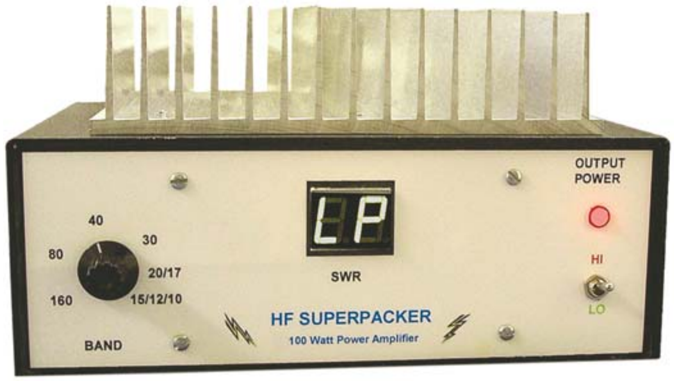
The SuperPacker HF Amplifier



Turn your QRP rig into a 100 W powerhouse with this project.

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Low power (QRP) operation is a lot of fun, but let's face it: there are times when a few more watts are welcome. Perhaps you want the extra power to help you crack a DX pileup, or maybe the waning solar flux is the real motivator. Either way, this homebrew project will add some welcome kick to your QRP rig when you want to have it. You might even let your QRP rig do double duty as your full power base station. To ensure the success of this homebrew project, it has been designed as a collection of small, manageable projects carefully packaged into one box. So, get out your drill bits and soldering iron—it is time to build your own 100 W HF amplifier.

In developing this project, our goal was to make an HF amplifier that was easy to build and (nearly) foolproof. The basic idea was simple. Use existing, proven designs as much as possible. We looked for circuits that have been published, tested, and ones with readily available parts. The result is an amplifier called the SuperPacker. It uses a popular Motorola amplifier board design, a low pass filter (LPF) and a programmable integrated circuit (PIC) SWR meter from past *QST* articles, three relays, some spare parts, and ideas shamelessly pilfered from other great projects.

The result is the all-band HF amplifier shown above. The SuperPacker delivers up to 100 W output with just a few watts of drive. Its low pass filter ensures a spectrally clean signal and its built-in SWR meter provides a direct digital display of the antenna SWR while automatically protecting the amplifier from even a serious mismatch.

Design

A good HF amplifier needs a stable gain stage, proper low-pass filtering to attenuate harmonics, TR switching and some way to protect against unexpected loads such as a disconnected or broken antenna. The heart of the SuperPacker is a robust bipolar amplifier design developed by Motorola in 1976 and still widely used today. A high quality circuit board, the original Motorola Semiconductor Products Applications Note, and all the parts needed to build the amplifier stage of the SuperPacker are available from Communications Concepts (CCI).[1]

The LPF is a solid design developed by Jim Valdes, WA1GPO, as part of the FARA HF Project featured in the June 2003 issue of *QST*.[2] All the construction details for the LPF, including the original *QST* article and an updated parts list, are available on the Falmouth Amateur Radio Association's Web site, **www.falara.org/tektalk/tektalkfs.html**. The PC board is available from FAR Circuits.[3,] Just remember to let them know you want the LPF board to build a SuperPacker.

A good amplifier also needs good transmit to receive switching. The SuperPacker TR switching is accomplished using two new circuit boards designed specifically for this project—the *relay board* and the *control board*. These two boards are also available from FAR Circuits. They are not complicated and are described in detail in this article.

