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Technical Manual

for

Antenna Tuning System

Model ATS-2

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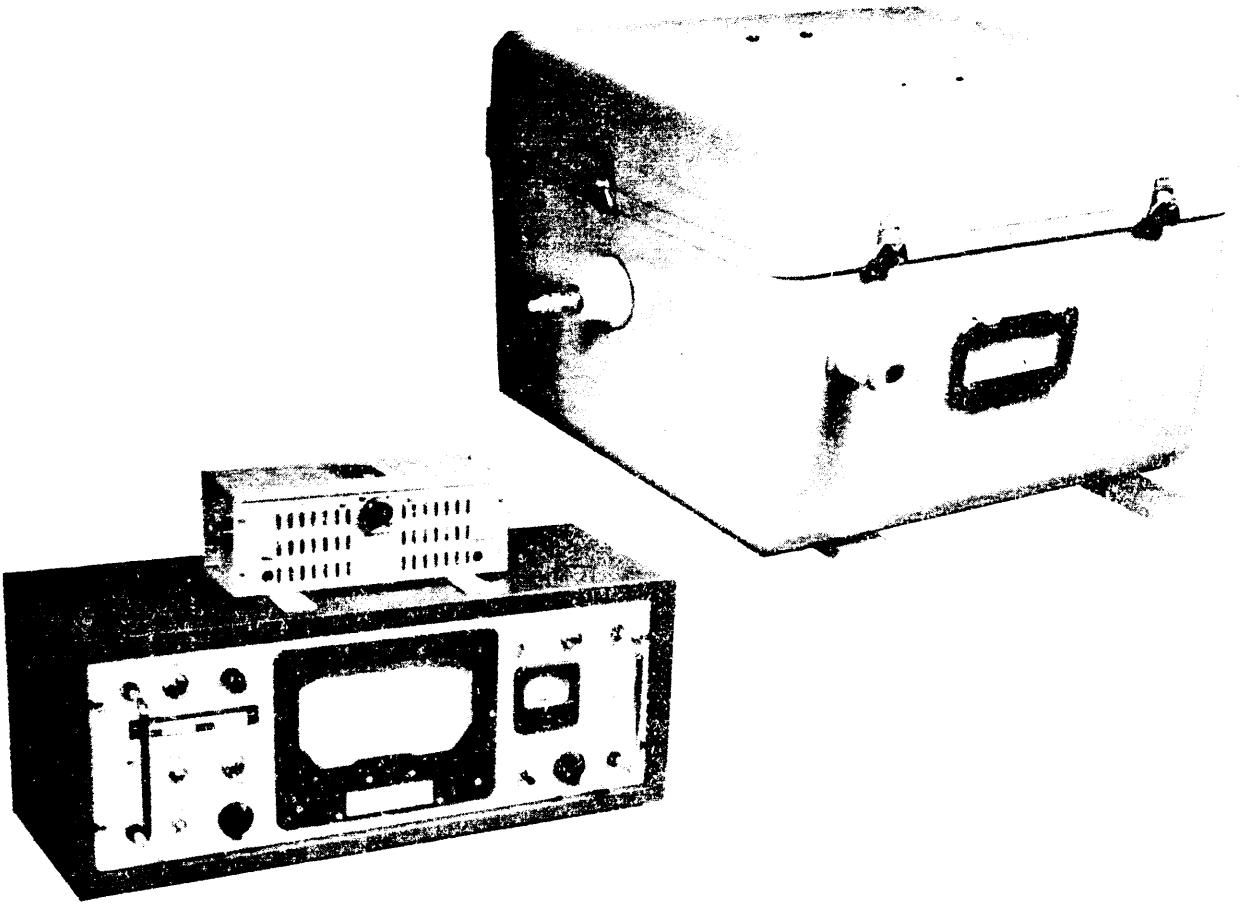


Figure 1-1. Antenna Tuning System, Model ATS-2B

SECTION 1

GENERAL DESCRIPTION

1-1. GENERAL

The Antenna Tuning System, Model ATS-2B, figure 1-1, impedance matches the output of any 1000-watt transmitter with a nominal output impedance of 50 ohms to a 35-foot vertical whip antenna. This is accomplished by inserting the necessary inductance or capacitance to resonate the antenna to the transmitter operating frequency, in the 2- to 30-MHz range.

1-2. DESCRIPTION

The ATS-2B consists of three units: antenna tuner, monitor control, and directional coupler.

The antenna tuner, employs (1) a helical transmission line as an inductance tuning element whose electrical length is varied by a motor-driven rolling contact, (2) a fixed air-dielectric capacitor, (3) a ferritecore autotransformer with taps selected by a motor-driven rotary switch, used to match various antenna resistance values, and (4) a humidity sensing circuit.

The monitor control has two meters, controlling switches, and an overload protection circuit. A triplescale meter indicates the position of the motor-driven short on the helical transmission line, the position of the antenna resistance selector switch, or the humidity in the unit. A large dual-pointer meter indicates the forward and reflected transmitter power, and indicates, at the intersection of the two pointers, the voltage standing wave ratio (vswr). Switches are located on the front panel to remotely control the motors in the antenna tuner. An overload circuit will disable the transmitter to prevent damage to the equipment when the vswr or transmitter power exceed preset levels.

The directional coupler is a balanced radiofrequency bridge, and is calibrated to operate with a 50-ohm coaxial line. Balancing and equalizing controls are provided.

1-3. LEADING PARTICULARS

Table 1-1 lists logistic type leading particulars of the antenna tuning system and its major subassemblies. Characteristics listed cover nomenclature, input power, dimensions, and weight. Some of the data represents approximate or nominal values.

1-4. CAPABILITIES AND LIMITATIONS

Table 1-2 lists operational capabilities and limitations of the antenna tuning system. Data cover specific functional and environmental characteristics.

1-5. EQUIPMENT SUPPLIED

Table 1-3 lists all major equipment supplied by quantity, TMC part numbers, and reference symbol designations. Also a brief function of each item is provided. Subassemblies of assemblies listed are not called-out; identification of subassemblies can be obtained by referring to section 6. Spare parts are not included in the table.

1-6. EQUIPMENT REQUIRED BUT NOT SUPPLIED

Table 1-4 lists equipment required to install and maintain the antenna tuning system. The list covers non-specialized installation and maintenance tools, test equipment, and pheripheral interequipment cabling. Non-specialized items are not supplied, since an equipped maintenance shop should contain them.

Table 1-1. Leading Particulars

NOMENCLATURE	POWER REQUIREMENTS							WEIGHT IN LB
	VOLTS	AMP	W	FREQ IN Hz	HGT	W	D	
Antenna Tuning System, Model ATS-2B	115/ 230	2/1	150	50 to 60				
Antenna Tuner, TU-2B	-	-	-	-	20 (OA)	19-1/4 (OA)	12/1/2 (OA)	49
Monitor Control, MCU-2A	115/ 230	2/1	150	50 to 60	7[a] (OA)	19[a] (OA)	9-1/8[a] (OA)	14[b]
Directional Coupler, CU-2B	-	-	-	-	9-1/4 (OA)	6-1/4 (OA)	3-1/2 (OA)	2

[a] When mounted in cabinet: HGT = 8-1/4, W = 20-3/8, and D = 10-1/2

[b] When mounted in cabinet: 25 pounds

Table 1-2. Capabilities and Limitations

CAPABILITIES	LIMITATIONS
Functional characteristics:	2 to 30 MHz
Frequency range	1000 watts continuous at 100% modulation
Power dissipation:	
Antenna tuner	
Directional coupler	1000 watts continuous at 100% modulation for vswr up to 2.5 to 1
Impedance:	
Transmission line	50 or 70 ohms
Input	Nominally 50 or 70 ohms unbalanced
Output:	
50-ohm system	Matches any antenna with a resistance of 5 to 500 ohms and - j 850 to + j 750 reactance to obtain a vswr of less than 2.5 to 1
70-ohm system	Matches any antenna with a resistance of 7 to 650 ohms and - j 850 to + j 750 reactance to obtain a vswr of less than 2.5 to 1.
Efficiency	Better than 80% over the 2- to 30-MHz range, when used with the TMC A-1486 35' antenna and Base Insulator
Attainable voltage standing wave ratio	Better than 2.5 to 1
Environmental characteristics:	
Operating temperature	0^{o} to 50^{o} C (32^{o} to 122^{o} F)

Table 1-3. Equipment Supplied

ITEM	EQUIPMENT	QTY	DESIGNATION TMC P/N	DESIGNATION SYMBOL	FUNCTION
1	Antenna Tuner, Model TU-2B	1		200 series	
2	Monitor Control, Model MCU-2A			100 series	
3	Directional Coupler, Model CU-2B			300 series	
4	Cables, Electrical:				
	ac Power	1	CA-103-72	W101	ac power cable for item 2.
	Antenna	1	CA-484	W102	Interconnect item 1 to antenna.
	Interlock	1	CA-498	W103	Interconnect item 2 to transmitter.
	Interconnect	1	CA-499-1	W104	Interconnect items 2 and 3.
	MCU-2A/TU-2B Interconnect	1	CA-1865-XX	W105	Interconnect items 1 and 2; shipped as per customers requirements.
5	Connector, Plugs: RF	2	UG-59B/U	P301 and P302	Plug P301 for transmitter RF output cable that connects to item 3. Plug P302 for RF cable that connects to jack J302 on item 3.
6	Clamps, Cable:	2	MX-564A/U		For plugs P301 and P302, when armor shielded cables are used. Part of cable W105 (if supplied).
	Armor	1	MS-3057-12		
7	Bushing, Rubber	1	MS-3420-12A		Part of cable W105 (if supplied).
8	Lug, Spade	10	TE-120-2		Part of cable W105 (if supplied). Otherwise attached to equivalent cable that connects to terminal board E201 in item 1.

Table 1-4. Equipment Required But Not Supplied

EQUIPMENT	PURPOSE
1. Coaxial transmission lines:	
a. 10-feet of RG-8/U for ATS(50)-2B or 10-feet of RG-11/U for ATS(70)-2B; preferably armor shielded	Connect transmitter to directional coupler
b. 10-wire AWG 22; preferably armor shielded. Length determined by distance between MCU and TU	Control cable
c. RG-8/U for ATS(50)-2B or RG-11/U for ATS(70)-2B. Length determined by distance between CU and TU; preferably armor shielded.	Connect directional coupler to antenna tuner.
2. 35-foot vertical whip antenna	
3. Copperweld AWG 6, 6 to 12 35-foot lengths	Antenna counterpoise radials
4. Drill bits, sizes: ¼ & 25/64 inch	Drill holes for mounting CU and TU
5. Screws, sizes ¼ & 25/64 (4 each)	Mounting hardware for CU and TU
6. 100-watt soldering gun or equ.	Installation, testing, maintenance
7. Vacuum tube voltmeter, 0- to 300-volts ac/dc,20,000 ohms/volt	Installation, testing, maintenance
8. Low-capacitance RF voltmeter probe, 2 to 30 MHz	Installation, testing, maintenance
9. 1000-watt resistive load equipped with RF ammeter	Installation, testing, maintenance

SECTION 2

INSTALLATION

2-1. INITIAL INSPECTION

The ATS-2B has been tested and calibrated before shipment. Only minor preparations are required to put the unit into operation.

Inspect the cases and their contents immediately for possible damage. Unpack the equipment carefully. Inspect all packing material for parts which may have been shipped as "loose items". Although the carrier is liable for any damage in the equipment, Technical Materiel Corporation will assist in describing and providing for repair or replacement of damaged items. The monitor control is shipped with tubes installed. Check that all such components are properly seated in their sockets.

2-2. 115-VS 230-VOLT POWER SUPPLY CONNECTIONS

ATS-2B's power supply is designed for 115- or 230-volt, 50- or 60-Hz, single-phase power; it is factory wired for 115 volts. If 230-volt operation is desired, a minor wiring change is required. The change is shown in figure 2-1.

2-3. INSTALLATION

The physical installation of the ATS-2B varies considerably from site to site. The three units should always be placed so that the interconnecting cables are as short as possible. Note that two cable lengths are critical. The cable between the transmitter and the directional coupler must not exceed 10 feet in length. The cable between the antenna tuner and the whip antenna must not be longer than 27 inches.

Dimensions for mounting the components of the ATS-2B are shown in figures 2-2, 2-3, and 2-4. After mounting components, connect cables as shown in Figure 2-5.

Since the antenna tuner is normally exposed to the weather, it is essential that cable connections to the unit be waterproof. Cables to the antenna tuner are passed through water-tight terminal tubes (see Figure 2-6).

Install the cables as follows:

a. Loosen and remove gland nut and gland ring from the tube body.

b. Insert cable through gland nut, gland ring, and tube body. Allow sufficient cable length within case to permit connection to terminal board.

c. Wind packing around cable and press firmly into tube body until packing is within 3/8 inch of tube rim.

d. Replace gland ring and tighten gland nut.

2-4. COUNTERPOISE FOR 35-FOOT VERTICAL WHIP ANTENNA

Performance of a vertical whip antenna is unusually improved when 6 to 12 radials, each 35-feet long, are installed at the base of the antenna as shown in Figure 2-7. Locate the radials in the plane of the base of the antenna at 90-degree angle to the mast, and space them 30 to 60 degrees apart. Make the radials from No. 6 copperweld wire. Join the radials at a point of intersection near the antenna base and connect the junction to one of the metal mounting lugs of the antenna tuner. Use of a counterpoise is especially recommended for rooftop installations or in locations where ground conductivity is poor.

2-5. INITIAL ADJUSTMENTS

Initial adjustments of the ATS-2B are included in Table 3-2.

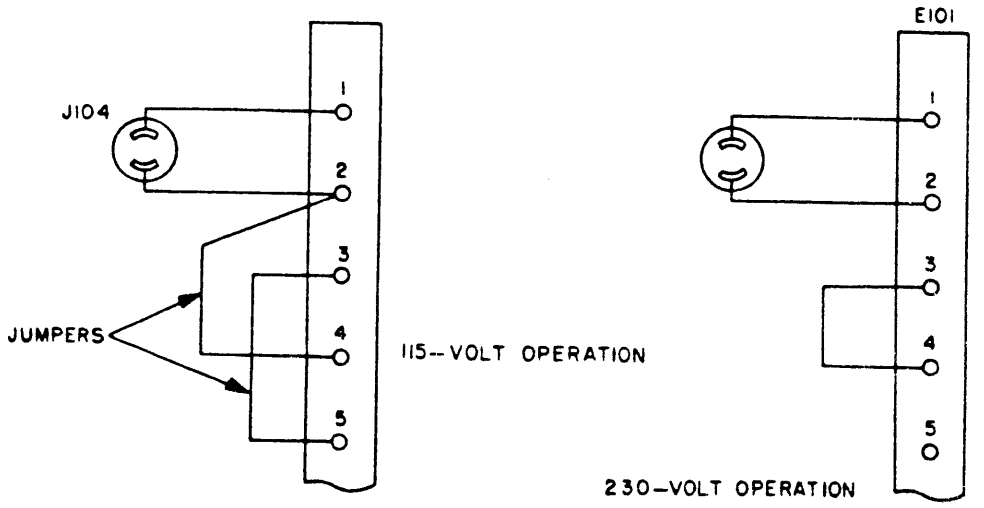
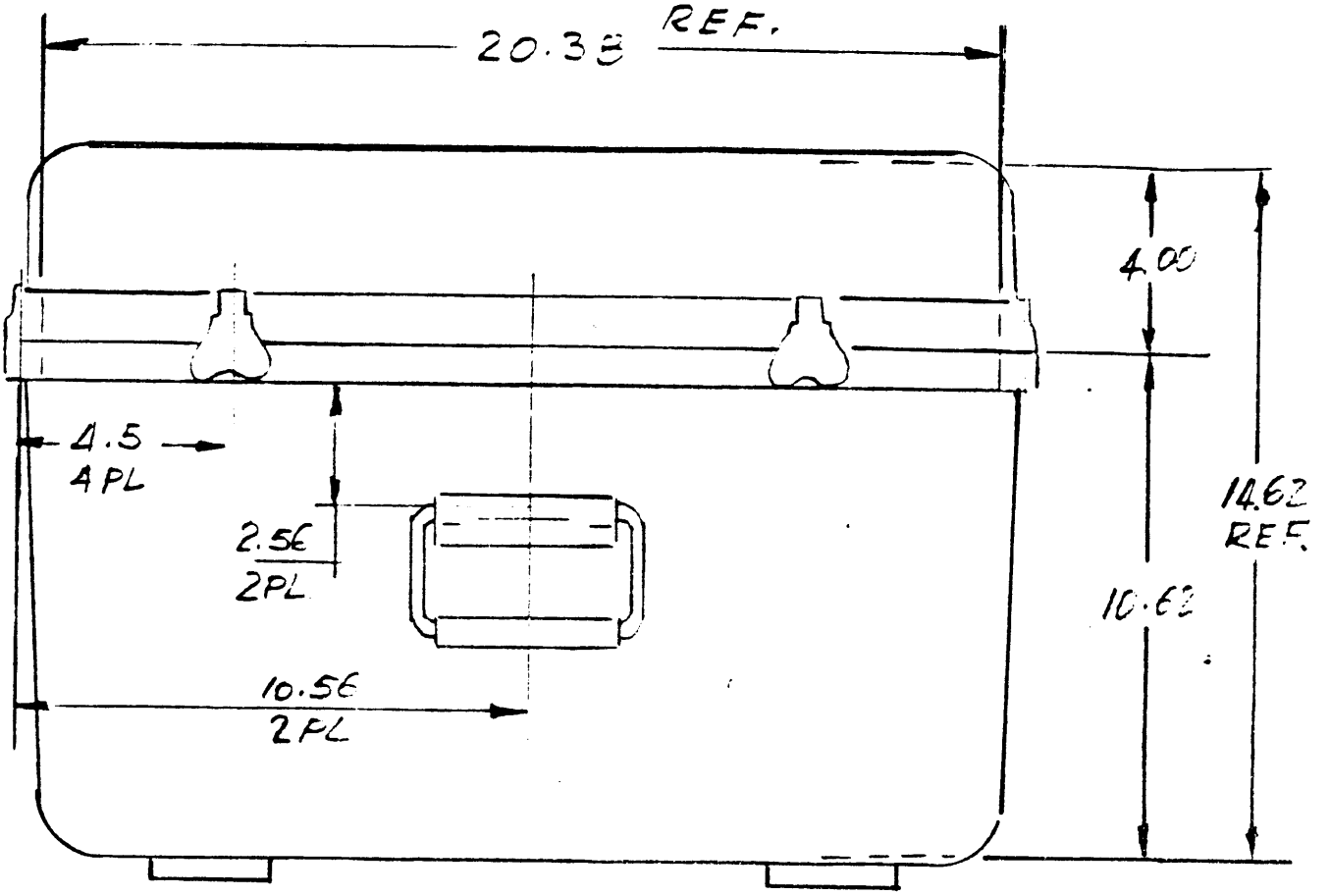


