TRANS WORLD COMMUNICATIONS, INC.

RAT1000
AUTOMATIC ANTENNA TUNER
TECHNICAL MANUAL

Publication #990442

MARCH 1987

RAT1000 ERRATA

The following changes to the parts lists also apply to the component locations and schematic diagrams.

1. Page 7-17, Figure 7-8. Schematic Diagram, Tuner.
   ECN #038 - Change the pin designations of J5 on the Relay Drive Board for the pin numbers listed as shown:

Pin #	Description
7	DATA
8	CHK TUNE
9	CLOCK
10	STROBE

   Pin designations for PIN numbers 1 through 6 are correct as shown on the schematic.

2. Page 7-19, Table 7-7. Parts List, Mainframe.
   ECN #035 - For units with RAT1000 Memory Option installed:

   Change C75, C77 and C78 to Not Used.

   Add:

J6	610217	Connector, Plug 2 Pin

   Pin 2 of J6 is connected from the collector of Q24 on the Relay Driver Board to the emitter of Q24 on the Voltage Change Board.

3. Page 7-23, Figure 7-9. Mainframe Diagram.
   ECN #033 - The connector pin designations for J3 between the Processor Board and Tuner should be changed as follows:

Processor		J3 Tuner
Q12	(V CHG/DET)	9
Q24	(KEY)	5

MAY 5, 1987

*** WARNING ***

RAT1000 MEMORY OPTION - SOFTWARE

If the RAT1000 Memory Option is to be used in a system with either Transcall or Transcall/R, the correct version of Transcall software must be used or DAMAGE TO THE TUNER WILL RESULT. The software revision levels to be used with the RAT1000 Memory Option are:

Transcall: -77 or higher (used in the TW100 or RT100/MP transceivers)
Transcall/R: -79 or higher (used in the TW5201 or RT5201 remote controls)

When the channel is changed on the transceiver, it may take as much as 200 milliseconds for the relays in the tuner to settle to their new tuning positions. The original software for both Transcall configurations used a 50 ms delay before the onset of RF output following the channel change. This would have resulted in "hot switching" of the tuner relays, causing arcing and temporary mismatch.

The new software revisions will increase the delay to a value which will prevent "hot switching." Systems with either Transcall configuration which are shipped after 3-26-87 will already have the new software installed. If you are retrofitting a RAT1000 Memory tuner to your Transcall system, please indicate to us that you require the new version of software and it will be sent to you free of additional charge.

Note that this "hot switching" problem is not evident in the RAT100 Memory Option, as the switching time in that tuner is already less than 50 milliseconds. Also note that the new revisions are completely compatible with existing systems in every other way. The two existing revision levels are -40 and -55 for Transcall, and -39 and -78 for Transcall/R.

TABLE OF CONTENTS

SECTION 1 - GENERAL INFORMATION

SECTION 2 - ANTENNA TYPES

SECTION 3 - INSTALLATION

SECTION 4 - OPERATION

SECTION 5 - THEORY OF OPERATION

SECTION 6 - ALIGNMENT & TEST

SECTION 7 - TROUBLESHOOTING

SECTION 8 - AUTO-TUNE OR MEMORY OPTION

FIGURES

FIGURES (Continued)

TABLES

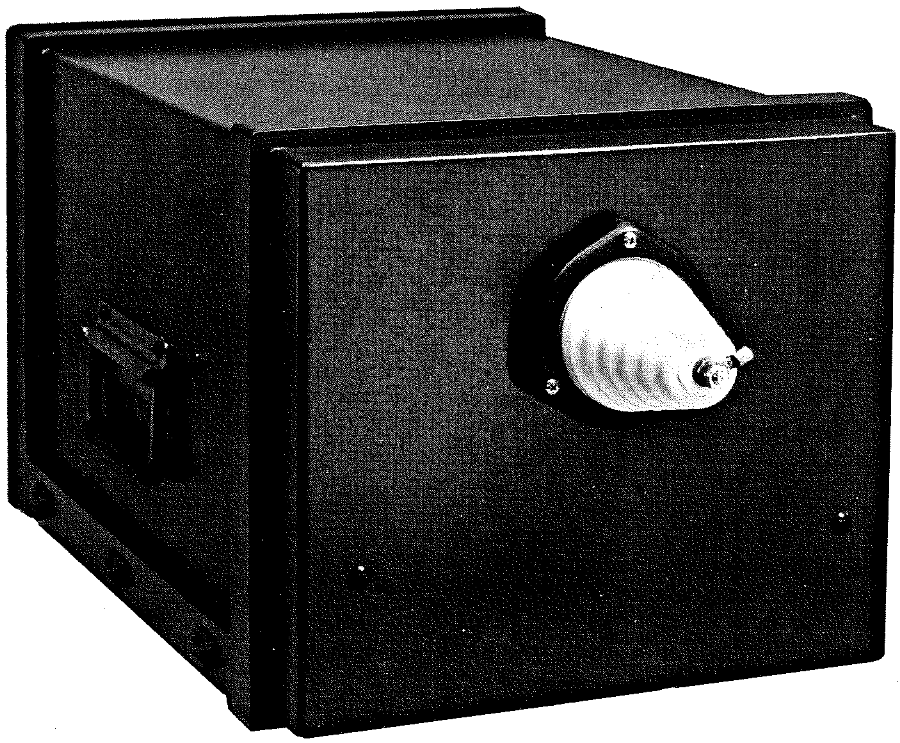


FIGURE 1-1. 1000W Automatic Antenna Tuner.

SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION
This manual contains the information required for the installation, operation, and maintenance of the Automatic Antenna Tuner. All pertinent installation instructions, operating procedures, schematic diagrams, parts lists and servicing data are included.

1.2 GENERAL DESCRIPTION
The Automatic Antenna Tuner is designed to automatically match the 50 ohm output of the transceiver into a variety of antennas for mobile and base station applications over the frequency range of 2-30MHz. All operation, including network tuning and VSWR monitoring, is fully automatic and microprocessor controlled. Tuning time is typically three seconds.

The Automatic Antenna Tuner is designed to provide tactical security by permitting remote location of the antenna up to 200 feet from the associated transceiver. Since a radiating antenna is always a potential target under combat conditions, the transceiver and operator can be protected at a safe distance from the antenna.

1.3 PHYSICAL DESCRIPTION
The Automatic Antenna Tuner is designed for continuous operation under the most severe environmental conditions.

It is contained in a rugged, waterproof, metal case which should be mounted as close as possible to the radiating part of the antenna.

1.4 ELECTRICAL DESCRIPTION
The Automatic Antenna Tuner has a reactance cancelling network consisting of 10 inductors in a binary coded sequence, two series capacitors and two parallel capacitors. Each inductor and capacitor is inserted into the network by a relay with the inductance variable from 1.0 microhenry to 64 microhenrys in 0.06 microhenry increments. Series capacitors of 25pF and 100pF and two parallel capacitors of 75pF and 200pF may be selected. The antenna is matched to the correct impedance by a broadband RF transformer providing 11 impedance steps from 3 ohms to 800 ohms.

Tuning is fully automatic. The tuner is connected to the transceiver by a 4-wire control cable (8-wire cable if the Memory option is installed). Supply voltage is 28Vdc and is normally supplied by the companion high power amplifier. Upon receipt of an INITIATE TUNE pulse from the transceiver, the tuning elements are all switched to a HOME position. The tuner generates a KEY signal which enables both the transmitter carrier output and the low-power ALC. At this time, an audio signal is also provided which indicates the transceiver is in the tune mode. When RF tune power is received, the tuner automatically matches the antenna to the best possible VSWR.

When tuning is completed, the coupler releases the KEY signal and turns off the tune tone at the transceiver; normal transmissions from the transmitter are then allowed.

1.5 TECHNICAL SPECIFICATIONS
Table 1-1 lists the technical specifications of the Automatic Antenna Tuner.

1.6 ANTENNA TUNING CHART
The following minimum antenna lengths should be used for whip antennas:

Frequency Range	Antenna Length
2-30MHz	32 ft.
3-30MHz	16 ft.

1.7 FSK OPERATION (CONTINUOUS TRANSMIT DUTY)
The following condition regarding ambient temperature must be observed when operating in the FSK mode:

SUN LOADING

The tuner is rated for operation to 55^{o}C ambient. This temperature can be exceeded if the case is exposed to direct sunlight. For FSK operation it is important that the tuner is installed so that the case is not exposed to direct sunlight.

TABLE 1-1. Technical Specifications.

Frequency Range:	2-30MHz
Tuning Capability:	
Whips	See Section 1.6
Long Wires	23-46M (75-150ft)
Rated RF Input Power:	1000W PEP and continuous
Tuning Mode:	Fully Automatic
Tuning Accuracy:	Typically greater than or equal to 1.5:1 VSWR referenced to 50 ohms; maximum VSWR of 3:1.
RF Efficiency:	Typically 50 to 90% depending on antenna type and frequency.
Tuning Time:	Typically 3 seconds.
RF Tune Power:	10W forward power throughout tuning cycle.
Primary Power Requirements (J7-I):	28Vdc @ 4.0A Peak, during tuning cycle, 1.8A when tuned.
Operating Environment:	Waterproof (sealed), designed for exposed installations.
Temperature Range:	-30°C to +55°C.
Weight:	22kg
Size:	34cm x 49cm x 29.7cm
RF Connections:	
Input	UG-21C type-N
Output	High voltage ceramic insulator
Ground Connection:	Ground Lug
Input Control Connector:	CA3102R12SA10S
Control Lines:	
ATU Initiate (J7-D):	Ground-going pulse from radio enables tune cycle.
Key (J7-A):	Ground from tuner during tune cycle.
Data (J7-E):	Memory Option Only.
Check Tune (J7-F):	Memory Option Only.
Clock (J7-G):	Memory Option Only.
Strobe (J7-H):	Memory Option Only.

SECTION 2
ANTENNA TYPES

2.1 GENERAL

The Automatic Antenna Tuner is designed primarily for use with end fed unbalanced antennas such as whips and long wires. The radiating portion of the antenna is connected directly to the tuner through a high voltage insulator.

Broad-band resonant antennas (e.g., log periodic) that cover the full range of the system may be used with the tuner if desired. Narrow-band resonant antennas, such as dipoles, may only be used if the antenna VSWR (including coaxial feeder) is less than or equal to 3:1 at the operating frequency. In both of these cases, connection to the tuner is made through the type-N input connector.

2.2 SELECTION

The Automatic Antenna Tuner will operate into almost any end fed antenna within the specified frequency range, provided an effective ground is used. The antenna efficiency will be proportional to length and in most applications will be maximum at a length of 1/4 wavelength. This means that the longest possible antenna should be selected for each installation. Very short antennas are only recommended where there is no other alternative such as in a vehicular mobile installation.

2.3 WHIP - 4.8M (16')

This antenna is recommended only for vehicular mobile installations and is able to be tuned only over the range specified in Section 1.6. The short length will result in poor performance compared with the longer antennas.

2.4 WHIP ANTENNA - 10.7M (35')

This is the preferred antenna for base station installation except when there is room for a long wire antenna. It will also provide reasonable efficiency for base station use and is the smallest recommended base antenna.

2.5 LONG WIRE ANTENNAS -23M (75') & 46M (150')

For most applications, the long wire antennas will give the best results and are recommended when practical. The diagrams at the end of this section show some recommended methods of installation. These are only a few of the many possible methods of installation and frequently a different configuration will be the best at a particular site.

2.6 TACTICAL WHIP ANTENNAS

The tuner will operate with the AT-1001/U Antenna. This antenna is made in sections four feet long. The minimum length is four sections. Always use the maximum number of sections practicable.

2.7 TYPICAL INSTALLATIONS

Figures 2-1 through 2-3 show some typical installations for the Automatic Antenna Tuner.

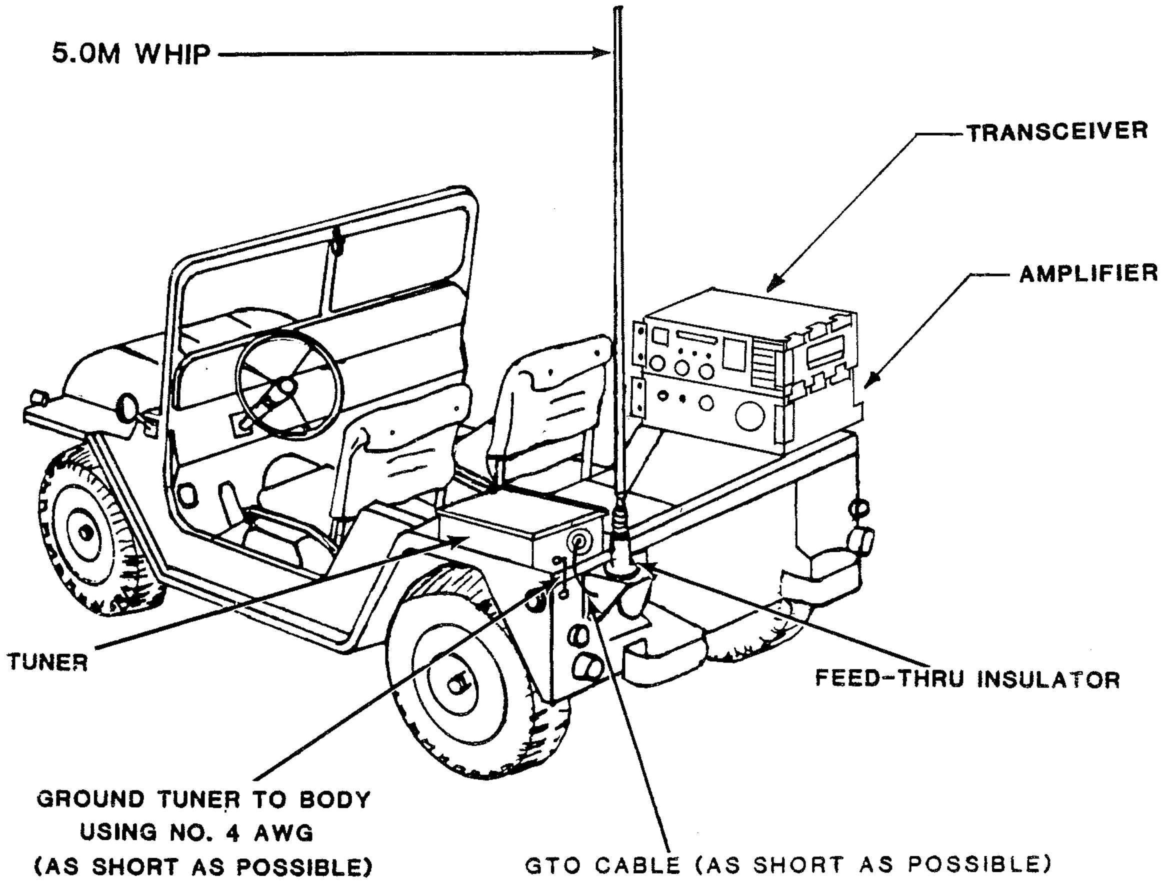


FIGURE 2-1. Jeep Installation, Whip.

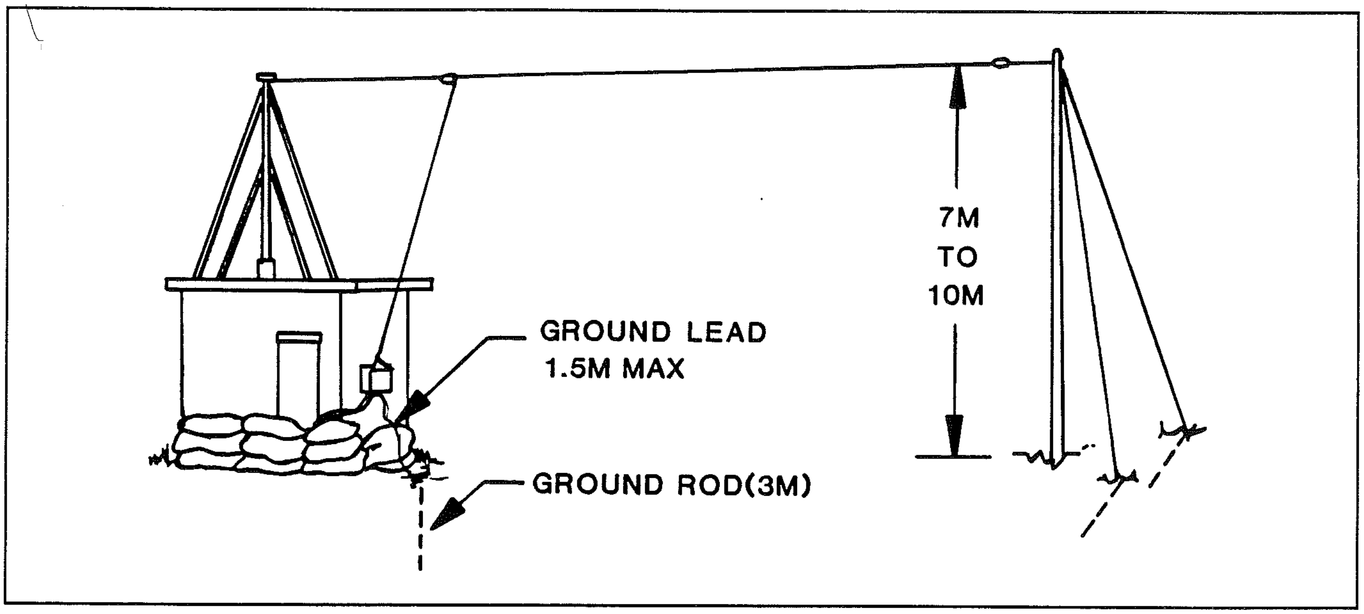


FIGURE 2-2. Base Station Installation, Horizontal.

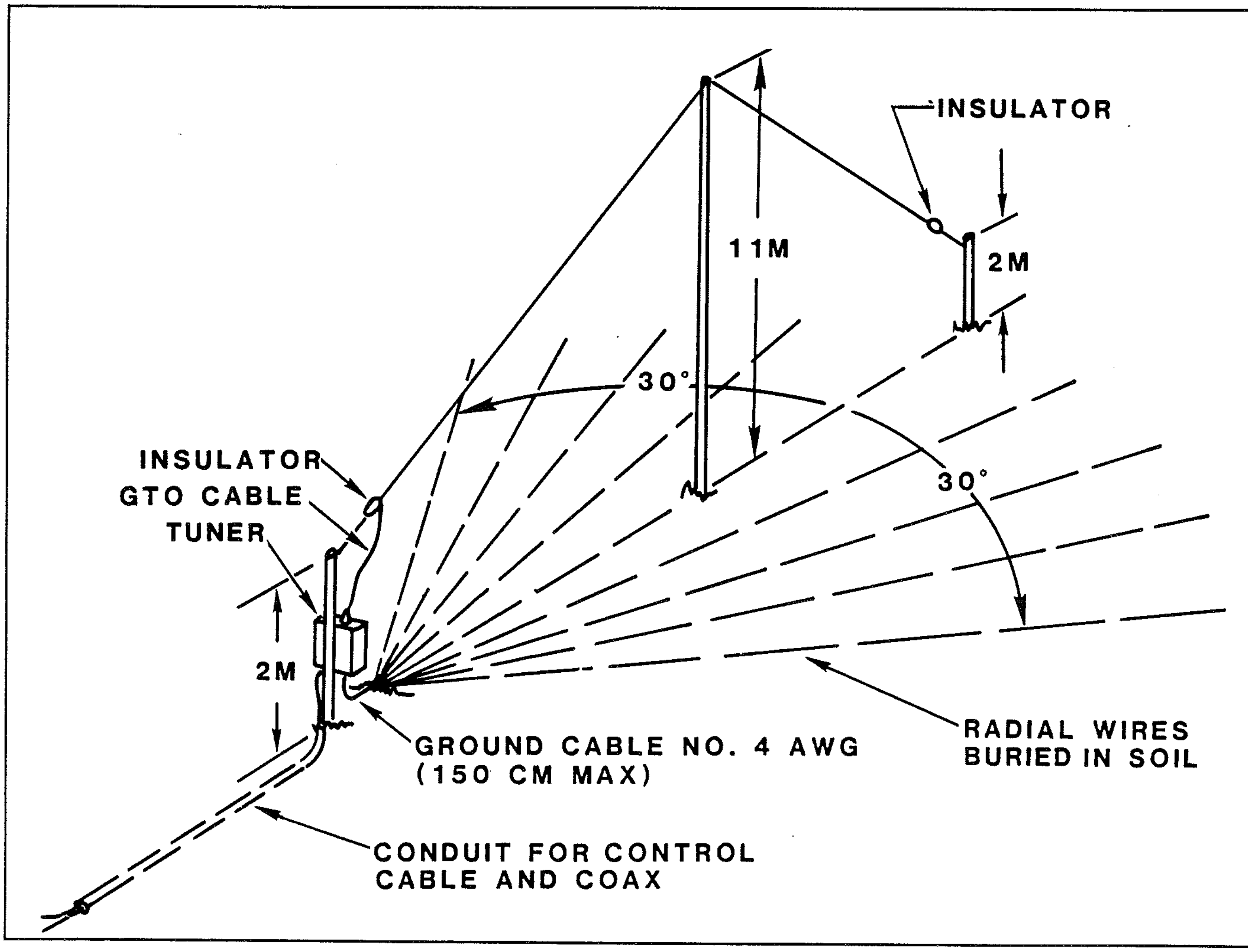


FIGURE 2-3. Base Station Installation, Inverted "VEE".

