HAMTRONICS® LPA 2-45 LINEAR POWER AMPLIFIER: CONSTRUCTION, OPERATION, AND MAINTENANCE

GENERAL DESCRIPTION.

The LPA 2-45 is designed to amplify the 2W pep output of the XV2 Transmitting Converter or the TA51 Exciter or any other 2W two-meter rf source to 45W p.e.p. It is a linear amplifier; so it may be used on any mode of operation, including ssb, am, cw, and fm. It has a 50 ohm input and output impedance. The unit may also be assembled for operation with 8-10W input by omitting the first stage. The LPA 2-45 operates on +13.6Vdc at 8-10 Amp. It may be tuned to any frequency in the 140-175 MHz range, and have a passband of 2 MHz.

CIRCUIT DESCRIPTION.

Refer to the schematic diagram. Amplifier transistors Q1 and Q2 are of the new high gain, emitter ballasted type. They are both normally operated well below their full output capability to remain in the linear range. Impedance matching is done with high Q, discrete coil-capacitor tuned circuits to aid signal purity.

The transistors are biased slightly above class B for linearity. Q1 is biased from a voltage regulated source for stiffness. The bias for Q2 is adjusted by installing either one or two 2W resistors. Both bias circuits (Q1 & Q2) use silicon diodes which are thermally coupled to the heatsink to regulate bias according to temperature for a stable idle current over a wide range of operating temperatures. As the transistors warm up, they tend to conduct more, but CR1 and CR2 reduce the bias, as warm up occurs, to counteract the drift in idle current. R1, L4, C4, and C5 provide feedback to suppress low frequency oscillations, which can occur in vhf pa's due to extremely high low-frequency gain of transistors.

CONSTRUCTION.

Most of the pertinent construction details are given on the component location and schematic diagrams. Note that the diagrams show the amplifier configurations for both 2W and 8W input. Following are details of coil winding and special parts mounting procedures. Note that all parts are tack soldered to the pc board; so it is necessary to cut and form leads so that they seat properly on the board.

a. Refer to component location diagram. Set heatsink flat on bench, and set two #8 flat washers over each of the six holes for screws used to mount board.

b. Carefully set the pc board over washers. Secure board with six 6-32 thread cutting screws, being careful not to move washers below board. Align pc board over transistor and diode holes before tightening screws.

c. Carefully open the package of heatsink compound with scissors. Use a toothpick or small piece of wire to apply a small amount of compound to the shoulder of the stud mount transistor where it contacts the heatsink.

d. Set the stud mount transistor in location Q1, and orient the notched collector lead to the right as shown. Secure transistor with #8 lockwasher, solder lug, and 8-32 nut. Orient solder lug next to diode hole. Do not overtighten nut; tighten only to the point of being snug. Hold transistor leads with fingers to prevent rotation. If leads still rotate, you are probably applying too much torque.

Note: Since heatsink compound is used, it is unnecessary to use a lot of torque. Excessive torque can break stud or leads.

e. Apply heatsink compound to flange type transistor and set in position Q2. Note that the collector lead is narrower than the base lead. The collector lead should be facing the right hand side. Secure transistor with two 4-40 screws. On the lower screw, install #4 lockwasher and 4-40 nut. On the upper screw, install solder lug and 4-40 nut. Orient solder lug next to diode hole.

f. Form the transistor leads down against the board. Then, tack solder them to the foil, using sufficient solder so that a bond is formed under the full length of the leads.

g. Solder the variable mica capacitors in the exact positions shown in the component location diagram. Doing so leaves adequate space for coil connections.

h. Wind the coils exactly as specified in the component location diagram, and tack solder them to the board. It helps to prestrip the #24 magnet wire by application of heat from the iron and solder before mounting. Note that all pertinent details of coil winding are given in the diagram. Any rod of the proper diameter (such as the shank of a drill bit) can be used as a forming tool for coil winding.

i. The ferrite chokes are wound (threaded) with #22 bus wire (fine) as shown in the diagram, by feeding the wire through adjacent holes and pulling tight. One hole will not be used. Ferrite chokes are mounted flat against the pc board, and their leads are tack soldered to the board.

j. Install CR1 and CR2 through holes provided in the heatsink. Solder cathode (banded end) to solder lug on the fin side of heatsink. Use short, direct lead connection to provide thermal connection to ground lug as well as electrical connection. On the pc board side of the heatsink, bend the anode leads over to the pad provided, and tack solder to the board. Note that the bodies of the diodes should be centered in the thickness of the heatsink for best thermal coupling. Be careful not to short anode leads to ground.

k. Tack solder all other parts to the pc board in the positions shown. Use short, direct lead dressing. Observe polarity of components, such as diodes and electrolytic capacitors. Note that leads may be tack soldered to the top side of power transistor leads if necessary. To mount fixed mica capacitors, the tabs should be bent down so they just touch the board when the case of the capacitor is flat against the board. Z1 is a ferrite bead installed over the hot lead of C19. Resistor R6 should not be installed at this time, but room should be left for it.

