WATKINS-JOHNSON

INSTRUCTION MANUAL

FOR

TYPE CSU-160 TUNER SWITCHING UNIT

WATKINS-JOHNSON COMPANY
700 QUINCE ORCHARD ROAD
GAITHERSBURG, MARYLAND 20760

WJ/125/HWO/5/28/76

WARNING

The CSU-160 contains voltages which may cause injury or death if contacted. Be extremely cautious when working on the CSU-160 with any of its protective covers removed.

CAUTION

Removing plug-in modules with power applied to the CSU-160 or its associated receiver may damage semiconductors in the CSU-160 or in the receiver.

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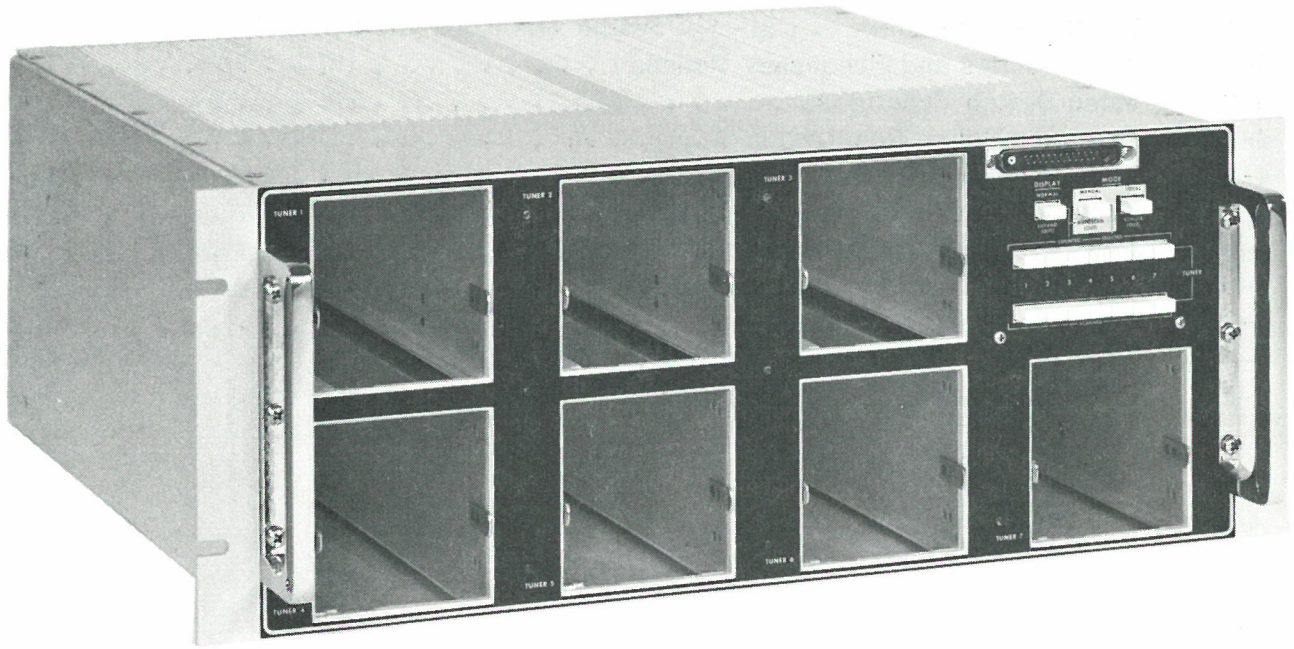


Figure 1-1. CSU-160 Tuner Switching Unit, Front View

SECTION I
GENERAL DESCRIPTION

1.1 ELECTRICAL CHARACTERISTICS

1.1.1 The Type CSU-160 Tuner Switching Unit is designed to operate with an SM-7301-( ) Signal Monitor and a Type 205-( ) Receiver or Type 215-( ) Receiver and any seven of the plug-in tuning heads which are available for use with both units. The plug-in tuning heads, which are normally mounted separately in the receiver, are mounted in front panel tuner openings in the CSU-160. Interconnections between the CSU-160 and the associated 205-( ) or 215-( ) Receiver are made through a Type EC-160 Extender Cable, which slides into the receiver tuning opening and mates with a multipin connector on the front panel of the CSU-160. A DRO-308-( ) Frequency Counter, and a DRX-308-( ) Digital Readout Extender, a DRO-335-( ) Frequency Counter, or a VM-101 Marker Unit can also be used with the CSU-160.

1.1.2 The CSU-160 operates in one of the following modes: AUTOSCAN, MANUAL, or REMOTE. An operating mode is selected by using the two front panel latching push-buttons labelled MODE.

1.1.2.1 Manual and Remote Modes. - In both the Manual and Remote modes the CSU-160 operates as a switchable tuner selector. In the Manual mode, the desired tuner is activated by depressing one of seven buttons in the front panel COUNTED/SELECTED switch bar. In the Remote mode, tuner selection is accomplished by applying a three-line binary coded input to a rear apron connector (TTL/DTL compatible). Connections between the active tuning head and the associated receiver are entirely electronic. The antenna inputs, IF and LO outputs, and power supply inputs to the tuners are all switched electronically.

1.1.2.2 Autoscan Mode. - In the Autoscan mode, the settings of the seven-button front panel SCANNED switch bar determine whether or not each of the seven tuners will be scanned. After the SCANNED switch bar is set, the electronics in the CSU-160 cyclically energizes each selected tuner. The front panel DISPLAY NORMAL/EXPAND switch determines whether the signal display traces of the tuner will appear in their normal one-seventh positions with the traces of unselected tuners missing (NORMAL), or will be amplified and level-shifted to fill the signal monitor screen no matter what number of tuners are scanned. Autoscan operation is intended for use with the receiver's Pan, Pan/Sec, or Sector operating modes. If the receiver is switched to the Manual or Remote modes, the CSU-160 will stop autoscanning.

For a typical example of CSU-160 operation, assume that the Autoscan mode has been selected, with DISPLAY Normal, Tuner 1 COUNTED, and Tuners 1, 3, and 4 SCANNED. Also assume that the associated receiver is operating in the PAN mode and that Tuner 1 is on. At the start of the operating cycle, the receiver generates a trigger and supplies it to the associated frequency counter and to the CSU-160 STEP TRIGGER INPUT. The trigger waveform rises at the completion of the receiver band scan, and

then falls 2 milliseconds later. On the negative transition, the DRO-308 counting cycle starts, and timing circuits are activated in the CSU-160. After a 2.75 millisecond delay (to allow completion of the frequency count) the CSU-160 switches to the next selected tuner, in this case Tuner 3. The scan repeats, and after the next trigger, Tuner 4 is energized. In the following cycle, the CSU-160 switches back to Tuner 1. Through the entire Autoscan sequence, the setting of the COUNTED switch determines that only the sector center frequency of Tuner 1 is read out by the frequency counter The INHIBIT COUNT OUTPUT of the CSU-160 suppresses the Tuner 3 or Tuner 4 count display. Of course, the SM-7301-( ) Signal Display displays the PAN traces of all three tuners. Because of the DISPLAY Normal setting, the traces are all at one-seventh amplitude, with the baseline of the Tuner 1 trace located 6/7 above the bottom of the monitor screen, that of Tuner 3 located at the 4/7 position, and that of Tuner 4 at 3/7. If the DISPLAY switch was changed to Expand, then the three traces would each occupy one-third of the screen, with Tuner 1 at the top, Tuner 3 at the center, and Tuner 4 at the bottom.

If the Receiver is switched to the SECTOR mode, the SM-7301( ) Signal Display will display the sector trace of each selected tuning head. The SECTOR WIDTH control on the receiver determines the upper and lower limits of the swept sector, while the manual tuning knob on each tuning head sets the sector's center frequency. In the example, the center frequency of the Tuner 1 sector is still read out on the frequency counter since the CSU-160 remains in the Autoscan mode with Tuner 1 counted.

If the Receiver is switched to PAN/SEC mode, the SM-7301( ) Signal Display will display a full set of PAN traces interspersed with SEC traces, that is, two traces will be displayed for each selected tuner. The frequency counter readout remains the same. Because of the slow repetition rate for each scan and the small size of the SM-7301( ) display screen, this mode of operation is not recommended when more than two tuners are being scanned.

1.2 MECHANICAL CHARACTERISTICS

1.2.2 The CSU-160 Tuner Switching Unit mounts in a standard 19-inch equipment rack. With the CSU-160 positioned directly below an associated Type 205-( ) or 215-( ) Receiver, interconnections between the receiver and the CSU-160 can be conveniently made through an EC-160 Extender Cable.

1.2.2 All front panel controls for the CSU-160 mount in plug-in control module A4. They consist of a seven push-button SCANNED switch bar, a seven push-button COUNTED/ SELECTED switch bar, a two push-button MODE selector switch, and a DISPLAY NORMAL/EXPAND pushbutton. The power line voltage input to the CSU-160 is controlled by a relay which is energized by an +18 V input from the associated receiver.

1.2.3 The rear panel of module A4 mounts multipin REMOTE CONTROL connector A4J1, STEP TRIG IN connector A4J2, VIDEO OUT connector A4J3, VIDEO IN connector A4J4, a permanently mounted power cord, and 115/220 V ac line voltage select switch S2.

1.2.4 All exterior panels and interior tuner housings are constructed of aluminum. The main frame mounts VHF/UHF switch assemblies A1 and A2; IF switch assembly A3; and control assembly A4. Modules A1 through A3 are built in brass chassis which have been plated to increase conductivity and prevent tarnishing. Assembly A4 is a plug-in aluminum subchassis which in turn mounts plug-in printed circuit modules A4A1 through A4A8.

1.3 EQUIPMENT SUPPLIED

The equipment supplied consists of the Type CSU-160 Tuner Switching Unit and a Type EC-160 Extender Cable only.

1.4 EQUIPMENT REQUIRED BUT NOT SUPPLIED

The CSU-160 is designed to operate with either a Type 205-( ) or 215-( ) Receiver, and up to seven of the tuners available for operation with these units. A BP-205 Blank Panel can be used to cover any tuner opening(s) that is not being used. If it is desired to indicate the tuned frequency of any selected tuner, a DRO-308-( ) or a DRO-335-( ) Frequency Counter is required. (A DRX-308-( ) Digital Readout Extender must be used with the DRO-308-( ) Frequency Counter when using a tuner that operates above 300 MHz.) The Type SM-7301-( ) Signal Display is required for displaying received signals.

Table 1-1. Type CSU-160 Tuner Switching Unit, Specifications

Tuning Head Complement	7 Tuning Heads selected from HH-11, VH-11, -12, -13, -14, -15, -16, -17; UH-11, -12, -13 (not included)
Antenna Input Connectors	Type N
Antenna Input Switching Loss	2 dB, maximum (0.9 MHz to 1 GHz)
Modes of Operation	Manual, Remote, and Autoscan
Remote Select Code Inputs	Positive logic, 3 line TTL/DTL compatible (Fan In = 3 standard unit loads)

Remote Select Code	Tuner Position
000	1
001	2
010	3
011	4
100	5
101	6
110	7

Autoscan Trigger Rate	Controlled by receiver SWEEP RATE Control, .04 to 25 Hz

Table 1-1. Type CSU-160 Tuner Switching Unit, Specifications (Continued)

Autoscan Trigger Level	Negative going, 500 μsec, 5 V pulse, compatible with trigger input on DRO-308 or DRO-335 Frequency Counter, or 2 msec, 18 V positive square wave generated by the associated 205 Receiver's counter gate.
Y-Axis Input Impedance	45 kΩ
Y-Axis Input Level	1.0 V, nominal
Y-Axis Output Level	1.0 V, nominal
Outputs (rear apron BNC connectors):	
Y-Axis Video Output	Compatible with SM-7301A Signal Display or Tektronix 602 Oscilloscope.
LO Output	Compatible with DRO-308 Frequency Counter. Output Switching loss 3 dB, maximum.
IF Output	IF output from selected HH, UH, or VH Tuning Head, compatible with associated receiver. Switching loss 1.5 dB, maximum.
Tuner On Outputs (7)	Tuner On output corresponding to active tuner goes to +18 V.
Counter Inhibit Output	+15 output to hold count of selected tuner on DRO-308-( ) or DRO-335-( ) Frequency Counter Display.
Preset/DAFC Code Outputs	Three bit binary output to program presets and DAFC speed of DRO-308-( ) or DRO-335-( ) Frequency Counter.
Display Modes:	
Normal	Allows up to 7 tuning heads to be displayed in sequence at predetermined horizontal increments on the associated signal display. Each tuner displayed occupies 1/7 of the CRT area. Traces for tuners not selected are blanked.
Expanded	Allows the CRT area to be equally divided among the tuners selected to provide an increase in vertical deflection for each display.
Front Panel Controls	Display mode select, Manual/Autoscan, Local/Remote, Tuner Scanning, Tuner Counted/Selected.
Power Requirements	115/230 V ac, ±10%, 48-420 Hz
Power Consumption	8 watts, approximately (without tuning heads installed)
Dimensions	7.0 inches high, 19 inches wide, and 17.75 inches deep (17.8 cm high, 48.3 cm wide, and 48 cm deep)
Weight	25.5 pounds (11.6 kg), approximately (without tuning heads installed)

SECTION II
INSTALLATION AND OPERATION

2.1 UNPACKING AND INSPECTION

Examine the shipping carton for damage before the CSU-160 is unpacked. If the carton has been damaged, try to have the carrier's agent present when the CSU-160 is unpacked. If not, retain the shipping cartons and padding material for the carrier's inspection if damage to the CSU-160 is evident after it has been unpacked.

See that the equipment is complete as listed on the packing slip. Contact Watkins-Johnson Company, Gaithersburg, or your Watkins-Johnson representative with details of any shortage.

The CSU-160 was thoroughly inspected and factory adjusted for optimum performance prior to shipment. It is ready for use upon receipt. After opening the shipping carton and checking its contents against the packing slip, visually inspect all exterior surfaces of the CSU-160 for dents and scratches. If external damage is visible, remove the dust covers and inspect the internal components for apparent damage. Then check internal cables for loose connections, and check to see that printed circuit boards have not been loosened from their receptacles.

2.2 INSTALLATION

2.2.1 RACK/MOUNTING SUPPORT. - Rack mounted equipment, manufactured by WJ Gaithersburg, is designed for assembly in standard 19 inch racks in accordance with MIL-STD-189, or E.I.A. standard No. RS-310. The unit may be supported on the front panel in static installations, but it is recommended that chassis slides be added for ease of assembly, access to the unit, and to provide additional support. The methods used to mount the equipment in mobile installations should be evaluated on an individual basis.

2.2.2 THERMAL CONSIDERATIONS. - This equipment is designed to operate at temperatures between 0° C and 50° C (32° F to 122° F). The operational temperature range is further qualified for free, unrestricted ambient air at sea level pressure. Equipment installation should provide for free flow of air around and through ventilated units. Multiple stacking, in particular close adjacent stacking of electronic equipment in a standard console, can produce an appreciable increase in the ambient air temperature for the units in comparison to the ambient air temperature in the vicinity of the the console. Forced-air ventilation may be necessary to maintain the proper ambient air temperature in a console which accommodates equipment that contributes to a high thermal density.

2.2.3 POWER CONNECTION. - Before energizing the CSU-160 it is necessary to set it to match the input power source voltage to be used. The CSU-160 can operate from either a 115 or 220 V ac, 48-420 Hz source. Rear panel switch S1 must be set accordingly. The tapped-primary main power transformer can be rewired for 230 V ac operation where high line voltages are common. (See note 3 in Figure 6-6.) The line voltage input to the CSU-160 is controlled by a relay and driver amplifier, which are in

turn controlled by a +18 V input from the associated receiver. Before plugging in the unit, make sure that the EC-160 Extender Cable is disconnected or that the receiver is turned off. The third pin on the power plug supplies a safety ground connection. If the two-pin to three-pin adapter supplied with the unit must be used, be certain that the ground wire of the adapter is securely connected to a low impedance ground.

2.2.4 SYSTEM INTERCONNECTIONS. - The CSU-160 is designed to function with any other components of the RS-160 Receiving System, including the Type 205-( ) Receiver and any of its associated heads, the Type SM-7301( ) Signal Display Unit, the Type DRO-308-( ) Frequency Counter and DRX-308-( ) Range Extender, or the DRO-335-( ) Frequency Counter. System interconnection diagrams for six common RS-160 System configurations that incorporate the CSU-160 are provided in Figure 2-1. The input and output connections on the front and rear panel of the CSU-160 are summarized in Table 2-1.

NOTE

Installing a CSU-160 in an RS-160 System manufactured before the CSU-160 was introduced may cause problems requiring the modification of the tuners, receiver, or frequency counter in the system. Modifications are required if one or more of the traces on the signal monitor are defective near the left (low frequency) end of its screen. The traces may be incomplete, distorted, give false signal indications or have non-linear baselines. If any of these symptoms appear after installing a CSU-160 in an older RS-160 System, contact Watkins-Johnson in Gaithersburg, Maryland for the modifications required.

2.2.5 TUNERS. - To install a tuner in the CSU-160, turn the LOCK lever on the tuner front panel fully counterclockwise. Insert the tuner into one of the openings in the CSU-160 so that its connectors mate with the connectors inside the tuner opening. Lock the tuner into the tuner opening by turning its LOCK lever one-quarter turn clockwise until the lever clicks. Table 2-2 lists the tuners that can be used in the CSU-160 and their frequency ranges. Use a VH- or HH-Series tuner in tuner position 1, a VH-Series tuner in tuner position 2 through 5, and a UH-Series in tuner positions 6 and 7.

NOTE

Inserting a UHF tuner in tuner positions 1 through 5 will degrade the performance of the tuner. Using the RF switches and antenna inputs on the unit at other than the frequencies for which they were intended may degrade their input signals.

Table 2-1. CSU-160 Inputs and Outputs

CONNECTOR	INPUT/OUTPUT	PIN NUMBER
J1 (Front Panel)	Tuning Voltage	1
	Manual Tuning Output	2
	Tuning Ground, Precision Regulator Ground, Manual Tuning Ground	3
	+30 V (NC)*	4
	+10.3 V	5
	-10.3 V	6
	+18 V	7
	-18 V	8
	10 kHz BW Select	9
	50 kHz BW Select	10
	300 kHz BW Select	11
	1 MHz BW Select	12
	WB IF Select	13
	NB IF Select	14
	+18 V Manual On	15
	AGC Voltage	16
	Preset Code 2^0	17
	2^1	18
	2^2	19
	VM 105 Code 2^0	20
	2^1	21
	Spares	22, 23, 24
	Power Ground	25
CP3J1	Tuner 1 Switched RF Input	
CP4J1	Tuner 1 RF Input	
CP6J1	LO Output 250-1000 MHz	
CP5J1	LO Output 2-300 MHz	
CP2J1	RF Input 250-1000 MHz	
CP1J1	RF Input 2-300 MHz	
A4J1 Remote Control (Back Panel)	Ground	1

* A +30 V power supply inside the CSU-160 provides +30 V supply inputs to the tuners in its tuner frame. The +30 V power supply input from the receiver is not used.

Table 2-1. CSU-160 Inputs and Outputs (Continued)

CONNECTOR	INPUT/OUTPUT	PIN NUMBER
(Back Panel)	Remote 2^0	2
	Tuner 2^1	3
	Select 2^2	4
	Counter Inhibit	5
	Step Trigger	6
	Tuner No. 1 On	7
	Tuner No. 2 On	8
	Tuner No. 3 On	9
	Tuner No. 4 On	10
	Tuner No. 5 On	11
	Tuner No. 6 On	12
	Tuner No. 7 On	13
	Manual (H)/Autoscan (L)	14
	Remote (H)/Local (L)	15
	Spares	16 through 19
A4J2	Step Trigger Input	
A4J3	Video Input	
A4J4	Video Output	

Table 2-2. Tuning Heads and Frequency Ranges

Tuning Head	Frequency Range
HH-11	2-30 MHz
VH-11	30-60 MHz
VH-12	60-120 MHz
VH-13	100-180 MHz
VH-14	180-300 MHz
VH-15	20-40 MHz
VH-16	40-80 MHz
VH-17	50-100 MHz
UH-11	250-500 MHz
UH-12	500-1000 MHz
UH-13	200-400 MHz

2.2.6 EC-160 CONNECTION. - One end of the EC-160 Extender Cable consists of a dummy tuning head, which may be inserted into the tuning head recess in the front panel of the Type 205-( ) or 215-( ) Receiver. The other end of the cable mates with receptacle J1 on the front panel of the CSU-160. (See Figure 6-17 for a schematic diagram of the EC-160 Extender Cable.)

2.2.7 ANTENNA CONNECTIONS. - Connect a VHF antenna to RF INPUT jack CP1J1. Connect a UHF antenna to RF INPUT jack CP2J1. If a separate HF antenna is to be used with Tuner 1, disconnect the jumper cable between CP3J1 and CP4J1, and connect the antenna to CP4J1.

2.2.8 LOCAL OSCILLATOR OUTPUT CONNECTIONS. - VHF local oscillator outputs (2-300 MHz) are available at rear panel LO OUT jack CP5J1, while UHF local oscillator outputs (250-1000 MHz) appear at LO OUT jack CP6J1. Connect these two outputs to a DRO-335-( ) Frequency Counter, DRO-308-( ) Frequency Counter, and/or a DRX-308-( ) Range Extender. (If a DRX-308-( ) Range Extender is used, set its Bypass Mode switch (S3) to the UHF/VHF position.)

2.2.9 VIDEO OUTPUT CONNECTION. - Connect VIDEO OUT jack A4J4 on the CSU-160 rear apron to the Y-axis input of the SM-7301( ) Signal Display unit.

2.2.10 REMOTE CONTROL CONNECTIONS. - Connect multipin REMOTE CONTROL connector A4J1 to A1J15 of a DRO-308-( ) Frequency Counter to J1 of a DRO-335-( ) Frequency Counter, to J10 of a 205-( ) Receiver, or to a remote control cable, as required by the system configuration.

2.2.11 STEP TRIGGER INPUT. - Connector A4J2 provides an alternate means for routing the step trigger into or out of the CSU-160. The step trigger input is usually routed into the CSU-160 via pin 6 of Remote Control Connector A4J1.

2.3 OPERATION

Refer to Table 3-1 for a summary of CSU-160 pushbutton positions and operating modes.

2.3.1 AUTOSCAN MODE. - Set the two latching pushbuttons on the MODE switch to AUTOSCAN (OUT) and LOCAL (IN). Set each of the latching pushbuttons 1 through 7 in the SCANNED switch bar IN if that numbered tuning head is to be scanned; OUT if it is not. Set the button on the COUNTED/SELECTED switch bar IN corresponding to the tuner whose frequency is to be read out on the frequency counter. Set the DISPLAY pushbutton to NORMAL (IN) to present the scan traces at 1/7 amplitude and in fixed locations on the Signal Display CRT. Set the DISPLAY pushbutton to EXPAND (OUT) to cause the scan traces to fill the display at amplitudes and locations on the CRT determined by the number of tuning heads being scanned. When operating the CSU-160 in the AUTOSCAN Mode, the associated Type 205-( ) or 215-( ) Receiver must be operated in the PAN, SEC, or PAN/SEC mode for scanning to occur. If the system includes a DRO-308-( ) or DRO-335-( ) Frequency Counter, it must also be activated during Autoscan operation.

2.3.2 MANUAL MODE. - Latching the left-hand MODE switch IN (Manual) converts the CSU-160 to operation with a single tuning head chosen by the COUNTED/SELECTED switch. The SCANNED and DISPLAY switches are disabled and the single trace on the Signal Display appears at full amplitude.

2.3.3 REMOTE MODE. - Unlatching the MODE switch converts the CSU-160 to remote control operation and disables all of the other pushbuttons on the CSU-160. In the Remote mode, the operating tuning head is selected by means of a 3-bit (TTL compatible) binary code input through pins 2, 3, and 4 of Remote Control connector A4J1.

2.4 PREPARATION FOR RESHIPMENT AND STORAGE

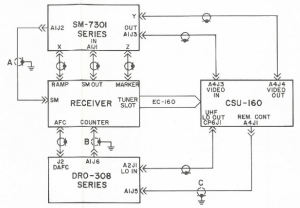
If the unit must be prepared for reshipment, the packaging methods should follow the pattern established in the original shipment. If the original materials are retained they can be reused or will at a least provide guidance for the repackaging effort.

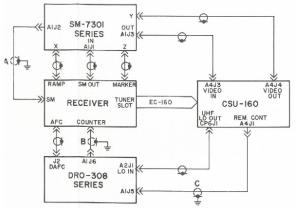
Conditions during shipment and storage should normally be limited as follows:

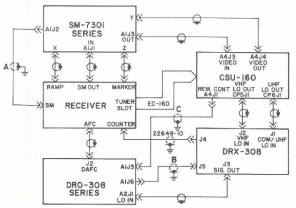
(1) Maximum humidity: 95% (no condensation)

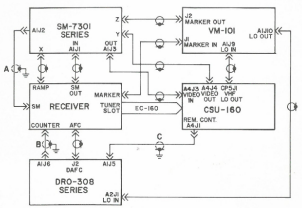
(2) Temperature range: -30° C to +85° C (-22° F to 185 ° F).

VARIABLE EQUIPMENTS	CABLE PART NOS. 22649-8	22649-9	22649-10	22649-11	22649-12
SM-7301	A				
SM-7301A	A				
SM-7301A-2	A				
SM-7301A-3	A				
SM-7301B		A			
SM-7301B-2		A			
SM-7301B-3		A			

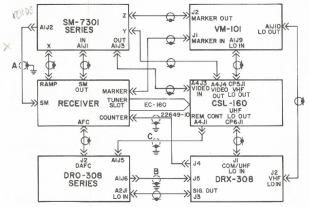


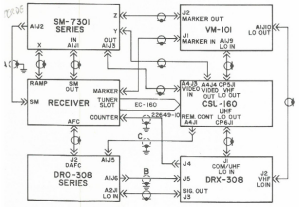


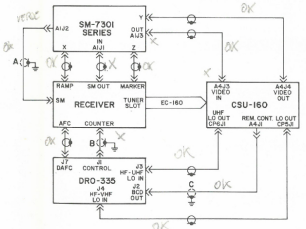


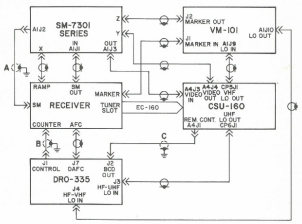


VARIABLE EQUIPMENTS	CABLE PART NOS. 22649-8	22649-9	22649-10	22649-11	22649-12
DRO-308	B		C		
DRO-308A		B	C		
DRO-335			C		B









NOTES
1. ALL COAXIAL CABLES SHALL BE PART NO. 17300-65-1.

Figure 2-1. Interconnection Diagrams for RS-160 System with CSU-160

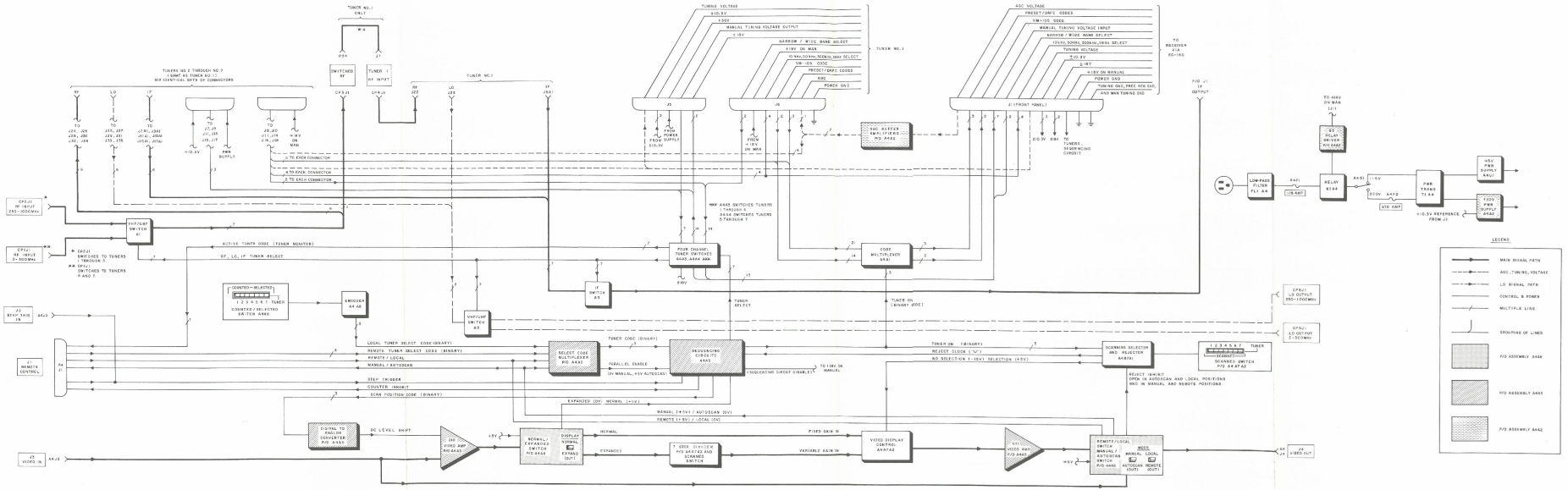


Figure 3-1. CSU-160 Tuner Switching Unit, Functional Block Diagram

SECTION III
CIRCUIT DESCRIPTION

3.1 GENERAL

The following paragraphs describe the circuits in the CSU-160 Tuner Switching Unit. A discussion of the schematic diagrams is preceded by a discussion of the overall functional block diagram. The schematic discussion is arranged in a functional sequence so that the operation of the CSU-160 can be better described and understood. The location of any specific schematic discussion can be found in the table of contents.

Each electrical component in the CSU-160 is identified using the unit numbering system, so that every circuit board or assembly part carries an assembly and subassembly prefix followed by an individual class letter and item number. For example, the full designation for resistor R1 on circuit board A4 in subassembly A1 of assembly A2 is A2A1A4R1. These prefixes are not given in full in the illustrations and in the text unless they are necessary to avoid confusion.

3.2 FUNCTIONAL DESCRIPTION

3.2.1 INTRODUCTION. - The circuits in the CSU-160 include switching and interface circuits, control circuits, video processing circuits, and power supply circuits. The switching and interface circuit connect the inputs and outputs of a selected tuner to the receiver in response to signals originating in the control circuits. The control circuits sequentially connect tuners that have been previously selected on the SCANNED switch to the receiver, or individually connect a tuner selected on the COUNTED/SELECTED switch. The control circuits also connect the tuner selected on the COUNTED/SELECTED switch to an external frequency counter. The video processing circuits scale and dc-level shift the video from the associated receiver so that frequency scans from one or more selected tuners can be displayed on an associated signal monitor. The power supply circuits provide power supply inputs for the circuits in the CSU-160 and voltages for each of the seven tuners installed in its tuning head frame. The mode switch controls the operation of the circuits in the CSU-160. A functional summary of the of CSU-160 switch positions operating modes appears in Table 3-1.

3.2.2 SWITCHING AND INTERFACE CIRCUITS. - When a tuner is selected by the control circuits for connection to the associated receiver the switching and interface circuits perform the following functions:

Table 3-1. Functional Summary of CSU-160 Switch Positions and Operating Modes

MODE SWITCH POSITION		TUNER SWITCHING	COUNTER INHIBIT	NORMAL/EXPANDED SWITCH POSITION	VIDEO PROCESSING
LOCAL	AUTOSCAN	Sequentially switches tuners that have been set on SCANNED switch.	Allows count of tuner set on COUNTED/SELECTED switch.	NORMAL	Each tuner scan occupies 1/7 of the tuner screen.
				EXPANDED	Each tuner scan occupies a vertical portion of the screen in proportion to the number of tuners selected for display.
	MANUAL	Tuner set on COUNTED/SELECTED switch is switched to receiver.	Allows count of tuner set on COUNTED/SELECTED switch.	NORMAL/EXPANDED switch disabled	Video is routed directly from the input to the output and remains unprocessed.
REMOTE	AUTOSCAN/MANUAL switch disabled	Tuner corresponding to remote tuner select code on REMOTE CONTROL connector J1 is switched to receiver.	Tuner corresponding to remote tuner select code is counted.	NORMAL/EXPANDED switch disabled	Video is routed directly from the input to the output and remains unprocessed.

(1) Antenna Switching - The RF input of the selected tuner is switched to an antenna with an appropriate frequency range.

(2) Local Oscillator Switching - The LO output from the selected tuner is is switched to an external frequency counter or its associated frequency extender.

(3) IF Switching - The IF output from the selected tuner is switched to the IF input of the associated receiver.

(4) IF Bandwidth Select, ±18 V, Manual Tuning Voltage Switching - The narrow and wide band outputs on the receiver are connected to two of four of its IF bandwidth inputs through a shorting plug on the selected tuner. The manual tuning voltage from the selected tuner is switched to the receiver, and the ±18 V power supply output from the receiver is switched to the selected tuner.

(5) Preset/DAFC Codes and VM-105 Code Switching - Tuner Codes and VM-105 codes are switched between the selected tuner and receiver.

(6) AGC Buffering - The tuners are supplied with AGC voltages from the receiver through three AGC Buffer amplifiers.

The circuits that provide these functions are described in the following paragraphs, and are keyed to the Functional Block Diagram in Figure 3-1.

3.2.3 ANTENNA SWITCHING. - VHF/UHF Switch A1 switches the output from an antenna with an appropriate frequency range to the RF input of the selected tuner. (See Figure 3-1). The VHF section of A1 switches the RF inputs of tuners* 2, 3, 4, and 5 to the output from a VHF antenna, and the UHF section of A1 switches the RF inputs of tuners 6 and 7 to the output from a UHF antenna.+ The RF input of tuner 1 can be connected to the VHF section of A1 through jumper cable W-4 or it can be connected to a separate HF antenna through rear panel connector CP4J1.

The VHF/UHF switch is activated by a set of seven lines from the two Four Channel Tuner Switches. Each line corresponds to one of the tuners, and when a line goes from -18 V to +18 V, the corresponding tuner input is connected to an antenna output.

* The tuner in position 1 will hereafter be referred to as tuner 1, the tuner in position 2 will hereafter be referred to as tuner 2, etc.

\+ An HH- or VH-Series Tuner should only be inserted in tuner position 1, VH-Series tuners should only be inserted in tuner posisions 2 through 5, and UH-Series Tuners should only be inserted in tuner positions 6 and 7.

3.2.4 LOCAL OSCILLATOR SWITCHING. - The output from the local oscillator of the selected tuner is switched to an external frequency counter by VHF/UHF Switch A2. The VHF section of A2 switches the LO outputs of tuners 1 through 5 and the UHF section of A2 switches the LO outputs of tuners 6 and 7. The outputs from the VHF and UHF sections of the switch are connected to separate VHF and UHF outputs on the back panel, which are compatible with the inputs on a DRO-308 Frequency Counter and/or a DRO-308X Frequency Extender, or a DRO-335 Frequency Counter.

VHF/UHF Switch A2 connects in parallel with A1 to the set of seven control lines originating from the two Four Channel Tuner Switches. When a control line goes from -18 V to +18 V, the LO output from the corresponding tuner switches to one of the LO outputs on the rear panel.

3.2.5 IF SWITCHING. - IF Switch A3 switches the IF output from the selected tuner to the IF input of the associated receiver through a connector on the front panel of the CSU-160. The IF outputs of each of the tuners connect to A3. The output of A3 connects to a coaxial connector that is physically a part of front panel connector J1.

The IF switch connects in parallel with A1 and A2 to the set of seven control lines from the Four Channel Tuner Switches. When a control line goes from -18 V to +18 V, the IF output from the corresponding tuner is switched to the front panel connector on the CSU-160 which is connected to the IF input on the associated receiver through an EC-160 extender cable.

3.2.6 IF BANDWIDTH SELECT, ±18 V, MANUAL TUNING VOLTAGE. - The Four Channel Tuner Switches (A4A3, A4A4) provide the receiver with IF bandwidth information and manual tuning voltage from the selected tuner and provide the selected tuner with a ±18 V power supply voltage. Each tuner switch channel provides these switching functions for one tuner. Tuner switch A4A4 connects to tuners 1 through 4 and tuner switch A4A3 connects to tuners 5 through 7, with one of its channels unused.

The four channel tuner switches provide the receiver with IF bandwidth information by connecting its Narrow Band and Wide Band Select outputs to two of its four IF bandwidth inputs via a shorting plug on the selected tuner. The two Four Channel Tuner Switches connect the narrow and wide band select outputs from the receiver (which connect to the CSU-160 through front receptacle J1) to the shorting plug of the selected tuner. The plug connects the wide and narrow band outputs of the receiver to one of its four IF bandwidth select inputs via receptacle J1 on the CSU-160 front panel and a mating receptacle (J8, J10, J11, J14, J16, or J18) on the CSU-160 tuning frame.

The Manual Tuning voltages are taken from potentiometers driven by the tuning dial on each tuner. The manual tuning voltage from the selected tuner connects to the receiver through one of the two Four Channel Tuner Switches. The receiver inverts the tuning voltage in the manual mode, and inverts and sums the tuning voltage with a ramp voltage when the receiver is in the PAN or SECTOR modes. The processed tuning voltage is returned to the tuners through the Tuning Voltage line, which connects in parallel to all of the tuners.

A ±18 V power supply input from the receiver is supplied to the active tuner through the one of the Four Channel Tuner Switches. Applying power supply voltage to

only one tuner at a time makes interaction between tuners unlikely, since only one tuner at a time is on. The ±18 V supply also illuminates the pilot lamps in the tuning dial of the active tuner, indicating that the tuner is on.

In addition to providing switching between the tuner and receiver, the Four Channel Tuner Switches also activate switch assemblies A1, A2, and A3 through seven Tuner Select lines. Each of the lines originates from one of the switch channels, and connects to the switch control inputs that activate the LO, RF, and IF inputs and outputs (A1, A2, A3) on the corresponding tuner. When the channel for a particular tuner is activated, its tuner select line goes from -18 V to +18 V, switching the IF, LO, and RF signals on the tuner corresponding to the channel activated.

Another set of seven Active Tuner Code lines supply external equipment with an indication of which tuner is active through Remote Control receptacle A4J1 on the rear panel. The Active Tuner code lines can also be used to preset an external frequency counter. Each of the lines connects to one of the channels on the Four Channel Tuner Switches. When a channel is activated, its Active Tuner Code line goes to +18 V, indicating to external equipment that the corresponding tuner is active.

A Tuner Select code on seven control lines from the sequencing circuits activates the tuner switches. The line corresponding to the selected tuner goes to +5 V, activating the appropriate tuner switch channel.