Figure 2-1. 115-vs 230-Volt Power Supply Connections



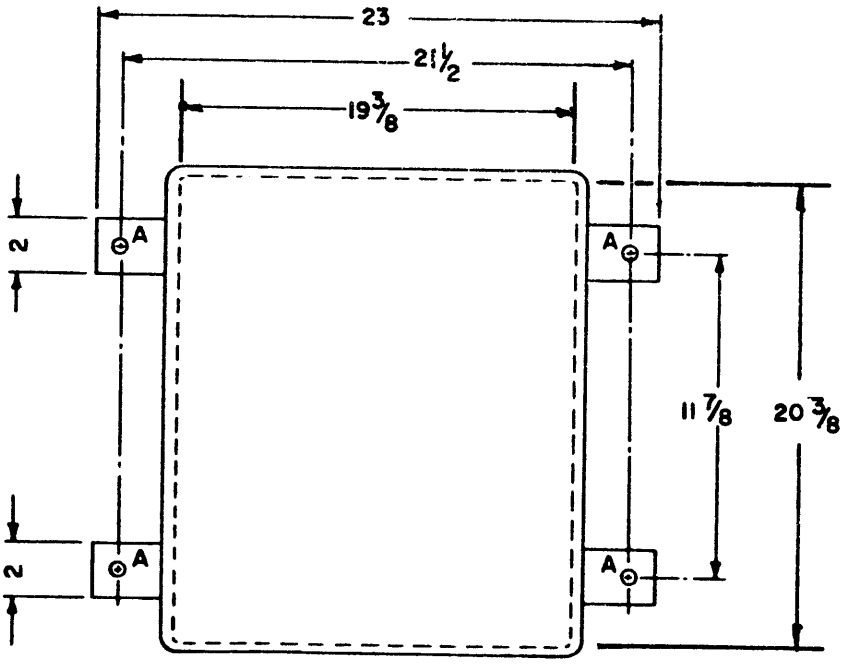


Figure 2-2. Antenna Tuner, Installation Dimensions

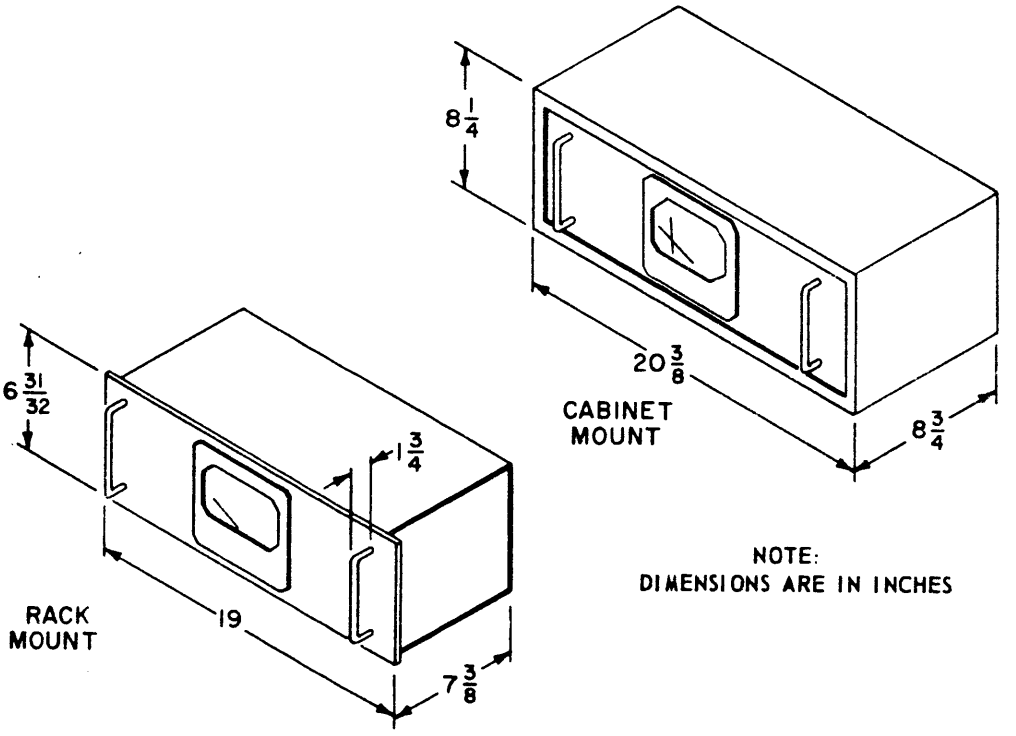


Figure 2-3. Monitor Control, Installation Dimensions

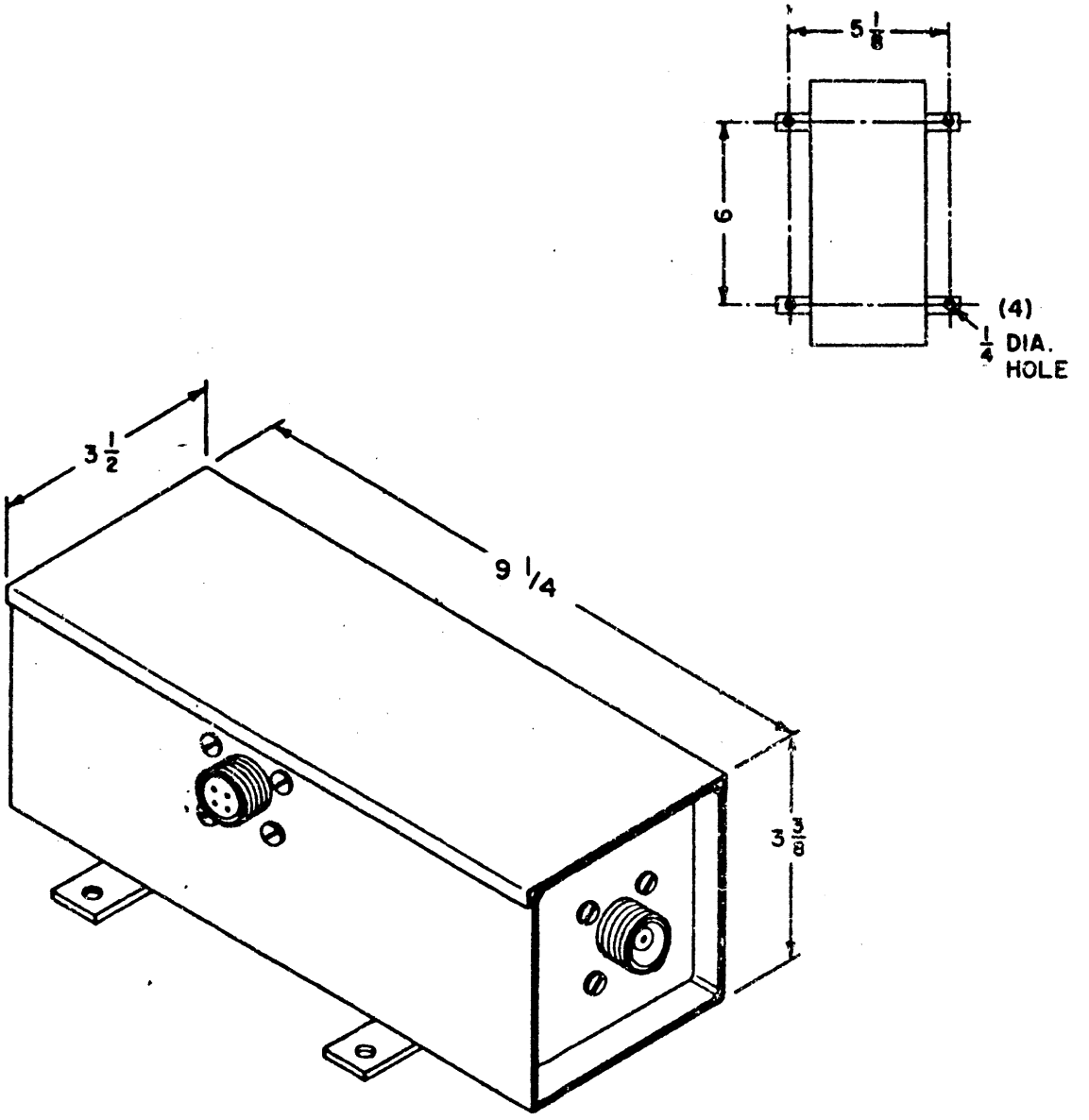
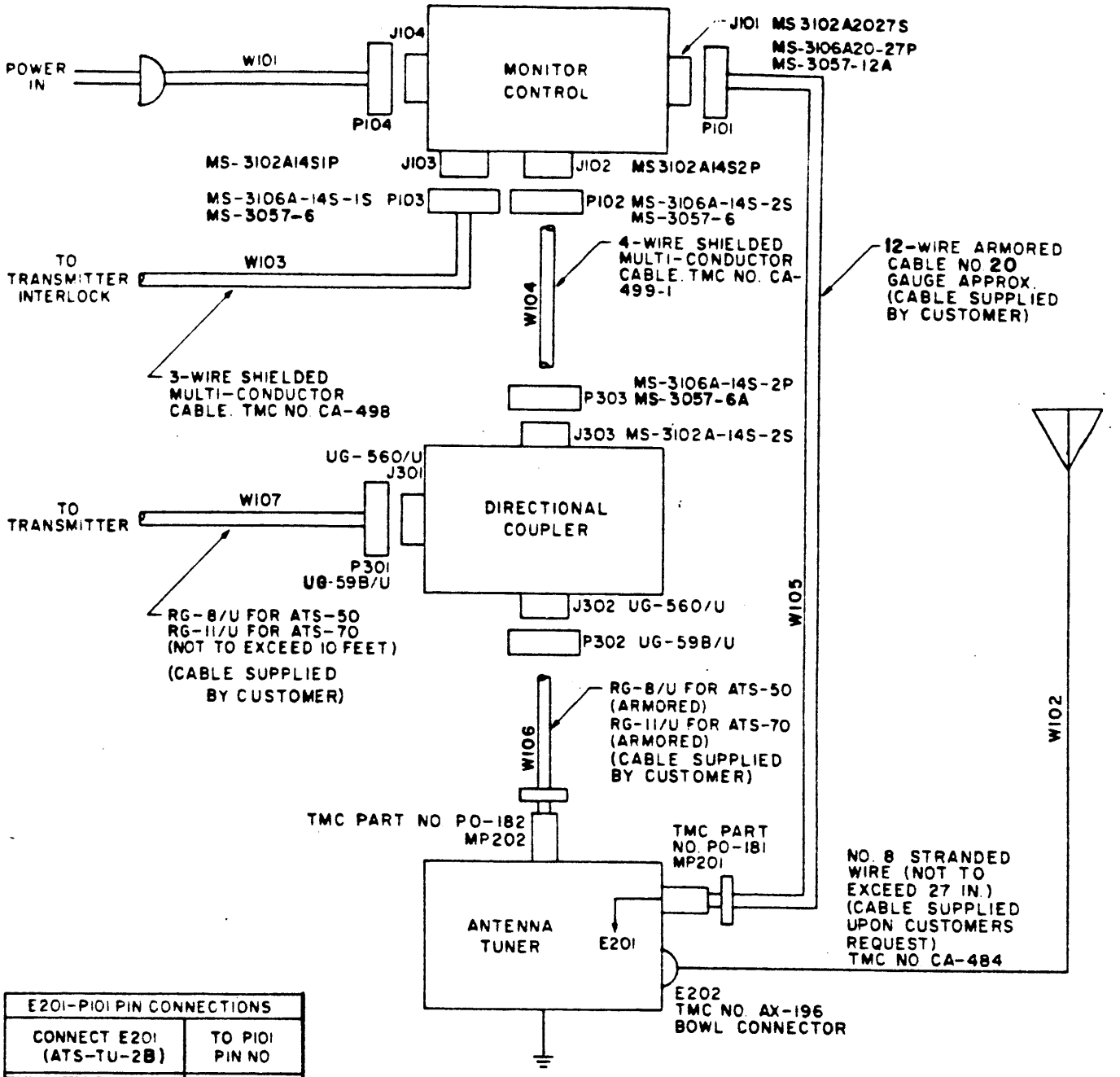


Figure 2-4. Directional Coupler, Installation Dimensions



E201-P101 PIN CONNECTIONS		
CONNECT E201 (ATS-TU-2B)		TO P101 PIN NO
E201	7	A
	4	B
	8	C
	1	D
	5	E
	3	F
	9	I
	10	H
	2	J
	6	K
E208	TERM 3	G

P102-P303 CONNECTIONS		
CONNECT P102 PIN NO.	TO P303 PIN NO.	REMARKS
A	A	
B	B	COMMON
C	C	COMMON
D	D	

Figure 2-5. Interconnecting Diagram, Model ATS-2B

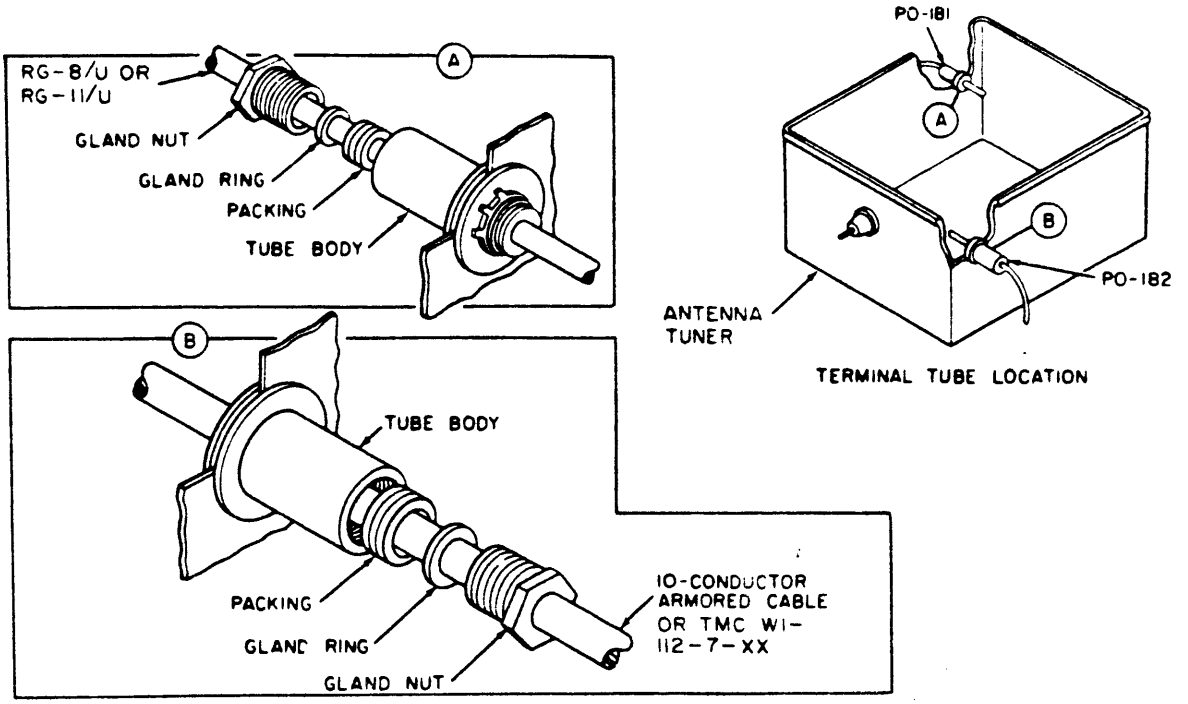


Figure 2-6. Assembly Instructions for Terminal Tubes

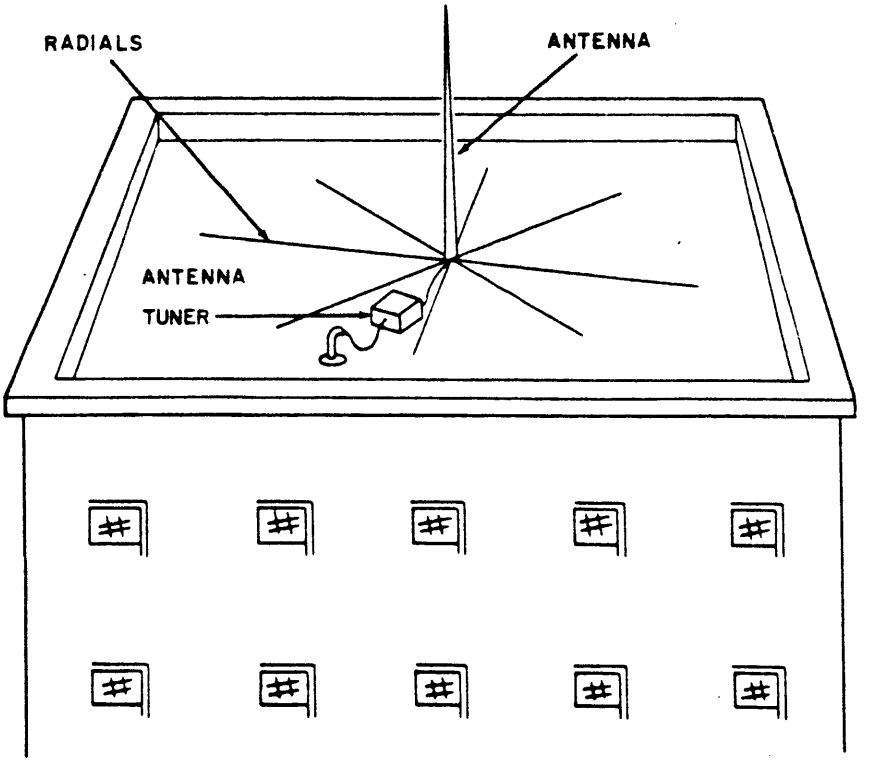


Figure 2-7. Rooftop Installation, 35-foot Whip Antenna with Radial Counterpoise

SECTION 3

OPERATOR'S SECTION

3-1. OPERATING INSTRUCTIONS

Table 3-1 lists controls and indicators of the monitor control. The antenna tuner and directional coupler have no operating controls or indicators. Use Table 3-1 and Figure 3-1 while employing Table 3-2 as an operating procedure.

