

USER'S MANUAL



ALPHA POWER 91β

HF LINEAR POWER AMPLIFIER



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for free by

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IMPORTANT

CRITICAL PRECAUTION DURING INSTALLATION OF YOUR ETO 91 β !

While the cover is removed to install the power transformer, make sure that the tubes are properly installed as described in Section 2 below. Failure to do this may cause severe damage or destruction of both tubes. Such damage is not covered under warranty.

CAUTION: Only the screws securing the 91 β top cover and front panel have ENGLISH threads (6-32 or 8-32). ALL OTHER HARDWARE IS METRIC. DO NOT REPLACE TRANSFORMER OR OTHER SCREWS WITH ENGLISH SIZES, as doing so will damage the captive nuts installed in the chassis.

Section 1 INTRODUCTION

General Description of the ETO 91 β Amplifier

The ETO 91 β is a self-contained, HF linear power amplifier capable of continuous operation at 1500 watts peak power output on SSB, keyed CW, SSTV, RTTY, digital modes or AM, with no time limit. *If periods of "continuous-key-down" carrier operation will exceed 5 minutes, the optional auxiliary cooling fan available from ETO must be installed to avoid possible damage not covered by the warranty.*

As shipped, units delivered within the USA and its territories are manually tunable to cover all HF amateur bands from 1.8 to 14.35 MHz, with extensive out-of-band capability for operation on MARS, etc. Appropriately-licensed users may contact ETO for information on modifying domestic amplifiers to extend coverage to 29.7 MHz.

Specifications, ETO 91 β

Frequency Coverage: U.S. units only, amateur bands 1.8-14.35 MHz as shipped (see note above); export units, 1.8-29.7 MHz.

Power Output: 1500 watts peak all modes, including SSB, CW and continuous or modulated carrier. Carrier operation (e.g., A0, RTTY or FM) for more than 5 minutes at or near maximum rated power requires use of the auxiliary cooling fan accessory.

Drive Power: 50 to 60 watts nominal for rated output.

Power Gain: Nominally 14 dB, a power increase of 25 times.

Input Impedance: 50 ohms nominal, unbalanced; VSWR <1.5:1.

Output Impedance: 50 ohms unbalanced.

Maximum Load VSWR: 2:1 at full rated power output.

VSWR Trip: Automatic standby when reflected power >250 watts.

Intermodulation Distortion: 36 dB below rated output.

Harmonic Output: < -55 dBc.

Tubes: Two Svetlana 4CX800A/GU74b ceramic-metal tetrodes.

Cooling: Full-cabinet, ducted forced air using cushion-mounted centrifugal blower.

Automatic Level Control (ALC): Negative from 0, adjustable.

Primary Power: 200/220/240 or 100/120 VAC nominal, 50-60 Hz, fused at 20 amperes.

Power Transformer: 3+ kVA with strip-wound Unisil-H(R) core.

Protective Functions: Primary and step-start fuses, primary AC interlock, high voltage crowbar, peak and average plate overcurrent trip-outs, arc protection trip, reflected power trip, grid current limiting & sustained overdrive trip.

Status Indicators: ON, WAIT (initial turn-on time delay), OPERATE and FAULT LEDs.

Metering: Dedicated, full-time LED bargraphs display forward and reflected rf power; grid current LEDs; LED bargraph selectable among plate voltage, plate current, and tune-up functions.

Size: 7.5" H x 17" W x 15.5" D (19 x 43 x 39 cm).

Weight: 66 lb. (30 kg) net, 75 lb (34 kg) ship; two cartons.

Note: ETO reserves the right to change design and/or specifications without prior notice or obligation.

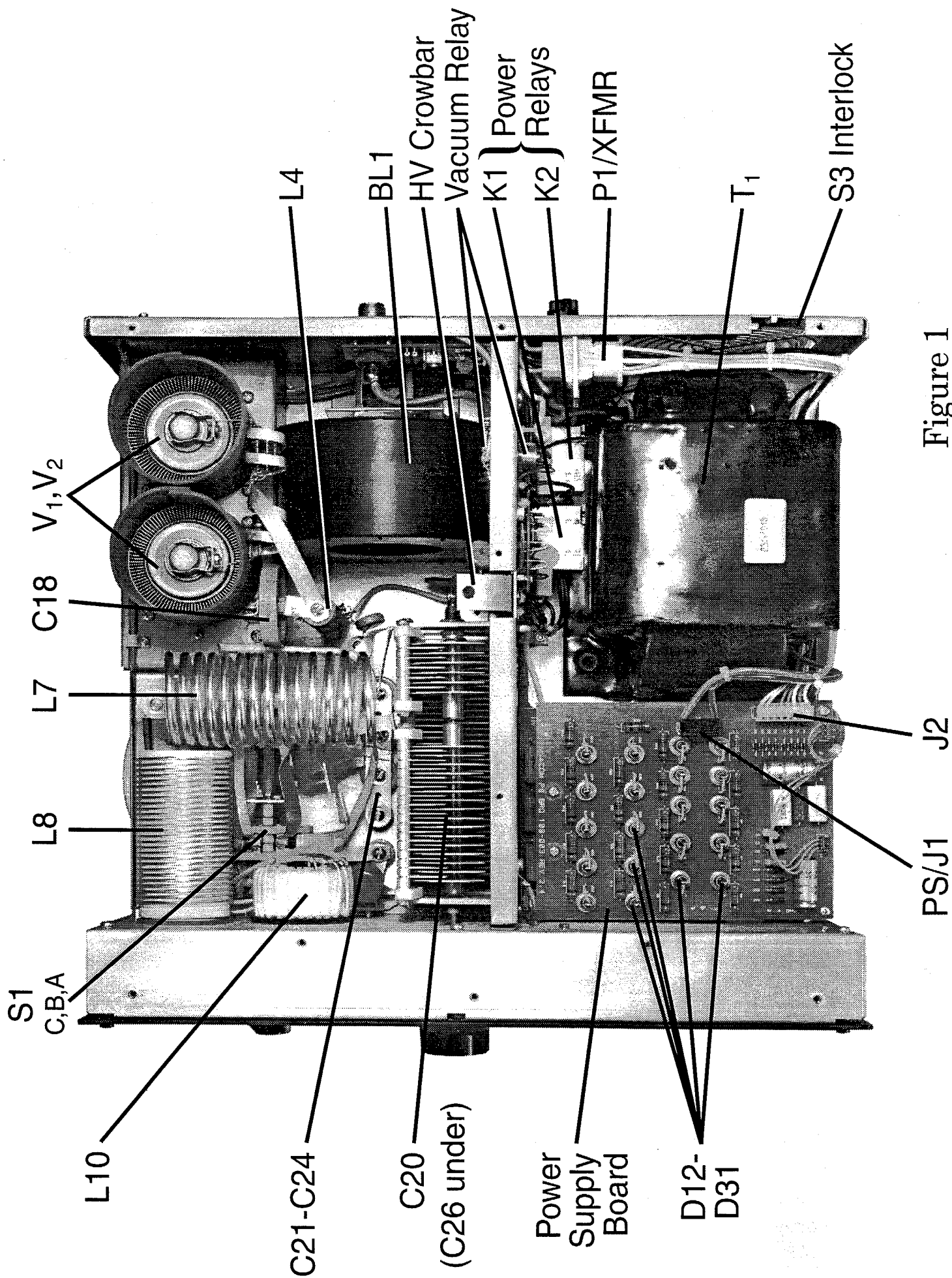


Figure 1
91β Top View

Section 2

PREPARING THE ETO 91β FOR OPERATION

Transformer Installation (See Figures 2-4)

Remove the amplifier top cover to install the transformer. Only one possible transformer orientation allows mating all its connectors without straining leads. Lift the transformer high enough to clear the right side chassis lip and move it sideways into the chassis. **USE CAUTION! PROCEED SLOWLY to avoid damaging wires or components.** From underneath, insert the supplied bolts with washers through the clearance holes in the chassis and into the nuts in the transformer base. **CAUTION! Mate transformer connectors carefully and gently to insure that all connector pins engage correctly and fully.**

Inspection of Tubes & Chimneys

While the top cover is removed, make sure tubes are firmly seated in their sockets, rubber exhaust chimneys are fully and correctly installed, and anode connectors are tightly clamped to tubes.

The silicone rubber chimneys installed on the 4CX800A/GU74b tubes are absolutely essential parts of the cooling system. Make sure the chimneys are straight and fully installed so that the bottom of each chimney is firmly against the tube deck and completely covers the airflow openings in the deck. Tube cooling air must exit only through the tube anode fins; it must not be allowed to escape outside them. **Failure to ensure proper cooling airflow may result in tube damage or destruction which is not covered under warranty.**

AC Primary Connections & Amplifier Grounding

Primary voltage taps are selected at the terminal strip numbered "1" to "7" and located on the chassis center divider, left of and above the transformer. Connect the two wires labeled "A" and "B" for the line voltage to be used, as shown in the following table. The two short jumper wires supplied are not used on 200-250V, but must be connected as shown for operation on 100-120V mains.

<u>PRIMARY</u>	<u>"A" to terminal</u>	<u>"B" to terminal</u>	<u>Jumpers</u>
230-250V	4 (factory setting)	2	Not used for
210-230V	4	3	190 to 250V
190-210V	5	3	operation
110-130V	4	6	1 -> 2, 6 -> 7
90-110V	5	6	1 -> 3, 6 -> 7

Power Cord Connections — WARNING!

To avoid hazard of potentially fatal electric shock and/or severe damage to the ETO 91β and other equipment, always use an AC plug which is appropriate for the primary mains voltage, current rating and configuration. **NEVER use 120V-type plugs and power recep-**

tacles for 200-240V circuits. ALWAYS use grounding type AC connectors which conform to local codes and ensure that the green/yellow wire in the 91β power cable is wired only to the AC mains safety ground (or to neutral, as may be necessary with a 240V circuit configured 120V-N-120V without a separate ground, commonly found in the US).

The green/yellow conductor in the power cord is wired to the ETO 91β chassis. It MUST be connected only to the power source safety ground or neutral. The blue and brown power cord wires connect to the two "hot" wires of the AC source; either wire may be connected to either side of the line. For best results use a dedicated 200-240V branch circuit of #10 AWG copper wire or equivalent, rated at 20A, to feed the amplifier.