SECTION 3
INSTALLATION

3.1 GENERAL

System installation is a three part process covering the following steps:

a. Installing the antenna.
b. Mounting the antenna tuner.
c. Connecting the appropriate interface cables between the tuner and the transceiver.

This manual section will discuss the above-mentioned three steps in detail. This should provide sufficient information to enable the user to confidently install a complete system in the proper manner.

3.2 ANTENNA INSTALLATION

The antenna system is a key part of the communication system and for satisfactory operation the system must be installed correctly. The unbalanced antennas used with the Automatic Antenna Tuner use the ground as half of the antenna system. The ground forms an "image" antenna and is a critical part of the system. This makes it essential to consider both the ground and the antenna when designing the system.

3.2.1 ANTENNA LOCATION

The figures in Section 2 illustrate several different antenna installations. The following points should be carefully considered when designing the antenna system.

a. The antenna should be located in a position free of obstructions, particularly in the desired direction of communication.

b. The antenna should be kept as far away as possible from buildings, trees and vegetation. If metallic masts or supports are used, arrange the insulators so that the antenna is spaced at least 2m from the mast.

c. Remember that the radiating part of the antenna starts at the tuner, and therefore, the lead-in cable from the tuner to the antenna should be as short as possible.

d. Vertical antennas have an omni-directional radiation pattern and will provide equal performance in all directions.

e. Horizontal wire antennas have maximum radiation broadside to the antenna when the frequency is less than 1/4 wavelength. As the frequency increases beyond 1/4 wavelength, lobes will appear in the radiation pattern with the principal lobes becoming closer to the plane of the antenna as the length increases. At all times, radiation will be minimum at the end of the antenna and it should be located so that the ends point in directions where communications are not required.

f. The "VEE" construction minimizes the directivity of the horizontal antenna and is recommended for all around coverage. In addition, the "VEE" antenna is a compromise between vertical and horizontal polarization and will give good results for communications with land or marine mobiles using vertical whip antennas.

g. High voltages (sometimes exceeding 15000V) are present on the antenna. All parts of the antenna and tuner must be located or protected so that there is no possibility of accidental contact.

h. Do not locate the antenna close to other antenna systems.

i. Make sure that the antenna is rigidly supported. The antenna will detune if it sags or sways.

j. The connection from the tuner to the ground must be a small percentage of the total length of the antenna. Do not let the length of the ground strap exceed 1-1.5m. Use heavy gauge wire or strap for ground connection.

k. Whip antennas should be connected with the minimum length of wire. (Do not exceed 0.6m).

l. Do not locate the tuner further from the transceiver than necessary. If the distance exceeds 35m it is recommended that low loss coaxial cable is used.

3.2.2 GROUND SYSTEM

The ground system is a key part of the overall antenna system and is the primary cause of poor performance and difficulty of adjusting the tuner. There is no point in installing the antenna unless a good ground can be provided.

3.2.2.1 VEHICLE GROUNDS

Connect the tuner directly to the frame of the vehicle. Ensure that a heavy strap is used from the tuner ground lug and that the connections are cleared of all paint and dirt so that the shiny metal is exposed. Make sure that the grounding point is not insulated from other parts of the vehicle by non-metallic couplings, brushings, fiberglass panels, etc.

3.2.2.2 BASE STATION GROUNDS

In areas of high ground conductivity, an effective ground can be made through a grounding rod. The rod should be approximately 3m in length and should be installed as close as possible to the tuner. It may be necessary to use several ground rods bonded together to improve the ground contact. Water pipes are sometimes recommended as grounds and may be used provided the following conditions are met.

a. The water pipe is close to the tuner.
b. The water pipe enters the ground very close to the tuner bonding point.
c. There are no joints or couplings in the pipe that will increase the resistance path to ground.
d. The water pipe enters soil with good conductivity.
e. A low resistance contact is made to the water pipe.

Frequently the ground conductivity will not be sufficient to provide satisfactory operation of the tuner. This is almost certainly the case with well drained sandy, rocky or loamy soils, and a counterpoise must be used as the ground system. This is also very important in a roof-top installation where there is no existing ground plate. The ideal ground would be a conducting surface extending several wavelengths in all directions around the antenna. On a rooftop this situation may be approximated by placing a screen of chicken mesh or similar material over the roof of the building. More frequently, a counterpoise system of radial wires must be used. We recommend the use of at least 8-10 radials bonded together. If the antenna is at ground level, the radials should be buried a few inches below the surface.

3.2.2.3 CORROSION

The ground connections are subject to corrosion and oxidation. All joints must be clean and the hardware adequately tightened. The joints may be protected by an application of silicon grease and, under severe conditions, covered with electrical tape and waterproof varnish.

3.3 ANTENNA TUNER MOUNTING

The tuner is mounted using the proper mounting brackets on the case. Choose a location immediately adjacent to the antenna feed point. High voltage connecting cable must be used. (RG8U cable with solid insulation may be used if the outer shielding is removed).

3.3.1 ANTENNA CONNECTION

The antenna lead is connected to the high voltage insulator. Use two wrenches when tightening the nut to prevent the stud rotating. Potentials of several thousand volts may be present at the antenna terminal and adequate protection must be made against accidental contact. It is also necessary to ensure that the antenna is spaced at least 3cm from the conducting surface. Sharp points should be avoided to prevent corona discharges.

3.4 CABLE CONNECTIONS

The 1kW antenna tuner is designed to be interfaced with a transceiver and high power amplifier. The tuner can interface with most transceivers and amplifiers under special system considerations, however, this section will discuss connections between the TWC tuner and TWC transceivers and amplifiers.

3.4.1 RF COAXIAL CABLE TO TUNER

The RF connection between the high power amplifier and tuner should be made with a good grade of RG213/U type 50 ohm coaxial cable. The tuner end of the cable should be terminated with a UG-21C type N connector.

3.4.2 CONTROL CABLE TO TUNER

The tuner uses a 10 pin control connector on the end of the control cable. Standard pin connections are as follows:

PIN	DESCRIPTION
A	Key Keys the transceiver into transmit mode for low-level (10W) carrier tune power. An open-collector transistor is switched "on" during the tune cycle.
B	+28Vdc The tuner needs +28 volts at 4.0 amps peak. (DC voltage is supplied from the high-power amplifier -- amplifier can be

Ser No 103 Modified
+28V on B

PIN J	DESCRIPTION
	(cont'd) turned off and DC power still provided to Tuner from power supply).
C	Ground
D	Tune Initiate A momentary ground from the transceiver starts the tune cycle (the ground on this line comes from the ATU button on the transceiver.

3.4.3 SYSTEM INTERFACING

This section describes the standard system configurations using the RAT1000 with other Trans World equipments.

3.4.3.1 TW100/TW500A/RAT1000

The block diagram of this system is shown in Figure 3-1. All major equipments and interconnecting cables are illustrated. Special drawings for the cables are also presented which describe physical make-up and show connector pin number information.

1. C991536 -- See Figure 3-8.
2. C991539 -- See Figure 3-9.
3. C991551 -- See Figure 3-10.
4. C991552 -- See Figure 3-11.
5. C991526 -- See Figure 3-12.

NOTE

A special interface box is required to provide +28Vdc to the RAT1000; this box also takes control line data from the TW100 and routes it (together with the +28Vdc) to the RAT1000. The interface box must have: 1) Coupler Input Connector -- 613051, 2) Coupler Output Connector -- 613003, and 3) AC Power Cord.

3.4.3.2 TW100/TW1000A/RAT1000

The standard configuration has a TW100 with a +28Vdc option and power obtained from the TW1000A (Figure 3-2). Interconnecting cables are described in the following figures:

1. C991537 -- See Figure 3-13.
2. C991539 -- See Figure 3-9.
3. C991538 -- See Figure 3-14.
4. C991551 -- See Figure 3-10.
5. C991526 -- See Figure 3-12.
6. C991541 -- See Figure 3-15.

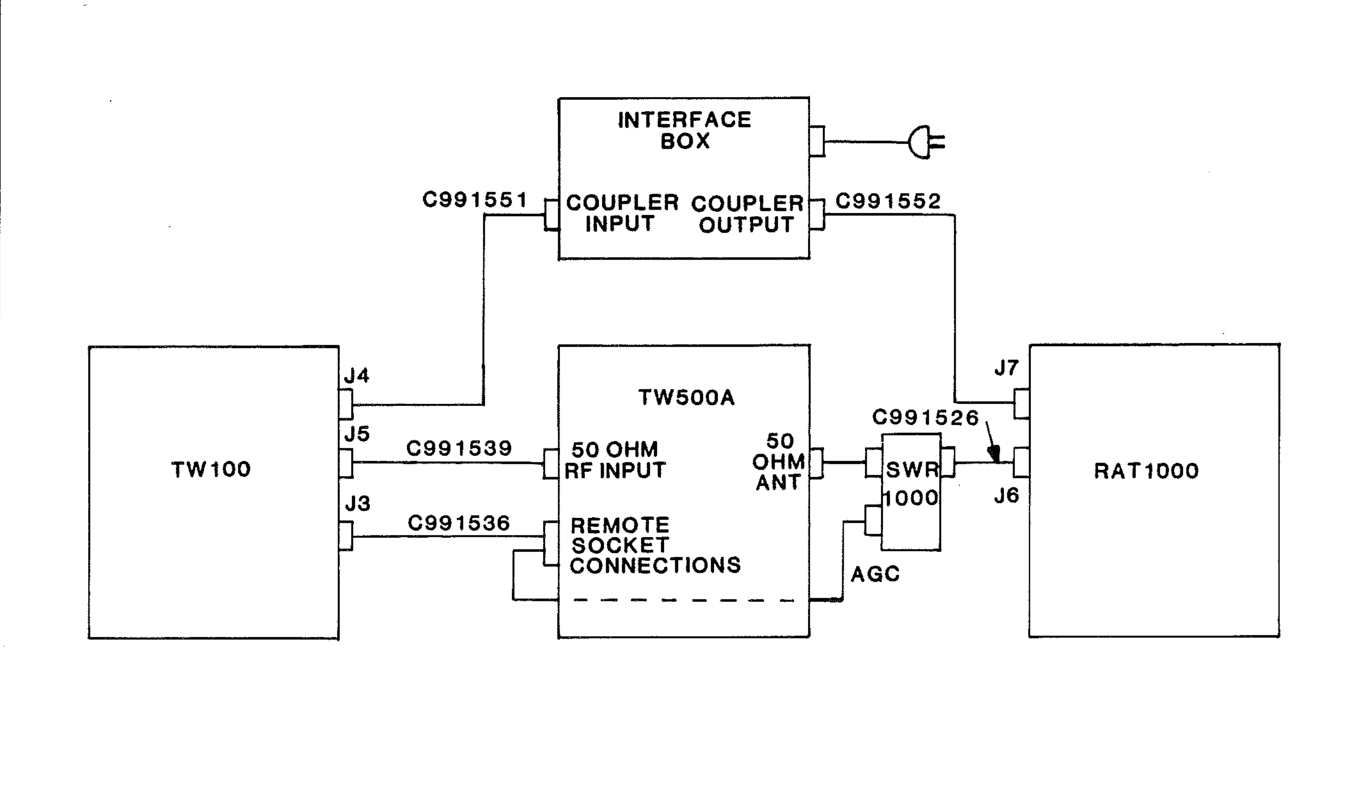


FIGURE 3-1. TW100/TW500A/RAT1000 Block Diagram.

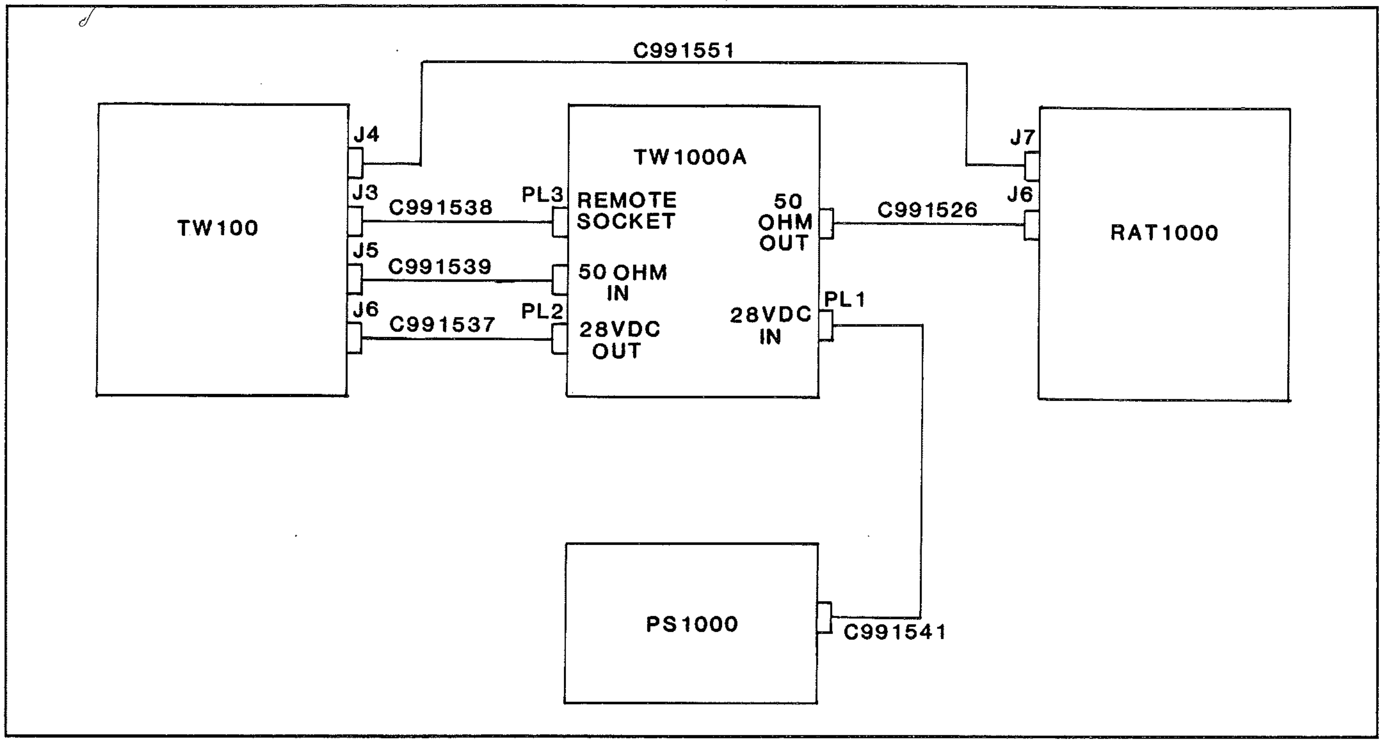


FIGURE 3-2. TW100/TW1000A/RAT1000 Configuration.

NOTE

A jumper must be connected inside the TW100 transceiver from J4-9 to the radio side of the fuse block; this connects +28Vdc to the C991551 cable to provide primary power to the RAT1000.

Figure 3-3 shows the configuration used when the TW100 is a +12Vdc version. In this case, two new connectors must be added to the TW1000A and internally wired as follows:

Interconnecting cables are shown in the following figures:

1. C991539 -- See Figure 3-9.
2. C991538 -- See Figure 3-14.
3. C991551 -- See Figure 3-10.
4. C991552 -- See Figure 3-11.
5. C991526 -- See Figure 3-12.
6. C991541 -- See Figure 3-15.

3.4.3.3 TW100/TW1000/RAT1000

This is the same configuration as described in Section 3.4.3.2 covering the TW1000A with this one exception: The TW1000 has an internal AC power supply. Therefore, cable C991541 is not used since the TW1000 is powered by the AC mains. All other cables are the same as in Section 3.4.3.2. See Figure 3-4.

Figure 3-5 shows the configuration used when the TW100 is a +12Vdc version. The TW1000 must be modified as described in Section 3.4.3.2. Cables are the same as used in Section 3.4.3.2, except that C991541 is not used.

3.4.3.4 RT100/RA400/RAT1000

Standard configuration has an RT100/MP with +28Vdc option and power obtained from the RA400. See Figure 3-6.

NOTE

A +12Vdc RT100/MP can also be used. In this case, cable C991511 is not used and the RT100/MP must obtain primary power from another source.

Cables used are as follows:

1. C991511 -- See Figure 3-16.
2. C991509 -- See Figure 3-17.
3. C991552 -- See Figure 3-11.
4. C991510 -- See Figure 3-18.
5. C991505 -- See Figure 3-19.

3.4.3.5 RT100/RA1000/RAT1000

The standard configuration has an RT100/MP with +28Vdc option and power received from the RA1000. See Figure 3-7.

1. To provide +28Vdc to the RAT1000, a jumper must be connected inside the RT100/MP from J3-6 to J1-I.

2. A +12Vdc RT100/MP can also be used. In this case, C991511 is not used and the RT100/MP must obtain primary power from another source.

3. A jumper must be added inside the RA1000 between J3-G and the unswitched +28Vdc input.

4. Interconnecting cables are the same as used in Section 3.4.3.4, except that C991508 (See Figure 3-20) must be used between the UPS1000 power supply and the RA1000 amplifier.

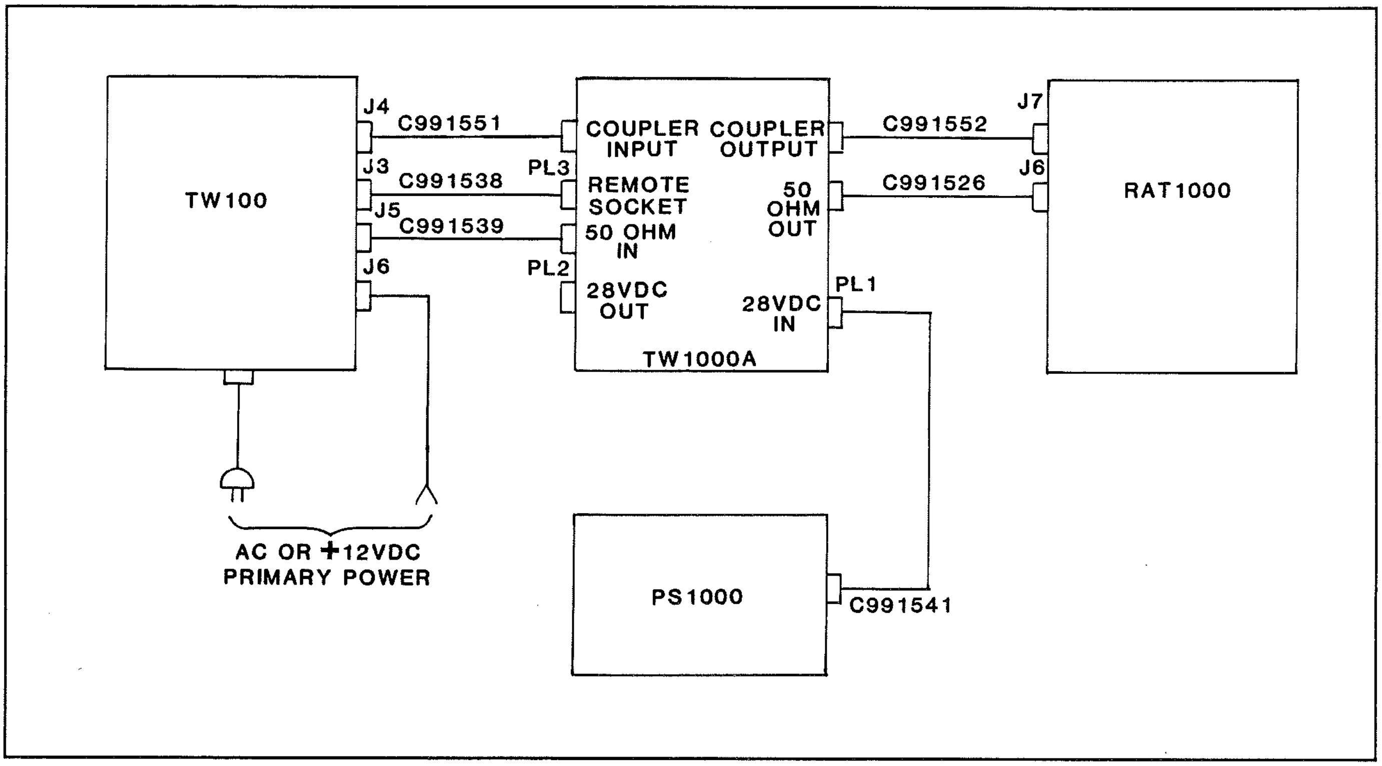


FIGURE 3-3. TW100/TW1000A/RAT1000 Configuration (12V version).

