialed in on its front panel or if the cellular telephone has a transmitter that is below normal power. This is visually verified by looking at the red Sig Lvl lamp on the R2008D/R2010D front panel and by checking the current drawn by the transceiver unit. Normally, the LED will light once for a split second to indicate the R2008D/R2010D has received a paging reply. If the LED flickers several times over a 2 second period, the cellular telephone is trying to reply but the R2008D/R2010D does not recognize the transmission as a valid page response. If the LED does not light, check to be sure the car telephone is set up and that power is applied properly.

ERROR 12

Page response not received. This error indicates that the cellular telephone is not responding to a page message issued by the R2008D/R2010D. Check the R2008D/R2010D Sig Lvl LED as in error 11 above. Also, if the transceiver unit is transmitting, as verified by increased current draw, the radio may be locked onto spurious signal from the R2008D/R2010D Duplex Generator. If this is suspected, a 60 dB attenuator (part no. 58-80314B21) may be inserted in series with the Duplex Generator output jack.

ERROR 13

Alert signaling tone not accepted. This error indicates that the analyzer did not detect the 10KHz signaling tone from the cellular telephone.

ERROR 14

Handoff Signaling Tone not accepted. The mobile issues a 50 msec burst of signaling tone (10 kHz) in response to a handoff order while in the conversation mode. This error indicates that the R2008D/R2010D detects this tone to be outside a 40 to 60 msec window.

ERROR 18

Service request message invalid. The R2008D/R2010D has received a data packet from the mobile but it is not interpreting the received data as a valid service request message. This can be caused by the squelch breaking prematurely on the R2008D/R2010D, or by noise mixed with the incoming data packet. Make certain that the squelch on the R2008D/R2010D is not 'breaking' on noise. In normal operation, the Sig Lvl LED on the R2008D/R2010D will flash briefly while the R2008D/R2010D difficulties recognizing the service request, the LED will flicker several times during a 2 second interval. Verify good RF cable connections. Check the attenuation setting on tohe R2008D/R2010D (typically set at -50 dB).

ERROR 19

SAT not returned. A supervisory audio tone (SAT), even the wrong SAT, has not been returned by the cellular telephone. This error generally indicates that the cellular telephone has not shifted frequencies correctly as a result of an initial voice channel designation message or a handoff message. This error can be induced if the background ambient noise during a test is excessive.

*NOTE: The following errors are related to the manual test mode. Refer to figure 11 for an example of the STATUS command transfer sequence.

ERROR 20

Too many butes were specified in the manual mode free format (00) command. Only 3 bytes are allowed.

ERROR 21

Manual test command not in 1-43 range. The command entered is not in the 1-43 range of commands allowe by the AMPS spec.

ERROR 22

Transceiver does not acknowledge the command. The transceiver does not acknowledge the command jus sent. It can result if the cable between the R2008D/R2010D and the transceiver unit is not making good con nection. Also check power connection to the mobile unit. Only 5 of the 43 commands will function before a 01 SUSPEND command is sent. These are: STATUS, TURNAROUND, RESTART, RESET and SUSPEND

ERROR 23

Transceiver has not set DCL high. This error indicates that a command requiring returned information has been sent, but the direction control line (DCL) has not been set high by the transceiver unit, a necessary condition for the returned data transfer. This line is controlled by the transceiver.

ERROR 24

Transceiver has not set TCL low. This error indicates that a command requiring returned data has been sent, and the direction control line (DCL) has gone high indicating the transceiver understands that it is to return data, however, the test control line (TCL) has not gone low. The TCL must go low to indicate valid data on the manual bus.

ERROR 25

Transceiver has not set TCL high. This error indicates that a command requiring returned information has been sent, and the DCL has gone high indicating the transceiver is to return data, and the TCL has gone low to flag the R2008D/R2010D to read the data from the manual bus, however, the TCL has not gone back high to indicate the R2008D/R2010D has read the manual bus. The transceiver should return the TCL high when it senses that the R2008D/R2010D has lowered the clock line (CL) and has returned it high after reading data from the transceiver on the manual bus.

