HFPA V4 R6 CONSTRUCTION MANUAL

HF PACKER –AMP VERSION 4 REV 6

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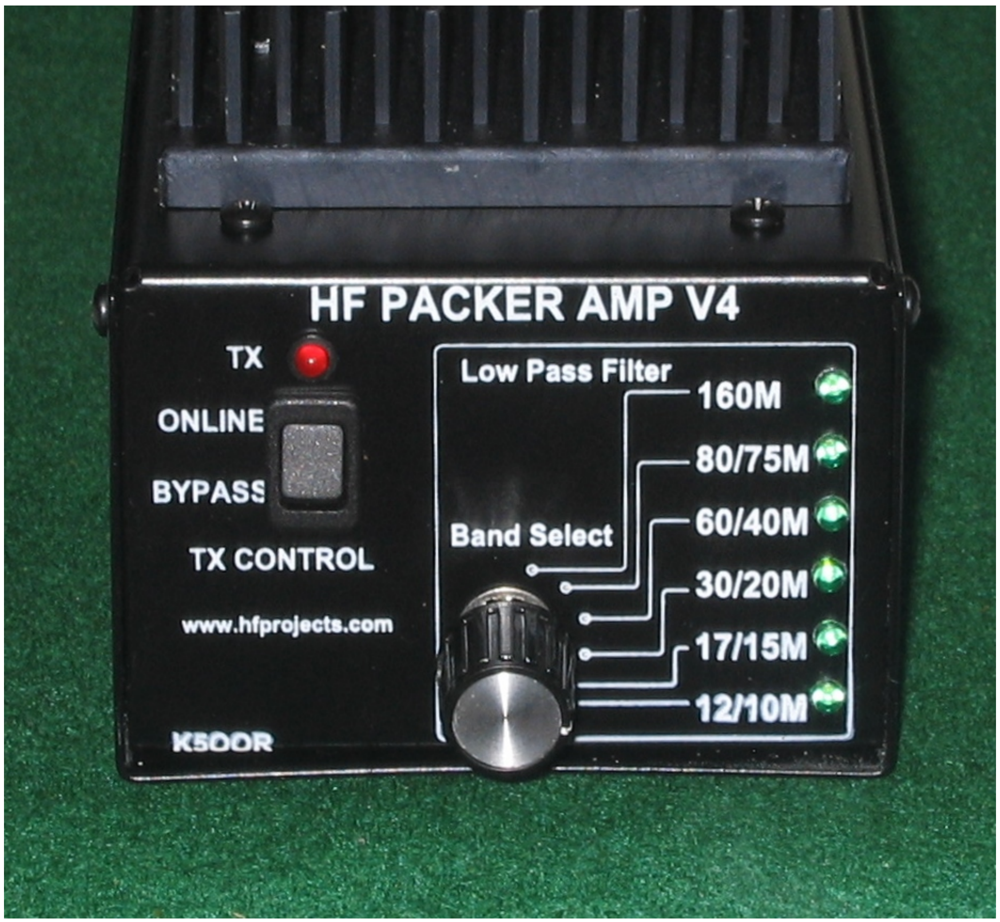


Rev 6 of the HF PackerAmp V4 includes LED indication for the band of operation plus all the features of Rev 5. The amp circuit board (R5) remains unchanged but there are significant additions warranting the Rev 6 designation for the project. Changes are:

1. The Low Pass Filter Module (LPF) is revised to include an interface cable for the LED module (HFPA-FILTER-12 R1).
2. A new LED Module (LEDM-100 R0) including an interconnecting cable between the LED and the LPF.
3. The chassis revised to include the holes for the LED module.
4. The front panel silk screen was revised for better clarity.

HF Packer-Amp V4 R6

Revised 10/10/2015

Contents

Section One - Introduction

Welcome all builders to the homebrew Hfpacker-Amp V4 R6 Project. This project parts and your efforts will eventually provide you with a compact 5 watt input to 30-35 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. In this section, you are introduced to the building of the HF Packer Amp. 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. You can take advantage of some fabricated options available to you.

- Fabricated Coil Set
- Fabricated Cable Set
- Fabricate and install Amp circuit board Inductors

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 receive the construction manual in a pdf format. You can also download from the hfprojects site: http://groups.yahoo.com/group/hfprojects/ Membership is free. 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 the basic amp 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. Full amplifier circuit design credit is given to Mike Kossor, WA2EBY. The amplifier module is mounted to the inside bottom of the chassis box and its MOSFETs are attached to a heat sink. The power supply unit is an integral part of the amplifier module while the filter board is mounted above the amplifier module.

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 50 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 network 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 C7 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. C5 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 C4, C6, C8 and C1 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 R2 and L3. At low frequencies, the amplifier's input impedance is essentially equal to the series value of R1 and R2. L1 and L3 improve the input-impedance match at higher frequencies. The low value of series resistance provided by R1 and R2 also reduces the Q. A Resistive Pi Network comprised of R3, R7 and R8 provide a 50 ohm impedance to the transceiver and to the AMP. The standard network attenuates the RF Input by 9dB which is a 8:1 power ratio. The maximum RF input of 5W is reduced to 0.63W to the gates of the MOSFETs. The attenuation matches the popular FT817 power setting of 5W. The maximum of 0.63W is below the distortion level of the MOSFETs. This is important for distortion free SSB operation. The bias current is 100mA per MOSFET while transmitting.

The switch-mode p**ower supply circuits** boost the nominal 12 VDC input to 29 VDC at 3-4 amperes during voice peaks. The power supply is normally off unless commanded to be on by the Controller IC, U2. During receive or standby current is very low. There is an approximate 26 mA current draw when power supply is off, and 95 mA current draw when power supply is on and 3-10A current draw when the amplifier is keyed by a transceiver.

Performance

The chart shows the typical gain vs frequency you can expect from the HF Packer-Amp. The average power out is approximately 35W. The fall off in performance at 30MHz is due to the MOSFET characteristics. This chart was made with a constant RF drive input.

The Controller , U2 is a Microchip PIC16F688 device. RF input at J3 is tapped by U6, RFM2 Module to provide a signal to the controller for Carrier Operated Sensing. This signal causes the controller to sequence the PSU signal, the IPS signal and TX signal for correct operation. The PTT input may also be used to activate the amp independent of RF sensing. The TX signal (Q6) operates the T/R relays K2 and K3 to switch from the RX state to the TX state. The controller is asleep during receive mode to inhibit controller noise..

Terms used in the descriptions

- PSU – Power Supply Unit
- IPS – Intelligent Power Switch
- PTT – Push To Talk
- AMP – Amplifier

- TX - Transmit
- On/Standby – TX Enable
- LPF – Low Pass Filter
- XCVR - Transceiver

The IPS signal passes the PSU voltage to the MOSFETs through the IPS electronic switch U5. The PSU signal activates the DC-DC converter on from a standby state. The IPS device acts as a power switch and a over-current sensor to protect the DC-DC converter IC, U4. The U5 device purposely heats up rapidly to provide a thermal time constant circuit breaker if the current exceeds 5A. After the U5 device cools, the circuit breaker automatically resets.

A TEST jack, H3, provides a means to set the bias current. A jumper is provided to activate during calibration. CW and SSB post delay time is an automatic function. If the amp senses you are operating SSB, the post delay time is optimized for SSB. Revert to CW mode by cycling power. A front panel switch through J5 sets the AMP for ON/STANDBY. In STANDBY, the transceiver signals are routed directly to the antenna jack via J4.

Preparation

You may have purchased a fabricated cable set or the fabricated coil set. Skip over the sections that don't apply. The most important preparation step before building is to completely and thoroughly read this section of the manual. This will familiarize you with the circuitry, building requirements and components.

After reading this document and prior to assembly you should do an inventory of parts (Appendix A-C). In the unlikely event that you appear to have missing parts, duplicates or wrong parts please first double check for the parts in all bags, recheck the inventory and if this fails 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 coding (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 de-soldering, 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
- toroids and inductors you will wind and solder in this project use enamel coated magnet wire. The enamel wire used is designed to be stripped by a soldering iron at 750 deg F. This makes it much easier to tin the wire before insertion into the circuit board holes. The project provides 2 sizes of magnetic wire #22 AWG (thickest), 24 AWG (thinnest).

Suggested Tools

- 12-25 watt electronics soldering iron, electronics grade solder, iron stand and sponge
- De-soldering 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
- LCR meter (used to measure inductance and capacitance)
- Crimp tools for Molex pins and Power Pole Terminals

Included Speciality Tools

- 1/16 and 7/64 Hex Head tool

Component Installation

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

- 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).
- Insert the component into the correct PCB position. Refer to the PCB component outline (silkscreen). 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.
- Arrange the resistors on the table before you from left to right with the lowest values on the left progressing to higher values on the right. Use the multi-meter to confirm the resistor values.

- Install all low profile components first: usually resistors, capacitors, diodes, then electrolytics and active components.
- Resistors should be mounted flush to the board.
- Mount all capacitors, relays and connectors as flush to the board as possible.
- Bend the wires of the components at the bottom side slightly outwards in order to hold the component in place for soldering.
- Solder as per techniques described above.
- Flush cut excess wire leads and reflow the solder connection for assurance and a better looking solder joint.

Mark off each installation step in sequence as you complete it, in the box provided (e.g. ☑).

Warnings and important points are posted with a ⓘ symbol.

Care of the IRF-510 MOSFET's

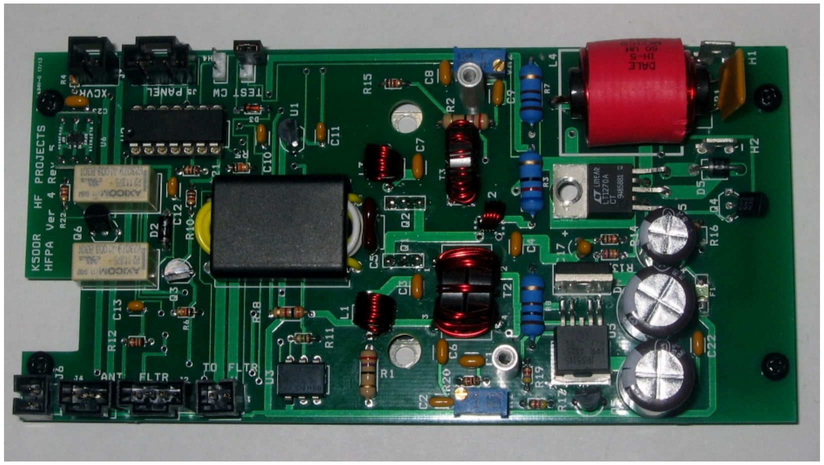
MOSFETs are susceptible to electrostatic discharge damage (ESD). It is important to use proper grounding techniques while handling the amp circuit board and the MOSFETs in particular. While working with MOSFETs you should wear a grounding strap and have an antistatic mat at your feet. At the very least you should frequently ground your hands to the nearest ground point. The IRF510 is a good compromise MOSFET that will work up to 30 MHz but has poor thermal characteristics of 3.5°C/Watt. When used in intermittent SSB and CW service forced-air cooling is not required. Tuning time with full power should be limited to less than 30 seconds with 1-2 minutes between cycles to prevent overheating. Operating at 29VDC does not press the MOSFET to their limits. The Sil-Pad TO220 mounting kit has excellent thermal performance and provides a greaseless thermal interface between the MOSFET and the heat sink. Users report that this amplifier can be safely used for contest CW operation without further cooling. For PSK/RTTY forced air cooling is necessary or a reduction of power by reducing the input drive.

Other Construction Notes

1. Follow the sequence given to locate the next component in a series to install.
2. The header parts are installed by matching the part to the outline. Start by soldering one pin and then while reheating, align the part flush and perpendicular to the board. Solder the remaining pins.
3. The IPS511S, U5 component is pre-mounted since it is a surface mount part.
4. The reference numbers used are not in sequence and some references are skipped.
5. The circuit boards should be cleaned after soldering to remove solder flux residue. I recommend “TechSpray BLUE SHOWER” available in a can: 1630-16S. Use in a ventilated area following instructions on the can.

Section Two – Amplifier Module Construction

Circuit Board ID is HFPA-2013 V 4 R5



Circuit Board Assembly, HFPA V5

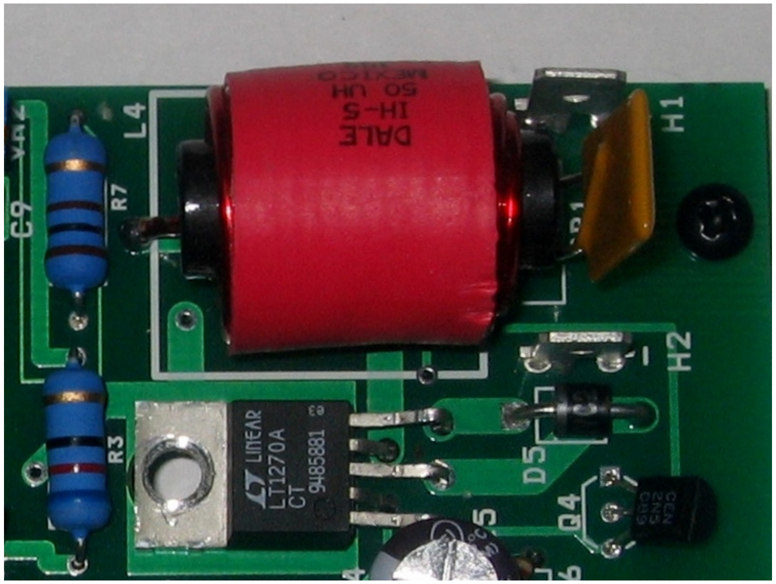
Assembly Steps

- Install 0.1 uF capacitors (104): C22, C4, C1, C9, C2, C6, C8, C3, C7, C23 Install ❒
- Install 47 pF (470J): C5
- Install 0.01 uF capacitors (103): C11, C10, C12
- Install 1000 pF capacitor (102): C13 Install ❒
- Install 1 uF capacitor (105): C17. The long lead is (+) and goes in square pad marked (+)
- Insert 1N4007 diode at D2 (smaller of two axial components with cathode stripe at one end). Bend leads very close to the body to match the component outline on the board. Make sure cathode bar on the part matches the cathode symbol on the silk screen outline.Install ❒
- Insert RL251 diode at D5. The leads are bent approximately 1/8 inch away from the body to fit the component outline on the board. Make sure cathode bar on the part matches the cathode symbol on the silk screen outline. Install ❒
- Install six 1K 1/8W resistors (BRN BLK RED): R14, R20, R15, R10, R21 and R12. Install ❒
- Insert two 4.7K 1/8W resistors (YEL VIO RED): R17, R19. Install ❒
- Insert two 27 ohm ½ w resistors (RED VIO BLK): R1,R2 Install ❒
- Insert three 10K 1/8w resistor (BRN BLK ORN): R5,R6 and R4 Install ❒   (R5 partial symbol on board)
- Insert one 27K 1/8w resistor (RED VIO ORN): R13. Install ❒
- Insert one 3K 1/4W resistor (ORN BLK RED): R18. Install ❒
- Insert two 1.2K 1/8W resistor (BRN RED RED): R16, R22. Install ❒
- Insert one 1M 1/8w resistor (BRN BLK GRN): R11 Install ❒

ⓘ Note: if you did not purchase the PINET 100-PI Option Module, install R3, R7 and R8 next. Otherwise wait until instructed to install alternate values for R3, R7 and R8 in the 100-PI section.

- Insert two 100 ohm 2W resistors at R7 and R8. Install ❒
- Insert one 62 ohm 2W resistor at R3. Install ❒

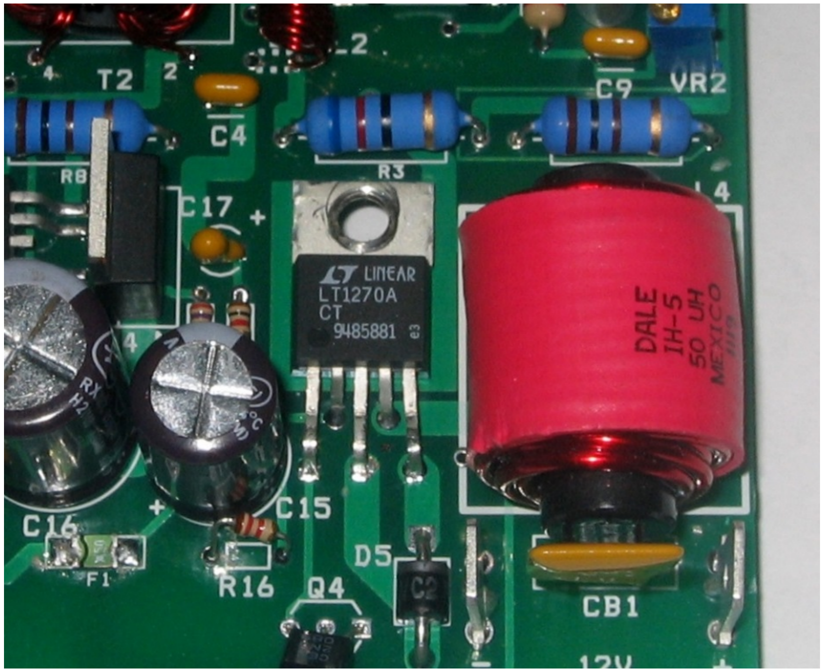
- Insert one 78L05 regulator (3 pin TO92 package) at U1. Match the outline.
- Insert four 2N5089 transistors (3 pin TO92 package) at Q3, Q4, Q5, Q6 Match the outline. Install ❒
- Insert two 2-pin headers (no rib back) at H3, H4. Install ❒
- Insert Diode D3, 1N4148 at the D3 location. Install ❒
- Insert three 2-pin headers at J1, J3, J6. Install ❒
- Insert one 3-pin header at J4. Install ❒
- Insert two 4-pin headers at J2 and J5. Install ❒
- Insert two Power Tabs at H1 and H2. Solder one pin, reheat and align perpendicular. Solder both pins of each tab Install ❒
- Insert one Circuit breaker, CB1. Leave leads long. Insert just the tips through the board. Install ❒



- Insert Inductor (Red 50 uh coil) at L4. Note that L4 leads are adjusted to fit the hole pattern. The ends are not symmetrical. Install the bent lead to the right as shown. Press the component flat on the circuit board. Solder the pins, flush cut and re-solder the connections. Install ❒
- Insert two 10K- potentiometers, VR1 and VR2, on the board. The lead under the adjustment screw is inserted in the square pad in the circuit outline. Do not bend the leads. Solder one pin, reheat and align part perpendicular and flat on the board. Solder all pins Install ❒
- Turn the 25-turn potentiometers CCW at least 20 turns. You will not hear a click and there is no mechanical stop.
- Install the 14 pin DIP socket for U2. Align the notch on the socket with the notch shown on the component outline. Solder one corner pin. Reflow connection while pressing the socket flat. Solder the other corner pin. Reflow the pin while pressing the socket flush. Solder the remaining pins.   Install ❒
- Insert U2, PIC16F688 Integrated Circuit in the socket Install ❒
- Insert two relays at K2, K3. Do not bend or cut the leads. Solder one corner pin. Reflow while pressing the relay flat to the board. Solder the other corner pin. Reheat pin as necessary to make the relay flat to the board. Solder all pins Install ❒
- Insert two 330 uF Capacitor at C21 and C16. The long lead (+) goes to the square pad of outline near the (+) symbol on the board. Solder one pin, reflow and align

part flush. Solder other pin repeating reflow and alignment. Flush cut leads and reflow. Install ❒

- Insert one 100 uF Capacitor at C15. The long lead (+) goes to the square pad of outline near the (+) symbol on the board. Solder one pin, reflow and align part flush. Solder other pin repeating reflow and alignment. Flush cut leads and reflow. Install ❒
- Insert a MBR1060G diode (2 pin package) in the outline for D4. The part is mounted vertically. Press the part down until the body is resting on the circuit board. Install ❒
- Insert a LT1270A Switching Regulator U4 is mounted horizontal into the 5 holes on the circuit board outline for U4. First bend the legs straight. Bend to match pattern while keeping the mounting hole centered. You will later screw this component down to a stud projecting from the heat sink below.