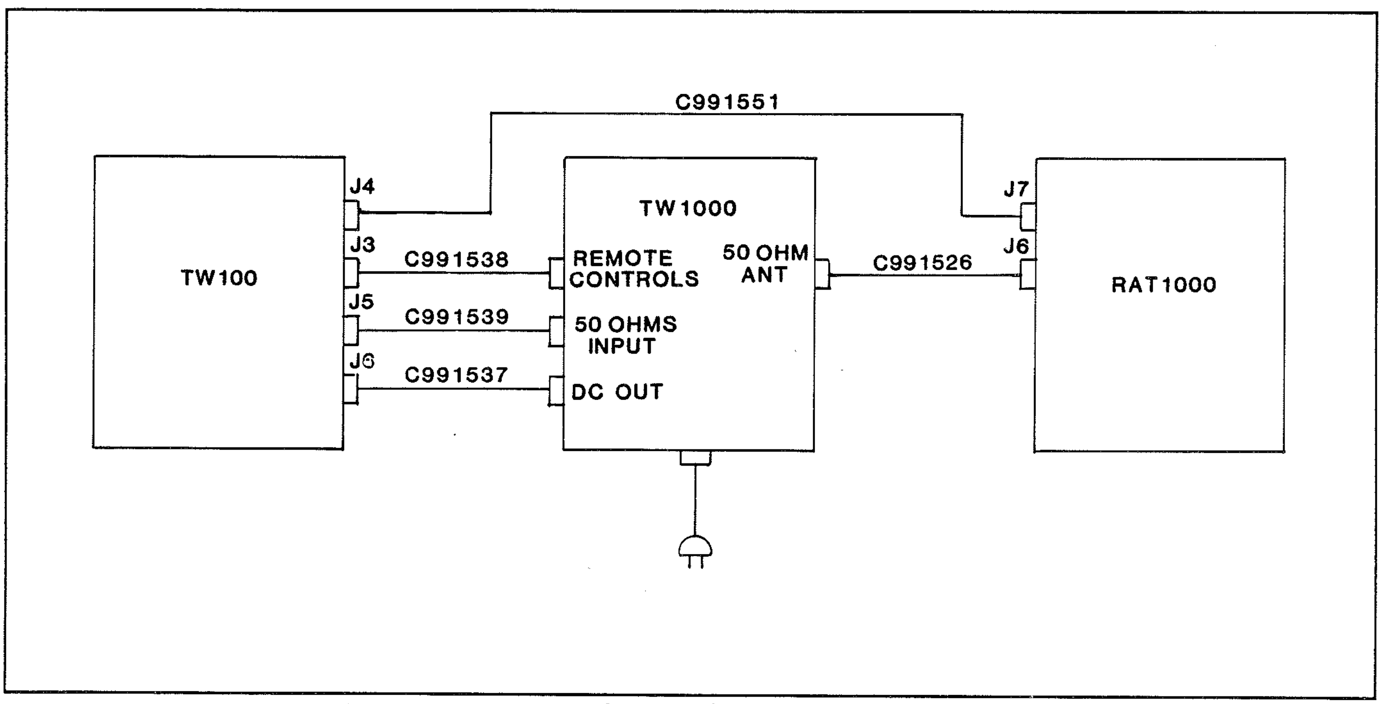


FIGURE 3-4. TW100/TW1000/RAT1000 Configuration.

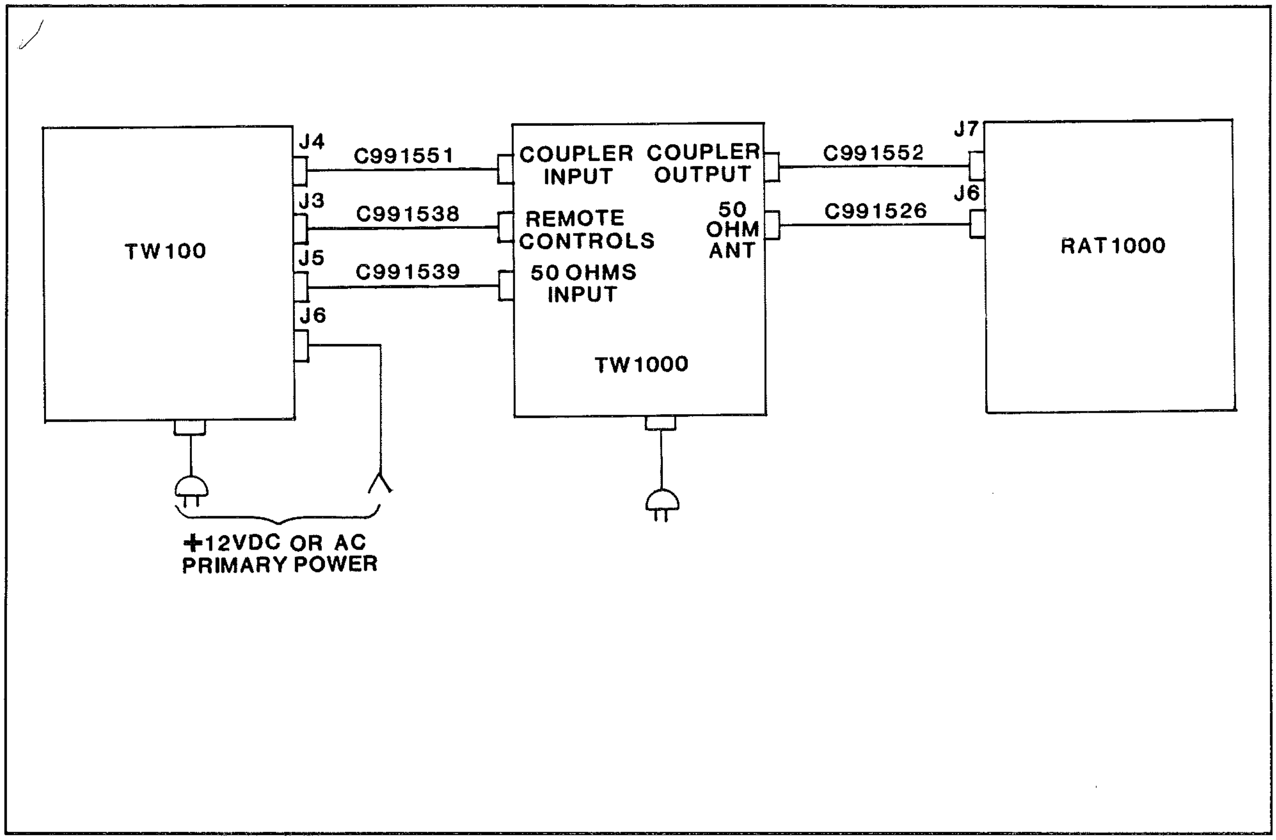


FIGURE 3-5. TW100/TW1000/RAT1000 Configuration (12V version).

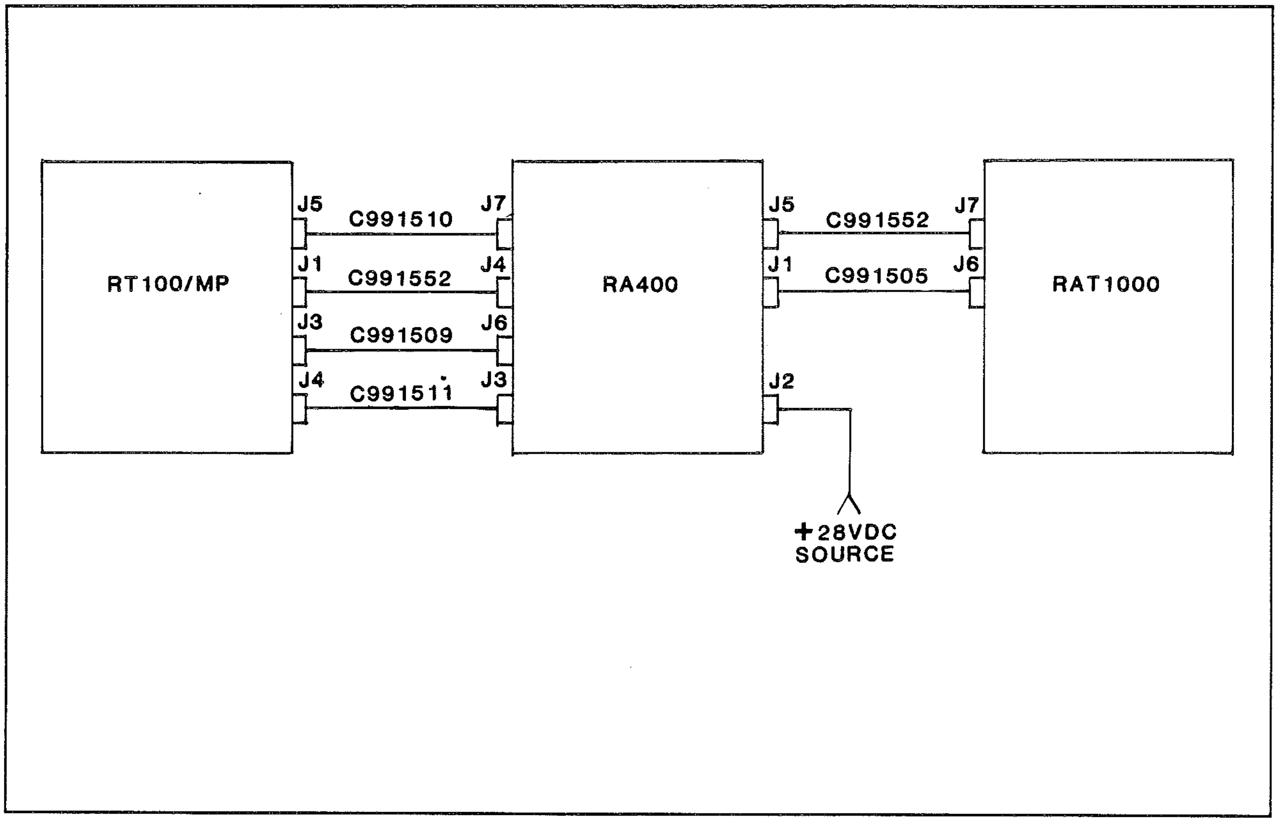


FIGURE 3-6. RT100/RA400/RAT1000 Configuration.

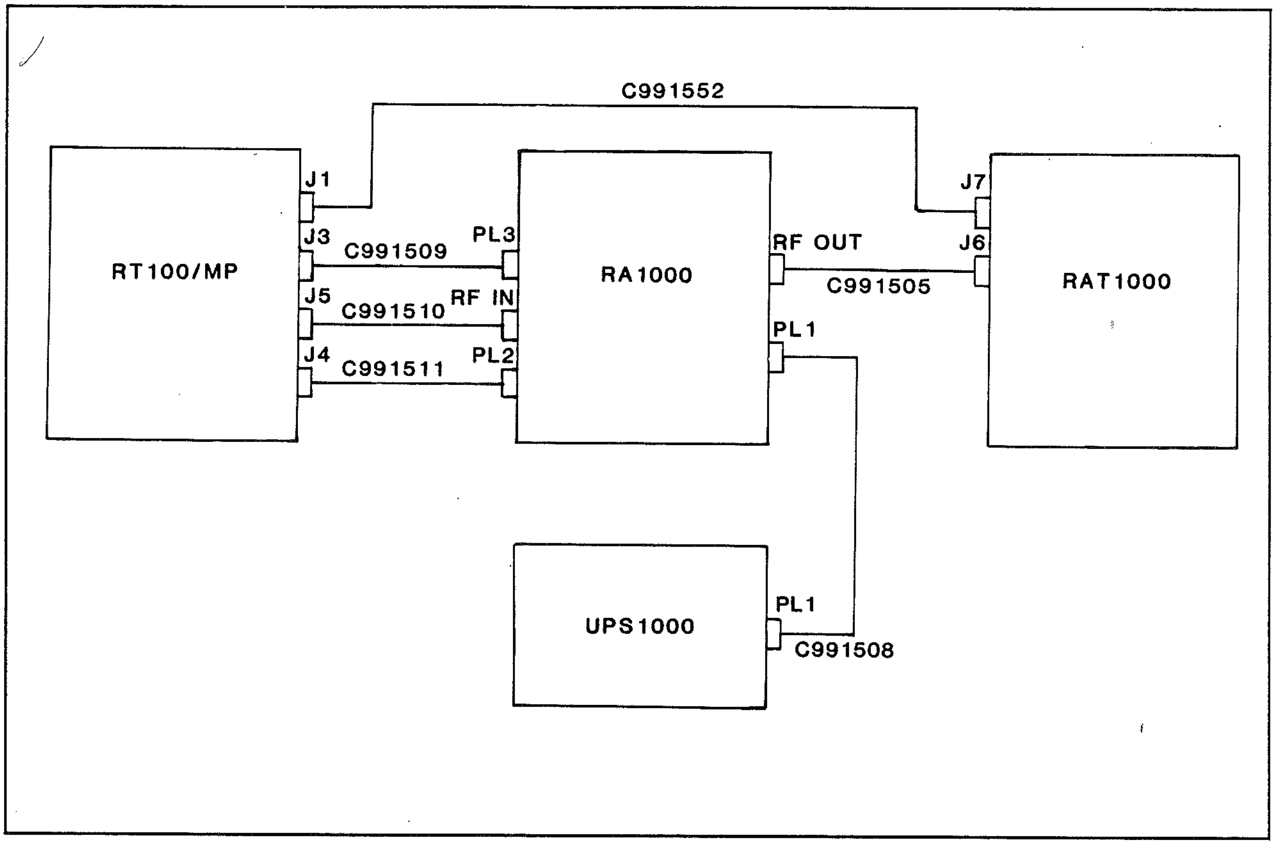
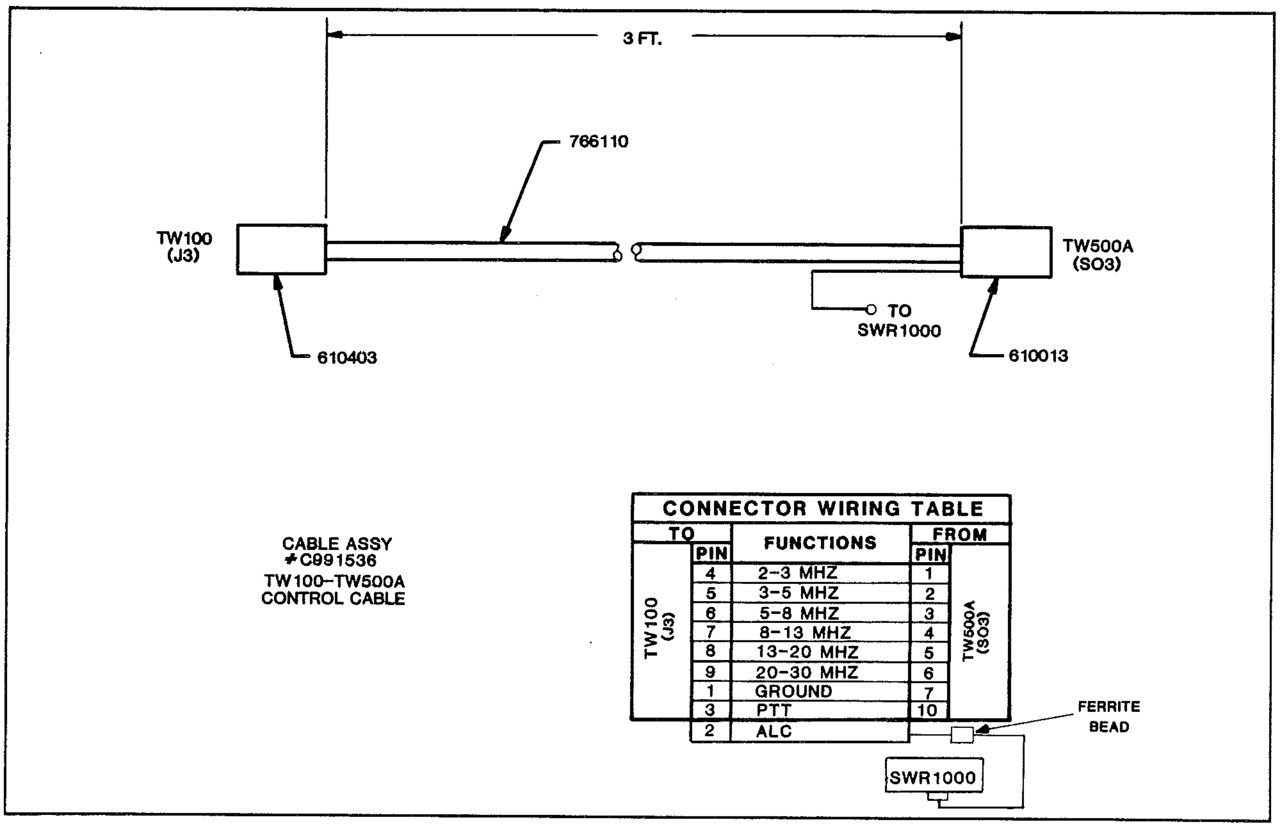


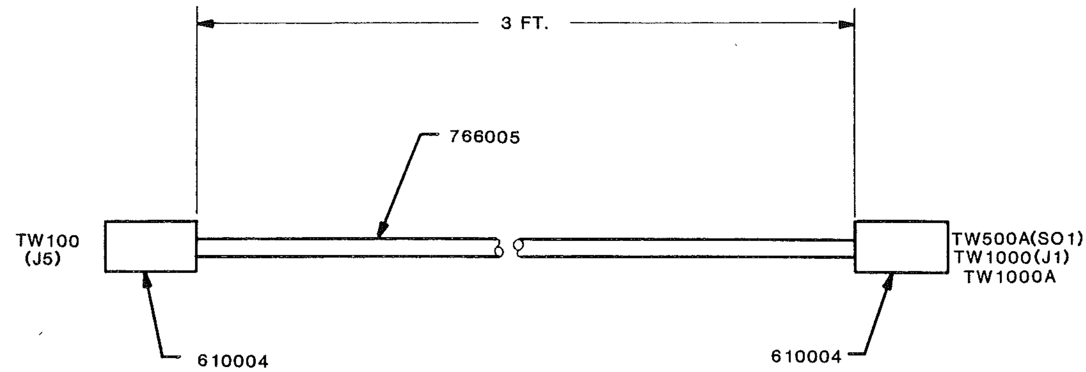
FIGURE 3-7. RT100/RA1000/RAT1000 Configuration.



CONNECTOR WIRING TABLE

TO TW100 (J3) PIN	FUNCTIONS	FROM TW500A (SO3) PIN
4	2-3 MHZ	1
5	3-5 MHZ	2
6	5-8 MHZ	3
7	8-13 MHZ	4
8	13-20 MHZ	5
9	20-30 MHZ	6
1	GROUND	7
3	PTT	10
2	ALC	

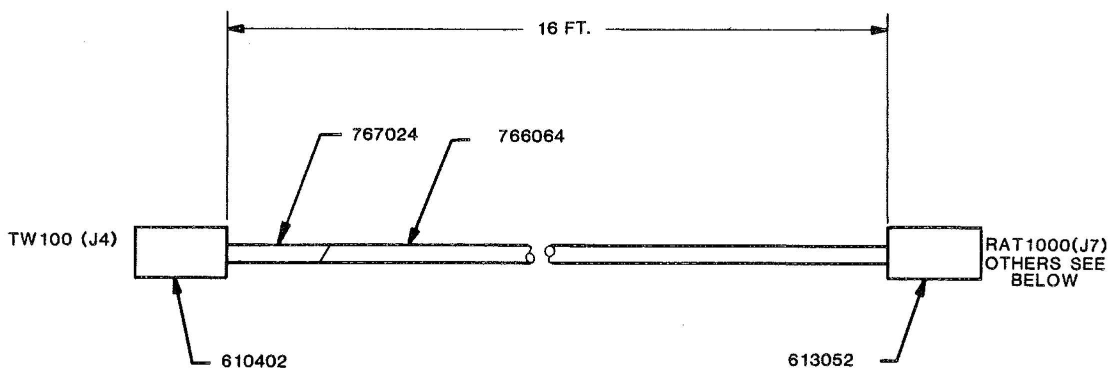
FIGURE 3-8. Control Cable (C991536).



CABLE ASSY
C991539
TW100 - TW500A
TW100 - TW1000
TW100 - TW1000A
RF CABLE

CONNECTOR WIRING TABLE				
TO		FUNCTIONS	FROM	
	PIN		PIN	
TW100 (J5)		RF CABLE		TW500A (SO1) TW1000 (J1) TW1000A

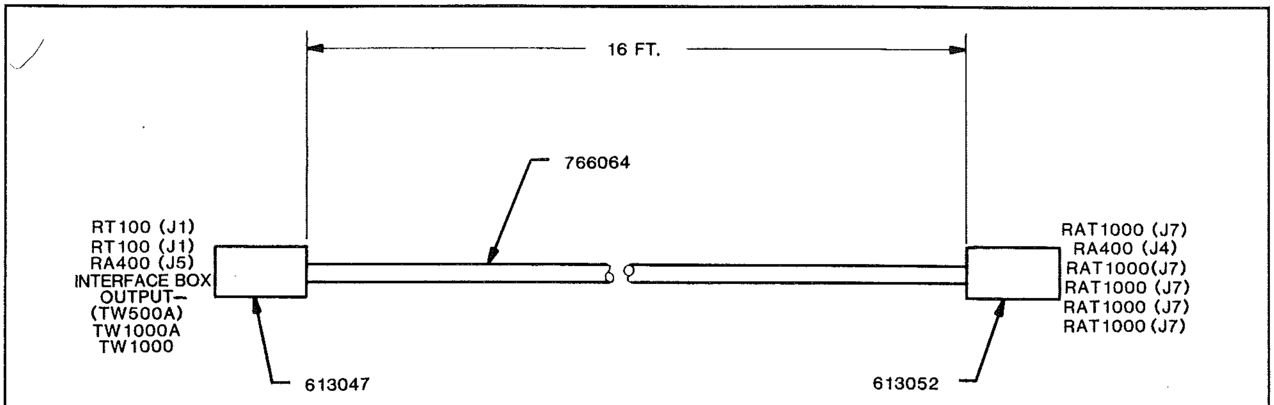
FIGURE 3-9. RF Cable (C991539).