Important information concerning operation from 90-130V mains

Electrical power equipment will draw twice as much primary current from 120V mains as from 240V mains. Therefore, *operating the ETO 91β on a typical 120V/20A household circuit without exceeding the 20A circuit rating will limit maximum peak power output to about 600-1000 watts.* Maximum possible RF output power for any particular primary AC voltage and current capacity may be estimated as

$$P_o \text{ max} = (V_{\text{line}} \times I_{\text{line}}) / 2.3 .$$

For example, if the 91β operates from a circuit which is capable of delivering 115VAC at a maximum current of 20A, with no other loads connected to the circuit maximum peak RF output possible without tripping the 20A breaker (or fuse) is approximately

$$P_o \text{ max} = (115V \times 20A) / 2.3 = 2300/2.3 = 1000 \text{ watts.}$$

If the same circuit also supplies a transceiver drawing peak line current of 5A and a lamp drawing 1A, only 20-5-1 = 14A is available for the amplifier and maximum possible output is about

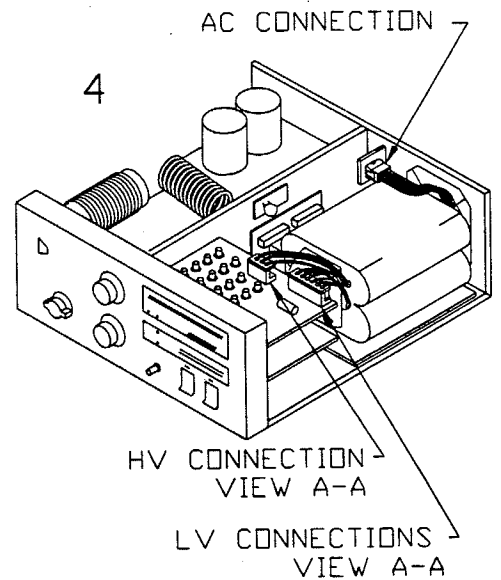
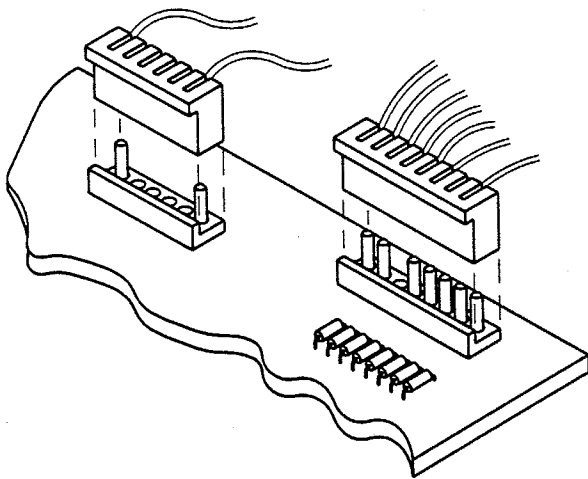
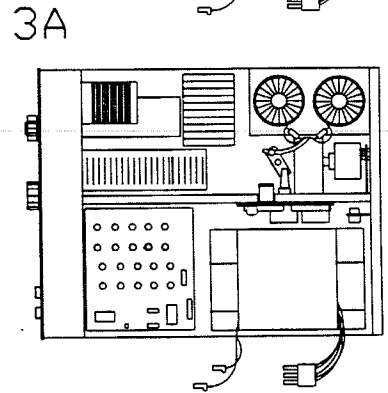
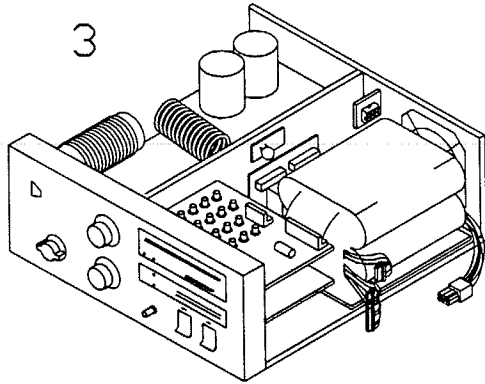
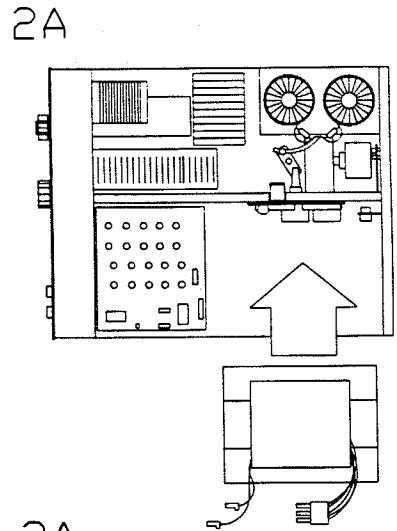
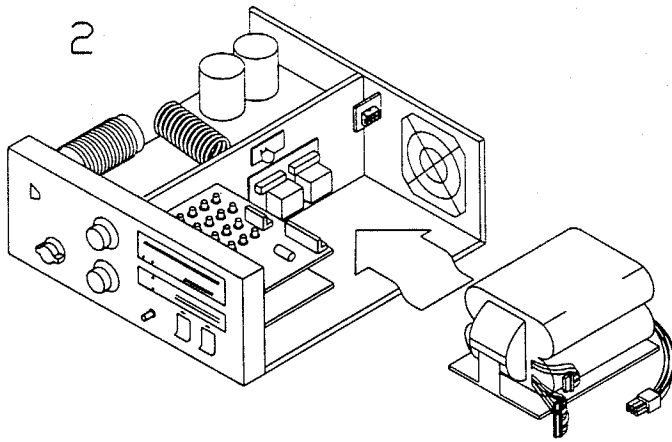
$$P_o \text{ max} = (115V \times 14A) / 2.3 = 1610/2.3 = 700W.$$

RF Grounding

A ground stud with wing nut is provided on the rear of the chassis. Connection should be made from this stud to a good RF earth ground, such as a copper water pipe or driven rod, via heavy copper braid or strap. **CAUTION:** *When using any high power amplifier, failure to connect ALL station equipment to a good common ground may allow RF feedback to leak into the transceiver and cause severe signal distortion.*

Replacing the Amplifier Cover

Use only the 6-32 screws supplied with the amplifier and do not tighten any of the screws until all are started.



VIEW A-A
HIGH AND LOW VOLTAGE BOARD CONNECTIONS

FIGURES 2-4
91 β TRANSFORMER
INSTALLATION

Section 3

AMPLIFIER/STATION INTERCONNECTIONS

(See Fig. 5)

Coaxial Cable Types & Connectors

Connect the transceiver RF output to the ETO *91β* RF INPUT with 50 ohm coaxial cable - RG-58C/U or equivalent. Use "UHF" type plugs, such as Amphenol 83-1SP, with reducing adapter to fit RG-58.

Coaxial cable from the *91β* RF OUTPUT to antenna should be RG-8A/U, RG-213/U, or equivalent high quality type with a PL-259 UHF-type plug on the amplifier end. RG8X cable is not recommended.

T/R Control Cable

The *91β* has a full break-in vacuum relay QSK system requiring only the normal interconnection when used with a modern QSK transceiver. The *91β* requires a contact closure (short circuit) on transmit from its RELAY jack center pin to chassis. This function is supplied by the transceiver, usually from a dedicated relay that is normally open in receive and closed in transmit. Shielded wire should be used for the T/R control cable. The *91β* end must be fitted with a common phono (RCA-type) plug and the other end with a plug suitable for the transceiver (usually supplied with the transceiver).

The T/R relay contact must close before application of RF drive. *91β* protection circuitry prevents "hot switching" with RF drive applied. If a T/R timing problem is suspected, contact ETO customer service for assistance.

ALC

The use of external ALC is not normally needed or recommended when the ETO *91β* is used with modern transceivers. However, the *91β* does generate a negative-going ALC control voltage that can be fed back to most transceivers if required, to minimize the possibility of overdriving the amplifier. This external ALC voltage is available at the *91β*'s rear panel ALC jack via a common phono connector. *91β* grid current exceeding about 1mA will initiate ALC and light the green GRID LED. About 5-10mA yields full ALC output - nominally -10 Vdc - and the red GRID LED lights. If the exciter requires a lower ALC voltage the *91β* ALC potentiometer may set accordingly. While driving the amplifier, adjust the ALC pot to limit maximum transceiver output as desired. We recommend contacting ETO customer service before attempting to use external ALC with the *91β*

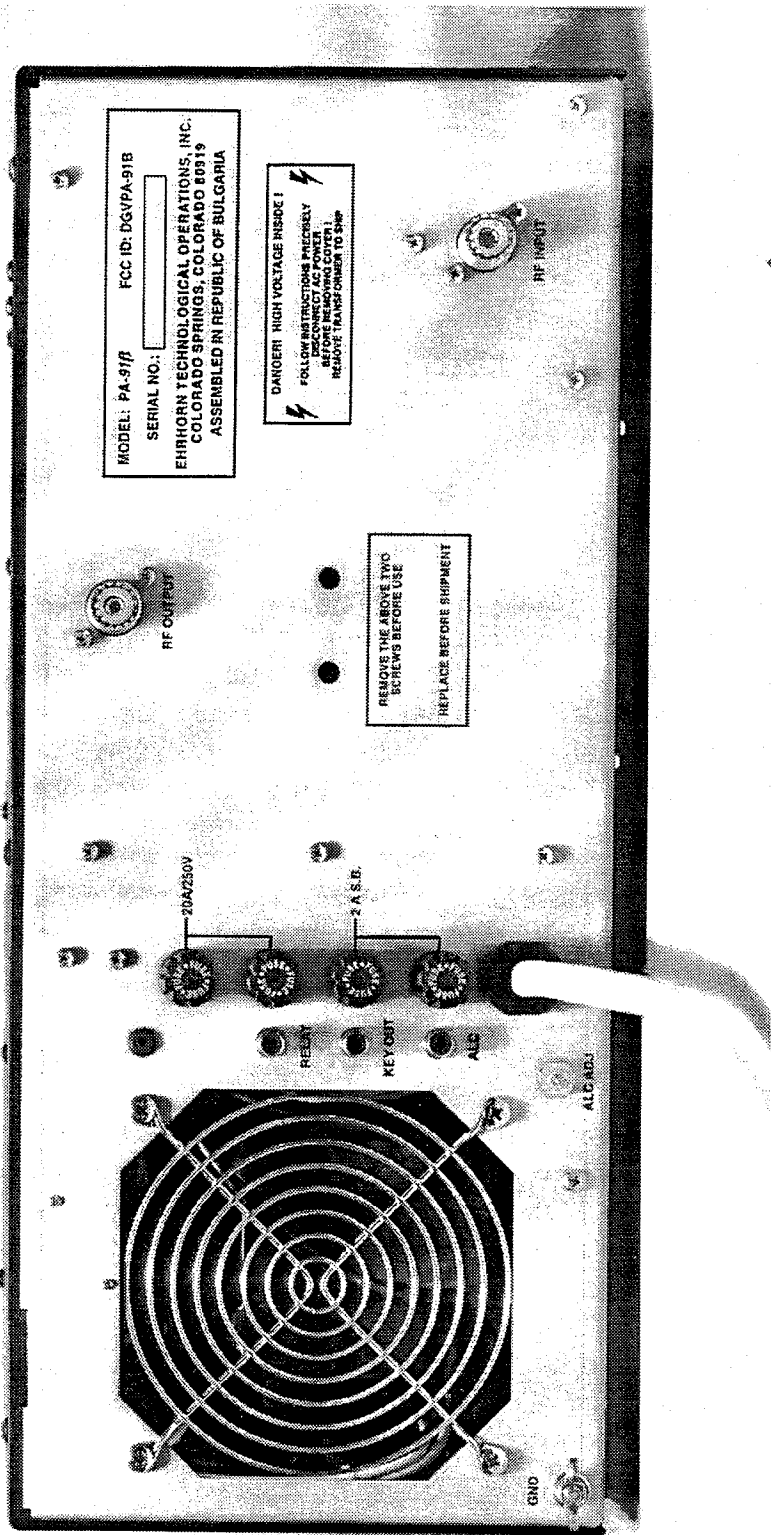


FIGURE 5
91B REAR PANEL

Section 4 OPERATION

4.1 Control Functions (See front cover photo)

BAND - Use to select amateur band desired (in MHz).

TUNE - Selects operating frequency. Higher frequencies tend to tune toward the "0" end of the dial scale, while lower frequencies tend to tune further toward the "100" end.

LOAD - Sets amplifier plate loading and determines the power level at which best efficiency and linearity are achieved. In general, loading is heavier at greater scale settings. Higher frequencies tend to load more toward the "100" end of the dial scale and lower frequencies toward the "0" end.

POWER - Press ON to apply primary AC power to the amplifier or to reset power if the plate overcurrent relay has tripped. Press OFF to remove primary AC power.

OPR/STBY - OPeRate places the amplifier in-line. With the 91β off, in STandBY, or in warm-up with the WAIT LED lighted, the amplifier is bypassed and the exciter is connected directly to the antenna.

Metering LEDs & Bargraphs - Separate bargraphs provide instantaneous full-time display of peak

RF OUTPUT and REFLECTED POWER. Red and green "GRID" LEDs indicate, respectively, that normal peak drive has been reached and the onset of overdrive and flattopping.

A switch-selected bargraph monitors three additional functions:

TUNE: Permits a simple and safe tune-up procedure to be performed at low output power. See section 4.2 below.