ERROR 26

Transceiver not powered up. The transceiver unit did not turn on or is not connected to a power source. Check all power connections and Re-Try the command.

ERROR 27

Transceiver did not accept all command words. The transceiver unit did not acknowledge receipt of all data sent by the R2008D/R2010D.

ERROR 28

Transceiver did not send all response words. The transceiver unit did not send all expected data to the R2008D/R2010D.

ERROR 29

Too many bits in response word.

ERROR 30

Too few bits in response word.

ERROR 31

Transceiver timed out in idle state.

ERROR 32

Transceiver timed out in data state.

Error 29, 30, 31, and 32 usually mean that the microprocessor in the transceiver malfunctioned.

ERROR 33

Opcode error-transceiver did not recognize a command word-usually with another error code.

ERROR 34

Transceiver did not transmit any response.

Words to the R2008D/R2010D. Check radio power and cabling connections to eliminate obvious sources of trouble and try again.

APPENDIX F
MANUAL TEST COMMANDS

01	SUSPEND	- Terminate the normal mode and enter the test mode. Perform initialization as specified b the INIT command and await further test commands. The autonomous timer shall be rese periodically unless a RESETOFF command received.
02	RESTART	- Terminate the test mode, enter the normal mode and restart call processing tasks.
03	STATUS	- Return the transceiver unit status to the R2008D/R2010D. Status definitions are: PL: Power level 0 (highest) - 7 (lowest) CARR: carrier (1-on) TN: Signaling tone (1-on) TXM: Transmit audio mute (1-muted) RXM: Receive audio mute (1-muted) WS: Word synchronization (1-ws acquired) MODE: 1-control channel, 0-voice channel BI: Current state of majority voted busy/idle (0-busy, 1-idle) SAT: SAT frequency is encoded as follows: 00 - 5970 HZ 01 - 6000 HZ 10 - 6030 HZ 11 - NO SAT LOCK
04	RESET	- Reset the autonomous timer
05	TURNAROUND	- echo the byte following the command to the R2008D/R2010D - requires 1 byte additional data
06	INIT	- Initialize the transceiver unit to the following state: 1 - Carrier off 2 - Attenuation - 0 DB 3 - Receive audio muted 4 - Transmit audio muted 5 - Signaling tone off 6 - Autonomous timer reset and its periodic resetting enabled 7 - SAT-OFF 8 - DTMF and audio tones-off
07	CARRIER-ON	- Turn the carrier on. Transpond sat only if the SATON command was previously receive
08	CARRIER-OFF	- Turn the carrier off.
09	LOAD-SYNTH	- Set the synthesizer to the channel specified by the 4 digits following the command: e.g. 03 sets synthesizer to channel #334.
10	SET-ATTN	- Set the RF power attenuation to the value specified in the data byte following the cor mand. 0-7 for lowest to high - attenuation
11	RXMUTE	- Mute the receive-audio signal.
12	RXUNMUTE	- Unmute the receive-audio signal.
13	TXMUTE	- Mute the transmit-audio signal.
14	TXUNMUTE	- Unmute the transmit-audio signal.
15	RESETOFF	- Discontinue periodic resetting of the autonomous timer (allow timer to time out).
16	STON	- Transmit a continuous signaling tone.

