HAMTRONICS® LPA 2-15R
2M REPEATER POWER AMPLIFIER:
ASSEMBLY, INSTALLATION, & MAINTENANCE

GENERAL INFORMATION.

The LPA2-15R Power Amplifier is a class C device designed to be installed as an integral part of a transmitter enclosure in a repeater installation with a 2.5 Watt exciter module. It is designed for 15-20 W output on 140-175 MHz. It operates on +13.6 Vdc at about 2.5A. It has a 50-ohm input and output impedance and is designed for continuous duty when properly heatsunk. A low-pass filter reduces harmonic output to very low levels. The unit is FCC type accepted for commercial operation in the 150-175 MHz band.

CONSTRUCTION.

General.

Most of the pertinent construction details are given in the component location and schematic diagrams and parts list.

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 and be sure to keep leads as short and direct as possible. This is especially true of the disc capacitors. Figure 1 shows how to trim and form the leads of capacitors.

Mounting the board.

Note: This series of power amplifiers is designed to be mounted in an rf tight enclosure with the exciter in a separate rf tight box to avoid feedback into the exciter. The unit is supplied less heatsink since the enclosure acts as a heatsink. It is important to mount the unit carefully to avoid damage to the transistor by pulling the leads off the ceramic case. The PA is designed to have the thickness of two thin #4 flat washers (about 0.050 inch total) as a spacer between the pc board and the chassis which the transistor is mounted on.

a. Mark and drill four clearance holes for mounting the board with 4-40 screws and one 8-32 clearance hole to mount the transistor in the center of the cutout in the board. The latter hole must be close to the diameter of the xstr stud to provide maximum surface for the shoulder of the transistor to contact the chassis for heatsinking; so do not make this hole oversize.

b. Carefully open the package of heatsink compound with scissors. Use the toothpick to apply a small amount of compound to the shoulder of the transistor where it contacts the heatsink. Only a light coating is needed.

c. Install four 4-40 x 3/8 inch screws from the bottom of the enclosure. Place two flat washers as spacers over each of the screws, as previously described.

d. Set pc board over screws, and align so transistor is centered over hole in enclosure. Secure the board with 4-40 nuts and lockwashers.

e. Secure transistor with #8 lockwasher and 8-32 nut. Do not overtighten nut; tighten with a nut driver only to the point of being snug. ***Caution: Since heatsink compound is used, it is unnecessary to use a lot of torque, which could break the stud.***

Installing Capacitors.

a. Solder variable mica capacitors C8 and C9 to the board in the exact positions shown in figure 2. Mount the capacitors oriented as shown so the rotor screw is connected to the proper side of the circuit (as shown in fig. 2).

b. Bend the leads of C2 and C3 gently at a 90° angle, and solder them as shown. Make sure the round end of C2 goes to ground.

c. Form the leads of C1 and C15 (if used) close to the body, as shown in figure 1, and tack solder on the board.

d. Tack solder C4-C5 (if used) as shown, bending the leads at right angles, and keeping them as short as possible, as shown in fig 1. It is important to angle the capacitors as shown in figure 2 and position them as close as possible to the body of the transistor. The idea is to connect them electrically as close as possible to the emitter and base terminals or the emitter and collector terminals. In fact, they should be soldered on top of those leads.

e. Tack solder C13 and C14 as shown, bending the leads at right angles, and keeping them as short as possible. Position the capacitors as shown in figure 2.

f. Tack solder chip capacitors C10 and C11 as follows. Position the capacitors as shown in figure 2 or 5. They are installed between the B+ pad and ground. Use small tweezers to handle them. *Be careful not to drop them; they are difficult to find. Since they have no markings, be sure to leave them in the package until installled so you can tell the values apart.*

g. Tack solder electrolytic capacitor C12. Bend the leads at right angles, and observe polarity.