CABLE ASSY
C991551
TW100 - RAT1000
TW100 - RA400
TW100 - TW1000A
TW100 - TW1000
TW100 - TW500A
TW100 - INTERFACE BOX
MEMORY OPTION CABLE

CONNECTOR WIRING TABLE				
TO		FUNCTIONS	FROM	
	PIN		PIN	
TW100 (J4)	4	KEY	A	RAT1000(J7) RA400(J4) TW1000A(COUPLER INPUT) TW1000(COUPLER INPUT) TW500A (I/O BOX INPUT) INTERFACE BOX INPUT
	1	GROUND	C	
	5	TUNE INITIATE	D	
	7	DATA	E	
	8	CHK TUNE	F	
	6	CLOCK	G	
	3	STROBE	H	
	9	+28VDC	J	

FIGURE 3-10. Memory Option Cable (C991551).

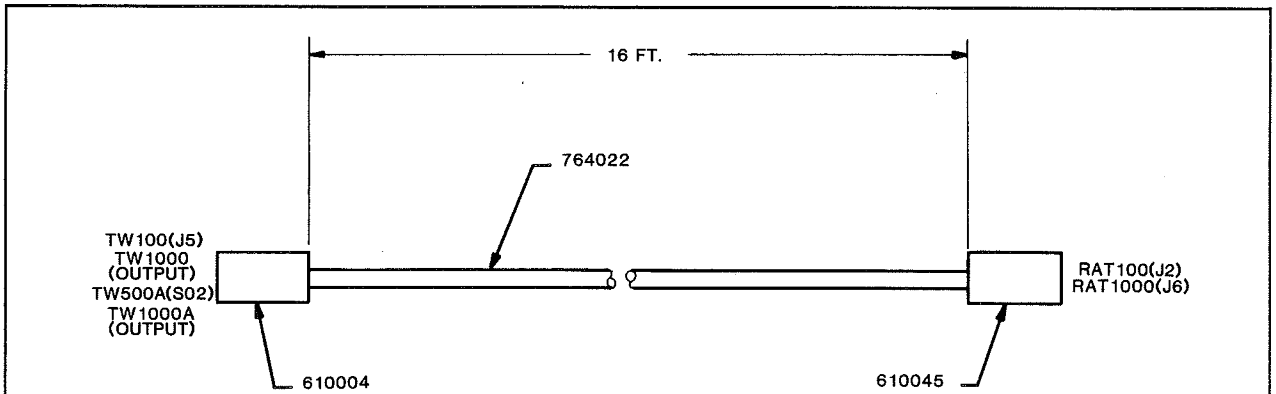


CABLE ASSY
C991552
RT100 – RAT1000
RT100 – RA400
RA400 – RAT1000
INTERFACE BOX
(TW500A) – RAT1000
TW1000A – RAT1000
TW1000 – RAT1000
CONTROL CABLE

CONNECTOR WIRING TABLE

TO	PIN	FUNCTIONS	PIN	FROM
RT100 (J1),RA400 (J5) INTERFACE BOX OUTPUT (TW500A) TW1000A & TW1000	A	KEY	A	RAT1000 (J7) RA400 (J4)
	B	12V	B	
	C	GROUND	C	
	D	TUNE	D	
	E	DATA	E	
	F	CHK TUNE	F	
	G	CLOCK	G	
	H	STROBE	H	
	J	+ 28VDC	J	
	K	SPARE	K	

FIGURE 3-11. Control Cable (C991552).

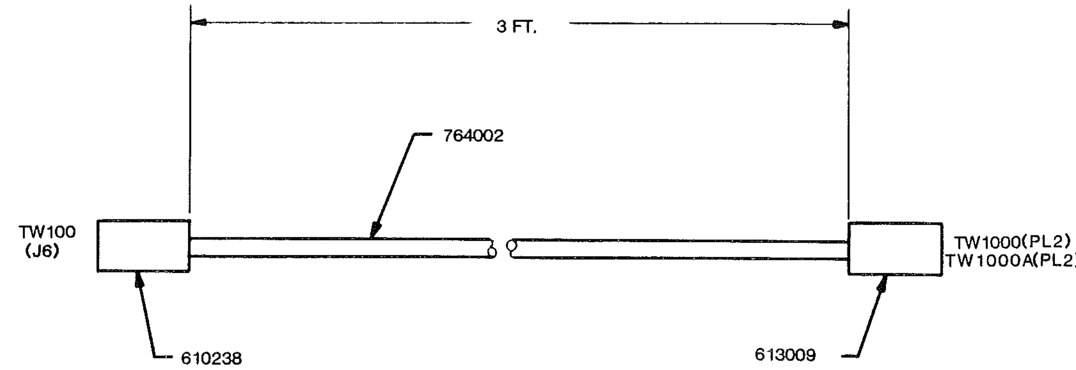


CABLE ASSY
C991526
TW100 – RAT100
TW1000 – RAT1000
TW500A – RAT1000
TW1000A – RAT1000
RF CABLE

CONNECTOR WIRING TABLE

TO	PIN	FUNCTIONS	PIN	FROM
TW100(J5) TW1000(OUTPUT) TW500A(S02) TW1000A(OUTPUT)		RF CABLE		RAT100 (J2) RAT1000 (J6)

FIGURE 3-12. RF Cable (C991526).

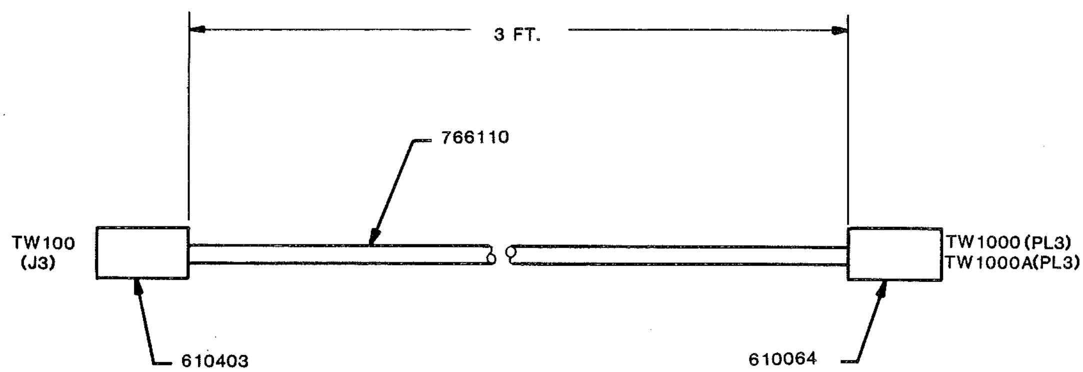


CABLE ASSY
C991537
TW100 - TW1000
TW100 - TW1000A
POWER CABLE

CONNECTOR WIRING TABLE

TO	PIN	FUNCTIONS	PIN	FROM
TW100 (J6)	A	+28 VDC	A	TW1000 (PL2) TW1000A (PL2)
	B	GROUND	B	

FIGURE 3-13. Power Cable (C991537).

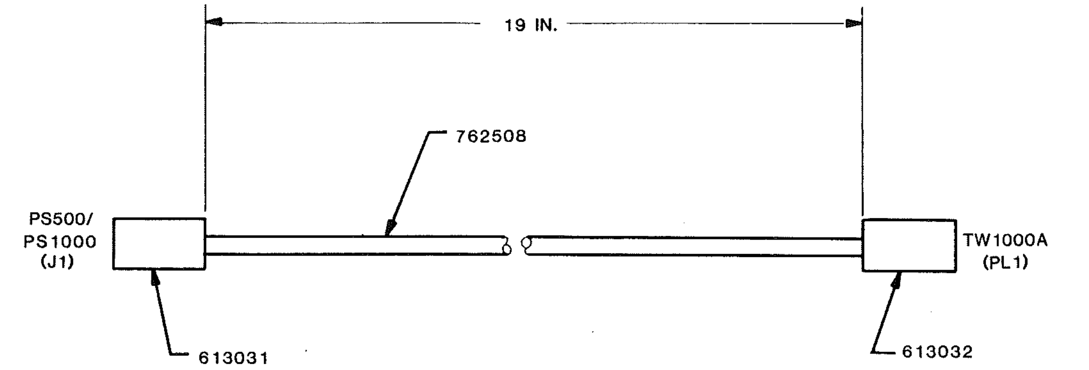


CABLE ASSY
#C991538
TW100 - TW1000
TW100 -TW1000A
CONTROL CABLE

CONNECTOR WIRING TABLE

TO	PIN	FUNCTIONS	PIN	FROM
TW100 (J3)	4	2-3 MHZ	A	TW1000 (PL3) TW1000A (PL3)
	5	3-5 MHZ	B	
	6	5-8 MHZ	C	
	7	8-13 MHZ	D	
	8	13-20 MHZ	E	
	9	20-30 MHZ	F	
	2	AMP ALC	I	
	1	GROUND	J	
	3	PTT	H	

FIGURE 3-14. Control Cable (C991538).

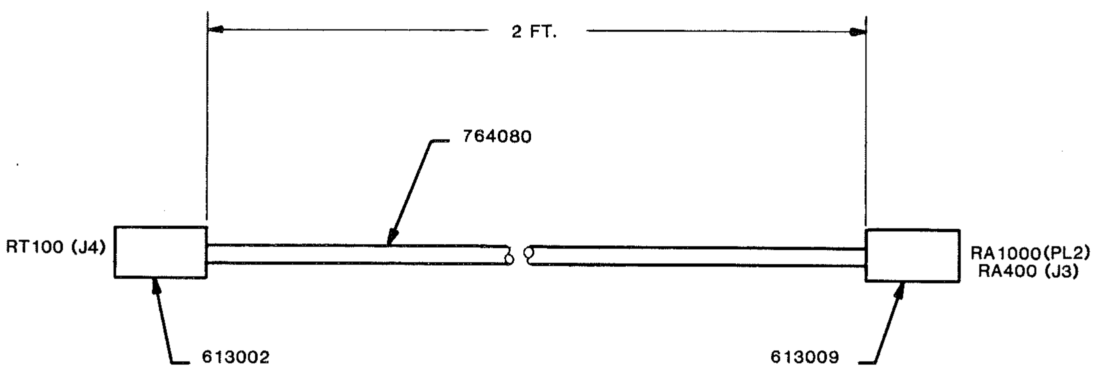


CABLE ASSY
#C991541
PS500/
PS1000-TW1000A
POWER CABLE

CONNECTOR WIRING TABLE

TO	PIN	FUNCTIONS	PIN	FROM
PS500/ PS1000 (J1)	A	+28VDC	A	TW1000A (PL1)
	B	GROUND	B	
	C	GROUND	C	
	D	+28 VDC	D	

FIGURE 3-15. Power Cable (C991541).

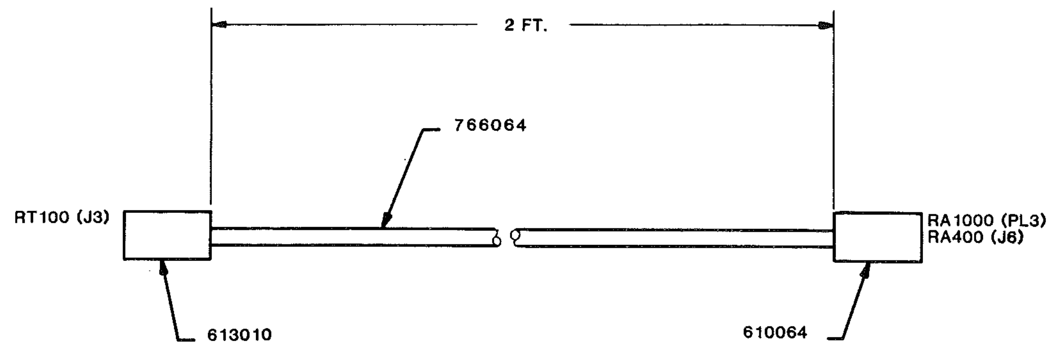


CABLE ASSY
C991511
RT100 - RA1000
RT100 - RA400
POWER CABLE

CONNECTOR WIRING TABLE

TO	PIN	FUNCTIONS	PIN	FROM
RT100 (J4)	A	+ 28 VDC	A	RA1000 (PL2) RA400 (J3)
	B	GROUND	B	

FIGURE 3-16. Power Cable (C991511).

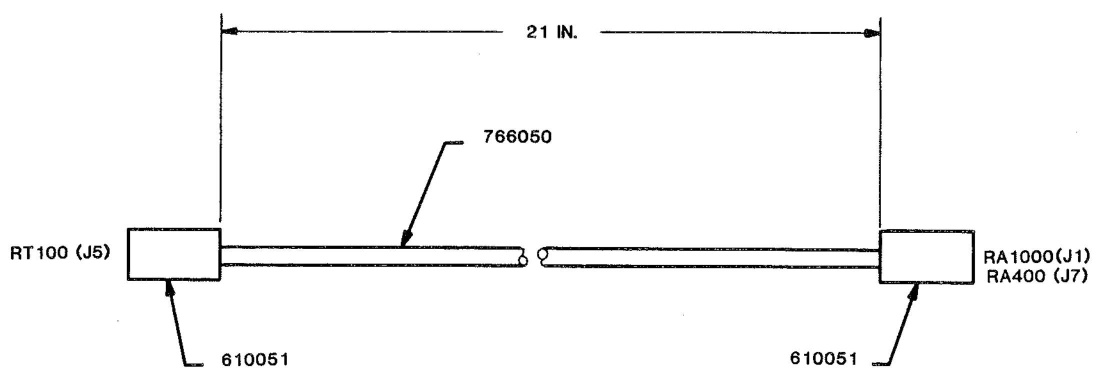


CABLE ASSY
C991509
RT100 - RA1000
RT100 - RA400
CONTROL CABLE

CONNECTOR WIRING TABLE

TO	PIN	FUNCTIONS	PIN	FROM
RT100 (J3)	A	2-3 MHZ	A	RA1000 (PL3) RA400(J6)
	B	3-5 MHZ	B	
	C	5-8 MHZ	C	
	D	8-13 MHZ	D	
	E	13-20 MHZ	E	
	F	20-30 MHZ	F	
	H	AMP PTT	H	
	I	AMP ALC	I	
	J	GROUND	J	
	G	+28VDC	G	

FIGURE 3-17. Control Cable (C991509).

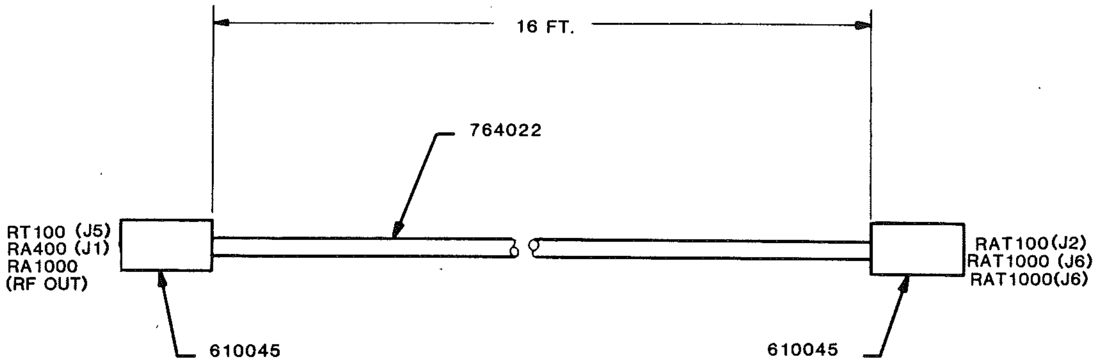


CABLE ASSY
C991510
RT100 - RA1000
RT100 - RA400
RF CABLE

CONNECTOR WIRING TABLE

TO	PIN	FUNCTIONS	PIN	FROM
RT100 (J5)		RF CABLE		RA1000 (J1) RA400 (J7)

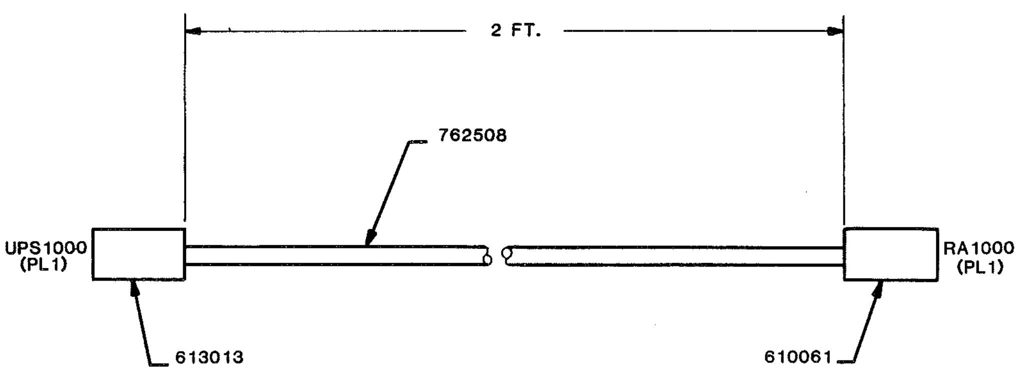
FIGURE 3-18. RF Cable (C991510).



CABLE ASSY
#C991505
RT100 - RAT100
RA400 - RAT1000
RA1000 - RAT1000
RF CABLE

CONNECTOR WIRING TABLE				
TO		FUNCTIONS	FROM	
	PIN		PIN	
RT100 (J5) RA400 (J1) RA1000 (RF OUT)		RF CABLE		RAT100 (J2) RAT1000 (J6)

FIGURE 3-19. RF Cable (C991505).



CABLE ASSY
#C991508
UPS1000-RA1000
POWER CABLE

CONNECTOR WIRING TABLE				
TO		FUNCTIONS	FROM	
	PIN		PIN	
UPS1000 (PL1)	A	+28VDC	A	RA1000 (PL1)
	B	GROUND	B	
	C	GROUND	C	
	D	+28VDC	D	

FIGURE 3-20. Power Cable (C991508).

SECTION 4
OPERATION

4.1 GENERAL

The Automatic Antenna Tuner is designed to operate with either the TW100 or RT100/MP series of transceivers, and companion high power amplifiers. After installing the antenna and the tuner, it is only necessary to connect the tuner to the system using the multi-wire Control Cable and RF coaxial cable described in Section 3.4

4.2 OPERATION WITH RT100/MP OR TW100 TRANSCEIVERS

The following procedure should be followed when operating the tuner with the RT100/MP or TW100 transceivers.

1. Select the operating mode of the RT100/MP or TW100, i.e., LSB, USB, AM or FSK.

2. Turn on the power using the Front Panel switch. Note that there are no operator controls on the tuner.

3. Select the operating frequency or channel.

4. Press and then release the "ATU Initiate" button on the front panel.

After the ATU INITIATE button is pressed, the TUNING TONE should come on indicating that a tune cycle is in progress (the transceiver internal tune tone is activated. During this period, the tuner holds the transceiver key line down (transmit mode) until the tune cycle is completed; it also disables the high power amplifier PTT line during the tune cycle. Upon completion of the tune cycle the TUNING TONE goes off and the key line is released. The system is ready for use when this occurs.

If the antenna tuner does not achieve satisfactory match, an interrupted tune tone will be heard at the end of the tuning cycle. The tuner will then be switched out of circuit, leaving a direct connection between the radio, amplifier and the antenna.

NOTE

If a match is not achieved, it may be due to a transient happening and the tuning cycle should be repeated.

4.3 LOW POWER OPERATION

4.3.1 RAT1000 WITH TW500A OR TW1000 AMPLIFIERS

For normal high power operation, turn both the AC Power switch and the DC Breaker switch on the Amplifier to "ON". This enables the Amplifier. In order to operate the system in a low power mode (i.e., on the 100W output of the transceiver only), keep the AC Power switch on the Amplifier "ON" and turn the DC Breaker switch "OFF". This will turn primary power off to the Amplifier and put it in a bypass mode; power will still be provided to the RAT1000.

4.3.2 RAT1000 WITH TW1000A, RA400 OR RA1000 AMPLIFIERS

For normal high power operation, turn the Amplifier On/Off switch "ON" and the companion external power supply "ON". For low power operation, keep the external power supply "ON" and turn the Amplifier On/Off switch "OFF".

NOTE

The transceiver must be unkeyed when the ATU INITIATE button is depressed in order to activate the tune cycle. The tuner will not go through a proper tune cycle if transmit power is present before the button is pressed.

NOTE

If the transceiver is being operated using the Remote Control, then antenna tuning is accomplished by pressing the "ATU" key on the Remote Control (after operating mode and frequency have first been inputted per the procedure).

SECTION 5
THEORY OF OPERATION

5.1 INTRODUCTION

The Automatic Antenna Tuner matches the 50 ohm output of a 1000W amplifier to a wide variety of whip or long wire antennas. Since the tuner is completely automatic, all tuning, control and monitoring functions are completely self-contained.

The RF input is routed directly to the detector circuits. There are four detector circuits which sense the condition of the input impedance of the tuning network:

1. A phase detector;
2. Impedance magnitude detector;
3. Forward power detector;
4. A reflected power detector.

All detector functions have a characteristic impedance of 50 ohms. The detectors provide all sense information used for tuning and monitoring. The phase detector output is an indication of the phase angle of the tuner input impedance (referenced to zero degrees), and is used to control the operation of the inductor relays in the tuning network.

