

PRICE: \$10.00

# OPERATING AND TECHNICAL MANUAL

HIGH FREQUENCY LINEAR POWER AMPLIFIER

## ALPHA 78



**ETO**

EHRHORN TECHNOLOGICAL OPERATIONS, INC.

CANON CITY, COLORADO 81212

OCTOBER, 1979

# IMPORTANT

## SERVICE ASSISTANCE

To help you secure technical assistance without wasted long distance calls, ETO has established a special SERVICE telephone line WHICH WILL BE ANSWERED ONLY WHEN A QUALIFIED SERVICE TECHNICIAN IS AVAILABLE TO HELP YOU IMMEDIATELY.

The special service number is (303) 275-0563. If your call to this number is NOT answered it indicates that no qualified technician is free to talk with you at the moment. Please wait a few minutes and try again. NOTE ALSO that business hours are 8:30 AM to 4:30 PM MOUNTAIN TIME Monday through Thursday.

If your call does NOT relate to service or other technical matters, our business office staff will be happy to help you at the number shown on the rear cover of this manual.

## CHECKING AND INSTALLING YOUR NEW ALPHA AMPLIFIER

The red silicone rubber chimneys and stacks installed on the 8874 tubes in your ALPHA are absolutely essential parts of the cooling system. While you have the cabinet cover removed to install the transformer, make certain that the conical rubber chimneys are smooth and press firmly against the tube subchassis, and that the cylindrical exhaust stacks are straight (vertical) and firmly installed on the tube anode coolers.

OPERATION OF THE AMPLIFIER WITHOUT THESE ITEMS WILL RESULT IN SERIOUS DAMAGE NOT COVERED UNDER WARRANTY.

## TEN METER OPERATION OF YOUR ALPHA

FCC rules permit an appropriately licensed amateur to modify his own amplifier for operation on 28-29.7 MHz. We strongly recommend that you contact our service department before attempting any modification. (If you enclose your request and a photocopy of your valid amateur radio license with the warranty registration card for your new amplifier, appropriate information will be sent without charge.)

## THE EXPECTED NEW 10, 18, and 24 MHz AMATEUR BANDS

If and when FCC permits amateur use of these bands with linear amplifiers, your ALPHA will be capable of 10 and 18 MHz operation with only slight modification. In the somewhat unlikely event that high power operation is eventually permitted on 24 MHz, ETO will make available information to permit safe operation of your ALPHA on that band. ANY ATTEMPT TO OPERATE YOUR ALPHA IN THE VICINITY OF 24 MHz WITHOUT APPROPRIATE MODIFICATION MAY CAUSE SERIOUS DAMAGE.

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## SECTION 1: INTRODUCTION

### 1-1 GENERAL DESCRIPTION

The ALPHA 78 is a self-contained, high frequency linear power amplifier capable of continuous operation at input powers in excess of two kilowatts PEP/SSB and one kilowatt average or continuous carrier, with no time limit. It is manually tunable from 1.8-2.0 plus 3-22 MHz, optimized for convenience in the 160 through 15 meter amateur bands (export models also cover 10 meters).

Four additional bandswitch positions provide NO-TUNE-UP operation at full legal power on the 80 through 15 meter amateur bands. The ALPHA 78 is capable of high speed break-in CW (QSK) when used with a transmitter or transceiver of suitable break-in capability. The ALPHA 78 also incorporates a feature permitting optimization of efficiency in either the CW or "phone" subband when using the NO-TUNE-UP feature on 80/75 through 15 meter amateur bands.

### 1-2 SPECIFICATIONS, MODEL ALPHA 78

Frequency Coverage: 1.8-2.0 and 3-22 MHz manually tuned. Amateur bands 3.5-4, 7-7.3, 14-14.35, and 21-21.45 MHz without tune-up when changing bands, using factory-preset circuitry. A nine position bandswitch permits selection of any desired manual or no-tune-up range. In export versions a tenth position provides no-tune-up 10 meter operation; output may be broadly peaked for optimum efficiency across 28-29.7 MHz, using the front panel LOAD control.

Subband Selection: Panel switch selects optimum no-tune-up arrangement for either CW or "phone" U.S. amateur subbands, 80 through 15 meters.

Power Input: To 2.5 kW PEP/SSB, 1 kW average or carrier, dc, CCS.

Typical Efficiency: 50-65% depending on load, frequency, drive level, etc.

Drive Power: Nominal 60-80 watts carrier, 100-140 watts PEP for rated input.

Input and Output Impedances: Nominal 50 ohms unbalanced; VSWR 2:1 or less. For bandpass (no-tune-up) operation, load VSWR should be 1.5:1 or lower.

Distortion: Third order IM more than 35 dB below 1 kW PEP rf output.

Harmonics: Substantially better than FCC requirements; typically -50 dB or better.

CW Break-In: High speed QSK capability when used with a suitable QSK exciter.

Tube Complement: Three Eimac 8874 ceramic, grounded-grid triodes, air cooled.

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

ALC: Negative-going, adjustable threshold (not normally used with solid state transceivers).

HV/LV Tap Change: Panel-controlled internal HV/LV relay is standard.

Operator and Equipment Protection: Primary line fuses, plate overcurrent relay, ac line and high voltage interlocks are standard.

Primary Power: 220-250 V @ 10A max. or 110-130 V @ 20A max., 50-60 Hz, single phase. Easily changed in field.

Size: 7.5" h x 17" w x 14.75" d (19 x 43 x 38 cm).

Weight: 62 lb (28 kg) net; 70 lb (32 kg) total shipping weight in two cartons.

Finish: Brown Nextel suede panel, tan wrapper.

## SECTION 2: INSTALLATION

### 2-1 UNPACKING

Carefully remove the amplifier and transformer from their cartons. **SAVE THE PACKING MATERIAL FOR RE-USE!** Shipment of your ALPHA in other than factory packing may result in damage which is not covered under warranty.

Inspect closely for evidence of shipping damage. If damage is found, notify the delivering carrier and the seller at once. Complete the warranty registration form and mail it to ETO immediately.

### 2-2 TRANSFORMER INSTALLATION

The cover of the amplifier is easily removed. Unscrew the four flat head Phillips screws from the top, the two pan head screws from the rear flange of the top cover, and the five pan head screws from each side of the cover -- then carefully lift off the cover straight up.

Orient the transformer so that both multi-pin molded plugs on the transformer harness point toward the front of the amplifier (do not bend or twist the transformer wires). In the amplifier itself, move the corresponding mating connectors temporarily out of the way. Carefully lower the transformer into position so that the 1/4-20 tapped mounting holes in its base line up with corresponding clearance holes in the amplifier base plate. Install the 1/4-20 bolts and washers provided, and tighten them securely.

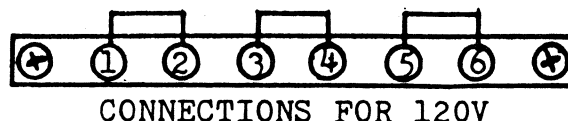
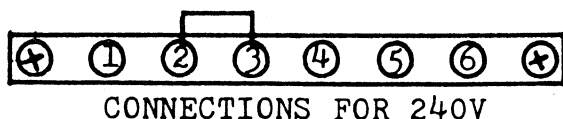
Check both pairs of mating connectors visually for proper mating orientation and mate them firmly, pushing together until the integral latches engage. Avoid excessive bending or twisting of harness wires or connectors, as it may cause damage to wires or connector pins.

Before replacing the amplifier cover, make sure the silicone rubber air exhaust chimneys are straight and firmly seated on the tubes.

### 2-3 ELECTRICAL INSTALLATION

2-3.1 Changeover to 110-130V Operation. Locate the six-terminal barrier strip on the right side of the center chassis partition, above and to the left of the transformer. With a short jumper between lugs #2 and #3 only, the amplifier is connected for a 240 V supply line.

Substituting instead a jumper between terminals #1 and #2, another between #3 and #4, and a third between #5 and #6 reconnects the wiring for a 120 V supply line. (See sketches below.)





2-3.2 Power Cable Connection. The green wire of the amplifier power cable is a chassis safety ground, and must always (and only) be connected to the safety ground of the ac mains -- NEVER to one of the "hot" power wires. The black and white wires are interchangeable and connect to the two "hot" service conductors.

#### 2-4 BLOWER

The cooling blower motor is mounted on an absorbent foam pad which dramatically reduces transmission of mechanical noise. Two 10-32 Phillips head screws secure the blower motor to the amplifier rear panel for safety in shipping, and must be completely removed for quietest operation (see Fig. 6). Remove both screws, as well as the rubber packing strips wedged between the rear panel and the blower motor; save these items for re-use in possible future shipping. WARNING: Serious damage to the amplifier may result if it is shipped without these screws and shims properly re-installed!

#### 2-5 PHYSICAL LOCATION

Your ALPHA must be located so that intake of cool air through the rear panel, and exhaust of warm air through the top cover perforations, is not impeded in any way. A minimum of 4 to 6 inches of clearance should be allowed behind and above the amplifier for air circulation. Be careful not to block the top cover exhaust openings with log books or equipment, as doing so is likely to result in destruction of the tubes.

#### 2-6 CONNECTOR FUNCTIONS

RF Input: An appropriate "RCA" or "phono" plug and RG-58C/U or similar small 50 ohm coaxial cable is required to connect to the transceiver or exciter rf output or "antenna" connector. This cable must be as short as possible -- preferably not longer than 2 to 3 feet.

RF Output: A standard PL-259 ("UHF" type) plug and RG-8A/U or similar 50 ohm coax is used to connect to the antenna system.

ALC: For use with tube-type transceivers having negative-going ALC systems with external ALC input jacks, this jack is patched to the mating one on the transceiver or exciter, using a standard "phono" type cable. Nearly all modern, solid state (broadband) transceivers use positive-going internal ALC with a level detector at the rf output point. This internal system normally functions adequately to control SSB drive power to the amplifier; in fact, most such transceivers provide no external ALC input jack and it is entirely unnecessary to make any external ALC connection.

Relay: This jack controls the ALPHA 78 T/R relay system. For conventional operation, this jack must be connected to transceiver or exciter relay contacts which are open on "receive" and shorted on "transmit." Nearly all transceivers provide such contacts via either phono-type or other accessory connectors on their rear panel or, in some cases, on their power supply chassis.

If your transceiver does not provide suitable relay contacts, but instead provides an output voltage which is switched "on" during transmit periods, it will be necessary to use an external relay operated by that voltage to provide the required "close on transmit" contacts to switch the amplifier.



For CW (or other mode) break-in (QSK) operation, the key itself is plugged directly into the RELAY jack on the amplifier.

Aux (or Key): The exciter/transceiver-keying contacts of the amplifier's QSK output relay appear at this jack. For break-in operation, this jack is connected directly to the exciter/transceiver "key" jack, so that the ALPHA 78 QSK system performs exciter keying. (This jack is not used in conventional non-QSK T/R operation.)

## 2-7 EQUIPMENT INTERCONNECTIONS

Interconnections for the ALPHA 78 are given in Figures 1 and 2. For conventional CW, VOX, or PTT operation, use the arrangement shown in Figure 1. Here, the amplifier T/R relays are controlled directly by the "amplifier" or "antenna relay" contacts of the exciter. The rf cable may be RG-58C/U or other small 50 ohm coax. For the amplifier rf output line use RG-8A/U or other high power coax. All other interconnections are "phono" plug type patch cords.