RF Choke, Ferrite Beads, and Resistors.

a. Z2 is a ferrite bead with leads tack soldered as shown. (Note ferrite choke as shown in inset.)

b. Install resistor R2 across Z2 as shown.

c. Tack solder one lead of a ferrite bead to the B+ pad to the left of C12 as shown. If you prefer, a hookup wire can be used with the ferrite bead clipped off its wire and installed over the hookup wire.

d. Twist together and tack solder one lead each of rf choke L2 and resistor R1. Trim the other lead of each part to about ¼ inch and form down to reach the board. Then, tack solder these leads to the board as shown, with the lead of L2 to the pad area for the base of the transistor and the lead of R1 to the ground plane.

Coil Forming and Placement.

Figures 2 & 3 show exactly how coils are formed. You need to form the coils exactly as specified, using #18 bus wire supplied. Tack solder them to the board in the positions shown.

Any rod of the proper diameter (such as the shank of a drill bit) can be used as a forming tool for coil winding. It is important that they not only be wound the proper inside diameter but that the leads be the proper length. Any extra lead length adds to the inductance and will affect performance. You don't need to be super precise, but do form them to resemble the detailed drawings as closely as you can.

Remember that the finished coils should fit on the pc traces as shown; so that will help you check that you formed the coils properly.

The coils are all either 1/8 or 1/4 inch inside diameter. Spacing between turns of the coils should be minimal, with turns separated just enough to prevent shorting together.

L1 is 1/8 inch i.d. and 1-1/4 turns. The feet are formed just so the bottom wire of the coil doesn't short to the ground plane. The feet should be only about 1/16 inch high. The other three coils are 1/4 inch i.d. L3 is 1-1/4 turns. L4 is 3-3/4 turns. L5 is 1-3/4 turns.

RF INPUT/OUTPUT CONNECTIONS.

The input and output connections are made with RG-174/u or similar 50-ohm coax cable connected to the appropriate input and output pads and ground plane of the pc board. See diagram. Connect cables by stripping as illustrated and tack-soldering to board. Note that stripped length of coax is inductive; so keep leads short and neat.

Avoid melting polyethelene insulation on cable by pretinning board and cable and then tacking them together quickly.

POWER CONNECTIONS.

+13.6Vdc should be connected to the B+ pad at the top of the pc board through the ferrite bead provided. A hookup wire should

be attached to the ferrite bead's lead or the bead can be removed and installed directly on hookup wire tack soldered in place of the lead the bead is on (as shown in Fig. 2). The ground return normally is connected to the pc board through the mounting hardware.

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.

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. 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. 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 about 10 Volts when you first apply power until the unit is tuned. Then, turn up to full 13.6Vdc. Of course, final tuning should be done at full 13.6V.

2. Never exceed 13.6Vdc, as even a small over-voltage causes strain on transistors because of additional heat.

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

4. Do not attempt to operate PA until exciter has been properly aligned by itself, operating into a 50-ohm load.

ALIGNMENT.

Alignment is very simple. Connect the input to an exciter which has already been tuned into a 50-ohm dummy load. Connect the output to a 50-ohm load of sufficient power rating. Use an in-line power meter, or monitor output with a dc voltmeter connected to rf detector test point pad on pc board.

Apply B+ and rf drive. Alternately tune the four variable capacitors for maximum output. Continue increasing drive slightly and repeaking capacitors until maximum output is achieved and all interactions between capacitors are worked out.

With 13.6Vdc power applied and 2.5W drive, a 144 MHz unit should put out about 15-20W. Current drain should be about 2.5A.

To minimize stress on the transistor, avoid running the pa over these maximum levels. A good way to reduce the output power and the current drain is to tighten loading capacitor C9 slightly and repeaking tuning capacitor C8. It is usually possible to reduce both the power level and the current drain that way. Watch both meters while tuning to be sure that is what is happening.

You can tell if the transistor is overheating by watching the output power and current drain as the unit heats up. Neither should change much. If the output power sags by more than a few watts as the transistor heats up, there is insufficient heatsinking. Either the heatsink is too small or the thermal interface between the transistor and heatsink is deficient. There should be heatsink compound between the two surfaces and the nut on the transistor stud should be tight (but not strained to the breaking point).

