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LIST OF ILLUSTRATIONS

SPECIFICATIONS

BAND COVERAGE	160, 80,40, 20, 17 AND 15 meters
POWER OUTPUT	1500 WATTS SSB AND CW , 1000 WATTS CONTINUOUS , RTTY , AND SSTV
DRIVING POWER	70 WATTS TYPICAL FOR 1500 WATTS OUT
DUTY CYCLE	A.) SSB-CONTINUOUS VOICE MODULATION 1500 WATTS PEP B.) CW-50% DUTY CYCLE CONTINUOUSLY 1500 WATTS PEP 30 MIN. KEY DOWN @1500 WATTS
EFFICIENCY	61.7% MEASURED @ 40 METERS UP TO 65% DEPENDING ON BAND, FREQUENCY, LINE VOLTAGE , AND LOAD
INPUT AND OUTPUT IMPEDANCE'S	50 OHMS UNBALANCED WITH VSWR <2:1
HARMONICS	MEETS OR EXCEEDS FCC REQUIREMENTS BETTER THAN FUNDAMENTAL -45dB
FULLY BREAK-IN QSK	BUILT IN T/R SWITCHING GUARANTEED CLOSURE <7mS OPEN ~ 15mS
PROTECTIVE CIRCUITS	A.) SCREEN GRID CURRENT REGULATION OVER VOLTAGE PROTECTION AND MOV ARC OVER PROTECTION LED OVERDRIVE INDICATION B.) CONTROL GRID CURRENT REGULATION, OVERDRIVE TRIP , AND LED INDICATION C.) PLATE CURRENT TRIP AT 1.6 AMP SERIES RESISTOR FOR ARC ABSORPTION
PRIMARY POWER	240 VAC @ 20 AMPS 50/60 Hz -10%+5%
LINE PROTECTION	PRIMARY LINE FUSES, INTERLOCK, AND STEP START INRUSH PROTECTION

TUBE	SVETLANA CERAMIC 4CX1600B POWER TETRODE
COOLING	DUCT FORCED AIR , VERTICAL EXHAUST , USING CENTRIFUGAL BLOWER TO PRODUCE .50 " PRESSURE DROP IN WATER AT SEA LEVEL 25 DEG C AIR TEMPERATURE. OPTIONAL FAN AVAILABLE FOR HIGH ALTITUDE OR CONTINUOUS DUTY.
METERING	FULL TIME PLATE CURRENT METER SWITCH SELECTABLE Ep,Is,FWD, AND REV POWER PEAK FDW POWER INDICATED ON FULL TIME BARGRAPH
STATUS INDICATORS	POWER ON , WAIT, STANDBY , OPERATE , SCREEN GRID OVERDRIVE, CONTINUOUS GRID CURRENT OVERDRIVE
PLATE VOLTAGE SUPPLY	STEP-START INRUSH PROTECTED 3000 VDC @ NO LOAD 2700 VDC @ FULL LOAD CURRENT TRIP @ 1.4 AMPS 6 AMP 1000 PIV DIODES IN FULLWAVE CONFIGURATION FILTERED BY 9 EACH 400 VDC 220 uF ELECTROLYTIC CAPACITORS 10 OHM ARC ABSORPTION RESISTOR
SCREEN SUPPLY	300 VDC CURRENT REGULATED TO MIN +23 mA OVER CURRENT TRIP SENSE
CONSTRUCTION	ALUMINUM .125" TRANSFORMER AND TANK CHASSIS. ALUMINUM .062 CONTROL CHASSIS AND COVERS
SIZE	H x W x D = 8.2" X 17" X 19"
WEIGHT	65 LB. 143.33 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 produce 3000 VOLTS which is LETHAL!!!

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 ***TITAN II*** Model 416 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 dedicated to full time plate current measurement. The other meter is switchable from plate voltage, screen current, forward power, or reflected power.

Two front panel leds indicate overdrive conditions in the control grid and screen grid circuits are about to be reached.

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

Primary power of 240 VAC is recommended. Operation on 110 VAC is possible with modification to the line input AC board. However, REDUCED OUTPUT POWER is necessary. Remember 1500 WATTS output @240 VAC line =20 amps. 1500 WATTS @ 110 VAC = 40 amps. No home line circuits are capable of 40 amp service. The primary AC lines are fused at 20 AMPS. MBD-20A or equivalent must be used in replacement to protect the tube. Interlocks in 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. 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 ***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 ABS-20 fuses	27038
2 ea.	4 AMP MDA-4 fuses	27015
1 ea.	.056 allen wrench	38040
1 ea.	.062 allen wrench	38088
1 ea.	# 8 allen wrench	38124

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

Repair dept. (423) 428-0364
Switchboard (423) 453-7172
FAX (423) 428-4483
E-mail TSALVETTI@TENTEC.COM

Before powering up your TITAN II , visually inspect the unit for possible physical damage, such as dents or parts jarred loose during shipment. Cover removal should not be necessary. If however, you do remove the top , remember the interlocks on both line and high voltage prevent power up. Replace the top cover securely before line voltage is applied to the ***TITAN II.***

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 18 AMPS at 240 VAC. Care should be taken not to overload house wiring circuits usually fused or breakered at 15 to 20 AMPS.
A straight run circuit with # 10 / 2 with ground and breaker or fuses at 20 AMPS is strongly advised.

1.3 TRANSCEIVER INTERCONNECTIONS : When using the ***TITAN II*** with TEN-TEC transceivers with TXEN-TXOUT connections, follow the diagram in figure 1-1. The QSK-PTT 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+ as well as the PARAGON I and II.
When connecting the ***TITAN II*** with other rigs, 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***, 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 switch on the amplifier must be in the QSK position for CW, and in the PTT position for SSB.

1.4 ANTENNA REQUIREMENTS :
The ***TITAN II*** amplifier is 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. Note that other than 1:1 impedances will result in TUNE and LOAD setting different from those in the reference chart (figure 2-7).
The nominal output impedance of the amplifier is 50 OHMS. Many antennas 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. TEN-TEC models 253,229 or 238 are suitable companion tuners.

CAUTION!!!