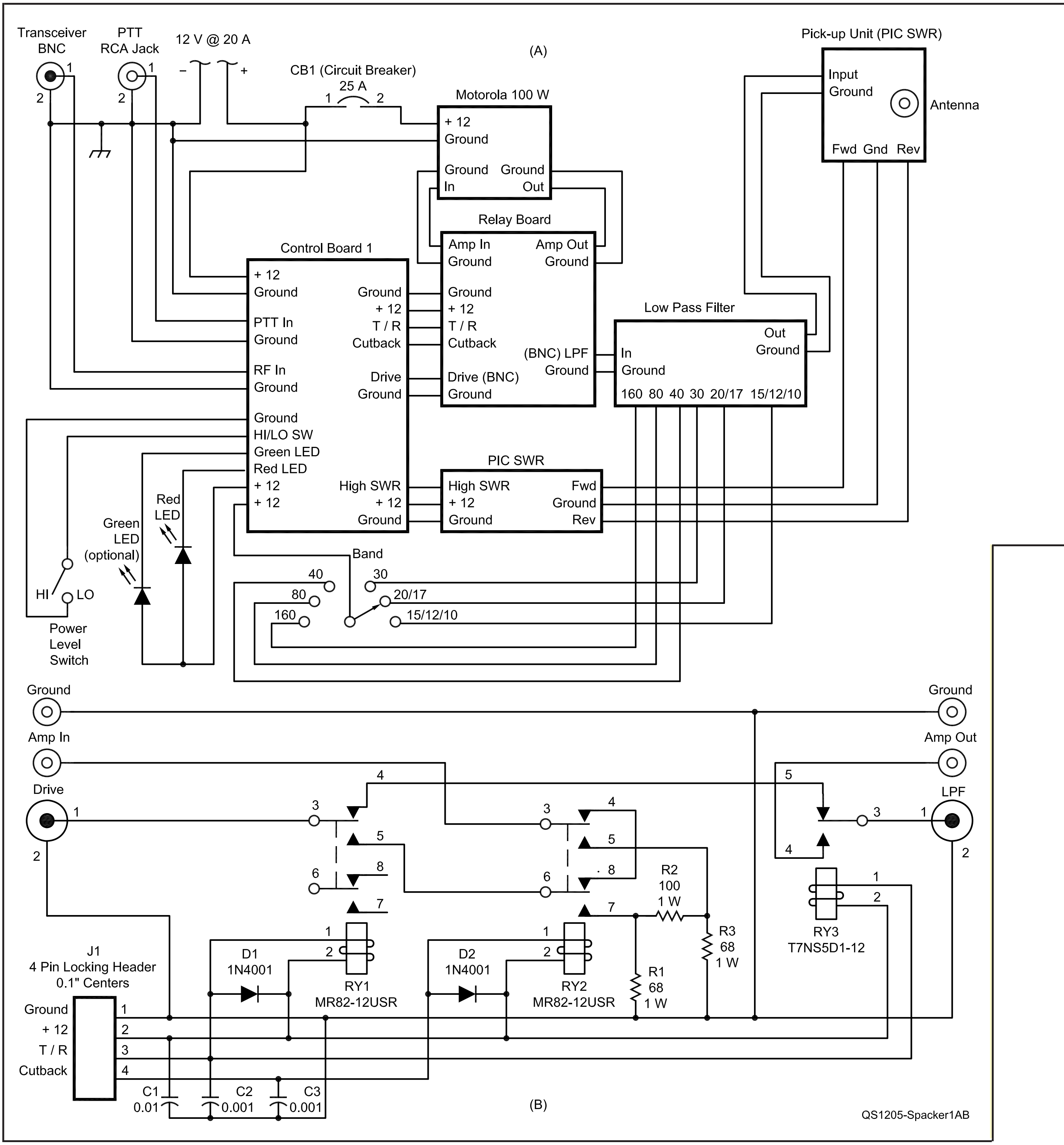
Now for the icing on the cake: The SuperPacker includes a digital SWR meter based on the Bert Kelley, AA4FB, PIC SWR meter project that was featured in the December 1999 issue of *QST*.[4] This SWR meter not only provides a direct readout of the SWR, but the PIC controller has been updated and reprogrammed to provide automatic power cutback whenever the SWR gets too high. The circuit board for the PIC SWR meter, including a pre-programmed PIC processor and the digital display, are all available from FAR Circuits. In short, the entire SuperPacker project is at its heart a modular design based on a collection of simple projects.

Description

The SuperPacker is housed in a 3.06×8.25×6.13 inch aluminum enclosure sold by Ten-Tec. This enclosure is not only sturdy and attractive, but it is inexpensive and makes for a professional looking finished project. The only two controls are the BAND switch and the HI/LO POWER switch. RF INPUT, RF OUTPUT, 12 V POWER and PTT connectors are all mounted on the rear of the enclosure. The front panel also has a two digit SWR display and red power level indicator LED. As described in the original PIC SWR article, the display shows SWR values from 1:1 to 10:1. Above 10:1 the display indicates HI. If the output power drops below about 8 W the display indicates LP. At a SWR above 4:1 the modified SWR program activates a circuit to reduce the amplifier drive by 10 dB, giving about 8 to 10 W of output. The red high power LED indicator turns off under the high-SWR condition. The arrangement is ideally suited for using a manual antenna tuner.

The amplifier requires a suitable power supply able to deliver 12 to 13.5 V at about 20 A. Internally, the 12 V power is split between the power amplifier board and the remaining circuitry. Each branch is separately fused and protected from accidental polarity reversal. The power transistors idle at about 250 mA. The PIC SWR meter can draw another 50 mA or more, so the amplifier requires around 300 mA when idling. A large heat sink on the top of the case keeps

[1]Notes appear on page 37.



the RF power transistors cool during typical use. With 5 W input, the output can be as high as 100 W. The amplifier is not intended for 100% duty cycle operation, but would tolerate the extra heat with an added fan.

RF coming into the SuperPacker goes directly to the control board. The control board has a very sensitive VOX circuit. The VOX circuit activates TR switching relays (on the relay board) at the start of transmission. You can, however, use the push-to-talk (PTT) input instead. Just ground the PTT input to transmit. The PTT line draws about 20 mA of current. PTT control of the amplifier speeds up TR switching and is ideally suited for contest operation. A jumper (JP1) on the control board can be used with PTT operation to eliminate the VOX delay.

