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THANK YOU AND 73 FROM ALL OF US AT TEN-TEC

TEN - TEC

OPERATOR'S MANUAL

Model 253
AUTOMATIC ANTENNA COUPLER

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SPECIFICATIONS

CIRCUIT TYPE:	Reversible "L" network.
RF POWER RATING:	2 KW maximum.
FREQUENCY RANGE:	1.8 to 30 MHz.
INPUT IMPEDANCE:	50 Ohms, nominal.
DC POWER INPUT:	12-14 Volts, 2 Amps maximum.
TUNING ACCURACY:	1.5:1 VSWR maximum after tuning. 2.5:1 VSWR maximum during tuning.
AUTOMATIC TUNING TIME:	5 seconds typical, 30 seconds maximum (from home position).
MANUAL TUNING:	Full range manual tuning available via front panel up/down switches.
MEMORY TUNING:	Tuner automatically returns to settings last used for each antenna switch position. Separate settings are stored for each band if remote band connector is used. Retuning (auto or manual) updates memory.
TUNE POWER:	50 Watts minimum, 150 Watts maximum. Radiated power at least 6 dB below input during tuning.
ANTENNA SWITCH:	4 position. Position 4 configurable for coax, single wire, or balanced line feed. Internal balun standard.
OUTPUT MATCHING RANGE:	At least 10:1 VSWR, any phase angle, 1.8 to 30 MHz. 1300 Ohms maximum parallel equivalent resistance at 1500 Watts output (2 KV peak, >26:1 VSWR). 5000 Ohms maximum parallel equivalent resistance across balanced line at 1500 Watts output (4 KV peak).
MINIMUM FULL POWER LONGWIRE LENGTH:	Single wire feed: 180/F (MHz) feet at 1500 Watts output.
OVER VOLTAGE:	"ARCING" indicator illuminates when RF voltage exceeds 2 KV. Tuner is reset to bypass mode if ARCING or OVER indication remains on for more than 1 second. Hot switching protection provided by internal relay interlock system.
SIZE:	HWD 5.5" x 14" x 10.5", overall (138 x 356 x 267 mm).
WEIGHT:	9 lbs 9 oz., (4.34 Kg).

INTRODUCTION

The Model 253 Automatic Antenna Coupler is an adjustable reactive network used for matching the unbalanced 50 ohm output impedance of transmitters and transceivers to a variety of balanced and unbalanced loads. It will automatically perform this function over a frequency range of 1.8 to 30 MHz. Capacitor and Inductor up/down switches are also provided for manual adjustment of the reactive elements. Provision is made for selecting one of four antennas or for bypassing the matching network. In addition, a built-in memory stores settings for each of the four antenna positions on each of seven band settings, giving a total of 28 memory combinations. A dual range power and SWR meter is also included.

UNPACKING

Carefully remove the antenna coupler from the packing carton and inspect it for signs of shipping damage. If the antenna coupler has been damaged, notify the delivering carrier immediately, stating the full extent of the damage. Save all damaged cartons and packing material. Liability for any shipping damage rests with the carrier. Complete the warranty registration form and mail to TEN-TEC immediately.

Save the packing material for re-use in the event that moving, storage, or reshipment is necessary. Shipment of your TEN-TEC antenna coupler in other than factory packing may result in damage which is not covered under warranty. The following hardware and accessories are packed with your Model 253. Make sure you have not overlooked anything.

1—#74020	Warranty Card
1—#74203	Operator's Manual
1—#86027-26	Cable-26 253

If any of the above items are missing, contact the customer service department at Ten-Tec for replacements.

CHAPTER 1

INSTALLATION

1-1 INTRODUCTION The Model 253 Automatic Antenna Coupler may be set up in any convenient location in your shack. The following sections describe the required connections.

1-2 TRANSMITTER CONNECTIONS The Model 253 is designed for connection to transmitters having a 50 ohm nominal output impedance. To protect the relays in the Model 253 from being hot switched, you **MUST** use the EXCITER CONTROL connections on the rear panel of the Model 253, as shown in FIGURES 2-4 through 2-11. If you will be using only a low power transmitter (less than 150 watts output), you may connect the transmitter as shown in FIGURE 2-6, which does

quality coax cable (RG-58) between the transmitter and the EXCITER CONTROL connectors. You may use either RG-58 or RG-8 coax cable for the INPUT connector.

Note: To reduce the possibility of rf getting into the transmitter, position the Model 253 as far away from the transmitter as is practical, especially when using a long wire antenna.

1-3 GROUND CONNECTIONS Connect the station ground buss to the GND terminal on the rear panel of the Model 253 with heavy metallic braid or wire. This lead should go directly to the earth ground system with as short a lead length as possible.

1-4 ANTENNA CONNECTIONS Connect

In both single wire and balanced line systems, take special care to route the transmission line as far away from station equipment as possible. Never drape lines over the transmitter. These lines may have high voltage points inside the shack which can produce strong rf fields and **a serious shock hazard**.

D. ANT 4 position can be coax, single wire or balanced line. ANT 1, 2 and 3 must be coax only.

NOTE: The SWR bridge power meter is in the circuit at all times, even in the BYPASS position.

1-5 DC POWER CONNECTION Connect a 12 to 14 VDC negative ground power source, capable of delivering at least 3 amperes, to the 12-14 VDC connector on the rear panel.

1-6 REMOTE CONTROL CONNECTIONS The Model 253 may be used without any connections to the REMOTE CONTROL connector. This connector is used for automatic bandswitching and/or band presets. For further information see section 2-3.5.

CHAPTER 2

OPERATING INSTRUCTIONS

2-1 INTRODUCTION The following instructions will enable the operator to quickly place the Model 253 Automatic Antenna Coupler into operation. Included are descriptions of the Front Panel controls and their functions followed by descriptions of the Rear Panel connections. Also included are instructions for antenna matching and selection, operating hints, and a discussion of antenna systems matching theory.

2-2 **FRONT PANEL CONTROL FUNCTIONS** The following sections describe the front panel controls and their functions. Refer to FIGURE 2-1 for control locations.

2-2.1 OPERATE / BYPASS SWITCH This rocker switch is used to apply or remove the 12-14 VDC from the Logic board. When the switch is in the BYPASS position all control circuits and relays are turned off and any rf applied to the INPUT is routed directly to the antenna connectors. The tuning network is disconnected from the system. The Power-SWR meter is still in line and may be used to monitor your forward and reflected power levels. Note however, that the meter pilot lamp and all annunciators will be turned off. Placing this switch in the OPERATE position applies the 12-14 VDC input power to the Logic board, turns on the meter pilot lamp, and enables all circuitry required for using the

band information has changed since the Model 253 was last used, then the preset memories for the new antenna and/or band settings will be recalled and the tuning network adjusted accordingly.

2-2.2 TUNE SWITCH This is a center off, spring return, momentary contact rocker switch, which is used to activate the automatic tuning procedure in the Model 253. To use this switch you must be in the OPERATE mode. Refer to section 2-4 for a complete tune up procedure and more detailed description of the TUNE switch's function.

2-2.3 MANUAL CAPACITOR/INDUCTOR SWITCHES These are spring return momentary rocker switches with a center off position. To use these switches you must be in the OPERATE mode. Pressing and holding the CAPACITOR switch in the up position will either increment or decrement the tuning capacitor one step at a time. Pressing and holding the switch in the down position will reverse the direction of the capacitor steps. The INDUCTOR switch functions in a similar manner to control a stepping motor attached to the roller inductor. When using the INDUCTOR switches you will notice a difference in motor speed depending on how long you hold the switch in. This occurs because the stepper motor speed must initially be ramped up

This ramp down is required because of the inertia of the roller inductor system. *NOTE: When using either the CAPACITOR or INDUCTOR switches, the direction of change is not readily apparent and will depend on the matching circuit configuration selected by the*

while in the OPERATE mode, the tune-up settings for the new antenna selection will be recalled and the matching capacitors and roller inductor will automatically be set to these new values. **Note: At this time the READY annunciator will not be turned on, even**

OVER — This yellow LED annunciator will be turned on whenever the input power level to the Model 253 exceeds 150 watts. If the "OVER" annunciator remains on for more than one second, then the "FAULT" annunciator will also be turned on. When this occurs, the EXCITER CONTROL relay will remove transmitter input power from the Model 253. **If the "OVER" annunciator comes on, you should immediately reduce the transmitter power level or turn the transmitter off.**

READY — This green LED annunciator will be turned on after the Model 253 has successfully completed its auto-tune routine. When this annunciator is on the Model 253 is tuned-up and you can proceed to operate at a higher power level if desired. When tuned-up the SWR will typically be less than 1.3 to 1.

ARCING — This is a red LED annunciator which will be turned on whenever internal rf voltages are dangerously high (typically greater than 2 KV). When this annunciator comes on it usually means that there is something seriously wrong with your antenna or feedline (possibly open or shorted), or that you may have the ANTENNA switch

problem by changing your feedline lengths. This annunciator will also be turned on for conditions of excessive input power while tuning up ("OVER"), and for excessive internal rf voltages possibly due to antenna problems ("ARCING"). When a "FAULT" condition occurs, the EXCITER CONTROL relay will be turned on to remove rf from the INPUT connector of the Model 253. After a short delay (about 100 mS), the tuning network is placed in the bypass position and any power applied to the EXCITER CONTROL IN connector is fed to an internal load resistor. This protection system is required to prevent possible damage to the relay contacts caused by hot switching of the relays when going from their auto-tune position into the bypass position. **The "FAULT" annunciator can only be cleared by placing the front panel switch, S4, into the STANDBY position and then back into the OPERATE position.**

2-3 REAR PANEL CONNECTIONS The following sections describe the rear panel connectors and their function. Refer to FIGURE 2-2 for the connector locations

annunciator will come on immediately after the "ARCING" and the Model 253 will be disconnected from the line to protect its circuitry. **If the "ARCING" LED comes on, shut down your transmitter and check your antenna and feedline before trying to tune**

2-3.1 INPUT COAX CONNECTOR This connector is an SO-239 type and is designed to mate with a PL-259 coaxial cable connector. This INPUT should be connected to your transmitter rf output connector with a short length of good quality 50 ohm coaxial cable, connected to your exciter's rf output connector. The OUT connector is usually connected to the rf input of your linear amplifier or the INPUT of the Model 253. However, if you are using the Model 253 with Ten-Tec transceivers having TX OUT and TX EN connections, the IN connector should go to the transceiver TX OUT connector and the OUT connector should go to the transceiver TX EN connector. Refer to FIGURES 2-4 through 2-8 for more detailed information. Use a good quality coax cable such as RG-58 for these connections. **Do not use shielded audio cables**. UHF-to-phono adapters are available at most elctronics supply stores to enable you to use PL-259 coaxial connectors for these cables. To reduce the possibility of rf getting back into your transmitter, the Model 253 should be placed as far away from the transmitter as is practical. This is especially important when using a long wire antenna.

2-3.3 ANT 1 — ANT 4 CONNECTORS These are SO-239 type coaxial connectors designed to mate with PL-259 type cable connectors. Connectors ANT 1, ANT 2, and ANT 3 should be used with coax-fed antennas (unbalanced transmission lines). Connector ANT 4 can be used with coax, single wire or a balanced line (requires a jumper wire).

2-3.4 SINGLE WIRE AND BALANCED LINE For a single wire antenna, connect to the SINGLE WIRE terminal or to connector ANT 4. For balanced feed line systems, connect a short jumper wire (16 to 18 gauge) provide rapid tune up from the memorized presets. The seven band programming lines and four antenna positions yield a maximum of 28 possible preset combinations. For further information on how the memory presets work, see section 2-6. To use the Model 253 with Ten-Tec transceivers having band information output, you will need to have one Model 236 Remote Control Cable. If you intend to use the band information with a Ten-Tec Model 420 Linear Amplifier and also with the Model 253, then you must have one Model 236 Remote Control Cable and one Model 264 Remote Control Extension Cable. Refer to FIGURES 2-4 and 2-5 for the correct interconnections. If you wish to build your own cable, use a Molex® 15 pin plug (03-06-2151) and Molex® male pins (02-06-2103) to connect to the REMOTE CONTROL receptacle on the rear of the Model 253. These parts are available from the Ten-Tec Service Department under part numbers 35205 and 41023 respectively.

Note: Some transceivers may use the same band select line for operation on more than one band. If you change to a band which shares a common output line with your previous band setting, the Model 253 will not detect that a band change has occurred. In this case, you will have to tell the Model 253 to auto tune the new band by pressing the TUNE switch.

The pinout designations and functions are listed below for your reference. Typical

REMOTE CONTROL PINOUTS

PIN NO.	FUNCTION
1	BAND SELECT #1
2	BAND SELECT #6
3	NOT USED
4	BAND SELECT #2
5	BAND SELECT #7
6	NOT USED
7	BAND SELECT #3
8	NOT USED
9	REMOTE READY LED OUTPUT
10	BAND SELECT #4
11	GROUND
12	NOT USED
13	BAND SELECT #5
14	NOT USED
15	REMOTE TUNE SWITCH INPUT

Pin #9 is an auxiliary "READY" output line

2-3.6 DC POWER INPUT This is an RCA type phono connector used to supply all dc operating power for the Model 253. It should be connected to a well regulated dc power supply capable of supplying at least 3 Amperes at 12-14 VDC. A cable (#86027-26) is provided with the Model 253. If you need a longer cable, be sure to use wire no smaller than 18 gauge and keep the length as short as possible to minimize loss. If desired, a good quality shielded cable may also be used, but this is usually not necessary.