LT1270ACT Lead Insertion Detail

- Install 4N33, 6-pin IC at U3. Make sure the round depression dot on the package is closest to the notch in the component outline. Install ❒

Spacer Assembly

- Locate four 4-40 x ¼ inch threaded hex spacers and four 4-40 x 3/16 inch length screws.
- Install the spacers on the bottom side of the circuit board. Tighten the screws extra snug so they will not

come loose when removing the circuit board from the case in the future.

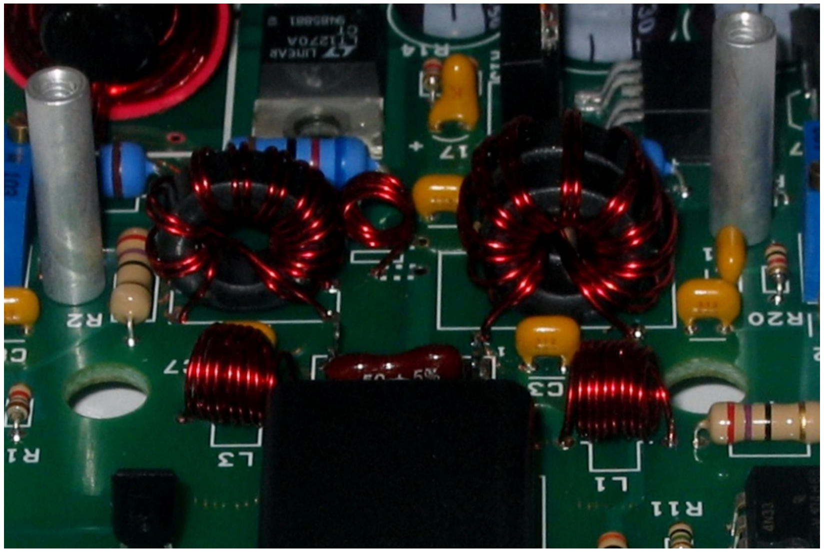
- Locate two 4-40 x ¾ inch threaded round spacer and two 4-40 x ¼ inch length screws.
- Install the spacers on the top side of the circuit board near VR1 and VR2. Tighten the screws extra snug so they will not come loose when removing the filter module in the future.

ⓘ Note: Identify the correct size wire for T2 and T3

Fabrication and Assembly of T2

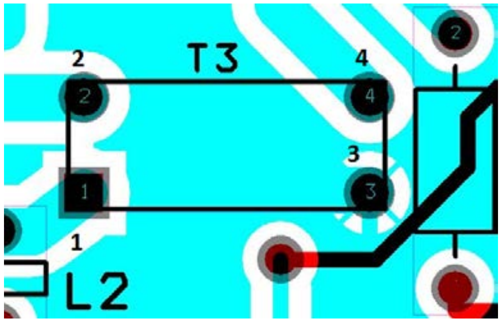
- Two stacked FT50-43 torroid cores are used for this transformer. Cut two #22 AWG wire (0.026 inch diameter) 15 inches long. Do not twist the wires. To prevent chaffing of the wire on the edge of ceramic cores, insert a common soda straw (same length as the thickness of the two stacked cores). Through the stacked cores, insert the two parallel wires. Bend the wires into a U-shape. Holding the two wires together in one hand with the cores at the bottom of the U-Shape, grasp the wires in the rear and insert the wires on front right side through the core four additional times. Pull each wrap snug keeping the wires parallel without crossovers. After completion of the loops on the right side, pass the remaining wires through the cores on the front left side 5 times. Pull each wrap snug keeping the wires parallel without crossovers. You will now have 10 turns passing through the core.

- Separate and scrape the ends of the wires so you can measure continuity and isolation to determine the start and finish of each wire.



Circuit board showing cores with wire exits for T2 and T3

- Winding # 1 goes to pins 1 and 2. Winding #2 goes to pins 3 and 4.
- Insert the wires through the appropriate holes and pull snug to form the leads in the shape required.



- Remove T2 from the mounting holes and use a soldering iron to heat the insulation at the points where you will be soldering to the board. You need at least 750 degrees F to remove the insulation. Tin the leads removing insulation and excess solder. ❒
- Re-insert T2 on the board at the T2 outline. Pull the leads tight and solder in place. Install ❒
- Trim the excess lead length and reflow connections.
- This is a typical spot where you can have a poor solder connection. Inspect and re-solder if necessary.

Adjust the wire spacing to match the picture. The top and bottom of the core should be clear so T2 and T3 will be minimum height to not create a clearance problem with the board above.

Fabrication and Assembly of T3

- One FT50-43 torroid core is used for this transformer. Cut two #24 AWG wire (0.022 inch diameter) 11 inches long . No twist is required or desired. Insert the two wires through the core. Bend the wires into a U-shape. Holding the two wires together in one hand with the cores at the bottom of the U-Shape, grasp the wire in the rear and insert the wires on the front right side through the core four additional times. Pull each wrap snug. Avoid crossover of the leads.
- After completion of the loops on the right side, pass the remaining wires through the core on the front left side 5 times. Pull each wrap snug. You will now have 10 turns passing through the core.
- Separate and scrape the ends of the wires so you can determine the start and finish of each wire. Use the multi-meter to measure continuity.
- Winding # 1 goes to pins 1 and 2. Winding #2 goes to pins 3 and 4.
- Insert the wires through the appropriate holes and pull snug to form the leads in the shape required.
- Pull T3 from the mounting holes and use a soldering iron to heat the insulation at the points where you will be soldering to the board. You need at least 750 degrees F to remove the insulation. Tin the leads removing excess accumulated Install ❒
- Re-insert T3 on the board at the T3 outline. Pull the leads tight and solder. Install ❒
- Trim the excess lead length and reflow connections.

Fabrication and Assembly of L1 and L3

- L1 and L3 are identical and require 12 inches each of the remaining #24AWG wire.

- Use a ¼ inch drill bit as a winding form and wrap 10 complete turns of the wire tightly around the drill bit.
- Trim the excess lead length to ½ inch and tin the leads.
- Insert L1 and L3 into the L1 and L3 positions on the circuit board. Install ❐
- Use the end of a ball point pen to push into the end of the air coils slightly to reform the wires should they become deformed during soldering.

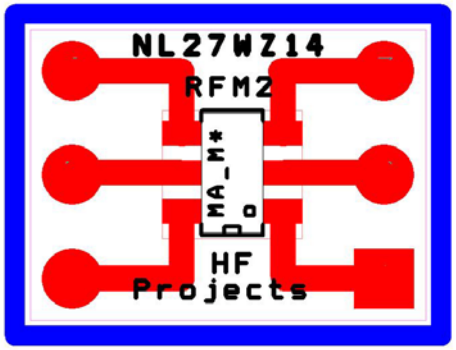
Fabrication and Assembly of L2

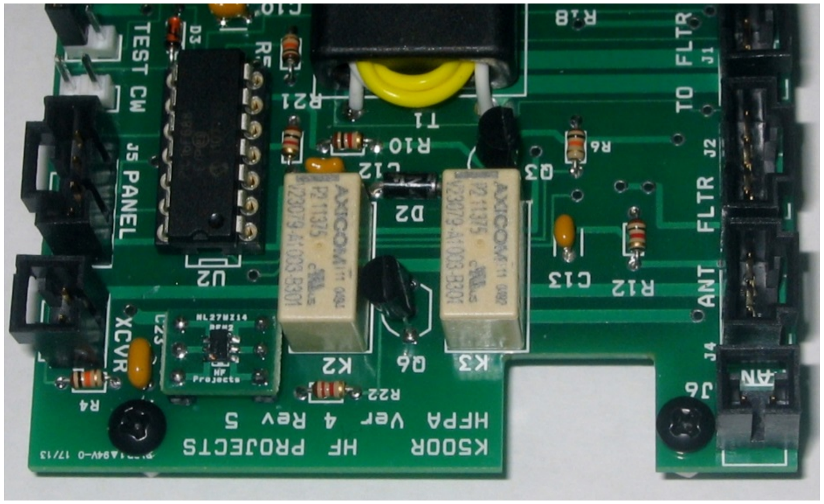
ⓘ Note: If you purchased the PINET 100-PI Module with your Amp, it is not necessary to install L2. Leave the holes clear. Instead, refer to the page for the PINET 100-PI Module option.

- L2 require 4 inches of the #24AWG remaining wire.
- Use a 3/16 inch drill bit as a winding form and wrap 4 complete turns of the wire tightly around the drill bit.
- Trim the excess lead length to ½ inch and tin the leads.
- Insert L2 into the L2 position on the circuit board. Install ❐
- Use the end of a ball point pen to push into the end of the air coils slightly to reform the wires should they become deformed during soldering.

Assembly of RFM2

- Insert the RFM-2 Module in the U6 location.
- The square pad (pin 1) on PCB aligns with the square pad on the RFM-2 Module. (see bottom right in pix below)



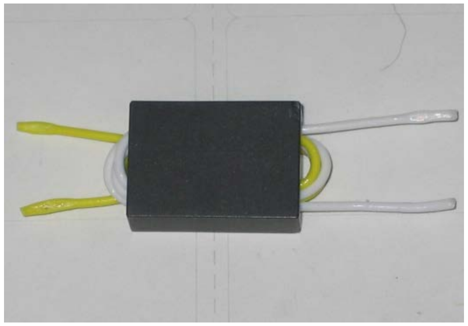


RFM-2 just below U2 above

- T1 is fabricated using a Binocular core with a primary and secondary winding.
- The primary is a 7 inch yellow #20AWG Teflon coated wire. There will be 2 loops through the cores.

- The secondary is a 10 inch white #20 AWG Teflon coated wire. There will be 3 loops through the cores.
- Make a U shape of the 7 inch yellow wire and insert into the two tubes. Equal distance the wires.
- Make a U shape of the 10 inch white wire and insert into the same end of the two tubes. Equal distance the wires. At this point, you have 2 yellow and two white wires coming out the same end.
- Push one of the yellow wire leads through the adjacent tube. Push the other yellow wire lead through the other adjacent tube. Pull the leads tight. You are finished with the yellow wire.
- Push the white wires through in the same manner. Pull the wires tight. Push the white wires through a final time through the adjacent tubes. You now have the yellow wire leads on one end and the white wire leads on the other.
- You are done winding the core.
- Trim about 3/8 inch length off each lead. Strip each wire about 3/8 inch and lightly tin the tip. You are now ready to install the transformer into the board. The yellow primary (input) and white secondary (output).
- Insert the primary wires at holes 1 and 2. Pin 1 is the square pad.

- Insert the secondary into holes 3 and 4
- Pull leads snug and solder. Install ❒



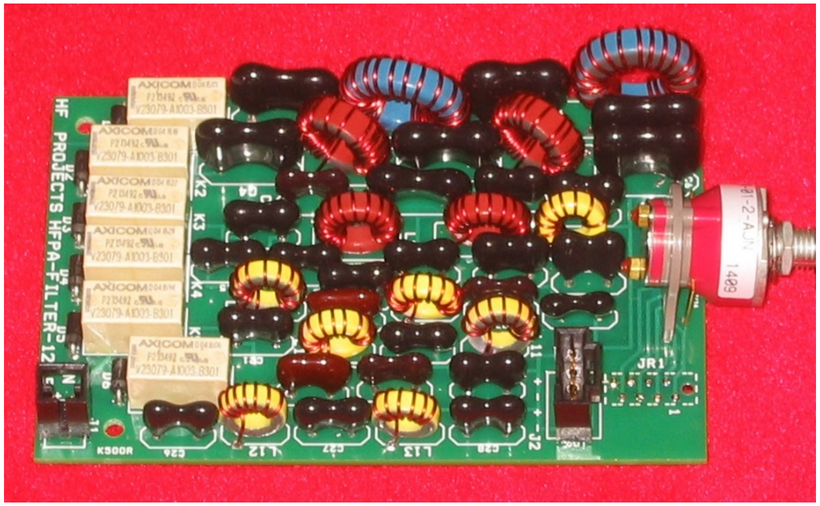
T1 with Yellow Primary, White Secondary

Clean and Inspect the Board

- Remove the flux from the circuit board with a flux removal spray in a ventilated space.
- Inspect the solder joints for the entire board

This completes assembly of this module. The MOSFETs will be installed in a later assembly.

Section 3 - Low Pass Filter Module Assembly



This is the 10-Band Filter Module HFPA-FILTER-12

- Size: 3.8 x 2.4 inch; Bands: 160-10M Power Rating: 50W; Control: Front panel switch
- Design: Four-Layer Ground Plane with greater than -40dB rejection in the stop band;
- Relay Front End controlled by front panel switch, LED display.

Organize for Assembly

- Place on the table in front of you all the capacitors ranging from smallest value to largest value from left to right.
- Organize the cores and relays into like groups.
- Two Blue Cores – T68-1
- Two Larger Red Cores – T50-2
- Two Smaller Red Cores – T44-2
- Seven Yellow Small Cores – T37-6
- Wind the cores referring to the core winding table

"REALLY CHECK THE POLARITY OF THE DIODES FOR THE RELAYS ON THE LPF BOARD"

Install Relays and Diodes

Install the six diodes on the circuit board observing that the stripe on the diode matches the board silkscreen for the part. Be careful that your tools do not damage the circuit board. The diodes require that the leads are bent very close to the body of the diode. Before installing, scrape the leads near the body to remove any oxidation on the leads. Install ❒

Install six relays. Solder one pin, reheat and align flat. Install ❒

Capacitor Assembly

ⓘ Install the capacitors in the sequence given and soldering when called for. The part may be oversized for the insertion holes. Form the leads for a best fit. Double check your work.

C1 1500, C2 2700, C3 1500 Install ❒

C4 1000, C5 1800, C6 1000 Install ❒

C7 39, C8 110, C9 390, C10, 680, C11 330 Install ❒

C12 27, C13 150, C14 100, C15 100, C16 220, C17 220, C18 47 Install ❒

C19 12, C20 39, C21 150, C22 220, C23 100 Install ❒

C24 12, C25 39, C26 82, C27 150, C28 68 Install ❒

Core Winding Table

REF	TYPE	T	IN.	Wire	IND.	Clock
L1, L2	T68-1 (BLU)	20	19	22	5.08 uH	7-5
L3,L4	T50-2 (RED)	22	17	24	2.65 uH	7-5
L5	T44-2 (RED)	15	13	24	1.37 uH	7-5
L6	T44-2 (RED)	13	12	24	1.17 uH	7-5
L7	T37-6 (YEL)	12	9	24	580 nH	7-5
L8	T37-6 (YEL)	11	8	24	470 nH	5-7
L9	T37-6 (YEL)	10	8	24	430 nH	8-3
L10	T37-6 (YEL)	11	8	24	470 nH	7-5
L11	T37-6 (YEL)	10	8	24	430 nH	7-5
L12	T37-6 (YEL)	8	7	24	360 nH	10-2
L13	T37-6 (YEL)	7	7	24	280 nH	11-1

Where: T=turns; IN.=inches; IND= inductance; Wire=AWG

ⓘ Clock – Clock Face where winding occupy space on the core between a start time (7pm) and a end time (5pm) example. Evenly adjust the wire spacing to match the clock setting.

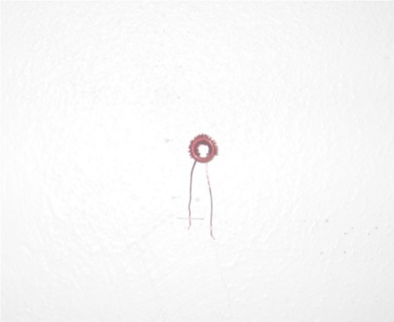
Core Winding Technique

The starting position: Divide the wire in half letting the core hang down. The wire passing through the core counts as one turn.

L3 Example:

Wind one side. Start with the wire in the back and wrap 10 turns on the right side.

Use a pair of needle nose pliers to aid in pulling the wire tight against the core as you wrap it around the core.

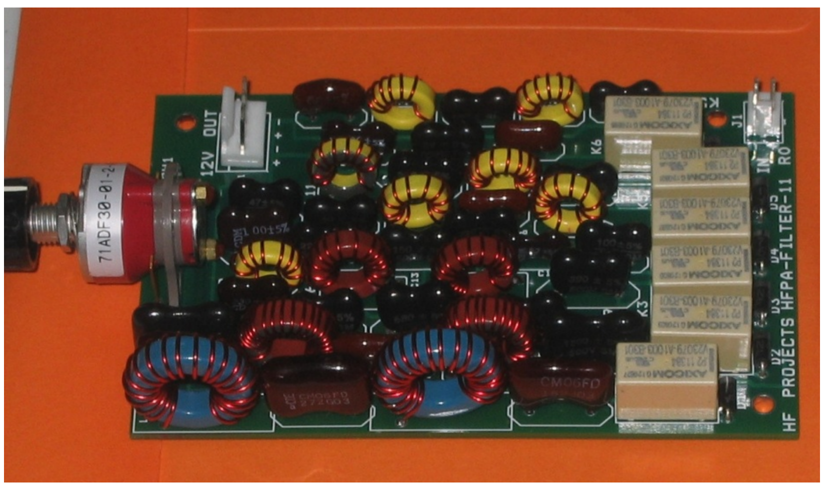


Wind the other side. Wrap 10 turns on the other side.You now have 21 turns through the core. I squeeze up the wraps to be tight. Your inductors must be wound with the wires on the sides shown or the inductor footprint will not match the circuit board layout.

ⓘ If the core does not fit the pattern (wound wrong), do not try to make it work, strip the wire and wind it again correctly. Spread the windings equally about the core using the clock code.

