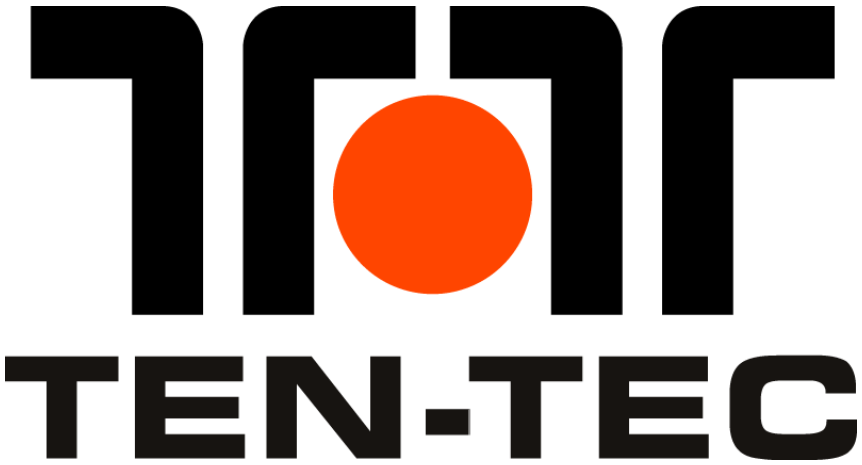


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**We can repair or service your Ten-Tec equipment at our facility in Sevierville, TN. We also offer support via telephone for all products via during usual business hours of 8 a.m. to 5 p.m. USA Eastern time, Monday through Friday. We have a large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

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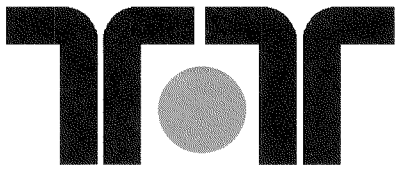
**Ten-Tec office line: (865) 453-7172**
**Service department email: service@tentec.com**
**Address: 1185 Dolly Parton Parkway, Sevierville, TN 37862 USA**

**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**



TEN-TEC

# OPERATOR'S MANUAL

# *TITAN II*

## MODEL 416

## HF LINEAR AMPLIFIER

# TABLE OF CONTENTS

Part No. 74367
2nd printing 07/2000
Printed in U.S.A.

# LIST OF ILLUSTRATIONS

# SPECIFICATIONS

| | |
|---|---|
| BAND COVERAGE | 160, 80, 40, 30, 20, 17, and 15 meters<br>(12 and 10 meters for authorized users) |
| POWER OUTPUT | 1500 watts continuous in SSB, CW, AMTOR/PACTOR (50% duty cycle modes). 1500 watts RTTY/SSTV for up to 10 minutes, 160-15 meters only. 1000 watts continuous key down, all bands. |
| DRIVING POWER | 80 watts typical for 1500 watts output |
| EFFICIENCY | Up to 65% depending on band, frequency, line voltage and impedance load. |
| INPUT AND OUTPUT IMPEDANCE | 50 ohms unbalanced with VSWR <2:1 |
| HARMONICS | Meets or exceeds FCC requirements. |
| CW BREAK-IN | Built-in T/R switching in less than 7 ms. |
| PROTECTIVE CIRCUITS | A.) Screen grid current regulation, over voltage protection and MOV arc over protection. LED overdrive indication.<br>B.) Control grid current regulation, over current limiting and LED overdrive indication<br>C.) Plate current overdrive trip at 1.5 amps. Series resistor for arc absorption. |
| PRIMARY POWER | 240 VAC –10%/+5% @ 20 amps, 50/60 Hz |
| LINE PROTECTION | Primary line fuses, chassis interlock, and step-start inrush protection |
| TUBE | Svetlana 4CX1600B ceramic tetrode in grid-driven configuration. |
| COOLING | Forced air, vertical exhaust, using centrifugal blower to produce .1" pressure drop in water at sea level, 25 degs. C air temperature |

| | |
|---|---|
| METERING | Full time plate current meter. Second meter selectable plate voltage, screen grid current, forward power, reflected power. Peak forward power indicated on full-time LED bargraph meter. |
| FRONT PANEL CONTROLS | TUNE and LOAD controls, band switch, standby / operate, QSK / PTT/VOX, meter switch for screen grid current, plate voltage, forward or reverse power, power on/off. |
| STATUS INDICATORS | Power on, wait, standby, operate, screen grid overdrive, control grid current overdrive |
| PLATE VOLTAGE SUPPLY | Step-start inrush protected. Approximately 3000 VDC @ no load, approximately 2700 VDC @ full load. 6 amp, 1000 PIV diodes in fullwave bridge. Filtered by 9 each 220 uF electrolytic capacitors. 10 ohm arc absorption resistor. |
| SCREEN SUPPLY | 300 VDC current regulated. |
| CONSTRUCTION | .125" aluminum transformer and tank chassis. .062" aluminum control chassis and covers. |
| SIZE | HWD = 8.5" x 17" x 20" (21.6 x 43.2 x 50.8 cm) |
| WEIGHT | 84 lbs. (38.18 kg) |

# WARNING!!!!!!!

This amplifier contains lethal voltages when operating. DO NOT operate this amplifier with the covers removed. The power supply circuits in this amplifier can produce up to 3000 volts and cause serious injury or death!

# CAUTION!!!

Never attempt to operate the ***TITAN II*** 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 *TITAN II* AMPLIFIER

FCC rules permit licensed amateurs to modify their own amplifiers 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 and an optional input matching circuit will be sent to you without charge.

## INTRODUCTION

The model 416 ***TITAN II*** is an advanced design linear amplifier using a single 4CX1600B high power tetrode in a grid driven configuration. This amplifier uses a ducted forced air cooling system and operates easily at 1500 watts output with maximum efficiency of 65% .

Two panel meters provide system monitoring. One meter is dedicated to full time plate current measurement. The other meter is switchable among plate voltage, screen grid current, forward power, or reflected power.

Two front panel LEDs indicate overdrive conditions for the control grid and screen grid circuits. Plate current overdrive trip is provided at 1.5 amps.

Band coverage includes 160, 80, 40, 30, 20, 17 and 15 meters as shipped from the factory. With proof of authorization, 12 and 10 meters may be enabled with an optional matching network from TEN-TEC.

Primary power of 240 VAC is required. Remember, 1500 watts output at 240 VAC line voltage = 20 amps current. The ***TITAN II*** primary AC lines are fused at 20 amps. ABC-20 fuses or equivalent must be used in replacement to protect the tube. Interlocks on the primary line and high voltage line are provided to ensure operator safety. ***NEVER DEFEAT THESE SAFETY PRECAUTIONS !!!!***

# UNPACKING

Carefully remove the amplifier from the packing carton and inspect it for signs of damage. Carefully remove the high voltage power transformer from its' packing carton and inspect it for signs of damage. If the amplifier or transformer 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 shipping 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 ***TITAN II*** in other than factory packing material may result in damage. This is not covered under TEN-TEC warranty.

The following hardware and accessories are packed with your ***TITAN II***. Make sure you have not overlooked anything.

| | | |
|---|---|---|
| 2 ea. | 20 AMP ABC-20 fuses | 27038 |
| 2 ea. | AMP MDA-4 fuse | 27015 |
| 1 ea. | key cable | 46160 |
| 1 ea. | .056 allen wrench | 38040 |
| 1 ea. | .062 allen wrench | 38088 |
| 1 ea. | # 8 allen wrench | 38124 |
| 11 ea. | 4x40 black screw | 60032 |
| | (to finish installation of top cover) | |
| 4 ea. | 10x32x1/2 bolts | 60011 |
| 1 ea. | warranty card | 74020 |
| 1 ea. | operator's manual | 74367 |
| 1 ea | spare 14" tube chimney clamp | 38265 |

If any of the above are missing, contact the repair department at TEN-TEC for replacement.

Repair dept. (865) 428-0364
Switchboard (865) 453-7172
FAX (865) 428-4483

Before powering up your ***TITAN II***, visually inspect the unit for possible physical damage, such as dents or parts jarred loose during shipment. If you remove the top cover, remember that safety interlocks on both line and high voltage prevent power up. Do not connect this amplifier to AC power without the power transformer installed and the top cover securely held to the chassis with the provided cabinet screws.

# 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 controls and adequate clearance for rear panel connections.

**1.2 ELECTRICAL CONNECTIONS:** The ***TITAN II*** amplifier draws up to 20 amps at 240 VAC. Care should be taken not to overload house wiring circuits usually fused or circuit breakered at 15 to 20 amps. A straight run circuit with # 10 / 2 wire with ground and breaker or fuses at 20 amps is strongly advised. Do not connect the *TITAN II* to AC voltage until installation of HV power transformer is completed.

**1.3 HIGH VOLTAGE TRANSFORMER INSTALLATION:** DO NOT CONNECT THE AC LINE CORD TO 240 VAC WALL OUTLET BEFORE INSTALLATION OF THE HV POWER TRANSFORMER. Check to make sure the amplifier is unplugged from the wall. Remove the top cover of the amplifier. Note only 8 screws were initially installed at the factory. This was done to simplify your task. Remove the left side chassis panel. There are four 10 x 32 x ½ bolts (TEN-TEC part #60011) in the packing kit. You must use these to mount the transformer and **not** the bolts in the transformer shipping carton. Identify the large open area in the chassis where the transformer mounts. Note the location of the four threaded holes in the chassis. Start two bolts only in the two holes closest to the center chassis of the amplifier. Just "start" the two bolts, engaging only a few threads. Orient the transformer with the two wire HV lead side of the transformer coil toward the center chassis shield. Align the slots in the transformer bottom mounting bracket with the two bolts that you just installed. Slide the transformer toward the shield until the bolts are seated in the transformer mounting slots about midway. Align the slots in the other bottom mounting bracket with the two remaining holes in the floor of the front chassis near the outside of the amp. Install the two remaining bolts in the open holes. Tighten all four bolts. Connect the two wire HV cable to the socket on the HV rectifier board (81809) mounted on the center shield. Note the plug will seat properly in the socket in one direction only. Visually inspect the connection for proper seating. Connect the four wire primary cable to the four wire cable extending from the rear chassis area near the smaller low voltage transformer. Again this plug will only seat properly in one direction. Care should be taken when re-installing the side panel and top cover not to pinch this cable. Remember to install all 19 screws on the top when re-assembling. The extras you need are in the packing kit.

**1.4 TRANSCEIVER INTERCONNECTIONS:** When using the ***TITAN II*** with TEN-TEC transceivers with TX EN and TX OUT connectors, follow the diagram in Figure 1-1. The QSK-PTT/VOX switch on the ***TITAN II*** should be in the QSK position for all modes of operation. This hook-up arrangement will work with the OMNI series V, VI, and VI+, PARAGON I and II, and PEGASUS. Some modern Yaesu transceivers are also equipped with a full break-in keying loop that can be utilized in a similar fashion. If you are unsure about connecting this equipment, please contact the TEN-TEC factory for instructions.

When connecting the ***TITAN II*** with all other transceivers, use the diagram in Figure 1-2. Note that the key or keyer must be connected to the KEY IN jack on the

*TITAN II*, a cable is run from KEY OUT to the key input jack on your transceiver, and the line from the external T/R N.O. relay contacts on the transceiver must be connected to the PTT/QSK jack on the *TITAN II.* When using this configuration, the QSK-PTT/VOX switch on the amplifier must be in the PTT/VOX position for SSB operation and in the QSK position for CW operation.

**1.5 ANTENNA REQUIREMENTS:**
The *TITAN II* amplifier is designed for use with antennas resonant at the frequency of operation and having an impedance within the limit of 25 to 100 ohms, or an SWR of 2:1 or less. Note that any SWR other than 1:1 will result in TUNE and LOAD settings different from those in the manual reference chart (Figure 2-1). The nominal output impedance of the amplifier is 50 ohms. Antennas can exhibit an SWR of more than 2:1 in some part of the band. For operation under these conditions, we recommend using an antenna matching network that will enable the *TITAN II* to work into a 50 ohm load for maximum power transfer to the antenna.

**CAUTION!!!**

Never attempt to operate the *TITAN II* without first connecting a suitable antenna or 50 ohm resistive load of sufficient power rating or SERIOUS DAMAGE MAY RESULT!

**1.6 GROUND CONNECTION:** In the interest of personal safety and to reduce the possibility of stray RF pickup on interconnecting cables, all station equipment should be well grounded to earth and to supply line ground bus. It is important to strap all equipment chassis together with short heavy leads. This ground bus may then be tied to an external earth grounding rod.

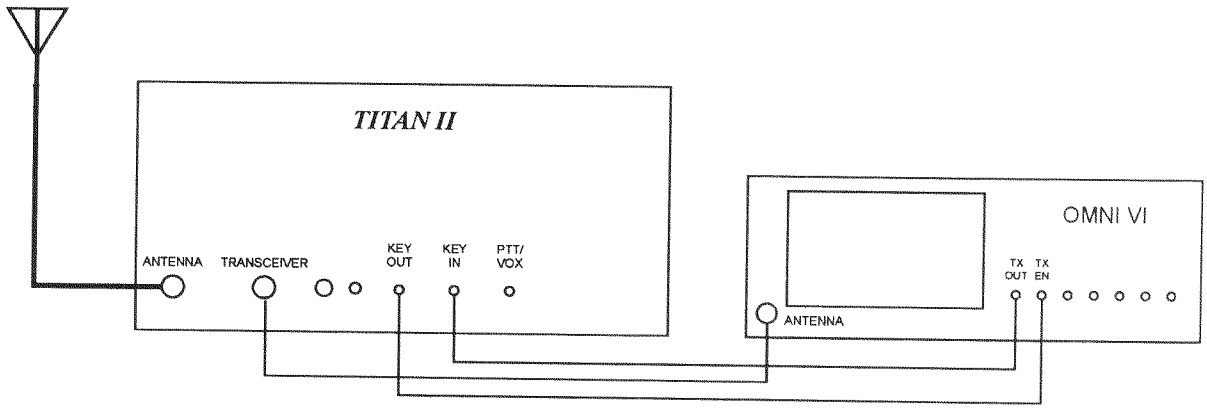
**1.7 HIGH POWER OPERATION**: The *TITAN II* amplifier operates comfortably at a maximum of 1500 watts output. New owners often find that other components in their station may not. Before operating at this power level, be certain to check the following items:

1. The coax from the *TITAN II* to the feed point of your antenna must be top quality RG-8 or better. We recommend silver plated connectors rather than chrome plated connectors. Make sure that all coax connectors are tight.
2. All coax switches or relays in the feed line must be rated at 1500 watts or higher. NEVER ACTIVATE IN-LINE SWITCHES WHILE TRANSMITTING.
3. Verify that the components in your antennas are rated for the *TITAN II* maximum power levels (dipole center insulator, end insulators, baluns, traps, etc.) Make sure that all radiating sections are well clear of metallic objects such as rain gutters and antenna supporting structures. For the first few hours of operation, check the SWR frequently. Any increase in reflected power is an indication that something between the amplifier and the antenna elements, including the end insulators, is heating and must be corrected.
4. A solid earth ground is often essential. Every station will have a unique electrical ground due to location of equipment, distance between units, distance from house wiring ground rod, distance from RF ground rod, etc. Keep equipment ground straps as short and thick as possible and RF ground rod as close to the station as possible.
5. If you use an antenna tuner, make all SWR/matching adjustments with the *TITAN II* in the STANDBY mode using transceiver low power only.

6. If any of your home entertainment electronic devices have RF leaks, the ***TITAN II*** may find them. If you are not familiar with standard procedure for controlling this type of interference, consult the ARRL Radio Frequency Interference Manual.

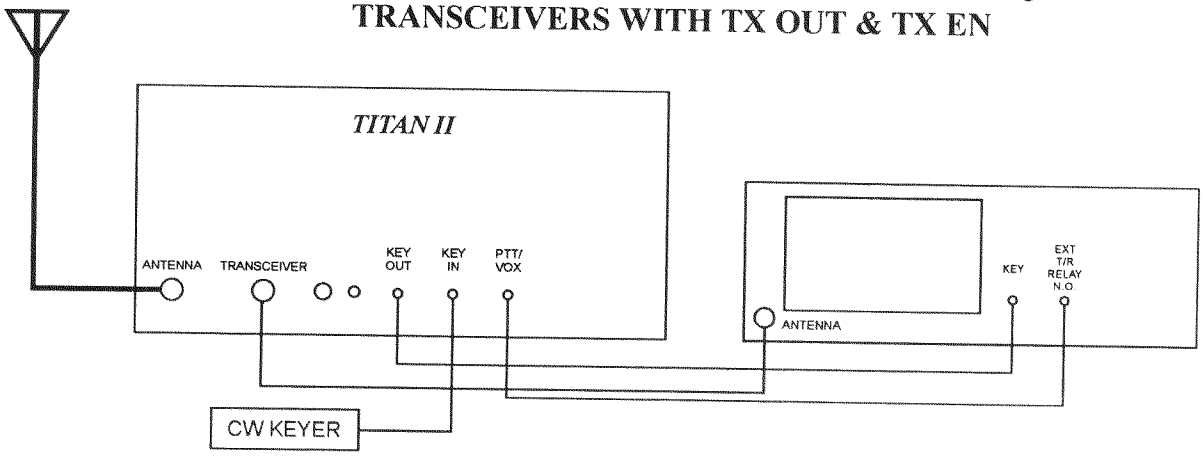
**1.8 ALC:** Most solid state transceivers do not provide connection for ALC input and it is unnecessary to make any external ALC connection to these rigs. The ALC output jack is used primarily with tube-type transmitters or transceivers with a negative going ALC system. The ALC ADJUST control is used to set the threshold for proper ALC action. This is -1 to -15 VDC depending on input RF drive level. This negative level will be present at the ALC jack even when the *TITAN II* is in the STANDBY mode or powered off.

**1.9 COOLING SYSTEM:** The *TITAN II* uses a pressurized cabinet with air intake through the rear left bottom of the chassis and exhaust through the tube chimney on the rear right top of the amplifier. It is safe to operate the amplifier without the front tilt bail extended as long as there are no impediments to the flow of air near the air intake and/or the exhaust.




| *TITAN II* | TEN-TEC TRANSCEIVERS |
|---|---|
| KEY IN | TX OUT |
| KEY OUT | TX EN |
| TRANSCEIVER | ANTENNA |

**FIGURE 1-1 T/R CONNECTIONS FOR TEN-TEC TRANSCEIVERS WITH TX OUT & TX EN**




| *TITAN II* | OTHER TRANSCEIVERS |
|---|---|
| KEY OUT | KEY |
| PTT/VOX | EXT. T/R N.O. RELAY |
| TRANSCEIVER | ANTENNA |

**FIGURE 1-2 T/R CONNECTIONS FOR OTHER TRANSCEIVERS**

# CHAPTER 2

## OPERATING INSTRUCTIONS

**2.1 INTRODUCTION:** The following instructions will enable the operator to quickly place the ***TITAN II*** in operation. Included are descriptions of the front panel controls and rear panel connections, followed by a detailed tune-up procedure. Refer to Chapter 3 operation and safety tips.

**2.2 FRONT PANEL CONTROLS:** The front panel controls and their functions are described below.

**2.2.1 BAND SWITCH:** This switch selects the desired frequency of operation. This is an eight position switch that covers the 160 meter to 10 meter bands. NOTE: A built-in switch stop prevents operation in the 10 and 12 meter bands. For 10 and 12 meter operation you must contact the factory for an authorized modification kit. 30 meter operation is done in the 40B position, 17 meter operation in the 15 meter position, 12 meter operation in the 10 meter position.

**2.2.2 TUNE:** This control adjusts variable capacitor C1 to provide resonance at the operating frequency. Figure 2-1 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 50 ohm resistive load. There is also a blank log chart that you may use to record the actual control settings for your antennas.