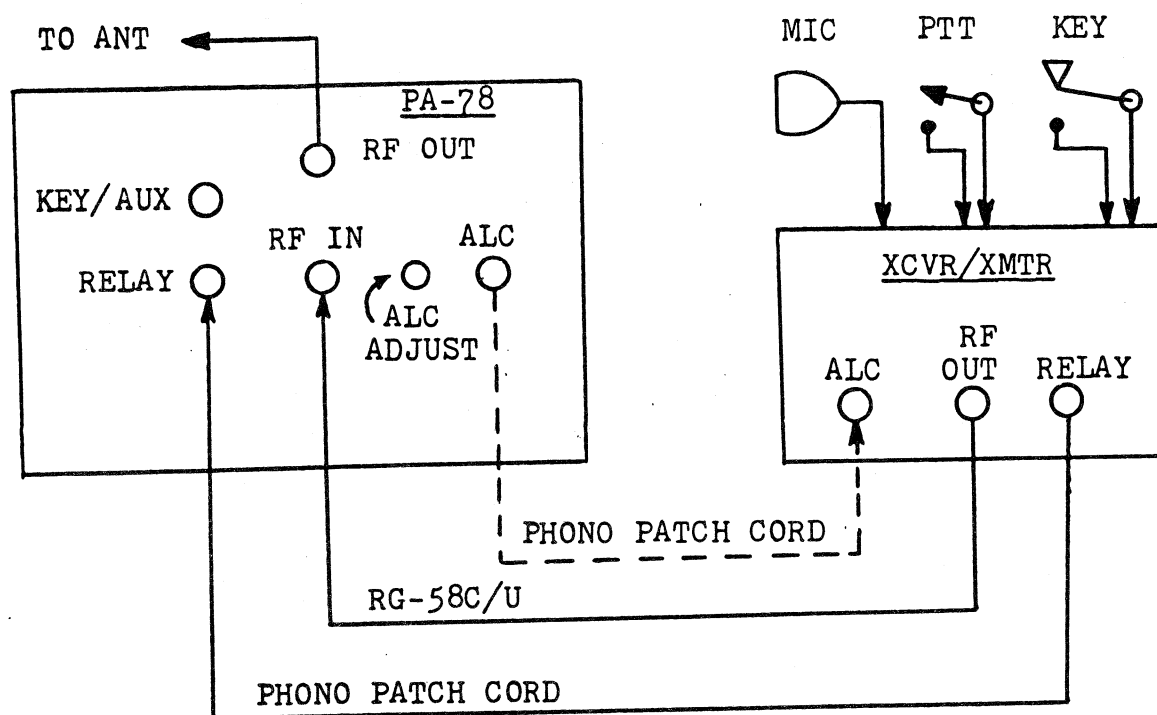
Interconnection arrangements for CW break-in (QSK) or fast VOX are shown in Figure 2. In this system, the amplifier itself is actually keyed, not the exciter. The amplifier QSK system then keys the exciter while insuring proper sequencing so that the amplifier's high speed vacuum T/R relays cannot be switched "hot." More detailed discussion of QSK system operation is given in the "Theory of Operation" section of this manual.

Figure 3 shows a simple switching arrangement that may be used to facilitate changing from conventional SSB PTT or VOX to CW break-in operation without having to change patch cables. The mode of operation desired is selected by simply setting the external DPDT switch appropriately.

The ALPHA 78 QSK system incorporates protective circuitry which senses the presence of rf drive power on the amplifier input line and prevents the amplifier T/R relays from changing state (R to T or T to R) if drive power exceeding 100-200 mW is present. A very few models of exciter/transceivers are known to exhibit undesirable T/R sequencing, such that they may deliver rf output to the amplifier before their amplifier-controlling relay contacts close. If the "conventional" PTT/VOX hook-up of Figures 1 and 3 is used with such an exciter or transceiver, the amplifier may sometimes refuse to switch to "transmit" when the exciter does, because to do so would result in "hot switching" of the T/R relay contacts and possible damage to them. Typically, the amplifier might then switch to "transmit" during the first brief (1-2 ms or longer) pause in drive power, such as during a syllabic pause in SSB speech or after the first dit or dah of CW. If the problem occurs and proves bothersome, the arrangement of Figure 2 should be used even for "manual" or "VOX" controlled CW or SSB.

Important Note: The protective rf interlock system of the ALPHA 78 will also keep it locked in the "transmit" condition, even if the external T/R control line is opened or the amplifier pushbuttons are switched to their "STANDBY" positions, until rf drive power to the amplifier is reduced below 100 mW or so. Merely switching the ALPHA 78 to STANDBY is not sufficient to switch it out of the rf line unless the rf drive power is completely removed.

**FIGURE 1.** ALPHA PA-78 Interconnections for Conventional VOX or PTT Operation.



**FIGURE 2.** ALPHA PA-78 Interconnections for CW Break-in or Fast VOX. (Also suitable for PTT, Manual T/R, etc.)

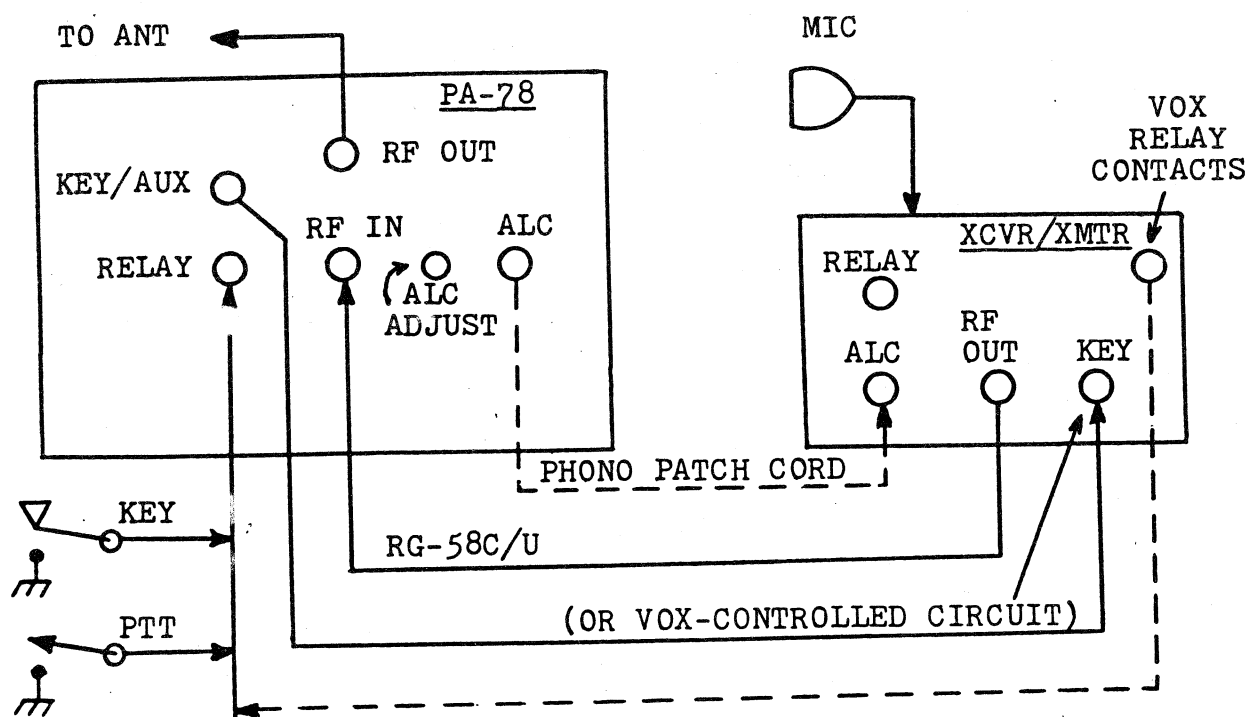
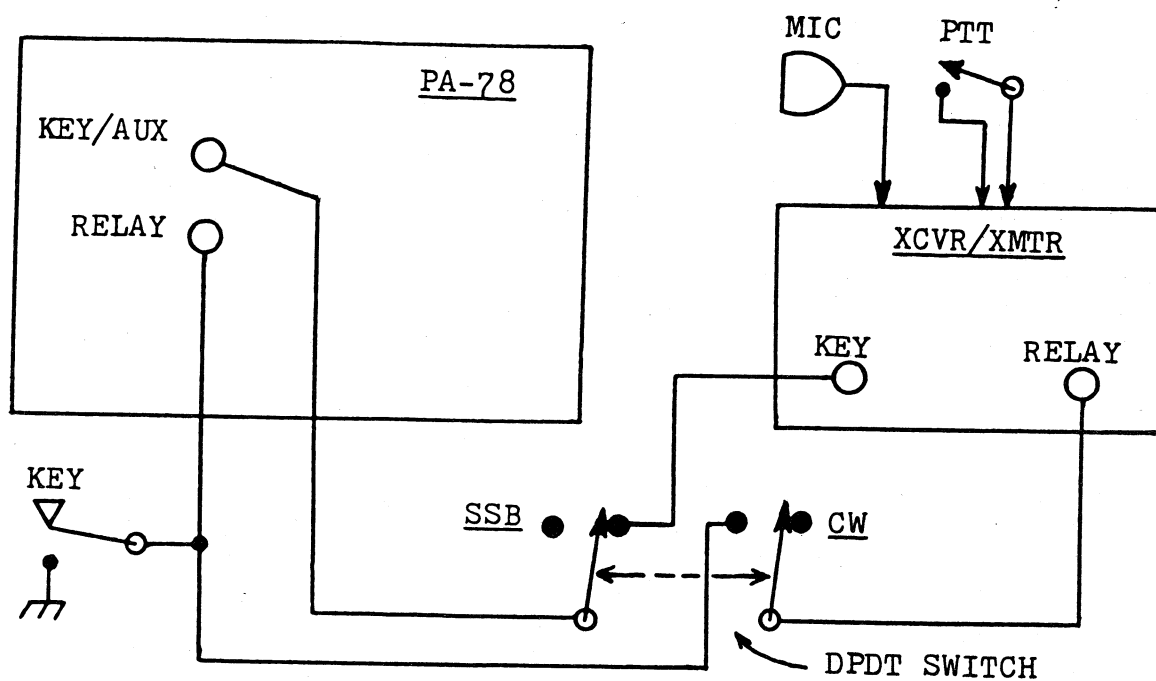


FIGURE 3. A Simple Method for Switching Between Conventional  
SSB PTT or VOX and CW Break-in.



## SECTION 3: OPERATION

### 3-1 CONTROL FUNCTIONS

BAND: Selects the desired MANUAL or BANDPASS (no-tune-up) frequency range.

SUBBAND (CW/PHONE): Optimizes bandpass circuits for highest efficiency in the lower or upper half, respectively, of each bandpass frequency range.

TUNE: Controls amplifier operating frequency when a MANUAL range is in use (a chart of approximate starting settings is given in section 3-6.1 of this manual).

LOAD: Controls amplifier output loading when a MANUAL range is in use (see section 3-6.1, as above). Allows broad peaking of 10 meter output across 28-29.7 MHz on export models only.

#### PUSH BUTTONS:

ON - Depress momentarily to apply ac power to the amplifier, or to restore ac power after an overload or fault trip-off.

OFF - Depress to remove ac power from amplifier.

HV - MULTIMETER monitors high voltage; 3000 VDC full scale.

GRID - MULTIMETER monitors dc grid current; 150 mADC full scale.

FWD - MULTIMETER monitors forward rf power; 2000 W full scale.

REFL - MULTIMETER monitors reflected (reverse) rf power; 200 W full scale.

CW - Selects "low" plate voltage for CW/FSK/SSTV and other emission types, including SSB, at plate inputs up to 1 kW dc.

SSB - Selects "high" plate voltage for SSB at plate inputs up to 2+ kW PEP.

OUT = STBY - When both the CW and SSB buttons are out, the amplifier is in STANDBY. T/R relay switching is disabled (locked in "receive"), permitting straight-through operation of transceiver/exciter alone.

ALC: Rear panel screwdriver adjustment sets the level of rf drive at which ALC output voltage begins to swing negative from zero. Use a small insulated screwdriver to avoid accidental shorting.

### 3-2 THE OBJECTIVE OF TUNE-UP

The objective of the tune-up procedure is to adjust the amplifier (and the drive power to it from the exciter) so as to secure maximum power output at (a) the desired dc plate power input level or (b) the maximum available level of rf drive power, if that is the limiting factor. When the amplifier is adjusted for the maximum attainable rf power output at a specific (fixed) level of rf carrier drive power from the exciter, it is automatically yielding the best combination of efficiency and linearity possible at that particular drive level. If greater drive (than the tune-up level) is applied, the result will be flattopping, off-frequency "splatter," and excessive amplifier grid current. Conversely, when the operating rf drive level is lower than the tune-up level, amplifier efficiency will be lower than normal. [These statements are true of any commonly-used linear amplifier.]

It is therefore essential that operating rf drive power always be adjusted to a level appropriate for the way the amplifier has been tuned up, whether manually by the operator or pre-set by the factory. Grid current drops off rapidly with too-low drive power and soars abruptly with over-drive; therefore proper grid current

is an excellent indicator of correct drive level to an otherwise properly-adjusted linear amplifier. For your ALPHA 78, the grid current (as indicated on the MULTIMETER) should not exceed 100 mA under normal CW/SSTV/RTTY conditions, nor should the HIGHEST SWINGS of the MULTIMETER exceed 50 mA under SSB (voice) modulation. If the grid current reaches these limits before the desired value of plate current is achieved, drive power should not be increased further.

### 3-3 POWER INPUT ON SSB

Tune-up of the amplifier establishes a ratio of dc plate voltage to dc plate current, HV/Ip, for which the optimum combination of efficiency and linearity occurs. When your ALPHA 78 is properly tuned up for maximum legal (U.S.) input power of 1 kW in the CW (low voltage) mode, approximate values are HV = 1400 V and Ip = 0.71 A. The ratio HV/Ip is then  $1400/0.71 = 1972$ , and dc plate power input is  $HV \times Ip = 1400 \times 0.71 = 994$  watts.

