TEN - TEC

OPERATOR'S MANUAL

CENTURION

MODEL 422

LINEAR AMPLIFIER

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SPECIFICATIONS

BAND COVERAGE:	1.8-2.0, 3.2-4.7, 6.5-9.0, 9.0-15.6, 16.4-24.0 MHz. 24.0-29.7 Mhz after authorized modification..
POWER OUTPUT:	1300 watts ssb. 1000 watts cw, 50% duty cycle. RTTY and SSTV 650 watts, 50% duty cycle, ten minute transmission limit.
DRIVING POWER REQUIRED:	100 watts for full rated output.
EFFICIENCY:	50-65%, depending on frequency and load impedance.
INPUT AND OUTPUT IMPEDANCES:	50 ohms unbalanced, VSWR < 2:1.
DISTORTION:	-35 dB from 1 KW rf output level.
HARMONICS:	-50 dB typical.
CW BREAK-IN:	High speed QSK capable. Relay switching.
TUBE COMPLIMENT:	Two 3-500Z glass tubes.
POWER AMPLIFIER CIRCUIT:	Class AB2, grounded grid.
PLATE VOLTAGE:	3100 volts, no load. 2600 volts, full load.
COOLING:	Forced air with full chassis air flow.
METERING:	Dedicated plate current meter. Selectable multi-meter for plate voltage, grid current, forward or reflected power. Ten element LED bargraph display for peak power indication.
STATUS INDICATORS:	Standby, Operate, Transmit.
PRIMARY POWER:	220-250 VAC @ 15 A. 110-125 VAC @ 30 A, 50/60 Hz. For full power operation, 220-250 VAC is strongly recommended.
CIRCUIT PROTECTION:	Primary line fuses. Plate transformer primary interlock and high voltage shorting bar.
FRONT PANEL CONTROLS:	Power (ON-OFF), Mode (STANDBY-OPERATE),Control Mode (QSK-PTT/VOX), Plate TUNE, LOADing, BAND Switch, METER Switch.
TUNE AND LOAD CONTROLS:	3:1 vernier drives with calibrated dial skirts.
SIZE:	Amplifier: HWD 7.75" x 15.5" x 20", (19.7 x 39.4 x 50.8 cm).
WEIGHT:	Amplifier: 52 lbs, (23.6 Kg).

INTRODUCTION

The CENTURION Model 422 is an advanced design linear amplifier which uses two 3-500Z triode tubes in a grounded grid configuration. This amplifier uses a forced air cooling system and operates at rated output power with an efficiency of up to 65%. Maximum input power of 2 KW requires approximately 100 watts of drive power. Three LED status indicators display Standby, Transmit or Operate mode. Two panel meters provide full time indication of plate current and switch selected choice of plate voltage, grid current, forward power or reflected power. Peak power is indicated on a ten element LED bar graph display. Band coverage of 1.8 through 23 MHz Amateur bands is standard. Export model extends coverage to 29.7 MHz. The power supply is conservatively designed for cool operation under full load and employs a tape wound Hypersil® transformer for minimum weight and size. Primary power of 220-250 volts @ 15 amperes is standard. Fuses are provided for primary circuit and plate current protection. Protective interlocks are provided on the ac and high voltage lines.

UNPACKING

Carefully remove the amplifier from the packing carton and inspect it for signs of shipping damage. If the amplifier 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 amplifier in other than factory packing may result in damage which is not covered under warranty. The following hardware and accessories are packed with your CENTURION. Make sure you have not overlooked anything.

2—#25281	Eimac 3-500Z tubes
1—#27015	MDL4 Fuse (Slo-Blow)
2—#35003	Phono Plug
1—#38040	.050" Allen Wrench
1—#38088	.062" Allen Wrench
1—#38124	#8 Allen Wrench
2—#98322	Plate Cap Heat Dissipator
1—#74020	Warranty Card
1—#74209	Operator's Manual

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

SPECIAL NOTES: *The two 3-500Z tubes are packaged in a separate box, in their original factory cartons.* **DON'T OVERLOOK THIS BOX!**

Before hooking up your CENTURION for the first time, carefully unpack and inspect the two amplifier tubes which are in a separate carton. Check to make sure that they are not damaged and that the base pins are not bent. Follow the instructions in section 1-2 for installing the tubes in the CENTURION.

WARNING NOTICES

WARNING!!!

**This amplifier contains lethal voltages when operating.
DO NOT operate this amplifier with the covers removed.
The power supply circuits in this amplifier produce
3100 VOLTS which is LETHAL!!!**

CAUTION!!!

Never attempt to operate the CENTURION without first connecting a suitable antenna or 50 ohm dummy load of sufficient power rating or SERIOUS DAMAGE MAY RESULT

TEN METER OPERATION OF THE CENTURION AMPLIFIER

FCC rules permit a licensed amateur to modify his own amplifier for operation in the 28-29.7 MHz band. If you enclose a copy of your valid amateur radio license with the warranty registration card for your new amplifier, appropriate information will be sent to you without charge.

CHAPTER 1

INSTALLATION

1-1 INTRODUCTION When setting up the station, provide adequate ventilation for the amplifier. Also, select a location that allows comfortable access to the front panel controls and adequate clearance for rear panel connections.

1-2 TUBE INSTALLATION Carefully unpack and inspect the two 3-500Z tubes which are shipped in a separate carton. Check to make sure that they are not damaged and that the base pins are not bent. **Make sure that the a.c. line cord is unplugged from the wall.** Remove the screws securing the top cover of the CENTURION. While spreading the bottom edge of the cover slightly, slide the top cover towards the rear and lift it off. Refer to FIGURE 1-1 to locate the tube socket index pin. Carefully install each tube following the procedure listed below:

1] Hold the tube in a horizontal position, with the base positioned to the right, away from the right side of the CENTURION chassis.

2] Carefully pass the tube under the right chassis support and above the tube socket mounting plate.

3] When the tube is as far to the left as possible, rotate the tube to an upright position.

4] Align the index pin (the widely spaced one) with the matching socket receptacle and carefully press the tube fully into the socket.

5] Repeat the above steps for the second tube.

6] Locate the two round aluminum plate cap heat dissipators and install on the plate caps as shown in FIGURE 1-1. Leave the set screws loose at this time.

7] Remove the 4-40 x 1/4" screw from each plate cap dissipator.

8] Rotate each plate cap dissipator until the hole on the edge of the cap lines up with the punched hole in the matching plate connecting strap. Then secure the strap to the dissipator with the screw previously removed.

9] Check to make sure that the plate connecting straps are not twisted and that they are aligned with the dissipators as shown in FIGURE 1-1. Carefully tighten the set screw in each dissipator to secure it to the tube plate contact.

10] Refer to FIGURE 1-0 and locate the 81542 QSK Board. Install the MDL4 fuse provided in the packing kit into the fuse clips on the QSK Board.

11] Inspect your work, then replace the cover.

1-3 ELECTRICAL CONNECTIONS The CENTURION amplifier draws as much as 3KW of line power and 120 VAC operation is not recommended.

Power Cable Connection. The power cable plug provided is recommended for 240VAC, 20A service. If another type connector must be used, the green wire of the amplifier power cord is the chassis safety ground. It must always (and ONLY) be connected to the safety ground of the ac mains -- NEVER to one of the "hot" power wires. The black and white wires are interchangeable and connect to the two "hot" service conductors.

Physical Location. Your CENTURION must be located so that a supply of cool air is available for the intake along the sides of the chassis. The exhaust of hot air from the right side of the chassis must not be obstructed in any way. A minimum of two inches of clearance should be allowed when placing other pieces of equipment beside the amplifier.

BLOCKING THE EXHAUST OR INTAKE AIRFLOW IS LIKELY TO RESULT IN THE DESTRUCTION OF THE TUBES!!!

In any installation, it is a good idea to guard against conditions which would result in recirculation of the exhaust air back to the intake.

1-4 EXCITER INTERCONNECTIONS When using the CENTURION with all late model TEN-TEC radios follow the diagram in FIGURE 1-2. The CONTROL MODE switch on the CENTURION should be placed in the QSK position for all modes of operation. This hookup arrangement will work for all operating modes when used with all late model TEN-TEC radios.

When connecting the CENTURION to other transceivers, use the diagram shown in FIGURE 1-3. Note that the key or keyer must be connected to the KEY IN jack on the CENTURION and that a line from the external T/R N.O. relay contacts on the transceiver must be connected to the PTT/VOX jack of the linear for proper SSB operation. When using this hookup system, the CONTROL MODE switch on the CENTURION must be in the QSK position for CW operation, and in the PTT/VOX position for use on SSB.

Today most solid state transceivers provide no connection for ALC input and it is entirely unnecessary to make any external ALC connection to these rigs.

1-5 ANTENNA REQUIREMENTS The CENTURION amplifier has been designed for use with antennas resonant at the frequency of operation and having impedances within the limits of 25 to 100 ohms, or an SWR of 2:1 or less.

The nominal output impedance of the amplifier is 50 ohms and the SWR of the load should not exceed 2:1. Many antennas exhibit an SWR range over an entire amateur band that exceeds 2:1. For operation under this condition, we recommend using an antenna matching network which will enable the CENTURION to work into a 50 ohm load for maximum power transfer to the antenna. The TEN-TEC Model 229, 238, or 253 Tuner is a suitable companion.

CAUTION!!!

Never attempt to operate the CENTURION without first connecting a suitable antenna or 50 ohm dummy load of sufficient power rating or SERIOUS DAMAGE MAY RESULT.

1-6 GROUND CONNECTIONS In the interest of personal safety and to reduce the possibility of stray RF pickup on interconnect-

ing cables, all station equipment should be well grounded to earth. It is important to strap all equipment chassis together with short, heavy leads.

1-7 HIGH POWER OPERATION We have had several cases of damage occuring to amplifiers through no fault of the amplifier. The CENTURION amplifier operates very comfortably at 1200 watts output. The problem is that other components in your station may not. Before you operate at this power level we suggest that you check the following items.

1. The coax from the CENTURION to the feed point of your antennas must be top quality RG-8 size or larger. We recommend silver plated connectors, not chrome plated. Make sure that all coax connectors are tight. (snug them up with a pair of pliers)

2. Any switching in the coax line must be rated at 2000 watts or higher. NEVER ACTIVATE IN-LINE SWITCHES WHILE TRANSMITTING.

3. Verify that the components in your antennas are rated for CENTURION RF power levels. Dipole center insulators, end insulators, etc. Make sure that the radiating sections are well clear of metallic objects such as rain gutters and antenna supporting structures. Tri-band antennas such as the Mosley TA-33JR and the Hy-Gain TH-3JR are NOT useable at CENTURION power levels. The BN-86 balun supplied with Hy-Gain beams is at risk at ssb power levels above 1000 watts and in key-down modes such as RTTY, do not operate above 800 watts. A good high power balun is the Palomar Engineers Model BA-2000. For use on a tri-bander, specify "optimized for 7 MHz through 30 MHz operation". Alternately, replace the balun with a coaxial choke, 12 turns of RG-8 with an 8" diameter.

4. A solid earth ground is essential.

5. If you use an antenna tuner, make all adjustments with the CENTURION in STANDBY and use exciter low power only.

6. If any of your home entertainment electronic goodies have rf leaks, the CENTURION will find them. The problem will be fundamental overload, not spurious emissions or harmonics. If you are not familiar with the standard practices for controlling this type of interference, consult the ARRL Handbook.

7. A good low pass filter is recommended. Verify that the filter will handle the power, and is adequately grounded.

8. For the first few hours of CENTURION operation check the SWR frequently. Any increase in reflected power during a transmission is a warning that something between the amplifier and the ends of the antenna elements, including end insulators, is heating and must be corrected.

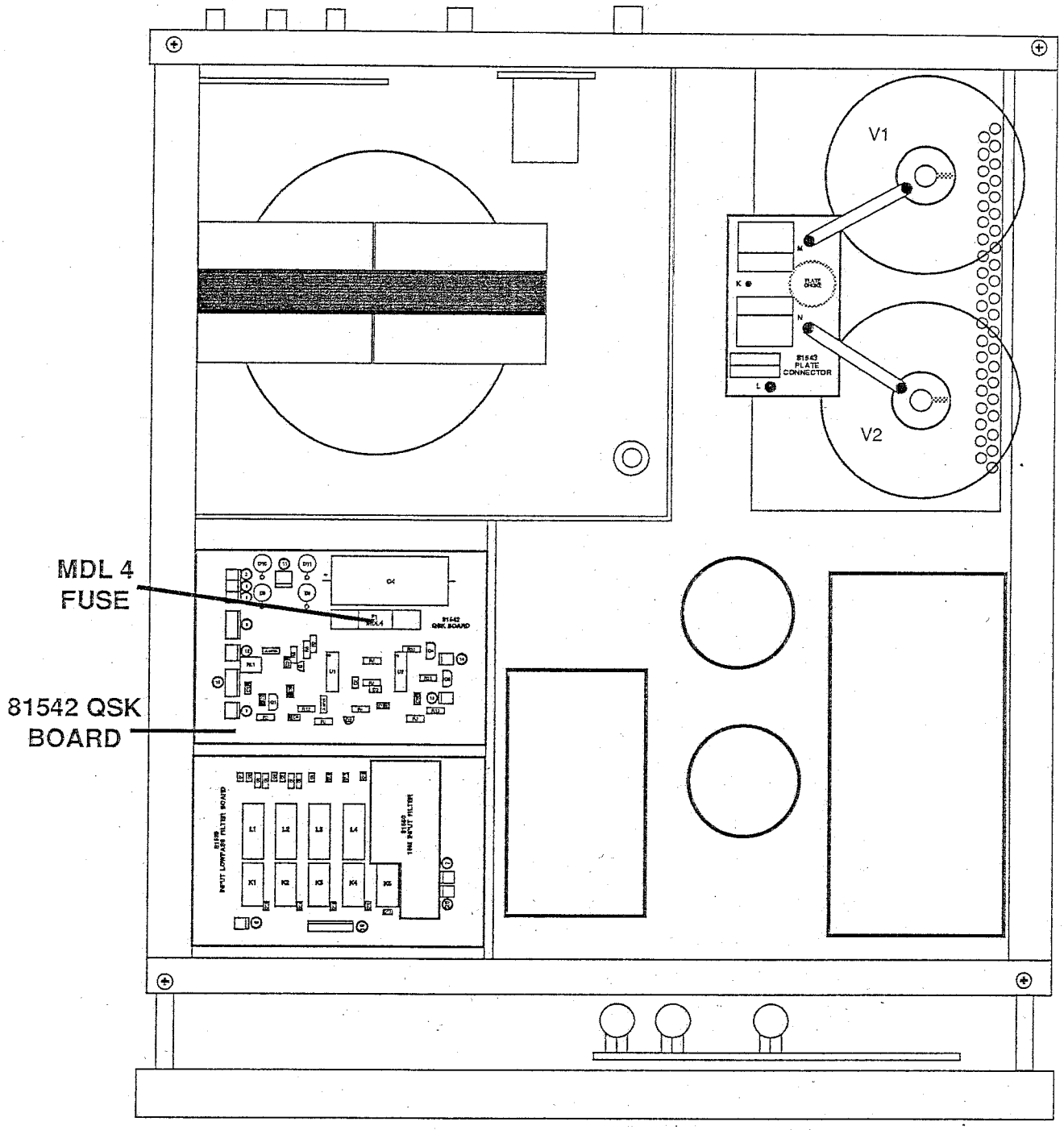
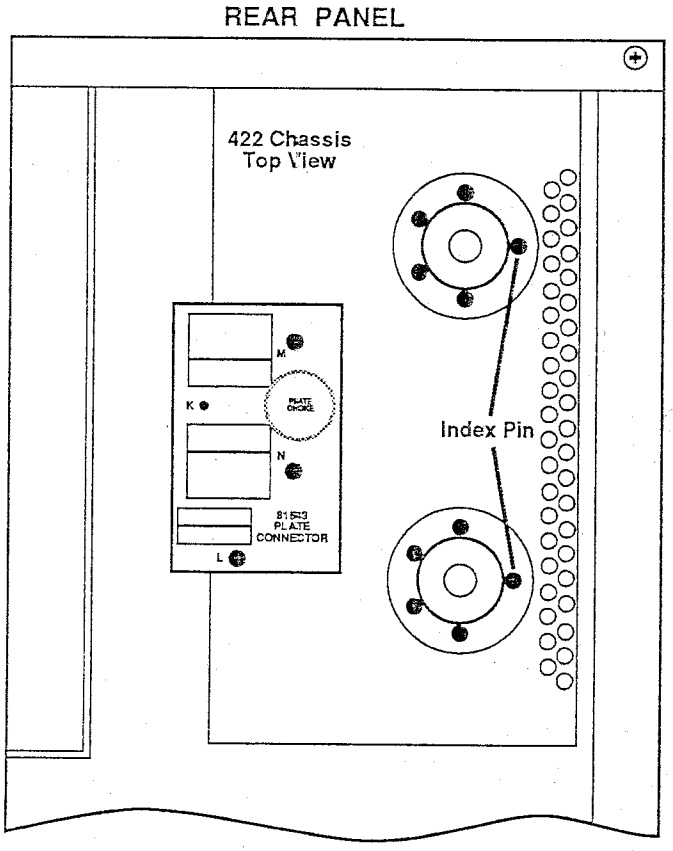
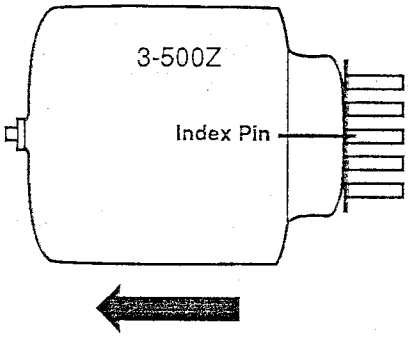


FIGURE 1-0. INSTALLATION OF MDL4 FUSE ON 81542 QSK BOARD





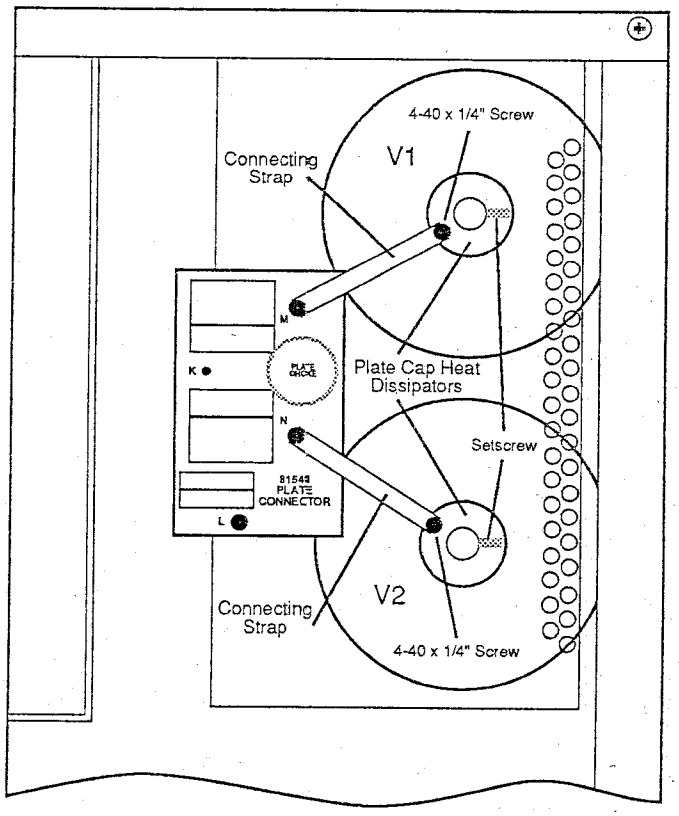
1. Hold tube in a horizontal position with base to the right and index pin on top.