Core Installation

- Install L1-L2 last because of the size (see picture for detail).
- Install L3-L13. Pull the leads tight. Align the core vertical and solder.
- Repeat for each inductor one by one. Solder as you go. Install ❒



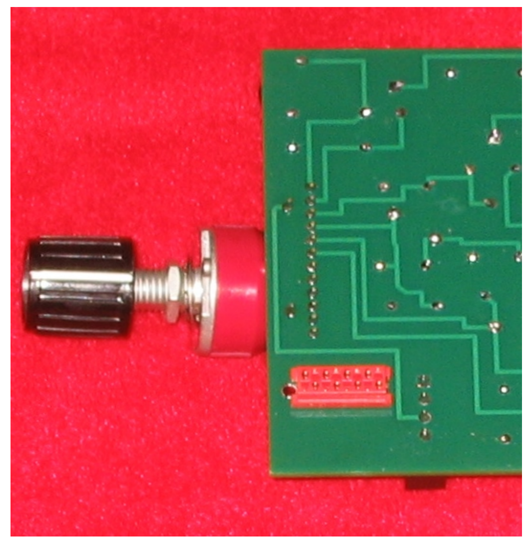
Switch Assembly

Insert the switch on the top side of the assembly. Make sure the leads are flush with the board. Install ❒

Connector Assembly

Insert J1 and J2. Make sure the parts are flush and vertical. Solder one pin to start, reheat while making final alignment. Solder the remaining pins. Make sure the friction tab is in the position shown below. The J1 tab is to the right and the J2 tab is down in the drawing below. Install ❒

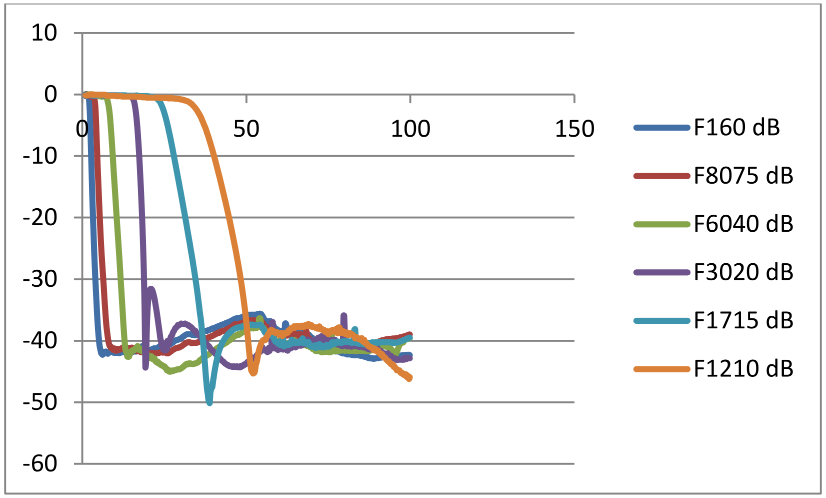
Insert JR1. This component is installed from the back side of the circuit board and soldered on the top side. It will only fit the pattern one way. See picture below. Solder. Install ❒



In-Circuit Tuning Adjustments

If you have a miniVNA device for your PC you can adjust the filter in real-time for the best response curve. If you do not, you can use the clock method of lead spacing and you should be pretty close.

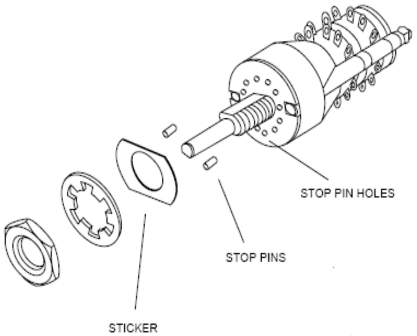
ⓘ Note: You must attach 12V to J2 in order to use a miniVNA. Observe polarity, pin 1 is +12V. You need power because only the energized circuit does not have the input and outputs grounded.



Consolidated Filter Response Where Y-axis = dB; X-axis = F MHz

The Plot was acquired using a miniVNA sweeping 1 – 100 MHz. Data was captured to an Excel spread sheet and graphed.

Selector Switch Stop Pins Installation



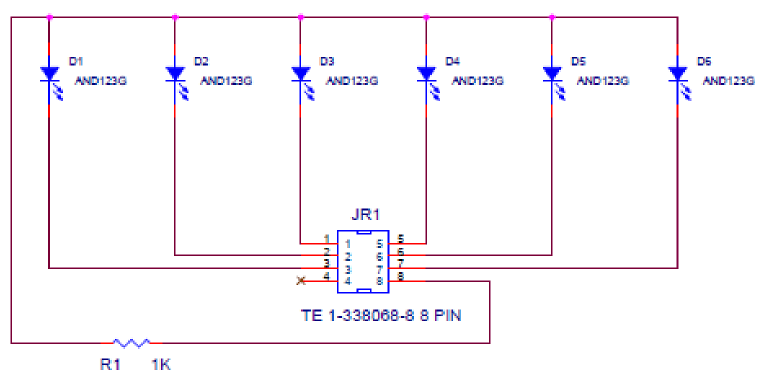
- The switch includes a little package that has two stop pins and a sticker. Your goal is to install the pins in the correct holes without losing the stop pins.

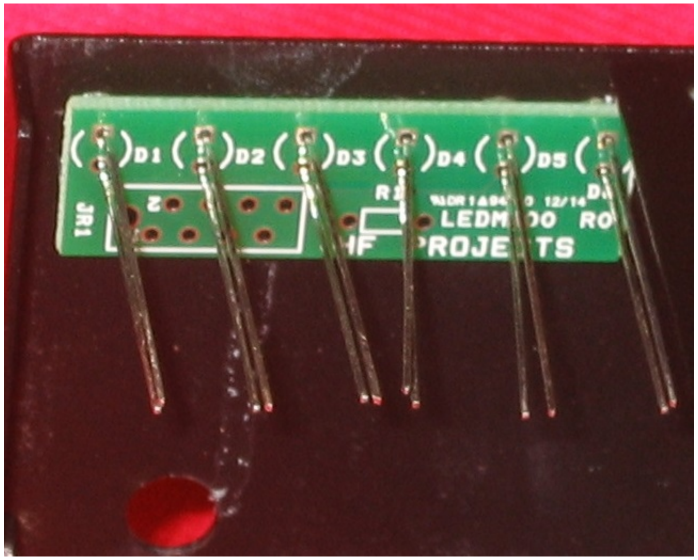
- Turn the shaft so the flat is on the right. Check ___
- Insert the pins at 12 and 6 o'clock. Cover with sticker.

Install ❒

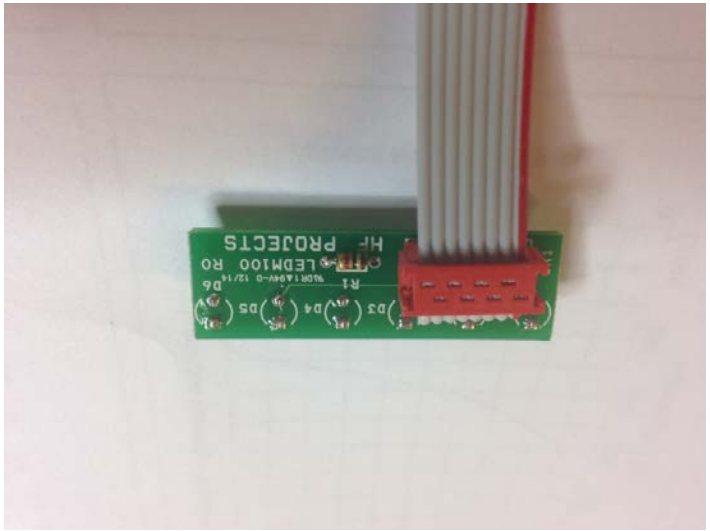
LED Module Assembly

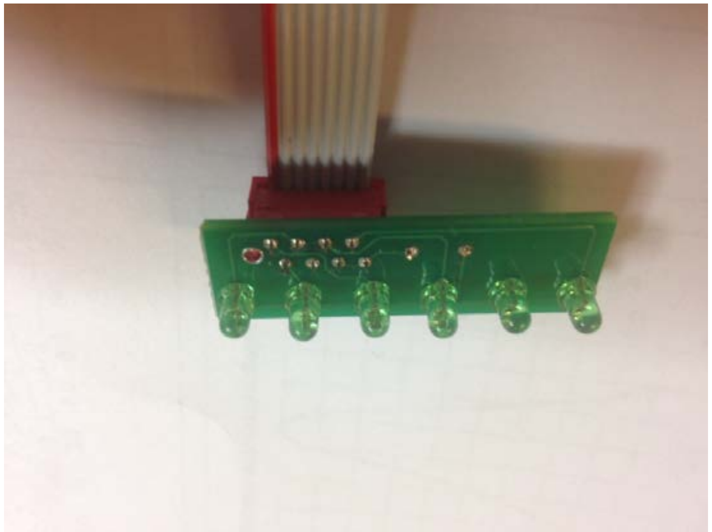
The LED Module consists of 6 LED's, a resistor and a 8-pin connector with a flat cable interface between the LED Module and the Low Pass Filter Module.





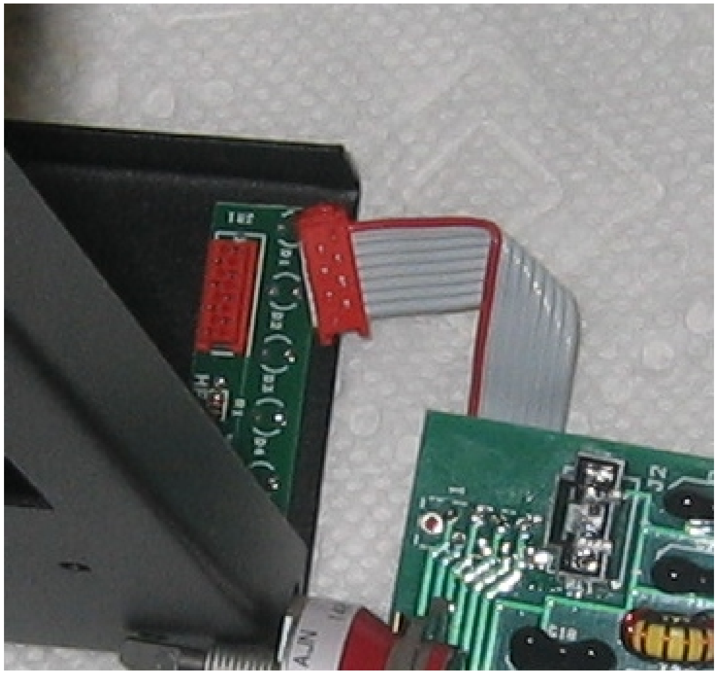
Note that the LED long lead is at the top. The LEDs mount on the side of the board without silk screen information. It is best to use the front panel as a temporary jig to hold the LEDs in position while soldering one pin on each LED. By using the front panel as a jig, the board will fit properly when installed.



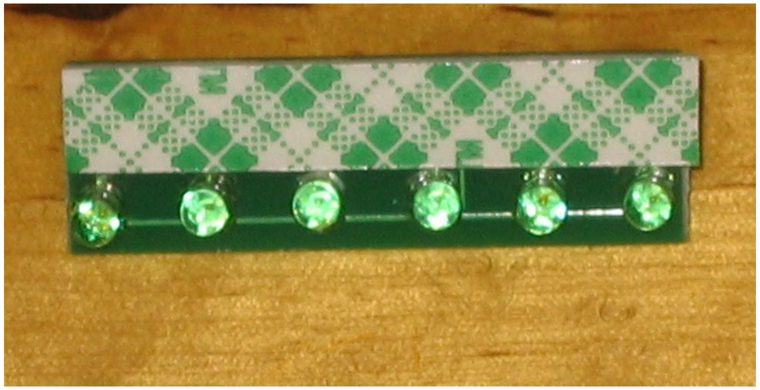


The LED Module and the Low Pass Filter Module are mated together with a 2.3 inch 8-conductor flat cable.

To assemble, position the two circuit boards to be connected and plug together.



Rotate Low Pass Filter Module into position and attach to the front panel. Minimize the flat cable by pinching the folds together as shown right.



Fit a length of double-side tape to the circuit board as shown and trim excess. Expose the tape and insert the LED module in the case

Section 4 – Case and Chassis Assemblies

Case Preparation

- Use a hobby knife to expose bare metal around the inside and outside of the holes for the RF IN, RF OUT and PTT so that when the panel part is inserted and secured, you will have a good case connection to the part body.

Heat Sink Assembly

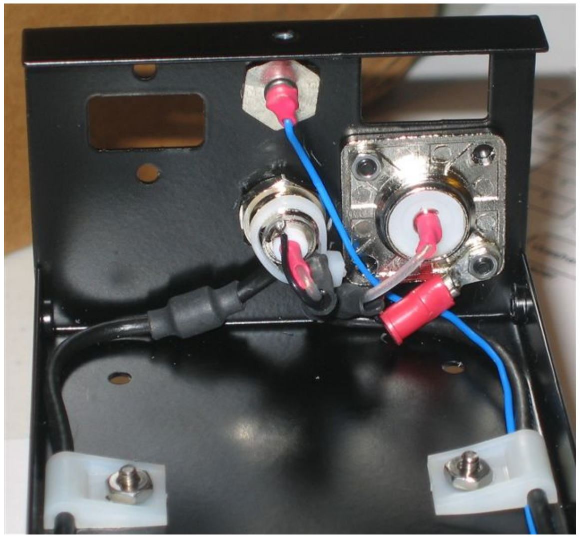
- Attach heat sink with four 4-40 x 5/16 screws to the case. Install one 4-40 threaded standoff through the case into the heat sink. Used to heat sink U4.
- Attach the heat sink assembly to the case with four 4-40 x ¼ inch screws, plastic wire clamps. Wires will be placed under the clamps during assembly so only loosely attach screws at this time.

RF Input Cable

The RF Input cable is best fabricated on the bench and then installed in the amplifier.

- The cable type is RG174. Length is 11 inches.
- Thread four 23-43 cores over the coax sleeve. Adjust to mid position. Shrink ½ inch length of black shrink over cores.
- Strip ¾ inch of the coax sleeve on each end. Comb out the shield and tightly twist into a pig-tail. Trim to 3/8 inch.
- Prepare two 1 3/8 inch lengths of black TEF 24AWG wire by stripping 1/8 inch from each end. Tin one end.

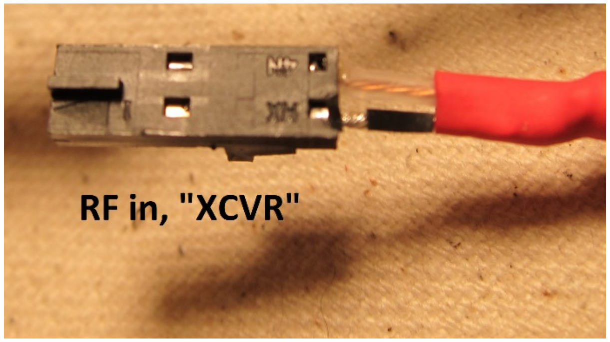
- The shields on both ends are connected to 1.4 inch TEF #24 black hookup wire. Heat sink the shield when soldering the wire to the shield so the inner conductor is not melted.
- Use 1/4 inch black heat shrink on the wire ends to cover the bare shields.
- Attach the cable to the BNC connector being careful to keep the wire straight so the center conductor insulation is not melted. Thread a short length of 1/8 inch red heat shrink over the center conductor. Form a hook in the black #24 TEF hookup wire and attach to the ground connection on the BNC. Solder this first. Next, solder the center conductor in the slot of the center pin of the BNC. Heat the 1/8 inch red heat shrink with a heat gun to constrict around the wire.



RF IN RF OUT and PTT Wires

- Tighten BNC to case with ½ inch open wrench. A BNC T is useful to help hold the BNC in a fixed position while tightening.
- Position the Cores near the BNC connector. The cable is routed along one edge under the circuit board under the wire clamps to relieve cable congestion in the box.

RF Input Cable



- Clamp the cable at the threads of the BNC with the 4 inch plastic Ty-wrap. See RF IN RF OUT and PTT Wires picture

RF Output Cable

The RF Output cable is best fabricated on the bench and then installed in the amplifier.

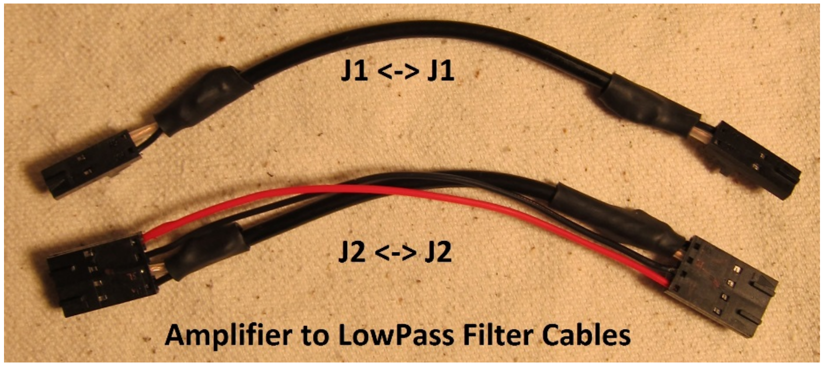
- The cable type is RG174. Length is 11 inches.
- The shields on both ends are connected to 1.5 inch TEF #24 black hookup wire. Heat sink the shield when soldering the wire to the shield so the inner conductor is not melted.
- Thread on four 23-43 cores on the wire near the end to be attached to a three pin Molex connector, J4. Cover with black heat shrink to hold the cores in place.
- Use 1/4 inch of black heat shrink on the wire ends to cover the bare shields.
- Attach the cable to the SO-239 connector being careful to keep the wire straight so the center conductor insulation is not melted. Thread a short length of red heat shrink over the center conductor. Heat the red heat shrink with a heat gun to constrict around the wire.
- Crimp the black #24 TEF hookup wire and attach to a red #4 ring terminal. Follow up by soldering the connection.
- Attach connector to rear panel using two 4-40 x ¼ inch screws, one split lock washer and two 4-40 nuts.
- Attach a 12 inch length of #24AWG Teflon coated hookup wire (white) to the PTT connector on the rear panel.
- This wire is routed along with the output cable and terminated into the 3-pin connector, J4.
- The cable is routed along one edge under the circuit board to relieve cable congestion in the box.

Low Pass Filter Input Cable Fabrication

- Cut a 5 inch length of the RG174 cable. Twist the shields and cut to ¼ - 3/8 inch length.
- Cut two ½ inch lengths of the black ¼ inch heat shrink tubing for bare wire covering.
- Tin the end. Use a heat sink clamp next to the coax so the heat does not reach the center conductor.
- Cut two 1 3/8 inch lengths of black #24 AWG Teflon coated wire.
- Strip the insulation from both ends 1/8 inch or slightly longer. Tin one end. The other end is crimped to terminal pins.
- Solder the black wires to the shields. Use a heat sink clamp next to the coax so the heat does not reach the center conductor.