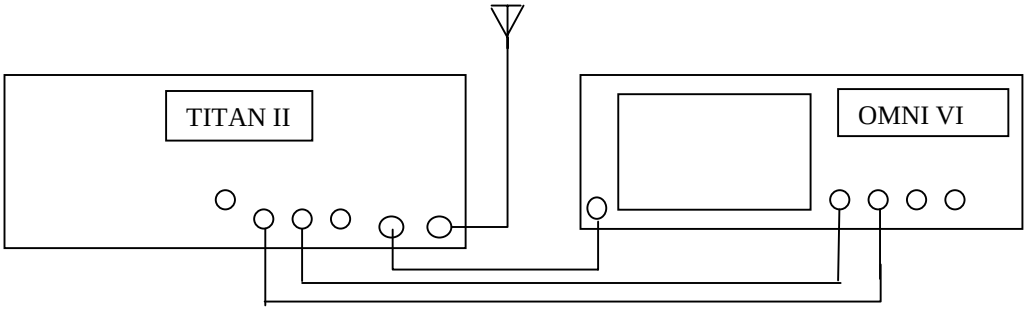
Never attempt to operate the ***TITAN II*** without first connecting a suitable antenna or 50 OHM resistive load of sufficient power rating or SERIOUS DAMAGE MAY RESULT!

1.5 GROUND CONNECTIONS : In the interest of personal safety an 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.

1.6 HIGH POWER OPERATION : The ***TITAN II*** amplifier operates very comfortably at a maximum of 1500 WATTS output. The problem is that other components in your station may not. Before operating at this power level , be certain to check the following items :

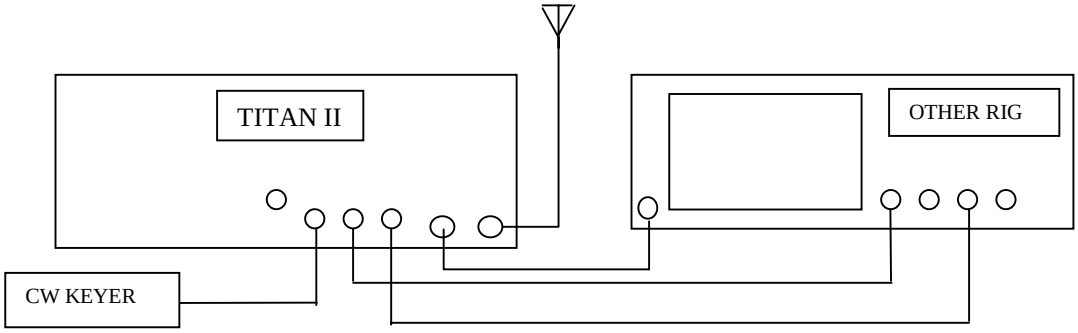
1. The coax from the TITAN II to the feed point of your antenna must be top quality RG- 8X or better. We recommend silver plated connectors rather than chrome plated connectors. Make sure that all coax connectors are tight(snug them up with a pair of pliers).
2. All coax switches or relays in the feed 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, balluns , 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 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. The only common theme should be to 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 and use transceiver low power only.
6. If any of your home entertainment electronic devices have RF leaks , the ***TITAN II*** will find them. The problem will develop because of fundamental overloading , rather than from spurious emissions or harmonics. If you are not familiar with the standard procedure for controlling this type of interference , consult the ARRL Radio Frequency Interference Manual.

1.7 ALC : 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. The ALC output jack is used primarily with tube-type transmitter/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 power off.



TEN-TEC TRANS.	***TITAN II***
TX OUT	KEY IN
TX EN	KEY OUT
ANTENNA	TRANSCEIVER

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



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

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 for further information and operating hints.

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 a six 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.

2.2.2 TUNE : This control adjusts variable capacitor C1 to provide resonance at the operating frequency. Figure 2-4 (page 2-8) 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 load. On page 2-8 there is 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 the chart on page 2-8.

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 switch will light.

2.2.5 OPR/STBY : This switch , when in the OPERATE position , places the amplifier online. When in the STBY 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.

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 TXEN and TX OUT , this position is used for all modes of keying. When in the PTT position , the key circuits are configured for voice operation with other than TEN-TEC transceivers.

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 dependant at the ratio of 10 V plate per 1 V line. Plate voltage is set to 3000 VDC at a line voltage of 240 VAC. Therefore at a line voltage of 250 VAC the meter will be a little higher (3100 VDC). Since the voltage is not critical , the meter is marked with a general area (box) of operation. As long as plate voltage is somewhere in or over this box , the ***TITAN II*** is happy**.**

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 75Ma. Always operate below 75 Ma of screen grid current. In addition to the analog meter, the screen overdrive LED indicates excessive screen current.

C. Forward power - When in this position , the meter is connected to

a bridge circuit at the antenna output. This measures forward output RF power. It is, however, more load dependant than an external watt meter such as a Bird. If your antenna is far from resonance , the accuracy is not as good and power measurements should be made externally.

D. Reflected power REV- When in this position, the meter is connected to the other port of the bridge at the antenna output. The meter reads reflected power (500 WATTS full scale).

2.2.8 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.

2.2.9 WAIT : This LED indicates a 3 minutes 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.

2.2.10 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 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-8X or similar 50 OHM coax rated for 1500 WATTS is required for connecting to the antenna.

2.3.3 KEY IN : This jack is the input for the TITAN II transmit/receive relay system. When used with all 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 plugged into 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 all late model TEN-TEC transceivers , this jack is connected to the TX EN 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 transceivers, this jack is not used. When used with other transceivers, this jack is connected to the N.O. 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 transceivers.

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 a 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 (ABS-20) are accessible through these panel fuse holders. Replace with ABS-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 Ep plate voltage 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.

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 watt meter 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 required.

2.5.2 IMPORTANT POINTS TO REMEMBER: The most important parameters to observe during tune up are the currents in the control grid and the screen grid. 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 lights. 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 re tune. After tune up , erratic lighting of either over drive indicator could indicate breakdown in the load (antenna components). Reduce drive and check for arcing or heating of balluns, 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 desire operating frequency.
B. Set the multimeter switch to the Ep position.
C. Place the STBY/OPR switch to OPR. The operate LED lights and high voltage is indicated on the multimeter (approximately 3000 VDC).
D. Set the meter switch to the Is position. Always monitor Is with the multimeter. Use FWD and REV positions momentarily for checking output power. Always monitor the

Overdrive LEDs and reduce drive when either is lit.