2. Carefully pass tube to the left under the right chassis support.

3. Rotate the tube to an upright position.

4. Align the index pin on the tube with the index pin on the socket and gently press the tube fully into the socket.

5. Repeat steps 1 - 4 for the second tube.



6. Locate the two round plate cap heat dissipators and install one on each tube as shown. Leave the setscrews loose at this time.

7. Remove the 4-40 x 1/4" screws from each plate cap dissipator.

8. Rotate each plate cap dissipator until the hole on the top edge of the dissipator lines up with the punched hole in the matching plate connecting strap.

9. Secure each strap with a 4-40 x 1/4" screw, removed previously.

10. Check to make sure that the connecting straps are not twisted and that they are aligned as shown.

11. Carefully tighten the setscrew in each dissipator to secure it to the tube plate contact.

FIGURE 1-1. INSTALLATION OF 3-500Z TUBES

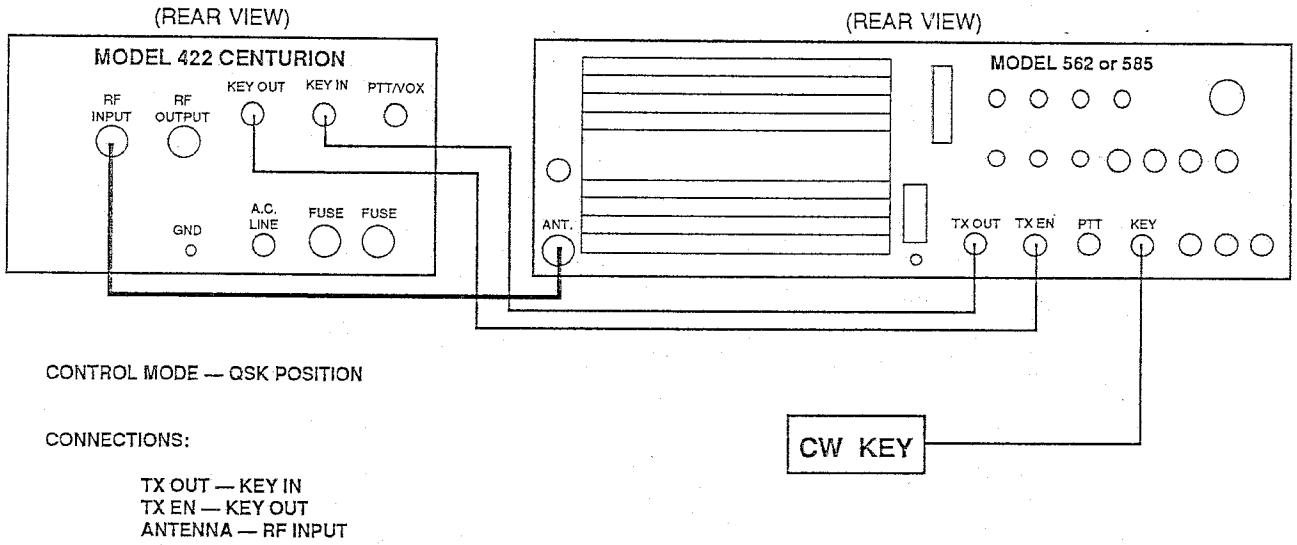


FIGURE 1-2. TEN-TEC TRANSCEIVERS (WITH TX OUT & TX EN)

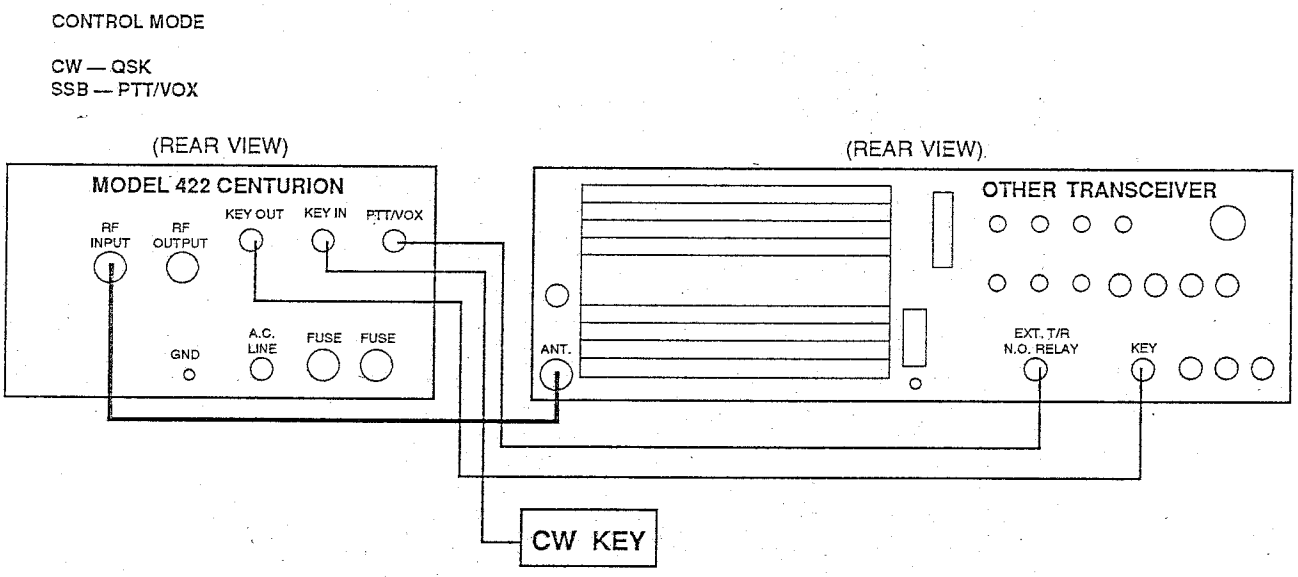


FIGURE 1-3. CENTURION HOOKUP DIAGRAM FOR OTHER TRANSCEIVERS

CHAPTER 2

OPERATING INSTRUCTIONS

2-1 INTRODUCTION The following instructions will enable the operator to quickly place the CENTURION into operation. Included are descriptions of the Front Panel controls and Rear Panel connections followed by a detailed Tune-Up procedure. Refer to CHAPTER 3 for further information and operating hints.

2-2 FRONT PANEL CONTROL FUNCTIONS The Front Panel controls and their function are described below.

2-2.1 BAND This switch is used to select the desired frequency range of operation. This is a six position switch and covers the 160 through 10 Meter bands. **Note: A built-in switch stop normally prevents operation on the 10 Meter band. For 10 Meter operation you must contact the factory for an authorized modification kit.**

2-2.2 TUNE This control adjusts variable capacitor C4 for the proper amplifier resonant frequency. A chart in FIGURE 2-4 on page 2-7, shows the approximate settings for both the TUNE and LOAD controls on each band. Keep in mind that the settings in this chart are for operation into an ideal 50Ω load. On page 2-8, there is a blank Tune and Load Log Sheet that you can use to record your actual settings.

2-2.3 LOAD This control adjusts variable capacitor C5 for the proper amplifier output loading. See the chart referred to above.

2-2.4 POWER This switch, located below the front panel, controls the a.c. power to the amplifier power supply circuits. When switched ON, the amplifier should power up and the STANDBY LED should light. However, if the Mode switch is in the OPERATE position, the STANDBY LED will go out and the OPERATE LED will come on.

2-2.5 MODE This switch, when in the OPERATE position, places the amplifier in the rf line. Selecting the STANDBY position will cause the amplifier to run in the bypassed mode.

2-2.6 CONTROL MODE When placed in the QSK position, the keying of the CENTURION is controlled by the KEY IN input and the KEY OUT signal is generated on the 81542 QSK Board. This position is used for CW operation where fast keying is required. Placing the switch in the PTT/VOX position allows the CENTURION to be controlled by the PTT/VOX input jack. This position is used for SSB (PTT/VOX) operation.

2-2.7 METER This switch is used to select what is being displayed on the built-in illuminated meter. When in the Ig position it selects grid current, 400 mADC full scale. The Ep position selects plate voltage, 4000 VDC full scale. When placed in the FWD position it selects forward power, 2.5 KW full scale. The

REV position selects reverse power, 250 W full scale.

2-2.8 PEAK POWER METER This is a ten segment LED readout used to display the peak output power of the CENTURION. *Please note that the first red LED of the bargraph display has been calibrated to light at 1250 watts output.*

2-3 REAR PANEL CONNECTOR FUNCTIONS The following sections describe the rear panel connectors and their function.

2-3.1 RF INPUT This is a standard SO-239 receptacle designed for a mating PL-259 ("UHF" type) plug. RG-58/U or similar small 50 ohm coaxial cable is required to connect to the station exciter or transceiver's output or antenna jack. This cable should be as short as possible, preferably 3 feet or less.

2-3.2 RF OUTPUT This is a standard SO-239 receptacle designed for a mating PL-259 plug. RG-8/U or similar large coaxial cable rated for 1.5 KW must be used to connect to the antenna system.

2-3.3 KEY IN This jack controls the CENTURION's transmit/receive relay system. When used with all late model TEN-TEC radios, this jack is connected to the TX OUT jack on the transceiver. When used with other transceivers, a key or keyer is plugged into this jack.

2-3.4 KEY OUT When used with all late model TEN-TEC radios, this jack is connected to the TX EN jack on the transceiver. When used with other transceivers, this jack is connected to the transceiver KEY input jack.

2-3.5 A.C. LINE This cable is terminated in a standard 240 VAC, 20A plug. Be sure that the circuit you use for powering the CENTURION is capable of safely providing at least 20 amperes of current at 240 VAC and that it is protected with either a fuse or circuit breaker of at least 20 ampere rating.

2-4 INITIAL TURN-ON The following steps should be followed when turning on your CENTURION:

1] Place the MODE switch in the STANDBY position.
2] Place the METER switch in the Ep position.
3] Press the POWER switch to ON. If any of the following does not occur, press OFF immediately and investigate be fore proceeding.
   a] The meter should promptly show about 3100 volts.
   b] The meter lights should illuminate.
   c] The STANDBY LED should come on.
   d] The blower should start immediately and exhaust air should be detectable from the right side of the top cover.
   e] The plate current meter should continue to read zero.

2-5 TUNE UP PROCEDURE The following sections describe important points to remember during tune up and a suggested procedure for safely tuning up the CENTURION.

2-5.1 CHECKS TO MAKE BEFORE TUNING UP Check the load connected to the CENTURION. This can best be done by leaving the CENTURION in the STANDBY mode and using only the exciter power. Use a reliable SWR bridge or wattmeter to determine the VSWR of the load (antenna) connected to the amplifier output. If the reflected power is less than 10% of the forward power, the VSWR is less than 2:1. If the reflected power is 4% or less, then the VSWR is 1.5:1 or better. A VSWR of 2:1 or less is desirable.

2-5.2 IMPORTANT POINTS TO REMEMBER The most critical parameter to observe during tune up is the grid current of the power amplifier tubes. Excess grid current, even for a relatively short period of time, can and will destroy the tubes. If grid current limits are not exceeded, the 3-500Z tubes will deliver many years of trouble free service. In the CENTURION amplifier, the **grid current should not exceed 260 mA** under normal CW/SSTV/RTTY conditions, nor should the grid current peak swings ever **exceed 130 mA under SSB voice modulation.** If the grid current reaches these limits before the desired value of plate current is obtained, the drive should NOT be increased further.

THE FIRST RED LED OF THE PEAK OUTPUT POWER BARGRAPH DISPLAY HAS BEEN CALIBRATED TO LIGHT AT 1250 WATTS OUTPUT.

Occasionally check the SWR while operating to make sure it remains below 2:1. Also, monitoring reflected power is useful in that any sudden change provides warning of antenna problems such as bad connections, antenna coupler faults, transmission line flaws, or trap or balun failure. Particularly in the case of flashover (arcing) problems, the reflected power indication may flicker sharply upward only on high voice peaks.

2-5.3 SUGGESTED TUNE UP PROCEDURE The following is a suggested procedure for proper tune up of the CENTURION.

1] Place the MODE switch in the STANDBY position.

2] If you have not turned on the POWER switch and allowed the filaments to warm up, do so now. When the POWER is turned on, the STANDBY LED will come on.

3] Place the BAND switch in the correct operating position.

4] Place the METER switch in the Ig position. Always monitor "grid current" using the multi-meter. Use the peak reading wattmeter LED display to monitor forward power.

5] For initial tune up you can set the TUNE and LOAD controls in the center of their ranges or alternatively you can refer to the suggested settings for each band shown in FIGURE 2-4. Keep in mind that these settings are for operation into an "ideal" 50 ý load.

6] Turn the exciter/transceiver drive or rf output control to minimum.

7] Place the MODE switch in the OPERATE position. The OPERATE LED should turn on. and the STANDBY LED should turn off.

IF AT ANY TIME THE AMPLIFIER DOES NOT RESPOND AS EXPECTED, REMOVE DRIVE IMMEDIATELY AND CORRECT THE PROBLEM BEFORE CONTINUING.

8] Turn on the exciter and slowly increase the input drive power until you see the plate current increase.

NOTE: For a quicker and easier to tune up the amplifier, use a keyer at approximately 30 wpm in step #8

9] Adjust the TUNE control for maximum rf power output and minimum grid current. Next adjust the LOAD control for maximum power output and minimum grid current. You will find that these values are not always synchronized. Always choose the lower grid current adjustment even if the power output is slightly less.

10] Gradually increase the drive level of the exciter until you obtain the desired power output while carefully touching up the LOAD and TUNE controls for minimum grid current and maximum output power.

11] Many operators prefer to "rag chew" at reduced power levels (500 watts, or so, output) but want the option to abruptly increase power to 1200 watts (new country mode) without re-tuning. To do this you must first tune the CENTURION for 1200 watts output. You can then reduce power to the desired level by reducing the drive from your exciter. The grid current will go down as you reduce drive and that is OK. The amplifier will not be quite as efficient at reduced power levels using this method but the 3-500Z tubes will not be damaged. The efficiency (plate current required for 500 watts output) can of course be restored by re-tuning the amplifier for operation at the 500 watt level but remember, if you then increase the drive you MUST re-tune the amplifier.

12] Once you have the amplifier tuned up and operating on the desired frequency, you can log the LOAD and TUNE settings in the chart provided on page 2-8. These settings will be repeatable for the same frequency and antenna when used in the future.