In addition to driving the VOX circuitry, the input RF passes through an attenuator formed by R5 through R7 on the control board. Almost any QRP rig can be connected to the input as long as attenuator (R5 to R7) is set to provide a maximum of 2.5 W output from the at-

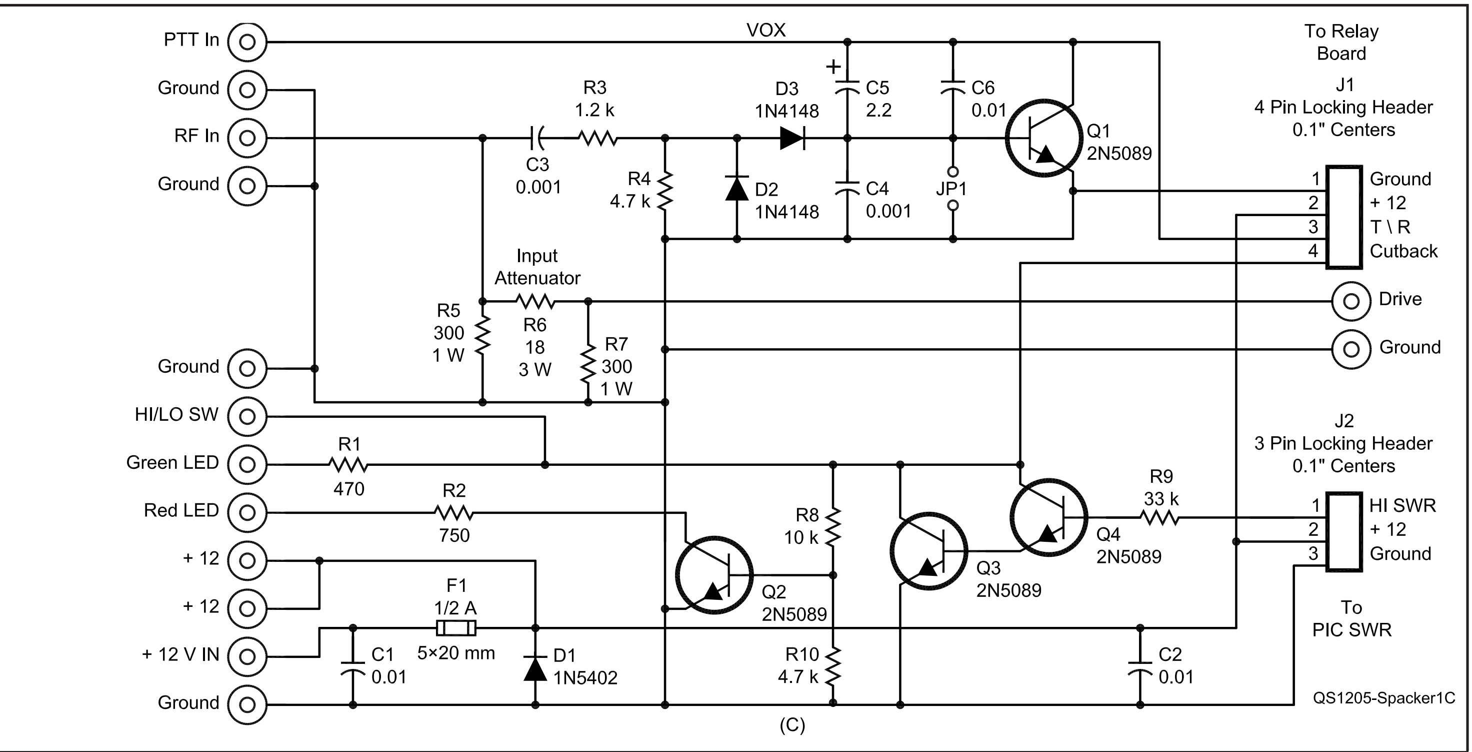


Figure 1—Detailed schematic diagram and parts list for the SuperPacker. At 1A is the interconnection diagram, at 1B the relay board and at 1C the control board. Most components are stocked by major distributors such as Digi-Key (www.digikey.com), Mouser (www.mouser.com) and Ocean State Electronics (www.oselectronics.com). Resistors are 5%.

Control board parts:
C1, C2, C6—0.01 µF, 100 V ceramic disc capacitor.
C3, C4—0.001 µF, 100 V ceramic disc capacitor.
C5—2.2 µF, 50 V electrolytic capacitor.
D1—1N5402 power rectifier.
D2, D3—1N4148 silicon rectifier.
F1—1/2 A, 5×20 mm fuse.
Holder for F1—5×20 mm fuse holder (Mouser 534-3527).
J1—4 pin, 0.1 inch locking header (Mouser 538-22-23-2041).
J2—3 pin, 0.1 inch locking header (Mouser 538-22-23-2031).
JP1—2 pin, 0.1 inch header.
Q1-Q4—2N5089 NPN transistor.
R1—470 Ω, 1/4 W carbon film resistor.
R2—750 Ω, 1/4 W carbon film resistor.
R3—1.2 kΩ, 1/4 W carbon film resistor.
R4, R10—4.7 kΩ, 1/4 W carbon film resistor.
R5, R7—300 Ω, 1 W carbon film resistor.
R6—18 Ω, 3 W carbon film resistor.
R8—10 kΩ, 1/4 W carbon film resistor.
R9—33 kΩ, 1/4 W carbon film resistor.

Relay board parts:
BNC1, BNC2—BNC connector, PC mount (Mouser 161-9317).
C1—0.01 µF, 100 V ceramic disc capacitor.
C2, C3—0.001 µF, 100 V ceramic disc capacitor.
D1, D2—1N4001 power rectifier.
J1—4 pin, 0.1 inch locking header (Mouser 538-22-23-2041).
R1, R3—68 Ω, 1/4 W carbon film resistor.
R2—100 Ω, 1 W carbon film resistor.
RY1, RY2—DPDT 12 V miniature relay (Mouser 551-MR82-12USR).
RY3—SPDT 12 V relay (Mouser 655-T7NS5D1-12).