2-3.7 FUSE To protect the internal control circuits from excessive current in the event of a major component failure, a 4 Ampere Slow Blow fuse should be used. Typical operating current required by the Model 253 is between

OMNI-VII

"I was struck by how clean, natural and quiet the receiver sounded in comparison to some DSP based radios. I found the Omni-VII a real pleasure to listen to – in any mode." – W1ZR, in the ARRL Product Review, QST July 2007

"What a neat little package! I'm having more fun with this thing!" – K1SA

"In 40+ years and many receivers, the Omni-VII is the most sensitive, most QRM proof and most pleasant to operate I have enjoyed. The noise blanker and noise reduction systems really help me in dealing my sometimes noisy location." – K6LE

"High quality manufacturing...overall a very impressive transceiver" – W9AC

"As an avid CW operator, it is like listening to your favorite music while operating." – N1SW

"Once again, Ten-Tec has produced a superb transceiver, with great SSB audio and their famous QSK." – K4SQR

"Close-in dynamic range unsurpassed by any other general coverage radio." – Radio Society of Great Britain RadCom review, September 2007

"I can say that in my 30+ years of operating I've never enjoyed a rig more than the Omni-VII. The audio is superb as is the QSK, ergonomics, receiver characteristics and on and on." – W7TEA

"My Dad, KB2LAU, in Florida has become active again using my Omni-VII in Vermont. He is enjoying daily contacts [via Internet remote control]. Being a ham with limited to no antenna options, this has been a great opportunity." – W1ZN

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3. Place the METER switch in either the 2 KW or 200 W position.

increase. To obtain an accurate SWR reading at the higher power level you must readjust the meter SET point

4. Press and release the TUNE switch. You will hear the relays click and the roller inductor will be placed at its minimum value. The TUNING annunciator will light followed shortly by the UNDER annunciator.

5. Key your transmitter and increase your output drive level until the UNDER annunciator turns off.

6. The Model 253 will now begin its auto-tune routine and you will hear the rapid clicking of the capacitor select relays and the whirring of the stepper motor and roller inductor. Tuning time will vary from about 1 second up to a maximum of about 30 seconds. In general, the higher frequency bands will tune up

8. Once the Model 253 has found an optimum match you may wish to verify that the SWR is sufficiently low by placing the METER switch in the SET position and keying your transmitter. Using the SWR SET control adjust the meter to the full scale SET mark. Place the METER switch in the SWR position and read the SWR on the lower meter scale. A reading less than 1.5 is usually acceptable.

9. If you wish to try to improve the match manually, you can use the CAPACITOR and INDUCTOR switches to adjust the matching network for a lower SWR reading. You will have to alternate between capacitor and inductor changes

5. **When finished, cycle the STANDBY/ OPERATE switch to STANDBY and back to OPERATE to reset the tuning network.**

2-5 ANTENNA SELECTION A maximum of four antennas may be connected to the Model 253 at one time, only one of which may be a wire fed antenna.

ANTENNA switch position 4 feeds ANT 4, SINGLE WIRE or with a jumper wire, BALANCED LINE. Only one antenna, coax, single wire or balanced line feed may be selected at one time. When using either ANT 4 (coax) or the SINGLE WIRE terminal, **do not** connect the jumper between SINGLE WIRE and one BALANCED LINE terminal as damage to the balun may result.

2-6 MEMORY PRESETS The Model 253 contains a non-volatile RAM for storage of memory preset information. This information is used for rapid preset tune ups when changing antenna or band switch settings. Details of memory operation are described below.

2-6.1 BAND INFORMATION There are seven band select lines available at the REMOTE CONTROL connector on the rear panel. These lines can be connected to a transceiver's band output connector or an external selector switch as described in section 2-3.4. Normally these lines are all pulled to ground by resistors on the Logic board. By applying a positive 10 to 14 VDC to these lines, only one at a time, seven possible band settings are available.

2-6.2 ANTENNA INFORMATION There are four possible ANTENNA switch positions available. Since there are seven band settings available, each with four possible antenna settings, a total of up to 28 combinations can be stored in memory.

2-6.3 MEMORY OPERATION When the TUNE switch is momentarily pressed and released, the Model 253 begins its auto-tune routine and trys to match the selected antenna system. If the match is successful, the READY annunciator comes on and the matched capacitor and inductor values are saved in a memory location determined by the current band and antenna switch settings. If for some reason the antenna can't be matched, (too high an SWR for example) a special BYPASS code is stored instead of the normal capacitor and inductor values. This BYPASS code will also be saved if the tune up procedure results in a FAULT indication. If you change band settings or antenna positions while the Model 253 is in the OPERATE mode, the new capacitor and inductor values will be recalled from the memory location determined by your new band and/or antenna selection. The capacitor and inductor will quickly be set to these new positions.

Note: There will be a delay of about one second from the time you change band or antenna settings until the Model 253 updates the capacitor and inductor settings. This delay is necessary to eliminate any possibility of false readings on the band and antenna switch lines caused by changing more than one step at a time. Also, after the completion of the capacitor and inductor update, the READY annunciator will NOT be turned on. The READY annunciator will be turned on immediately after you press the TUNE switch if the recalled settings provide an acceptable match.

If the recalled memory contains the special BYPASS code, then the capacitor and inductor will not be changed and the tuning network will be removed from the line for straight-through operation.

2-6.4 PROGRAMMED BYPASS

Occasionally you may wish to use a selected antenna and band combination that already has a good match and does not need to be tuned. To do this, first select the desired band and antenna settings. Then initiate the auto-tune routine by pressing and releasing the TUNE switch as usual, however, don't apply any transmitter power to the Model 253. The UNDER annunciator will turn on and after about ten seconds the Model 253 will power down and turn off all annunciators. Just before it powers down, it will store the special BYPASS code in the selected band/antenna memory location. Whenever this location is recalled in the future, the Model 253 will be placed in a straight-through bypass condition instead of going through the auto-tune routine.

2-6.5 SKIP MEMORY OPTION This is a memory option that will allow you to perform the auto-tune routine but will not cause the preset memories to be changed. Use this technique when you wish to experiment with different antenna and band combinations, but don't want to affect the memory presets you have been using. To use this option follow the auto-tune procedure as usual, except when you press the TUNE switch, **hold the TUNE switch in for more than 2 seconds before releasing it**. This will tell the program not to save the new capacitor and inductor values

have been checked and aligned at the factory. Occasionally, however, the stepper motor position and roller inductor position may lose alignment. This is most likely to occur when dc power is suddenly removed from the Model 253 logic circuits while in the middle of the auto-tune routine. Possible symptoms for this condition include the inability to match antenna systems which previously could be matched or a longer than usual tune up time. If you suspect that the alignment is off, simply perform the following steps to properly align the stepper and roller inductor.

1. Place the OPERATE/BYPASS switch in the OPERATE position.

2. Simultaneously place the manual CAPACITOR and INDUCTOR switches in the up (top) position and keep them depressed for about 1 second.

3. Simultaneously release both switches. You will hear the stepper motor and roller inductor begin operating. Within a few seconds you should hear a clacking sound as the roller inductor hits the built-in safety stop. Once the noise stops, the stepper motor and roller inductor will again be aligned and you can proceed to use the Model 253 as usual. *Note: This procedure will not harm any of the components in the*

indication that a significant portion of the transmitter power is being lost in the balun. This will be the case when the antenna impedance is greater than 5000 ohms. Changing the

IF NO LOAD IS CONNECTED. IN SUCH CASES THE "ARCING" ANNUNCIATOR WILL USUALLY BE TURNED ON TO ALERT YOU into the surrounding medium depends on many factors — length, frequency, amount of current, configuration, etc. Since the antenna absorbs power from the device feeding it, it can be replaced with a resistance whose value is such that the power delivered to this resistance is the same as that delivered to the antenna. The value of this resistance is now a measure of the radiating effectiveness of the antenna and is termed "radiation resistance". For a given value of antenna current, the higher this resistance, the more power that is radiated. ($P=I^2R$)

Due to the facts that an antenna has physical length, that currents travel at a velocity less than instantaneous and that the conductor possesses a certain amount of self-inductance and capacitance, the current at the feed point may not be in phase with the voltage at this point. As a result, the impedance at this point may not look like the pure resistance first suspected, but as an impedance consisting of resistance and either inductive or capacitive reactance. This added reactance will limit the amount of current supplied to the antenna for a given voltage, and therefore reduce the

cancelling out the reactance of the antenna, leaving only the 50 ohms resistive. This can be looked on as a series R,L,C circuit that is in resonance, whose total impedance is only that of the resistance. Another term for this approach to maximize power transfer is "conjugate impedance matching".

In the above example, we used a value of 50 ohms for the radiation resistance. If this value were not 50 but 150 ohms, the impedance after cancelling the reactance out would be 150 ohms. Connecting this load to the transmitter designed to operate with 50 ohms load would not result in optimum power transfer. It would, however, be better than leaving the inductive reactance in, since the antenna current is maximized for the conditions that do exist. To obtain design performance, it is necessary to transform the 150 ohms to 50 ohms. This can be done with a transformer with a turns ratio of 1.73 to 1. (Impedance transformation is equal to the square of the turns ratio). It is also possible to accomplish this transformation with a parallel tuned circuit with primary and secondary taps properly

2-10.2 THE TRANSMISSION LINE In the above example, we assumed that the transmitter output was connected directly to the feed point. This is hardly practical. So that the transmitter can be located at a distance from the antenna, we use a transmission line to deliver the power. Unless we have a perfectly matched system, i.e. antenna, line and transmitter output impedances all the same value without reactive components, the addition of the transmission line completely changes the

to balanced configuration, it will radiate power. In the case of parallel lines, the current in one conductor at a given location should be flowing in the opposite direction to the current in the adjacent conductor, and if the system is well balanced, the amplitudes of the two will be equal. Under these conditions, the two sets of fields exactly cancel each other and very little radiation will result. If the two currents are not equal or not in exact opposite phase, there will be radiation. Also, if the spacing

2-10.3 TRANSMISSION LINE EFFECT ON ANTENNA IMPEDANCE As a result of all of the above, in situations where we do not have a matched system throughout, and this is most of the time, the impedance presented to the transmission line by the antenna sets up standing waves on the line. These standing waves will alter the antenna impedance all along the line towards the transmitter. What we really want to accomplish with the antenna tuner is to take whatever impedance that is established at the transmitter end of the line and alter it to a 50 ohm resistance. Then the transmitter will be happy, at least. The tuner will not affect the mismatch of antenna to line — only constructing the antenna differently will do that — nor eliminate a standing wave on the transmission line. It will eliminate a standing wave on the line between transmitter and tuner input, but not on the output side of the tuner. A good antenna is still needed to "get out". If the antenna has a low resistance, the tuner will transform it, along with the cable loss resistance, to 50 ohms. The full power will enter the system, but it will be divided between radiation and cable heat loss. It is not uncommon that more than half of the

2-10.4 STANDING WAVE RATIO A measure of how badly a system is mismatched is given by the standing wave ratio (SWR) on the line. SWR is the ratio of the maximum voltage encountered along a transmission line, greater than one half wavelength long, to the minimum voltage. It is also the ratio of maximum to minimum current. The more nearly uniform the voltage distribution along the line, the more closely matched it is, and the ultimate is when the voltage is constant down the length of a lossless line, or drops slowly and uniformly along a line with losses. This is the matched condition, represented by a 1 to 1 SWR. The impedance at the load end of such a line is the same as that at the generator end and maximum power is delivered to the load. When adjusting a matching network properly, the way to do it is to observe the SWR and tune for as low a ratio as possible.

The SWR is also an indication of the value of resistance at the load end. The ratio is the same as the ratio of load resistance to line characteristic impedance. This ratio can mean that the load is either greater than or less than the line's impedance. For example, if the SWR on a length of 50 ohm line is 3 to 1, the

2-10.5 OVERALL SUMMARY

1. Any antenna can be represented as an equivalent resistive/reactive impedance whose resistive component, termed radiation resistance, is a measure of the power radiated. Reactance can be either inductive or capacitive.

2. Antenna impedance is a function of frequency, configuration, selection of feed point location, height above the

7. Due to slowing down of the current flow in the transmission line from that in free space, the electrical length of a line will be longer than the physical length.

8. One special situation where the line does not alter the impedance is when its length is an exact multiple of the electrical half wavelength.