E. For initial tune up you set the TUNE and LOAD controls to their center positions. Alternately you may refer to the suggested settings in the chart in figure 2-4. Keep in mind that these settings are for operation into an ideal 50 OHM load and may vary slightly.

F. Turn the transceiver RF output control to minimum. IF AT ANY TIME THE TITAN II DOES NOT RESPOND AS EXPECTED remove drive immediately and correct the problem before continuing.

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

NOTE: To prevent sustained arcs, use a keyer and a string of dits at approximately 30 WPM.

H. Adjust the TUNE control for a peak in plate current and a peak in RF power output.

Adjust the LOAD control for a 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 on page 2-9. These settings will be repeatable for the same frequency , antenna , and SWR when used in the future.

CHAPTER 3

OPERATING HINTS

3.1 INTRODUCTION : The following paragraphs provide additional information for getting the best performance 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 substantially exceeded.

3.1.4 TRANSFORMER RATINGS : The transformer in the TITAN II is rated at 2.5 KVA CCS (continuous commercial service). It weighs 42 lbs. The weight of a transformer is directly proportional to the capacity of that transformer. A 35 lb. transformer may be rated higher by another manufactor but only if different standards are applied, such as heat rise. Just for comparison , if our transformer was rated for IVS (intermittent voice service) or SSB operation only, It would be 9 KVA. In summary , your power supply is more than adequate.

3.1.5 OPERATION ON 120 VAC : The TITAN II is normally shipped from TEN-TEC wired for operation on 240 VAC. The power supplies in the TITAN II can be modified for 120 VAC operation (but not recommended). If you operate on 120 VAC , POWER OUTPUT MUST NOT EXCEED 1000 WATTS. To change the TITAN II for operation on 120 VAC you will need the following tools :

1 - medium size phillips screwdriver
1 - pair long nosed pliers
1 - soldering iron and solder

To perform the modification , refer to figure 3-1 and proceed as follows.

A. Make sure that the AC line is unplugged and that all other cables are disconnected.
B. Remove both bottom inspection plate of the TITAN II.
C. Locate the (81815) Screen supply board. There should be two jumper wires already installed . For 120 VAC terminals #1 and #4 are jumpered together
D. Remove the jumper at #1 and move to #5
E. Remove the jumper at #4 and move to #7
F. Add jumper #10 between #4 and #1
G. Replace the inspection plate and secure tightly.
H. The AC lines are still fused at 20 AMPS The internal wiring of the TITAN II is not rated for full output at 120 VAC. NEVER EXCEED 1000 WATTS.

CHAPTER 4

MAINTENANCE AND TROUBLE SHOOTING

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 frequently enough (using a soft bristled brush and vacuum cleaner) to prevent visible accumulation of dust. DO NOT blow air directly into the fan input: this con over rev the motor and damage the bearings

SYMPTOM	POSSIBLE CAUSE/CURE
1. Will not turn on: nothing happens when the ON switch is activated.	A] Fuse missing or open. B] House wiring incorrect or breaker open. C] Power cable to amplifier disconnected. D] Fuse on HV-AC board (81810) open. E] Problem with low voltage power supply on QSK board (81814)
2. Lights turn on but no high voltage, relays do not close.	A] Interlock open, cover not tight
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 . B] K1 on 81810 is defective.
4. Relays K1, K2, K3 on 81810 HV-AC board close but no high voltage at turn on.	A] K2 , K3 defective. B] HV short to ground. C] High voltage transformer disconnected. D] High voltage bridge open. CAUTION: NEVER TRUST ONLY ONE HV METERING CIRCUIT. THERE COULD BE HV PRESENT BUT THE METER DOESN'T REGISTER IT. ALWAYS DOUBLE CHECK WITH AN EXTERNAL HV METER

TABLE 4-1 TROUBLE SHOOTING HINTS

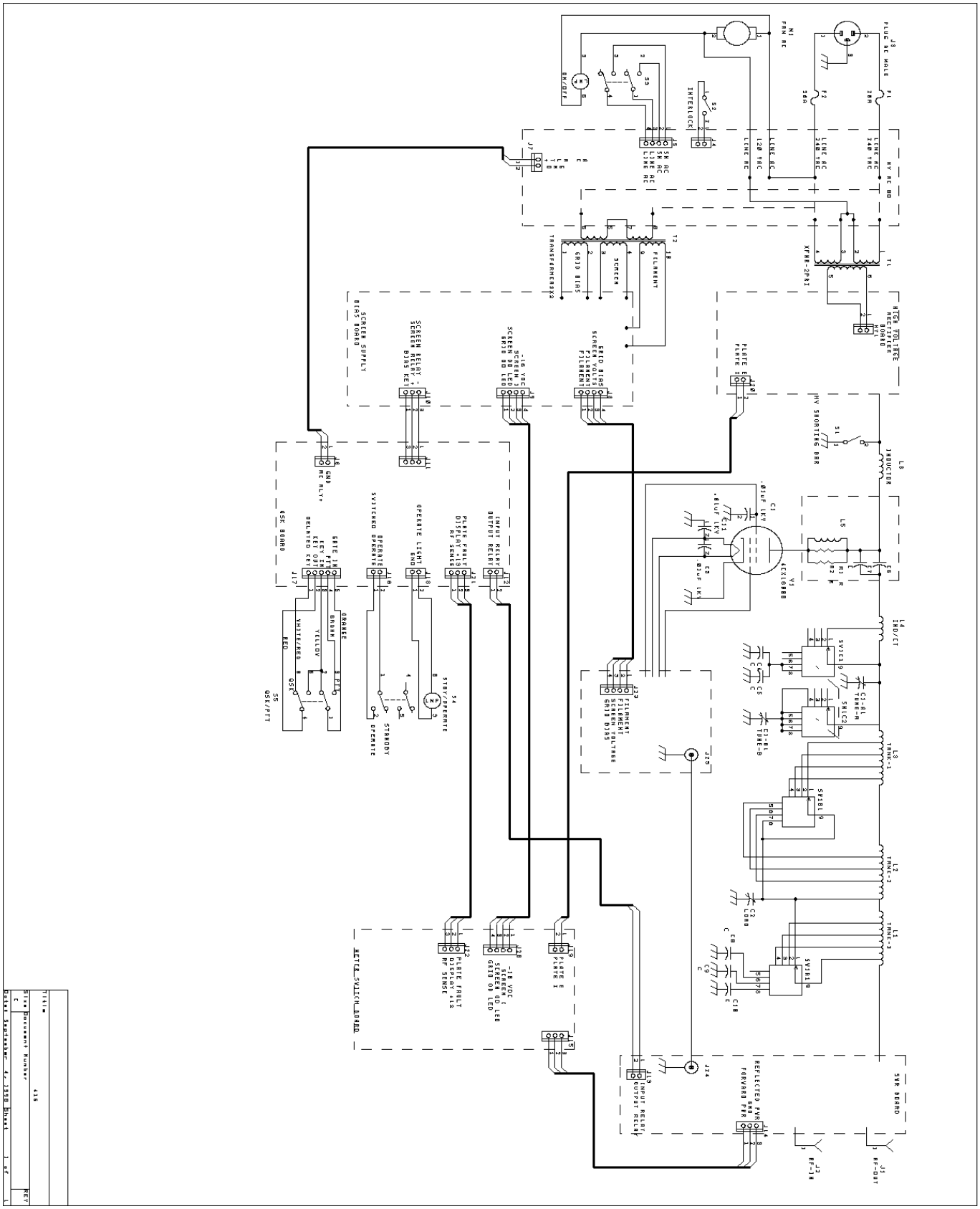
TABLE 4-1 TROUBLE SHOOTING HINTS (Continued)