When the ALPHA 78 is then switched to the SSB (high voltage) mode, the tune-up adjustment will continue to yield optimum efficiency and linearity when the ratio HV/Ip is approximately 1972 (or whatever figure was actually achieved during CW tune-up). Since on SSB, HV = 2100 approximately, the peak (or "single tone") value of Ip should be approximately 1.06 A for best performance [ $HV/Ip = 2100/1.06 = 1972$  approximately]. This results in a PEP ("peak envelope power") or "single tone" input of  $HV \times Ip = 2100 \times 1.06 = 2226$  W.

After proper tune-up in the CW mode, adjustment for best operating results in the SSB mode (high voltage) consists simply of setting the exciter/transceiver rf output on SSB to the point that yields the desired amplifier plate current as discussed above.

**IMPORTANT NOTE:** The amplifier meters are average-reading&cannot follow the very rapid instantaneous plate current variations resulting from SSB (voice) modulation. Therefore the PLATE CURRENT meter will not indicate 1+ ampere when this desired level is reached on voice crests, but will typically swing to approximately 30-50% of the actual peak dc plate current depending on voice and exciter/transceiver characteristics. The swing may be somewhat greater when an ALPHA/VOMAX or high quality rf speech processor is used.

FCC rules define the highest swings of the dc plate current meter, mentioned in the previous paragraph, as "average dc plate current." One kilowatt of average dc power input, which is "maximum legal power" under FCC rules, occurs on SSB when the average dc plate current (the highest swings of the PLATE CURRENT meter) TIMES the dc plate voltage (HV) at the same time equals 1000 W. Thus, if HV is approximately 2100 V under SSB modulation and the highest PLATE CURRENT METER swings are about 0.47 A, average dc power input is  $2100 \times 0.47 = 990$  watts.

The actual peak or envelope-crest value of plate current under these conditions may range from roughly 0.9 to 1.5 A, depends on such factors as microphone and operator voice characteristics, the exciter ALC system (if any), and the use of speech processing. The actual PEP (peak envelope power) plate input might range from  $2100 \times (0.9 \text{ to } 1.5) = (1890 \text{ to } 3150 \text{ W})$  ... all the way from about 1.9 kW to over 3 kW in extreme cases. The average case will approximate 2 to 2.5 kW PEP at 1 kW average input ... roughly equivalent to the "rule of thumb" 2 kW PEP which is often (mistakenly) referred to as "maximum legal power."

### 3-4 PRELIMINARY CHECKS BEFORE TUNE-UP

3-4.1 Checking the Load VSWR. Leave the amplifier OFF or in STANDBY, and use only exciter power for this test. Use a reliable SWR bridge or rf wattmeter, such as the Drake WH-7 or Bird 43, to determine VSWR of the load (antenna) connected to the amplifier output. [If the reflected power is 10% of the forward power, or less, VSWR is 2:1 or better. If reflected power is 4% or less, VSWR is 1.5:1 or better.]

When a high accuracy external rf meter is not available, the ALPHA 78's built-in rf wattmeter may be used. Although intended mainly as a tuning aid and power output indicator, this meter has sufficient accuracy for this use. The MULTIMETER forward rf power scale reads 2000 W full scale, while the reflected power scale is 200 W full scale. Thus, for a VSWR of 2:1 or lower it is simply necessary that the meter deflection in the REFL position does not exceed the deflection in FWD. Because of the 10:1 ratio of the meter scale factors, this situation indicates 10% or lower reflected power, corresponding to a VSWR of 2:1 or better.

A load VSWR of 2:1 or better is required for safe manually-tuned operation of your ALPHA 78. For safe and efficient operation in the bandpass (no-tune-up) mode, a load VSWR of 1.5:1 or lower is desirable.

3-4.2 Initial Turn-On. Observe the following steps when turning on your ALPHA 78:

- 1] Place the amplifier in STANDBY (both the CW and SSB buttons out).
- 2] Press the MULTIMETER HV button; the MULTIMETER scale is now 0 to 3000 VDC.
- 3] Press the ON button momentarily; if any of the following does not occur, press OFF immediately and investigate before proceeding -
  - a) MULTIMETER should promptly swing to  $1650 \pm 100$  VDC.
  - b) Panel meters should illuminate pale red or amber.
  - c) Blower should start immediately and exhaust air should be detectable flowing from the top cover vents.
  - d) The PLATE CURRENT METER should continue to read zero at all times.
- 4] When the tube warm-up delay is completed after 45 to 90 seconds, the meters will change to a pale green or blue color, indicating STANDBY.

3-4.3 Ready-to-Transmit. (Do not yet apply any rf drive power.) Pushing either the CW or SSB button will place the ALPHA 78 into "ready-to-transmit" condition. The meters will illuminate pale red or amber, and the closure of relay K10 may be audible. (When SSB is pushed, the closure of relay K3 will also be audible.)

If the external RELAY line to the amplifier is now closed (shorted), the following approximate meter readings should be observed: (Do not apply rf drive!)

CW Mode: Plate idling current between 0 and about 10 mADC.

Grid current indication approximately 10 mADC.

High voltage =  $1650 \pm 100$  VDC if ac line voltage is normal.

SSB Mode: Plate idling current less than 75 mADC.

Grid current indication approximately 10 mADC.

High voltage =  $2300 \pm 100$  VDC if ac line voltage is normal.

Note: It is normal for the high voltage under load (in either CW or SSB mode) to be approximately 200 V less than its "no load" value.

### 3-5 BANDPASS OPERATION OF THE ALPHA 78

3-5.1 Summary of Procedure. Basic BANDPASS operation of the ALPHA 78 on the amateur 80/75 through 15 meter bands requires no adjustment of the TUNE or LOAD controls. Proceed as follows:

- 1] Insure that the VSWR of the connected load does not exceed approximately 1.5:1 (4% reflected power).
- 2] With the exciter in STANDBY or RECEIVE, select the desired BANDPASS position of the bandswitch. These positions are indicated by the wide scale marks labeled 3.5, 7, 14, and 21 MHz. (On export models only, there is also a 28 MHz position available which provides "semi-bandpass" operation. On this band (10 meters), the LOAD control must be broadly "peaked" to yield maximum rf output power for the frequency and drive level used. In general the LOAD setting on 10 meters will be somewhere near 90 on the dial.)
- 3] SUBBAND Switch: Select the desired position of the front panel SUBBAND switch, either CW or PHONE. This toggle switch is operational only in the four BANDPASS bandswitch positions (80/75 through 15 meters). It controls relays which shift the adjustment of the bandpass circuitry slightly in order to optimize amplifier efficiency over the desired segment of the amateur band selected. Since this adjustment is made for a matched 50 ohm load (VSWR 1:1) and real antenna loads seldom present such a perfect match, it is often advantageous to try both positions of the SUBBAND switch at any given frequency to determine which position yields better amplifier efficiency without allowing grid current to exceed the values given previously and in Section 3-5.2 below.

WARNING: DO NOT CHANGE THE POSITION OF SUBBAND SWITCH WHILE ANY RF DRIVE IS APPLIED TO THE ALPHA 78. SUCH "HOT SWITCHING" WILL CAUSE SERIOUS DAMAGE NOT COVERED UNDER WARRANTY.

- 4] When adjusting operating conditions as described below, always increase the rf drive power very slowly, until the desired values of plate and/or grid current are reached. IMPORTANT: Study Sections 3-5.2 and 3-5.3 below before attempting to operate your ALPHA 78 in the BANDPASS mode. Study Section 3-6 carefully before attempting MANUAL tune-up operation.

3-5.2 Adjustment for 1 kW DC Input. Make certain that the exciter/transceiver rf output control is set to zero; then press the amplifier CW button. Place the exciter in the appropriate mode to deliver a steady (adjustable) carrier output -- usually called "CW" or "Tune." Press the MULTIMETER GRID button on the ALPHA 78. Slowly increase the exciter carrier output from zero until either (a) the PLATE CURRENT METER indicates 0.7 A, or (b) the MULTIMETER indicates a GRID current of 100 mA.

Normal operating grid current is 40 to 90 mA, however values up to 100 mA are acceptable. If the grid current reaches 100 mA before the desired value of plate current is achieved, do not increase the drive power any further. Instead, if a higher level of plate input is desired, switch to MANUAL tune-up as described in Section 3-6; this will permit compensating for load characteristics and achieving the desired operating conditions, up to full rated power.

With drive adjusted for approximately 0.7 A of plate current and grid current in the range of about 40 to 100 mA maximum, your ALPHA 78 is properly set up for operation at about 1 kW of dc plate power input on CW/RTTY/SSTV. For 1 kW PEP/SSB, simply adjust the SSB drive level from the exciter so that the highest grid current swings of the MULTIMETER are approximately 50 mA. (Refer to Section 3-3 for discussion of meter response.)

3-5.3 Final Adjustment for 2+ kW PEP SSB Input. For high power (2+ kW PEP) SSB operation, first complete the preliminary set-up for 1 kW operation as above, then return the exciter to STANDBY or RECEIVE. Press the amplifier SSB button and confirm with the MULTIMETER (HV position) that HV is  $2300 \pm 100$  VDC. Switch the exciter to the SSB mode and slowly increase its output level while speaking normally into



the microphone. The correct operating level is reached when either (a) the highest swings of the PLATE CURRENT METER reach approximately 0.45 A ( $2200\text{ V} \times 0.45\text{ A} = 990\text{ W}$  = maximum legal power input, average) or (b) the highest swings of the MULTIMETER (monitoring grid current) reach approximately 50 mA. Higher grid current swings may result in distortion, interference to other stations, and possible tube damage.

Occasionally check the load VSWR while operating, to make sure that it remains at or below 1.5:1. Also, monitoring reflected power is useful in that any sudden increase provides warning of antenna problems such as bad connections, transmission line flaws, or trap or balun failure. Particularly in the case of flashover (arcing) problems, the reflected power indication may flicker sharply upward only on high power voice peaks.

### 3-6 MANUAL TUNE-UP OPERATION OF THE ALPHA 78

3-6.1 Preliminary Control Settings. It is important initially to make certain that the load VSWR does not exceed 2:1 (10% reflected power). If the VSWR exceeds 2:1, an antenna tuner of adequate power-handling capability should be used in order to maintain amplifier efficiency and avoid amplifier damage.

Place the ALPHA 78 in STANDBY (both the CW and SSB buttons out). Select the desired MANUAL position of the bandswitch. (Manual tune-up positions are indicated by the narrow scale marks labeled 1.8, 3.5, 7, 14, and 21 MHz. (On export models only, there is also a 28 MHz position which is "semi-bandpass." See section 3-5.1.)

Set the TUNE and LOAD controls to the preliminary settings shown in Table 1, below. The final settings will vary with operating frequency, load characteristics, and drive level.

Table 1: Preliminary Settings for Initial Manual Tune-Up

<u>FREQ</u>	<u>BAND</u>	<u>TUNE</u>	<u>LOAD</u>	<u>FREQ</u>	<u>BAND</u>	<u>TUNE</u>	<u>LOAD</u>
1.8	1.8	60	40	7.1	7	50	45
2.0	1.8	55	45	14.15	14	16	75
3.6	3.5	65	30	21.20	21	10	82
3.9	3.5	60	35	28.7*	28*	N/A	90

\* Factory-provided 28 MHz coverage (semi-bandpass) is included on export versions only..

3-6.2 Adjustment for 1 kW DC Input. Make certain that the exciter/transceiver power output control is set to zero; then press the ALPHA 78 CW button. Place the exciter in the appropriate mode to deliver a steady (adjustable) carrier, usually called "CW" or "Tune." Press the MULTIMETER "GRID" button on the ALPHA 78. Slowly increase the exciter carrier power output from zero until either (a) the PLATE CURRENT METER indicates 0.5 A, or (b) the MULTIMETER indicates GRID current of 50 mA.

Press FWD and carefully adjust LOAD for maximum rf watts indicated on the MULTIMETER. (If an external rf wattmeter is used, leave the MULTIMETER in its GRID position.) Then adjust TUNE for maximum rf watts indicated on the meter. Repeat

the process of alternately peaking first LOAD, then TUNE, until no further increase in forward rf power can be achieved (without changing the drive level).

Note the PLATE CURRENT METER reading; the desired value for 1 kW dc power input is approximately 0.7 A. If the actual plate current reading at this point is less than 0.7 A, slightly increase the exciter carrier output. If the plate current reading is more than 0.7 A, slightly decrease the exciter output. In either case, repeat the alternate LOAD-TUNE adjustment procedure, as above, while striving for maximum forward rf power. Continue (as necessary) changing the exciter carrier output level in very small steps as above until, after the final LOAD-TUNE adjustments, the PLATE CURRENT METER indicates the desired value.

NOTE: On export models only, the 28 MHz (10 meter) position is available. In this "semi-bandpass" position, the LOAD control has a broad output-peaking effect; the TUNE control is not used at all on 28 MHz. Simply adjust LOAD for maximum forward rf power and set the exciter carrier output level so that the final PLATE CURRENT METER reading is as desired.