IP: Plate current, 1.5 amperes full scale (approximately 75 mA per segment).

HV: Plate voltage, 3000 VDC full scale (150 V per segment).

4.2 Tune-up

Objective

The objective of tune-up is to adjust the amplifier (and the drive applied to it) to obtain optimum efficiency and linearity at the desired output power.

Any linear amplifier must be adjusted for optimum efficiency and linearity at a specific power level. If operation at higher power is then attempted without appropriate readjustment, the result will be flattopping, "splatter," and (usually) excessive amplifier grid current. If operated at a much lower power level than it has been adjusted for, the amplifier's efficiency decreases considerably.

Grid Current

The ETO 91 β operates in Class AB2 when delivering maximum output power consistent with excellent linearity. A small amount of grid current flows and the green GRID MIN LED lights as drive approaches the optimum level. The green GRID LED should flicker on some SSB voice peaks, and light under CW/SSTV/RTTY carrier conditions. As overdrive approaches, grid current increases rapidly and the red GRID MAX LED lights. At maximum output and efficiency, the red LED lights dimly; full illumination of the red LED indicates overdrive and must be avoided. If the red LED lights before the desired value of plate current and/or power output is reached, readjust amplifier loading before continuing. On SSB, optimum output consistent with good linearity occurs when the green GRID LED lights on most voice peaks and the red LED flickers dimly only on the highest peaks.

Excessive grid current results from overdrive and/or inadequate loading. The solution is to reduce drive, and/or increase amplifier loading. The 91B's 4CX800A/GU74b tubes are well protected and these adjustments tend to be less critical than in many other amplifiers.

ALC

The 91 β grid current limiting circuits provide substantial tube protection against possible damage. The ALC voltage generated by the 91 β cannot control the amplifier itself and so is not applied internally. If ALC control is required, a connection must be made from the 91 β to the transceiver ALC input. (See Sections 3 and 4.4)

Tune-up Procedure

NOTE: The forward and reflected power LED bargraphs and GRID LEDs are peak-responding.

BEFORE INITIAL TUNE-UP, MAKE SURE A SUITABLE ANTENNA OR 50 OHM DUMMY LOAD IS CONNECTED TO THE 91 β . Leave the amplifier off or in standby and apply exciter power to make a forward vs. reflected power check. If reflected power is less than ten percent of forward power, the VSWR is lower than 2:1 and it is safe to proceed with tuneup.

1. Turning On the Amplifier

- * Place the OPR-STBY switch in STBY (standby).
- * Rotate the multimeter selector switch to HV.
- * Depress POWER/ON.

If any of the following does NOT occur, depress power OFF switch immediately and investigate before proceeding:

- * The blower starts (note air exhausting above tubes).
- * The multimeter bargraph automatically displays HV; it should indicate approximately 2.8 KV.
- * The WAIT LED is lighted.

IMPORTANT: EXHAUST AIR MUST BE DETECTABLE FROM THE TOP VENTS: If it is not, TURN OFF the amplifier and verify that the exhaust chimneys are properly positioned over the tubes. When the warm up delay is complete (about 150 seconds), the WAIT LED will extinguish. The ETO 91 β is now "ready".

2. Tuning Up for Operation at 1,500 Watts RF Output

1) Preset BAND, TUNE, and LOAD controls to the nominal positions given in TABLE I, below.

TABLE I - Preliminary Tuneup Settings

<u>Frequency</u>	<u>Band</u>	<u>Tune</u>	<u>Load</u>
1.8 MHz	1.8	95	30
2.0	1.8	55	80
3.5	3.5	85	55
4.0	3.5	65	80
7.15	7	60	40
10.13	10	85	70
14.2	14	55	60
18.1	18-21	90	50
21.2	18-21	45	70
24.9	24-28	90	70
28.0	24-28	40	80
29.7	24-28	20	80

NOTE: Final TUNE and LOAD settings will vary with the operating frequency, antenna characteristics, and power level.

- 2) Reduce transceiver carrier output control to ZERO.
- 3) Press OPR (operate) on OPR-STBY switch. OPR LED should light.
- 4) Select TUNE function of the multimeter bargraph.

IF AT ANY TIME IN THE FOLLOWING PROCEDURE THE AMPLIFIER FAILS TO RESPOND AS DESCRIBED, REMOVE DRIVE IMMEDIATELY!

5) Switch transceiver to CW and increase its carrier output to approximately 15 watts (91 β output approx. 300-500 watts).

NOTE! *If more than about 15 W drive is applied while the 91 β is substantially mistuned, the 91 β will switch to STBY. If the amplifier is returned to receive (key-up) it will automatically reset to OPR in about 4 seconds.*

6) Adjust TUNE control to deflect the TUNE LED maximum leftward.

7) Adjust LOAD control to place the illuminated TUNE LED below the "V" mark on the TUNE scale.

8) Repeat steps 6 and 7 above.

9) Increase excitation until 91 β output is about 1500 watts.

10) Repeat steps 6 and 7 at least twice.

11) Touch up TUNE for maximum power output.

The ETO 91 β is now correctly tuned to deliver 1500 watts RF output on SSB, CW, FSK, SSTV and FM. The TUNE LED normally fluctuates during modulation or keying. Illumination of the first red LED on the RF OUTPUT bargraph indicates output has exceeded 1500 watts.

To operate at reduced power in any mode, simply decrease drive (i.e., transceiver power output).

4.3 Reflected Power Protection

While operating, check the bargraph to ensure that reflected power remains below about 165 watts peak (2:1 VSWR when amplifier output is 1,500 watts). Fluctuating reflected power may indicate a problem in the feedline or antenna. If reflected power exceeds 250 watts the 91 β will automatically switch to standby. The FAULT LED will illuminate, indicating that the 91 β protection system has tripped it to STBY. Such faults reset automatically if the transceiver is returned to receive for a few seconds.

4.4 Automatic Level Control (ALC)

If external ALC is used, amplifier grid current peaks greater than approximately 3 mA will initiate ALC. At grid current of 5-10 mA, ALC output is nominally -10 V. If the transceiver requires less ALC voltage, adjust the rear panel ALC potentiometer counterclockwise until smooth ALC action results. Increase the exciter RF output until the red GRID LED just illuminates on voice peaks.

A VOM can be used to measure ALC voltage while the pot is adjusted for suitable peak ALC voltage. Many Kenwood and Yaesu transceivers work well with -8 and -10 VDC maximum. Icom transceivers generally require lower peak voltage, typically -2 to -3 VDC.

Section 5

OPERATING AND MAINTENANCE NOTES

TUBES - The 4CX800A/GU74b tubes used in the ETO 91 β are very rugged and normally operate with a large margin of safety. They should provide outstanding service for many years if not damaged by abuse- especially overdrive or blockage of cooling airflow. *Allow at least twelve inches (31 cm) unobstructed clearance around the air intake and exhaust areas.* Stacking equipment is not recommended.

Never allow key-down plate current to exceed 1.5 amperes for more than one or two seconds. If you do and a plate current trip occurs, it will automatically reset in about 4 seconds if the amplifier is returned to receive (key-up). Never allow the red GRID LED to stay brightly illuminated for more than a second.

Frequent on-off AC power cycling may shorten tube life. It's better to leave equipment in standby for several hours than to cycle power repeatedly on-off-on-off over the same period.

INTERLOCKS — The ETO 91 β is equipped with a cover interlock switch intended to remove primary power from the amplifier, and a crowbar to short-circuit the high voltage to chassis whenever the cover is lifted. These interlocks are designed to protect against dangerous electric shock resulting from accidental contact with potentially lethal voltages inside the amplifier.

WARNING! WARNING! WARNING! WARNING! WARNING! WARNING!

ALWAYS DISCONNECT THE AC LINE CORD FROM THE POWER SOURCE BEFORE REMOVING THE TOP COVER FROM THE 91 β FOR ANY REASON!

Cover interlocks are intended only as back-up protection against accidents. Never depend on them! Always disconnect the power cord from the AC mains before removing the cover! Interlock switches should never be disabled for any reason except by a skilled and experienced technician.

FUSES — Never replace any fuse with one of a different type or greater current rating. Blowing of one or both primary line fuses indicates that the maximum safe average power capability of the amplifier has been substantially exceeded or that an equipment failure has occurred. **USE ONLY 20 AMP, 250 VOLT RATED FUSES.**

Slow-blow fuses F3 and F4, located above the primary line fuses, may prevent damage to the step-start resistors and HV rectifiers in the event of abnormal turn-on conditions or HV faults. If the AC interlock is defeated and primary power is applied while the HV crowbar is closed, the step-start fuses normally will blow.

DAMAGE RESULTING FROM USE OF A FUSE OF INCORRECT SIZE OR TYPE WILL NOT BE COVERED UNDER WARRANTY AND MAY VOID THE WARRANTY.

PLATE OVERCURRENT RELAY — This relay will quickly turn off the amplifier in the event of grossly excessive plate current or fault in the high voltage circuitry. The relay will not prevent tube or other damage due to either short or long term overdrive or improper tuning. It is the operator's responsibility to ensure safe tuning, drive, and general operating conditions. *Should the overcurrent relay trip and remove AC power from the amplifier, determine and correct the cause of the trip before turning the 91 β on again.*

IDLING PLATE CURRENT AND ELECTRONIC BIAS CONTROL (EBS)

Idling plate current of the ETO 91 β is approximately 350 to 400 mA during transmission. A detector senses RF drive, and reduces plate current to 30-50 mA during pauses in speech and key-up intervals, thus substantially reducing average power supply loading, heat generation, and wasted energy.

ARC & MISTUNING PROTECTION

ETO's exclusive circuit senses the beginning of any RF arc in, for example, a TUNE or LOAD variable capacitor and automatically switches the 91 β to standby within a few milliseconds. This system has virtually eliminated RF arc damage in current ETO amplifiers. The system similarly detects severe mis-tuning of the 91 β , and if drive exceeds about 15 watts switches the amplifier to standby. The 15 watt threshold permits safe tuneup at low power levels using the TUNE indicator, without aggravating and unnecessary trip-outs.

PREVENTIVE MAINTENANCE - The amplifier interior, particularly high voltage areas, should be cleaned with a vacuum cleaner and a soft bristle brush frequently enough to prevent visible accumulation of dust. In extremely dusty conditions it may be advisable to secure a thin air filter of the type used for window air conditioners across the air intake on the rear panel. The ETO accessory cooling fan also should be installed to insure adequate cooling airflow.

There are no user-accessible lubrication points in the amplifier. Do not apply oil or grease to any of the components. The exterior of the ETO 91 β may be cleaned with a mild household liquid detergent such as *Formula 409* or *Fantastik*. Do not use chemical solvents, as these may severely damage the front panel or cabinet finish. Never use an abrasive cleaner.

Section 6

TROUBLESHOOTING HINTS

- A) *91β* will not turn on; nothing happens when ON switch is pushed.
- 1) External AC wiring, fuse or circuit breaker may be open.
 - 2) Amplifier cover not in place; cover safety interlock open.
 - 3) Fuse F1-F4 open or missing; check fuses with an ohmmeter.
 - 4) Step-start resistor R6 or R7 open.
- B) Amplifier turns on but no HV is indicated by the multimeter LED bargraph.
- 1) Multimeter selector switch in wrong position, e.g., Ip.
 - 2) Possible HV circuit fault.
 - 3) HV sampling resistor in power supply damaged.
 - 4) Transformer plugged into power supply incorrectly.
- C) Amplifier turns on but no multimeter indications; other LED bargraphs are operative.
- 1) Low voltage power supply problem.
 - 2) Defect or damage on control board.
- D) Amplifier turns on but time delay will not complete; WAIT LED does not turn off.
- 1) Defect or damage in timing circuitry on control board.
- E) Amplifier turns on, time delay completes but amplifier will not transmit.
- 1) Open T/R control line from transceiver to RELAY jack.
- F) Amplifier transmits but red GRID LED often lights.
- 1) Amplifier overdriven or underloaded; reduce transceiver output and/or increase amplifier loading.
 - 2) Load VSWR (reflected power) exceeds 200W.
 - 3) Exciter output poorly controlled. External ALC may help.
- G) Amplifier operates but green GRID LED will not light and plate current is low; transceiver does not seem to be able to drive amplifier to its rated RF output power level.
- 1) External ALC control voltage to transceiver excessive (see section 5.6, ALC Provision).
 - 2) Input rf load resistor or bias circuitry damaged.
 - 3) Possible damaged or defective tube(s).
- H) Receive signals disappear or are severely attenuated when switching from STBY to OPR.