3.2.7 PRESET/DAFC AND VM-105 CODES. - Code Multiplexer A4A1 switches the Preset/DAFC and VM-105 Codes between the selected tuner and the receiver. The DAFC codes preset an external frequency counter to subtract the IF frequency from the LO frequency of a tuner so that a readout of the tuned frequency is obtained. The VM-105 code sets an external marker generator to generate markers in the frequency range of the selected tuner. The Code Multiplexer switches the preset codes from the selected tuner to the receiver in response to a binary tuner on code from the Sequencing Circuit. The code for the selected tuner is sent over three lines, each of which represents one binary digit in the Tuner Active code. A high on one of the lines represents a "1" and ground represents a zero. Table 3-2 lists the binary codes for each of the seven tuners.

Table 3-2. Tuner Codes and Frequency Ranges

Tuner Number	Binary Code	Frequency Range
1	000	VHF or HF*
2	001	VHF
3	010	VHF
4	011	VHF
5	100	UHF
6	101	UHF
7	110	UHF

* Tuner number one can be connected to a separate HF antenna through back panel connector CP4J1, or it can be connected to VHF/UHF switch A1 through jumper cable W4 and connector CP3J1.

3.2.8 AGC VOLTAGES. - The AGC voltage from the receiver is continually supplied to the tuners through three AGC Buffer Amplifiers (P/O A4A2). One of the amplifiers connects to three of the tuners and the other two amplifiers each connect to two of the tuners. The AGC amplifiers isolate the AGC output of the receiver from load changes as the tuners switch on and off. The AGC inputs to the tuners are in turn isolated from each other by RC networks at the outputs of each of the amplifiers.

3.2.9 CONTROL CIRCUITS. - The control circuits coordinate the switching and video processing functions of the CSU-160. The Control Circuits include the REMOTE/LOCAL and MANUAL/AUTOSCAN sections of the MODE Switch, the COUNTED/SELECTED switch and its associated encoder circuits, the Select Code Multiplexer, the Sequencing Circuits, and the Scanning Selector and Rejector circuit.

3.2.10 REMOTE/LOCAL AND MANUAL/AUTOSCAN SWITCHES (P/O A4A6). - The REMOTE/LOCAL and MANUAL/AUTOSCAN switches send a +5 V level to the Sequencing Circuits via the Select Code Multiplexer when they are in the MANUAL and REMOTE positions and a 0 V level when they are in AUTOSCAN and LOCAL positions (See Table 3-3). The significance of these logic levels will be apparent shortly.

Table 3-3. Mode Switch Functions

MANUAL/ AUTOSCAN Switch Position	REMOTE/ LOCAL Switch Position	VIDEO	REJECT/ INHIBIT LINE	REM/LOCAL LINE	MAN/ATSCN LINE
MANUAL	REMOTE	Bypassed	Gnd.	High (+5 V)	Low (Gnd.)
AUTOSCAN	REMOTE	Bypassed	Gnd.	High (+5 V)	High (+5 V)
MANUAL	LOCAL	Bypassed	Gnd.	Low (Gnd.)	Low (Gnd.)
AUTOSCAN	LOCAL	Processed	Open	Low (Gnd.)	High (+5 V)

3.2.11 COUNTED/SELECTED SWITCH AND ENCODER (A4A8). - The COUNTED/SELECTED switch and its associated Encoder determine which tuner is connected to the receiver in the Manual Mode and the tuner that has its frequency read out by an external frequency counter in the Manual and Autoscan Modes. The COUNTED/SELECTED switch and Encoder sends the Select Code Multiplexer a binary Local Tuner Select code corresponding to the tuner that is to be counted and/or selected. The binary code for each tuner is listed in Table 3-2.

3.2.12 SELECT CODE MULTIPLEXER (P/O A4A5). - The Select Code Multiplexer routes a binary Remote Tuner Select code from the Remote Control input to the Sequencing Circuit when there is a high on the line from the REMOTE/LOCAL switch and routes the Local Tuner Select code from the COUNTED/SELECTED switch and encoder to the Sequencing Circuit when there is a low on the line from the REMOTE/LOCAL switch. The Select Code Multiplexer also sends a low input to the parallel enable inputs on the counters in the Sequencing circuit when there is a high on the line from the MANUAL/AUTOSCAN switch.

3.2.13 SEQUENCING CIRCUITS. - The Sequencing Circuits sends control signals to the Four Channel Tuner Switches, Code Multiplexer, and Scaning Selector and Rejector circuit. The Sequencing Circuits also send an Inhibit pulse to an external frequency counter, and a binary Scan Position Code to a digital to analog converter in the video processing circuitry.

In the Manual mode, the Sequencing Circuit receives the binary Tuner Select Code from the COUNTED/SELECTED Switch and Encoder through the Select Code Multiplexer and in turn sends a Tuner On Code on the Code Multiplexer. (The Scanning Selector and Rejector circuit also connects to the Tuner On output of the Sequencing Circuit, but it is disabled in the Manual mode so that the select code has no effect.) The Sequencing Circuit also translates the Tuner Code from the multiplexer into a high on the corresponding Tuner Select line to the Four Channel Tuner Switches.

In the Autoscan mode, the Sequencing Circuit changes the Tuner On code to the next higher tuner number selected on the SCANNED switch at the end of each frequency scan until the highest selected tuner number is reached. The Sequencing circuit then cycles back to the lowest numbered tuner selected on the SCANNED switch in response to a Reject Clock pulse generated by the Scanning Selector and Rejector Circuit. The Code Multiplexer and Four Channel Tuner Switches respond to the changing tuner code by sequentially connecting the tuners selected on the SCANNED switch to the receiver. The Sequencing Circuits change the Tuner On code when they receive a step trigger input from the receiver at the end of each tuner frequency scan. The Sequencing Circuits can operate in the Autoscan mode only when their parallel enable input is high (AUTOSCAN/MANUAL switch in AUTOSCAN position) and the +18 V On Manual input from the receiver is off (Receiver in PAN/SEC, SECTOR, or PAN mode). These conditions enable the Step Trigger inputs to the counters in the Sequencing Circuits allowing them to generate the Tuner On Code.

When the Sequencing Circuits are in the Autoscan mode, they also send a Counter Inhibit pulse to an external frequency counter. The counter inhibit pulse only allows the frequency counter to display the output from the tuner corresponding to the code from the COUNTED/SELECTED Switch and Encoder. When the Tuner On code corresponds to the Local Tuner Select Code from the COUNTED/SELECTED Switch and Encoder, the sequencing circuit generates a +18 V Counter Inhibit pulse that activates a gate on the input to the frequency counter. A 2 ms Step Trigger pulse from the receiver is simultaneously connected to the frequency counter and CSU-160 via Remote Control receptacle A4J1 or Step Trigger In connector A4J2. The frequency counter begins counting the LO frequency of the tuner on the trailing edge of the trigger pulse, and finishes its count 2.5 ms later. The falling edge of the counter inhibit pulse occurs 2.75 ms after the trailing edge of the trigger pulse, allowing the frequency counter to complete its count before the sequencing circuit activates another tuner. The frequency counter stores this count on its display until the tuner chosen on the counted switch is again activated.

3.2.14 SCANNING SELECTOR AND REJECTOR (P/O A4A7A1). - The Scanning Selector and Rejector circuit generates Reject Clock pulses when the CSU-160 is in the Autoscan mode. In all other modes the circuit is disabled by a low on the Reject Inhibit line from the REMOTE/LOCAL and MANUAL/AUTOSCAN switches.

The Scanning Selector and Rejector receives the Tuner On binary code from a counter in the Sequencing Circuits. When the Sequencing circuit generates a Tuner On code and the SCANNED pushbutton corresponding to the Tuner On code is not depressed, the Scanning Selector and Rejector generates a Reject Clock Pulse. The Reject Clock pulse causes the counter in the Sequencing Circuit to rapidly sequence through the tuner code represented by the pushbutton. The counter sequences through the unselected tuner code in less than two microseconds, effectively skipping that particular Tuner On Code.

The counter in the Sequencing Circuits continues to rapidly sequence through each tuner code in response to a Reject Clock pulse until it reaches a code with a depressed SCANNED pushbutton. The Sequencing Circuits then pause until the next step trigger pulse, since the Sequencing Circuits do not generate a Reject Clock pulse for a code corresponding to a depressed pushbutton the Sequencing Circuits generate the Tuner On Code for tuner 7 the Scanning Selector and Rejector generates a Reject Clock pulse that causes the Sequencing Circuits to cycle back to the Tuner On Code for tuner 1.

If none of the pushbuttons in the SCANNED switch are depressed, the Scanning Selector and Rejector puts a -18 V level on the No Selection/Selection line to the Video Display Control circuit. This disables the Variable Gain input of the Video display control, which is discussed in paragraph 3.2.2.1.

3.2.15 VIDEO PROCESSING CIRCUITS - The video processing circuits scale and dc level shift the video output from the associated receiver so that the frequency scans of several tuners can be simultaneously displayed on a signal monitor. The video processing circuits only operate when the CSU-160 is in the Autoscan mode and the receiver is in the PAN, SEC, or PAN/SEC modes. When the CSU-160 is in the LOCAL/MANUAL or REMOTE modes and/or when the receiver is in the Manual mode, the video is connected directly between the Video In (A4J3) and Video Out (A4J4) connectors, and no video processing occurs. (See Table 3-1.) The Video Processing Circuits include the Digital to Analog converter, Video Amplifiers U10 and U11, the NORMAL/EXPANDED switch, the 7 Step Divider, and the Video Display Control circuits. The REMOTE/LOCAL and MANUAL/AUTOSCAN Switches route the video signal between CSU-160 inputs and outputs and activate the Scan Selector and Rejector Circuit when they are in the Autoscan and Local Positions.

3.2.16 REMOTE/LOCAL AND MANUAL/AUTOSCAN SWITCHES (P/O A4A6). - In addition to the functions described in paragraphs 3.2.14 and 3.2.15, the REMOTE/LOCAL and MANUAL/AUTOSCAN switches also connect the output of the Video Processing Circuits to the Y input of the signal monitor in the Autoscan mode, and bypass the Video Processing Circuits and connect the receiver output directly to the signal monitor input when in the manual mode. Thus the following discussion only applies to the Video Processing circuits when the CSU-160 is operating in the Autoscan mode.

3.2.17 DIGITAL TO ANALOG CONVERTER (P/O A4A5) - The Digital to Analog Converter takes the binary Scan Position Code and generates dc levels which are used to vertically position the scan of each tuner on the signal monitor screen. The Scan position code is taken from one of two counters in the Sequencing Circuit, each of which is sequenced by the step trigger pulse from the associated receiver. One of the Counters is

connected to the Reject Clock pulse, and has been described in paragraph 3.2.14 and the other counter is not.

When the NORMAL/EXPANDED switch is in the NORMAL depressed position, a high (+5 V) is on the Expanded Normal line to the Sequencing circuit, and the Sban Position Code is taken from the counter that is connected to the Reject Clock pulse. The Scan Position code is then the same as the Tuner On code, and the output level from the Digital to Analog converter is in direct proportion to the Tuner On code. Each tuner scan occupies one seventh of the signal monitor screen in the NORMAL mode, and if the SCANNED pushbutton corresponding to a particular tuner is not depressed, the voltage from the D/A converter causes the portion of the signal monitor screen corresponding to that particular tuner to be left blank.

When the NORMAL/EXPANDED switch is in the EXPANDED position, a low is on the Expanded Normal line to the Sequencing Circuit, and the Scan Position code is taken from the counter in the Sequencing Circuit that is not connected to the Reject Clock line. This counter sequences to the next binary code each time a Step Trigger is received and stays at that code even if it does not correspond to a tuner that has been selected for scanning by the SCANNED switch. The code from the counter returns to zero after the highest numbered tuner selected by the SCANNED switch has been scanned. As a result, the number of tuners selected for scanning by the SCANNED switch determines the number of voltage increments from the Digital to Analog converter each time the Sequencing Circuit cycles through the Tuner On Codes.

3.2.18 VIDEO AMPLIFIER U10 (P/O A4A5) - Video Amplifier A4A5U10 sums the output from the Digital to Analog converter with the Video signal from the associated receiver. It also presents the input of the seven step divider with a constant impedance. The output of A4A5U10 is applied to the NORMAL EXPANDED switch.

3.2.19 NORMAL/EXPANDED SWITCH (P/O A4A6) - The output from Video Amplifier U10 goes to the Video Display Control circuit when the NORMAL/EXPANDED Switch is in the NORMAL position, and to the 7 Step Divider when it is in the EXPANDED position. In the NORMAL position scans from the selected tuners each occupy one seventh of the tuner screen, with tuner number one occupying the top seventh of the screen, tuner number two occupying the second seventh of the screen, etc. The portions of the screen corresponding to unselected tuners are left blank. In the EXPANDED position, the output from the Video amplifier goes to the 7 Step Divider, and the switch sends a low to the Sequencing circuit causing the video of the scans from the tuners to be dc level shifted so that they fill equal portions of the height of the signal monitor screen. If, for instance, three tuners are selected with the SCANNED pushbuttons, each tuner scan occupies one third of the screen and when four tuners are selected each tuner scan occupies one fourth of the height of the screen, etc.

3.2.20 STEP ATTENUATOR (P/O SCAN SELECT SWITCH). - The Seven Step Attenuator attenuates signals from the NORMAL/EXPANDED switch when it is in the EXPANDED Position. One section of the attenuator is mechanically linked to each of the SCANNED switch pushbuttons, so that one step of attenuation is added for each tuner selected for scanning. Since the steps are equal, the video is attenuated in proportion to the number

of tuner scans being displayed. (If two tuner scans are displayed each scan is attenuated by half; if three scans are displayed, each scan is attenuated by a half; if three scans are displayed, each scan is attenuated by a two thirds, etc.). The video from each scan contains a dc level from the Digital to Analog Converter that is also attenuated as it passes through the 7 Step Divider. The dc levels on the video from each of the tuner scans would shift the scans down the height of the signal monitor screen if they were not attenuated by the seven step divider. The 7 Step Divider attenuates the level shifts on each of the video signals in proportion to the number of tuners selected for display by the SCANNED switch, causing each scan display to be shifted to fill an equal portion of the screen. If, for instance, four tuners are selected for scanning, the Digital to Analog Converter will supply a dc level shift on each of the video signals from the scans of the selected tuners, and the 7 Step Divider will attenuate each of these dc level shifts so that its associated video signal will be shifted down one quarter of the height of the signal monitor screen.

3.2.21 VIDEO DISPLAY CONTROL (A4A7A2) - The Video Display Control circuit has a Fixed gain input used in the Normal mode, and a Variable Gain input used in the Expanded mode. The Fixed gain input attenuates the signals from Video Amplifier A4A5U10 by one seventh of their original value so that each of the video signals from the receiver will occupy one seventh of the height of the tuner screen, and the level shifts from the Digital to Analog Converter will cause each scan to be shifted across one seventh of the height of the tuner screen. The Variable gain input matches the output from the seven step attenuator in the Expanded mode and blocks the input from the 7 Step Divider when the No Selection/Selection line is at -18 V and none of the SCANNED pushbuttons have been depressed.

3.2.22 VIDEO AMPLIFIER U11 (P/O A4A5) - Video Amplifier A4A5U11 buffers the output of the video display control and contains circuitry that centers the video display on the signal monitor screen.

3.2.23 POWER SUPPLY CIRCUITS - The power supply voltages for the CSU-160 and the tuners it switches are obtained from the associated receiver and two self-contained power supplies. The power supplies inside the CSU-160 include a +30 V power supply and a +5 V power supply. The +30 V power supply provides voltages for the tuning voltage shaping circuits in the tuners and the +5 V power supply provides voltages for the logic circuits in the CSU-160.

The precision ±10.3 V power supply input from the receiver provides voltages for the potentiometers in the tuning heads and a positive reference voltage for the +30 V power supply. It also provides voltages for the Digital to Analog Converter. The ±18 V power supply input from the receiver provides power supply voltages for the active tuner and the remainder of the circuits in the CSU-160.

3.2.24 FILTER A1FL1, RELAY A4K1 AND RELAY DRIVER A4A2Q3 - Line voltage age enters the CSU-160 through Low Pass Filter A4FL1 which isolates the unit from power line borne interference and transients. Line voltage is connected from A4FL1 to relay A4K1 through 115 V fuse A4F1. The +18 V On Manual input from the receiver

actuates Relay K1 through Relay Driver A4Q3. The ±18 V power supply connects to the CSU-160 through front panel connector J1. With this arrangement, power line voltage connects to the CSU-160 power supplies only when the associated receiver is on and connected to the CSU-160.

3.2.25 POWER TRANSFORMER A4T1. - The voltage from relay A4K1 goes to power transformer A4T1 through switch A4S1 and fuse A4F2 when A4S1 is in the 230 V position. Line voltage select switch A4S1 allows the unit to be operated from 230 or 115 V power line voltages and A4F2 protects the power transformer primary when the unit is operated at 230 V. The power transformer converts the 115/230 V line voltage to low voltage ac for the +5 V and +30 V power supply circuits.

3.2.26 +30 V AND +5 V REGULATOR CIRCUITS - Low voltage ac from the power transformer is rectified and applied to regulator module A4U1, an integrated circuit that provides a regulated +5 V output for the logic circuits in the CSU-160. Low voltage ac from the power transformer is also rectified and regulated by the +30 V power supply circuits. The +30 V power supply provides voltages for the tuning voltage shaping circuits in the tuners and is referenced to the precision +10.3 V power supply input from the associated receiver.

3.2.27 RECEIVER POWER SUPPLY INPUTS - The ±10.3 V power supply input from the receiver provides a reference for the +30 V regulator in the receiver and voltages for the tuning potentiometers in the tuners. The output voltages from the tuning potentiometers and the tuning voltage shaping circuits are thus kept at the same relative levels. The ±10.3 V input also provides voltages for the Digital to Analog Converter. The ±18 V power supply input provides power supply voltages for the remainder of the circuits in the CSU-160 and provides power supply voltages for the active tuner.

3.3 MAIN CHASSIS SCHEMATICS

3.3.1 The CSU-160 consists of four major subassemblies, A1 through A4, which mount on the tuner frame (main chassis). RF switch A1, LO switch A2 and IF switch A3 are shown in Figure 6-16. Control Assembly A4 carries the rest of the switching circuitry, the control and video processing circuitry, and the power supply circuitry are shown in Figure 6-16. A wiring harness on the tuner frame connects the receptacles on the backs of the tuner openings and front panel receptacle A4J1 to subassemblies A1 through A4. Terminal board TB1 mounts behind a cover plate on the right side of the CSU-160 and provides test points for the wiring harness on the main tuning frame. A schematic diagram of the wiring harness and terminal board TB1 is shown in Figure 6-15. J5 through J18 connect the tuners to the wiring harness. The RF, IF, and LO switch assemblies (A1 through A3) connect to the wiring harness through A1P1 and J20, A2P1 and J21, and A2P1 and J19, respectively. The wiring harness in turn connects to Control Assembly A4 through J3 and A4P1, J2 and A4P2, and J4 and A4P3. Inputs to and outputs from Control Assembly A4 are made through connectors mounted on the assembly which protrude through the back panel openings in the CSU-160 tuner frame.

3.3.2 The RF Switch outputs (from assembly A1) and LO Switch inputs (to assembly A3) connect to the tuners through receptacles J22 through J35 at the back of the tuning frame. (See Figure 6-16). The RF input from tuner position 1 can be connected to the RF switch through cable W4 and connectors CP3J1 and CP4J1, or it can be connected to an HF antenna through connector CP4J1. The tuner IF outputs connect to the IF switch through J5A1, J7A1, J9A1, J11A1, J13A1, J15A1, and J17A1, which are physically parts of receptacles J5, J7, J9, J11, J13, and J15, respectively (see Figure 6-15). The output of IF Switch Assembly A3 connects to the receiver through IF output connector J1A1 which is part of front panel receptacle J1. A UHF and a VHF antenna connect to the inputs of RF switch through back panel connector CP2J1 and the LO switch connects to the input of a frequency counter through back panel connectors CP5J1 and CP6J1.

3.4 TYPE 791121 RF/LO VHF/UHF SWITCH ASSEMBLY (A1 and A2)

Switch assemblies A1 and A2 both contain two positive intrinsic negative (PIN) diode switching circuits for the UHF frequency range and five PIN diode switching circuits for the VHF frequency range. Switch assembly A1 switches the input from a UHF antenna between tuners 6 and 7 and the input from a VHF antenna between tuners 1 through 5, while RF Switch Assembly A2 switches the LO outputs from tuners 6 and 7 to UHF LO output CP6J1 and switches the outputs from tuners 1 through 5 to VHF LO output CP5J1. * Paragraphs 3.4.1 and 3.4.2 describe the operation of the UHF and VHF switching circuits on switch boards A1A1 and A1A2, while paragraph 3.4.3 describes the inputs and outputs to RF Switch Assembly A2. The operation of switch boards A2A1 and A2A2 is not discussed since they are identical to A1A1 and A1A2 except that their inputs and outputs have been reversed.

3.4.1 VHF SWITCH BOARD (A1A1). - The output from a VHF antenna connects to VHF/UHF Switch Assembly A1 at A1J1. (See Figure 6-1.) A PIN diode switching network routes this signal to the active VHF tuner through one of output connectors A1J3 through A1J7. The four channel tuner switch control outputs connect to the control inputs on the assembly via feedthrough capacitors C1, C3, C5, C7, and C9. The -18 V power supply connects to the control inputs through pull down resistors R1 through R5 via C2, C4, C6, C8, and C10. R1 through R5 hold the control inputs at -18 V when the control outputs from the four channel tuner switches are at 0 V. When an input from the four channel tuner switch goes to +18 V, it forward biases one of the diodes on A1A1, creating a low resistance path between J1 and one of outputs J2 through J7.

Refer to the schematic of switch board A1A1 in Figure 6-2. Isolation resistors R1 through R5 keep the RF signal from being shorted to ground by the control inputs. PIN diodes CR1 through CR5 are normally reverse biased by the negative voltages on their respective isolation resistors and their common dc ground path through chokes L1 and L2 and resistor R6. L1 and L2 keep the RF signal from being grounded through R6, and blocking capacitors C1 through C6 keep the dc bias across the diodes from appearing at the switch input (E11) and the switch outputs (E1, E3, E5, E7, and E9). Only one of the control inputs switches to +18 V at a time, forward biasing one of the

* See Note in paragraph 2.2.5.

diodes through its isolation resistor and the common dc ground path, and allowing the signal to pass from the input to one of the outputs through their respective blocking capacitors. The isolation resistor of the forward biased diode and the resistance of R6 limit its forward bias current.

3.4.2 UHF SWITCH BOARD A1A2. - The output from a UHF antenna connects to the UHF switch assembly at A1J2. (See Figure 6-1.) Two PIN diode switches route this signal to the active UHF tuner through output connector J8 or J9. The four channel tuner switches connect to the control inputs on the assembly via feedthrough capacitors C11 and C13. The -18 V power supply connects to the control inputs via pull down resistors R6 and R7 and bypass feedthrough capacitors C12 and C14. R6 and R7 normally hold the control inputs at -18 V. When an output from the four channel tuner switch goes to +18 V, it forward biases one of the diodes, creating a low resistance path between J2 and J8 or J9.

Figure 6-3 shows the schematic of UHF switch board A1A2. Isolation resistors R1 and R2 and chokes L1 and L2 keep the RF signal from being shorted to ground by the control inputs. PIN diodes CR1 and CR2 are normally reverse biased by the negative voltages on their isolation resistors and chokes and their common dc ground path through choke L3. L3 keeps the signal from being grounded through the bias path and blocking capacitors C1 through C3 keep the dc bias across the diodes from appearing at the switch input (E5) and outputs (E1 and E3). Only one of the control inputs is switched to +18 V at a time, biasing one of the diodes through L3 and allowing the signal to pass from the input to one of the outputs through its respective blocking capacitors. Isolation resistors R1 and R2 limits the current through CR1 and CR2, respectively, when they are forward biased.

3.4.3 RF SWITCH ASSEMBLY A2. - RF Switch Assembly A2 connects the LO output of the active tuner to a UHF LO output if the active tuner is in positions 6 and 7, and to a VHF output if the active tuner is in positions 1 through 5. The UHF and VHF LO outputs are compatible with the inputs on DRX-308-( ) Frequency Extender or a DRO-335-( ) Frequency Counter. The operation of RF switch assembly A2 is identical to the operation of RF switch assembly A1, except that the inputs on A1 are used as outputs on A2 and the outputs on A1 are used as inputs on A2. Refer to the schematic diagram in Figures 6-16. The LO outputs from tuners 1 through 5 connect to VHF switch board A2A1 via A2J3 through A2J7, (also see Figure 6-1), and the output of VHF switch board A2A1 connects to VHF LO output connector CP5J1 via A2J1 and cable W12. The LO outputs from tuners 6 and 7 connect to UHF switch board A2A2 via A2J8 and A2J9 (also see Figure 6-1), and the output of the board connects to the UHF LO output connector CP6J1 via A2J2 and and W13.

3.4.4 TYPE 791123 IF SWITCH ASSEMBLY, A3. - Refer to the schematic diagram of the IF Switch Assembly in Figure 6-4. The IF output from the tuners connect to IF Switch Assembly A3 via J2 and J8 and blocking capacitors C10 through C16. A diode switching network in IF Switch A3A1 connects the IF output of the selected tuner to the IF output connector on the main chassis of the CSU-160 via blocking capacitor C9 and connector J1. Control inputs from the four channel tuner switch connect to the switching

network via isolation resistors R1 through R7, which keep the input signals to the switch from being grounded through the tuner switch channels. Blocking capacitors C9 through C16 keep the dc control bias applied to the switching network from appearing at the inputs and output. The -18 V power supply connects to the switching network via feedthrough capacitor C1. Choke L1 forms a common dc bias path for the diodes in the network and keeps the IF signals from being grounded.

Refer to the schematic diagram of IF Switch board A3A1 in Figure 6-4. Resistors A3A1R1 through A3A1R7 reverse bias the diodes via the -18 V power supply. When one of input terminals E2 through E8 goes to +18 V, the diode connected to that terminal is forward biased through E1 and A3L1, allowing the IF signal to pass from the input terminal to output connector A3J1 via terminal E1 and blocking capacitor A3C9.

3.5 TYPE 791115 FOUR-CHANNEL TUNER SWITCHES, A4A3, A4A4.

Four Channel Tuner Switches A4A3 and A4A4 switch the narrow/wide band select voltages, the marker preset code, and the manual tuning voltage between the active tuner and the receiver. (Refer to Figure 6-9.) The Four Channel Tuner Switches also switch the ±18 V power supply input from the receiver to the selected tuner. A control output for each of the tuners from the four channel tuner switches activates the corresponding sections of the RF, LO, and IF switches. A tuner monitor output for each of the tuners indicates to external equipments whether the tuner is on. Tuner switch A4A4 connects to tuners 1 through 4 while tuner switch A4A3 connects to tuners 5, 6, and 7. (One of its channels is not used.) (Refer to paragraph 3.3.2 for connections between the tuner switches and tuning frame.) The tuner switches each contain four identical channels, which switch the manual tuning voltage, wide/narrow band select voltage, VHF/UHF switch control voltage (RF and LO switch) and IF Switch control voltage, tuner monitor voltage, and ±18 V Supply voltage for a particular tuner. A logical low on a control input from the sequencing circuit activates each switch channel. The control input drives one half of a dual peripheral OR driver circuit, which connects to each of the switching circuits in the channel through an isolating diode. When the control input goes low, it grounds the diodes, turning on switching circuit transistors through biasing networks which connect to the diodes. Since the four switch channels are identical, only the channel consisting of Q1 through Q9 is described.

3.5.1 MANUAL TUNING VOLTAGE SWITCHES. - Transistors Q1 and Q2 switch the tuning voltage between the tuning voltage input (pin 1) and the tuning voltage output (pin 2). When the Tuner 1 select input (pin U) to the switch channel goes low, the 1Y output of Dual Peripheral Positive OR Driver U1 goes low, and the current from the ±18 V power supply flowing through R2 and R3 holds zener diode VR1 in conduction. The current through VR1 causes a voltage drop across R3, biasing Q2 on and applying -18 V to the gate of JFET Q1, turning it off and isolating the tuning voltage input and output. A high on the Tuner Select input (pin U), grounds the cathode of VR1 through isolating diode CR1, lowering the bias voltage across VR1 and turning it off. When VR1 turns off, it stops drawing current through R3, biasing Q2 off, and turning FET Q1 on by lowering the voltage drop across R1.

3.5.2 NARROW AND WIDE BAND IF SELECT VOLTAGE SWITCHES. - Refer to Figure 6-9. Transistors Q3 and Q4 connect the Narrow and Wide band Tuner Bandwidth Select control outputs (pins 13 and 9) from the receiver to the control inputs of one of its four IF amplifiers. These connections are made through a shorting plug on the back of the active tuner, which is wired so that the receiver selects the proper narrow and wide IF bandwidths for the tuner. Since the circuits associated with Q3 and Q4 are identical, only the circuits associated with Q3 are described. If the wide band IF output from the receiver is active, -18 V will be applied to the emitter of Q3. A low to the control input of Dual Peripheral Positive OR Driver U1 grounds R4 and R5 through isolating diode CR2, biasing Q3 on, and connecting the Wide Band IF Select Input (pin C) to the Wide Band IF Select Output (pin 9) through CR3.

Diode CR3, and the diodes on the collectors of the rest of the IF Select switching transistors in the Four Channel Tuner Switch (CR5, CR7, CR12, CR14, etc.), keep two IF amplifiers from being switched on at the same time if the wide band IF selected by one tuner corresponds to the narrow band IF selected by another tuner. For instance, if the narrow band selection of tuner 1 and the wide band selection of tuner 2 are both 300 kHz, and if the Narrow Band IF Select input goes to +18 V when tuner 2 is on, the Wide band output of the tuner switch will turn on the 300 kHz IF amplifier in the receiver. The +18 V control voltage passes through the shorting plug on tuner 2 to the control input of the 300 kHz IF amplifier. But, since the IF amplifier control lines connect in parallel to all of the shorting plugs of the tuners installed in the CSU-160, the control voltage also appears at the narrow band output at pin 13 through the shorting plug for tuner 1. If protective diode CR5 was not present, Q4 would also turn on, placing the emitter of Q13 at ±18 V. Since isolating diode CR13 is grounded, Q13 would also turn on, activating the Wide Band IF selected by tuner 2. With CR5 in the circuit, Q4 cannot be turned on by the +18 V potential on the narrow band select output for tuner 1, since the +18 V on pin 13 reverse biases CR5, blocking current to the collector of Q4 and keeping two IF amplifiers from turning on at the same time.

3.5.3 RF, IF, AND LO SWITCH AND TUNER MONITOR DRIVER. - Refer to Figure 6-9. Transistor Q5 drives the control inputs to the RF, IF, and LO switches for tuner 1 via the Tuner 1 IF, RF, and LO +18 V Switch Output (pin 16) and provides a +18 V level on the Tuner Monitor outputs via the Tuner 1 Monitor output (pin 15) on the Remote Control receptacle when tuner 1 is active. (Refer to Figure 6-9.) A low on the Tuner 1 Select Input causes U1 to ground R8 and R9 through CR6, turning Q5 on. Transistor Q5 connects the +18 V power supply to the control inputs on the RF, IF, and LO switches, and to the tuner monitor line via CR7 and R10. CR7 and R10 protect Q5 from shorts or voltages at the tuner monitor input connector. A high on the control input puts a high on the cathode of CR6, turning Q5 off and putting -18 V on the tuner monitor, RF, IF, and LO control inputs via the pull down resistors in the RF, IF, and LO switches. (See paragraphs 3.4.2 and 3.4.3.)

3.5.4 TUNER SUPPLY VOLTAGE SWITCHES. - Refer to Figure 6-9. Q6 and Q7 switch the +18 V power supply input from the receiver while Q8 and Q9 switch the -18 V power supply input from the receiver. Transistors Q6 and Q7 form a Darlington pair that switches on when the Tuner 1 Select input goes low, biasing CR8 on. When the

cathode of CR8 goes low, the voltage drop across R11 turns Q6 on, causing a voltage drop across R13, which turns Q7 on and connects the +18 V power supply at the emitter of Q7 to the +18 V output to Tuner 1 (pin X). Q6 and Q7 also switch on the Darlington pair formed by Q8 and Q9 through zener diode VR2. The +18 V on the collectors of Q6 and Q7 causes the breakdown voltage of zener diode VR2 to be exceeded and current flows through R15 and VR2 from the -18 V power supply. The voltage drop across R15 biases Q8 on, causing a voltage drop across R16 and turning Q9 on. Transistor Q9 connects the -18 V at its emitter to the -18 V output to Tuner 1 (pin Y). Zener diode VR2 keeps the power supply decoupling capacitor in the tuner from holding Q8 and Q9 on after Q6 and Q7 have been turned off through CR8. Clamping diode CR9 keeps the -18 V power supply output from rising above ground and damaging components in the tuner when the tuner is turned off. Without the diode, the -18 V line would be driven positive by the +30 V power supply for the shaping amplifier in the tuner, which remains on when the ±18 V power supply inputs to the tuner are turned off.

3.6 TYPE 791127 CODE MULTIPLEXER (A4A1)

Refer to Figure 6-7. The tuner code multiplexer connects the Tuner Code and VM-105 Marker Generator code from the selected tuner to the receiver. Plugs on the tuners ground or leave open connectors on mating receptacles in the tuning frame to form the Tuner code and VM-105 Marker Generator code.

The three Tuner code lines from each tuner receptacle connect to the I inputs on multiplexers U3 through U5 marked 2^0, 2^1, and 2^2 on the schematic diagram. The Tuners On code from the Sequencing circuits connect to each of the multiplexers at its S0, S1, and S2 inputs. The Tuners On code determines which of its I inputs each of the multiplexers will connect to its Z output. Inverters U6C through U6E invert the Z outputs of the multiplexers and drive the Tuner Code inputs on the associated receiver.

Multiplexers U1 and U2, and inverters U6A and U6B switch the two VM-105 marker generator code lines from each of the tuner receptacles in the same way that U3 through U5 and U6C through U6E switch the Tuner Code inputs. The Binary On inputs to the S inputs of U1 and U3 connect in parallel with the S inputs on U3 through U5, causing the multiplexers switch the Tuner On and VM-105 codes from the selected tuner simultaneously.

3.7 AGC BUFFER AMPLIFIERS

Refer to the schematic in Figure 6-8. The AGC buffer amplifiers protect the AGC output of the receiver from load changes as the tuners are switched on and off. The AGC Buffer Amplifiers have emitter follower output stages with low output impedances so that they can drive more than one AGC input at a time. Amplifier P4-Q5 drives the AGC inputs on three of the tuners and amplifiers Q6-Q7 and Q8-Q9 each drive the AGC inputs on two of the tuners. Transistor pairs Q4 and Q5, Q6 and Q7, and Q8 and Q9 are three identical two stage complementary emitter follower amplifiers. Resistors R18 R19, R31, and R41 set the base bias for Q4, Q6, and Q8. The amplifiers drive the AGC inputs through RC isolation networks. Since the networks are identical, only the network connected to Tuner 1 is described. Resistor R24 isolates the AGC input of tuner one from impedance changes at the other two AGC outputs. Since the AGC inputs to the tuners are capacitive, C7 and R25 act as a "speed up" network for rapidly

changing AGC signals. C7 and R25 bypass rapidly changing signals around R24, allowing the capacitance at the AGC input to charge up faster. R25 limits the current from the collector of Q5 when rapidly changing signals are present.

3.8 REMOTE/LOCAL AND MANUAL/AUTOSCAN SWITCHES (P/O A4A6)

The Remote/Local and Manual/Autoscan switches send logic levels to the Sequencing circuits and Select Code Multiplexer that determine its operating mode. The switches also route video signals from the receiver through the video processing circuits or directly to the video output. Refer to the schematic diagram in Figure 6-11. Grounding pull up resistors R1 and R2 through their respective switches, sends a low to the sequencing circuits, and leaving the lines connected to R1 and R2 open through their respective switches, sends a high to the sequencing circuits. The logic level on the Remote/Local line (connected to R1) causes the Select Code Multiplexer to apply either the Local Tuner Select Code or the Remote Tuner Select code to the Tuner Code input on the Sequencing Circuit. The logic level on the Manual/Autoscan line (connected to R2) is applied to the parallel enable inputs on the counters in the Sequencing Circuit through the Select Code Multiplexer, allowing them to count when the switches are in the Autoscan and Local positions. The Video Input, Video Output and Processed Video Output lines are interconnected by the switches, so that the Video Input goes through the Video processing circuits when the switches are in the Local and Autoscan positions and connects directly to the Video Output when the switches are in all other positions. Table 3-1 summarizes the functions of the Remote/Local and Manual/Autoscan switches and Table 3-3 summarizes the states of their output lines.

3.9 TYPE 79101 SWITCH AND ENCODER (A4A8)

The COUNTED/SELECTED Switch and Encoder send a binary Local Tuner Select Code to the Code Multiplexer that selects the active tuner in the Manual mode and the counted tuner in the Autoscan mode. (Refer to the schematic diagram in Figure 6-14.) Counted/Selected switches S1A through S1F, each corresponding to one of the tuners, connect to ground and to the inputs of encoder AND gates U1A through U1C. A mechanical interlock allows only one switch to be closed at a time. The closed switch puts a low on one or more of the gates by grounding their inputs. Pull up resistors R1 through R6 keep the ungrounded gate inputs high. The switches connect to the gate inputs to produce a binary code at their outputs corresponding to the selected tuner. S1G does not connect to any of the gate inputs, since it corresponds to tuner 1, whose code is 000. The outputs of U1A through U1C go to 000 since when the other switches are open, S1G is closed, due to the mechanical interlock between the switches.

3.10 SELECT CODE MULTIPLEXER (P/O A4A5)

Refer to Figure 6-10. Select Code Multiplexer U1 connects the Local Tuner Code (pins 19, 21, Y) and the Manual/Autoscan line (pin W) to its Z outputs when its S input is low (Local Mode) to the Remote Tuner Code (pins X, 18, 20) and +5 V to its Z outputs when its S input is high (Remote Mode). The S input of U1 connects to the Remote/Local output from the REMOTE/LOCAL Switch (see paragraph 3.8). When the S input of U1 goes high, the Remote Tuner code connects to its Za, Zb, and Zc outputs and its Zd output goes high due to the +5 V on its lid input. When the S input of U0 goes low,

the Local Tuner Select Code connects to its Za, Zb, and Zc outputs and the Manual Autoscan line connects to its Zd output.

3.11 SEQUENCING CIRCUITS (P/O A4A5)

The Sequencing Circuits coordinate the switching and video processing functions of the CSU-160 in response to the levels present on the Z outputs of the Select Code Multiplexer. (Refer to the schematic diagram in Figure 6-10. The Sequencing Circuits include counter U4, a comparator made up of exclusive NOR gates U2A through U2C and driver transistor Q1, 1 of 8 decoder U3, one shot multivibrator U9A, and a Schmitt trigger made up of NOR gates U8A and U8B. Figure 3-2 shows the relationships between the signals in the Sequencing Circuits.