FIGURE 2-1. MODEL 422 FRONT PANEL

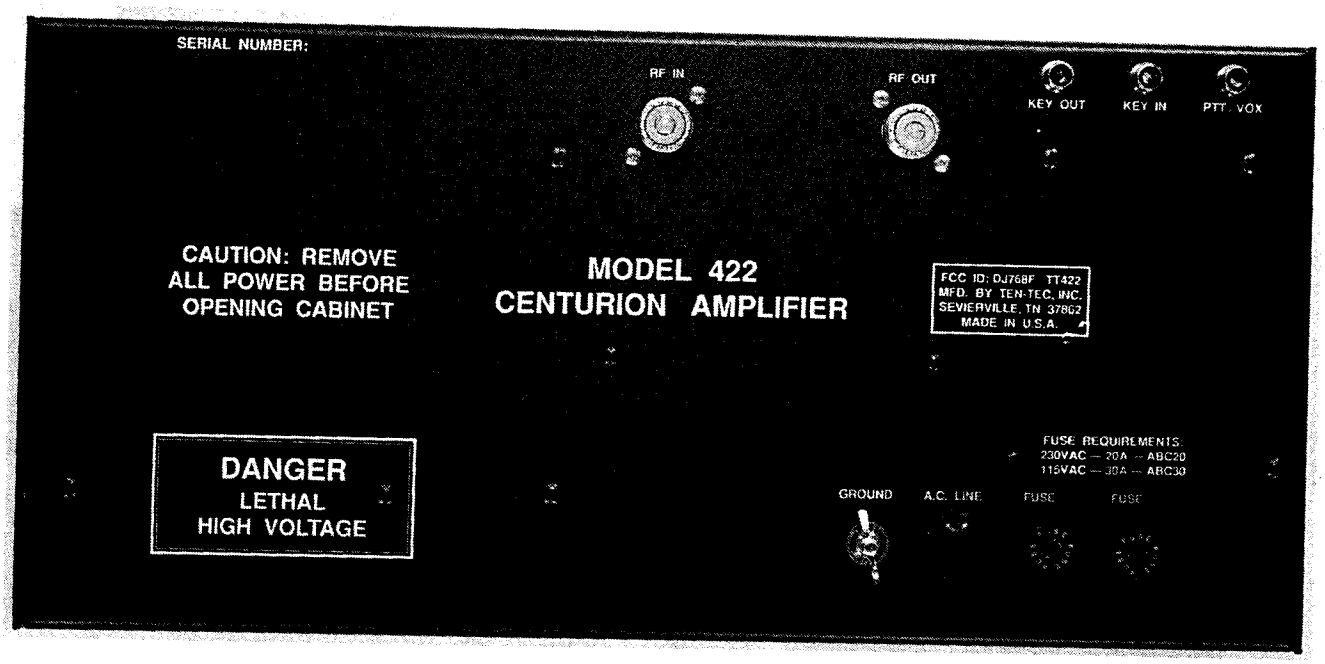


FIGURE 2-2. MODEL 422 REAR PANEL

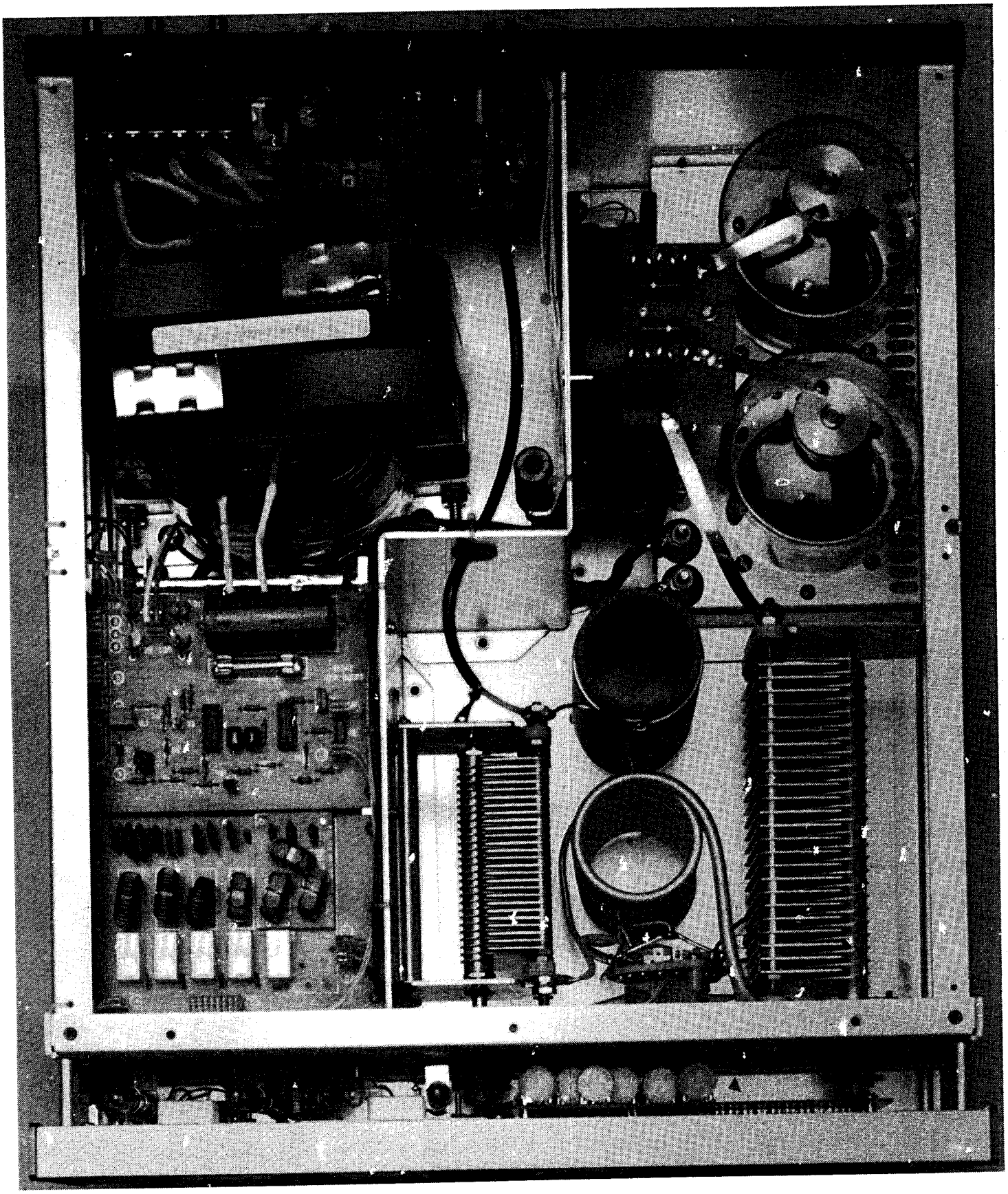


FIGURE 2-3. MODEL 422 TOP VIEW

BAND	FREQUENCY	LOAD	TUNE
160	1.800	9	8
160	1.900	6	7
160	2.000	1	6
80	3.500	9	6
80	3.600	8	6
80	3.700	6	5
75	3.800	6	5
75	3.900	5	5
75	4.000	4	4
40	7.000	8	3
40	7.100	7	3
40	7.200	7	3
40	7.300	6	3
40	7.400	6	3
40	7.500	5	3
30	10.125	9	3
20	14.000	5	1
20	14.100	5	1
20	14.200	5	1
20	14.300	5	1
20	14.400	5	1
20	14.500	5	1
18	18.125	8	2
15	21.000	5	1
15	21.100	5	1
15	21.200	5	1
15	21.300	5	1
15	21.400	5	1
15	21.500	5	1

FIGURE 2-4. MODEL 422 TUNING CHART

BAND	FREQUENCY	LOAD	TUNE	ANTENNA	NOTES

FIGURE 2-5. MODEL 422 TUNING LOG

CHAPTER 3

OPERATING HINTS

3-1 INTRODUCTION The following paragraphs provide additional useful information for getting the best performance out of your CENTURION.

3-1.1 TUBES The 3-500Z glass envelope triodes are very rugged and normally operate with a large margin of safety in the CENTURION amplifier. They will deliver outstanding service for many years if not damaged by abuse --- especially excessive grid current (which leads to excessive grid dissipation) or blockage of the cooling airflow leading to envelope heating and possible seal failure.

KEEP THE AIR INTAKE AND EXHAUST VENT AREAS COMPLETELY CLEAR!

WARNING!!!! DO NOT ALLOW the PLATE CURRENT indication to ever exceed 800 milliamperes for more than 5 seconds.

DO NOT ALLOW the GRID CURRENT ever to exceed 260 mA.

3-1.2 INTERLOCKS The CENTURION is equipped with interlock switches intended to shut off the power and to short out the high voltage power supply when the cabinet cover is not securely fastened in place. These protective interlocks are provided to protect you against a **POTENTIALLY FATAL ELECTRIC SHOCK** resulting from accidental contact with lethal voltages inside the amplifier and power supply. **HOWEVER,** you should **never** depend on the interlock switches alone to protect you by removing dangerous voltages : **ALWAYS DISCONNECT THE AC LINE CABLE TO THE CENTURION AMPLIFIER BEFORE REMOVING THE TOP COVER.**

WARNING!!

The amplifier **SHOULD NEVER BE ENERGIZED WITH THE COVER REMOVED** except by thoroughly knowledgeable service personnel!

3-1.3 FUSES Except in rare instances of component failure, blowing one or both primary line fuses indicates that the maximum safe average power capability of the amplifier has been substantially exceeded.

3-1.4 TRANSFORMER RATINGS The transformer used in the CENTURION is a tape wound Hypersil® that we manufacture in-house. It is rated at 2.5 KVA CCS (continuous commercial service). It weighs 35 lbs. The weight of a transformer is directly proportional to the capacity of that transformer. A 30 pound transformer of the same type may be rated higher by another manufacturer but only if different standards are applied, such as heat rise. Just for comparison, if our transformer were rated for IVS (intermittent voice service) or SSB operation only, it would be 8 KVA. In summary, your power supply is adequate.

3-1.5 OPERATION ON 115 VAC The CENTURION is normally shipped from the factory wired for operation on 220 - 250 VAC. The power supplies in the CENTURION can be modified for operation on 110 - 125 VAC if absolutely necessary, however this is not recommended. If you must operate the CENTURION on a 110 - 125 VAC circuit please note the following cautions:

1. Make sure that the wiring in the AC circuit you intend to use can safely handle at least 30 Amperes and that it is protected by a fuse or circuit breaker of the correct size and type.

2. Make sure that your AC outlet is a three wire grounded type and that the grounding of the outlet is adequate.

3. If your proposed AC operating circuit does not meet the requirements in items 1 and 2 above, have a licensed electrician perform the required changes to your wiring ***before*** *attempting to operate the CENTURION on 110 - 125 VAC.*

To modify the CENTURION for operation on 110 - 125 VAC you will need the following tools:

1 — medium size phillips screw driver
1 — short straight blade screw driver
1 pair — long nose pliers

To perform the modification refer to FIGURE 3-1 and proceed as follows:

1. Make sure that the a.c. line cord is unplugged and that all other cables are disconnected.

2. Remove the top cover of the CENTURION amplifier. This cover is secured with 8 screws on each side and 6 screws on top.

3. Locate the 81536 HV-AC Board. This board is mounted on the left side of the rear panel (as viewed from the front). There should be two jumper wires already installed on the terminal block at the top of this board. For 220 - 250 VAC operation, terminals 1 - 3 and 2 - 4 are jumpered.

4. Using a short screw driver, loosen the top screws on terminals 3, 4, and 5.

5. Move the jumper connector from terminal 4 to terminal 5. This jumper wire should now be connecting terminals 2 and 5 together. Tighten the screw on terminal 5.

6. Move the jumper connector from terminal 3 to terminal 4. This jumper wire should now be connecting terminals 1 and 4 together. Tighten the screws on terminals 3 and 4.

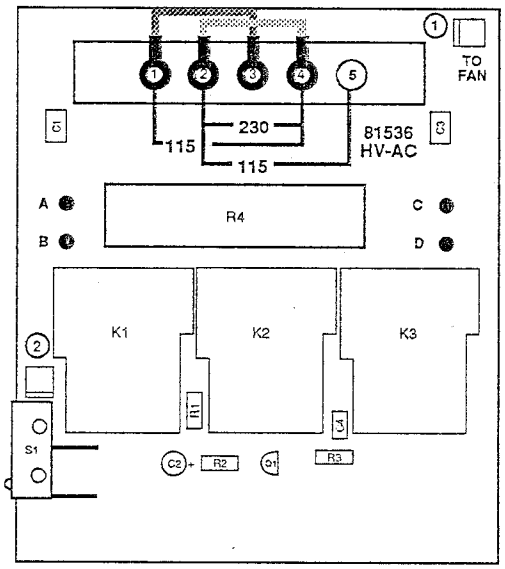
7. Locate the 81537 FILAMENT-AC Board. This board is mounted on a vertical bracket on the left side of the CENTURION, next to the filament transformer.

8. Repeat steps 4 - 6 above for the terminal block located on this board. Check that all screw connections are secure.

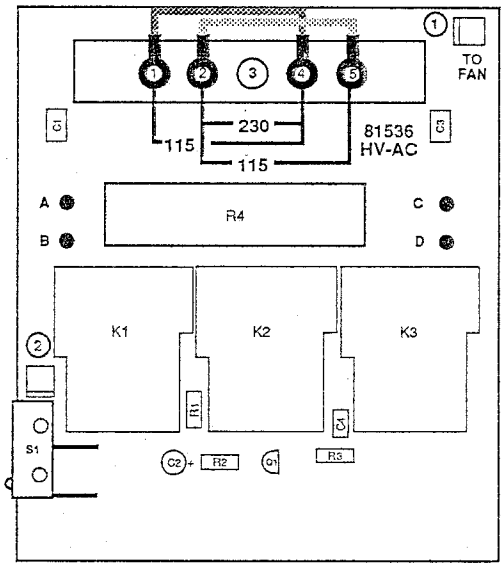
9. Replace the two (2) 20 Ampere fuses located in the rear panel fuseholders with 30 Ampere fuses (ABC 30 type).

   Note: The two (2) fuses on the 81537 FILAMENT-AC Board are NOT changed for operation on 115 VAC.

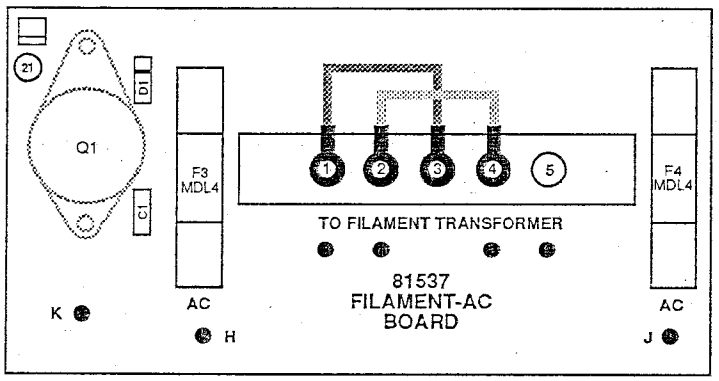
10. Replace the top cover and secure with the screws removed previously.



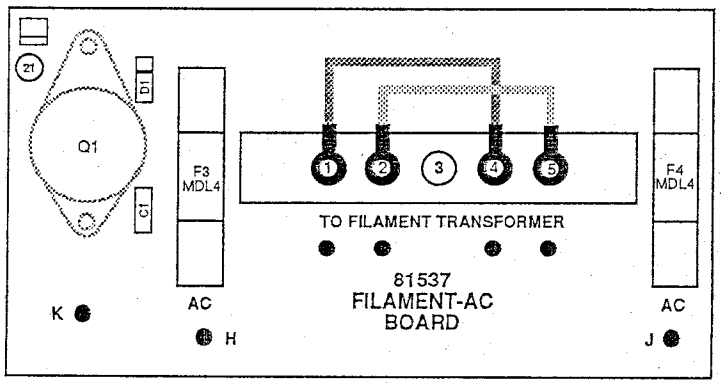
230 VAC WIRING



115 VAC WIRING



230 VAC WIRING



115 VAC WIRING

FIGURE 3-1. WIRING CHANGE FOR 115 VAC OPERATION

CHAPTER 4

MAINTENANCE AND TROUBLESHOOTING

4-1 INTRODUCTION If you encounter a problem, the troubleshooting hints listed in TABLE 4-1 below will help isolate the nature of the problem.

4-2 MAINTENANCE The amplifier compartment, particularly areas around high voltage components and the rf compartment, should be cleaned frequently enough (using a soft bristle brush and vacuum cleaner) to prevent visible accumulation of dust. DO NOT blow air directly into the fan blades; you can over-rev the fan and damage the bearings. If extremely dusty conditions prevail, it may be advisable to secure a thin plastic foam air filter, of the type commonly used in window air conditioners, and tape it across the air intake perforations on the sides of the cabinet. Make certain that the filter material does not restrict the air flow into the amplifier.

TABLE 4-1. TROUBLE SHOOTING HINTS

SYMPTOM	POSSIBLE CAUSE/CURE
1. Will not turn on; nothing happens when the ON switch is pressed.	a] Fuse missing or open. b] House wiring incorrect or breaker open. c] Power cable to amplifier disconnected. d] Fuse on QSK (81542) board blown. e] Shorted 12V power supply.
2. Lights turn on, no high voltage, relays do not close.	a] Interlock open, cover not tight.
3. Relay K1 and K3 on 81536 Board close but relay K2 does not. Plate voltage drops when rf is applied.	a] Q1 on 81536 Board is defective. b] K2 on 81536 Board is defective.
4. Relays K1, K2, and K3 on 81536 Board close but no high voltage at turn on.	a] K1, K2, or K3 defective b] HV short to ground. c] Shorted tube.

TABLE 4-1. TROUBLE SHOOTING HINTS (Continued)

5. Relays K1, K2, K3 close at turn on, but line fuse(s) blows immediately.	a] HV shorted at crowbar or elsewhere. b] Shorted tube. c] Malfunction in 12V supply.
6. Relays close, fan starts, HV meter deflects downscale, fuse(s) may blow.	a] Interelectrode short in tube. b] Shorted or deformed HV electrolytic filter capacitor.
7. Amplifier won't drive, zero grid and plate current, high input SWR.	a] Defective cable from driver to amplifier input. b] Input relay (RL1 on 81535 Board.) not closing. c] Damage to input network.
8. Amplifier drives easily, but grid meter pins at low drive.	a] Grid current metering resistors R39, R40 on 81538 Board open or damaged by severe overdrive or insufficient loading of amplifier.
9. Amplifier difficult to drive, grid current low, high input SWR.	a] BAND switch in wrong position. b] Defective input coax cable. c] Contacts of RL1 on 81535 Board not closing. d] Damaged input network. e] Interelectrode short in tube.
10. Amplifier drives easily, grid current low, little or no output (may be accompanied by "frying" sound).	a] Arc-over of component in rf tank. b] Defective output T/R relay (K1 on 81545 Board). c] Amplifier bandswitch in wrong position. d] Excessively high load SWR.
11. Excessive plate current flows in RCV or standby condition.	a] Defective QSK circuit on 81542 Board.
12. Amplifier drives normally, PLATE CURRENT very high.	a] Plate meter shunt resistors R37, R38 on 81538 Board damaged.

TABLE 4-1. TROUBLE SHOOTING HINTS (Continued)

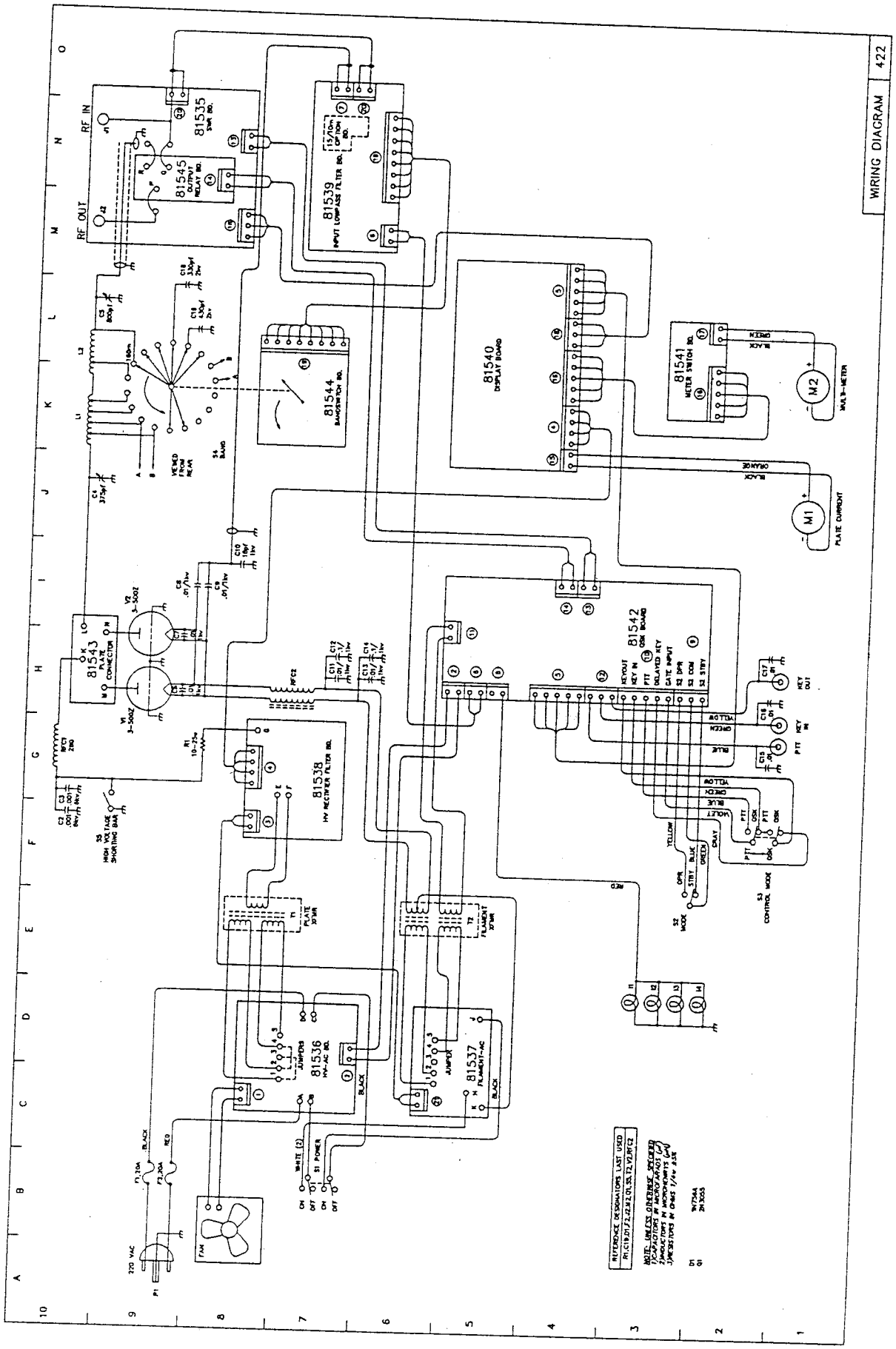
13. T/R relays remain in transmit even on STBY condition.	a] Rf drive power is present from exciter. b] Defective QSK circuit on 81542 Board.
14. Flashover in rf compartment, usually between TUNE or LOAD capacitor plates.	a] Excessive load SWR - wrong antenna b] Defective rf output cables. c] Improper tune-up procedure and/or excessive drive from exciter. d] Dirt or other foreign matter between capacitor plates. e] BAND switch in wrong position. f] Defective output T/R relay (K1 on 81545 Board).
15. Distorted ssb output signal, possibly with severe TVI.	a] Excessive load SWR. b] Defective rf cables and/or connectors. c] Improper tune-up — especially excessive drive from exciter. d] Antenna trap, balun, or feedline arc-over on voice peaks. e] RF feedback from antenna or feedline into exciter/microphone.
16. No indication on multi-meter.	a] Meter damaged or open.
17. No indication of FWD or REF power on METER or BARGRAPH meter.	a] Diodes on SWR bridge open. b] Null capacitor shorted.
18. Wattmeter highly inaccurate.	a] Very high SWR. b] SWR null capacitor misadjusted. c] Multi-meter damaged.
19. Amplifier will not key to transmit condition using conventional PTT or VOX control hookup for cw or ssb (stays in STBY mode).	a] RF appears at RF INPUT jack before T/R line closure from exciter. b] Defective QSK Board (81542). c] QSK/PTT switch S3 defective.
20. In QSK, exciter keys immediately when amplifier OPR switch is pressed.	a] Contacts of relay RL1 on 81542 Board welded due to damage.
21. With QSK hookup, exciter is not fully keyed, or will not key by the amplifier KEY OUT line.	a] Defective QSK Board (81542).