9. An antenna tuner will <u>not</u> affect the

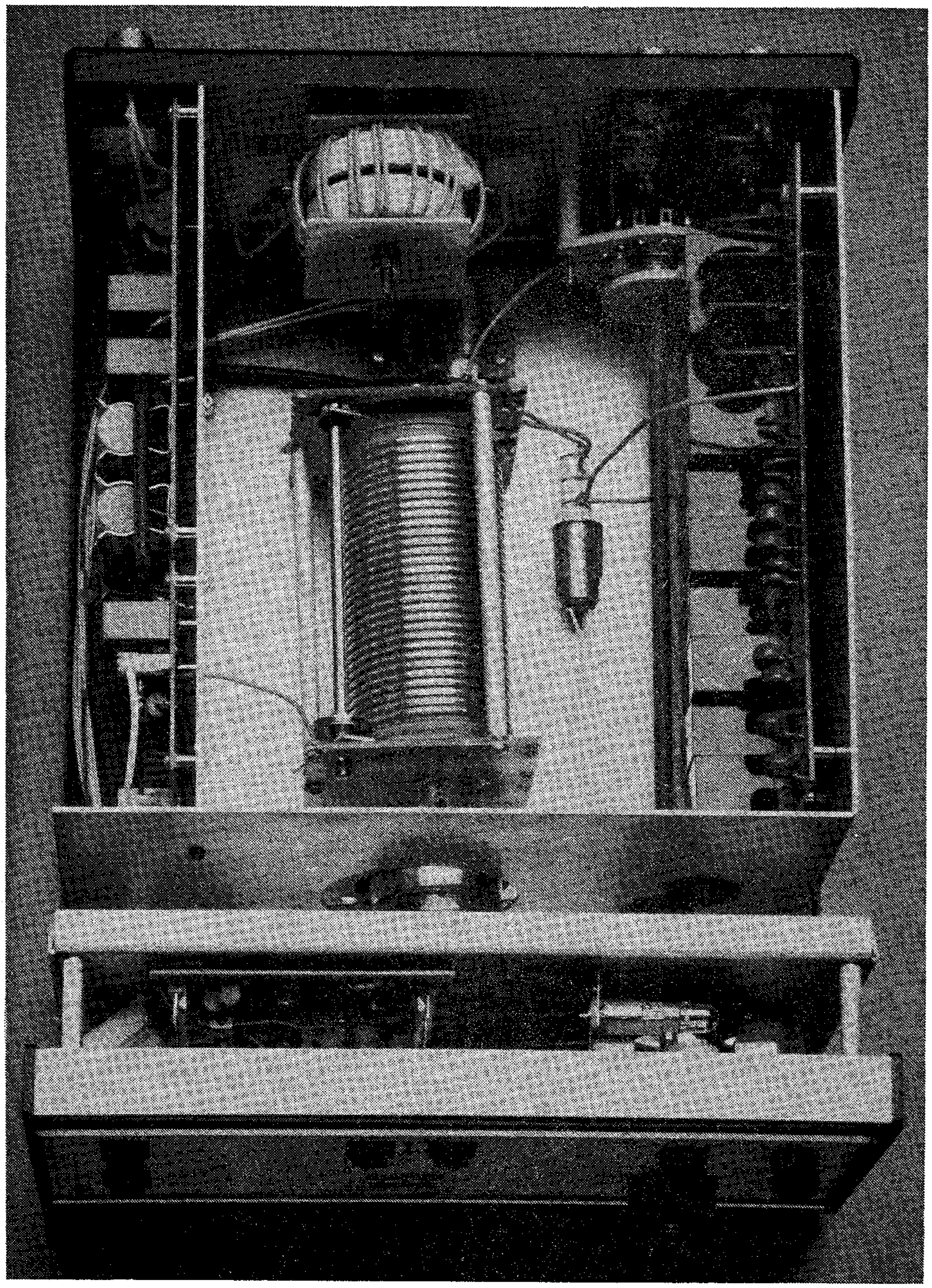


FIGURE 2-3. MODEL 253 INSIDE VIEW

SPECIAL NOTE: NEVER install station coaxial accessories, such as a Low Pass Filter, between the Model 253 and your antenna. The power ratings on the accessories will be greatly reduced. Install them between the transmitter output and the INPUT to the Model 253.

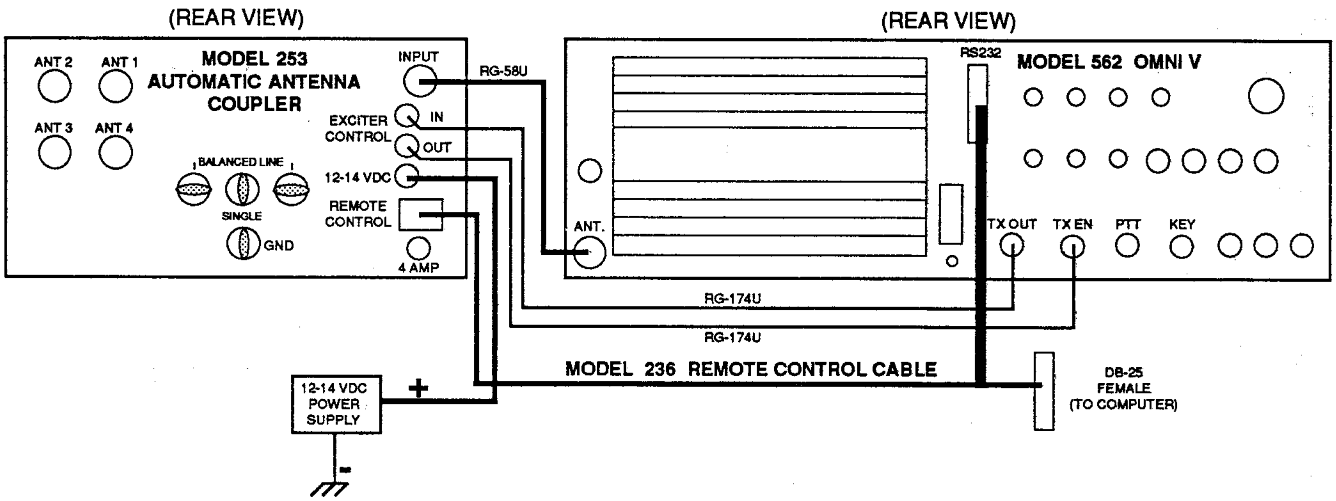


FIGURE 2-4. MODEL 253 WITH TEN-TEC TRANSCEIVER

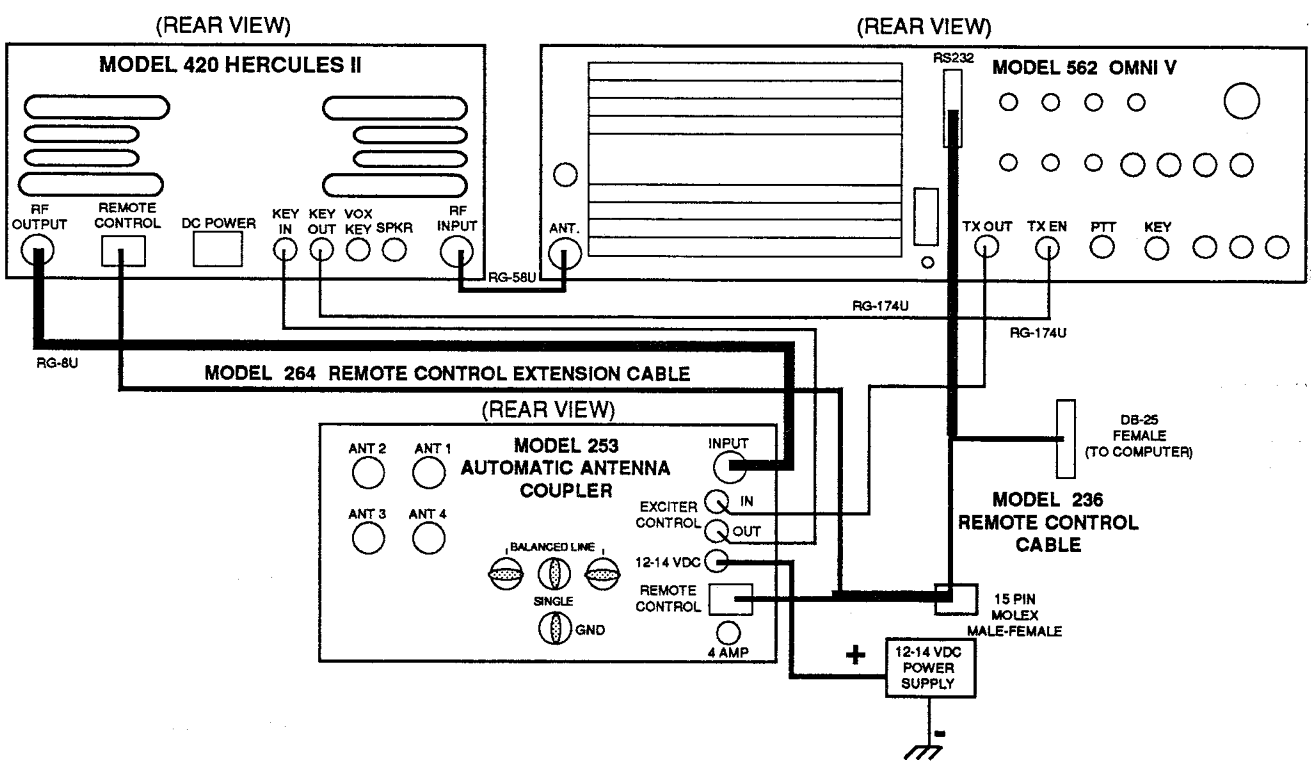
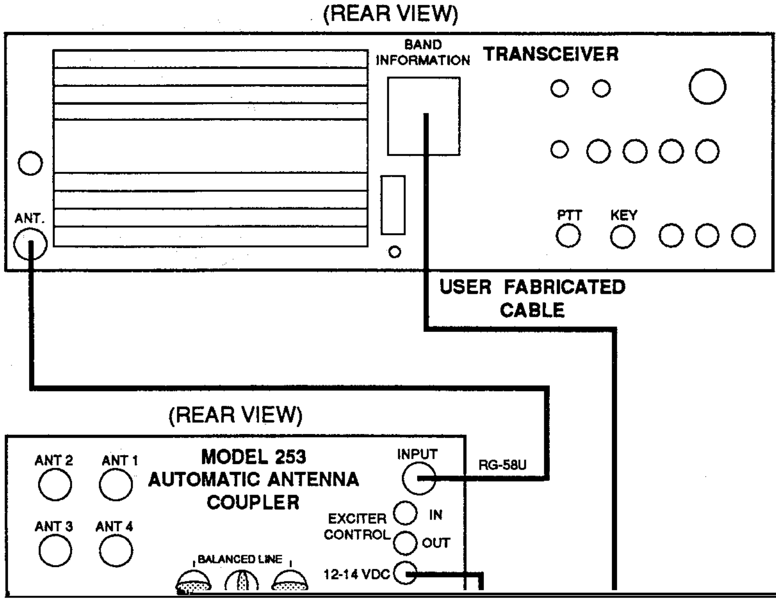
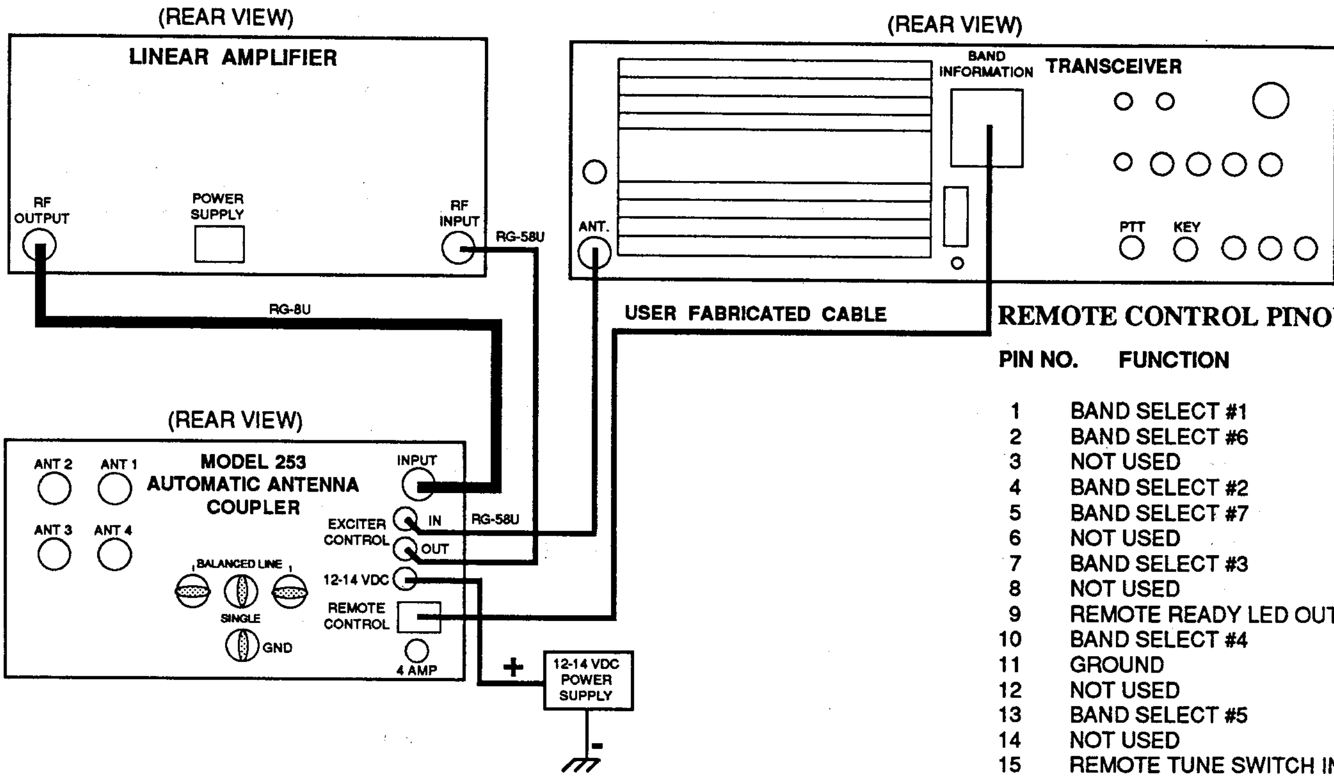