3-2. OPERATOR'S MAINTENANCE

Operator's maintenance consists of lamp and fuse replacement; refer to Section 5. All other maintenance should be done by a qualified maintenance technician.

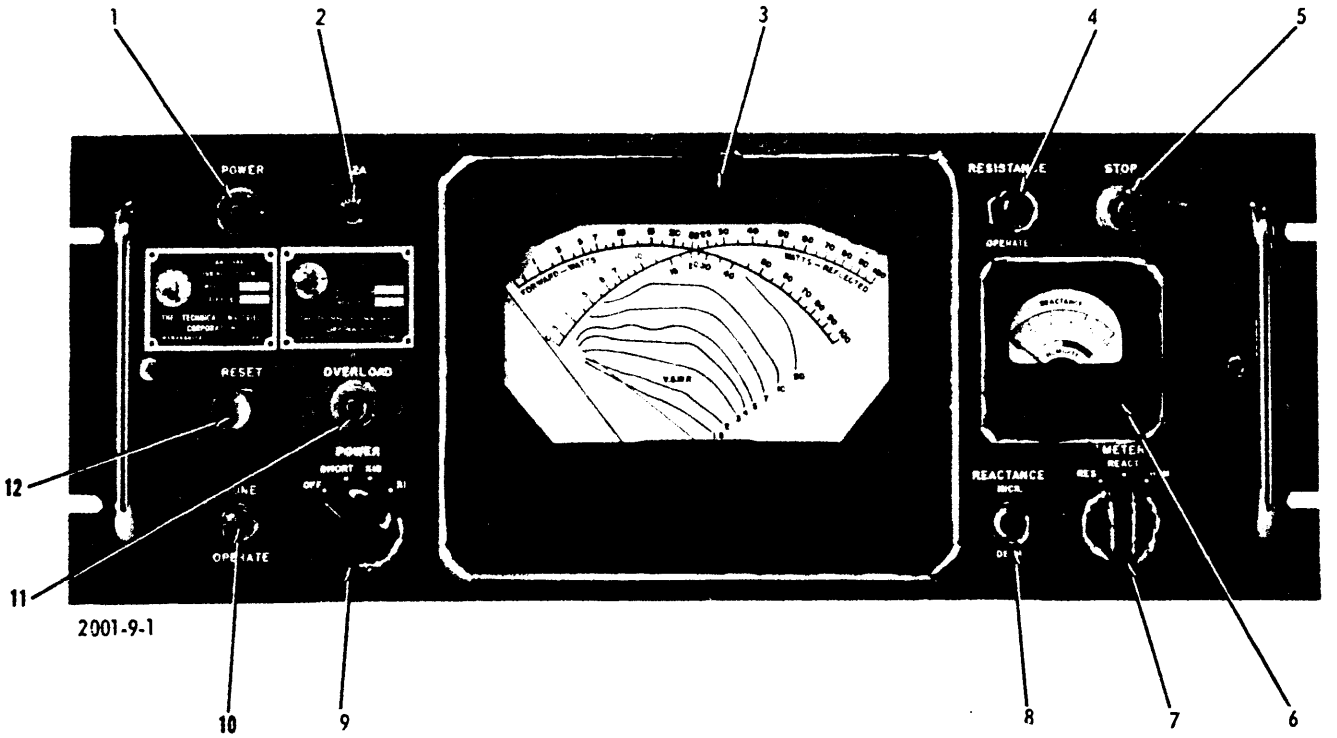


Figure 3-1. Monitor Control, Controls and Indicators

ITEM NO.	CONTROLS AND INDICATORS	SYMBOL	FUNCTION
1	POWER indicator	I102	Indicator that lights to indicate that monitor control is turned on.
2	2A fuse	F101	Protect power supply a-c input circuits.
3	Power meter (Standing wave indicating meter)	M101	Dual-pointer meter with scales calibrated for forward-watts, reflected-watts, and VSWR (voltage standing wave ratio). The watts scales are calibrated 0 to 100. The scale readings are multiplied by 10 when the POWER (ON-SHORT-X10-X1) switch is in the X10 position. The vswr on the transmission line is indicated by the point of intersection of the meter pointers.
4	RESISTANCE-OPERATE switch	S102	Push-button switch that controls and unidirectional motor that drives the selector switch in the antenna tuner for selection of autotransformer taps to match antenna resistance. The selector switch contacts resistance positions 1 to 6 in a clockwise direction and repeats the cycle.
5	STOP indicator	I101	Indicator that indicates when maximum or minimum inductances of the variable inductor in the antenna tuner have been reached. Microswitches are incorporated in the antenna tuner to prevent the reactance changing motor from overdriving at either end of the moving contact travel. These switches interrupt the motor power and energize the STOP indicator.
6	Resistance, reactance, humidity meter	M102	Three-scale meter that indicates reactance on an upper black scale calibrated 0 to 100, resistance on a middle red scale calibrated 1 to 6, and humidity on a lower scale.
7	METER (RES. - REACT. - HUM.) selector switch	S104	Three-position rotary switch that returns to REACT. position when released. When in RES. position, read the red RESISTANCE scale of meter M102, calibrated 1 to 6. When in REACT. position, read the upper black reactance scale of meter M102, calibrated 0 to 100. When in HUM. position, read the lower humidity scale of meter M102.
8	REACTANCE (INCR. - DECR.) lever action switch	S103	Three-position level action switch that returns to a neutral-center open circuit position when released. Controls and direction of the reversible motor that drives the contact on the variable inductance in the antenna tuner. When the switch is held in the INCR. position, the motor shaft rotates in a direction to increase the inductance of the DECR. position, the motor shaft rotates in a direction to decrease the inductance of the variable inductor.
9	POWER (ON-SHORT-X10-X1) selector switch	S101	Four-position rotary switch that turns on monitor control, selects watts scales factors, and shorts power meter coils.
10	TUNE-OPERATE switch	S106	Toggle switch that limits transmitter output power to 100 watts when in TUNE position.
11	OVERLOAD indicator	I103	Indicator that lights to indicate that relay K103 has tripped, interrupting transmitter main power.
12	RESET switch	S105	Push-button switch that operates relay K103 to return it to the latched position if it has tripped due to excessive vswr or transmitter output.

Table 3-2. Tuning Procedure (Example For 4-MHz Transmitter Frequency With Dry Antenna)

STEP	CONTROL	OPERATION	PURPOSE
	CAUTION		
	Initial tuning, required to produce a minimum voltage standing wave ratio on the transmission line, must be performed at low transmitter output. This will prevent overheating of components in the directional coupler, particularly if the voltage standing wave ratio is greater than 3 to 1. Keep the maximum power output below 100 watts so that all tuning may be accomplished with POWER switch 9 (see figure 3-1) in the X1 position and the TUNE-OPERATE switch 10 in the TUNE position. Do not turn on transmitter until step 9.		
1	POWER switch 9	Turn to X10 position.	Turns system on and selects 1000-watt range for power meter.
	NOTE		
	Table 3-3 indicates the approximate setting of the ATS-2 before operation. During operation, the visual indication of voltage standing wave ratio is the best guide.		
2	METER switch 7	Place in RES. position.	Sets meter to indicate autotransformer tap position.
3	Meter 6	Read resistance switch position indication on meter 6.	Determines autotransformer tap position.
	CAUTION		
	Do not operate RESISTANCE-OPERATE switch 4 unless transmitter output is 100 watts or less.		
4	RESISTANCE-OPERATE switch 4	Depress for 2 seconds and release. Read meter 6.	Changes resistance switch position one tap.
5	RESISTANCE-OPERATE switch 4	Repeat step 5 until resistance switch position is that determined in step 2.	Establishes correct resistance switch position
6	METER switch 7	Place in REACT. position.	Sets meter to indicate inductance tap position.
7	TUNE-OPERATE switch 10	Place in TUNE position.	
8		Turn transmitter on. Adjust power output to not more than 100 watts. If 100 watts is exceeded, the overload relay will trip, shutting off the transmitter. If this occurs, reduce power and press RESET switch 12.	
9	Power meter 3	Observe forward-watts and reflected-watts indications. If less than 100 watts, turn POWER switch 9 to X1 position.	Determines that power output is sufficiently low.

Table 3-2. Tuning Procedure (Example For 4-MHz Transmitter Frequency With Dry Antenna) (Cont)

STEP	CONTROL	OPERATION	PURPOSE
	CAUTION Observe reactance scale readings on meter 6 while performing step 11 to make certain that reactance scale readings never exceed 20 when frequencies above 10-mc are being transmitted.		
10	REACTANCE switch 8	Operate to INCR. or DECR. positions to minimize reflected-watts and vswr readings on power meter 8.	Brings antenna into resonance at transmitter frequency.
11	TUNE-OPERATE switch 10	Place in OPERATE position.	
12	POWER switch 9	Turn to X10 position.	
13		Increase transmitter power not to exceed 1000 watts.	
14	REACTANCE switch 8	Operate to INCR. or DECR. positions to minimize reflected-watts and vswr readings on power meter 8.	Brings antenna into resonance at transmitter frequency.
15	POWER switch 9	Turn to SHORT position to prevent meter damage due to surges in the transmitter power output.	Protects power meter.

Table 3-3. Operating Frequency VS Resistance Switch Positioning

OPERATING FREQUENCY IN MHz	RESISTANCE SWITCH POSITION	
	HIGH HUMIDITY CONDITIONS	LOW HUMIDITY CONDITIONS
2 Through 5	1	1
6	3	3
7	4	4
8 Through 9	6	6
10 Through 11	5	5
12	3	3
13 Through 15	1	1
16	2	2
17	4	2
18	1	1
19 Through 22	3	3
24	1	1
26	3	3
28 Through 30	4	4

SECTION 4

PRINCIPLES OF OPERATION

4-1. INTRODUCTION

The ATS-2B provides impedance matching of a transmitter to a 35-foot whip antenna. The properties of the antenna that affect matching are antenna resistance and antenna reactance. These properties vary with transmitter frequency and environmental conditions at the antenna site.

Matching an antenna to a transmission line requires that:

a. The antenna be made resonant at the transmitter frequency.

b. The antenna resistance be made equal to the characteristic impedance of the transmission line.

If the above requirements are not met, the length of the line will be critical with transmitter frequency, and reflected power will result in losses. The ATS-2B has three units. Their principles of operation are discussed in the following paragraphs.

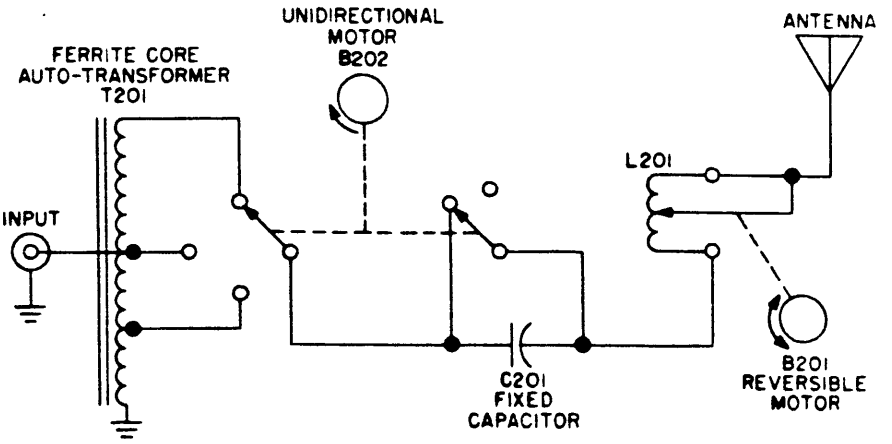


Figure 4-1. Antenna Tuner, Simplified Schematic Diagram

4-2. ANTENNA TUNER

When the antenna displays capacitive reactance (denoted by the symbol -j before its reactance value in ohms), the antenna may be brought to resonance by operation of motor B201 (see figure 4-1) to change the series inductance provided by L201. When the inductive reactance provided by L201 (denoted by the symbol +j before the reactance value in ohms) balances the antennas capacitive reactance, the antenna becomes a purely resistive load. Figure 4-2 illustrates the vector relationship of an antenna whose impedance is 175-j 305 ohms.

When the antenna displays inductance reactance, a fixed capacitor C201 is inserted into the circuit. Variable inductance L201 is adjusted until its reactance plus the antennas reactance is neutralized by C201's reactance. Figure 4-3 illustrates the vector relationship of antenna whose impedance is r + j235 ohms. Related values are:

antenna	= r + j235
L201	= 0 + j150
C201	= 0 - j385
net	= r + j0

Antenna resistance matching is accomplished by autotransformer T201. Taps on T201 are selected by operation of motor B202 to match the antenna resistance to the transmission line.

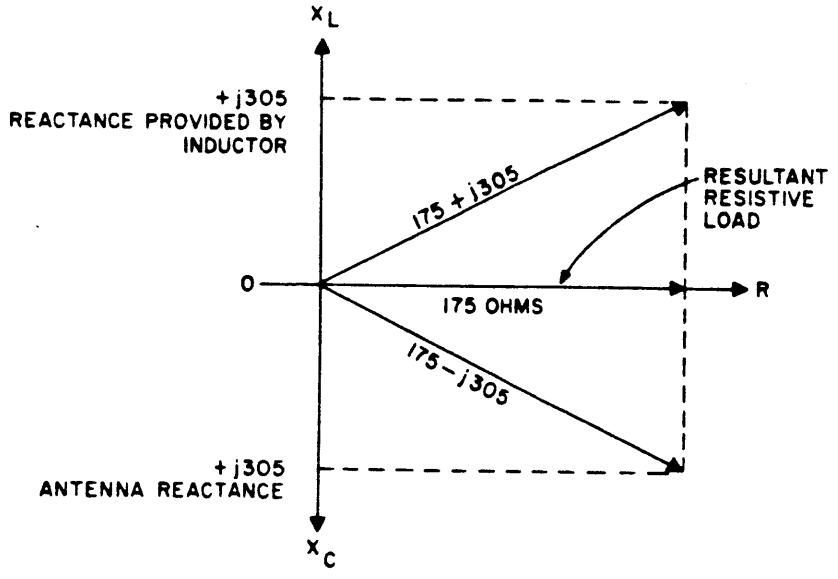


Figure 4-2. Capacitive Antenna

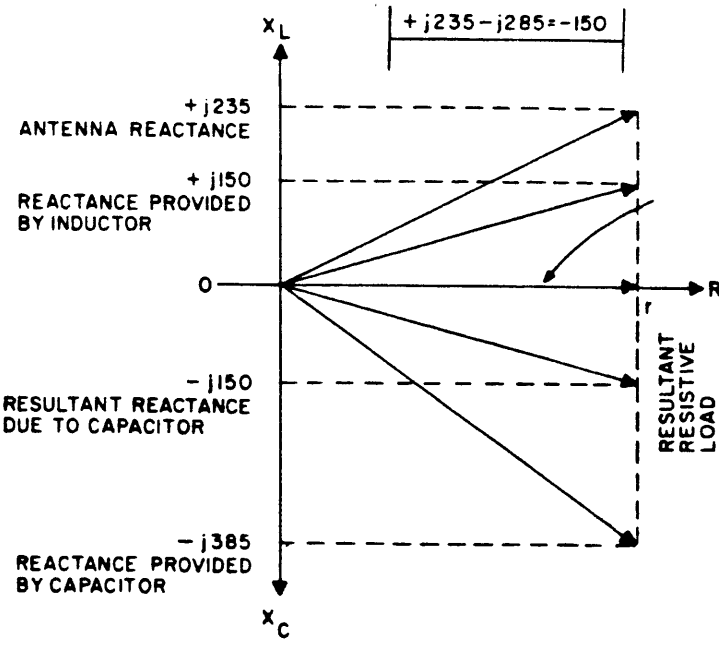


Figure 4-3. Inductive Antenna

4-3. DIRECTIONAL COUPLER

The directional coupler, Figure 4-4, provides the monitor control with signals that are proportional to forward and reflected power. These signals are derived from the RF input applied to bridge circuit ABCD.