CHAPTER 5

CIRCUIT DESCRIPTIONS AND ILLUSTRATIONS

5-1 INTRODUCTION The following sections contain detailed circuit descriptions for all of the printed circuit board subassemblies used in the Model 422 Linear Amplifier. Also included are circuit trace drawings and detailed component layout diagrams. These drawings are followed by schematic diagrams for each circuit board subassembly. In addition, there is an overall wiring diagram for the Model 422 Amplifier.

FIGURE 5-1. MODEL 422 AMPLIFIER WIRING DIAGRAM



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5-2 INPUT LOW PASS FILTER BOARD (81539) This board contains five permanently installed low pass filter circuits and a plug-in board for either one or two additional filters. The RF INPUT signal, coming from the SWR Board (81535), is passed through the appropriate filter circuit and then on to the cathodes of amplifier tubes V1 and V2. The correct filter is selected by the operator using the BAND switch. Voltage from S1 on the BAND-SWITCH Board (81544) is applied to the selected relays (K1 through K5) via connector 19. For the 160M switch position, filter components L1,C1,C2,C3, and C4 are used. For the 80M position, L2, C5, C6, C7, and C8 are used. On the 40M band, L3, C9, C10, and C11 are switched in. The 20M filter consists of L4, C12, and C13. The 15M filter, located on the 15M INPUT FILTER Board (81550), plugs into the 81539 board assembly. An optional 15/10M INPUT FILTER Board (81546), available from Ten-Tec to qualified amateur radio operators, provides improved efficiency on 15M and also allows operation on the 10M band. **Note: Operation on the 10M band will also require additional modifications to the bandswitch assembly. Please contact the factory for instructions or further information.**

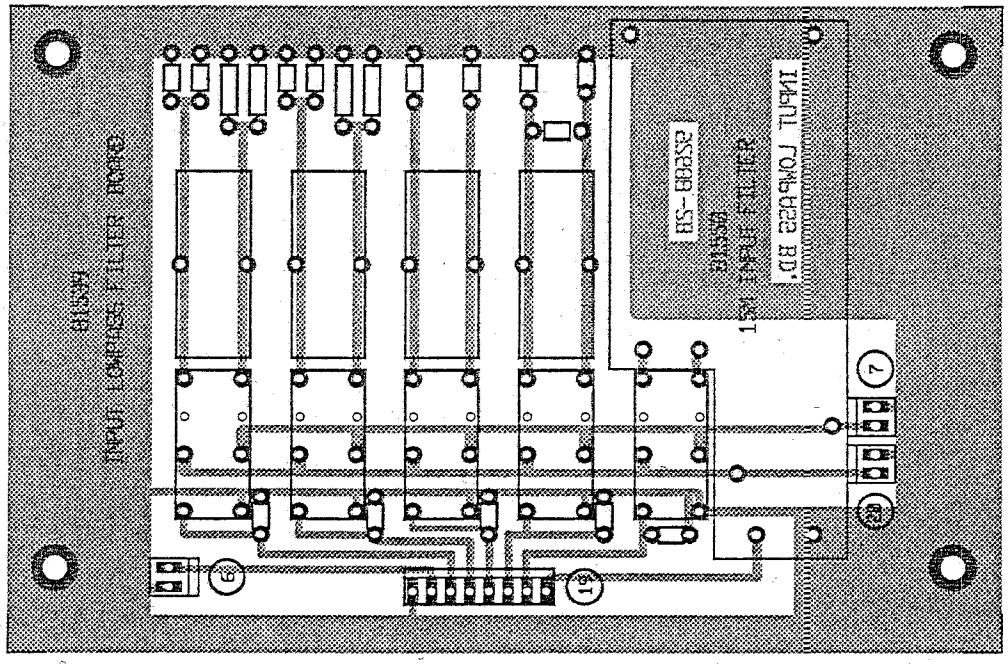


FIGURE 5-2. 81539 INPUT LOW PASS FILTER BOARD CIRCUIT TRACE

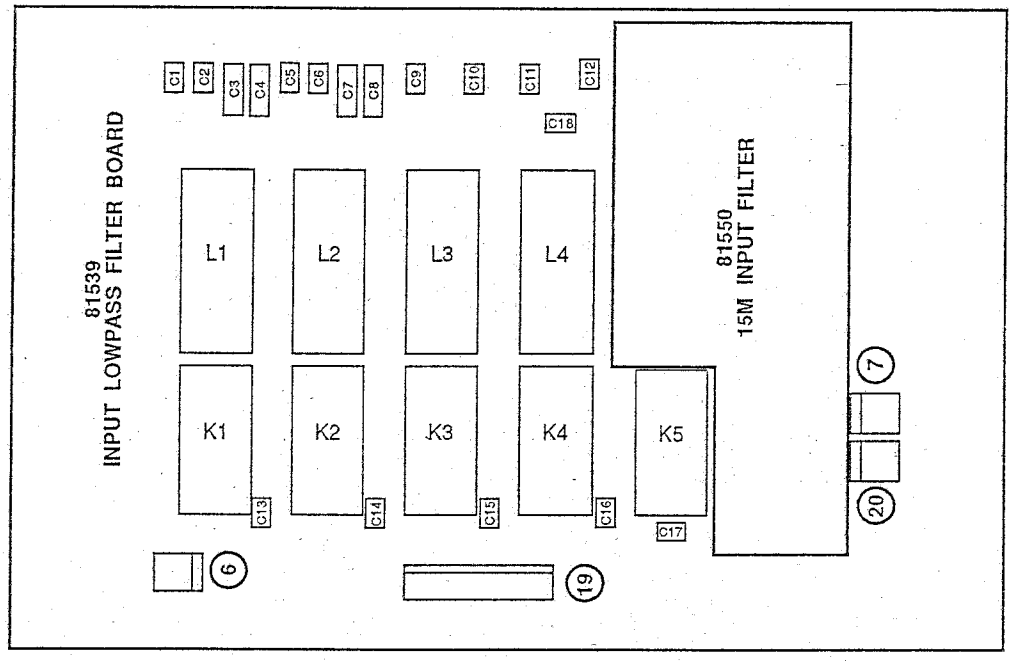


FIGURE 5-3. 81539 INPUT LOW PASS FILTER BOARD COMPONENT LAYOUT

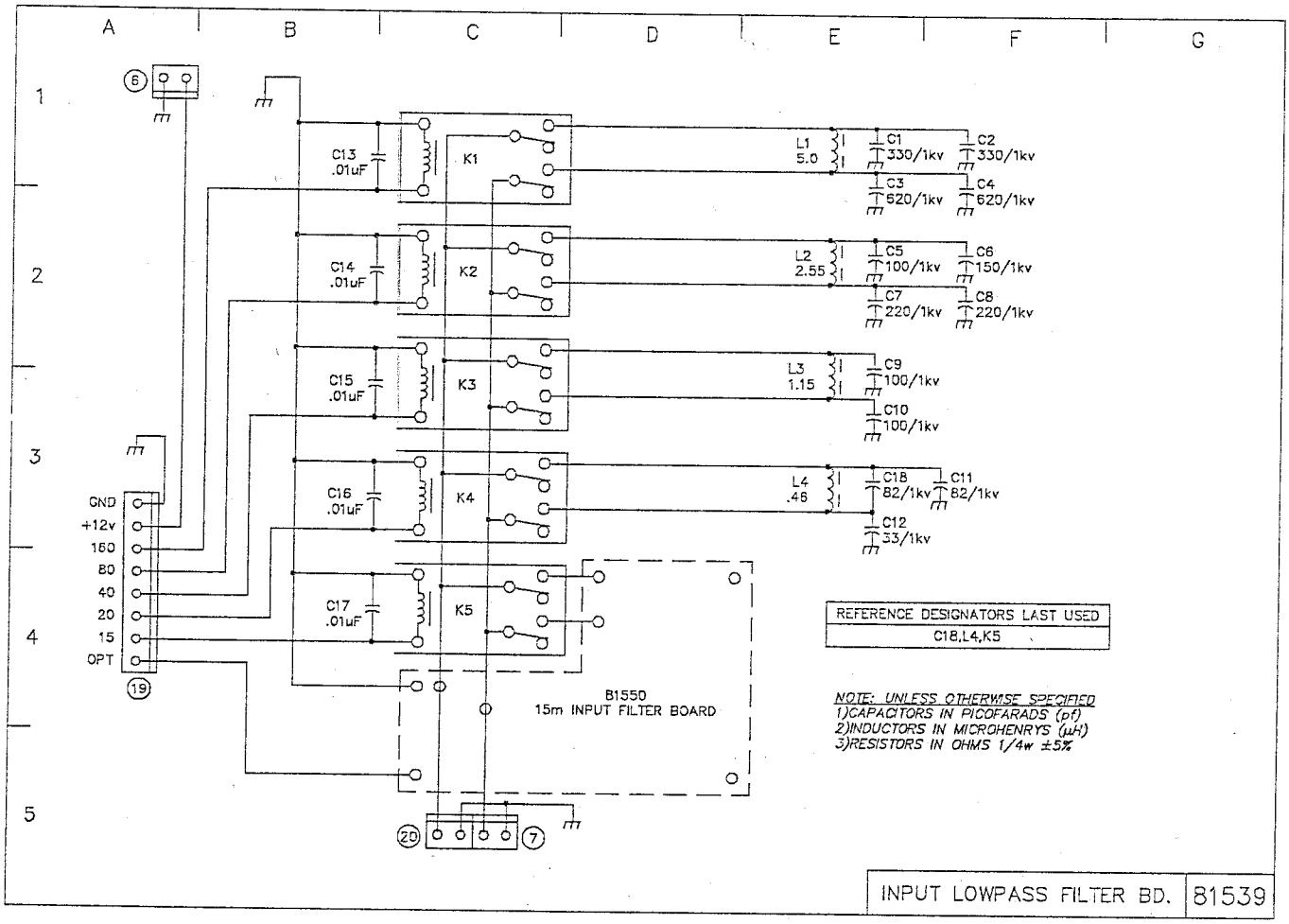


FIGURE 5-4. 81539 INPUT LOW PASS FILTER BOARD SCHEMATIC

5-3 15M INPUT FILTER BOARD (81550)

This board contains the standard factory supplied 15M low pass filter circuit. This is a five pole elliptic filter consisting of L1, L2, L3, C1, C2, and C3. This filter provides increased roll-off of frequencies above the 15M band.

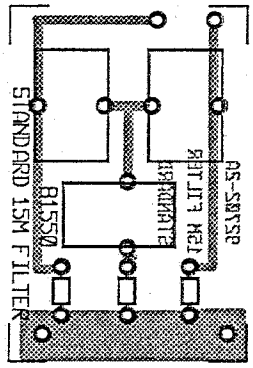


FIGURE 5-5. 81550 15M INPUT FILTER BOARD CIRCUIT TRACE

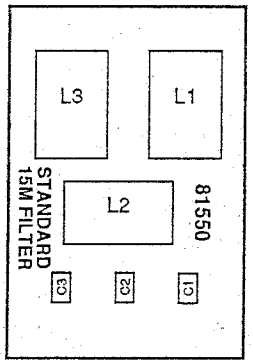


FIGURE 5-6. 81550 15M INPUT FILTER BOARD COMPONENT LAYOUT

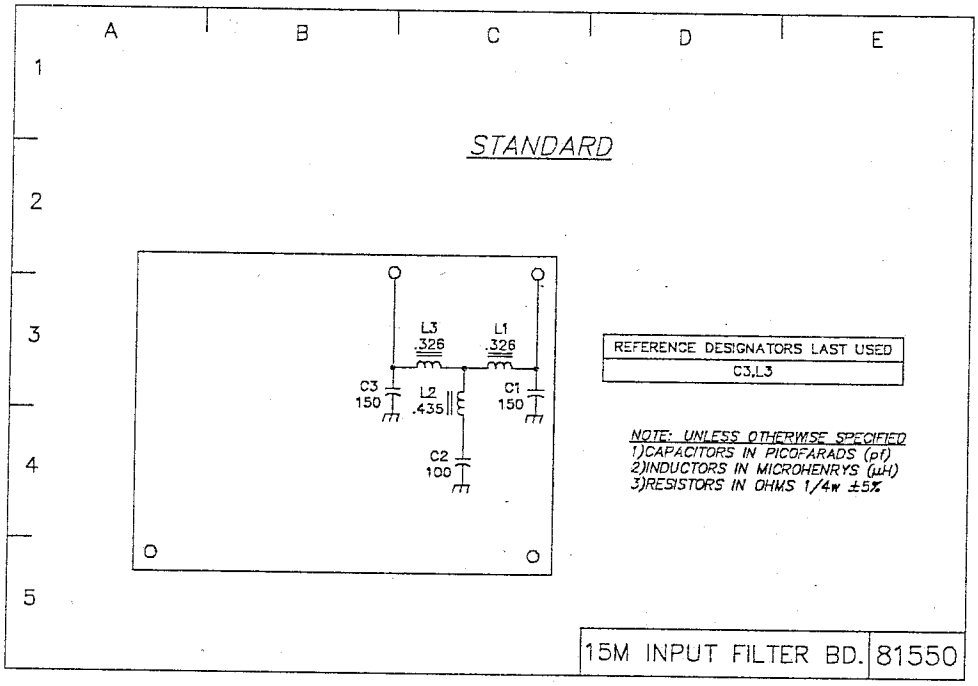


FIGURE 5-7. 81550 15M INPUT FILTER BOARD SCHEMATIC

5-4 POWER AMPLIFIER TUBES The CENTURION linear amplifier uses two 3-500Z glass envelope tubes for power amplification. These tubes are compact power triodes intended for use as cathode-driven Class AB2 amplifiers in rf applications. They exhibit high gain with low intermodulation distortion characteristics, are very rugged and will deliver outstanding service for many years if not damaged by abuse — especially excessive grid current (which leads to excessive grid dissipation). Care must also be taken not to block or restrict the cooling air flow to the tubes.

KEEP THE AIR INTAKE AND EXHAUST VENT AREAS COMPLETELY CLEAR.

Failure to observe this precaution can lead to anode overheating and possible seal failure. Play it safe. The grid dissipation is the weakest link in the system. Excess drive power always generates elevated grid current. Either reduce the drive or increase the loading to take advantage of the extra drive to produce more output power.

WARNING!! DO NOT ALLOW the PLATE CURRENT indication to ever exceed 800 milliamperes for more than 5 seconds. DO NOT ALLOW the GRID CURRENT <u>ever</u> to exceed 260 mA.

The manufacturer's **absolute maximum ratings** for a pair of 3-500Z's in AB2 service are:

DC PLATE VOLTAGE	4000 VOLTS
DC PLATE CURRENT (single tone)	0.8 AMPERE
PLATE DISSIPATION	1000 WATTS
GRID CURRENT	260 mA
GRID DISSIPATION	20 WATTS

Listed below is the pinout of a 3-500Z tube:

PIN No. 1	CATHODE
PIN No. 2	GRID
PIN No. 3	GRID
PIN No. 4	GRID
PIN No. 5	CATHODE
CAP	PLATE

5-5 PLATE CONNECTOR BOARD

(81543) This board is used to route the high voltage d.c. to the plates of triode tubes V1 and V2. High voltage d.c. from the plate choke RFC1 is applied to terminal K. R1,L1 and R2,L2 parallel combinations are connected between the high voltage d.c. and the tube plate connectors of V1 and V2 respectively. These components act as parasitic suppressors in the plate circuit of the tubes. RF power from the plates of V1,V2 is coupled through C1,C2 to the Tune Capacitor C4 via terminal L.