Other parts:
30 A Anderson PowerPole connectors, 2 red, 2 black.
Bracket set for PowerPole, 1462G1.
25 A circuit breaker ETA 1610-92-25A (Digi-Key 302-1245).
Socket for circuit breaker (Mouser 441-R347B).
Enclosure (Ten-Tec TG-38).

tenuator. The values shown on the schematic provide 3 dB of attenuation, which is suitable for a 5 W transceiver like the Yaesu FT-817. Both the attenuator and VOX circuitry are taken directly from K5OOR's "HF Packer-Amplifier" project, which is a refinement of *The 2001 ARRL Handbook* design by WA2EBY. See K5OOR's Web site (**www.hfprojects.com**) for details.

In addition to the RF input circuitry, the control board has a power fuse, and the dc amplifier for power cutback. When the PIC SWR meter detects a high SWR condition, it drives the base of Q4 through R9. Q3 and Q4 form a Darlington pair amplifier for activating relay RY2 on the relay board. RY2 adds R8 through R10, another π-section attenuator, in series with the power amplifier board's input. R8 through R10 introduce 10 dB of attenuation, corresponding to a 10:1 reduction in drive power. These resistor values are fixed and do not depend upon the transceiver being used.

Looking at the control board again, when Q3 activates the relay for power cutback it also lights up the green LED circuit. Q2 acts as an inverter and lights the red LED when Q3 is off (no power cutback). The green and red LEDs can be part of a single common-anode red-green LED, separate LEDs, or you can use just one color (as we did). R1 and R2 determine the brightness of the green and red LEDs, respectively. The schematic and parts list are shown in Figure 1.

Construction and Testing—The Control Board

The control board is simple to build and easy to test. Wire all the connections on the left side of the schematic, and a coax cable to the DRIVE output. This cable should be made using RG-174 miniature coax with a BNC male connector on the end. For now, connect the BNC connector through a low power wattmeter to a 50 Ω dummy load. The dummy load only needs to handle about 5 W. Two 100 Ω, 3 W resistors in parallel (of the same type as R6) can be used.

Check to see if the full power of your transceiver remains below 2.5 W at the wattmeter. Attach a 1 kΩ resistor between your 12 V power supply and the PTT IN connection. Connect a high-impedance voltmeter between ground and the PTT IN connection. A very small amount of RF from the transceiver should make the voltage at PTT IN drop from 12 V to nearly zero. This test verifies the operation of the VOX circuitry. Remove the 1 kΩ re-

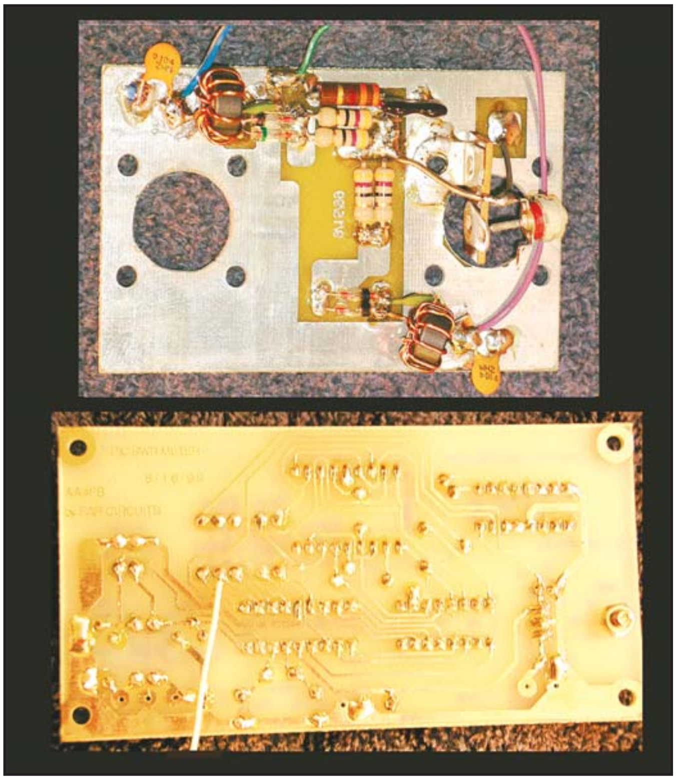


Figure 2—Modified PIC SWR boards.

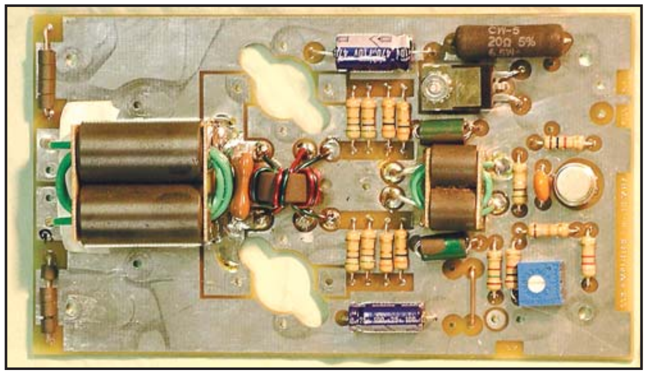


Figure 3—Amplifier board with major portions assembled.