At this point, your ALPHA 78 is properly adjusted for operation at approximately 1 kW of dc plate input power on CW/RTTY/SSTV. To operate SSB at 1 kW PEP input, simply switch the exciter to SSB and adjust its SSB output power level so that the maximum GRID current swings of the ALPHA 78 MULTIMETER are approximately 50 mA. (For further information, refer to the discussion of meter response in section 3-3 of this manual.)

3-6.3 Final Adjustment for 2 kW PEP SSB Input. For high power (2+ kW PEP) SSB operation of the ALPHA 78, first complete the adjustments for 1 kW tune-up as in section 3-6.2 above. Then return the exciter to STANDBY or RECEIVE. Press the amplifier SSB button and confirm with the MULTIMETER (in HV position) that the HV is  $2300 \pm 100$  VDC.

Switch the exciter to the SSB mode and slowly increase its output level while speaking normally into the microphone. Correct operating adjustment is achieved when either (a) the highest swings of the PLATE CURRENT METER reach approximately 0.45 A, or (b) the highest swings of the MULTIMETER (monitoring GRID current) reach approximately 50 mA. At this operating level -- FCC maximum legal power of approximately 1 kW average dc plate input and 2+ kW PEP input -- no LOAD-TUNE adjustments are required, other than those already performed during the initial tune-up a 1 kW input. (Refer back to section 3-3 for discussion of proper operating level.)

Check antenna VSWR occasionally during operation to make sure that it remains at or below 2:1. As mentioned previously, it is a good idea to make a habit of frequently monitoring reflected rf power for any sign of transmission line, antenna coupler, or antenna fault -- especially for flashover which may occur only on high power voice peaks.

### 3-7 ALC

When the amplifier's negative-going ALC is used (usually with tube-output types of exciters or transceivers), adjustment of ALC threshold is accomplished via trimpot R209, accessible via a hole on the back panel of the amplifier. If the exciter manufacturer does not provide instructions for adjustment of ALC with a linear amplifier, the following procedure is usually satisfactory:

Set the ALPHA 78's ALC trimpot R209 to yield the desired amplifier PLATE CURRENT swings on voice crests, while alternately adjusting the exciter microphone gain (or its rf output control, if it has such a control independent of the mike gain) to provide the desired degree of exciter ALC action. With those exciter/transceivers having no way to monitor ALC action, follow the manufacturer's instructions for achieving "normal" exciter/transceiver operation. It is desirable in such a case to have a friend listen to your signal "on the air" to confirm that excessive ALC "pumping" does not result; if it does, the solution is to reduce microphone gain until the "pumping" is barely noticeable. CAUTION: Be sure that your listener does not confuse "pumping" of his receiver's AGC with ALC action -- receiver AGC should be turned off and rf gain turned down for such a listening test.

### 3-8 CW BREAK-IN (QSK) OPERATION

Interconnections for CW break-in are given in Figure 2. A complete explanation of QSK system operation is given in the "Theory of Operation" section of this manual, section 4-4.

### 3-9 OPERATING NOTES

3-9.1 Tubes. The 8874 ceramic-metal triodes are extremely rugged and normally operate with a large margin of safety in the ALPHA 78. They will deliver outstanding service for many years IF not damaged by abuse -- such as excessive grid current (leading to excessive grid dissipation) or airflow blockage leading to anode overheating. KEEP THE AIR INTAKE AND EXHAUST VENT AREAS COMPLETELY CLEAR!

WARNING! DO NOT ALLOW the ALPHA 78 PLATE CURRENT METER indication ever to exceed 1.0 ampere (full scale on the meter) for more than 5 seconds.  
DO NOT ALLOW GRID CURRENT ever to exceed 150 mA (full scale in the MULTIMETER GRID position); normal operation requires only 40-90 mA.

3-9.2 Interlocks. Your ALPHA 78 is equipped with switches intended to shut off ac power and to short out the high voltage power supply when the cabinet cover is not securely fastened in place. These protective interlocks are provided to protect you against POTENTIALLY FATAL ELECTRIC SHOCK resulting from accidental contact with lethal high voltages inside the amplifier. HOWEVER, you should never depend on the interlocks alone to protect you by removing dangerous voltages: ALWAYS DISCONNECT THE AC SERVICE CABLE TO THE ALPHA 78 BEFORE REMOVING THE COVER.

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

3-9.3 Fuses. Except in rare instances of component failure, blowing of one or both primary line fuses indicates that the maximum safe average power capability of the amplifier has been substantially exceeded. Use only 15 A/250 V CERAMIC fuses. (Ceramic-body fuses of 20 A rating may be substituted for operation from 120 V line only.) The slo-blo fuse (F3) located just behind the front sub-panel on the center partition is intended to protect the HV rectifiers and step-start resistors in the event of abnormal turn-on conditions or HV faults. DO NOT SUBSTITUTE A FUSE OF HIGHER RATING under any conditions.

3-9.4 Plate Overcurrent Relay. This relay serves primarily to de-energize primary circuits quickly in the event of a major HV fault or grossly excessive drive conditions. The relay should not be relied upon to prevent damage due to either short- or long-term overdrive -- that is the operator's responsibility. Should the overcurrent relay trip, thus removing ac power from the amplifier, it is essential to

determine and correct the cause before re-applying power by pressing the ON button.

3-9.5 Maintenance and Troubleshooting. Most problems and apparent failures with ALPHA amplifiers result from the operator's failure to read and thoroughly understand the contents of the instruction manual ... as well as basic linear amplifier principles ... rather than from actual equipment defects. Should problem arise, the troubleshooting hints of Table 2 will help isolate the nature of the problem.

The amplifier interior, particularly high voltage dc areas of the power supply and rf compartment, should be cleaned frequently enough (with a soft brush and a vacuum cleaner) to prevent visible accumulation of dust. If extremely dusty conditions prevail, it may be advisable to secure a thin plastic-foam air filter, of the type commonly used in window air conditioners, and tape it across the air intake perforations at the rear of the cabinet. Make certain that the filter does not restrict air flow into the amplifier.

TABLE 2 -- TROUBLESHOOTING HINTS

SYMPTOMS

POSSIBLE CAUSE/CURE

- |   |  |
|---|--|
| 1. Won't turn on; nothing happens when ON button is pushed.   | a) F1, F2, or F3 missing or open.<br>b) Incorrect or no jumper across required terminals of ac primary selection strip.<br>c) Cover ac interlock S5 not closed by lid.<br>d) House wiring incorrect or breaker open.<br>e) K7 contacts welded together (shorted).<br>f) R4 open. |
| 2. K1 relay closes (and blower may start) but no HV or meter lamp illumination at turn-on.  | a) Step-start relay K2 not closing due to malfunction in +28 VDC supply.<br>b) Fuse F3 missing or open.<br>c) HV short to ground.<br>d) Shorted 8874 tube.   |
| 3. K1 (and possibly K2) closes at turn-on, but F3 and/or F1 and F2 blows immediately.   | a) HV shorted at crowbar or elsewhere.<br>b) Shorted 8874 tube.<br>c) Malfunction in +28 VDC supply, such as shorted electrolytic capacitor C108.  |
| 4. Relays close, fan starts, HV normal, but meter lamps do not change to green after time delay; T/R relays remain in "receive."        | a) CW or SSB button depressed (not in STANDBY condition).<br>b) Defective time delay component or lamp driver transistor.  |
| 5. Relays close, fan starts, HV meter deflects downward, fuse(s) may blow or plate overcurrent relay K7 may trip.                       | a) Interelectrode short in 8874 tube.<br>b) Shorted or deformed HV electrolytic filter capacitor.  |
| 6. Amplifier won't drive; zero grid and plate current, high input VSWR.   | a) Defective cable from exciter to amplifier input.<br>b) Input reed relay K4 not closing.<br>c) Damage to amplifier input matching network.   |
| 7. Amplifier drives easily but grid current meter pins at low drive.  | a) Grid current metering resistor R116 open or damaged due to severe over-drive or insufficient loading of amplifier.  |
| 8. Amplifier difficult to drive, grid current low, high input VSWR (may cause "turn-down" of rf output with some solid state exciters). | a) Amplifier bandswitch in wrong position.<br>b) Defective RF Input coaxial cable.<br>c) Contacts of relay K4 not closing.<br>d) Bias zener diode D110 damaged or open.<br>e) Damaged amplifier input matching network.<br>f) Interelectrode short in 8874 tube.                 |
| 9. Amplifier drives easily, plate current at or above normal, grid current low, no output (may be accompanied by a "frying" sound).     | a) Arc-over of rf component in tank circuit.<br>b) Defective output T/R vacuum relay contacts.<br>c) Amplifier bandswitch in wrong position.<br>d) Excessively high load VSWR.   |

10. Plate current flows in receive or standby condition.
  - a) Q305 on CB-3 shorted or damaged.
  - b) Fault-protective diode D106 shorted.
  - c) Tube interelectrode short, complete or partial, cathode-to-filament or -grid.
11. Meter lamps remain amber and T/R relays remain in "transmit," even in standby condition.
  - a) RF drive power is present from exciter.
  - b) Q305 on CB-3 shorted or damaged.
12. Low output, exciter drive appears lower than normal.
  - a) Amplifier ALC sensitivity control R209 set too high (excessive ALC voltage).
13. Flashover in rf compartment, usually between load capacitor plates.
  - a) Excessive load VSWR -- mismatched or wrong antenna connected.
  - b) Defective RF Output cables or other cables or connectors in path to antenna.
  - c) Improper tune-up procedure and/or excessive drive from exciter.
  - d) Dirt or other foreign matter between variable capacitor plates.
  - e) Amplifier bandswitch in wrong position.
  - f) Defective output T/R vacuum relay.
14. Distorted SSB output signal, possibly with severe TVI.
  - a) Excessive load VSWR.
  - b) Defective rf cables, connectors.
  - c) Improper tune-up - especially excessive drive power from exciter.
  - d) Antenna "trap," balun, or feedline arc-over on voice peaks.
  - e) RF feedback from antenna or feedline into exciter/microphone line.
15. No indication on multimeter.
  - a) Appropriate button not pushed.
  - b) Multimeter damaged or open.
16. No indication on multimeter of forward or reflected power, but rf output verified with an external rf wattmeter or equivalent.
  - a) Diode(s) D201 or D202 on CB-2 defective.
  - b) R201 or R202 damaged or open.
  - c) Capacitor C202 shorted.
17. Wattmeter highly inaccurate. (Refer also to Sect. 4-1.3.)
  - a) Highly reactive/mismatched load.
  - b) C202 null adjustment incorrect.
  - c) R205 (forward calibration) misadjusted.
  - d) Multimeter damaged and inaccurate.
18. Amplifier will not key to transmit condition using conventional PTT or VOX control hookup for CW or SSB (stays in "thru").
  - a) RF appears at RF Input jack before T/R line closure from exciter. See Sect. 2-7.
  - b) Defective Q302.
  - c) Defective output T/R vacuum relay K5.
19. With QSK hookup, exciter is not keyed (or is not fully keyed on) by amplifier QSK output line.
  - a) Resistance of protective resistor R302 (100 ohms) too large to permit full exciter keying. See section 4-4(d), NOTE.
20. In QSK, exciter keys immediately when ampl. CW mode button pressed.
  - a) K11 contacts welded due to damage.
  - b) Transistor Q302 shorted.

## SECTION 4: THEORY OF OPERATION

### 4-1 AMPLIFIER RF SECTION

4-1.1 Tubes. Ceramic-metal triodes V1, V2, and V3 are parallel-connected in a class AB<sub>2</sub> grounded-grid configuration. +28 V is applied as cathode bias via R115 and L3 to cut off plate current during non-transmit periods. The bias is reduced to the operating level of approximately +5 V whenever the T/R relays are actuated. RF excitation is applied to the cathodes via an input matching network which is carefully designed to present to the exciter a nominal 50 ohm load at all frequencies. NOTE: Changing this input network may result in excessive input VSWR and/or distortion.

4-1.2 Pi-L Network. The full pi-L plate output network is switched by the four sections (S1A-S1D) of the bandswitch. When a MANUAL tuning range is selected, the bandswitch connects the manual TUNE and LOAD capacitors, C18 and C19 respectively, to appropriate taps on the pi and L inductors. The resultant conventional pi-L network has excellent harmonic rejection. When one of the BANDPASS ranges is selected, factory-preset variable and fixed capacitors and inductor taps provide the special values of L and C required.

The ALPHA 78 also uses a front panel toggle switch, labeled CW/PHONE, which controls internal relays that switch in additional fixed capacitance, as needed, to optimize BANDPASS operating efficiency in the upper (PHONE) or lower (CW) half of each of the BANDPASS frequency ranges. Thus exceptionally efficient operation across the entire amateur band is possible without the need for any tune or load adjustments by the operator. (In the 28 MHz position provided on export models only, the LOAD control may be used manually to broadly "peak" output and efficiency at any point in the 28-29.7 MHz band. TUNE has no effect on this band.) Diodes D2, D3, and D4 provide a dc path to ground from the output line as a safety precaution in the (unlikely) event that a high voltage blocking capacitor should break down (short).