3.11.1 COUNTER U4 AND OCTAL DECODER U3. - The Tuner On Code from the Q_2, Q_4, and Q_8 outputs of counter U4 determines which tuner will be connected to the the receiver by the Four Channel Tuner Switches and Code Multiplexer A4A1. (Refer to Figure 6-10.) The Tuner On code from the Q_2, Q_4, and Q_8 outputs switches Code Multiplexer A4A1 to the selected Tuner Code and VM-105 Codes through the Tuners On (Binary Out) output. The Q outputs of U4 also connect to the I_1, I_2, and I_4 inputs on on 1 of 8 decoder U3. 1 of 8 decoder U3 puts a high on one of its O outputs in response to the levels on its I inputs, activating the channel on the Four Channel Tuner switch corresponding to the active tuner. The Tuner On Code from multiplexer U1 connects to Counter U4 at its D_2, D_4, and D_8 inputs. When the mode switch is in the LOCAL and and MANUAL positions, or in the REMOTE position, the Zd output on multiplexer U1 is high, driving the parallel enable input on the counter low through NOR gate U8C. A low on the Parallel Enable (PE) input of U4 connects its D_2, D_4, and D_8 inputs to Q_2, Q_4, and Q_8 outputs. When the mode switch is in the LOCAL and AUTOSCAN positions, the Zd output on the multiplexer is low, driving the PE input on counter U4 high through NOR gate U8C. A high on the PE input of U4 disables its D inputs and makes it sequence the binary code on its Q outputs in response to negative going pulses on its Clock (CL) input.

3.11.2 COMPARATOR. - Refer to Figure 6-10. When the mode switch is in the LOCAL and the MANUAL positions, or in the REMOTE position, comparitor U2A-U2B-U2C allows the frequency counter to continuously display the LO output of the selected tuner. However, when the mode switch is in the LOCAL and the AUTOSCAN positions, the comparator causes the frequency counter to only display the tuned frequency of the tuner selected on the COUNTED/SCANNED switch. (The counter counts the LO frequencies of the unselected tuners but only displays the frequency of the selected tuner.)

The comparator consists of exclusive NOR gates U2A, U2B, and U2C, driver transistor Q1 and zener diode VR5. One input on each of the exclusive NOR gates connect to the Z outputs on multiplexer U1, and the remaining gates connect to the Q outputs on counter U4. When both sets of gate inputs are at the same level, the gate outputs go high, causing the anode of breakdown diode VR5 to go positive. VR5 stops conducting, and the decreased voltage drop across R9 turns transistor Q1 off. When Q1 is off the Counter Inhibit output goes to 0 V, allowing the counter to display the local

Figure 3-2

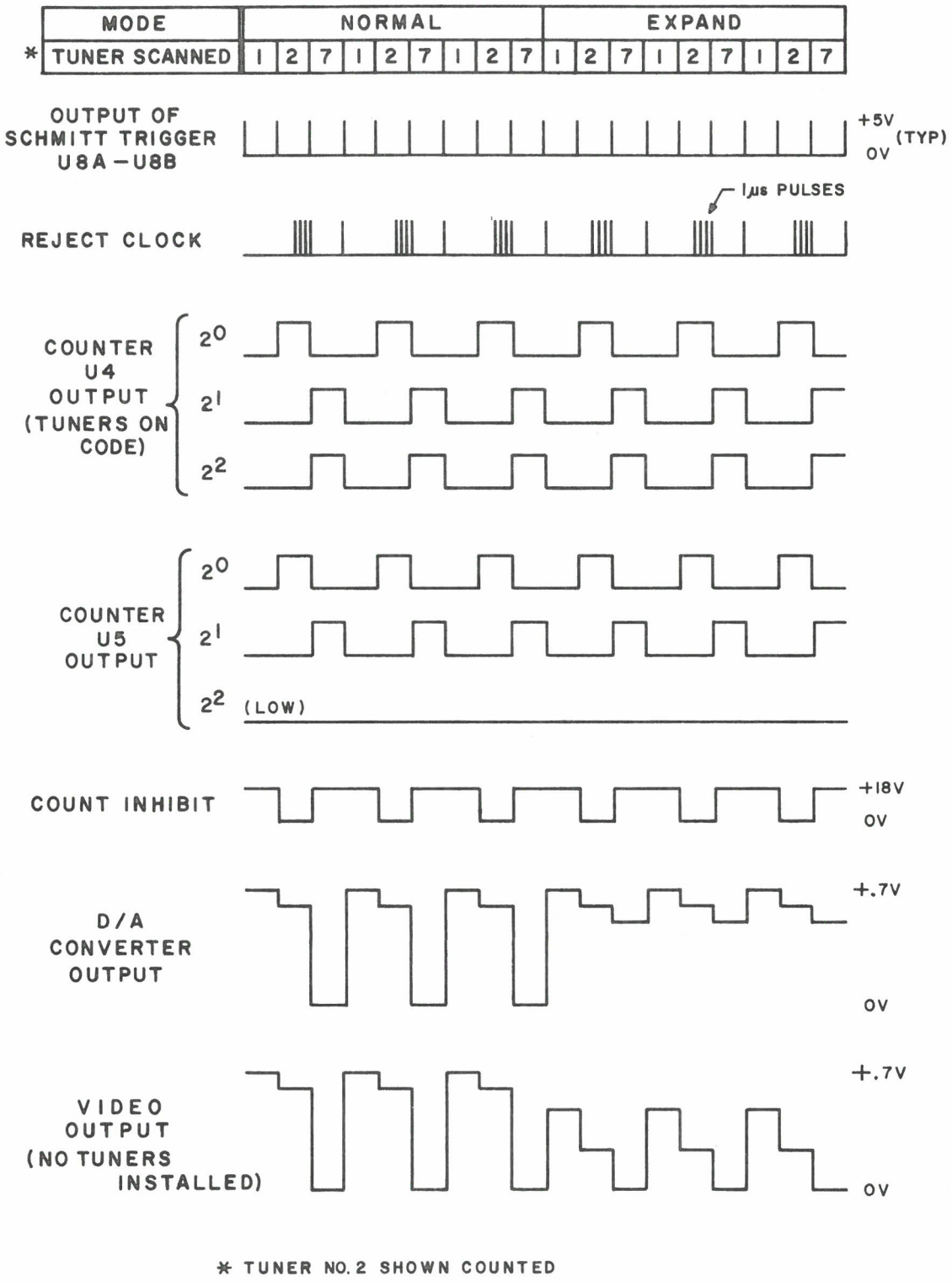


Figure 3-2. Relationships Between Signals in Sequencing Circuits, Digital to Analog Converter Circuits and Video Amplifier Circuits with No Tuners Installed

Tuner Code from Multiplexer U1, since when the outputs from the counter and multiplexer are not the same, the exclusive NOR gate outputs will go low, allowing VR1 to conduct through CR7, turning on transistor Q1 and putting the counter inhibit output a +18 V. With the counter inhibit at +18 V the counter holds its frequency count on its display until the tuner code selected by the COUNTED/SELECTED switch again appears at the Q outputs of the frequency counter.

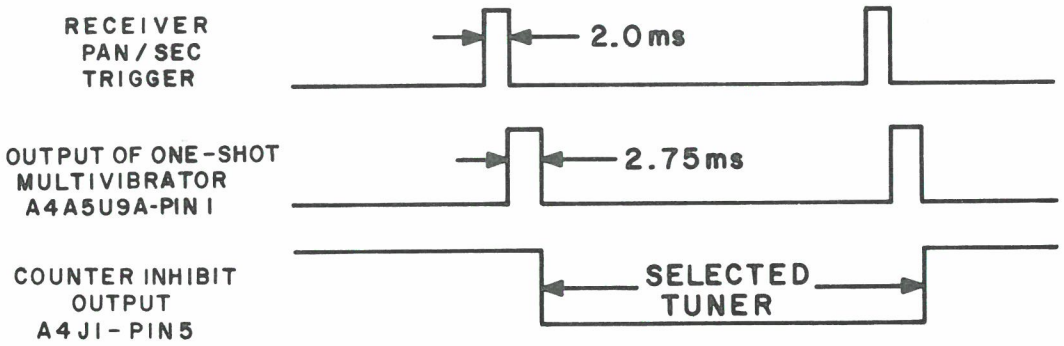


Figure 3-3. Generation of Counter Inhibit Output

3.11.3 ONE SHOT MULTIVIBRATOR AND SCHMITT TRIGGER. - Refer to Figure 6-10. One shot multivibrator U9A and Schmitt trigger U8A-U8B condition the pulse at the Trigger Input (pin 9 of A4A5) so that it is compatible with the logic circuits in the CSU-160. The one-shot multivibrator is triggered by the trailing edge of a positive going squarewave from the associated receiver. An input circuit clamps and limits the trigger pulse from the receiver before it is applied to U9A and its associated components, which form a gated, non-retriggerable, one-shot multivibrator. Multivibrator U9A delays the transition of the clock (CL) input of counter U4 until 2.75 mS after the application of the falling edge of the trigger pulse. The frequency counter takes 2.5 ms to complete its count of the tuned frequency of the tuner selected on the COUNTED/SELECTED switch, and the falling edge of the trigger pulse coincides with the beginning of the counting period between frequency scans. The delay supplied by multivibrator U9A makes the comparitor hold the Counter Inhibit output at 0 V for 2.75 mS before the counter U4 switches the CSU-160 to another tuner. This gives time for the local oscillator frequency from the tuner to stabilize and be counted before the Store Hold input on the

the comparitor hold the Counter Inhibit output at 0 V for 2.75 mS before the counter U4 switches the CSU-160 to another tuner. This gives time for the local oscillator frequency from the tuner to stabilize and be counted before the Store Hold input on the counter goes low causing the tuned frequency of the tuner to be displayed. (Refer to Figure 3-3 for an illustration of the relationship between the Counter Inhibit, and PAN, SEC, or PAN/SEC trigger pulses from the receiver.)

Refer to the schematic diagram in Figure 6-10. Resistor R2 and capacitor C11 differentiate the Trigger Input signal developed across input load resistor R1. Diodes CR1 and CR4 limit the differentiated Trigger Input signal to 0 and +5 V (neglecting diode voltage drops), so that the positive going portion of the differentiated trigger signal has no effect on the circuit. (The junction of CR4 and C11 is held at +5 V with no signal present.) Current limiting resistor R3 and CR5 apply the limited signal from CR1 and CR4 to the inverting input of operational amplifier U9A. CR5 and R5 increase the input impedance of operational amplifier U9A by allowing current from the +5 V power supply to drive its inverting input. Resistors R42 through R45 and CR6 hold the non-inverting input of U9A at +3 V and R5 holds the inverting input of U9A at +5 V when a Trigger Input signal is not present. Operational amplifier U9A operates as a comparator, and with its inverting input at a higher voltage than its non-inverting input, its output goes to -18 V, putting about 20 V across C1.

A negative going signal at the Trigger Input causes the voltage at the inverting input of U9A to drop about 4 V, putting its non-inverting input at a higher potential than its inverting input, and causing the output voltage from U9A to rise toward the +18 V power supply voltage. The increasing output voltage from U9A causes the voltage across C1 to decrease as it discharges through R42, R43, and R44, speeding up the voltage change at the operational amplifier output, increasing the voltage at its non-inverting input. When the voltage at the non-inverting input of U9A goes above +5 V, its inverting input no longer affects the output, and its output latches to the +18 V positive power supply voltage. With the output of U9A at +18 V, C1 reverse biases CR6, and R45 holds the non-inverting input at +18 V. As the amplifier output rises above +5 V, CR3, R4, and R5 reverse bias CR5, isolating the input of the multivibrator from the trigger input.

The output of U9A swings from -18 V to +18 V in about 10 μs, and its output remains at +18 V until C1 discharges enough to forward bias CR6, putting the voltage at the non-inverting input of U9A lower than the voltage at its inverting input. The non-inverting input of U9A then falls below +5 V, putting the inverting input at a higher voltage than the non-inverting input and forcing the amplifier output to swing back to -18 V. Capacitor C1 recharges at the polarity it had before the Trigger Input pulse, removing the forward bias across CR5 enabling the Trigger Input for the next PAN/SEC Trigger pulse.

The time constant of C1, R42, R43, and R44 determine the amount of delay introduced by U9A. Potentiometer R44 is set to give a time constant of 2.75 mS. Terminal L of A4A5 connects to the +18 V On Manual output from the receiver. When the receiver is in the manual mode, the +18 V On Manual output goes to +18 V, reverse biasing CR5 through CR2, R4 and R5, and disabling the Trigger Input.

The output of U9A connects to the cathode of breakdown diode VR1 through current limiting resistor R6. A negative output from U9A forward biases VR1, clamping

the output of U9A near ground, and a positive output from U9A reverse biases VR1 and the breakdown voltage of VR1 limits the input voltage to U8B to +5 V, so that U9A can drive the input of U8B.

After being limited by VR1, the risetime of the square wave from U9A is improved by Schmitt Trigger U8A and U8B. When the output of U9A rises above +1 V, it drives the output of NOR gate U8B low, (0 V) driving the output of NOR gate U8A high (+4 V). R40 feeds the output of U8A back to the input of U8B, locking U8A and U8B on until the output signal from U9A goes negative. Capacitor C12 increases the amount feedback current during pulse transitions, preventing oscillation and increasing the rise time of the signal appearing at the output of U8A. The output of the Schmitt Trigger connects to one of the inputs of Exclusive NOR gate U2D. Since the other input of U2D connects to the Reject Clock line which is high when a trigger pulse is generated, the output from the Schmitt Trigger passes through U2D to the clock (CL) input of counter U4. The CL input of U4 sequences the Q outputs of U4 to the next binary code on the negative transition of the output pulse from Schmitt Trigger U9A, which occurs 2.75 ms after the trigger pulse. Figure 3-2 shows the output of Schmitt Trigger U8A-U8B and the Reject Clock.

3.12 PART 17153 SCANNING SELECTOR AND REJECTOR (A4A7A1)

Refer to Figure 6-10. The Scanning Selector and Rejector circuit makes counter A4A5U4 skip the Tuner On Codes for tuners that have not been selected on the SCANNED switch when the mode switch is in the LOCAL and the AUTOSCAN positions and makes the counter cycle back to the code for tuner 1 (000) when it reaches the code for tuner 7 (110). The Scanning Selector and Rejector Circuit generates a negative pulse when the Tuner On Code (from the Q outputs on A4A5U4) corresponds to a push button on the SCANNED switch that has not been depressed or when it is 111. The input of A4A5U2D that connects to Schmitt Trigger A4A5U8A-U8B is always low just after the counter has sequenced to the next binary code, passing the negative going pulse on the Reject Clock line to the CL input of counter U4, and causing it to sequence to the next Tuner On Code.

Refer to the schematic diagram of the Scanning Selector and Rejector Circuit in Figure 6-12. The I inputs of 1 of 8 decoder U5 connect to the Q outputs of counter A4A5U4 (shown in Figure 6-10). The output from the 1 of 8 decoder U5 which corresponds to the Tuners On Code on its I inputs, drives the input on one of seven inverters low (U3A through U3D and U4A, U4B, and U4E). If, for instance, the code corresponding to tuner 2 (001) appears at the I inputs of U5, its O_1 output goes low, making the output of U3C go high, and putting a high on the input to NAND gate U1B. If S1F is not depressed, the other input of U1B is held high through pull up resistor R4 and R1. The Reject Clock output is normally high, but when both of the inputs of NAND gate U1B are high its output goes low, producing the negative going leading edge of the Reject Clock pulse. U3E, U3F, and U4C invert and delay the leading edge of the Reject Clock Pulse by 2 mS before it appears as a high at the inhibit (INH) input of decoder U5. Inverter U3F inverts the leading edge of the pulse to produce a high on the input of inverter U3E. The output of U3E drives the input of inverter U4C low at a rate determined by the time constant of R2 and C2, and U4C drives the input of inverter U4C high at a rate determined by the time constant of R11 and C3, which in turn drives the inhibit input

of decoder U5 high. The high at the inhibit input of U5 drives its O outputs high, which in turn drives one of the inputs of each of the NAND gates low through their rerpective inverters. The outputs of the NAND gates go high, producing the positive going trailing edge of the reject clock pulse.

The Scanning Selector and Rejector Circuit also generates a Reject Clock Pulse when the I inputs to the 1 of 8 decoder are all high (binary 111), which drives the O_7 output of the decoder low, causing the output of inverter U4D to go high. Since NAND gate U2B is wired as an inverter, its output drives the Reject Clock line low, producing the leading edge of a Reject Clock pulse. The delayed regenerative action described in the last paragraph generates the trailing edge of the pulse.

3.13 DIGITAL TO ANALOG CONVERTER (P/O A4A5)

Refer to the schematic diagram in Figure 6-10. The Digital to Analog Converter and counter U4 or counter U5 generate a dc level that is summed with the signal applied to Video Amplifier U10, causing the video signals from each of the tuners to be dc level shifted so that they are displaced to different levels on the signal monitor screen. The digital to analog converter consists of NAND gates U6 and U7, the circuitry associated with Q2 through Q4, and operational amplifier U9B. Counter U5 provides the Digital to Analog converter with a digital code when the NORMAL/EXPAND pushbutton is in the EXPAND position and Counter U4 provides the Digital to Analog Converter with a binary code when the NORMAL/EXPAND pushbutton is in the Normal position. Figure 3-2 shows the signals on the inputs and outputs of the Digital to Analog Converter.

The clock input of U5 connects directly to the output of Schmitt trigger U8A-U8B so that it shifts the binary code on its outputs in response to a trigger pulse, and stays at that binary code until the next trigger pulse is received. The reset input of the counter connects to the O_7 output of decoder U3 (pins 12 and M are jumpered together), so that the Q outputs of the counter reset to zero at the same time that the reject clock resets the outputs of U4 to zero. This arrangement causes the counter outputs to count up, with the number of pushbuttons depressed on the SCANNED switch determining the highest binary code reached before the counter outputs reset back to zero.

The Q outputs from either counter U4 or counter U5 connect to the Digital to Analog Converter depending on the position of the mode switch. The counters connect to the digital to analog converter through a multiplexer made up of NAND gates U6A through U6D and U7A through U7D. When the mode switch is put into the NORMAL, AUTOSCAN, and LOCAL positions, both inputs of U6A go high and the output of U6A drives one input on each of NAND gates U7A through U7C low, keeping the Q outputs of counter U5 from appearing on their outputs. The output of U6A also drives one of the inputs of each of NAND gates U6B through U6D high through U7D, which is connected as an inverter. This allows the Q outputs of U4 to drive the input circuits of Q2 through Q4 through NAND gates U6B through U6D. When the mode switch is in the EXPAND position, the gate of U6A connected to the Normal/Expand input (pin K) of A4A5 goes low, reversing the levels described above, allowing the Q outputs of U5 to drive Q2 through Q4 and isolating the Q outputs of U4. Q2, Q3, and Q4 act as switches that connect the input of operational amplifier U9B to the +10.3 V power supply input through collector resistors R16, R17, and R18, respectively. The values of resistors R16,

R17, and R18 are weighted according to the binary place value of the Q output to which their transistors are connected. Resistor R18, representing the least significant digit, is four times the value of R16, which handles the most significant binary digit. The transistors are switched through current limiting resistors R10 through R12 and zener diodes VR2 through VR4. If for instance, the NAND gate connected to R10 goes low, the breakdown voltage of VR2 is exceeded and VR2 conducts. The current through VR2 causes a voltage drop across R15 which forward biases the base of Q4, turning Q4 on, raising the voltage at the inverting input of U9B through R18.

The circuitry associated with Q2 and Q3 operates in an identical fashion. Operational amplifier U9B sums the voltages supplied by R16 through R18. Resistors R20 and R21 set the gain of U9B, and thus the (voltage) level shift between tuner codes. Resistor R19 puts a positive voltage on the output of U9B even when the code at the input to the Digital to Analog D/A Converter is 000. The output of U9B is summed with the video signals from the receiver at Video Amplifiers U10 and U11.

3.14 VIDEO AMPLIFIER U10 (P/O A4A5)

Refer to Figure 6-10. Video Amplifier U10 sums the dc levels from the Digital to Analog Converter with the video signals from the receiver at its non-inverting input. U10 also isolates the Seven Step Divider from impedance changes at the video input. Input resistors R23 and R24 sum the dc levels from the Digital to Analog Converter and the video signals at the non-inverting input of U10. Resistors R25 and R28 set the gain of the amplifier at unity, and C5 sets its high frequency rolloff. Resistor R29 provides feedback for the output stages of Video Amplifier U10 and R27 and C4 provide phase compensation. The output of Amplifier U10 connects to the NORMAL/EXPAND pushbutton of the mode switch via A4A5 pin 3.

3.15 SEVEN STEP DIVIDER (P/O A4A7A2)

When the NORMAL/EXPAND Switch is in the EXPAND position, the output from A4A5U10 goes to the seven step divider. Refer to the schematic diagram in Figure 6-13. Each of pushbutton switches S1A through S1G shorts out one of series connected resistors R4 through R10 when it is not depressed. Depressing a pushbutton switch removes a short from its resistor increasing the division of the output voltage from the divider by one step. The ratio between feedback resistor R16 and the total amount of reristance in the divider sets the amount of division provided by the divider. Since the values of R4 through R10 and R16 are equal, the amount of attenuation varies in proportion to the number of tuners selected with the SCANNED pushbuttons. Thus if two tuners are scanned, the output of U10 is reduced by one half, and if three tuners are scanned the output of U10 is reduced by two thirds, etc. By attenuating the video signals from the receiver and dc levels from the Digital to Analog Converter in proportion to the number of tuners selected for scanning, the seven step divider causes the video displays to be positioned and attenuated so that they occupy equal portions of the signal monitor screen.

3.16 PART 17152 VIDEO DISPLAY CONTROL (A4A7A2)

The Video Display Control circuit isolates the video processing circuits in the CSU-160 from the input of the associated signal monitor. Refer to the schematic diagram

in Figure 6-13. The Video Display Control circuit consists of operational amplifier U1 and FET Q1. When the mode switch is in the NORMAL position, the output from Video Amplifier A4A5U10 goes to U1 via the Fixed Gain Input at pin 1. When the mode switch is in the EXPAND position, the output of video amplifier A4A5U10 is routed through the seven step divider and is applied to the input of U1 through FET Q1.

The No Selection/Selection input from the Scanning Selector and Rejector circuitry (pin 3) biases FET Q1 on and off. Refer to the schematic diagram in Figure 6-12. Depressing a SCANNED pushbutton grounds one or more of resistors A4A7A1R3 through A4A7A1R9, drawing current from the +5 V supply through A4A7A1R1. The voltage drop across R1 forward biases the base-emitter junction of Q1, turning it on, and putting +5 V on the No Selection/Selection output A4A7A1 pin 1. With all of the pushbuttons up, no current flows through A4A7A2R1 and biasing FET A4A7A2Q1 is off (Refer back to the schematic diagram in Figure 6-13) and putting -18 V on the No Selection/Selection line via resistor A4A7A2R1.

Negative 18 V on the No Selection/Selection line forward biases CR1 through A4A7A2R2 and turns FET A4A7A2Q1 off, disconnecting the output of the seven step divider from the input of A4A7A2U1. Positive 5V on the No Selection/Selection line reverse biases CR1 and turns A4A7A2Q1 on, connecting the output of the Seven Step Divider to the input of U1. Negative 18 V on the Selection/No Selection line forward biases A4A7A2CR1, cutting off A4A7A2Q1 and disconnecting the input of U1 from the seven step divider. This keeps U1 from latching up due to the direct connection between its input and the output of Video Amplifier A4A5U11 when none of the SCANNED pushbuttons is depressed.

The output from the video amplifier connects to the Fixed Gain input when the mode switch is in the NORMAL position, and the ratio between the parallel value of resistors A4A7A2R3 and A4A7A2R11 and feedback resistor A4A7A2R16 causes the output from the video amplifier to be divided by seven. Capacitor A4A7A2C4 sets the rolloff frequency of amplifier U1, and R17 provides feedback for the output stages of U1. R13 and C2 provide phase compensation for U1, preventing spurious oscillations. The output U1 connects to video amplifier A4A5U11 via the Scaled Video output at A4A7A2 pin 8.

3.17 VIDEO AMPLIFIER U11 (P/O A4A5)

Video amplifier A4A5U11 buffers the output of the seven step divider and centers the display on the signal monitor screen. Refer to the schematic diagram in Figure 6-10. (Figure 3-2 shows the output signal from Video Amplifier U11 with none of the tuners installed in the CSU-160.) The output from the Video Display Control connects to the inverting input of Video Amplifier U11 through R34. The output from operational amplifier U9B in the Digital to Analog Converter connects to the inverting and non-inverting inputs of U11 via resistors R46 and R48 and the wiper arm of R47. R47 gives a fine adjustment of the amount of dc offset provided by the Digital to Analog Converter so that the tuner scans can be centered on the signal monitor screen. The non-inverting input of U11 also receives a dc offset voltage from R38 that allows all seven traces to be positioned in the center of the signal monitor screen. Resistors R31 and R34 set the gain of the amplifier at unity, and C13 sets its high frequency rolloff. R32 provides feedback to the output stages of the amplifier and C6 and R33 provide it with phase compensation. The output of Video Amplifier U11 connects to VIDEO OUTPUT connector A4J4 the

signal monitor through the Manual/Autoscan and Local/Remote sections of the mode switch. (Refer to paragraph 3.8 for a discussion of the mode switch.)

3.18 POWER SUPPLY CIRCUITS

The power supply provides a +5 V output for the logic circuits in the CSU-160 and a +30 V output to power the shaping amplifier circuits in the tuners installed in the CSU-160 tuning frame. Refer to Figure 6-6. The power line connects to power transformer T1 through relay K1. Line voltage select switch S1 connects the power transformer windings to the power line in series or in parallel, allowing T1 to operate from a 115 V or a 220 V power line. Fuse F2 protects the power transformer when S1 is in the 220 V position and fuse F2 protects the power transformer when S1 is in the 115 V position.

Relay K1 and relay driver A2Q3 switch the power line voltage to the primary of transformer T1. The relay and its driver turn the power supply on only when the receiver is on and connected to the CSU-160. Refer to Figure 6-8.

The +18 V power supply from the receiver connects to terminal B of A4A2 through front panel receptacle J1 (Main Chassis, Figure 6-15). Resistors R11 and R13 forward bias the base of Q3 when the +18 V power supply input appears at terminal B, turning Q3 on. The current through Q3 develops a +5 V potential across R14, which turnr Relay A4K1 on. Bridge rectifier U2 rectifies the low voltage output from the secondary of transformer T1, connected to terminals 9 and 12 to provide a pulsating dc output for +5 V regulator module A4U1 and filter capacitor A4C1 at pins 10 and 11.

The +30 V power supply regulator circuits on A4A2 consist of a bridge rectifier (U3), an operational amplifier (U1) and its output transistor (Q2), a protective circuit for pass transistor A4Q1 (Q1 and CR1), and a startup circuit for the power supply inputs to the operational amplifier (CR2, CR3). Bridge rectifier module U3 rectifies the output from the secondary of T1 which connects to terminals 5 and 8 to provide a pulsating dc output which is filtered by capacitor A4C2 and applied to the +30 V regulator at terminals 4 and E. The output from bridge rectifier U3 passes through transistor Q1 (Q1 protects pass transistor A4Q1 from shorts) and pass transistor A4Q1 to the output of the power supply at pin K. Operational amplifier U1 and output transistor Q2 provide a control current to the base of pass transistor A4Q1 via pin 2, regulating the output of the power supply by controlling the voltage drop across the collector and emitter of A4Q1. The +10.3 V power supply input from the receiver (at pin D) provides a reference voltage to the inverting input of U1 through input resistor R4. Voltage divider R5 through R8 develops a control voltage from the output of the supply that is applied to the inverting input of U1.

Potentiometer R7 is set to make the voltage at the inverting input of U1 equal to the voltage at its non-inverting input (+10.3 V) when the output of the supply is at precisely +30 V. When the inputs to U1 are equal, its output is at 0 V. Resistors R9 and R10 set the quiescent current through Q2 so that when the output of U1 is 0 V, the current from Q2 to the base of A4Q1 sets the voltage drop across the collector and emitter of A4Q1 to keep the output of the supply at +30 V. If the supply output drifts away from +30 V, the voltages at the inputs to U1 become unequal. The resultant output voltage from U1 changes the the current through Q2, changing the base current into A4Q1 and its emitter collector voltage drop to bring the output of the supply back to +30 V.

Transistor A4A2Q1 and diode A4A2CR1 protect pass transistor Q1 from shorts or power supply overloads. Current from bridge rectifier U3 passes through resistor R2 and the voltage drop across it sets the base emitter bias of Q1. R1 provides a forward bias current path for CR1. The collector current from Q2 splits between CR1 and the collector circuit of Q1. When an excessive amount of current is drawn through the pass transistor, the voltage drop across R2 increases, increasing the amount of current through Q1, and reducing the amount of current through CR1, and the base of pass transistor Q1. If a short occurs at the supply output, Q1 goes into saturation, cutting off the current into to the base of pass transistor Q1, and shutting down the power supply.

Diodes CR1 and CR3 form a startup circuit for the power supply regulator circuit. When the unregulated input is first applied to the circuit, operational amplifier U1 has no power supply voltage, since its power supply inputs are connected to the +30 V output of the supply. When the supply output is at 0 V, the +10.3 output from the receiver forward biases CR2, and the current through CR2 supplies current to U1. As the power supply output comes up to +30 V, CR3 reverse biases CR2 and the operational amplifier obtains its power supply current from the output of the power supply.

NOTES

SECTION IV
MAINTENANCE

4.1 GENERAL

The Type CSU-160 Tuner Switching Unit has been conservatively designed to operate for extended periods of time with little or no routine maintenance. An occasional cleaning and inspection is the only preventive maintenance recommended. The intervals for this should be based on the operating environment. Should trouble occur, repair time will be minimized if the maintenance technician is familiar with the circuit descriptions found in Section III. Reference should also be made to the block diagram in Figure 3-1 and the schematic diagrams in Section VI. A complete parts list with photographs showing part locations can be found in Section V.

4.2 CLEANING AND LUBRICATION

The CSU-160 should be kept free of dust, moisture, grease and foreign matter to ensure trouble-free operation. If available, use low-velocity compressed air to blow accumulated dust from the exterior and interior of the unit. A clean, dry cloth, a soft bristled brush, or a cloth saturated with cleaning solution may also be used. The CSU-160 does not require lubrication.

4.3 INSPECTION FOR DAMAGE OR WEAR

Many potential or existing troubles can be detected by a visual inspection of the unit. For this reason a complete visual inspection should be made periodically or whenever the unit is inoperative. Electronic components that show signs of deterioration should be checked and a thorough investigation of the associated circuitry should be made to verify proper operation. Damage due to overheating may be the result of other less apparent troubles in the circuit. It is essential that the cause of overheating be determined and corrected before replacing the damaged parts. Mechanical parts such as front-panel controls and switches should be inspected for excessive wear, looseness, misalignment, corrosion, and other signs of deterioration.

4.4 TEST EQUIPMENT REQUIRED

Table 4-2 lists the test equipment required to perform preventive and corrective maintenance on the CSU-160.

The circuit boards in assembly A4 are mounted close together to achieve a high packaging density. Extender boards are available to facilitate voltage and waveform measurements on these boards. Table 4-1 lists the circuit boards and the part number of the corresponding extender boards. The extender boards may be ordered directly from Watkins-Johnson Company, Gaithersburg, or from a Watkins-Johnson representative. Refer to paragraphs 4.5.2 and 4.5.3 for instructions on the use of the extender boards.

Table 4-1. Extender Boards Required

BOARD NUMBER	EXTENDER BOARD STOCK NUMBER
A4A1	791213
A4A2	791211
A4A3	791211
A4A4	791211
A4A5	791211
A4A6	791212
A4A7A1*	791212
A4A7A2*	791212
A4A8	791212

* These boards have been wired together into a sandwich, and must be extended as a as a unit; two 791212 extender boards must be used.

4.5 TROUBLESHOOTING PROCEDURES

Troubleshooting efforts should first be directed toward localizing the problem to a particular module or circuit group. The troubleshooting chart in Table 4-3, the oscilloscope waveforms in Figures 4-2a through 4-2f and 4-3, the functional block diagram in Figure 3-0, and the circuit description in Section III can be used as trouble-shooting aids. Once the faulty module has been located, the defective component can be isolated guided by the circuit descriptions, the voltage measurements in Table 4-11 and the circuit diagrams in Section VI. Signal voltage and resistance checks should be made using the equipments listed in Table 4-2 or their equivalents.

WARNING

This unit contains voltages which are dangerous and may be fatal if contacted. Be especially careful when working on the unit with the clear plexiglas cover over the power transformer terminals removed.

CAUTION

The CSU-160 and its associated receiver must be turned off before removing any of the printed circuit cards in Control Assembly A4. The cards could be damaged by removing them when the power is on.

Table 4-2. Test Equipment Required

Instrument Type	Required Characteristics	Recommended Instrument
Oscilloscope	15 MHz bandwidth; Dual trace	Tektronix Type 516A
Digital Voltmeter	+10 V, +100 V Range 10 MΩ input resistance	Fluke 8100A
Variac	Output variable from 180 to 220 V ac	General Radio W10HMT3
Variac	Output variable from 90 to 125 V ac	General Radio W5MT3W
Receiver	Compatible with CSU-160	Watkins-Johnson 205-( ) or Watkins-Johnson 215-( )
Tuning Head	Compatible with CSU-160 and associated receiver.	Watkins-Johnson VH-( ), UH-( ), or HH-( ) Series Tuning Heads.
Extender Cable	Compatible with CSU-160 and associated receiver.	Watkins-Johnson EC-160.
Extender Cable	Compatible with CSU-160 and associated receiver.	Watkins-Johnson EC-205.
Signal Generator	10 to 480 MHz frequency range.	HP-608E
Signal Generator	50 kHz to 65 MHz frequency range.	HP-606B
Signal Generator	450 to 1230 MHz frequency range.	HP-612A
Oscilloscope	100 μV sensitivity.	HP-1202A
VTVM	50 V dc scale.	RCA WV-98C

CAUTION

Remove the CSU-160 from the RS-160 system when performing maintenance on any associated equipments. If the CSU-160 is not removed from the system, damage to control assembly A4 could result.

4.5.2 EXTENDER BOARDS. - Use the extender boards listed in Table 4-1 to gain access to the components on printed circuit cards A4A1 through A4A8. To use an extender board with printed circuit cards A4A1 through A4A5, proceed as follows:

(1) Turn off the receiver associated with the CSU-160.

(2) Unplug the printed circuit board to be examined.

(3) Insert the appropriate extender board into the printed circuit board socket.

(4) Plug the printed circuit board into the extender socket.

CAUTION

Make sure that the component side of the printed circuit board faces in the same direction that it did when plugged into its socket. Reversing the printed circuit board could cause damage to the board and/or the rest of the circuitry in the Control Module.

4.5.3 To use an extender board with printed circuit cards A4A6 through A4A8, proceed as follows:

(1) Remove the A4 assembly from the CSU-160 by following the instructions in paragraph 4.8.1.

(2) Remove the small bracket to which the pushbutton assemblies are bolted.

(3) Unplug the printed circuit board to be examined. (For A4A7A1 and A4A7A2 see NOTE.)

NOTE

A4A7A1 and A4A7A2 have been soldered on either side of a pushbutton switch assembly to form a "sandwich", and must be extended together by using two extender boards.

(4) Plug the appropriate extender board into the printed circuit board socket.

(5) Plug the printed circuit board into the socket on the edge of the extender board.

4.5.4 ACCESS PANEL. - A terminal board behind an access panel on the right side of the unit (the side nearest tuner opening 7) provides test points on the main wiring harness, whose schematic is shown in Figure 6-15. The terminal board is marked TB1 on the schematic diagram. To gain access to TB1, proceed as follows:

(1) Remove the chassis slide on the right side of the unit.

(2) Remove the five phillips head screws around the edges of the panel inset into the side panel of the unit.

(3) Remove the panel by pulling its top edge away from the side and pulling its bottom edge out of the cutout in the side panel. The terminal board is near the bottom edge of the cutout in the side of the unit.

CAUTION

When removing the access panel, always have the PUSH ON-OFF switch on the receiver in its OFF position. Shorting out the terminal board when removing the access panel with voltage present could damage the circuits in the CSU-160.

Table 4-3. Troubleshooting Chart

TROUBLE INDICATION	PROBABLE FAULT	DIAGNOSTIC PROCEDURE
1. No tuning heads operate (as indicated by dial lamps in faces of tuners) regardless of how controls are set.	a) No voltage at power receptacles; defective line cord or line filter A4FL1; blown fuse A4F1 or A4F2; defective switch A4S1.	a) Check power supply input circuits with ac voltmeter. If a fuse is blown, check position of switch A4S1 before replacing. If replacement fuse also blows, check for shorted transformer A4T1 or defective power supply in module A4A2.
	b) Power relay A4K1 or power transformer A4T1 open.	b) Check A4K1 and A4T1 with ac voltmeter.
	c) Power relay driver A4A2-Q3 defective.	c) Check A4A2-Q3 with dc voltmeter.

Table 4-3. Troubleshooting Chart (Continued)

TROUBLE INDICATION	PROBABLE FAULT	DIAGNOSTIC PROCEDURE
	d) Module A4A2 power supplies defective; no +10.3 V or ±18 V input from receiver. NOTE: Turn the receiver off before unplugging EC-160.	d) Use dc voltmeter to check the following: +5V at A4A6-R1 (Read voltage at end of resistor nearest connector.) +30 V at A4A2-TP1 +10.3 at pin 5* +18 V at pin 7* -18 V at pin 8* *P3 of EC-160 extender cable socket.
	e) Counter A4A5-U4 or 1-of-8 decoder.	e) Check operation of A4A5-U4 and A4A5-U3.
	f) Driver U1 or U2 inoperative on board A4A4 or A4A3.	f) Check operation of U1 and U2 on boards A4A4 and A4A3.
2. One or more tuners will not operate in MANUAL mode, but will function properly in AUTOSCAN mode.	a) Inoperative encoder U1 in module A4A8.	a) Check operation of A4A8-U1.
	b) Inoperative multiplexer A4A5-U1 or counter A4A5-U4.	b) Check operation of A4A5-U1 and A4A5-U4.
3. Unit does not switch tuners in Autoscan mode; Unit operates properly in Manual mode.	a) +18 V control voltage is present at pin 15 of J1.	a) Make sure that mode switch on receiver is set to PAN, SEC, or PAN/SEC. Check for 0 V at pin 15 of J1.
	b) Trigger input missing.	b) Make sure that +5 V square-wave or negative going pulse is present at A4J2.
	c) Defective trigger or counter circuitry in module A4A5; defective multiplexer A4A5-U1 or inverter A4A5-U8C.	c) Check waveforms shown in Figures 4-2a and 4-2b. Check for 0 V at A4A5-U1, pin 9 and +5 V at A4A5-U8C, pin 13.