After the input and output connections have been made, RF input power applied, and input and output impedances matched, NULL and EQUALIZER capacitors are adjusted to balance the bridge (voltage measured between B and D is zero). Note that the output load is connected across bridge leg CD. Circuit BD provides the equivalent zero-level reflected-power signal to the monitor control. The circuit connected to AE provides the monitor control with a forward-power signal proportional to transmitter output power, or that essentially developed across R301.

When the bridge is unbalanced due to input/output impedance mismatch, the circuit between BD (C303, L301, and CR301) causes an increased reflected-power signal to be filtered by L302 and C307 and applied to the monitor control. The unbalanced condition also effects the circuit between AE (C306, L303, and CR302) such that a decreased forward-power signal is filtered by L304 and C308 and applied to the monitor control. Forward and reflected power are inversely proportional.

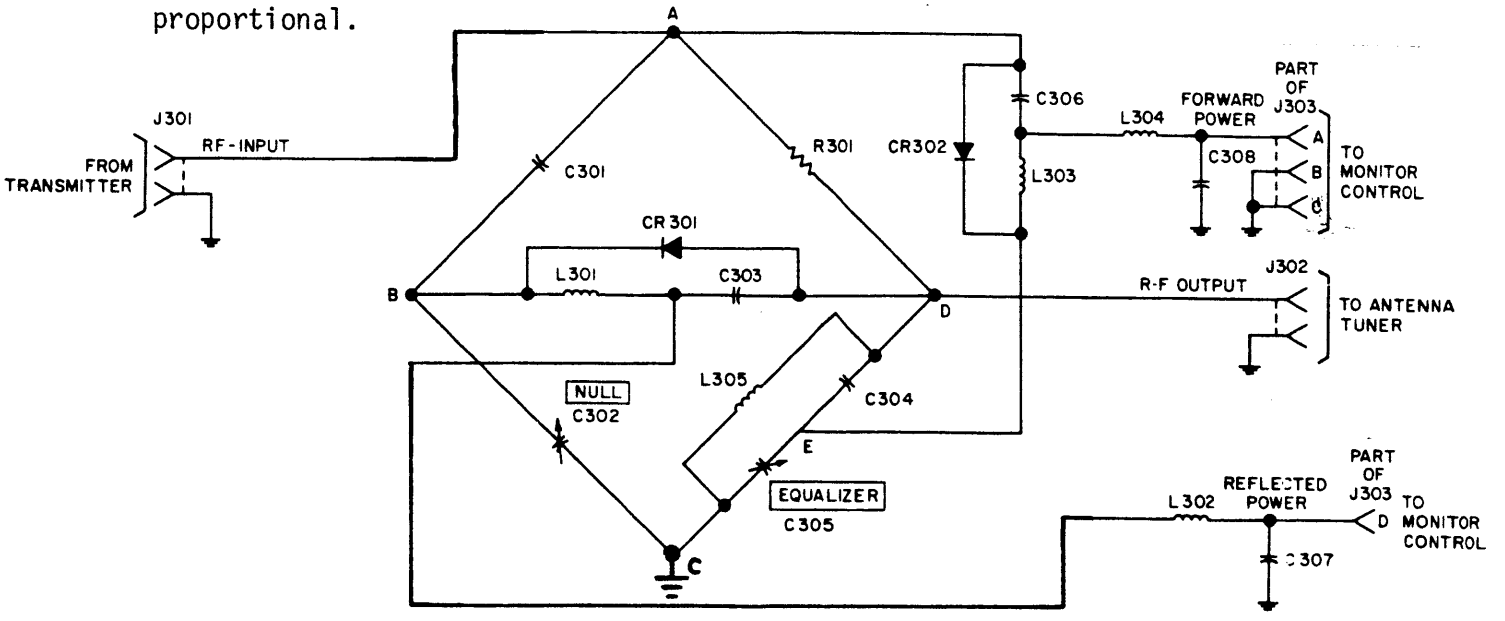


Figure 4-4
Directional Coupler, Simplified Schematic Diagram

4-4. MONITOR CONTROL

a. POWER SUPPLY CIRCUIT. - The power supply circuit, Figure 4-6, provides operating voltages for the circuits in the monitor control and antenna tuner. The circuit operates on 115- or 230- volt ac, 60-cycle, single phase power.

With ac power applied and POWER switch S101 placed at SHORT, X10, or X1, ac line voltage is connected to the primary windings of T101. The secondary voltage (117- or 123-volt ac) of T101 is applied to the half-wave rectifier/filter/regulator circuit; the result is a regulated 105-volt dc bias and plate voltage. The secondary windings also provide a 6.3-volt ac filament voltage, and a 117/230-volt ac for monitor control relays and the antenna tuner.

b. HUM./REACT./RES. METER CIRCUIT. - The meter circuit, Figure 4-5, provides visual indications of humidity, amount of reactance added, and resistance switch position in the antenna tuner.

When S104 is placed at HUM., meter M102 measures the voltage across the bridge circuit consisting of R107, R108 and humidity sensing element in the antenna tuner, R109, and R110.

Initially R108 is adjusted (in conjunction with a dry antenna tuner) so that the meter needle deflection is minimum. If humidity increases, the bridge circuit becomes unbalanced and the meter produces an indication proportional to antenna tuner humidity.

When S104 is set at REACT., meter M102 is provided with a signal that is proportional to the amount of reactance the antenna tuner is adding to the antenna.

When S104 is set at RES., meter M102 indicates the position of the antenna tuner resistance switch (essentially the amount of resistance being added to the antenna).

c. CONTROL, POWER/VSWR METER, AND OVERLOAD CIRCUIT. - This circuit, Figure 4-7, controls the antenna tuner. Also, the circuit provides overload protection against excessive forward and reflected power. The circuit covers two ranges of transmitter output power: 0 to 100 watts (X1) or 0 to 1000 watts (X10).

Initially, R120 is adjusted so that the maximum permissible reflecter-power signal (proportional to a vswr of 2:1) turns V102B on. Next, S106 is set at TUNE and R122 is adjusted so that a forward-power signal (proportional to 100 watts) turns V102A on; similarly S106 is set at OPERATE and R121 is adjusted so that a forward-power signal (proportional to 1,000 watts) turns V102A on. For purpose of simplifying the discussion, it is assumed that S101 is set at X10. Resistors R102 through R105 are adjusted with POWER switch S101 in respective X1 and X10 positions, so that meter M101 is calibrated to indicate amounts of forward and reflected power. RESISTANCE/OPERATE switch S102 and REACTANCE switch S103 are also initially operated to have the antenna tuner add the necessary impedence components to resonate the antenna to a specific transmitter operating frequency.

If the STOP lamp lights, it indicates that one of the maximum physical reactance extremes have been reached in the atnenna tuner; to extinguish the lamp, REACTANCE switch S103 must be set at INCR. or DECR. and it may be necessary to press S102 (select a different resistance range) and retune the ATS.

Under these initial conditions and if the forward power exceeds 1,000 watts, a positive-going forward-power signal causes: V102A to conduct, relay K101 to energize, contacts 1 and 6 of K101 to close, set windings of K103 to energize, contacts of K103 to open and turn the transmitter off, and overload contacts 1 and 5 of K103 to close and light OVERLOAD lamp I103.

Subsequently, the loss of the positive forward-power signal on grid of V102A (due to transmitter turn off) restores the initial V102A cut off condition; relay K101 de-energizes. To fully restore operation, RESET switch S105 must be pressed to reset K103, restore continuity in the interlock circuit, and permit the transmitter to be turned on again at reduced power.

If reflected power exceeds a level that is proportional to a vswr of 2:1, and positive-going signal causes: V102B to conduct, relay K102 to energize and result in the same circuit operation outlined for excessive forward power.

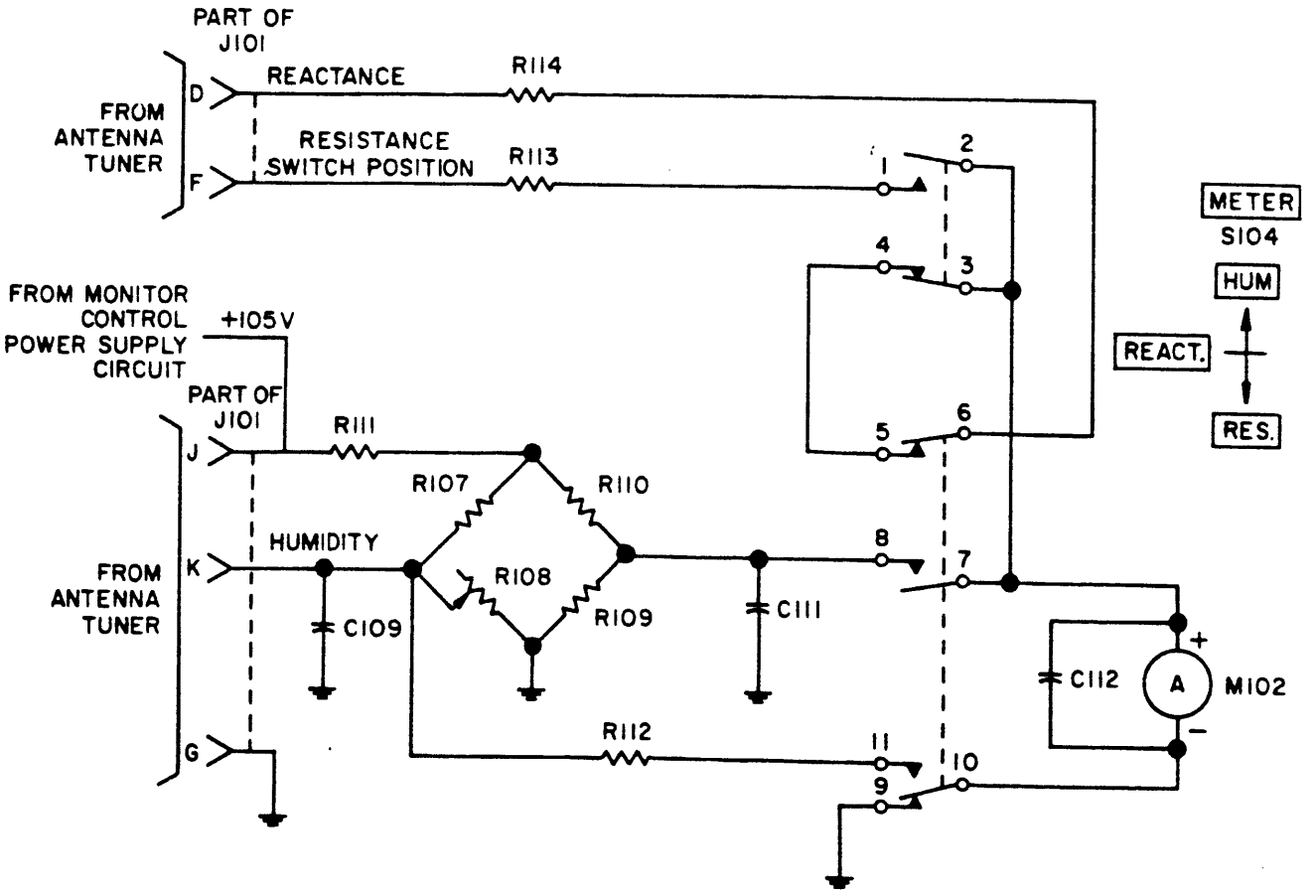


Figure 4-5. HUM./REACT./RES. Meter Circuit, Simplified Schematic Diagram

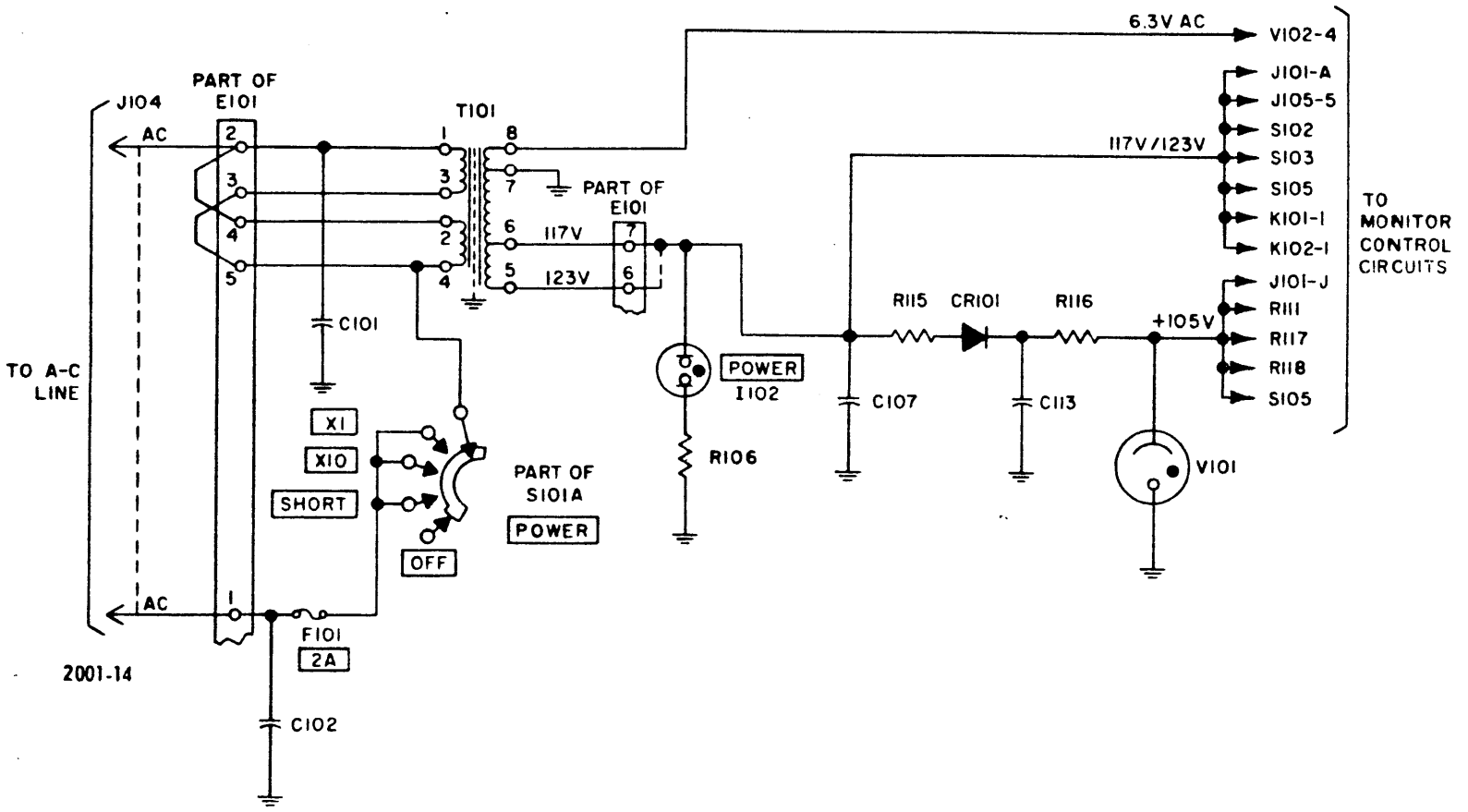


Figure 4-6. Power Supply Circuit, Simplified Schematic Diagram

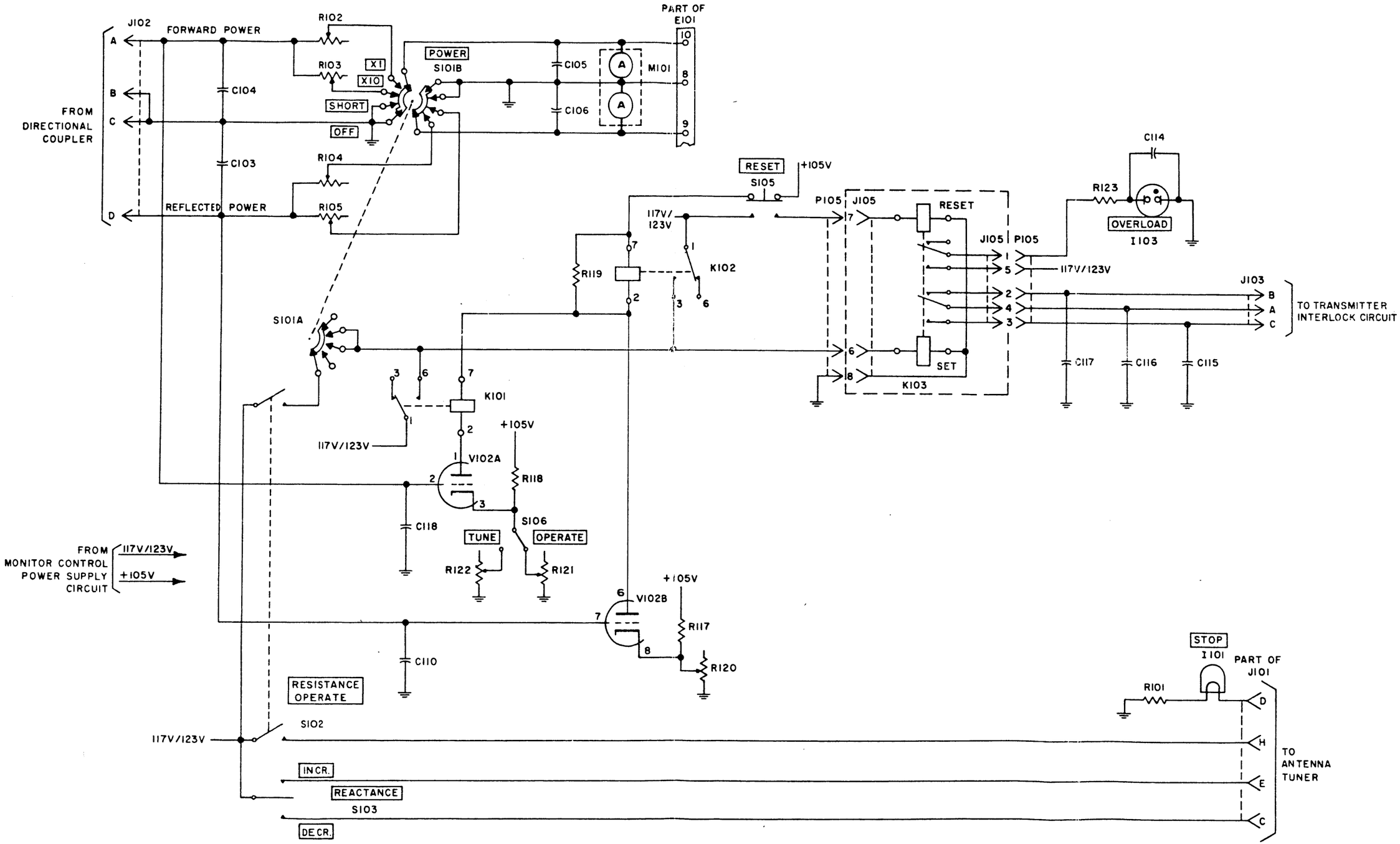


Figure 4-7. Control, Power/VSWR Meter, and Overload Circuit, Simplified Schematic Diagram

