

The PFR-3
Three band "Portable Field Ready" QRP CW Transceiver
40/30/20 meters
Hendricks Kits – www.qrpkits.com
KD1JV Designs

Production manual 6/10/08
Rev B



PFR-3 shown with optional paddle installed.

Specifications:

Bands : 40 meters, 30 meters and 20 meters
Tuning range: Full band coverage
DDS VFO with 50 Hz slow tuning rate and 100 Hz fast tuning rate
Mode: CW only

Receiver MSD: 0.2 uV typical
Selectivity : 300 Hz
Four crystal IF filter and 600 Hz center frequency audio band pass filter

Receive current, no signal typical:
Active, 47 ma
Idle, 34 ma

Transmitter:
5 watts at 12.0 volts, all bands
Transmitter current: 650 ma (40 M) to 750 ma (20 M) typical at 5 watts.
Spurs: - 50 dBc maximum, all bands

5 to 40 wpm internal iambic keyer
Selectable A or B mode
Two (2) 63 character keyer memories.

Coax or balanced line output
Built in BLT (balanced line tuner)

Size: 7.2" wide X 4.2" deep X 1.5" high (less knob height).
Weight: 18 oz, no batteries installed.

Power supply voltage: 8 volts minimum, 12.5 volts maximum. 12 to 9 volts recommend.
External power or internal battery pack

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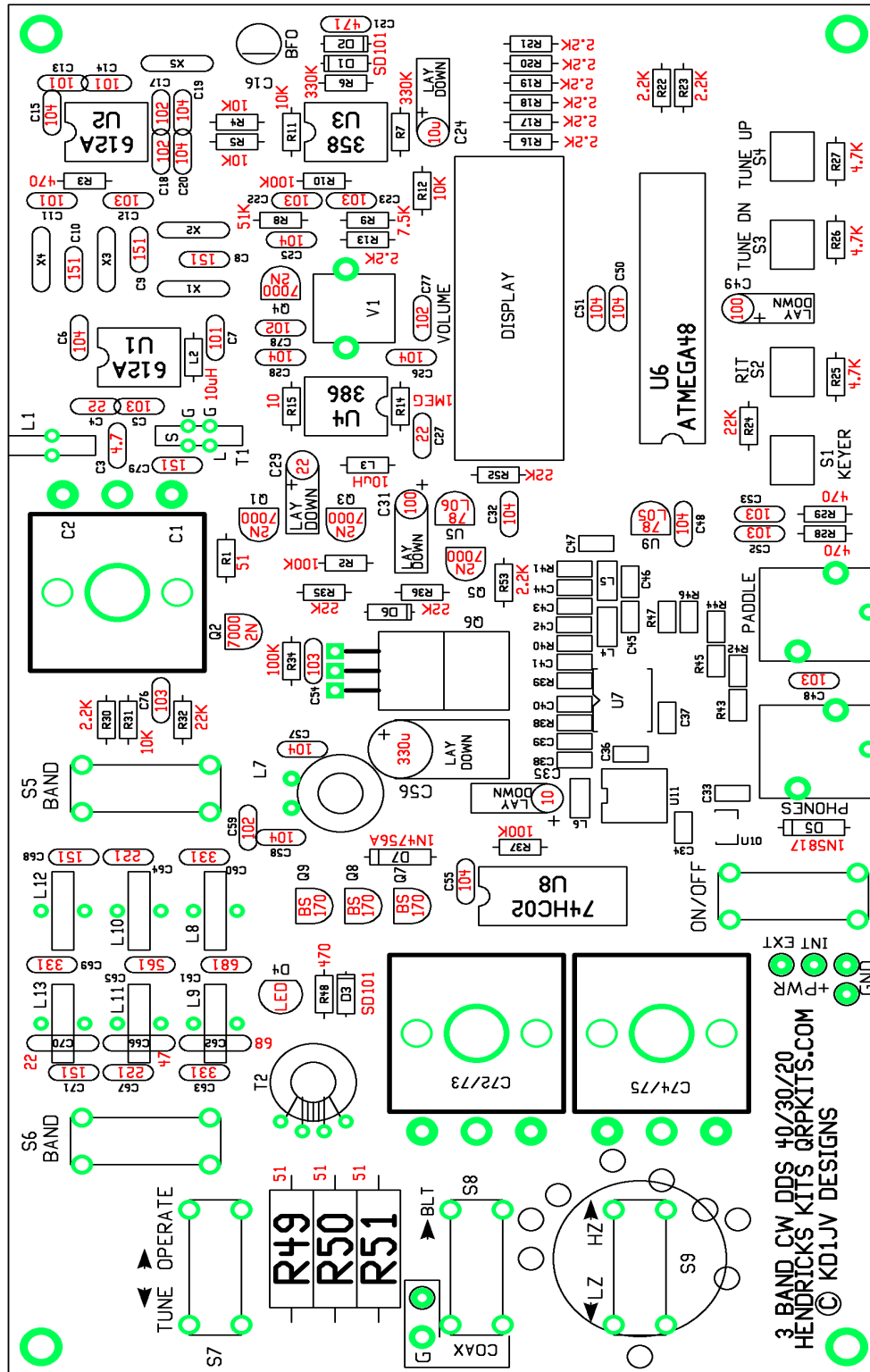
Parts check list:

QTY	VALUE		QTY	VALUE	
1	10 ohms	Brown, black, black, gold	1	4.7 p or 5p NPO	Disk, brown, black dot on top edge
1	51 ohms	Green, brown, black, gold	3	22 p NPO	Disk, brown, black dot on top edge
4	470 ohms	Yellow, Violet, brown, gold	1	47 p C0G	Disk, brown, black dot on top edge
11	2.2 K	Red, red, red, gold	1	68 p NPO	Disk, brown, black dot on top edge
3	4.7 K	Yellow, violet, red, gold	4	100 p C0G	Mono, yellow or NPO disk
1	7.5K	Violet, green, red, gold	6	150 p C0G	Mono, yellow
5	10 K	Brown, black, orange, gold	2	220 p C0G	Mono, yellow
1	51 K	Green, brown, orange, gold	3	330 p C0G	Mono, yellow
5	22 K	Red, red, orange, gold	1	560 p C0G	Mono, yellow
4	100 K	Brown, black, yellow, gold	1	680 p C0G	Mono, yellow
2	330 K	Orange, orange, yellow, gold	1	470 p DISK	Disk, brown
1	1 MEG	Brown, black, green, gold	5	.001 ufd disk	Disk, brown
1	50K audio	Vertical PCB mount	7	0.01 ufd X7R	Mono, yellow
3	51 ohm 2W	Green, brown, black, gold	14	0.1 ufd X7R	Mono, yellow
2	SA612AN	8 pin DIP IC	2	0.01 ufd film	Film, green
1	LM358N	8 pin DIP IC	1	30 p trimmer	Green
1	LM386N	8 pin DIP IC	3	poly-variable	Variable capacitor, dual section
1	74HC02N	14 pin DIP IC	2	10 ufd /16V or 25V	Aluminum electrolytic
1	ATMEGA48	28 pin DIP IC	1	22 ufd /16V or 25V	Aluminum electrolytic
1	78L05	TO-92 plastic	2	100 ufd /16V or 25V	Aluminum electrolytic
1	78L06	TO-92 plastic	1	330 ufd /16V or 25V	Aluminum electrolytic
1	1N5817	Plastic diode shottky rectifier, 1A	4	8 pin DIP sockets	
1	1N4756A	Larger glass diode, 47V 1W zener	1	14 pin DIP socket	
3	SD101C	Glass diode, fast shottky	1	28 pin DIP socket	
1	FQPF7P06	TO-220 plastic P MOSFET	2	FT37-43	Ferrite core, gray or black
5	2N7000	TO-92 plastic N MOSFET	6	T37-2 Red	Powdered iron core
3	BS170	TO-92 plastic N MOSFET	2	T37-6 Yellow	Powdered iron core
1	4 dig LED	4 digit multiplexed display module, hi eff	1	T100-2 Red	Powdered iron core
1	Super bright	LED clear	4	6mmx13mm tack	Push button switch
2	10 uhy rfc	Brown, black, black, gold	6	DP3T slide switch	
5	4.9152 MHz	Crystals HU-49US	2	Stereo jacks	
1	Power jack	2.5 mm pin	4	Knobs	
1	BNC jack		1	Red filter	
2	Binding posts	1 Red, 1 Black	1	PC board	
			3		Sets of vari-cap mounting hardware
4	1/4" 4-40 screw		4	#4 lock washers	
	#30, #28, #24	Magnet wire, #24 hook up wire	6	#4 Nylon washers	