5. Relays K1, K2, and K3 close at turn on , but line fuses blow.	A] High voltage at crowbar or elsewhere. B] Shorted tube. 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. B] Input relay K2 on 81816 SWR board defective. C] Input filter on 81811 input matching board loose or damaged.
7. Grid over drive led lights with no drive.	A] Q7 on 81815 shorted or leaky. B] Shorted or leaky tube.
8. Screen over drive led lights with no drive.	A] R23 on 81815 board open or increased in value. 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. B] Excessively high load SWR. C] Defective output relay on 81816 SWR board. D] Arcing in tank circuit or antenna feed line.
10. Excessive plate current in receive mode.	A] Defective bias circuit on 81814 board. 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. B] Defective key line cables. 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. B] Shorted key-in or key-out cable. 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 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 416 Amplifier.

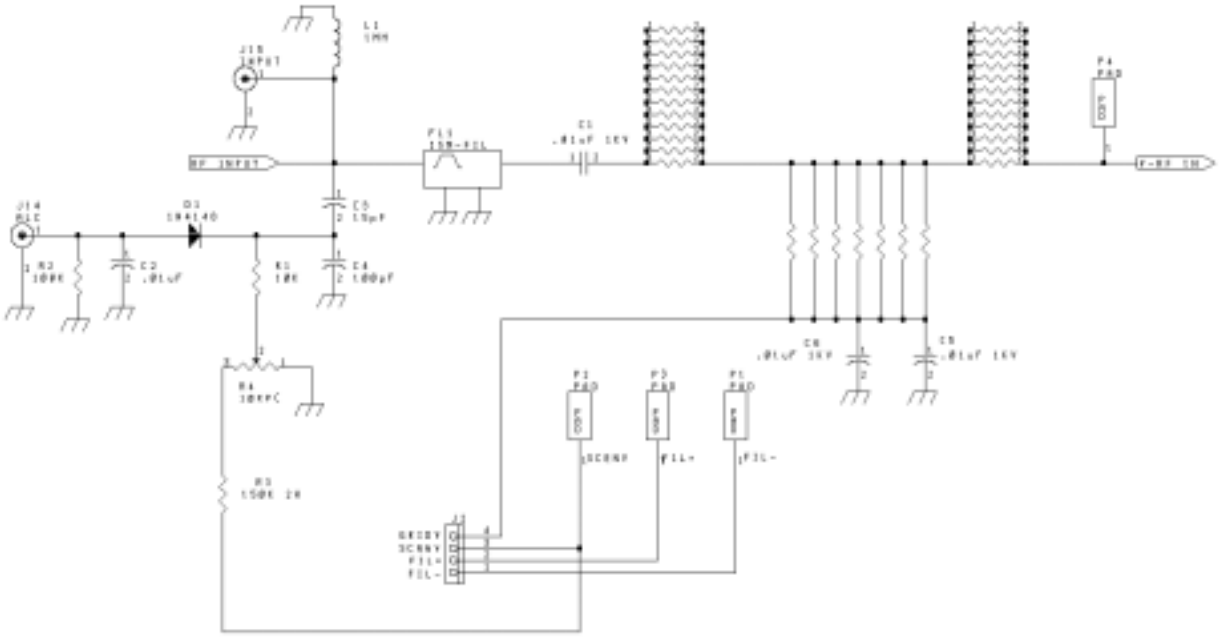


INPUT MATCHING BOARD (81811)
This board contains the input filter, impedance matching networks , and ALC circuits.