4-1.3 Built-in RF Wattmeter. An rf directional wattmeter, consisting of L201 and associated components on CB-2, senses forward and reflected power in the rf output line. Trimmer C202 allows the reflected power detector to be nulled into a 50 ohm nonreactive load. Trimpot R205 provides calibration of the forward power scale.

WARNING! POTENTIALLY LETHAL VOLTAGES exist very near the wattmeter etched circuit board, CB-2. If adjustment of C202 or R205 should ever become necessary, it should be performed only by experienced and knowledgeable personnel!

C206 provides a semi-peak-reading function for the forward power detector. Due to the meter's ballistic characteristics, the MULTIMETER will approach (but never quite reach) a true PEP indication -- hence the term, "semi-peak-reading." NOTE: The ALPHA's wattmeter readings may not agree precisely with those of high-accuracy external wattmeters (especially on the reflected power scale) due to slight nonlinearities and other effects inherent in the internal wattmeter design.

4-1.4 ALC Detector. ALC rectifier circuit C209, C210, D203, and associated components develop a negative-going ALC voltage whenever the preset rf input voltage threshold level is exceeded. Trimpot R209, accessible through the rear panel of the amplifier, permits setting the ALC threshold to suit the exciter in use.



## 4-2 POWER SUPPLY

4-2.1 Transformer. The ALPHA 78 power transformer (T1) is a nominal 2.4 KVA, Hipersil®-core, continuous commercial service unit which supplies all required operating voltages for the amplifier. Dual primaries permit connection for either 117 V or 234 V (nominal), 50-60 Hz, single phase primary power mains. No wiring changes (other than the simple jumper changes described in section 2-3) are necessary for operation from either the U.S. standard 117-N-117 V, or from typical overseas 234 V (nominal) two-wire systems with or without a "central" neutral wire. In any case, the third power cable wire (green) must always be connected only to ground, for safety purposes.

4-2.2 Supply Voltages. High voltage dc for the tube anodes is provided by full wave bridge rectifier D101-D104, and is filtered by a composite 35 uf, 2.7 KVDC capacitor bank consisting of C101-C106. These are computer-grade electrolytic capacitors, factory matched for both nominal capacitance and dc leakage, and burned in to insure low ripple and long life.

Relay K3 selects high or "low" voltage taps from the high voltage secondary of T1, and is controlled by the front panel CW/SSB push button switches. Cover interlock switch S5 prevents actuation of main power relay K1 unless the amplifier cover is secured in place. Additional operator protection is provided by the safety "crow-bar" , which shorts the high voltage supply and discharges the filters when the cover is opened.

D107, D108, and C108 provide +28 VDC for various bias and control circuits, including the time delay and T/R functions.

## 4-3 CONTROL AND METERING CIRCUITS

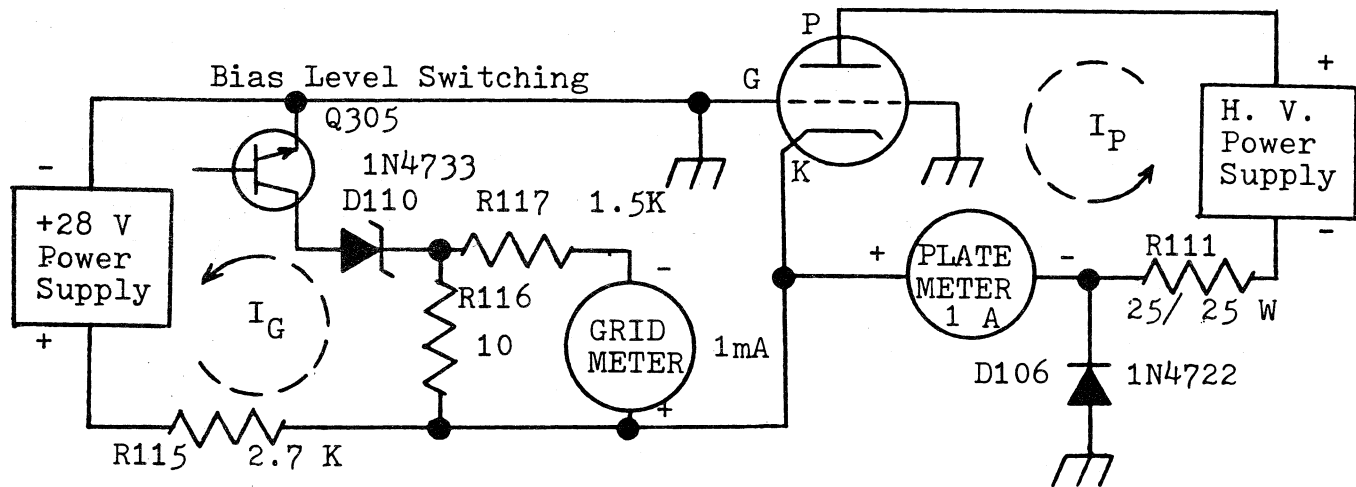
4-3.1 On-Off. The ON and OFF pushbuttons (S2) are momentary contact switches. When ON is pushed, voltage is applied to the coil of K1, which latches closed. At the same time, the transformer is energized via the relay (K1) and step-start current limiting resistors R1 and R2 which prevent the initial in-rush surge from exceeding 12 A maximum. As soon as the HV filter capacitor approaches full charge (a few milliseconds), the +28 V supply line reaches the pull-in level of step-start relay K2 which then closes and shunts the step-start resistors out of the circuit.

F3 protects the HV rectifiers and R1/R2 in the event of faults which prevent K2 from closing normally. When OFF is pushed, the coil of K1 is momentarily shorted, causing it to un-latch and remove all ac power from amplifier circuits. R4 is a voltage dropping resistor which allows the coil of K1 to operate safely from a 240 V line.

4-3.2 Time Delay. The 8874 tubes are protected against cathode current flow during their mandatory (60 second nominal) heater warmup period by the time delay circuit located on CB-1. The gate of programmable unijunction transistor (PUT) Q101 is clamped at about +14 V by voltage divider R121-R122. At initial turn-on, C109 charges through R120 until the anode of Q101 becomes more positive than its gate. At that point Q101 turns on abruptly, triggering SCR Q102 which activates relay K6. Until K6 closes, the amplifier is locked in the STANDBY mode, since T/R enable relay K10 (on CB-3) cannot be closed. Once K6 closes, the green meter lamps light, indicating STANDBY. Depressing either the CW or SSB pushbutton closes K10 and puts the amplifier in a "ready-to-transmit" state.

4-3.3 Lamp Circuit. During the time delay interval, the amber lamps are on because the base of Q103 is prevented by D112 from being turned on by the +28 V bias line. When K6 closes, voltage from CB-3 turns Q103 on, lighting the green meter lamps and extinguishing the amber. Pushing either CW or SSB, however, again grounds the base of Q103 and lights the amber lamps. Note that the base of Q103 is also grounded, keeping the amber lamps lighted, if the QSK system's rf detectors lock the T/R system in "transmit" due to the continued presence of rf drive power after the amplifier is switched to the (nominal) STANDBY condition (the ground path is via Pin 10 of CB-1 and D112).

4-3.4 Metering and Bias. The metering and bias circuits may be understood most readily by reference to the simplified schematic shown below.



The plate current meter (M2, 0-1 ADC) is in series with the negative return of the high voltage plate supply, and it indicates plate current only. Grid current is separately monitored by sensing the voltage drop ( $I_g \times R_{116}$ ) across resistor R116 using the multimeter (M1, 0-1 mADC) and resistor R117 as a scale-factor multiplier.

When the ALPHA 78 is in STANDBY (or receive), the bias switching transistor Q305 is off, resulting in cathode-to-grid voltage of +28 V which biases the tubes past cut-off. When Q305 is turned on by keying the amplifier T/R relay line in either CW or SSB mode, bias voltage is switched to the operating level of approximately +5 VDC.

High voltage fault current limiting is provided by R111 and D106. Should the positive HV line be accidentally grounded, R111 limits the resultant fault current to a safe level and D106 provides a protective fault current return path to the power supply.

4-3.5 Plate Overcurrent Relay. The voltage drop across R111 is sampled via voltage divider R112-R113 and activates the coil of relay K7 (on CB-1) when a preset safe level is exceeded. Zener diode D105 protects K7 against extreme voltage surges such as are likely to occur in the event of a HV short. Note that the contacts of K7 are in parallel with the OFF pushbutton, so that closure of the plate overcurrent relay (even momentarily) removes all ac power from the amplifier.

#### 4-4 CW BREAK-IN (QSK) SYSTEM

Basic operation of the QSK system is best understood by following through the sequence of events which occurs when a pair of contacts (a CW key or keyer, PTT contacts, or other contacts to control T/R switching) connected to the amplifier's RELAY jack (J3) is first closed, and then opened. (Placing the amplifier in either the CW or SSB mode closes T/R enable relay K10, on CB-3, activating the QSK system.)

- a] Immediately upon closure of the RELAY line contacts, Q304 turns off because its base is pulled to ground via R311. If Q303 is also turned off, then Q305 will be turned on by base current via R309. Q303, in turn, will be off if Q306 is on and clamps the base of Q303 to ground.
- b] Q306 is normally turned on (via R312, D307, and Pin 2/CB-3 which is floating at the +28 VDC cutoff bias level) whenever the RELAY line is open, provided that no RF drive power is present at the amplifier input jack (J4). If the "Pre-K4 RF Detector" does provide a negative voltage as a result of the presence of RF drive, however, Q306 will be turned off thus preventing completion of the sequence described in a] above. NOTE that once Q305 is turned on, Q306 must always be off since its base is clamped near ground potential by the collector of Q305. Thus, Q306 serves only to inhibit T/R relay closing in the event that RF drive power is present at the amplifier input before the amplifier external RELAY line is closed, initiating the events in a]. Once the T/R relay activation sequence above is completed, Q306 is inactive.
- c] Assume that no RF drive is present initially, so that Q305 is in fact turned on upon closure of the RELAY line contacts. Then the collector of Q305 will switch to near-ground potential, activating relays K4 and K5 via Pin 1/CB-3. Also, the bias voltage is pulled down to the operating level established by zener diode D110, via Pin 2/CB-3. Thus, Q305 switches the amplifier into its "transmit" condition.
- d] Q301 is normally turned on by two sources -- via R304 and D302, and via R310, R305, and D303. The second source goes to zero when the RELAY line contacts close. The first source goes to zero when output T/R relay K5's N.O. contacts close. This latter path to ground is via Pin 7/CB-3, L7, feedthru capacitor C48, L8, the contacts (N.O.) of K5, and L9. (NOTE: The voltage drop across diode string D2-D3-D4 is sufficient to keep Q301 turned on until the contacts of K5 close. The purpose of the diode string is to maintain a low impedance dc path to ground as a safety measure - to prevent high voltage dc from reaching the output coax line in the event of a blocking capacitor failure.) Thus, Q301 turns off only when the RELAY line is closed and after K5 has also closed.
- e] Once Q301 has turned off after closure of K5, Q302 immediately turns on and energizes the coil of exciter-keying relay K11. K11, a high speed reed relay, grounds the KEY (exciter-keying) jack (J8), completing the QSK "make" sequence. (Note that K4's contacts close more quickly than those of the larger K5. Also, K5 has excellent "bounce" characteristics, so that any bounce has ended by the time K11 closes and keys the exciter on.)
- f] Upon opening the external RELAY line contacts, Q301 turns on instantly, thus turning off Q302 and causes K11 to open within about 0.5 msec (typically). HOWEVER, should "Post-K4 RF Detector" sense the continuing presence of RF drive after K11 opens, the resulting negative voltage (via Pin 5/CB-3) prevents Q304 from turning on ... and thus prevents Q305 from turning off and releasing the T/R relays back to "receive" ... until the rf drive from the exciter drops below the detector's threshold of about 100 mW. Thus, once RF from the exciter drops near zero, Q305 turns off and the amplifier T/R relays return to their "receive" or "key up" condition.

Overall operation of the QSK system may be summarized simply as follows: on "make" (closure of the external RELAY line by key, PTT, VOX or other contacts), closure of the exciter KEY circuit via J8 is delayed only long enough for main vacuum T/R relay K5 to close, and to insure that no RF drive is present at the amplifier RF Input at the time. No arbitrary or unnecessary time delays are introduced by the QSK system, since "break" or return to "receive" after the RELAY line is opened is also delayed only the minimum time required for exciter output to drop to zero after the exciter KEY contacts open. Keying speed is limited only by the closing time of K5 (about 2.0 msec) and of K11 (about 0.5 msec), and by the "break" shaping of the exciter keying characteristic. Even so, proper sequencing of keying functions is assured and it is virtually impossible to "hot switch" the T/R relays. Full break-in keying is possible to speeds well in excess of 50 WPM -- provided that the exciter has equivalent capability!