17	STOFF	- Stop transmission of the signaling tone.
18	SETUP	- Transmit a 5-word reverse control channel message. The digital color code shall be 11 and each of the five words shall consist of the following 48-bit data pattern (repeated 5 times): FF,00,AA,55,CC,33. No channel scan, busy-idle determination, or BCH encoding is to be performed. (There may or may not be forward control channel data present). The transceiver unit shall turn on the carrier at the start of transmission and turn off the carrier at the termination.
19	VOICE	- Transmit a 2-word reverse voice channel message. Each of the 2 words shall consist of the same 48-bit data pattern specified for the setup command. The Transceiver unit shall turn on the carrier at the start of transmission and turn off the carrier at the termination.
20	RCVSU	- Receive a 2-word forward control channel message, perform majority voting but no error correction and return the 10 bytes of data received to the TS.
21	RCVVC	- Receive a 1-word forward voice channel message perform majority voting but no error correction, and return the 5 bytes of data received to the TS.
22	SEND-NAM	- Return the information contained in the number assignment module (NAM) to the TS.
		- Number assignment module. The number assignment module (NAM) is a separate entity in the mobile equipment that shall store the following information.
		- System identification of home mobile service area (SID). The SID is a 15-bit number that is used by the mobile equipment to make the home/roam decision.
		- Local use mark. This 1-bit mark is used to make the local control state decision.
		- Min mark. This 1-bit mark when set to '1' indicates that home mobile equipment shall send extended address information upon origination and page response.
		- Mobile identification number (MIN). The MIN (consisting of MIN1 and MIN2) is a 34-bit number that identifies the mobile equipment.
		- Station class mark (SCM). The SCM is a 4-bit number that identifies the type of the mobile equipment.
		- Initial paging channels in home MSA (IPCH). The IPCH is an 11-bit number that is the channel number of the first control channel on which the mobile equipment will receive pages when it is in its home MSA.
		- Access overload class (ACCOLC). The ACCOLC is a 4-bit number that identifies which overload class field is used to control access by the mobile equipment.
		- Preferred system mark. This 1-bit mark when set to '1' identifies that the mobile equipment's preferred system is system A; otherwise, the preferred system is system.
		- Group identification mark (GIM). The GIM is a 4-bit number indicating how many bits of the SIDH, starting with the most significant, comprise the group identification.
		- Lock combination. This 12-bit number represents the sequence of three decimal digits that is used in unlocking the mobile equipment.
		- End-to-end signaling mark. This 1-bit mark when set to '1' indicates that the mobile equipment will have a DTMF keypad while in conversation mode.
		- Repertory mark. This 1-bit mark when set to '1' indicates that the mobile equipment is optioned for repertory storage.
		- Horn-alert mark. This 1-bit mark when set to '1' indicates that the mobile equipment is optioned for horn-alert.

		- Hands-free mark. This 1-bit mark when set to '1' indicates that the mobile equipment is o tioned for use with a hands-free control unit.
23	VERSION	- Return the software version information to the R2008D/R2010D.
24	SEND-SN	- Return the 32-bit serial number to the R2008D/R2010D. Display in hexadecimal.
25	MEM	- Return the resident memory data located at the address specified in the 2 bytes followin the command. The first and second bytes shall contain, respectively, the most and lea significant parts of the 16-bit address.
26	RSVS1	- Receive contiguous 1-word messages on the control channel. Perform majority voting an error correction on each message. Maintain separate counts of the number of uncorrectabl and correctable errors detected until a terminate command is received. If the count exceed 255 (decimal), a count of 255 is to be returned.
27	RCVV1	- Same as RCVS1 except on the voice channel.
28	WSTS	- Receive contiguous 1-word messages on the control channel. Maintain a count of th number of word synchronization sequences (11100010010) detected until a terminate command is received. The counter shall be 16 bits wide and the data shall be returned in th following format: BYTE 1 15 - - - - - - 8 BYTE 2 7 - - - - - - 0
29	WSTV	- Same as WSTS except on the voice channel.
30	BIBIT	- Receive continiuous forward control channel data, extract and perform majority voting or the busy-idle bits, and respond to status commands, and return the current state of the majority voted busy-idle bit. Reception of an INIT command terminates sequence.
31	TERMINATE	- Terminate operation off the previously issued RCVS1, RCVV1, WSTS, or WSTV command and return the data collected to the TS.
32	SATON	- Enable the transmission of SAT. The byte of data following the operational code shall contain the color code of the SAT frequency that the transceiver unit may expect to receive (see table below). SAT shall be transmitted if the carrier is currently on or if a subsequent carrier-on command is received. **COLOR CODE VALUE** — **SAT FREQUENCY** 00 — 5970 HZ 01 — 6000 HZ 02 — 6030 HZ
33	SATOFF	- Disable the transmission of SAT.
34	CDATA	- Transmit continuous 5-word reverse control channel messages. The digital color code shall be 10. Each of the 5 words shall consist of the 48-bit data pattern specified by the 6 bytes of data following the command. The data messages shall be contiguous. Subsequent reception of an init command shall terminate the transmission. The transceiver unit shall turn on the carrier at the start of the transmission.
15	HITNON	- Activate the high audio tone (1150 HZ) and apply it to the receive-audio line.
36	HITNOFF	- Deactivate the high audio tone.
37	LOTNON	- Activate the low audio tone (770 HZ) and apply it to the receive-audio line.
38	LOTNOFF	- Deactivate the low audio tone.
39	INVM	- Initialize non-volatile memory. Set registration memory and called-address repertory memory to zeros. Set lock state to active (locked).

