

PRICE: \$10.00

OPERATING AND TECHNICAL MANUAL

HIGH FREQUENCY LINEAR POWER AMPLIFIER

ALPHA 78



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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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ETO/"ALPHA" PRODUCTS WARRANTY BACK COVER

EHRHORN TECHNOLOGICAL OPERATIONS, INC.

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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.

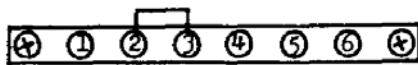
Check both pairs of mating connectors visually for proper mating orientation and mate them firmly, pushing together until the integral latches engage. Avoid excessive bending or twisting of harness wires or connectors, as it may cause damage to wires or connector pins.

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

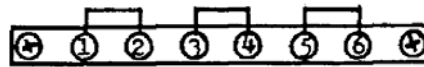
2-3 ELECTRICAL INSTALLATION

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.)



CONNECTIONS FOR 240V



CONNECTIONS FOR 120V

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.

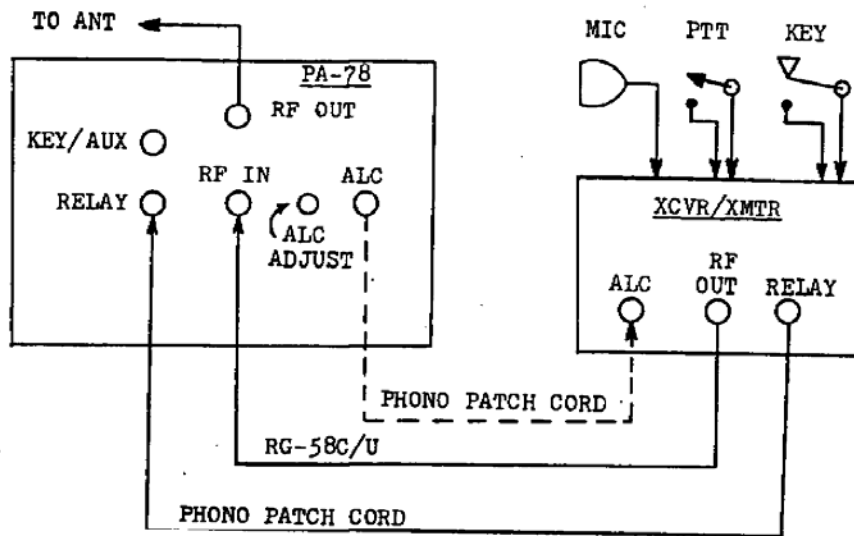


FIGURE 2. ALPHA PA-78 Interconnections for CW Break-in or Fast VOX. (Also suitable for PTT, Manual T/R, etc.)

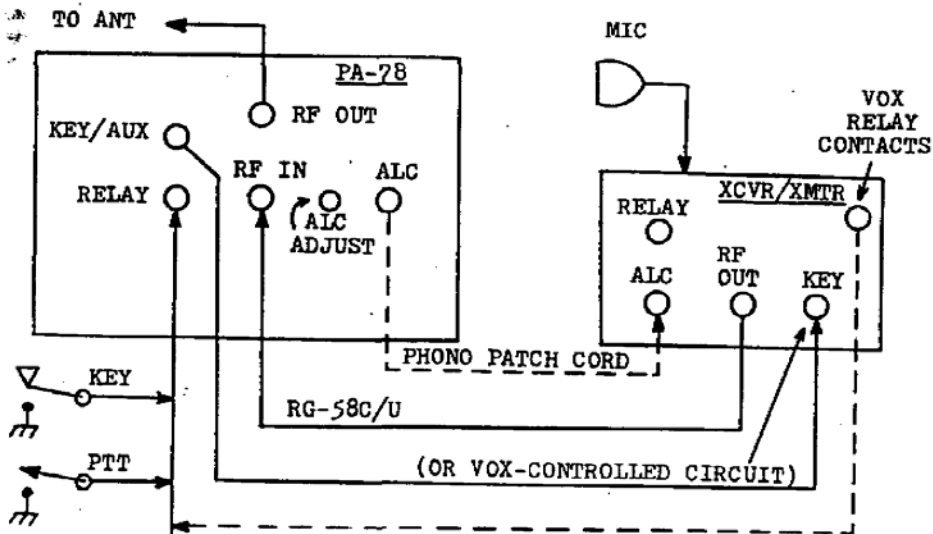
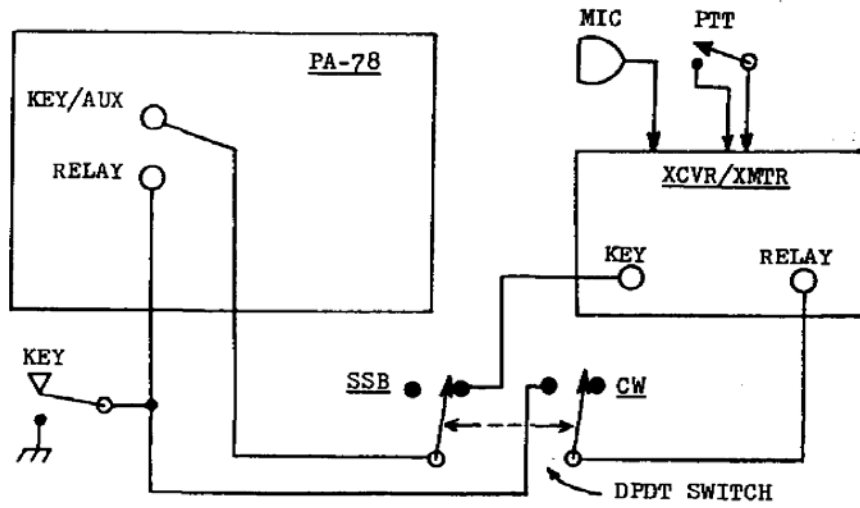