Table 4-3. Troubleshooting Chart (Continued)

TROUBLE INDICATION	PROBABLE FAULT	DIAGNOSTIC PROCEDURE
4. Unit switches tuners erratically in AUTO-SCAN mode.	a) Defective circuitry in A4A7A1 module.	a) Check operation of circuits in A4A7A1 module using procedure in paragraph 4.6.5.
	b) Defective A4A5-U9A, A4A5-U8A, or A4A5-U8B.	b) Check that squarewave amplitude across A4A5-VR1 is 5 V.
	c) Defective ±18 V supplies in associated receiver.	c) Check for large switching transients on power supply inputs at pins 7 and 8 of EC-160.
5. One or more tuners stay on constantly, or two tuners switch on and off together (indicated by tuning dial lamps on faces of tuning heads).	a) Defective A4A5-U3.	a) Depress COUNTED SELECTED pushbutton with MODE switch set to manual and check for proper outputs from U3.
	b) Defect in +18 V and -18 V switches on modules A4A4 and A4A3 or defective cabling in tuner frame.	b) Check ±18 V supplies to tuners as follows:

Tuner	Voltage Vdc	Tuner Pin Nos.
1	+18	J5 pin 10
	-18	J5 pin 9
2	+18	J7 pin 10
	-18	J7 pin 9
3	+18	J9 pin 10
	-18	J9 pin 9
4	+18	J11 pin 10
	-18	J11 pin 9
5	+18	J13 pin 10
	-18	J13 pin 9
6	+18	J15 pin 10
	-18	J15 pin 9
7	+18	J17 pin 10
	-18	J17 pin 9

Table 4-3. Troubleshooting Chart (Continued)

TROUBLE INDICATION	PROBABLE FAULT	DIAGNOSTIC PROCEDURE
6. One tuning head fails to operate.	a) Defective tuner.	a) Unplug and replace one of operating tuners with suspected one. If still inoperative, troubleshoot tuner; if not, check for defects in A4A3 and A4A4
	b) Partial failure or 1-of-8 decoder A4A5-U3.	b) Use Diagnostic Procedure 5a.
	c) Tuner supply voltage switch defective.	c) Select inoperative tuner. Use Diagnostic Procedure 5b.
	d) RF, IF, and LO switch driver defective.	d) Select inoperative tuner and check for +18 V dc remote TUNER ON indicator output at A4J1.
	e) A1 or A3 switch assemblies defective.	e) Check operation of A1 and A3 switch assemblies.
7. Tuners operate but sensitivity is low, especially in Manual mode.	a) RF, IF, and LO switch driver defective.	a) Use Diagnostic Procedure 6d.
	b) Defective AGC amplifier.	b) Check operation of AGC transistors A4A2-Q4 through A4A2-Q9.
	c) A1 or A2 switch assemblies defective.	c) Check operation of A1 and A3 switch assemblies.
8. Signal display disappears when CSU-160 is switched to Autoscan mode.	a) Cables to VIDEO IN and VIDEO OUT connectors reversed.	a) Connect cables properly.
	b) In module A4A5, potentiometer R20, R38 or R47 misadjusted.	b) Refer to adjustment procedure in paragraph 4.5.5 to adjust potentiometers.

Table 4-3. Troubleshooting Chart (Continued)

TROUBLE INDICATION	PROBABLE FAULT	DIAGNOSTIC PROCEDURE
	c) Defective operational amplifiers A4A5-U9B, A4A5-U10, A4A5-U11, or A4A7A2-U1.	c) Check output waveform of D/A converter shown in Figure 4-2e. Check operation of amplifiers A4A5-U9B, A4A5-U10, A4A5-U11, and A4A7A2-U1.
9. Signal display shows no video for one tuner with receiver in PAN mode.	a) Defective tuner.	a) Use Diagnostic Procedure 6a.
	b) Defective wideband IF switch; defective RF, LO, and IF switch driver; defective A1 or A3 assembly.	b) Check operation of A4A4-Q3, -Q12, -Q21, or -Q30, or A4Q3-Q3, -Q12, or -Q21. Make sure the waveform is similar to Figure 4-2f at A4A4-Q5, -Q14, -Q23, or -Q32 and at A4A3-Q5, -Q14, or -Q23; Check operation of switch assemblies A1 and A3.
10. Trace for one tuner is missing from signal display with mode switch on receiver set to SEC and SECTOR WIDTH control set to its maximum counter-clockwise position.	a) Defective tuner.	a) See Diagnostic Procedure 6a.
	b) Defective narrowband IF switch; A1 or A3 assembies or their associated driver defective.	b) Turn SECTOR WIDTH control on receiver clockwise. If trace returns, check operation of A4A4-Q4, -Q13, -Q22, or -Q31, A4A3-Q4, -Q13, or -Q22. Check operation of switch assemblies A1 and A3; Check waveform shown in Figure 4-2f at A4A4-Q5, -Q14, -Q23, or -Q32, or A4A3-Q5, -Q14, or -Q23.
11. Signal display shows pulses with narrow peaks and abrupt transitions to broad shoulders.	a) Simultaneous operation of more than one IF strip in associated receiver.	a) Check for shorts in transistors A4A3-Q3, -Q4, -Q12, -Q13, -Q21, -Q22, -Q30, -Q31 and A4A4-Q3, -Q4, -Q12, -Q13, -Q21, and -Q22.

Table 4-3. Troubleshooting Chart (Continued)

TROUBLE INDICATION	PROBABLE FAULT	DIAGNOSTIC PROCEDURE
		Check the diodes associated with these transistors for shorts.
12. Signal display shows low-amplitude traces for one or more tuners with normal noise levels.	a) Defective switch assembly A1.	a) Check operation of switch assembly A1.
13. Signal display shows low-amplitude traces for one or more tuners and display noise level is reduced.	a) Defective switch assembly A3.	a) Check operation of switch assembly A3.
14. Changing dial setting on a tuning head changes SEC display of other tuning head.	a) Short-circuited manual tuning voltage switch in module A4A4 or A4A3.	a) Check for the following on the tuning voltage switches: Tuner — Module A4A4- 1 — VR1 shorted, Q2 open, Q1 shorted 2 — VR3 shorted, Q11 open, Q10 shorted 3 — VR5 shorted, Q20 open, Q19 shorted 4 — VR7 shorted, Q29 open, Q28 shorted Tuner — Module A4A3- 5 — VR1 shorted, Q2 open, Q1 shorted 6 — VR3 shorted, Q11 open, Q10 shorted

Table 4-3. Troubleshooting Chart (Continued)

TROUBLE INDICATION	PROBABLE FAULT	DIAGNOSTIC PROCEDURE
		Tuner 7: Module A4A4- VR5 shorted, Q20 open, Q19 shorted
15. Changing dial setting on tuning head has no effect on the SEC display for that tuning head.	a) Open-circuited manual tuning voltage switch in module A4A4 or A4A3.	a) Check for defects in manual tuning voltage switch as follows: Tuner 1: Module A4A4- VR1 open, Q2 shorted, Q1 open Tuner 2: Module A4A4- VR3 open, Q11 shorted, Q10 open Tuner 3: Module A4A4- VR5 open, Q20 shorted, Q19 open Tuner 4: Module A4A4- VR7 open, Q29 shorted, Q28 open Tuner 5: Module A4A3- VR1 open, Q2 shorted, Q1 open Tuner 6: Module A4A3- VR3 open, Q11 shorted, Q10 open Tuner 7: Module A4A3- VR5 open, Q20 shorted, Q19 open
16. Associated frequency counter will not count, or gives erratic count for one or more tuners; signal display normal.	a) Defective A2 assembly. b) Defective count inhibit circuitry.	a) Check operation of assembly A2. b) Check waveform shown in Figure 4-2c. If pulse is not present, check for defective A4A5-U2A through U2C, or A4A5-Q1.

Table 4-3. Troubleshooting Chart (Continued)

TROUBLE INDICATION	PROBABLE FAULT	DIAGNOSTIC PROCEDURE
17. Frequency counter display changes rapidly showing the frequencies of more than one tuning head.	a) Defective count inhibit circuitry.	a) Use Diagnostic Procedure 16b.
18. Counter readout does not agree with reading on manual tuning dial for one or more tuners.	a) Defective tuner code multiplexer circuits.	a) Check multiplexers A4A2-U3, -U4, and -U5, and inverters A4A1-U6C through -U6E.
19. Faulty TUNER ON indicators (remote operation only).	a) Defective isolating diodes; defective RF, IF, and LO switch driver.	a) Check operation of A4A4-CR7, -CR16, -CR25, and -CR34 and A4A3-CR7, -CR16, and -CR25. Use Diagnostic Procedure 6d.

4.6 PERFORMANCE TESTS

4.6.1 GENERAL. - The performance test procedures given here may be used as an incoming inspection, for periodic checks, as an aid in troubleshooting, or after repairs have been made. These procedures should be carried out only by a skilled technician using the equipments listed in Table 4-1, or their equivalents.

4.6.2 PRELIMINARY. - Some of the tests given here depend on the proper operation of other equipment of the system in which the CSU-160 is installed. The equipment associated with the CSU-160 should therefore be checked for proper operation before carrying out the following procedures.

4.6.3 POWER SUPPLY REGULATOR TESTS. - Proceed as follows:

(1) Connect the CSU-160 and its associated receiver to a W5MT3W Variac. At least one tuning head must be installed in the CSU-160.

(2) With the Variac set to 105 V ac, 115 V ac, and 125 V ac, check the output voltages of the power supplies at A4U1-E4 and A4A2-TP1.

(3) The voltages at A4-E4 and A4A2-TP1 should stay within the limits listed in Table 4-4 at all of the voltages set in step (2).

Table 4-4. Power Supply Regulator Output Voltages

Measurement Point	Minimum	Maximum
A4U1-E4	+4.8 V	+5.2 V
A4A2-TP1	+29.99 V	+30.01 V

(4) Disconnect the Variac from the CSU-160 and the associated receiver and set the line voltage select switches on both units to 220 V ac.

(5) Connect the CSU-160 and its associated receiver to the output of a W10MT3A Variac. Connect the Variac to a 220 V ac, 50 to 400 Hz source. Set the Variac to 200 V ac, 220 V ac, and 240 V ac and check the output voltages of the power supplies at A4U1-E4 and A4A2-TP1.

(6) The power supply regulator output voltages should not exceed the limits set in Table 4-4 at any of the voltage settings in step (5).

(7) Set the Variac to give a 220 V ac output. Connect the vertical input of an HP-1202 oscilloscope to A4A2-TP1. The ac ripple at A4A2-TP1 should not exceed 500 μV, peak-to-peak.

4.6.4 SEQUENCING CIRCUIT AND TUNER SWITCH VOLTAGE WAVEFORM CHECKS. - To check the waveforms appearing in the trigger and counter circuits, proceed as follows:

(1) Set up the equipment as shown in Figure 4-1. Do not use the EC-205 extender cable. Use an HP-1202 Oscilloscope.

(2) Set the MANUAL/AUTOSCAN pushbutton on the CSU-160 to the AUTOSCAN position. Depress all seven SCANNED PUSHBUTTONS.

(3) Set the mode switch on the 205-( ) or 215-( ) Receiver to the PAN position. Turn the SWEEP RATE control to its fully clockwise position.

(4) Connect the oscilloscope to the test points listed in Table 4-6. The waveforms obtained on the oscilloscope should be similar to the descriptions and figures listed in the table.

(5) Set the mode switch on the 205-( ) or 215-( ) Receiver to the MAN position.

(6) Connect the digital voltmeter to the junction of CR5 and R3 on A4A5. The voltmeter should read approximately +11 V dc.

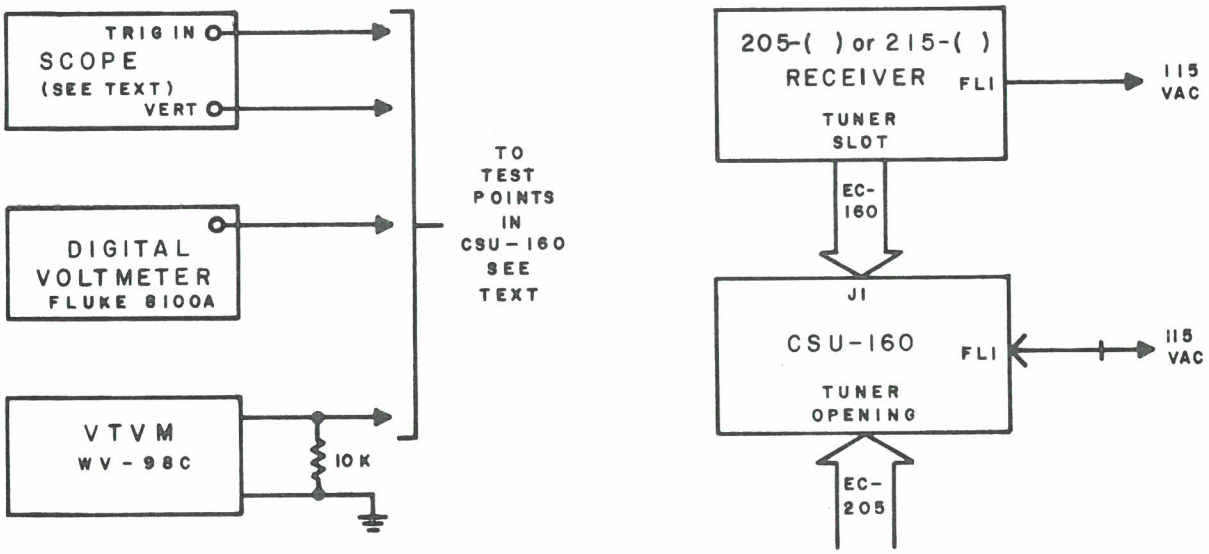


Figure 4-1. Test Setup, CSU-160 Performance Tests

(7) Connect the digital voltmeter to A4A5-U9A, pin 1. The voltmeter should read -18 V dc.

(8) Depress the SCANNED pushbuttons for tuners 1, 2, and 3. Depress the COUNTED SELECTED pushbutton for tuner 1.

(9) Connect the oscilloscope to pin 5 on REMOTE CONTROL receptacle J1. The waveform should appear similar to the waveform described in Table 4-5.

(10) Depress all seven SCANNED pushbuttons. Connect the oscilloscope to A4A5 U9B pin 7. (Refer to Table 4-6 for the correct waveform characteristics.)

4.6.5 REJECT CLOCK WAVEFORM CHECK (SCANNING SELECTOR AND REJECTOR, A4A7A1). -

(1) Set up the equipment as shown in Figure 4-1. Use an HP-1202 oscilloscope.

(2) Set the MANUAL/AUTOSCAN pushbutton on the CSU-160 to the AUTOSCAN position. Leave the seven SCANNED pushbuttons in their most projecting positions so that no tuners are scanned. Set the mode switch on the 205-( ) Receiver to the PAN position.

(3) Connect the oscilloscope to A4A5 pin 15. A continuous train of reject clock pulses should appear on the oscilloscope, as shown in Figure 4-3.

Table 4-5. CSU-160 Waveform Checks

TEST POINT	WAVEFORM DESCRIPTION	FIGURE
A4A5-U9A, pin 2	-5 V pulse at 12.5 ms intervals	4-2a
A4A5-U9A, pin 1	+3.0 V pulse symmetrical about 0 V, 2.75 ±0.5 ms duration at intervals of approximately 30 ms	4-2b
A4A5-U8A, pin 3	+5 V pulse, 1.75 ±0.5 ms duration at intervals of approximately 30 ms	4-2c
A4A5-Q1 Collector	-18 V square wave, duration of approximately 25 ms	4-2d
A4A5-U9B, pin 7	Seven negative going stairsteps, of approximately 35 ms duration	4-2e
A4A4 Collectors of Q5, Q14, Q23, and Q32 A4A3 Collectors of Q5, Q14, Q23, and Q32	+36 V pulse symmetrical about 0 V, duration of approximately 25 ms	4-2f

4.6.6 VIDEO AMPLIFIER NOISE CHECKS. - To check the noise level in the Video Processing Circuits, proceed as follows:

(1) Remove all the tuners from the tuner openings in the CSU-160.

(2) Depress the LOCAL and MANUAL pushbuttons on the CSU-160.

(3) Short the VIDEO IN connector (A4J3) to ground.

(4) Connect the vertical input of the 1202 oscilloscope to the VIDEO OUT connector (A4J4).

(5) With the BW LIMIT switch on the oscilloscope in its least projecting position, the noise level observed on the oscilloscope should not exceed 560 μV peak-to-peak.

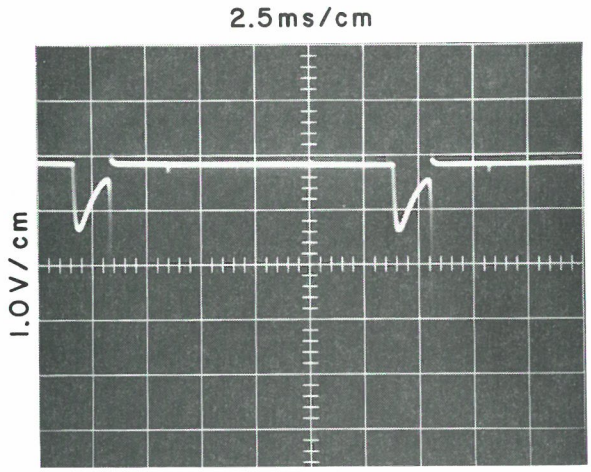


Figure 4-2a. Input to One Shot Multivibrator A4A5-U9A, pin 2

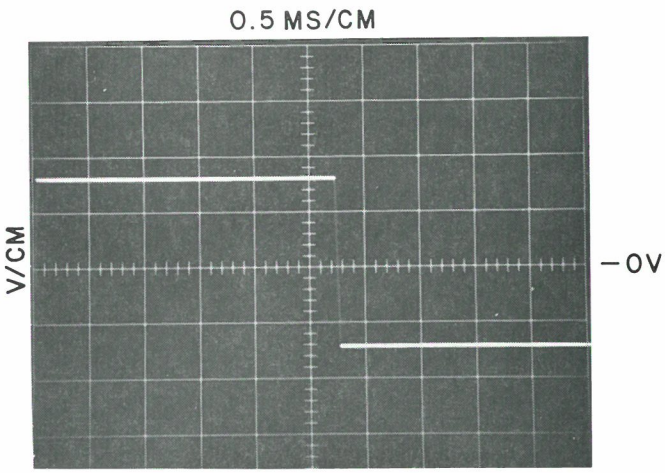


Figure 4-2b. Output of One Shot Multivibrator A4A5-U9A, pin 1

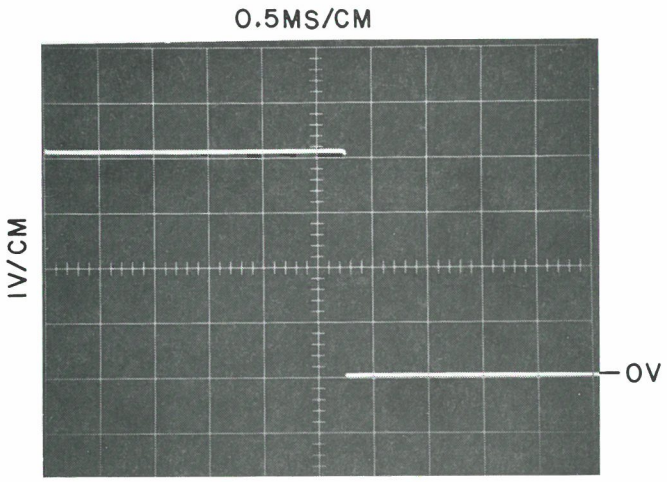


Figure 4-2c. Output of Schmidt Trigger A4A5-U8A, pin 3

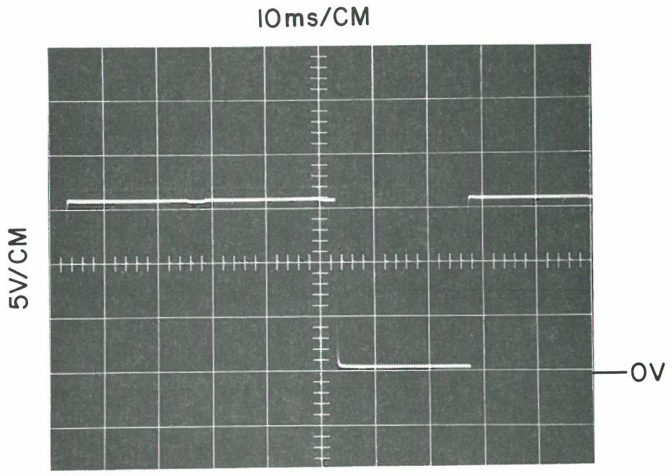


Figure 4-2d. Counter Inhibit Pulse, Collector of A4A5-Q1

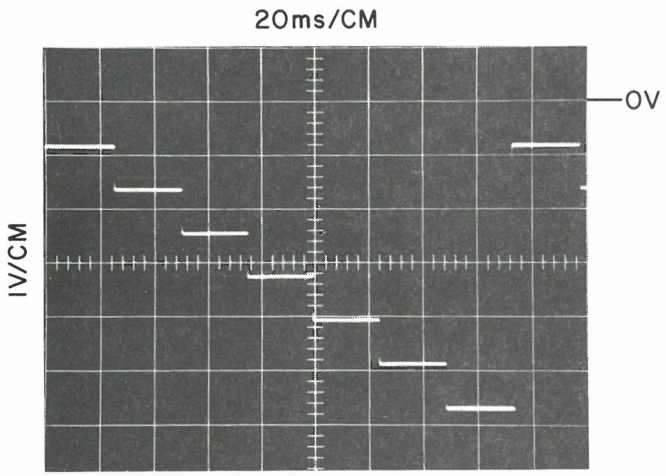


Figure 4-2e. Output of Digital to Analog Converter, A4A5-U9B, pin 7

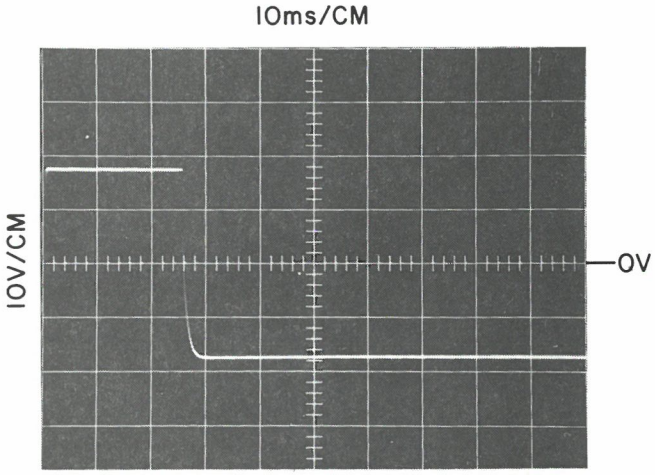


Figure 4-2f. Output of IF, RF, and LO Switch Drivers, Collectors of Q5, Q14, Q23, and Q32 of A4A3 and A4A4

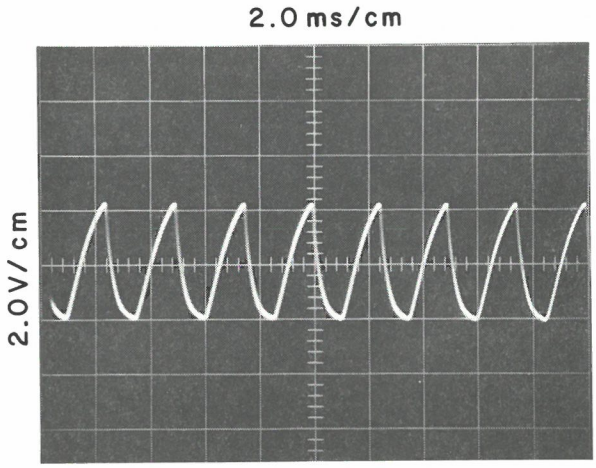


Figure 4-3. Reject Clock Pulses, A4A5, pin 15

4.6.7 RF SWITCH CHECKS. - To check the RF Switch (A1) in the CSU-160 for the proper isolation and insertion loss, proceed as follows:

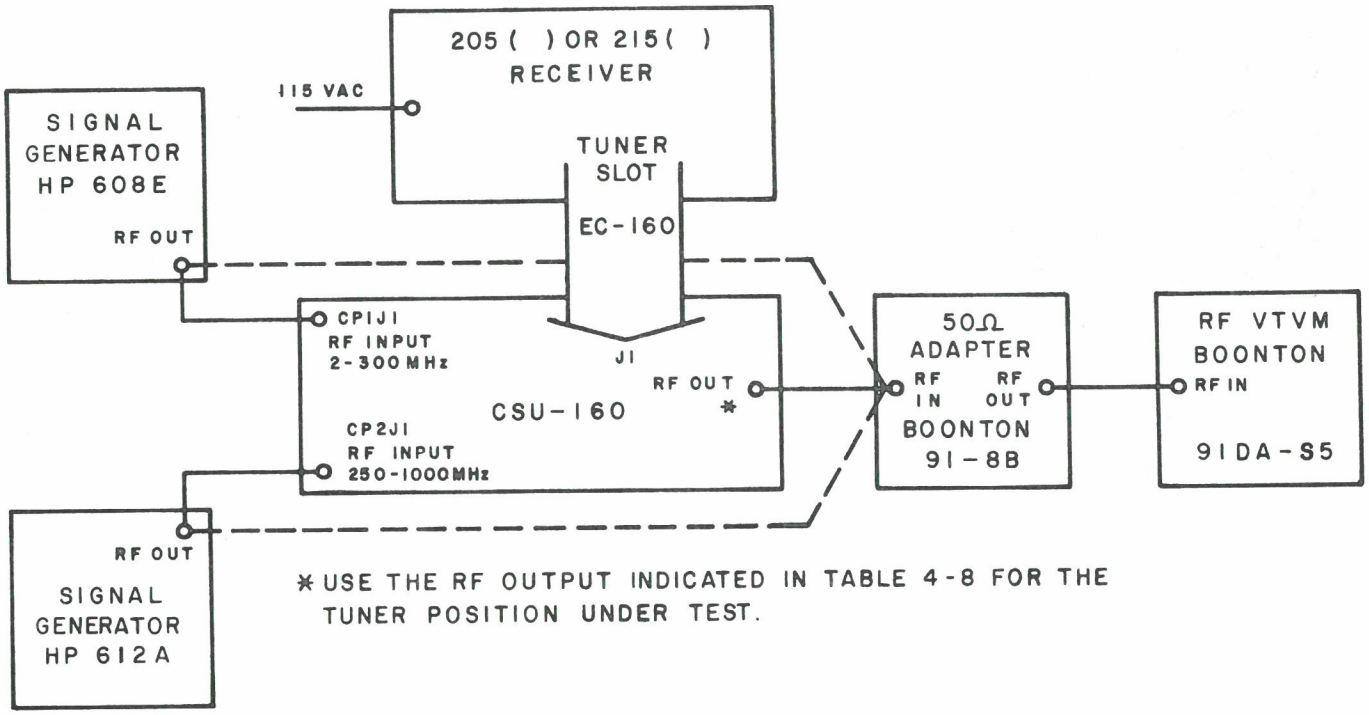


Figure 4-4. Test Setup, RF Switch Checks

(1) Set up the equipment as shown in Figure 4-4. Do not connect the HP-612A Signal Generator to the CSU-160.

(2) Turn on the 205-( ) or 215-( ) Receiver. Set the mode switch to MAN.

(3) Set the MODE pushbuttons on the CSU-160 to LOCAL and MANUAL. Set the DISPLAY pushbutton to NORMAL.

(4) Tune the HP-608E Signal Generator to 300 MHz and set its attenuator to -20 dBm.

(5) Connect the signal generator to the 50 Ω adapter as indicated by the dotted line in Figure 4-4. Note the reading obtained on the VTVM.

(6) Depress the COUNTED/SELECTED pushbutton for Tuner 1. Connect the 50 Ω adapter and the signal generator to the CSU-160 as indicated by the solid lines in Figure 4-4. Note the reading obtained on the VTVM.

(7) Subtract the reading on the VTVM in step (6) from the reading on the VTVM in step (5) to obtain the insertion loss of the switch. The insertion loss should not exceed 2.0 dBm.

(8) Depress each of the other COUNTED/SELECTED pushbuttons. The reading on the VTVM should be zero at each of the other connectors.

(9) Connect the 50 Ω adapter to each of the other RF output connectors listed in Table 4-6. The reading on the VTVM should be at least 20 dBm lower than the level set in step (5).

(10) Repeat steps (5) through (9) for tuner positions 2 through 5. The RF output connectors for each of the tuner positions are listed in Table 4-6. The locations of the connectors are shown in Figure 5-1.

(11) Tune the HP-612A Signal Generator to 1 GHz and set its attenuator to -20 dBm.

(12) Disconnect the HP-608E Signal Generator from the CSU-160.

(13) Repeat steps (5) through (9) for tuner positions 6 and 7.

Table 4-6. Tuner Inputs and Outputs

TUNER POSITION	IF OUTPUT	VHF INPUT	UHF INPUT	LO OUTPUT
1	J5A1	J22		J23
2	J7A1	J24		J25
3	J9A1	J26		J27
4	J11A1	J28		J29
5	J13A1	J30		J31
6	J15A1		J32	J33
7	J17A1		J34	J35

4.6.8 LO SWITCH CHECKS. - To check the LO switch (A2) for the proper isolation and insertion loss, proceed as follows:

(1) Set up the equipment as shown in Figure 4-5. Do not connect the HP-612 Signal Generator to the LO inputs on the CSU-160.

(2) Turn on the 205-( ) or 215-( ) Receiver. Set the mode switch to MAN.

(3) Set the MODE pushbuttons on the CSU-160 to LOCAL and MANUAL. Set the DISPLAY pushbutton to NORMAL.

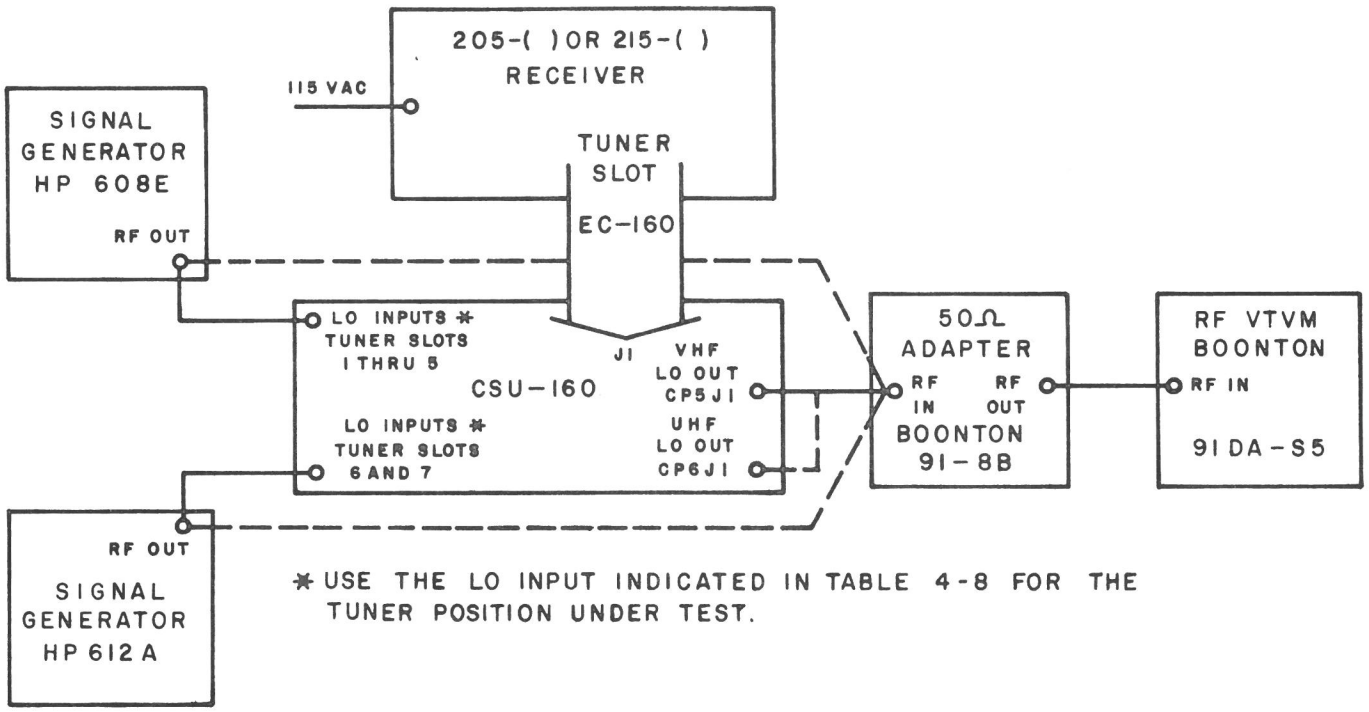


Figure 4-5. Test Setup, LO Switch Checks

(4) Tune the HP-608E Signal Generator to 321.4 MHz and set its attenuator to -20 dBm

(5) Connect the signal generator to the 50 Ω adapter as indicated by the dotted line in Figure 4-5. Note the reading obtained on the VTVM.

(6) Depress the COUNTED/SELECTED pushbutton for Tuner 1. Connect the 50 Ω adapter and the signal generator to the CSU-160 as indicated by the solid lines in Figure 4-5. Note the reading obtained on the VTVM.

(7) Subtract the reading on the VTVM in step (6) from the reading on the VTVM in step (5) to obtain the insertion loss of the switch. The insertion loss should not exceed 3.0 dBm.

(8) Depress each of the other COUNTED/SELECTED pushbuttons. The reading on the VTVM should be 0 V. Depress the pushbutton for the tuner under test.

(9) Connect the 50 Ω adapter to each of the other LO input connectors listed in Table 4-6. The reading on the VTVM should be at least 20 dBm lower than the level set in step (5) at each of the other connectors.

(10) Repeat steps (5) through (9) for tuner positions 2 through 5. The LO input connectors for each of the tuner positions are listed in Table 4-6. The locations of the connectors are shown in Figure 5-1.

(11) Tune the HP-612A Signal Generator to 1160 MHz and set its attenuator to to -20 dBm.

(12) Disconnect the HP-608E Signal Generator from the CSU-160.

(13) Repeat steps (5) through (9) for tuner positions 6 and 7. The LO input con-connectors for tuner positions 6 and 7 are listed in Table 4-6.

4.6.9 IF SWITCH CHECKS. - To check the IF Switch (A3) for the proper isolation and insertion loss, proceed as follows:

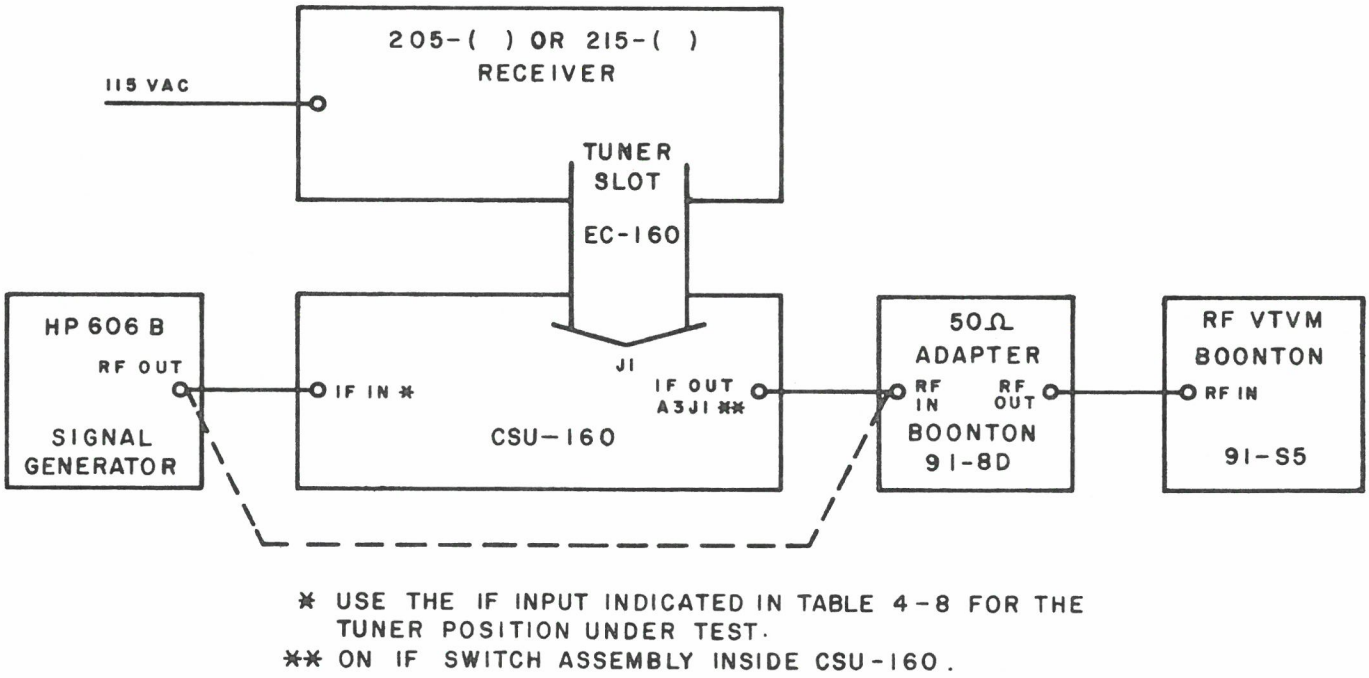


Figure 4-6. Test Setup, IF Switch Checks

(1) Set up the equipment as shown in Figure 4-6.

(2) Turn on the 205-( ) or 215-( ) Receiver. Set the mode switch to MAN.

(3) Set the MODE pushbuttons on the CSU-160 to LOCAL and MANUAL. Set the DISPLAY pushbutton to NORMAL.

(4) Tune the HP-608B Signal Generator to 21.4 MHz and set its attenuator to -20 dBm.

(5) Connect the signal generator to the 50 Ω adapter as indicated by the dotted line in Figure 4-6. Note the reading obtained on the VTVM.

(6) Depress the COUNTED/SELECTED pushbutton for Tuner 1. Connect the 50 Ω adapter and the signal generator to the CSU-160 as indicated by the solid line in Figure 4-6. Note the reading obtained on the VTVM.

(7) Subtract the reading on the VTVM in step (6) from the reading on the VTVM in step (5) to obtain the insertion loss of the switch. The insertion loss should not exceed 1.5 dBm.

(8) Depress each of the other COUNTED/SELECTED pushbuttons. The reading on the VTVM should drop to zero. Depress the pushbutton for the tuner positions under test.

(9) Connect the 50 Ω adapter to each of the other IF input connectors listed in Table 4-6. The reading on the VTVM should be at least 20 dBm lower than the level set in step (5) at each of the other connectors.

(10) Repeat steps (5) through (9) for tuner positions 2 through 7. The IF input input connectors for each of the tuners are listed in Table 4-6. The locations of the connectors are shown in Figure 5-1.