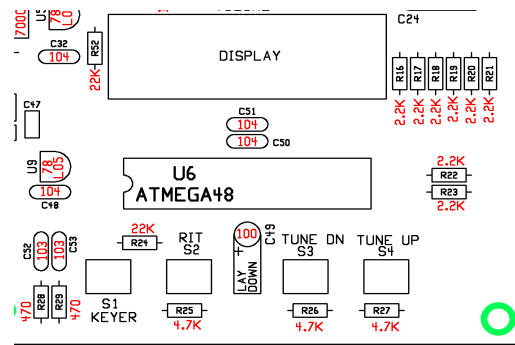
		These parts are premounted			
1	AD9834BRUZ	DDS	3	22 K	0805 chip resistor
1	50.00 MHz clk	Clock oscillator	1	22 p	0805 NPO chip resistor
1	10 uhy	1206 Choke inductor	2	8 p	0805 NPO chip capacitor
2	1.5 uhy	1206 Choke inductor	2	150 p	0805 NPO chip capacitor
1	815C35UA	3.5V low drop out regulator	1	220 p	0805 NPO chip capacitor
3	270 ohm	0805 chip resistor	4	0.01 ufd	0805 X7R chip capacitor
1	3.9 K	0805 chip resistor	3	0.1 ufd	0805 X7R chip capacitor
3	10 K	0805 chip resistor			

Parts placement overview.

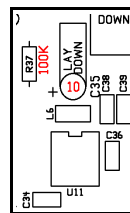
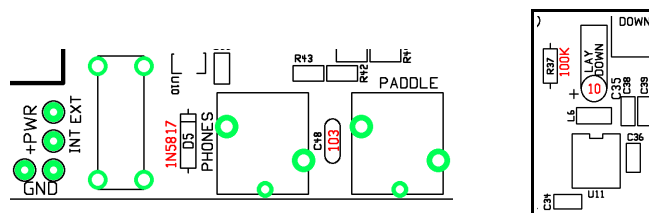
Print this page out for handy reference while building. SMT parts are preassembled.



Group 1 assembly, Microprocessor and display:



- R16 to R23 - 8 places. 2.2K (RED/RED/RED/GLD)
- R24, R52 – 22 K (RED/RED/ORG/GLD) – be careful not to mix up the 2.2 K and 22 K !
- R25 to R27 – 4.7 K (YEL/VOL/RED/GLD)
- R28 and R29, 470 ohms (YEL/VOL/BRN/GLD)
- C32, 48, C50, C51, 0.1 ufd (104, mono, yellow) [note, there is another C48 labeled on the board]
- C52,C53 0.01 ufd (103, mono, yellow)
- C49, 100 ufd / 16V (or 25V) Long lead is plus. Bend leads at right angle to part and lay part flat to board along extended outline. (You will do this with all the other electrolytic caps on the board too)
- U9, 78L05. Do not mix up with the 78L06 or 2N7000 which are in same TO-92 package.
- 28 pin dip socket at U6 When installing sockets, make sure all the pins are sticking out the holes in the board before soldering. If one or more pins happens to fold over under the socket as you insert it, it will be very difficult to remove the socket to fix this once you start soldering pins! Also make sure the notch is facing the right way.
- LED display module. This will only go in one way due to the missing pins on the display and corresponding missing holes on board. Space the display slightly from board so that the pins only stick out 1/32" from bottom of board. Solder two corner pins first, then double check to make sure the display is evenly spaced from the board and not tilted. Re-heating one pin will allow you to make adjustments.
- S1, S2, S3, S4 - Four (4) TACT switches. These have the long red actuators.