FIGURE 3. A Simple Method for Switching Between Conventional
SSB PTT or VOX and CW Break-in.



SECTION 3: OPERATION

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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.

HY - 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/PSK/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 excitor 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 ± 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 ± 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 ± 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 ± 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 V x 0.45 A = 990 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 ± 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. b) Incorrect or no jumper across required terminals of ac primary selection strip. c) Cover ac interlock S5 not closed by lid. d) House wiring incorrect or breaker open. e) K7 contacts welded together (shorted). 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. b) Fuse F3 missing or open. c) HV short to ground. 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. b) Shorted 8874 tube. 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). 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. 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. b) Input reed relay K4 not closing. 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. b) Defective RF Input coaxial cable. c) Contacts of relay K4 not closing. d) Bias zener diode D110 damaged or open. e) Damaged amplifier input matching network. 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. b) Defective output T/R vacuum relay contacts. c) Amplifier bandswitch in wrong position. 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.

78	8901	Jul-88
86	001 – 274	12/1987 – 10/1989
86 Samples		
86	001	Dec-87
86	100	Dec-88
86	200	Mar-89
86	274	Oct-89

This list is not certified as complete or accurate and is still under construction.
Please help us if you have exact model # and date information.

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*Last Updated on 19-DEC-99
By ALPHA/POWER*

Legacy Amplifier Specifications (Alpha Amps no longer in production)

Amplifier Production Dates

MODEL	TUBES	OUTPUT POWER	BANDS	TUNING	T / R SWITCHING	PRIMARY POWER	DIMENSIONS
91B	Svetlana 4CX800 (x2)	Legal Limit	160m - 10m	Manual	QSK, Vacuum Relay (keying voltage = 25vdc, 7ma)	120/240vac Unisil Xfmr (3+ kVA)	7.5"h x 17"w x 15.5"d
86	Eimac 3CX800 (x2)	Legal Limit	160m - 10m	Manual	QSK, PIN Diode (keying voltage = 10vdc, 1ma)	240vac Hypersil Xfmr (3.5kVA)	7.5"h x 17"w x 15"d
78	Eimac 8874 (x3)	Legal Limit	160m - 10m (except 12m)	Manual and Pre-tuned (Bandpass)	QSK, Vacuum Relay (keying voltage = 23vdc, 3ma)	120/240vac Hypersil Xfmr (2.4kVA)	7.5"h x 17"w x 14.75"d
77Sx	Eimac 3CX1500 (x2)	Legal Limit	160m - 10m (except 12m)	Manual	QSK, Vacuum Relay (keying voltage = 20vdc, 2ma)	240vac Hypersil Xfmr	11"h x 19"w x 22"d
77Dx	Eimac 3CX1500 (x1)	Legal Limit	160m - 10m (except 12m)	Manual	QSK, Vacuum Relay (keying voltage = 20vdc, 2ma)	240vac Hypersil Xfmr	11"h x 19"w x 22"d
77D	Eimac 3CX1500 (x1)	Legal Limit	80m - 10m (except 12m)	Manual	QSK, Vacuum Relay (keying voltage = 20vdc, 2ma)	240vac Hypersil Xfmr	11"h x 19"w x 22"d
77	Eimac 3CX1500 (x1)	Legal Limit	80m - 10m (except 12m)	Manual	QSK, Vacuum Relay	240vac	9.5"h x 17"w x 17"d
70	Eimac 3CV1500 (x1)	Legal Limit	80m - 10m (except 12m)	Manual	Vacuum Relay	240vac	9.5"h x 17"w x 17"d
			160m -		Open-frame	120/240vac	