SECTION 5

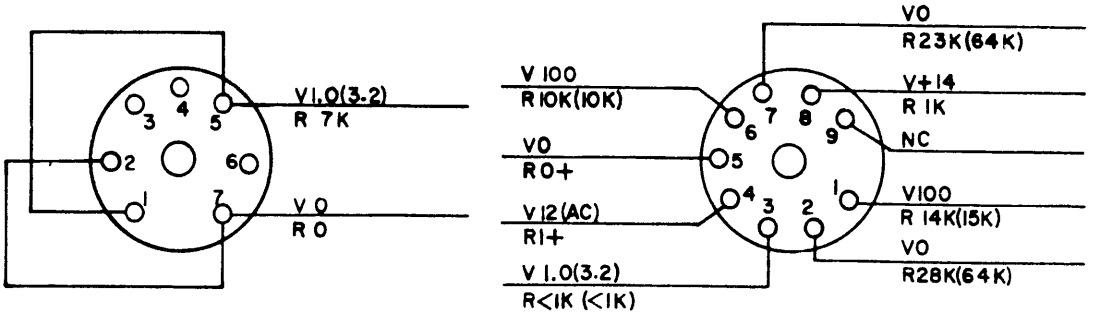
TROUBLE-SHOOTING AND MAINTENANCE

5-1. GENERAL

A systematic troubleshooting chart (Table 5-1) is given to localize a cause of trouble to a particular circuit, section, or component. However, the units should first be visually inspected; common causes of trouble such as arcing in the RF circuits and mechanical defects in switches and other components may usually be determined in this manner. Where correction involves realignment, see paragraph 5-2 or this section. Tube voltage and resistance data are given in Figure 5-1.

NOTE

Check the stability of line voltage, absence of power, and condition of fuses and electron tubes before extensive troubleshooting.



Notes:

1. Resistances are in ohms, voltages and resistances are measured from tube socket pins to ground with a 20,000 ohms-per-volt meter. For resistances only, measurements are made with main power disconnected.
2. Voltages not in parentheses are measured with tune-operate switch in tune position; voltages in parentheses are measured with tune-operate switch in operate position.
3. Resistances not in parentheses are measured with power switch in X1 position; resistances in parentheses are measured with power switch in X10 position.
4. Voltages are dc unless otherwise indicat d.