The impedance detector output indicates the real part of the tuner input impedance (referenced to 50 ohms). When the tuner input impedance is purely resistive, this detector also controls operation of the impedance matching transformer. The reflected power detector provides a voltage proportional to reflected RF power and is used to monitor tuning accuracy and to indicate VSWR for comparison with predetermined tuning thresholds.

The forward power detector is used to ensure the correct tune power is applied to the tuner.

The basic matching system used in the tuner is shown in Figure 5-2. If the antenna appears capacitive, the series inductance is adjusted until the reactance is cancelled. If the antenna is inductive, series or parallel capacitance is added until the antenna appears capacitive. Series inductance is then added until the reactance is cancelled. At this point the antenna appears resistive and the correct tap is selected on the input matching transformer. This transformer has five impedance ratios and can be reversed to give eleven output impedances from 3 ohms to 800 ohms.

The inductances are selected by relays controlled by the microprocessor. Ten inductances are used, arranged in a binary sequence from .06microhenry to 32 microhenrys. This means that the inductances may be selected to give a total inductance range of 1.0 microhenry to 64 microhenrys in .06 microhenry steps. Two values of series capacitance and two values of parallel capacitance are selected by relays. High voltage relays are used at all points where the voltage exceeds 500V.

All of the interface and control information from both the associated transceiver and the detector circuits is routed to and processed by the microprocessor circuit. The circuitry in this section is used to monitor input control lines, RF power level, and antenna load condition; it then makes the appropriate sequence of responses required to provide automatic operation.

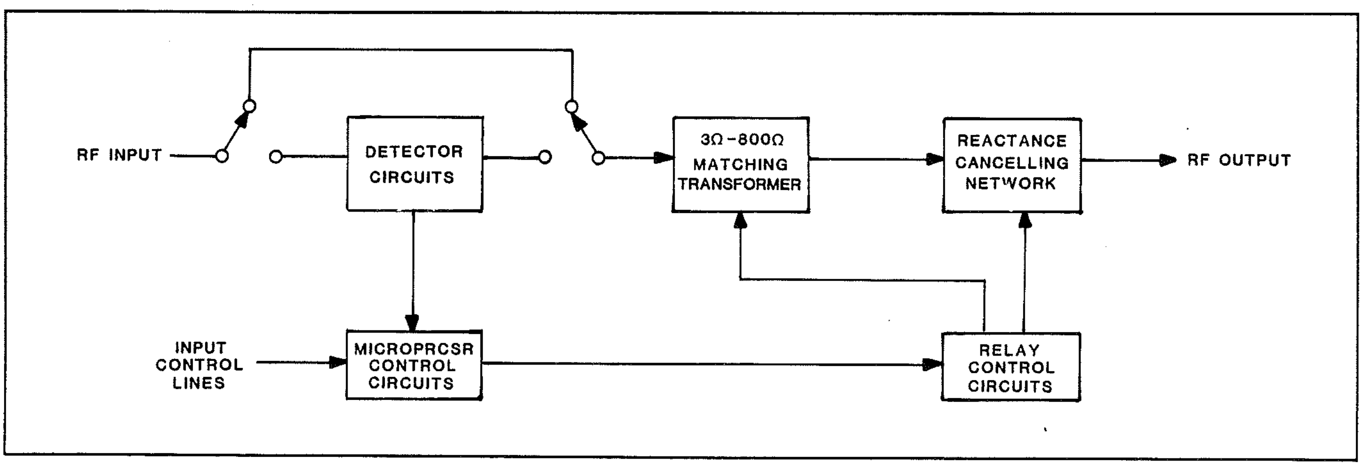


FIGURE 5-1. Block Diagram.

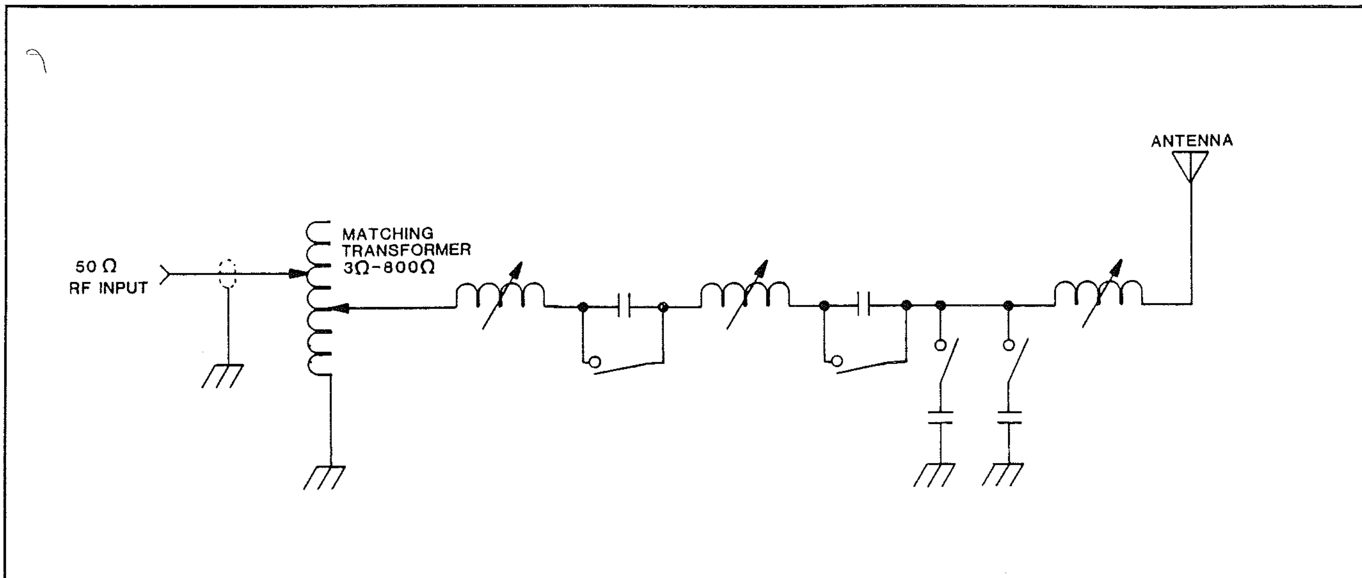


FIGURE 5-2. RF Tuning Network.

5.2 SYSTEM OPERATION

Figure 5-3 shows the sequence of events in the tuner from initial application of primary power through completion of the tune cycle.

5.3 TUNING

5.3.1 TUNING CHARACTERISTICS

The tuner has been designed to have the capability to tune 16 ft. short whip antennas over the frequency range of 3-30MHz, and 32 ft. long whip antennas over the frequency range of 2-30MHz. If the system is properly installed and good grounding is provided, tuning capability is directly proportional to antenna impedance and operating frequency (for a given set of tuning element values). Figure 5-4 gives an illustration of how the tuning network operates to match a typical antenna impedance. A 16 ft. whip antenna has a load impedance (depending on ground conditions) of 10-j1000 ohms at 3MHz. In order to tune this antenna, the tuner adds inductance until the capacitive reactance is cancelled and the antenna appears resistive ($Z_T = R_T + j0$). The correct tap is selected on the input matching transformer so that the antenna resistance is transformed to 50 ohms.

5.3.2 RF TUNE POWER

The tuner operates at a tune power of 10W. If the power level is insufficient to operate the tune detectors, the tuner will not start the tune cycle and an immediate "fault" tone will be heard. If the tune power level is excessive, a proper tune cycle will not occur due to faulty detector data being processed. In the TW100 and RT100 transceivers, the carrier is used for tuning, thus preventing interference during the tune cycle. The power level is automatically controlled to 10W by the transceiver ALC system.

5.4 DETECTOR MODULE-DETAILED DESCRIPTION

5.4.1 PHASE DETECTOR (Refer to Figure 7-2)

The phase detector senses the relative phase between the voltage and current flowing into the RF circuit. Referring to the schematic diagram, the RF current is sensed by L2. L2 is the output which causes conduction through D1 and D2 on positive-going peaks. C1 and L1 form a 90°C phase-shifter circuit which senses the voltage on the RF line. Into a resistive load, the current peak occurs simultaneously with a voltage null from C1 and L1. This causes equal conduction through D1 and D2 and the net output voltage from the detector is zero. If the RF load is not pure resistive, output from the detector will be positive or negative due to the voltage from C1 and L1 arriving out of phase as compared to the output from L2.

5.4.2 /Z/ DETECTOR (Refer to Figure 7-2)

When the RF load is purely resistive, the /Z/ detector determines if the resistance is above or below 50 ohms by comparing the ratio of voltage and current flowing into the RF circuit. L3 senses the current and causes D3 to conduct. C14 and C15 divide the RF voltage to a suitable level and output from this divider is applied to D4. When the load is exactly 50 ohms, the current

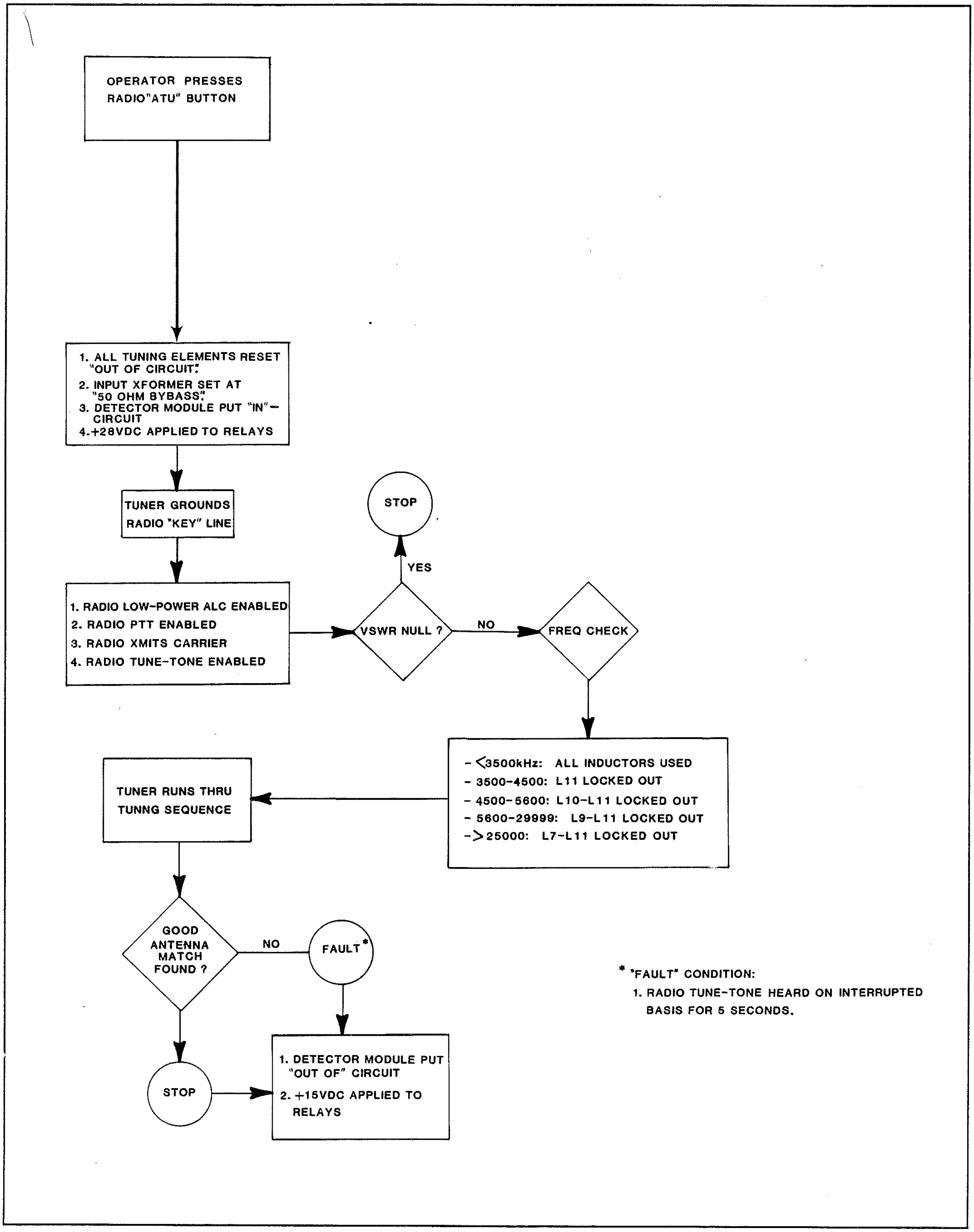


FIGURE 5-3. Sequence of Events.

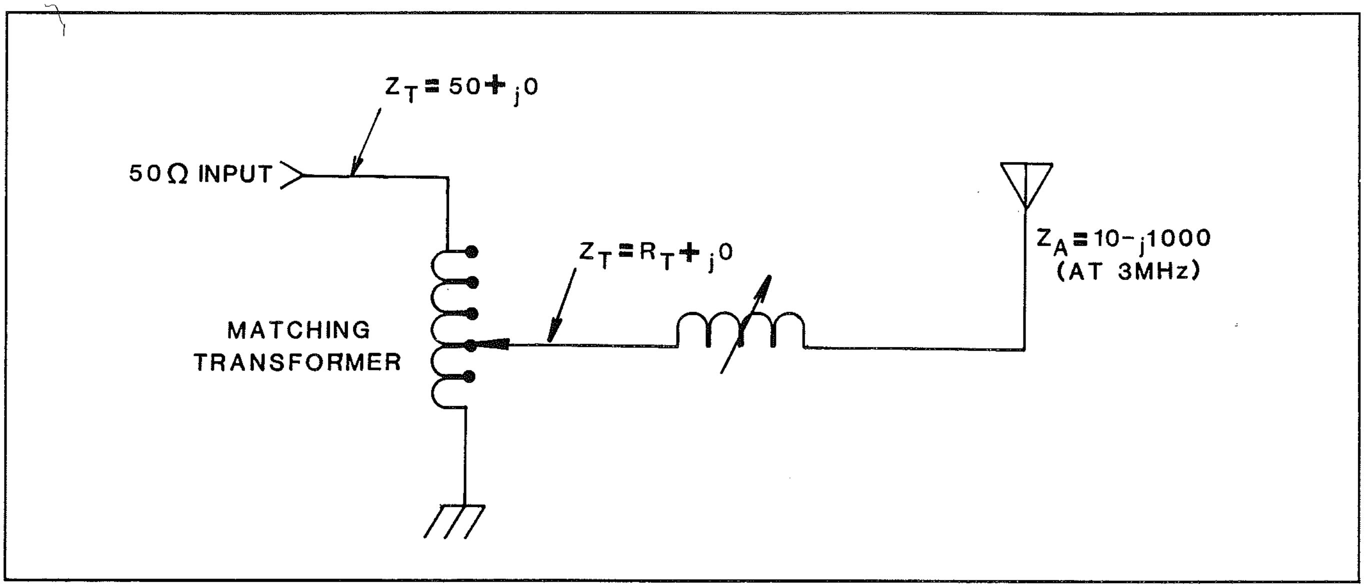


FIGURE 5-4. Tuning Example.

signal from L3 balances the voltage from the divider and output from the detector will be zero. If the impedance on the line varies either above or below the 50 ohm value, output from the detector will be a positive or negative DC value. Note that the /Z/ detector output is valid only when the load is purely resistive.

5.4.3 VSWR DETECTOR (Refer to Figure 7-2)
The VSWR detector delivers zero output when a pure 50 ohm condition exists on the line. If the line condition varies from 50 ohms either in resistance or reactance, the detector produces a DC output.

L4 provides a current pickup while C20 and C21 deliver a divided sample of the voltage on the line. As long as the two inputs to D6 are equal in amplitude and phase (50 ohm resistive condition) there is no diode conduction and detector output is zero. An unbalance in either amplitude or phase, however, will cause the diode to conduct and a DC output will appear proportional to the VSWR.

5.4.4 FORWARD POWER (Refer to Figure 7-2)
The forward power leg of the VSWR bridge is used to determine the power level. D5 provides a DC voltage proportional to the forward power.

5.4.5 DETECTOR MICROPROCESSOR INTERFACE
The output of the phase and resistance magnitude detector is applied to the output of two operational amplifiers U1A and U2A. The output of the operational amplifiers is 4V when the detectors are balanced for a 50 ohm resistive load. Small changes in balance cause the operational amplifiers to swing towards rail (8V) or ground (2V).

The reflected power output from the VSWR detector is amplified by a simple bipolar amplifier with a voltage gain of approximately 10. The forward power output from the VSWR detector is at high level and requires no amplification.

All four detector outputs then go to U5, which is an 8-channel multiplexer with three binary control inputs. This circuit acts like a digital switch, with the input that is passed on to the output port (pin 3) selected by the Processor. For instance, when the Processor wants to interrogate the Phase detector, it puts all 0's on lines U5-9, 10, and 11; this causes U5-13 to be connected to U5-3 and ultimately to the Processor Module through D5 and J1-2. The other detector outputs are interrogated in a similar fashion.

U3 is an operational amplifier used to set different thresholds for comparing to the detector outputs. The particular threshold is selected by input lines J-3, 4, 5, 6, 11, and 12 and sets the level at U3-6. This level is then compared to the particular detector output at U3-5.

Q1 and the dividers U6 and U7 are used in conjunction with the microprocessor to form a frequency counter. The frequency information is used to minimize the tuning time by eliminating selection of components not required in specified frequency ranges.

TABLE 5-1. Element Lock-Out Table.

FREQUENCY	ELEMENTS
Freq. < 3500kHz	All elements can be used.
3500kHz ≤ Freq. < 4500kHz	L11 not used.
4500kHz ≤ Freq. < 5800kHz	L10, L11 not used.
5800kHz ≤ Freq.	L9, L10, L11 not used.
25000kHz ≤ Freq.	L7 - L11 Not Used.

The counter output is routed to the Processor Module through J1-10. The different elements left out of the tuning program at various frequency ranges are listed in Table 5-1.

5.5 TUNING NETWORK - DETAILED DESCRIPTION

The tuner schematic, Figure 7-5, shows the complete tuning network. T1 is the input matching transformer. This transformer has five impedance taps selected by relays K19-K23. Relays K17 and K18 are used to reverse the inputs and outputs of the transformer to provide step up or step down ratios; K1 is used to bypass the detectors after tuning.

L2-L11 are a series of inductors arranged in a binary progression. L2 is .06 microhenry and each inductor doubles in size, ending with L11 at 32 microhenrys. Relays K2-K11 short out each inductor and by selecting the appropriate relays, it is possible to increment the inductances in .06 microhenry steps up to 64 microhenrys.

Two parallel capacitors, C14 and C15, are selected by relays K14 and K15. The series capacitor C13 is selected by K13. At frequencies above 25MHz the series capacitor C16 is selected by K16.

A special relay with low capacitance and very good isolation between the contacts and the frame is used for switching functions up to 500V. Special high voltage relays are used for switching the other components. These relays are rated for 15kV and are specially constructed and gapped to handle the high voltages in the tuner. All inductors are specially built air-wound types wound on high-voltage forms.

All relays are +28Vdc types and are operated at the full +28 volts during the tuning cycle. At other times, however, the relay coil voltage is reduced to +15 volts by the circuit composed of U1, Q24, Q25 and K24. This is still high enough to provide adequate "hold-in" voltage for the relays, but the lower voltage considerable reduces both power consumption and relay coil heating.

5.6 PROCESSOR CONTROL CIRCUITRY — DETAILED DESCRIPTION (Figure 7-4)

The Processor Module contains the microprocessor and associated components that perform the various control functions within the Antenna Tuner. This includes interrogating the detectors, locking out frequency-restricted elements, keying the transceiver and determining which tuning elements are in the circuit at any given time.

5.6.1 CPU PORT FUNCTIONS

The circuit is based on the 80C39 Microprocessor (CPU). The CPU has 27 input/output lines (I/O) for communication with the rest of the circuit. These take the form of three 8-bit ports, two 1-bit I/O lines, and an interrupt line. One of the 8-bit ports is called the bus port and performs two functions in this system. First, it acts as the port for transfer of data between the CPU and the other devices on the bus. Second, it is time-multiplexed with the lower 8 bits of the internal address bus such that the external latch, U5, latches those address bits at the proper time in conjunction with the Address Latch Enable (ALE) signal. The data bus port consists of pins 12 through 19 of U1, and ALE is pin 11.

The other ports are split among the various other communications requirements in the system. Some of the port bits are actually performing more than one function. These ports are designated as port 1 and port 2. Port 1 contains pins 27 through 34, and port 2 contains pins 21 through 24, and pins 35 through 38.

The lower three bits of port 2 serve as the three most significant address lines. This is their only function. P23 is located at pin 24 of the CPU, and its dedicated function is to input the test program start-up line to the CPU.

The three higher order bits of port 2, pins 36 to 38, form a serial output port which drives the interface to the Tuner PCB. Pin 37 or P26 serves only as a clock for the Tuner PCB shift registers, U1 through U3.

P25, or pin 36, is the latch strobe signal for the shift registers. When this signal goes to a high level, the data which has been shifted into the interface will appear at the outputs.

P27, or pin 38, serves as the data line in the transceiver interface.

The lower six bits of port 1 are used to set thresholds for detector output level comparisons. The top two bits of port 1 and the fifth bit of port 2 (pin 35) are used to address the multiplexer in the Detector Module in binary fashion.