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.**

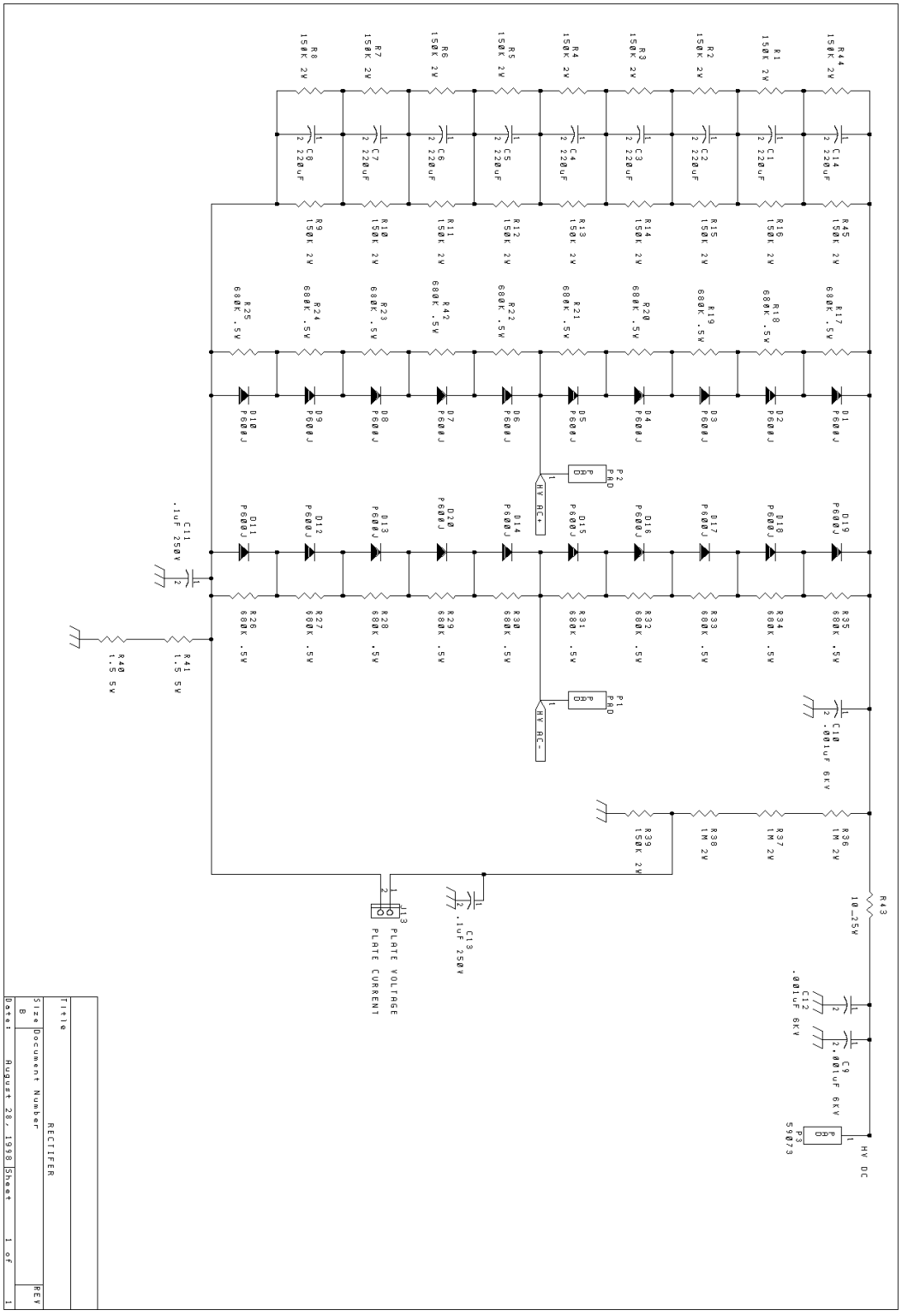
The impedance matching network of resistors R5 –R40 match the input impedance of the 4CX1600B to the input filter board.

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.



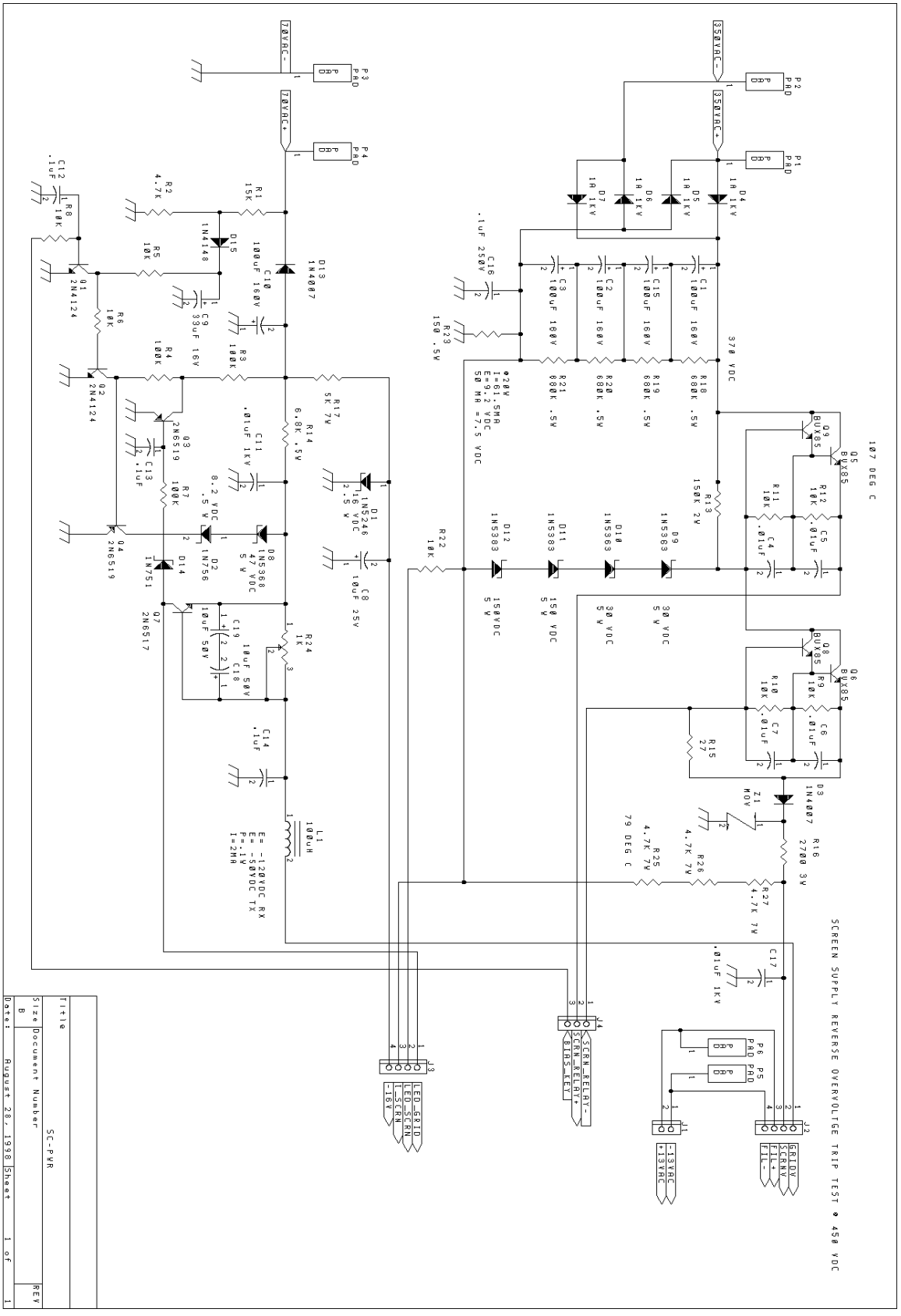
Title	51811 INPUT MATCHING BOARD	
Size B	Document Number	REV
Date:	August 23, 1990 Sheet 1 of 1	