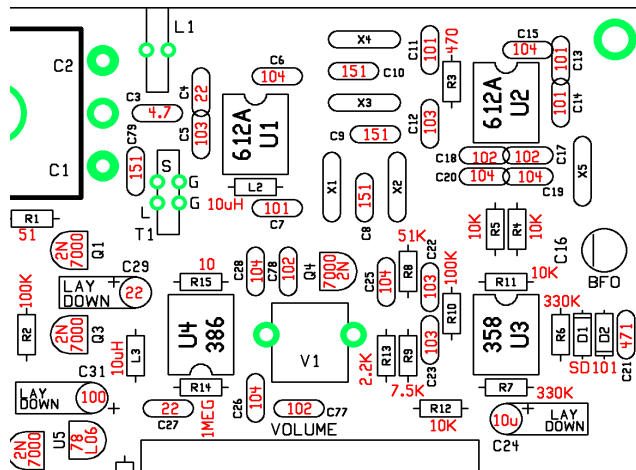
C48 location above SMT parts.

- D5, 1N5817 diode, black body. Band on part goes towards line on part outline.
- C48, 0.01 ufd (103) [C48 designation repeated on board by mistake, this one is located between the phone jacks and is labeled as C30 on schematic]
- Paddle and phone jacks.
- DP3T slide switch. (ON/OFF) – make sure switch is flush to board before soldering more than one mounting tab.
- C35, 10 ufd / 16V (or 25V) Again, long lead is plus and lay down part flat to board. Located above SMT parts, next to the R37 location.

Group 1 smoke test:

- Install the ATMEGA48 microprocessor chip into the U6 socket.
- Connect a 9 to 12 volt power supply to the power input pads next to the on/off switch. A 9 volt radio battery would be adequate for this test.
- Apply power to the board and turn on power switch if it is not already on.
- The LED display should light up with four "8"s for a second. This is the display test. Then the display should display "40" for another couple of seconds (indicating the band), then 030.0 (this is the frequency)
- Clicking closed the Tune UP or Tune DN switches should make the display increment or decrement.
- Clicking the RIT switch should make the left most decimal point on the display light up.
- The DDS chip should also be working at this point. This can be tested with a frequency counter connected to the R39/R41 junction at U7 or general coverage receiver tuned to about 2.115 MHz (+/- 1 kHz) with a short pick up lead for an antenna placed near the DDS chip (U7)

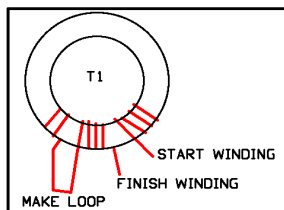
Group 2 Assembly, receiver section:



R15	10 ohm	BRN/BLK/BLK		C3	4.7 p or 5p	NPO, DISK	BROWN
R1	51 ohm	GRN/BRN/BLK		C4,C27	22 p	NPO, DISK	BROWN
R3	470 ohm	YEL/VOL/BRN		C7,11,13,14	100 p (101)	C0G	YELLOW
R13	2.2 K	RED/RED/RED		C8,9,10,79	150 p (151)	NPO, DISK	BROWN
R9	7.5 K	VOL/GRN/RED		C21	470 p (471)	DISK	BROWN
R4,R5,R11,R12	10 K	BRN/BLK/ORG		C17,18,77,78	.001 u (102)	DISK	BROWN
R8	51 K	GRN/BRN/ORG		C22, C23	0.01 u (103)	FILM	GREEN
				C5, C12	0.01 u (103)	MONO	YELLOW
R10	100 K	BRN/BLK/YEL		C6,15,19,20	0.1 u (104)	MONO	YELLOW
R6,R7	330 K	ORG/ORG/YEL		C25,26,28	0.1 u (104)	MONO	YELLOW
R14	1 MEG	BRN/BLK/GRN		C24	10 u/16V or 25V	LAY FLAT	ELECTRO
L2,3	10 uHy	BRN/BLK/BLK/GLD		C29	22 u/16V or 25V	LAY FLAT	ELECTRO
				C31	100 u /16V or 25V	LAY FLAT	ELECTRO
D1,2	Glass diode	SD101					
U5	6V reg	78L06		Q1,2,3,4	2N7000	MOSFET	

NOTE: L2/L3 look like resistors, but the body is a little shorter and fatter. Do not mix up with 10 ohm resistor. Also, be careful not to mix up 51 ohm resistor with 1 MEG, as colors are very similar.