- 1) RELAY (T/R) control cable from transceiver is shorted.
- 2) Transceiver locked in transmit.

I) Plate current indicated when amplifier is in STBY or receive.

- 1) 4CX800A/GU74b tube heater-to-cathode leakage or short.
- 2) Tube bias supply or T/R bias switch faulty.

J) Distorted SSB signal; possible severe television interference.

- 1) Excessive RF drive from transceiver and/or insufficient amplifier loading.
- 2) Coaxial connector, coax feedline, antenna feedpoint balun, tuner, or antenna trap arcing on voice peaks.
- 3) RF feedback from antenna into transceiver via the transceiver power cord, microphone or key cable, or other unshielded station patch cables.
- 4) Poor station RF ground.

K) Low frequency audio hum on transmitted signal.

- 1) Defective microphone cord (especially, broken ground lead).
- 2) Dynamic (magnetic) microphone located within about two feet of 91β power transformer. All dynamic microphones pick up some magnetically-coupled hum from the external field of nearby power transformers. In cases where objectionable hum is experienced while using the 91β and popular microphones such as the Heil series, the problem usually can be resolved by keeping the microphone at least 18 to 24 inches from the front of the amplifier and insuring that transceiver mike gain (speech processing) and internal drive (ALC) levels are not adjusted to exceed 10 dB. In rare cases it may be necessary to use a ceramic or condenser type microphone.

Section 7

ETO 91 β DESIGN AND CIRCUIT OVERVIEW

RF Amplifier Section (See Figure 6, 11)

Two 4CX800A/GU74b tubes are employed in a grounded-cathode, grid-driven circuit. Excellent linearity is achieved by operating the tubes as tetrodes with normal control grid (G1), screen grid (G2), and plate (anode) DC voltages. Drive voltage required under these conditions is low enough to permit using an untuned input loaded by non-inductive 50 ohm resistor R1. A simple network (C7, C8, K2, L1, L2 in Figure 11) compensates for tube and wiring reactances on the highest-frequency bands, yielding extremely low input VSWR across the entire HF range.

RF negative feedback provided by un-bypassed cathode resistors R2 and R6 stabilizes amplifier power gain at the desired level of about 14 dB and further enhances linearity. Protection of tubes and other components against damage due to internal tube flash-over is provided by a gas-discharge surge suppressor, GT, connected from the screen grids to ground, as well as D1, D2, and R8.

The ETO 91 β RF output network is a conventional pi-L except that plate RF choke L4 is switched by bandswitch section S1C to optimize performance across all nine 1.8-29.7 MHz amateur bands. Two-section TUNE and LOAD capacitors C20 and C26 are switched to provide an "electrical vernier" for smooth, easy and accurately-resettable tuneup "by the numbers" on all bands.

Power Supplies (Figures 6, 9, 10)

Transformer T1 supplies all raw AC voltages required. Step-start resistors R4 and R5 in series with the primary of T1 limit inrush current to a safe level and are shorted out by relay K2 shortly after turn-on. Cooling blower B1 operates at approximately 100VAC (provided by a tap on T1) to minimize noise. *For heavy-duty use when operating from 50 Hz mains, the blower motor lead shown wired to pin 5 of J1 should be reconnected to pin 4 to insure optimum cooling. Contact ETO service or (overseas) your dealer for help in making this change.*

The high voltage full-wave bridge rectifier (Figure 9) consists of 600V/5A power diodes D12-D31. Some units may employ a molded block HV rectifier assembly instead. Bridge D1-D4 provides rectified DC for the screen grids, while D5-D8 and associated components make up the regulated bias supply.

Figure 10 shows HV filter capacitor bank C2-C10 and the monitoring points for HV and IP. K1 is the plate overcurrent relay. MOSFET Q12 and associated components provide regulated screen grid voltage for the tubes and also limit maximum screen current to a safe value. Q12 is mounted to the rear of the 91 β subpanel for heat sinking.

Control Circuits (Figure 7)

Control and monitoring circuits are grouped on the Control Board, which is physically located on the front of the *91β* subpanel. Generally, monitoring and protective functions are clustered on the left side of the schematic, warm-up and status indicator functions at lower right, and keying/switching functions at upper right.

Front Panel Displays (Figure 8)

The Display Board, located on the rear side of the *91β* front panel, incorporates all indicator LEDs and their associated driver chips. The RF forward (output) power bargraph is at top right, reflected power bargraph center right, multimeter bottom-right, and the individual indicator LEDs at bottom left.

Output RF Wattmeter Detector Board - See Figure 12

Multimeter Selector Switch Wiring - See Figure 13.

91β

SCHEMATICS

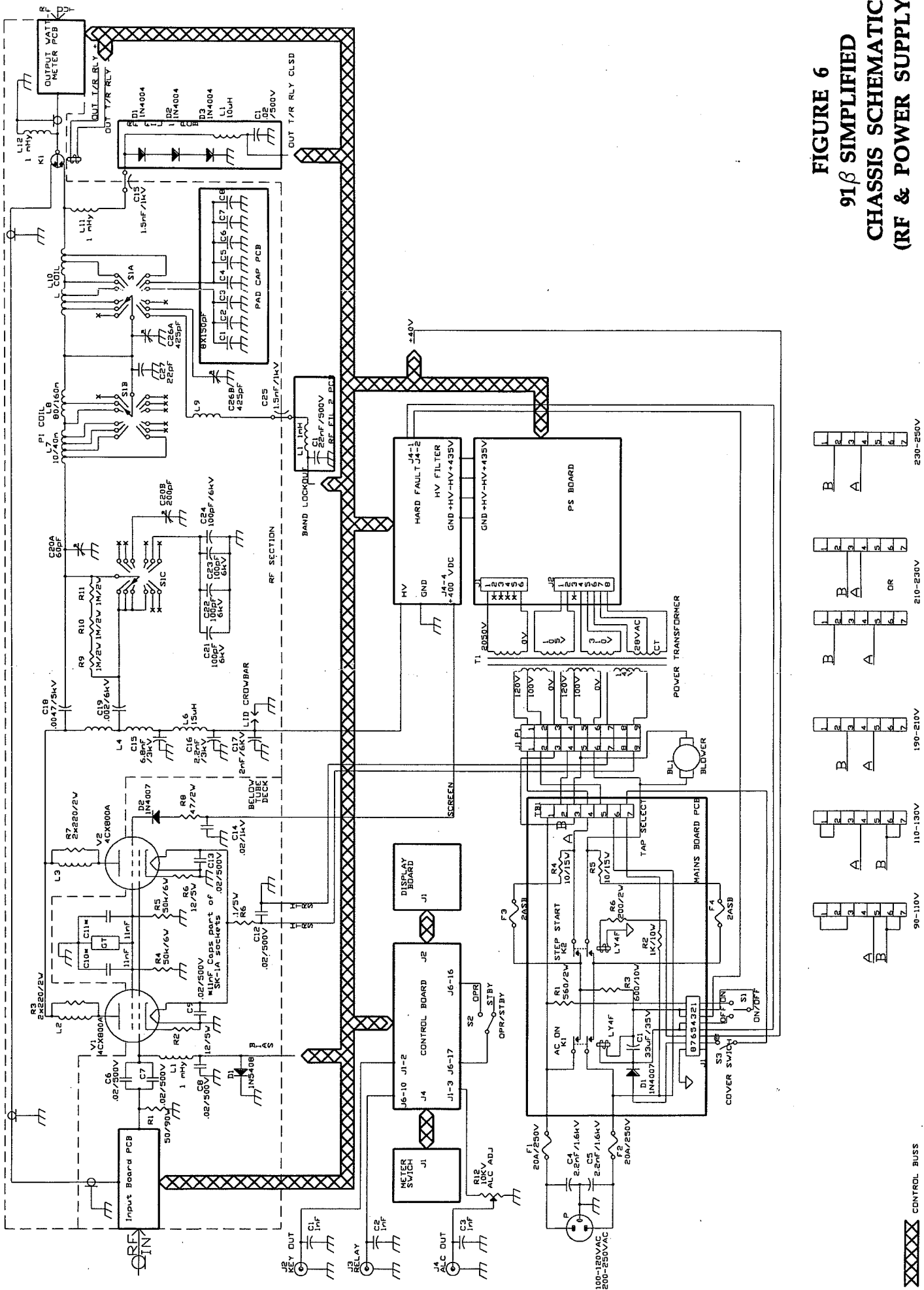
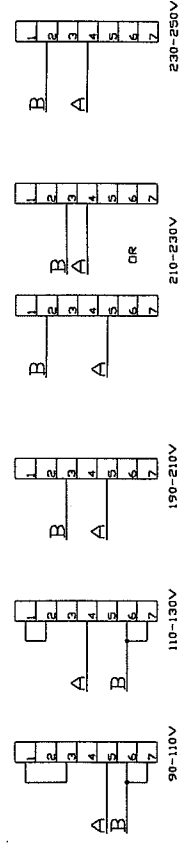


FIGURE 6
91β SIMPLIFIED
CHASSIS SCHEMATIC
(RF & POWER SUPPLY)