4.6.10 IF BANDWIDTH SELECT SWITCH CHECK. - To check the IF bandwidth select switches printed circuit boards A4A3 and A4A4, proceed as follows:

(1) Set up the equipment as shown in Figure 4-1.

(2) Set the MODE pushbuttons on the CSU-160 to LOCAL and MANUAL. Set the DISPLAY pushbuttons to NORMAL.

(3) Set the mode switch on the 205-( ) or 215-( ) Receiver to PAN.

(4) Insert the EC-205 Extender Cable into tuner position 1. Depress the COUNTED/SELECTED pushbutton for tuner position 1.

(5) Use a VTVM to read the voltages at pin 13 and pin 14 of J4 on the EC-205. The voltage at pin 14 should be +18 V and the voltage at pin 13 should be 0 V.

(6) With the meter connected to pin 14 of J4 on the EC-205, depress each of the other COUNTED/SELECTED pushbuttons. The meter reading should be 0 V.

NOTE

A 10 kΩ 1/2 W resistor should be connected across the meter terminals to draw current from the circuit under test.

(7) Repeat steps (4) through (6) for each of the other tuner positions in the CSU-160.

(8) Reverse the positions of printed circuit boards A4A3 and A4A4.

(9) Repeat steps (4) through (6) for tuner position 4.

(10) Set the mode switch on the 205-( ) or 215-( ) Receiver to SEC. Set the SECTOR WIDTH control to its most counterclockwise position.

(11) Insert the EC-205 Extender Cable into tuner position 1. Depress the COUNTED/SELECTED pushbutton for tuner position 1.

(12) Use a VTVM to read the voltages at pin 13 and pin 14 of J4 on the EC-205. The voltage at pin 14 should be 0 V and the voltage at pin 13 should be +18 V.

(13) With the meter connected to pin 13 of J4 (EC-205) depress each of the other COUNTED/SELECTED pushbuttons. The meter reading should be 0 V.

(14) Repeat steps (11) through (13) for each of the other tuner positions in the CSU-160.

(15) Reverse the positions of printed circuit boards A4A3 and A4A4. Repeat steps (11) through (13) for tuner position 4.

4.6.11 TUNER SUPPLY VOLTAGE SWITCH CHECKS. - To check the switching circuits that supply +18 V to the active tuner in the CSU-160, proceed as follows:

(1) Set up the equipment as shown in Figure 4-1.

(2) Insert an EC-205 Extender Cable into tuner position 1. Set the MODE switch on the CSU-160 to MANUAL. Set the mode switch on the 205-( ) or 215-( ) Receiver to MAN.

(3) Set the COUNTED/SELECTED switch on the CSU-160 to tuner 1.

(4) Use a VTVM to check the voltages at pins 9 and 10 on J3 of the EC-205. The voltage at pin 9 should be -18 V and the voltage at pin 10 should be +18 V.

(5) Repeat steps (2) through (5) for tuner positions 2 through 7.

NOTE

A 10 kΩ 1/2 W resistor should be connected across the meter terminals to draw current from the circuits under test.

4.6.12 TUNER CODE MULTIPLEXER CHECKS. - To check the operation of the Code Multiplexer A4A1, proceed as follows:

(1) Set up the equipment as shown in Figure 4-1.

(2) Turn on the 205-( ) or 215-( ) Receiver. Set the mode switch on the receiver to MAN. Set the MANUAL/AUTOSCAN pushbutton on the CSU-160 to MANUAL and set the REMOTE/LOCAL pushbutton to LOCAL.

(3) Insert the EC-205 Extender Cable into tuner position 1. Depress the COUNTED/SELECTED pushbutton corresponding to tuner position 1.

Table 4-7. Test Points, Tuner Code Multiplexer Checks

Code	Pins on P3 of EC-205	Pins in Counter Receptacle J10 on Receiver
Tuner 2	1	2
Tuner 2	2	3
Tuner 2	4	4
Marker 2	9	9
Marker 2	15	10

(4) Set the WV-98C VTVM to its +15 V range. Connect the VTVM between the pin on receptacle J10 on the receiver listed in the first row and third column of Table 4-7 and ground. The VTVM should read +5 V dc. Connect the pin on connector P3 listed in the first row and second column of Table 4-7 to ground. The VTVM should then read 0 V. Repeat this step for each of the other rows in Table 4-7.

(5) Repeat steps (3) and (4) for tuner positions 2 through 7.

4.7 ADJUSTMENT PROCEDURES

4.7.1 GENERAL. - The following adjustment procedures should not be performed on a routine basis. Rather the test setups should be used as troubleshooting aids and for post-repair tests, and the corresponding adjustment procedures should be performed

only if tests indicate that troubleshooting and repair have disturbed the adjustments. Adjustments to the CSU-160 are made with five trimpots on two of the printed circuit cards in assembly A4, which are accessable when the top cover of the unit has been removed.

4.7.2 +30 V POWER SUPPLY REGULATOR ADJUSTMENT. - To adjust the +30 V power supply regulator, proceed as follows:

NOTE

At least one tuning head must be installed in the CSU-160 during this adjustment.

(1) Remove the top cover of the unit after loosening the fourteen Camloc fasteners that fasten it to the main chassis.

(2) Connect the positive lead of the digital voltmeter to testpoint TP1 of A4A2. (TP1 is a red pin jack near the top edge of printed circuit card A4A2.) Connect the negative lead of the voltmeter to the main chassis.

(3) Adjust the trimpot next to TP1 (A4A2-R7) for a reading on the Digital Voltmeter of +30.00 ±0.01 V dc.

4.7.3 STEP TRIGGER DELAY ADJUSTMENT. - To adjust the delay introduced by the one shot multivibrator in the Sequencing Circuit (A4A5) proceed as follows:

(1) Remove the top cover of the unit after loosening the fourteen Camloc fasteners that fasten it to the main chassis.

(2) Connect the CSU-160 into an RS-160 System as shown in Figure 4-1. Use a dual trace Tektronix 516A Oscilloscope.

(3) Set the mode switch of the 205-( ) Receiver to PAN. Set the SWEEP RATE and SECTOR WIDTH controls to their fully clockwise positions.

(4) Set the MODE pushbuttons on the CSU-160 to LOCAL and AUTOSCAN. Set the DISPLAY pushbutton to NORMAL. Depress the COUNTED/SELECTED pushbutton for Tuner 1 and depress the SCANNED pushbuttons for Tuners 1 and 2.

(5) Set the channel A attenuator on the oscilloscope to 2 V/CM and the channel B attenuator to 5 V/CM. Set the MODE switch to CHOPPED. Set the coupling switches on both channels to DC. Set the horizontal attenuator to 1 mS/CM. Set the TRIGGER SELECTOR switch to EXTERNAL.

(6) Connect the probe from channel A and the external trigger input of the oscilloscope to pin 9 of A4A5.

(7) Connect the probe from channel B to pin 6 of A4A5.

(8) Adjust the oscilloscope controls to display the counter trigger and the counter inhibit pulses.

(9) Adjust trimmer potentiometer A4A5-R44 for a 2.75 mS delay between the leading edge of the trigger pulse and the leading edge of the counter inhibit pulse.

4.7.4 DISPLAY MODIFIER ADJUSTMENTS. - The three trimpots on printed circuit board A4A5 are used to adjust the video display control circuits. To adjust these trimpots proceed as follows:

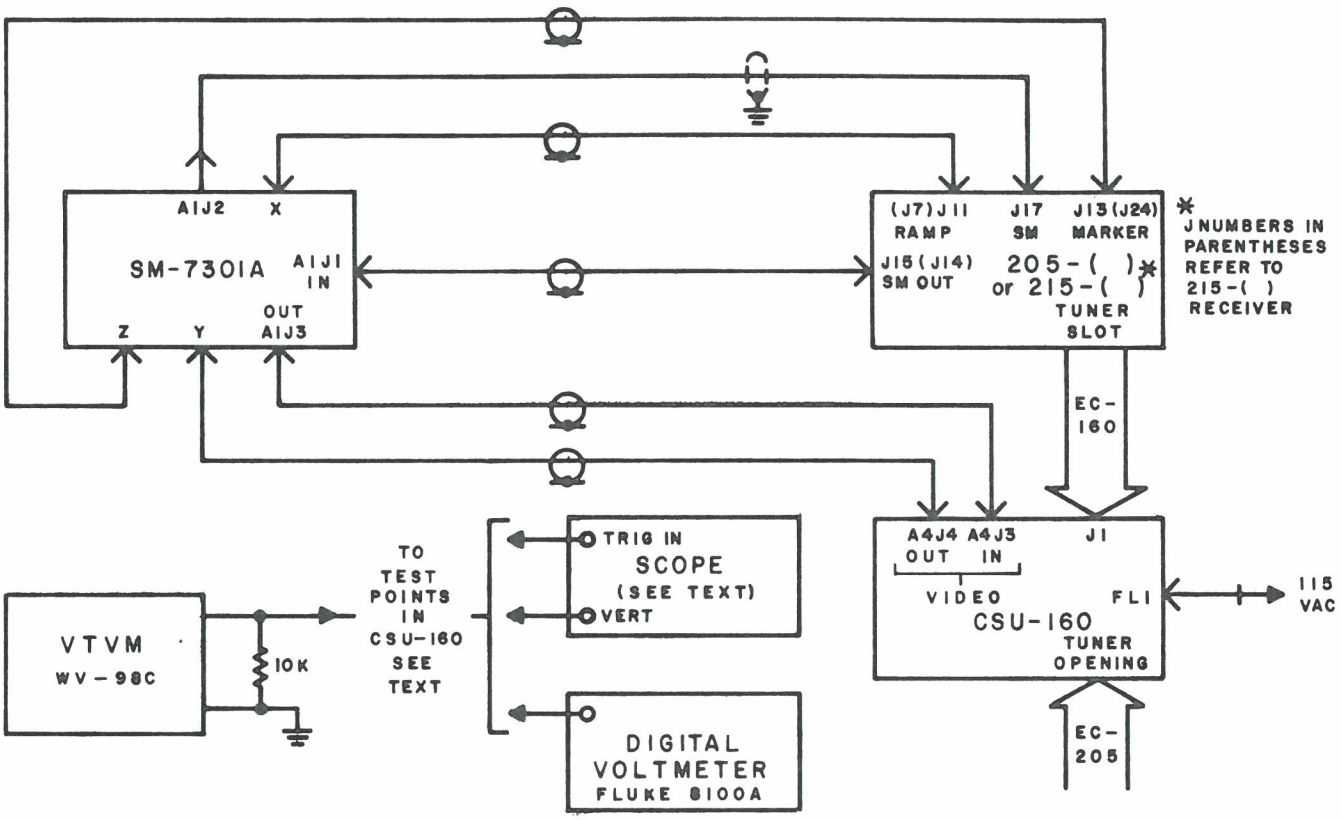


Figure 4-7. Test Setup, CSU-160 Adjustment Procedures

(1) Connect the equipment into an RS-160 System as shown in Figure 4-7.

(2) Set the mode switch on the 205-( ) Receiver to PAN. Set the SWEEP RATE and SECTOR WIDTH controls to their fully clockwise positions.

(3) Set the MODE pushbuttons on the CSU-160 to LOCAL and AUTOSCAN. Set the DISPLAY pushbutton to EXPAND and depress the SCANNED pushbuttons for tuners 1 and 7.

(4) Remove all of the tuning heads from the CSU-160.

(5) Use the VERTICAL POSITION control on the SM-7301 Signal Monitor (located behind the hinged door next to the signal monitor screen) to bring the bottom trace even with the baseline on the signal monitor screen.

(6) Adjust trimpot A4A5-R20 to put the upper trace in the exact center of the signal monitor screen. (R20 adjusts the position of both traces, so that each time the pot is turned, both traces will move.)

(7) Readjust the VERTICAL POSITION control on the signal monitor to bring the bottom trace even with the baseline on the signal monitor screen.

(8) Repeat steps (5) through (7) until the top and bottom traces are both in their proper positions on the signal monitor screen.

(9) Change the DISPLAY pushbutton from the NORMAL to the EXPAND positions. If the bottom trace on the signal monitor screen moves, adjust A4A5-R47 until it does not move when changing between NORMAL and EXPAND.

(10) Set the DISPLAY pushbutton to EXPAND. Change the MANUAL/AUTOSCAN pushbutton between its MANUAL and AUTOSCAN positions. If the bottom trace on the signal monitor screen moves, adjust trimmer potentiometer A4A5-R38 until the bottom trace does not move when changing between MANUAL and AUTOSCAN.

(11) Repeat steps (5) through (11) until the interaction between the adjustments is minimized.

4.8 CONTROL ASSEMBLY REMOVAL AND REPLACEMENT

4.8.1 To remove control assembly A4, proceed as follows:

(1) Turn OFF the associated receiver. Unplug the EC-160 Extender Cable and the CSU-160 ac power cord.

(2) Remove the CSU-160 from the equipment rack. Loosen the 14 Camloc fasteners on the top cover and remove it from the main chassis.

(3) Remove the two Phillips-head screws which secure assembly A4 to the rear apron.

(4) Loosen the 10 Camloc fasteners which secure the rear apron of the CSU-160 to the main chassis.

(5) Disconnect the 6 RF cables from the connectors inside the rear apron and remove the rear apron.

(6) Unplug and remove circuit boards A4A1 through A4A5.

(7) Disconnect cable W21 from jack J1 on the A3 module. (This cable runs to the front panel.)

(8) Unscrew the two captive bolts which fasten module A3 to the main chassis, and rotate A3 up and out to the rear, carefully removing the module power cable from the slot beneath A3.

(9) Disconnect plugs A4P1, A4P2, and A4P3 from the sockets along the side of the main chassis.

(10) Remove the two Phillips-head screws which secure assembly A4 to the front panel.

(11) Carefully slide assembly A4 to the rear until the main power transformer (T1) passes the rear of the main chassis.

(12) Rotate the assembly 90 degrees clockwise as viewed from the rear and remove it from the main chassis.

(13) To reinstall the control assembly, reverse the above procedure, taking particular care that cable W21 remains above assembly A4 as it is inserted, that the A3 power cable returns to the correct slot, and that the 6 RF connectors are mated with the proper rear apron jacks.

Table 4-8. CSU-160 Typical Voltage Readings

REF. DESIG	TYPE	TRANSISTOR ELEMENTS			INTEGRATED CIRCUIT PIN NUMBERS							
		Emitter	Base	Collector	1	2	3	4	5	6	7	8
A4-Q1	2N4919	+45.40	+44.80	+30.00								
A4-U1	7805				+11.55	+5.00	0.00					
A4A2-Q1	2N3906	+45.80	+45.40	+44.30								
A4A2-Q2	2N3904	+4.60	+5.20	+44.20								
A4A2-Q3	2N2222A	+4.60	+5.25	+16.10								
A4A2-Q4(1)	2N3904	-0.64	-0.02	+17.60								
A4A2-Q5(1)	2N3906	-0.17	-0.82	-17.60								
A4A2-Q6(1)	2N3904	-0.64	-0.02	+17.60								
A4A2-Q7(1)	2N3906	-0.17	-0.82	-17.60								
A4A2-Q8(1)	2N3904	-0.64	-0.02	+17.60								
A4A2-Q9(1)	2N3906	-0.17	-0.82	-17.60								
A4A2-U1	741C				---	+10.30	+10.30	0.00	---	+5.20	+29.40	---
Manual tuning voltage switch drivers: A4A4-Q2, Q11, Q20, Q29, A4A3-Q2, Q11, Q20	2N3904	-17.80	-17.78 (2) -17.10 (3)	-17.80 (4)								

Notes:

(1) Receiver in MAN and AM AGC modes; no RF input.
(2) Voltage present when tuner position associated with transistor is selected.
(3) Voltage present when tuner position associated with transistor is not selected.
(4) Voltage present when tuner position associated with transistor is not selected. When tuner position is selected, voltage varies with frequency set on tuning dial of tuner.

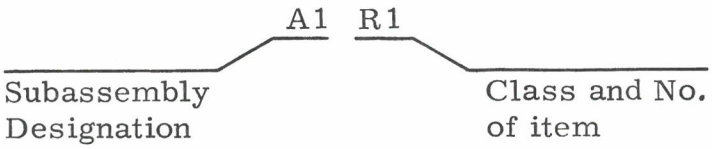
TEST CONDITIONS: All units operated from 115 V ac, 60 Hz; receiver in MAN mode.

NOTES

SECTION V
REPLACEMENT PARTS LIST

5.1 UNIT NUMBERING METHOD

The unit numbering method of assigning reference designations (electrical symbol numbers) has been used to identify assemblies, subassemblies (and modules), and parts. An example of the unit method follows:



Identify from right to left as: First (1) resistor (R) of first (1) subassembly (A)

As shown on the main chassis schematic, components which are an integral part of the main chassis have no subassembly designation.

5.2 REFERENCE DESIGNATION PREFIX

Partial reference designations have been used on the equipment and on the illustrations in this manual. The partial reference designations consist of the class letter(s) and identifying item number. The complete reference designations may be obtained by placing the proper prefix before the partial reference designations. Reference Designation Prefixes are provided on drawings and illustrations in parenthesis within the figure titles.

5.3 LIST OF MANUFACTURERS

Mfr. Code	Name and Address
01121	Allen-Bradley Company 1201 South 2nd Street Milwaukee, Wisc. 53204
01295	Texas Instruments, Inc. Semiconductor-Components Div. 13500 North Central Expressway Dallas, Texas 75231
02735	RCA Corporation Solid State Division Route 202 Somerville, N.J. 08876
04713	Motorola Incorporated Semiconductor Products Div. 5005 East McDowell Road Phoenix, Arizona 85008
05820	Wakefield Engineering, Inc. Audobon Road Wakefield, Mass. 01880
07263	Fairchild Camera and Instrument Corporation Semiconductor Division 464 Ellis Street Mountain View, Calif. 94040

Mfr. Code	Name and Address
11139	Deutsch Company Electronic Component Div. 700 South Hathaway Municipal Airport Banning, Calif. 92220
14632	Watkins-Johnson Company 700 Quince Orchard Road Gaithersburg, Md. 20760
15818	Teledyne Semiconductor 1300 Terra Bella Avenue Mountain View, Calif. 94040
16179	Omni-Spectra, Inc. 24600 Hallwood Court Farmington, Mich. 48024
18324	Signetics Corporation 811 East Arques Avenue Sunnyvale, Calif. 94086
19505	Applied Eng. Products, Co. Division of Samarius Inc. 300 Seymour Avenue Derby, Conn. 06418
28480	Hewlett Packard Company Corporate Headquarters 1501 Page Mill Road Palo Alto, Calif. 94304
33095	Spectrum Control Inc. 152 E. Main Street Fairview, Penn. 16415
56289	Sprague Electric Co. Marshall Street North Adams, Mass. 01247
71400	Bussman Manufacturing Div. of McGraw-Edison Co. 2536 W. University Street St. Louis, Mo. 63107
71468	ITT Cannon Electric 666 East Dyer Road Santa Ana, Calif. 92702
71590	Centralab Electronics Div. of Globe-Union Inc. 5757 North Green Bay Ave. Milwaukee, Wisc. 53201
71785	TRW Electronic Components Cinch Connector Operations 1501 Morse Avenue Elk Grove Village, Ill. 60007
72136	Electro Motive and Manufacturing Company, Incorporated South Park & John Streets Willimantic, Conn. 06226
72982	Erie Technological Products, Inc. 644 West 12th Street Erie, Penn. 16512
73138	Beckman Instruments, Inc. Helipot Division 2500 Harbor Boulevard Fullerton, Calif. 92634
73445	Amperex Electronic Corp. 230 Duffy Avenue Hicksville, New York 11802
73899	JFD Electronics Company 15th at 62nd Street Brooklyn, New York 11219

Mfr. Code	Name and Address
74868	Bunker Ramo Corp. Amphenol RF Division 33 East Franklin Street Danbury, Conn. 06810
75042	TRW Electronic Components IRC Fixed Resistors Philadelphia Division 401 North Broad Street Philadelphia, Penn. 19108
78277	Sigma Instruments, Inc. 170 Pearl Street South Braintree, Mass. 02185
79515	Emco Wheaton Inc. Springfield Road Union, New Jersey 07033
80058	Joint Electronic Type Designation System
80131	Electronic Industries Assoc. 2001 Eye Street, N.W. Washington, D.C. 20006
81312	Winchester Electronics Div. Litton Industries, Incorporated Main Street & Hillside Avenue Oakville, Conn. 06779
81349	Military Specifications
81483	International Rectifier Corp. 9220 Sunset Boulevard Los Angeles, Calif. 90069
82389	Switchcraft, Incorporated 5555 North Elston Avenue Chicago, Illinois 60630
84411	TRW Electric Components TRW Capacitors 112 W. First Street Ogallala, Nebraska 69153
91418	Radio Materials Company 4242 West Bryn Mawr Ave. Chicago, Illinois 60046
91737	ITT Gremar Incorporated 922 S. Lyon Street Santa Ana, Calif. 92705
93332	Sylvania Electric Products, Inc. Semiconductor Products Division 100 Sylvan Road Woburn, Mass. 01801
95712	Bendix Corporation Electrical Components Div. Microwave Devices Plane Hurricane Road Franklin, Ind. 46131
98291	Sealectro Corp. 225 Hoyt Mamaroneck, New York 10544
99800	American Precision Industries Delevan Electronics Division 270 Quaker Road East Aurora, N.Y. 14052
99848	Wilco Corporation 4030 West 10th Street P.O. Box 22248 Indianapolis, Indiana 46222

5.4 PARTS LIST

The parts list which follows contains all electrical parts used in the equipment and certain mechanical parts which are subject to unusual wear or damage. When ordering replacement parts from the Watkins-Johnson Company, specify the type and serial number of the equipment and the reference designation and description of each part ordered. The list of manufacturers provided in paragraph 5.3 and the manufacturer's part number for components are included as a guide to the user of the equipment in the field. These parts may not necessarily agree with the parts installed in the equipment, however, the parts specified in this list will provide satisfactory operation of the equipment. Replacement parts may be obtained from any manufacturer as long as the physical and electrical parameters of the part selected agree with the original indicated part. In the case of components defined by a military or industrial specification, a vendor which can provide the necessary component is suggested as a convenience to the user.

NOTE

As improved semiconductors become available it is the policy of Watkins-Johnson to incorporate them in proprietary products. For this reason some transistors, diodes and integrated circuits installed in the equipment may not agree with those specified in the parts lists and schematic diagrams of this manual. However, the semiconductors designated in the manual may be substituted in every case with satisfactory results.

5.4.1 TYPE CSU-160 TUNER SWITCHING UNIT, MAIN CHASSIS

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
A1	VHF/UHF SWITCH	2	791121	14632	
A2	Same as A1				
A3	IF SWITCH	1	791123	14632	
A4	CONTROL MODULE	1	791130	14632	
CP1	CONNECTOR, ADAPTER	6	21011	16179	
CP2 Thru CP6	Same as CP1				
J1	CONNECTOR, RECEPTACLE, MULTIPIN	1	DCM27W2P	71468	
J1A1	CONNECTOR, PLUG, INSERT	1	DM53740-5001	71468	
J2	CONNECTOR, RECEPTACLE, MULTIPIN	3	SRE34SNSS	81312	
J3	Same as J2				
J4	Same as J2				
J5	CONNECTOR, RECEPTACLE, MULTIPIN	7	DAM11W1S	71468	
J5A1	CONNECTOR, RECEPTACLE, INSERT	7	DM53742-5001	71468	
J6	CONNECTOR, RECEPTACLE, MULTIPIN	7	DAM15S	71468	
J7	Same as J5A1				
J7A1	Same as J6				
J8	Same as J5				
J9	Same as J6				
J9A1	Same as J5A1				
J10	Same as J6				
J11	Same as J5				
J11A1	Same as J5A1				
J12	Same as J6				
J13	Same as J5				
J13A1	Same as J5A1				
J14	Same as J6				
J15	Same as J5				
J15A1	Same as J5A1				
J16	Same as J6				
J17	Same as J5				
J17A1	Same as J5A1				
J18	Same as J6				
J19	CONNECTOR, RECEPTACLE, MULTIPIN	3	M9SLRN	81312	
J20	Same as J19				
J21	Same as J19				

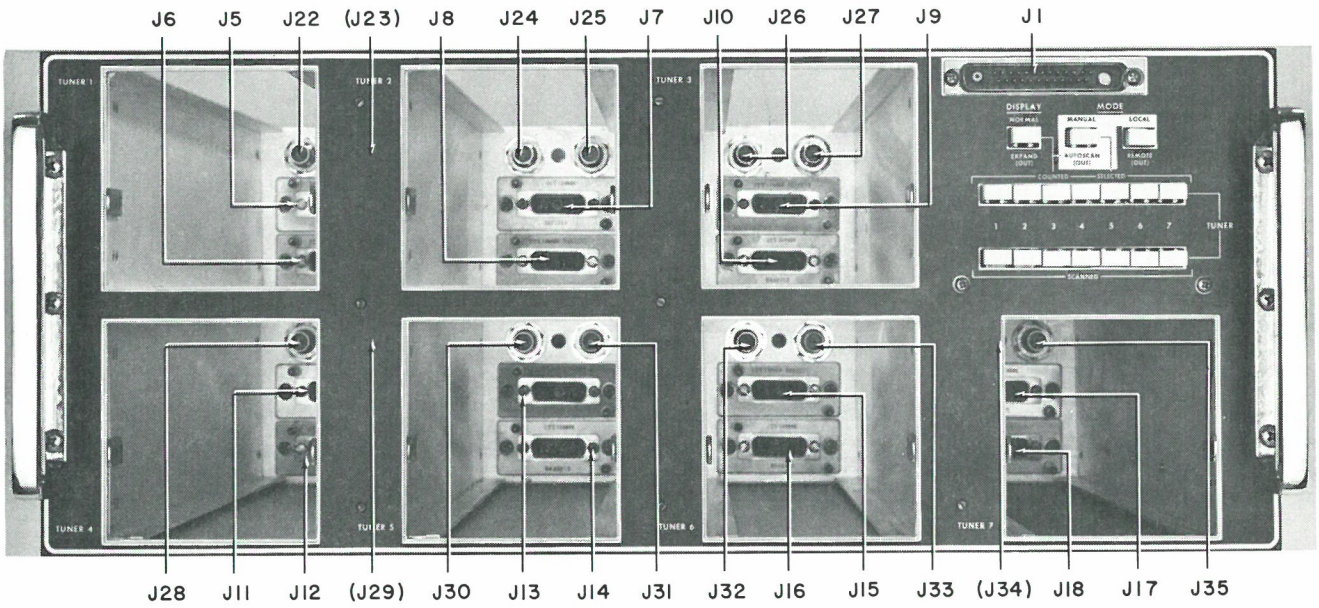


Figure 5-1. Type CSU-160 Tuner Switching Unit, Front View, Component Locations

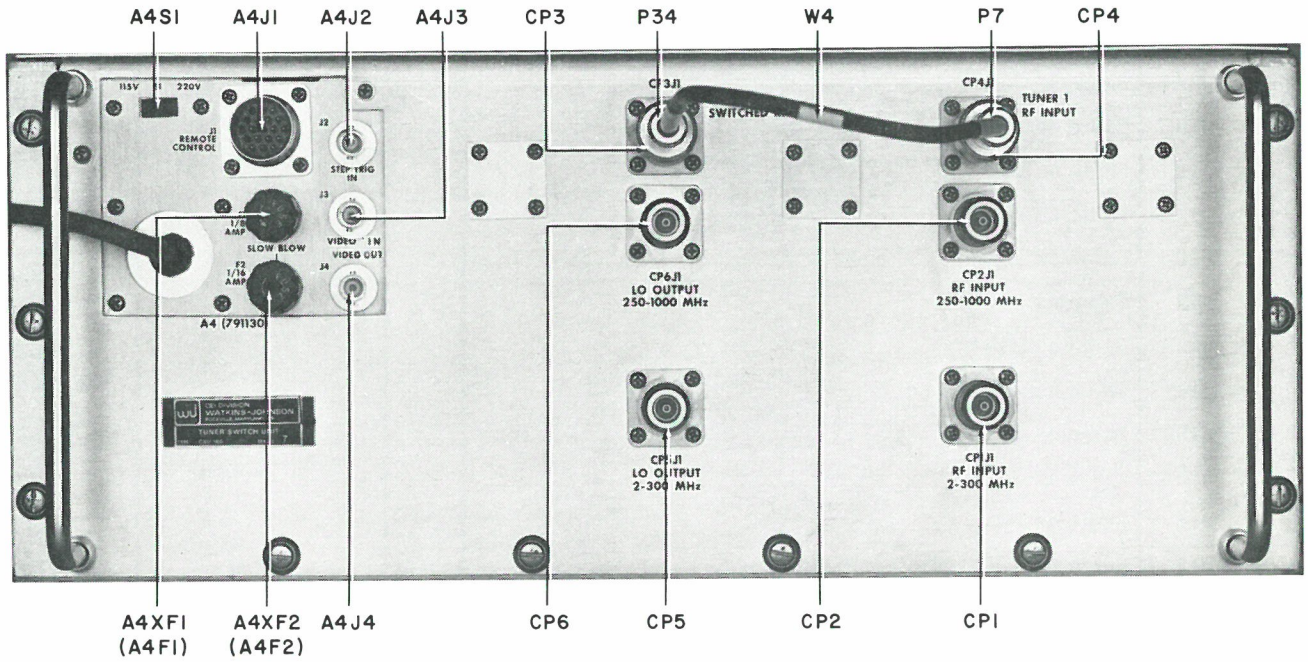


Figure 5-2. Type CSU-160 Tuner Switching Unit, Rear View, Component Locations

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
J22	CONNECTOR, JACK, PUSH-ON	12	33700-4	95712	
J23 Thru J31	Same as J22				
J32	CONNECTOR, JACK, PUSH-ON	2	8212B	91737	
J33	Same as J22				
J34	Same as J32				
J35	Same as J22				
P1	CONNECTOR, PLUG, SMA SERIES	5	521-3	16179	
P2	CONNECTOR, PLUG, SMA SERIES	15	501-3	16179	
P3	CONNECTOR, PLUG, SMA SERIES	4	501-1	16179	
P4	Same as P3				
P5	Same as P1				
P6	Same as P2				
P7	CONNECTOR, PLUG, N SERIES	2	UG526B/U	80058	74868
P8	Same as P1				
P9 Thru P12	Same as P2				
P13	Same as P3				
P14	Same as P3				
P15	Same as P1				
P16	Same as P2				
P17	Same as P2				
P18	Same as P1				
P19 Thru P25	Same as P2				
P26	CONNECTOR, PLUG, SMC SERIES	8	UG1465/U	80058	19505
P27 Thru P33	Same as P26				
TB1	TERMINAL BOARD	1	23182-1	14632	
W1	CABLE ASSEMBLY	1	30020-1867	14632	
W2	CABLE ASSEMBLY	1	30020-1868	14632	
W3	CABLE ASSEMBLY	1	30020-1869	14632	
W4	CABLE ASSEMBLY	1	30020-1870	14632	
W5	CABLE ASSEMBLY	1	30020-1871	14632	

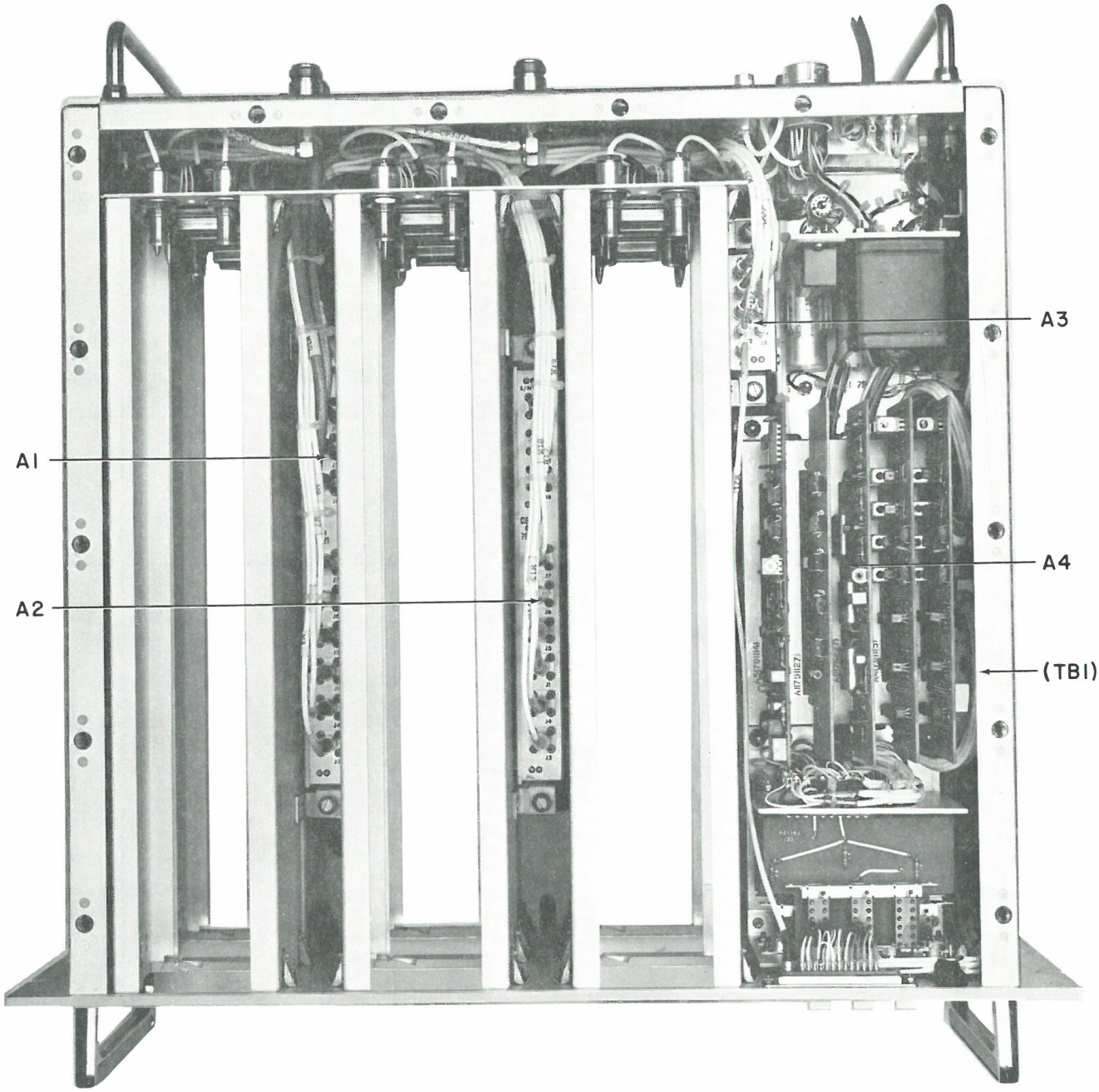


Figure 5-3. Type CSU-160 Tuner Switching Unit, Top View, Component Locations

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
W6	CABLE ASSEMBLY	1	30020-1872	14632	
W7	CABLE ASSEMBLY	1	30020-1873	14632	
W8	CABLE ASSEMBLY	1	30020-1874	14632	
W9	CABLE ASSEMBLY	1	30020-1875	14632	
W10	CABLE ASSEMBLY	1	30020-1876	14632	
W11	CABLE ASSEMBLY	1	30020-1877	14632	
W12	CABLE ASSEMBLY	1	30020-1878	14632	
W13	CABLE ASSEMBLY	1	30020-1879	14632	
W14	CABLE ASSEMBLY	1	30020-1880	14632	
W15	CABLE ASSEMBLY	1	30020-1881	14632	
W16	CABLE ASSEMBLY	1	30020-1882	14632	
W17	CABLE ASSEMBLY	1	30020-1883	14632	
W18	CABLE ASSEMBLY	1	30020-1884	14632	
W19	CABLE ASSEMBLY	1	30020-1885	14632	
W20	CABLE ASSEMBLY	1	30020-1886	14632	
W21	CABLE ASSEMBLY	1	30020-1887	14632	
W22	CABLE ASSEMBLY	1	30020-1888	14632	
W23	CABLE ASSEMBLY	1	30020-1889	14632	
W24	CABLE ASSEMBLY	1	30020-1890	14632	
W25	CABLE ASSEMBLY	1	30020-1891	14632	
W26	CABLE ASSEMBLY	1	30020-1892	14632	
W27	CABLE ASSEMBLY	1	30020-1893	14632	
W28	CABLE ASSEMBLY	1	30020-1894	14632	

5.4.2 TYPE 791121 VHF/UHF SWITCH REF DESIG PREFIX A1, A2

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
A1	VHF SWITCH	1	16317-2	14632	
A2	UHF SWITCH	1	16318-2	14632	
C1	CAPACITOR, CERAMIC, FEEDTHRU: 470 pF, 20%, 500 V	14	54-794-009-4712	33095	
C2 Thru C14	Same as C1				
J1	CONNECTOR, RECEPTACLE, SMA SERIES	9	245	16179	
J2 Thru J9	Same as J1				
P1	CONNECTOR, PLUG, MULTIPIN	1	M9PLSH19C	81312	
R1	RESISTOR, FIXED, COMPOSITION: 10 kΩ, 5%, 1/4W	7	RCR07G103JS	81349	01121
R2 Thru R7	Same as R1				

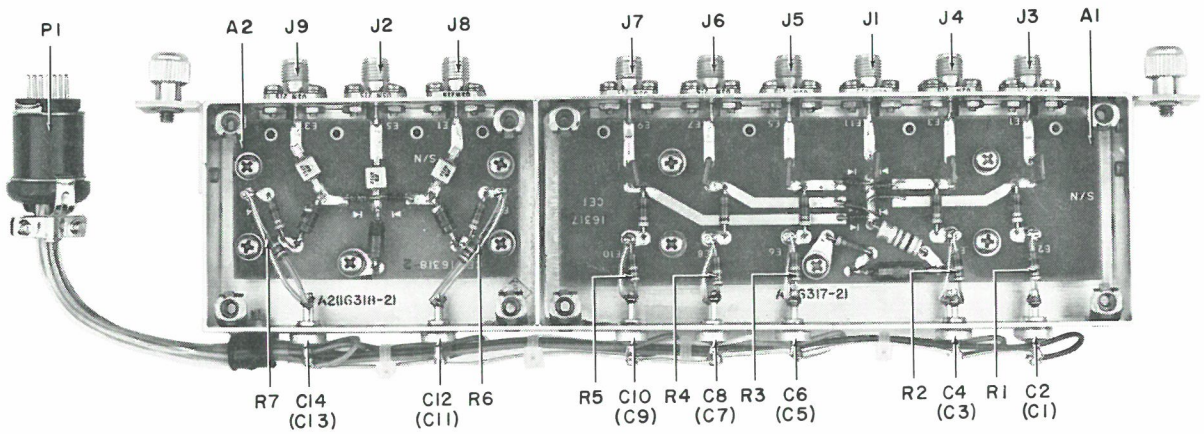


Figure 5-4. Type 791121 VHF/UHF Switch Assembly, A1, A2, Component Locations

5.4.2.1 Part 16317-2 VHF Switch

REF DESIG PREFIX A1A1, A2A1

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C1	CAPACITOR, CERAMIC, DISC: 0.1 μF, 20%, 100 V	6	8131M100-651-104M	72982	
C2 Thru C6	Same as C1				
CR1	DIODE	5	5082-3039	28480	
CR2 Thru CR5	Same as CR1				
L1	COIL, FIXED: 82 μH	1	1537-72	99800	
L2	COIL, FIXED: 2.2 μH	1	209-11	99848	
R1	RESISTOR, FIXED, COMPOSITION: 1 kΩ, 5%, 1/4W	5	RCR07G102JS	81349	01121
R2 Thru R5	Same as R1				
R6	RESISTOR, FIXED, COMPOSITION: 510 Ω, 5%, 1/4W	1	RCR07G511JS	81349	01121

