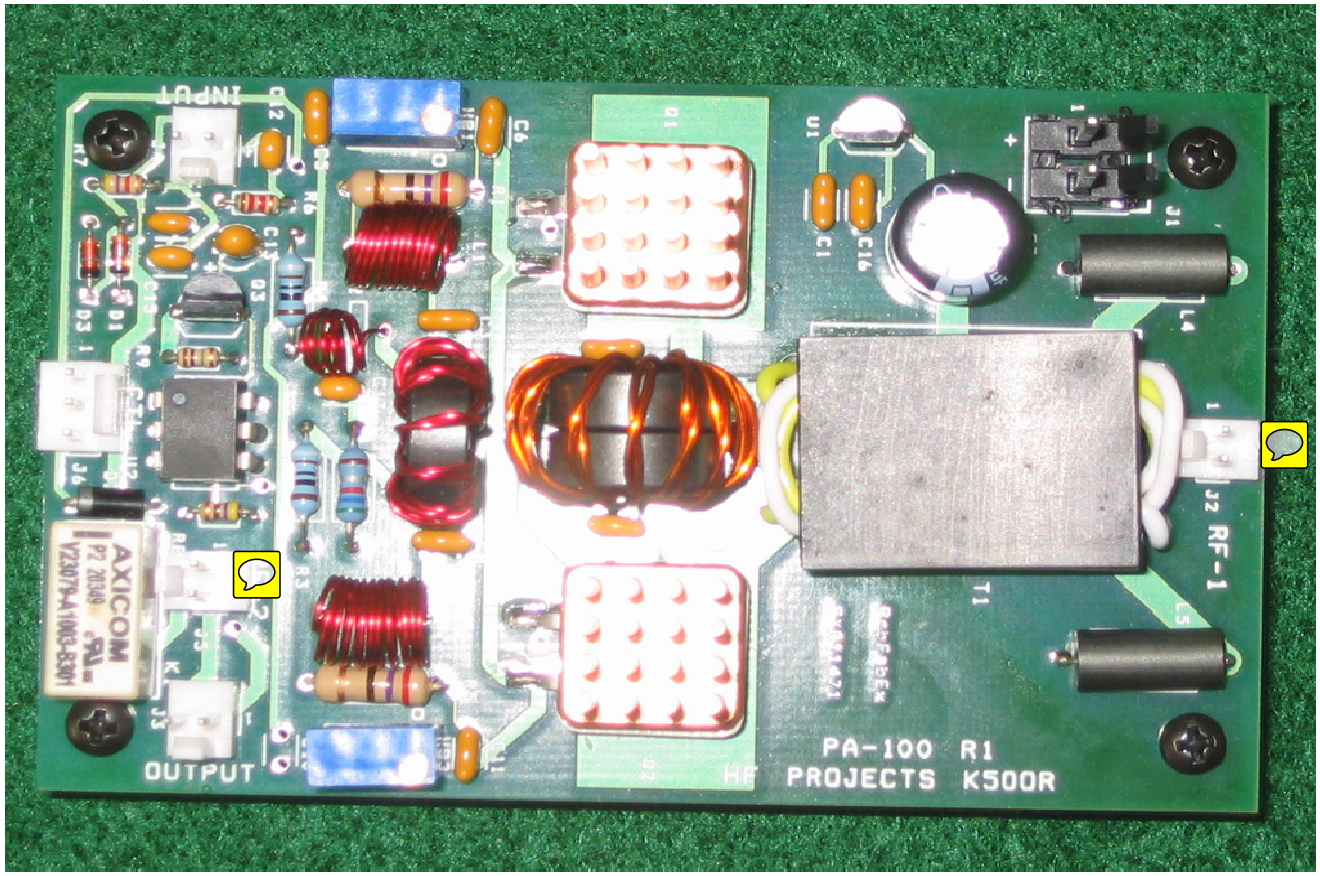
Builder's Construction Manual



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Introduction

Welcome all builders to the homebrew 5W AMP Model PA-100 Project. This project parts and your efforts will eventually provide you with a compact 0.1 watt input to 5 watt output linear amplifier for use with QRP SSB/CW transmitters on the amateur bands 160 through 10 meters and which can be powered from a 12 volt DC supply. The design is a good balance between output power, physical size and battery power consumption. The completed amplifier will reward the builder with a clean, more powerful output signal for a QRP rig when radio conditions become marginal.

This project is not a beginner's project and requires a medium skill level to complete it successfully. Builders require soldering, hand tool, basic electronics and component identification skills. This project manual is not included with the kit in order to keep kit costs to a minimum. All builders will thus require Internet access to download this PDF document file from http://www.hfprojects.com. The manual is produced in landscape format to allow more readable text per screen. This manual provides all you will need to successfully complete the amplifier project, however, some additional PDF files are provided at the above website for those interested in seeing more pictures of the project at various stages of construction.

The genesis of this circuit is fully described in the 2001 ARRL Handbook and in reprint articles from the ARRL. If you are an ARRL member, you can view the amplifier articles on-line at: http://www.arrl.org/members-only/tis/info/pdf/9903040.pdf and http://www.arrl.org/members-only/tis/info/pdf/9903043.pdf. Full design credit is given to Mike Kossor, WA2EBY. This amplifier project comprises one printed circuit board *module:* an RF amplifier module containing the MOSFETs, The amplifier module may be mounted within a SDR box thereby keeping the heat and RF out of the computer box and provide a suitable drive signal for the HF PROJECTS HF SuperPackerPro 100W Amplifier. The amp may also be optionally mounted in a stand-alone Bud Box case with the companion HF PROJECTS Low Pass Filter module. In this mode the drive input may be increased to a maximum of 1W at the gates of the MOSFETs. The Pi Resistive Attenuator (R2-R4) may be custom computed for the desired input drive level.