FIGURE 2-5. MODEL 253 WITH TEN-TEC TRANSCEIVER AND MODEL 420 AMPLIFIER



REMOTE CONTROL PINOUTS

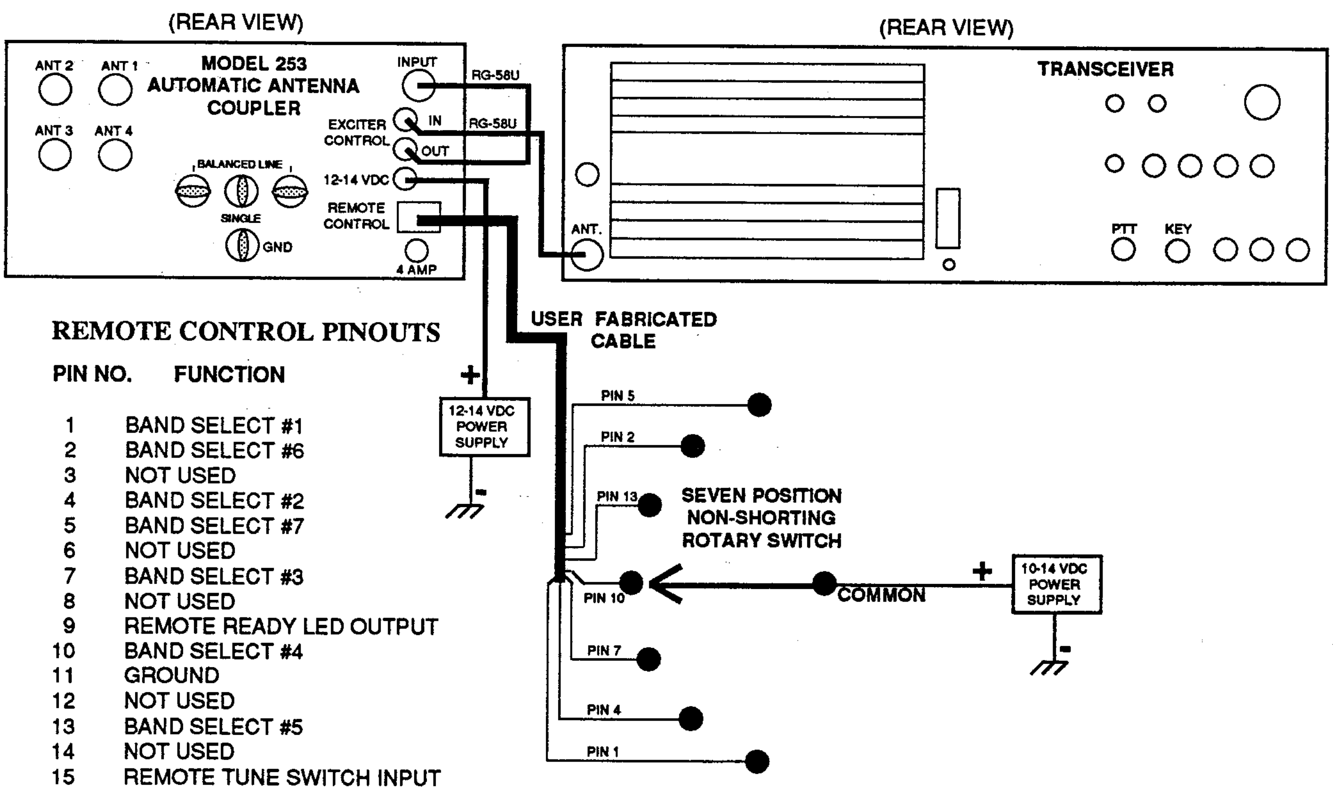
PIN NO.	FUNCTION
1	BAND SELECT #1
2	BAND SELECT #6
3	NOT USED
4	BAND SELECT #2
5	BAND SELECT #7
6	NOT USED
7	BAND SELECT #3
8	NOT USED
9	REMOTE READY LED OUTPUT



REMOTE CONTROL PINOUTS

PIN NO.	FUNCTION
1	BAND SELECT #1
2	BAND SELECT #6
3	NOT USED
4	BAND SELECT #2
5	BAND SELECT #7
6	NOT USED
7	BAND SELECT #3
8	NOT USED
9	REMOTE READY LED OUTPUT
10	BAND SELECT #4
11	GROUND
12	NOT USED
13	BAND SELECT #5
14	NOT USED
15	REMOTE TUNE SWITCH INPUT

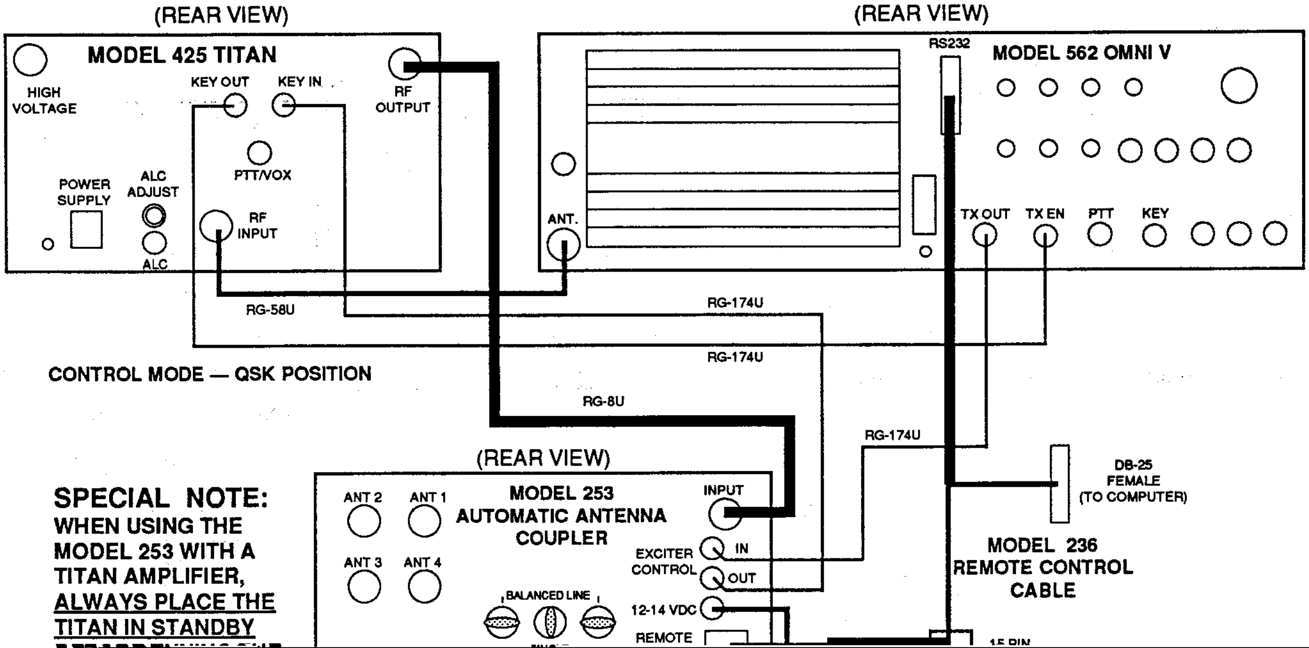
FIGURE 2-8. MODEL 253 WITH OTHER TRANSCEIVER AND AMPLIFIER



REMOTE CONTROL PINOUTS

PIN NO.	FUNCTION
1	BAND SELECT #1
2	BAND SELECT #6
3	NOT USED
4	BAND SELECT #2
5	BAND SELECT #7
6	NOT USED
7	BAND SELECT #3
8	NOT USED
9	REMOTE READY LED OUTPUT
10	BAND SELECT #4
11	GROUND
12	NOT USED
13	BAND SELECT #5
14	NOT USED
15	REMOTE TUNE SWITCH INPUT

FIGURE 2-9. MODEL 253 WITH REMOTE SELECTOR SWITCH



SPECIAL NOTE:
WHEN USING THE MODEL 253 WITH A TITAN AMPLIFIER, ALWAYS PLACE THE TITAN IN STANDBY

CHAPTER 3

CALIBRATION AND SERVICE

3-1 INTRODUCTION The following sections contain calibration and service procedures for the Model 253. These are followed by a trouble shooting chart. There are very few adjustments required and usually if a component fails or is damaged you should return the Model 253 to the factory for service. We suggest that you contact our customer service department prior to returning the unit. Also, be sure to include a note listing all problems encountered and any information that might prove helpful in servicing the unit.

3-1.1 SWR BRIDGE The SWR bridge is permanently calibrated at the factory and should not be modified.

3-1.2 WATTMETER CALIBRATION To calibrate the built-in wattmeter proceed as follows:

1. Remove top cover from Model 253.

2. Connect a 50 ohm dummy load to any

5. Set the METER switch to the 200 W position.

6. Apply 50 to 100 watts from the transmitter and adjust R2 (on the 81487 METER SWITCH board) to agree with an external wattmeter of known accuracy.

7. Set the METER switch to the 2 kW range.

8. Apply 500 to 1000 watts from the transmitter and adjust R1 (on the 81487 METER SWITCH board) to agree with the external wattmeter.

9. Turn off transmitter and install top cover.

3-1.3 PILOT LAMP REPLACEMENT The meter lamp is a 6.3 volt, bayonet type, No. 47. Access to this bulb is obtained by removing the top cover of the unit.

SYMPTOM	POSSIBLE CAUSE
Model 253 dead, no meter illumination, no annunciators, manual switches don't work.	Check Operate/Bypass switch, should be in Operate position. Check Fuse on rear panel of Model 253. Check power switch on power supply. Check power cable. Check power supply for correct voltage.
FAULT comes on during auto-tune.	Check ANTENNA switch for correct position. Make sure it is not set to an open position. Check SWR with switch S4 in BYPASS position. It should not be greater than 10 to 1. Check antenna and coax for shorted or open connections. If FAULT occurs only at higher frequencies, try changing antenna feedline length.
FAULT and ARCING come on in transmit.	Check ANTENNA switch for correct position. Make sure it is not set to an open position. Check antenna and coax for shorted or open connections. If operation is normal on this antenna on other frequencies, try changing feedline length.
OVER comes on during auto-tune.	Reduce transmitter drive level. Check transmitter output power level. It must be less than 150 watts during tune up.
OVER and FAULT come on during auto-tune.	Reduce transmitter drive level. Check transmitter output power level. It must be less than 150 watts during tune up.

CHAPTER 4

CIRCUIT DESCRIPTIONS AND ILLUSTRATIONS

4-1 INTRODUCTION The following sections contain detailed circuit descriptions for all of the printed circuit board subassemblies used in the Model 253 Automatic Antenna Coupler. Also included are circuit trace drawings and detailed component layout diagrams. These drawings are followed by schematic diagrams for each circuit board subassembly.

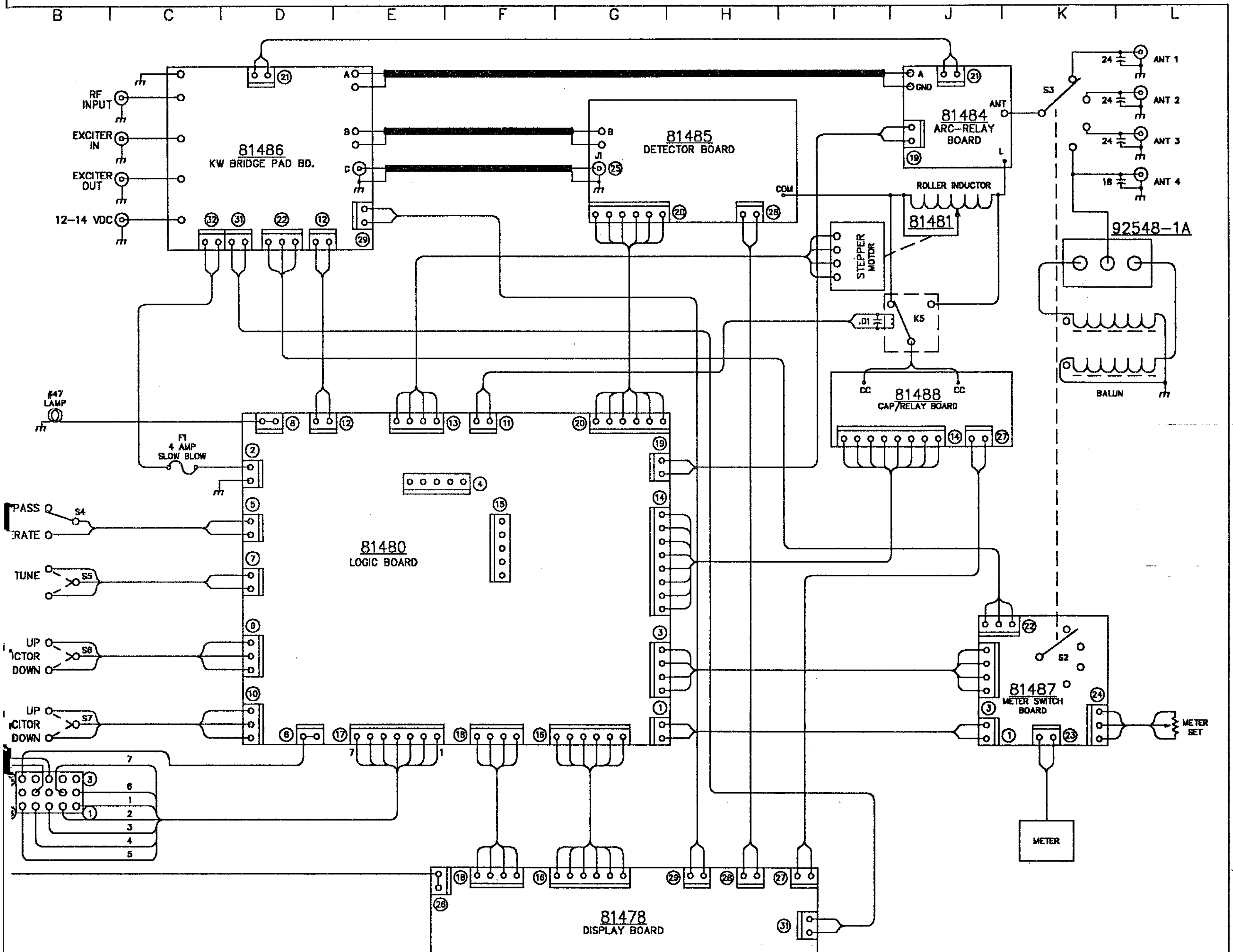


FIGURE 4-1 | WIRING DIAGRAM | 253

4-2 THEORY OF OPERATION The problem of matching a 50 Ω transmitter to an unknown antenna impedance can be solved by several different circuit configurations. For the Model 253 Automatic Antenna Coupler, a reversible low pass L-network was chosen over a PI or TEE configuration for the following reasons:

1. After tuning, the bandwidth of the match is wider than can be obtained with a single section PI or TEE network and, for a given inductor Q, the loss is lower. This means that after tuning on a given frequency, larger excursions from that frequency can be tolerated without having to retune. Also, lower inductor loss translates to higher coupler efficiency.