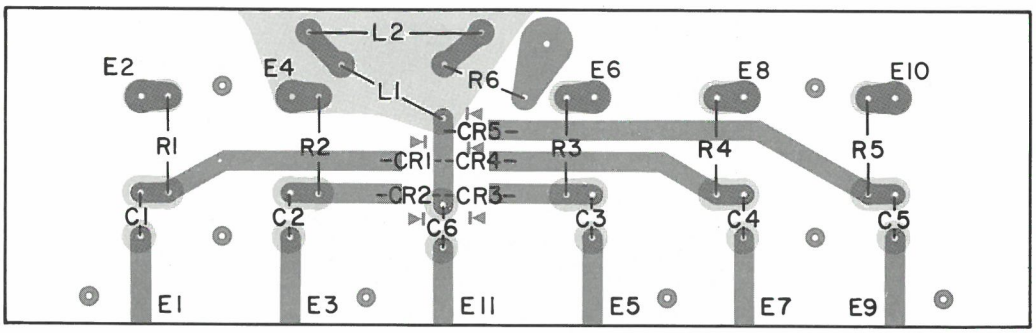


Figure 5-5. Part 16317-2 VHF Switch, A1A1, A2A1, Component Locations

5.4.2.2 Part 16318-2 UHF Switch REF DESIG PREFIX A1A2, A2A2

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C1	CAPACITOR, CERAMIC, DISC: 470 pF, 5%, 300 V	3	UY03471J	73899	
C2	Same as C1				
C3	Same as C1				
CR1	DIODE	2	5082-3039	28480	
CR2	Same as CR1				
L1	COIL, FIXED: 0.47 μH	2	201-11	99848	
L2	Same as L1				
L3	COIL, FIXED: 1.0 μH	1	205-11-10	99848	
R1	RESISTOR, FIXED, COMPOSITION: 1 kΩ, 5%, 1/4W	2	RCR07G102JS	81349	01121
R2	Same as R1				

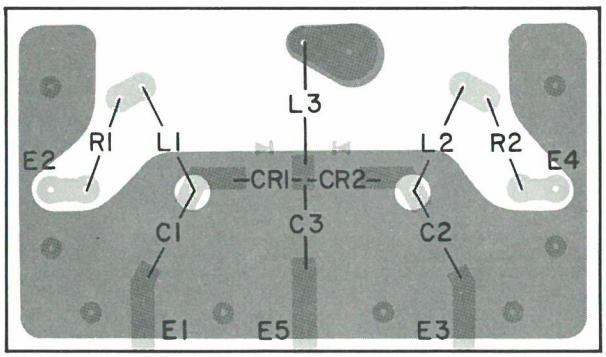


Figure 5-6. Part 16318-2 UHF Switch, A1A2, A2A2, Component Locations

5.4.3 TYPE 791123 IF SWITCH REF DESIG PREFIX A3

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
A1	IF SWITCH	1	17111	14632	
C1	CAPACITOR, CERAMIC, FEEDTHRU: 1000 pF, GMV, 500 V	8	54-794-009-102W	33095	
C2 Thru C8	Same as C1				
C9	CAPACITOR, CERAMIC, DISC: 5000 pF, 20%, 100 V	8	C023B101E502M	56289	
C10 Thru C16	Same as C9				
J1	CONNECTOR, RECEPTACLE, SMC SERIES	8	10-0104-002	19505	
J2 Thru J8	Same as J1				
L1	INDUCTOR	1	1131-37	14632	
P1	CONNECTOR, PLUG, MULTIPIN	1	M9PLSH19C	81312	
R1	RESISTOR, FIXED, COMPOSITION: 1.5 kΩ, 5%, 1/4W	7	RCR07G152JS	81349	01121
R2 Thru R7	Same as R1				

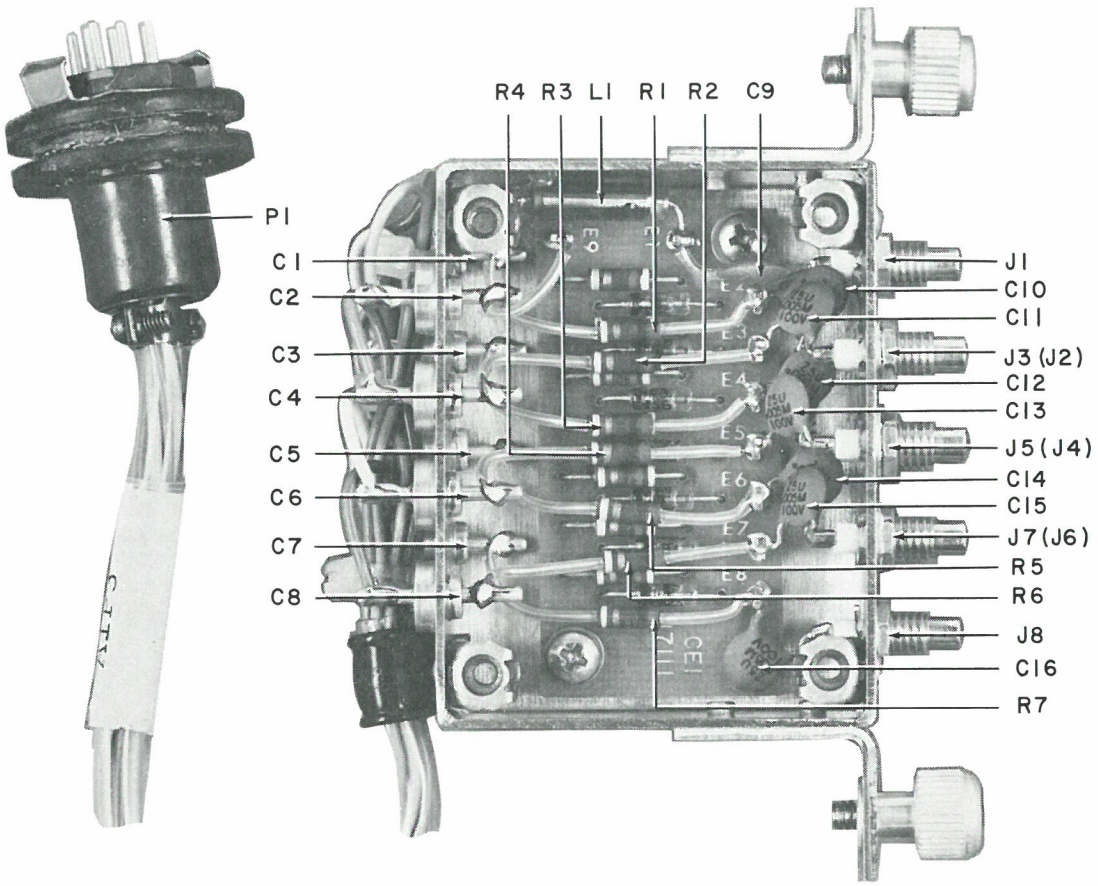


Figure 5-7. Type 791123 IF Switch Assembly, A3, Component Locations

5.4.3.1 Part 17111 IF Switch REF DESIG PREFIX A3A1

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
CR1	DIODE	7	1N4449	80131	93332
CR2 Thru CR7	Same as CR1				
R1	RESISTOR, FIXED, COMPOSITION: 4.7 kΩ, 5%, 1/4W	7	RCR07G472JS	81349	01121
R2 Thru R7	Same as R1				

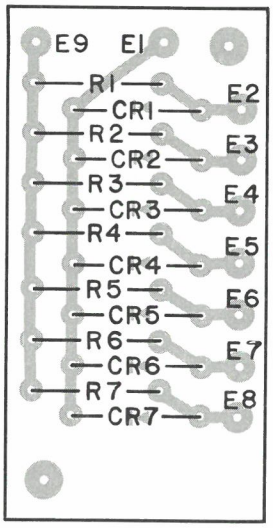


Figure 5-8. Part 17111 IF Switch, A3A1, Component Locations

5.4.4 TYPE 791130 CONTROL MODULE REF DESIG PREFIX A4

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
A1	CODE MULTIPLEXER	1	791127	14632	
A2	POWER SUPPLY AND BUFFER	1	76227	14632	
A3	FOUR CHANNEL TUNER SWITCH	2	791115	14632	
A4	Same as A3				
A5	SEQUENCING CIRCUIT	1	791114	14632	
A6	MASTER SELECTOR	1	791129	14632	
A7	SCANNING CONTROL	1	791102	14632	
A8	SWITCH AND ENCODER	1	791101	14632	
C1	CAPACITOR, ELECTROLYTIC, ALUMINUM: 1000 μF, -10+75%, 15 V	1	34D108G015GL4	56289	
C2	CAPACITOR, ELECTROLYTIC, ALUMINUM: 220 μF, ±4%, 63 V	1	ET221X062A02	73445	
C3	CAPACITOR, ELECTROLYTIC, TANTALUM: 22 μF, 20%, 10 V	1	196D226X0010JE3	56289	
C4	CAPACITOR, CERAMIC, DISC: 0.01 μF, GMV, 2000 V	1	2KV. 01μF	91418	
CR1	DIODE	2	1N4446	80131	93332
CR2	Same as CR1				
F1	FUSE, CARTRIDGE: 1/8 AMP, 3AG, SLOW-BLOW	1	MDL1/8	71400	
F2	FUSE, CARTRIDGE: 1/16 AMP, 3AG, SLOW-BLOW	1	MDL1/16	71400	
FL1	FILTER, POWER LINE	1	JN33-694B	56289	
J1	CONNECTOR, RECEPTACLE, MULTIPIN	1	DS00-19P	11139	
J2	CONNECTOR, RECEPTACLE, BNC SERIES	3	17825-1002	74868	
J3	Same as J2				
J4	Same as J2				
K1	RELAY	1	70R4-12DCSC0	78277	
P1	CONNECTOR, PLUG, MULTIPIN	3	SRE34PNSSH13	81312	
P2	Same as P1				
P3	Same as P1				
Q1	TRANSISTOR	1	2N4919	80131	04713
S1	SWITCH, SLIDE: DPDT	1	11A1211	82389	
T1	TRANSFORMER, POWER	1	17110	14632	
U1	INTEGRATED CIRCUIT	1	UGH7805393	07263	
XA1	CONNECTOR, PRINTED CIRCUIT BOARD	1	251-25-30-160	71785	
XA2	CONNECTOR, PRINTED CIRCUIT BOARD	4	251-22-30-160	71785	
XA3 Thru XA5	Same as XA2				

REF DESIG PREFIX A4

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
XA6	CONNECTOR, PRINTED CIRCUIT BOARD	4	251-10-30-160	71785	
XA7A1	Same as XA6				
XA7A2	Same as XA6				
XA8	Same as XA6				
XF1	FUSEHOLDER	2	342004	79515	
XF2	Same as XF1				

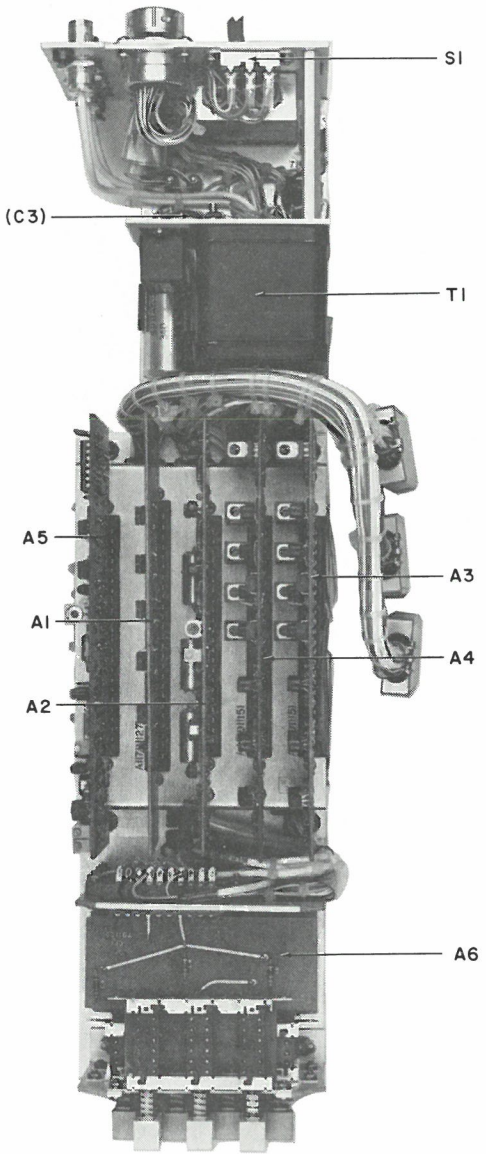


Figure 5-9. Type 791130 Control Module Assembly, A4, Top View, Component Locations

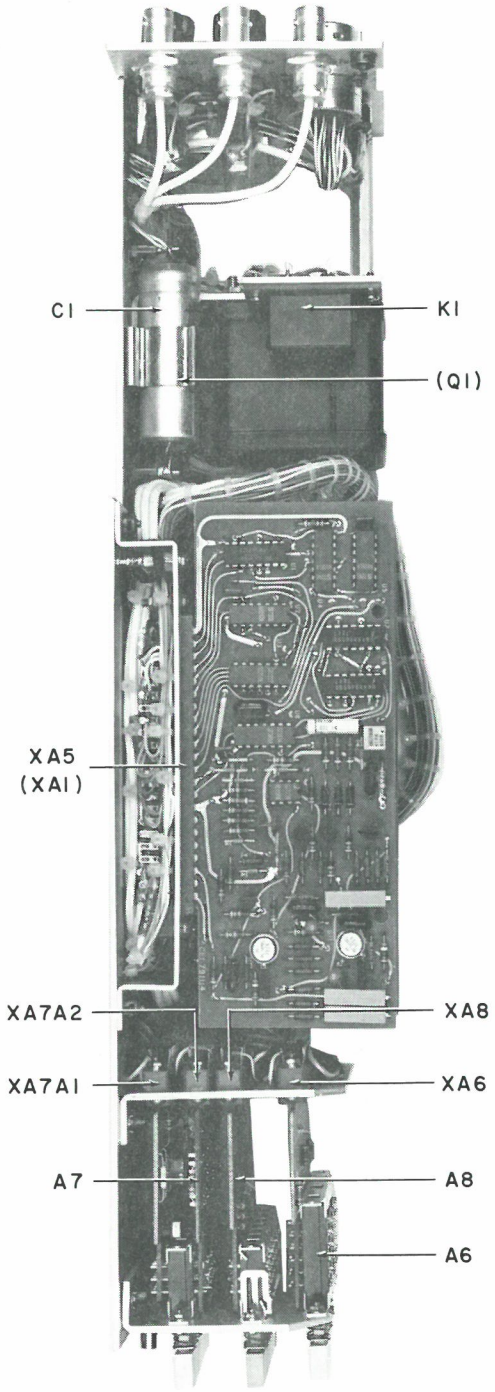


Figure 5-10. Type 791130 Control Module Assembly, A4, Left Side View, Component Locations

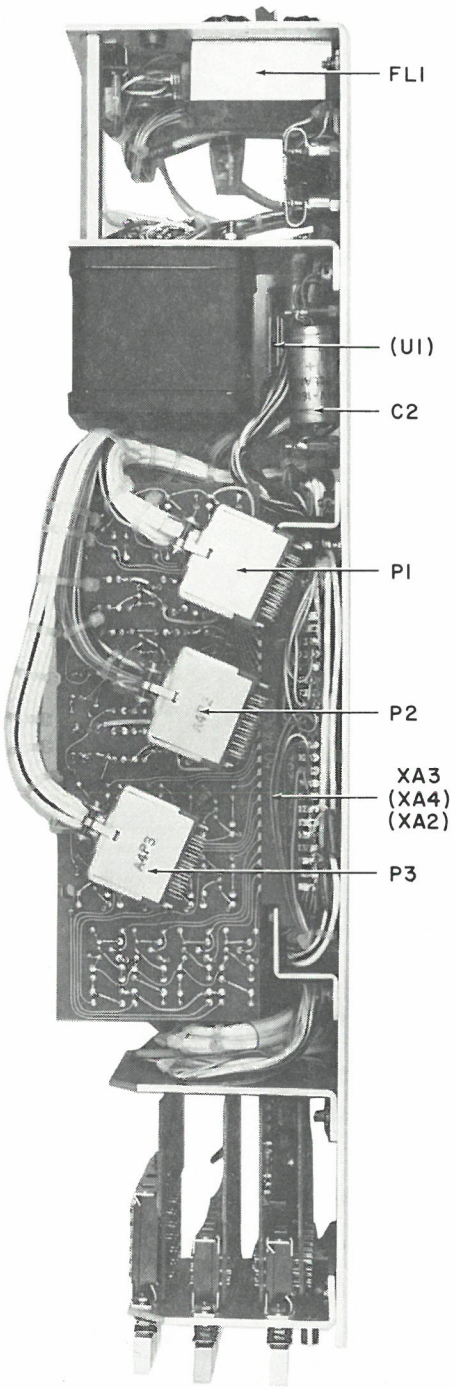


Figure 5-11. Type 791130 Control Module Assembly, A4, Right Side View, Component Locations

5.4.4.1 Type 791127 Code Multiplexer REF DESIG PREFIX A4A1

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: 47 μF, 10%, 6 V	1	CS13BB476K	81349	56289
U1	INTEGRATED CIRCUIT	5	8693L12	14632	
U2 Thru U5	Same as U1				
U6	INTEGRATED CIRCUIT	1	867404	14632	

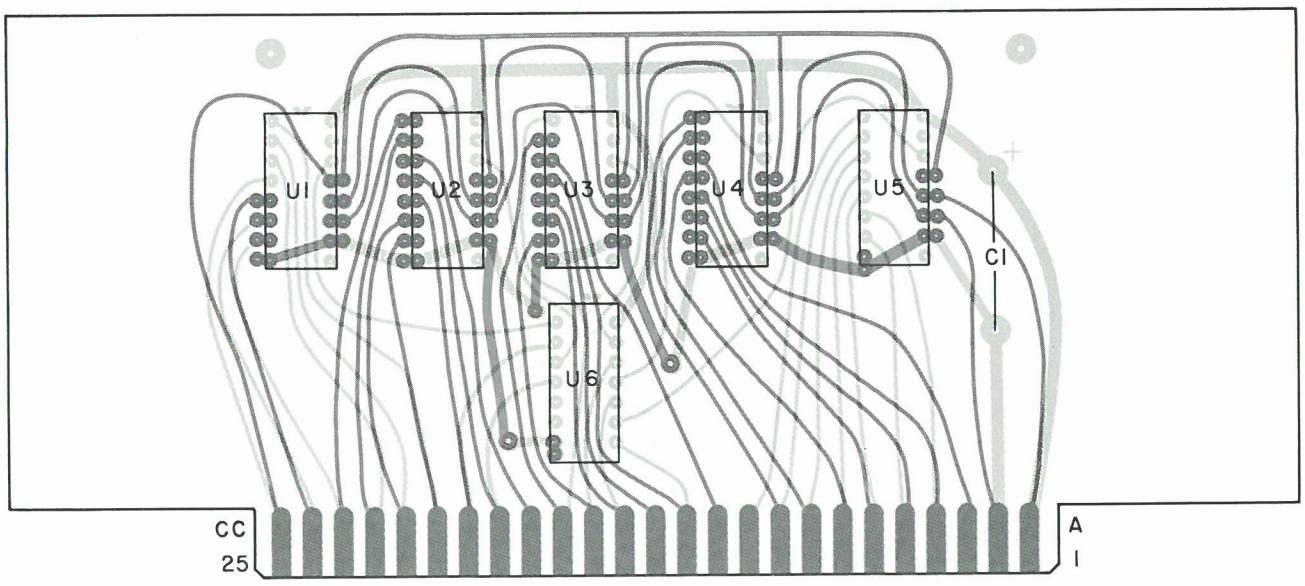


Figure 5-12. Type 791127 Code Multiplexer, A4A1, Component Locations

5.4.4.2 Type 76227 Power Supply and Buffer — REF DESIG PREFIX A4A2

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: 47 μF, 10%, 35 V	6	CS13BF476K	81349	56289
C2 Thru C6	Same as C1				
C7	CAPACITOR, CERAMIC, DISC: 0.01 μF, 20%, 200 V	7	8131A200Z5U103M	72982	
C8 Thru C13	Same as C7				
CR1	DIODE	3	1N4446	80131	93332
CR2	Same as CR1				
CR3	Same as CR1				
Q1	TRANSISTOR	1	2N3906	80131	04713
Q2	TRANSISTOR	4	2N3904	80131	04713
Q3	TRANSISTOR	1	2N2222A	80131	04713
Q4	Same as Q2				
Q5	TRANSISTOR	3	2N4037	80131	02735
Q6	Same as Q2				
Q7	Same as Q5				
Q8	Same as Q2				
Q9	Same as Q5				
R1	RESISTOR, FIXED, COMPOSITION: 10 kΩ, 5%, 1/4W	10	RCR07G103JS	81349	01121
R2	RESISTOR, FIXED, COMPOSITION: 3.9 Ω, 5%, 1/4W	1	RCR07G3R9JS	81349	01121
R3	Same as R1				
R4	RESISTOR, FIXED, COMPOSITION: 1.0 kΩ, 5%, 1/4W	12	RCR07G102JS	81349	01121
R5	RESISTOR, FIXED, FILM: 19.1 kΩ, 1%, 1/10W	1	RN55C1912F	81349	75042
R6	RESISTOR, FIXED, FILM: 6.81 kΩ, 1%, 1/10W	1	RN55C6811F	81349	75042
R7	RESISTOR, VARIABLE, FILM: 1 kΩ, 10%, 3/4W	1	89PR1K	73138	
R8	RESISTOR, FIXED, FILM: 10 kΩ, 1%, 1/10W	1	RN55C1002F	81349	75042
R9	Same as R1				
R10	RESISTOR, FIXED, COMPOSITION: 1.5 kΩ, 5%, 1/4W	1	RCR07G152JS	81349	01121
R11	Same as R4				
R12	RESISTOR, FIXED, COMPOSITION: 33 Ω, 5%, 1/4W	1	RCR07G330JS	81349	01121
R13	RESISTOR, FIXED, COMPOSITION: 2.4 kΩ, 5%, 1/4W	1	RCR07G242JS	81349	01121
R14	Same as R1				
R15	RESISTOR, FIXED, COMPOSITION: 10 Ω, 5%, 1/4W	2	RCR07G100JS	81349	01121
R16	Same as R15				
R17	RESISTOR, FIXED, COMPOSITION: 100 Ω, 5%, 1/4W	9	RCR07G101JS	81349	01121

REF DESIG PREFIX A4A2

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
R18	RESISTOR, FIXED, COMPOSITION: 100 kΩ, 5%, 1/4W	1	RCR07G104JS	81349	01121
R19	Same as R4				
R20	Same as R1				
R21	Same as R17				
R22	Same as R1				
R23	Same as R17				
R24	Same as R4				
R25	RESISTOR, FIXED, COMPOSITION: 47 Ω, 5%, 1/4W	7	RCR07G470JS	81349	01121
R26	Same as R4				
R27	Same as R25				
R28	Same as R4				
R29	Same as R25				
R30	Same as R17				
R31	Same as R4				
R32	Same as R1				
R33	Same as R17				
R34	Same as R1				
R35	Same as R17				
R36	Same as R4				
R37	Same as R25				
R38	Same as R4				
R39	Same as R25				
R40	Same as R17				
R41	Same as R4				
R42	Same as R1				
R43	Same as R17				
R44	Same as R1				
R45	Same as R17				
R46	Same as R4				
R47	Same as R25				
R48	Same as R4				
R49	Same as R25				
RA1	HEATSINK	1	203CB	05820	
TP1	JACK, TIP	1	SKT103PC RED	98291	
U1	INTEGRATED CIRCUIT	1	741HC	07263	
U2	RECTIFIER ASSEMBLY	2	MDA920A3	04713	

REF DESIG PREFIX A4A2

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
U3	Same as U2				

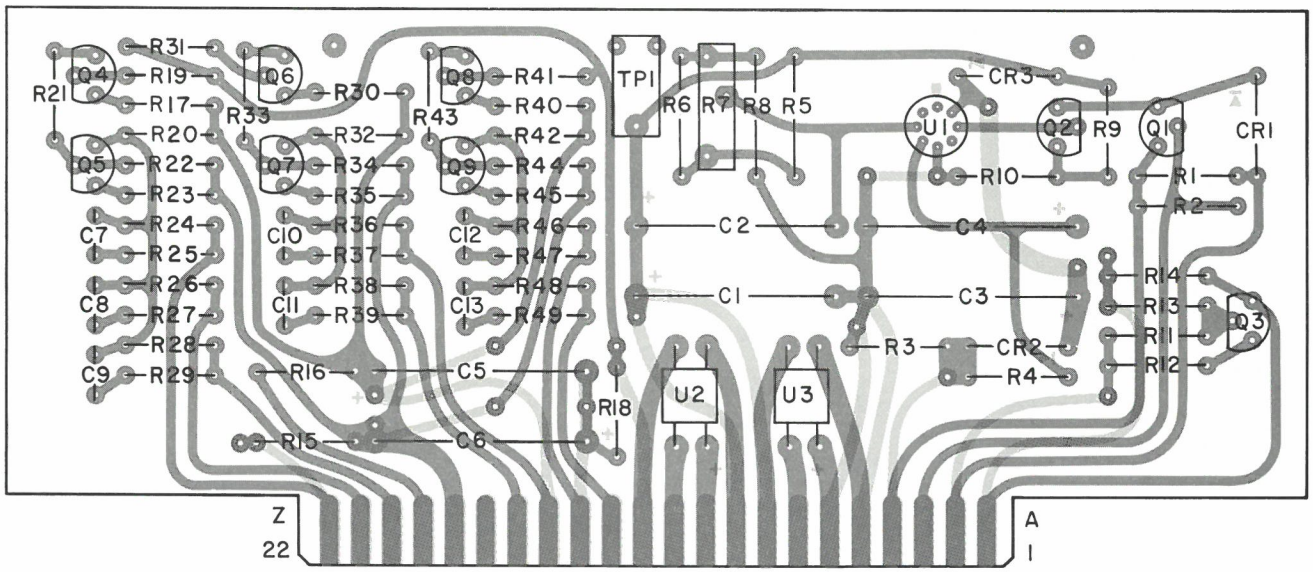


Figure 5-13. Type 76227 Power Supply and Buffer, A4A2, Component Locations

5.4.4.3 Type 791115 Four Channel Tuner Switch REF DESIG PREFIX A4A3, A4A4

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C1	CAPACITOR, CERAMIC, DISC: 0.1 μF, 20%, 100 V	1	8131M100-651-104M	72982	
CR1	DIODE	36	1N4446	80131	93332
CR2 Thru CR36	Same as CR1				
Q1	TRANSISTOR	4	U1899E	15818	
Q2	TRANSISTOR	8	2N3904	80131	04713
Q3	TRANSISTOR	12	2N3906	80131	04713
Q4	Same as Q3				
Q5	TRANSISTOR	8	2N4918	80131	04713
Q6	Same as Q3				
Q7	Same as Q5				
Q8	Same as Q2				
Q9	TRANSISTOR	4	2N4921	80131	04713
Q10	Same as Q1				
Q11	Same as Q2				
Q12	Same as Q3				
Q13	Same as Q3				
Q14	Same as Q5				
Q15	Same as Q3				
Q16	Same as Q5				
Q17	Same as Q2				
Q18	Same as Q9				
Q19	Same as Q1				
Q20	Same as Q2				
Q21	Same as Q3				
Q22	Same as Q3				
Q23	Same as Q5				
Q24	Same as Q3				
Q25	Same as Q5				
Q26	Same as Q2				
Q27	Same as Q9				
Q28	Same as Q1				
Q29	Same as Q2				
Q30	Same as Q3				
Q31	Same as Q3				

REF DESIG PREFIX A4A3, A4A4

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
Q32	Same as Q5				
Q33	Same as Q3				
Q34	Same as Q5				
Q35	Same as Q2				
Q36	Same as Q9				
R1	RESISTOR, FIXED, COMPOSITION: 2.2 MΩ, 5%, 1/8W	4	RCR05G225JS	81349	01121
R2	RESISTOR, FIXED, COMPOSITION: 9.1 kΩ, 5%, 1/8W	16	RCR05G912JS	81349	01121
R3	RESISTOR, FIXED, COMPOSITION: 10 kΩ, 5%, 1/8W	20	RCR05G103JS	81349	01121
R4	Same as R3				
R5	Same as R2				
R6	Same as R3				
R7	Same as R2				
R8	RESISTOR, FIXED, COMPOSITION: 1.0 kΩ, 5%, 1/8W	16	RCR05G102JS	81349	01121
R9	RESISTOR, FIXED, COMPOSITION: 5.1 kΩ, 5%, 1/8W	4	RCR05G512JS	81349	01121
R10	Same as R8				
R11	Same as R3				
R12	Same as R2				
R13	Same as R8				
R14	RESISTOR, FIXED, COMPOSITION: 2 kΩ, 5%, 1/8W	4	RCR05G202JS	81349	01121
R15	Same as R3				
R16	Same as R8				
R17	Same as R1				
R18	Same as R2				
R19	Same as R3				
R20	Same as R3				
R21	Same as R2				
R22	Same as R3				
R23	Same as R2				
R24	Same as R8				
R25	Same as R9				
R26	Same as R8				
R27	Same as R3				
R28	Same as R2				
R29	Same as R8				
R30	Same as R14				
R31	Same as R3				

REF DESIG PREFIX A4A3, A4A4

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
R32	Same as R8				
R33	Same as R1				
R34	Same as R2				
R35	Same as R3				
R36	Same as R3				
R37	Same as R2				
R38	Same as R3				
R39	Same as R2				
R40	Same as R8				
R41	Same as R9				
R42	Same as R8				
R43	Same as R3				
R44	Same as R2				
R45	Same as R8				
R46	Same as R14				
R47	Same as R3				
R48	Same as R8				
R49	Same as R1				
R50	Same as R2				
R51	Same as R3				
R52	Same as R3				
R53	Same as R2				
R54	Same as R3				
R55	Same as R2				
R56	Same as R8				
R57	Same as R9				
R58	Same as R8				
R59	Same as R3				
R60	Same as R2				
R61	Same as R8				
R62	Same as R14				
R63	Same as R3				
R64	Same as R8				
U1	INTEGRATED CIRCUIT	2	SN75453P	01295	
U2	Same as U1				
VR1	DIODE, ZENER: 22 V	4	1N969A	80131	81483

REF DESIG PREFIX A4A3, A4A4

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
VR2	DIODE, ZENER: 30 V	4	1N972B	80131	04713
VR3	Same as VR1				
VR4	Same as VR2				
VR5	Same as VR1				
VR6	Same as VR2				
VR7	Same as VR1				
VR8	Same as VR2				

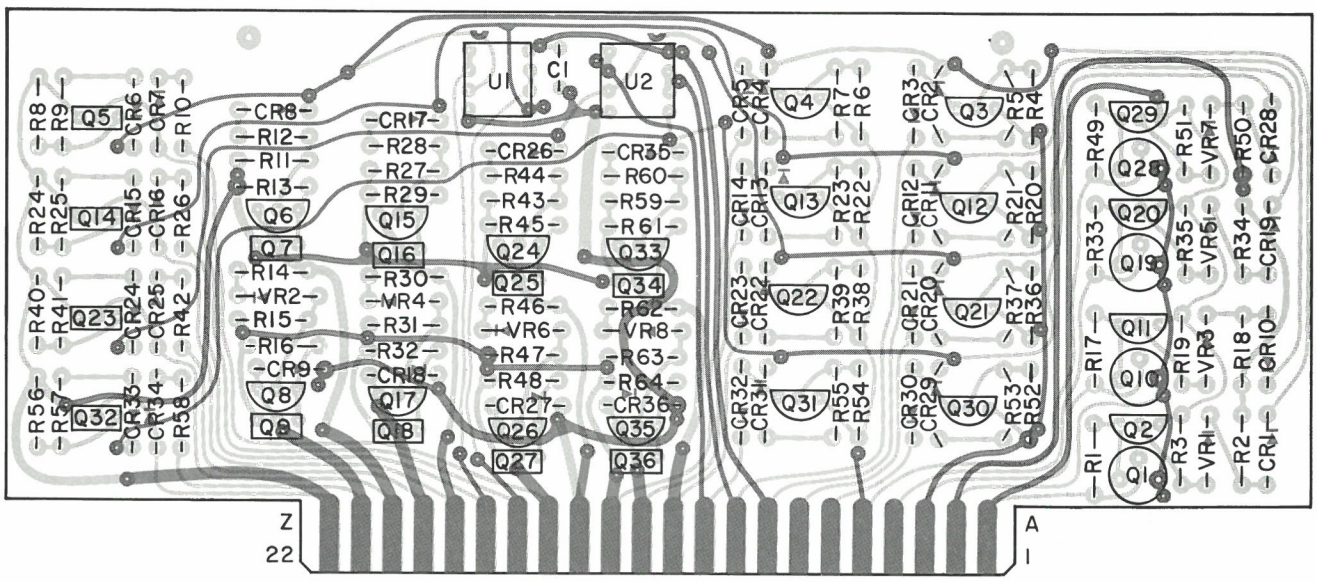


Figure 5-14. Type 791115 Four Channel Tuner Switch, A4A3, A4A4, Component Locations

5.4.4.4 Type 791114 Sequencing Circuit REF DESIG PREFIX A4A5

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C1	CAPACITOR, PLASTIC, TUBULAR: 0.022 μF, 5%, 100 V	1	663UW223-5-1W	84411	
C2	CAPACITOR, ELECTROLYTIC, TANTALUM: 4.7 μF, 20%, 35 V	2	196D475X0035JE3	56289	
C3	CAPACITOR, MICA, DIPPED: 10 pF, ±0.5 pF, 500 V	2	CM05CD100D03	81349	72136
C4	CAPACITOR, CERAMIC, DISC: 2200 pF, 10%, 200 V	2	CK06BX222K	81349	56289
C5	CAPACITOR, MICA, DIPPED: 47 pF, 2%, 500 V	1	CM05ED470G03	81349	72136
C6	Same as C4				
C7	CAPACITOR, CERAMIC, DISC: 0.1 μF, 20%, 100 V	3	8131M100-651-104M	72982	
C8	Same as C7				
C9	Same as C7				
C10	Same as C2				
C11	CAPACITOR, CERAMIC, DISC: 0.01 μF, 20%, 200 V	1	8131A200Z5U103M	72982	
C12	CAPACITOR, MICA, DIPPED: 360 pF, 2%, 500 V	1	CM05FD361G03	81349	72136
C13	Same as C3				
CR1	DIODE	7	1N4446	80131	93332
CR2 Thru CR7	Same as CR1				
Q1	TRANSISTOR	4	2N3906	80131	04713
Q2 Thru Q4	Same as Q1				
R1	RESISTOR, FIXED, COMPOSITION: 1 MΩ, 5%, 1/4W	2	RCR07G105JS	81349	01121
R2	RESISTOR, FIXED, COMPOSITION: 1 kΩ, 5%, 1/4W	2	RCR07G102JS	81349	01121
R3	RESISTOR, FIXED, COMPOSITION: 10 kΩ, 5%, 1/4W	9	RCR07G103JS	81349	01121
R4	Same as R3				
R5	RESISTOR, FIXED, COMPOSITION: 47 kΩ, 5%, 1/4W	1	RCR07G473JS	81349	01121
R6	Same as R3				
R7	RESISTOR, FIXED, COMPOSITION: 2.2 kΩ, 5%, 1/4W	1	RCR07G222JS	81349	01121
R8	Same as R2				
R9	Same as R3				
R10	RESISTOR, FIXED, COMPOSITION: 820 Ω, 5%, 1/4W	3	RCR07G821JS	81349	01121
R11	Same as R10				
R12	Same as R10				
R13 Thru R15	Same as R3				

REF DESIG PREFIX A4A5

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
R16	RESISTOR, FIXED, FILM: 24.9 kΩ, 1%, 1/10W	1	RN55C2492F	81349	75042
R17	RESISTOR, FIXED, FILM: 49.9 kΩ, 1%, 1/10W	1	RN55C4992F	81349	75042
R18	RESISTOR, FIXED, FILM: 100 kΩ, 1%, 1/10W	2	RN55C1003F	81349	75042
R19	Same as R18				
R20	RESISTOR, VARIABLE, FILM: 5 kΩ, 10%, 3/4W	1	89PR5K	73138	
R21	RESISTOR, FIXED, FILM: 5.11 kΩ, 1%, 1/10W	1	RN55C5111F	81349	75042
R22	RESISTOR, FIXED, COMPOSITION: 7.5 kΩ, 5%, 1/4W	1	RCR07G752JS	81349	01121
R23	RESISTOR, FIXED, FILM: 47.5 kΩ, 1%, 1/10W	4	RN55C4752F	81349	75042
R24	Same as R23				
R25	Same as R23				
R26	RESISTOR, FIXED, COMPOSITION: 100 Ω, 5%, 1/4W	2	RCR07G101JS	81349	01121
R27	RESISTOR, FIXED, COMPOSITION: 390 Ω, 5%, 1/4W	2	RCR07G391JS	81349	01121
R28	Same as R23				
R29	Same as R3				
R30	Same as R26				
R31	RESISTOR, FIXED, FILM: 20.5 kΩ, 1%, 1/10W	4	RN55C2052F	81349	75042
R32	Same as R3				
R33	Same as R27				
R34 Thru R36	Same as R31				
R37	RESISTOR, FIXED, FILM: 8.45 kΩ, 1%, 1/10W	1	RN55C8451F	81349	75042
R38	RESISTOR, VARIABLE, FILM: 1 kΩ, 10%, 3/4W	1	89PR1K	73138	
R39	RESISTOR, FIXED, FILM: 499 Ω, 1%, 1/10W	1	RN55C4990F	81349	75042
R40	RESISTOR, FIXED, COMPOSITION: 100 kΩ, 5%, 1/4W	1	RCR07G104JS	81349	01121
R41	RESISTOR, FIXED, COMPOSITION: 3.3 kΩ, 5%, 1/4W	1	RCR07G332JS	81349	01121
R42	RESISTOR, FIXED, FILM: 51.1 kΩ, 1%, 1/10W	1	RN55C5112F	81349	75042
R43	RESISTOR, FIXED, FILM: 75 kΩ, 1%, 1/10W	1	RN55C7502F	81349	75042
R44	RESISTOR, VARIABLE, FILM: 50 kΩ, 10%, 1/2W	1	62PAR50K	73138	
R45	Same as R1				
R46	RESISTOR, FIXED, FILM: 90.0 kΩ, 1%, 1/10W	2	RN55C9092F	81349	75042
R47	RESISTOR, VARIABLE, FILM: 10 kΩ, 10%, 3/4W	1	89PR10K	73138	
R48	Same as R46				
U1	INTEGRATED CIRCUIT	1	8693L22	14632	
U2	INTEGRATED CIRCUIT	1	868242	14632	
U3	INTEGRATED CIRCUIT	1	868250	14632	