X1,2,3,4,5	Crystals	Tack solder case to solder pads next to crystal case. Running fine grit file along edge of crystal case will make the solder easier to stick.	
C16	30 p trimmer (Green)	Make sure flat side of trimmer faces line on outline. This can be mounted to bottom side of board for easier access once board is wired into cabinet.	
U1,2,3,4	8 pin sockets	Make sure all the pins come through the board holes!	
V1	50 K variable resistor	Solder mounting tabs to board.	
	The following parts	mount on Bottom of board	
C1/2	Poly-varicap	Mounts on bottom of board. Use 2.5 mm washers between board and cap.	
L1	T37-2 (red core)	40 turns, 24" of # 30 wire	
T1	T37-2 (red core)	40 turns (#30) secondary, 5 turns primary see next page for winding details.	



L1 and T1 are mounted on the bottom side of the board!

T1 winding: Wind with # 30 wire. **T1 must be wound in a specific way so that the “hot” end of each winding will end up on the same side of the core and line up with the proper holes in the board.** Wind the core in a counter clockwise direction, passing the wire down into the hole from the top side of the core as you hold it. At the end of 40 turns, make a short loop and continue winding five (5) more turns. The start and end wire ends will go into the two pads towards the top edge of the board, with the start end going into the pad labeled “S”.

The wire which makes the loop will be sniped to separate the wire and these go into the two holes towards the center of the board. It is important to get the windings in the proper holes or the receiver sensitivity will be poor.

Group 2 smoke test:

Install U1 and U2 (SA612A) into sockets

Install U3, LM358

Install U4, LM386 **NOTE : U4 pin 1 faces “down”, the opposite direction of U1, U2 and U3**

The receiver section is now done and should now be functional. Give the BFO trimmer (C16) about a ¼ turn from its factory setting. If you look closely in the trimmer hole, you will see an arrow at one end of the screwdriver slot. When the arrow points towards the flat side of the body, it is a maximum capacitance. When it points to the round end opposite the flat end, it is at minimum. Using leads connected to the BNC connector, you can tack these wires across R1 in order to connect up an antenna (make the connections on the bottom of the board). The end of R1 near Q1 is the signal side of the resistor. Apply power to the board and you will be receiving in the 40 meter band. Adjust the Rx tuning cap (C1/2) for best band noise or signal. **The peak should occur near full counterclockwise rotation.** Plugging in a paddle to the paddle jack and then operating the paddle should result in hearing the side tone sending dits and dahs. The MENU function switch annunciations can now also be heard.

DDS frequency calibration and precise BFO setting adjustment:

If you have an accurate frequency counter, the DDS frequency can be calibrated. Without calibration, the operating frequency maybe off as much as +/- 200 or 300 Hz on the 20 meter band and to lesser extent on the lower bands. This is due to variations in the reference clock oscillator for the DDS chip. Calibration is done at 10.000,000 MHz, so it could be possible to zero beat WWV, but it is better left alone if an accurate frequency counter is not available. It is also possible to tweak the IF offset frequency so that it is centered in the passband of the crystal filter. This adjustment is done with the aid of an Oscilloscope, which could be a virtual one running on PC, as all you need to see is audio frequencies. The IF offset adjust mode is also used to set the BFO trimmer to match the side tone of the rig and this can be done by ear.

Entering Calibration modes:

While holding the DOT paddle and MENU switch closed, turn power on to the board. The LED display will read [CAL.r].