2. The L-network offers the lowest component count possible for a general impedance matching network. This is especially important in an automatic coupler since the component values must be variable. Each additional network component requires another motor or relay bank to adjust its value.

currents. Any network with internal nodes or loops can develop voltage or current stresses on internal components that are several orders of magnitude higher than would be expected based on external conditions.

4. For an L-network, there is only <u>one</u> set of component values that provides an impedance match to any given load. Therefore, when a match is found, it is automatically the "best match" (lowest loss and widest bandwidth). PI and TEE networks can produce a match at several different settings, each with a different circuit Q.

5. The lowpass configuration of the L-network provides 2 additional poles of harmonic filtering at the transmitter output. This can help reduce TVI caused by harmonic and high frequency spurious outputs of the transmitter. Many antenna tuners use a <u>highpass</u> circuit configuration. Although a properly operating highpass tuner will not <u>cause</u> TVI, it will not help it either!

6. With only two variable circuit elements

The diagrams in FIGURE 4-2 represent "smith" charts in which all possible load impedances Z are mapped inside the circle bounded on the horizontal axis by R=0 and R=∞. All points above the horizontal axis represent impedances with positive phase angles and all points below the horizontal axis represent impedances with negative phase angles. Points <u>on</u> the horizontal axis have a

to the center of the smith circle." Also, since the proper <u>configuration</u> is not entirely determined by quadrant boundaries (notice the dashed line in the right hand smith chart dividing quadrants II and IV into circuit 1 and circuit 2 areas), the algorithm must determine somewhere along the way "which network configuration to use."

The entire tuning algorithm of the Model

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2. The L-network offers the lowest component count possible for a general impedance matching network. This is especially important in an automatic coupler since the component values must be variable. Each additional network component requires another motor or relay bank to adjust its value.

3. There are no "internal" nodes or loops in an L-network. This means that the voltages and currents inside the coupler are never higher than the input and output voltages and currents. Any network with internal nodes or loops can develop voltage or current stresses on internal components that are several orders of magnitude higher than would be expected based on external conditions.

4. For an L-network, there is only <u>one</u> set of component values that provides an impedance match to any given load. Therefore, when a match is found, it is automatically the "best match" (lowest loss and widest bandwidth). PI and TEE networks can produce a match at several different settings, each with a different circuit Q.

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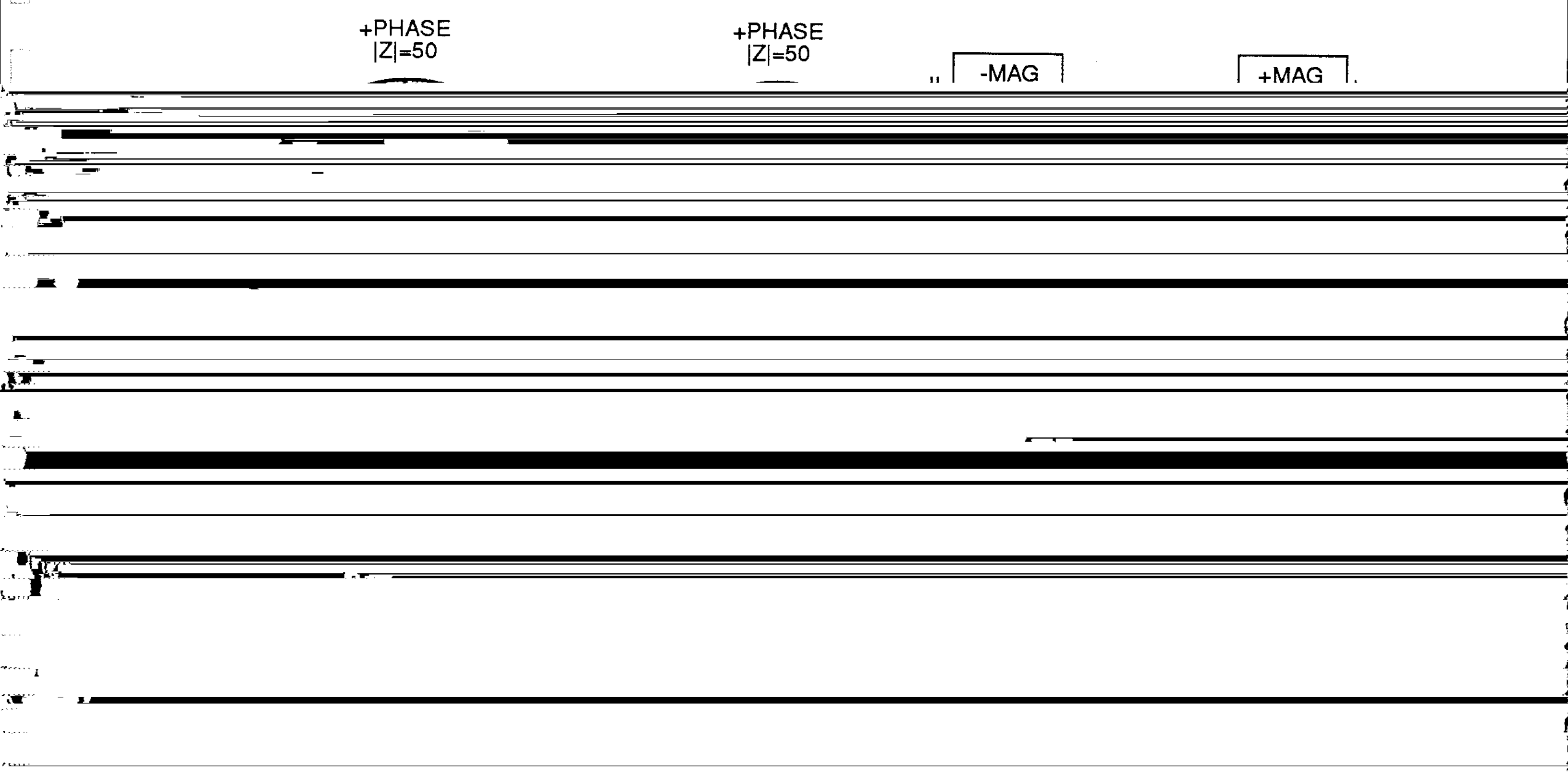
6. With only two variable circuit elements (and a reversing switch) the automatic tuning procedure or "algorithm" is much simplified.

To get an idea of how the tuning algorithm in the Model 253 works, refer to FIGURE 4-2.



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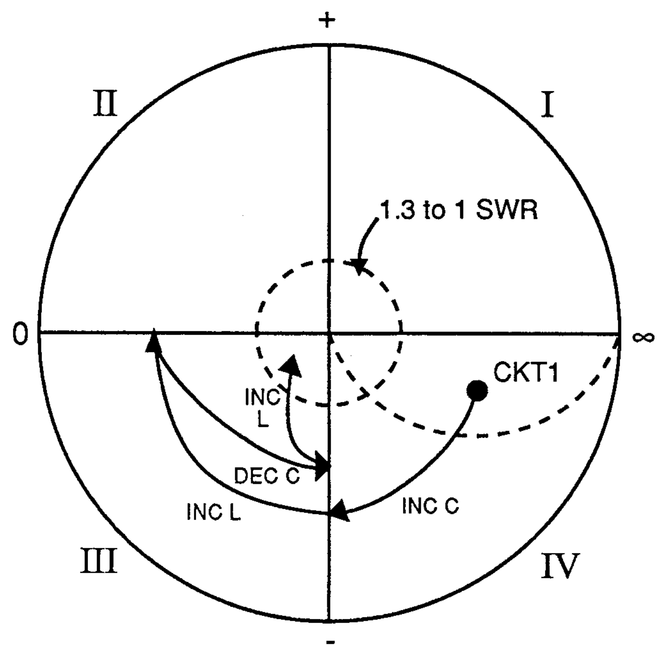
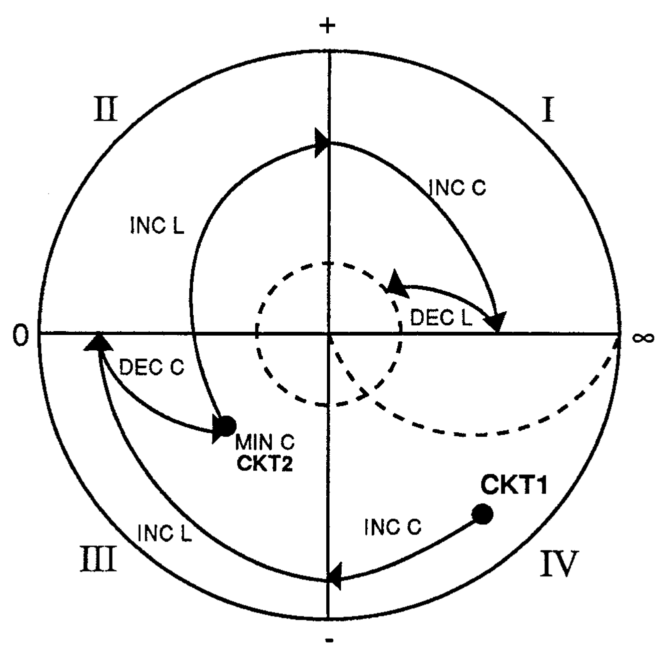
to the center of the smith circle." Also, since the proper configuration is not entirely determined by quadrant boundaries (notice the dashed line in the right hand smith chart dividing quadrants II and IV into circuit 1 and circuit 2 areas), the algorithm must determine somewhere along the way "which network configuration to use."

The entire tuning algorithm of the Model



Tuning an impedance
from the CIRCUIT 1
area of Quadrant IV



Tuning an impedance
from the CIRCUIT 2
area of Quadrant IV

FIGURE 4-3. TYPICAL TUNING PATHS

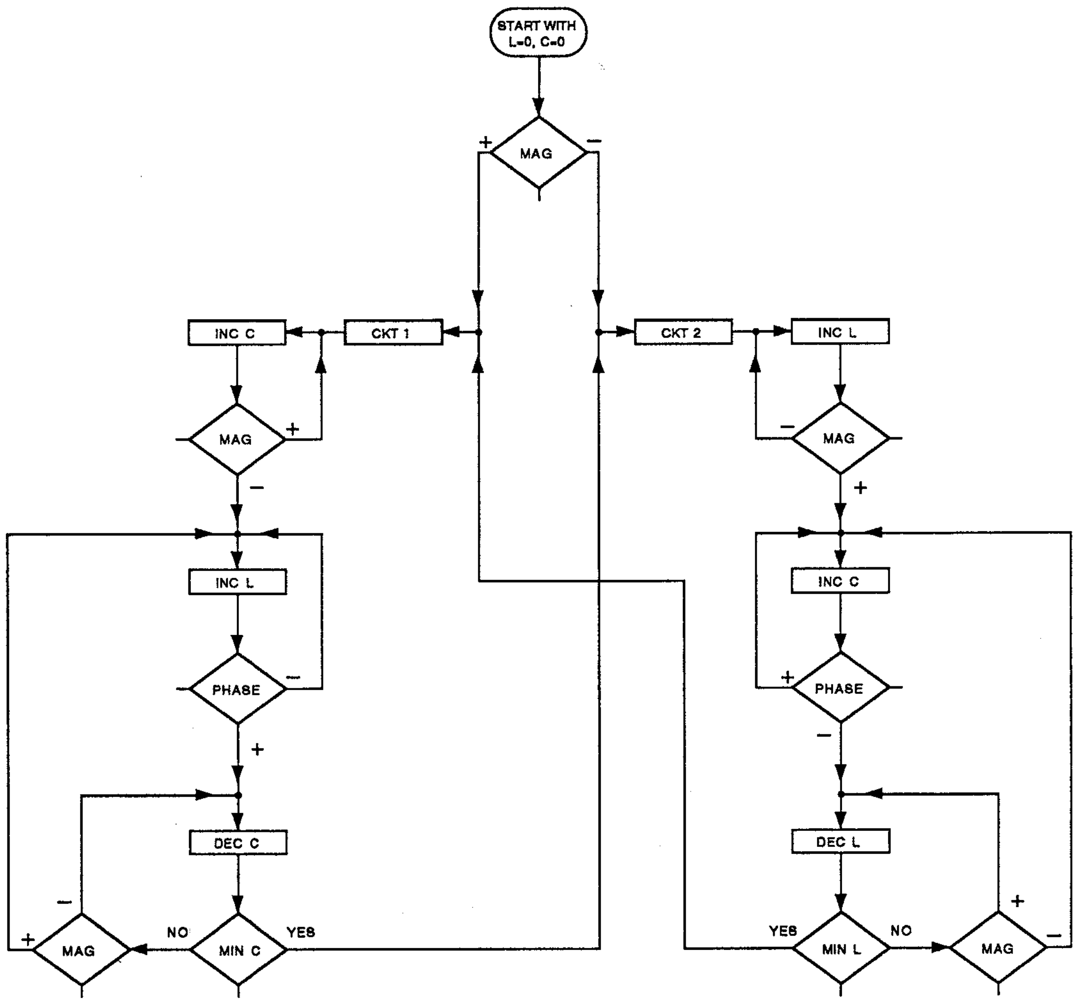
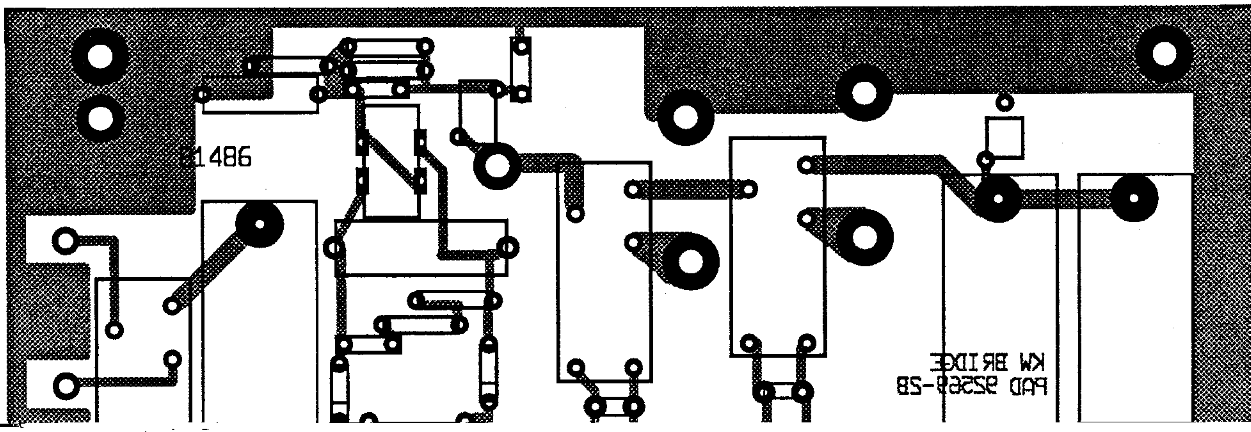
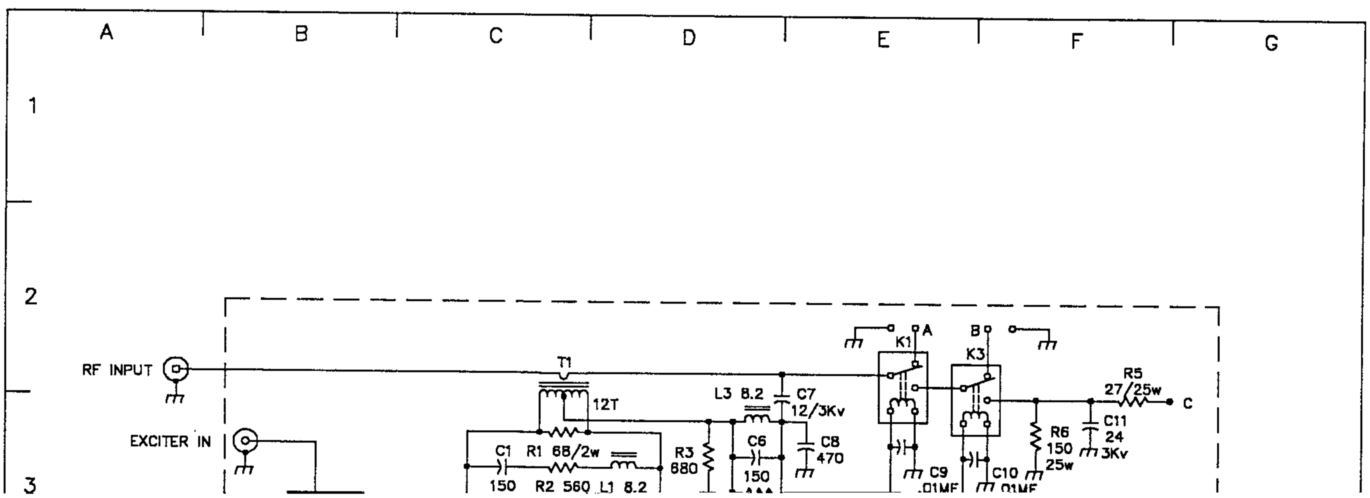