Figure 4—C6 on amplifier board.

sistor from the PTT IN and touch it to pin 1 of J2. Power to the red LED should go off and power to the green LED should go on. The HI/LO POWER switch must be in the high power position for this test to work.

PIC SWR Boards

The PIC SWR requires two printed circuit boards. The main PIC SWR board has all the control and display circuitry. The pick-up unit has the RF sensing circuit. Build the main PIC SWR board exactly as described in the original article. Then, add a wire to the board by soldering it to the side of R6 that connects to the PIC (lower board in Figure 2). This wire will be the HIGH SWR signal. The HIGH SWR signal requires using a revised version of the *PIC SWR* program, so be sure to order the PIC chip programmed for the SuperPacker.[5] The original PIC chip (16C71) is out of production, but the replacement chip (16C711) is widely available. The new program supports the 16C711 and is fully backward compatible with the original PIC SWR circuit. The source code and Hex files for the PIC program can be downloaded from the ARRL Web site.[6]

Building the PIC SWR pick-up board for the SuperPacker is a bit different from the original article. Do not use a pick-up board purchased before May 2004; the silkscreen on the board does not match the copper traces. Mount most of the components on this board as directed in the article, but do not mount the input connector.

The top board in Figure 2 shows a partly assembled pick-up board. Look at the terminal strip (upper right). The terminal strip replaces the INPUT connector (J1). It is used to support C10 and the input end of the coaxial cable (not yet on the board). The mounting scheme differs from the original article.

Low-Pass Filter Board

The SuperPacker uses the LPF board from the FARA project. It works well, but the coils can get warm when filtering a 100 W amplifier. We redesigned the circuit values with larger toroid cores. Table 1 shows the new values. The cores are available through Amidon Associates.[7] Testing at the ARRL Laboratory verified that the new coil set provides excellent harmonic suppression.

Amplifier Board

The most critical board is the amplifier board. Most of its parts, including a high-quality circuit board, can be purchased from CCI. The board is supplied with the original Motorola Applications Note and some additional helpful instructions. Build the board with care. There are a few surface mount capacitors. If this is your first try at surface mount, see the *QST* articles by Sam Ulbing, N4UAU, for detailed instructions.[8] Figure 3 shows the assembled board without transistors. Figure 4 will help with the placement of C6, made from two surface mount capacitors and a regular silver mica capacitor.

The amplifier board was designed for use with IRF454 transistors from Motorola, and the transistors must be a matched pair. CCI will sell you a matched pair of transistors. The other option is to use the less expensive Toshiba 2SC2290 transistors, available from RF Parts Company as matched pairs.[9] These have about 2 or 3 dB less gain and slightly thicker leads. The lower gain requires a change to the input attenuator. In fact, the transistors we tested worked with a Yaesu FT-817 running 5 W without any attenuation (R5 and R7 removed, R6 shorted). The thicker leads require a small modification to the printed circuit board.

Because the amplifier board mounts on the inside of the case, and the heat sink is on the outside side of the case, the transistors must be mounted lower than usual. To accomplish this deeper position the transistor leads are bent upward (Figures 5 and 6); see instructions below. You must enlarge the holes in the amplifier board to let the 2SC2290 power transistors pass through freely. We did not need to enlarge the holes for the IRF454 transistors. Transistor mounting is the most critical part of assembly, and mounting will go smoothly only if the heat sink is drilled

Table 1
New Capacitor and Coil Values for the FARA LPF

Band	Turns (L1/L2)	C1/C3 (pF)	C2 (pF)	Core	AWG	Wire length (inches)
160(A)	26	1500	2700	T80-2	24	24
80(B)	20	910	1600	T80-2	24	18
40(C)	15	470	820	T80-2	24	14
30(D)	14	360	600	T80-6	22	14
20-17(E)	9	180	360	T80-6	22	10
15-10(F)	8	91	180	T80-10	22	8

Figure 5—Detail of bending of the power transistor connections.

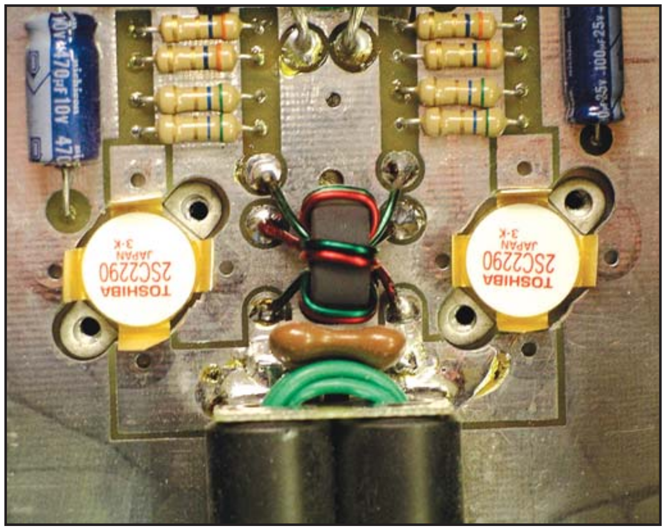


Figure 6—Mounting of power transistors.

and tapped with care. The power cable and both coaxial cables must be soldered to the amplifier board before it is mounted. RG-174 type small coaxial cable is used for the input circuit. RG-58 type cable is used for the output (see Figure 7). The cables can be cut to length after the board is mounted.