REF DESIG PREFIX A4A5

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
U4	INTEGRATED CIRCUIT	2	868281	14632	
U5	Same as U4				
U6	INTEGRATED CIRCUIT	2	86946	14632	
U7	Same as U6				
U8	INTEGRATED CIRCUIT	1	SP380A	18324	
U9	INTEGRATED CIRCUIT	1	MC1458V	18324	
U10	INTEGRATED CIRCUIT	2	MC1439G	04713	
U11	Same as U10				
VR1	DIODE, ZENER: 5.1 V	1	1N751A	80131	04713
VR2	DIODE, ZENER: 8.2 V	3	1N756A	80131	04713
VR3	Same as VR2				
VR4	Same as VR2				
VR5	DIODE, ZENER: 12 V	1	1N759A	80131	04713

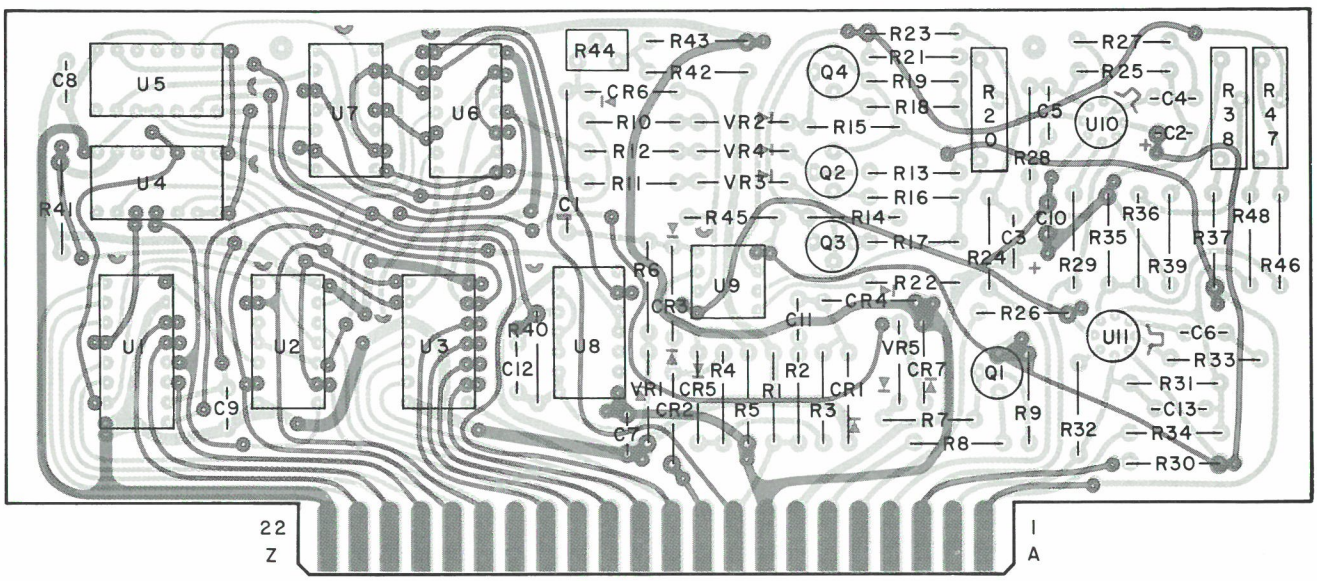


Figure 5-15. Type 791114 Sequencing Circuit, A4A5, Component Locations

5.4.4.5 Type 791129 Master Selector Switch REF DESIG PREFIX A4A6

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
R1	RESISTOR, FIXED, COMPOSITION: 3.3 kΩ, 5%, 1/4W	3	RCR07G332JS	81349	01121
R2	Same as R1				
R3	Same as R1				
S1	SWITCH, PUSHBUTTON, DPDT	1	2KDB00C000-675	71590	

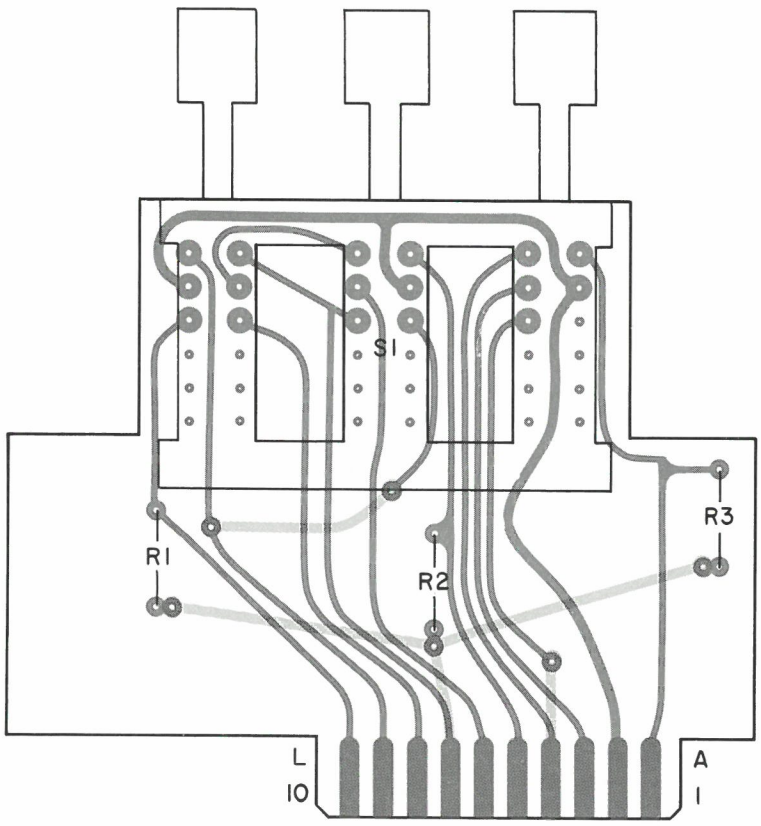


Figure 5-16. Type 791129 Master Selector Switch, A4A6, Component Locations

5.4.4.6 Type 791102 Scanning Control REF DESIG PREFIX A4A7

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
A1	SCANNING SELECTOR AND REJECTOR	1	17153	14632	
A2	VIDEO DISPLAY CONTROL	1	17152		
S1	SWITCH, PUSHBUTTON: DPDT	1	2KBB070000-708	71590	

5.4.4.6.1 Part 17153 Scanning Selector and Rejector REF DESIG PREFIX A4A7A1

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C1	CAPACITOR, MICA, DIPPED: 240 pF, 2%, 500 V	1	CM05FD241G03	81349	72136
C2	CAPACITOR, CERAMIC, DISC: 1000 pF, GMV, 500 V	2	SM(1000pF,P)	91418	
C3	Same as C2				
C4	CAPACITOR, CERAMIC, DISC: 0.1 μF, 20%, 100 V	2	8131M100-651-104M	72982	
C5	Same as C4				
Q1	TRANSISTOR	1	2N3906	80131	04713
R1	RESISTOR, FIXED, COMPOSITION: 1.0 kΩ, 5%, 1/4W	1	RCR07G102JS	81349	01121
R2	RESISTOR, FIXED, COMPOSITION: 47 Ω, 5%, 1/4W	2	RCR07G470JS	81349	01121
R3	RESISTOR, FIXED, COMPOSITION: 3.3 kΩ, 5%, 1/4W	7	RCR07G332JS	81349	01121
R4 Thru R9	Same as R3				
R10	RESISTOR, FIXED, COMPOSITION: 2 kΩ, 5%, 1/4W	1	RCR07G202JS	81349	01121
R11	Same as R2				
U1	INTEGRATED CIRCUIT	2	867403	14632	
U2	Same as U1				
U3	INTEGRATED CIRCUIT	2	86936	14632	
U4	Same as U3				
U5	INTEGRATED CIRCUIT	1	868250	14632	

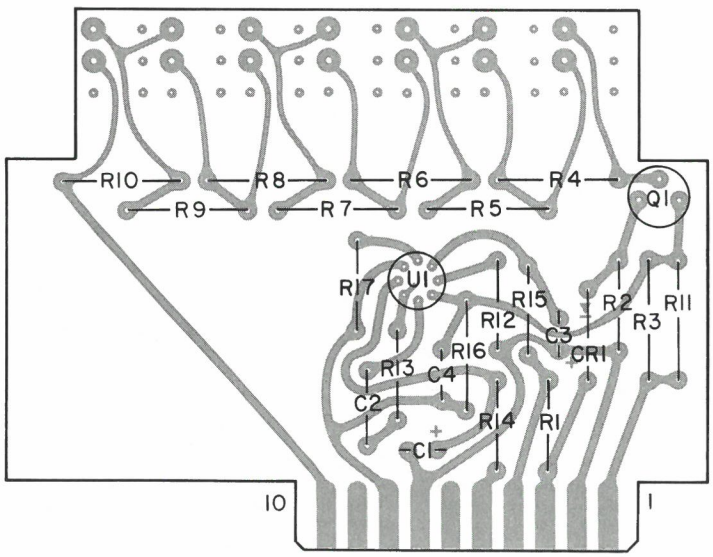


Figure 5-17. Part 17153 Scanning Selector and Rejector, A4A7A1, Component Locations

5.4.4.6.2 Part 17152 Video Display Control REF DESIG PREFIX A4A7A2

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: 4.7 μF, 20%, 35 V	2	196D475X0035JA1	56289	
C2	CAPACITOR, CERAMIC, DISC: 2200 pF, 20%, 1000 V	1	JF2200PFM	91418	
C3	Same as C1				
C4	CAPACITOR, MICA, DIPPED: 10 pF, ±0.5 pF, 500 V	1	CM05CD100D03	81349	72136
CR1	DIODE	1	1N4446	80131	93332
Q1	TRANSISTOR	1	U1899E	15818	
R1	RESISTOR, FIXED, COMPOSITION: 10 kΩ, 5%, 1/4W	2	RCR07G103JS	81349	01121
R2	RESISTOR, FIXED, COMPOSITION: 100 kΩ, 5%, 1/4W	1	RCR07G104JS	81349	01121
R3*	RESISTOR, FIXED, COMPOSITION:	1	RCR07GXXXJS	81349	01121
R4	RESISTOR, FIXED, FILM: 21.5 kΩ, 1%, 1/8W	8	RN55D2152F	81349	75042
R5 Thru R10	Same as R4				
R11	RESISTOR, FIXED, FILM: 150 kΩ, 1%, 1/8W	1	RN55D1503F	81349	75042
R12	RESISTOR, FIXED, COMPOSITION: 1 kΩ, 5%, 1/4W	1	RCR07G102JS	81349	01121
R13	RESISTOR, FIXED, COMPOSITION: 390 Ω, 5%, 1/4W	1	RCR07G391JS	81349	01121
R14	RESISTOR, FIXED, COMPOSITION: 100 Ω, 5%, 1/4W	2	RCR07G101JS	81349	01121
R15	Same as R14				
R16	Same as R4				
R17	Same as R1				
U1	INTEGRATED CIRCUIT	1	MC1439G	04713	

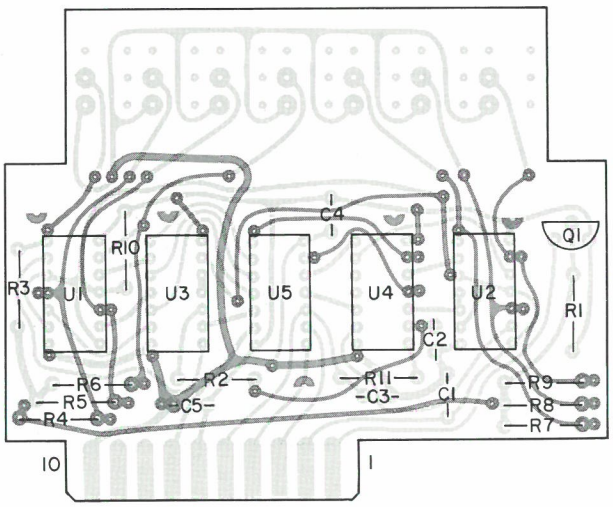


Figure 5-18. Part 17152 Video Display Control, A4A7A2, Component Locations

5.4.4.7 Type 791101 Switch and Encoder

REF DESIG PREFIX A4A8

REF DESIG	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C1	CAPACITOR, CERAMIC, DISC: 0.1 μF, 20%, 100 V	1	8131M100-651-104M	72982	
R1	RESISTOR, FIXED, COMPOSITION: 3.3 kΩ, 5%, 1/4W	6	RCR07G332JS	81349	01121
R2 Thru R6	Same as R1				
S1	SWITCH, PUSHBUTTON: DPDT	1	2KBC070000-709	71590	
U1	INTEGRATED CIRCUIT	1	867410	14632	

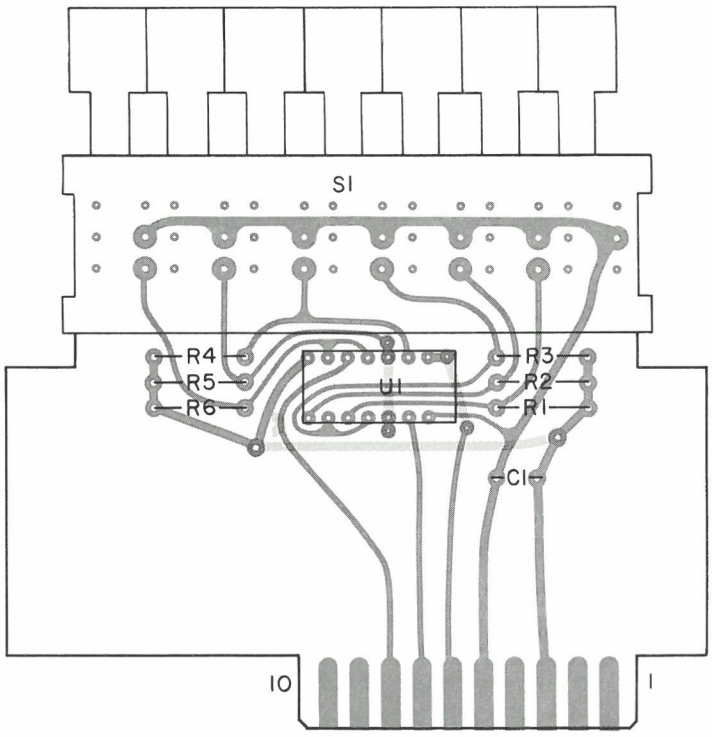
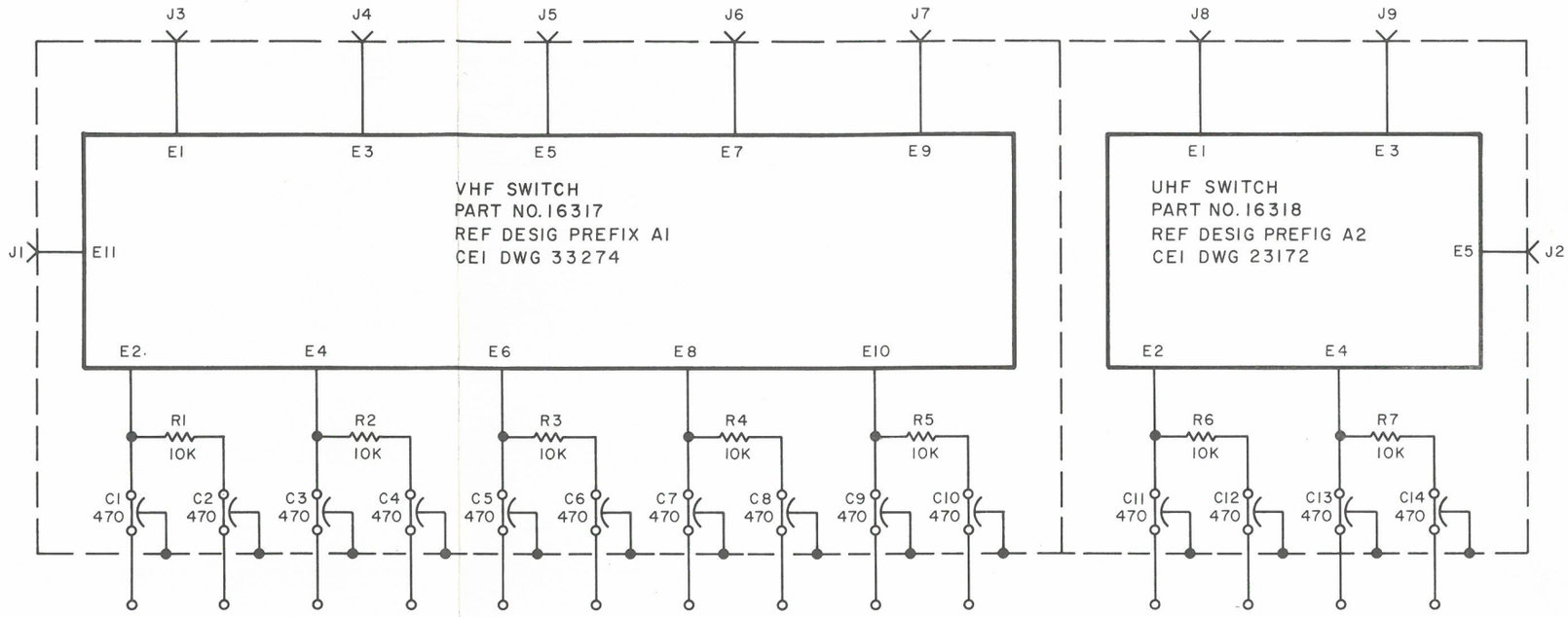


Figure 5-19. Type 791101 Switch and Encoder, A4A8, Component Locations

SECTION VI
SCHEMATIC DIAGRAMS



NOTES:
1. UNLESS OTHERWISE SPECIFIED;
   a) RESISTANCE IS IN OHMS, ±5%, 1/4W.
   b) CAPACITANCE IS IN pF.
2. FOR WIRING TO PLUG, SEE DETAIL A.

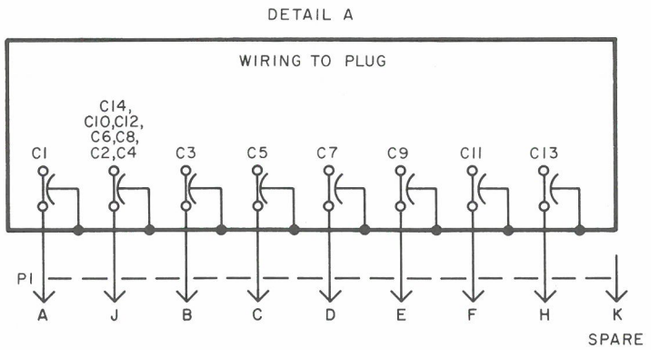
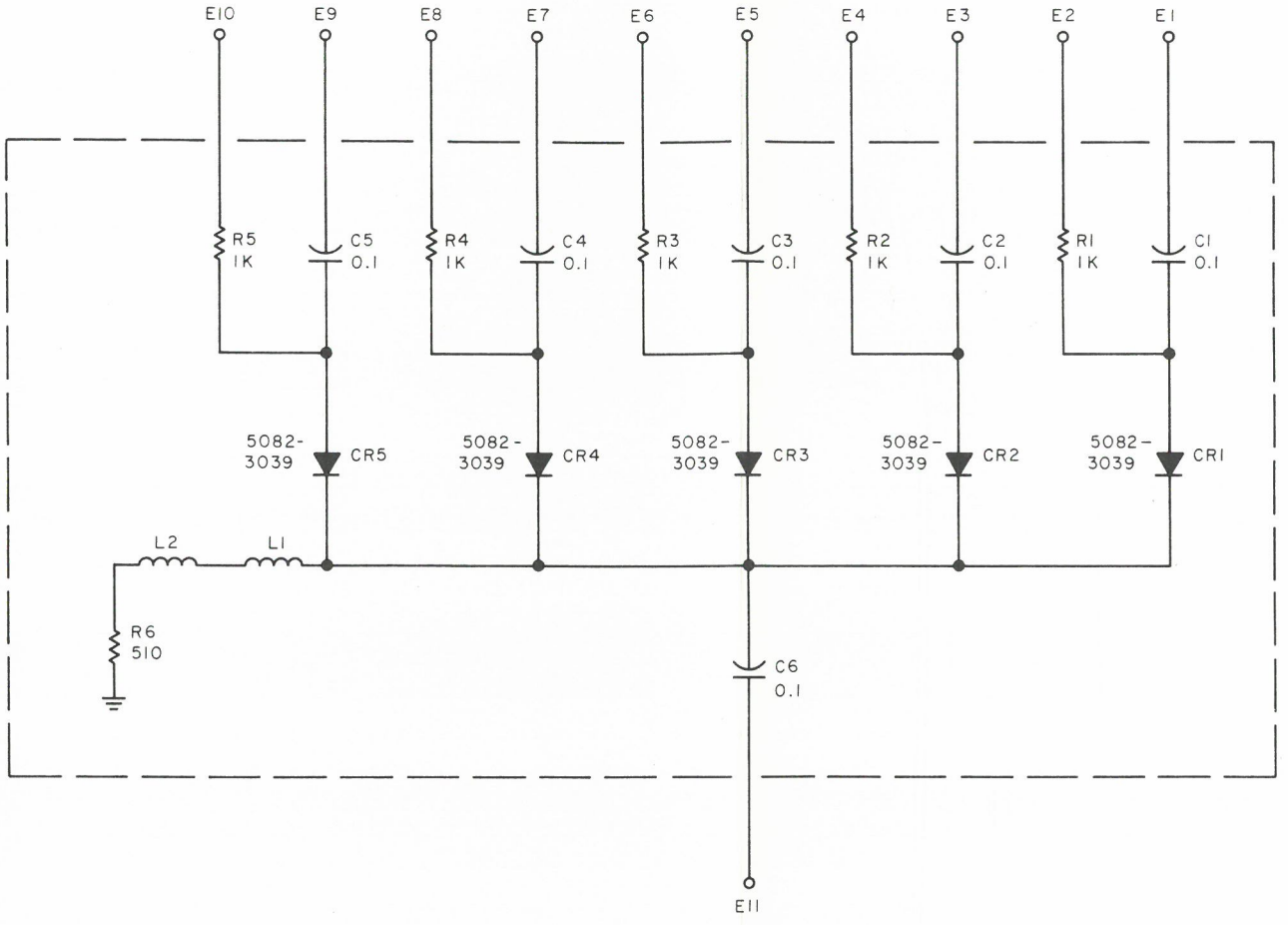


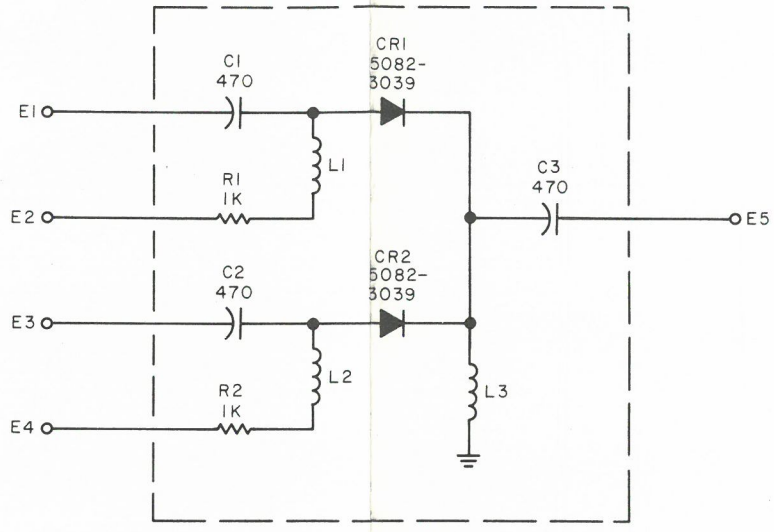
Figure 6-1. Type 791121 VHF/UHF Switch Assembly (A1, A2), Schematic Diagram



NOTES;

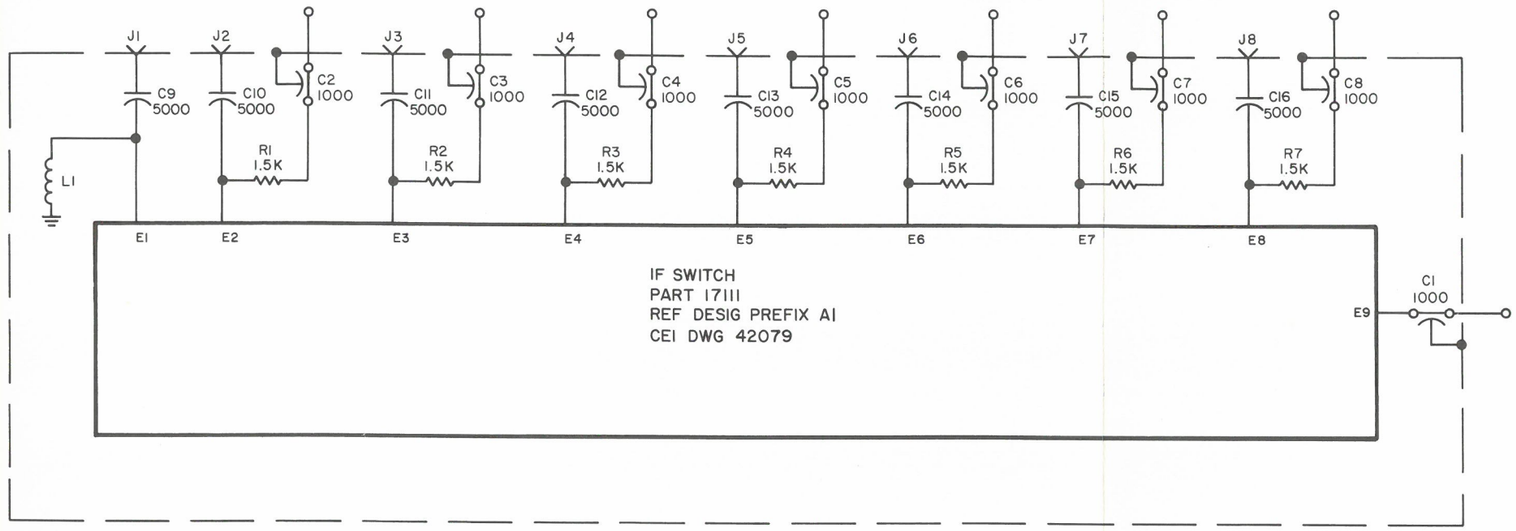
1. UNLESS OTHERWISE SPECIFIED:
   a) RESISTANCE IS IN OHMS, ±5%, 1/4 W.
   b) CAPACITANCE IS IN μF.

Figure 6-2. Part 16317 VHF Switch (A1A1, A2A1), Schematic Diagram



NOTES:
1. UNLESS OTHERWISE SPECIFIED;
   a) RESISTANCE IS IN OHMS, ±5%, 1/4W.
   b) CAPACITANCE IS IN pF.

Figure 6-3. Part 16318 UHF Switch (A1A2, A2A2), Schematic Diagram



NOTES

1 UNLESS OTHERWISE SPECIFIED
a) RESISTANCE IS IN OHMS, ±5%, 1/4 W
b) CAPACITANCE IS IN pF

2 FOR WIRING TO PLUG SEE DETAIL A

DETAIL A

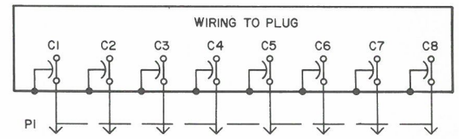
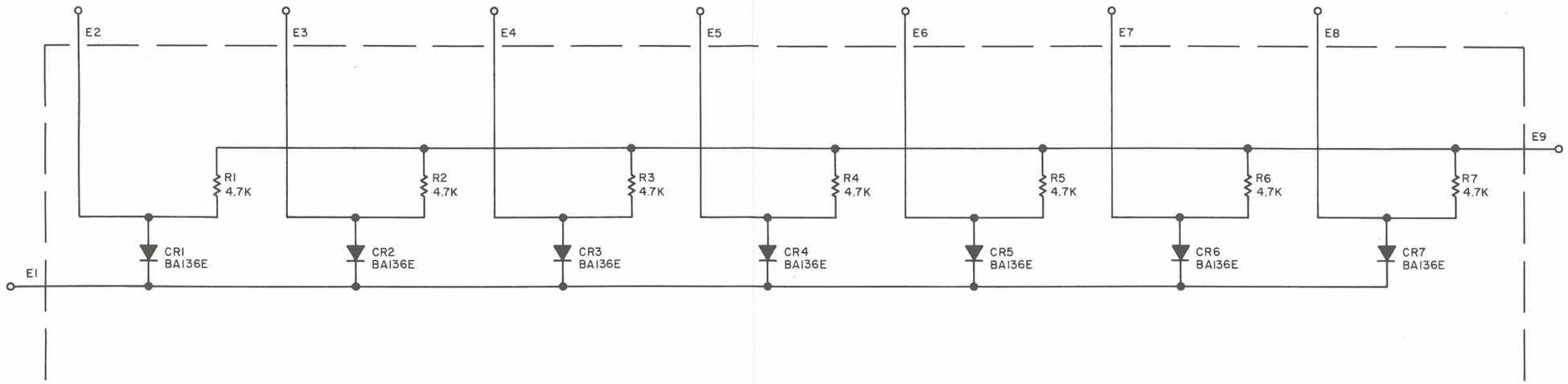


Figure 6-4. Type 791123 IF Switch Assembly (A3), Schematic Diagram



NOTES
1 UNLESS OTHERWISE SPECIFIED
a) RESISTANCE IS IN OHMS, ±5%, 1/4 W

Figure 6-5. Part 17111 IF Switch (A3A1), Schematic Diagram

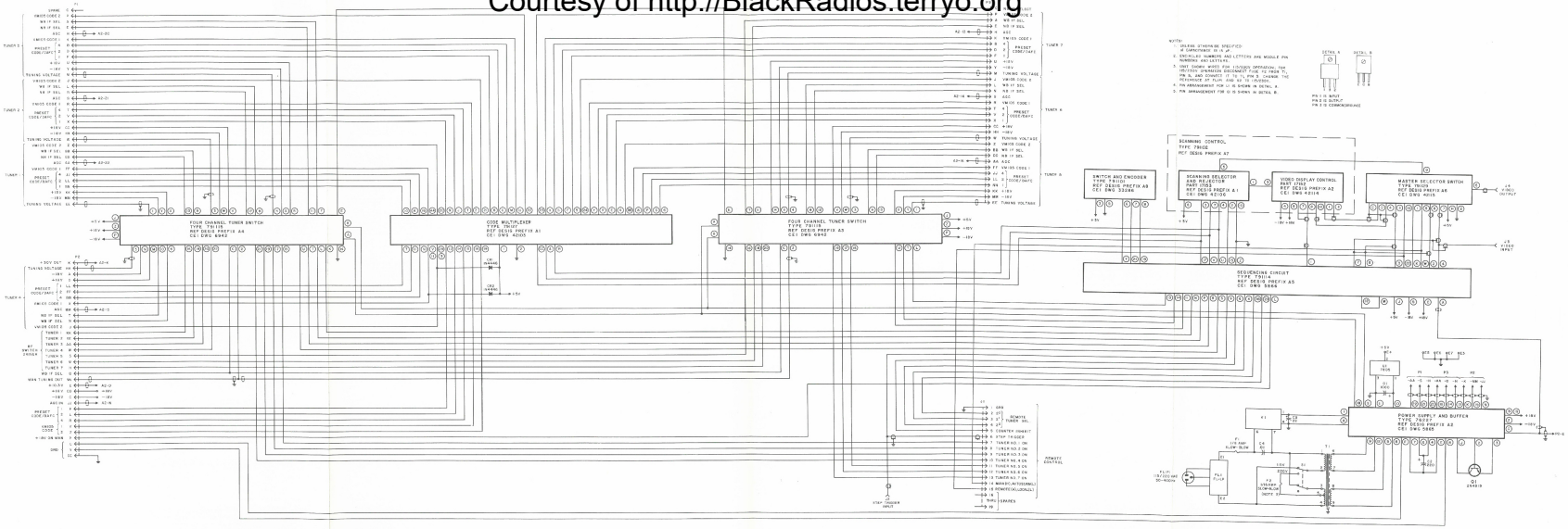
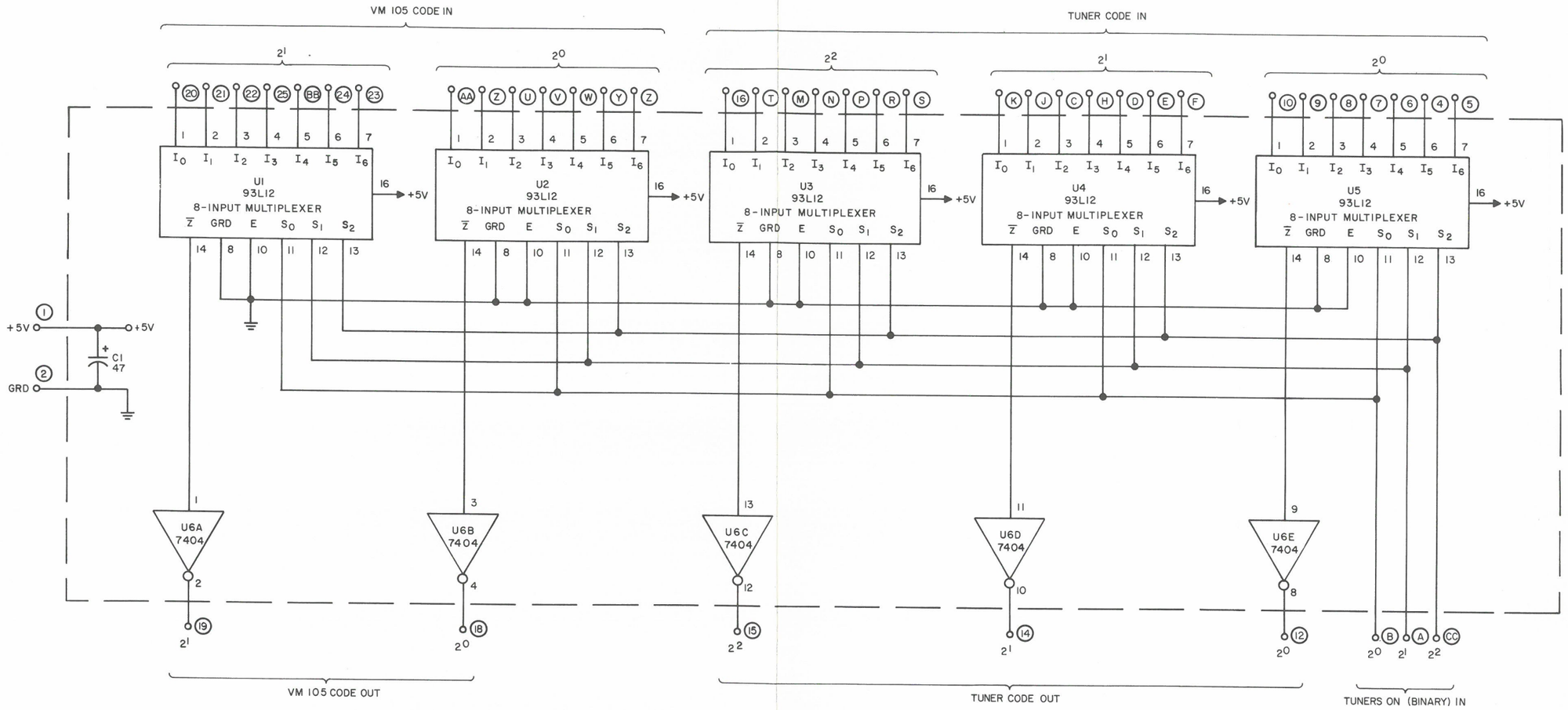


Figure 6-6. Type 791130 Control Assembly (A4), Schematic Diagram



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   a) CAPACITANCE IS IN µF.
2. ENCIRCLED NUMBERS AND LETTERS ARE MODULE CONNECTOR NUMBERS AND LETTERS.
3. PIN ARRANGEMENT OF U1 THRU U5 IS SHOWN IN DETAIL A.
4. PIN ARRANGEMENT OF U6 IS SHOWN IN DETAIL B.
5. Vcc FOR U6 IS PIN 14, GRD IS PIN 7.