FIGURE 4-4. TUNING ALGORITHM FLOW CHART

4-3 KW BRIDGE PAD BOARD (81486) The KW Bridge Pad board is located between the RF Input connector and the Detector board. It contains the high power SWR bridge, input and detector bypass relays, and tuning attenuator pad.

The SWR bridge is a standard reflectometer circuit with the addition of two low-Q tuned circuits to flatten the frequency response. This bridge is in the circuit at all times. It indicates




A
B
C
D
E
F
G
1
2
3
RF INPUT
EXCITER IN
T1
12T
L3 8.2
C7
12/3Kv
C8
470
R3
680
C6
150
C1
150
R1 68/2w
R2 560
L1 8.2
K1
K3
A
B
C
R5
27/25w
R6
150
25w
C11
24
3Kv
C9
.01MF
C10
.01MF

4-4 DETECTOR BOARD (81485) The Detector board, located at the input side of the matching network, provides magnitude, phase

and high when the magnitude is less than 50 ohms.

Phase is detected by comparing the

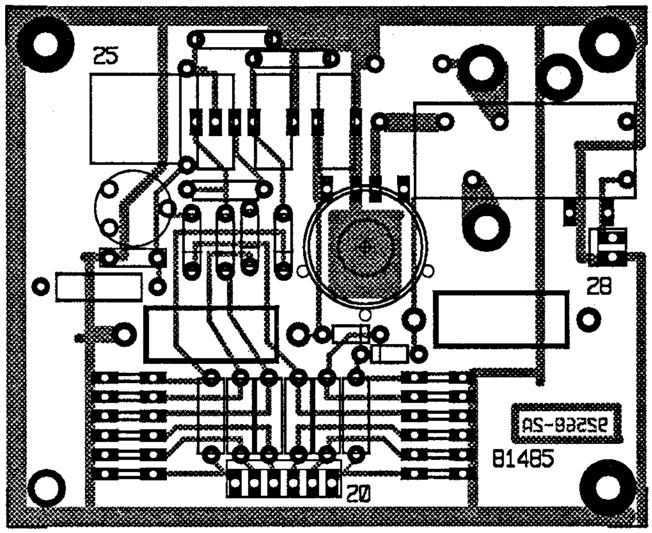


FIGURE 4-9. 81485 DETECTOR BOARD CIRCUIT TRACE

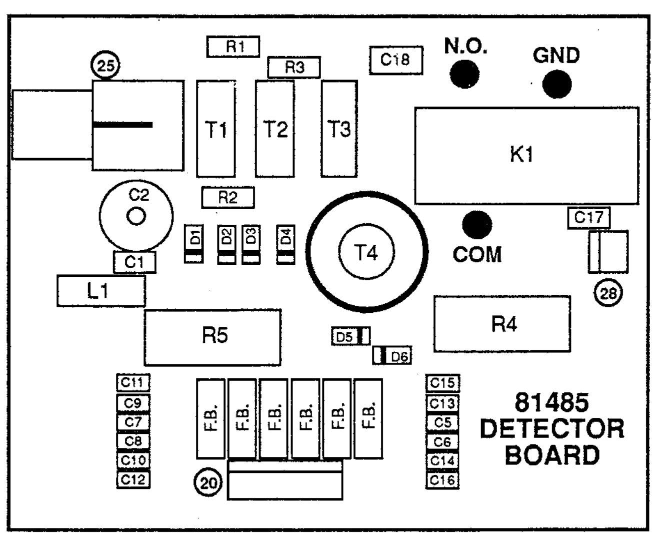


FIGURE 4-10. 81485 DETECTOR BOARD COMPONENT LAYOUT

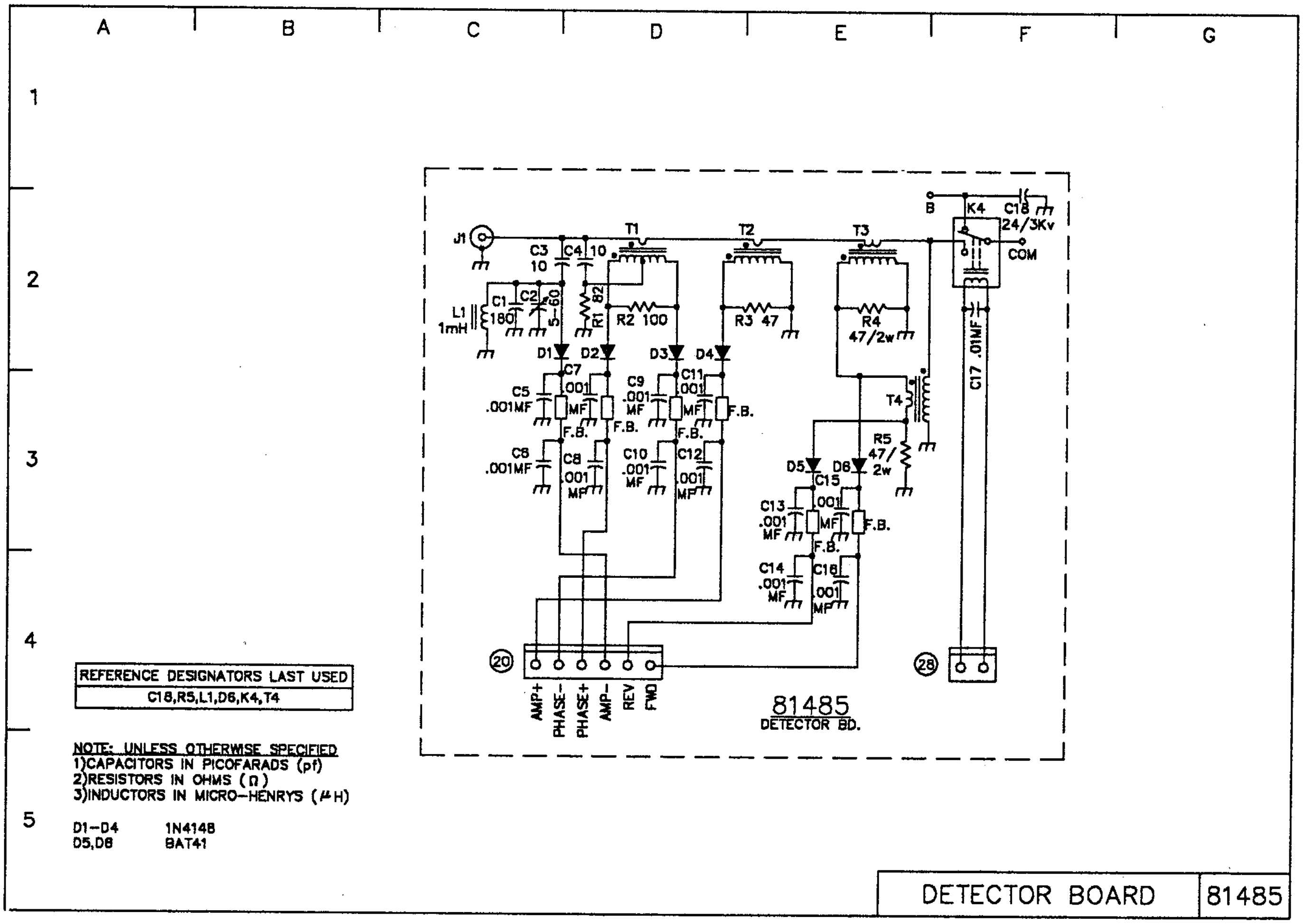
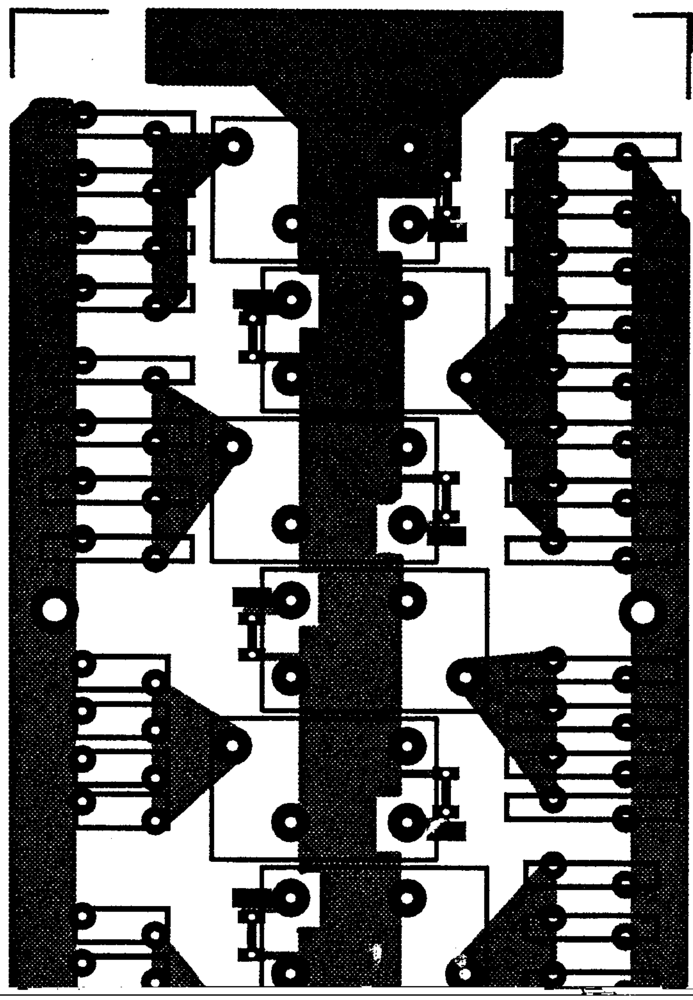
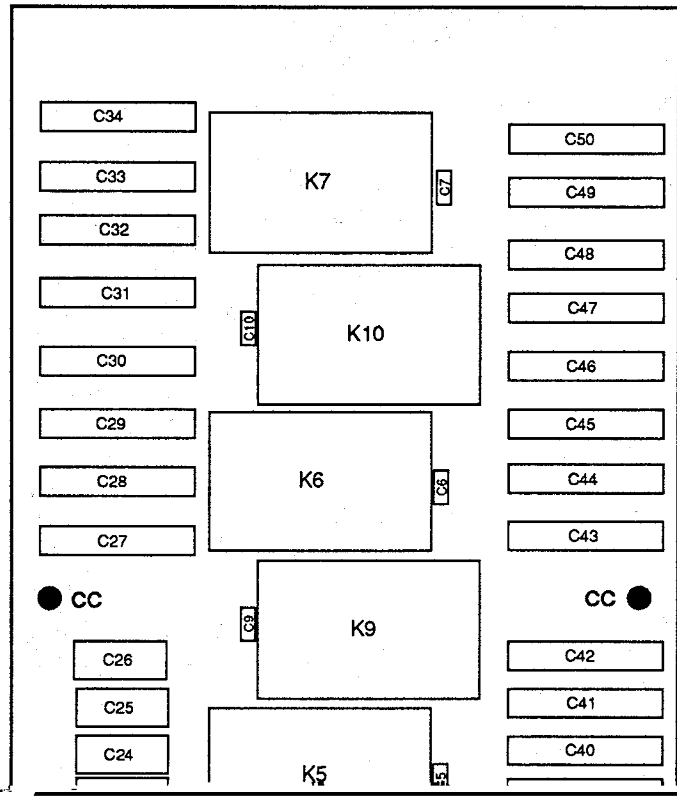


FIGURE 4-11. 81485 DETECTOR BOARD SCHEMATIC

4-5 CAPACITOR-RELAY BOARD (81488) This board provides for the selection of the appropriate capacitors to be used in tuning the L-network. Relays K1-K10 each select a value of capacitance to be used with the roller inductor to match the antenna system. Selection of the relays is provided via connectors 27 and 14 and determined by the microprocessor on the Logic board. The capacitors are arranged in a binary sequence beginning with C11,C12 [5 pf] and progressing upwards through C43-C50 [2560 pf]. This enables a wide range of values to be generated with the minimum number of components. Connection point CC is routed to the common terminal of external relay K5, which is used to select the configuration of the L-network. Capacitors C1-C10 provide rf bypassing for relays K1-K10.