Figure 5-1. Voltage and Resistance Diagram

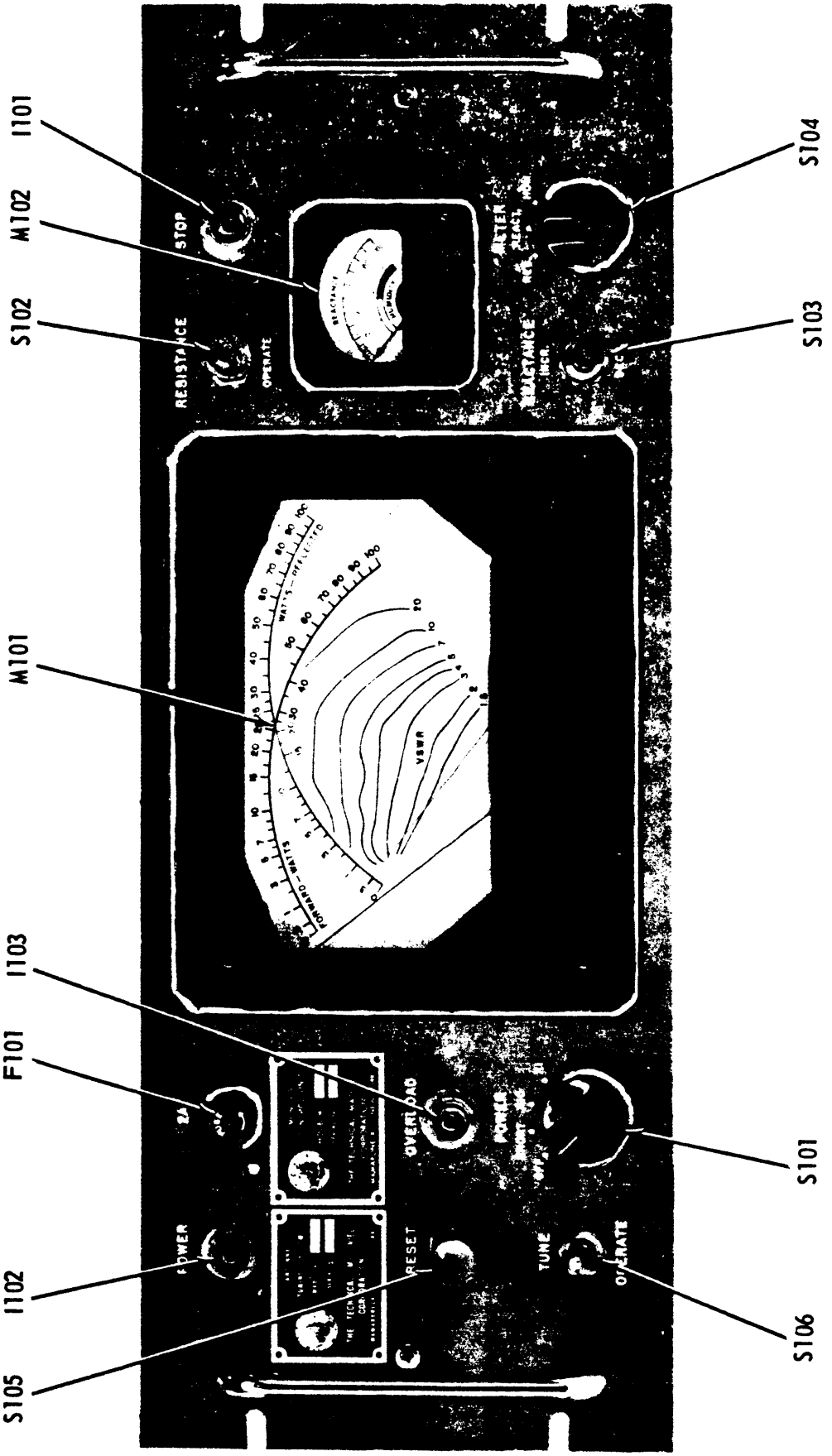


Figure 5-2. Monitor Control Front Panel, Component Identification

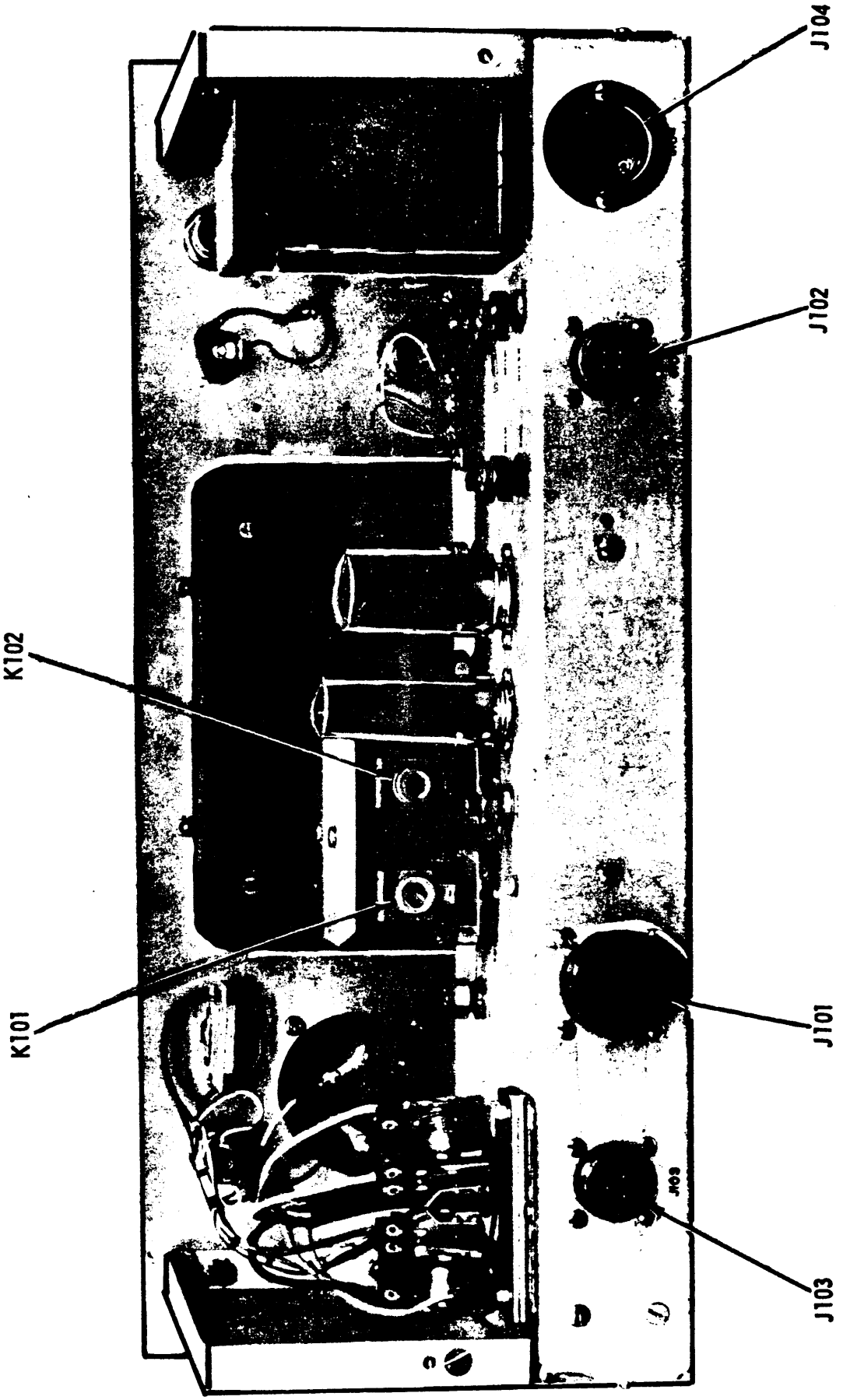


Figure 5-3. Rear of Monitor Control, Component Identification

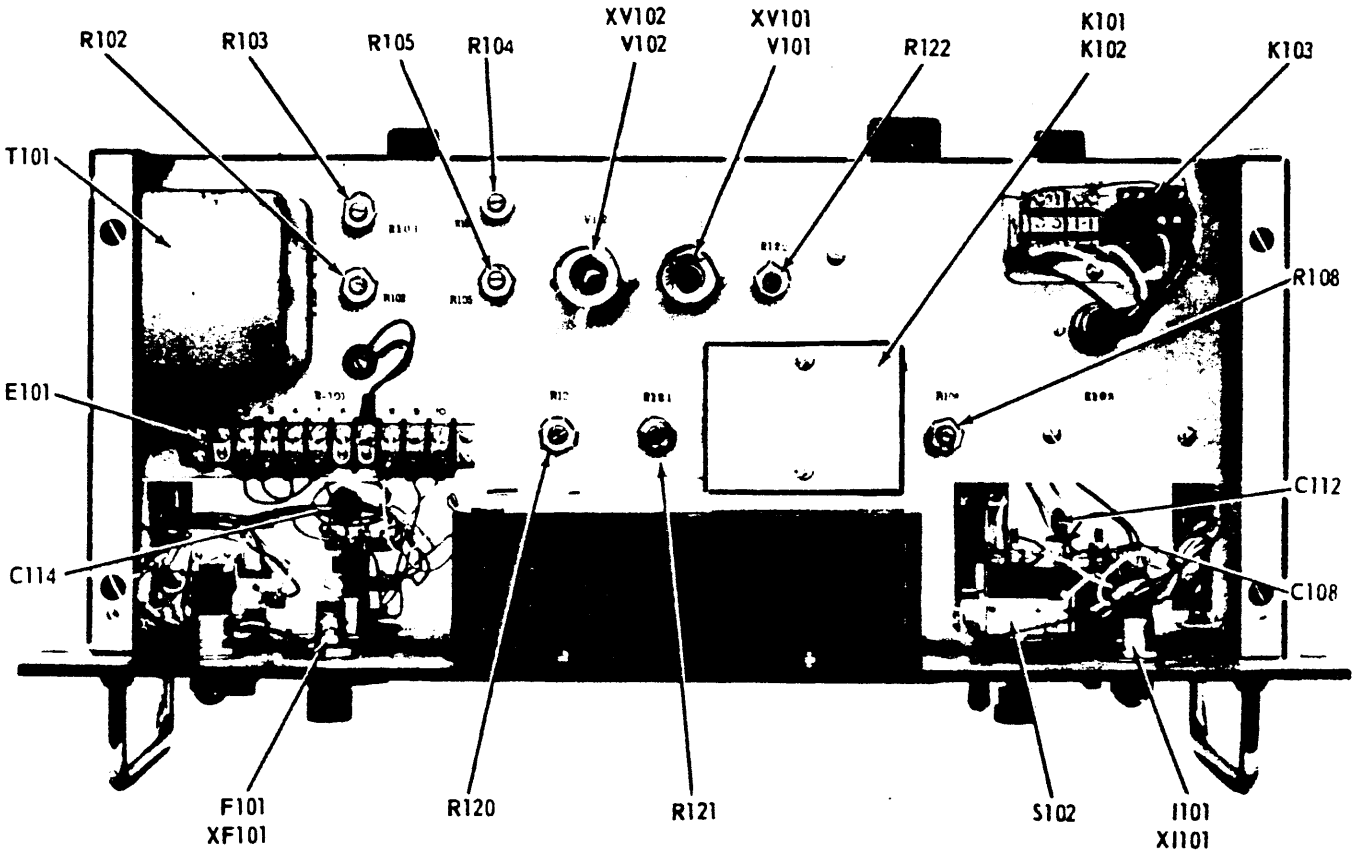


Figure 5-4. Top of Monitor Control, Component Identification

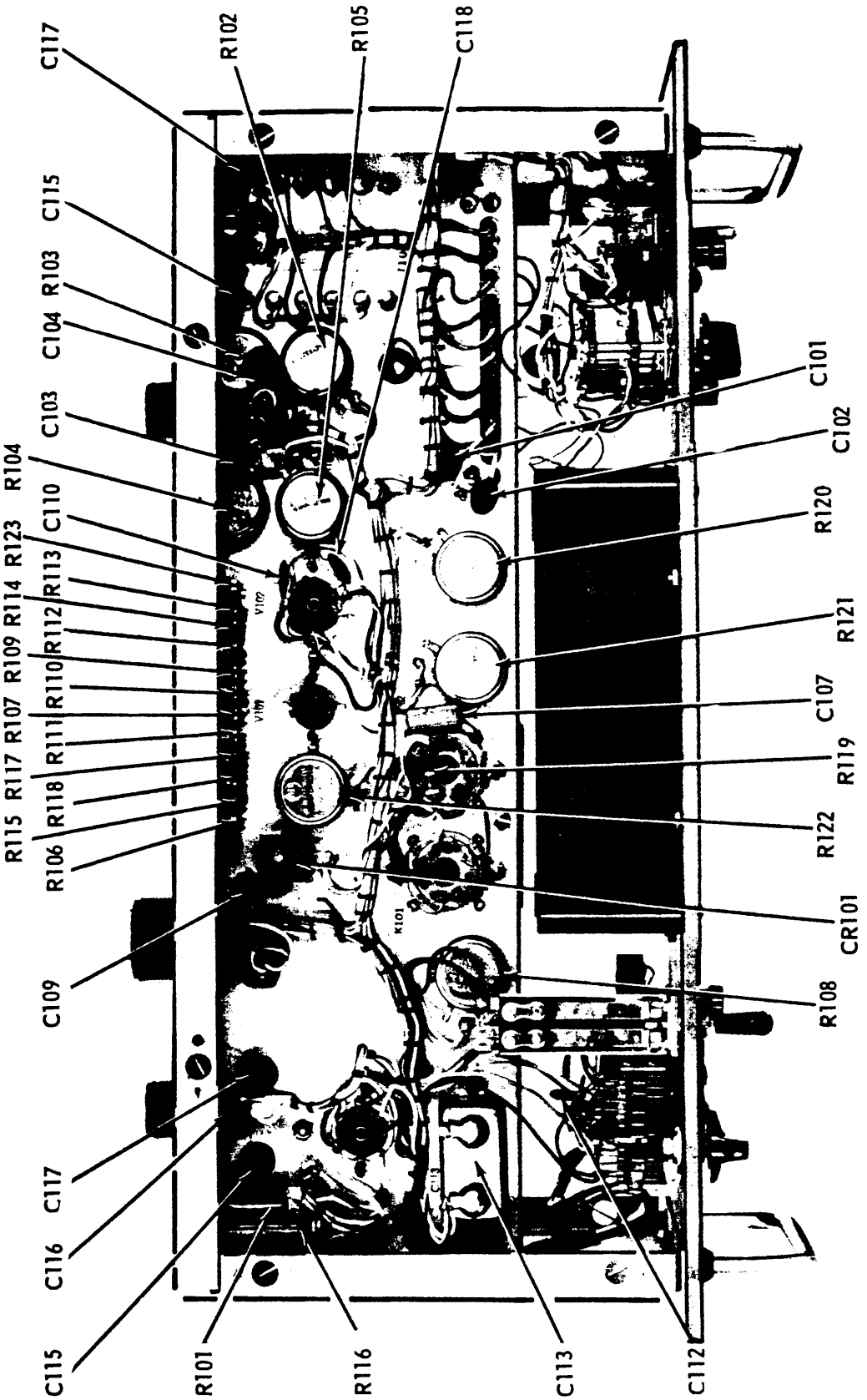
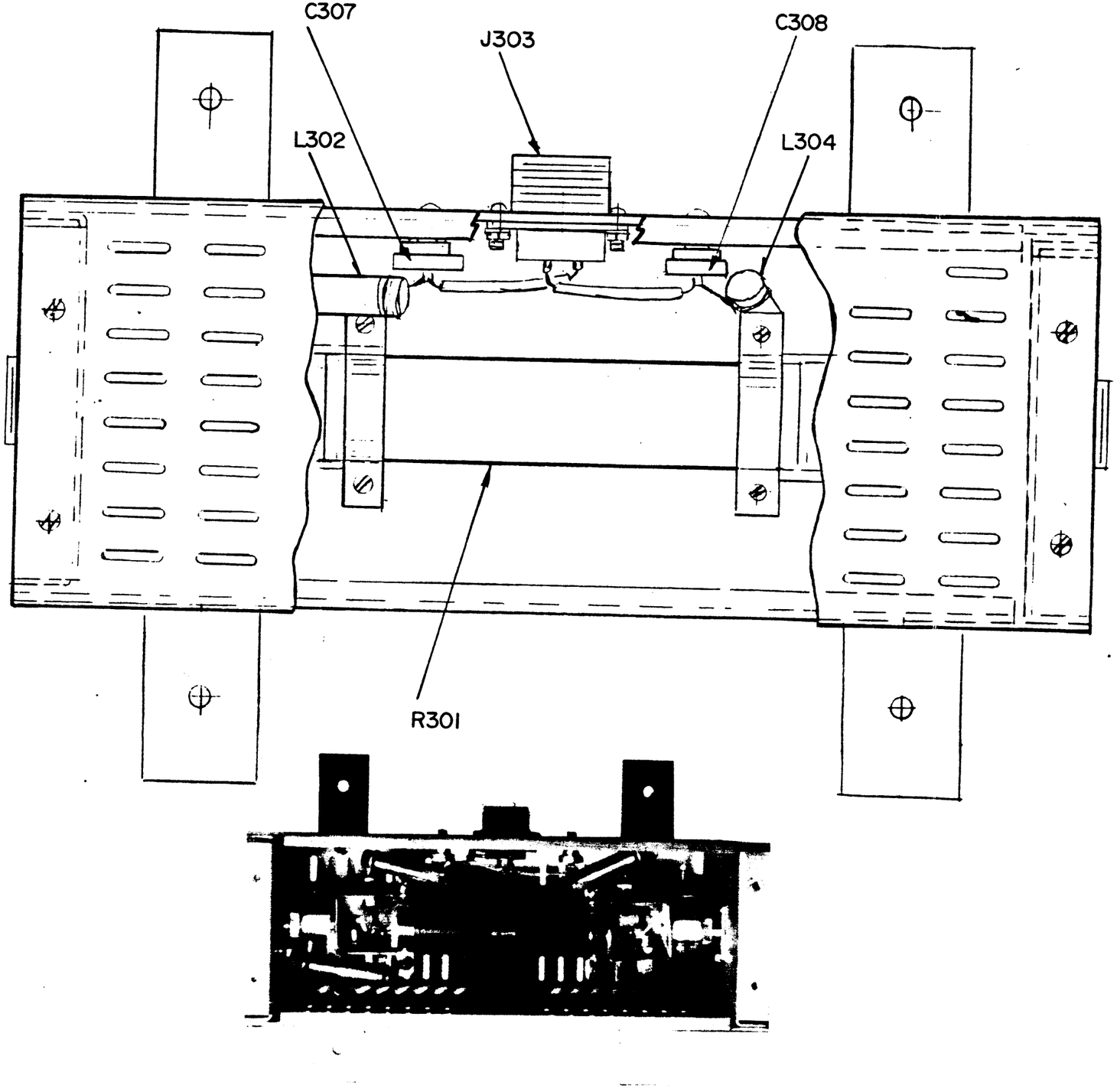
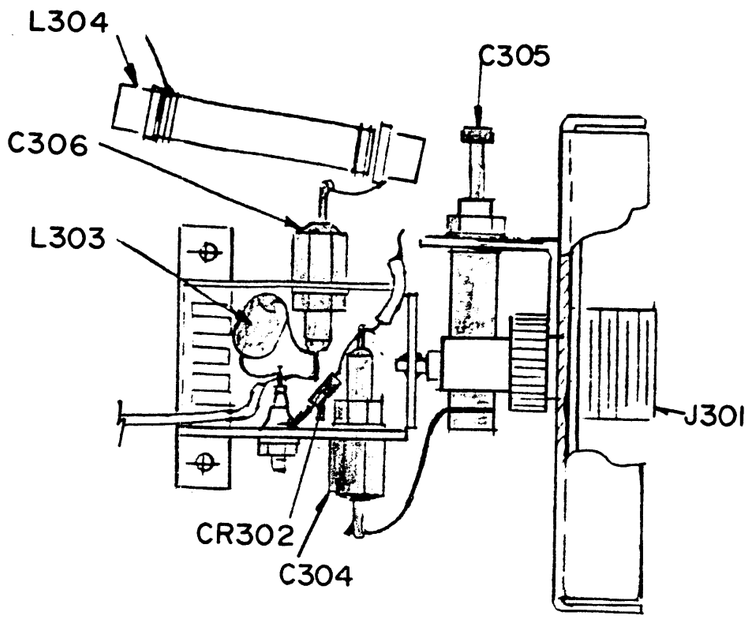


Figure 5-5. Bottom of Monitor Control, Component Identification





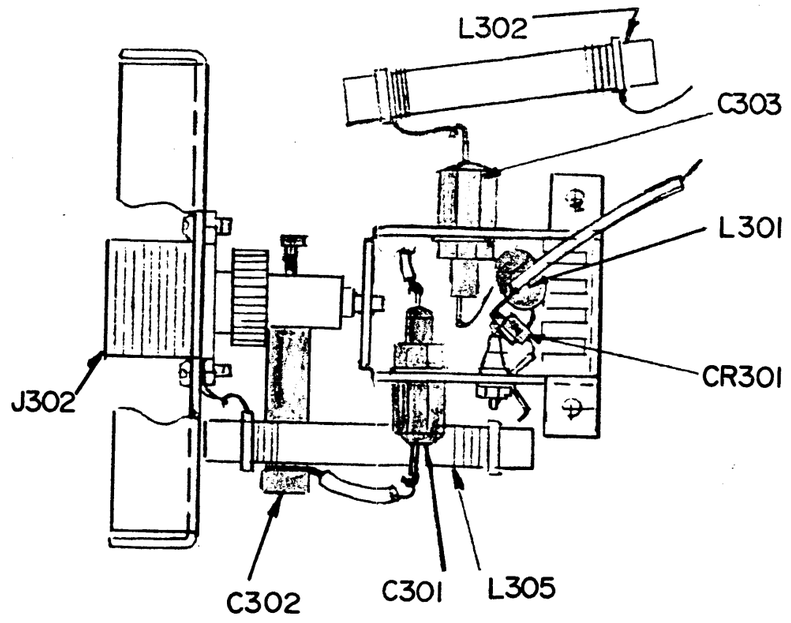


Figure 5-6.

Directional Coupler, Component Identification

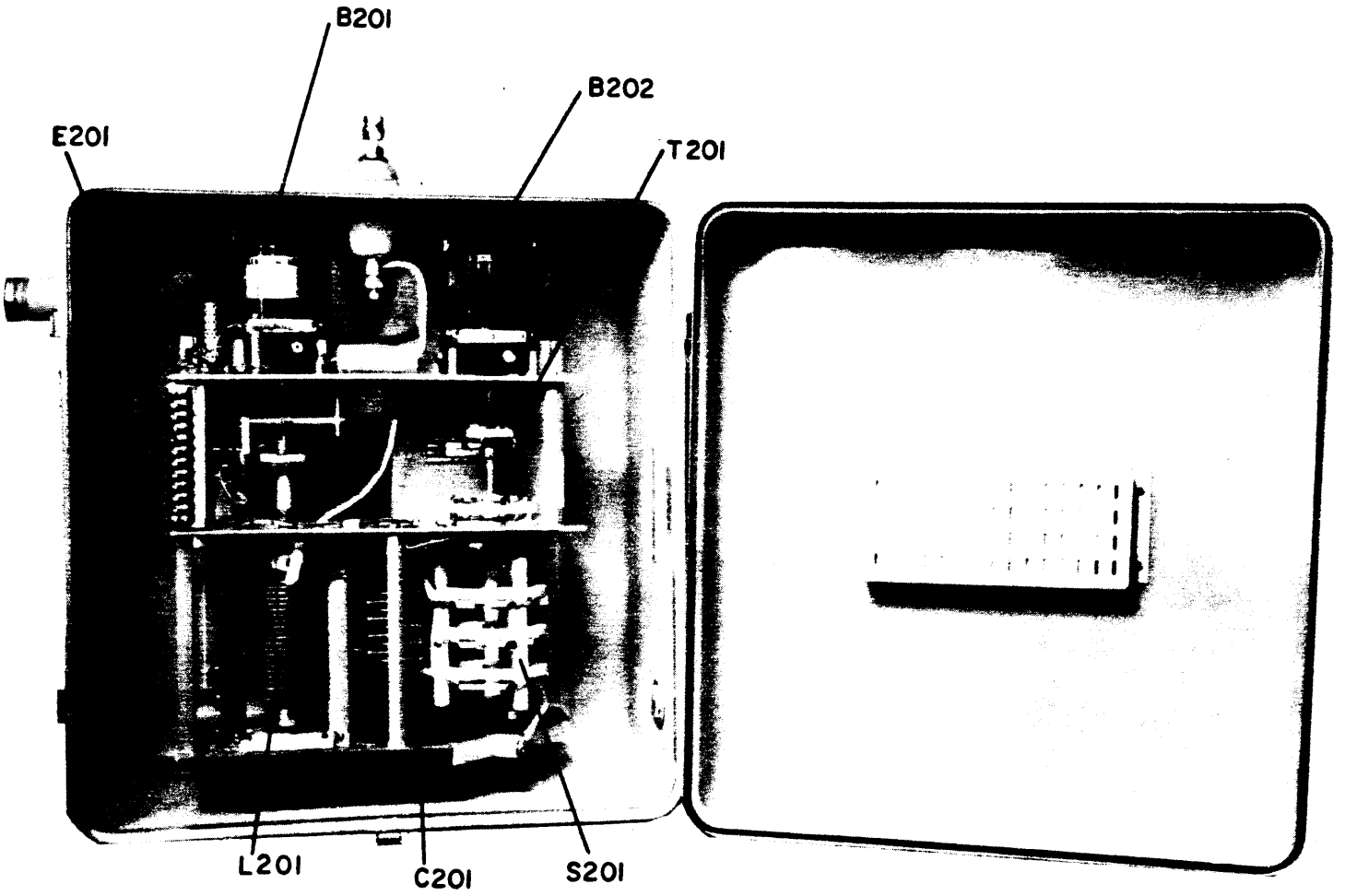


Figure 5-7. Antenna Tuner, Component Identification

Table 5-1. Trouble-Shooting Chart

STEP	TROUBLE	PROBABLE CAUSE	REMEDY
		CAUTION When performing resistance checks, do not attempt to measure the internal resistance of meters M101 and M102 with an ohmmeter. The meter movement can be damaged by excessive current flow.	
1	No antenna radiation when TUNE-OPERATE switch S106 is in TUNE or OPERATE position.	Transmitter cut off because overload relay in monitor control is tripped.	Antenna radiation can be reestablished by performing one or more of following procedures: (1) Reduce transmitter output. (2) Push RESET pushbutton on monitor control. (3) Check threshold adjustments for overload relay K103 as discussed in Table 5-4. (4) Check main power supply to monitor control.
		Defective system interconnections. (1) Loose or improperly connected cables (see Figure 2-5) (2) Broken or defective plugs, jacks, and connectors. Replace if necessary.	Solder, tighten, or replace.
		Defective directional coupler.	Repair.
		Defective antenna tuner.	Check antenna tuner for open or shorted r-f line.
2	Low antenna radiation when TUNE-OPERATE switch S106 is in OPERATE position.	Transmitter improperly matched to antenna.	Adjust as follows: (1) Adjust tuning to obtain minimum vswr indication. (2) Above 10 MHz readjust tuning to obtain REACTANCE indication less than 20 on meter M102.
3	Incorrect monitor control vswr meter indication	1. Improper vswr voltages from directional coupler give low power reading.	1. Check directional coupler.
		2. Faulty monitor control vswr meter circuit.	2. Check meter circuit.

Table 5-1. Trouble-Shooting Chart (Cont)

STEP	TROUBLE	PROBABLE CAUSE	REMEDY
4	Excessive power in TUNE or OPERATE positions does not activate overload protection circuits	Overload plate relays K101 and K102 improperly set or inoperative.	Check and adjust or replace.
		Latching relay K103 does not release on overload.	Check and replace, if necessary.
		Tube V102 defective.	Check and replace, if necessary.
5	POWER indicator I102 does not glow when POWER switch S101 is set at SHORT, X10, or X1.	Defective connector J104.	Replace connector.
		Fuse F101 blown.	Replace fuse.
		Defective POWER switch.	Replace switch S101.
		Defective power transformer.	Replace transformer T101.
		Terminal board E101 connected for 230-volt operation when 115-volt supply is available at connector J104.	Rearrange jumpers for 115-volt operation as shown in Figure 2-1.
		Defective neon lamp I102 or socket.	Replace lamp or socket.
		Open current-limiting resistor for neon lamp.	Replace resistor R106.
		Short to ground through one of following capacitors: C101, C102, C107, or C113.	Replace defective capacitor.
6	POWER indicator lamp I102 glows purple when POWER switch S101 is set at SHORT, X10, or X1.	Current-limiting resistor R106 shorted or reduced in value.	Replace resistor.
		Terminal board E101 connected for 115-volt operation when 230-volt supply is available at connector J104.	Reconnect for 230-volt operation as shown in Figure 2-1.
7	VSWR meter M101 does not read power on either scale when POWER switch S101 is set at X10 or X1.	Transmitter inoperative or intersystem connections defective.	See Figure 2-5 for proper connections; replace defective connectors or cables.
		Defective directional coupler.	Replace directional coupler.
		Defective POWER switch.	Replace POWER switch S101.
		Open circuit in potentiometer R102 or R105.	Replace potentiometer when there is no reading in X1 position only.
		Open circuit in potentiometer R103 or R104.	Replace potentiometer when there is no indication in X10 position only.