Circuit Details

The amplifier module is a push-pull design, biased for Class AB linear operation and uses low-cost power MOSFETs in its output stage. Maximum efficiency is at 10 MHz and develops over 20 watts output. QRP transmitter RF input is first sensed, which trips a relay, feeding RF through an RF attenuator pad. The signal is then applied to the primary of T3 via an input impedance-matching net-work consisting of L2. T3 is a 1:1 balun that splits the RF signal into two outputs 180 degrees out of phase. One of these signals is applied by C3 to Q1's gate. The other signal is routed via C8 to Q2's gate. The drains of Q1 and Q2 are connected to the primary of output transformer T1, where the two signals are recombined in phase to produce a single output. T1 also provides impedance transformation from the low output impedance of the MOSFETs to the 50Ω antenna port. DC power is provided to the drains of Q1 and Q2 by phase-reversal choke, T2. This is a very effective method to provide power to Q1 and Q2 while presenting a high

impedance to the RF signal over a broad range of frequencies. The drain chokes for Q1 and Q2 are wound on the same core, and the phase of one of the chokes is reversed. C7 increases the bandwidth of impedance transformation provided by T1, especially at 21 MHz. The 5 V bias supply voltage is derived from a 78L05 regulator. Bypass capacitors C5, C6, C10 and C11 remove RF voltages from the bias supply voltage. Gate bias for Q1 and Q2 is controlled independently. VR1 adjusts Q1's gate-bias voltage via R1 and L1. VR2 works similarly for Q2 via R5 and L3. At low frequencies, the amplifier's input impedance is essentially equal to the series value of R1 and R5. L1 and L3 improve the input-impedance match at higher frequencies. The low value of series resistance provided by R1 and R5 also reduces the Q.

Specifications

Size	3.7 x 2.4 x 1.4” (LWH, including heat spreaders and spacers)
Weight	less than 3 oz. When populated
Supply voltage	8.5 to 15 VDC (13.8V nominal); no reverse-polarity protection;
Current drain,	
Standby	approximately 30mA
Transmit	1-1.3 A at 8 Watts
Filter Selection	6-position rotary switch (ext filter reqd)
Frequencies	160, 80, 60-40, 30-20, 17-15, 12-10 M
Control	Standby/Operate, PTT
Input	2-pin Friction lock plug 0.1” 50 ohm
Indicator	none
Output	2-pin Friction lock plug 0.1” 50 ohm
Power cable	2-pin Friction lock plug .156”
Drive requirement	0.1 watts RF (with internal 0.1dB pad)
Power output	3-8 watts RF 160 – 10 meters
Duty cycle	Designed for intermittent SSB service
Forced air	100%
Intermittent	50%
Spurious products	-40 dB or better @ 5 watts w/ext filter
Harmonic content	-45 dB or better @ 5 watts w/ext filter
Load tolerance	2:1 or better SWR recommended
T-R delay	approximately 0.2 second
Control	RF sensing or isolated PTT T-R relay

Specifications above assume a 13.8 VDC supply and 50-ohm load at the antenna.

Preparation

The most important preparation step before building is to completely and thoroughly read this manual. This will familiarize you with the project, its circuitry, building requirements and components.

There are two steps in the PA-100 Amplifier assembly process:

1. Amplifier board assembly
2. Bias adjustment and Testing

After reading this document and prior to assembly you should do an inventory of parts (Appendix A). In the unlikely event

that you appear to have missing parts, duplicates or wrong parts please contact the project organizers. This might also be the time to re-acquaint yourself with how to identify resistors and capacitors by the standard codings (Appendix E), if you have forgotten.

Construction Techniques

It is a fact that 90-95% of problems with completed electronics/radio kits are due to either component misplacement or soldering faults. We cannot stress highly enough the importance of double checking component installation before soldering and then good soldering technique in order to have a working amplifier at the end of this project. Other builder faults are active component damage due to over-heating and damage to circuit board pads and tracks caused by poor desoldering, too high a wattage of soldering iron or carelessness. It is very rare to have initially faulty components or printed circuit boards (PCBs).

Good Soldering Technique

- use a 12-25 watt soldering iron with a clean, non-corroded, well-tinned, fine tip
- keep the tip clean by frequently rubbing it along a wet sponge
- keep the tip tinned
- ensure all circuit board pads and component leads are clean (not a problem with this project because boards and components are new)
- ensure the soldering iron tip is at its working temperature and is in contact simultaneously with both surfaces to be soldered (the pad and the component)
- let the contact zones heat before applying only electronics grade rosin cored solder (usually 3-6 seconds will do)
- apply the solder to the two surfaces (not the iron tip) and only enough solder to coat both surfaces
- ensure that the joint does not move after you remove the soldering iron tip and until the solder has solidified
- the resultant good solder joint should be shiny, in perfect contact with pad and wire and often has a concave upwards appearance
- special care for toroid coils: the toroids and inductors you will wind and solder in this project use enamel coated magnet wire. You must remove this insulation coating at the ends of the wires prior to soldering. Two techniques are: 1) use a small butane cigarette lighter to burn off the insulation material or 2) take a large drop of hot solder on your soldering iron tip and run the wire end through the hot solder blob to remove the insulation (this may not work with low wattage irons). Other methods such as using sandpaper or a razor knife will work but you may damage the wire or the toroid windings if you are not careful.

Suggested Tools

- 12-25 watt electronics soldering iron, electronics grade solder, iron stand and sponge
- desoldering braid and/or desoldering pump or bulb
- fine needle nose pliers, small fine wire cutters, wire stripper
- small screwdrivers including jewelers screwdrivers, small file
- multi-meter, test leads
- 50 ohm dummy load with watt meter

Component Installation

For each component, our word *"Install"* always means:

1. Pick the correct part to start with – in the assembly notes that follow we often provide a part number only. You must match this part number with the correct component using the parts lists (Appendix A). Some parts may be in bags other than their own module bags.
2. Insert the component into the correct PCB position. Refer to the PCB component outline (silkscreen) and Appendix D for the filter module.
3. Orient it correctly, following the PC board outline. This is vital for active components, electrolytic and tantalum capacitors and diodes. Also, it is good practice to mount resistors and capacitors in identical orientations (for resistors normally read color code left to right in same direction as the silkscreen on the PC board). This makes component checks easier.
4. Install all low profile components first: usually resistors, capacitors, diodes, then electrolytics and active components.
5. Resistors should be mounted about 1/8" above the board.
6. Mount all capacitors, relays and connectors as flush to the board as possible.
7. Bend the wires of the components at the bottom side slightly outwards in order to hold the component in place for soldering.
8. Solder as per techniques described above.
9. Trim excess wire leads.
10. Mark off each installation step in sequence as you complete it, in the box provided (e.g. ☑).
11. Warnings and important points are posted with a ⓘ symbol.

Winding Toroids

To wind a toroidal inductor, pull the correct wire length through the toroid core center, dividing the wire length in half. Wrap half the turns with one wire end and then wrap the remaining turns with the other end. Each pass through the center of the core counts as one turn (e.g., in Figure 1 there are 3 turns). After winding, the turns should be evenly spaced around most of the core, leaving a small (about 30º) gap between the first and last turns (i.e. about 85% of the circumference of the toroidal core should contain evenly spaced wire turns). You must then remove the insulation coating the ends of the two toroid wire ends using techniques described above. All coils are started in the direction shown below.