C34
C33
C32
C31
C30
C29
C28
C27
CC
C26
C25
C24
K7
C7
K10
C10
K6
C6
K9
C9
K5
C50
C49
C48
C47
C46
C45
C44
C43
CC
C42
C41
C40

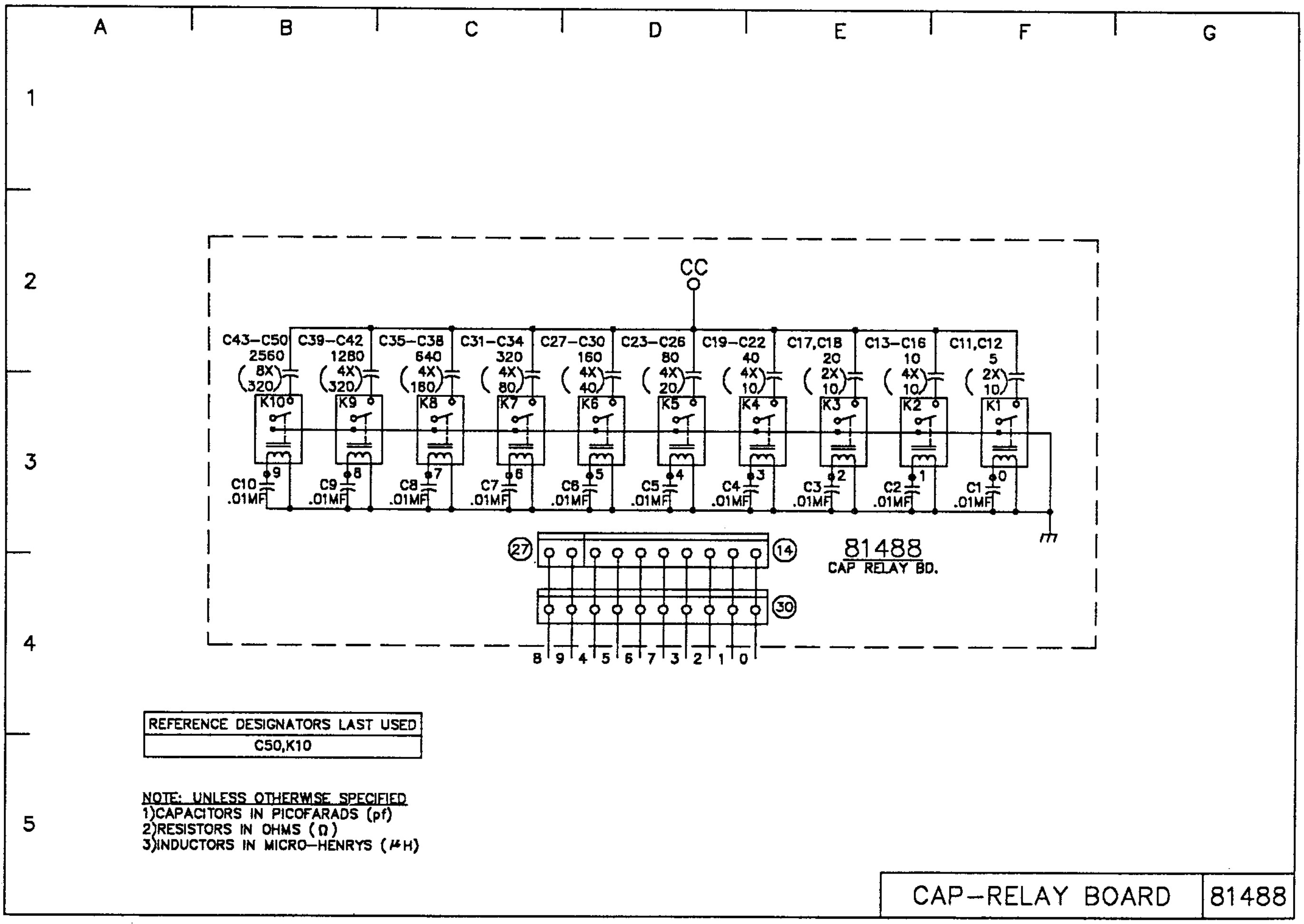
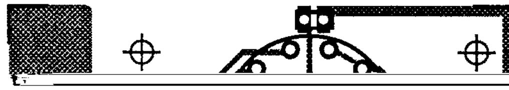


FIGURE 4-14. 81488 CAPACITOR-RELAY BOARD SCHEMATIC

4-6 METER SWITCH BOARD (81487)

The Meter Switch board provides two switches used to select the Meter functions and provide Antenna select information to the Logic board. Switch S1 is a 3-pole 4-position rotary switch. The wiper of S1A is connected to the Meter via connector 23. This switch determines which voltage the Meter is displaying. In the SWR and SET positions, the Meter is connected to the wiper of the METER SET potentiometer. In the SET position, KW FWD from the bridge circuit on the 81486 KW Bridge Pad board is routed via connector 22 and switch S1B to the METER SET potentiometer. When placed in the SWR position, switch S1C routes the KW REV signal from connector 22 to the METER SET potentiometer. In the 2KW position, KW FWD is applied via S1B to the 2KW calibration potentiometer R1, and then via S1A to the Meter. Likewise, in the 200W position KW FWD is applied via S1B to the 200W calibration potentiometer R2 and then on to the Meter via S1A.

Switch S2 is a 11 position rotary switch. The switch positions are set up on 30° indexing but the switch index is modified for 60° selections. Thus, the switch stops only in the 60° detented positions but passes through each 30° position in sequence. The purpose of this is to generate a negative going pulse each time the Antenna switch is rotated to a new position. This occurs as the wiper of S2 momentarily connects to the intermediate non-detented switch positions. This negative pulse is applied via connector 3 to the INT pin of the microprocessor on the Logic board, and is used to tell the microprocessor that a new antenna selection has been made. The antenna selection is decoded by D1 and D2 and routed via connector 3 to the Logic board.



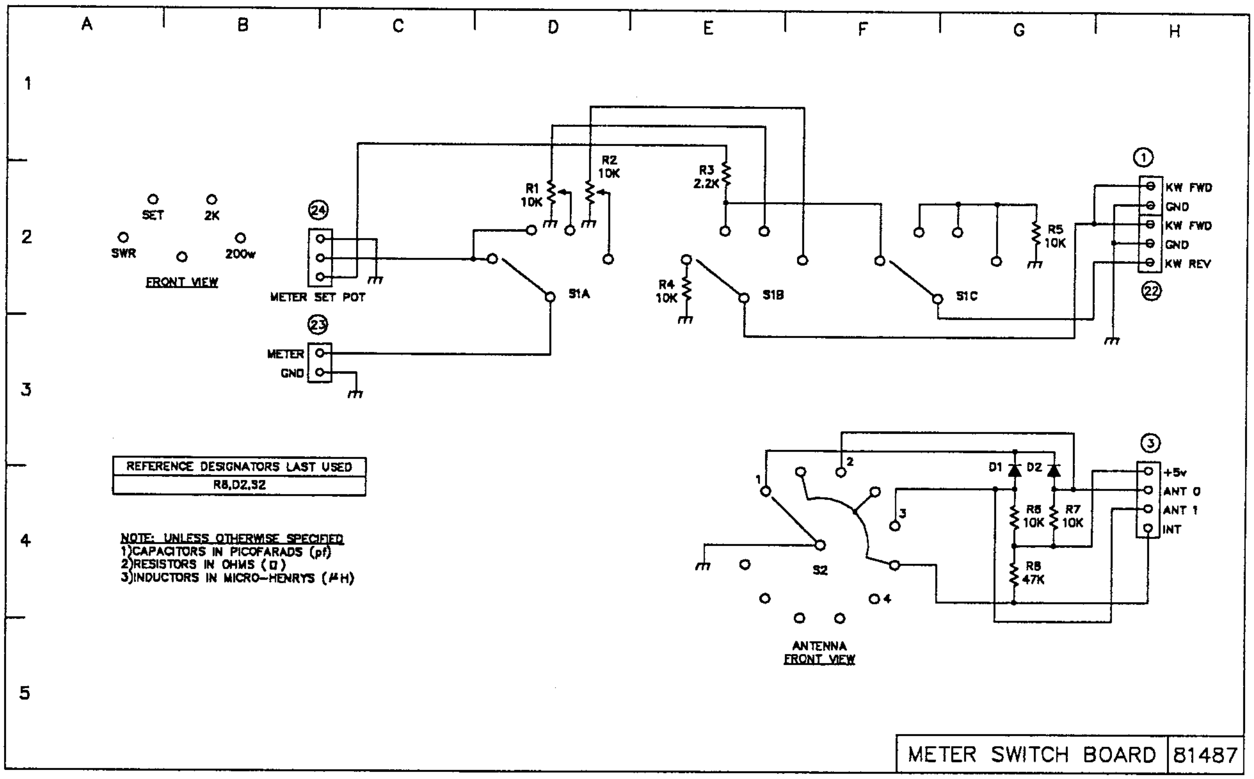
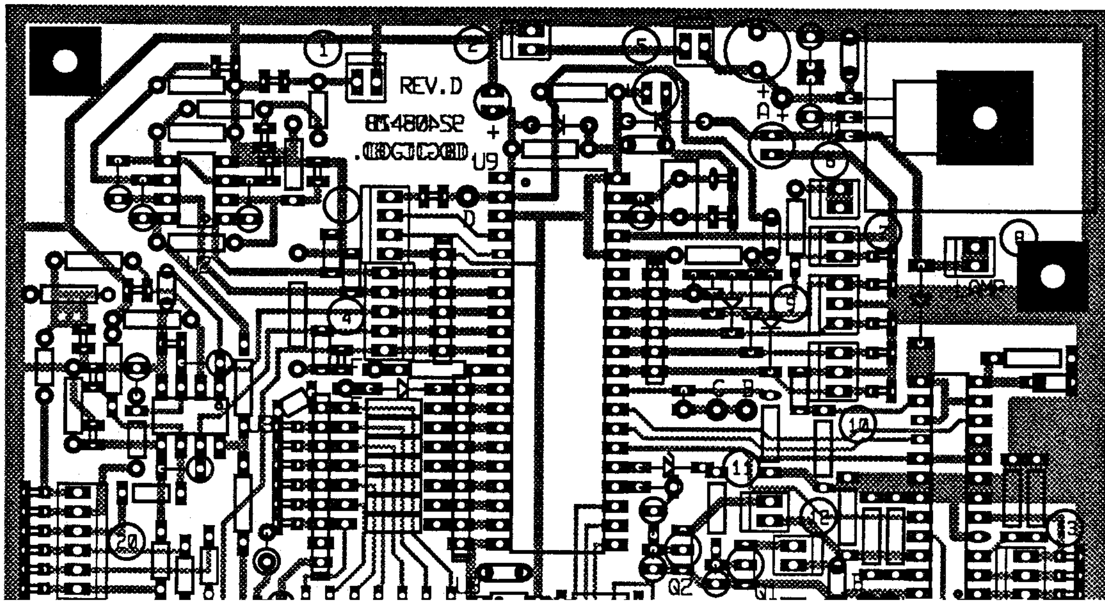


FIGURE 4-17. 81487 METER SWITCH BOARD SCHEMATIC

4-7 LOGIC BOARD (81480) The Logic board controls all functions of the Model 253. The heart of the system is

Additionally, there is a stepper motor control circuit consisting of U7 and associated