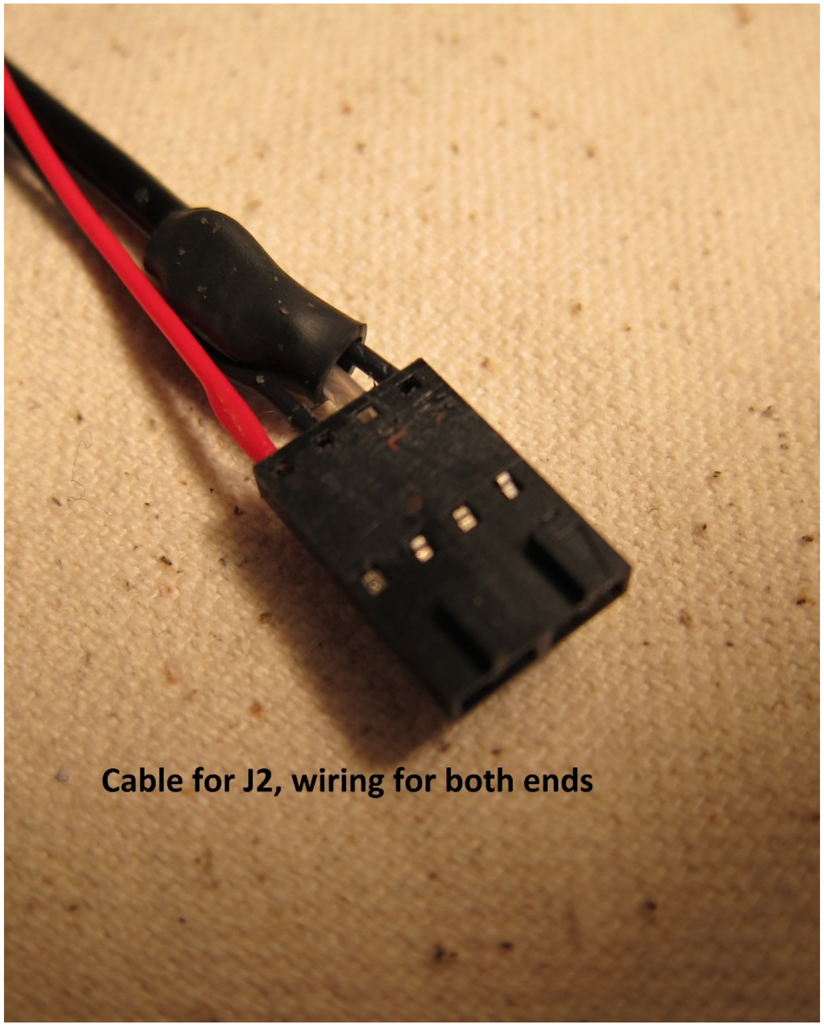
- Place the heat shrink over the coax end with both wires of each end exiting the tubing. The shield and black wire are folded back against the coax outer covering. The black wire is pulled forward to be the same length as the coax center wire.

- Crimp Molex pins on both ends of the cable
- Heat-shrink the cable bare connections with the ½ inch length of ¼ inch black heat shrink tubing. View the picture on the next page for the finished cable appearance.

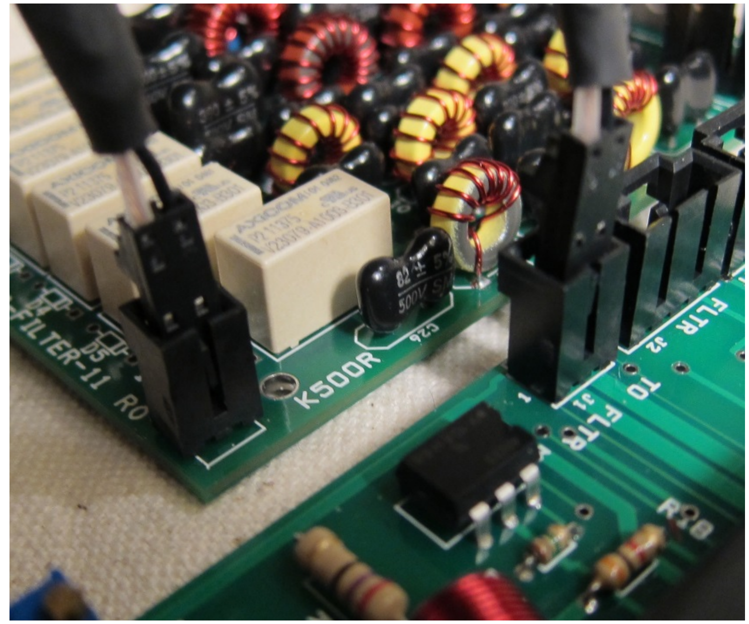


Low Pass Filter Output Cable Fabrication

- The top cable is the finished Low Pass Filter Input Cable.
- Fabricate the Output cable in a similar manner.
- Cut the length of the RG174 cable to 5.0 inches.
- Prepare the ends with the crimp pins.
- Cut a 5 inch length #24 AWG Red and Black Teflon coated wire and attach crimp terminals to both ends.
- Attach the four wires to the four pin Molex connectors.
- The 4-pin LPF cable plugs in either direction. Make sure that you have J2 oriented in the same way as shown in the picture at right.



Cable Pictures courtesy of Bruce Baskett



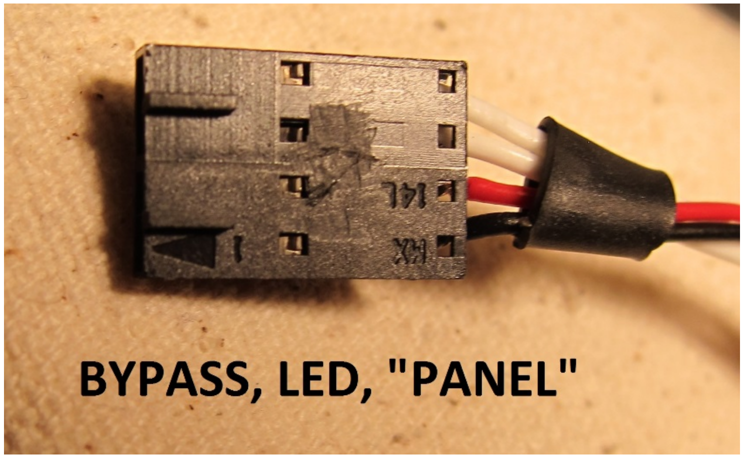
Make sure your connectors match the LPF and AMP circuit board connectors.

On/Bypass Switch and LED Wiring

- Attach two 5 inch lengths of hook up wire to the small rocker switch. Shrink with ¼ inch red shrink tubing.

ⓘ The switch can be damaged with too much heat.

- Insert in the panel with the two connections away from the base plate of the case.
- In the On-Line position, the switch is shorted. That puts the two terminals of the switch the greatest distance away from the LED. The depressed switch lever would be next to the LED.
- Insert the LED into the hole adjacent to the rocker switch.
- Slip four 1/8 inch length of red shrink on the wires equally spaced. Shrink the tubings.
- Cut the wires to be equal length for termination into a four pin Molex connector.
- Strip 1/8 inch insulation from each wire and crimp Molex pins on the wires.
- Insert the wires in the 4 position Molex Housing (last).



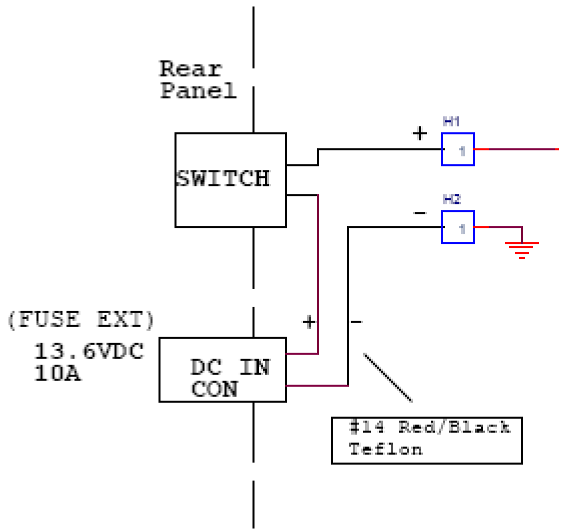
Power Pole Physical Installation

- Locate the bottom notched keeper used to retain the Power Pole Housing in the panel.
- Locate the Red and Black Power Pole pieces.

ⓘ The Power Pole housing can be joined in various ways. There is one standard that is used on the HF PACKER-AMP. Looking at the front of the red/black housing, mate the two pieces side to side with the red on the left and the contacts in the lower position.

- The top keeper is in the top mounting hole with the tab extending into the hole between the red/black housing. Use a black 4-40 x ¼ inch screw with split washer and nut.
- Install the bottom keeper in the bottom mounting hole with the tab extending up into the hole between the red and black housing. Use a black 4-40 x ¼ inch screw with split washer and nut.
- Secure the screws tight while keeping the keeper pieces level. When complete, the power pole housing will be able to move around a bit (float).

Power Wiring Connections



Connection of Power Wires

Install Rear Panel Power Switch

- Snap in the power switch with the "1" label towards the outside.

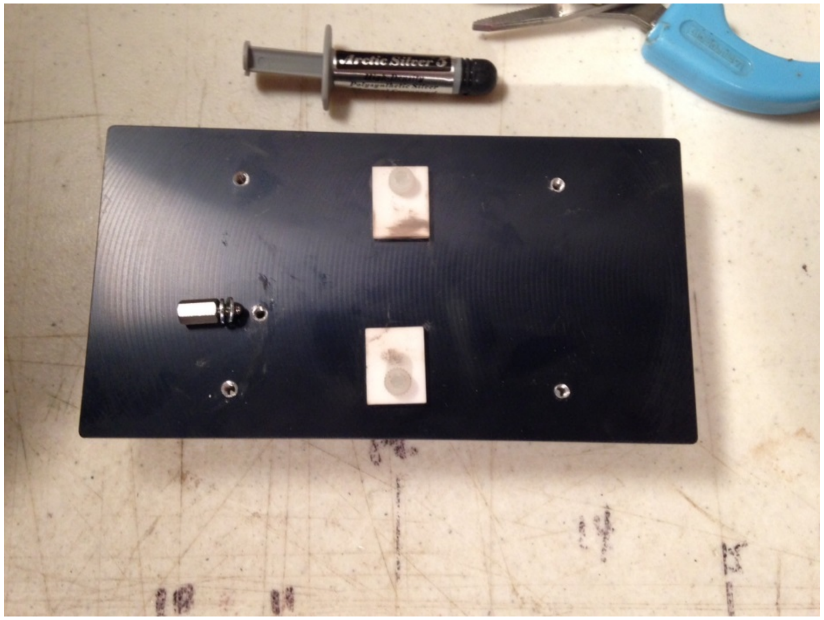
Install Wiring for Power

- Crimp one end of a 4 inch length, #14AWG RED Teflon coated wire to a Blue Flag Terminal.
- Crimp the other end to a Power Pole (PP) 30A Terminal.
- Insert PP Terminal into the RED PP housing.

ⓘ Note: Use the end of a thin flat blade screw driver to press the PP terminal into the PP housing until you hear it click. Use a pull test to be certain the wire is firmly seated in the PP housing.

- Plug the Blue Flag Terminal on the Power Switch outside terminal.
- Crimp both ends of another 4 inch length , #14AWG RED Teflon coated wire to a Blue Flag Terminal
- Plug the Blue Flag Terminal on the remaining Power Switch terminal.
- The other end of this 4 inch RED wire will plug on the circuit board at H1 during circuit board and case assembly.
- Crimp one end of a 4 inch length, #14AWG BLACK Teflon coated wire to a Blue Flag Terminal.
- Crimp the other end to a PP 30A Terminal.
- Insert PP Terminal into the BLACK PP housing.
- Use a pull test to be sure wire is firmly seated in PP housing.
- The other end of this 4 inch BLACK wire will plug on the circuit board H2 during circuit board and case assembly.

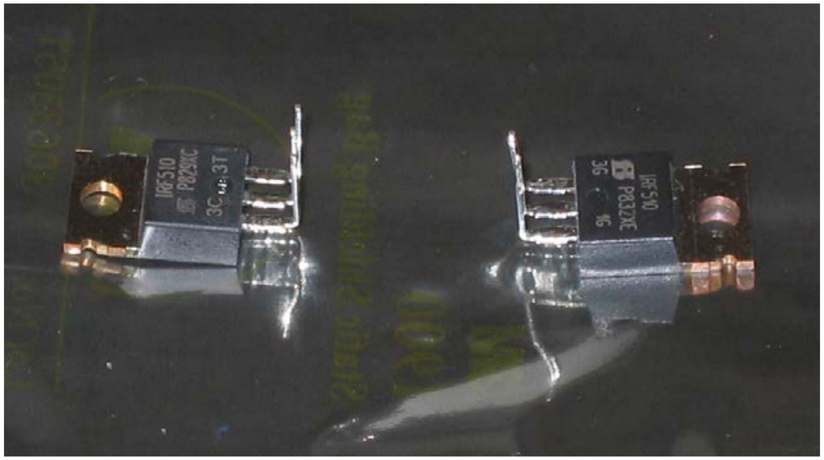
TO-220 Ceramic Washer and MOSFET



The heat sink area should be clean and dry. Use a touch of alcohol tor maximum clean. The thermal conductive ceramic washers shown on the heat sink (right) are superior devices and eliminate short-circuits that can happen with the thin peel and stick insulators. You can assemble without thermal compound and it will work but I like to maximize performance. I prefer to use a thin layer of a thermal compound on both sides of the washers and the MOSFET back side for maximum thermal connection. Practically any available thermal compound will work. My personal choice is Artic Silver. Only a tiny dab is required. The washers are considerably thicker (0.08 inch) which puts the MOSFETs closer to the bottom of the circuit board. An extra washer will be required on the male-female spacer that screws into the heat sink so that the U4 chip and the male-female spacer come into physical contact.

To aid in keeping the ceramic washers in place, I screw them down tight and let them set for a while before removing the screws. This step will encourage the washers to stay in place during final assembly.

IRF510 MOSFET Lead Bend



In my experience the bend should be a little bit closer to the body than shown in the photo above.

MOSFET Attachment to the Circuit Board

The MOSFETs should be bent very close to spot where the leads neck down. To space the MOSFETs, use the circuit board with the 4 corner mounting spacers installed. On a flat surface feed the MOSFETs from the backside thru the mounting holes of the circuit board. Observe that the MOSFETs are flat against the table and that the mounting hole of the MOSFET aligns with the access hole on the circuit board. Solder the MOSFETs in place on the circuit board. Inspect the solder job on the back side and reheat as required.

Circuit Board and Case Assembly Procedure

Place the PSU End of the AMP Module back into the case towards the rear panel and then lower the remainder of the circuit board down to the case. The slot in the circuit board fit over the front panel switch wires. Arrange the other cables to not interfere with board mounting.

Attach the circuit board from the top of the case using four black 4-40 x 3/16 inch screws.

MOSFET Alignment over Heat Sink Holes

- Micro-adjust as necessary by moving the body of a MOSFET so that the hole in the MOSFET matches the threaded mounting hole in the heat sink.

ⓘ Do not over-tighten the nylon screws. You could shear off the head with too much torque.

Insert the two black Nylon 6-32 x 5/16 inch length Socket Head Cap Screws through the MOSFET holes into the tapped holes on the heat sink using the 7/64 inch hex head tool. Tighten the screw until resistance is encountered. Inspect the screws to make certain that it they are firmly in contact with the MOSFETs. Peering into the heat sink, the tips of the nylon screws should barely be visible on the pin side of the heat sink if properly installed.

Use the multi-meter to measure ohms. Connect one probe to chassis ground and the other probe to any pins on the MOSFETs. You should have a very high megohm or infinite reading on the meter. This measurement is made before any cables are attached to the board.

Note: When you measure continuity to make sure the MOSFETs are not shorted to ground, you must not have the screw holding the LT1270A, U4, installed. With no cables attached, you should read a very high resistance.

LT1270A, U4 Attachment to the heat sink

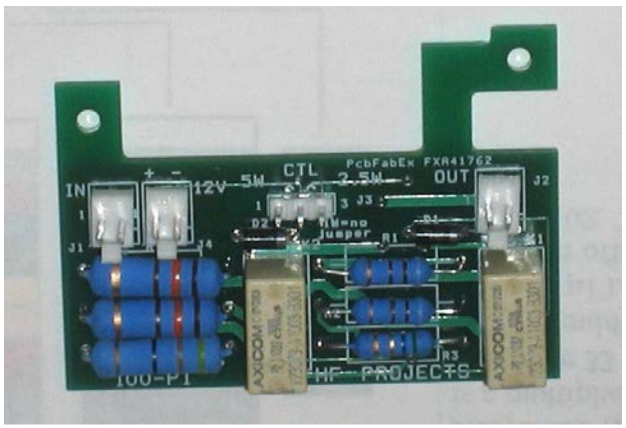
A 4-40 male/female threaded spacer, 5/16 inch length should be installed on the heat sink by this time. The LT1270A, U4 part is attached to the spacer by passing a 4-40 x ¼ inch screw through the tab of the part and screwing into the spacer. No insulator is required or desired.

PINET 100-PI Option Module

ⓘ section is for those who purchased the PINET 100-PI Option Module. (skip this section otherwise)

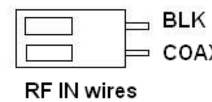
100-PI Assembly

- Install Diodes D1 and D2
- Install Relays K1 and K2
- Install Connectors J1, J2, J3 and J4 according to silkscreen pattern.
- Install Resistors R1, R2, R3, R4, R5 and R6 (refer BOM)
- Clean circuit board and set aside after inspection.

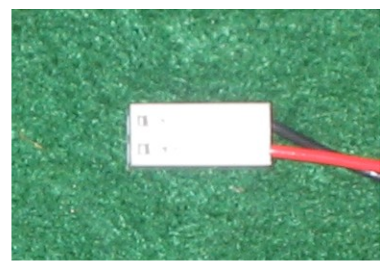


100-PI Cable Fabrication

- Fabricate two 3-inch cables. Use the supplied RG174 cable, black 1 ¼ inch hook up wire and shrink tubing.
- Strip ½ inch insulation from each end. Twist the braid and trim to ¼ inch. Tin the braid and attach a black hookup wire to the braid. Cover with heat shrink tubing. The wires are positioned as shown.
- Attach a 2-pin connector on one end of each cable. Note in the picture that the openings for the terminal tabs are up in the picture. Attach the coax center wire to the pin indicated in the picture.

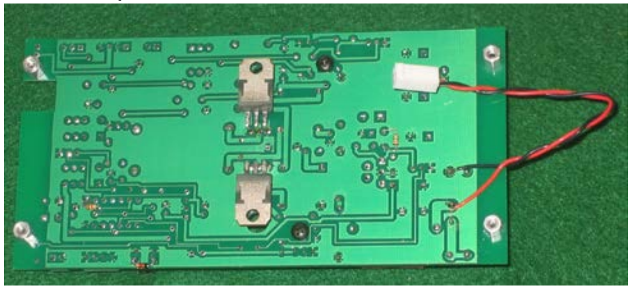


- Fabricate a five inch 2-wire cable from the red/black wires supplied. Attach a crimp terminal to one end of each wire. Strip 3/8 inch insulation from the other ends and tin the wire lightly.
- Insert the crimp terminals in the 2-pin housing as shown below. Note in the picture that the openings for the terminal tabs are up in the picture.



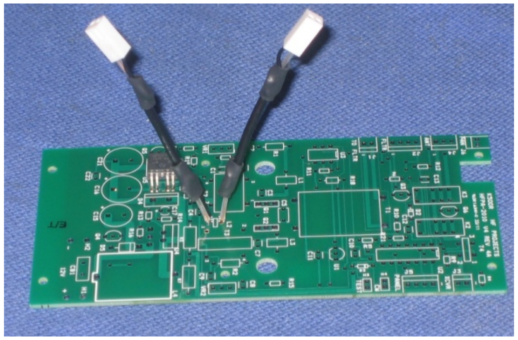
- Install a 430 ohm resistor at R7 and R8. Install a 12 ohm resistor at R3. This is the new 2dB pi-resistive network.