**2.2.3 LOAD:** This control adjusts variable capacitor C2 for the proper amplifier output loading. See Figure 2-1.

**2.2.4 POWER:** This switch routes the AC line to the primary of the low voltage supply. When on, the ***TITAN II*** will power up and the indicator light in the POWER switch will light.

**2.2.5 OPERATE/STANDBY:** This switch, when in the OPERATE position, places the amplifier online. When in the STANDBY position, the amplifier is bypassed and only the transceiver power is routed to the antenna. When in the OPERATE position, the indicator light in the switch will light. NOTE: No high voltage will be read on the metering when this switch is in STANDBY.

The OPERATE/STANDBY switch also serves as the plate current trip-off circuit reset switch. At 1.5 amps plate current, the plate current trip-off circuitry will activate. The lighted segment of the OPERATE/STANDBY switch will go out when plate current trip-off has occurred. To reset, switch back to STANDBY and immediately back to OPERATE. The lighted segment of the switch should now be lit again and the amplifier is ready to use.

**2.2.6 QSK/PTT:** This switch, when in the QSK position, configures the key circuits for CW/QSK operation. For late model TEN-TEC transceivers with TX EN and TX OUT connectors, or late model Yaesu transceivers connected using a full break-in keying loop, this position is used for all modes of operation. Placing the switch in the PTT position allows the ***TITAN II*** to be controlled by the PTT/VOX input jack rather than the KEY IN/KEY OUT loop.

**2.2.7 MULTIMETER SWITCH:** This switch connects the right hand meter to various monitoring sites in the amplifier.

A. Plate voltage (Ep) - When in this position, the meter reads plate voltage. This voltage is line voltage dependent at a ratio of 12.5 V plate per 1 V line. Plate voltage is approximately 3000 VDC at a line voltage of 240 VAC. Therefore, at a line voltage of 250

VAC the meter will read a little higher (3125 VDC).

B. Screen current (Is) - When in this position, the meter is paralleled with a resistor in series with the screen supply. This monitors screen grid current. The upper limit for screen current is 55 mA. NEVER OPERATE THE ***TITAN II*** IN EXCESS OF 55 mA SCREEN GRID CURRENT. A warning zone indicator is used on the face of the meter to alert the operator. In addition to the analog meter, the screen overdrive LED indicates excessive screen current.

C. Forward power (FWD) - When in this position, the meter is connected to a bridge circuit at the antenna output. This measures forward RF output power. It is, however, more load dependent than an external wattmeter. If your antenna is far from resonance, the accuracy is not as good and power measurements should be made externally.

D. Reflected power (REF) - When in this position, the meter is connected to the other port of the bridge at the antenna output. The meter reads reflected power at 1/10 indication scale of forward power (200 watts full scale).

**2.2.8 PLATE CURRENT METER:** Full time plate current metering is provided by the left analog meter.

**2.2.9 OVERDRIVE:** These two LEDs indicate grid overdrive conditions.

A. When the screen overdrive LED is lit, the screen current is approaching or has passed its limit. Reduce drive from the transceiver immediately and retune.

B. When the control grid overdrive LED is lit, the control grid current is approaching or has passed its limit. Reduce drive from the transceiver immediately and retune.

**2.2.10 WAIT:** This LED indicates a 3 minute warm-up period for the tube at initial power up. After being turned on for 3 minutes, the wait LED goes out and the ***TITAN II*** can be placed in the operate mode.

**2.2.11 PEAK POWER BARGRAPH:** This meter is connected to the bridge at the antenna output through an emitter follower to monitor peak RF output power. When the red LED is lit, 1500 watts output has been reached.

**2.3 REAR PANEL CONNECTIONS AND CONTROLS:** The rear panel connections and their functions are described below.

**2.3.1 TRANSCEIVER:** This is a standard SO-239 receptacle designed for a mating PL-259 plug. RG-58U or similar 50 ohm coax is required to connect the ***TITAN II*** to the transceiver.

**2.3.2 ANTENNA:** This is a standard SO-239 receptacle designed for a mating PL-259 plug. RG-8 or similar 50 ohm coax rated for 1500 watts is required for connection to the antenna.

**2.3.3 KEY IN:** This jack is the input for the ***TITAN II*** transmit/receive relay system. When used with late model TEN-TEC transceivers, this jack is connected to the TX OUT connector on the transceiver. When used with other transceivers, a key or keyer is connected to this jack for CW operation.

**2.3.4 KEY OUT:** This jack is a protected output from the ***TITAN II*** which passes the KEY IN to the transceiver after all relays in the ***TITAN II*** have closed and it is ready to transmit. When used with late model TEN-TEC transceivers, this jack is connected to the TX EN connector on the transceiver. When used with other transceivers, this jack is connected to the transceiver key input jack.

**2.3.5 PTT/VOX:** This jack is an input to the ***TITAN II*** transmit/receive relay circuits. When used with late model TEN-TEC

# OMNI-VII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Sales: Mon-Fri 8:00-5:30 Eastern sales@tentec.com. Service: Mon-Fri 8:00-5:00 Eastern service@tentec.com (865) 428-0364.

transceivers, this jack is not used. When used with other transceivers, this jack is connected to the normally open contacts of the relay key out jack of the transceiver.

**2.3.6 ALC:** This jack provides a negative going ALC voltage, used primarily with tube type transmitters/transceivers. See section 1.8 for detailed information.

**2.3.7 ALC CONTROL:** This control adjusts the ALC voltage from approximately -1 to -15 VDC depending on RF input from the transceiver.

**2.3.8 AC LINE:** This cable is connected to standard 240 VAC. Be sure the line used to power the ***TITAN II*** is capable of supplying 20 amps of current at 240 VAC, and that it is protected by either fuses or circuit breakers of 20 amps. Wire size of the AC feed line should be at least 10/2 with ground or larger.

**2.3.9 LINE FUSES:** Primary line fuses (ABC-20) are accessible through these panel fuse holders. Replace with ABC-20 or comparable fuses only.

**2.4 INITIAL TURN-ON:** The following steps should be followed when turning on your ***TITAN II***.

A. Set multimeter switch to the plate voltage (Ep) position.

B. Place the power switch to ON. If any of the following do not occur, press OFF at once and investigate before proceeding.

1. The power switch light should light.
2. The meter lights should light.
3. The fan motor should start and air flow should be felt at the exhaust port on top of the amplifier.
4. The wait LED should light.
5. All meter indications are zero.
6. All other LEDs are not lit.

NOTE: HIGH VOLTAGE IS PRESENT ONLY IN THE OPERATE MODE .

**2.5 TUNE UP PROCEDURE:** The following section describes important points to observe during tune up. A suggested procedure for safely tuning up the ***TITAN II*** is included.

**2.5.1 CHECKS TO MAKE BEFORE TUNING UP:** Check the load connected to the amplifier. This can best be done by leaving the ***TITAN II*** in the BYPASS mode and using only the transceiver output power. Use a reliable SWR bridge or wattmeter to determine the SWR of the load (antenna) connected to the amplifier. 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, the VSWR is 1.5:1 or lower. A VSWR of 2:1 or less is essential.

**2.5.2 IMPORTANT POINTS TO REMEMBER:** The most important parameters to observe during tune up are the control grid current and screen grid current. Excessive grid current even for a relatively short period of time can and will damage the tube. If grid currents are not exceeded, the 4CX1600B tube will deliver many years of trouble free service. In the ***TITAN II*** the control grid is monitored by front panel LED indicator. When control grid current is exceeded, the LED will light. Reduce the drive immediately and retune the ***TITAN II***. Screen grid current is monitored by the multimeter, (when in the Is position) and by an LED overdrive indicator continuously. Screen grid current should be kept to a minimum during tune up and always in a positive direction. When screen current is exceeded the screen overdrive LED will light. Reduce drive immediately and retune. After tune up, erratic lighting of either overdrive indicator could indicate breakdown in the load (antenna components). Reduce drive and check for arcing or heating of baluns, coax or other elements.

**2.5.3 SUGGESTED TUNE UP PROCEDURE:** Following is the recommended procedure for safe and proper tune up of the ***TITAN II***.

A. Set the band switch to the desired band. For 30 meter operation, use position 40B. For 17 meters, position 15. For 12 meters, position 10.

B. Set the multimeter switch to the Ep position.

C. Place the STANDBY/OPERATE switch to OPERATE. The STANDBY/ OPERATE switch will light and high voltage is indicated on the multimeter (approximately 3000 VDC).

D. Set the meter switch to the Is position. Always monitor Is (screen grid current) with the multimeter during tune up. Use FWD and REF positions momentarily for checking output power. Output power can also be monitored on the LED bargraph power meter. Always monitor the overdrive LEDs. Reduce drive and re-tune the amplifer if either is lit.

E. For initial tune up you may set the TUNE and LOAD controls to their center positions. Alternatively you may refer to the suggested settings in the chart in Figure 2-1. Keep in mind that these settings are for operation into an ideal 50 ohm load and will vary with your installation.

F. Turn the transceiver RF output control to between 10 and 20 watts. Note: at very low transceiver power outputs (<10 watts) the amplifier may not respond when attempting to tune up. This is normal. Increase drive power slightly and continue tune up. IF AT ANY TIME THE ***TITAN II*** DOES NOT RESPOND AS EXPECTED, REMOVE DRIVE POWER IMMEDIATELY AND CORRECT THE PROBLEM BEFORE CONTINUING.

G. Key the transceiver and slowly increase the drive power until you see the plate current increase.

H. Adjust the TUNE control for a peak in plate current and a peak in RF power output. Adjust the LOAD control for minimum grid current. You will find that these values are not always synchronized. Choose the lower grid current adjustment even if the power output is slightly less. Readjust the TUNE control for a plate current peak each time you adjust the LOAD control. There will be some interaction between these controls.

I. Gradually increase the drive level from the transceiver until you reach the desired output power level while carefully touching up the TUNE and LOAD controls for minimum grid current and maximum output power.

J. 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 (Figure 2-2). These settings should be repeatable for the same frequency, antenna, and SWR when used in the future.

| BAND | FREQUENCY MHz | LOAD | TUNE |
|---|---|---|---|
| 160A | 1.820 | 5 | 4 |
| 160B | 1.980 | 5 | 7 |
| 80 | 3.500 | 2 | 8 |
| | 3.980 | 1 | 6 |
| 40A | 7.040 | 3 | 1 |
| 40B | 10.120 | 2 | 1 |
| 20 | 14.050 | 2 | 4 |
| | 14.250 | 2 | 2 |
| 15 | 18.110 | 2 | 5 |
| | 21.050 | 2 | 4 |
| 12 | 24.900 | 2 | 6 |
| 10 | 28.100 | 2 | 5 |

**FIGURE 2-1 MODEL 416 TUNING CHART FOR AN IDEAL 50 OHM LOAD**

| BAND | FREQUENCY | LOAD | TUNE | ANTENNA | NOTES |
|---|---|---|---|---|---|
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**FIGURE 2-2 MODEL 416 TUNING LOG**