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


R44 150K 2W
R45 150K 2W
R1 150K 2W
R16 150K 2W
R2 150K 2W
R15 150K 2W
R3 150K 2W
R14 150K 2W
R4 150K 2W
R13 150K 2W
R5 150K 2W
R12 150K 2W
R6 150K 2W
R11 150K 2W
R7 150K 2W
R10 150K 2W
R8 150K 2W
R9 150K 2W
C14 220uF
C1 220uF
C2 220uF
C3 220uF
C4 220uF
C5 220uF
C6 220uF
C7 220uF
C8 220uF
R17 680K .5W
R18 680K .5W
R19 680K .5W
R20 680K .5W
R21 680K .5W
R22 680K .5W
R42 680K .5W
R23 680K .5W
R24 680K .5W
R25 680K .5W
D1 P600J
D2 P600J
D3 P600J
D4 P600J
D5 P600J
D6 P600J
D7 P600J
D8 P600J
D9 P600J
D10 P600J
D19 P600J
D18 P600J
D17 P600J
D16 P600J
D15 P600J
D14 P600J
D20 P600J
D13 P600J
D12 P600J
D11 P600J
P2 PAD
HV AC+
P1 PAD
HV AC-
R35 680K .5W
R34 680K .5W
R33 680K .5W
R32 680K .5W
R31 680K .5W
R30 680K .5W
R29 680K .5W
R28 680K .5W
R27 680K .5W
R26 680K .5W
C10 .001uF 6KV
R36 1M 2W
R37 1M 2W
R38 1M 2W
R39 150K 2W
R43 10_25W
C12 .001uF 6KV
C9 .001uF 6KV
P3 59073
HV DC
C11 .1uF 250V
R40 1.5 5W
R41 1.5 5W
C13 .1uF 250V
J13
PLATE VOLTAGE
PLATE CURRENT
Title
RECTIFIER
Size B
Document Number
REV
Date: August 28, 1998
Sheet 1 of 1

81815 SCREEN SUPPLY AND GRID BIAS BOARD 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 protect 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.

The grid bias voltage is rectified by D13 then filtered by C10. Q1 senses the key condition and switches zener diodes D2 and D8 in during key down and out during key up. This zeners the bias voltage to –50 VDC during TX and –130 VDC in RX. 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.


SCREEN SUPPLY REVERSE OVERVOLTGE TRIP TEST @ 450 VDC
107 DEG C
370 VDC
79 DEG C
350VAC-
350VAC+
70VAC-
70VAC+
-13VAC
+13VAC
GRIDV
SCRNV
FIL+
FIL-
LED_GRID
LED_SCRN
-16V
SCRN_RELAY-
SCRN_RELAY+
BIAS_KEY
Title
Size B
Document Number SC-PWR
REV
Date: August 28, 1998 Sheet 1 of 1

81814 QSK BOARD 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.

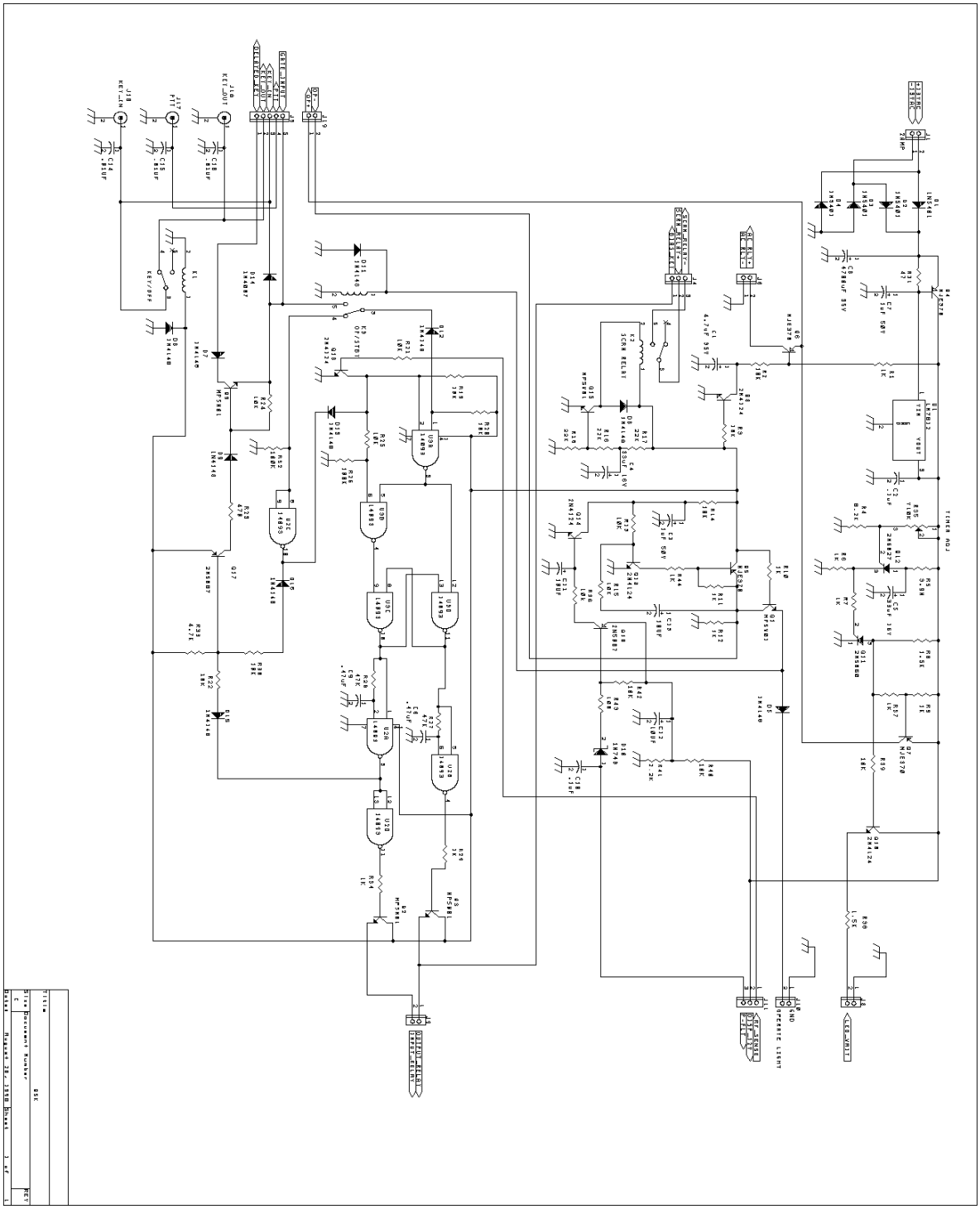
After a 3 minute warm-up period determined by RC time constant of R5 and C5 ,Q12 will fire turning on the pass element Q7. This initiates amplifier power up. When the operate switch is put in the operate position this voltage is applied to relay sequencing circuits of Q5,Q15, and Q13.