Reference frequency calibration:

A frequency counter connected to the TP1 test point near the DDS chip will now read about 10 MHz. Use the Tune up and Tune down switches to adjust the frequency to be exactly 10.000,000 MHz. Once this is done, store by clicking the KEYSER switch. Or you can skip this adjustment by clicking the KEYSER switch. This will store the default values and advance to the offset adjustment

IF offset adjust and BFO trimmer set:

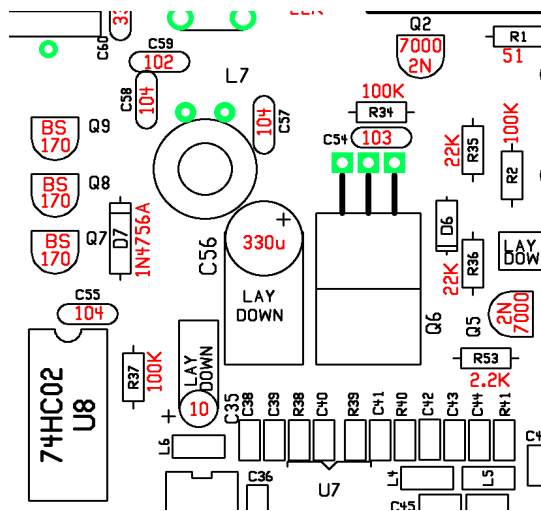
Once the MENU switch has been clicked, the LED display will now read [CAL.o]. Connect an Oscilloscope to Pin 7 of U3. You will see the audio product detector beat note on this pin. If you do not have an Oscilloscope, do not make any adjustments to the IF offset frequency and just go do the BFO adjustment.

Tune through the pass band of the crystal filter using the tuning switches. You will likely see the amplitude of the signal peak a little at the edge of the pass band, just before the amplitude rolls off sharply. Tune to one end of the pass band, the point the amplitude of the signal starts to roll off. Count how many clicks of the tuning switch it takes to get to the other end of the pass band. Divide that number by 2 and tune back up or down depending on which way you went initially by that number of clicks to center the frequency in the pass band of the filter.

BFO adjustment:

Plug headphones into phones jack and you will hear the side tone and BFO beat note. Adjust the volume control until they have about the same volume. Adjust the BFO trimmer until both tones are the same. The tones will wobble when they get close to being equal and seem to merge when they are. This can also be seen on an Oscilloscope. Once you match the tones, store the adjusted IF offset or leave the default values in place by clicking the MENU switch The rig will now reset.

Group 3 assembly: Transmitter section.



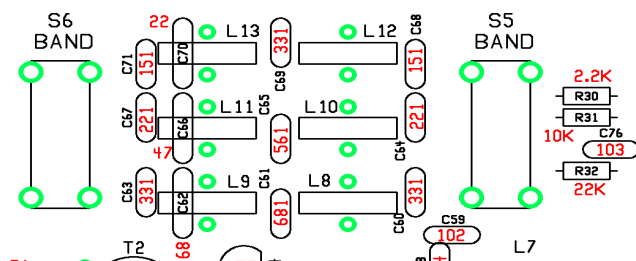
R53	2.2 K	RED/RED/RED
R35, 36	22 K	RED/RED/ORG
R2,R34,R37	100 K	BRN/BLK/YEL
D6	Not used	
D7	1N4756A	Glass diode, large
C54	0.01 ufd (103)	MONO, Yellow
C55, 57, 58	0.1 ufd (104)	MONO, Yellow
C59	.001 ufd (102)	Disk, brown
C56	330 ufd/16V or 25V	Electro lay flat
Q5	2N7000	TO-92
Q7,8,9	BS170	TO-92
Q6	FQPF7P06	TO-220
U8	14 pin socket	74HC02A IC
DO NOT	MOUNT L7 YET	Do pretests first
L7	8 T on FT37-43	8" #28 black core

Pretests:

Before installing L7, we need to make a few tests first.