Wrapping Up

Finishing the enclosure is relatively simple and will not require any special tools to result in a clean, professional look. The panel labels were made following Bill Sepulveda's, K5LN, instructions in his December 2002 *QST* article.[10]

Assembling the Top of the Chassis

Final assembly begins with mounting the heat sink and relay board on the top cover, and then mounting the amplifier board onto the heat sink. There should be holes (cut-outs) in the top cover that line up with the power transistors and with diode D1 on the CCI amplifier board. These holes expose the heat sink so the transistors and diode can be screwed directly to it. Wire both coaxial cables and the power cables to the amplifier board prior to mounting the board to the top cover. Number 8 nuts are perfect spacers for mounting.

Inspect the space under that board to make sure nothing from the board touches ground except for diode D1. D1 is held in place against the heat sink with a 4-40 screw. Instead of having the screw head push down on the circuit board, we enlarged the screw hole in the board and used a screw with a small head. The screw pushes directly on D1 and holds it firmly to the heat sink. You must put silicone thermal grease (heat sink compound) on this diode for good thermal conductivity with the heat sink. Now mount the board as shown in Figure 7.

The next steps are the most critical for the project. Look at the two power transistors. The lead (gold tab) that is cut off at an angle on each transistor is the collector. It must face in the direction of the large output transformer (see Figure 6). Very carefully bend all four leads toward the top of the transistor as shown in Figure 5. Make this bend as sharp as possible without stressing the leads or the case of the transistor. Too much stress will break the sealing compound or crack the case. Put the transistor into place through the cutout of the printed circuit board. Do not use any heat sink compound yet.

Slowly screw the transistor into place. The oval metal bottom of the transistor must press *firmly* against the heat sink. If the tapped holes in the heat sink are not lined up properly, it is possible to bend a lead too sharply and damage the transistor. If the transistors line up properly, bend the leads flat onto the top of the circuit board where they will eventually be soldered. Do not solder them yet!

Now, remove the transistors. Use your soldering iron and a touch of solder to coat the solder pads of the circuit board where the leads of the transistors will go. Coat the bottom of each transistor with a thin layer of heat sink compound. Mount the transistors again making sure the collector is still pointed in the proper direction. Tighten the mounting screws firmly.

Follow this procedure for soldering each transistor lead: Press the transistor lead to the circuit board with your hot soldering iron. Apply solder to the iron and then the lead to get solder flowing on the top of the lead. Continue to heat the lead for a few moments until solder flows on the circuit board. Let go of the solder and grab a flat blade screwdriver. Press the lead down with the screwdriver and remove the hot iron. Hold the screwdriver in place until the solder cools. You can breathe now. For safety, make sure the bias potentiometer is set fully clockwise before going on to the next assembly step.

Assembling the Bottom of the Chassis

Mount all the rear-panel parts except the 12 V power connector (see Figures 8 and 9). The rear-panel parts include the PIC SWR pick-up board. Hold the main PIC SWR circuit board in place on the front panel and measure and cut all the wires for it. Three wires go to the pick-up board and three wires go to a connector that will plug into the control board. Wind the three pick-up board wires twice through a T37-43 toroid before connecting them. Before mounting the PIC SWR main board you might want to assemble the test circuit (Figure 4 of the original article) and use it to adjust R1 and R2. Otherwise, you will have to unmount the PIC SWR main board later to adjust R1 and R2.

Once you have mounted the PIC SWR board, mount the HI/LO POWER switch and mount one or both LEDs. Don't mount either LED too close to the top of the case. You will need clearance for a connector on the relay board during final assembly.

Assemble the rear panel 12 V power connector next. Cut one of the in-line fuse socket wires to 4 inches and strip off 1/2 inch of insulation. Strip 1/2 inch from some red

Figure 7—Inside of the top of the amplifier box.

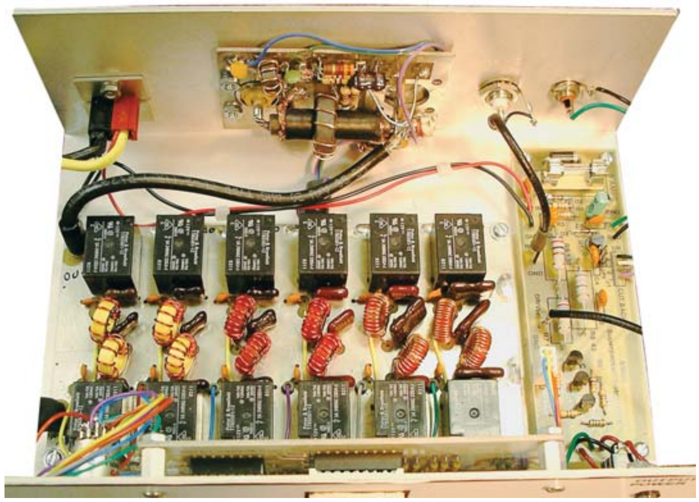


Figure 8—Inside of the bottom of the amplifier box.