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 e parameters are exceeded (such as excessive plate current during a tube arc).Both plate voltage and screen voltage are removed when plate current of 1.2 AMPs is reached.

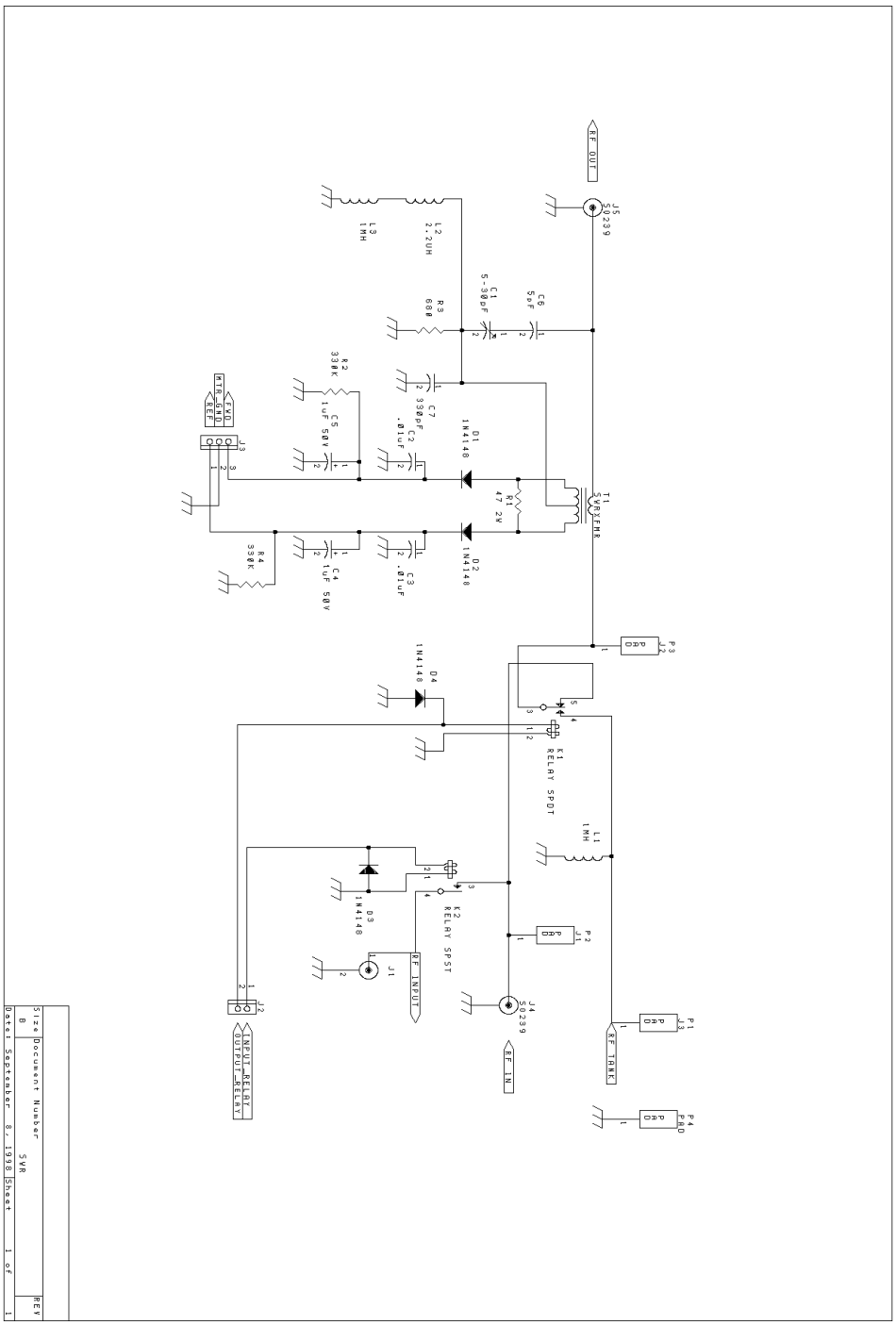
U2 and U3 are the gated array that controls the input and output relays. This circuit samples input key requests , standby/operate modes, power on/off state and RF presence at the antenna connection. Hot switch protection is provided regardless of mode. In the QSK mode, using the key in / key out loop , the key in request from the transceiver is tailored by U1 and U2 to insure smooth QSK action of the input and output relays.

K1 senses power off and places the key circuit in bypass mode for operation in barefoot mode.