- Attach a red/black wire 5 inch power cable to the Amp module. Solder the wires to the bottom side of the amp at the H2 terminal and at CB1. Reheat CB1 connection and push CB1 leads further into the holes to expose a ¼ inch stub. Wrap the tinned stranded wire ends around the points on H2 and CB1 and solder. This



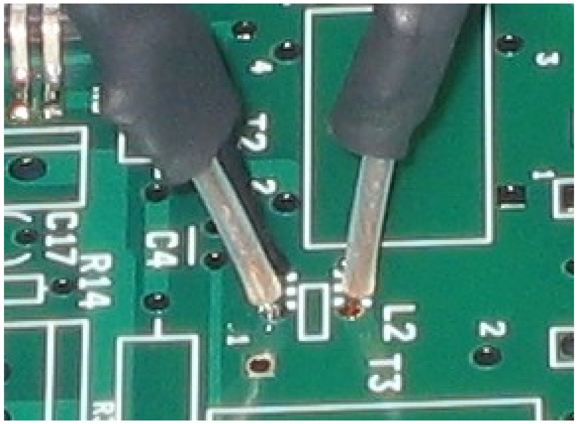
cable will plug into J4 on the 100-PI Module when installed.

- Remove L2 from the circuit board if installed. It will not be used. We will attach the PI-networks to these holes.



- Attach the two 3-inch cables at L2 and grounds as shown in pictures above and to the right.

- Note that the coax center goes into the hole on the left in the L2 position. The shield wire connects to the hole directly above it.
- This cable will connect to J1 on the PINET 100-PI module. Identify the cable as J1 with a marking pin on the 2-pin connector.
- The silk screen shows two dashed lines indicating where the cables are attached.



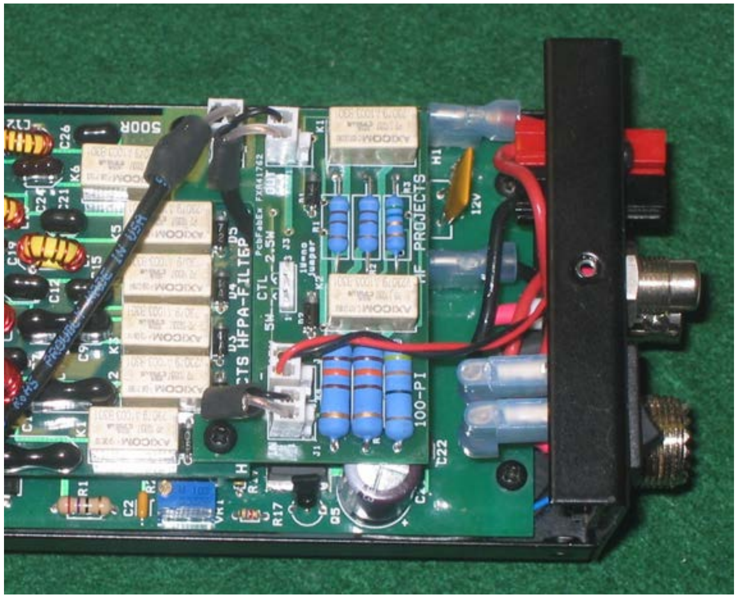
- Note that the coax center goes into the hole on the right in the L2 position. The shield wire connects to the hole directly above it.
- This cable will connect to J2 on the PINET 100-PI module. Identify the cable as J2.
- Attach a peal and stick rubber bumper to the top of C16, a 330uF capacitor.

Attach the Model PI-100 Module

- Attach the PI-100 Module using two 4-40 x3/16 inch screws into the Male/Female Jack Screw just added. The PI-100 Module will extend towards the rear over the PSU and rest on top of the rubber bumper.

Cable Connections on the Model PI-100 Module

- Plug in the two RF Cables to J1 and J2.
- Attach the Power Cable to J4.



The two RF cables at J1 and J2 route with very short connections from the Amp.

Set the Jumper at the 3-pin header J3 on the PI-100 Module

- Install the provided jumper in one of three ways.
- With no jumper, the maximum RF Drive input is 1W
- With the jumper in the 2-3 position, max RF Drive is 2.5W
- With the jumper in the 1-2 position, max RF Drive is 5W

ⓘ set to 5W for testing procedure of Amp

100-PI Theory of Operation

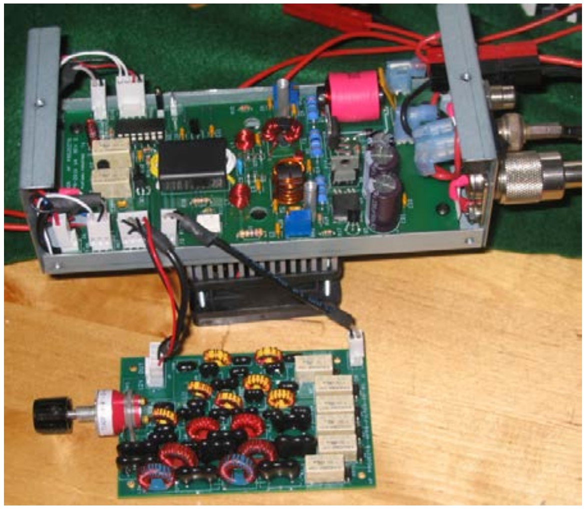
A 2dB resistive pi network is installed on the AMP module. Add additional attenuation using the PINET 100-PI module. Choices are 2dB, 6dB and 9dB corresponding to 1W, 2.5W and 5W Max RF Input scales.

Section Five – Adjustment and Testing

- Turn the pots fully CCW so we can test the RF functions without generating power output.
- Place the LP Filter to the side and cabled up as shown.

Ohmmeter Test

- Resistance from Red to Black DC Input with switch ON should be about 500 - 1K ohm.
- Online/Bypass Switch placed in Bypass position
- Attach a watt meter and dummy load in series to the SO239 RF Output connector.



Test Mode Setup

- Connect XCVR to the BNC RF Input Connector.
- Set LPF for 160M. Set the XCVR for 160M.

- Set the XCVR Power Setting for Low Power (about 1W).
- Key XCVR. The 1W of power should be displayed on Watt meter and SWR should 1.0:1 Record _____ W

Basic Current Test

- I recommend a special cable that allows you to easily measure current. Power Poles are on each end. Plug the test cable into the multi-meter set to read amps. The current passing through the red wire registers on the meter.

Test cable puts the meter in series with the Red wire.

- Connect for Current Measurement on the 10A scale.
- Online/Bypass Switch placed in Bypass position.
- Connect to a DC 12V source and Power Up. The current is less than 30mA.

ⓘ If the Meter reading is negative, reverse the meter leads. If your meter does not have high resolution, you may have to use a smaller scale to measure mA. **There can be a current surge when power is first applied that can blow the low current fuse in your meter**. Use a jumper across the meter during turn on to shunt the current around the meter. Remove the jumper after a second or two.

- LED should be OFF. Record: _______mA
- Use small screw driver to short TEST pins. The LED should light.
- Current is about 85 mA while the pins are shorted together and the LED is on. Record: _______mA .

RF Signal Testing

- Switch the Online/Bypass Switch to ON. Key the XCVR. The LED lights. (1W RF drive)
  - If Fan option, fan is ON. Current = 0.25A.
  - Else, Current = 90mA
- Release XCVR KEY. The LED is OFF and the FAN turns off after the hold time expires.
- Measure from case ground to the right side of R18. Key the XCVR. The voltage switches from 0.0VDC to about 29.5VDC.
- H4 no longer has function. CW/ SSB selection is now automatic. See description in section six.
- Tap the key on XCVR. Note the time that the LED is ON and that the fan runs.
- Tap the key on XCVR. Note a longer LED ON time and fan runs.
- Rig a toggle switch and RCA plug to test the PTT function. Plug into the RCA Jack.
- Close the PTT test switch. The LED lights and the fan runs.
- Open the PTT test switch. The LED is off and fan stops running.

DC Current Test and Bias Adjustment

- Insert the jumper plug over the TEST pins of H3.
- Start with either potentiometer and turn clockwise while measuring current. You may have to turn the pot screw about 15 turns CW before the current starts to climb. It will climb sharply when the MOSFET begins to conduct. Adjust the current to increase the current by 100mA. New current reading: _______mA.
- Turn the other potentiometer clockwise to increase the current by an additional 100 mA. New current reading: ________mA.
- Remove the jumper plug from H3.

Voltage Test

- It is handy to have a second multi-meter to make a voltage measurement s while monitoring current. If a second meter not available, reconfigure meter to measure voltage.

- Re-connect DC power if not connected as this time.
- Measure from Case to the rectifier tab, D4, next to the electrolytic capacitors. The voltage is the DC Input Voltage. Approximately 13.6V. Record _____ VDC
- Use the screw driver again to jumper the TEST pins of H3. The LED lights and you measure about 29.5VDC. Record _____VDC

ⓘ At this point, you have proven the functionality of the AMP and you have completed the adjustments.

- Remove Power. Install LPF into the case. Secure with two 4-40 x ¼ inch screws.
- Attach front panel nut and tighten. Install Knob and tighten.

LPF RF Testing

Although not as good as a VNA, you should be able to tweak the band edges. This procedure also provides a way to test signal continuity from the LPF IN to the SO239 connector out.

These steps describe a method to test the LPF for signal continuity and performance at the band edge. In this test the AMP output is bypassed and the transceiver is used as a signal source.

1. The RF In cable normally at J3 on the amp board is rerouted to plug instead into the LPF input connector, J1. You will have to physically free this cable up to re-route to the LPF input.

2. Attach transceiver to BNC connector on the case. Set the transceiver RF out to about 1W.

3. Attach a watt meter and dummy load to the SO239 connector.

4. Jumper the PTT input to cause the LED to light. You must be ONLINE for this to work.

5. Set the band switch to 160M and the rig to 160M at the top of the band.

6. Key the transceiver. You should see your 1W (or slightly less) on the watt meter.

7. If the watt meter is attenuated, try in the middle of the band. If the signal comes up, you need to adjust your 160M inductor. Try spreading the turns. If still no joy, you may have to remove 1 turn.

8. Repeat this process for all bands. Removing a turn probably only applies to 160 - 40M. All other bands are adjusted by spreading or squeezing the coils (stop RF while adjusting).

9. After satisfactory completion of the tests and adjustments, restore the RF In cable back to J3 on the AMP board.

LT1270ACT Alert Notice

"Be careful when probing around the DC -DC Converte
have received one user report of the chip arcing and going

violently up in flames when grounding pin 2, the fly back sensor to control output voltage. The voltage divider R13 and R16 is used to tell the sensor the output voltage. The LT1270A will try to increase voltage on pin 4 until voltage on pin 2 from the voltage divider reaches 1.24V. This can result in dangerously high voltages on pin 4, when pin 2 is mistakenly grounded. Also note, that the middle pin 3 is at ground while pin 4 carries output voltage of about 30V.

Those two pins can be easily shortened when probing. Better, measure input voltage (pin 5) at the cathode of D5, measure output voltage (pin 4) at the anode of D4, measure fly back voltage (pin 2) at R13, and measure the control state (pin 1) at R14 (converter off when at ground). Be very careful!"

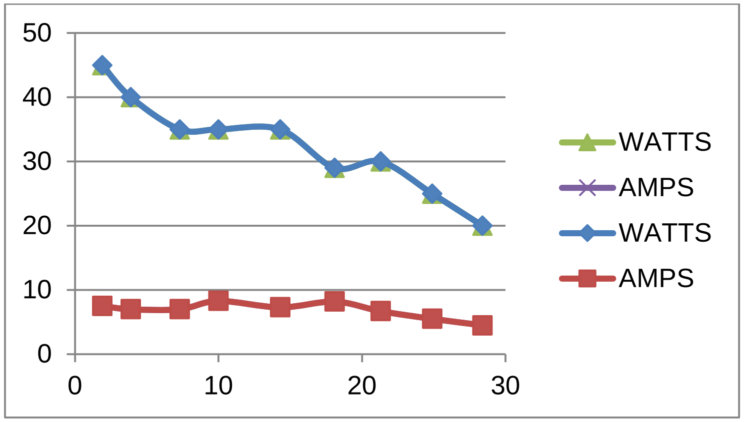
RF Power Testing

- Attach 12VDC power source capable of supplying 10A continuous current. The 12VDC source should be fused at 20A.
- Monitor Current
- Connect XCVR set for 160M and 5W setting
- Set Band Switch for 160M.
- In BYPASS mode, adjust the power out to 5W _______
- In ONLINE mode and key down for a few seconds, observe the power output and DC current.
- Record your power output and DC current for each band in the Frequency vs Watts vs Amps Table.
- Plot your Power Out and Amps results vs Frequency.

ⓘ If you see an unusual spike up in DC current or drop in power, your LP filter may be suspect.

FREQ MHZ	WATTS	AMPS
1.9	45	7.5
3.9	40	7
7.3	35	7
10	35	8.3
14.3	35	7.3
18.7	29	8.2
21.3	30	6.7
24.9	25	5.5
28.4	20	4.5

Frequency vs Watts vs Amps Table



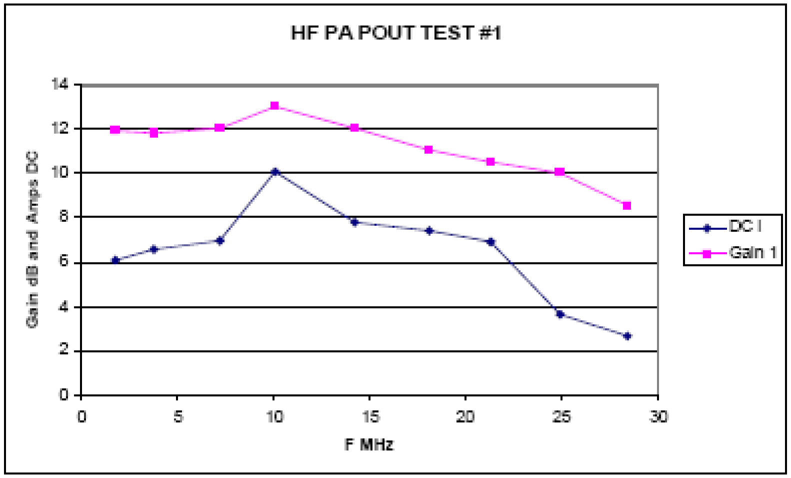
Frequency vs Watts vs Amps Plot

ⓘ Power Input Constant at 5W set for each band

PTT Connections FLEX 1500 and FT817

FLEX 1500 – Connect the center wire from the PTT jack to pin pin 3 of a serial connector which corresponds to the Flex 1500 Flexwire connector on the back of the radio. This connection allowed the Flex 1500 to key the Packer Amp. Do not connect the ground connection as the Amp and Radio are already referenced to the same ground. Using an additional ground connection has been reported to cause distortion.

FT817 – Connect the center wire from the PTT jack to pin 1 of the ACC jack on the FT817 (PTT). Do not connect the ground as the Amp and Radio are already referenced to the same ground. Using an additional ground connection has been reported to cause distortion.



Section SIX – Specifications and Operation

Specifications

- The drive is 0.1 - 5W RF 160-10M
- Input impedance: 50 ohms
- Control: Carrier operated or PTT (RCA jack)
- DC Input: 12VDC, 10A max (9-16V range)
- Standy current: 23-29mA
- Chassis mount Power Pole Connector 30A contacts
- Power Switch: Rocker Power Switch
- RF In: BNC 5W Max Input (if 9dB pi-network installed)
- RF Out: SO-239
- Power Out: nominal 30-35W Average 160 - 10M.
- 100% Modulation without distortion (according to 2-tone tests)
- Weight: 1lb 15 oz.
- Case Size: 6.5 x 3 x 2.25 inch
- Front panel band switch knob: 0.75 inch additional length
- Rear panel controls: 0.5 inch additional length
- Heat sink Size: 2.25 .2.25 x 0.8 inch
- Fan Size: 2.25 x 2.25 x 1.2 inch (60mm) 12V, 24 CFM
  LP Filter Switch: 6 position 160, 80/75, 60/40, 30/20, 17/15, 12/10
- Front panel Switch: ON/BYPASS
- TX LED Indicator
- Case painted black with white silkscreen legends front and rear.
- Two piece 20ga galvanized steel case,
- Rubber Feet
- Unused Mode Jumper (now autoset) for optimized hold time of T/R relay
- Digital control, RF sense and sequencing of T/R relay and Intelligent Power Switch and fan control.
- Amplifier: IRF510 MOSFET Push-Pull Class AB1 Linear Amplifier.
- Bias set to 100mA per transistor. Easy pot adjustment.
- A test Jumper activates the PSU for adjustment.
- Fan option not required for intermittent SSB operation.
- For high duty cycle CW or digital modes, either reduce drive or include a user supplied fan. Internal fan jack provided.
- Fan Operation SSB and CW at full speed.
- Spurious products -40 dB or better @ 35 watts
- Harmonic content -45 dB or better @ 35 watts
- Load tolerance 2:1 or better SWR recommended
- CW/SSB mode auto selection

Operation

Amplifier operation theory is described in Section One with the practical aspects expanded on in this section.

Choice of XCVR: The HFPA V4 Amp is compatible with most QRP XCVR's but accommodates the FT817 RF Power Input choice of 5W RF drive as the default power input setup. The pi resistive network on the amplifier front end can be customized for other attenuation levels to work from the range of 0.1W up to a practical 5W limit. Contact HF Projects for more specific details.

CW and Digital Modes: The AMP provides excellent operation for digital modes including PSK. Monitor the temperature. Adjust drive accordingly.

Do's and Don'ts for Successful Operation

- Do set the band switch to match the XCVR band
- Do not exceed 5W drive
- Do tune the antenna only in the BYPASS position
- Do not touch up antenna tuning in the ON position
- Do not operate with an SWR > 2.0:1

Maintenance Issues

- If your power drops to near zero or the TX LED does not light during transmit or you hear a squealing noise from the amp, you have probably blown a MOSFET

ⓘ Warning, the surface mount chip, U5, can be hot to the touch if you short a MOSFET. The hot U5 chip purposely gets hot acting as a thermal controlled circuit breaker for the DC power to the MOSFETs.

- Replace both MOSFETs: Always replace both. Spares are available from Radio Shack or HF Projects.
- Remove the four top screws and two MOSFET Socket Cap screws to allow the circuit board to be removed. Also disconnect the two flag terminals for the 12VDC input.
- Unplug the cables to the board. Remove the circuit board from the case.
- Clip out the MOSFETs and remove the pins remaining in the board. Tweezers and soldering iron works.
- Remove excess solder. Clean up flux.

ⓘ The most important issue is to save the board circuit connections by carefully removing the old pins.

- Follow the installation procedure outlined in Section Four
- Re-install MOSFETs using the non metallic 6-32 x 5/16 cap head screws.

CW/SSB Auto Selection

The amp has auto switching between CW and SSB hang time delay.
CW hang time is 0.15 seconds while the SSB hang time is 0.50 seconds.

The amp powers up in the CW mode. To switch to SSB mode, key the amp for greater than 2.5 seconds. It will remain locked in the SSB mode until you cycle power.

Normal CW keying will typically not exceed a continuous carrier of greater than 2.5 seconds.
Normal SSB use will exceed 2.5 seconds of carrier in normal conversation at some point.
If you hear the relay chattering between syllables it is still in the CW mode. No harm done because the amp switches on and off without missing a beat. To activate into SSB make one continuous sound (such as **Hellllllloooo**) and it is now locked to SSB.
In CW, you will have to be aware that holding the key down > 2.5 seconds will switch the mode to SSB.
The H4 posts on the amp where you could put a jumper is no longer assigned any function.

If you are using PTT, CW/SSB selection is not active and timing is solely dependent upon the PTT signal.