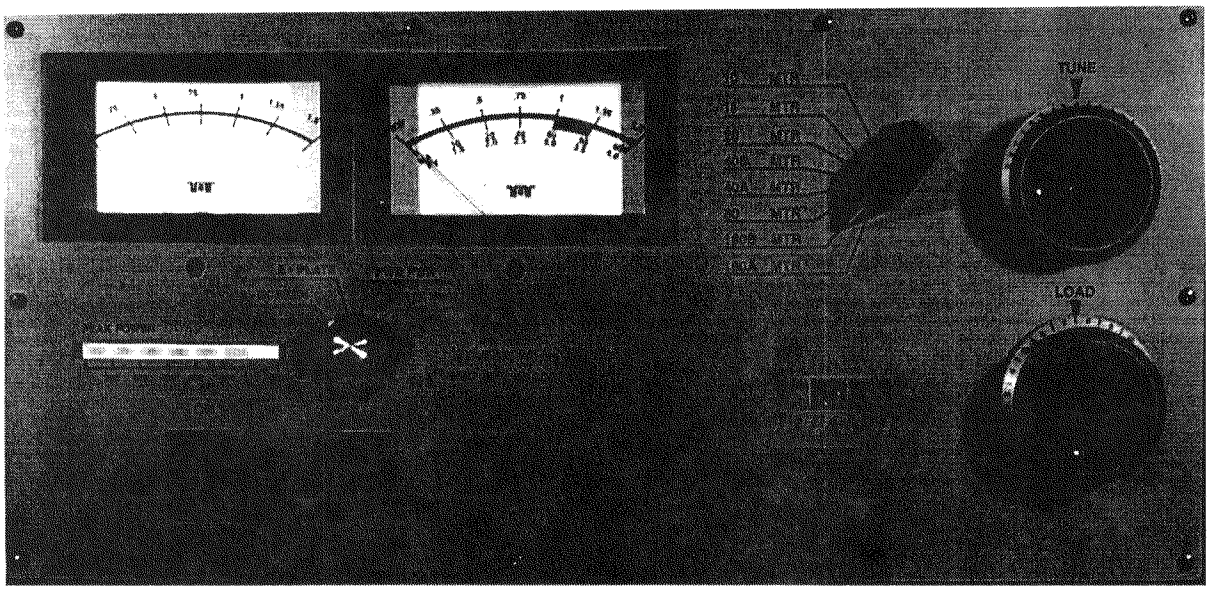



**FIGURE 2-3 *TITAN II* FRONT VIEW**

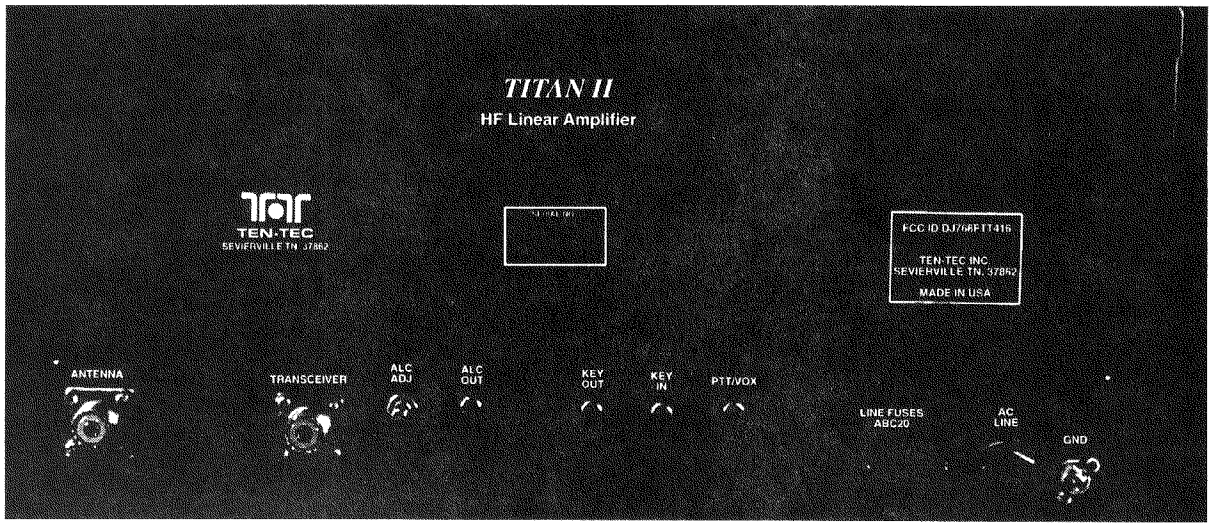



**FIGURE 2-4 *TITAN II* REAR VIEW**

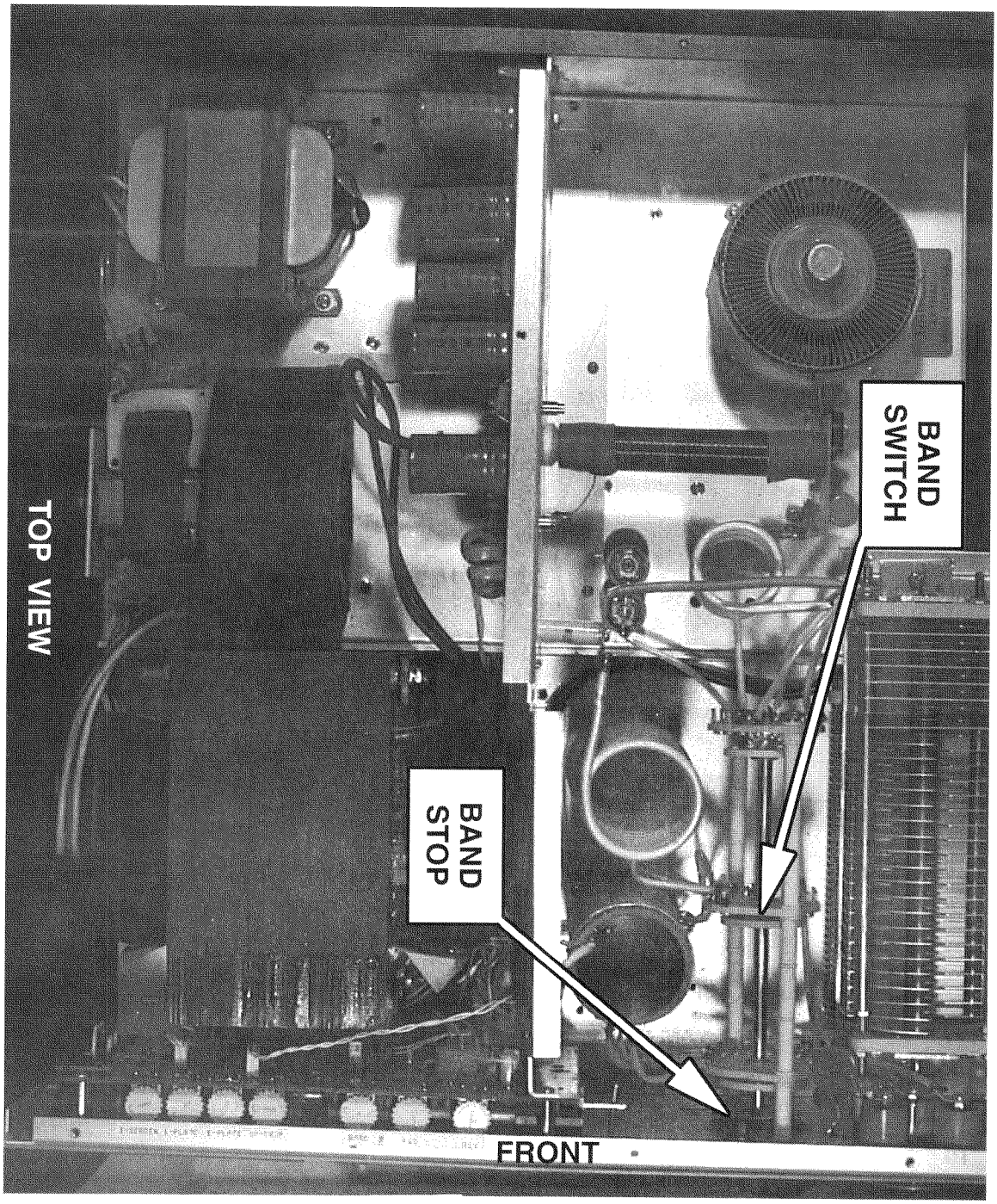



**FIGURE 2-5 *TITAN II* TOP VIEW**

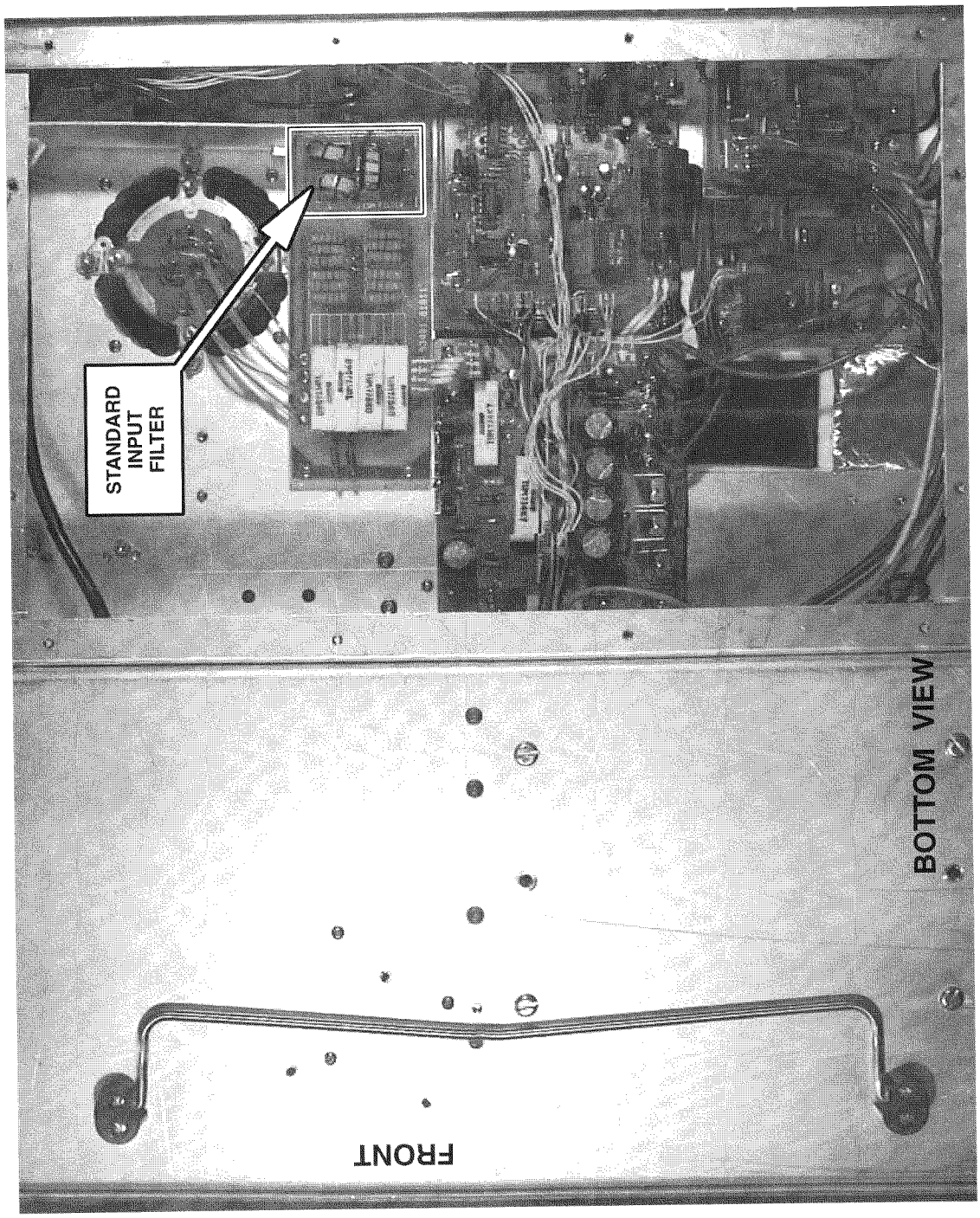



**FIGURE 2-6 *TITAN II* BOTTOM VIEW**

# CHAPTER 3

## OPERATION AND SAFETY

**3.1 INTRODUCTION:** The following paragraphs provide additional information for operation of and safety from your ***TITAN II*** amplifier.

**3.1.1 HIGH POWER TETRODE:** The 4CX1600B is very rugged and normally operates with a large margin of safety in the ***TITAN II.*** It will deliver outstanding service for many years if not damaged by abuse...especially excessive grid current or blockage of cooling air flow.

KEEP THE AIR INTAKE AND EXHAUST VENT AREAS COMPLETELY CLEAR !!!

WARNING !!! DO NOT ALLOW THE SCREEN GRID CURRENT TO EXCEED 55 mA!

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

**WARNING !! THE AMPLIFIER SHOULD NEVER BE ENERGIZED WITH THE COVERS REMOVED!! DO NOT DEFEAT THE INTERLOCK SAFETY SWITCHES!!**

**3.1.3 FUSES:** Except in rare instances of component failure, blowing one or both primary fuses indicates that maximum safe average power capabilities of the amplifier have been exceeded.

# 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 should be cleaned often (using a soft bristled brush and vacuum cleaner) to prevent visible accumulation of dust. DO NOT blow air directly into the fan input: this can over rev the motor and damage the bearings.

**TABLE 4-1 TROUBLESHOOTING HINTS**

| SYMPTOM | POSSIBLE CAUSE/CURE |
|---|---|
| 1. Will not turn on: nothing happens when the ON switch is activated. | A] Fuse missing or open.<br>B] House wiring incorrect or breaker open.<br>C] Power cable to amplifier disconnected.<br>D] Fuse on HV-AC board (81810) open.<br>E] Problem with low voltage power supply on QSK board (81814) |
| 2. Lights turn on but no high voltage. | A] No HV will be present until amp is switched to OPERATE mode. |
| 3. Relays K2 and K3 on HV-AC board (81810) close but relay K1 does not. Plate Voltage drops when RF is applied. | A] Q1 ON 81810 HV-AC BOARD IS defective .<br>B] K1 on 81810 is defective. |
| 4. Relays K1, K2, K3 on 81810 HV-AC board close but no high voltage when switched to OPERATE mode. | A] Interlock open, cover not tight<br>B] K2, K3 defective.<br>C] HV short to ground.<br>D] High voltage transformer disconnected.<br>E] High voltage bridge open. |

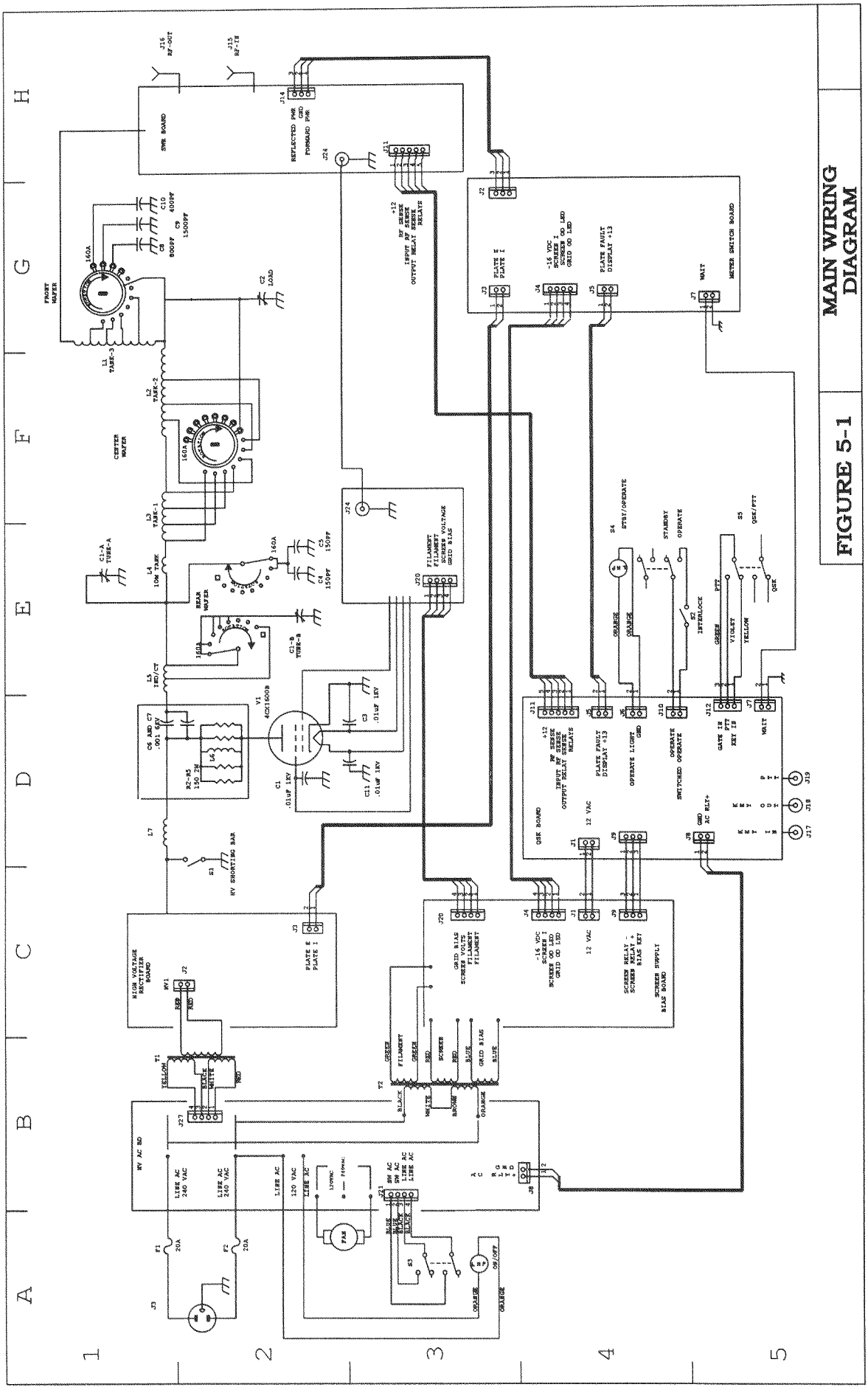
## TABLE 4-1 TROUBLESHOOTING HINTS (Continued)

| | |
|---|---|
| 5. Relays K1, K2, and K3 close at turn on, but line fuses blow. | A] High voltage at crowbar or elsewhere.<br>B] Shorted tube.<br>C] Leaky electrolytics in high voltage supply. |
| 6. Amplifier won't drive, zero grid and plate current, high input SWR . | A] Defective cable from transceiver to amplifier.<br>B] Input relay K2 on 81816 SWR board defective.<br>C] Input filter on 81811 input matching board loose or damaged. |
| 7. Grid overdrive LED lights with no drive. | A] Q7 on 81815 shorted or leaky.<br>B] Shorted or leaky tube. |
| 8. Screen overdrive LED lights with no drive. | A] R23 on 81815 board open or increased in value.<br>B] Low or no high voltage. TURN OFF THE AMPLIFIER IMMEDIATELY. |
| 9. Amplifier difficult to drive, little or no output, high plate current (may be accompanied by a "frying sound"). | A] Band switch in wrong position.<br>B] Excessively high load SWR.<br>C] Defective output relay on 81816 SWR board.<br>D] Arcing in tank circuit or antenna feed line. |
| 10. Excessive plate current in receive mode. | A] Defective bias circuit on 81814 board.<br>B] Shorted grid /cathode in tube. |
| 11. Transceiver does not key using key-in/key-out loop. | A] Key-in and key-out lines reversed at amplifier or at transceiver.<br>B] Defective key line cables.<br>C] Defective relay control circuit on 81814 QSK board. |
| 12. Transceiver stays keyed in receive mode. May be accompanied by loss of receive signal. | A] Relay K1 on 81816 SWR board stuck.<br>B] Shorted key-in or key-out cable.<br>C] Defective relay control circuit on 81814 QSK board. |

# CHAPTER 5

## CIRCUIT DESCRIPTIONS AND ILLUSTRATIONS

**5-1 INTRODUCTION** The following sections contain detailed circuit board subassemblies used in the Model 416. 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.


MAIN WIRING DIAGRAM
FIGURE 5-1
SWR BOARD
METER SWITCH BOARD
GSK BOARD
SCREEN RIPPLE BIAS BOARD
HIGH VOLTAGE RECTIFIER BOARD
4CX1500B
FRONT WAFER
CENTER WAFER
REAR WAFER
FAN
STBY/OPERATE
STANDBY
OPERATE
INTERLOCK
PTT
QSK/PTT
QSK
WAIT
METER SWITCH BOARD
PLATE FAULT DISPLAY +13
OPERATE LIGHT GRID
OPERATE SWITCHED OPERATE
GATE IN KEY IN
KEY OUT
GRID AC BIAS+
12 VAC
-16 VDC SCREEN I SCREEN GD LED GRID GD LED
SCREEN RELAY - SCREEN BIAS KEY
GRID BIAS SCREEN VOLTS FILAMENT
PLATE I
PLATE E
RF SHORTING BAR
ON/OFF
LINE AC 240 VAC
LINE AC 120 VAC
SW AC LINE AC
REFLECTED PWR GRD
FORWARD PWR
RF-OUT
RF-IN
1 2 3 4 5
A B C D E F G H

## 5.2 INPUT MATCHING BOARD (81811)

This board contains the input filter, impedance matching networks, and ALC circuits.

The input filter network (81550) is the standard input filter shipped with the ***TITAN II***. 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. An optional 15/10M INPUT FILTER BOARD (81840) is available from TEN-TEC to qualified amateur radio operators, upon receipt of a copy of their amateur radio license.

**Note: Operation on the 10m band will also require additional modifications to the bandswitch assembly. Please contact the factory for instructions or further information.**

The impedance matching network of resistors R5 –R40 matches the input impedance of the 4CX1600B to the input filter board.

The ALC circuit samples the input RF power to the amplifier. D1 rectifies this sample and produces a negative voltage proportional to input power for control of some exciters.

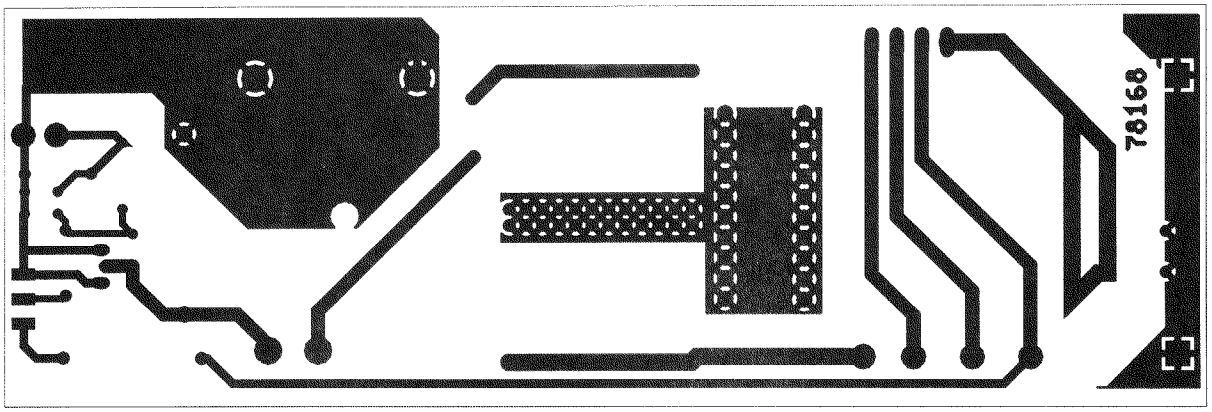



FIGURE 5-2 INPUT MATCHING BOARD CIRCUIT TRACE
AS VIEWED THROUGH BOARD

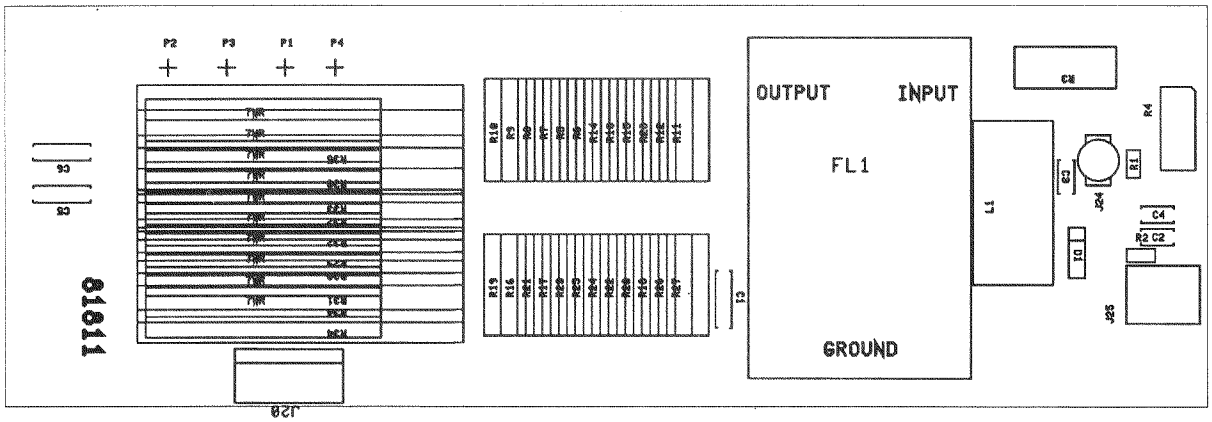



FIGURE 5-3 INPUT MATCHING BOARD COMPONENT LAYOUT TOP VIEW

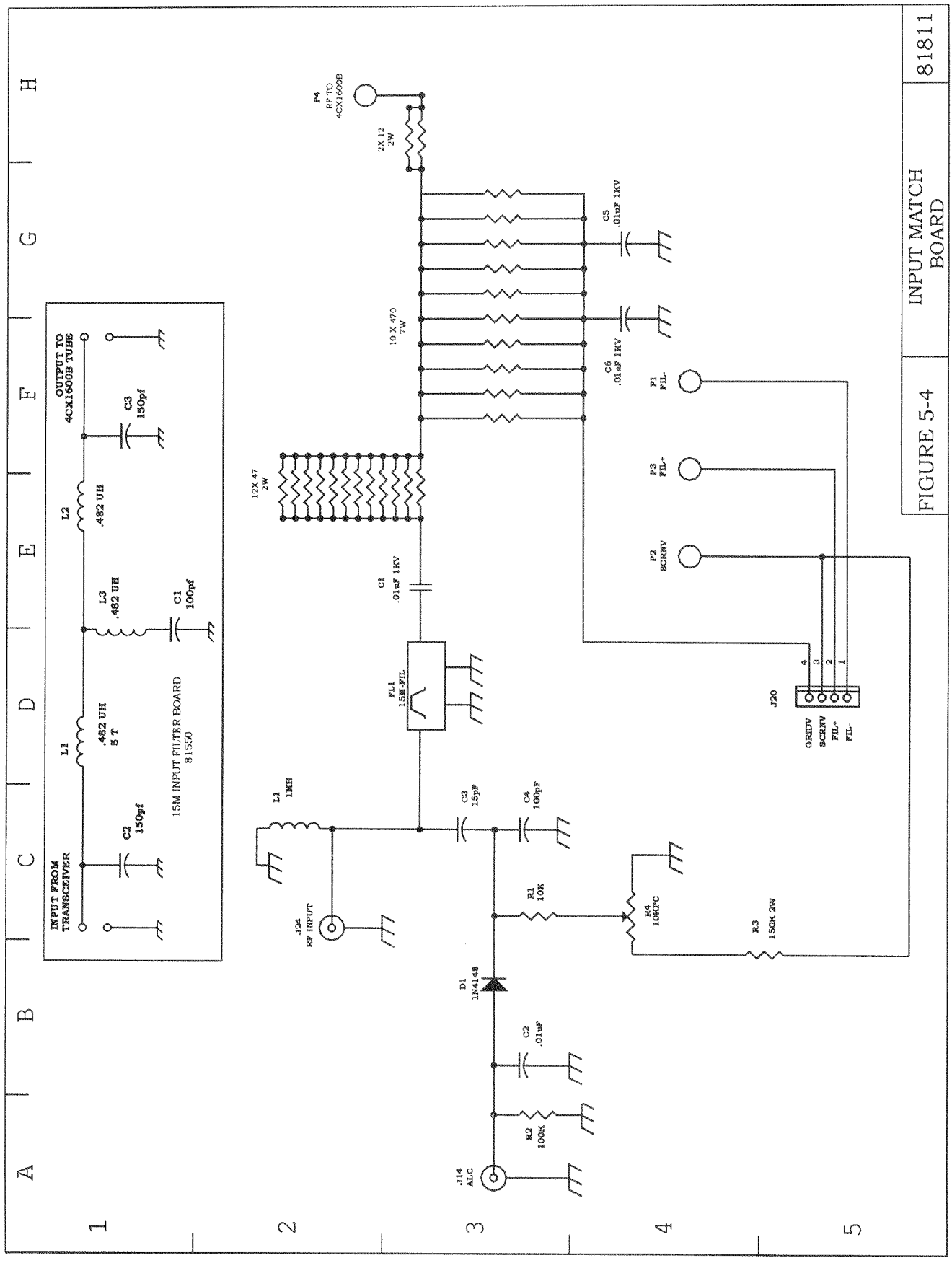

INPUT MATCH BOARD
81811
INPUT FROM TRANSCEIVER
OUTPUT TO 4CX1600B TUBE
15M INPUT FILTER BOARD 81550
L1 .482 UH 5 T
L2 .482 UH
L3 .482 UH
C1 100pf
C2 150pf
C3 150pf
P4 RF TO 4CX1600B
2X 12 2W
10 X 470 7W
12X 47 2W
C1 .01uF 1KV
C5 .01uF 1KV
C6 .01uF 1KV
P1 FIL-
P2 SCRNV
P3 FIL+
FL1 15M-FIL
J20
GRIDV
SCRNV
FIL+
FIL-
J24 RF INPUT
L1 1MH
C3 15pF
C4 100pF
R1 10K
R4 10KPC
R3 150K 2W
D1 1N4148
C2 .01uF
R2 100K
J14 ALC
A
B
C
D
E
F
G
H
1
2
3
4
5

FIGURE 5-4

# Catch the wave.


# Great Audio.

Distinctive audio is what separates one brand of HF transceiver from another. Ten-Tec's reputation for having the finest transmit audio in Amateur Radio dates back to the release of the first Omni transceivers in the late 1970's. The Omni-VI set a new standard for 3rd order SSB IMD transmit performance when reviewed by ARRL for a Product Review in 1993. We've continued the same high performance engineering in the 21st century with tailorable transmit audio available on all of our current HF rigs: Orion II, Omni-VII, and Jupiter. Heard a great sounding signal on the air lately? Ask what they're running. Chances are, it's a Ten-Tec.