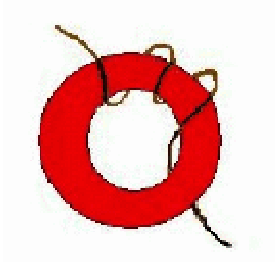


Figure 1

Care of the IRF-510S MOSFET's

MOSFETs are susceptible to electrostatic discharge damage

(ESD). It is important to use proper grounding techniques while handling the amp circuit board and the MOSFETs in particular. While working with MOSFETs you should wear a grounding strap and have an antistatic mat at your feet. At the very least you should frequently ground your hands to the nearest ground point. The IRF510S is a good compromise MOSFET that will work up to 30 MHz but has poor thermal characteristics of 3.5°C/Watt. This application requires the use of some forced air cooling. Mounting the module in a SDR-100 will provide that cooling.

Amplifier Module Board Assembly

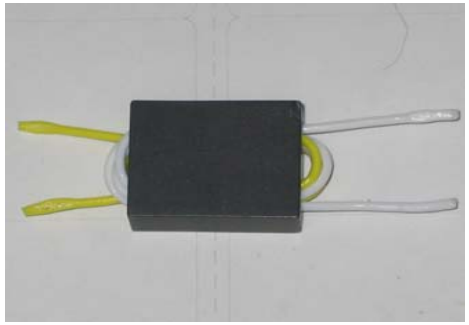
❒ Install resistors R1 through R7.
__R1 __R5: 27Ω, ½ W (red, viol, blk)
__R2: 5.6Ω, 1/4 W 1%
__R3 __ R4: 910Ω, 1/8W 1%
__R6: 1.2K, 1/8 W (brn, red, red)
__R7: 4.7K, 1/8 W (ylw, viol, red)
__R8: 470Ω, 1/8W (ylw, viol, brn)
__R9: 1M, 1/8W (brn, blk, grn)
❒ Install ceramic disc capacitors C1, C3, C4, C5, C6, C8, C9, C10 , C11, C13 and C16.(all 0.1 uF (104)).
__C1 __C3 __C4 __C5 __C6 __C16
__C8 __C9 __C10 __C11 __C13 (not polarized)
❒ Install C14 (0.01uF, 103).
❒ Install C12, C15 and C17 (.001uF, 102).
❒ Install C7 (47pF).
❒ Install C2, a radial electrolytic capacitor (337). This cap is polarized. Insert + lead in the square pad at C2 outline on. The + lead is longest.
❒ Install diodes D1 and D3 (1N4148). The black ring on the diode is the cathode. Form the diode leads with approximately 3/16-inch lead on each side of the body. Use a pair of needle-nose pliers and make a 90- degree bend. The white line on the PCB outline is the cathode end. D3 needs to be mounted towards the edge of the board to clear the connector jack J4, installed later.
❒ Install diode D2 (1N4004). The cathode band on the diode aligns with the white stripe of the component outline. The holes are almost too small, but you can work it through.
❒ Install L4 and L5. Use a component lead clipping for the wire.
❒ Install the 25-turn potentiometers VR1 and VR2. The symbol on the board for the pots is a circle but the pots are square. There is a small “o” on the artwork indicating where the adjustment screw of the pot is oriented on the board.
❒ ⓘ Using a small bladed screwdriver, turn both pots fully counter clockwise. This will be the starting position when adjusting the MOSFET transistor bias later. Fully counter clockwise places the wiper of the potentiometer at ground or zero bias voltage.
❒ Install K1. Make certain the pins are straight. Two pins on the end of the relay are spaced further apart from the other pins. Orient the relay to align with the pattern on the board. Insert the relay and ensure that all 8 leads are visible on the solder side. Solder one corner pin making sure relay is flush to the board. Press down on the relay while quickly re-heating the pin just soldered to ensure relay is flush to the board. Solder the remaining pins.
❒ Install U1 (78L05). Ensure the flat of the IC matches the flat of the component outline. The body of U1 should be spaced about 1/4 inch away from the board.
❒ Install U2 (4N33). The dot is pin 1 (square pad).
❒ Install J6 (3-pin connector). Ensure connector is flush against the board and perpendicular. Solder one pin. Inspect alignment. Re-flow the soldered pin for final position. Solder the remaining pins.
❒ Install J1 (2-pin connector), as above.
❒ Install Q3 (2N5089). Ensure that the flat of the transistor matches the flat of the component outline. Q3 should be spaced about 1/4 inch away from the board.
❒ Install J2, J3, J4, J5. Orient the board with the relay viewed in the lower right corner. The locking ramps of J3 (OUTPUT) is to the right and J5 (RF-2) is down. J2 (RF-1) has its locking ramp down, while J4 (INPUT) has the locking ramp to the right. Symbols on the board outline the locking ramp position.

❒ Install four ½ inch nylon spacers on the bottom side of the circuit board in the four corners with the black 4-40 x ¼ screws.

T1 Transformer Construction

T1 has a primary and secondary winding on the BN-43 3312 balun core (the large 2 hole ferrite core). Use the two #20 AWG Teflon covered wires to construct T1. See picture below for a photo of a completed T1.

❒ Prepare two wires. The first *primary* wire is 7 inch [178 mm] YLW. The second *secondary* wire is 10 inch [254 mm] WHT. The primary will be two loops while the secondary will be three full loops.



T1 with Yellow Primary, White Secondary

❒ Run the primary wire through first. Make sure to keep the wires from crossing over and unnecessarily blocking the wiring tube.
❒ Run the secondary wires through. Be careful to organize the path the wire takes so as to not block the wiring path. It may appear difficult to pass the last wire through the tube but it can be done. After you complete the windings, you will have primary wires on one end and secondary wires on the other end.
❒ Strip the wires within ¼ inch [6.35mm] of the tube hole.
❒ Place the primary yellow wires towards the middle of the board near capacitor C7. The secondary wires go to the outside of the rectangle near J2.
❒ Feed the primary wires into the board and pull them up tight into the holes. You should not have any strands of wires showing when you pull the wire tight into the hole. Solder the primary wires.
❒ Feed the secondary wires into the board and pull them up tight into the holes. A tiny bit of solder right at the very tip end of the strands will hold them together as you push them through the holes. Solder the secondary wires.
❒ Position the transformer over the T1 outline. The transformer is now suspended by the four wires and hovering possibly 1/8 inch or less [3.18 mm] above the board. Press the transformer down to the board. The leads will hold the transformer in this position.