Note: Disc capacitors may be marked with two significant figures and a multiplier much the same as resistors. Thus, for instance, a .01 uf capacitor may be marked "103" and a 220 pf capacitor may be marked "221".

INPUT/OUTPUT CONNECTIONS.

The input and output connections are made with lengths of 50 ohm coax cable connected to the appropriate input and output pads and ground

(shield) of the pc board. Connect cables by stripping as illustrated and tack-soldering to board. Keep leads short and neat. Connect the shield by pretinning all around the shield and then tack soldering just the part of the shield which contacts the board. Avoid melting polyethelene insulation on cable by pretinning board and cable and then tacking them together quickly. If desired, light gauge wire can be wrapped around the shield before soldering to make a neater shield termination. Connectors deliberately avoided at the pa, since connectors must be used at the other ends of the cable at the Exciter and rear panel and short connections to the pa board are desired. RG-174/u cable is convenient to use for short connections to the pa.

The unit does not have provisions for t/r switching of the antenna. If one antenna is to be used with the pa and a receiver, some form of coax relay must be provided between the pa and the antenna.

POWER CONNECTIONS.

+13.6Vdc should be connected to the B+ pad at the top of the pc board. A ground return cable should be connected from the power supply to the ground plane of the pc board as shown in the component location diagram. The cable should be #16 or larger wire to minimize voltage drop. A 10 Amp, quick acting fuse should be connected in the positive supply line for protection.

A well regulated power supply should be used for any ssb equipment, including the PA. Current drain of the PA at full output is about 10 Amp. Note that the output capability of the PA drops rapidly as the voltage is reduced below 13.6Vdc; therefore, you should try to use a power source of sufficient voltage and minimize cable losses so that you have full B+ available at the PA.

If the unit is used in a mobile application, or on anything other than a well regulated and protected power supply, a hash filter consisting of a choke and large electrolytic capacitor should be connected in series with the B+ line and a rectifier diode, such as a 1N4001, should be connected across the line with reverse polarity to shunt any reverse voltage transients which may occur on the B+ line. This is in addition to the fuse mentioned above. The rest of the transmitter may also be operated on the same filtered line output if desired.

In addition, both power lines should be run directly to the battery or power supply. Do not depend on other conductors for a good, low-impedance ground. the battery in a car acts as a huge filter capacitor for the electrical system, and it is the only place good, clean power can be obtained in a vehicle. If ignition switch operation is desired, use a relay to switch the power to the radio.

CAUTIONS TO PROTECT TRANSISTORS.

Because it is so easy to damage rf power transistors in the field due to accidents and abuse, transistor manufacturers do not provide any warranty to cover replacements once a transistor is installed in the unit. They test them thoroughly at the factory because they are expensive parts and they want to be sure you get good parts with your kit. Therefore, they do not honor claims that "the transistor must have been bad from the factory". For your protection, please be sure to observe the following precautions:

1. Transistors are made to operate in specific circuits. Do not try to check with ohmmeter, etc. Sometimes, you can blow a transistor when you reverse polarity.

2. Observe power and duty cycle ratings in the specifications published in our catalog. some units are not designed for continuous operation. Keep heatsink fins in free air, not closed in, and not upside down on solid surface blocking air circulation. When tuning on bench, allow for cooling periods to avoid overheating.

3. Sometimes, transistors may be destroyed by parasitic oscillations occurring during tuning because of the extremes of capacitor settings, or due to accidental shorting of components. To protect against such damage as much as possible, turn power supply voltage down to 9 or 10 Volts when you first apply power until the unit is tuned. Then, turn up to full 13.6Vdc. Of course, bias adjustments and final tuning should be done at full 13.6V.

4. Never exceed 13.6Vdc, as even a small over-voltage causes strain on transistors.

5. Be sure you have a low impedance connection to the power supply, i.e., short, heavy cable.

ALIGNMENT.

Alignment is very simple. Connect the input to a two-meter (or 6-meter) transmitting converter or exciter which has already been tuned into a 50-ohm dummy load. Connect the output to a 50-ohm load of sufficient power rating. Apply moderate drive and B+. Alternately tune the various pairs of mica trimmer capacitors for maximum output. Continue increasing drive slightly and repeaking capacitors until maximum output is achieved.