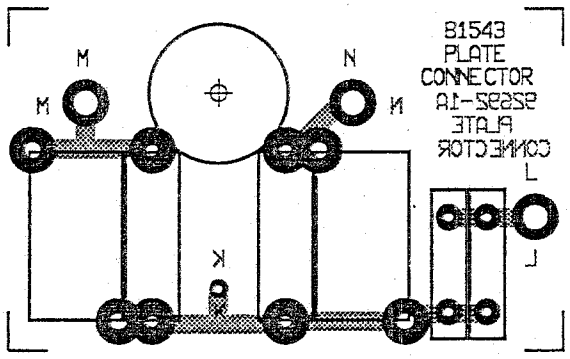


FIGURE 5-8. 81543 PLATE CONNECTOR BOARD CIRCUIT TRACE

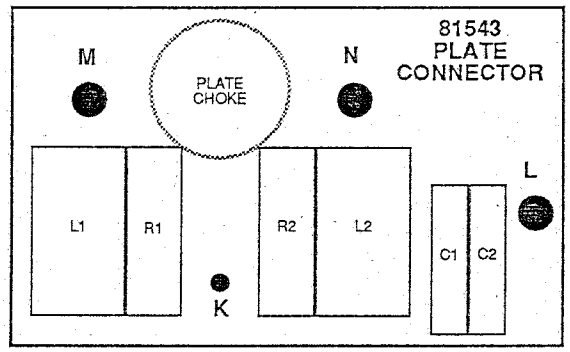


FIGURE 5-9. 81543 PLATE CONNECTOR BOARD COMPONENT LAYOUT

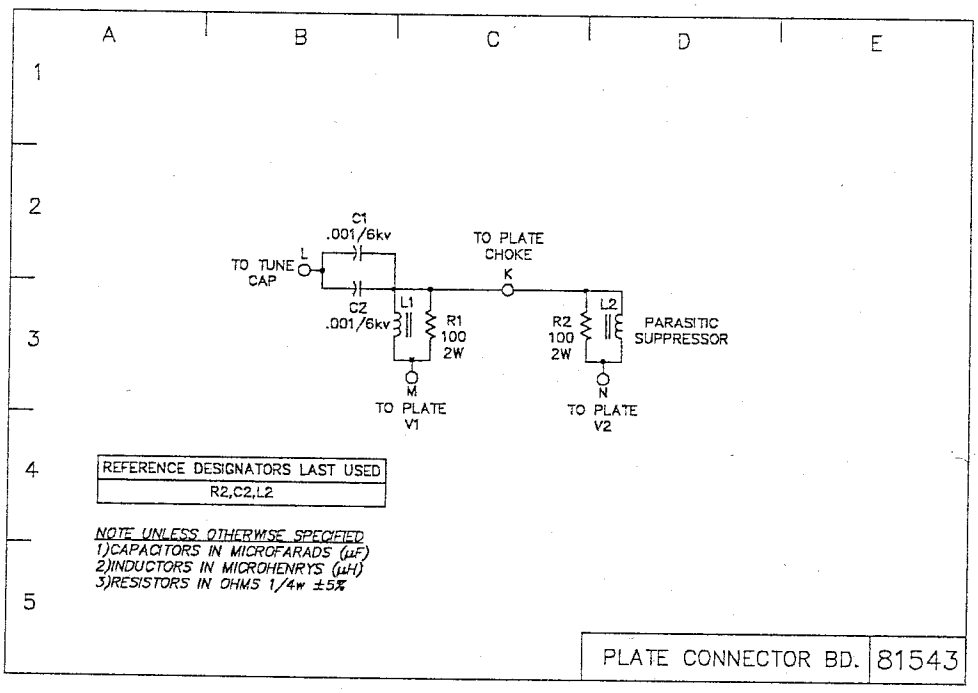


FIGURE 5-10. 81543 PLATE CONNECTOR BOARD SCHEMATIC

5-6 QSK BOARD (81542) This board contains the hotswitch latching, T/R sequencing, and +12 vdc power supply circuits. Low voltage a.c. is applied to connector 11 from filament transformer T2. This voltage is rectified by D8-D11 and filtered by C4 before being passed through fuse F1 and on to the control circuits.

T/R sequencing is controlled by U2, Q4, and Q5. Hotswitch latch protection is provided by U1 and Q3.

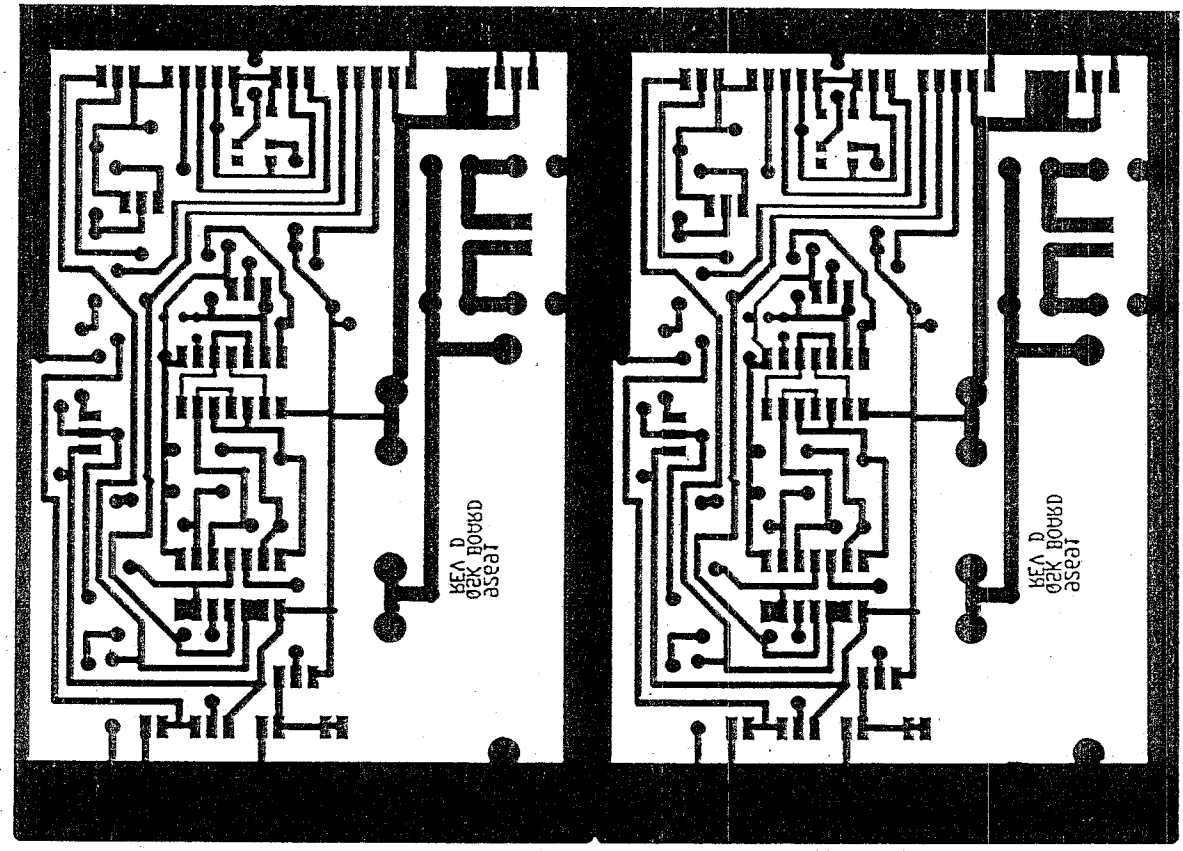


FIGURE 5-11. 81542 QSK BOARD CIRCUIT TRACE

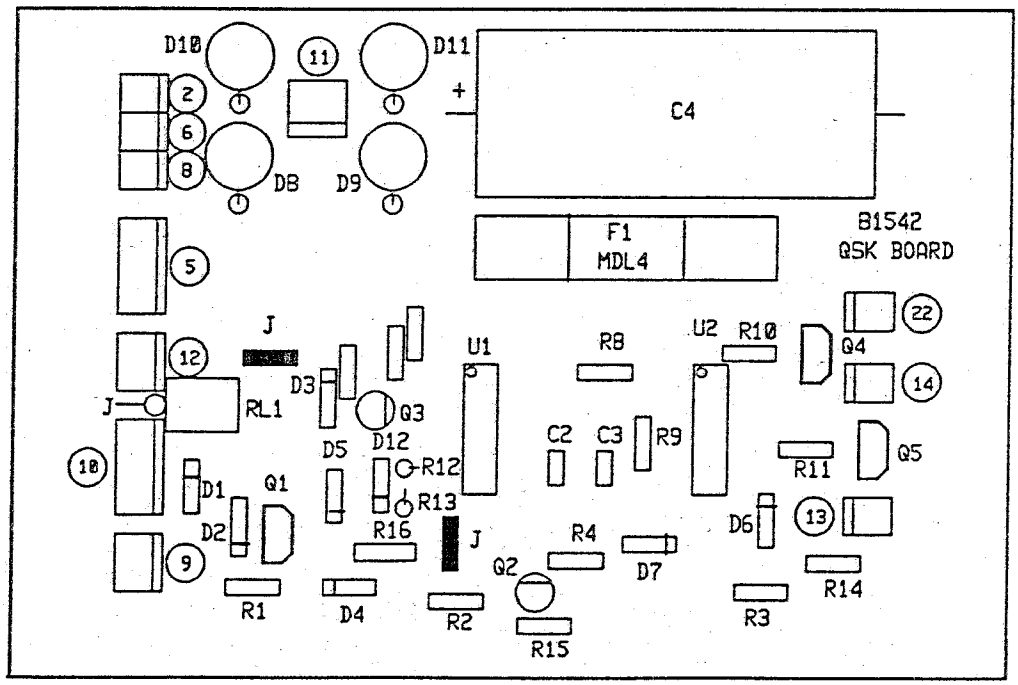


FIGURE 5-12. 81542 QSK BOARD COMPONENT LAYOUT

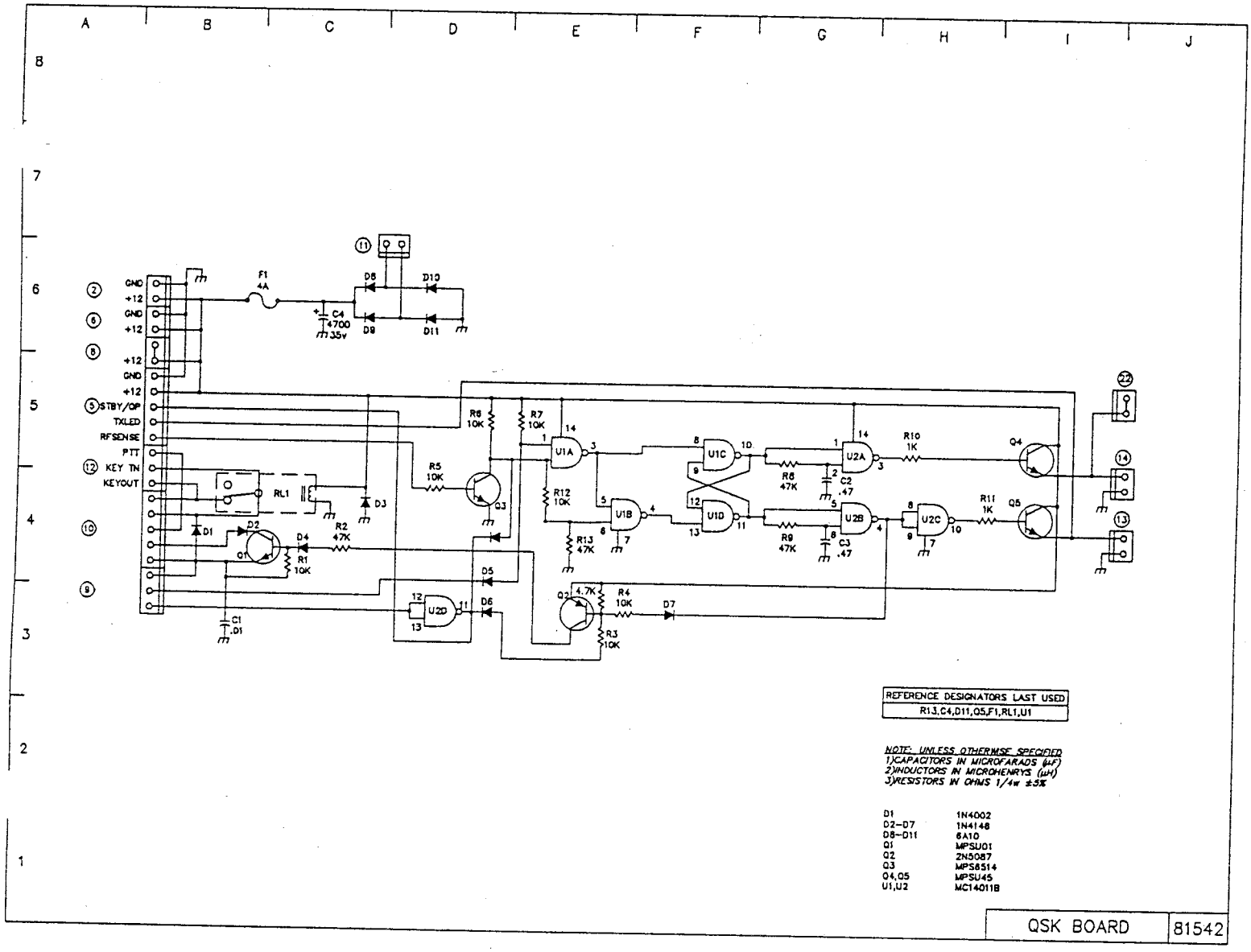
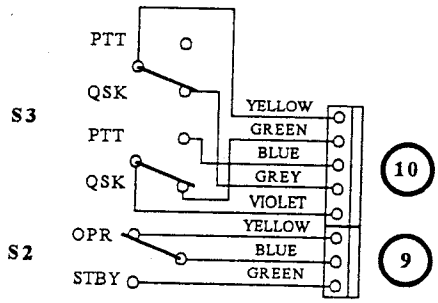


FIGURE 5-13. 81542 QSK BOARD SCHEMATIC



S2 & S3 WIRING DETAILS

5-7 OUTPUT RELAY BOARD (81545)

This board contains a high quality high voltage rf switching relay, K1. This relay is controlled by the T/R switching circuits on the 81542 QSK Board. When the CENTURION is keyed by the exciter, K1 closes, connecting the RF OUTPUT jack to the output load circuit of the amplifier. When unkeyed and in receive mode, K1 is turned off, thus connecting the RF OUTPUT jack directly to the RF IN jack. When the CENTURION is used in QSK mode, the keying of relay K1 directly follows the KEY IN line. When used in PTT/VOX mode, the release of K1 is delayed to provide smooth VOX operation.

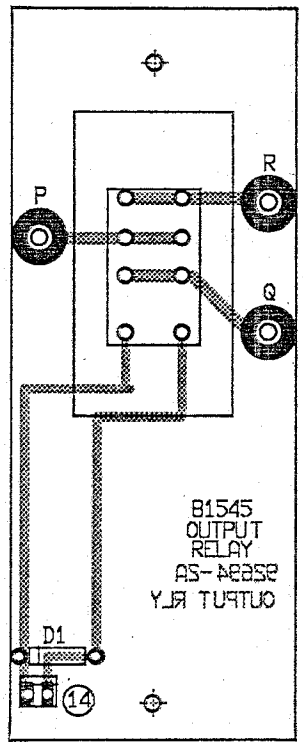


FIGURE 5-14. 81545 OUTPUT RELAY BOARD CIRCUIT TRACE

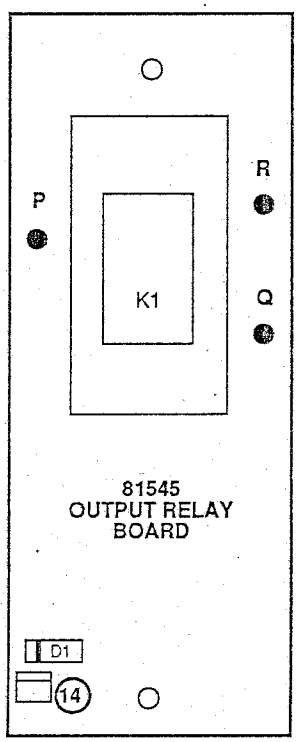


FIGURE 5-15. 81545 OUTPUT RELAY BOARD COMPONENT LAYOUT

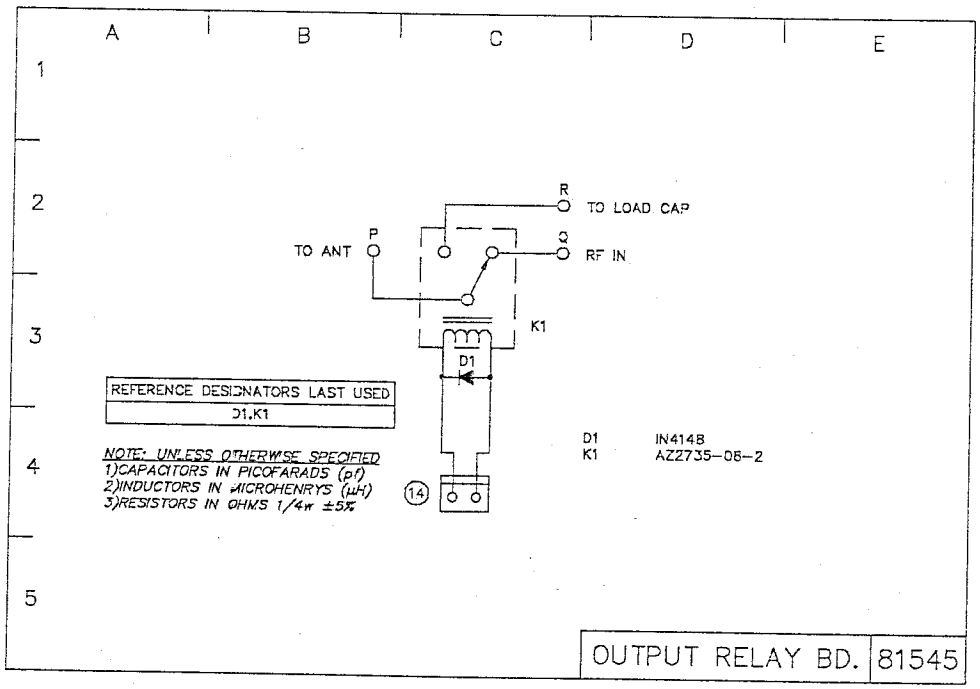


FIGURE 5-16. 81545 OUTPUT RELAY BOARD SCHEMATIC

5-8 SWR BOARD (81535) This board contains an RF bridge circuit which is used to measure the forward and reflected RF power levels at the output of the CENTURION. The RF output is passed through transformer T1 and detected by diodes D1 and D2 which are connected in a bridge configuration. The output of diode D1 is proportional to the forward output power while the output of diode D2 is proportional to the reverse output power level. The SWR bridge circuit is balanced or nulled by trimmer capacitor C2. The outputs of D1 and D2 also go to the DISPLAY Board (81540) via connector 18.

Also located on this board are the rf input switching relay, RL1 and the 81545 OUTPUT RELAY Board sub-assembly. These two relays control the path of the input and output rf power in the amplifier.

WARNING!!! POTENTIALLY LETHAL VOLTAGES, both rf and dc exist very near the SWR Board. If adjustment of the NULL trimmer should ever become necessary, it should be performed by experienced and knowledgeable personnel!!!