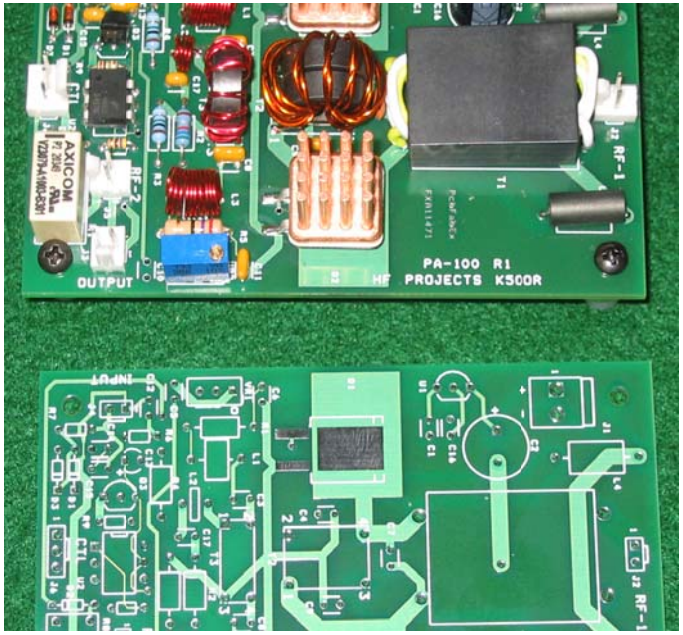
T2 Transformer Construction

Metric conversions: #22 = [0.6452 mm] #24 = [0.5105 mm]
T2 uses two stacked FT-50-43 cores and has ten bifilar turns of #22 wire. See the picture below.

Note: Ignore T1 (left) in this old photo.
❒ Measure and cut two #22 wires[0.6542 mm], each 15 inches

[381 mm] long. Twist these two wires together, with about 4 twists per inch. [25.4 mm]

Figure 2. T2 and T3



❒ Pass the twisted wire through the center of the two cores. Find the center of the wire and bend around the cores in a U shape. Hold one half wire set steady and wind the other wire half through the center of the cores 5 times.
❒ Pass the remaining wire end through the center 4 more times. You now have a total of ten (10) turns through the center of the cores.
❒ Equally distribute the windings on the cores.
❒ Unravel the twists on the wire ends.
❒ Trim these ends so that only 3/8-inch [9.52 mm] leads remain.
❒ Use a butane cigarette lighter, hot blob of solder, sandpaper, emery board or small file to remove the enamel from the 4 wires. Tin these leads.
❒ Use an ohmmeter to determine the two windings. On the schematic diagram (Appendix C) the first winding is labeled pins 1 and 2 (there should be zero ohms reading between pins 1 and 2). The second winding is labeled pins 3 and 4 (zero ohms reading between pins 3 and 4). Make certain the two windings are not shorted. The circuit board the four leads of the transformer identified.
❒ Lay the board flat in front of you with T1 at the top.
❒ T2 will fit the component outline with cores as shown in the picture. One start/finish winding will go into holes 1-2. The other start/finish winding will go into holes 3-4.
❒ Put the 4 leads through the board and snug up T2 tight to the board. Solder. Inspect your joints to make certain that solder flows onto the wire and into the holes.

T3 Transformer Construction

T3 uses one FT-50-43 core and has ten (10) bifilar turns of #24 wire [0.5105 mm].

❒ Measure and cut two #24 wires, each 11 inches [279 mm] long. Twist these two wires together with about 4 twists per inch. [25.4 mm]
❒ Wind 10 turns exactly as explained in the section above for transformer T2.
❒ Equally distribute the windings on the core. Unravel the twist on the remaining ends of the wires. Trim these ends so that only 3/8-inch [9.52 mm] leads remain.
❒ Remove the enamel insulation (see “Soldering Techniques”) from the 4 wire ends. Tin the leads thoroughly.
❒ Use an ohmmeter to determine the two windings. The first winding is labeled pins 1 and 2 (there should be a zero ohms

reading between pins 1 and 2). The second winding is labeled pins 3 and 4 (zero ohms reading between pins 3 and 4). Make certain the two windings are not shorted. The circuit board has a square pad identifying lead 1 of the transformer.
❒ T3 will fit the component outline as shown in the picture. One start/finish winding will go into holes 1-2. The other start/finish winding will go into holes 3-4.

❒ Put the 4 leads through the board and snug up T3 tight to the board. Solder. Inspect your joints to make certain that solder flows onto the wire and into the holes. It will take a little more heat to flow pin 3 since it is the ground plane.

Inductors Assembly

NOTE ⓘ: Frequent questions concerning 10 or 9 1/2 inductor turns are answered in Figure 7. The next series of steps fabricate L1, L2 and L3 using #24 enameled transformer wire. L1 and L3 have 9 ½ turns of #24 close wound on a 0.25 inch ID. These two inductors are identical in size and are formed by wrapping the turns over the shaft of a ¼ inch drill bit.
❒ Cut two 12 inch [305 mm] lengths of #24 AWG enameled magnet wire. Wrap each wire around a ¼" [6.35 mm] drill bit shaft 10 times to make two separate inductors. By wrapping the wire around the shaft 10 times you will get 9 turns. The last turn arcs only ½ turn before entering the circuit board.
❒ Trim the excess leads to 3/16 inch [4.76 mm]. Burn or scrape the insulation off the ends of the wires, tin with solder and insert into the circuit board. The wires poking through on the circuit side should be adjusted to protrude only about 1/8 inch [3.18 mm]. Solder.