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**5.3 H.V. POWER SUPPLY BOARD (81809)** This board contains the high voltage rectifier bridge (D1 – D20), H.V. filters (C1 – C9), and H.V. meter circuits.

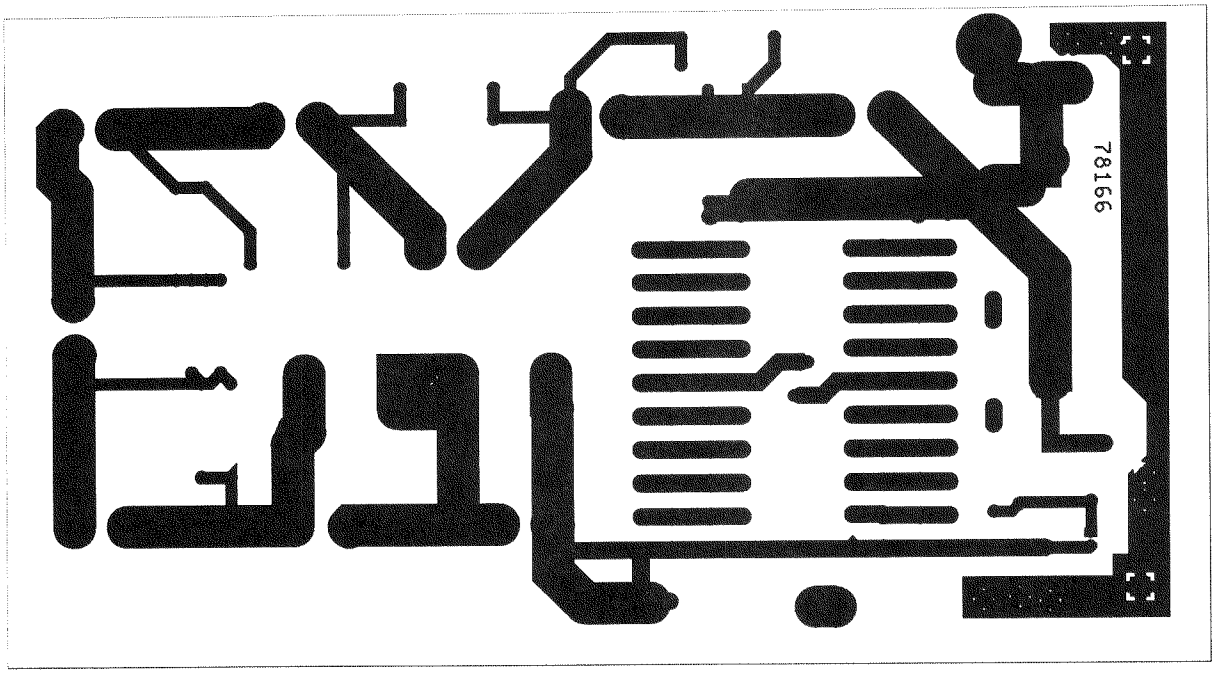



FIGURE 5-5 INPUT MATCHING BOARD CIRCUIT TRACE
AS VIEWED THROUGH BOARD

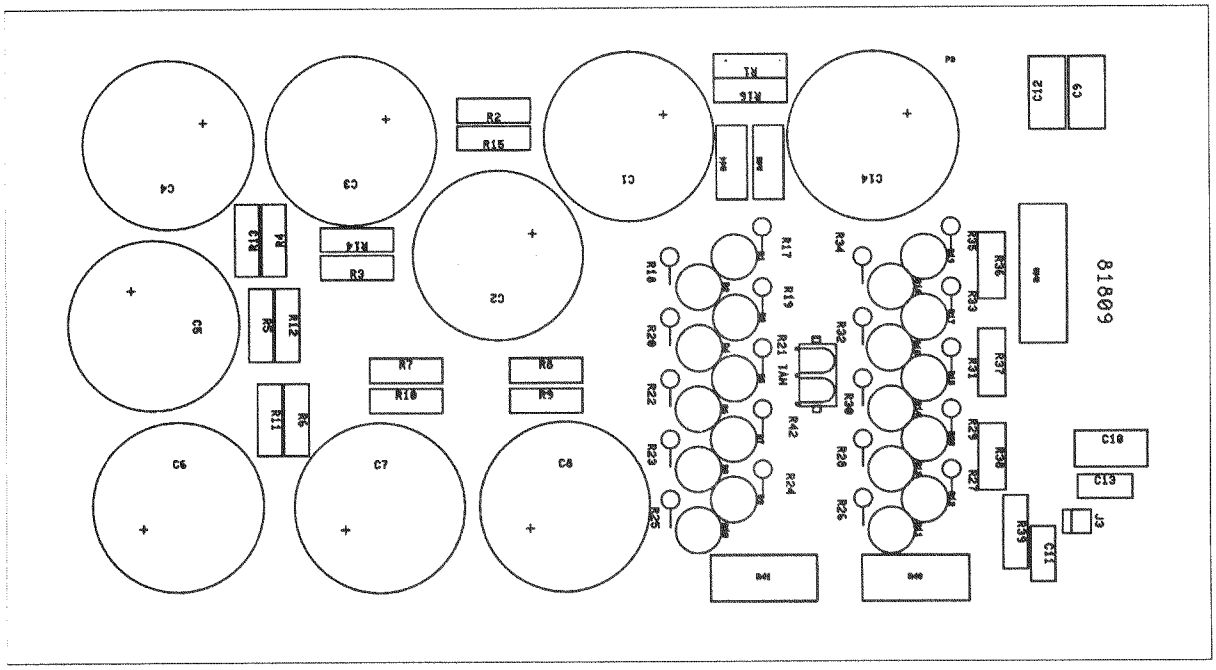
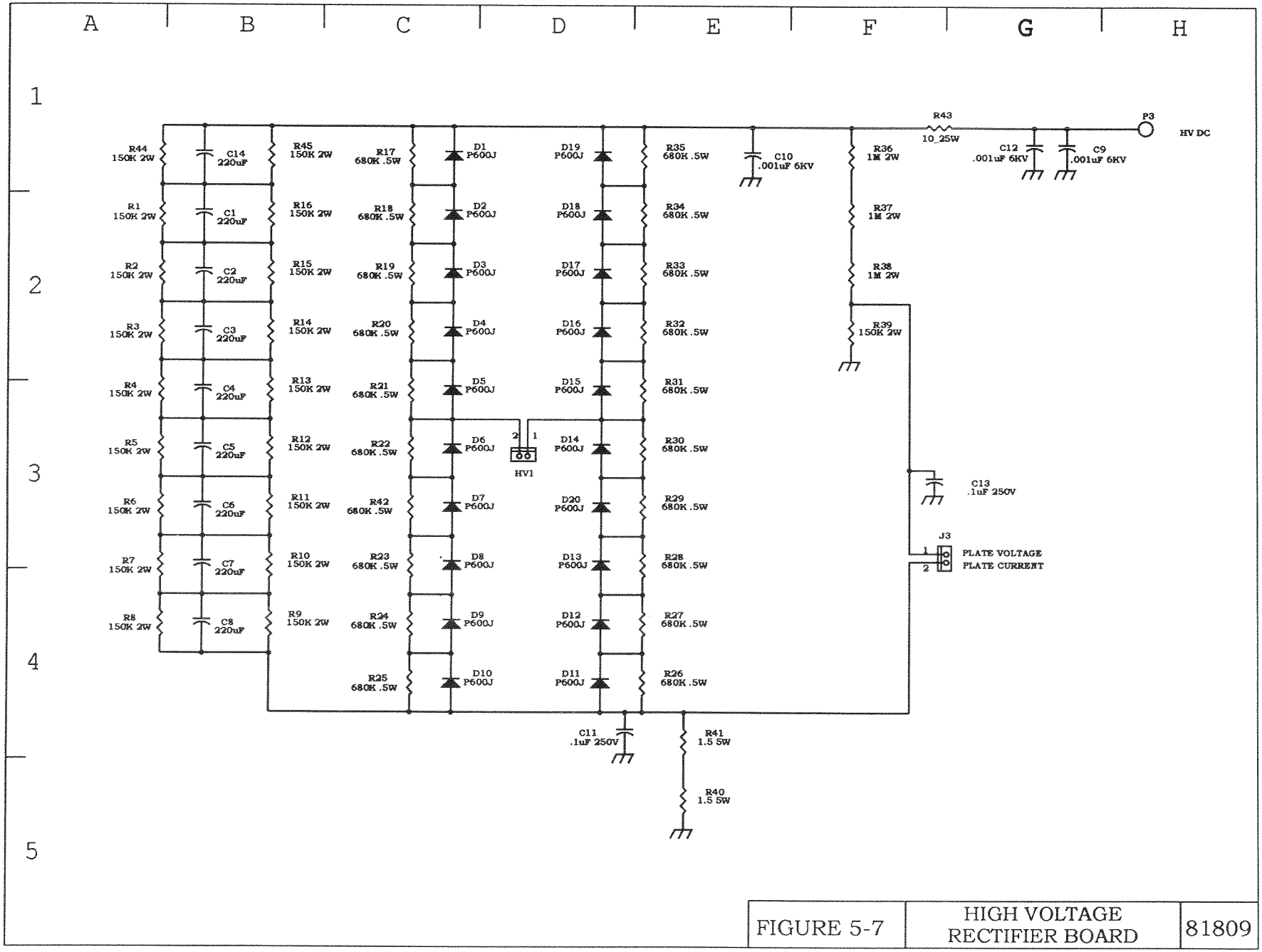



FIGURE 5-6 HIGH VOLTAGE RECTIFIER BOARD COMPONENT LAYOUT TOP VIEW




| FIGURE 5-7 | HIGH VOLTAGE RECTIFIER BOARD | 81809 |
|---|---|---|

**5.4 SCREEN SUPPLY AND GRID BIAS BOARD (81815)** This board contains the screen supply, grid bias supply, and protective circuits for the 4CX1600B. The screen voltage is rectified by diodes D4 – D7 and filtered by C1 – C4. This DC voltage is then regulated by pass elements Q9, Q5, Q6, and Q8. Load resistors R25 – R27 provide a current drain to insure screen current remains in the positive direction. MOV Z1 protects the power supply in the event of tube arc and insures the screen voltage can't surge above 450 VDC. R23 provides a voltage drop proportional to the screen current to drive the front panel screen current meter.

Grid bias voltage is rectified by D13, then filtered by C10. Q1 senses the key condition and switches zener diodes D2, D8 and D16 in during key down and out during key up. This zeners the bias voltage to approximately –50 VDC during TX and –130 VDC in RX. Due to differences in tubes, J21 allows adjustment of grid bias in 3 settings:

-55V Pins 2 and 3 shorted
-60V Pins 1 and 2 shorted
-65V no pins shorted

This adjustment is factory set to match the tube shipped with the amp. If the tube is ever replaced, the jumper setting should be selected to produce approximately 100 – 200 ma of plate current when keyed with no drive. The circuitry of Q7 senses grid current and begins to fold back grid bias toward cutoff as grid current approaches 2 watts. Zener diode D1 provides regulation for the negative 16 VDC power supply to run the meter circuits on the meter switch board.

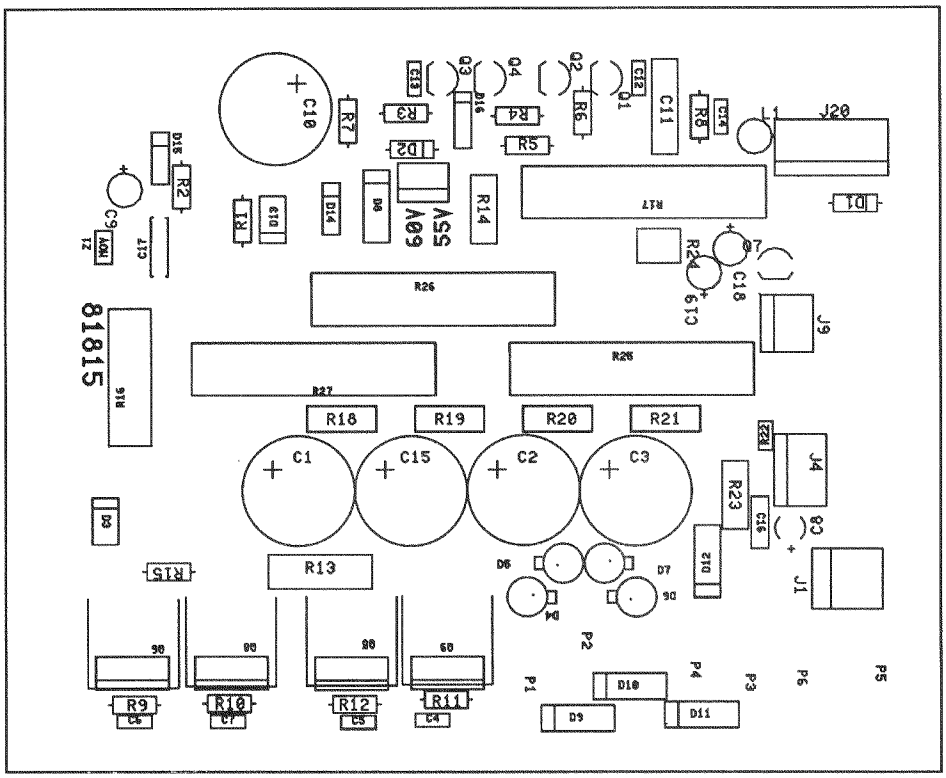
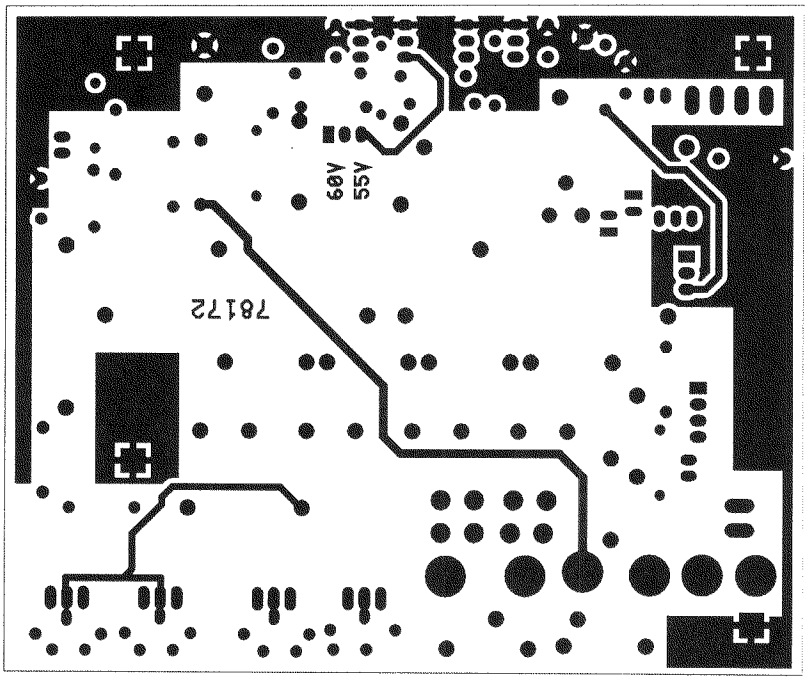