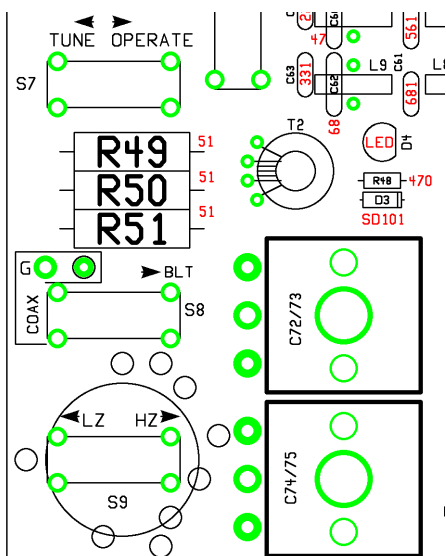
- Make sure R37 is 100K!
- Put rig in straight key mode by applying power with dash paddle closed or use straight key. If using paddle, dot paddle will now key the transmitter.
- Measure the voltage on pins 3 and 11 of U8. They should read about 3.5 volts. If not, check soldering of R37 and check for 5 volts on pin 14.
- Measure the voltage on pins 1 and 13 of U8. They should read 0 volts.
- Key the transmitter and measure the voltage on the L7 pad to the right, next to C57. The voltage should be about the same as the supply voltage to the board. If not, check the connections and proper values of R34, R35 and R36. Also check Q5.
- With the transmitter keyed, check the voltage on pins 1 and 13 of U8 again. These should now read about 2.5 volts. Since these pins now have a square wave at the transmitter frequency on them, exactly how a DVM responds to this signal may depend on the particular DVM used.
- If all these tests are OK, it is now safe to install L7.

Group 4, low pass filters:



R30	2.2 K (RED/RED/RED)	
R31	10 K (BRN/BLK/ORG)	
R32	22 K (RED/RED/ORG)	
C76	0.01 ufd (103, mono)	
C68,C71	150 pfd (151, mono)	
C67,C64	220 pfd (221, mono)	
C69,C63,C60	330 pfd (331, mono)	
C65	560 pfd (561, mono)	
C61	680 pfd (681, mono)	
C62	68 pfd (68, disk)	
C66	47 pfd (47, disk)	
C70	22 pfd (22, disk)	
Low pass filter	Coils mount from bottom	Of board!
L8	17 turns on T37-2	Red core 10" #28
L9	19 turns on T37-2	Red core 10" #28
L10	13 turns on T37-2	Red core 8" #28
L11	15 turns on T37-2	Red core 8" #28
L12	14 turns on T37-6	Yellow core 8" #28
L13	18 turns on T37-6	Yellow core 10" #28
S5, S6	DP3T slide switch	

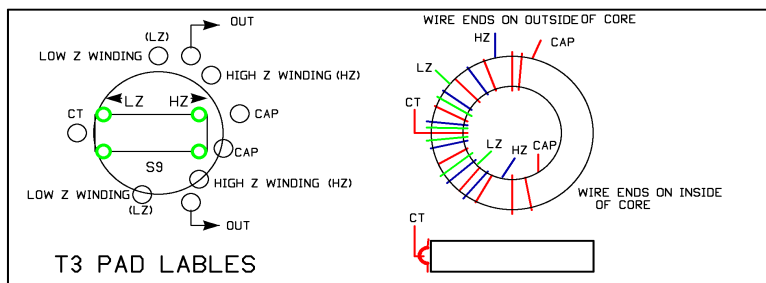
Group 5, SWR bridge and balanced line tuner:



- R48, 147 ohm (YEL/VOL/BRN)
- R49, R50, R51 - 51 ohm, 2 watt (GRN/BRN/BLK)
- D3 – SD101, small glass diode
- D4 – clear LED – Align flat side of LED with flat on part outline. Long lead goes into hole opposite the flat. **Space bottom of LED 5/16" from top of circuit board.**
- S7 – DP3T slide switch
- S8 - DP3T slide switch
- S9 – DP3T slide switch – this mounts above T3. Cut pins flush to board after soldering.
- T2 – Black FT43-37 core. Use # 28 wire and wind 25 turns as secondary and 5 turn primary in middle between ends of the secondary turns. Secondary ends go to into the two outside holes and the primary goes into the two middle holes.
- T3 – **Mounts on bottom of board.** Core is about same diameter as the mounting holes for the wire connections. See below for winding and mounting details.
- C72/73 and C74/75 Poly-variable capacitors. Mount on bottom of board with 2.5 mm washers on screws between board and body of capacitor. These washers space the body of the cap slightly from the bottom of the board. Adjust the trimmers on the bottom of C74/75 to be fully meshed.