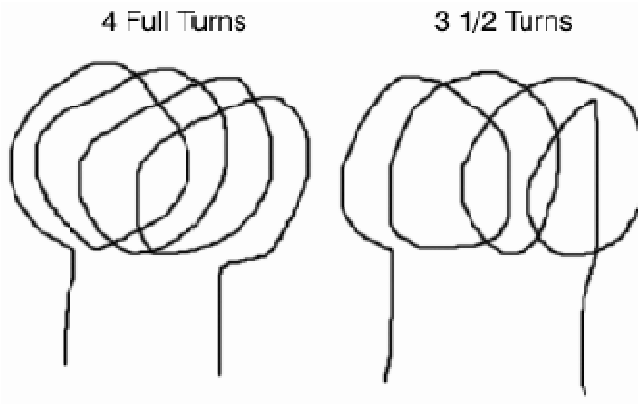
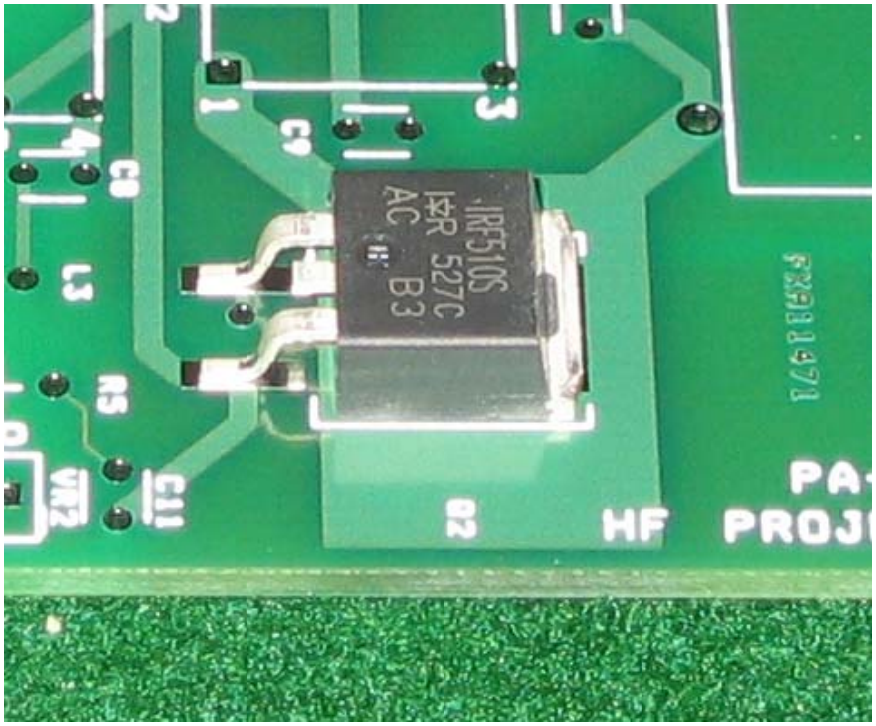


Figure 3. Counting inductor turns.

❒ Align the inductors directly over the L1 and L3 outline on the board using tweezers. The windings should remain close wound.
❒ Cut a 4-inch [101 mm] length of #24 AWG [0.5105 mm] enameled magnet wire. L2 has 3 ½ turns of #24 close wound on a 0.19 inch ID [4.83 mm]. Form the inductor by wrapping the turns over the body of a .187 [4.75 mm] aluminum spacer. Wrap the wire around the spacer 4 times. Trim the excess leads to 3/16 inch [4.76 mm]. Burn or scrape the insulation off the ends of the wires, tin with solder and insert into the circuit board. Solder.
❒ Adjust the inductor position to be directly over the L2 outline on the board. The windings should remain close wound.

MOSFET Installation

❒ ⓘ Be aware that the sensitivity of a MOSFET's gate makes them vulnerable to damage by ESD. If possible, use a soldering iron with a grounded tip. It is recommended the builder wear a wrist strap and use an anti-static mat. At the very least, you should frequently ground your hands to the nearest ground point.



❒ Install the MOSFET's on top of the circuit board. This may be the first surface mount you have ever soldered. It is an easy task especially since the device is so large. Lay the MOSFET on the pads as shown in the photo below. Put a tiny amount of solder on a circuit board pad and tack the MOSFET in place. You want to make sure that it is lined up and that you have some circuit board slightly visible where the body sits. Solder the part to the board. Put the tip of the iron making contact with the body and the circuit board. Feed some solder to the heated joint until it is wetted (solder flowing under neath the part).

❒ Install the MOSFET Heat Spreaders on top of the MOSFETs.

Peal and press the heat spreader to the top of the MOSFET. Hold with some pressure for 30 seconds.

Making Coax Pig Tails

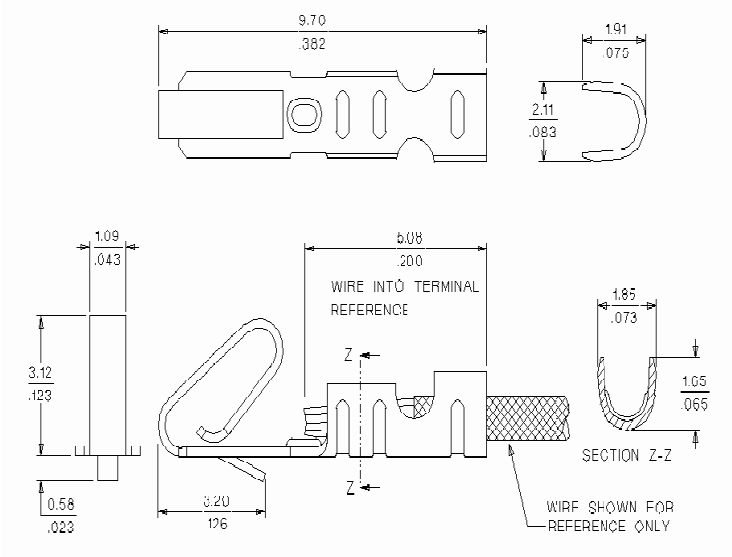
1. Remove sleeve from RG174 coax back one inch [25.4mm].
2. Trim braid back. Tin and attach a 1 inch [25.4mm] length of hookup wire. Solder to the end of the coax braid.
3. Attach Molex pins to the end of the wires. Crimp and solder. Do not deform the contacts in the process.
4. Put a ½ inch [13mm] length of ¼ inch [6.3mm] diameter shrink tubing over the braid and shrink.
5. Plug the cable in between J2 (RF-1) and J5 (RF-2) to strap the output of the amp back to the T/R relay.
6. Make a cable attaching to INPUT J4 and a BNC input

connector.
7. Make a cable attaching to OUTPUT J2 and a BNC or SO239 connector for the antenna output.

Poke wires into Housing

Insert the crimped and soldered pins into the housing. Make certain that the coax center conductor will go to the pin 1 of any circuit board connector where used. The friction lock is towards you in this picture.

1. **If you have assembled this correctly, the pins will click into position in the housing and be retained.**



Testing and Alignment

For this exercise the builder will require the following:

- a small flat bladed screwdriver for potentiometer adjustments
- multimeter to measure volts, ohms and amperes
- dummy load to handle 35 watts
- 12VDC, 2A power source
- cable to connect 12v power source to the power cable.