FIGURE 5-8 SCREEN SUPPLY BOARD COMPONENT LAYOUT

TOP SIDE COPPER




BOTTOM SIDE COPPER

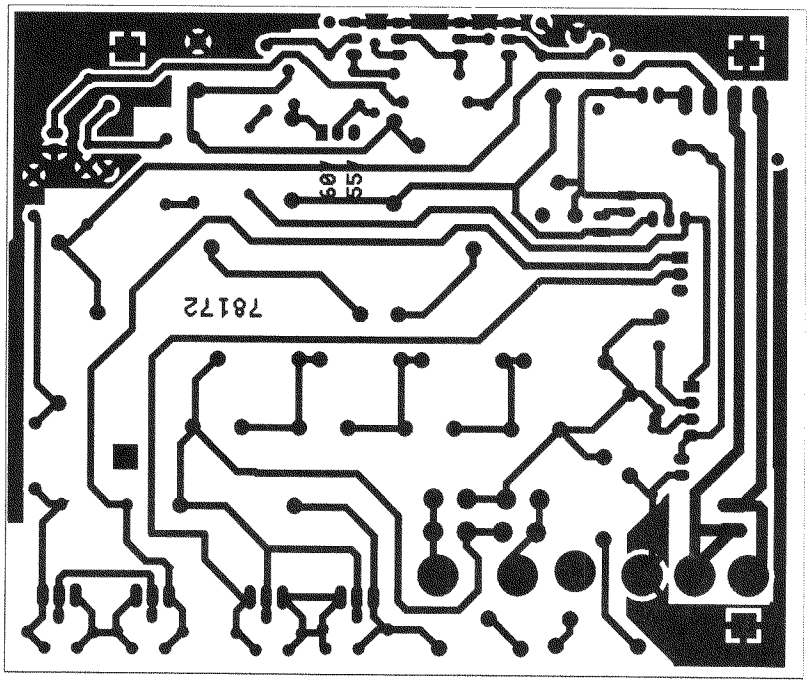
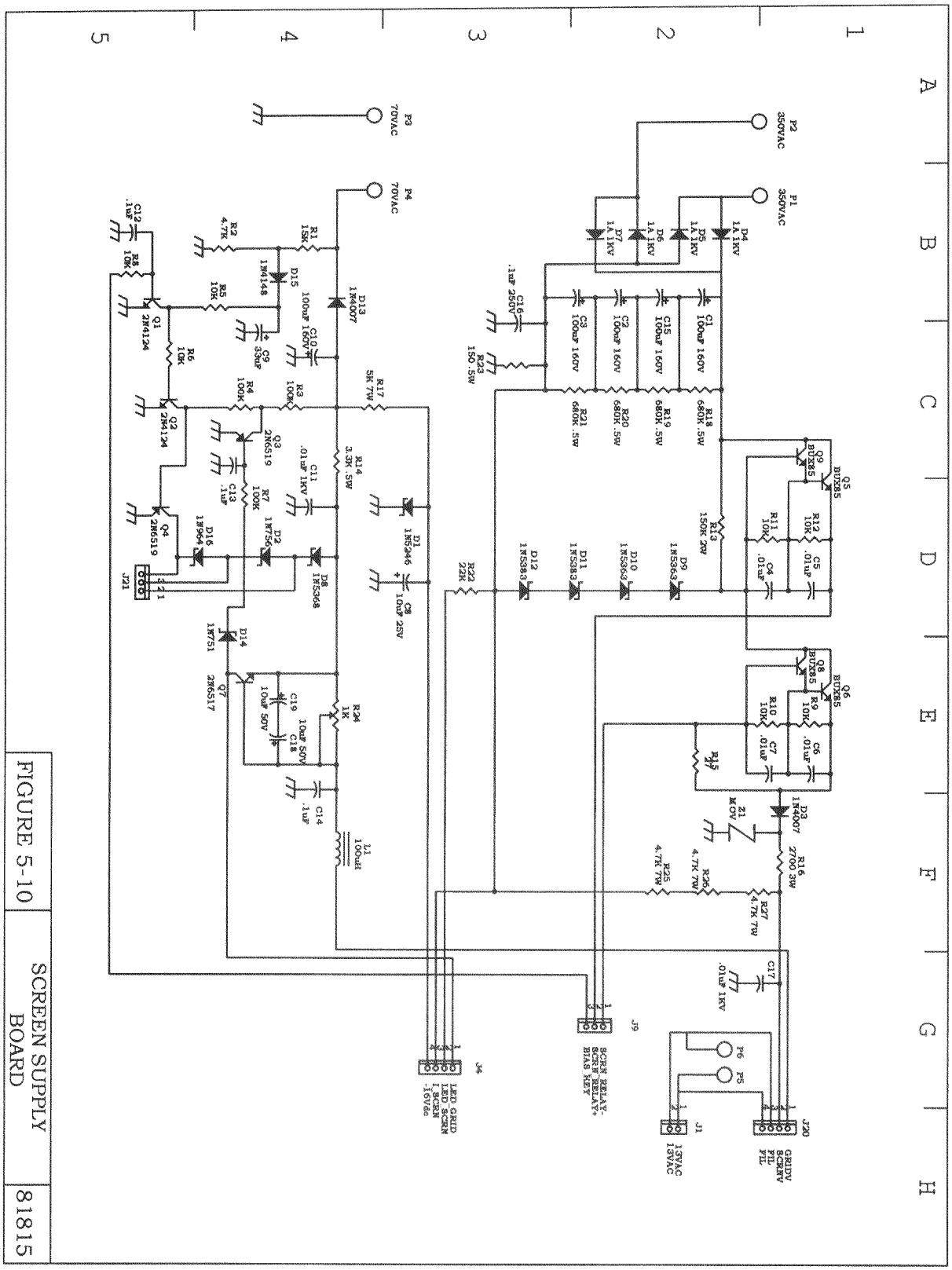



FIGURE 5-9 SCREEN SUPPLY BOARD CIRCUIT LAYOUT AS VIEWED THROUGH BOARD



| FIGURE 5-10 | SCREEN SUPPLY BOARD | 81815 |
|---|---|---|

**5.5 QSK BOARD (81814)** This board contains the low voltage supply, turn-on relay sequencing circuits, and T/R relay control.

The low voltage is rectified by D1 – D4 and filtered by C6. U1 and Q4 provide regulation for all low voltage circuits except the negative 16 VDC supply.

After a 3 minute warm-up period determined by RC time constant of R5 and C5,Q12 will fire, turning on the pass element Q7. This initiates amplifier power up. When the STANDBY/ OPERATE switch is put in the OPERATE position, this voltage is applied to relay sequencing circuits of Q5, Q15, and Q13. These circuits insure plate and screen voltages arrive at and leave the tube in the proper order. Q18 senses plate current and disables the amplifier when plate current parameters are exceeded (such as excessive plate current during a tube arc). Both plate voltage and screen voltage are removed when plate current of 1.5A is reached.

The QSK CONTROL CIRCUIT consists of Q15-Q17 and Q21-Q23. This circuit samples input key requests, standby/operate modes, power on/off state, state of output relay, and RF presence at the antenna connection and input of the amp. Hot switch protection is provided regardless of mode. In the QSK mode, using the key in / key out loop, the key in request from the transceiver is tailored by the QSK CONTROL circuit to insure smooth QSK action of the input and output relays.

K2 senses power off and places the key circuit in bypass mode for operation in barefoot mode.

K3 senses STANDBY/OPERATE mode and routes the key request either to the amplifier control circuit in OPERATE mode, or to the KEY OUT jack in the standby mode.

K4 Passes the "key in" to the KEY OUT jack when all relays are closed and ready for RF.

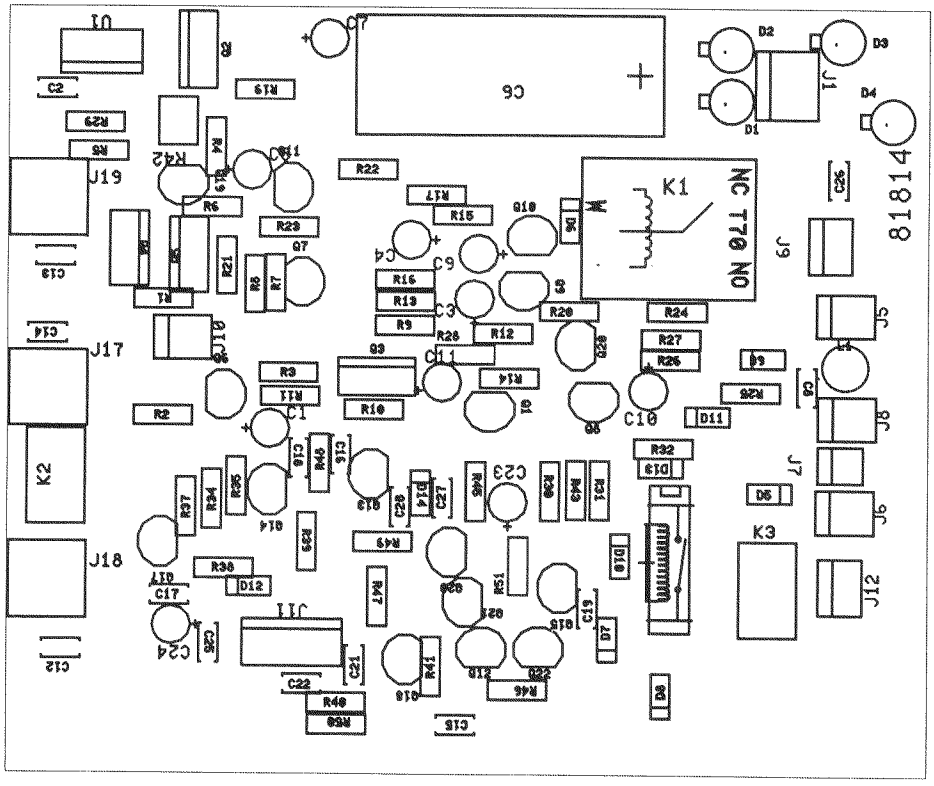
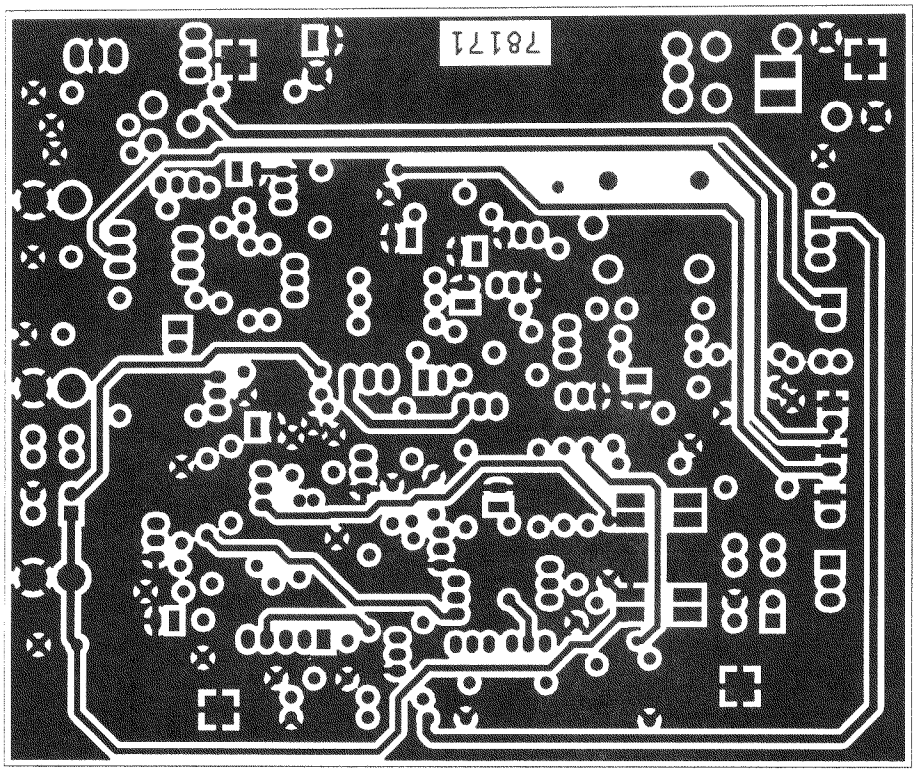



FIGURE 5-11 QSK BOARD COMPONENT LAYOUT TOP VIEW

TOP COPPER




BOTTOM COPPER

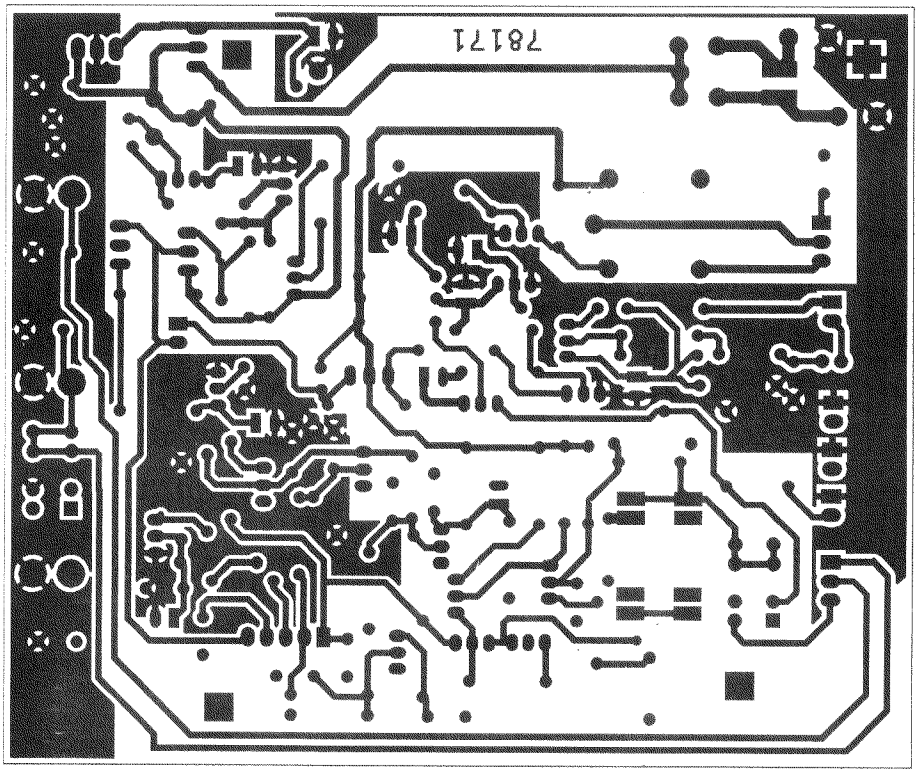



FIGURE 5-12 QSK BOARD CIRCUIT TRACE
LAYOUT AS VIEWED THROUGH BOARD

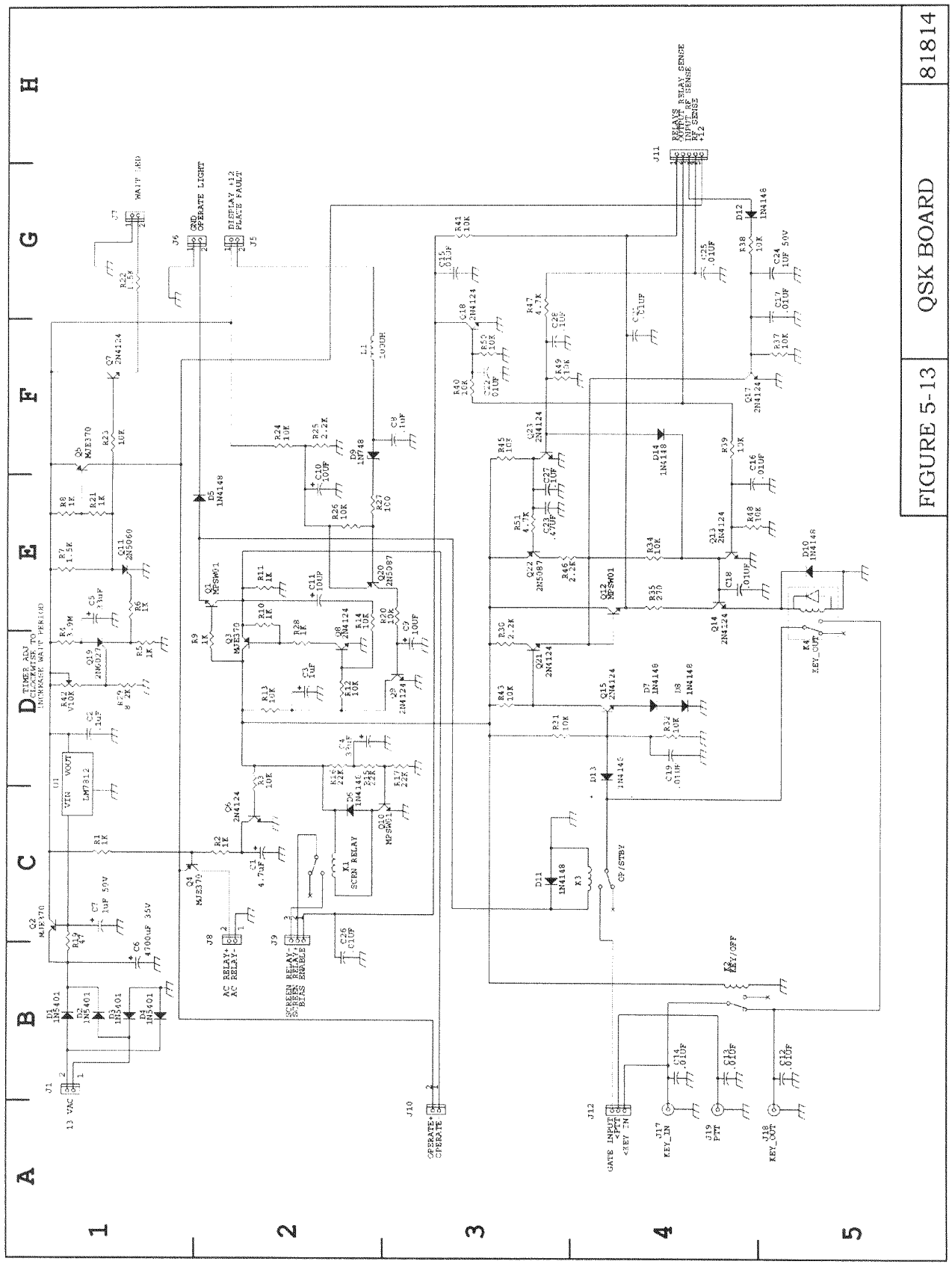
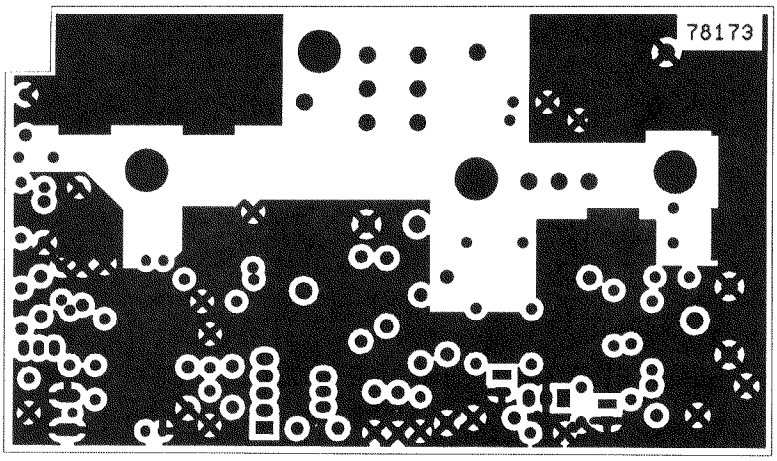


FIGURE 5-13 | QSK BOARD | 81814

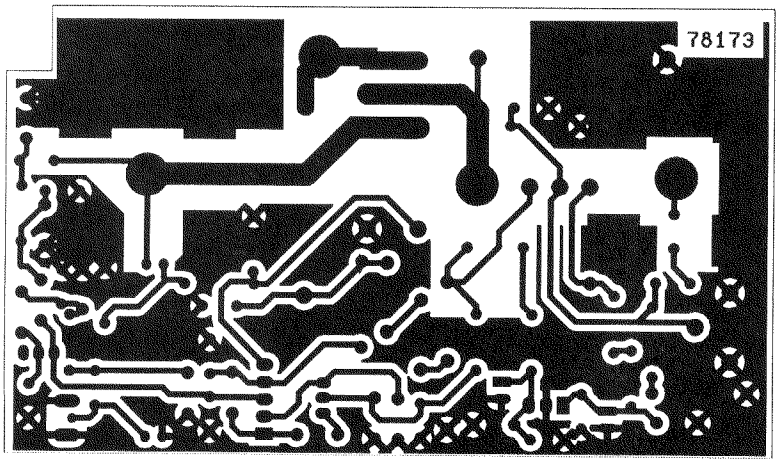
**5.6 SWR BOARD (81816)** This board contains the input relay, output relay, and the SWR bridge for output power measurement.