The two other I/O lines, T0 and T1, at pins 1 and 39 respectively, act as the recipient of the multiplexed detector information and as the input for the frequency counter data.

Pin 6 of the CPU is the "INT" input of the device. It is connected to the external transceiver "ATU" tune line. A momentary ground placed on this line enables the start of the coupler tune cycle.

5.6.2 OPERATIONAL DESCRIPTION

Upon power up, the reset capacitor, C3 is charged from the zero-voltage state, and when the internal threshold is reached, the processor starts executing instructions. The sequence is for the CPU to first fetch the instruction from the program memory, U5, by asserting a low level on the PSEN line. This enables the ROM to write data to the data bus and the CPU can then read the data. Just before this operation the CPU has made sure that the address has been latched by U5, by asserting the ALE line, which pulses high.

5.6.3 TUNER PCB INTERFACE

U1, U2, and U3 are 8-stage serial shift registers having a storage latch associated with each stage for strobing data from the serial input to the parallel buffered 3-state outputs. Each output is connected to a 2N3567 Darlington transistor which acts as the relay driver. There are 23 relays on the Tuner PCB, and each is driven by one of the shift register outputs. The 24th line is used as the transceiver "key" line (Q24, U3-4); this will go to ground immediately on receipt of a "TUNE" pulse on U4-6.

All of the relays on the Tuner PCB are activated by turning their respective driver transistor "ON" (ground).

5.7 TUNING PROCEDURE

The software program controlling the antenna tuner is quite complex, with many procedures designed to minimize the tuning time and to avoid situations where the detectors may not give correct information. The following basic method of tuning is used.

a) Initially, all elements in the tuner are switched out of circuit so that the detectors are connected directly to the antenna.

b) If the output of the phase detector indicates capacitive reactance, inductance is added until the detector indicates zero phase (resistive load).

c) The output of the R detector is then examined. The impedance taps are selected progressively going higher or lower according to whether the detector indicates low or high impedance.

d) If the phase detector indicates inductive reactance, series and parallel capacitors are selected in turn) until the phase changes to indicate capacitive reactance. The tuning procedure used in steps (b) and (c) is then followed.

e) The output of the VSWR detector is monitored continuously and the tuning procedure is stopped immediately when match is achieved (when VSWR is less than 1.2:1. If match cannot be reached, the best match below 1.5:1 is selected. Alternate timing procedures will be tried if a match of 1.5:1 cannot be found. The program will finally accept a match of less than 2:1 or, if this cannot be achieved, will indicate no match (pulsating tune tone in transceiver).

SECTION 6
ALIGNMENT & TEST

6.1 GENERAL

The Automatic Antenna Tuner has been thoroughly tested and aligned at the factory. Realignment in the field should not be attempted unless good quality test equipment is available and all other possible causes of malfunctioning have been investigated.

6.2 EQUIPMENT REQUIRED

1. 50 ohm Dummy Load (Bird 8321 or equivalent).
2. Inductance Measuring Equipment:
   Minimum requirements 0-150 microhenrys in .02 microhenry resolution (RLC Meter - MM2).
3. High Impedance Voltmeter (VTVM or FET).

6.3 DETECTOR ALIGNMENT

1. Connect the Antenna Coupler to the transceiver using the RF coaxial cable and the DC control cable.

2. Connect the output of the detector module to the 50 ohm dummy load. (Note: This requires removing the tuner input coaxial cable from the detector first).

3. Set the transceiver frequency to 8.00MHz.

4. Key the transceiver into the tune mode by placing a short across the "key" line. (Note: This is best accomplished by connecting a clip lead from ground to the "key" pin in the Processor Module. See Figure 7-4 for location of this pin). Make sure that the RF forward power is a minimum of 10W.

5. Adjust R17 to a fully CCW position.

6. Connect the voltmeter to test point 3 on the Detector PCB (Figure 6-1). Adjust the voltmeter to read -DC volts at the lowest voltage scale.

7. Adjust C20 for a minimum output on the voltmeter (this "minimum" should be less than 50mV).

8. Connect the voltmeter to Test Point 2 on the Detector PCB (Figure 6-1). Adjust the voltmeter to read +DC volts on a range equal to 10V.

9. Adjust C14 (using an insulated tuning tool) until the voltage at Test Point 2 is approximately 4V.

10. Connect the voltmeter to Test Point 1 on the Detector PCB (Figure 6-1).

11. Adjust R3 until the voltage at Test Point 1 is approximately 4V.

NOTE

Making the adjustment at items (9) and (11) to exactly 4V may be impossible due to the "Snap-Action of the circuit. It is sufficient to adjust the control as closely as possible to the "transition point" between high and low. Using an oscilloscope to monitor TP1 and TP2 is a more accurate way to align those functions. Adjust C14 and R3 until the waveform at TP2 and TP1, respectively, is a square wave.

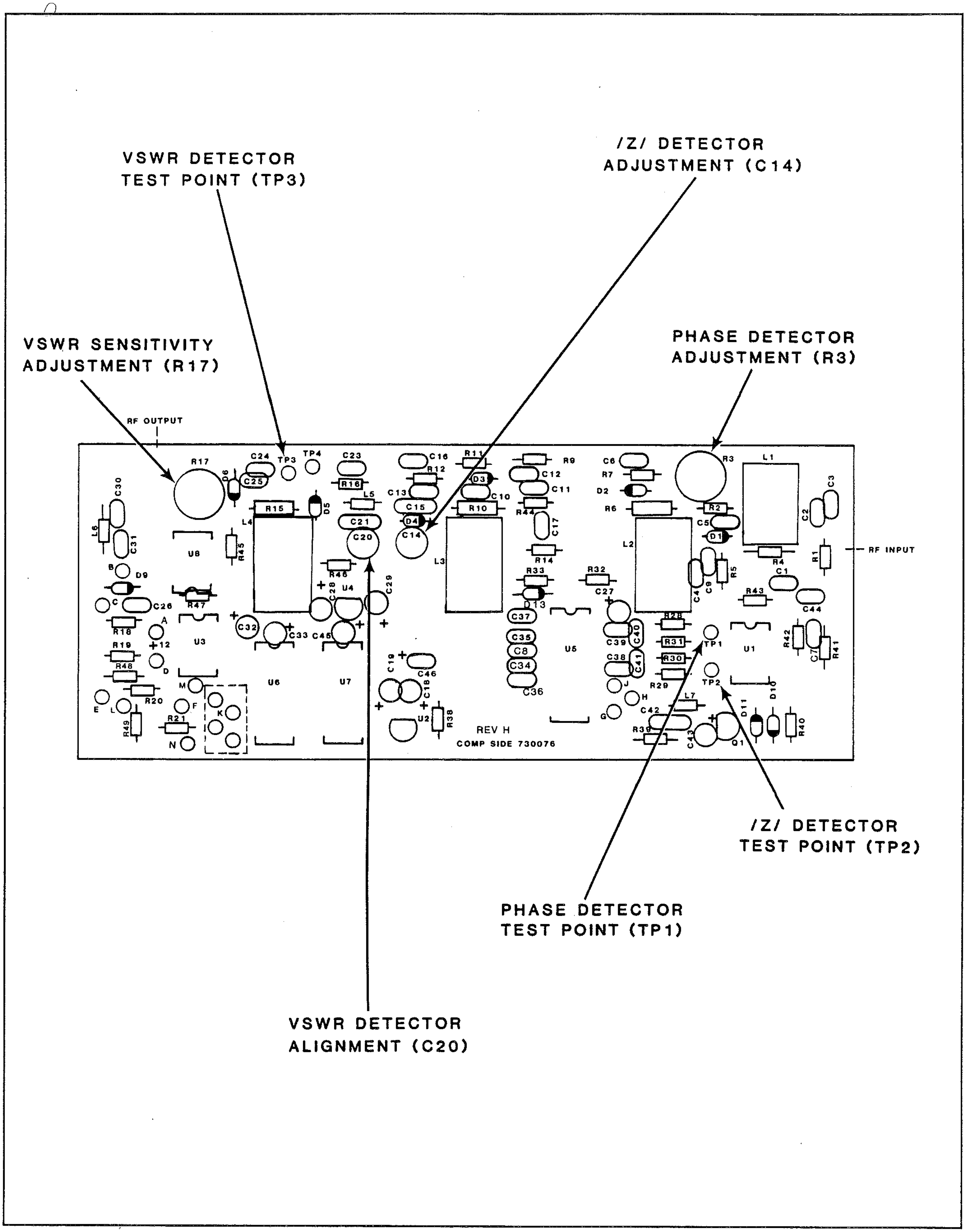


FIGURE 6-1. Test Points.

SECTION 7
TROUBLESHOOTING

7.1 INSPECTION

Check the interior of the antenna tuner carefully. There should be no signs of heating, arcing or mechanical damage. If there are signs of arcing or heating, it has probably been caused by dirt or moisture. Before making the repair, clean out the case and dry thoroughly with warm, dry air. Check all of the case seals before reassembly.

7.2 RELAYS

1. Although the relays have an extended life and the calculated MTBF is approximately one million tune cycles, relays are the most likely components to require service. If the tuner does not operate correctly, first check the relays.

2. The first and easiest step is to check the relays for audible operation. Remove the connectors from J1, J2 and J3. Short the pins listed in Table 7-1 to ground, in turn, and listen to the relay action. It is always possible to detect an open circuit coil, and frequently possible to detect faulty contact action. (**NOTE:** K1 through K16 are solenoid driver relays whose operation can be visually monitored).

3. The contacts on K17 to K23 can be checked for continuity with an ohmmeter.

4. If a faulty relay is located, it should be replaced. The adjustment of relays is not recommended.

5. Table 7-2 shows the impedance transformer tap settings and the relay positions for each setting. An "X" indicates an energized relay.

7.3 DETECTOR MODULE

1. Check that the detectors are correctly aligned (refer to Section 6.3). The basic detector circuitry is passive and faults are unlikely. Check that the diodes are not defective. Note that D5 and D6 are germanium diodes and should only be replaced by a similar type. The potentiometers R3 and R4 can be checked with an ohmmeter. Defects in the trimmer capacitors C14 and C20 are usually revealed by erratic mechanical action.

2. Check the voltage at test points 1 and 2 with no RF power applied. If the voltage is not approximately 4V, U1 should be checked by replacement.

3. DC Voltage Checks. Table 7-3 shows the semiconductor DC voltages in the Detector Module with no RF power applied. This table can be used to pin-point a bad IC in some cases.

4. Dynamic Voltage Checks. It is difficult to completely check the operation of the Detector Module by making voltage measurements because of the serial nature of some of the circuitry. This is especially true in the case of U5, the multiplexer. This IC receives the detector data in parallel form and transfers it serially to its output as it is interrogated in binary fashion by the Processor Module. The binary code on pins 9, 10, and 11 determines which input detector signal is transferred to the output as shown in Table 7-4.

In other words, if the binary code on pins 11, 10, and 9 is 1, 0, 0, the /Z/ detector input on pin 14 is transferred to the output pin 3. It is possible to check this IC by manually applying the different binary inputs; however, IC substitution is probably easier.

U3 is an operational amplifier that takes Processor determined thresholds and compares them to the selected detector output. During a tune cycle, U5-3 should vary between 0.5 and 3.0 volts. The voltage on pins 9, 10, and 11 should vary between 2 and 8 volts during a a tune cycle.

5. Counter IC. U6 and U7 form a counter that provides frequency data to the Processor Module.

An oscilloscope should be used to see if the circuit is working properly (a voltmeter should show a fluctuation at J1-10 of between 0.2 and 0.8 volts).

7.4 PROCESSOR MODULE

Accurate troubleshooting of the Processor Module requires a good oscilloscope, a test fixture to provide serial data, and a knowledge of the circuitry. It is recommended that the following be done in case of module failure.

a. Visual inspection of joints, connectors, pins, etc.

b. Check operation of crystal at U4-2, 3.

c. The best way of troubleshooting the module in the event that adequate test equipment or fixtures are not available, is through part substitution.

TABLE 7-1. Relay Connections.

Relay	Connector	Pin Number	Contacts
K1A	J3	9	DT
K1B	J3	9	DT
K2	J2	7	N/O
K3	J2	6	N/O
K4	J2	5	N/O
K5	J2	4	N/O
K6	J2	3	N/O
K7	J3	2	N/O
K8	J2	9	N/O
K9	J3	7	N/O
K10	J3	6	N/O
K11	J3	4	N/O
K13	J2	10	N/O
K14	J3	1	N/O
K15	J3	3	N/O
K16	J2	2	N/O
K17	J1	5	DT
K18A,B	J1	6	DT
K19	J2	1	N/O
K20	J1	10	N/O
K21	J1	9	N/O
K22	J1	8	N/O
K23A,B	J1	7	N/O
K24	J3	9	N/O

N/O = Normally Open DT = Double Throw

TABLE 7-2. Impedance Matching Transformer.

Relay Ohms	K17	K18	K19	K20	K21	K22	K23
3.0		X					X
7.0		X				X	
12.5		X			X		
19.5		X		X			
28.0		X	X				
50.0							
89.0	X		X				
128.0	X			X			
200.0	X				X		
355.0	X					X	
800.0	X						X

X = Indicates relay activity.

TABLE 7-3. Detector Module - DC Voltages.

U1

Pin 1	2.0 - 7.0V
Pin 2	4.0V
Pin 3	4.0V
Pin 4	Ground
Pin 5	4.0V
Pin 6	4.0V
Pin 7	2.0 - 7.0V
Pin 8	8.0V

U5

Pin 1	5.0V	Pin 9	0.0V			
Pin 2	5.0V	Pin 10	5.0V			
Pin 3	0.0V	Pin 11	5.0V			
Pin 4	0.0V	Pin 12	0.0V		0.0V	
Pin 5	0.0V	Pin 13	3.0V	NO	1.0 - 3.0V	10W-
Pin 6	0.0V	Pin 14	3.0V	RF	1.0 - 3.0V	"Matched
Pin 7	0.0V	Pin 15	0.0V		1.5V	Condition"
Pin 8	0.0V	Pin 16	5.0V			

U8

Pin 1	0.0V	9.0V (Open Circuit)
Pin 2	0.0V	
Pin 3	0.0V	
Pin 4	Ground	
Pin 5	—	
Pin 6	—	
Pin 7	—	
Pin 8	12.0V	

U3

Pin 1	0.0V
Pin 2	0.0V
Pin 3	0.0V
Pin 4	Ground
Pin 5	0.0V
Pin 6	0.0V
Pin 7	0.0V
Pin 8	12.0V

Q1

D	5.0V
S	2.0V
G	0.0V

U6

Pin 1	0.3V	Pin 8	0.2V
Pin 2	0.0V	Pin 9	0.2V
Pin 3	0.3V	Pin 10	0.2V
Pin 4	1.0V	Pin 11	0.2V
Pin 5	4.0V	Pin 12	0.0V
Pin 6	4.5V	Pin 13	0.2V
Pin 7	0.0V	Pin 14	5.0V

U7

Pin 1	1.5V	Pin 8	0.2V
Pin 2	0.0V	Pin 9	0.2V
Pin 3	0.2V	Pin 10	0.2V
Pin 4	4.0V	Pin 11	0.2V
Pin 5	0.2V	Pin 12	0.0V
Pin 6	0.2V	Pin 13	0.2V
Pin 7	0.0V	Pin 14	5.0V

TABLE 7-4. Multiplexer Transfer Chart.

PIN 11	PIN 10	PIN 9		PIN 3	FUNCTION
0	0	0	Selects	13	Phase
1	0	0	Selects	14	/Z/
0	1	0	Selects	15	Forward Power
1	1	0	Selects	12	VSWR

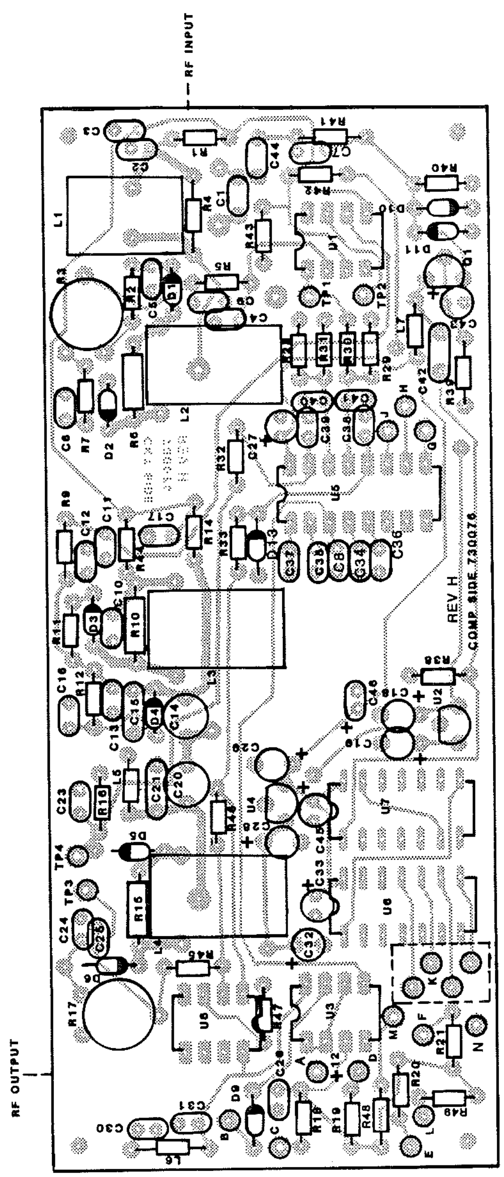
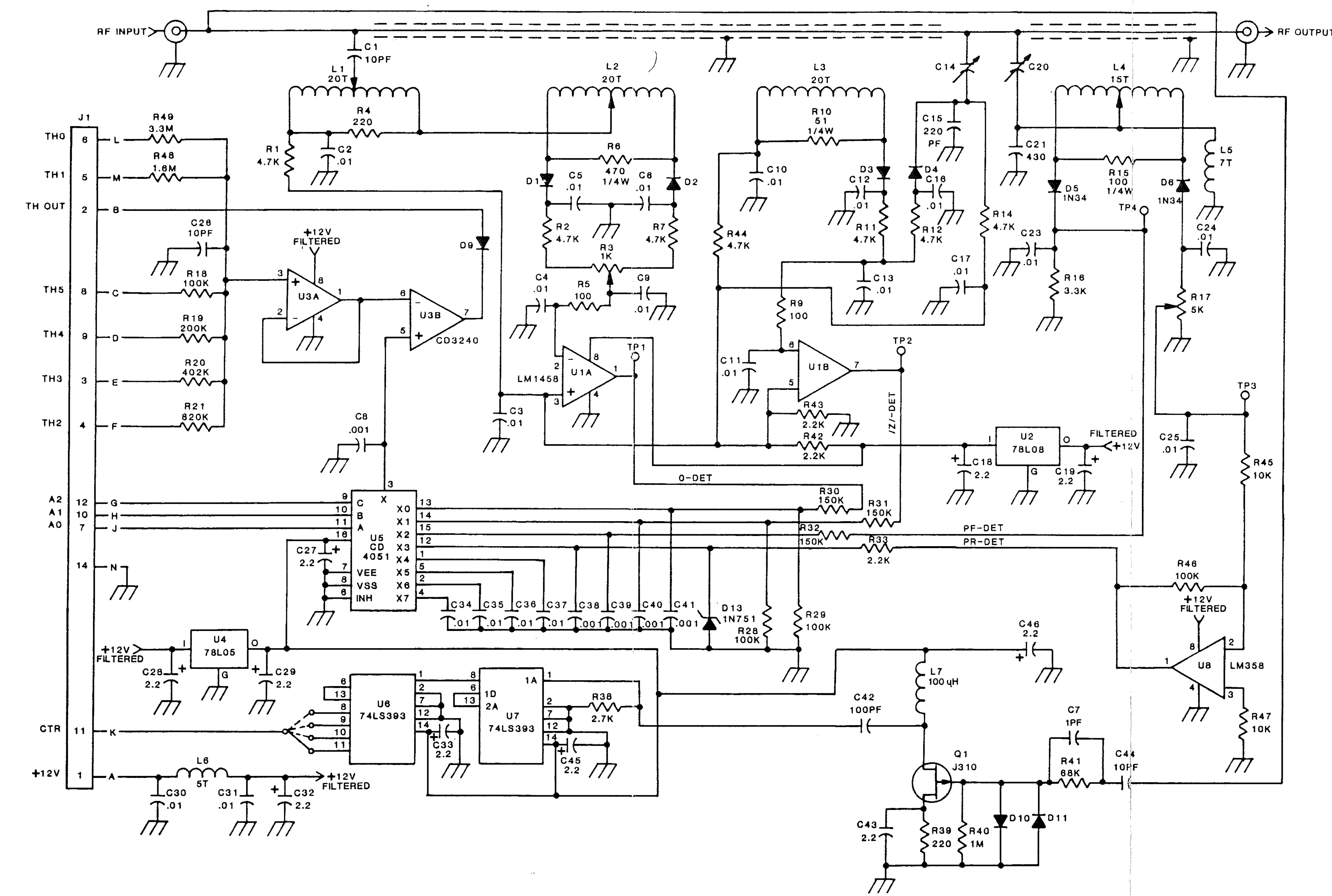


FIGURE 7-1. Component Locations, Detector Module.



NOTES: (UNLESS OTHERWISE SPECIFIED)

1. RESISTANCE IS IN OHMS.
2. CAPACITANCE IS IN MICROFARADS.
3. DIODES ARE 1N4148.
4. S1 NOT USED.

FIGURE 7-2. Schematic Diagram, Detector Module.