MOSFET Amplifier Bias Adjustment

❒ ⓘ Ensure that the two potentiometers (VR1, VR2) are both in the fully counter clockwise position. Failure to do so can lead to excess current in the MOSFETs and their consequent failure.

❒ Measure resistance between J1 pin 1 (+) to J1 pin 2 (-) on the amp board. The reading should be very high or infinite.

❒ Put the multimeter in series with the power source and the power cable in order to measure current. Plug in 12VDC power. The T-R relay will click closed for about 1 second then it will open again. The amp will have a fast surge current that will blow 200mA fuse in your multimeter on the most sensitive scale. Use the higher amp scale or jumper across the meter during plug-in.

❒ Measure in-line current of about 10 mA. quiescent.

❒ Put the meter in series with the power source and the power cable to measure current. You will monitor the current while turning VR1 clockwise. At some point the current will start to rise. Increase the current by 10mA. Turn VR2 clockwise. At some point, the current will start to rise. Raise the current an additional 10mA

for a total of 10mA through each MOSFET plus the 10mA minimum current.
❒ You are now finished preliminarily setting the bias for both MOSFETs. The total current should be 20mA above the quiescent. Do not attempt to run more bias current than 10 mA for each MOSFET device. There will be a touch up requirement after the MOSFET is at operating temperature.

Final Tests

❒ Ensure that the QRP transmitter you will be using with the Hfpacker-Amp has an RF power output of about 0.1 watts for this test. .
❒ Connect a 35 watt, 50 ohm dummy load to the OUTPUT ANT jack, preferably also with an inline wattmeter. (A homebrew dummy load can easily be constructed with appropriate high wattage parallel resistors mounted in a small container with mineral oil, e.g. 4 – 200Ω, 10 W resistors in parallel).
❒ Connect your QRP transmitter to the BNC jack.
❒ Connect the amp power cable to a 11.5-14VDC, 2A power source.
❒ Place SW1 in the operate position.
❒ Key your transmitter and check for approximately 3-8 watts output on each band during voice peaks and for a clean sounding signal on a nearby receiver.
❒ After a minute or so, the MOSFETs will begin to heat up. After they are up to a warm to the touch feeling, readjust the bias again for 10mA per MOSFET.

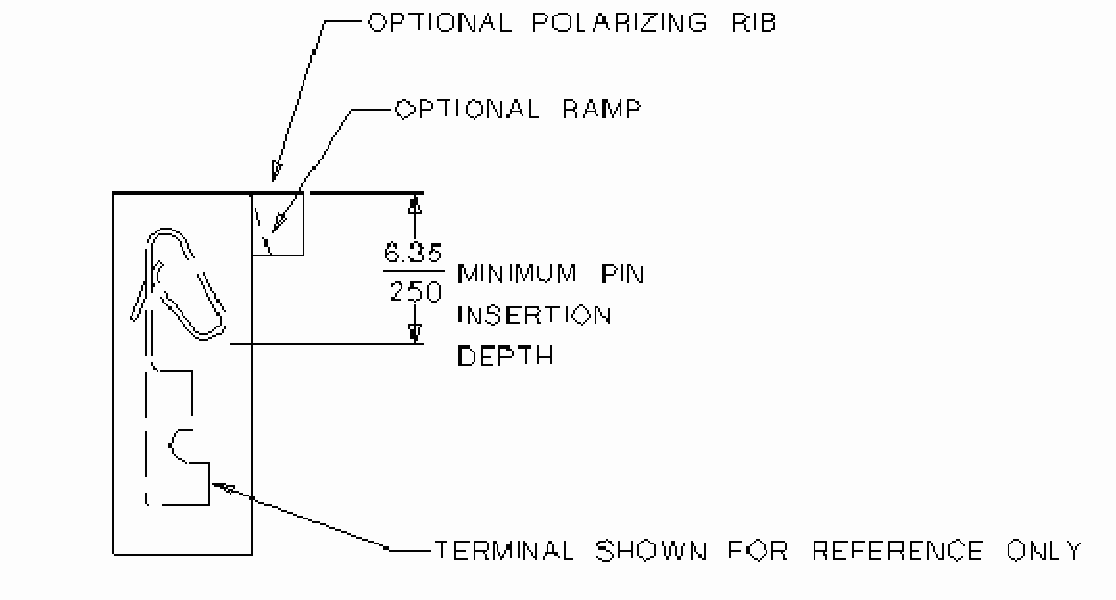
Any problems encountered need to be traced back to their likely module using standard troubleshooting techniques, along with studying the schematics in Appendix C. Assistance is also available at the user forums at http://www.hfprojects.com.

Appendix A – Parts Lists

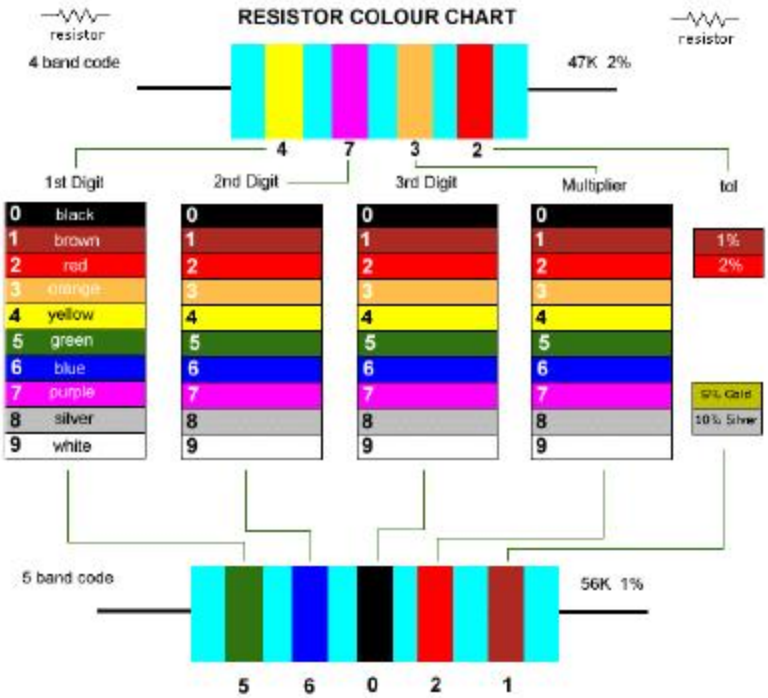
ⓘ The parts for the 5W AMP Model PA-100 are in a sealed bag. A check box column is provided in the following Parts Lists in order to assist with inventory.