IMPORTANT NOTE: The contacts of exciter-keying relay K11 are protected against damage by a protective network consisting of R301-C302 and R302. On rare occasions an exciter may be encountered which will not key properly (to full output) with 100 ohms (R302) in series with the key line. In such a case, CB-3 may be unplugged and R302 changed to a smaller resistance. Use the largest value which permits normal exciter keying, and not less than 47 ohms unless absolutely necessary.

Finally, when the ALPHA 78 is OFF or in STANDBY, RELAY jack J3 is connected directly through to (exciter-keying) KEY jack J8 (via relay K10). This permits keying the exciter without changing interconnecting cables when the amplifier is not in-line.

## SECTION 5: ILLUSTRATIONS

FIGURE 4. Top View of ALPHA 78.

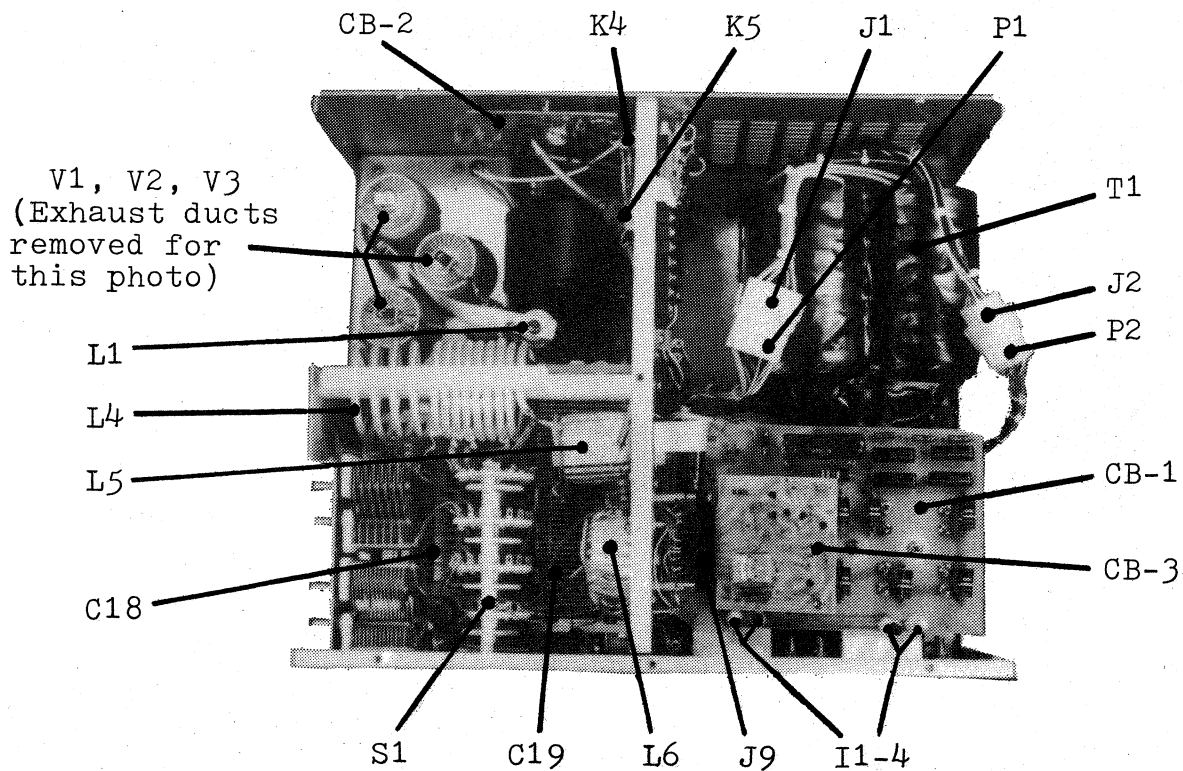


FIGURE 5. Rear View.

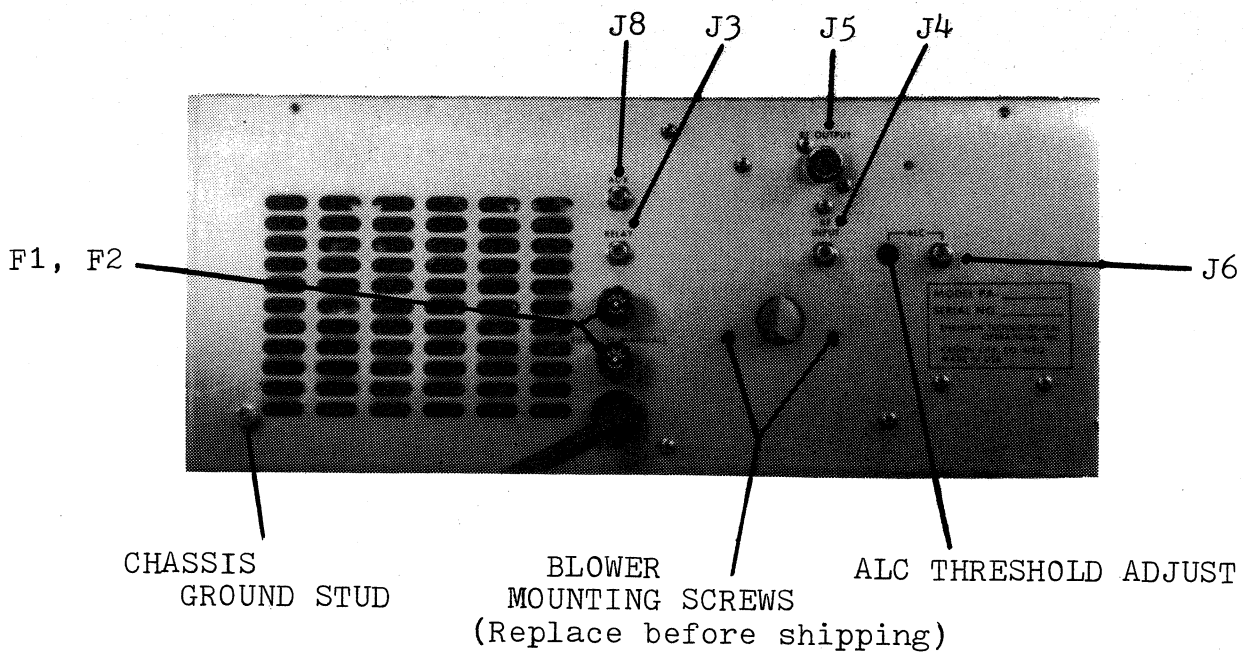


FIGURE 6. Power Supply Section.

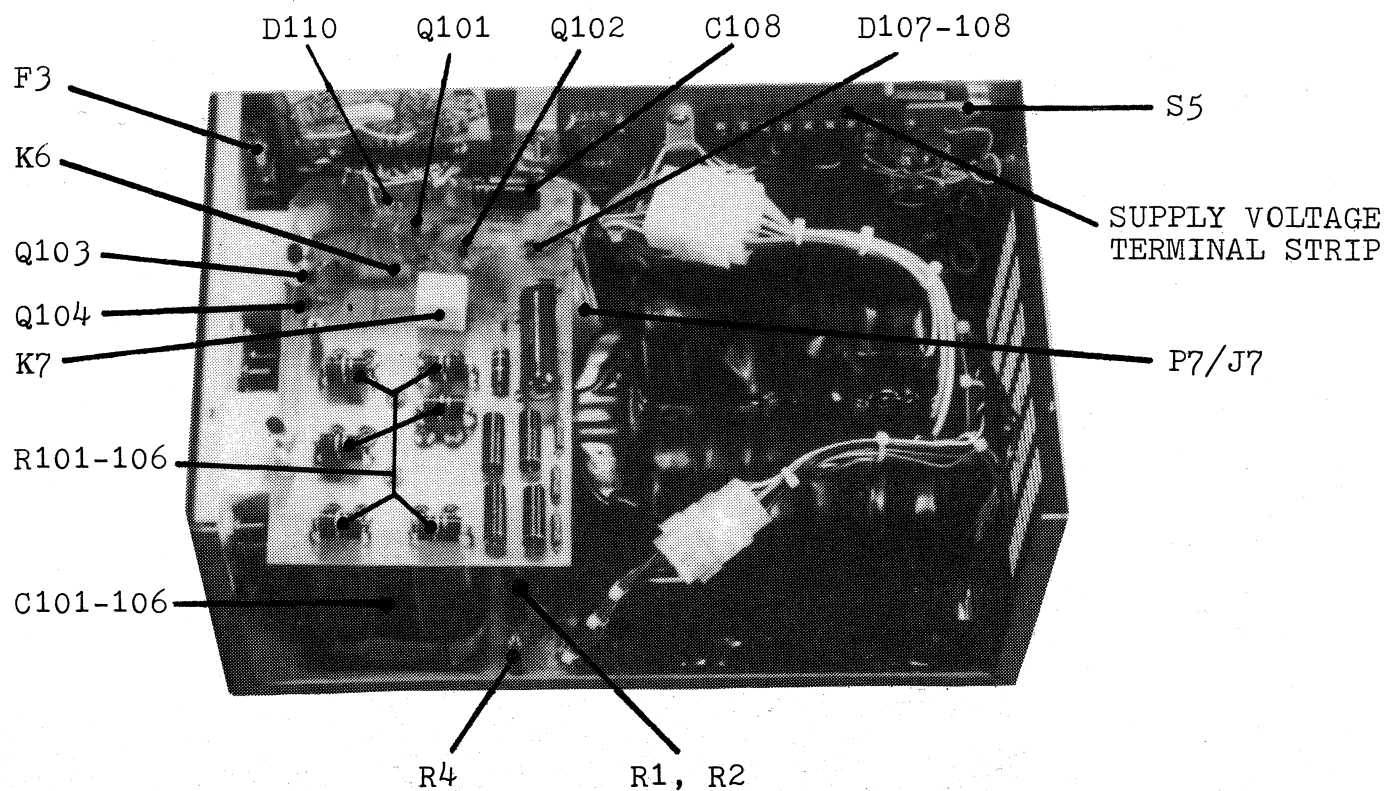
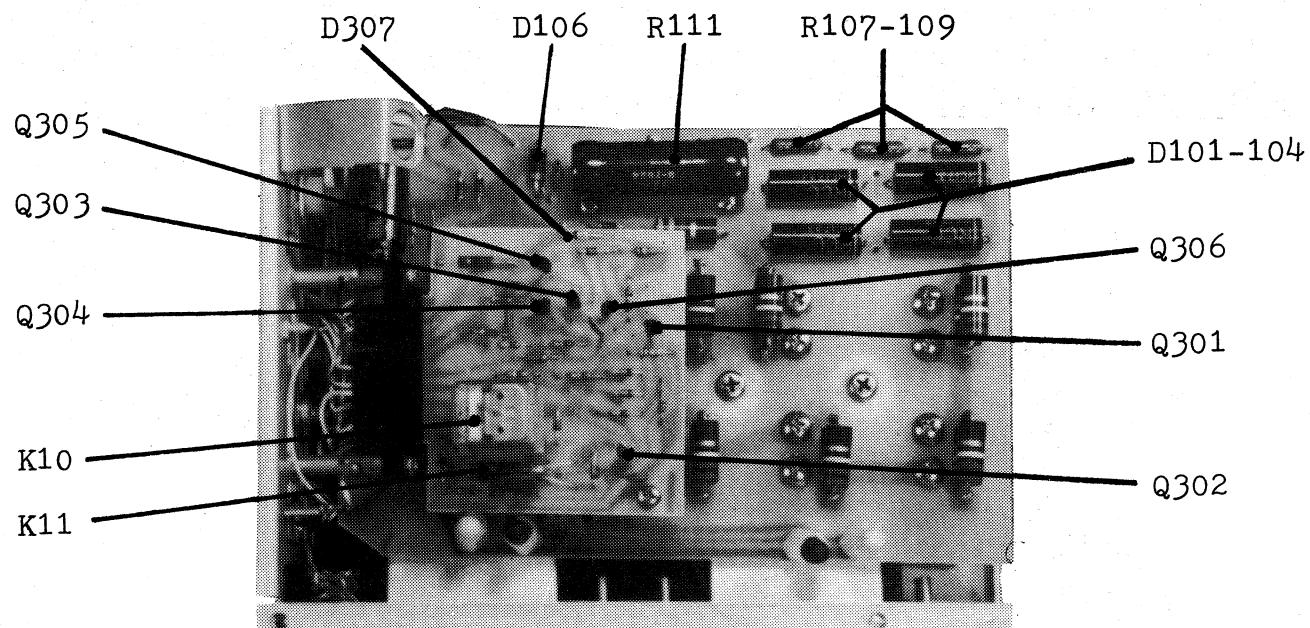


FIGURE 7. Close-up of CB-1 and CB-3.