20 gauge stranded wire and twist the red wire and the larger fuse socket wire together. Tin, trim, and solder them to the PowerPole connector pin. Solder some 20 gauge and 16 gauge black hookup wire to a PowerPole pin in the same manner. Link together a black and red PowerPole housing and snap the completed pins into the housings. Next, measure 4 inches from the free end of the in-line fuse socket. Strip and solder this end to a pin; snap it into a red housing. Trim the free end of the 16 gauge black wire so it can be assembled to a black housing linked with this red one. The fuse holder will be in the positive lead. Mount the PowerPole pair with double wires onto the rear chassis. The free black wire is connected to the chassis via a ground lug. Keep this lead very short.

Install the band switch and LPF circuit board next. Note the positions of the input and output of the board. The output of the LPF circuit board connects directly to the input terminal strip of the PIC SWR pick-up board. Use a short length of RG-58 coax cable.

The input cable is also made of RG-58, but has a BNC connector on the far end. The BNC connector must reach the LPF input on the relay board mounted to the chassis lid. Excess cable is stuffed inside the box when the lid is closed, so do not make this cable any longer than necessary. A length of 10 inches is about right. Once all the connections are wired, firmly bolt the LPF to the bottom of the chassis using $^{1}/_{4}$ inch metal standoffs.

The control board is wired into the chassis after the LPF is installed. Orient the board near its final position. Trim and strip the wires that will solder to the board, then solder the wires into place before mounting the board with screws. A three pin cable comes from the PIC SWR board and a four wire cable goes to a connector that will plug into the relay board. A coaxial cable made with RG-174 also goes to the relay board.

Preassembly for Testing

The amplifier and relay boards on the top half of the box (Figure 7) are connected to the boards on the bottom half of the box (Figure 8) through four cables—a small coax cable and four wire cable to the control board, a larger coax cable from the LPF board and the power cable. In constructing the SuperPacker, these four cables should be kept as short as possible. Make the small coax cable and four wire control cable just long enough to lay the top half of the box along the right side of the bottom half. Cut the other two cables just long enough to assemble the two halves of the case together. You might want to make extension cables for testing. The power extension cable is made from heavy gauge wire and four Power Pole connectors. The RF extension cables are best made using a length of RG-58 cable with a male BNC connector on each end. Use a double female BNC connector (barrel connector) to convert the double male cable into an extension cable.

Adjusting and Testing the Unit

Careful adjustment and testing can save you a lot of grief in the long run, so plan to spend some time making sure everything is just right. In fact, it will probably pay off to spend some time checking all the connections and looking to see that transistors, diodes and resistors are all oriented properly in the printed circuit boards. Use an ohmmeter to confirm that the polarity of the power connections are correct from the power supply all the way to the circuit boards.

The power amplifier board has one potentiometer that adjusts the idling current of the amplifier transistors. We recommend an idle current of 240 to 300 mA.

Remove the fuse from the control board so power to the SuperPacker energizes only the amplifier circuit board. Place a digital ammeter or multimeter in line with your power supply. It must be able to accurately read 350 mA (0.35 A). Follow the directions that come with the amplifier circuit board.

Check out the TR switch operation next. Remove the 25 A circuit breaker and put the control board fuse back in place. Power up the SuperPacker and connect your transceiver to the input (BNC) connector. Connect the output of the SuperPacker to a dummy load. The dummy load only needs to tolerate 5 W for this test. Transmit a signal and listen for the antenna relays to switch. Convince yourself that the relays switch on with the start of speech and off again a moment after you stop talking. If you are unsure about the relay sound, try grounding the PTT input—that should also switch the relays.

Now we will verify the LPF switching and wiring. Leave the transceiver in receive mode and connect an antenna to the SuperPacker. Listen on 40 meters. Tune in a station, if possible. Switch the band switch on the SuperPacker to 40 meters, then to 80 meters. The signals received on 40 meters should be attenuated when the SuperPacker is set to 80 meters or 160 meters. Try each band, and verify that when the SuperPacker band switch matches your transceiver band, there is little or no noticeable loss of signal strength. When the SuperPacker is set to any band below the transceiver's frequency, there should be an appreciable loss of signal. These tests help verify the LPF board is working properly.

If you want to test the LPF board more completely, disconnect the LPF board from the Relay board. Connect a 100 W rig to the LPF board; if your rig does not have a

Figure 9—Amplifier rear panel.

built-in SWR meter, place one between the rig and the LPF board. Connect the output connector of the SuperPacker to a 50 Ω dummy load. Using between 20 and 50 W, check the SWR reading on each band. A high SWR on any band indicates a problem with that section of the LPF. The most common fault is not energizing the relays for a given band.

The PIC SWR may be calibrated using the same test arrangement that was used for the LPF. Refer to the original PIC SWR meter article for the calibration steps.

The PIC SWR meter is a digital circuit that generates its own high frequency signals. Sometimes these spurious signals can be heard in the transceiver connected to the SuperPacker. Check for a "birdie" at 7.250 MHz. If you can detect the signal, try reducing it by moving the wires that come off the main board of the PIC SWR meter. If the noise is strong, make sure you wrapped the leads around a ferrite core (see above), and then try adding a ground wire from the PIC SWR board to the LPF board or control board. We were able to reduce the birdie to near the background noise level.