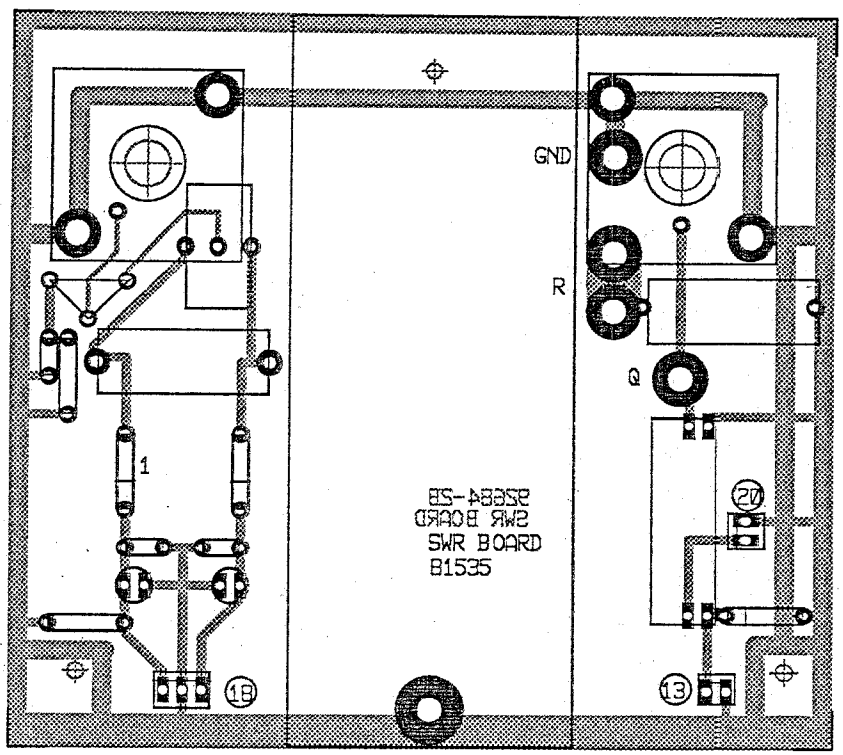


FIGURE 5-17. 81535 SWR BOARD CIRCUIT TRACE

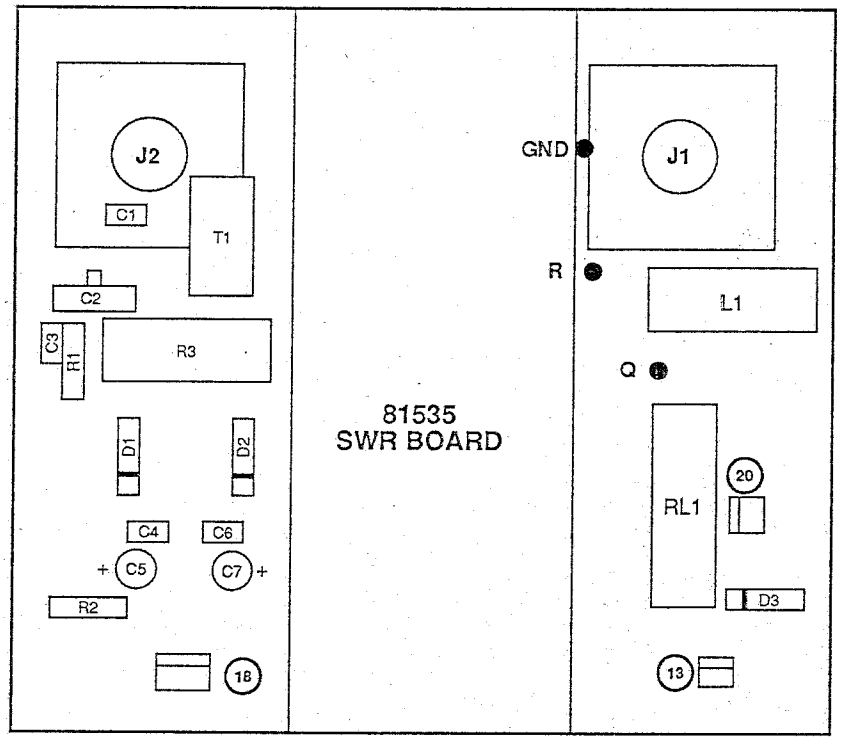


FIGURE 5-18. 81535 SWR BOARD COMPONENT LAYOUT

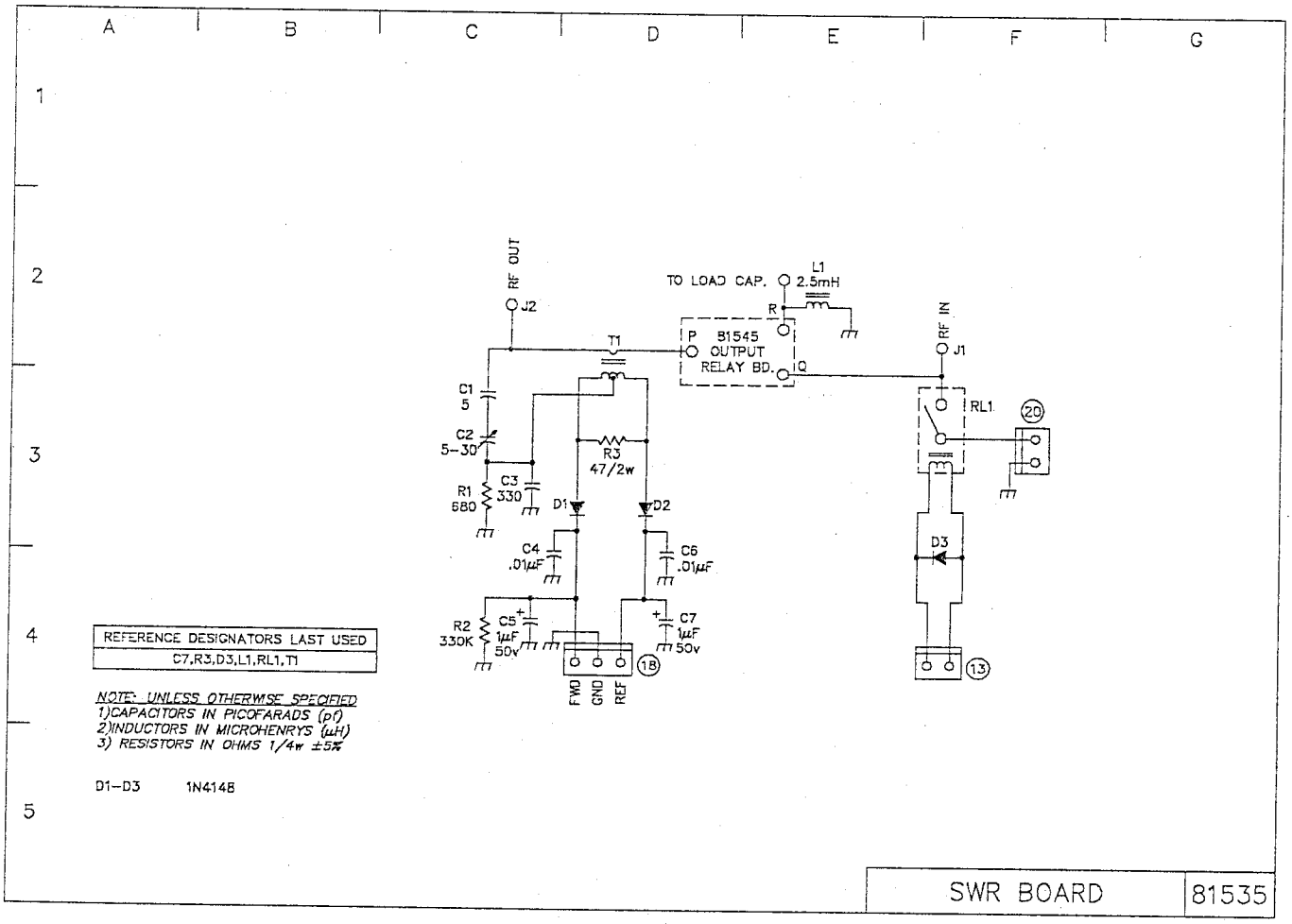


FIGURE 5-19. 81535 SWR BOARD SCHEMATIC

5-9 BANDSWITCH BOARD (81544) This board contains S1, a p.c. mounted six position rotary switch used to select the proper input low pass filter, located on the INPUT LOW PASS FILTER Board (81539), via connector 19.

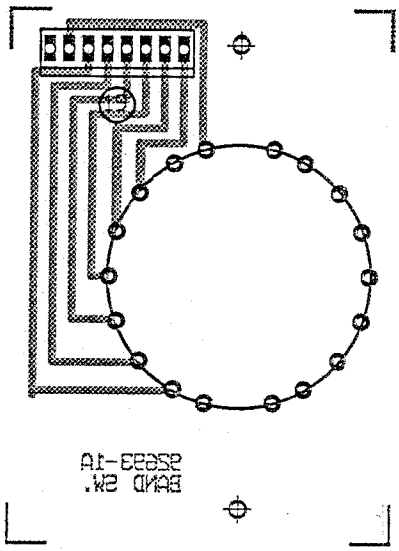


FIGURE 5-20. 81544 BANDSWITCH BOARD CIRCUIT TRACE

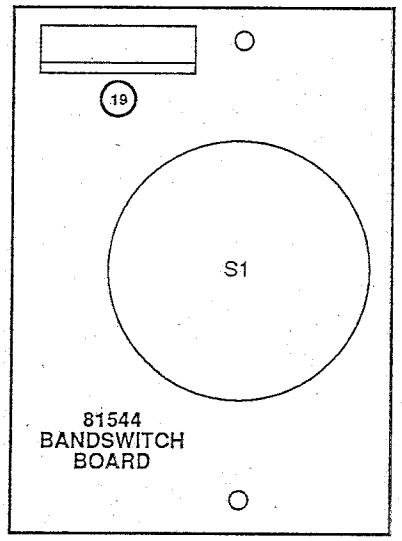


FIGURE 5-21. 81544 BANDSWITCH BOARD COMPONENT LAYOUT

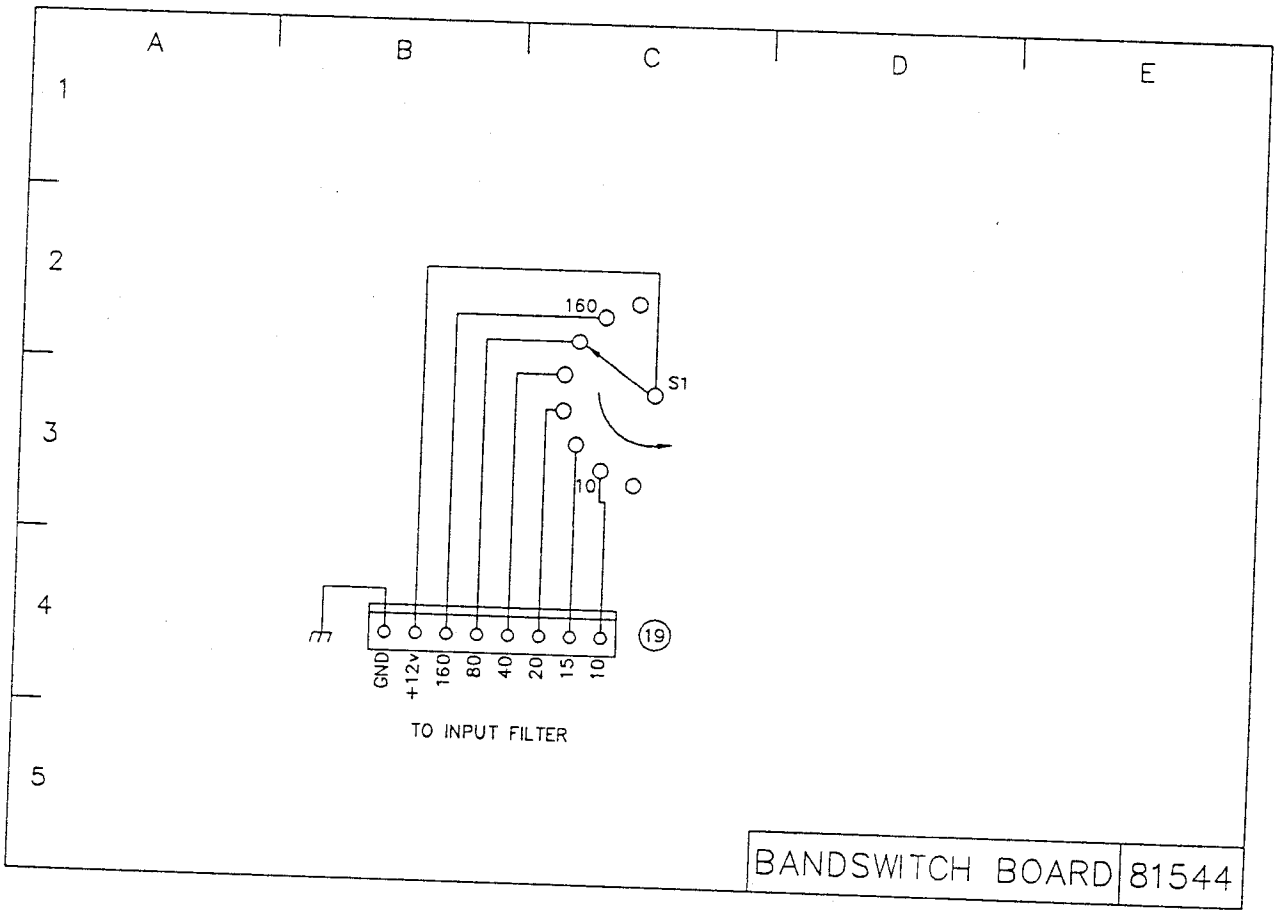


FIGURE 5-22. 81544 BANDSWITCH BOARD SCHEMATIC

5-10 METER SWITCH BOARD (81541)

This board contains S1, a p.c. mounted four position rotary switch used to select the appropriate signals for the multi-meter readout, M2. The plate voltage (Ep), grid current (Ig), and forward (FWD) and reflected (REF) power signals are supplied from the DISPLAY Board (81540) via connector 16. Connector 17 routes the output from switch S1A to the multi-meter, M2.

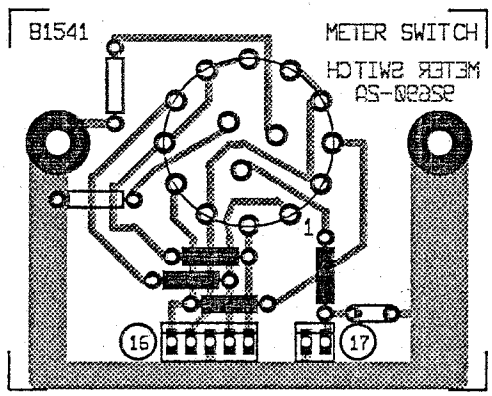


FIGURE 5-23. 81541 METER SWITCH BOARD CIRCUIT TRACE

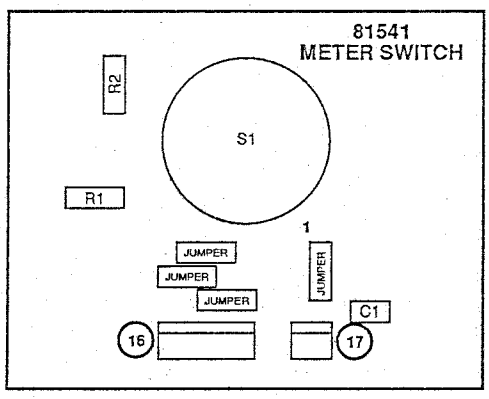


FIGURE 5-24. 81541 METER SWITCH BOARD COMPONENT LAYOUT

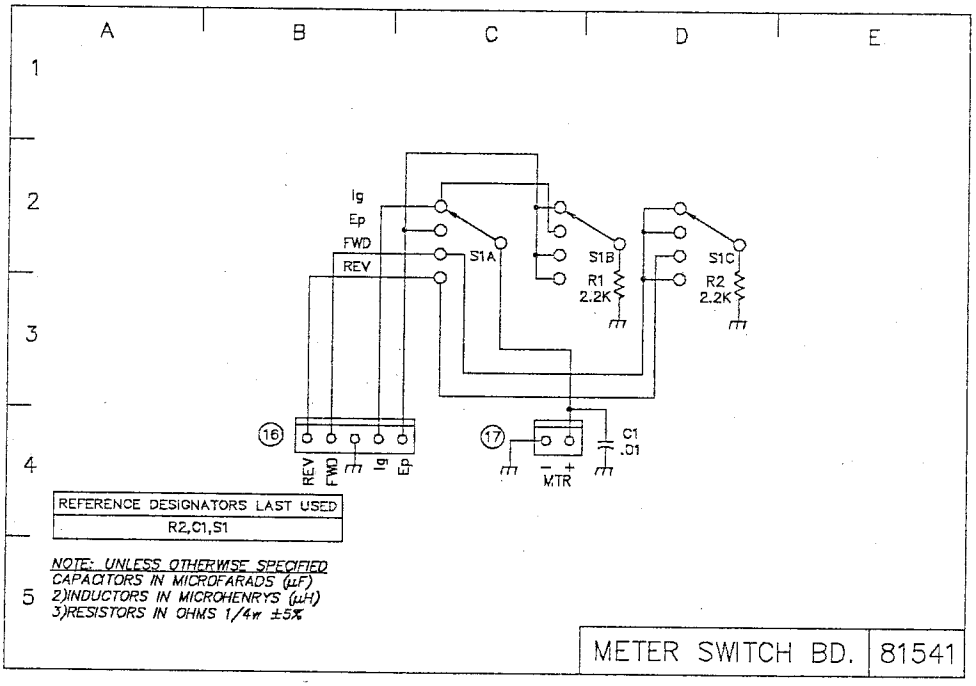


FIGURE 5-25. 81541 METER SWITCH BOARD SCHEMATIC

5-11 DISPLAY BOARD (81540) The display board contains a peak reading wattmeter circuit with LED readout and annunciators for the operating status of the CENTURION. Integrated circuit U1 contains a ten step bar graph display system. The peak output power signal from the SWR Board (81535) is routed via connector 18 to emitter follower Q1, which buffers the bridge output signal. The output of Q1 is fed to potentiometer R8, which is used to calibrate the peak power readout of the bar graph circuit. The ten outputs of U1 directly drive LED's D4 through D13. Bias and operating voltage for the LEDs is provided from the +12 volt supply via connector 5. This supply voltage is filtered by C10 and used to supply a reference voltage to U1. Resistor R9 determines the maximum current level for each of the LED output lines. LEDs D2 and D3 indicate the "standby" and "operate" modes respectively. These LEDs are controlled by S2, the MODE switch. LED D1 indicates when the CENTURION is in "transmit" and is controlled by circuits on the QSK Board (81542).