CONTROL BUS

TQZE = TAKAMI SWWK
X12W-K

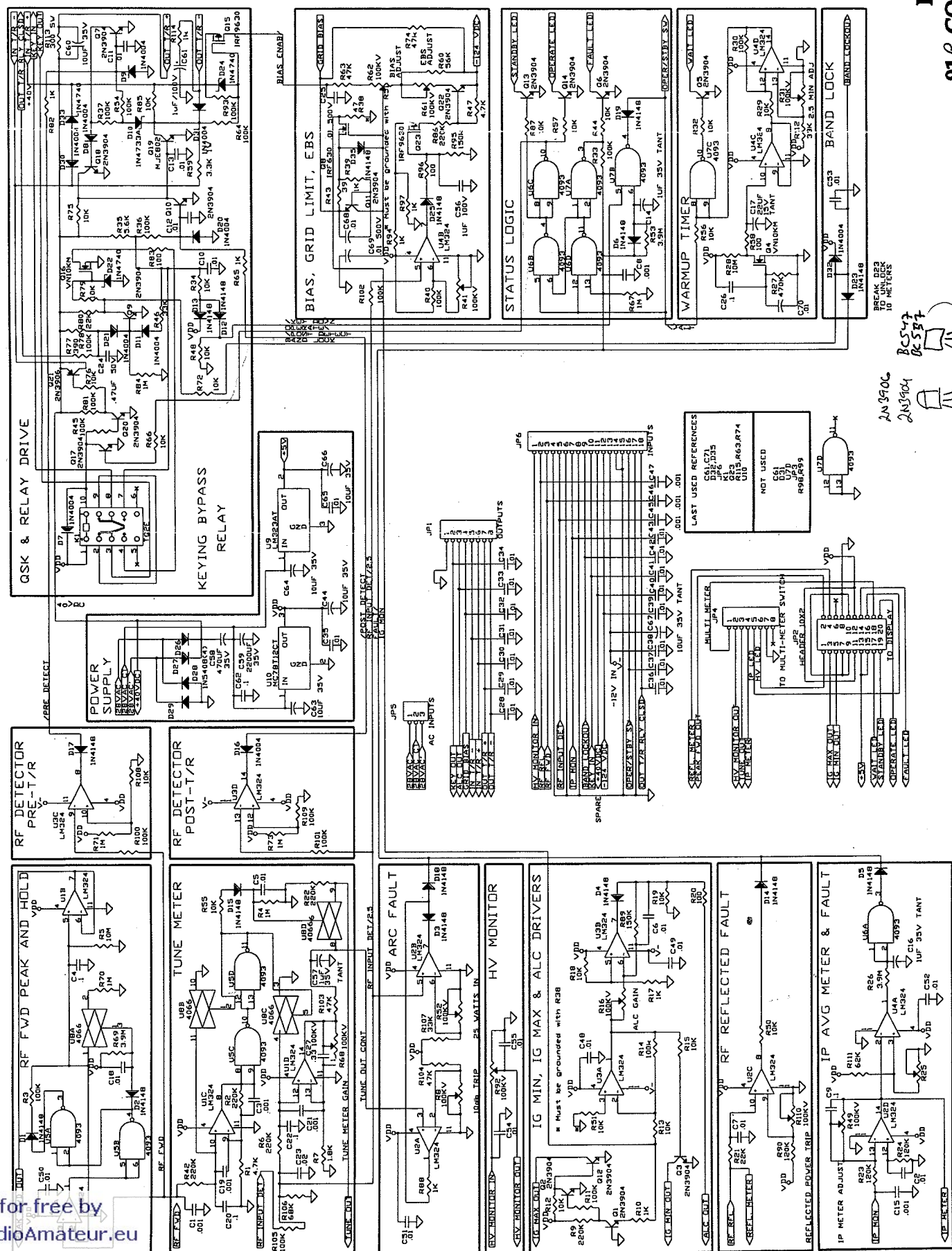
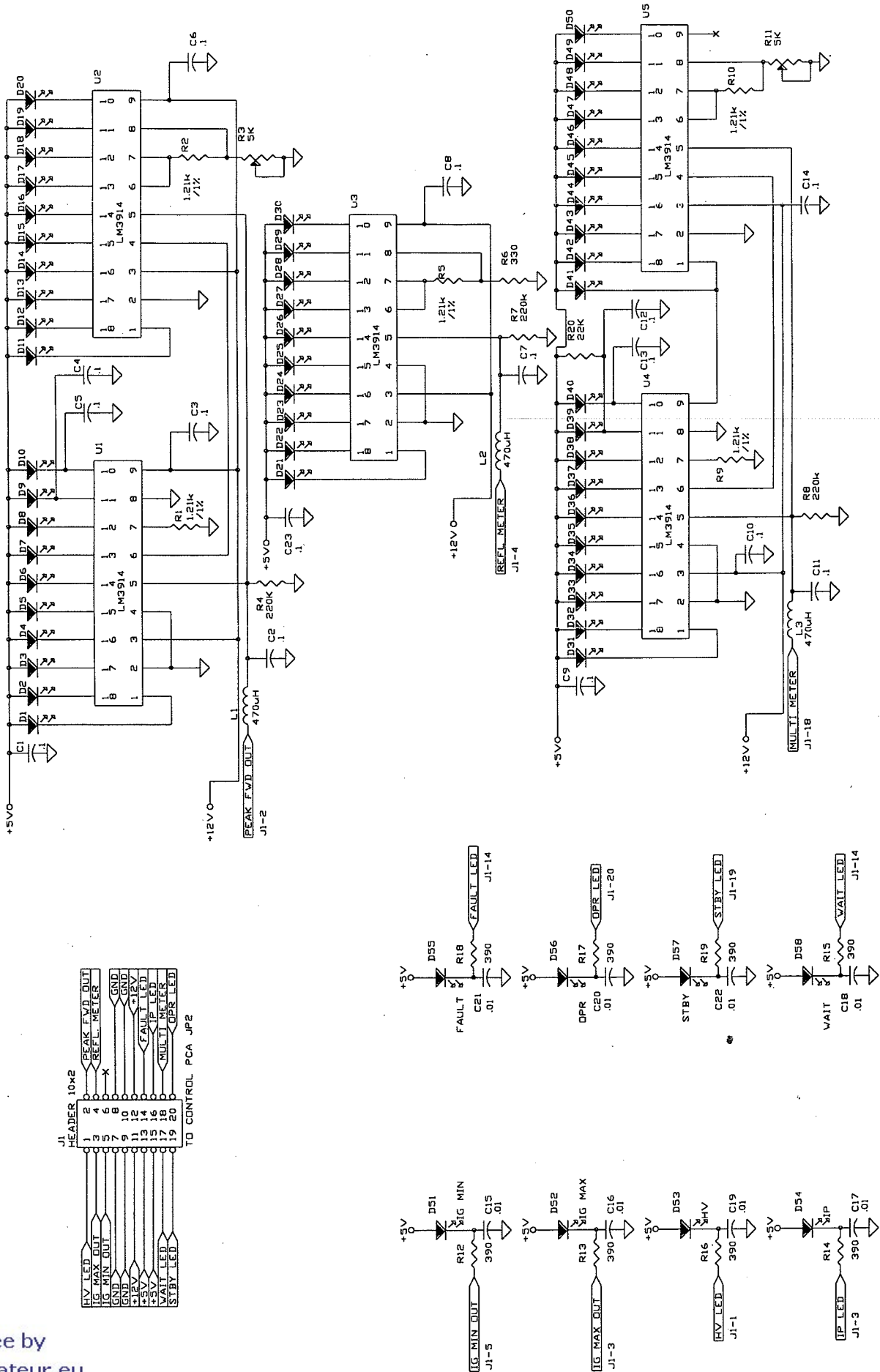