Appendix A	AMPLIFIER MODULE PARTS LIST		
Designator	**Description**	**QTY.**	☑
C7	010-140-500N5-470J Cap, 47 Pf 500V 5% NPO	1	
C17,C12,C15	010-80-C320C102K5R Cap, .001uF KEMET 50V 10%	3	
C14	010-581-SR151C103K Cap, .01uF AVX 100V 10%	1	
C1,C3-C6,C8-C11,C13,C16	010-581-SR201C104K Cap, .1uF AVX 100V 10%	11	
U2	050-512-4N33 Fairchild Optocouplers DIP-6 PHOTO DARL	1	
C2	010-140-ESRL16V330 CAP 330UF 16V 20% RADIAL ELECTROLYT	1	
	015-PA100_VER1.0 5W AMP Circuit Board Rev 1	1	
J6 (CTL)	020-538-22-23-2031 Connector 3-pin .1" pitch Molex	1	
J1 (POWER)	020 538-26-60-4020 Connector, 2-pin .156 Vert Tin	1	
J2,J3,J4,J5	020-538-22-23-2021 Header .100 K.K. Friction lock 2 CKT Molex	4	
Q1,Q2	035-Heat Spreader Swiftech BGA Memory RamSinks	2	
T2,T3	045-FT50-43 Core, FT50-43	3	
T1	045-BN-43-3312 Balun Core, BN-43-3312	1	
L4,L5	045-623-2673021801 EMI SHIELD BEAD	2	
U1	050-512-LM78L05ACZ 5V Regulator, Fairchild	1	
K1	070-655-V23079A1003B301 Relay, 12VDC Non-latching Axicom 070-	1	
R2	075-660-MF1/4DCT52R5R6F Resistor, 5.6 ohm 1% 1/4W	1	
R1,R5	075-293-27-RC Resistor 27 ohm 1/2W	2	
R3,R4	075-271-910-RC Resistor 910 OHM 1/4W 1%	2	
R6	075-299-1.2K-RC Resistor 1.2K 1/8W 5% 299-1.2K-RC	1	
R7	75-299-4.7K-RC Resistor 4.7K 1/8W 5% CF	1	

Appendix A	AMPLIFIER MODULE PARTS LIST		
R9	075-299-1M-RC Resistor, 1M 1/8W	1	
R8	075-299-470-RC Resistor, 470 ohm 1/8W 5%	1	
VR1,VR2	072-652-3296-W-1-103 Pot, 10K 3/8 SQ	2	
Q1,Q2	080-512-IRF510S MOSFET, SM N-Ch Power	2	
Q3	080-610-2N5089 NPN, 2N5089	1	
D1,D3	080-512-1N4148 Diode, 1N4148	2	
D2	080-583-1N4004 Diode, 1N4004 1A 400V	1	
T1	095-602-5856-100-05 TEF-20 Wire, Teflon covered #20 AWG YEL	7in.	
T1	095-602-5856-100-01 TEF-20 Wire, Teflon covered #20 AWG WHT	10 in.	
T2	095-566-8051 Wire, #22 AWG magnet wire, Poly-Thermaleze 1-ft	3 ft	
T3	095-566-8052 Wire, #24 AWG magnet wire, Poly-Thermaleze 1-ft	5 ft	
J1	020-538-09-50-3021 CONN HOUSING 2POS .156 W/RAMP	1	
J1	020-58-08-50-0106 CONN 08-50-0106 TERM FEM 18-24 AWG TIN	2	
J6	020-538-08-55-0102 Crimp term sel gold Molex .100K.K	3	
J6	020-538-22-01-2037 HSG 3P with LKG Ramp	1	
J2,J3,J4,J5	020-538-22-01-2027 Locking Ramp Housing 2P MOLEX 538-22-01-2027	4	
J2,J3,J4,J5	020-538-08-50-0114 Crimp Terminal MOLEX 538-08-50-0114	8	
	036-MSPPK0404 Black Pan Head 4-40x1/4 Screw - Phillips	4	
	035-561-TSP3 Spacer, Nylon 1/2" 4-40 tap	4	
	RG-174 Cable	2 ft	