TABLE 7-5. Parts List, Detector Module.

C1	210100	Capacitor, Disc NPO 10pF
C2	214103	Capacitor, Monolithic .01
C3	214103	Capacitor, Monolithic .01
C4	214103	Capacitor, Monolithic .01
C5	214103	Capacitor, Monolithic .01
C6	214103	Capacitor, Monolithic .01
C7	210010	Capacitor, Disc NPO 1pF
C8	210102	Capacitor, Disc .001
C9	214103	Capacitor, Monolithic .01
C10	214103	Capacitor, Monolithic .01
C11	214103	Capacitor, Monolithic .01
C12	214103	Capacitor, Monolithic .01
C13	214103	Capacitor, Monolithic .01
C14	261250	Capacitor, Trimmer 1-25pF
C15	220221	Capacitor, Mica DM15 220pF
C16	214103	Capacitor, Monolithic .01
C17	214103	Capacitor, Monolithic .01
C18	241020	Capacitor, Tantalum 2.2
C19	241020	Capacitor, Tantalum 2.2
C20	261250	Capacitor, Trimmer 1-25pF
C21	220431	Capacitor, Mica DM15 430pF
C22		Not Used.
C23	214103	Capacitor, Monolithic .01
C24	214103	Capacitor, Monolithic .01
C25	214103	Capacitor, Monolithic .01
C26	210100	Capacitor, Disc NPO 10pF
C27	241020	Capacitor, Tantalum 2.2
C28	241020	Capacitor, Tantalum 2.2
C29	241020	Capacitor, Tantalum 2.2
C30	214103	Capacitor, Monolithic .01
C31	214103	Capacitor, Monolithic .01
C32	241020	Capacitor, Tantalum 2.2
C33	241020	Capacitor, Tantalum 2.2
C34	214103	Capacitor, Monolithic .01
C35	214103	Capacitor, Monolithic .01
C36	214103	Capacitor, Monolithic .01
C37	214103	Capacitor, Monolithic .01
C38	210102	Capacitor, Disc .001
C39	210102	Capacitor, Disc .001
C40	210102	Capacitor, Disc .001
C41	210102	Capacitor, Disc .001
C42	220101	Capacitor, Mica DM15 100pF
C43	241020	Capacitor, Tantalum 2.2
C44	210100	Capacitor, Disc NPO 10pF
C45	241020	Capacitor, Tantalum 2.2
C46	241020	Capacitor, Tantalum 2.2
D1	320002	Diode, 1N4148
D2	320002	Diode, 1N4148
D3	320002	Diode, 1N4148
D4	320002	Diode, 1N4148
D5	320003	Diode, 1N34A
D6	320003	Diode, 1N34A

TABLE 7-5. Parts List, Detector Module, Continued.

D7		Not Used.
D8		Not Used.
D9	320002	Diode, 1N4148
D10	320002	Diode, 1N4148
D11	320002	Diode, 1N4148
D12		Not Used.
D13	320204	Diode, Zener 1N751
L1	450388	Transformer, 20T CT Bifilar
L2	450388	Transformer, 20T CT Bifilar
L3	450389	Transformer, 20T
L4	450391	Transformer, 15T CT Bifilar
L5	450390	Inductor Bead, 7T
L6	450392	Inductor Bead, 5T
L7	430014	Inductor, Molded 100uH
Q1	310033	Transistor, FET J310
R1	113472	Resistor, Film 1/8W 5% 4.7K
R2	113472	Resistor, Film 1/8W 5% 4.7K
R3	170116	Resistor, Trimmer 10MM 1K
R4	124221	Resistor, Film 1/4W 5% 220
R5	113101	Resistor, Film 1/8W 5% 100
R6	124471	Resistor, Film 1/4W 5% 470
R7	113472	Resistor, Film 1/8W 5% 4.7K
R8		Not Used.
R9	113101	Resistor, Film 1/8W 5% 100
R10	124510	Resistor, Film 1/4W 5% 51
R11	113472	Resistor, Film 1/8W 5% 4.7K
R12	113472	Resistor, Film 1/8W 5% 4.7K
R13		Not Used.
R14	113472	Resistor, Film 1/8W 5% 4.7K
R15	124101	Resistor, Film 1/4W 5% 100
R16	113332	Resistor, Film 1/8W 5% 3.3K
R17	170111	Resistor, Trimmer 10MM 5K
R18	1111003	Resistor, Film 1/8W 1% 100K
R19	1112003	Resistor, Film 1/8W 1% 200K
R20	1114023	Resistor, Film 1/8W 1% 402K
R21	113824	Resistor, Film 1/8W 5% 820K
R22		Not Used.
R23		Not Used.
R24		Not Used.
R25		Not Used.
R26		Not Used.
R27		Not Used.
R28	113104	Resistor, Film 1/8W 5% 100K
R29	113104	Resistor, Film 1/8W 5% 100K
R30	113154	Resistor, Film 1/8W 5% 150K
R31	113154	Resistor, Film 1/8W 5% 150K
R32	113154	Resistor, Film 1/8W 5% 150K
R33	113222	Resistor, Film 1/8W 5% 2.2K
R34		Not Used.
R35		Not Used.

TABLE 7-5. Parts List, Detector Module, Continued.

R36		Not Used.
R37		Not Used.
R38	113272	Resistor, Film 1/8W 5% 2.7K
R39	113221	Resistor, Film 1/8W 5% 220
R40	113105	Resistor, Film 1/8W 5% 1M
R41	113683	Resistor, Film 1/8W 5% 68K
R42	113222	Resistor, Film 1/8W 5% 2.2K
R43	113222	Resistor, Film 1/8W 5% 2.2K
R44	113472	Resistor, Film 1/8W 5% 4.7K
R45	113103	Resistor, Film 1/8W 5% 10K
R46	113104	Resistor, Film 1/8W 5% 100K
R47	113103	Resistor, Film 1/8W 5% 10K
R48	113165	Resistor, Film 1/8W 5% 1.6M
R49	113335	Resistor, Film 1/8W 5% 3.3M
S1	530023	DIP Switch, 4 Position
U1	330019	IC, RC1458CP-1
U2	330018	IC, 78L08
U3	330211	IC, CD3240
U4	330025	IC, 78L05
U5	330194	IC, CD4051BE
U6	330193	IC, 74LS393
U7	330193	IC, 74LS393
U8	330081	IC, LM358N

NOTE: Unless otherwise specified, capacitance is in microfarads and resistance is in ohms.

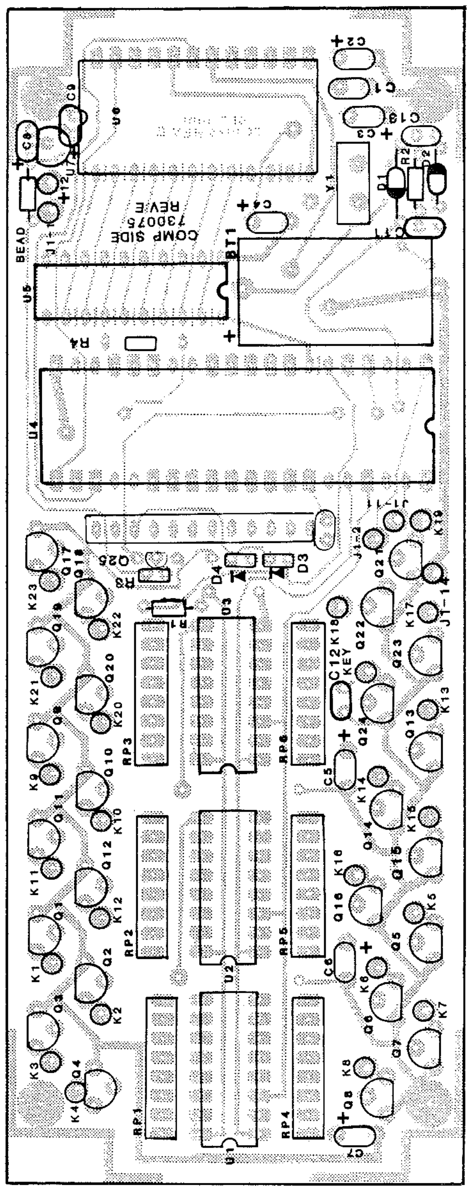
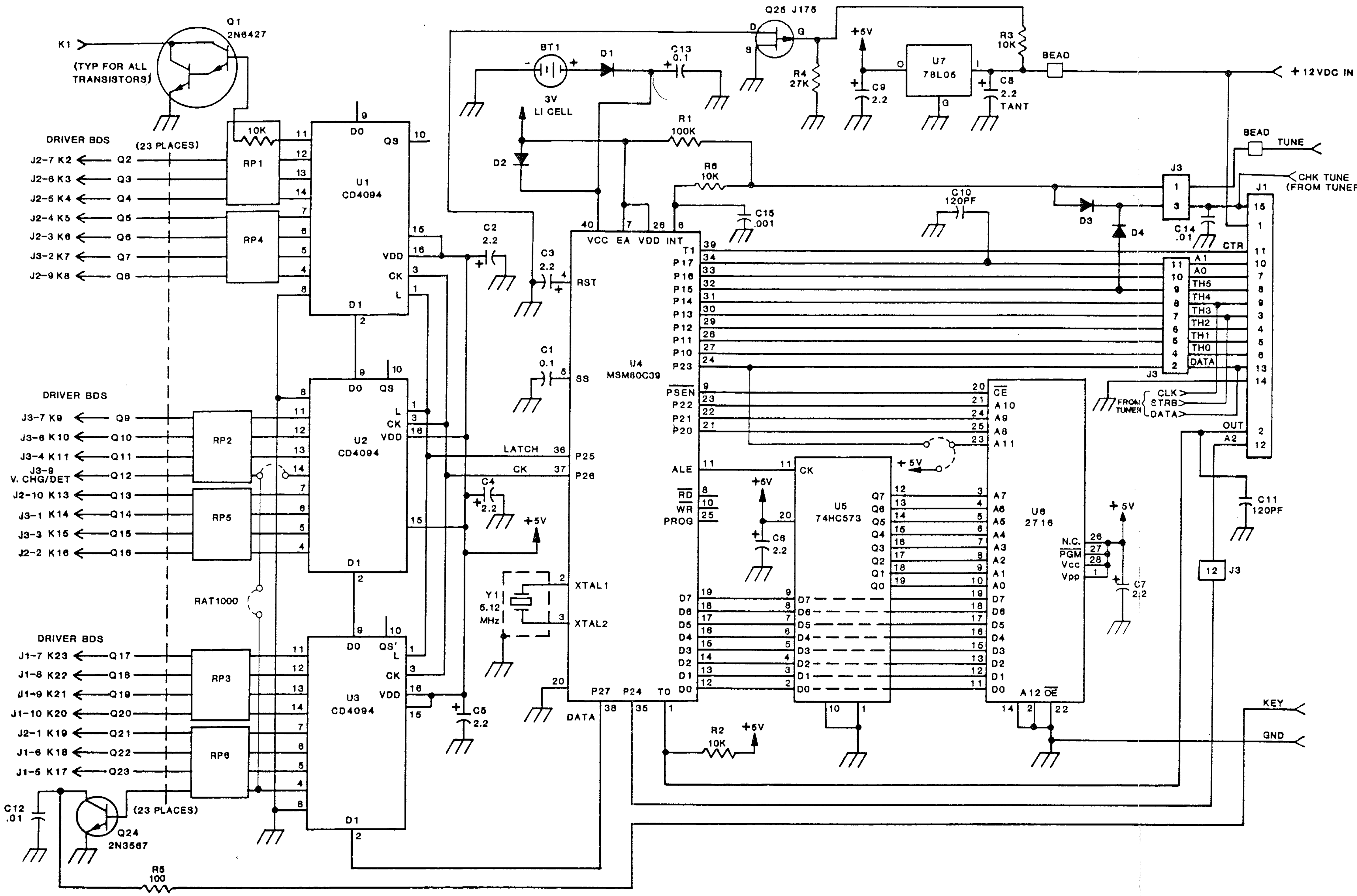


FIGURE 7-3. Component Locations, Processor Module.



NOTES: (UNLESS OTHERWISE SPECIFIED)
1. RESISTANCE IS IN OHMS.
2. CAPACITANCE IS IN MICROFARADS.
3. DIODES ARE 1N4148

FIGURE 7-4. Schematic Diagram, Processor Module.

TABLE 7-6. Parts List, Processor Module.

BT1	750006	Battery, Lithium
C1	275104	Capacitor, Monolithic .1
C2	241020	Capacitor, Tantalum 2.2
C3	241020	Capacitor, Tantalum 2.2
C4	241020	Capacitor, Tantalum 2.2
C5	241020	Capacitor, Tantalum 2.2
C6	241020	Capacitor, Tantalum 2.2
C7	241020	Capacitor, Tantalum 2.2
C8	241020	Capacitor, Tantalum 2.2
C9	241020	Capacitor, Tantalum 2.2
C10	210121	Capacitor, Disc NPO 12pF
C11	210121	Capacitor, Disc NPO 12pF
C12	214103	Capacitor, Monolithic .01
C13	275104	Capacitor, Monolithic .1
C14	214103	Capacitor, Monolithic .01
C15	210102	Capacitor, Disc 25V .001
D1	320002	Diode, 1N4148
D2	320002	Diode, 1N4148
D3	320002	Diode, 1N4148
D4	320002	Diode, 1N4148
Q1	310064	Transistor, Darlington 2N6427
Q2	310064	Transistor, Darlington 2N6427
Q3	310064	Transistor, Darlington 2N6427
Q4	310064	Transistor, Darlington 2N6427
Q5	310064	Transistor, Darlington 2N6427
Q6	310064	Transistor, Darlington 2N6427
Q7	310064	Transistor, Darlington 2N6427
Q8	310064	Transistor, Darlington 2N6427
Q9	310064	Transistor, Darlington 2N6427
Q10	310064	Transistor, Darlington 2N6427
Q11	310064	Transistor, Darlington 2N6427
Q12	310064	Transistor, Darlington 2N6427
Q13	310064	Transistor, Darlington 2N6427
Q14	310064	Transistor, Darlington 2N6427
Q15	310064	Transistor, Darlington 2N6427
Q16	310064	Transistor, Darlington 2N6427
Q17	310064	Transistor, Darlington 2N6427
Q18	310064	Transistor, Darlington 2N6427
Q19	310064	Transistor, Darlington 2N6427
Q20	310064	Transistor, Darlington 2N6427
Q21	310064	Transistor, Darlington 2N6427
Q22	310064	Transistor, Darlington 2N6427
Q23	310064	Transistor, Darlington 2N6427
Q24	310003	Transistor, NPN 2N3567
Q25	310072	Transistor, J175
R1	113104	Resistor, Film 1/8W 5% 100K
R2	113103	Resistor, Film 1/8W 5% 10K
R3	113103	Resistor, Film 1/8W 5% 10K
R4	113273	Resistor, Film 1/8W 5% 27K

TABLE 7-6. Parts List, Processor Module, Continued.

R5	113101	Resistor, Film 1/8W 5% 100
R6	113103	Resistor, Film 1/8W 5% 10K
RP1	182009	Resistor Pack, 10K x 4
RP2	182009	Resistor Pack, 10K x 4
RP3	182009	Resistor Pack, 10K x 4
RP4	182009	Resistor Pack, 10K x 4
RP5	182009	Resistor Pack, 10K x 4
RP6	182009	Resistor Pack, 10K x 4
U1	330126	IC, CD4094BE/MC14094BCP
U2	330126	IC, CD4094BE/MC14094BCP
U3	330126	IC, CD4094BE/MC14094BCP
U4	330142	IC, 80C39
U5	330141	IC, 74HCT573
U6	330102	IC, UPD2716-6
U7	330025	IC, 78L05
Y1	360018	Crystal, 5,120.000kHz

NOTE: Unless otherwise specified, capacitance is in microfarads and resistance is in ohms.

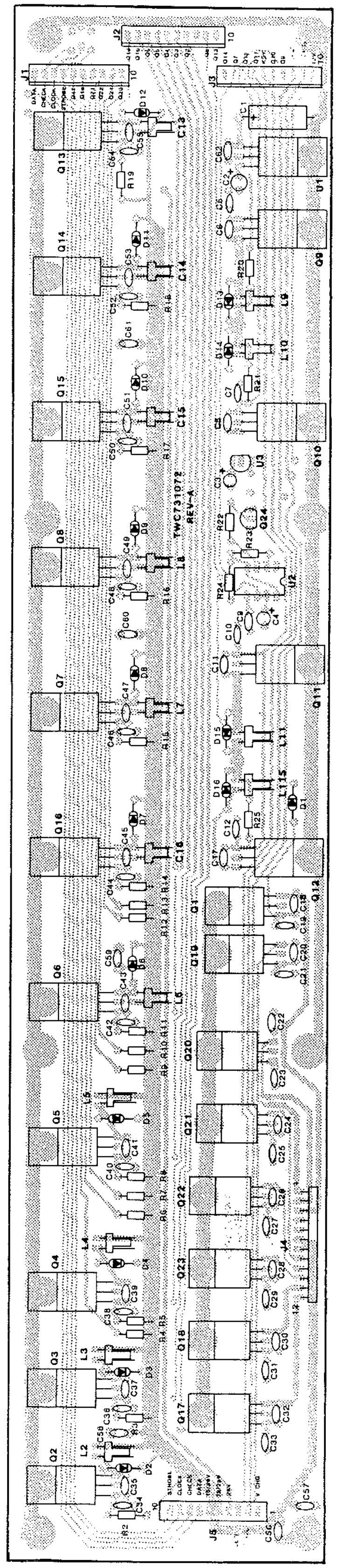


FIGURE 7-5. Component Locations, Relay Driver Board.

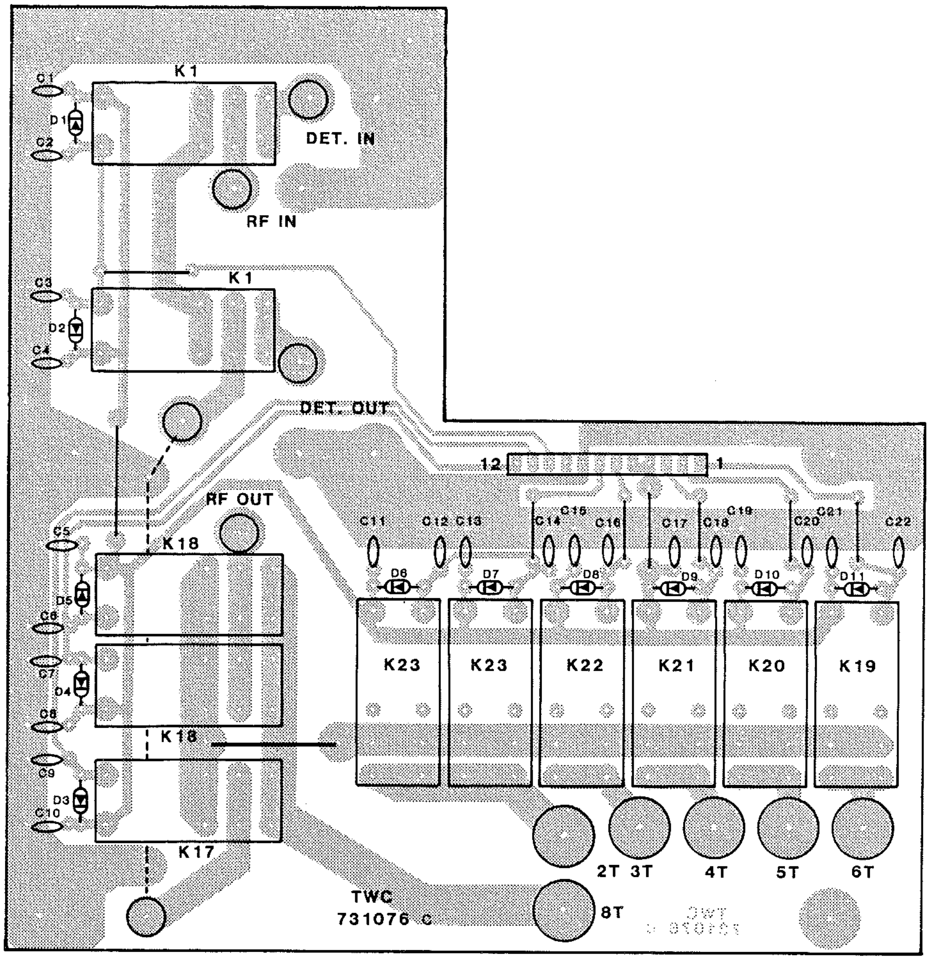


FIGURE 7-6. Component Locations, Impedance Tap Board.

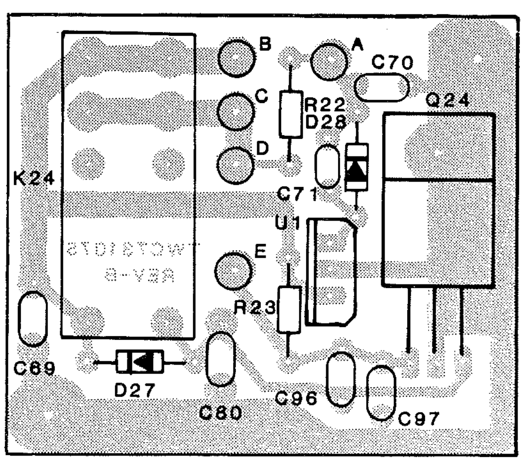


FIGURE 7-7. Component Locations, Voltage Change Board.