FIGURE 7
91β CONTROL BOARD

FIGURE 8
91β DISPLAY BOARD



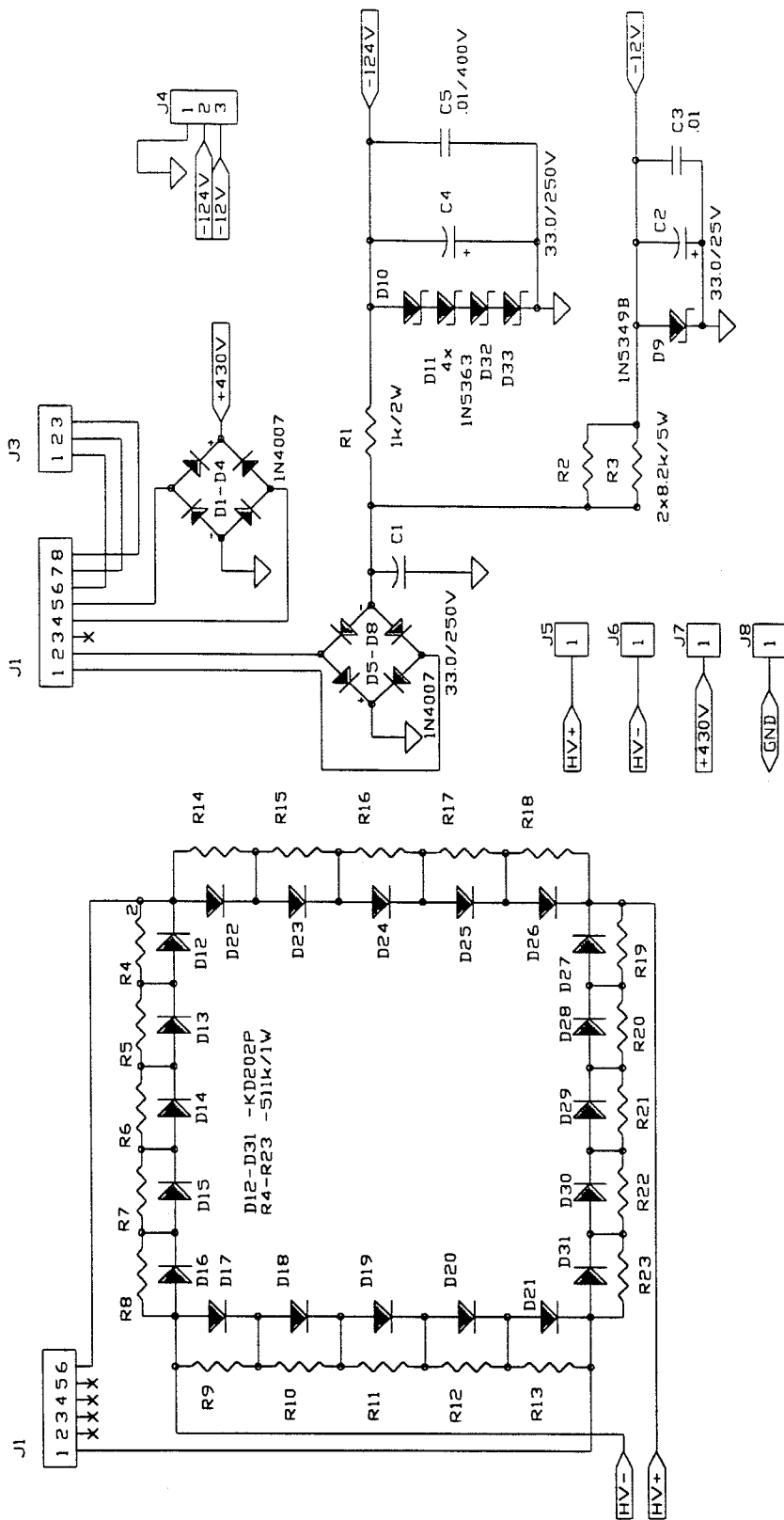


FIGURE 9
91β POWER SUPPLY BOARD

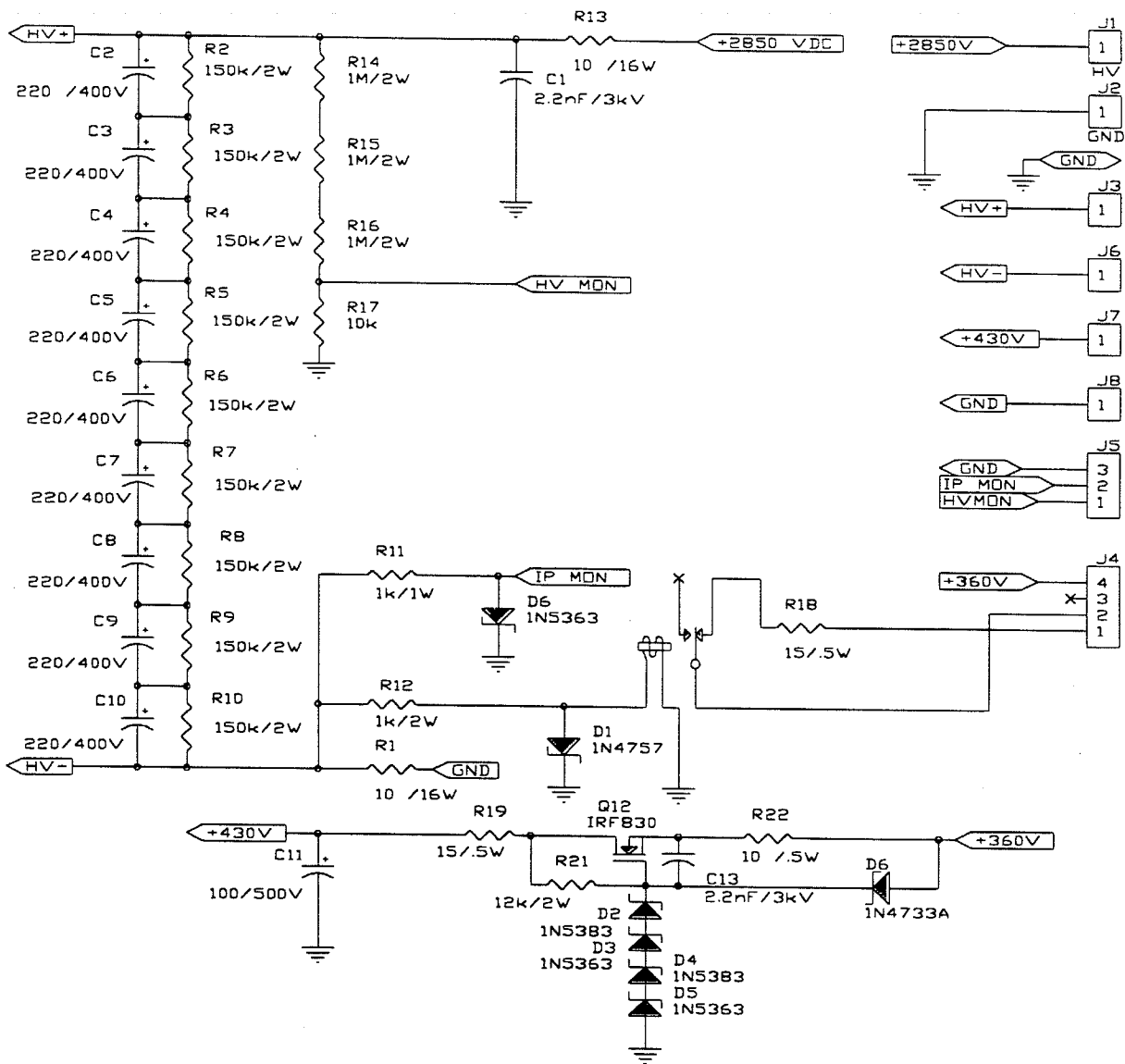


FIGURE 10
91 β HV FILTER
& SCREEN SUPPLY

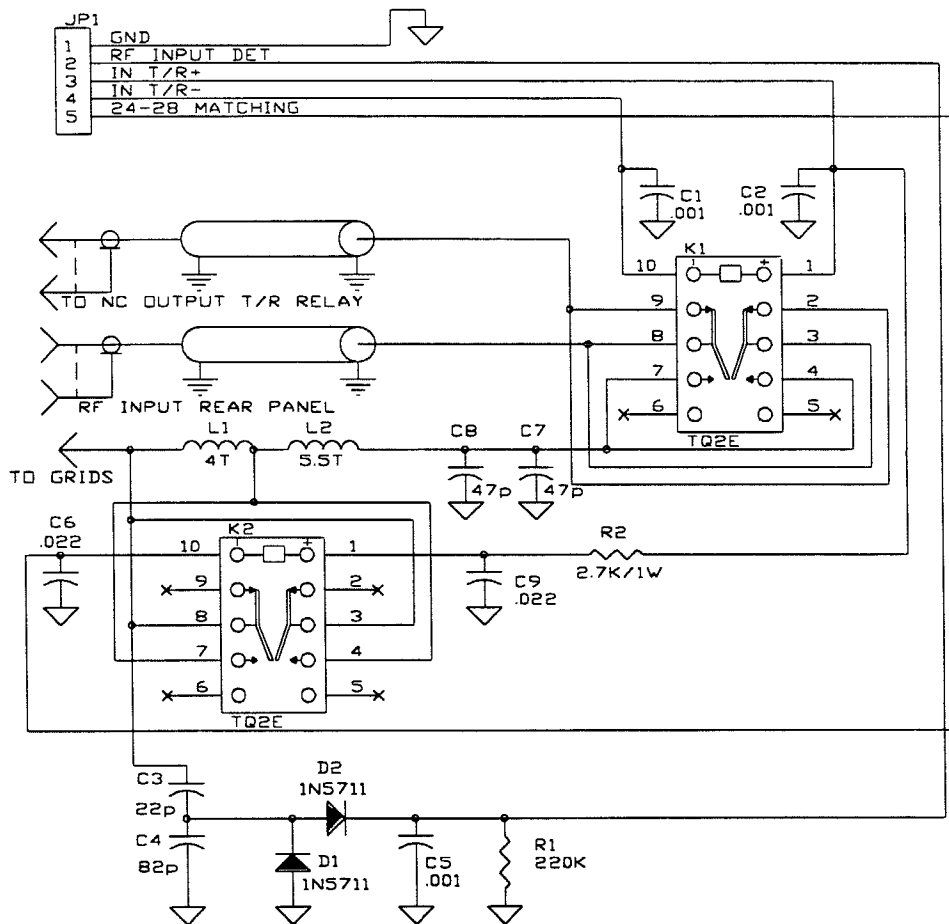


FIGURE 11
91 β INPUT BOARD

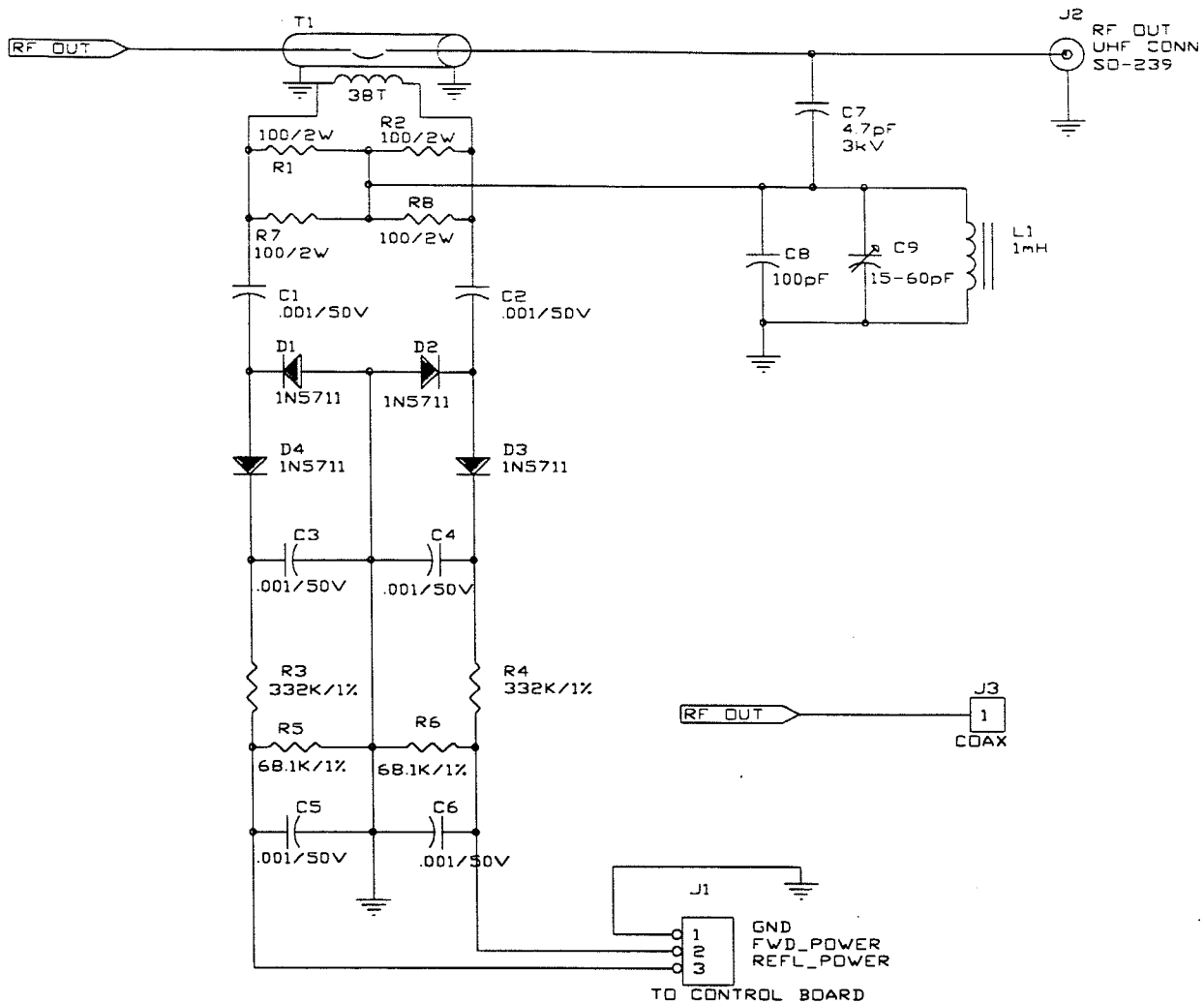


FIGURE 12
91 β OUTPUT RF WATTMETER

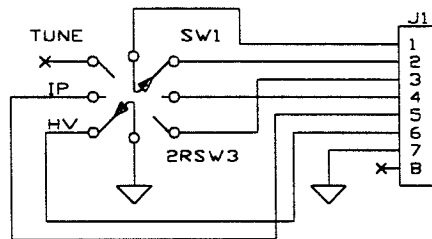


FIGURE 13
91 β MULTIMETER SWITCH

ALPHA PRODUCTS WARRANTY

ALPHA/POWER, INC. (API) WARRANTS AS FOLLOWS EACH NEW AMATEUR RADIO PRODUCT OF ITS MANUFACTURE, SOLD AND USED IN THE UNITED STATES, ITS POSSESSIONS, AND CANADA:

- (1) Workmanship and all components except rf power tubes are warranted for **FOUR YEARS** from date of original purchase if used exclusively in licensed amateur radio service. **WARRANTY IS VOIDED BY ILLEGAL SALE OR USE OF EQUIPMENT** (e.g. U.S. sale of export models).
- (2) *Eimac* power tubes are warranted by their manufacturer; API will assist owners in securing warranty service if requested.

Svetlana power tubes are warranted by API for one year from date of original purchase.
- (3) Warranty does not apply to repair of damage resulting from improper maintenance or repair, misuse, neglect, abuse, or improper installation, nor to units not operated in accordance with specifications and instructions furnished by API, nor to units repaired or altered by persons not authorized by API, nor in cases where the serial number has been removed, altered, or defaced.
- (4) If a malfunction is suspected, before attempting repairs or returning equipment to API or the selling dealer for service, the owner shall contact API or the selling dealer factory service department, providing model and serial number plus details of equipment hookup, accessory equipment used, operating conditions, and abnormalities observed. API will furnish a new part in exchange for any covered defective part or, if it is determined that factory service is required, will authorize return to factory. Equipment authorized for return shall be shipped to API fully prepaid and insured via United Parcel or air express, **USING ONLY FACTORY APPROVED PACKING; REMOVE POWER TRANSFORMER BEFORE SHIPPING ANY UNIT WHICH WAS ORIGINALLY SHIPPED FROM THE FACTORY WITH TRANSFORMER REMOVED!** All shipping charges are the responsibility of the owner.
- (5) In order to receive service under this warranty, the owner must either (a) have returned a completed warranty registration form to API within 30 days of original purchase OR (b) provide proof of ownership as well as proof of the original date of sale by API or by an authorized API dealer.
- (6) No person is authorized to assume for API any liability in connection with our products, other than as set forth in this warranty. API reserves the right to change its products as it deems desirable, without obligating itself to make such changes available for previously manufactured products.

UNDER PROVISIONS OF THE FEDERAL MAGNUSON-MOSS WARRANTY ACT, THIS WARRANTY POLICY IS CLASSIFIED AS A LIMITED WARRANTY.