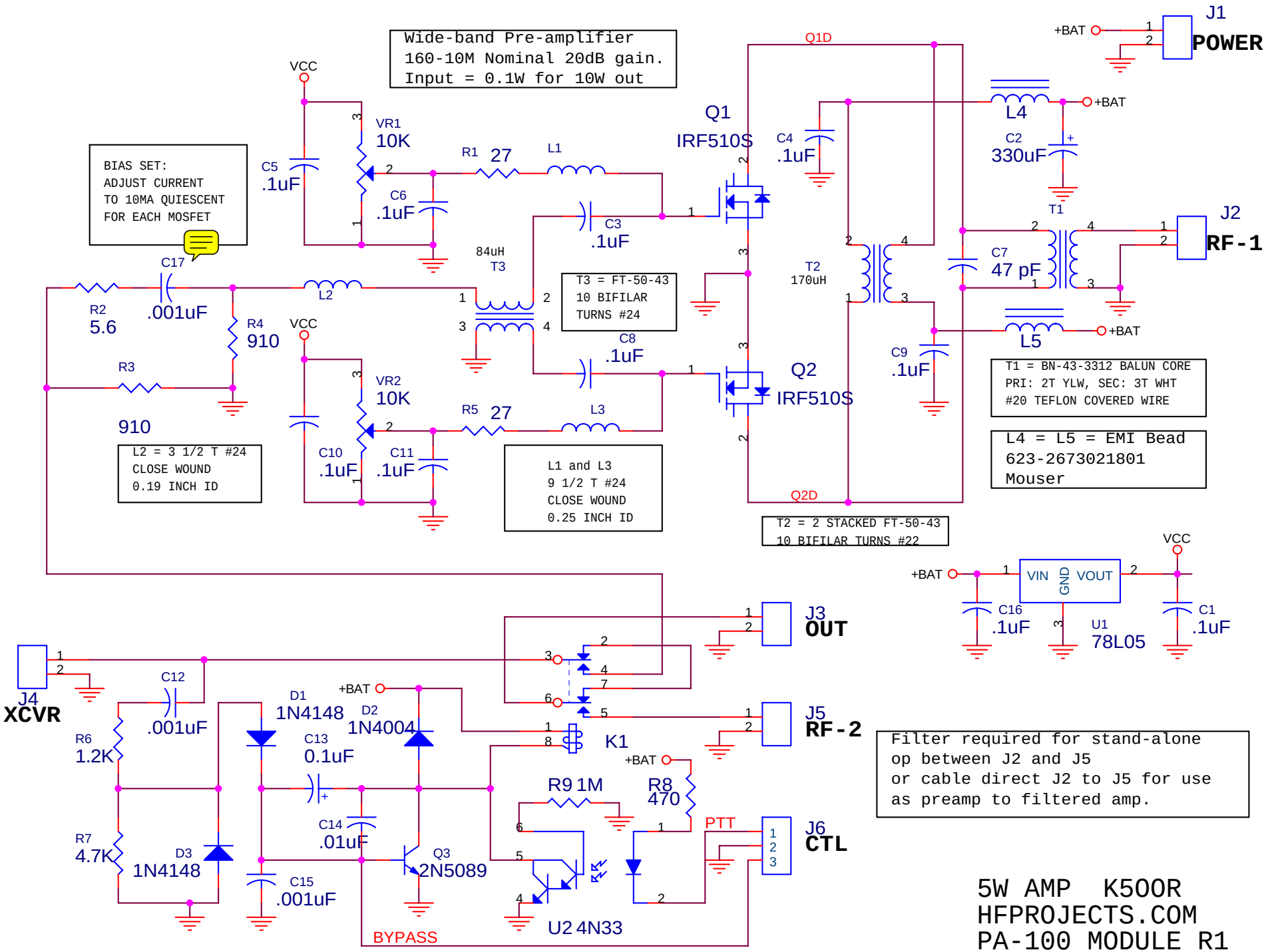

OPTIONAL POLARIZING RIB
OPTIONAL RAMP
6.35
250
MINIMUM PIN
INSERTION
DEPTH
TERMINAL SHOWN FOR REFERENCE ONLY

Appendix E: Resistor and Capacitor Identification



Identifying Capacitors

Small-value fixed capacitors (such as the silver mica capacitors for the filter module) are usually marked with one, two, or three digits and no decimal point. If one or two digits are used, that is always the value in *picofarads* (pF). If there are three digits, the third digit is a multiplier. For example, a capacitor marked "330" would be 33 pF (33 with a multiplier of 0). Similarly, "151" would be 150 pF, and "102" would be 1000 pF (or .001 µF). Fixed capacitors with values of 1000 pF or higher often use a decimal point in the value, such as .001 or .02. This is the value in *microfarads* (µF).

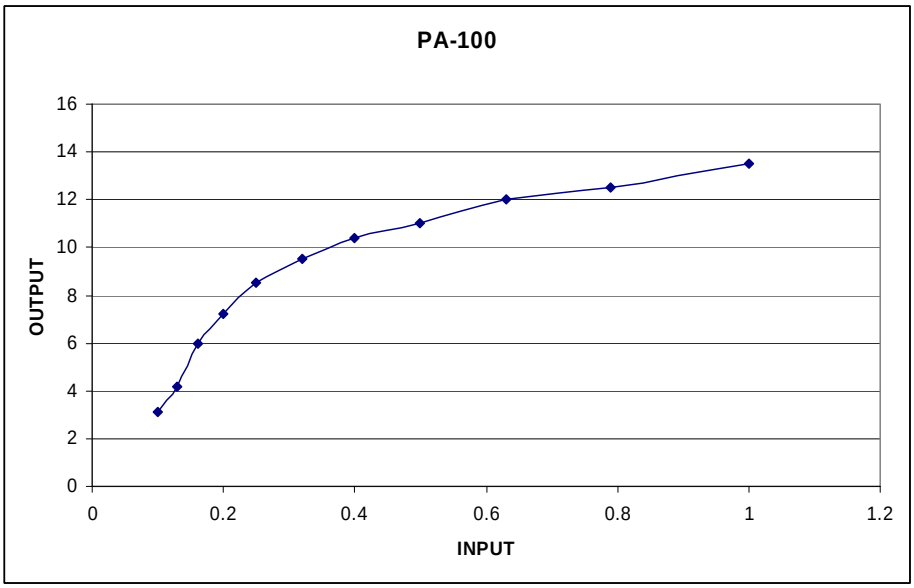

Wide-band Pre-amplifier
160-10M Nominal 20dB gain.
Input = 0.1W for 10W out
BIAS SET:
ADJUST CURRENT
TO 10MA QUIESCENT
FOR EACH MOSFET
VCC
VR1
10K
C5
.1uF
R1
27
L1
C6
.1uF
C3
.1uF
Q1
IRF510S
Q1D
C4
.1uF
L4
+BAT
C2
330uF
J1
POWER
+BAT
T1
J2
RF-1
C7
47 pF
T2
170uH
L5
+BAT
C9
.1uF
T1 = BN-43-3312 BALUN CORE
PRI: 2T YLW, SEC: 3T WHT
#20 TEFLON COVERED WIRE
L4 = L5 = EMI Bead
623-2673021801
Mouser
84uH
T3
T3 = FT-50-43
10 BIFILAR
TURNS #24
C8
.1uF
Q2
IRF510S
Q2D
T2 = 2 STACKED FT-50-43
10 BIFILAR TURNS #22
C17
.001uF
R2
5.6
R4
910
L2
R3
910
L2 = 3 1/2 T #24
CLOSE WOUND
0.19 INCH ID
VCC
VR2
10K
R5
27
L3
C10
.1uF
C11
.1uF
L1 and L3
9 1/2 T #24
CLOSE WOUND
0.25 INCH ID
VCC
+BAT
VIN
GND
VOUT
C16
.1uF
U1
78L05
C1
.1uF
J3
OUT
J4
XCVR
C12
.001uF
D1
1N4148
D2
1N4004
+BAT
K1
J5
RF-2
R6
1.2K
C13
0.1uF
R9 1M
R8
470
+BAT
PTT
J6
CTL
R7
4.7K
D3
1N4148
C14
.01uF
Q3
2N5089
C15
.001uF
U2 4N33
BYPASS
Filter required for stand-alone
op between J2 and J5
or cable direct J2 to J5 for use
as preamp to filtered amp.
5W AMP K500R
HFPROJECTS.COM
PA-100 MODULE R1

LINEARITY PLOT

PA-100 SDR-AMP

Virgil Stamps, K5OOR HF Projects

PA-100



The PA-100 linear region starts about 0.2W input.