Final Assembly and Operation

The top section connects to the bottom section with two coaxial cables, the power cable, and one four wire control cable. Make sure none of these wires gets trapped or crimped as you gently lower the top of the box into place. Make sure the LED doesn't interfere with the coaxial connector just above it. Install the four case screws. That's it—you're ready for operation!

Connect the amplifier input to your QRP rig, the output to a suitable dummy load and the power to a 12 V supply capable of at least 20 A. Select your favorite band both on the QRP rig and on the SuperPacker band switch. Switch the HI/LO POWER switch to HI. The SWR display will indicate LP (power too low for a reading) until you transmit. Try transmitting a carrier. The amplifier should switch from receive to transmit automatically. If all is well, the digital display will indicate an SWR reading close to 1.0 (assuming a good 50 Ω dummy load). If you have a power meter in line with the dummy load, it should read between 80 and 110 W when the drive is maximum.

Switch the amplifier to LO and transmit again. The red LED should turn off (the green LED will turn on, if you have one installed) and the output power will drop to 10 or 20 W. Check every band on high power to make sure the amplifier is working properly. You can safely test the automatic power cutback circuitry using an antenna tuner and dummy load as described earlier. When the SWR is above 4:1, the red LED will turn off and power will drop until six seconds after the SWR returns to a safe level. If everything is working properly you are ready to go on the air. The amplifier is almost indestructible. (There is one danger, however. If you drive the amplifier with much over 10 W, you will burn out the power transistors.)

If you use the SuperPacker for contesting or other rapid operations, the carrier operated TR switch can be circumvented with the PTT input. The PTT input operates by shorting it to ground for transmit. Install jumper J1 on the control board to eliminate the VOX delay.

The SuperPacker has a HI/LO POWER switch, but it has no provision to run the transceiver straight through to the antenna (i.e., "barefoot"). Disconnecting the power supply disconnects the antenna, because the LPF is in the signal path during receive and the LPF relays are all de-energized without power. You could wire the LPF between the amplifier board output and the relay board. With the power off, barefoot operation is limited only by the input attenuator. If the input attenuator is placed between the amplifier board input and the relay board, this limitation is also lifted. If you are not using much input attenuation, you might simply connect jumper J1 to a switch. The switch will inhibit carrier-operated TR switching and let you run barefoot. Power must be on to the SuperPacker and the band switch must be set correctly.

At the time of this writing the FCC still bans the manufacture and sale of HF amplifiers for low power radios. Whether or not the ban is lifted, it makes sense to build your own. Now that you have an easy, robust and well-tested project to work from, there is every reason to sharpen those drill bits, warm up the soldering iron and get started!

Notes

[1]Circuit board, power transistors, most other parts, and helpful construction hints for the Motorola AN762 are available from Communication Concepts Inc, 508 Millstone Dr, Beavercreek, OH 45434, tel 937-426-8600, **cci.dayton@pobox.com**.

[2]J. Valdes, WA1GPO, "The FARA HF Project," *QST*, Jun 2003, pp 35-39.

[3]The following SuperPacker parts are available for $48 from FAR Circuits, 18N640 Field Ct, Dundee, IL 60118-9269, tel 847-836-9148 (voice and fax), **www.farcircuits.net**—the FARA low-pass filter board, the control and relay PC boards, the two PIC SWR boards with programmed PIC, crystal, 7445, 7805 and LED display.

[4]B. Kelley, AA4FB, "A PIC SWR Meter," *QST*, Dec 1999, pp 40-43.

[5]See Note 3.

[6]Drill templates, panel drawings and other construction information is available in SuperPacker.ZIP, and the updated *PIC SWR* software code (.ASM and .HEX) is available in PICSWRS.ZIP at **www.arrl.org/files/qst-binaries**.

[7]Amidon Associates Inc, 240 Briggs Ave, Costa Mesa, CA 92626, tel 800-898-1883, **www.amidon-inductive.com**.

[8]S. Ulbing, N4UAU, "Surface Mount Technology—You Can Work With It!" Parts 1 to 4, *QST*, Apr 1999, pp 33-39; May 1999, pp 48-50; Jun 1999, pp 34-36; Jul 1999, pp 38-41.

[9]Matched pairs of 2SC2290 transistors are available through RF Parts Company, 435 S Pacific St, San Marcos, CA, 92078, tel 760-744-0700, **www.rfparts.com**. If you use these transistors select R5-R7 on the control board for 4 to 5 W of drive to the amplifier board. That is, use about 2 to 3 dB less attenuation on the input.

[10]B. Sepulveda, K5LN, "Panel Layout with Microsoft PowerPoint," *QST*, Dec 2002, p 61.

Jonathan Gottleib, WA3WDK, has been a licensed ham since 1973. After taking a 25-year break, he became active in ham radio again in 2001. He operates DX phone at home and loves to take a QRP rig camping or traveling. Over the past few years he has been bitten by the homebrew bug and the SuperPacker was an outgrowth of this newfound love. Jonathan is a practicing lawyer, which he says qualifies him as a test subject to see if the SuperPacker project will be easy to build. You can reach Jonathan at 9317 W Parkhill Dr, Bethesda, MD 20814; **jwg@xebec.cc**.

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