This board also contains several trimmer poteniometers used to calibrate the readings obtained on the plate current and multi-mode meters, M1 and M2 respectively. R1 is used to calibrate M1 for correct value of plate current. Trimmer R2 is used to calibrate M2 for plate voltage when the meter switch is in the Ep position. R3 calibrates M2 for a correct value of grid current when the meter switch is in the Ig position. Likewise, R4 and R5 calibrate M2 for forward and reflected power readings when the meter switch is in the FWD and REF positions respectively.

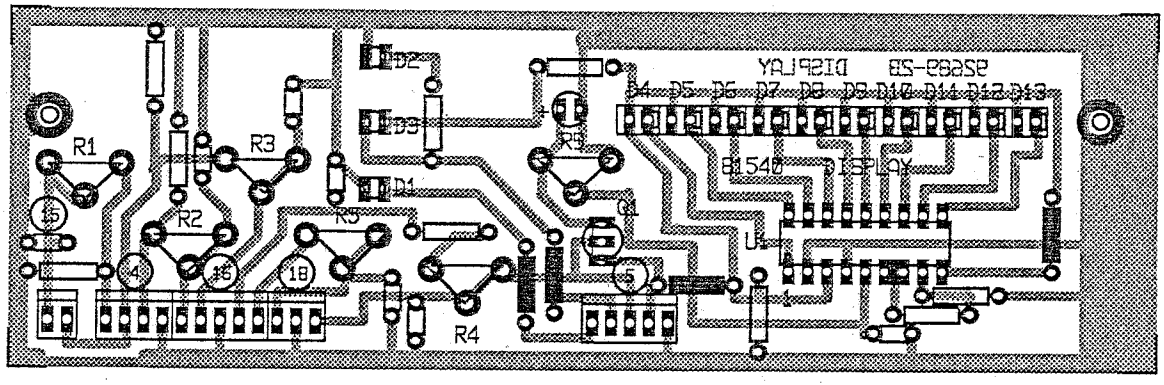


FIGURE 5-26. 81540 DISPLAY BOARD CIRCUIT TRACE

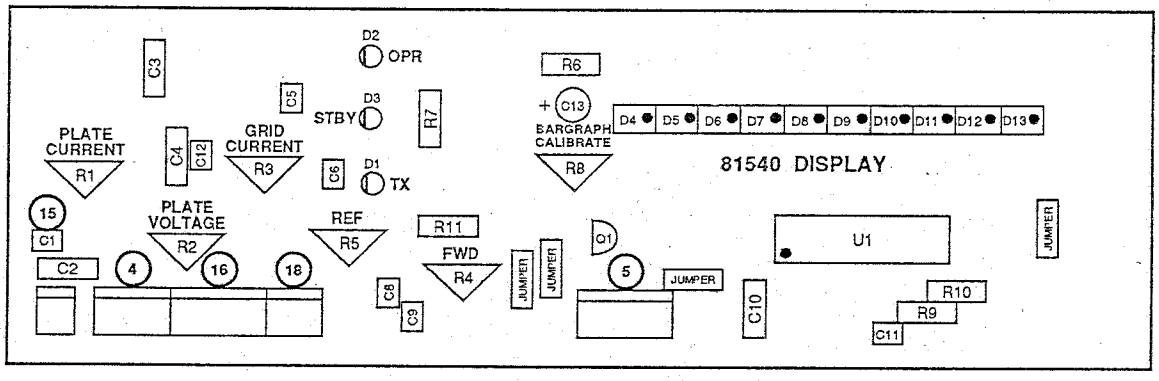


FIGURE 5-27. 81540 DISPLAY BOARD COMPONENT LAYOUT

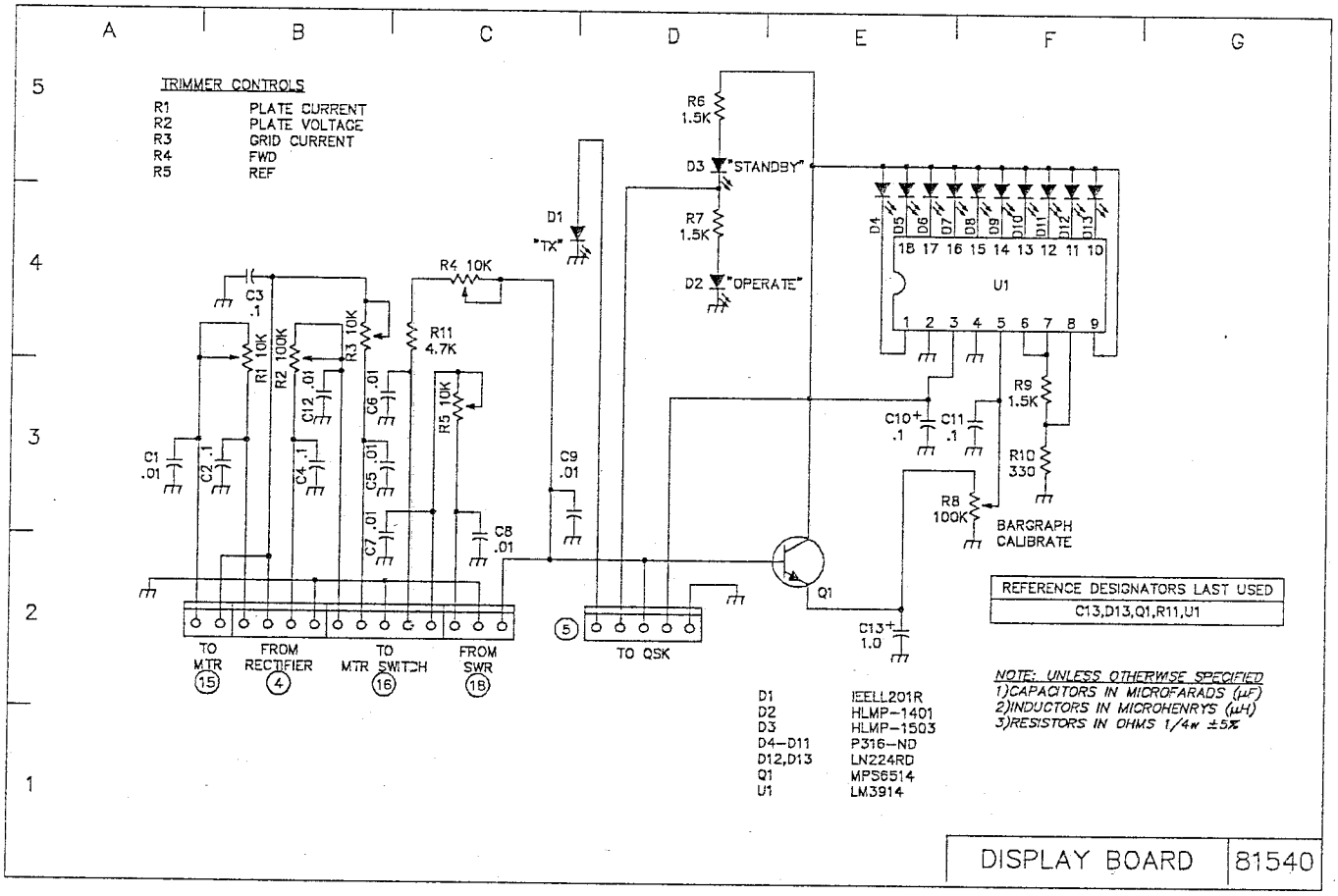


FIGURE 5-28. 81540 DISPLAY BOARD SCHEMATIC

5-12 FILAMENT-AC BOARD (81537)

This board contains a 5 terminal barrier strip , two 4 ampere slow blow (MDL4) fuses, and a regulator circuit for the tube bias supply. A.C. line voltage is applied to terminals H and J. The filament transformer primary windings are connected to the 5 terminal barrier strip. This strip is normally jumpered for 230 VAC operation but may be rewired for 115 VAC operation if needed. Transistor Q1 and zener diode D1 provide a regulated voltage for the tube bias supply.

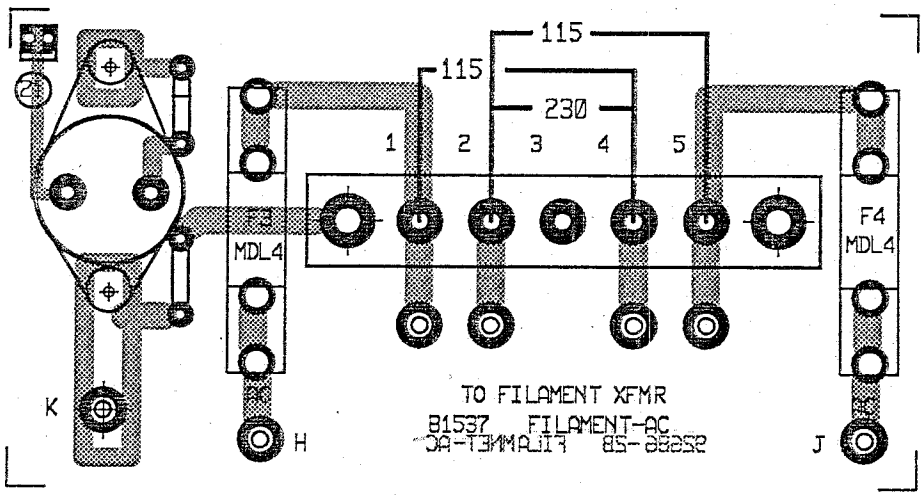


FIGURE 5-29. 81537 FILAMENT-AC BOARD CIRCUIT TRACE

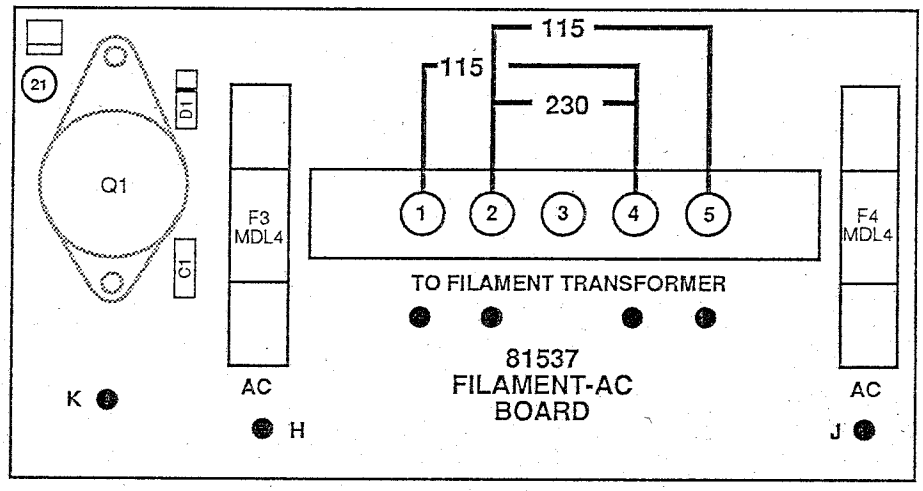


FIGURE 5-30. 81537 FILAMENT-AC BOARD COMPONENT LAYOUT

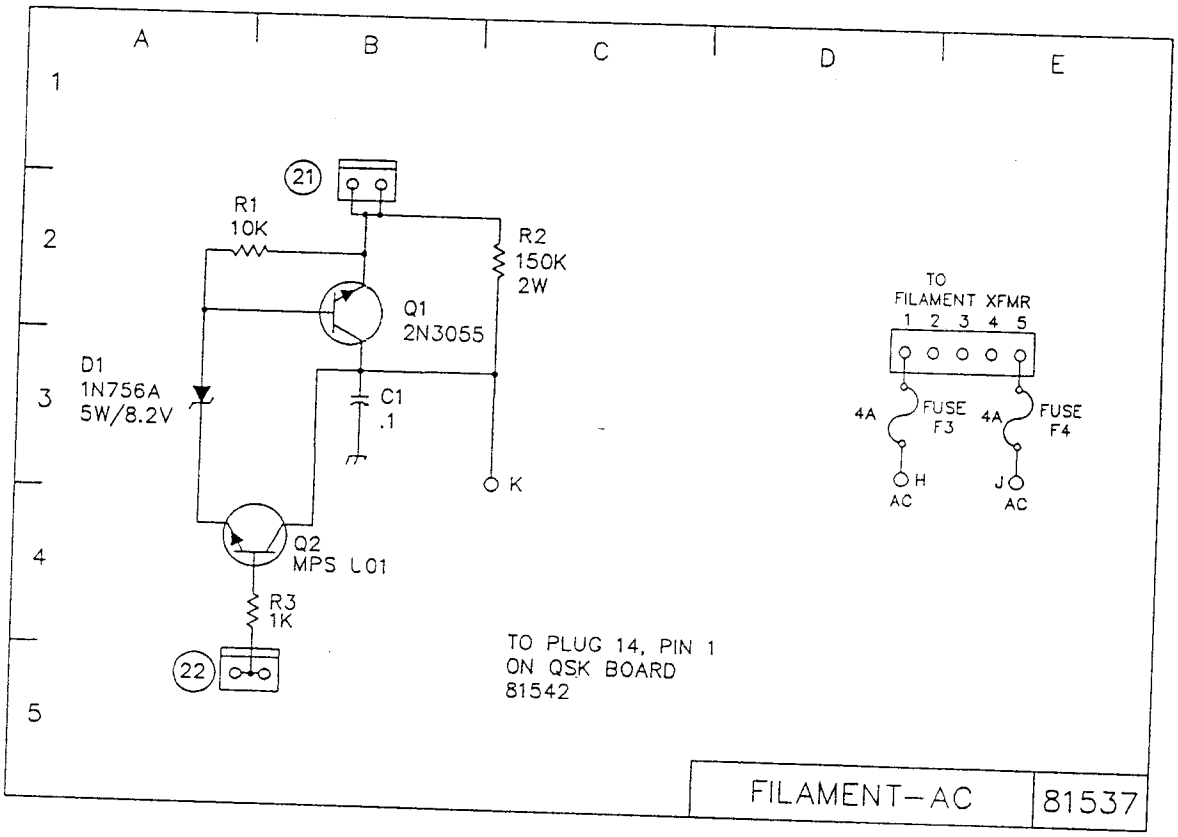


FIGURE 5-31. 81537 FILAMENT-AC BOARD SCHEMATIC

5-13 HV-AC BOARD (81536) This board contains three relays, K1, K2, and K3, which switch the a.c. line voltage to the plate transformer primaries and the built-in fan. When the front mounted POWER switch is turned on, a.c. line voltage is applied to filament transformer T2 via the 81537 FILAMENT-AC Board. This in turn supplies low voltage a.c. to the input of a +12 vdc supply located on the 81542 QSK Board. The filtered +12 vdc is applied to connector 2 and immediately energizes relays K1 and K3, provided the INTERLOCK switch S1 is closed. The +12 vdc is also applied to a soft-start delay circuit comprised of Q1, R1-R3, and C2. This provides about a one second delay before energizing relay K2. Before K2 is turned on, current limited a.c. line voltage is applied to plate transformer T1 via resistor R4. When K2 is turned on, R4 is bypassed and the full a.c. line voltage is applied to T1. This soft-start circuit reduces turn on transients which might otherwise damage components in the high voltage power supply.