# PARTS LIST

C1,2,41-44,46 .002 uF/1 kV disc  
 C3-6 .002 uF/3 kV disc  
 C9,14-16,302 .02 uF/1 kV disc  
 C17 .004 uF/6 kV special  
 C48 1500 pF feedthru  
 C101-106 210 uF/480 V matched electrolytics  
 C108 500 uF/50 V elect.  
 C109 22 uF/20 V tantalum  
 C201 18 pF/1 kV disc  
 C202 5-11 pF/1 kV Trimmer  
 C203 300 pF silver mica  
 C206 10 uF/25 V elect.  
 C209 27 pF silver mica  
 C210 100 pF silver mica  
 C303 4.7 uF/35 V tantalum

Capacitors not listed are .01 uF/  
 50 V disc.

D5-8,201-203 1N4148  
 D101-104 3 kV PIV/.5 A (CCS)  
 D105 1N4757 (51 V Zener)  
 D106 1N4722  
 D110 1N4733 (5.1 V Zener)  
 D307 1N4733 (1N4746 on early models)

Diodes not listed are 1N4004 or equivalent.

F1,2 3AB or ABC 15 A/250 V  
 F3 MDL 1 $\frac{1}{4}$  A Slo-Blo  
 I1-4 G.E. #85 Lamp  
 K1 Guardian 1390-2C-120A DPST/120 VAC  
 K2 Guardian 1395-2C-24D DPST/24 VDC  
 K3 P.B. #PRD11DY0-24 or equiv. DPST/24 VDC  
 K4 Magnecraft W102RMX7  
 K5 ITT RJ1A or Kilovac HC-1  
 K6 5 VDC reed relay  
 K7 SPST, N.O./24 VDC  
 K8,9 DPST, N.O./24 VDC  
 K10 DPDT/ 24 VDC  
 K11 24 VDC reed relay  
 L2 15 uH/1 A H. Duty  
 L3,7 15 uH/1 A  
 L8,9 1 mH/100 mA  
 L202 1 mH molded

Q101 2N6027 PUT  
 Q102 2N5061 SCR  
 Q103 2N5307 NPN  
 Q104,301-304,306 2N3904 NPN or equiv.  
 Q305 MJE 802 (2N5822 on early models)

R1,2 10 ohm/12 W (Wire Wound)  
 R4 10 K/8 W (W.W.)  
 R107-109 1 M/ 1%  
 R111 25/25 W (W.W.)  
 R205,209 5 K Trimpot

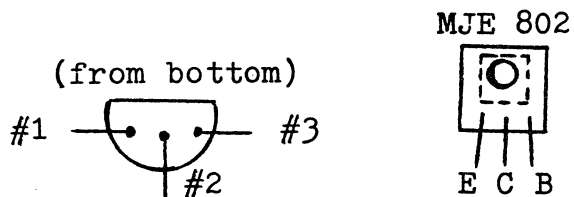
Other resistors 5% composition or film as shown on schematic.

S5 Microswitch V3L-4-D8, SPST  
 S6 SPST Toggle

V1,2,3 Eimac 8874

PARTS NOT LISTED: Specials available from factory.

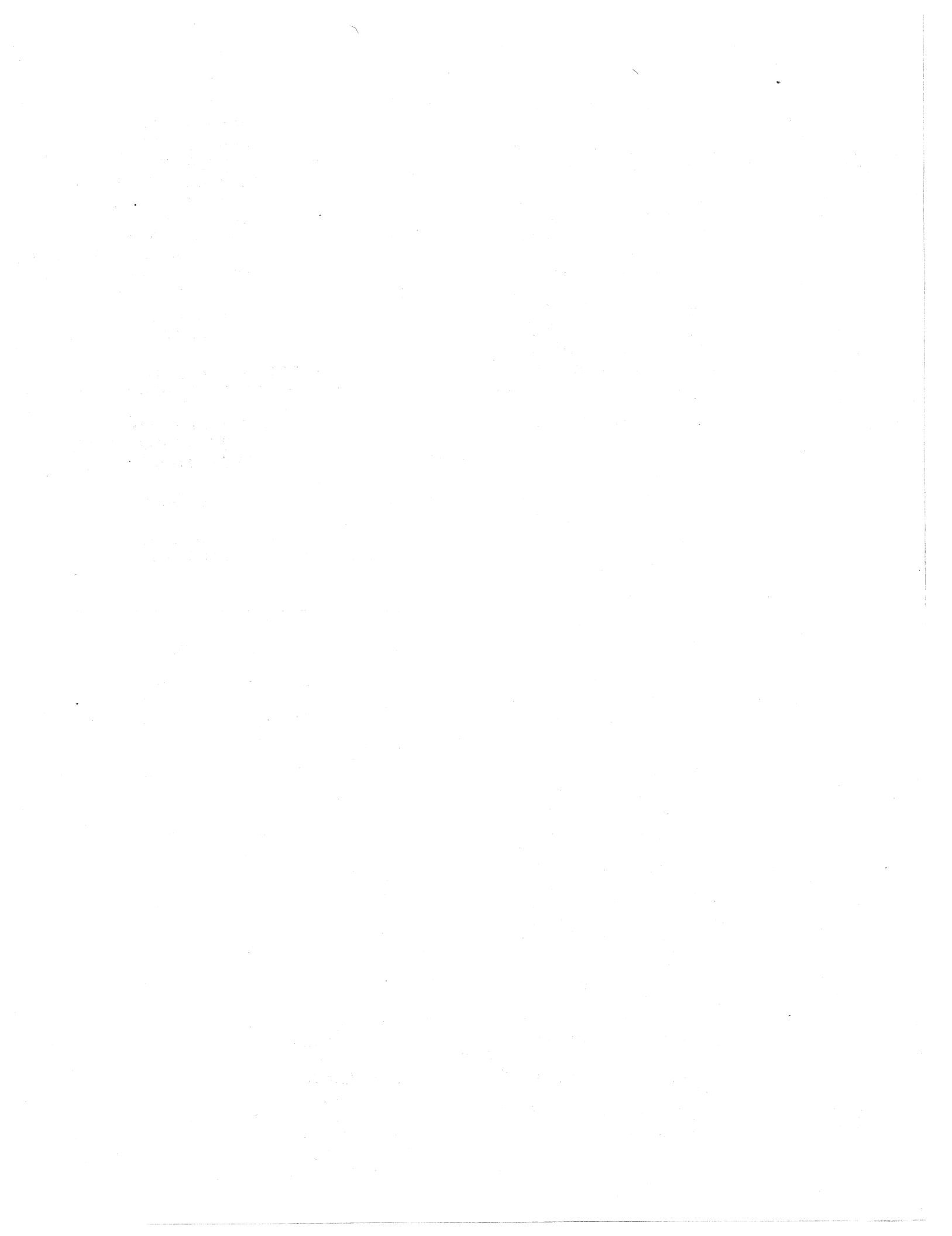
## Transistor Pin Locations:

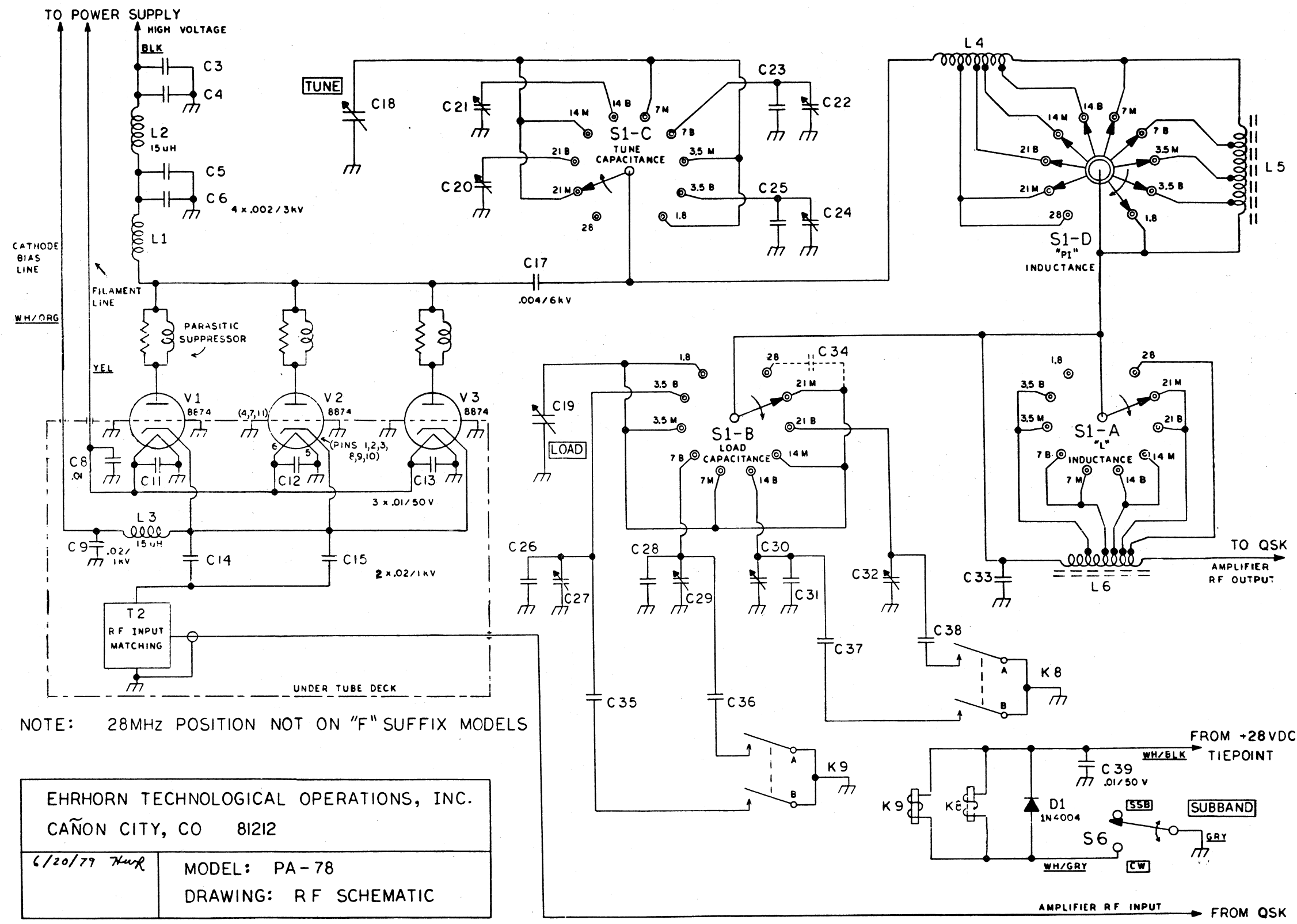


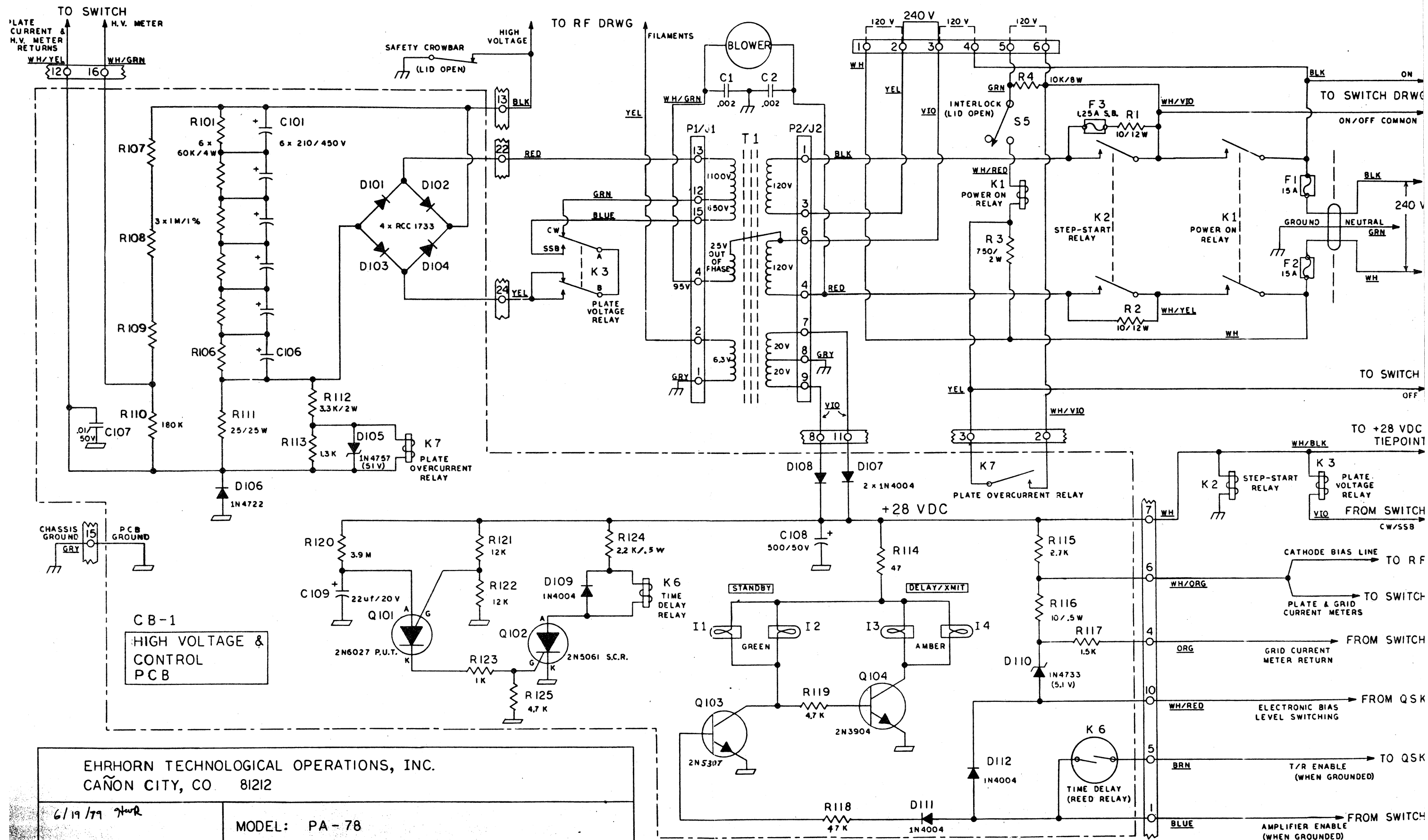
	#1	#2	#3
2N6027	A	G	K
2N5061	K	G	A
2N3904	E	B	C
2N5307	E	C	B
GES5822 (if used)	E	B	C