Table 5-1. Trouble-Shooting Chart (Cont)

STEP	TROUBLE	PROBABLE CAUSE	REMEDY
7 (Cont)		One of following capacitors shorted to ground: C103 through C106, C110, or C118.	Replace shorted capacitor.
		Defective vswr meter M101.	Replace meter when either meter movement is defective.
8	VSWR meter M101 gives abnormal indications with POWER switch S101 set at X1 and X10.	Zero settings incorrect.	Remove power and set pointers at zero.
		Defective directional coupler.	Replace directional coupler.
		High-resistance contact or loose contact on POWER switch S101.	Replace POWER switch S101 when contact cannot be cleaned or tightened.
		Defective potentiometer R102 or R105.	Replace potentiometer when trouble occurs only in X1 position.
		Defective potentiometer R103 or R104.	Replace potentiometer when trouble occurs only in X10 position.
		One of following capacitors defective: C103 through C106, C110, or C118.	Replace defective capacitor.
		Defective resistance selector switch S201 in antenna tuner unit.	Return to factory for replacement of resistance selector switch S201.
		Open or shorted impedance-matching transformer T201.	Repair or replace.
		Open or shorted tuning coil L201.	Return to factory for replacement.
		Open loading coil L202.	Return to factory for replacement.
		Defective capacitor C201.	Replace when abnormal indication on vswr meter occurs at tap position 2, 4, or 6 of resistance switch.
9	No step advance shown on multiple indication meter when RESISTANCE OPERATE switch S102 is depressed METER switch S104 is held in RES. position	Defective RESISTANCE OPERATE switch S102.	Replace switch.
		Defective METER switch S104.	Replace switch.
		Defective multiple indication meter M102.	Replace meter.
		Open or high-resistance current-limiting resistor R113.	Replace resistor if open or above 378,000 ohms.

Table 5-1. Trouble-Shooting Chart (Cont)

STEP	TROUBLE	PROBABLE CAUSE	REMEDY
9 (Cont)		Switch S201A, or associated resistors R203 through R209, defective or open.	Switch S201A in resistance transformer and capacitance switch assembly of antenna tuner is not replaceable. Individual resistors, when accessible, can be replaced.
		Motor B202 inoperative.	Check motor and replace when necessary.
		Shorted capacitor C205, C206, or C212.	Replace capacitor.
10	Reactance indication does not increase or decrease when REACTANCE switch S103 is held in either INCR. or DECR. positions.	Defective meter M102.	Replace meter.
		Defective METER switch S104.	Replace switch.
		Defective potentiometer R201 or resistor R202.	Replace defective potentiometer and resistor.
		Defective motor B201.	Replace motor.
		Shorted capacitor C202, C208 or C211.	Replace capacitor.
		Defective microswitch S202 or S203.	Replace microswitch.
		Open or high-resistance current-limiting resistor R114.	Replace resistor when open or when resistance is above 168,000 ohms.
11	STOP indicator I101 does not glow when meter M102 reads 0 or 100 on REACTANCE scale.	Defective lamp.	Replace lamp.
		Shorted capacitor C108	Replace capacitor.
		Open resistor R101.	Replace resistor.
		Defective microswitch S202 or S203.	Replace microswitch.
		Shorted capacitor C207.	Replace capacitor.
		Microswitch actuating arm slipping on shaft.	Tighten arm after resetting as discussed in section 6.
12	Abnormal indication when meter switch S104 is held in HUM. position.	Defective humidity-sensing element R210.	Replace humidity-sensing element.
		Defective switch S104.	Replace switch.
		Defective resistor in humidity sensing bridge, resistors R107 through R112.	Replace defective resistor
		Defective capacitor C111 or C203.	Replace defective capacitor.
		Shorted capacitor C209.	Replace capacitor.

5-2. MAINTENANCE

a. CLEANING. Inspect interior of units for dirt, dampness, charring, or corrosion. Correct any defect. Clean the electronic components with a clean, soft brush moistened with trichloroethylene or equivalent.

WARNING

When using trichloroethylene, make certain that adequate ventilation exists. Avoid prolonged contact with the skin.

b. VOLTAGE AND RESISTANCE TESTING. Test voltages and resistances as discussed in paragraph 5-1. Investigate any large discrepancies from values given.

c. ELECTRON TUBE TESTING. Test each electron tube with a reliable tube tester or by substitution. Replace each satisfactory tube in the socket from which it was removed. Discard defective electron tubes.

d. DESSICANT. A 16-unit bag of dessicant is attached to the antenna tuner cover to prevent moisture from gathering on the internal components. Should the humidity meter show that a change of dessicant is necessary, replace with a fresh bag. Allow time for dessicant action to change the indication on the humidity meter.

The dessicant may be reconditioned by baking the bag(s) in an oven.

e. SPARK GAP. Make sure the spark gap adjustment in the antenna tuner is set at a 1/8 of an inch.

f. LAMP AND FUSE REPLACEMENT.

CAUTION

Do not replace fuse with a fuse of higher rating. If the fuse blows immediately after replacement, do not replace again until the trouble has been corrected.

In the event of lamp or fuse failure replace with exact replacement.

5-3. ALIGNMENT

Table 1-4 lists the test equipment required for alignment of the antenna tuning system. Tables 5-2 through 5-5 outline the alignment procedures for the antenna tuning system.

Table 5-2. Complete Calibration Procedure for VSWR Meter

STEP	OPERATION	PURPOSE
1	Couple system cabling as shown in figure 2-5. Do not connect antenna tuner.	Readies system for calibration of vswr meter.
2	Connect the 50-ohm, ATS-2B resistive load to J302 of the directional coupler.	Loads the transmitter.
3	Connect r-f vacuum tube voltmeter across resistive load at J302 of the directional coupler.	Permits measurement of r-f voltage across resistive load.
4	Rotate all potentiometers on rear of monitor control fully counter clockwise.	Prepares monitor control for calibration.
5	Zero meter M101 pointers by turning screwheads at pointer hubs.	Zeros vswr meter.
6	Set power switch of monitor control at X10.	Selects 1000-watt range for VSWR meter.

Table 5-2. Complete Calibration Procedure for VSWR Meter (Cont)

STEP	OPERATION	PURPOSE
7	Tune transmitter to an output frequency of 6.0-MHz.	Applies r-f energy through directional coupler.
8	Increase transmitter power until VTVM at dummy load indicates 224 volts.	Brings transmitter output power to 1000 watts.
9	Adjust R104 until vswr meter indicates approximately 3/4 scale on reflected power (red) scale.	Increases sensitivity of reflected power indicator.
10	Adjust null capacitor C302 in directional coupler until meter M101 indicates minimum power on the REFLECTED-WATTS scale.	Nulls r-f bridge in directional coupler.
11	Repeat steps 9 and 10 until no further reduction in reflected power indication can be obtained.	Nulls r-f bridge in directional coupler.
12	Rotate R104 fully counter clockwise.	Reduces sensivity at reflected power indicator.
13	Turn transmitter off. Interchange coaxial cables at the directional coupler by connecting resistive load to J301 and the transmitter to J302.	Interchanges resistive load and transmitter output.
14	Turn transmitter on. Increase power until vtvm indicates as in step 8 above.	Applies r-f energy through directional coupler.
15	Adjust R103 until VSWR meter indicates approximately 3/4 scale on forward power (black) scale.	Increases sensitivity of forward power indicator.
16	Adjust equalizer capacitor C305 on the directional coupler until meter M101 indicates minimum power on the FORWARD-WATTS black scale.	Equalizes r-f bridge in directional coupler.
17	Repeat steps 15 and 16 until no further reduction in forward power indication can be obtained.	Equalizes r-f bridge in directional coupler.
18	Adjust R104 of monitor control until meter M101 indicates 100 (1000/10) on the REFLECTED-WATTS red scale.	Calibrates meter M101 for reflected power indication.
19	Reduce transmitter power until vtvm at dummy load indicates 70.7 volts.	Sets transmitter output at 100 watts.
20	Set POWER switch on monitor control at X1.	Selects 100-watt range for vswr meter.
21	Adjust R105 of monitor control until meter M101 indicates 100 on the REFLECTED-WATTS red scale.	Calibrates meter M101 for reflected power indication.

Table 5-2. Complete Calibration Procedure for VSWR Meter (Cont)

STEP	OPERATION	PURPOSE
22	Turn transmitter off. Restore original coaxial connections at the directional coupler as instructed in steps 1 and 2.	Restores original connections at directional coupler.
23	Set POWER switch on monitor control at X10.	Selects 1000-watt range for vswr meter.
24	Turn transmitter on. Adjust output level until r-f vacuum tube voltmeter indicates 224 volts.	Brings transmitter output to 1000 watts.
25	Adjust R103 of monitor control until meter M101 indicates 100 on the FORWARD-WATTS black scale.	Calibrates meter M101 for forward power indication.
26	Reduce transmitter power output as indicated in step 19.	Sets transmitter output at 100 watts.
27	Set POWER switch on monitor control at X1.	Selects 100-watt range for vswr meter.
28	Adjust R102 of monitor control until meter M101 indicates 100 (1000/10) on the FORWARD-WATTS black scale.	Calibrate meter M101 for forward power indication.

Table 5-3. Calibration Procedure for Meter M102

STEP	OPERATION	PURPOSE
1	Connect system cabling as shown in figure 2-5.	Readies system for calibration of meter M102.
2	Disconnect cable from J101 on monitor control.	Disconnects antenna tuner.
3	Set switch S101 in SHORT position.	Shorts meter M101.
4	Hold switch S104 in HUM. position. Adjust R108 until meter M102 indicates zero on the humidity scale.	Calibrates meter M102 for humidity indication.
5	Connect cable to J101 on monitor control.	Connects antenna tuner.
6	Set switch S101 in SHORT position.	Shorts meter M101.
7	Hold switch S103 in INCR. position until indicator I101 lights.	Increases reactance to maximum.
8	Hold switch S104 in REAC. position.	Permits meter M102 to indicate reactance.
9	Determine that meter M102 reads 100 on the reactance scale.	Confirms accuracy of reactance indication on meter M102.

Table 5-4. Adjustment Procedure for Overload Circuitry

STEP	OPERATION	PURPOSE
1	Connect the 50-ohm resistive load to J302 of the directional coupler.	Loads the transmitter.
2	Couple system cabling as shown in Figure 2-5.	Readies system for adjustments of overload circuits.
3	Set power switch on monitor control at X1.	Turns on monitor control and selects 0 to 100 watts ranges for meter M101.
4	Place switch S106 in TUNE position.	Readies monitor control for adjustment of 100-watt overload trip.
5	Wait one minute before proceeding.	Allows V102 warmup time.
6	Turn R120, R121, and R122 fully counterclockwise.	Sets potentiometers for maximum resistance.
7	Tune transmitter to an output frequency of 6.0 MHz. Adjust transmitter power output to 120 watts.	Provides transmitter output required to adjust overload circuit.
8	Turn R122 clockwise until relay K103 trips and cuts transmitter main power.	Sets threshold for 100-watt output trip.
9	Reduce transmitter output power. Press switch S105 to reset relay K103.	Prepares for retesting of 100-watt output trip.
10	Increase transmitter output power slowly. Determine that relay K103 trips when 120 watts is reached.	Tests threshold adjustment for 100-watt output trip.
11	Repeat steps 7 through 10 until R122 is correctly set. Tighten locknut after setting.	Confirms correct adjustment of R122.
12	Turn switch S101 to X10 position.	Selects 0 to 1000-watts ranges for meter M101.
13	Place switch S106 in OPERATE position.	Readies monitor control for adjustment of 1000-watt overload trip.
14	Adjust transmitter output to 1200 watts. Note that meter M101 forward-watts indication exceeds full scale by 1/4 inch. If the transmitter is not rated for 1200 watts, tune for maximum output.	Provides transmitter output required to adjust overload circuit.
15	Turn R121 clockwise until relay K103 trips and cuts transmitter power. Proceed as in steps 9 and 10 until R121 is properly adjusted. Tighten locknut after setting.	Sets the threshold for 1000-watt overload trip.
16	Turn transmitter off, disconnect dummy load from directional coupler, and connect antenna tuner as indicated in Figure 2-5.	Connects system for SWR overload calibration.

Table 5-4. Adjustment Procedure for Overload Circuitry (Cont)

STEP	OPERATION	PURPOSE
17	Turn transmitter on, tune transmitter and antenna to obtain 1000-watts output with minimum vswr.	Provides r-f power necessary for vswr overload calibration.
18	Operate switch S103 until vswr meter indicates 3:1 vswr.	Provides reflected power required for vswr overload.
19	Turn R120 clockwise until relay K103 trips and cuts transmitter power. Proceed as in steps 9 and 10 until R121 is properly adjusted. Tighten locknut after setting.	Sets the threshold for excessive vswr trip.
20	Perform vswr meter alignment (except Null and Equalization adjustments) as outlined in Table 5-2.	Compensates for interaction between overload adjustments and vswr meter adjustments.

Table 5-5. Adjustment Procedure for Inductance Drive System

STEP	OPERATION	PURPOSE
1	Connect antenna tuner to monitor control as shown in figure 2-5.	Readies system for adjustment of inductance drive system.
2	Unclamp and remove antenna tuner housing cover.	Exposes inductance drive system.
3	Loosen setscrews that secure gear and microswitch actuating arms to control shaft of R201.	Permits gear and arms to be rotated on control shaft.
4	Turn switch S101 on monitor control to SHORT position.	Applies control voltage to antenna tuner.
5	Hold switch S103 in DECR. position until motor-driven tap of L201 is 1/4 turn from end of coil (end away from motor).	Establishes end point for motordriven tap travel.
6	Turn control shaft of R201 by hand until meter M102 reads zero when switch S104 is in REACT. position.	Zero positions R201.
7	Tighten gear setscrews.	Secures gear to control shaft of R201.
8	Turn switch S101 on monitor control to OFF.	Disconnects power from motor B201.
9	Rotate arm that actuates switch S203 until it depresses the switch plunger. Tighten setscrews.	Positions arm.
10	Turn switch S101 on monitor control to SHORT.	Applies control voltages to antenna tuner
11	Hold switch S103 in INCR. position until motor-driven tap is 1/4 turn from the other end of the coil.	Establishes end point for motor-driven tap travel.
12	Turn switch S101 on monitor control to OFF.	Disconnects power from motor B201.
13	Rotate arm that actuates switch S202 until it depresses the switch plunger. Tighten setscrews.	Positions arm.