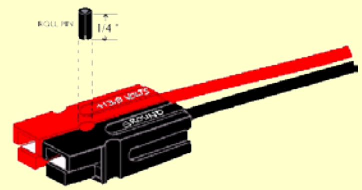
Section 7 Theory of Operation and Troubleshooting

Power Supply Unit

The PSU has the job of converting the 12V DC Input (8-16V range) to 29.5V for the MOSFET transistor drains. Why do we do that? Several reasons, the state of the battery no longer affects operation until all useful energy in the battery is expended. Operating the MOSFETs at a higher voltage overcomes IR (current and resistance) losses in a 12V system. The higher the voltage the more the gain is possible. Why stop at 35W? Why not 100W? Well have you tried lugging around the heavy car battery on your back pack trip? When you boost your 2.5W signal up to 40W, you go from2.5 to 5 to 10 to 20 to 40W. Each time you double you increase your received signal by 1 S-Unit. A signal increase from in the noise to a S4 means your signal is readable. Your power pack to do this can be a 7AH Gel Cell or some of the newer light weight Lithium Ion battery packs. I used to fabricate 25, 50, 75 and 100WH battery packs from harvested cells in DEWALT power packs. But that is another story. The point is that you can operate from a light weight power source and only be down 1 or 2 S-units from a 100W rig. Many can testify how effective this is.

Power Input

The 12V is input through the 30A contacts of the Power Pole connectors. There is a right way and a wrong way of putting the little plastic pieces together to insure your connectors are polarized correctly. The industry has a certain way of joining the pieces together to be compatible with everybody else. Make sure you set up your jack to receive plugs that are configured according to the drawing below.



"Housings should be mated according to the diagram above, viewing from the contact side (opposite the wire side), tongue down, hood up, RED on the LEFT, BLACK on the RIGHT. Also notice the 3/32-inch-diameter roll pin, 1/4 inch long, is used to keep the housings from sliding apart

Reverse Voltage Protection

No one can stop a lightning bolt from wrecking havoc but we attempt it with our reverse polarity diode and thermal circuit breaker. If you ever apply voltage in reverse, there will be enough time to fuse the reverse protection diode into a lump of metal before the thermal circuit breaker from kicking in to open the circuit. It will do its job however and save the other components in the amp. The thermal circuit breaker is the tan colored tab that is mounted by its tips to the circuit board. Why is mounted this way? It is done on purpose so that the thermal mass of the circuit board traces will not unduly influence the reaction time of thermal circuit breaker. It must get hot in order to open the circuit. It will remain open until it cools down again. So in that sense, it is self-resetting. It is designed so that it takes a sustained 10A or more to trigger the circuit breaker. There are no recorded cases where this part fails. In case of reverse voltage, you will have to replace the diode with a similar high current diode. We have spares.

DC-DC Converter, U4

The DC-DC Converter is operated on demand (when we transmit) otherwise, it is off and silent during receive. If you follow along by looking at the schematics page **PSU HFPA 10.** There are only very few components to make this chip work. We have the high current inductor, L4 50uH, the high current series diode D4 and the two resistor R13 and R18. We will touch on the controls a little later. TheLT1270A is a 10A device. Meaning the device is rated for 10A current. It operates under the principal that if you ground one end of the inductor the current flowing through the inductor will attempt to keep flowing at its current level when the ground is removed. Pin 4 provides that ground. The inductor, following the laws, will raise the voltage to near infinity to attempt to keep the same current flowing. As a result, we get a step up of voltage. On the anode side of D4, you will see a switching waveform between ground and about 30V. On the cathode side you will see a constant DC thanks to the electrolytic capacitors C16 and C21. So how do we regulate this beast? Glad you asked. The resistors R13 and R18 form a voltage divider which sends a small sample of the output voltage back to the U4 chip pin 2 (FB) or feedback pin. The sampled voltage on pin 2 is internally compared to an internal voltage reference of 1.244V. The U4 chip will adjusting the switching duty cycle of the output on pin 4 to make the voltage on pin 2 equal to 1.244V, the internal reference. So now the output voltage is set by the ratio of R13 and R18 using simple ohms law principals. To figure it out, you have 1.244V across R18, a 1.2K resistor. That will set a known current flowing through R18. I=E/R or 1.224/1,200 or 0.001037A. This current is also flowing through R13, the 27K resistor. So what is the voltage across R13? E=I*R or 0.001037 * 27,000 = 28V. The voltage at the top of R13 is equal to 1.244V + 28V or 29.25V. Your voltage may vary due to the tolerance of the resistors and other subtle variances. I find a typical of about 29.5V in several amps. If you are trouble shooting this circuit you want to measure the voltage on the tab of D4 (cathode). When the PSU is off, you will essentially measure your battery input. When the PSU is on, you will measure approximately 29.5VDC.

Timing Sequence of Control Signals

The PSU, IPS and TX are three control lines which are synchronized by the Controller, U2. When RF input is detected, the PSU is turned on first to get the 29.5V ready for use. Next the TX line is switched from receive to transmit with no power to MOSFETs at the time of switching. Next the IPS line is asserted by U2 which operates the switch, U5 and delivers the 29.5V to the drains of the MOSFETs. When RF goes away, a reverse sequence is followed. First, the IPS control line is made inactive which removes the 29.5V from the MOSFET drains and then the PSU control line is made inactive and finally the TX control is made inactive which switches the AMP from transmit to receive. This can be visualized (somewhat on the timing diagram shown on the

PSU HFPA 10 drawing. The waveforms shows that the RF signal may come and go due to keying or speaking but the PSU is active until a hold time has been exceeded.

U4 Control

U4 is controlled by the digital on/off control labeled **PSU**. When PSU measures 0V, the PSU is on. When PSU is 5V, the PSU is off. This control signal switches Q4 connected to pin 1 of U4 (VC) voltage control. You can learn more about U4 at: http://cds.linear.com/docs/Datasheet/lt1270afc.pdf

Fully Protected High Side Power MOSFET Switch, U5

See http://www.irf.com/product-info/datasheets/data/ips511.pdf This device is a combination power switch and circuit breaker. The IPS511S switch is controlled by the digital on/off control signal **IPS.** This signal is switched on (0V) when the PSU is already on and switches off (5V) before or at the same time that PSU is switched off. The device also acts as a thermal operated circuit breaker. The IPS511S is rated up to 5A. Above that, the switch will purposely heat up and the output will drop to zero volts. It will recover when it cools down. This part neatly switches voltage to the AMP drain connections when on. In the event of a short-circuit the circuit breaker will kick in. Because of the circuit breaker action you will keep from destroying the DC-DC converter chip, U4. Without the protection, the DC-DC converter will deliver the battery current into the short-circuit until the U4 blows up. How can you know if you have a short-circuit? The front panel LED will not light. You might hear a squeal from the amp and U5 will get hot. Don't worry; it is doing its job. What is the most likely thing to cause a short-circuit? The MOSFETs. We will get more into MOSFET failure in the AMP descriptions to follow.

At this point, you should sufficiently know how the PSU works, what controls it and what safe guards you have. What to measure? You can use a volt meter probing R18 on the end closest to the PSU for the voltage measurements. This voltage is what lights the LED. It means, when lit, that the MOSFET has a transmit source voltage on the drain connections. You can see the control signals on U2 pins 9 and 10. Placing a jumper on H3 (TEST) will cause both of these control signals to have 0V outputs.

This concludes the PSU discussions. We will discuss the timing of the PSU and IPS signals when we talk about the controller chip, U2.

CONTROL HFPA 10

The next discussion is about signal flow through the AMP from RF IN to RF-OUT. Follow along by looking at **CONTROL HFPA 10** Schematic during this description.

Big Picture

RF enters at the case mount BNC connector and is attached via a cable to J3.

U6 is a RF Module that provides RF detection for the amp without impacting the Input SWR. It consists of a dual CMOS Schmidt trigger device.

K2, K3 and J4

Relays K2 and K3 form the T/R (transmit/receive) function controlled by the control signal TX. K2 is used to divert the RF output from the transceiver to the AMP input. (Signal name

RF_IN). If not in transmit, the signal passes through the normally closed contacts of K2 to K3. The also normally closed contacts of K3 (when not in transmit) are routed directly to J4 which is connected to the SO239 connector on the rear panel. So in receive mode, the BNC Connector is connected to the SO239 connector. This is the bypass mode where you can operate the transceiver with the AMP out of the circuit. When K2 and K3 are closed (transmit mode), we divert the BNC signal to the AMP input where it is amplified. Further processing occurs in the LPF (low pass filter) which rejects the harmonics of the AMP output. The signal from the LPF is returned to J2 on the board where it passes through K3 to the SO239 connector. The diode, D2, clamps the transient voltage that occurs when current stops flowing in K2 and K3. Without D2, you might see voltage spikes of 25 to 50V when the relay is opened. It is best to prevent this transient noise from happening.

TX Signal Generation

The TX signal comes from the collector of Q6. This transistor output is either at 12V (receive) or 0V (transmit). Q6 is controlled by U2 pin 5 through R21. TX cannot occur unless the front panel switch is in the ON position. By placing the switch in the ON position, you are enabling the AMP to function. In the ON position you will have a ground signal on pin 6 of U2. Otherwise this signal will be 5V as provided by the pull-up resistor, R6.

PTT Control

We have discussed that the presence of RF through R4 can trigger TX. There is an additional way to achieve TX. It is by the Push-To-Talk input sensed on pin 3 of J4. This would be an external contact closure to ground (12V common or case ground). The contact closure is normally supplied by the transceiver or SDR (software defined radio). A current flows through an opto-isolation circuit in the 4N33 device, U3. The output of U3 on pin 5 becomes an input to the controller, U2 on pin 3. An internal pull-up resistor in U2 keeps pin 5 at 5V unless a valid PTT signal is detected. If detected, the pin 5 switches to 0V. With PTT control, you can hold the AMP in transmit mode without having to have RF excitation on the input. This is useful to reduce relay switching while pausing to speak in SSB. The base of the transistor in the 4N33 has a 1M resistor which reduces sensitivity and provides stable operation.

CW or SSB option

CW or SSB is automatically selected. If you are using SSB, the amp will optimize the hold time for SSB operation. For CW operators, the default power up condition optimizes the hold time for CW. As long as you are sending dots and dashes in a normal CW manner, you will remain in the CW mode with the hold time optimized for CW.

TEST Jumper, H3

A 2-pin header, H3 senses the users desire to test the AMP. The TEST mode is useful for setting the bias current or checking the DC-DC converter operation. You must have the front panel switch in the BYPASS position for the TEST jumper to function. If in bypass and the jumper installed, the PSU and IPS signals will be at 0V while pin 5 of U2 will be +5V to activate TX. Removing the jumper at H3 TEST will return PSU and IPS signals to +5V and pin 5 of U2 will be 0V. The fan output does not operate in the TEST mode.

Note: The TEST jumper is transition sensitive since you are waking the processor when applying the jumper. Multiple transitions will cause the U2 chip not to respond. If this occurs, try again. You may have to cycle power and try again to get the LED to light.

FAN Option J6

An external fan is controlled by an output on pin 7 of U2 connected to transistor, Q3. The fan is plugged into J6. The fan has red/black leads signifying the polarity of the leads. The plus lead is red. It must be connected to pin 1 of J6 with the black wire to pin 2 of J6. The fan is operated by the controller, U2. If carrier is detected or PTT is activated, you will have the fan activated. The fan is triggered on when carrier or PTT is present and goes off when the hold time has expired.

5V Regulator

While we are on the CONTROL HFPA 10 schematic, let us look at the voltage circuit, U1. This is a part which regulates the 12V input down to 5V for the controller, U2. (Vcc = 5V). The part requires bypass capacitors C10 and C11 as stated on the data sheet for the part to prevent instability.

Panel LED

The front panel houses the TX LED. This LED is powered by the transmit voltage (29.5V) and is a direct indication that you have this voltage. It will be LIT during actual transmit or during TEST when the H3 jumper is in place. Current is limited by the R18, the 3K 1/4w resistor. A common building problem is the connections from the panel to J5 on the wrong pins.

MOSFET AMP HFPA 10 Schematic

Follow along the descriptions as you view this schematic. **RF_IN** signal is shown on the extreme left side. This is the transmit output from the transceiver at this point. The signal reaches this point if **TX** is activated. The impedance of the transceiver is 50 ohms and the transceiver is happiest when it sees a 50 ohm impedance load.

Pi-resistive Network

That is where R3, R7 and R8 comes into play. This combination of resistors is actually a pi-resistive network that has two functions. First is the impedance termination and second is an attenuator for the amplifier input. The AMP is set up for a max RF input of 0.63W at the gates of the MOSFETs. Overdriving the amp will cause audio distortion at the least and failure of the MOSFETs at the most. We must transition between the max RF output from the transceiver to the 0.63W level with the pi-resistive network. The standard default network is set up for 9dB attenuation. This is equivalent to an 8:1 power ratio. Looking at the choice, 5W/8 = 0.625W at the gates of Q1 and Q2. The table in the upper left quadrant of the schematic shows values of the pi-resistive network for other max transceiver output levels. It is not physically possible due to size constraints to have each network on board and choose between them. This is a build option that the user must decide. What is the best network to match their transceiver? The FT817 has both a 2.5W and 5W output either the 6 or 9 dB network could be used but there is always a danger if using the 6 dB network that the user may accidently operate with 5W. The overdrive will distort and blow the MOSFETs. So, for safety reasons, the 9 dB attenuator is the best choice.

L2 and T3

The signal out of the pi-resistive network next passes through L2 , an impedance matching, to reach T3. The function of T3, 1:1 BALUN is to provide two outputs with 180 degrees phase relationship. Each output is fed to one input of the Push-Pull Linear Amplifier.

T2

DC powered is supplied to Q1 and Q2 through a phase reversal dual choke designated 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.

T1

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 output connector, J1. C5 is important since it increases the bandwidth of impedance transformation provided by T1, especially at 21 MHz. It is responsible for low distortion at higher RF levels while the bias provides low distortion at low RF levels.

BIAS

The 5 V bias supply voltage is derived from a 78L05 regulator. Bypass capacitors C4, C6, C8 and C1 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 R2 and L3. At low frequencies, the amplifier's input impedance is essentially equal to the series value of R1 and R2. L1 and L3 improve the input-impedance match at higher frequencies. The low value of series resistance provided by R1 and R2 also reduces the Q.

BIAS Adjustment

The bias adjustment puts the MOSFETs slightly into conduction for each half cycle. The amount of bias was chosen to eliminate low level cross over distortion that would exist otherwise. It is not necessary to increase or decrease the bias from the nominal 100mA specification. Once you have removed the distortion, it is pointless to increase the bias further. To do so only increases self heating of the MOSFET. You cannot adjust the power level of the AMP by adjusting the bias. If you want to change the power level, which is best done by changing the DC volts on the drains of the MOSFETs. The bias level is set by first turning both pots (VR1 and VR2) completely CCW (counter clock wise). Monitor the DC input current. The pots are 25-turn and there is no mechanical stop or audible noise. So count the turns. You can measure ohms from the wiper to ground for zero ohms as a secondary means of determining you are fully CCW. Next, jumper the TEST pins of H3 to activate the PSU. Note the current and turn VR1 until you increase the current by 100mA. Now turn VR2 until you increase the current an additional 100mA. You may find the setting sensitive at the 100mA set point. Make tiny pot adjustments to raise/lower the current.

Heat Sinking the MOSFETs

The MOSFETs are thermally attached to while electrically isolated from the heat sink. SIL-PADs are used for a neat clean thermal solution. The little fiber washers traditionally used with the TO220 case is not used due to their possible failure to maintain isolation. In its place we use a 6-32 x 5/16 inch Nylon Hex Head screw to thermally couple the MOSFET to the heat sink. A hex wrench is provided with the project to aid in the assembly process. The wrench provides sufficient torque to hold the MOSFET is intimate contact with the SIL-PAD below. Things to consider are the cleanliness of the SIL-PAD installation (no burrs) and using alcohol to remove oily residue where the SIL-PADs are placed. It is important when installing the MOSFETs that the metal face of the MOSFET is flat against the pad and not be under strain with the AMP board connections. The construction manual suggests a procedure to follow when installing MOSFETs.

HFPA FILTER MODULE 12

To follow the circuit explanations, turn to the HFPA Filter Module schematic. This design uses Relay selection of the RF input and a rotary switch for RF output selection. The switch operates a single low pass filter path at a time. All other filter circuits have shorted inputs while not in use for minimal interaction between adjacent circuitry. The relay input selection provides a high degree of isolation and improved filter overall performance. All of the HF bands are selected with 6 choices from the front panel switch. It is very important that the filter choice equal the band of operation. For instance operating on 15M with the filter set to 80M is a recipe for MOSFET failure. There is no interlocking or cross checking provided except by the alert operation of the user.

J1, Filter Input

The AMP output is received at J1 and is routed to the circuitry of one LP filter circuits through relay K1-K6.

J2, Filter Output

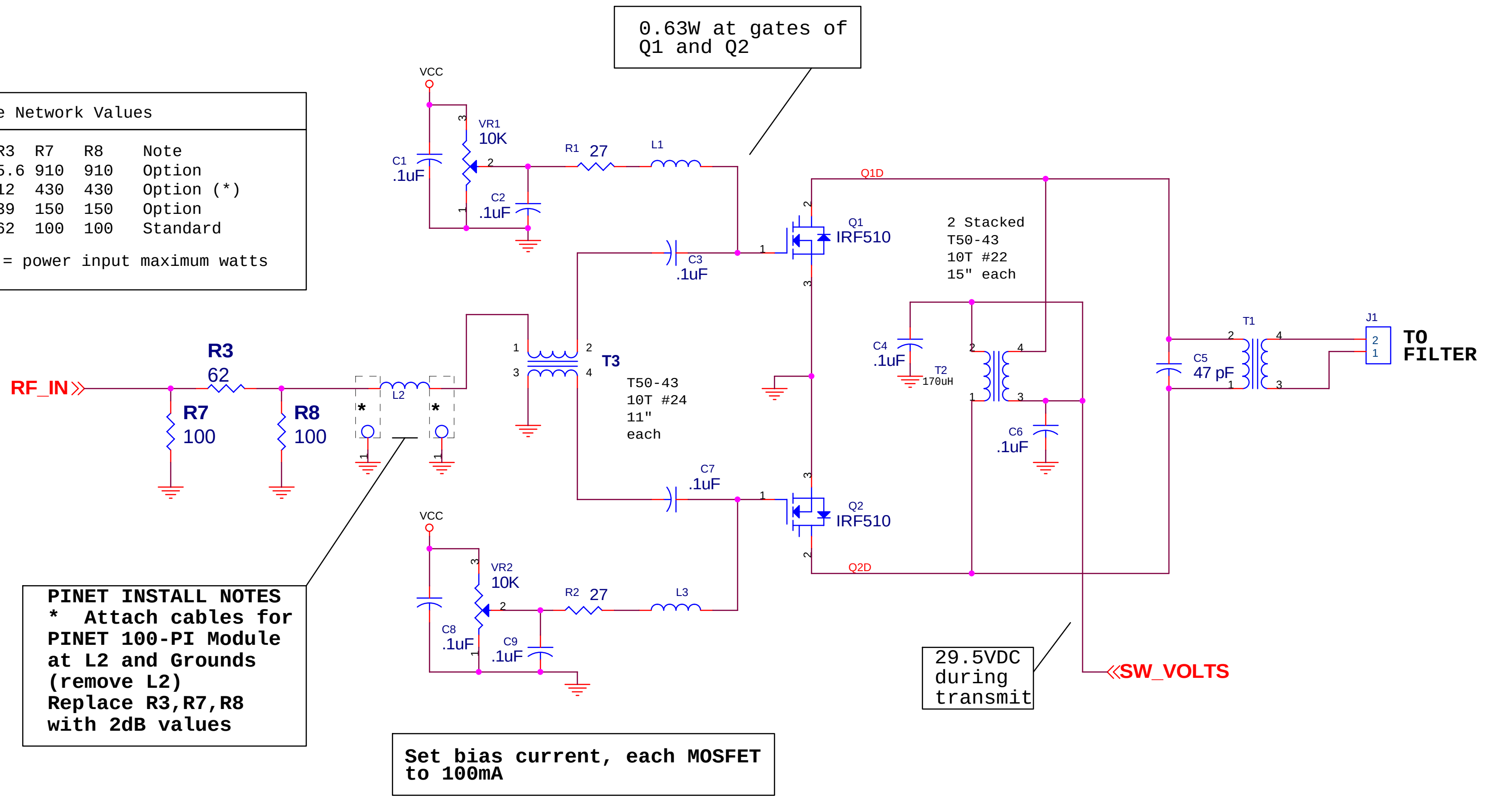
The selected filter circuit output is routed through the contacts of SW1 to J2. Note that 12V is also on J2. This is the operating voltage for the relays.