OPERATION.

Operation is quite simple. B+ can be applied all the time if desired. Merely apply an rf signal to the PA when you want to transmit. Being class C, the pa only draws current when driven.

TROUBLESHOOTING.

Since the unit has only one simple amplifier stage, there isn't much which can go wrong. The circuitry is straightforward. The first things to suspect should there be no output are shorted coax cables or incorrect or shorted pc board component connections.

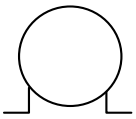
Should it be necessary to replace rf power transistor Q1, be sure to use an exact replacement. There are other transistors rated at similar output level, but they may have lower gain or different impedance characteristics.

To replace the 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 and remove the old heatsink compound. Add new heatsink compound, and install new transistor with collector lead in correct location. Carefully tighten nut on transistor without over-torquing. 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.

PARTS LIST.

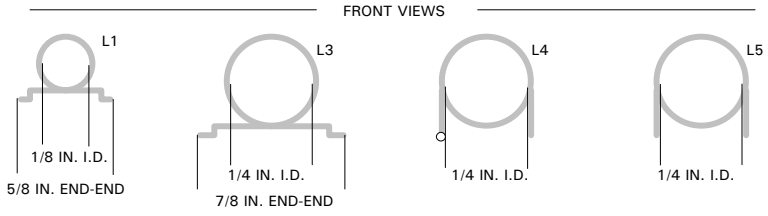
Note: Some design changes have been made since the diagrams were made. Text and parts list take preference.

Ref Desig	Description
C1	33 pf disc capacitor
C2	30 pf (green) ceramic var.
C3	20 pf (pink) ceramic var.
C4	47pf
C5-C7	not used
C8-C9	mica variable (C4203/08)
C10	.001 uf chip capacitor
C11	0.1 uf chip capacitor
C12	47 uf electrolytic cap
C13-C14	56 pf disc capacitor
C15	not used
L1, L3-L5	wind per text
L2	0.22 uh rf choke marked red-red-silver-red
Q1	M25C18
R1	3.3Ω, ¼W resistor
R2-R3	10Ω, ¼W resistor
Z1-Z2	Ferrite bead