Rev. 03/05/97



ALPHA/POWER, INC. RF Power for Communications and Industry
14440 Mead Court • Longmont, Colorado 80504 • (970) 535-4173 • FAX (970) 535-0281

ALPHA 91B

PART DESCRIPTION	PART #	SCHEMATIC SYMBOL
BLOWER 115V (COMPLETE ASSEMBLY)	91B-AHX-X002	B1
BLOWER MOTOR 115V	BLX-X129	
BLOWER SQUIRREL CAGE	BLX-X104	
BLOWER HOUSING	BLX-X106	
BLOWER FINGER GUARD	BLX-X303	
BLOWER MOTOR SUPPORT PLATE	MSX-X018	
BLOWER BASE PLATE		
BLOWER NEOPRENE STRIP	XKX-X118	
BLOWER BASE PLATE	91B-MSX-1102	
BOARD CONTROL-UNSTUFFED (REV 2.4)		
BOARD CONTROL-STUFFED (REV 2.4)	91B-ABX-X001	
BOARD DISPLAY-UNSTUFFED (2.2)		
BOARD DISPLAY-STUFFED (2.2)	91B-ABX-X002	
BOARD PWR SUPPLY-UNSTUFFED		
BOARD PWR SUPPLY-STUFFED	91B-ABX-X003	
BOARD HV FILTER-UNSTUFFED (REV 2.2)		
BOARD HV FILTER-STUFFED (REV 2.2)	91B-ABX-X004	
BOARD WATTMETER-UNSTUFFED		
BOARD WATTMETER-STUFFED	91B-ABX-X005	
BOARD INPUT-UNSTUFFED		
BOARD INPUT-STUFFED	91B-ABX-X006	
BOARD MAINS-UNSTUFFED (REV 2.1)		
BOARD MAINS-STUFFED (REV 2.1)	91B-ABX-X007	
CAPACITOR 33uF 35V (MAINS BRD)		C1
CAPACITOR 2.2nF 1.6KV (AC INPUT)		C4,C5
CAPACITOR 2nF 3KV (AC INPUT)	CDX-2022	C4,C5 (UNIT)
CAPACITOR 1nF (RCA JACK)	CKM-1021-C	C1-C3
CAPACITOR .02uF 500V (RF SECT)		C6-C9,C12,C13
CAPACITOR .02uF 1KV (RF SECT)	CDX-2030-C	C6-C9,C12,C13 (BRD)
CAPACITOR .02uF 1KV (RF SECT)	CDX-2030-C	C14
CAPACITOR 2nF 6KV (RF SECT)	CDX-2021	C17
CAPACITOR 2.2nF 3KV (RF SECT)		C16
CAPACITOR 2nF 3KV (RF SECT)	CDX-2022	C16 (UNIT)
CAPACITOR 6.8nF 3KV (RF SECT)		C15
CAPACITOR 2nF 6KV (RF SECT) (2 IN PARALLEL)	CDX-2021	C15 (UNIT)
CAPACITOR .002uF 6KV (RF SECT)	CDX-2021	C19
CAPACITOR .0047uF 5KV DOORKNOB (RF SECT)	91B-CDX-4720-C	C18
CAPACITOR .0033uF 5KV DOORKNOB (RF SECT)		C18
CAPACITOR 11nF (BUILT INTO TUBE SOCKET)		C10,C11
CAPACITOR 22nF 500V (BAND LOCKOUT)		C1
CAPACITOR 1.5nF 1KV (FEEDTHROUGH)	CKX-1520	C15,C25
CAPACITOR 100pF 6KV (RF SECT)	91B-CDX-1012-B	C21-C24
CAPACITOR 22pF (RF SECT)	91B-CDX-2200-B	C27
CAPACITOR 150pF 8KV (PAD CAP PCB)	CDX-1510-A	C1-C8 (C9 WITH MOD.)
CAPACITOR .02uF 500V (RF FILL 1 PCB)		C1
CAPACITOR .02uF 1KV (RF FILL 1 PCB)	CDX-2030-C	C1(BRD)
CAPACITOR .01uF (CNTRL BRD)	CKM-1030	C2,C5-C7,C10-C13,C18,C28-42,C48-C54,C65 C68,C70
CAPACITOR 10uF 35V TANT (CNTRL BRD)	CLX-1060	C67
CAPACITOR 10uF 63V (CNTRL BRD)	CEX-1065-C	C44,C60,C63,C64,C66
CAPACITOR .1uF (CNTRL BRD)	CKM-1040	C4,C9,C20,C22,C26,C62
CAPACITOR 2200uF 35V RADIAL (CNTRL BRD)	CEX-2282-C	C59
CAPACITOR 470uF 35V RADIAL (CNTRL BRD)		C58
CAPACITOR 1uF 35V TANT (CNTRL BRD)	CLX-1050	C14,C16,C57, C56
CAPACITOR .001uF (CNTRL BRD)	CKM-1021-C	C1,C3,C8,C15,C19,C21,C43,C45-C47
CAPACITOR .02uF (CNTRL BRD)		C23
CAPACITOR .022uF (CNTRL BRD)	CKM-2230-C	C23(BRD)
CAPACITOR .01uF (CNTRL BRD)	CKM-1030	C23(BRD)
CAPACITOR .33uF (CNTRL BRD)	CKM-3340-D	C27
CAPACITOR 22uF 15V TANT (CNTRL BRD)	CLX-2260 (see note C17)	

To fix most time-delay failures, replace C17 with higher voltage rated part. Use CLX-2262

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CAPACITOR 1uF 100V ELEC (CNTRL BRD) Change C56 to CLX-1050 Tantalum, more reliable.	CEX-1051-C	C56,C61
CAPACITOR .47uF 50V (CNTRL BRD)	CKM-4740-C	C24
CAPACITOR .1uF (DSPLY BRD)	CKM-1040	C1,C3-C14,C23
CAPACITOR .01uF (DSPLY BRD)	CKM-1030	C15-C22
CAPACITOR .01uF (PWR SUPPLY)	CKM-1030	C3
CAPACITOR 33uF 25V RADIAL (PWR SUPPLY)	CEX-3360-C	C2
CAPACITOR .01uF 400V (PWR SUPPLY)		C5
CAPACITOR .01uF 500V DISC (PWR SUPPLY)	CKD-1031	C5
CAPACITOR 33uF 250V AXIAL (PWR SUPPLY)		C1,C4
CAPACITOR 2.2nF 3KV (HV FILTER)		C1,C13(BRD)
CAPACITOR .002uF 6KV (HV FILTER) (use CDX-2021)	CDX-2021	C1,C13(BRD)
CAPACITOR 4.7uF 450V AXIAL (HV FILTER)	CEX-4751-C	C14
CAPACITOR 100uF 500V (HV FILTER)	CEX-1076-C	C11
CAPACITOR 220uF 400V (HV FILTER)	CEX-2271-C	C2-C10
CAPACITOR .001uF (RF INPUT)	CKM-1021-C	C1,C2,C5
CAPACITOR 82pF (RF INPUT)	CDX-8200-B	C4
CAPACITOR 22pF (RF INPUT) Change to below	CDX-2200-B	C3
CAPACITOR 10pF (RF INPUT) (Hi-pwr diode mod)	CDX-1000-B	C3
CAPACITOR .022uF (RF INPUT)	CKM-2230-B	C6,C9
CAPACITOR 47pF (RF INPUT)	CDX-4700-B	C7,C8
CAPACITOR .001uF 50V (RF OUTPUT)	CKM-1021-C	C1-C6
CAPACITOR 100pF 1KV (RF OUTPUT)		C8
CAPACITOR 4.7pF 3KV (RF OUTPUT)	CKD-47G0	C7,C8
CAPACITOR 15-60pF VAR (RF OUTPUT)	CVX-6000	C9
CAPACITOR 60-200pF TUNE	91B-CTX-2110	C20
CAPACITOR 35-425pF LOAD	91B-CTX-8210	C26
CHIMNEY (4CX800A)	APP-X217	
COVER (WRAPPER)	91B-MSX-1101	
DIODE 1N4004 (RF FILL 1 BRD)	DRX-X102	D1-D3
DIODE 1N5711 (RF OUTPUT WATTMETER)	DRX-X104	D1-D4
DIODE 1N5711 (RF INPUT)	DRX-X104	D1,D2
DIODE 1N5250B (OUTPUT WATTMETER)	DZX-X149	D5
DIODE 1N4007 (PWR SUPPLY)	DRX-X128	D1-D8
DIODE KD202P (PWR SUPPLY)	91B-DRX-X146	D12-D31
DIODE ZENER 1N5349 12V (PWR SUPPLY)	DZX-X124	D9
DIODE ZENER 1N5363 30V (PWR SUPPLY)	DZX-X114	D10,D11,D32,D33
DIODE LED GREEN .1 X .2 (DSPLY BRD)		D1-D16,D21-D27,D31-D50
DIODE LED RED .1 X .2 (DSPLY BRD)		D17-D20,D28-D30
DIODE LED GREEN (DSPLY BRD)	DLX-X122	D51,D53,D54,D56
DIODE LED RED (DSPLY BRD)	DLX-X123	D52,D55,D58
DIODE LED YELLOW (DSPLY BRD)	DLX-X124	D57
DIODE 1N4004 (CNTRL BRD)	DRX-X102	D7-D9,D11,D16,D20,D21,D30-D32
DIODE 1N4148 (CNTRL BRD)	DRX-X107	D1-D6,D12,D13,D14,D15,D17-D19,D23,D25,D35
DIODE ZENER 1N4740 10V (CNTRL BRD)	DZX-X102	D22,D24,D33
DIODE ZENER 1N4733 5.1V (CNTRL BRD)	DZX-X101	D10
DIODE 1N5408 (CNTRL BRD)	DRX-X131	D26-D29
DIODE 1N4007 (AC MAINS BRD)	DRX-X128	D1
DIODE 1N5408 (TUBE DECK)	DRX-X131	D1
DIODE 1N4007 (TUBE DECK)	DRX-X128	D2
DIODE ZENER 1N4733 5.1V (HV FILTER)	DZX-X101	D6 (+360 supply D6)
DIODE ZENER 1N5363 30V (HV FILTER)	DZX-X114	D3,D5,D6 (lp MON D6)
DIODE ZENER 1N5383 150V (HV FILTER)	DZX-X148	D2,D4
DIODE ZENER 1N4757 51V (HV FILTER)	DZX-X104	D1
FRONT PANEL ASSEMBLY	91B-ARX-X229	
FRONT PANEL	91B-MSX-1100	
FRONT SUBPANEL	91B-MSX-1104	
FUSE 20A 250V CERAMIC	FSX-X109	F1,F2
FUSE 2A 250V GLASS SLOW BLOW	FSX-X111	F3,F4
GROMMET (TUBE DECK) NEW STYLE	HGX-X103	
GROMMET (TUBE DECK) OLD STYLE	HGX-X106	
HEADER MTA 3 PIN (LARGE) (CNTRL)	JAX-X725	JP5
HEADER MTA 8 PIN (CNTRL)	JAX-X708	JP1,JP4
HEADER MTA 18 PIN (CNTRL)	JAX-X714	JP6
HEADER 10 X 2 (CNTRL)	JMX-X155	JP2
HEADER 10 X 2 CURVED (DSPLY)	JMX-X099	J1
HEADER MTA 3 PIN (HV FILTER)	JAX-X303	J5