76CA *	Eimac 8874 (x3)	Legal Limit	10m (except 12m)	Manual	Relay (keying voltage = 25vdc,75ma)	Hypersil Xfmr (2.4kVA)	7.5"h x 17"w x 14.75"d
76PA *	Eimac 8874 (x3)	Legal Limit	160m - 10m (except 12m)	Manual	Open-frame Relay (keying voltage = 25vdc,75ma)	120/240vac	7.5"h x 17"w x 14.75"d
76A *	Eimac 8874 (x2)	Legal Limit **	160m - 10m (except 12m)	Manual	Open-frame Relay (keying voltage = 25vdc,75ma)	120/240vac	7.5"h x 17"w x 14.75"d
76C	Eimac 8874 (x3)	Legal Limit	160m - 10m (except 12m)	Manual	Open-frame Relay	120/240vac Hypersil Xfmr (2.4kVA)	7.5"h x 17"w x 14.95"d
76P	Eimac 8874 (x3)	Legal Limit	160m - 10m (except 12m)	Manual	Open-frame Relay	120/240vac	7.5"h x 17"w x 14.95"d
76	Eimac 8874 (x2)	Legal Limit **	160m - 10m (except 12m)	Manual	Open-frame Relay	120/240vac	7.5"h x 17"w x 14.95"d
374A	Eimac 8874 (x2)	Legal Limit **	160m - 10m (except 12m)	Manual and Pre-tuned (Bandpass)	Open-frame Relay (keying voltage = 25vdc,75ma)	120/240vac	7.5"h x 17"w x 14.75"d
374	Eimac 8874 (x3)	Legal Limit **	80m - 10m (except 12m)	Manual and Pre-tuned (Bandpass)	Open-frame Relay (keying voltage = 23vdc,95ma)	120/240vac	7.5"h x 17"w x 13"d
274	Eimac 8874 (x2)	Legal Limit **	80m - 10m (except 12m)	Manual	Open-frame Relay	120/240vac	7.5"h x 17"w x 13"d

* **NOTE:** All 3 models in 76A family have **76A** on front panel. Differences are as above. Hypersil transformers are black epoxy coated and have rounded corners.

** **NOTE:** "Legal Limit" as defined by the FCC when these amps were manufactured was 1 Kw DC INPUT (2 Kw PEP).

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Last Updated on 17-NOV-99

ALL "ALPHA" AMPLIFIERS IN THE PA-76 SERIES CARRY THE DESIGNATION, "ALPHA 76A" ON THEIR FRONT PANELS. SPECIFIC MODEL NUMBERS ARE STAMPED WITHIN THE TITLE BLOCK ON THE REAR PANEL OF EACH AMPLIFIER: PA-76A (two tubes, standard transformer), PA-76PA (three tubes, standard transformer), or PA-76CA (three tubes, heavy duty Hipersil[®] transformer).

Type accepted models for sale and delivery within FCC's jurisdiction (U.S. and possessions, except U.S. Government customers) also carry FCC's specifically-required type acceptance identifications: "FCC TX DATA: PA-76AF" for all two tube '76A's, "FCC TX DATA: PA-76PAF" for all three tube versions (including ALPHA 76CA, which for FCC purposes is a 76PA with "C" option). For identification, the "standard transformer" is of conventional open frame construction, while the "heavy duty Hipersil[®]" unit provided with the ALPHA 76CA amplifier has more rounded corners and is covered with a black epoxy coating.

- 10 MRS.
1. Remove the bandswitch knob (two Allen setscrews)
 2. Remove the now-visible extra rotation stop screw
 3. Replace the bandswitch knob
 4. Remove the top cover of the amplifier
 5. Remove the rotational stop screws in the collars on the front shafts of variable capacitors C16 and C17
 6. Replace the top cover

13 TUBE

To reduce drive power requirements, remove the input swamping resistance pad which is connected (underneath the tube deck) between the cathode input line and chassis ground. REPLACE THE ORIGINAL RESISTOR ASSEMBLY with five 470-ohm, 2-watt ALLEN BRADLEY COMPOSITION resistors connected in parallel with short leads. Move the wire jumper (originally connected from lug 1 to lug 3 of the 7-lug strip) from lug 3 to lug 2 (now jumpering lug 1 to lug 2). If the outer braid shield of the miniature white coax input cable was originally grounded via lug 3, be sure to move it also to a new ground at lug 2.

2 TUBE

To reduce the drive power requirement, remove five (5) only of the input swamping resistors from the original assembly of 15 resistors underneath the tube deck. The remaining 10 must be left connected for proper matching and operation.

$5 \times 470 \text{ ohm} \Rightarrow 94 \text{ ohms}$
 $15 \times 220 \text{ ohm} \Rightarrow 14.6 \text{ ohms}$

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