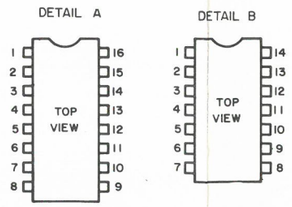
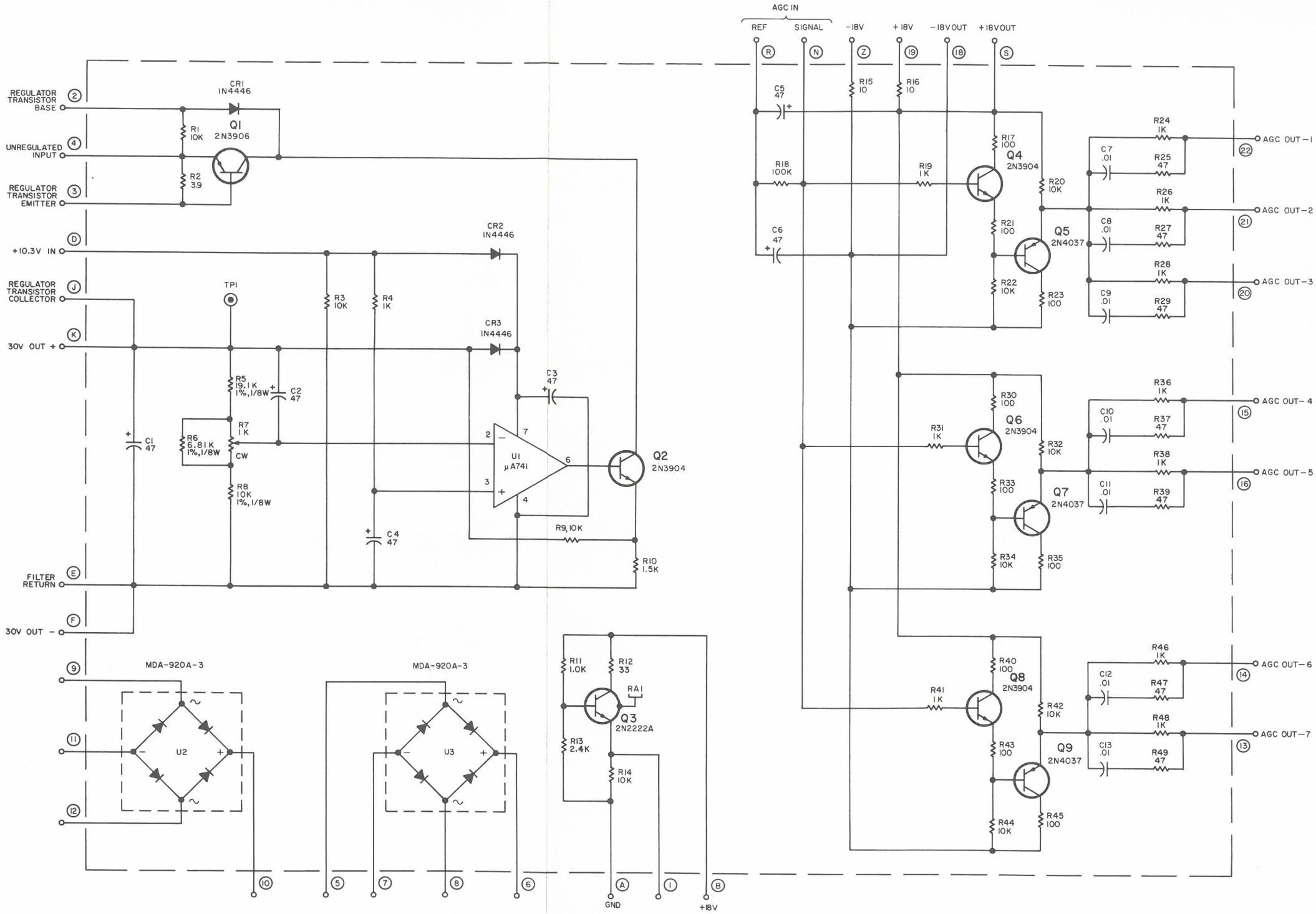


Figure 6-7. Type 791127 Code Multiplexer (A4A1), Schematic Diagram



NOTES

1. UNLESS OTHERWISE SPECIFIED
   a) RESISTANCE IS IN OHMS, ±5%, 1/4 W
   b) CAPACITANCE IS IN μF
2. FOR LEAD ARRANGEMENT OF U1 SEE DETAIL A.
3. CW ON R7 INDICATES CLOCKWISE ROTATION OF ACTUATOR.

HIGHEST REF DESIG USED	REF DESIG NOT USED
C13	–
CR3	–
Q3	–
R49	–
U3	–
RA1	–

DETAIL A

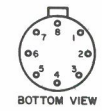


Figure 6-8. Type 76227 Power Supply and Buffer (A4A2), Schematic Diagram

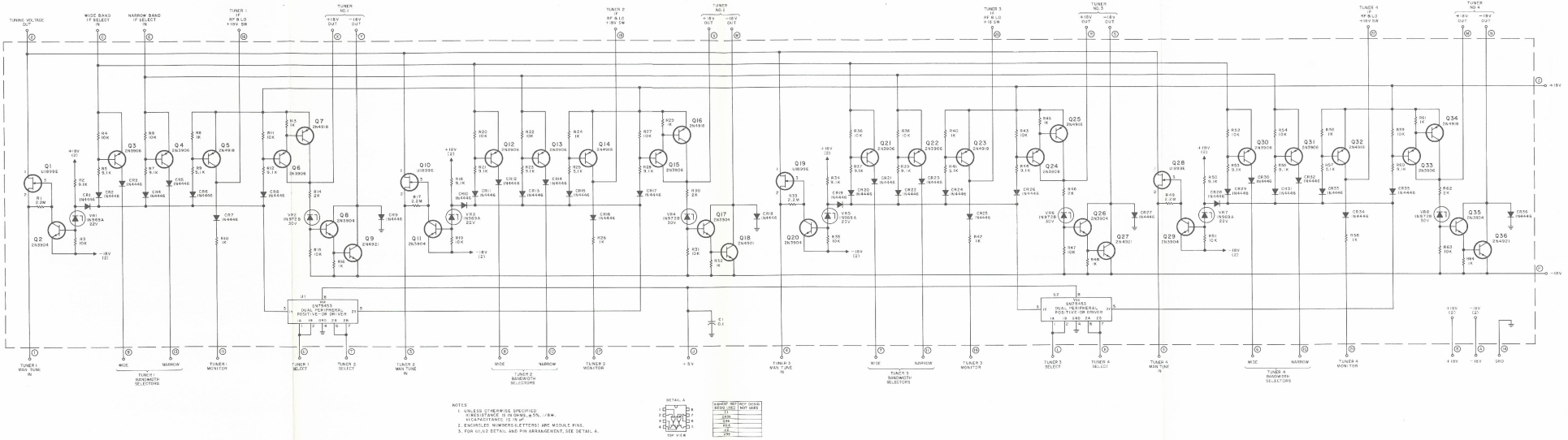
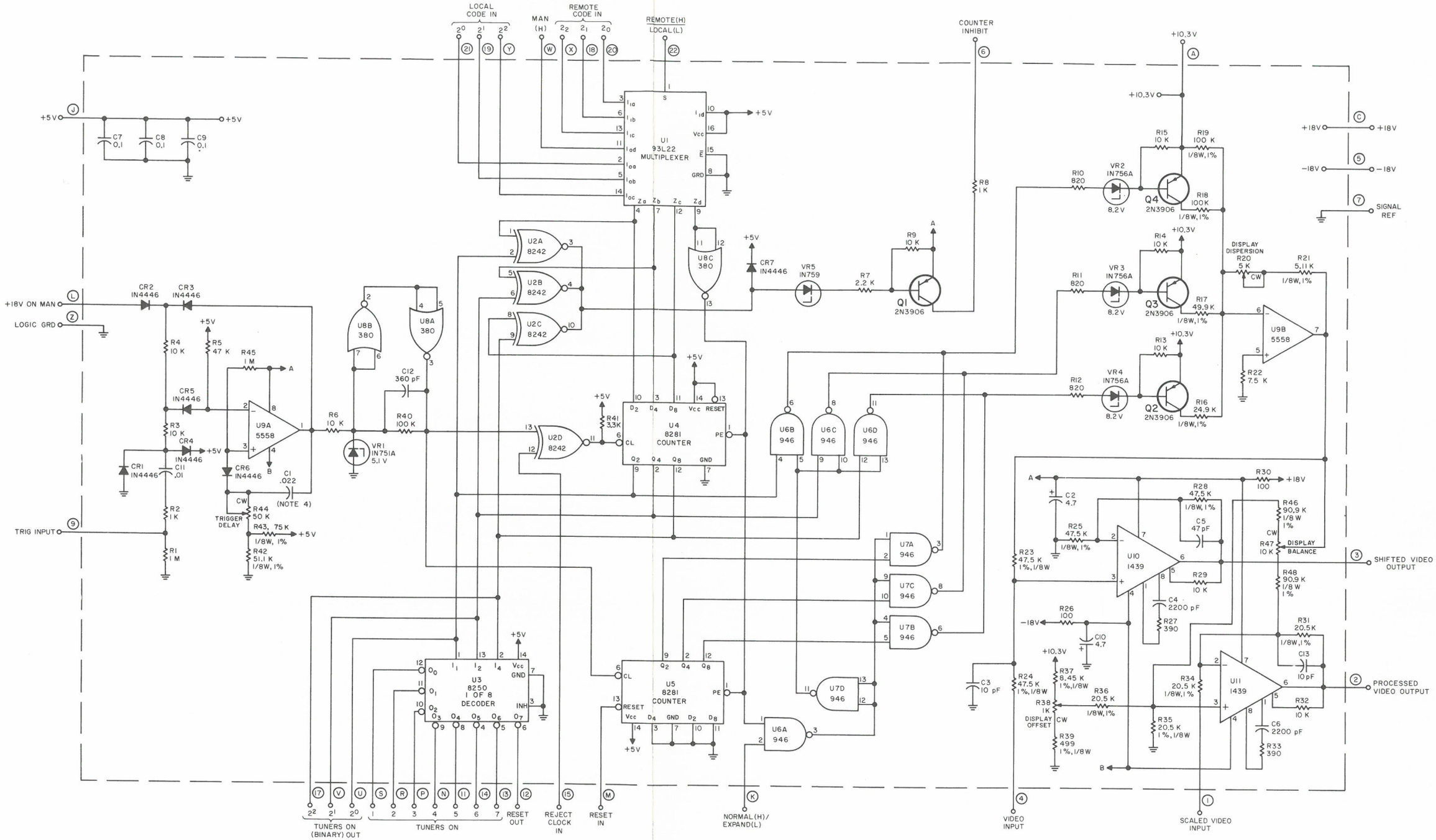
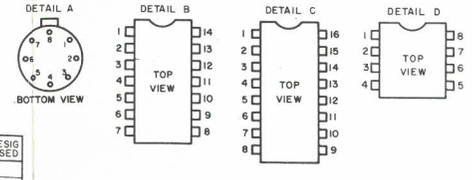


Figure 6-9. Type 791115 Four-Channel Tuner Switch (A4A3, A4A4), Schematic Diagram



NOTES:

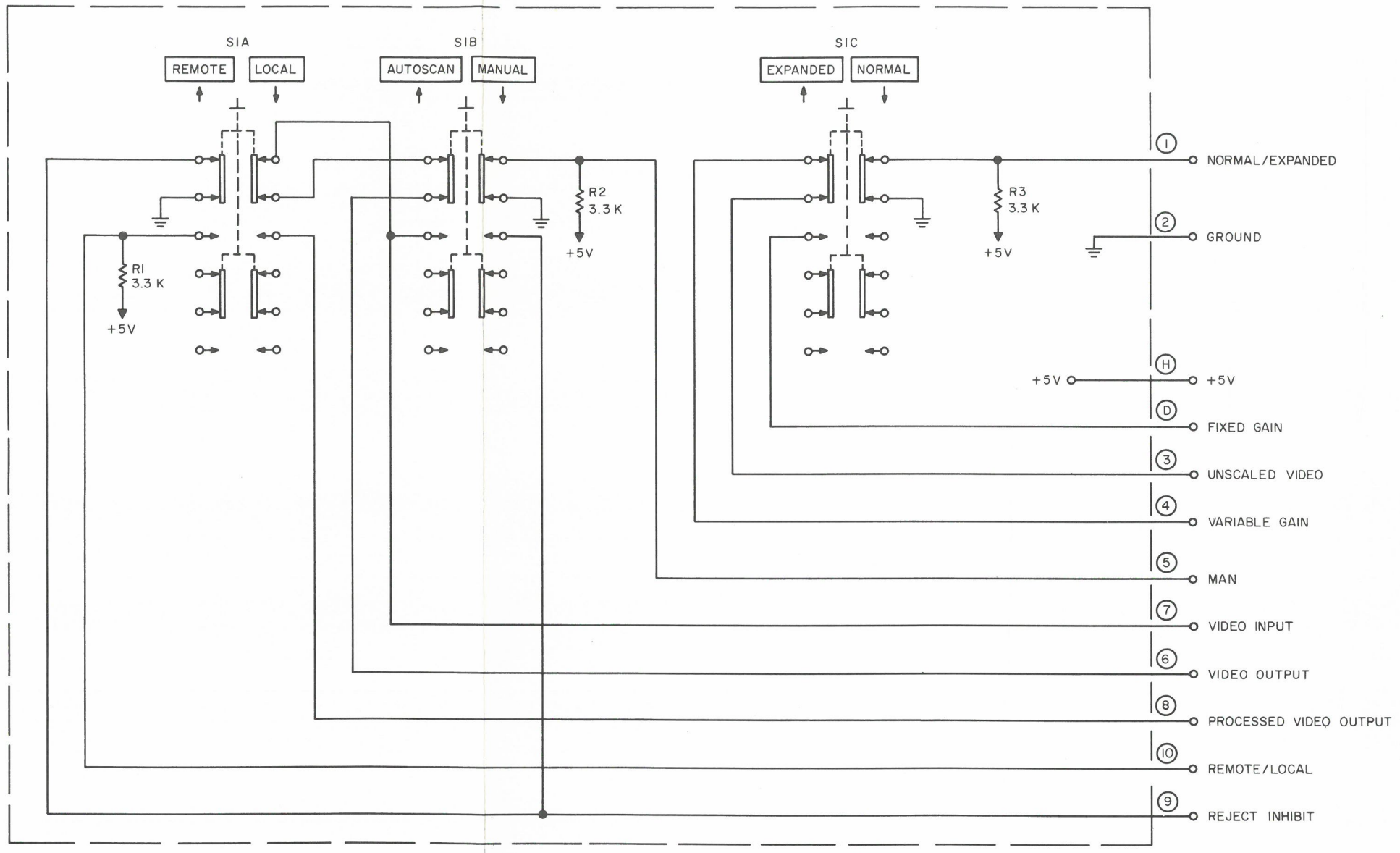
1. UNLESS OTHERWISE SPECIFIED:
   a) RESISTANCE IS IN OHMS, ± 5%, 1/4 W.
   b) CAPACITANCE IS IN μF.
2. ENCIRCLED NUMBERS AND LETTERS ARE MODULE CONNECTOR NUMBERS AND LETTERS.
3. CW ON POTENTIOMETERS INDICATES CLOCKWISE ROTATION OF ACTUATOR.
4. CONNECT OUTSIDE FOIL OF CI (BAND END) TO PIN 1 OF U9A.
5. PIN ARRANGEMENT OF UI0 AND UII IS SHOWN IN DETAIL A.
6. PIN ARRANGEMENT OF U2 THRU U8 IS SHOWN IN DETAIL B.
7. PIN ARRANGEMENT OF UI IS SHOWN IN DETAIL C.
8. PIN ARRANGEMENT OF U9 IS SHOWN IN DETAIL D.



I.C. TYPE	REF DESIG	Vcc	GND
380	U8	8	1
8242	U2	14	7
946	U6, U7	14	7

HIGHEST REF DESIG USED	REF DESIG NOT USED
C13	
CR7	
Q4	
R48	
U11	
VR5	

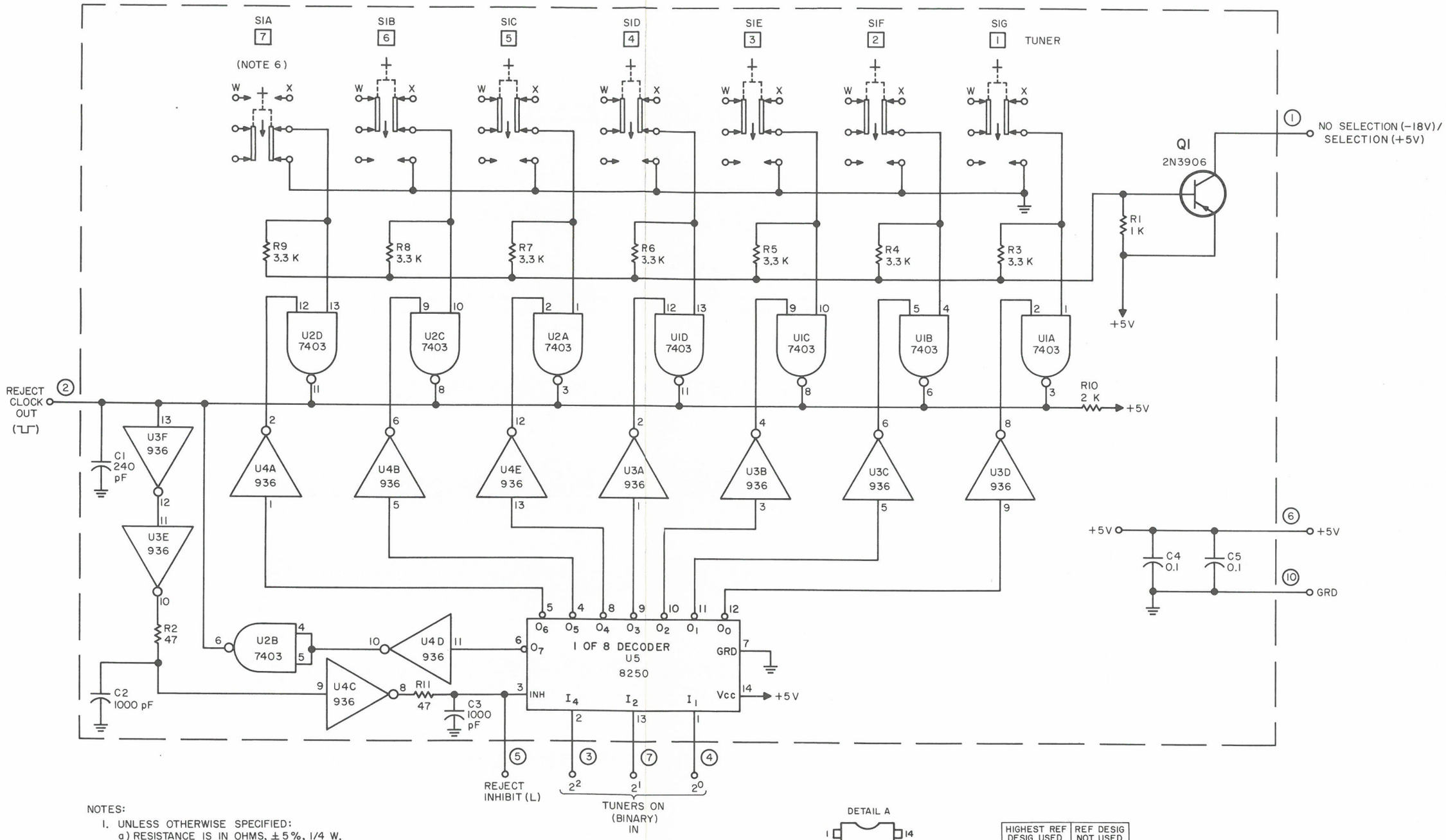
Figure 6-10. Type 791114 Sequencing Circuit (A4A5), Schematic Diagram



NOTES:

1. UNLESS OTHERWISE SPECIFIED;
   a) RESISTANCE IS IN OHMS, ±5%, 1/4 W.
2. ENCIRCLED NUMBERS AND LETTERS ARE MODULE CONNECTOR NUMBERS AND LETTERS.
3. ▭ INDICATES FRONT PANEL CONTROL.

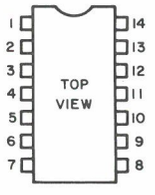
Figure 6-11. Type 791129 Master Selector Switch (A4A6), Schematic Diagram



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   a) RESISTANCE IS IN OHMS, ±5%, 1/4 W.
   b) CAPACITANCE IS IN µF.
2. ENCIRCLED NUMBERS ARE MODULE CONNECTOR NUMBERS.
3. PIN ARRANGEMENT FOR U1 THRU U5 IS SHOWN IN DETAIL A.
4. ▭ INDICATES FRONT PANEL CONTROL.
5. U1 THRU U4 Vcc IS PIN 14, GRD IS PIN 7.
6. SWITCH S1 IS SHOWN WITH TUNER 7 ENERGIZED. S1A THRU S1G, SECTION X, IS USED ON TYPE 17153 ONLY.

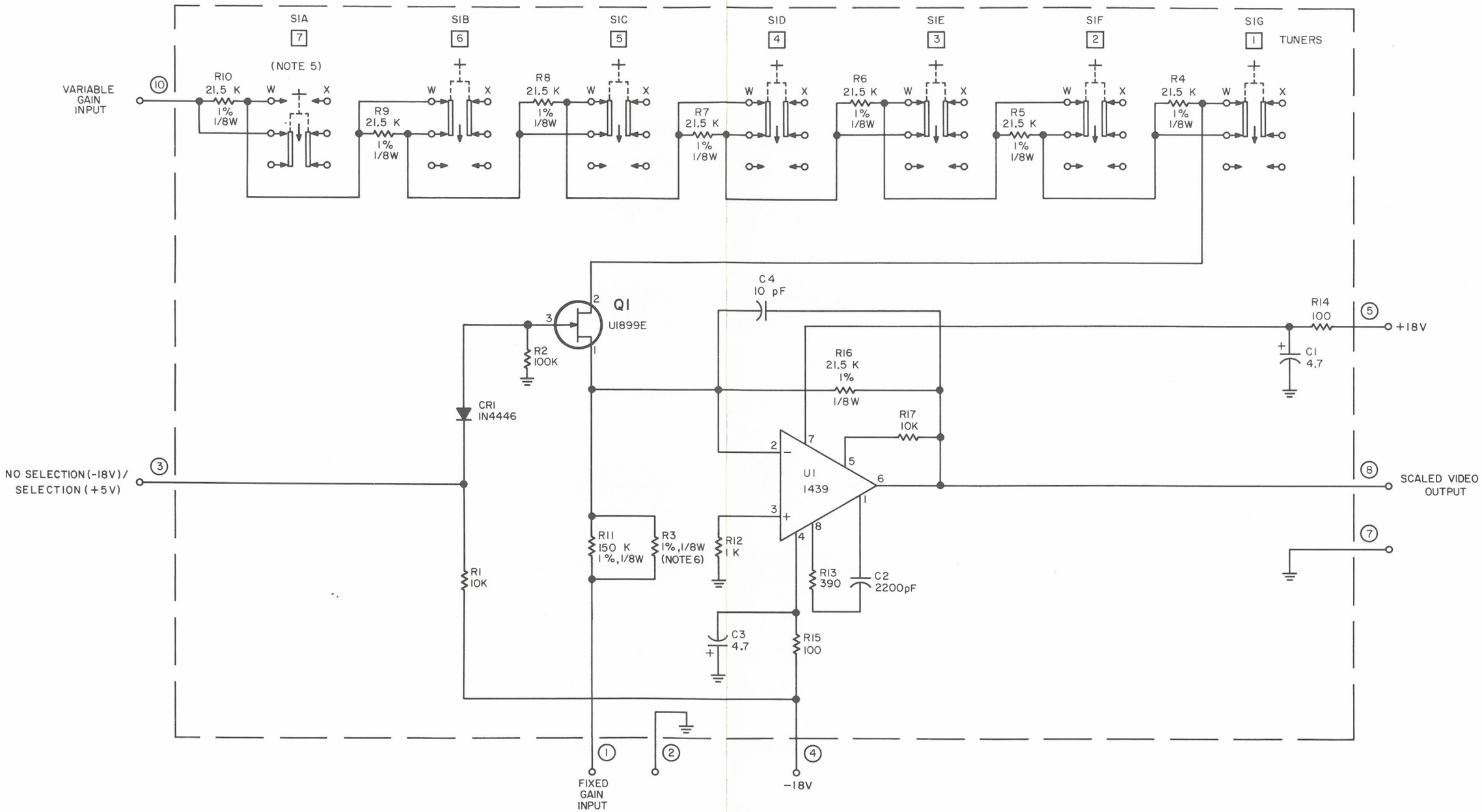
DETAIL A



HIGHEST REF DESIG USED	REF DESIG NOT USED
C5	
Q1	
R11	
S1	
U5	

Figure 6-12. Part 17153 Scanning Selector and Rejector (A4A7A1), Schematic Diagram

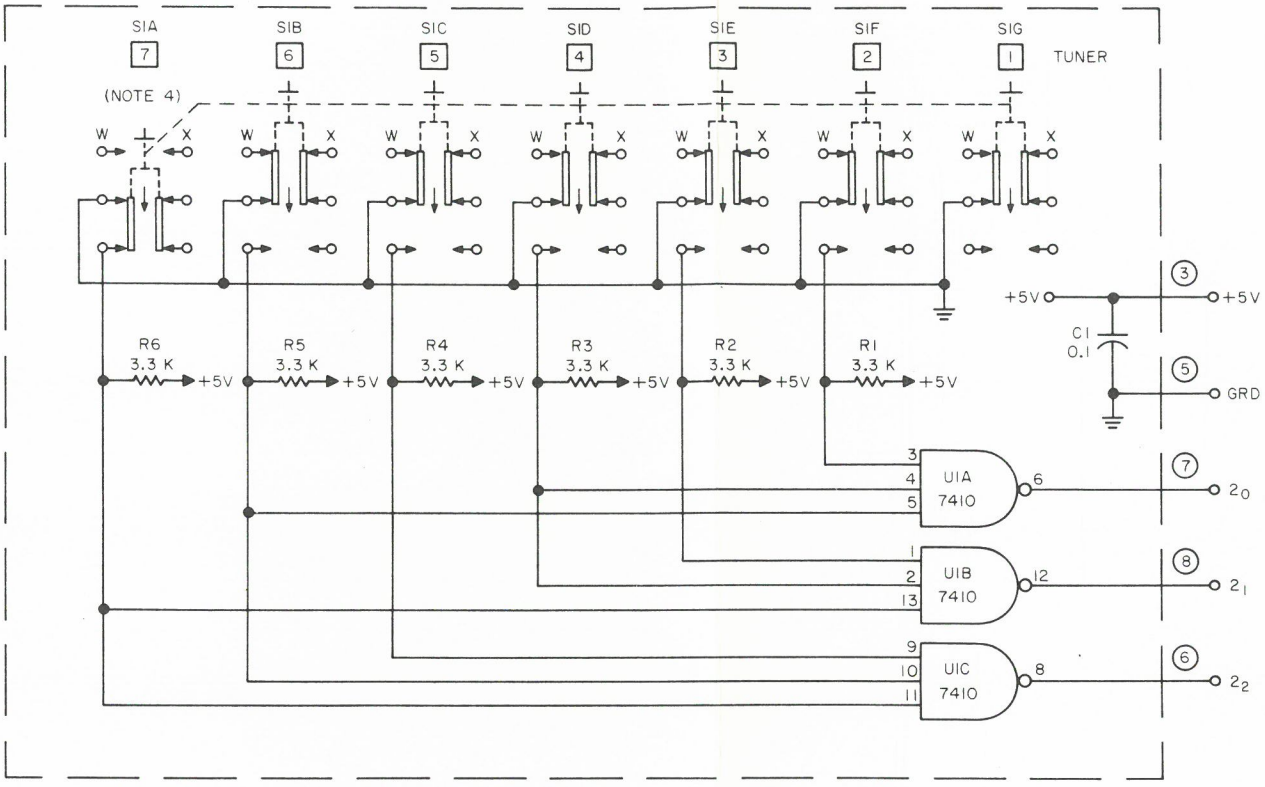
Figure 6-13



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   a) RESISTANCE IS IN OHMS, ±5%, 1/4 W.
   b) CAPACITANCE IS IN μF.
2. ENCIRCLED NUMBERS ARE MODULE CONNECTOR NUMBERS.
3. PIN ARRANGEMENT FOR U1 IS SHOWN IN DETAIL A.
4. ▭ INDICATES FRONT PANEL CONTROL.
5. SWITCH S1 IS SHOWN WITH TUNER 7 ENERGIZED. S1A THRU S1G, SECTION W, IS USED ON TYPE 791102 ONLY.
6. ADD FOR TRIMMING ONLY

Figure 6-13. Part 17152 Video Display Control (A4A7A2), Schematic Diagram



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   a) RESISTANCE IS IN OHMS, ±5 %, 1/4W.
   b) CAPACITANCE IS IN µF.
2. ENCIRCLED NUMBERS ARE MODULE CONNECTOR NUMBERS.
3. PIN ARRANGEMENT, Vcc AND GRD FOR UI IS SHOWN IN DETAIL A.
4. SWITCH SI IS SHOWN WITH TUNER 7 ENERGIZED.
5. ▭ INDICATES FRONT PANEL CONTROL.

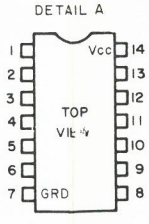


Figure 6-14. Type 791101 Switch and Encoder (A4A8), Schematic Diagram

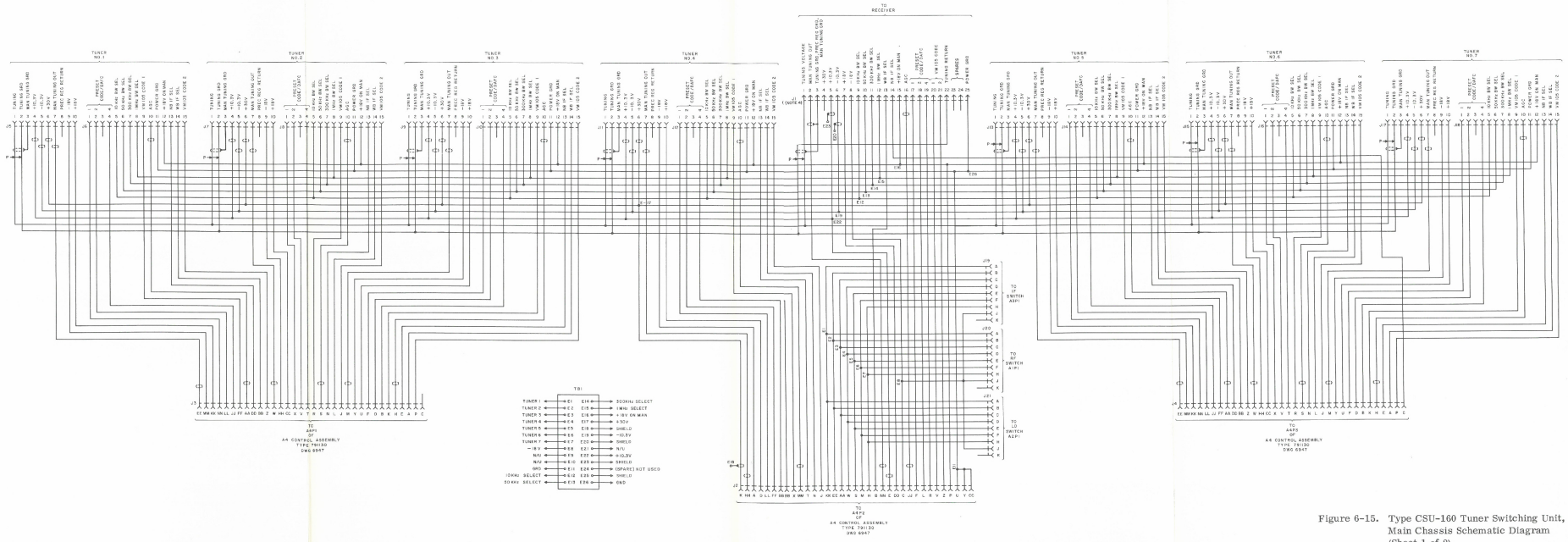
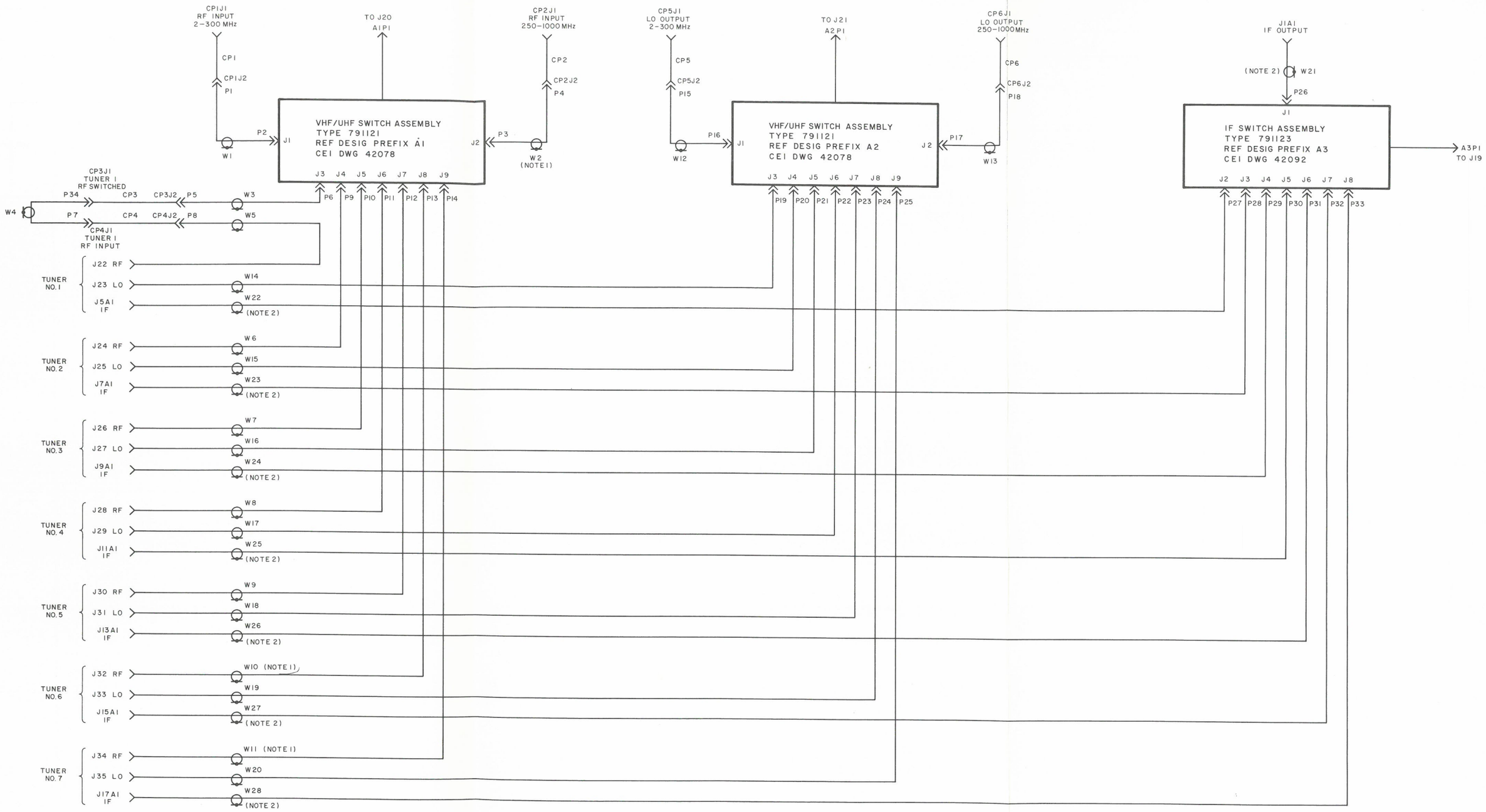


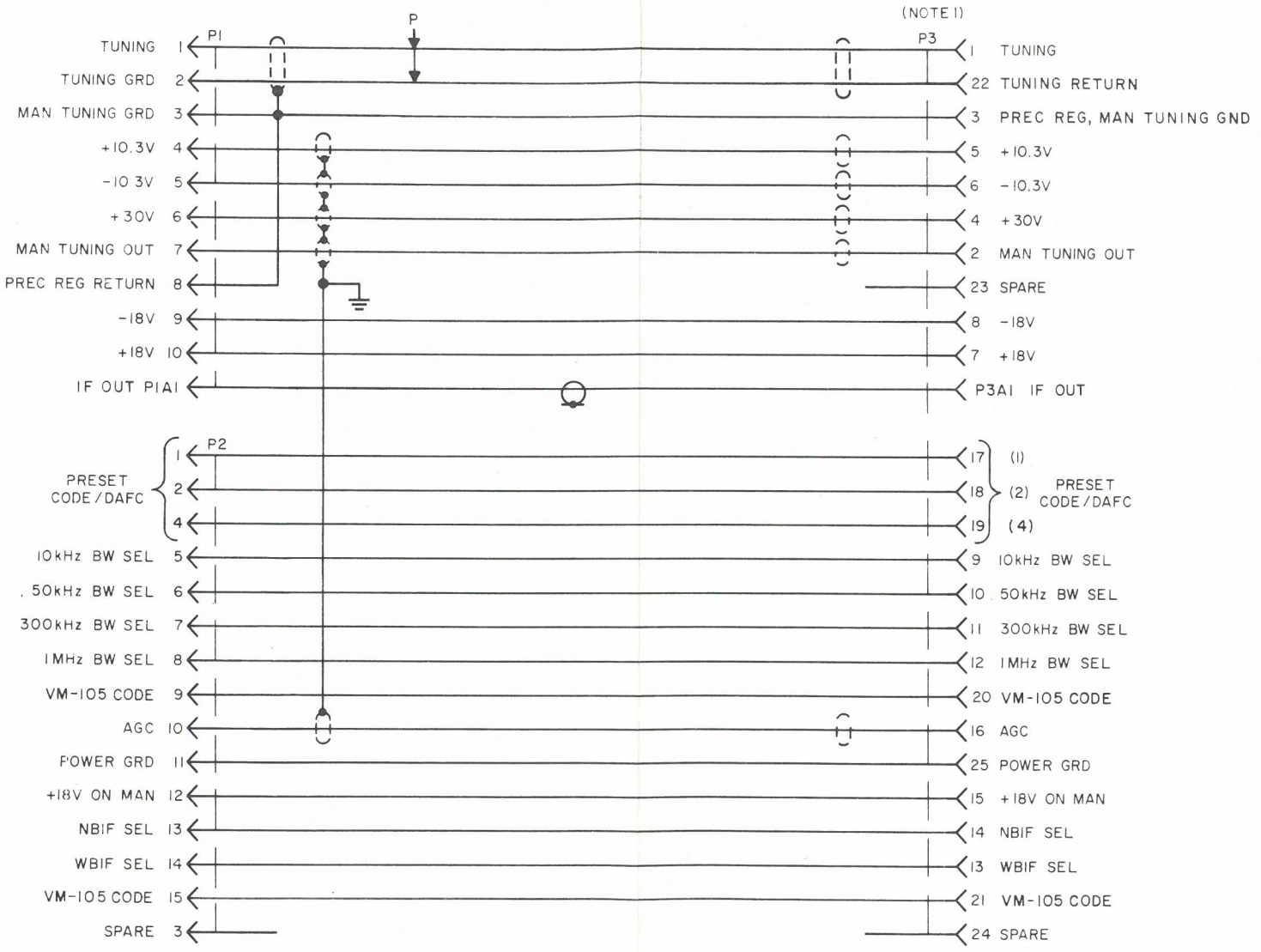
Figure 6-15. Type CSU-160 Tuner Switching Unit, Main Chassis Schematic Diagram (Sheet 1 of 2)



NOTES:

1. CABLES ARE TYPE RG-142 B/U.
2. CABLES ARE TYPE RG-188.
3. CABLES, UNLESS MARKED, ARE TYPE 250-4021.
4. WITH THE EXCEPTION OF THE TUNING LINE SHIELD, WHICH IS CONNECTED TO J1 PIN 3, ALL SHIELDS ASSOCIATED WITH J1 ARE TERMINATED ON, AND CONNECTED TO E26.
5. —⊣⊢— INDICATES TWISTED PAIR.

Figure 6-16. Type CSU-160 Tuner Switching Unit, Main Chassis Schematic Diagram (Sheet 2 of 2)



NOTE:

1. ALL SHIELDED WIRE SHIELDS CONNECTED TOGETHER ONLY AT END CONNECTED TO P1

Figure 6-17. Type EC-160 Extender Cable, Schematic Diagram