FIGURE **5-14** SWR BOARD CIRCUIT TRACE
LAYOUT AS VIEWED THROUGH BOARD

TOP COPPER




BOTTOM COPPER



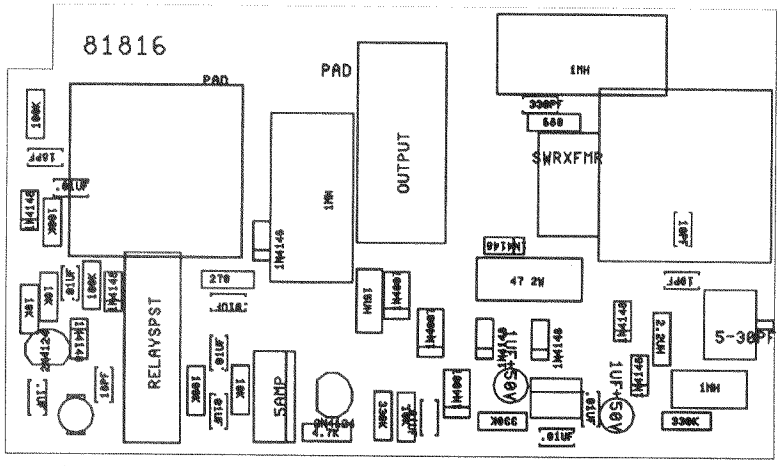
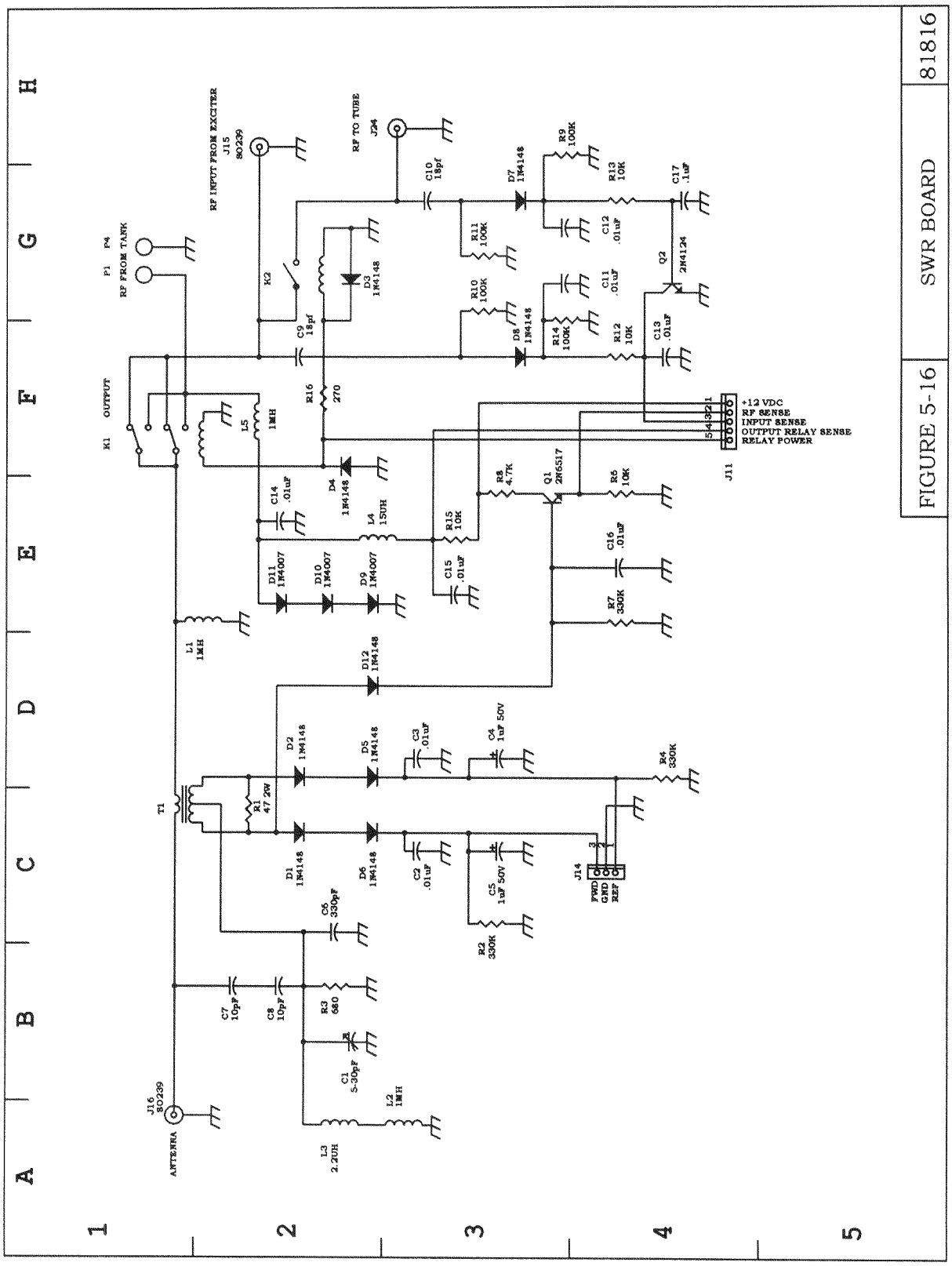
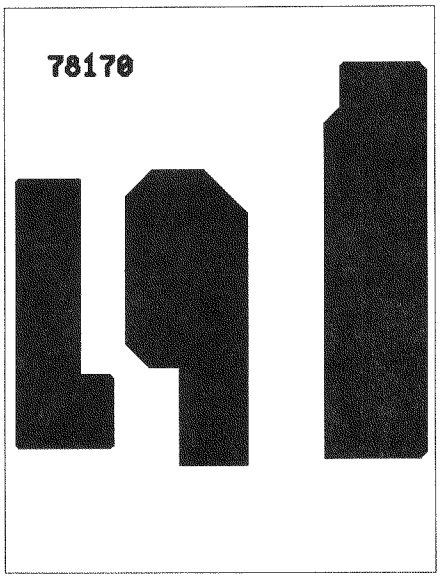




FIGURE **5-15** SWR BOARD COMPONENT LAYOUT TOP VIEW


A
B
C
D
E
F
G
H
1
2
3
4
5
FIGURE 5-16
SWR BOARD
81816
RF INPUT FROM EXCITER
J15
SO239
RF TO TUBE
J24
P1 P4
RF FROM TANK
K1 OUTPUT
K2
J16
SO239
ANTENNA
T1
L1 1MH
L2 1MH
L3 2.2UH
L4 150H
L5 1MH
C1 5-30pF
C2 .01uF
C3 .01uF
C4 1uF 50V
C5 1uF 50V
C6 330pF
C7 10pF
C8 10pF
C9 18pf
C10 18pf
C11 .01uF
C12 .01uF
C13 .01uF
C14 .01uF
C15 .01uF
C16 .01uF
C17 .1uF
R1 47 2W
R2 330K
R3 680
R4 330K
R5 10K
R6 10K
R7 330K
R8 4.7K
R9 100K
R10 100K
R11 100K
R12 10K
R13 10K
R14 10K
R15 10K
R16 270
D1 1N4148
D2 1N4148
D3 1N4148
D4 1N4148
D5 1N4148
D6 1N4148
D7 1N4148
D8 1N4148
D9 1N4007
D10 1N4007
D11 1N4007
D12 1N4148
Q1 2N6517
Q2 2N4124
J14
FWD
GND
REF
J11
+12 VDC
RF SENSE
INPUT SENSE
OUTPUT RELAY SENSE
RELAY POWER

**5.7 PLATE BOARD (81813)** This board contains the parasitic suppressors and coupling capacitors to connect the 4CX1600B plate to the amplifier tank circuit.

FIGURE **5-17** PLATE CONNECTOR BOARD CIRCUIT TRACE LAYOUT AS VIEWED THROUGH BOARD



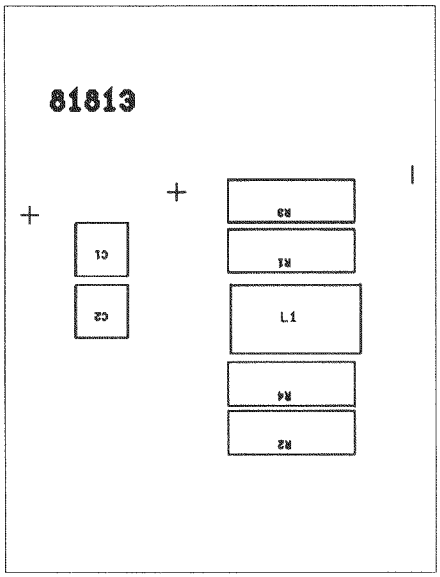
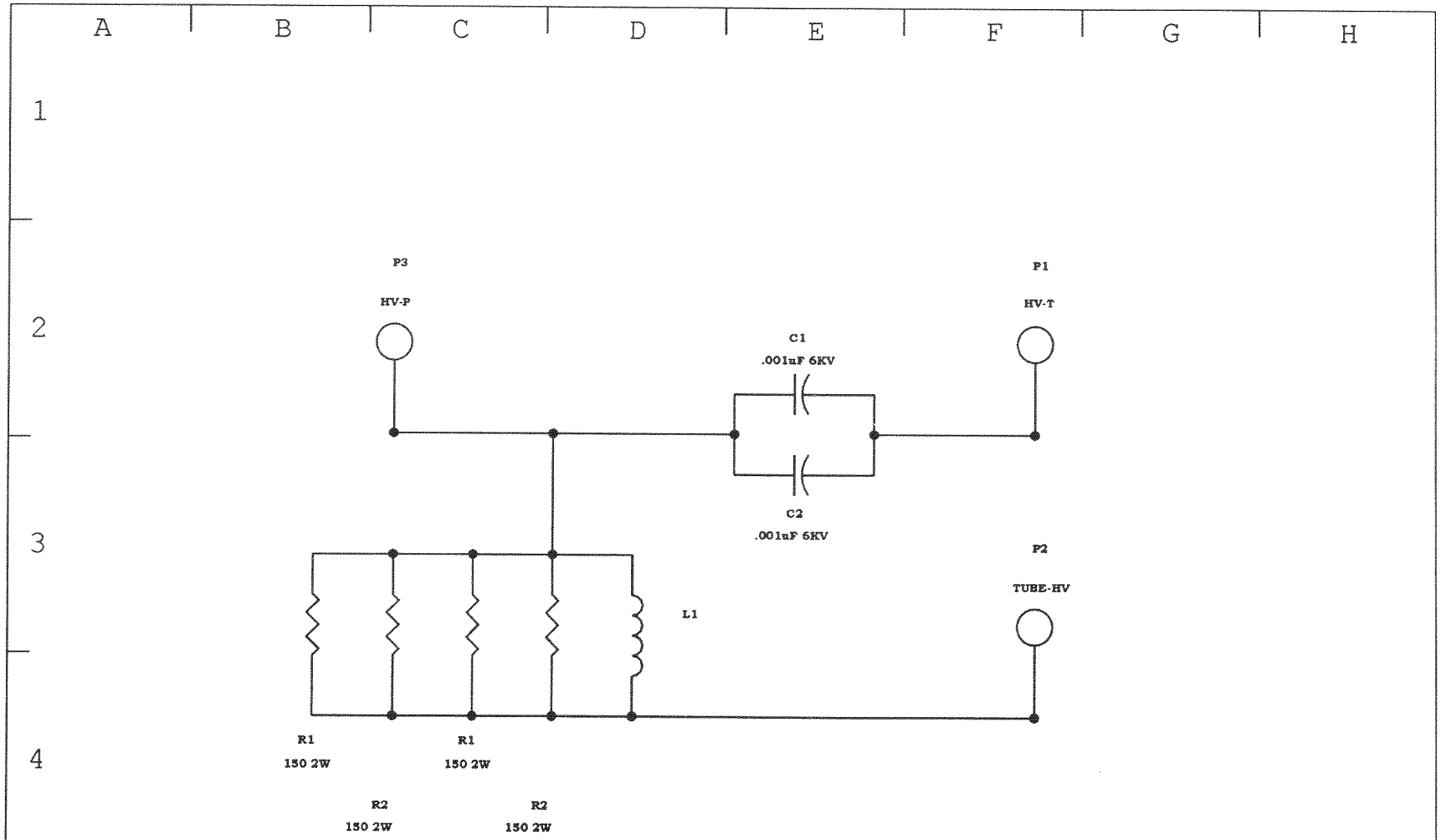




FIGURE 5-18 PLATE CONNECTOR BOARD COMPONENT LAYOUT TOP VIEW




| FIGURE 5-19 | PLATE BOARD | 81813 |
|---|---|---|

**5.8 METER SWITCH BOARD (81812)** This board contains the metering circuits for the front panel meters. SW1 selects the parameter to be monitored. This selection is then sent to M2. The multimeter has three calibrated scales for measuring either plate voltage, screen current or RF power (forward or reverse). U1 samples screen and control grid current and drives the appropriate LED to indicate excessive current of either screen or control grid. Q1 samples forward RF power voltage from the SWR board. This voltage is peaked by C8 and sent to U2 to drive the peak reading display.

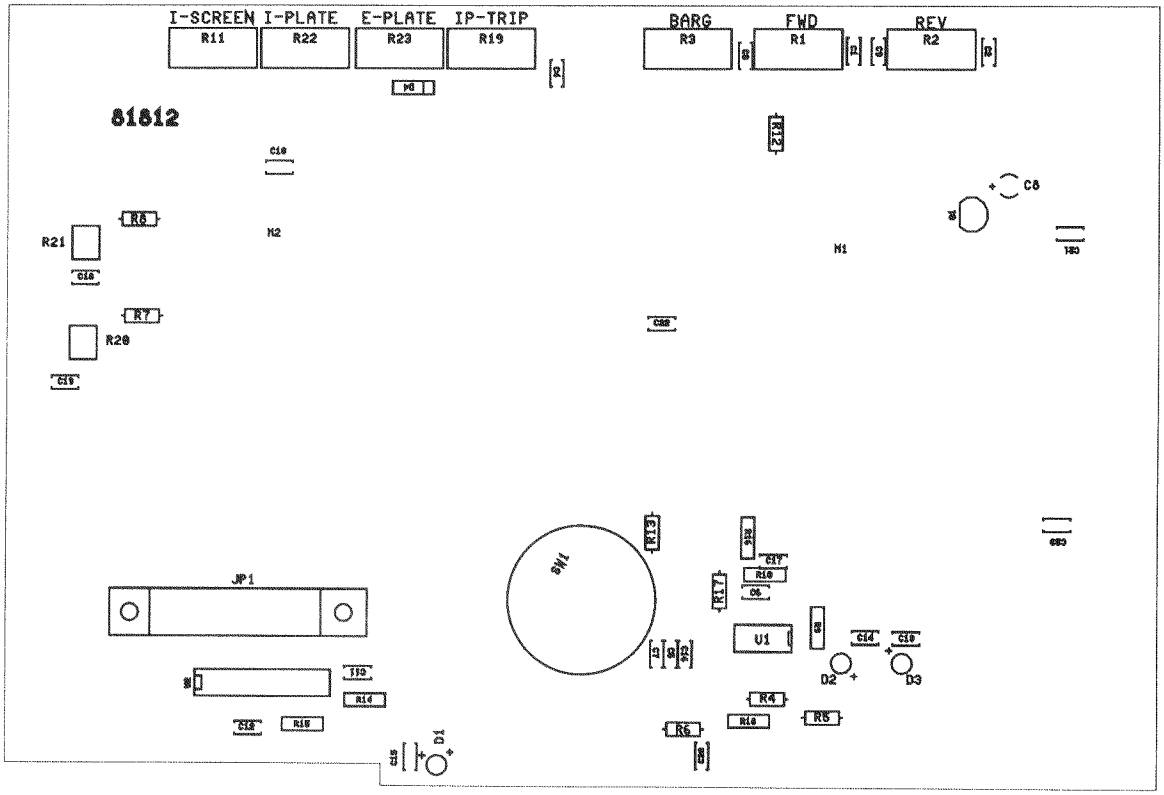
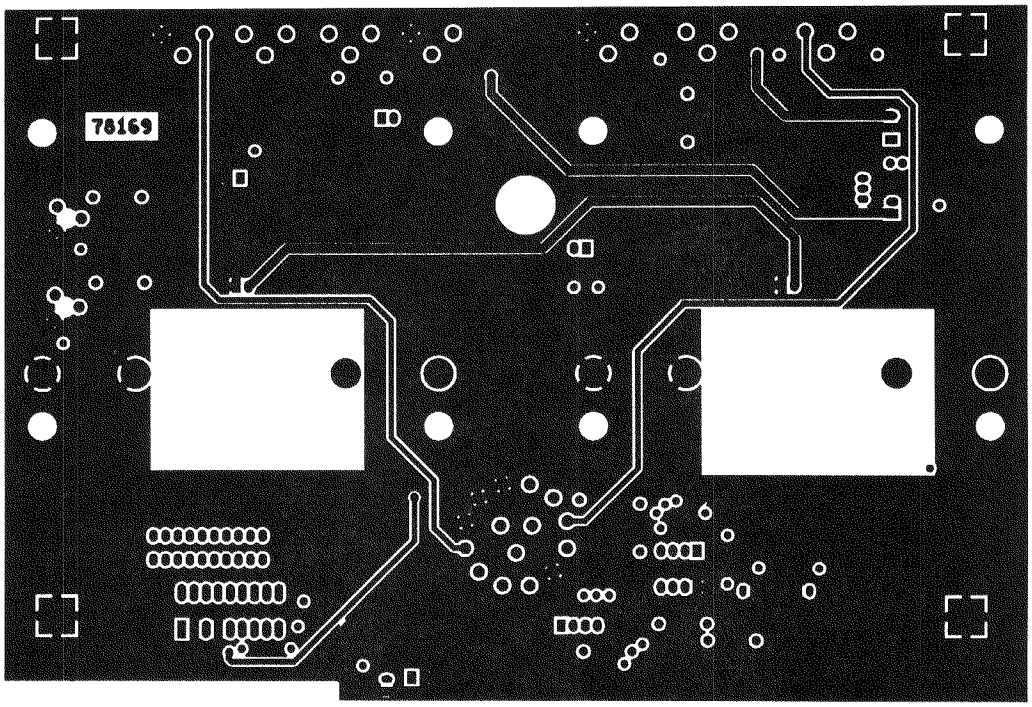



FIGURE 5-20 METER SWITCH BOARD
COMPONENT LAYOUT

TOP SIDE COPPER




BOTTOM SIDE COPPER

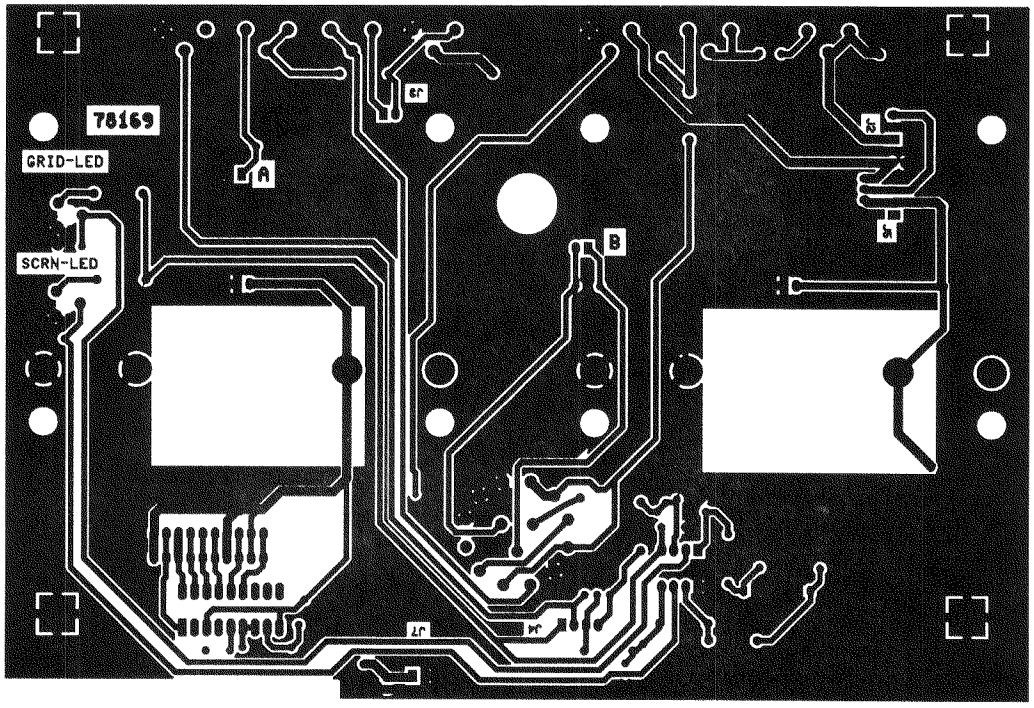



FIGURE 5-21 METER SWITCH BOARD
CIRCUIT LAYOUT AS VIEWED THROUGH BOARD

# FOLLOW THE LEADER

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The first dual 32-bit processing, selectable I-F roofing filter HF transceiver (Orion)