A = Anode  
 B = Base  
 C = Collector  
 E = Emitter  
 G = Gate  
 K = Cathode









NOTES: ☆ ALL INTERFACES ARE VIA P7/J7 FOR CB-1  
 ☆ ALL RESISTORS 5 OR 10 %, 1/4 W UNLESS NOTED

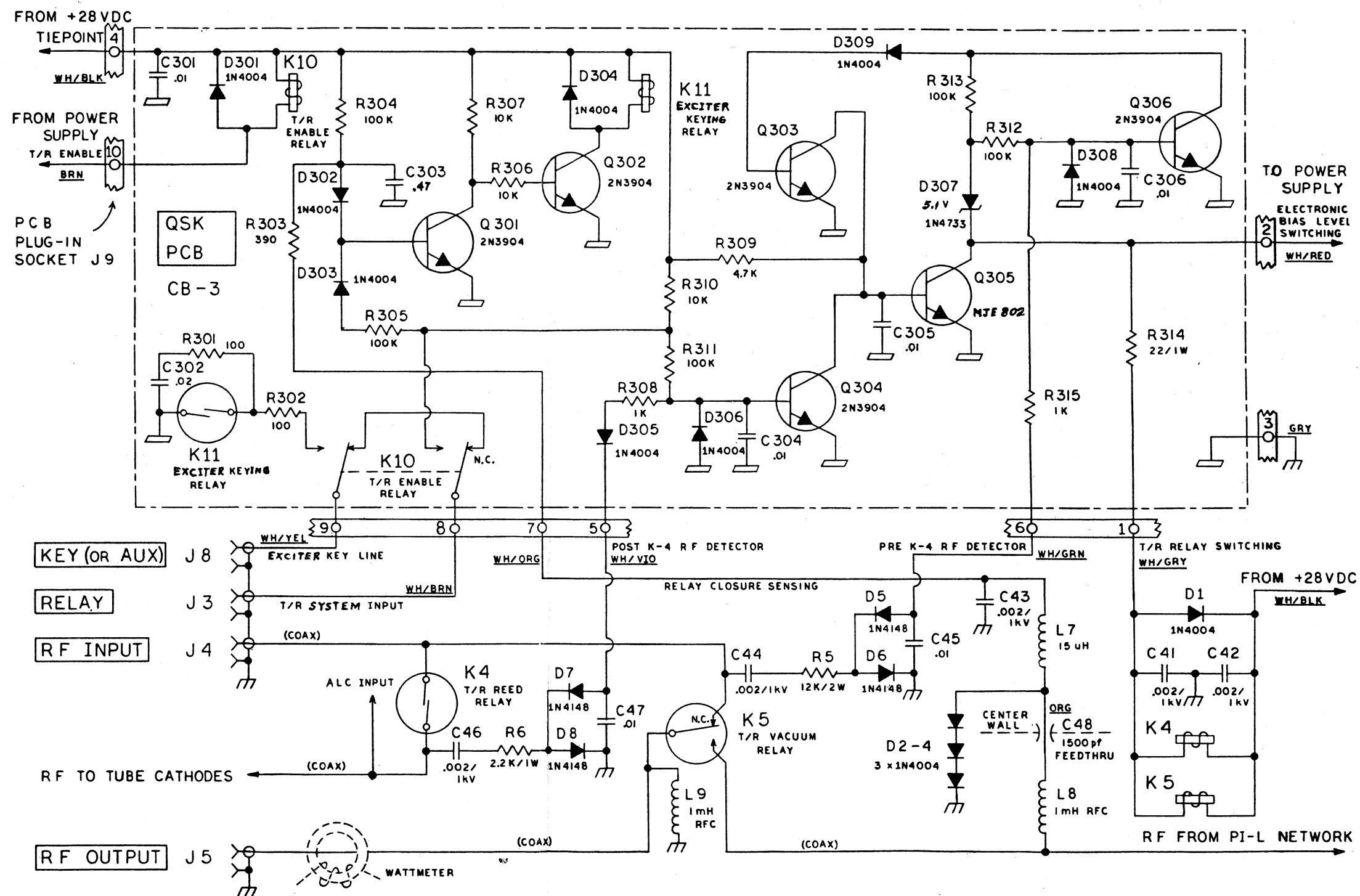
☆ ALL CAPACITORS 1KV UNLESS NOTED  
 ☆ ALL RELAYS SHOWN IN OFF POSITIONS

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 CAÑON CITY, CO 81212

6/19/79 *hwr*

MODEL: PA-78

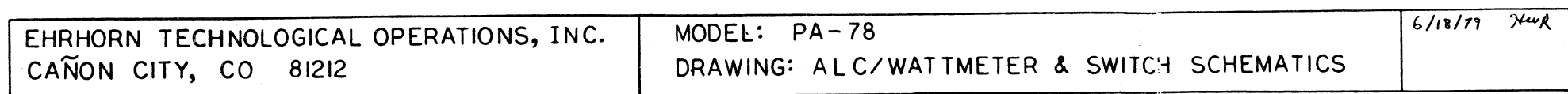
DRAWING: POWER SUPPLY & CONTROL SCHEMATIC

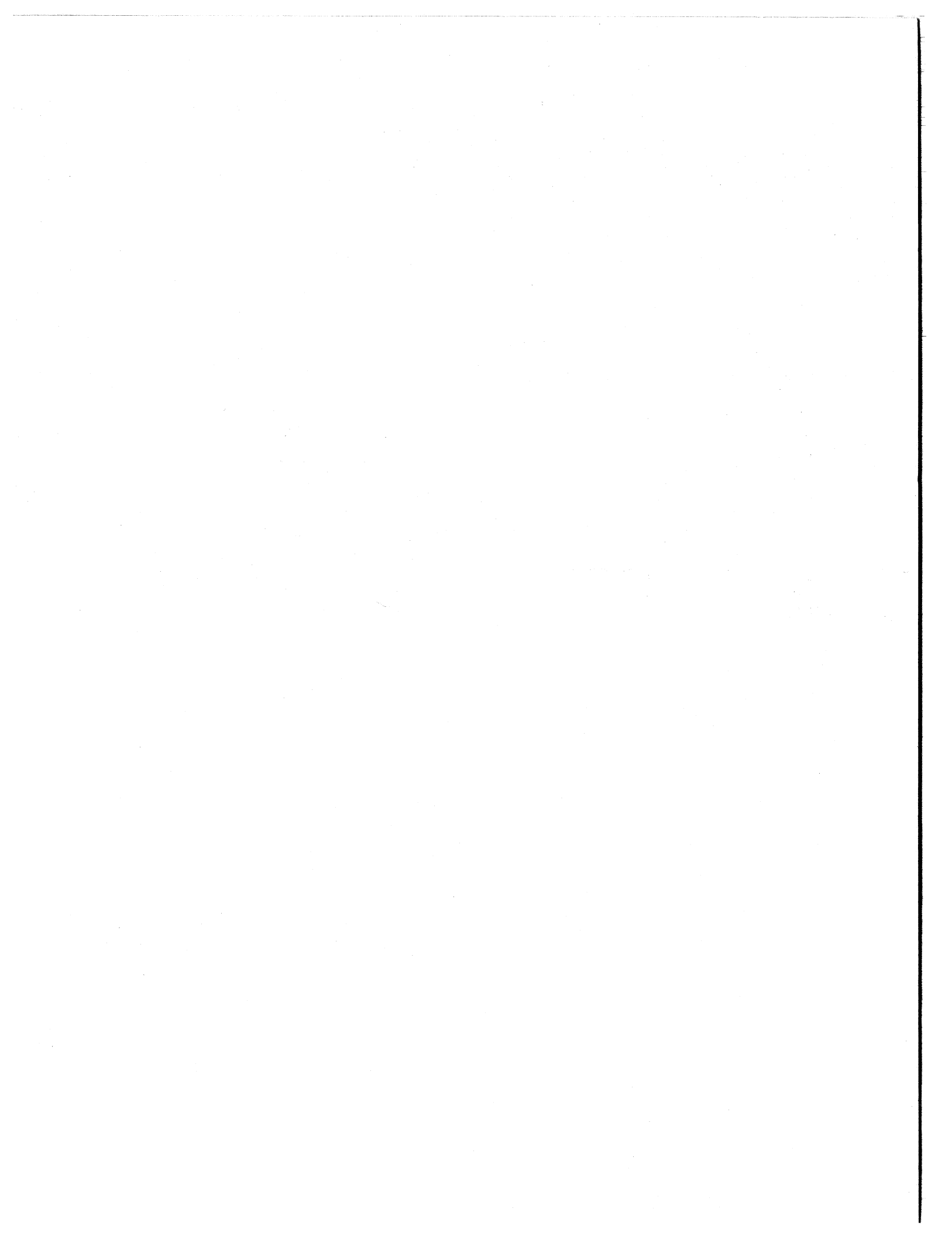


EHRHORN TECHNOLOGICAL OPERATIONS, INC.  
CAÑON CITY, CO 81212

MODEL: PA-78  
DRAWING: QSK (FULL BREAK-IN) T/R SYSTEM

6/23/79 HWR





## **ETO/"ALPHA" PRODUCTS WARRANTY**

### **EHRHORN TECHNOLOGICAL OPERATIONS, INC. (ETO) WARRANTS AS FOLLOWS EACH NEW ELECTRONIC PRODUCT OF ITS MANUFACTURE:**

- (1) Workmanship and all components except rf power tubes are guaranteed for TWO YEARS from date of original purchase if used exclusively in licensed amateur radio service, and for ninety days in non-amateur service. WARRANTY IS VOIDED BY ILLEGAL SALE OR USE OF EQUIPMENT (e.g., U.S. sale of export models).
- (2) Power tubes are warranted by their manufacturer; ETO will assist owners in securing warranty service if requested.
- (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 ETO, nor to units repaired or altered by persons not authorized by ETO, 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 ETO for service the owner shall contact selling dealer or factory service department, providing model and serial numbers plus details of equipment hook-up, accessory equipment used, operating conditions, and abnormalities observed. ETO 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 fully prepaid and insured via United Parcel or air freight (to Colorado Springs airport only), using only FACTORY APPROVED PACKING; REMOVE POWER TRANSFORMER BEFORE SHIPPING ANY UNIT WHICH WAS ORIGINALLY SHIPPED FROM THE FACTORY WITH TRANSFORMER REMOVED!
- (5) In order to receive warranty service, owner must have returned a completed warranty registration form to ETO within 15 days of original purchase, or must provide proof of purchase date when requesting service. Warranty will be transferred to subsequent owner provided he notifies ETO in writing of his name, address, date of purchase, and the equipment model and serial.
- (6) No person is authorized to assume for ETO any liability, other than as set forth in this warranty, in connection with our products. ETO 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.)

#### **EHRHORN TECHNOLOGICAL OPERATIONS, INC.**

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Canon City, Colorado 81212  
Phone: (303) 275-1613

7/14/78