REV.D
U9
Q2
Q1

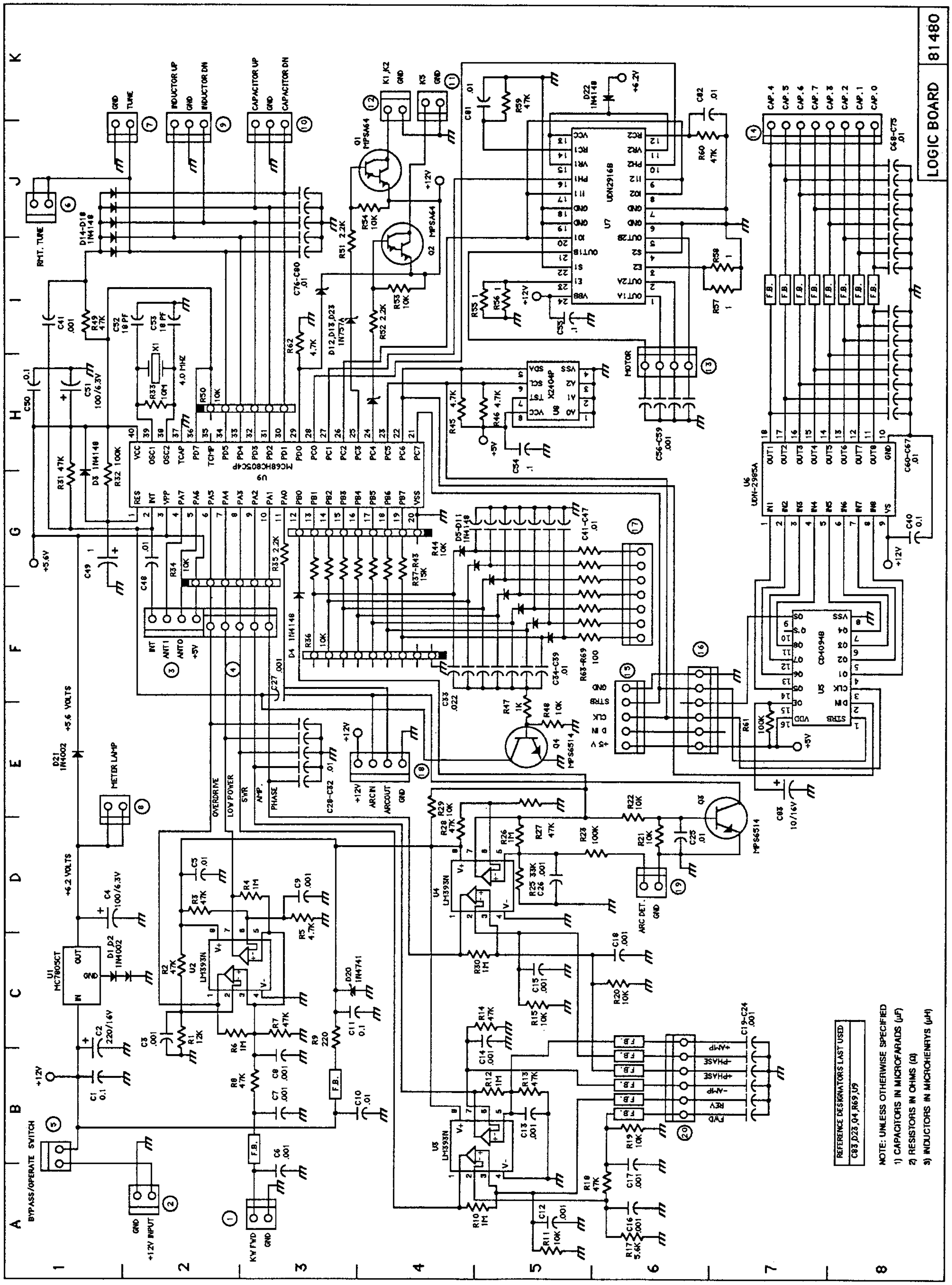


FIGURE 4-20. 81480 LOGIC BOARD SCHEMATIC

4-8 LED DISPLAY BOARD (81478) The Display board contains six LED annunciators, LED1-LED6, used to monitor the Model 253's operation. LED1 (UNDER) provides an

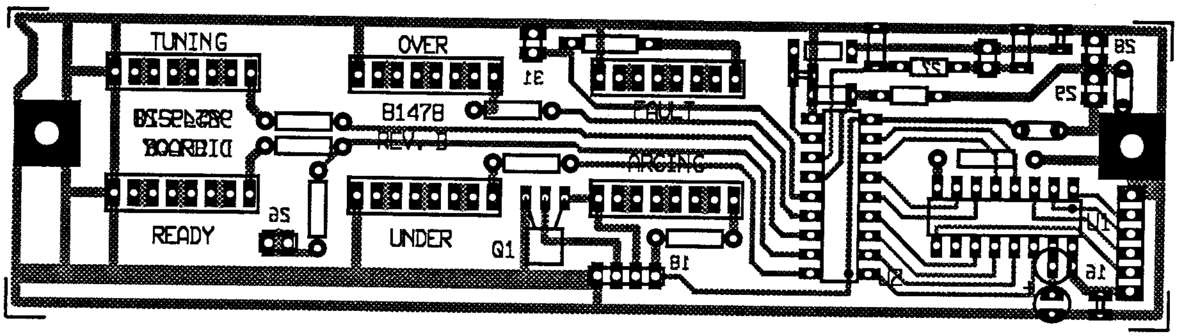


FIGURE 4-21. 81478 LED DISPLAY BOARD CIRCUIT TRACE

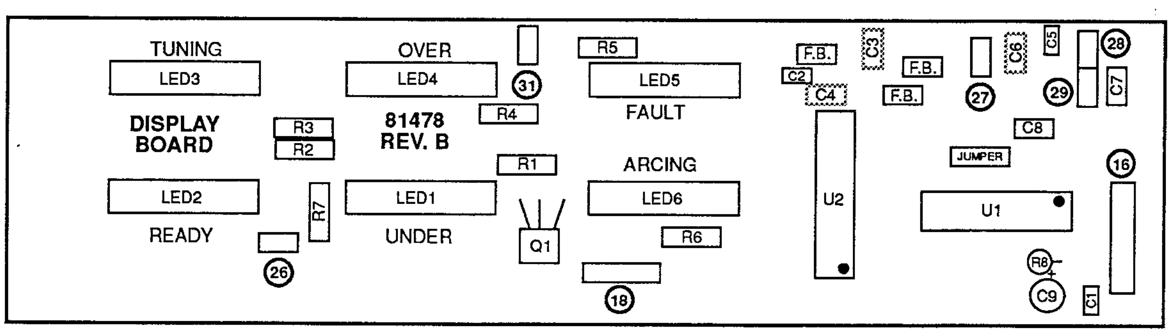
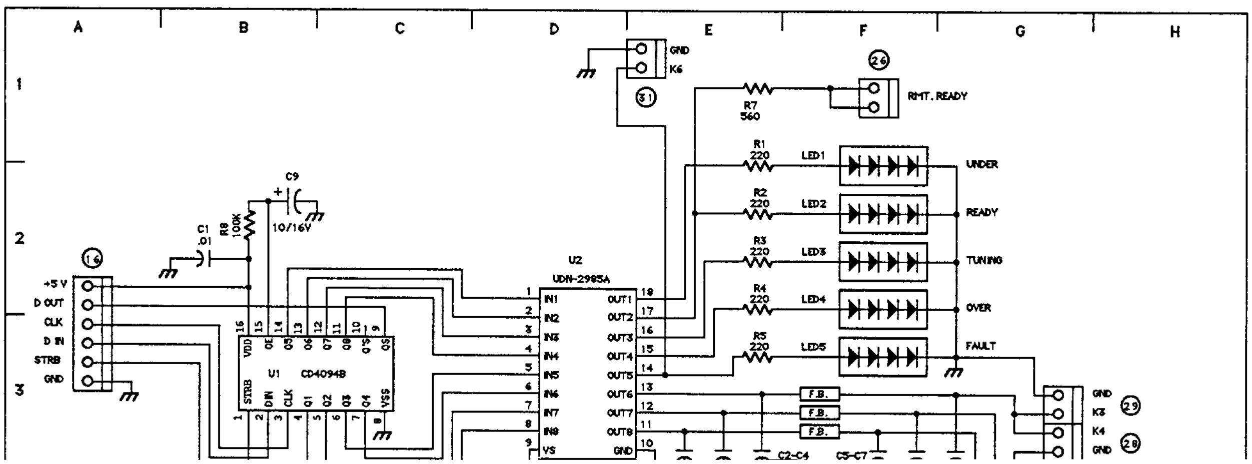


FIGURE 4-22. 81478 LED DISPLAY BOARD COMPONENT LAYOUT


A
B
C
D
E
F
G
H
1
2
3
GND
K6
31
26
R7
560
RMT. READY
R1
220
LED1
UNDER
R2
220
LED2
READY
R3
220
LED3
TUNING
R4
220
LED4
OVER
R5
220
LED5
FAULT
C9
10/16V
C1
.01
R8
100K
16
+5 V
D OUT
CLK
D IN
STRB
GND
U2
UDN-2985A
U1
CD4094B
F.B.
F.B.
F.B.
C2-C4
C5-C7
GND
K3
K4
GND
29
28

4-9 ARC-RELAY BOARD (81484) This board contains a vacuum relay, K2, which is used to switch the antenna output line. When in the BYPASS mode, rf power applied to the RF INPUT connector on the rear panel will be routed through K1 on the 81486 KW Bridge Pad board and K2 on the Arc-Relay board to the wiper of ANTENNA switch S3, and then on to the selected antenna connector, bypassing the matching network and detector circuits. During tune up, and when used in the OPERATE mode, relay K2 connects the antenna circuit to the output of the matching network. Also on this board is an rf detector consisting of D1, R1, C2, C3, and C4. This circuit monitors the rf voltage present at the antenna output connectors. The dc voltage from the detector is routed to the Logic board via connector 19.

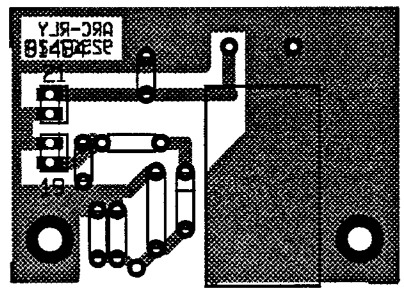


FIGURE 4-24. 81484 ARC-RELAY BOARD CIRCUIT TRACE

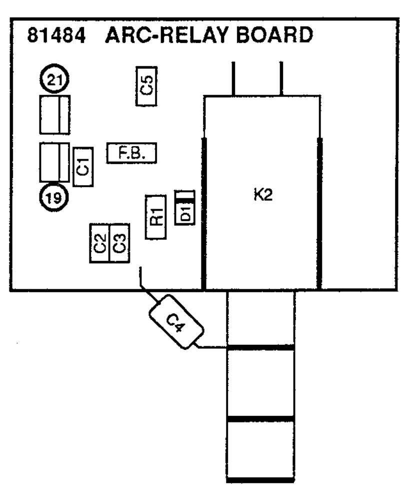


FIGURE 4-25. 81484 ARC-RELAY BOARD COMPONENT LAYOUT

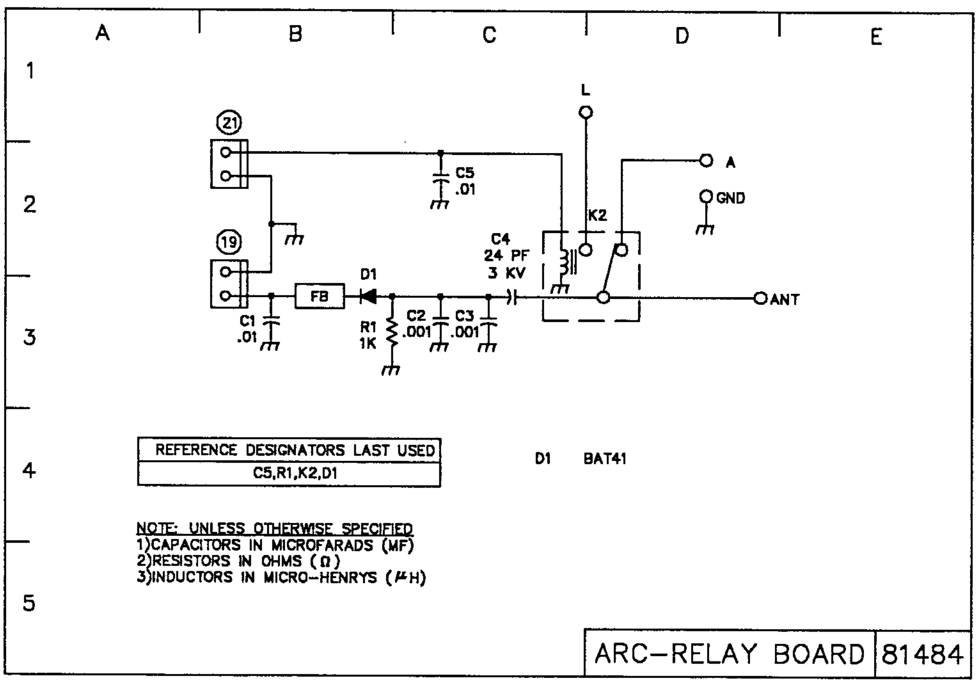


FIGURE 4-26. 81484 ARC-RELAY BOARD SCHEMATIC

Ten-Tec, Inc.
1185 Dolly Parton Parkway
Sevierville, TN 37862
Repair Service: (865) 428-0364

LIMITED WARRANTY AND SERVICE POLICY, U.S.A. AND CANADA

Ten-Tec, Inc., warrants this product to be free from defects in material and workmanship for a period of one (1) year from the date of purchase, under these conditions:

This obsolete manual file is provided as a courtesy to you by Ten-Tec, Inc.

Ten-Tec's service department can repair and service virtually everything we have built going back to our first transceivers in the late 1960's. It is our ability to continue offering service on these rigs that has led to their re-sale value remaining high and has made a major contribution to our legendary service reputation.

Printed and bound copies of all manuals are available for purchase through our service department if you would prefer not to use this copy as your transceiver manual.

We can repair or service your Ten-Tec equipment at our facility in Sevierville, TN. We also offer support via telephone for all products via during usual business hours of 8 a.m. to 5 p.m. USA Eastern time, Monday through Friday. We have a large supply of parts for obsolete products. Repairing a transceiver or amplifier yourself? Contact us for parts pricing information.

Service department direct line: (865) 428-0364
Ten-Tec office line: (865) 453-7172
Service department email: service@tentec.com
Address: 1185 Dolly Parton Parkway, Sevierville, TN 37862 USA

We have found it is most effective for us to help you troubleshoot or repair equipment with a consultation via telephone rather than by email.

Suggested contact methods are:

Troubleshooting or repairing equipment – call (865) 428-0364
Other inquiries – call (865) 428-0364 or email service@tentec.com

THANK YOU AND 73 FROM ALL OF US AT TEN-TEC