VERY SHORT LEADS
ON DISC CAPACITORS

Figure 1. Lead Trimming and Forming Details



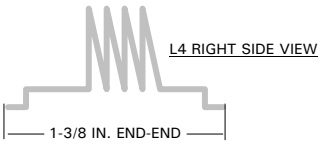


Figure 3. Coil Winding Details for 144 MHz

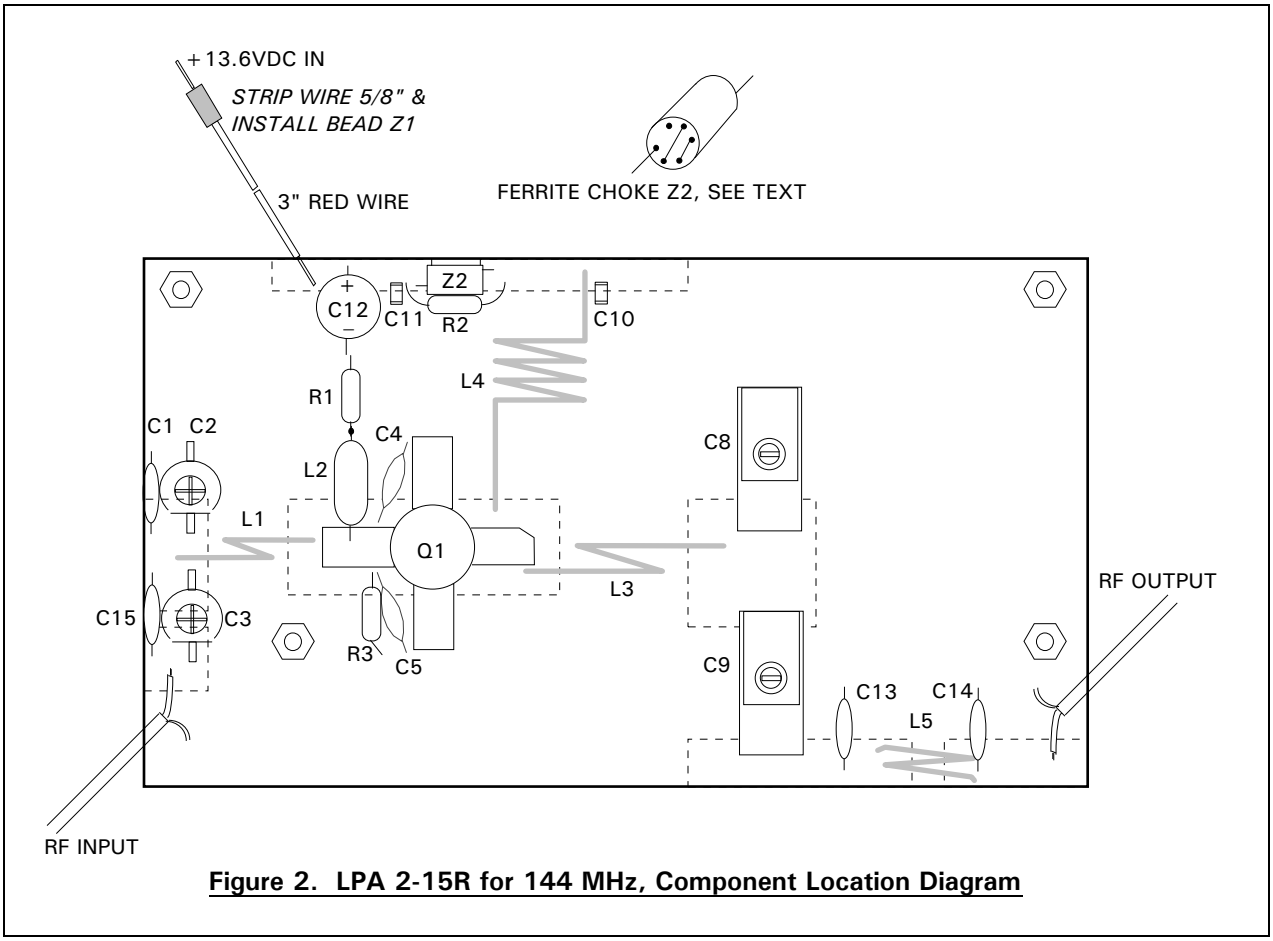


Figure 2. LPA 2-15R for 144 MHz, Component Location Diagram

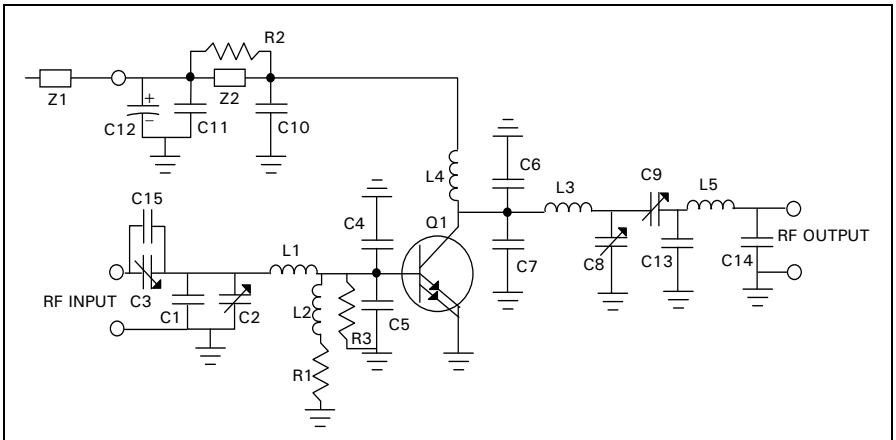


Figure 4. Schematic Diagram

 Revised: 12/22/11