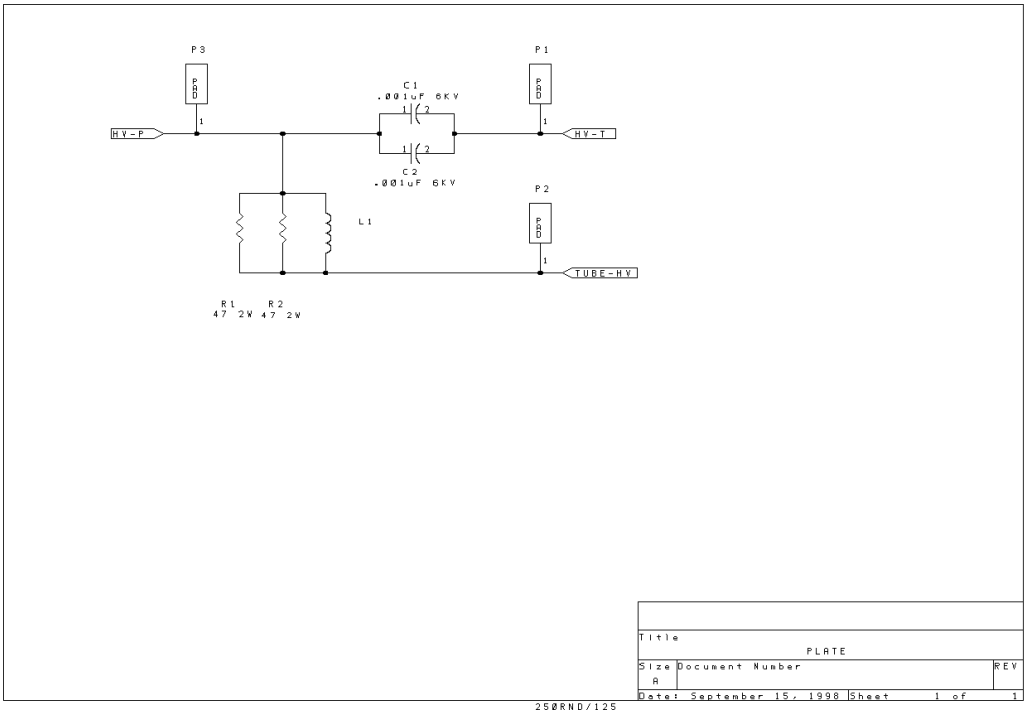
K2 senses Operate/standby mode and routes the key request either to the amplifier control circuit in Operate mode, or to the key out jack in the standby mode.



81816 SWR BOARD This board contains the input relay, output relay, and the swr bridge for output power measurement.


RF OUT
J5
50239
L3
1MH
L2
2.2UH
R3
68Ω
C1
5-80pF
C6
5pF
R2
330K
C7
330pF
C2
.01uF
C5
1uF 50V
D1
1N4148
J3
XTR GND
REF
T1
CWXFMR
R1
47 2W
R4
330K
C4
1uF 50V
C3
.01uF
D2
1N4148
P3
PAD
J2
D4
1N4148
K1
RELAY SPDT
L1
1MH
D3
1N4148
K2
RELAY SPST
P2
PAD
J1
J1
RF INPUT
J4
50239
RF IN
P1
PAD
J3
RF TRNK
P4
PAD
J2
INPUT RELAY
OUTPUT RELAY
Size
B
Document Number
SVR
Date: September 8, 1998
Sheet 1 of 1
REV

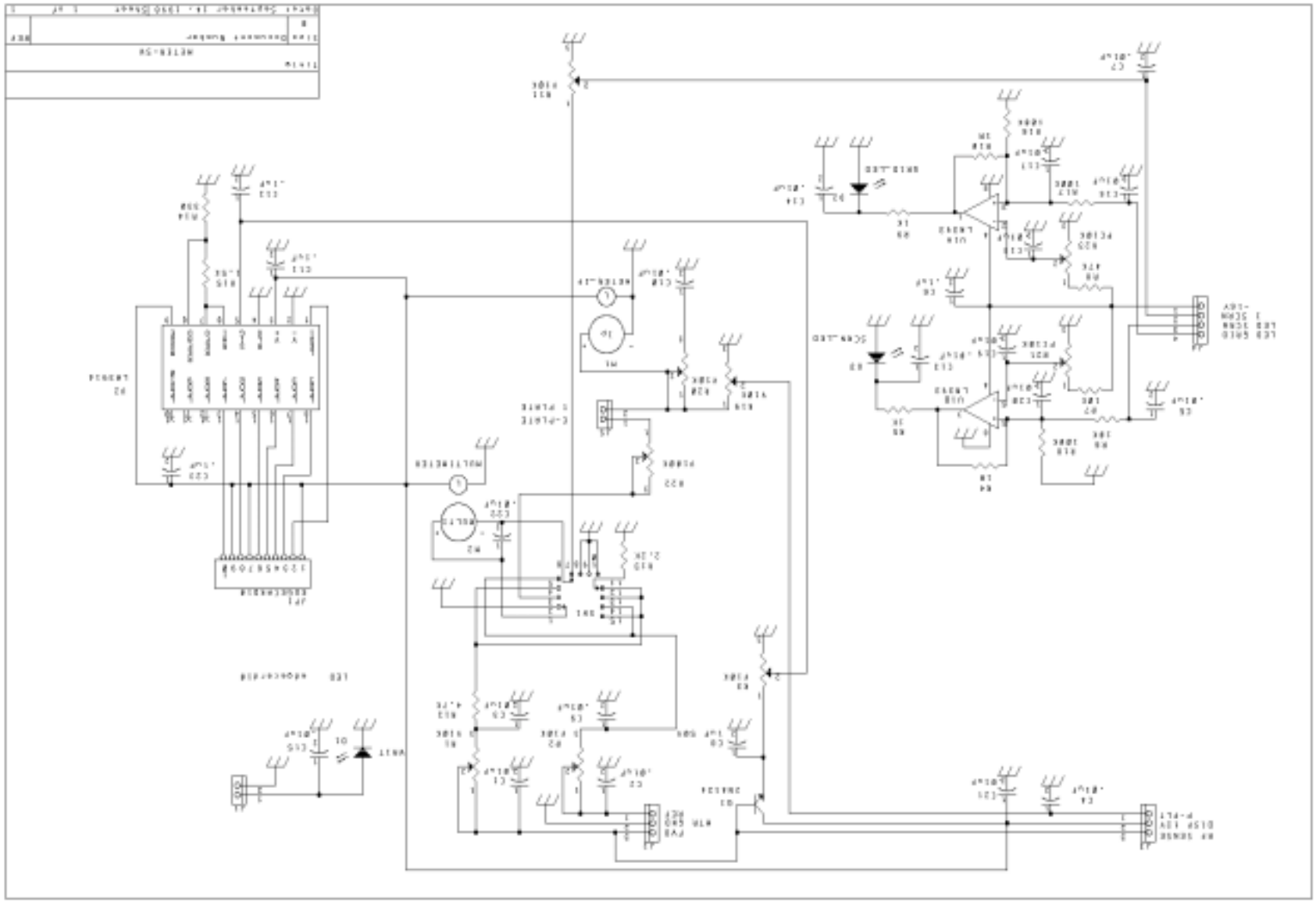
81813 PLATE BOARD This board contains the parasitic suppressors and coupling capacitors to connect the 4CX1600b plate to the amplifier tank circuit.



81812 METER SWITCH BOARD 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.



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