MANUAL CHANGES

Release 11/18/14

Release 10/19/2015.This release adds:

- detail for the LED Module assembly and mounting
- detail for using ceramic TO220 washers



PI-Resistive Network Values

dB	PImax	R3	R7	R8	Note
1	0.8	5.6	910	910	Option
2	1.0	12	430	430	Option (*)
6	2.5	39	150	150	Option
9	5.0	62	100	100	Standard

where: PImax = power input maximum watts

PINET INSTALL NOTES
*** Attach cables for PINET 100-PI Module at L2 and Grounds (remove L2)**
Replace R3,R7,R8 with 2dB values

Set bias current, each MOSFET to 100mA

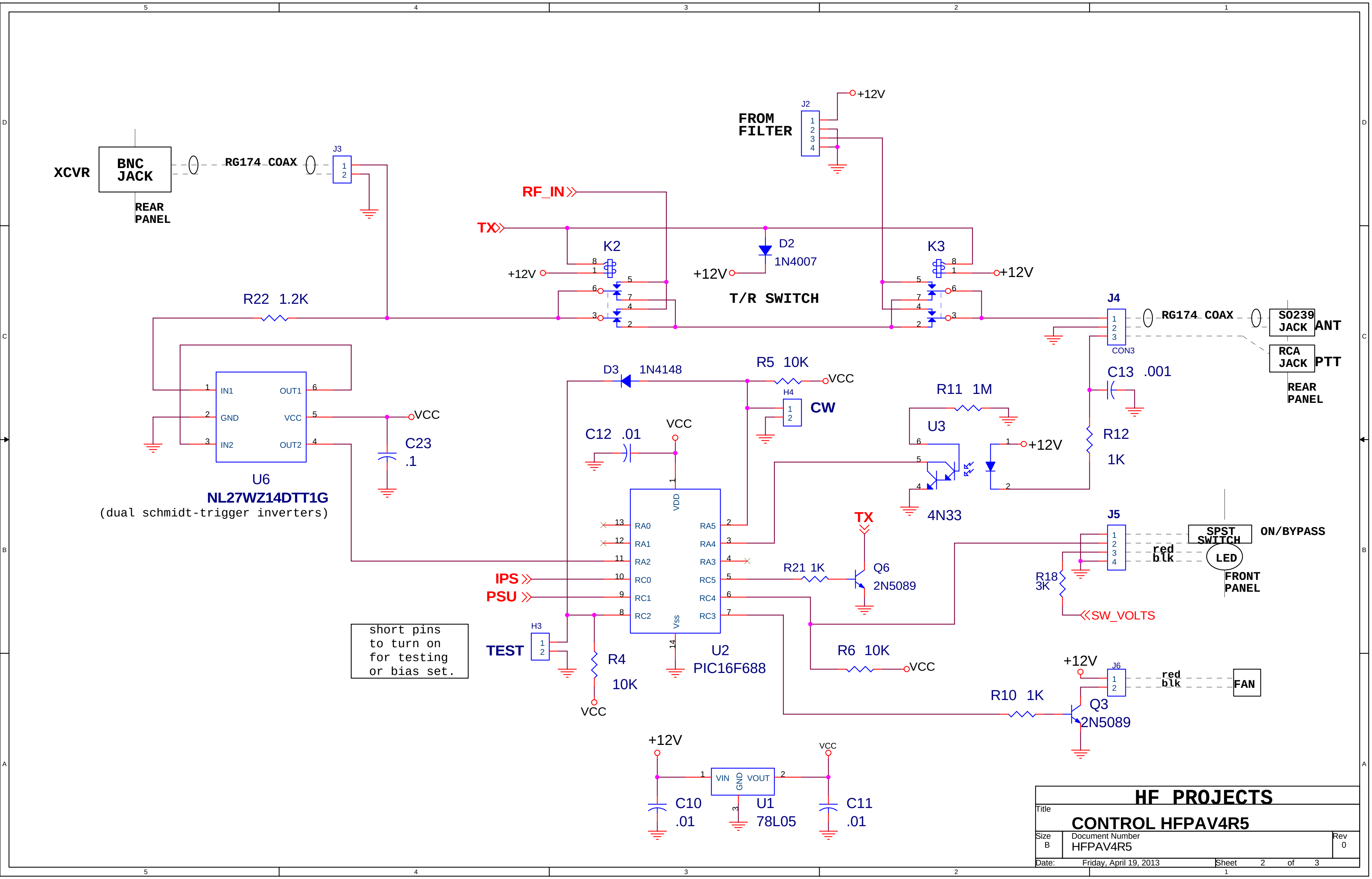
Revised: 3/28/13

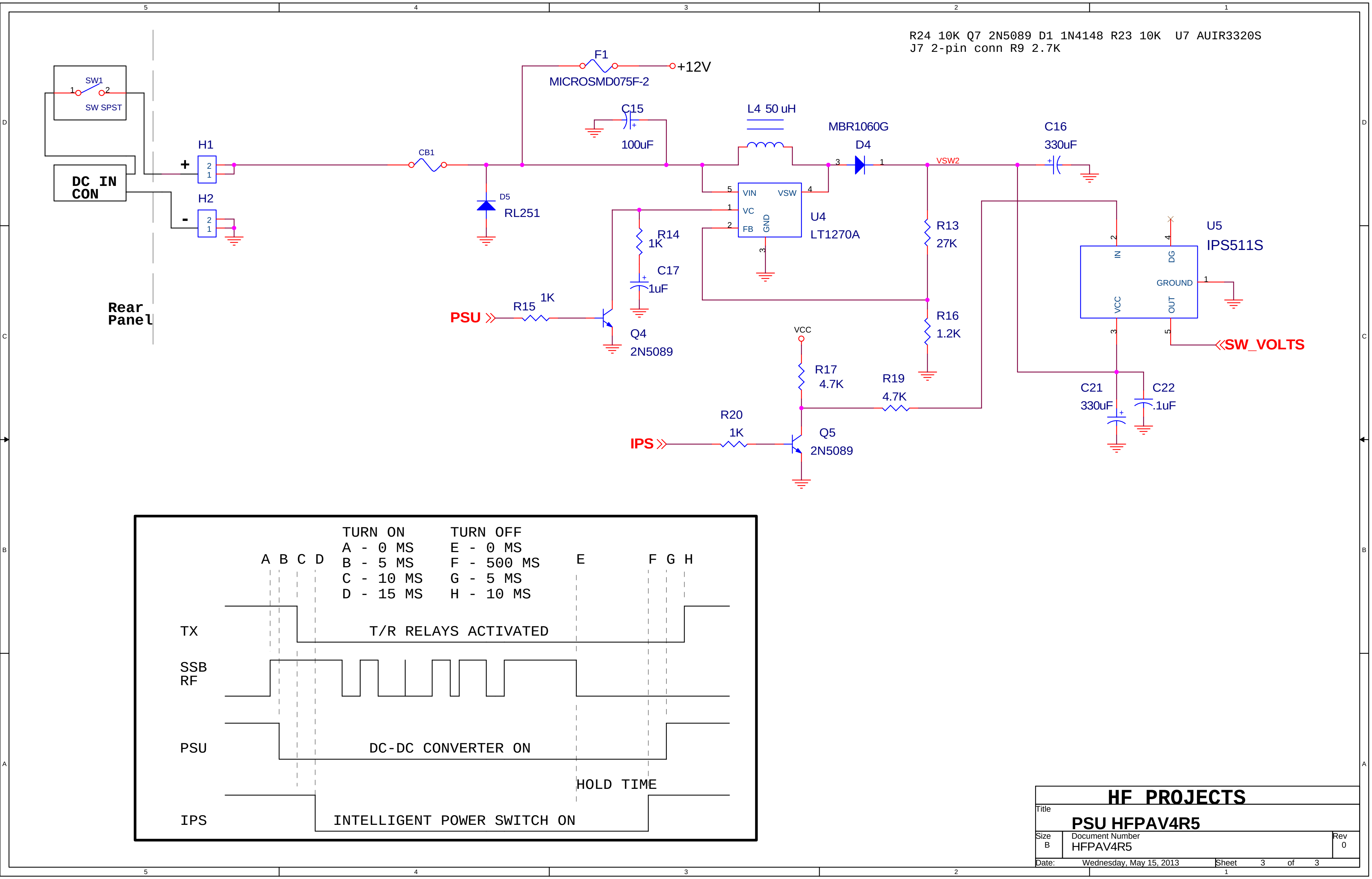
HF PROJECTS

Title: **MOSFET AMP HFPAV4R5**

Size: B | Document Number: HFPAV4R5 | Rev: 0

Date: Friday, April 19, 2013 | Sheet 1 of 3


XCVR
BNC JACK
REAR PANEL
RG174 COAX
J3
FROM FILTER
J2
+12V
RF_IN
TX
K2
K3
D2
1N4007
T/R SWITCH
R22 1.2K
J4
CON3
RG174 COAX
SO239 JACK
ANT
RCA JACK
PTT
REAR PANEL
IN1
GND
IN2
OUT1
VCC
OUT2
U6
NL27WZ14DTT1G
(dual schmidt-trigger inverters)
C23 .1
VCC
D3 1N4148
R5 10K
H4
CW
R11 1M
U3
4N33
C13 .001
R12 1K
C12 .01
VDD
RA0
RA1
RA2
RC0
RC1
RC2
RA5
RA4
RA3
RC5
RC4
RC3
Vss
U2
PIC16F688
IPS
PSU
TEST
H3
short pins to turn on for testing or bias set.
R4 10K
R21 1K
Q6 2N5089
J5
SPST SWITCH
ON/BYPASS
red
blk
LED
FRONT PANEL
R18 3K
SW_VOLTS
R6 10K
R10 1K
Q3 2N5089
J6
FAN
VIN
GND
VOUT
U1 78L05
C10 .01
C11 .01
HF PROJECTS
Title
CONTROL HFPAV4R5
Size B
Document Number
HFPAV4R5
Rev 0
Date: Friday, April 19, 2013
Sheet 2 of 3


R24 10K Q7 2N5089 D1 1N4148 R23 10K U7 AUIR3320S
J7 2-pin conn R9 2.7K
F1
MICROSMD075F-2
+12V
SW1
SW SPST
DC IN CON
H1
H2
Rear Panel
CB1
D5
RL251
C15
100uF
L4 50 uH
MBR1060G
D4
VSW2
C16
330uF
U4
LT1270A
VIN
VSW
VC
FB
GND
R14
1K
C17
1uF
R13
27K
R16
1.2K
U5
IPS511S
IN
DG
GROUND
VCC
OUT
SW_VOLTS
PSU
R15
1K
Q4
2N5089
VCC
R17
4.7K
R19
4.7K
C21
330uF
C22
.1uF
R20
1K
IPS
Q5
2N5089
TURN ON
A - 0 MS
B - 5 MS
C - 10 MS
D - 15 MS
TURN OFF
E - 0 MS
F - 500 MS
G - 5 MS
H - 10 MS
A B C D
E
F G H
TX
T/R RELAYS ACTIVATED
SSB RF
PSU
DC-DC CONVERTER ON
HOLD TIME
IPS
INTELLIGENT POWER SWITCH ON
HF PROJECTS
Title
PSU HFPAV4R5
Size
B
Document Number
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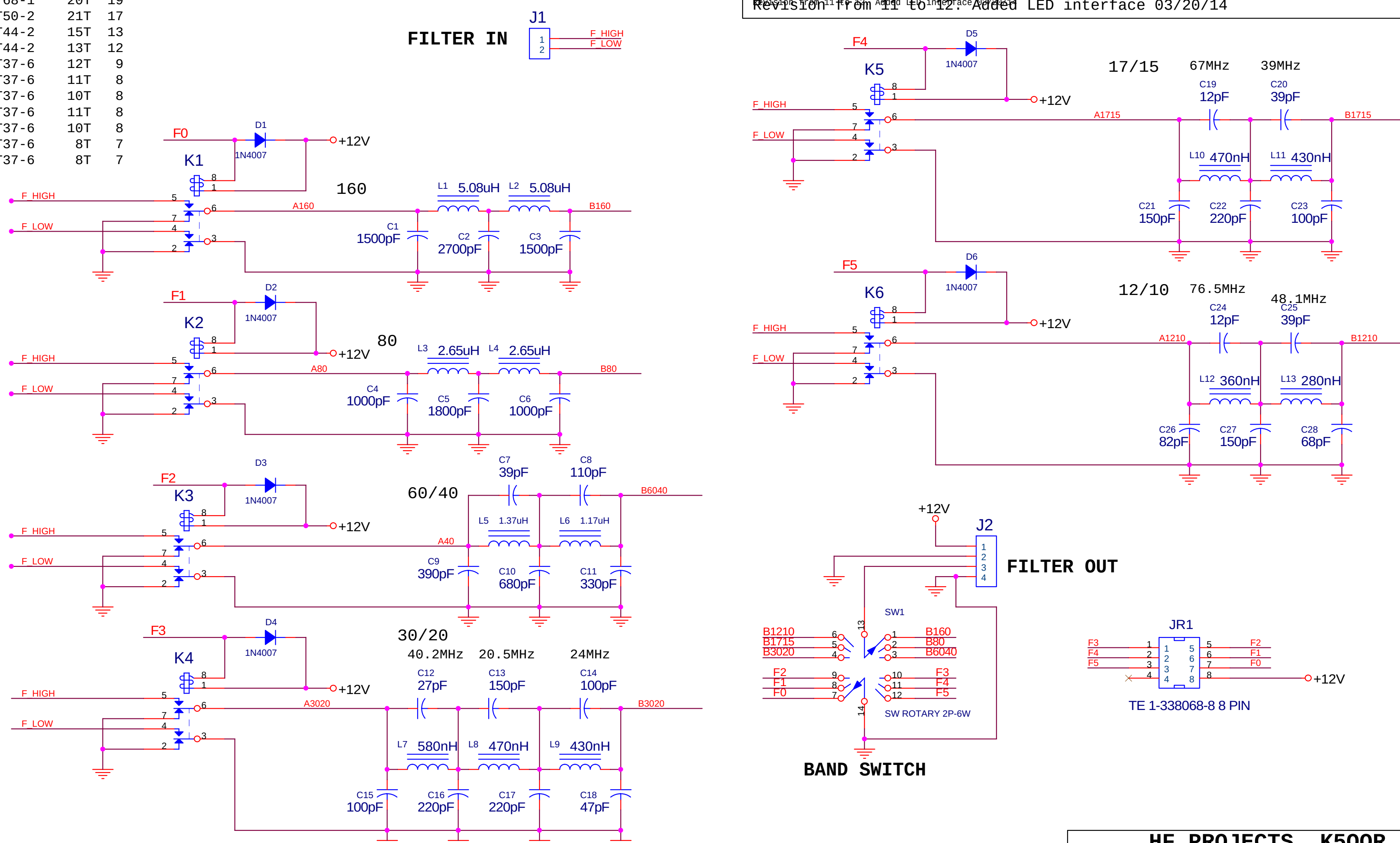
0
Date: Wednesday, May 15, 2013
Sheet 3 of 3

REF	TYPE	TURNS	INCHES
L1,L2	T68-1	20T	19
L3,L4	T50-2	21T	17
L5	T44-2	15T	13
L6	T44-2	13T	12
L7	T37-6	12T	9
L8	T37-6	11T	8
L9	T37-6	10T	8
L10	T37-6	11T	8
L11	T37-6	10T	8
L12	T37-6	8T	7
L13	T37-6	8T	7

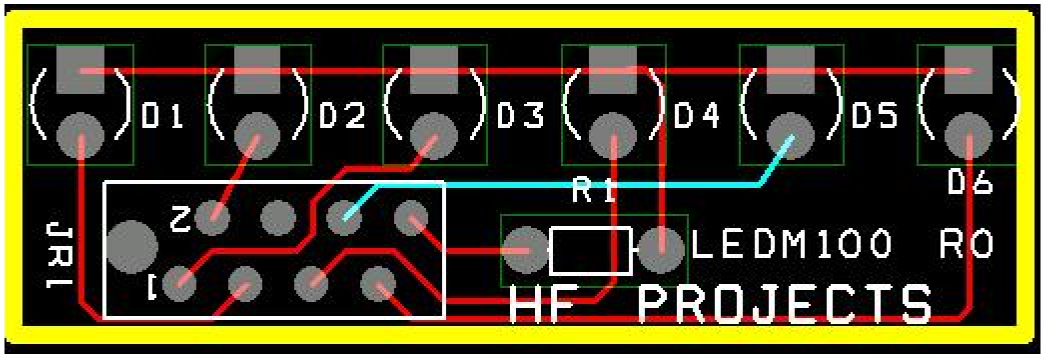
Revision from 10 to 11. Improved part footprints for ease of assembly 11/22/2012
Revision from 11 to 12. Added LED interface 03/20/14



HF PROJECTS K5OOR		
Title: HFPA FILTER MODULE 12		
Size: B	Document Number: HFPA FM V4A	Rev: 0
Date: Thursday, March 20, 2014	Sheet 1 of 1	

LEDM100 DESIGN HF PROJECTS 3/12/14

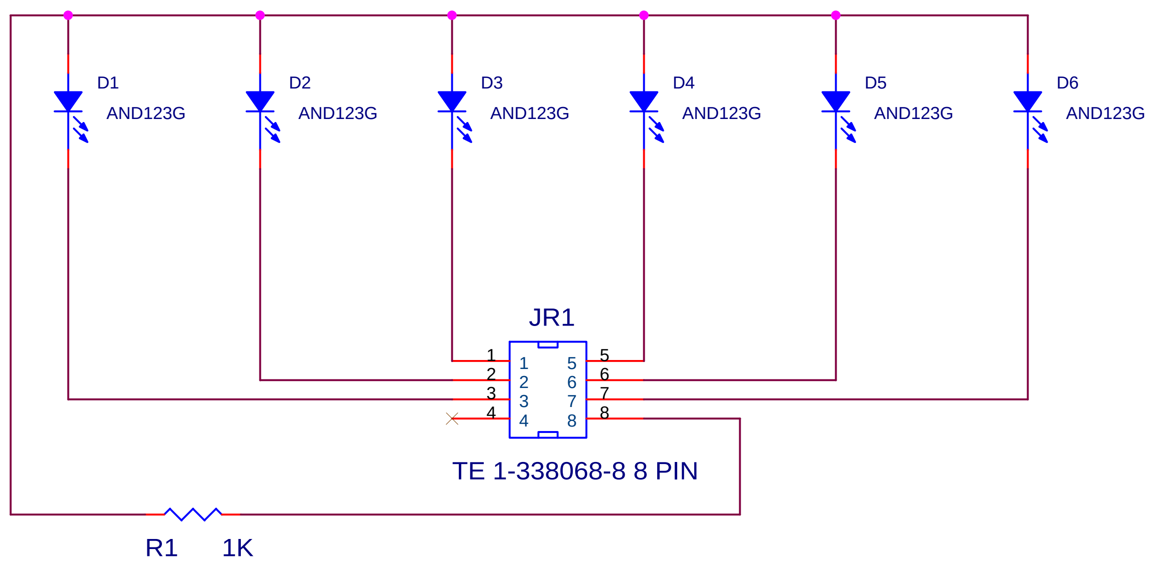
12/10M 17/15M 30/20M 60/40M 80/75M 160M



This is the LED Module Model LEDM100 R0

The dimensions are 1.525 x 0.475 inch with LED spacing 0.268 inch.