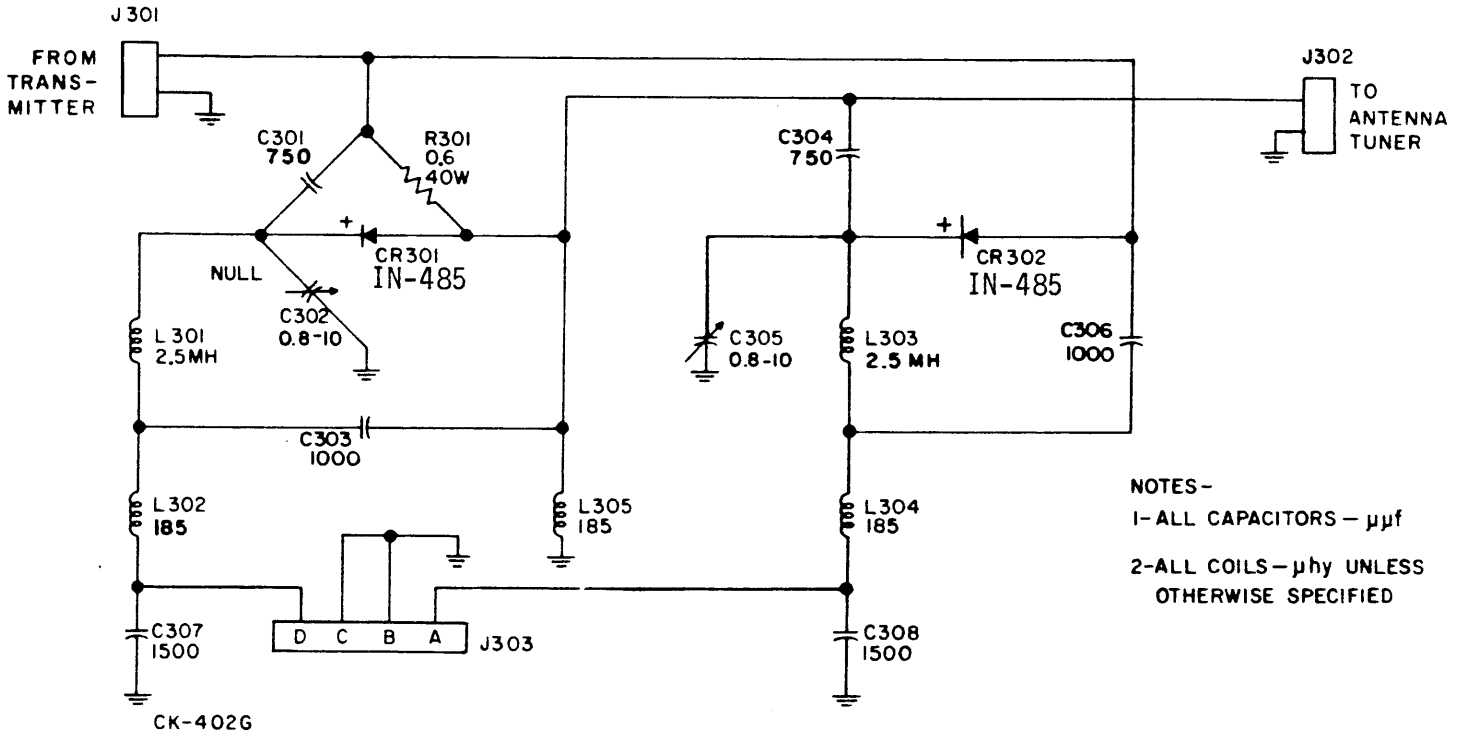


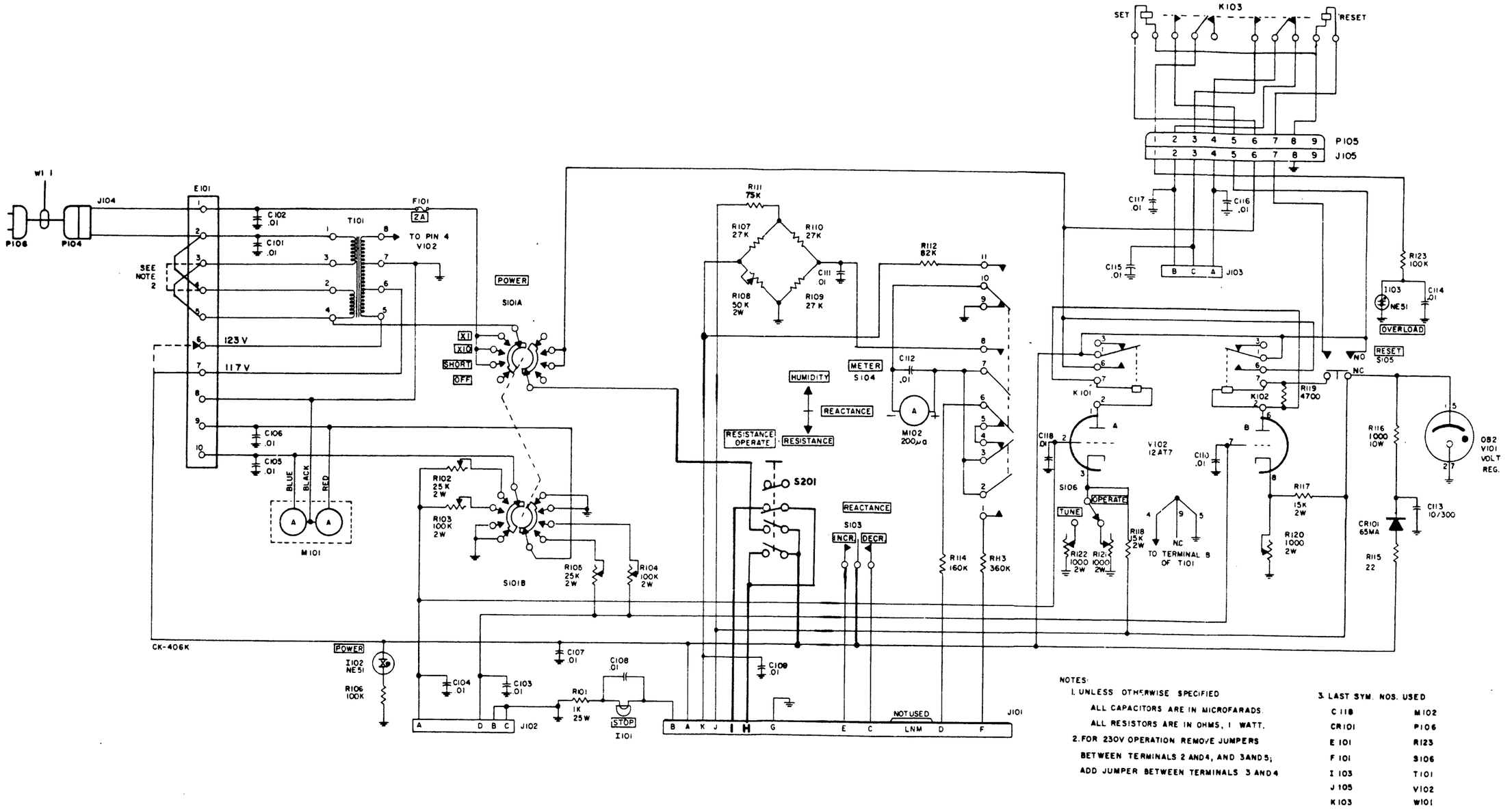
Figure 6-1. Directional Coupler, Schematic Diagram

SECTION 6

PARTS LIST & DIAGRAMS

6-1. INTRODUCTION

Reference designations have been assigned to identify all electrical parts of the equipment. These designations are used for marking the equipment (adjacent to the part they identify) and are included on drawings, diagrams and the parts list. The letters of a reference designation indicate the kind of part (generic group), such as resistor, capacitor, transistor, etc. The number differentiates between parts of the same generic group. Sockets associated with a particular plug-in device, such as transistor or fuse, are identified by a reference designation of the plug-in device. For example, the socket for fuse F101 is designated XF101. To expedite delivery, when ordering replacement parts, specify the TMC part number and the model number of the equipment.



NOTES:

1. UNLESS OTHERWISE SPECIFIED
   - ALL CAPACITORS ARE IN MICROFARADS.
   - ALL RESISTORS ARE IN OHMS, 1 WATT.
2. FOR 230V OPERATION REMOVE JUMPERS
   - BETWEEN TERMINALS 2 AND 4, AND 3 AND 5;
   - ADD JUMPER BETWEEN TERMINALS 3 AND 4

3. LAST SYM. NOS. USED

C 118	M102
CR101	P106
E 101	R123
F 101	S106
I 103	T101
J 105	V102
K 103	W101

Figure 6-2. Monitor Control, Schematic Diagram

S201 RESISTANCE POSITION	CENTER ARM(C) CONNECTED TO	CENTER ARM(C) CONNECTED TO	
	SECTION B & C	SECT. A	SECT. D
1	2 & 3	3	4
2	4 & 5	5	6
3	6 & 7	7	8
4	8 & 9	9	10
5	10 & 11	11	12
6	C & 1	1	2

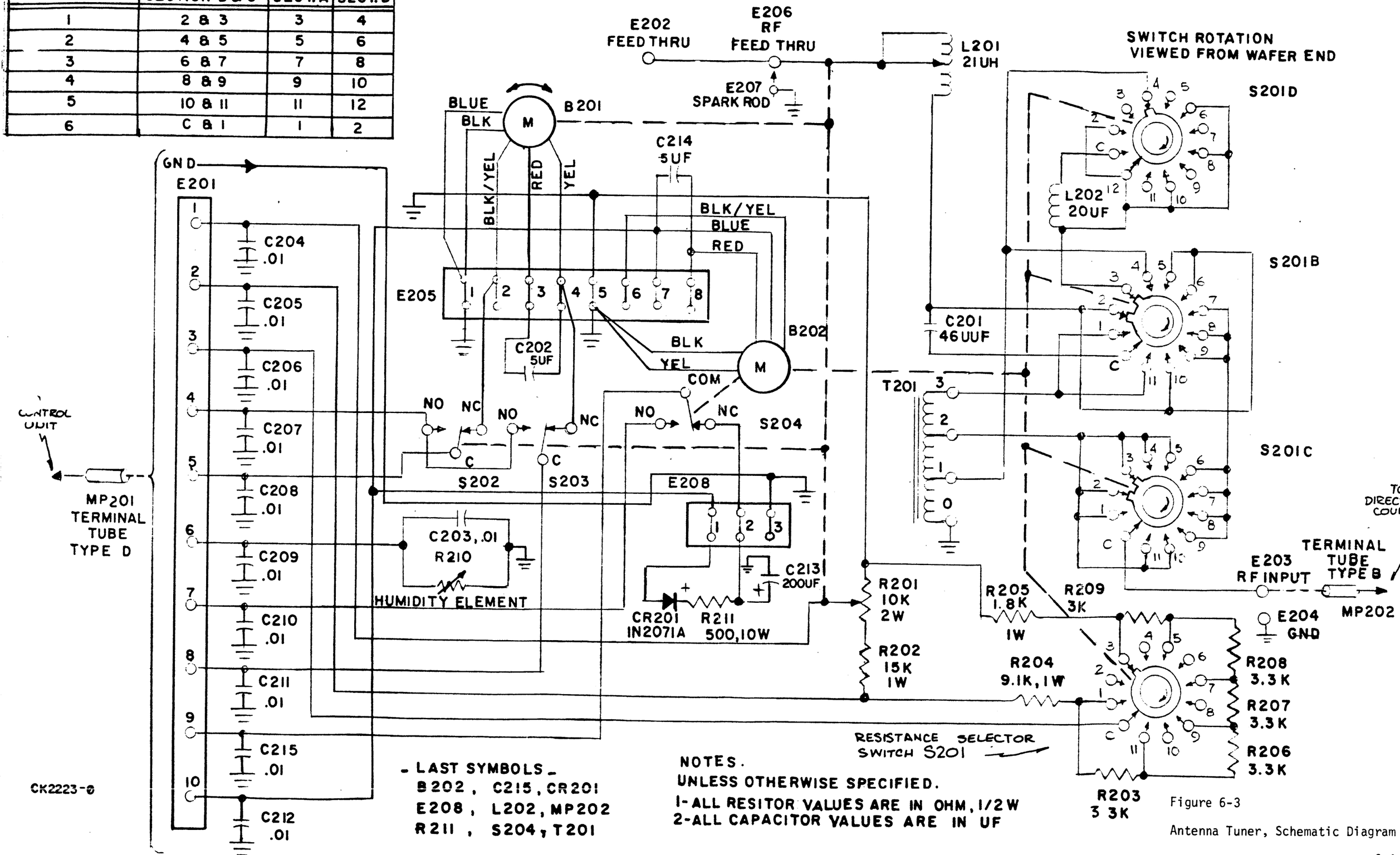


Figure 6-3

Antenna Tuner, Schematic Diagram

ATS-2B System Component Parts

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
	Antenna Tuning Unit	TU-2B
	Coupler Unit	CU-2B
	Monitor Control Unit	MCU-2A
P101	CONNECTOR, PLUG, ELECTRICAL: male.	MS3106A2027P
P102	CONNECTOR, PLUG, ELECTRICAL: female.	MS3106A14S2S
P103	CONNECTOR, PLUG, ELECTRICAL: female.	MS3106A14S1S
P301	CONNECTOR, PLUG, ELECTRICAL: RF	UG59B/U
P302	Same as P301.	
P303	CONNECTOR, PLUG, ELECTRICAL: male.	MS3106A14S2P
W101	For reference see Monitor Control Unit parts breakdown.	
W102	CABLE ASSEMBLY, ELECTIRICAL: #8 stranded wire, not to exceed 27" in length. (Shipped only on customer's request)	CA484
W103	CABLE ASSEMBLY, ELECTRICAL: 3-wire shielded, multi-conductor.	CA498
W104	CABLE ASSEMBLY, ELECTRICAL: 4-wire shielded, multi-conductor.	CA499
W105	CABLE ASSEMBLY, ELECTRICAL: 12-wire cable, 20 gauge approx. (Shipped only on customer's request. (Length as per customer request)	CA1865-XX

Monitor Control Components MCU-2A

Part Number	Description	Used On	Qty	Symbol Number
AR115	RLY, TRIP	MCU-2A	2	K103,P105
BI100-51	LAMP, GLOW	MCU-2A	2	I102,I103
BI101-47	LAMP, INCAND	MCU-2A	1	I101
CA555-4	CBL ASSY, PWR	MCU-2A	1	W101
CC100-16	CAP, FXD, CER	CA472	14	C103,C104,C105,C106, C108,C109,C110,C111, C112,C114,C115,C116, C117,C118
CE64C100N	CAP, FXD, ELECT	MCU-2A	1	C113
CM35F103F03	CAP, FXD, MICA	MCU-2A	3	C101,C102,C107
FH100-3	FUSEHOLDER	MCU-2A	1	XF101
FU100-2	FUSE, CTG	MCU-2A	1	F101
JJ175	CONN, RECP, ML	MCU-2A	1	J104
MR100-7	AMMETER	MCU-2A	1	M102
MR112	METER, SWR	MCU-2A	1	M101
MS3102A14S1P	CONN, RECP, ML	CA472	1	J103
MS3102A14S2P	CONN, RECP, ML	CA472	1	J102
PL176	CONN, PL, FML	CA555-4	1	P104
PL218	CONN, PL, ML, AC	CA555-4	1	P106
RC32GF104J	RES, FXD, COMP	A1683-4	2	R106,R123
RC32GF164J	RES, FXD, COMP	A1683-4	1	R114
RC32GF220J	RES, FXD, COMP	A1683-4	1	R115
RC32GF273J	RES, FXD, COMP	A1683-4	3	R107,R109,R110
RC32GF364J	RES, FXD, COMP	A1683-4	1	R113
RC32GF472J	RES, FXD, COMP	MCU-2A	1	R119
RC32GF753J	RES, FXD, COMP	A1683-4	1	R111
RC32GF823J	RES, FXD, COMP	A1683-4	1	R112
RC42GF153J	RES, FXD, COMP	A1683-4	2	R117,R118
RL120-5-502	REL, ARM-OCT	MCU-2A	2	K101,K102
RV4LAYSA102A	RES, VAR-COMP	MCU-2A	3	R120,R121,R122
RV4LAYSA104A	RES, VAR-COMP	MCU-2A	2	R103,R104
RV4LAYSA503A	RES, VAR-COMP	MCU-2A	1	R108
RW109-24	RES, FXD	MCU-2A	1	R116
RW111-20	RES, FXD	MCU-2A	1	R101
RX104	RECT, MTL-SE, HW	MCU-2A	1	CR101
ST22N	SW, TOGGLE-DPDT	MCU-2A	1	S106
SW186-2	SW, LEVER	MCU-2A	1	S103
SW208	SW, ROTARY	MCU-2A	1	S101A,B
SW214	SW, ROTARY	MCU-2A	1	S104
SW227R	SW, PUSH-2CKT	MCU-2A	1	S105
SW347	SW, PUSH-DPDT	MCU-2A	1	S102
TF0207	XFMR, PWR, SD/SU	MCU-2A	1	T101
TM100-10	TERM BD-BARR	MCU-2A	1	E101
TS101P01	SOC, EL TUBE	MCU-2A	2	XK101,XK102
TS102P01	SOC, EL TUBE	MCU-2A	1	XV101
TS102U03	SHLD, EL TUBE	MCU-2A	1	EV101
TS103P01	SOC, EL TUBE	MCU-2A	1	XV102
TS103U02	SHLD, EL TUBE	MCU-2A	1	EV102
TS106-1	LIGHT, IND-RED	MCU-2A	1	XI101
TS106-2	LIGHT, IND-WHT	MUC-2A	2	XI102,XI103
TS131MPW	SOC, EL TUBE	MCU-2A	1	J105
0B2	ELECTRON TUBE	MCU-2A	1	V101
12AT7	ELECTRON TUBE	MCU-2A	1	V102

Tuner Unit Component Parts (TU-2B)

Part Number	Description	Used On	Qty	Symbol Number
AC104	COIL, RF, FXD	TU-2B	1	L202
AC106	COIL, RF, TUN	TU-2B	1	L201
AS113	SW, RES, SEL	TU-2B	1	S201BCD
AS114	SW, METER	A1777	1	S201A
AX196	FEEDTHRU, ANT	TU-2B	1	E202
CC100-16	CAP, FXD	TU-2B	11	C203,C204,C205,C206, C207,C208,C209,C210, C211,C212,C215
CE134	CAP, FXD, ELECT	A5321	1	C213
C0105	CAP, FXD, AIR	TU-2B	1	C201
CP120-5-236SE	CAP, FXD, P	TU-2B	2	C202,C214
M0155	MOTOR, AC	TU-2B	2	B201,B202
NS118-3	INS, FDTHRU	TU-2B	1	E206
NS3W0308	INS, STANDOFF	TU-2B	1	E203
P0206-2	STUFFING TUBE	TU-2B	1	MP202
P0206-4	STUFFING TUBE	TU-2B	1	MP201
RW109-19	RES, FXD, COMP WW	TU-2B	1	R211
RC20GF302J	RES, FXD, COMP	A1777	1	R203
RC20GF332J	RES, FXD, COMP	A1777	4	R206,R207,R208,R209
RC32GF153J	RES, FXD, COMP	A1723-4	1	R202
RC32GF182J	RES, FXD, COMP	A1723-4	1	R205
RC32GF912J	RES, FXD, COMP	A1723-4	1	R204
RR128	RES, HDFY DCTOR	TU-2B	1	R210
RV105ATRL103A	RES, VAR, COMP	TU-2B	1	R201
SW189	SW, SENS-SPDT	TU-2B	2	S202,S203
SW260	SW, SENS-SPDT	TU-2B	1	S204
TM100-10	TERM BD-BARR	TU-2B	1	E201
TM102-3	TERM BD-BARR	TU-2B	1	E208
TM102-8	TERM BD-BARR	TU-2B	1	E205
TR151	XFMR, RF	TU-2B	1	T201
TS144	SOC, EL TUBE	TU-2B	1	XR210
IN2071A	SCOND DEV, DIO	TU-2B	1	CR201

Part Number	Description	Used On	Qty	Symbol Number
CB21PX152K	CAP, FXD, MICA	A5775	2	C307,C308
CK70AW102M	CAP, FXD, CER	A5774-2	2	C303,C306
CK70AW751M	CAP, FXD, CER	A5774-1,-2	2	C301,C304
CL140-1	COIL, RF, FXD	A5774-1,-2	2	L301,L303
CL254	COIL, RF, FXD	A5775	3	L302,L304,L305
CV102	CAP, VAR, GL	A5774-1,-2	2	C302,C305
MS3102A14S2S	CONN, RECP, FML	A5775	1	J303
RR122-0.6	RES, FXD, FILM	A5775	1	R301
UG560/U	CONN, RECP-HN	A5774-1,-2	2	J301,J302
IN485	SCOND DEV, DIO	A5774-1,-2	2	CR301,CR302

Directional Coupler Component Parts (CU-2B)