At this point, the current drain should not exceed about 10 Amp, and the exciter or transmitting converter should be within proper current limit (i.e., no more than 450 mA). Of course, during normal operation, you would not drive the PA to its limit such as this unless you were running fm or cw; you would stay in the linear region. However, for alignment, you want to tune for absolute maximum output to establish the proper load for the pa transistors for best linearity on ssb.

Note: Do not retune exciter or transmitting converter with PA connected. Once it is tuned into a 50-ohm load, it should never be tuned again. Tuning the input of the PA takes care of matching the PA to the exciter or transmitting converter.

To check the idle bias of the PA, remove drive, and operate the PA with a milliameter in series with the B+ line. The PA should draw in the range of 100-250 mA total idle current. If less than this amount, R6 should be installed in parallel with R5 to increase the idle current of the output stage. The exact idle current is not critical.

OPERATION.

Operation is quite simple. B+ can be applied either just during transmit or all the time if desired. Merely apply a signal to the PA when you want to transmit.

It is necessary to avoid overdriving the PA. Moderate overdrive will not damage the unit, but it will cause excessive intermodulation distortion of ssb signals. About 1-1/2 to 2 Watts of drive should be sufficient to obtain 45W p.e.p. output.

Do not drive the PA to the saturation point on ssb. Of course, avoid drive levels in excess of 2 Watts entirely, as PA transistor damage may occur on severe overdrive (over 3-4 Watts). The rf output meter detector circuit may be used during normal operation if desired as an operating

aid. A voltmeter, or even a sensitive panel microammeter, may be used to monitor output. An ammeter in the B+ line is handy too as an operating aid.

Remember, though, that no meter movement can follow sideband peaks; so don't expect to watch the meter "talk" up to full output on ssb. During ssb voice operation, the meter will probably only indicate about 1/5 the level of a full carrier signal because the average power level is much lower, even though the voice peaks are reaching near saturation. Increasing drive to make the meter read "nice" only produces distortion if you drive the PA into flat-topping.

For cw or fm operation, where linear operation is not necessary, the bias to the PA stages can be disconnected and the cold side of L2 and L6 can be grounded. This will change the mode of operation from class B to class C for slightly more efficiency. However, it is not recommended that this be done if you will be changing modes. There is very little difference in operation, and it is not worth the inconvenience of switching.

TROUBLESHOOTING.

Since the unit has only two simple amplifier stages, there isn't much which can go wrong. It is helpful to know that the Q1 and Q2 base voltages should be about +0.5 to +0.7 Vdc and that the regulated voltage at VR1 should be about +6.8 Vdc. The rest of the circuitry is straightforward, with shorted coax cables or incorrect or shorted pc board component connections being the first things to suspect should there be no output.

Should it be necessary to replace rf power transistor Q1 or Q2, be sure to use an exact replacement. There are other transistors rated at similar output levels, but they may have lower gain or different impedance characteristics.

To replace a transistor, carefully peel each lead away from the pc board while melting the solder. Then, remove the mounting hardware and gently push the old transistor out of the heatsink. Clean all the old solder off the pc board. Add new heatsink compound, and install new transistor with collector lead in correct location. Carefully tighten nut on Q1 transistor without over-torquing or tighten the screws on Q2. Then, flatten leads against the board, and sweat solder them to the board. Remember to resolder any components removed for access to the transistor leads.

A word about relay coils. Any relay coil connected to the same B+ line as solid state equipment should have a reverse diode connected across it to absorb the inductive kickback which occurs when the coil is de-energized. Relay coils and similar inductors can cause transients up to several hundred volts. This is the most common problem related to damaged semiconductors. You should also be sure that your power supply does not have an inductive surge when you turn it on or off. If in doubt, borrow an oscilloscope and watch the B+ line when you turn the switch on and off.

MOUNTING.

If desired, the PA can be mounted to a panel with screws in the left and right hand edges of the heatsink as indicated in the component location diagram. It can be mounted with standoffs to clear the components, or a cutout can be made in the rear panel to clear the pc board and the heatsink can then be mounted flush to the panel. Standard 6-32 or #6 self-threading screws can be threaded into the aluminum heatsink if 1/8-inch pilot holes are drilled, or screws can be used with nuts if you are careful to clear the fins.

However the unit is mounted, the fins should be in free air to allow for good convection cooling and keep the heat away from the oscillator on the Exciter or Transmitting Converter board. Do not mount the PA with the fins inside a cabinet.