JR1 is a little flat cable connector where a flat cable snaps in.



HF Projects

Title
LED Display Module HFPA V4R5

Size	Document Number	Rev
A	**Model LEDM100 R0**	0

Date: Tuesday, March 11, 2014 Sheet 1 of 1

Inventory of Parts: HFPA V4 R5 Amplifier Module

(revised: 5/17/13)

HFPA 2013 V4 R5				
Item	Quantity	Reference	Description	Part Number
1	1	CB1	Circuit breaker 16V, 7A Hold 11.9A Trip	650-RGEF700
2	10	C1,C2,C3,C4,C6, C7,C8,C9,C22,C23	CAP CER .1UF 50V 10% X7R 1206	581-SR201C104KAR
3	1	C5	CAP dip mica 47PF	DM15
4	3	C10,C11,C12	Cap, .01uF SR151C103K AVX 100V 10% 581-SR151C103K AVX 100V 10% Mouser 581-SR151C103K; Allied stk 507-0210 1C10X7R103K050B Vishay	581-SR151C103K
5	1	C13	Cap 1000pF 100volts 10% X7R C315C102K1R5CA	80-C315C102K1R5CA
6	1	C15	Cap, 100 uF 50V LOW ESR 140-ESRL50V100	140-RXJ101M1HBK1016P
7	2	C21,C16	Cap, 330 uF 50V LOW ESR 140-ESRL50V330	140-RXJ331M1HBK1320P

8	1	C17	Cap, 1 uF 35V 10% Dip Radial Tantalum T350A105K035AT 80-T350A105K035AT Mouser; Allied stk 541-0548	581-TAP105K035SCS
9	1	D2	Diode, 1N4007	512-1N4007
10	1	D4	Diode, MBR1060G	MBR1060G
11	1	D5	Diode, 2.5A 100 PRV DO41 RL251-B Rectron Mouser 583-RL251-B	583-RL251
12	2	H1,H2	KeyStone Electronics .25 PCB TAB 032TPBR Keystone 534-1287	534-1287-ST
13	1	J4	Connector 3P Molex 70543-0002 Vertical header	538-70543-0002
14	2	J2,J5	Connector, 4P Molex 70543-0003 Vertical header	538-70543-0003
15	3	J1,J3,J6	Connector, 2P 70543-0001 Vertical header	538-70543-0001
16	2	H3,H4	Header .100 K.K. Connector 2 CKT Molex 538-22-03-2021	538-22-03-2021

17	2	K2,K3	Relay, 12VDC Non-latching Single coil P2 Tyco Electronics/ Axicom V23079A1003B301	655-V23079A1003B301
18	3	R4,R5,R6	Resistor 10K 1/8W 5%	299-10K-RC
19	1	L4	INDUCTOR 70-IH-5-50 RADIAL HI CUR 50uH DALE/VISHAY	70-IH-5-50
20	2	Q1,Q2	MOSFET, TO-220AB N-Ch Power Fairchild IRF510	512-IRF510
21	4	Q3,Q4,Q5,Q6	2N5089 Small Signal Transistors NPN Gen Pur SS Central Semiconductor 2N5089 610-2N5089 Mouser	610-2N5089
22	2	R1,R2	Resistor 27 ohm 1/2W 293-27	293-27
23	1	R3	Resistor, 62 ohm 2W	282-62-RC
24	2	R7,R8	Resistor, 100 ohm 2W	282-100-RC
25	6	R10,R12, R14,R15, R20, R21	Resistor 1K 5% 1/8W Carbon Film XICON 299-1K	299-1K
26A	1	R11	Resistor, 1M 1/8W 5% Carbon Film	299-1M-RC

			Xicon 299-1M-RC Mouser 299-1M-RC	
26B	1	R13	Resistor, 27K 1/8W	299-27K-RC
27	1	U2	Socket, 14 pin DIP D2814-42 Harwin	855-D2814-42
28	2	R16, R22,	Resistor, 1.2K 1/8W	299-1.2K-RC
29	2	R17,R19	Resistor, 4.7K 1/8W	299-4.7K-RC
30	1	R18	Resistor, 3K 1/4W	291-3.0K-RC
31	3	T2,T3	Core, Grey (0.5" OD)	FT50-43
32	1	T1	Balun Core Binocular	BN-43-3312
33	1	U5	Intelligent Power Switch IR	IPS511S
34	1	U1	5V Regulator, Fairchild 512-LM78L05ACZ Mouser 512-LM78L05ACZX	512-LM78L05ACZ
35	1	U2	IC, Microchip PIC16F688-E/P Microchip Microcontrollers (MCU) 7KB 256 RAM 12 I/O	579-PIC16F688-E/P
36	1	U3	Optocouplers DIP-6 PHOTO DARL 4N33 Allied Stk 307-0194	4N33
37	1	U4	Integrated Circuit, LT1270ACT 10	LT1270ACT#PBF

			AMP PWR SWITCH REG 5 TO-220	
38	1	U6	NL27WZ14DTT1G	RFM2 MODULE
39	2	VR1,VR2	Pot, 10K 652-3362P-1-103 10K	T93YA-10K
40	3	mating parts	Headers & Wire Housings 2P Molex	538-50-57-9402
41	1	mating parts	Headers & Wire Housings Molex 3P	538-50-57-9403
42	2	mating parts	Headers & Wire Housings Molex 4P	538-50-57-9404
43	1	mating parts	Headers & Wire Housings SHUNT OPEN TOP 2P	538-15-38-1024
44	20	mating parts +spares	Socket 24-22 Molex Header and Wire Housing	538-16-02-0103
45	1	Inductors (12T)	Wire #24AWG 5FT (0.022” OD)	566-8052
46	1	Inductors (7T)	Wire #22 AWG 3FT (0.026” OD)	566-8051
46	1	inductors	Wire, #20 TEF 7 inch	602-5856-100-05
47	1	inductors	Wire, #20 TEF 10 inch	602-5856-100-05
48	1	PCB	Circuit Board blank with IPS-511S Installed	HFPA 2010 V4 R3 with IPS511S
49	1	F1	Resettable Fuse, 13.2V 0.5A	650-MICROSMD050F-2

50	2	Spacer	Hex .187x.75 ALUM 4-40 tap	534-2029
51	6	Screw	4-40 x 3/16 inch	
52	4	Spacer	Hex .187x .25 ALUM 4-40 tap	534-1891
53	1	D3	Diode, Signal	1N4148

PINET 100-PI Option Module

Bill of Materials

Item	Quantity	Reference	Part Description	Mfg/PN/Dist.
1	2	D1,D2	Diode, 1N4007	863-1N4007G Mouser
2	2		Jack Screw KeyStone 7228	839-0994 Allied
3	3	J1,J2,J4	Header .100 K.K. Connector 2 CKT Molex	538-22-23-2021
4	1	J3	Vertical PC Header .100 K.K. 3 CKT Molex 538-22-03-2031	538-22-03-2031
5	2	K1,K2	RELAY DPDT	Relay, 12VDC Non-latching Single coil P2 Tyco Electronics/ Axicom V23079A1003B301 Mouser:
6	2	R1,R2	Resistor, 220 ohm 1W	281-220-RC (4dB)
7	1	R3	Resistor, 24 ohm 1W	281-24-RC (4dB)
8	1	R6	Resistor, 43 ohm 3W	283-43-RC (7dB)
9	2	R4,R5	Resistor, 130 ohm 3W	283-130-RC (7dB)
10	1	Amp 2dB PI	Resistor, 12 ohm 1W	281-12-RC (2dB)
11	2	Amp 2dB PI	Resistor, 430 ohm 1W	281-430-RC (2dB)
12	2	J1,J2	RG174 Coax Cable 3 inch length	

13	3	J1,J2,J4	Locking Ramp Housing 2P	MOLEX 538-22-01-2027
14	6	J1,J2,J4	Terminals, crimp	538-08-50-0114
15	1	J4	Wire, Black 5 inch	
16	1	J4	Wire, Red, 5 inch	
17	4	J1,J2	Wire, Black 1.4 inch for pig tails	
18	4	J1,J2	Black Shrink Tubing 1/2 inch length	
19	1		Bumper, peal/stick	517-SJ-5303CL
20	2		Screw, 4-40 x 3/16 inch	
21	1		Circuit Board	PINET 100-PI R1
22	1	J3	Jumper 2-pin	538-15-38-1024

APPENDIX A

Inventory of Parts: Low Pass Filter Module

Low Pass Filter Module				
Item	**Qty**	**Ref**	**Description and Typical Value Marking**	**P/N Mfg**
1	2	C19,C24	Cap, 12pF 500V [120xxx]	
2	1	C12	Cap, 27pF 500V [27]	
3	3	C7,C20,C25	Cap, 39pF 500V [39]	
4	1	C18	Cap, 47pF 500V [47]	
5	1	C28	Cap, 68pF 500V [68]	
6	1	C26	Cap, 82pF 500V [82]	
7	3	C14,C15,C23	Cap, 100pF 500V [100 or 101x]	
8	1	C8	Cap, 110pF 500V [110J]	
9	3	C13,C21,C27	Cap, 150pF 500V [150]	
10	3	C16,C17,C22	Cap, 220pF 500V [220]	
11	1	C11	Cap, 330pF 500V [330]	
12	1	C9	Cap 390pF 500V [390]	
13	1	C10	Cap 680pF 500V [680]	
14	2	C6,C4	Cap, 1000pF 500V [1000]	
15	2	C3,C1	Cap, 1500pF 500V [152xxx]	
16	1	C5	Cap, 1800pF 500V [182xxx]	
17	1	C2	Cap, 2700pF 500V [272xxx]	
18	6	D1,D2,D3,D4,D5,D6	Diode, 1N4007	
19	1	J1	Connector, CON2	538-70543-0001
20	1	J2	Connector, CON4	538-70543-0003
21	6	K1,K2,K3,K4,K5,K6	Relay, 12V DPDT	655-V23079A1003B301
22	2	L2,L1	Inductor	T68-1
23	2	L4,L3	Inductor	T50-2

24	2	L5,L6	Inductor	T44-2
25	7	L7	Inductor	T37-6
26	1	SW1	Switch, Rotary, 18 Inch Shaft, Adjustable Stop, 1 Deck, 2 Pole, Non-Shorting	71ADF30-01-2-AJN
27A	1		Wire, 24 AWG, 10 ft (24T)	Belden 8052
27B	1		Wire, 22 AWG, 38 inch	Belden 8051
28	1	PCB	Circuit Board	
29	1	mating parts	Headers & Wire Housings HSG 2P WITH LKG RAMP	538-50-57-9402
30	1	mating parts	Headers & Wire Housings HSG 4P WITH LKG RAMP	538-50-57-9404
31	6	mating parts	Headers & Wire Housings CRIMP TERM 22-30 TIN	538-16-02-0103
32	1	Connector	JR1: TE Conectivity: 7-215079-8	A99471CT-ND

Note: xx = don’t care

Inventory of Parts: Case Assembly

Revised 1/12/2014

FAN Assembly Option

Item	Quantity	Reference	Description	Part Number
1	1		FS6020 Screw Set	S001Z80N
2	1		Heat Sink Alpha NovaTech FS6020PF	FS6030PF
3	1		Fan 60x25mm 12V 4500RPM 24CFM 35DB Ball Bearing Orion OD6025HB	OD6025-12HB
4	1		Finger Guard 60mm Plastic Orion Fans	G60-P
5	4		4-40 Hex Nuts	
6	4		Screw, 4-40 x 5/16	
7	4		Split lock Washer #4	
8	1		Grommet, Rubber .187	534-730

Finished Case

Item	Quantity	Reference	Description	Part Number
3	1		Case, fabricated, painted and screened	

Case Assembly and Special Tools

Item	Quantity	Reference	Description	Part Number
1	1	Omit if fan option ordered	Heat Sink AAVID (black rectangular finned)	
2	1		TyWrap 4 inch	644-PLT1M-M69
3	1	Mating Connector	Power Pole 30A Red/Black	PP30-50
4	1		Switch Power Rocker 611-DA102J12S215HQF	676-0031
5	1		Knob BLK AL KNRLD IND LN	PKG50B1/8
6	4		Foot F2-ENCLOSURE-BLACK-FEET	537-F2
7	3	Q1,Q2	Nylon Socket Cap Head Screw 6-32 x 5/16 Black (1 spare)	McMaster Carr 95868A295

8	4		Eagle Cable Mounting & Accessories 1/8" HVY DTY CLIP	561-1250CC
9	2	Q1,Q2	Alum oxide insulator TO220	DK 4171G-ND
10	4		Screw 4-40 x 3/16	MSPPK0403
11	6		Screw 4-40 x 1/4 Pan Phil Black Oxide	PANPMS0404-10D4
12	8		Screw, 4-40 x 5/16	
13	4		4-40 Hex Nuts	
14	8		Split lock Washer #4	
15	0			
16	1		Powerpole Mounting Clamp Pair for 2 or 4 PP15/30/45 Powerpoles	1462G1
17	1		1/16 Hex Key-Long	116HK-L pointe-products.com
18	1		7/64 Hex Key-Long	764HK-L pointe-products.com

19	1		3/16 inch hex 4-40 threaded male/female spacer, 5/16 inch length. FASCOMP FC4502-440-SS	Mouser 728-FC4502-440-SS

Fabricated Cable Set Option (if ordered, uses cable components in fabrication)

Item	Quantity	Reference	Description	Part Number
1	1		RF In Cable	
2	1		RF Out Cable	
3	1		DC Power Cable	
4	1		Front Panel Cable	
5	1		LPF RF In Cable	
6	1		LPF RF Out Cable	

Cable Components List (supplied if fabricated cable set not ordered)

Item	Quantity	Reference	Description	Part Number
1	8 inch	RF Cable finishing	Shrink Tubing 1/4 inch x ½ inch lengths as	FIT221V1/4 BK103

			required	
2	2 inch	Bare Wire Covering	Shrink Tubing 1/8 inch x ¼ inch lengths as required **FP301 1/8 RED 48" BK**	Mouser 5174-1184
3	1	RF In Cable	Connector, BNC	530-CP-1094-AST
4	1	RF Out Cable	Connector, SO239	25-7350
5	1	Front Panel Switch Cable	Switch TX On/Bypass PRK22J5BBBNN Switch, Rocker, ULTRA Miniature, ON-OFF, NO LEGEND Cherry	908-0065
6	2	Front panel switch cable	Hookup wire, Gray, #24 5 inch length	
7	1	DC Cable	Power Pole Set 30A Red/Black	PP30-50
8	1	DC Power In	Wire Red #14AWG Teflon red 4 inch	Wire-TF-14-
9	1	DC Power In	Wire Red #14AWG Teflon red 4 inch	Wire-TF-14-

10	1	DC Power In	Wire Black #14AWG Teflon black 4 inch	Wire-TF-14-
11	4	Power Wiring	Terminals FLAG RECP 16-14 BULK .250 x .032	571-35201332
12	1	RF Cable Ends	Hookup wire, Black #24 Teflon 17 inch Cut to 1.4 inch lengths for pig tails	
13	1	LPF Control cable	Hookup wire Black #24 Teflon 5 inch	
14	1	LPF Control Cable	Hookup wire Red #24 Teflon 5 inch	
15	1	PTT Wire, RF Output Cable	Hookup wire, White #24 15 inch length	
16				
17	1	PTT component RF Out Cable	Switchcraft Phono (RCA) Connectors REAR MOUNT JACK	502-3501FRX
18	1	RF Out Cable	RG174, 11 inch	
19	1	RF In Cable	RG174, 11 inch	
20	1	LPF RF Out Cable	RG174, 5.0 inch	

21	1	LPF RF In Cable	RG174 5.0 inch	
22	1	LED Front panel switch cable	LED Panel Mount Indicators HI EFF RED DIFFUSED 5in WIRE LEADS	645-558-0101-007F
23	8	RF In, RF Out Cable	Core 23-43, 4 per cable with shrink tube covers	
24	1	RF Out Cable	Terminals RING 22-18 AWG 4	517-2204A

Appendix D   LPF Coil Set

L1, L2

5.08uH

L3, L4

2.51uH

L5

1.37uH

L6

1.17uH

L7

580nH

L8, L10

470nH

L9, L11

430nH

L12

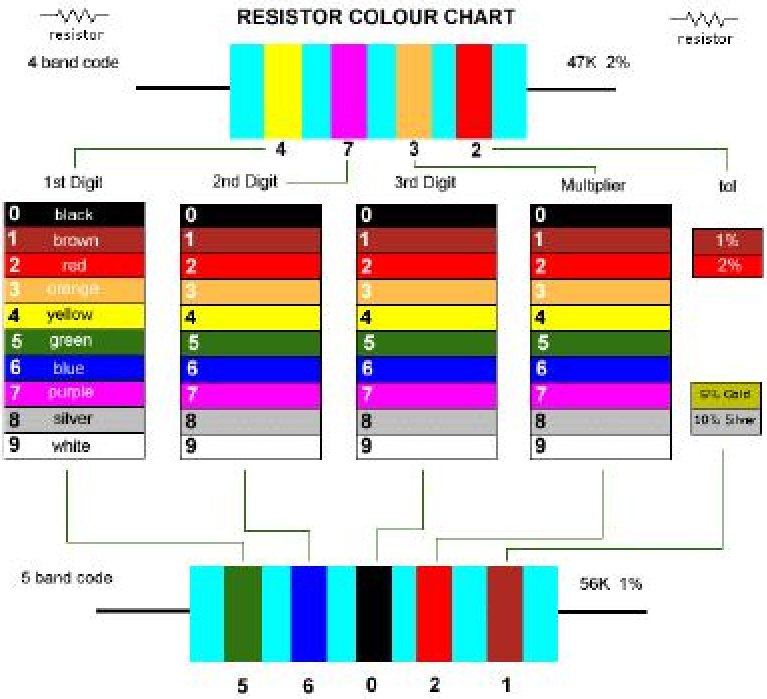
360nH

L13

280nH

Use the ZOOM feature to see greater detail

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).