40 RNVM - Read non-volatile memory and return to TS. The least-significant bit of the first byte transmitted shall contain the lock state, 1-active (locked). The next 80 bytes transmitted shall contain the called-address repertory (10 called-addresses (0-9), 8 bytes each). The first byte transmitted shall contain the two most-significant digits of called-address 9. The next 20 bytes shall contain the registration memory (4 entries of 5 bytes each) in the format shown below. Each group of 5 bytes shall be transmitted with the most-significant byte first.

41 WNVM - Receive 101 bytes from the TS (formatted as in TNVM) and write them to the non-volatile memory.

42 DTMFON - Activate the DTMF generator with the tones associated with the keycode given in the byte following the command. Apply DTMF signals to the modulator and DTMF sidetone to the receive-audio line.

KEY CODES

00-09	CORRESPOND TO 0-9 ON KEYPAD		
10	*	15	AUX ALERT
11	#	16	CLR
12	SEND	17	STORE
13	END	18	RECALL
14	LOCK	19	MUTE

43 DTMFOFF - deactivate the DTMF generator.

APPENDIX G
EPSON RX-80/LX-80 PRINTER SETUP

The optional RT-RX80/8148 printer as shipped by EPSON is configured for parallel operation. To use it with th R2008D/R2010D, the 8148 serial interface card must be installed. Both the main PC board in the printer and the interface card have a series of DIP switches that must be set as follows:

Main Board

DIP SW1	1-1 off	DIP SW2	2-1 on
	1-2 off		2-2 on
	1-3 off		2-3 off
	1-4 off		2-4 off
	1-5 off		
	1-6 on		
	1-7 on		
	1-8 on		

8148 Serial Board

DIP SW1	1-1 off	DIP SW2	2-1 on (off-parallel)
	1-2 off		2-2 on
	1-3 off		2-3 off
	1-4 off		2-4 off
	1-5 on		2-5 off
	1-6 off		2-6 off
	1-7 off		
	1-8 off		

Leave jumpers in factory set position.

Note: If the printer is also to be used as a parallel printer for the R-1801A NAM application, DIP SW2-1 on the 814 board may be brought out to an external toggle switch. In this case, leave SW2-1 off.

These switch settings correspond to:
1200 baud, no parity, 8 bit word length

APPENDIX H
U.K. CELLULAR SYSTEM ANALYZER (R2010D) DIFFERENCES

Basically, the U.K. (United Kingdom) TACS cellular system is very similar to the U.S. system. The pertinent differences are as follows:

A. Signaling Tone

The R2010D has been modified to accept a signaling tone of 8KHz, at a peak deviation of 6.4 KHz. The U.S. system uses a tone of 10KHz.

B. System Deviation

The TACS system uses the following deviations:

AUDIO: 2-3 KHz at a standard microphone input. See transceiver manual for required input levels.

DATA: 6.4 KHz at an 8KHz rate.