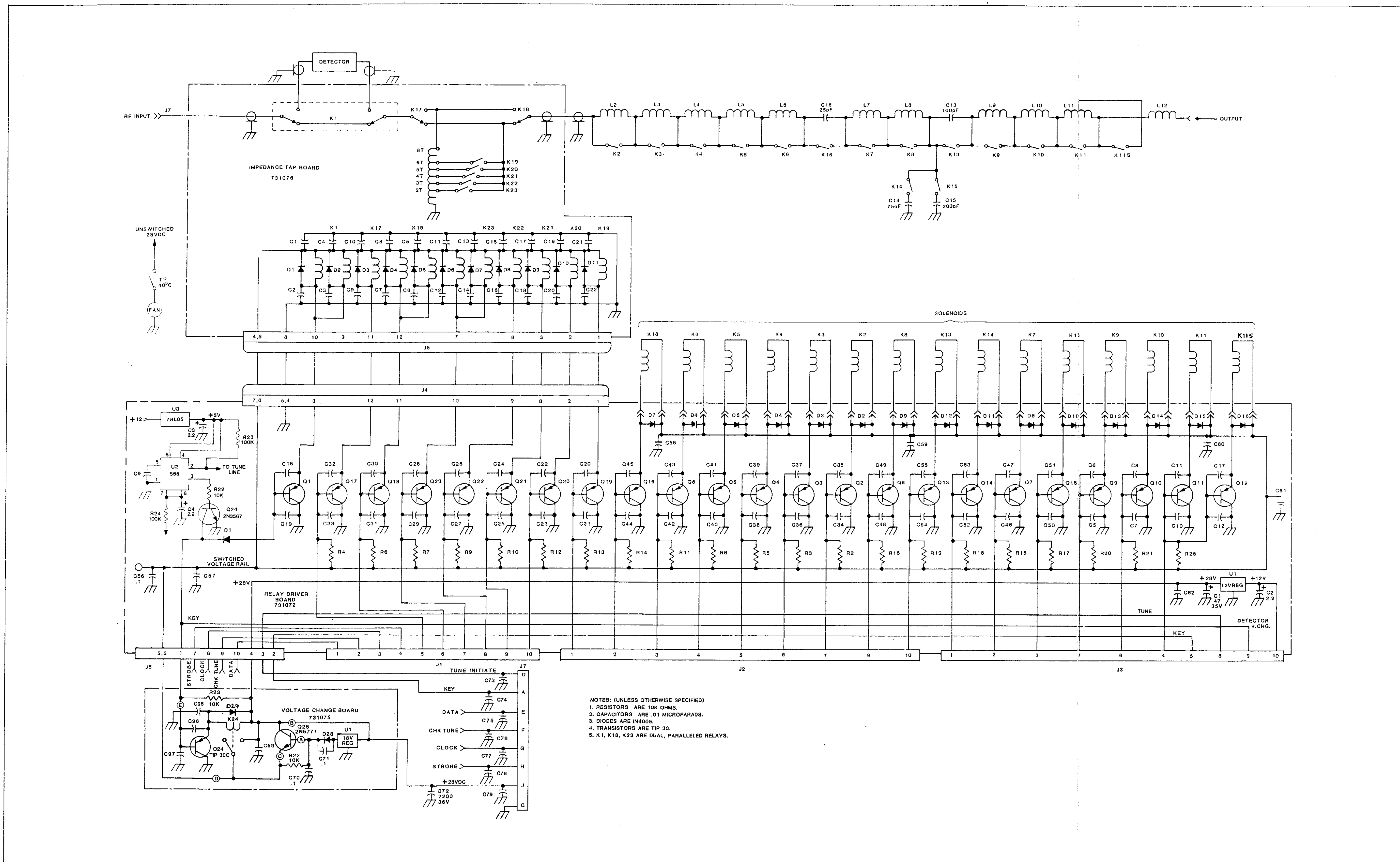


FIGURE 7-8. Schematic Diagram, Tuner.

TABLE 7-7. Parts List, Mainframe.

COIL BASE SUBASSEMBLY		
C13	216101	Capacitor, HV Door Knob, 100pF
C16	216250	Capacitor, Ceramic 25pF 7.5K
L2	460202	Inductor, Coil
L3	460203	Inductor, Coil
L4	460204	Inductor, Coil
L5	460205	Inductor, Coil
L6	460206	Inductor, Coil
CHASSIS SUBASSEMBLY		
C14	216500	Capacitor, HV Door Knob, 50pF
C14	216250	Capacitor, Ceramic 25pF 7.5k
C15	216101	Capacitor, HV Door Knob, 100pF
C73	211103	Capacitor, Disc 500V .01
C74	211103	Capacitor, Disc 500V .01
C75	211103	Capacitor, Disc 500V .01
C76	211103	Capacitor, Disc 500V .01
C77	211103	Capacitor, Disc 500V .01
C78	211103	Capacitor, Disc 500V .01
C79	211103	Capacitor, Disc 500V .01
K9	540105	Solenoid 24V
K10	540105	Solenoid 24V
K11	540105	Solenoid 24V
K115		
L10	460209	Inductor, Coil
L11	460210	Inductor, Coil
L12	460211	Inductor, Coil
L7	460206	Inductor, Coil
L8	460207	Inductor, Coil
L9	460208	Inductor, Coil
CHANNEL SUBASSEMBLY (Includes Relay Driver & Voltage Change Boards)		
C1	231470	Capacitor, Electrolytic 35V 47
C2	241020	Capacitor, Tantalum 2.2
C3	241020	Capacitor, Tantalum 2.2
C4	241020	Capacitor, Tantalum 2.2
C5	211103	Capacitor, Disc 500V .01
C6	211103	Capacitor, Disc 500V .01
C7	211103	Capacitor, Disc 500V .01
C8	211103	Capacitor, Disc 500V .01
C9	211103	Capacitor, Disc 500V .01
C10	211103	Capacitor, Disc 500V .01
C11	211103	Capacitor, Disc 500V .01
C12	211103	Capacitor, Disc 500V .01
C17-C55	211103	Capacitor, Disc 500V .01
C56	275104	Capacitor, Monolithic 50V .1
C57	211103	Capacitor, Disc 500V .01
C58	211103	Capacitor, Disc 500V .01

TABLE 7-7. Parts List, Mainframe, Continued.

CHANNEL SUBASSEMBLY - Continued
(Includes Relay Driver & Voltage Change Boards)

C59	211103	Capacitor, Disc 500V .01
C60	211103	Capacitor, Disc 500V .01
C61	211103	Capacitor, Disc 500V .01
C62	211103	Capacitor, Disc 500V .01
C69	211103	Capacitor, Disc 500V .01
C70	275104	Capacitor, Monolithic 50V .1
C71	275104	Capacitor, Monolithic 50V .1
C72	232222	Capacitor, Electrolytic 35V 2200uF
C95	211103	Capacitor, Disc 500V .01
C96	211103	Capacitor, Disc 500V .01
C97	211103	Capacitor, Disc 500V .01
D1-D16	320101	Diode, 1N4005
D28	320101	Diode, 1N4005
D29	320101	Diode, 1N4005
K2	540106	Solenoid, 24V
K3	540106	Solenoid, 24V
K4	540106	Solenoid, 24V
K5	540106	Solenoid, 24V
K6	540106	Solenoid, 24V
K7	540106	Solenoid, 24V
K8	540106	Solenoid, 24V
K13	540106	Solenoid, 24V
K14	540106	Solenoid, 24V
K15	540106	Solenoid, 24V
K16	540106	Solenoid, 24V
K24	540041	Relay SPDT 16A 24V
Q1-Q23	310083	Transistor, TIP30A
Q24	310003	Transistor, 2N3567
Q24	310083	Transistor TIP 30A
Q25	310008	Transistor 2N3771
R2	124103	Resistor, Film 1/4W 5% 10K
R3	124103	Resistor, Film 1/4W 5% 10K
R4	124103	Resistor, Film 1/4W 5% 10K
R5	124103	Resistor, Film 1/4W 5% 10K
R6	124103	Resistor, Film 1/4W 5% 10K
R7	124103	Resistor, Film 1/4W 5% 10K
R8	124103	Resistor, Film 1/4W 5% 10K
R9	124103	Resistor, Film 1/4W 5% 10K
R10	124103	Resistor, Film 1/4W 5% 10K
R11	124103	Resistor, Film 1/4W 5% 10K
R12	124103	Resistor, Film 1/4W 5% 10K
R13	124103	Resistor, Film 1/4W 5% 10K
R14	124103	Resistor, Film 1/4W 5% 10K
R15	124103	Resistor, Film 1/4W 5% 10K
R16	124103	Resistor, Film 1/4W 5% 10K
R17	124103	Resistor, Film 1/4W 5% 10K
R18	124103	Resistor, Film 1/4W 5% 10K

TABLE 7-7. Parts List, Mainframe, Continued.

CHANNEL SUBASSEMBLY - Continued,		
(Includes Relay Driver & Voltage Change Boards)		
R19	124103	Resistor, Film 1/4W 5% 10K
R20	124103	Resistor, Film 1/4W 5% 10K
R21	124103	Resistor, Film 1/4W 5% 10K
R22	124103	Resistor, Film 1/4W 5% 10K
R22	124103	Resistor, Film 1/4W 5% 10K
R23	124104	Resistor, Film 1/4W 100K
R23	124103	Resistor, Film 1/4W 5% 10K
R24	124104	Resistor, Film 1/4W 100K
R25	124103	Resistor, Film 1/4W 5% 10K
U1	230007	Transistor 7812CP8
U1	330022	IC, 7815
U2	330094	IC LM555CJ
U3	330025	IC, 78L05
IMPEDANCE TAP SUBASSEMBLY		
C1	211103	Capacitor, Disc 500V .01
C2	211103	Capacitor, Disc 500V .01
C3	211103	Capacitor, Disc 500V .01
C4	211103	Capacitor, Disc 500V .01
C5	211103	Capacitor, Disc 500V .01
C6	211103	Capacitor, Disc 500V .01
C7	211103	Capacitor, Disc 500V .01
C8	211103	Capacitor, Disc 500V .01
C9	211103	Capacitor, Disc 500V .01
C10	211103	Capacitor, Disc 500V .01
C11	211103	Capacitor, Disc 500V .01
C12	211103	Capacitor, Disc 500V .01
C13	211103	Capacitor, Disc 500V .01
C14	211103	Capacitor, Disc 500V .01
C15	211103	Capacitor, Disc 500V .01
C16	211103	Capacitor, Disc 500V .01
C17	211103	Capacitor, Disc 500V .01
C18	211103	Capacitor, Disc 500V .01
C19	211103	Capacitor, Disc 500V .01
C20	211103	Capacitor, Disc 500V .01
C21	211103	Capacitor, Disc 500V .01
C22	211103	Capacitor, Disc 500V .01
D1	320101	Diode, 1N4005
D2	320101	Diode, 1N4005
D3	320101	Diode, 1N4005
D4	320101	Diode, 1N4005
D5	320101	Diode, 1N4005
D6	320101	Diode, 1N4005
D7	320101	Diode, 1N4005
D8	320101	Diode, 1N4005
D9	320101	Diode, 1N4005
D10	320101	Diode, 1N4005
D11	320101	Diode, 1N4005

TABLE 7-7. Parts List, Mainframe, Continued.

IMPEDANCE TAP SUBASSEMBLY - Continued

K1	540041	Relay, SPDT 16A 24V
K17	540041	Relay, SPDT 16A 24V
K18	540041	Relay, SPDT 16A 24V
K19	540041	Relay, SPDT 16A 24V
K20	540041	Relay, SPDT 16A 24V
K21	540041	Relay, SPDT 16A 24V
K22	540041	Relay, SPDT 16A 24V
K23	540041	Relay, SPDT 16A 24V

NOTE: Unless otherwise specified, capacitance is in microfarads and resistance is in ohms.

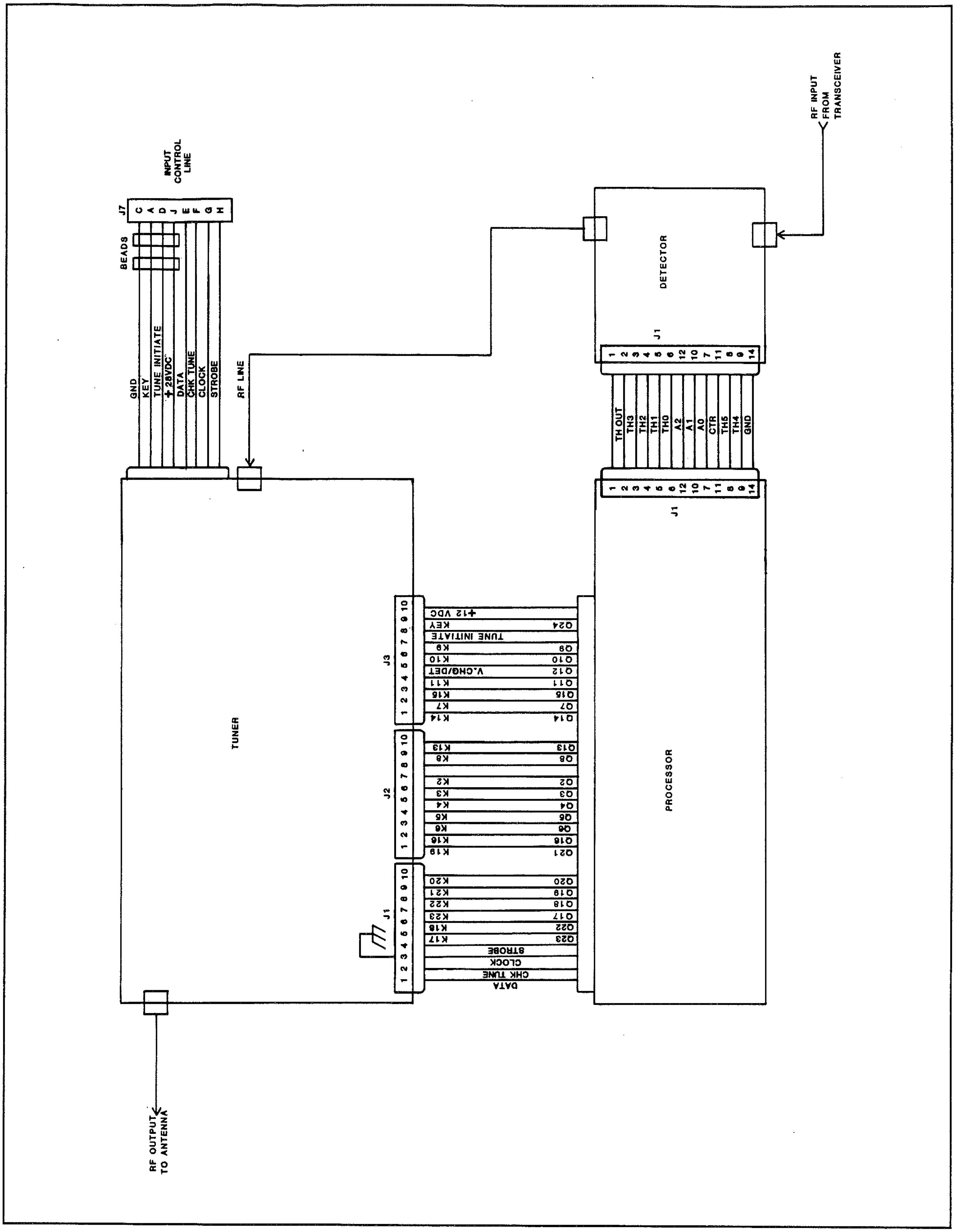


FIGURE 7-9. Mainframe Diagram.

SECTION 8
AUTO-TUNE OR MEMORY OPTION

8.1 GENERAL DESCRIPTION

The RT100/MP and TW100 series of transceivers can be configured to interface with the Automatic Antenna Tuner to provide either an Auto-Tune or Memory option. These options utilize the same hardware, but different software and are mutually exclusive. Neither option precludes the use of the transceiver front panel "tune button" for manual tuning which can be used anytime the operator desires. The options also affect only the "programmable" channels -- channel ØØ frequencies must still be tuned manually by depressing the tune button.

8.2 DESCRIPTION

8.2.1 AUTO-TUNE OPTION

The Auto-Tune option provides for automatic initiation of the coupler tune cycle under one of the following conditions:

1. After the channel has been changed, or
2. After the channel has been changed and the PTT has been engaged. It is possible to configure the option for either of the above conditions. See section 8.4 for instructions.

8.2.2 MEMORY TUNER OPTION

The Memory Tuner option provides for storage and retention of the antenna tuner settings on up to ten pre-programmed channels when used with the microprocessor controlled transceivers. A lithium cell is installed in the tuner's microprocessor module to achieve memory retention. The cell will not reach the end of its useful life in the service life of the tuner and should not require replacement.

8.3 OPERATION

Auto-Tune Option -- When configured for condition 1 of paragraph 8.2.1 (automatic initiation of the coupler tune cycle after the channel has been changed), the tune sequence will be initiated whenever a channel number is entered at the transceiver. When configured for condition 2 of paragraph 8.2.1 (automatic initiation of the coupler tune cycle after the channel has been changed and the PTT has been engaged), the channel must be changed and then the PTT must be activated to start the tune cycle. In both cases, the operator must wait for the tune cycle to be completed before beginning the transmission of information. The tune cycle is indicated by the presence of an audible tone.

Memory Tuner Option -- The tune sequence must first be manually initiated on each of the channels Ø-10 which are to be memorized. Thereafter, when any of those channels is selected, the tuner will set its network to the memorized setting. The time from the channel change until the tuner is set is approximately 30ms. In the case of the 1000W Tuner, the large solenoids require a longer time to transit. That time is of the order of 150ms. This retained setting may be changed at any time by manually initiating the tune sequence on that channel.

8.4 INSTALLATION HARDWARE MODIFICATIONS

When configured for condition 1 of paragraph 8.2.1, install R11 (100K, P/N 113104) and remove jumper "A-B." When configured for condition 2 of paragraph 8.2.1, remove R11 and install jumper "A-B." For Memory Tuner operation, install R11 and remove jumper "A-B."

8.5 TECHNICAL DESCRIPTION

The Auto-Tune and Memory Tuner options utilize the same circuit contained inside the transceiver. It is composed of three subsections -- a parity detector, a pulse generator, and a shift register. Refer to the transceiver technical manuals for the schematic diagram of the option circuitry.

The seven BCD channel lines from the Frequency Control Module, (M9MP), are connected to U1 and U2 in the Memory Tuner PCB. U2 is the parity detector whose output, pin 9, changes whenever the channel is changed. This signal in turn triggers the first stage of the dual monostable multi-vibrator ("one-shot"), U3.

When connected for condition 1 of paragraph 8.2.1, the first stage one-shot outputs a pulse on U3 pin 7, the width of which is controlled by R11 and C13. The width of this pulse is not critical and its rising edge triggers the second one-shot. When connected for condition 2 of paragraph 8.2.1, pin 7 will go low, and will not produce a rising edge until the PTT line, and hence pin 3, the reset for the first one-shot, is grounded.

The second one-shot produces a pulse approximately 20ms in width. In the Auto-Tune configurations, the second one-shot output, pin 9, is connected to the tune initiate line.

In the Memory Tuner configuration, pin 9 is connected to a special input in the antenna tuner's microprocessor module. This is the CHECK TUNE line, and the pulse indicates that the tuner should retrieve the channel number from the transceiver and set itself to the memorized setting, if any.

The antenna tuner then places a high logic level on the STROBE line, in order to parallel load the BCD channel data into the serial-out shift register, U1. The CLOCK line is then toggled high, then low again to accomplish this. The tuner then toggles the clock line eight times and reads the eight data bits in serial fashion. If the channel number is ten (10) or less, the memorized setting is output and the tuner awaits the next command. If the channel number is higher than ten (10), the tuner will default to the channel (10) setting and await the next command.

8.6 ANTENNA TUNER MODIFICATIONS
Inside the antenna tuner, some of the threshold output lines double in function as STROBE, CLOCK, and CHECK TUNE lines. The serial data is read in on the P23 line. The lithium cell added to the Processor Module is a 3Vdc nominal, 0.5AH cell which keeps the microprocessor's internal RAM memory at sufficient voltage for data retention when the power is off. The cell current, which remains below 10microAmps at all times, is fed to pin 40 of the microprocessor through a diode to prevent charging of the cell.

CAUTION

Shorting of the cell because of a diode failure or soldering of the cell with a grounded iron while the tuner is still connected can cause the cell to out-gas toxic materials or even explode. **Use extreme care** when servicing this portion of the circuit.

The terminal voltage for this type of cell is about 2Vdc. Whenever necessary, measure the cell voltage with the power to the tuner switched off. Replace the cell if it measures less than the terminal voltage. Remember to disconnect the tuner from all cables and grounds before soldering in the new cell.

If a problem is encountered with intermittent memory loss, observe the various power supply voltages with an oscilloscope as the transceiver's power is switched on and off. The rise and fall of the regulated +12V must be smooth and uniform. Any "jagged transitions" can cause memory loss problems. This is most often encountered in mobile installations as the engine is started or stopped. It may be necessary to install transient absorbers in the lines from the battery.