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**1990**
Pioneered tunable crystal filters; "Jones" filter (Delta II/Argonaut II)

**1989**
The first full legal limit automatic antenna tuner for ham radio (253)

**1980**
The first legal limit solid state linear (Hercules)

**1975**
The first 100 watt solid state transceiver (Triton II)

**1971**
The first all solid state transceiver (Argonaut)

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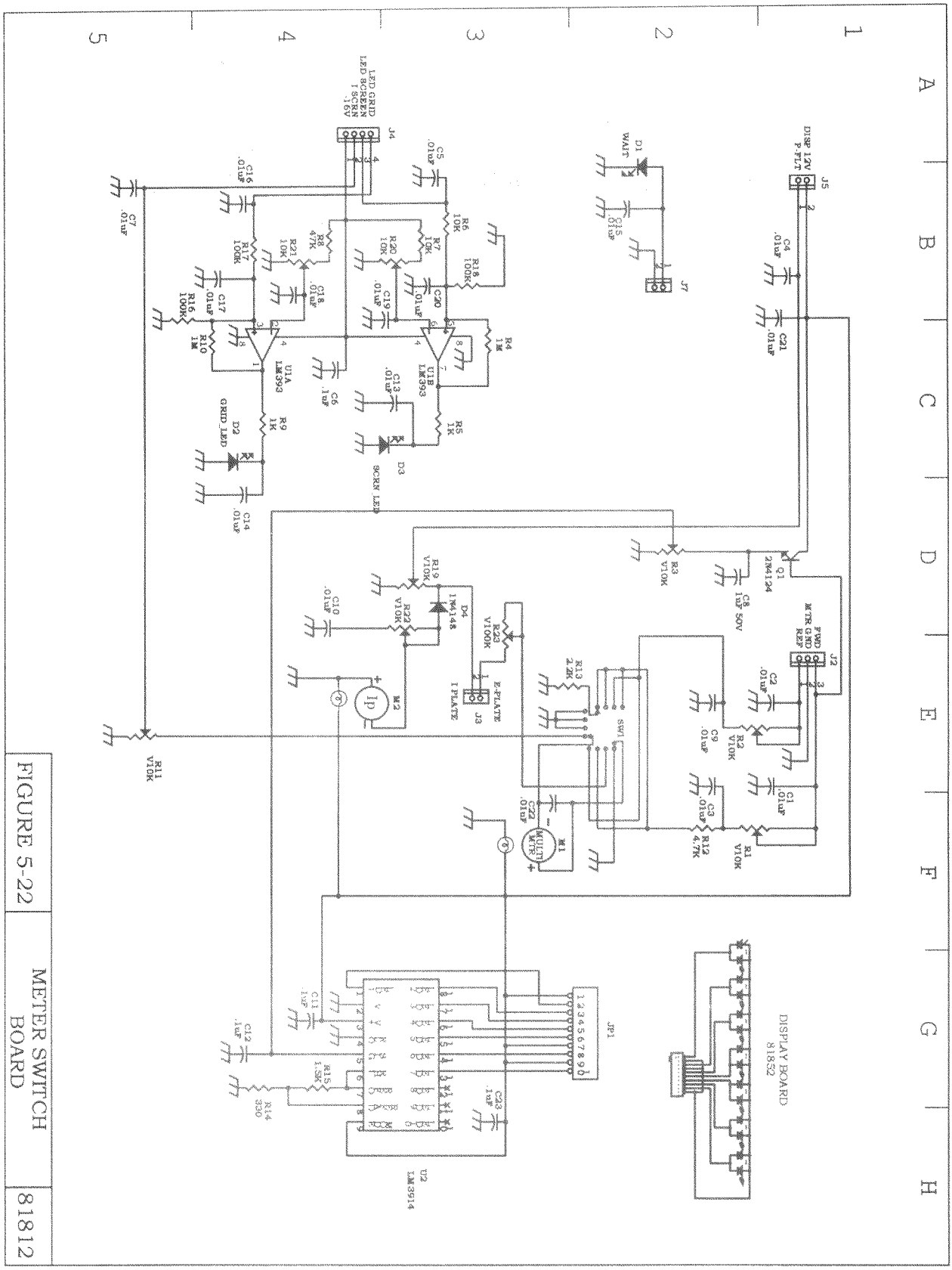


FIGURE 5-22
METER SWITCH BOARD
81812
DISPLAY BOARD 81852
LED GRID
LED SCREEN
SCRN
GRID LED
SCRN LED
WAIT
DISP 12V
P.PLT
FWD
MTR GND
REF
E-PLATE
I PLATE
SW1
MULTI METER
U1A LM393
U1B LM393
U2 LM3914
2N4124
1N4148

**5.9 AC LINE DELAY BOARD (81810)** This board contains the step start relays and associated circuitry to control inrush current while the H.V. filter capacitors charge.

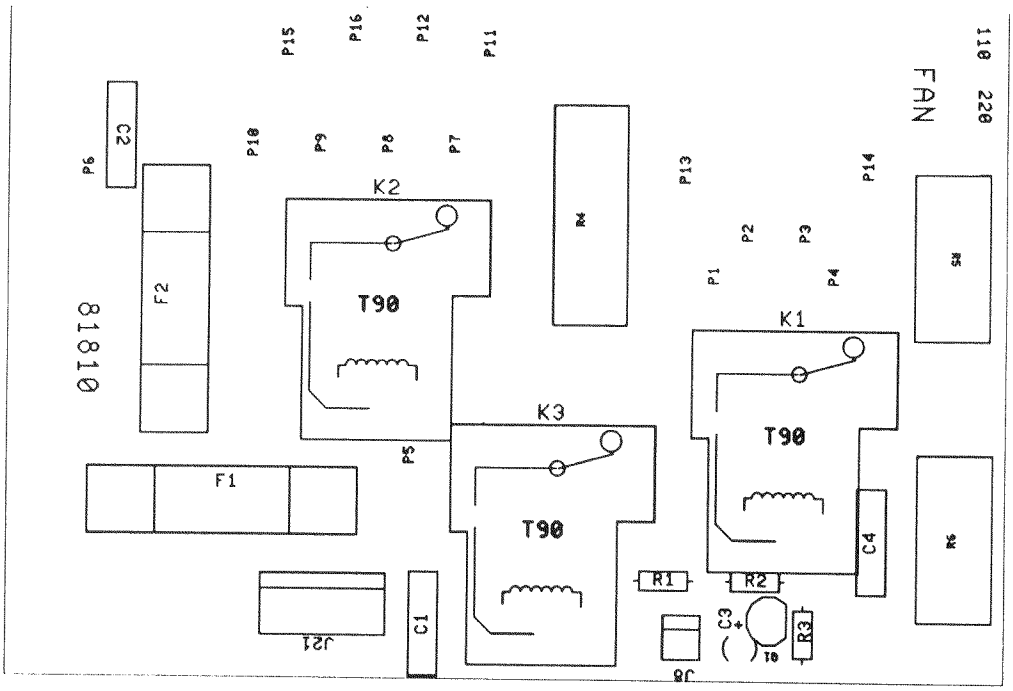
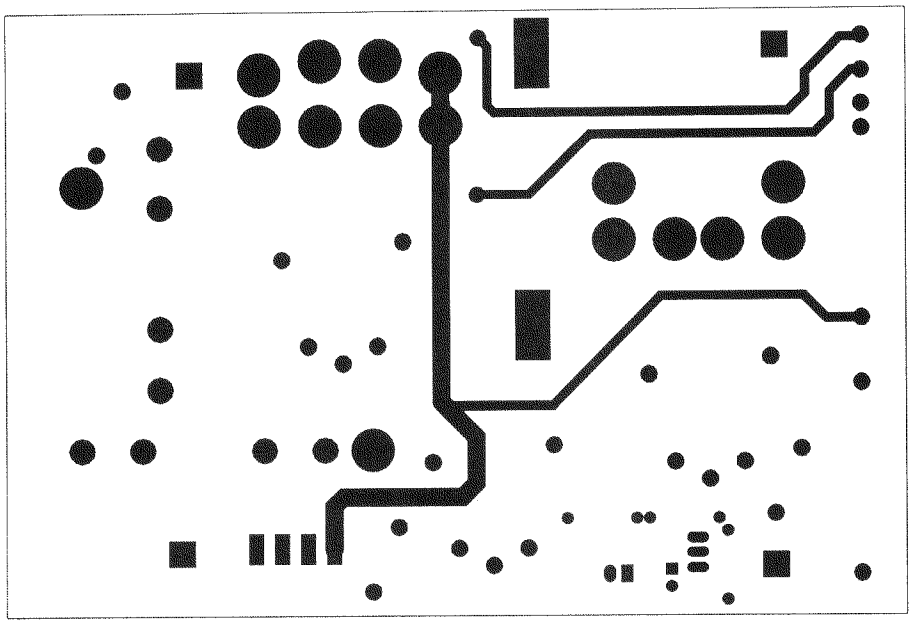



FIGURE 5-23 AC LINE DELAY BOARD COMPONENT LAYOUT TOP SIDE

TOP COPPER



BOTTOM COPPER

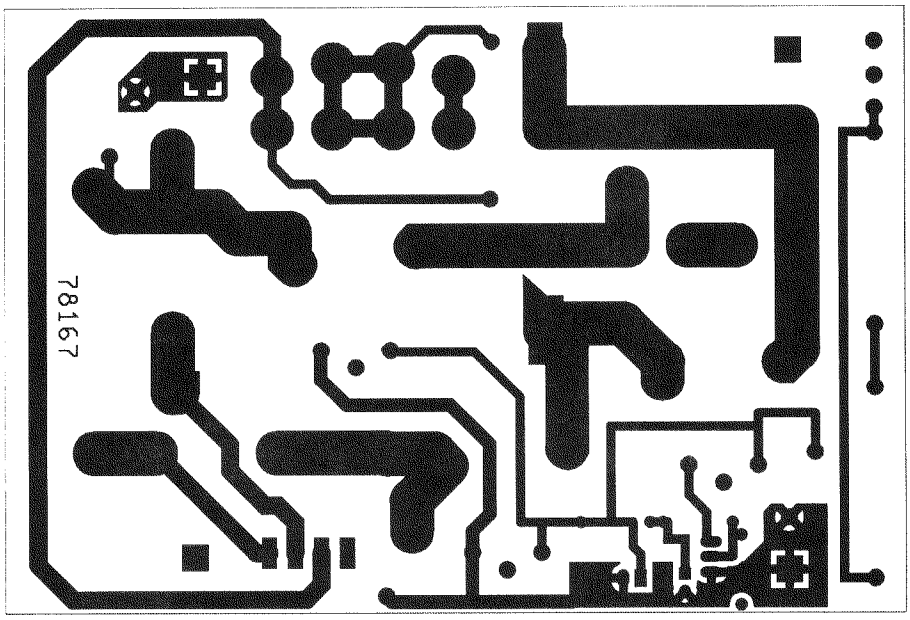
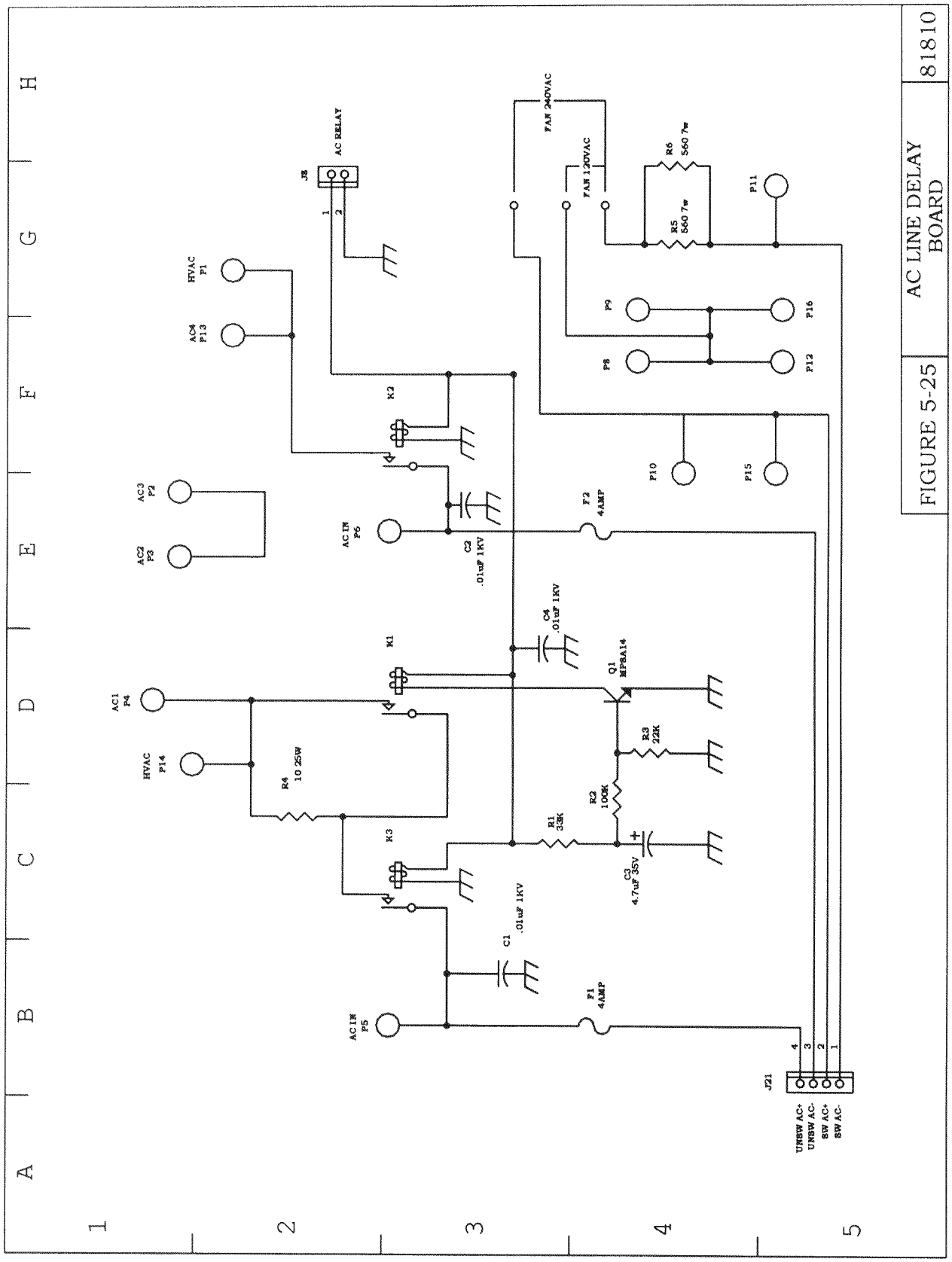



FIGURE 5-24 AC LINE DELAY CIRCUIT TRACE
AS VIEWED THROUGH BOARD


AC LINE DELAY BOARD
81810
J8
AC RELAY
FAN 240VAC
FAN 120VAC
R6 560 7w
R5 560 7w
P11
HVAC P1
AC4 P13
P9
P16
P8
P12
K2
P10
P15
AC3 P2
AC2 P3
AC IN P6
C2 .01uF 1KV
F2 4AMP
C4 .01uF 1KV
K1
Q1 MPSA14
AC1 P4
HVAC P14
R4 10 25W
R3 22K
R2 100K
R1 33K
K3
C3 4.7uF 35V
C1 .01uF 1KV
AC IN P5
F1 4AMP
J21
UNSW AC-
UNSW AC+
SW AC+
SW AC-
FIGURE 5-25

**5.10 LOAD SHUNT BOARD (81808)** This board contains the extra load capacitance needed for the tank circuit. Capacitance is paralleled across the variable load capacitor on bandswitch positions 160A, 160B, and 80.

FIGURE 5-26 LOAD SHUNT BOARD CIRCUIT
TRACE AS VIEWED THROUGH BOARD

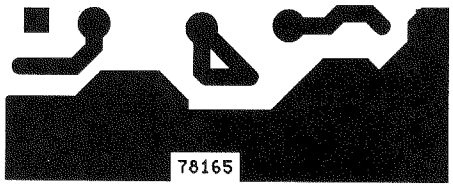
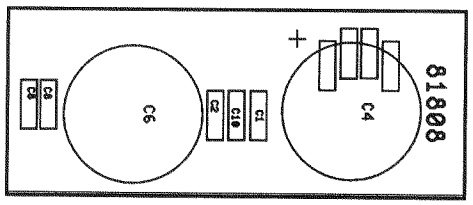
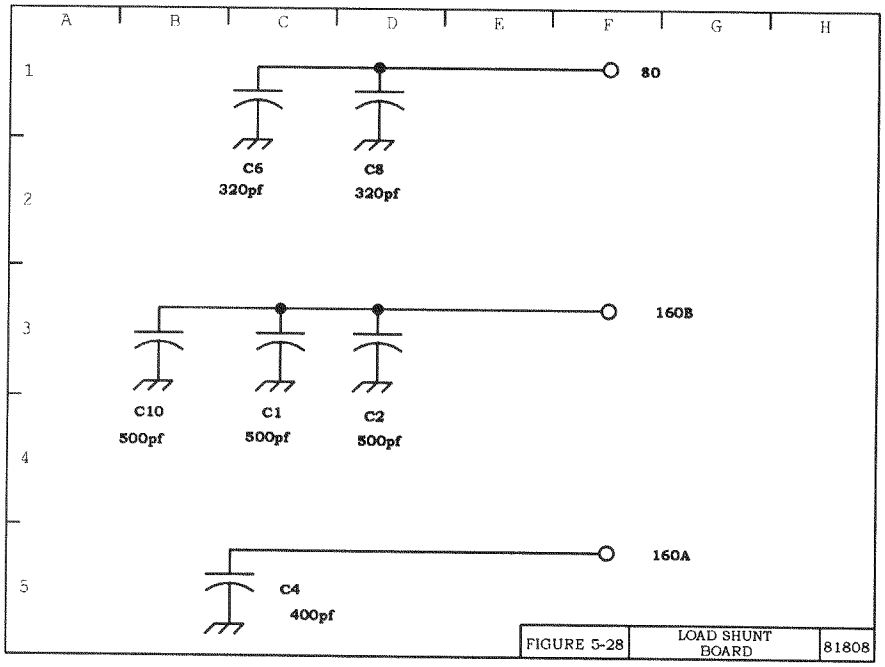



FIGURE 5-27 LOAD SHUNT BOARD COMPONENT LAYOUT
TOP SIDE



# MASTER PARTS LIST

MODEL 416

| ITEM | DESCRIPTION | TEN-TEC PART # |
|---|---|---|
| T1 | HV TRANSFORMER | 81859 FROM 21199 |
| T2 | LV TRANSFORMER | 21198 |
| FAN | CENT. BLOWER | 81858 FROM 38275 |
| S1 | SHORTING BAR | 91914 |
| S2 | INTERLOCK SW | 32063 |
| S3 | ON-OFF SW | 32128 |
| S4 | STBY-OPR SW | 32129 |
| S5 | QSK –PTT SW | 32130 |
| S6 | BAND SW | 98451 FROM 32123 |
| L1 | TANK-3 | 85422-2 |
| L2 | TANK-2 | 85422-2 |
| L3 | TANK-1 | 85422-3 |
| L4 | 10M TANK | 85422-6 |
| L5 | PLATE MATCH | 85422-4 |
| L6 | PLATE CHOKE | 85422-1 |
| C1A C1B | TUNE CAPACITOR | 23520 |
| C2 | LOAD CAPACITOR | 23526 |
| C4 | TUNE SHUNT | 23297 |
| C5 | TUNE SHUNT | 23297 |
| J3 | AC PLUG | 35153 |
| V1 | 4CX1600B TETRODE | 25408 |
| V1-S | TUBE SOCKET | 27070 |
| F1-F2 | 20 ABS FUSE | 27038 |
| | FUSE HOLDER | 27009 |
| | 6:1 VERNIER | 38146 |
| | FAN GUARD | 38183 |
| | TUBE RETAINER | 38265 |
| | BAR KNOB | 34058 |
| | LOAD-TUNE KNOB | 81601 |
| | DIAL SKIRT | 91209-1CU |
| | METER SW KNOB | 80529-1 |
| | BAIL | 91178 |
| | RT BAIL FOOT | 90926 |
| | LF BAIL FOOT | 90925 |
| | REAR FEET | 42020 |