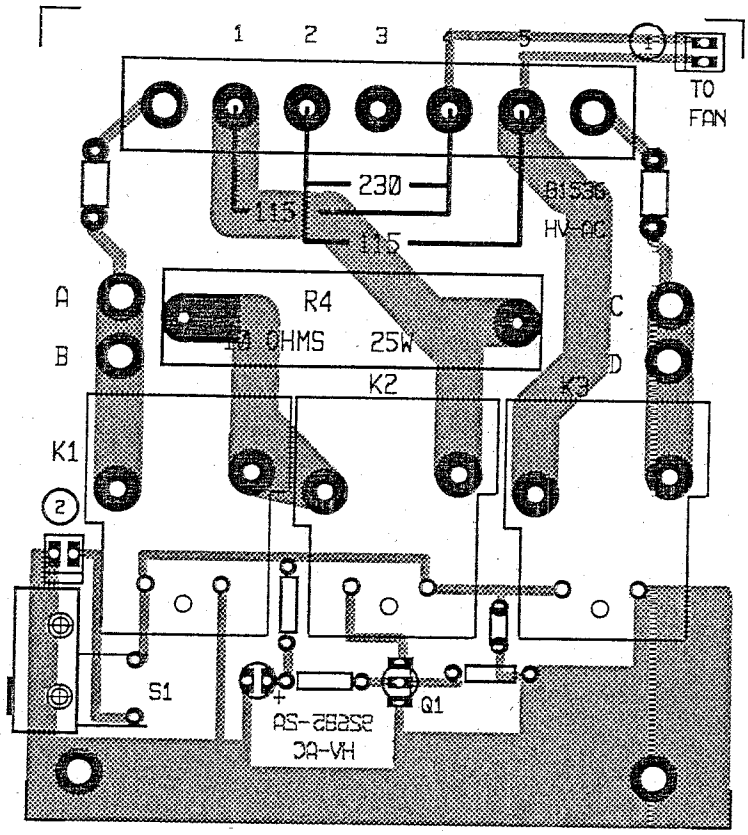


FIGURE 5-32. 81536 HV-AC BOARD CIRCUIT TRACE

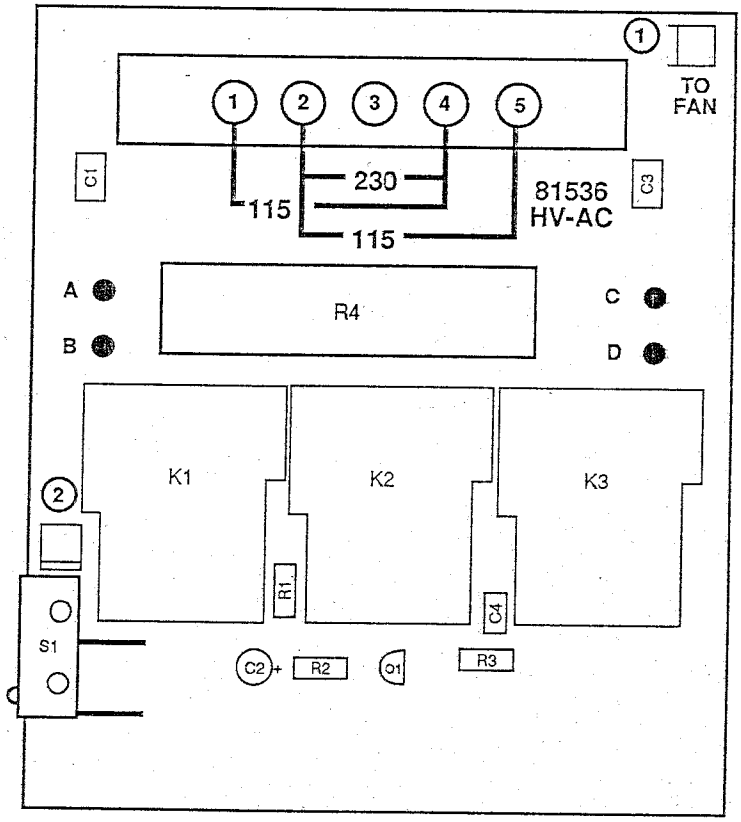


FIGURE 5-33. 81536 HV-AC BOARD COMPONENT LAYOUT

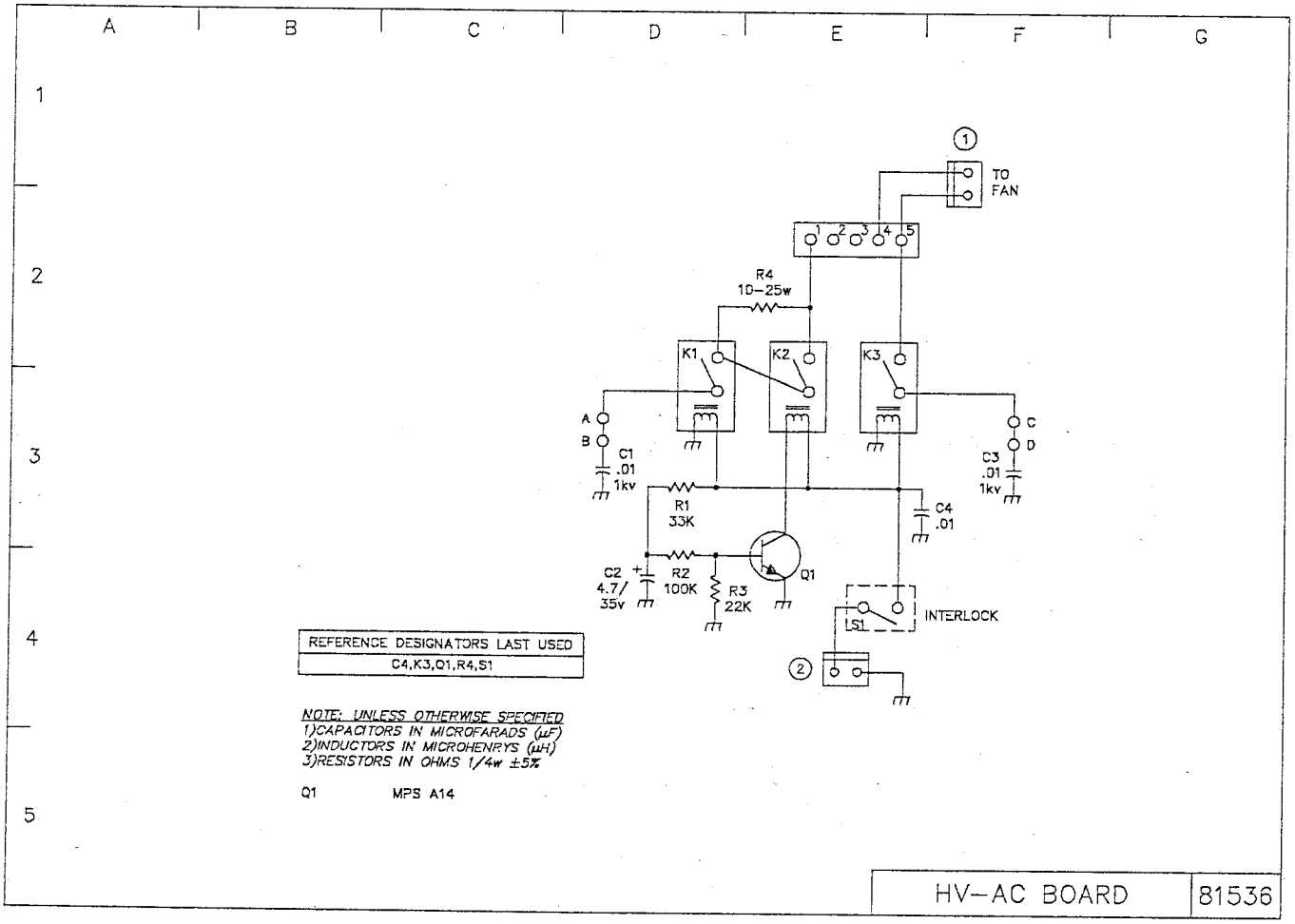


FIGURE 5-34. 81536 HV-AC BOARD SCHEMATIC

5-14 HV RECTIFIER-FILTER BOARD

(81538) This board contains a high voltage bridge rectifier, a filter circuit, and voltage dividers for metering of the plate current and voltage. High voltage a.c. is applied to terminals E and F from the plate transformer T1. Diodes D1-D20 and resistors R17-R36 form a complex high voltage bridge rectifier assembly used to generate the +3100 volts. Five diodes are connected in series in each leg of the bridge to obtain the required breakdown ratings. The high voltage output from the bridge is filtered by eight computer grade electrolytic capacitors, C1-C8. Resistors R1-R16 provide both bleeder action and voltage equalization for the capacitor bank. The filtered high voltage d.c. is applied to terminal G which is connected to the plate circuits of tubes V1 and V2.

Resistors R42-R45 form a voltage divider, whose output is routed to the multi-meter circuit via connector 4. This output monitors the high voltage output to the tube plates. Resistors R37 and R38 are used to develope a voltage proportional to the plate current of V1,V2. This voltage is routed to the 81540 DISPLAY Board via connector 4. Resistors R39, R40 are used to monitor the grid current of V1,V2. Resistor R41 is used to unbias tubes V1, V2 when in STANDBY operation.

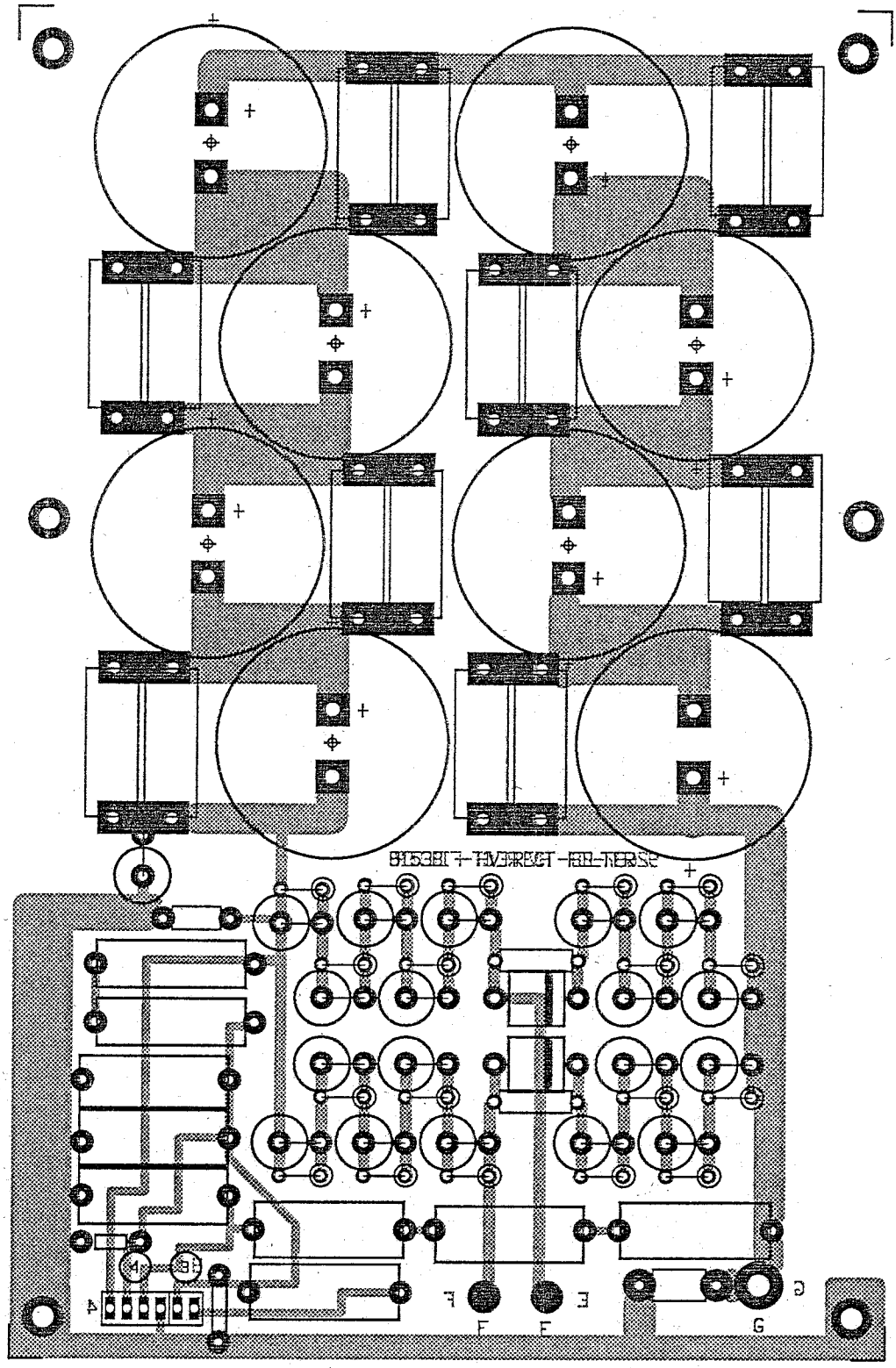


FIGURE 5-35. 81538 HV RECTIFIER-FILTER BOARD CIRCUIT TRACE

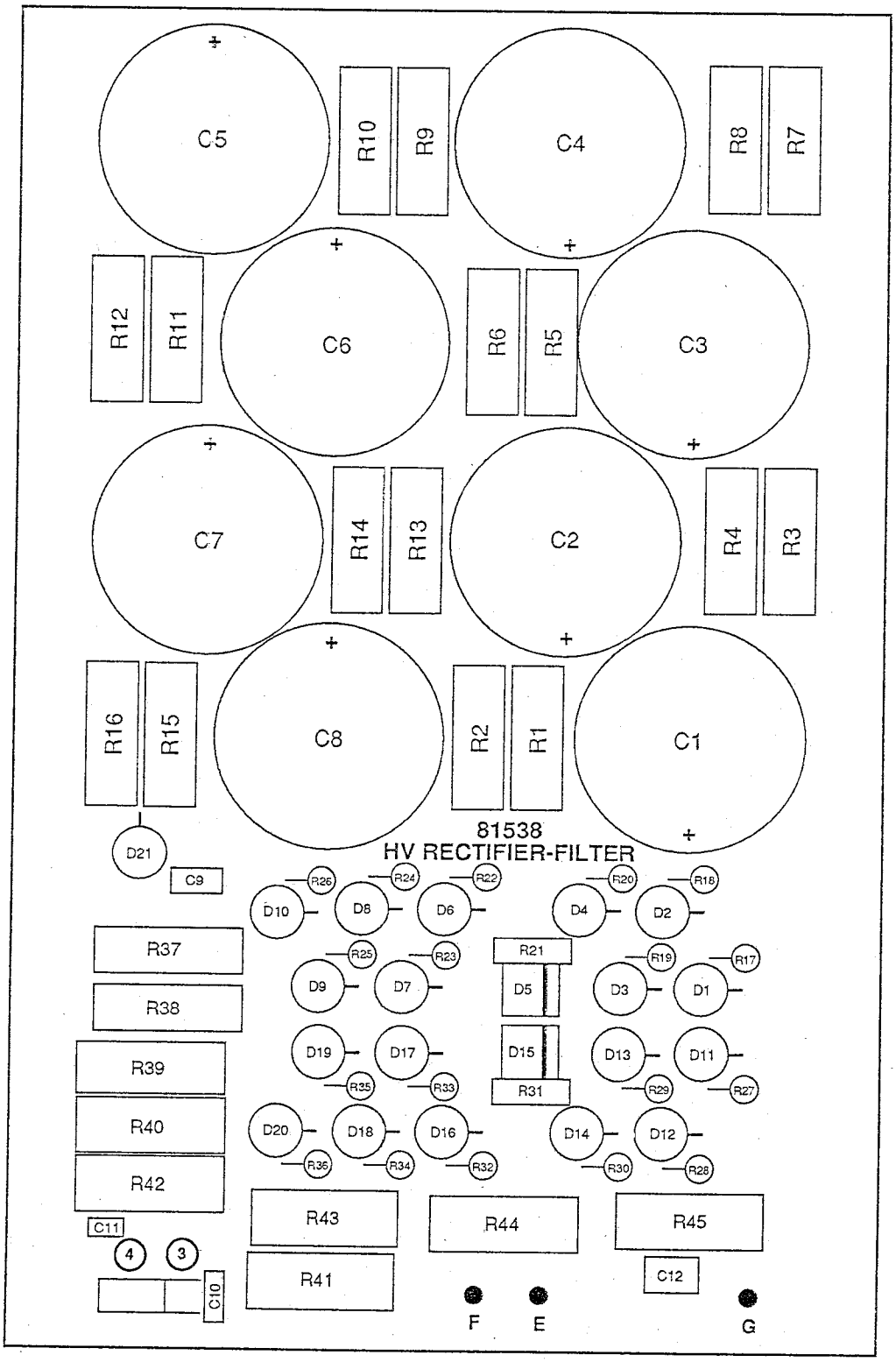


FIGURE 5-36. 81538 HV RECTIFIER-FILTER BOARD COMPONENT LAYOUT

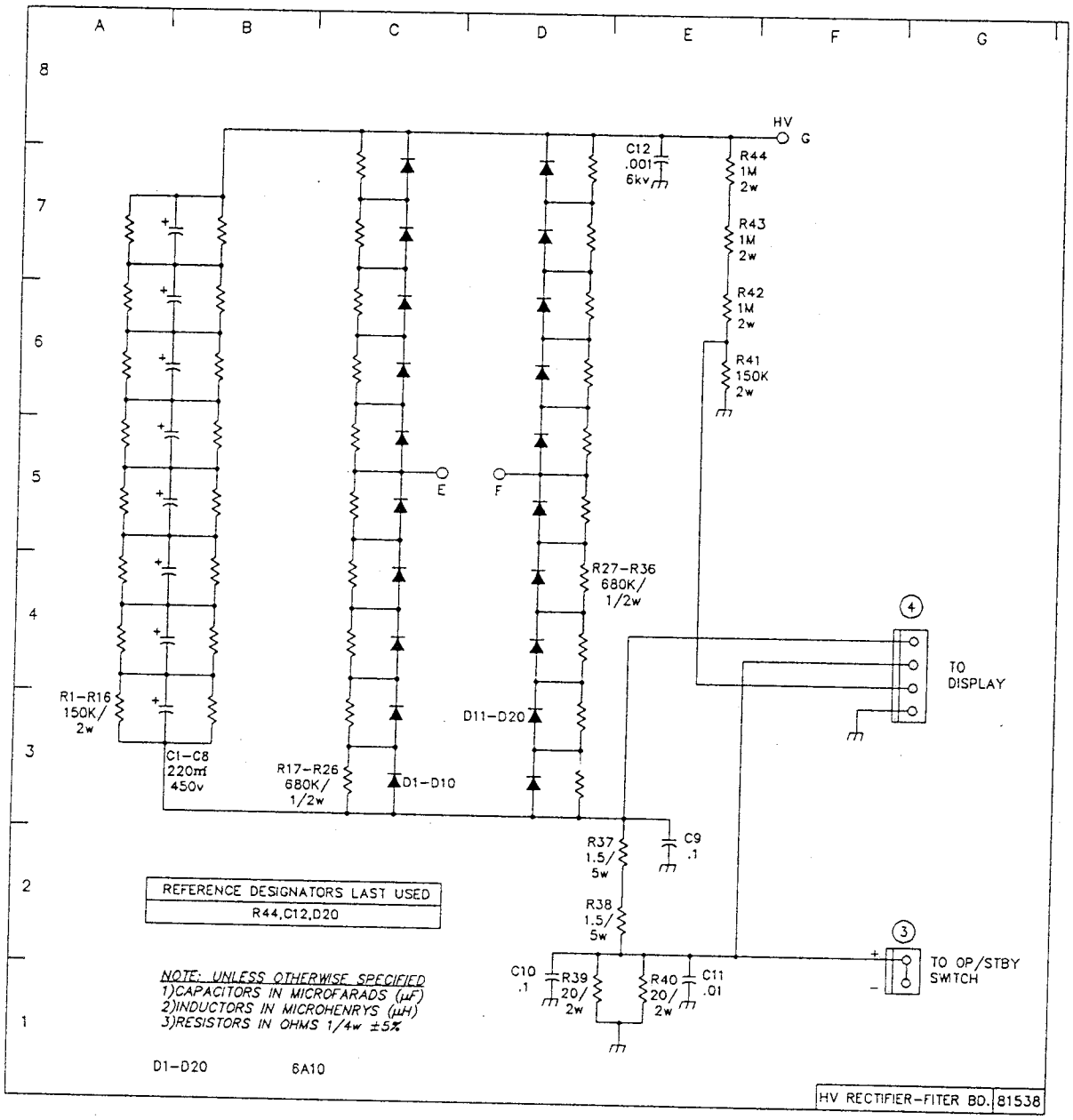


FIGURE 5-37. 81538 HV RECTIFIER-FILTER BOARD SCHEMATIC

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:

1. THIS WARRANTY APPLIES ONLY TO THE ORIGINAL OWNER. It is important that the warranty registration card be sent to us promptly.

2. READ THE MANUAL THOROUGHLY. This warranty does not cover damage resulting from improper operation. Developing a thorough understanding of this equipment is your responsibility.

3. IF TROUBLE DEVELOPS we recommend you contact our customer service group direct at the address or phone number shown above. It has been our experience that factory direct service is expeditious and usually results in less down-time on the equipment. Some overseas dealers do offer warranty service and, of course, have our complete support.

4. EQUIPMENT RETURNED TO THE FACTORY must be properly packaged, preferably in the original shipping carton(s). You pay the freight to us and we prepay surface freight back to you. Canadian customers must have proper customs documentation sent with incoming repair equipment. Duties or fees charged due to improper documenting are the responsibility of the owner of the equipment.

5. EXCLUSIONS. This warranty does not cover damage resulting from misuse, lightning, excess voltages, polarity errors or damage resulting from modifications not recommended or approved by Ten-Tec. In the event of transportation damage, a claim must be filed with the carrier. Under no circumstances is Ten-Tec liable for consequential damages to persons or property caused by the use of this equipment.

6. TEN-TEC RESERVES the right to make design changes without any obligation to modify equipment previously manufactured, or to notify owners of changes to existing equipment.

7. THIS WARRANTY is given in lieu of any other warranty, expressed or implied.

SERVICE OUTSIDE OF THE U.S.A. OR CANADA

Many of our international dealers provide warranty service on the equipment they sell. Many of them also provide out of warranty service on all equipment whether they sold it or not. If your dealer does not provide service or is not conveniently located, follow the procedure outlined above. Equipment returned to us will be given the same attention as domestic customers but roundtrip freight expense, customs and broker fees will be paid by you.

Part no. 74244