SAT TONES: 1.7 KHz.

SIGNALLING TONES: 6.4 KHz.

C. Channel Frequencies

The TACS system uses 1000 channels at 25 KHz channel spacing. The mobile transmitter frequencies start at 890.0125 MHz (channel 1) and the mobile receiver is 45 MHz higher (channel 1 = 935.0125 MHz). To determine channel frequency, use the following formulas:

TX frequency = (889.9875 + (channel #) x 0.025) MHz
RX frequency = (934.9875 + (channel #) x 0.025) MHz

Enter channels into the R2010D in the format channel #1 = 001, channel #1000 = 000, because the R2010D channel field is only 3 digits. Refer to figure 19.

D. Telephone Number and N.A.M. Protocols

See the transceiver manufacturer's literature for a full discussion of N.A.M. and telephone number formats.

CELLULAR SPECTRUM FOR UNITED KINGDOM

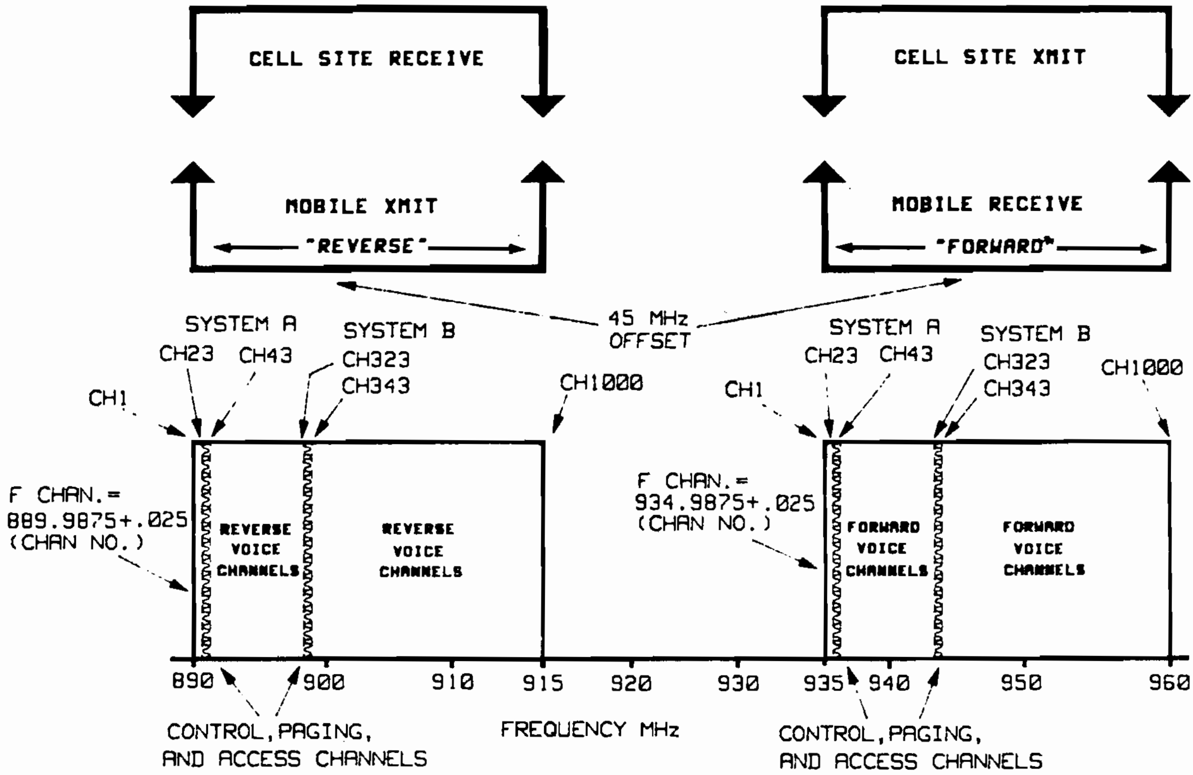


FIGURE 19.