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HEADER MTA 4 PIN (HV FILTER)	JAX-X304	J4
HEADER MTA 3 PIN (WATTMETER)	JAX-X303	J1
HEADER MTA 5 PIN (INPUT)	JAX-X305	JP1,JP4
HEADER MTA 8 PIN (MAINS)	JAX-X708	J1
HV CROWBAR		
IC LM3914 LED DRIVER (DSPLY BRD)	UCX-X064	U1,U2,U5
IC LM324 OP-AMP (CNTRL BRD)	UCX-X114	U1-U4
IC 14093 NAND (CNTRL BRD)	UCX-X104	U5-U7
IC 14066 SWITCH (CNTRL BRD)	UCX-X030	U8
INDUCTOR 470uH (BARE WIRE) (DSPLY)		L1-L3
INDUCTOR 4T (RF INPUT)		L1
INDUCTOR 5.5T (RF INPUT)		L2
INDUCTOR 9.5T AIR CORE (RF INPUT)		L1/L2(BRD)
INDUCTOR 1mH IRON CORE (RF OUTPUT)		L1
INDUCTOR 38T (RF OUTPUT)		
INDUCTOR 1mH (BAND LOCKOUT)	LCX-X106	L1
INDUCTOR 1mH (RF SECT)	LCX-X106	L11,L12
INDUCTOR LOCKOUT CHOKE (RF SECT)	91B-ACX-X006	L9
INDUCTOR PI COIL 10m (RF SECT)	91B-ACX-X001	L7
INDUCTOR PI COIL 160m (RF SECT)	91B-ACX-X002	L8
INDUCTOR L COIL (RF SECT)	91B-ACX-X003	L10
INDUCTOR 10uH (RF FILL 1 PCB)		L1
INDUCTOR 1mH (TUBE DECK)	LCX-X106	L1,
INDUCTOR PARASITIC CHOKE (RF SECT)	91B-ACX-X004	L2,L3
INDUCTOR PLATE CHOKE (RF SECT)	91B-ACX-X005	L4
Like 99 plate choke, 92 t on top, 100 t on bottom.		
INDUCTOR 15uH (RF SECT)	LCX-X101	L6(BRD)
INDUCTOR 15uH (RF SECT)	LCX-X102	L6(BRD)
KNOB TUNE/LOAD	SKX-X102	
KNOB BANDSWITCH	SKX-X103	
MANUAL	ZMX-X151	
RCA JACK (REAR CHASSIS)	JCX-X126	J2-J4
RELAY IP GUARDIAN 1575-1C-24D (HV FILTER)	KDX-X115	K1
RELAY IP MAGN W178RE1-24DC (HV FILTER)	KDX-X115	K1
RELAY AC ON (MAINS BRD)	KDX-X137	K1 (SINGLE OMRON LY4ZF)
RELAY STEP-START (MAINS BRD)	KDX-X137	K2 (SINGLE OMRON LY4ZF)
RELAY AC ON (MAINS BRD) (QTY 2)		K1 (DOUBLE OMRON LY2ZF)
RELAY STEP-START (MAINS BRD) (QTY 2)		K2 (DOUBLE OMRON LY2ZF)
RELAY KEYING BYPASS TQ2E (CNTRL)	KDX-X124	K1
RELAY T/R VACUUM (RF SECT)	KVX-X105	K1
RELAY TQ2E (RF INPUT)	KDX-X124	K1,K2
RESISTOR 390 OHM 1/4W (DSPLY BRD)	RFF-B391-C	R12-R19
RESISTOR 1.21K OHM 1% (DSPLY BRD)	RFM-B1211-A	R1,R2,R5,R9,R10
RESISTOR 220K OHM 1/4W (DSPLY BRD)	RFF-B224-C	R4,R7,R8
RESISTOR 22K OHM 1/4W (DSPLY BRD)	RFF-B223-C	R20
RESISTOR 330 OHM 1/4W (DSPLY BRD)	RFF-B331-C	R6
RESISTOR 5K OHM (POT.) (DSPLY BRD)		R11,R13
RESISTOR 8.2K OHM 5W WW (PWR SUPPLY)	RFW-G822-C	R2,R3
RESISTOR 1K OHM 2W (PWR SUPPLY)	RFC-E102-C	R1
RESISTOR 511K OHM 1W (PWR SUPPLY)		R4,R23
RESISTOR 220K OHM 1/4W (RF INPUT)	RFF-B224-C	R1
RESISTOR 2.7K OHM 1/4W (RF INPUT)	RFF-B272-C	R2
RESISTOR 100 OHM 2W 1% (RF OUTPUT)	RFM-E1000-A	R1,R2,R7,R8
RESISTOR 332K OHM 1% (RF OUTPUT)	RFM-B33231-A	R3,R4
RESISTOR 68.1K OHM 1% (RF OUTPUT)	RFM-B6812-A	R5,R6
RESISTOR 1MEG OHM 2W (RF SECT)		R9-R11
RESISTOR 220 OHM 2W (PARASITIC) (QTY 4)	RFC-E221-D	R3,R7
RESISTOR 220 OHM 3W (PARASITIC) (QTY 2)	RFM-F2200-C	R3,R7
RESISTOR 47 OHM 2W (TUBE DECK)	RFC-E470-C	R8
RESISTOR 1MEG OHM 1/4W (CNTRL)	RFF-B105-C	R4,R67,R70,R71,R73,R84
RESISTOR 10K OHM 1/4W (CNTRL)	RFF-B103-C	R12,R13,R15R18,R19,R29,R32,R34,R44,R48
		R50,R51,R55-R57,R66,R72,R75,R76,R79,R85
Change R34 to 100 ohm RFF-B101-C		R87,R108
RESISTOR 100K OHM 1/4W (CNTRL)	RFF-B104-C	R3,R11,R14,R33,R36,R37,R40,R45,R54,R64,R78
		R81,R93,R100-R102,R109

(R105 was originally 100k)

RESISTOR 15K OHM 1/4W (CNTRL) (R105 was originally 100k) June 04 changed R105 and C3, lower V on Input Diodes.	RFF-B153-C	R105
RESISTOR 3.9MEG OHM 1/4W (CNTRL)	RFF-B395-C	R26,R53,R69
RESISTOR 62K OHM 1/4W (CNTRL)	RFF-B623-C	R111
RESISTOR 120K OHM 1/4W (CNTRL)	RFF-B124-C	R23,R24,R90
RESISTOR 100K OHM "100KV" (POT.) (CNTRL)	RKX-1040	R8,R16,R31,R41,R49,R52,R61,R62,R68,R92,R25 R110
RESISTOR 22K OHM 1/4W (CNTRL)	RFF-B223-C	R21,R80
RESISTOR 100 OHM 1/4W (CNTRL)	RFC-B101-C	R20
RESISTOR 150K OHM 1/4W (CNTRL)	RFF-B154-C	R89,R95
RESISTOR 20K OHM 1/4W (CNTRL)	RFF-B203-C	R95 (EBS MOD.-1998)
RESISTOR 1K OHM 1/4W (CNTRL)	RFC-B102-C	R10,R17,R39,R65,R82,R88,R94,R97,R114
RESISTOR 220K OHM 1/4W (CNTRL)	RFF-B224-C	R2,R6,R9,R22,R42,R86
RESISTOR 33K OHM 1/4W (CNTRL)	RFF-B333-C	R37,R46,R112
RESISTOR 47K OHM 1/4W (CNTRL)	RFF-B473-C	R63,R74,R103,R104
RESISTOR 1.8K OHM 1/4W (CNTRL)	RFF-B182-C	R7
RESISTOR 68K OHM 1/4W (CNTRL)	RFF-B683-C	R106
RESISTOR 4.7K OHM 1/4W (CNTRL)	RFF-B472-C	R1,R47
RESISTOR 10MEG OHM 1/4W (CNTRL)	RFF-B106-C	R5,R6,R28
RESISTOR 470K OHM 1/4W (CNTRL)	RFC-B471-C	R27
RESISTOR 100 OHM 1/4W (CNTRL)	RFC-B101-C	R58,R83,R96
RESISTOR 56K OHM 1/4W (CNTRL)	RFF-B563-C	R60
RESISTOR 39 OHM 1/4W (CNTRL)	RFF-B390-C	R43
RESISTOR 47 OHM 1/4W (CNTRL)	RFF-B470-C	R38
RESISTOR 3.3K OHM 2W (CNTRL) changed, see next line	RFC-E332-C	R59
RESISTOR 2.2K OHM 2W (CNTRL) Changed by ECO	RFO-E222-C	R59
RESISTOR 5.6K OHM 1/4W (CNTRL)	RFC-B562-C	R35
RESISTOR 390 OHM 1/4W (CNTRL)	RFC-B391-C	R77
RESISTOR 300 OHM 5W (CNTRL)	RFW-H301-C	R113
RESISTOR 560 OHM 2W (MAINS)	RFC-E561-C	R1
RESISTOR 600 OHM 10W (MAINS)	RFW-J601-D	R3
RESISTOR 680 OHM 10W (MAINS)		R3
RESISTOR 750 OHM 10W (MAINS) (TUM15J750)		R3 (REPLACEMENT)
RESISTOR 1K OHM 10W (MAINS)	RFW-J102-A	R2
RESISTOR 200 OHM 2W (MAINS)		R6
RESISTOR 10 OHM 15W (MAINS) (TUW15J10R)		R4,R5
RESISTOR 50 OHM 90W (TUBE DECK)	RLX-X103	R1
RESISTOR 47 OHM 2W (SCREEN/FILAMENT BRD)	RFO-E470-D	R8
RESISTOR 12 OHM 5W (TUBE DECK)		R2,R6,R9,R22,R42,R86
RESISTOR 12 OHM 10W 10% (TUBE DECK)	RFL-J120-D	R2,R6
RESISTOR 50K OHM 6W (TUBE DECK) (3 150K-PARALL.)		R4,R5
RESISTOR .1 OHM 5W (TUBE DECK) OLD REV.	91B-RFW-H100-C	R6
RESISTOR .2 OHM 3W (TUBE DECK) (2 IN PARALLEL)	RFM-F20B-C	R6
RESISTOR 10K OHM "10KV" (POT.) (ALC)		R12
RESISTOR 10 OHM 1/2W (HV FILTER)	RFC-C100-C	R22(SCHEMATIC)=R21(BOARD)
RESISTOR 12K OHM 2W (HV FILTER)	RFO-E123-C	R21(SCHEMATIC)=R20(BOARD)
RESISTOR 15 OHM 1/2W (HV FILTER)	RFC-C150-C	R19,R18
Change R19 to 15 OHM 1W FLAMEPROOF (HV FILTER)	RFM-D1500-C	R19
RESISTOR 10 OHM 16W (HV FILTER)	RFW-K100-D	R1,R13
RESISTOR 1K OHM 2W (HV FILTER)	RFC-E102-C	R12
RESISTOR 1K OHM 1W (HV FILTER)	RFC-D102-C	R11
RESISTOR 10K OHM 1/4W (HV FILTER)	RFF-B103-C	R17
RESISTOR 1MEG OHM 2W (HV FILTER)	RFO-E105-D	R14-R16
RESISTOR 150K OHM 2W (HV FILTER)	RFC-E154-C	R2-R10
SCREWS SHIPPING (QTY 2) 8-32	HSS-5036	
SCREWS SHIPPING (QTY 2) METRIC	HSS-M031	
SCREWS COVER (QTY 16)	HSA-X001	
SCREWS FRONT PANEL (QTY 6)	HSA-X002	
SHIPPING BOX	ZCX-X127	
SHIPPING FOAM (2 PIECES)	ZFX-X133	
SPARK ARRESTOR 800V (TUBE DECK)	CGX-8010-D	GT1
SWITCH BANDSWITCH	91B-AHX-X001	S1
SWITCH COVER (LID INTERLOCK)		S3
SWITCH MULTIMETER	91B-SWX-X115	SW1

ALPHA 91B

SWITCH ON/OFF	SWX-X114	S1
SWITCH OPR/STBY	SQR-X109	S2
TRANSFORMER POWER	91B-TPX-X153	T1
TRANSISTOR 2N3904 (CNTRL)	QTX-X104	Q1-Q3,Q5-Q7,Q9-Q14,Q17,Q18,Q20,Q22
TRANSISTOR 2N3906 (CNTRL)	QTX-X109	Q21
TRANSISTOR VN10KM FET (CNTRL)	QTX-X112	Q4,Q16
TRANSISTOR IRF-9630 (CNTRL)	QTX-X173	Q15,Q23
TRANSISTOR IRF-630 (CNTRL)	QTX-X159	Q8
TRANSISTOR MJE802 (CNTRL)	QTX-X101	Q19
TRANSISTOR IRF-830 (HV FILTER)	QTX-X172	Q12
TUBE 4CX800A SVETLANA	91B-VTX-X001	V1,V2
TUBE SOCKET 4CX800A SVETLANA SK1A	VSX-X111	
TUBE STANDOFF 7/16"D 17/16"L	XDX-X144	
VOLT REGULATOR MC78T12CT 12V	UCX-X105	U10
VOLT REGULATOR LM323AT 5V (CNTRL-REPLACEMENT)	UVX-X008	U9
VOLT REGULATOR LM323AT 5V (CNTRL)	UCX-X037	U9