HV-AC BOARD
81810

| | | |
|---|---|---|
| C1 | .01uF 1KV | 23013 |
| C2 | .01uF 1KV | 23013 |
| C3 | 4.7uF 35V | 23310 |
| C4 | .01uF 1KV | 23013 |
| K1 | RELAY SPST | 32067 |
| K2 | RELAY SPST | 32067 |
| K3 | RELAY SPST | 32067 |
| Q1 | MPSA14 | 25253 |
| R1 | 33K | 30155 |
| R2 | 100K | 30161 |
| R3 | 22K | 30154 |
| R4 | 10 25W | 30310 |
| FAN DROPPING RESISTOR | | |
| OR CAPACITOR | 4.7 UF | 23533 |
| | 560 7w | 30712 |

INPUT MATCHING BOARD
81811

| | | |
|---|---|---|
| C1 | .01uF 1KV | 23013 |
| C2 | .01uF | 23260 |
| C3 | 15pF | 23372 |
| C4 | 100pF | 23385 |
| C5 | .01uF 1KV | 23013 |
| C6 | .01uF 1KV | 23013 |
| D1 | 1N4148 | 28001 |
| FL1 | 15M-FIL | 81550 |
| L1 | 1MH | 21135 |
| R1 | 10K | 30150 |
| R2 | 100K | 30161 |
| R3 | 150K 2W | 30311 |
| R4 | 10KPC | 30267 |
| R27 | 47 2W | 30408 |
| R30 | 470 7W | 30721 |
| R31 | 470 7W | 30721 |
| R32 | 470 7W | 30721 |
| R33 | 470 7W | 30721 |
| R34 | 470 7W | 30721 |
| R35 | 470 7W | 30721 |
| R36 | 470 7W | 30721 |
| R37 | 470 7W | 30721 |
| R38 | 470 7W | 30721 |
| R39 | 470 7W | 30721 |
| R40 | 47 2W | 30408 |
| R41 | 47 2W | 30408 |
| R42 | 47 2W | 30408 |

| | | |
|---|---|---|
| R43 | 47 2W | 30408 |
| R44 | 47 2W | 30408 |
| R45 | 47 2W | 30408 |
| R46 | 47 2W | 30408 |
| R47 | 47 2W | 30408 |
| R48 | 47 2W | 30408 |
| R49 | 47 2W | 30408 |
| R50 | 47 2W | 30408 |
| R51 | 12 2W | 30405 |
| R52 | 12 2W | 30405 |

METER-SW BOARD
81812

| | | |
|---|---|---|
| C1 | .01uF | 23260 |
| C2 | .01uF | 23260 |
| C3 | .01uF | 23260 |
| C4 | .01uF | 23260 |
| C5 | .01uF | 23260 |
| C6 | .1uF | 23261 |
| C7 | .01uF | 23260 |
| C8 | 1uF 50V | 23264 |
| C9 | .01uF | 23260 |
| C10 | .01uF | 23260 |
| C11 | .1uF | 23261 |
| C12 | .1uF | 23261 |
| C13 | .01uF | 23260 |
| C14 | .01uF | 23260 |
| C15 | .01uF | 23260 |
| C16 | .01uF | 23260 |
| C17 | .01uF | 23260 |
| C18 | .01uF | 23260 |
| C19 | .01uF | 23260 |
| C20 | .01uF | 23260 |
| C21 | .01uF | 23260 |
| C22 | .01uF | 23260 |
| C23 | .1uF | 23261 |
| D1 | LED | 28024 |
| D2 | LED | 28024 |
| D3 | LED | 28024 |
| D4 | 1N4148 | 28001 |
| M1 | MULTIMETER | 98398 |
| M2 | METER_IP | 98397 |
| Q1 | 2N4124 | 25258 |
| R1 | V10K | 30038 |
| R2 | V10K | 30038 |
| R3 | V10K | 30038 |

| | | |
|---|---|---|
| R4 | 1M | 30173 |
| R5 | 1K | 30138 |
| R6 | 10K | 30038 |
| R7 | 10K | 30038 |
| R8 | 47K | 30157 |
| R9 | 1K | 30138 |
| R10 | 1M | 30173 |
| R11 | V10K | 30038 |
| R12 | 4.7K | 30146 |
| R13 | 2.2K | 30142 |
| R14 | 330 | 30132 |
| R15 | 1.5K | 30140 |
| R16 | 100K | 30161 |
| R17 | 100K | 30161 |
| R18 | 100K | 30161 |
| R19 | V10K | 30038 |
| R20 | PC100K | 30620 |
| R21 | PC100K | 30620 |
| R22 | V10K | 30038 |
| R23 | V100K | 30198 |
| SW1 | METER SW | 98449 FROM 32050 |
| U1A | LM393 | 25260 |
| U1B | LM393 | 25260 |
| U2 | LM3914 | 25101 |

PLATE BOARD
81813

| | | |
|---|---|---|
| C1 | .001uF 6KV | 23295 |
| C2 | .001uF 6KV | 23295 |
| L1 | PARASITIC SUP | 85422-5 |
| R1 | 150 2W | 30407 |
| R1 | 150 | 30407 |
| R2 | 150 2W | 30407 |
| R2 | 150 2W | 30407 |

QSK BOARD
81814

| | | |
|---|---|---|
| C1 | 4.7uF 35V | 23310 |
| C2 | .1uF | 23261 |
| C3 | 1uF 50V | 23264 |
| C4 | 33uF 16V | 23308 |
| C5 | 33uF 16 | 23308 |
| C6 | 4700uF 35V | 23191 |
| C7 | 1uF 50V | 23263 |
| C8 | .1uF | 23261 |
| C9 | 10UF | 23266 |

| | | |
|---|---|---|
| C10 | 10UF | 23266 |
| C11 | 10UF | 23266 |
| C12 | .01UF | 23260 |
| C13 | .01UF | 23260 |
| C14 | .01UF | 23260 |
| C15 | .01UF | 23260 |
| C16 | .01UF | 23260 |
| C17 | .01UF | 23260 |
| C18 | .01UF | 23260 |
| C19 | .01UF | 23260 |
| C21 | .01UF | 23260 |
| C22 | .01UF | 23260 |
| C23 | .47UF | 23263 |
| C24 | 1uF 50V | 23263 |
| C25 | .01UF | 23260 |
| C26 | .01UF | 23260 |
| C27 | .1uF | 23261 |
| C28 | .1Uf | 23261 |
| D1 | 1N5401 | 28047 |
| D2 | 1N5401 | 28047 |
| D3 | 1N5401 | 28047 |
| D4 | 1N5401 | 28047 |
| D5 | 1N4148 | 28001 |
| D6 | 1N4148 | 28001 |
| D7 | 1N4148 | 28001 |
| D8 | 1N4148 | 28001 |
| D9 | 1N750 | 28058 |
| D10 | 1N4148 | 28001 |
| D11 | 1N4148 | 28001 |
| D12 | 1N4148 | 28001 |
| D13 | 1N4148 | 28001 |
| D14 | 1N4148 | 28001 |
| J17 | KEY_IN | 35238 |
| J18 | KEY_OUT | 35238 |
| J19 | PTT | 35238 |
| K1 | SCRN RELAY | 32103 |
| K2 | KEY/OFF | 32120 |
| K3 | OP/STBY | 32120 |
| K4 | KEY_OUT | 32081 |
| L1 | 100UH | 21060 |
| Q1 | MPSW01 | 25023 |
| Q2 | MJE371 | 25105 |
| Q3 | MJE371 | 25105 |
| Q4 | MJE371 | 25105 |
| Q5 | MJE371 | 25105 |
| Q6 | 2N4124 | 25258 |
| Q7 | 2N4124 | 25258 |
| Q8 | 2N4124 | 25258 |
| Q9 | 2N4124 | 25258 |

| | | |
|---|---|---|
| Q10 | MPSW01 | 25053 |
| Q11 | 2N5060 | 25039 |
| Q12 | MPSW01 | 25053 |
| Q13 | 2N4124 | 25258 |
| Q14 | 2N4124 | 25258 |
| Q15 | 2N4124 | 25258 |
| Q17 | 2N4124 | 25258 |
| Q18 | 2N4124 | 25258 |
| Q19 | 2N6027 | 25185 |
| Q20 | 2N5087 | 25001 |
| Q21 | 2N4124 | 25258 |
| Q22 | 2N5087 | 25001 |
| Q23 | 2N4124 | 25258 |
| R1 | 1K | 30138 |
| R2 | 1K | 30138 |
| R3 | 10K | 30150 |
| R4 | 3.9M | 30180 |
| R5 | 1K | 30138 |
| R6 | 1K | 30138 |
| R7 | 1.5K | 30140 |
| R8 | 1K | 30138 |
| R9 | 1K | 30138 |
| R10 | 1K | 30138 |
| R11 | 1K | 30138 |
| R12 | 10K | 30150 |
| R13 | 10K | 30150 |
| R14 | 10K | 30150 |
| R15 | 22K | 30154 |
| R16 | 22K | 30154 |
| R17 | 22K | 30154 |
| R19 | 47 | 30122 |
| R20 | 10K | 30150 |
| R21 | 1K | 30138 |
| R22 | 1.5K | 30140 |
| R23 | 10K | 30150 |
| R24 | 10K | 30150 |
| R25 | 2.2K | 30142 |
| R26 | 10K | 30150 |
| R27 | 100 | 30126 |
| R28 | 1K | 30138 |
| R29 | 8.2K | 30149 |
| R30 | 2.2K | 30142 |
| R31 | 10K | 30150 |
| R32 | 10K | 30150 |
| R34 | 10K | 30150 |
| R35 | 270 | 30131 |

| | | |
|---|---|---|
| R37 | 10K | 30150 |
| R38 | 10K | 30150 |
| R39 | 10K | 30150 |
| R40 | 10K | 30150 |
| R41 | 10K | 30150 |
| R42 | V10K | 30619 |
| R43 | 10K | 30150 |
| R45 | 10K | 30150 |
| R46 | 2.2K | 30142 |
| R47 | 4.7K | 30146 |
| R48 | 10K | 30150 |
| R49 | 10K | 30150 |
| R50 | 10K | 30150 |
| R51 | 4.7K | 30146 |
| U1 | LM7812 | 25232 |

SCREEN SUPPLY BOARD
81815

| | | |
|---|---|---|
| C1 | 100uF 160V | 23516 |
| C2 | 100uF 160V | 23516 |
| C3 | 100uF 160V | 23516 |
| C4 | .01uF | 23260 |
| C5 | .01uF | 23260 |
| C6 | .01uF | 23260 |
| C7 | .01uF | 23260 |
| C8 | 10uF 25V | 23266 |
| C9 | 33uF 16V | 23308 |
| C10 | 100uF 160V | 23516 |
| C11 | .01uF 1KV | 23013 |
| C12 | .1uF | 23261 |
| C13 | .1uF | 23261 |
| C14 | .1uF | 23261 |
| C15 | 100uF 160V | 23516 |
| C16 | .1uF 250V | 23006 |
| C17 | .01uF 1KV | 23013 |
| C18 | 10uF 50V | 23266 |
| C19 | 10uF 50V | 23266 |
| D1 | 1N5246 | 28141 |
| D2 | 1N756 | 28019 |
| D3 | 1N4007 | 28043 |
| D4 | 1A 1KV | 28122 |
| D5 | 1A 1KV | 28122 |
| D6 | 1A 1KV | 28122 |
| D7 | 1A 1KV | 28122 |
| D8 | 1N5368 | 28136 |
| D9 | 1N5363 | 28134 |
| D10 | 1N5363 | 28134 |

| | | |
|---|---|---|
| D11 | 1N5383 | 28135 |
| D12 | 1N5383 | 28135 |
| D13 | 1N4007 | 28043 |
| D14 | 1N751 | 28041 |
| D15 | 1N4148 | 28001 |
| D16 | 1N964 | 28010 |
| L1 | 100uH | 21060 |
| Q1 | 2N4124 | 25258 |
| Q2 | 2N4124 | 25258 |
| Q3 | 2N6519 | 25107 |
| Q4 | 2N6519 | 25107 |
| Q5 | BUX85 | 25409 |
| Q6 | BUX85 | 25409 |
| Q7 | 2N6517 | 25393 |
| Q8 | BUX85 | 25409 |
| Q9 | BUX85 | 25409 |
| R1 | 15K | 30076 |
| R2 | 4.7K | 30146 |
| R3 | 100K | 30161 |
| R4 | 100K | 30161 |
| R5 | 10K | 30150 |
| R6 | 10K | 30150 |
| R7 | 100K | 30161 |
| R8 | 10K | 30150 |
| R9 | 10K | 30150 |
| R10 | 10K | 30150 |
| R11 | 10K | 30150 |
| R12 | 10K | 30150 |
| R13 | 150K 2W | 30311 |
| R14 | 3.3K .5W | 30027 |
| R15 | 27 | 30119 |
| R16 | 2700 3W | 30717 |
| R17 | 4.7K 7W | 30719 |
| R18 | 680K .5W | 30066 |
| R19 | 680K .5W | 30066 |
| R20 | 680K .5W | 30066 |
| R21 | 680K .5W | 30066 |
| R22 | 22K | 30154 |
| R23 | 150 .5W | 30059 |
| R24 | 1K | 30138 |
| R25 | 4.7K 7W | 30719 |
| R26 | 4.7K 7W | 30719 |
| R27 | 4.7K 7W | 30719 |
| Z1 | MOV | 30718 |

SWR BOARD
81816

| | | |
|---|---|---|
| C1 | 5-30pF | 23169 |
| C2 | .01uF | 23260 |
| C3 | .01uF | 23260 |
| C4 | 1uF 50V | 23264 |
| C5 | 1uF 50V | 23264 |
| C6 | 330pF | 23165 |
| C7 | 10pF | 23371 |
| C8 | 10pF | 23371 |
| C9 | 18pf | 23373 |
| C10 | 18pf | 23373 |
| C11 | .01uF | 23260 |
| C12 | .01uF | 23260 |
| C13 | .01uF | 23260 |
| C14 | .01uF | 23260 |
| C15 | .01uF | 23260 |
| C16 | .01uF | 23260 |
| C17 | .1uF | 23261 |
| D1 | 1N4148 | 28001 |
| D2 | 1N4148 | 28001 |
| D3 | 1N4148 | 28001 |
| D4 | 1N4148 | 28001 |
| D5 | 1N4148 | 28001 |
| D6 | 1N4148 | 28001 |
| D7 | 1N4148 | 28001 |
| D8 | 1N4148 | 28001 |
| D9 | 1N4007 | 28043 |
| D10 | 1N4007 | 28043 |
| D11 | 1N4007 | 28043 |
| D12 | 1N4148 | 28001 |
| K1 | OUTPUT | 32101 |
| K2 | RELAYSPST | 32049 |
| L1 | 1MH | 21135 |
| L2 | 1MH | 21007 |
| L3 | 2.2UH | 21116 |
| L4 | 15UH | 21126 |
| L5 | 1MH | 21135 |
| Q1 | 2N6517 | 25393 |
| Q2 | 2N4124 | 25258 |
| R1 | 47 2W | 30408 |
| R2 | 330K | 30302 |
| R3 | 680 | 30136 |
| R4 | 330K | 30302 |
| R6 | 10K | 30150 |

| | | |
|---|---|---|
| R7 | 330K | 30302 |
| R8 | 4.7K | 30146 |
| R9 | 100K | 30161 |
| R10 | 100K | 30161 |
| R11 | 100K | 30161 |
| R13 | 10K | 30150 |
| R14 | 100K | 30161 |
| R15 | 10K | 30150 |
| R16 | 270 | 30131 |
| T1 | SWRXFMR | 85380-15 |

81808
LOAD CAPACITOR SHUNT BOARD

| | | |
|---|---|---|
| C1 | 500pf | 23360 |
| C2 | 500pf | 23360 |
| C4 | 400pf | 23300 |
| C6 | 320pf | 23395 |
| C8 | 320pf | 23395 |
| C10 | 500pf | 23360 |

TEN-TEC, Inc.
1185 Dolly Parton Parkway
Sevierville, TN 37862 USA

Customer Service Telephone
(865) 428-0364

**THREE YEAR LIMITED WARRANTY, MODEL 416 TITAN II AMPLIFIER**

Ten-Tec, Inc. warrants this product to be free from defects in material and workmanship for a period of three years 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 to establish you as the owner of record. This will also insure that any bulletins pertaining to this equipment will be sent to you.

2) The 4CX1600B power amplifier tube is warranted by Svetlana. The warranty is 5000 hours or 2 years, whichever comes first, pro-rated. Full replacement is provided for 0-500 hours of use. 501-5000 hours pro-rated by time of service.

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

4) IF TROUBLE DEVELOPS we recommend that you contact our customer service group direct at the telephone number above. Our service technicians should be able to determine what (if any) action needs to be taken. Please do not call our (800) sales department order line for warranty service as service technicians cannot be reached at that number.

5) WE ENCOURAGE SELF HELP. Taking the covers off does not void the warranty. Be sure to observe all safety information provided in this manual. In many cases our customer service technicians, with your help, can identify a faulty circuit board or part. When appropriate, we will send you a replacement board which you can change out. This will be shipped on a 30 day memo billing and when the defective board is returned we will issue credit.

6) EQUIPMENT RETURNED TO THE FACTORY must be properly packaged, preferably in the original shipping carton. You pay the freight to us and we prepay the surface freight back to you.

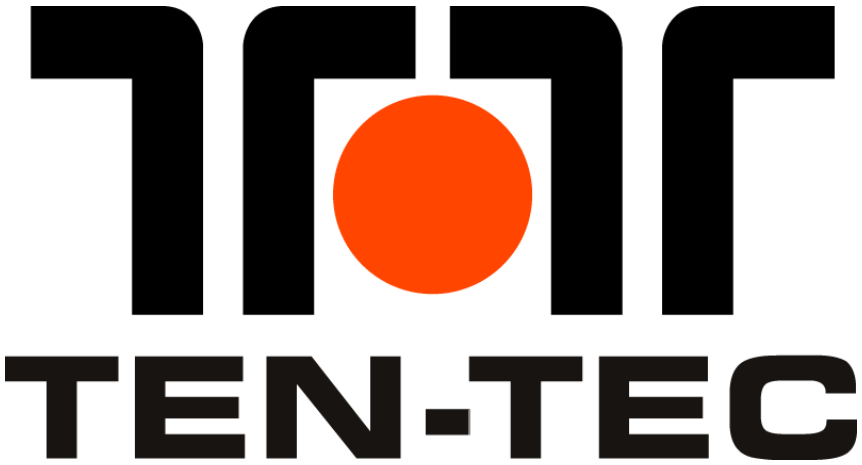
7) EXCLUSIONS. This warranty does not cover damage resulting from misuse, lightning, excess voltages, polarity errors or damage resulting from modifications not recommended or approved by Ten-Tec. In the event of transportation damage a claim must be filed with the carrier. Under no circumstances is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

8) TEN-TEC RESERVES the right to make design changes without any obligation to modify equipment previously manufactured.

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

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

Many of our dealers provide warranty service on the equipment they sell. Many of them also provide out of warranty service on our 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 all freight expense, customs and broker fees will be paid by you.




**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**