Winding T3:

- Cut a 30" (2 1/2 foot) length of the # 24 wire.
- Wind 11 turns on the T100-2 core (this is the large red core)
- Start the winding of the core by passing the starting end of the wire into the hole from the top (side facing you as you hold it) and wind by passing the long end of the wire up from the bottom of the core. Wind the rest of the turns in a counter clock wise direction. Winding the core in this fashion will make the ends of the wire more or less line up with the staggered holes in the board. Try to wind the wire fairly flat to sides of the core.
- Pull the 6th turn slightly away from the middle, outside edge of the core. (this is actually turn 5 1/2)
- Scrape away the insulation on the wire of this 6th turn, just a little near the middle of the core.
- Cut a 2" length of the # 24 wire and tin one end.
- Attach this wire to the 8th turn on the core. Make a small, half loop on the end of the wire and lightly crimp to wire on core, then solder.
- Cut a 18" length of the # 24 wire and wind 6 turns inter-weaved between the first winding and centered around the tap you just made, so there are 3 turns on either side of the tap. It is easiest to start the winding of these turns from the center tap of the first winding.
- Now cut a 8" length of the # 24 wire and wind 1 turns on either side of the tap, for a total of 2 turns. This winding will also be inter-weaved between the other two windings.
- Push the windings together so they are close to each other and not spaced around the core.
- The core is mounted to the bottom of the board and the wires are soldered from the top. Suspend the core slightly off the bottom of the board so that the wires do not touch the ends of the switch mounted above it. In fact, it is a good idea to snip the ends of the switch terminals flush to the board before mounting the coil. Be careful not to put the High Z winding into the pads marked "OUT", as these pads will connect to the binding posts on the cabinet.



This diagram shows how the wire should be wound on the core so the wire ends more or less line up with the mounting holes in the board. The LZ winding is shown with an extra 2 turns.

Final tests:

The board is now complete and the only thing left to test is the transmitter. Connect the BNC jack to the COAX terminals on the board by S9. Now connect a watt meter and dummy load to the jack. Make sure both BAND switches are set to the same band, you might as well start with 40 meters. Set the Tune / Operate switch to the operate position and the COAX / BLT switch to the coax position. Apply power to the board and send some dots. There should be some power output showing on the watt meter. If not, remove power and start looking for missing solder connections, that the insulation on the toroid coils has been soldered through and that both band switches are in the same position. If you see power output, go on and check the other two bands.

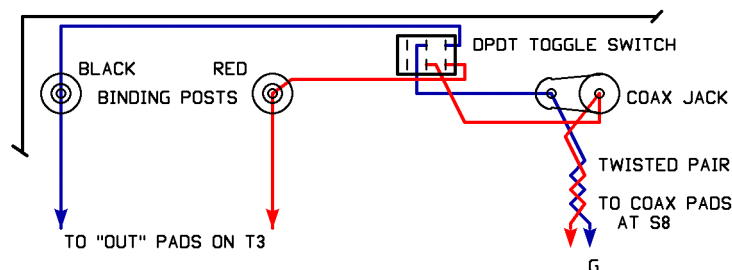
Power output

Power output is influenced by both power supply voltage and the way in which the turns on the transmitter low pass filter coils are spaced around the core. To measure full power output, put the rig in straight key mode or use "Tune" mode. With a 12.0 volt supply, power output should be close to 5 watts on all bands, with the possible exception of 20 meters, which seems to be running more like 4.5 watts on average. If power output is higher than 5 watts, move some of the turns on L8, L10 or L12 (depending on the band) closer together and recheck the power output. Repeat if needed to get close to 5 watts output. If power out is less than 5 watts, try making the spacing of the turns more evenly spaced around the core. If power output is significantly lower (or higher) than it should be, double check the number of turns on the coils. Remember, a turn is each time the wire passes through the center of the core. Having one extra turn is common, as many forget to count the first turn when the wire is initially passed through the center of the core. This can have a significant affect on the power output.

Mounting the board in the cabinet and final wiring:

It is possible to enlarge the holes for the three tuning caps with a step drill so that the knobs are recessed and reduce the overall height of the rig. You will also need to cut down the nylon spacers and screw. If you decide to do this, be careful – you don't want to scratch the paint job on the cabinet!

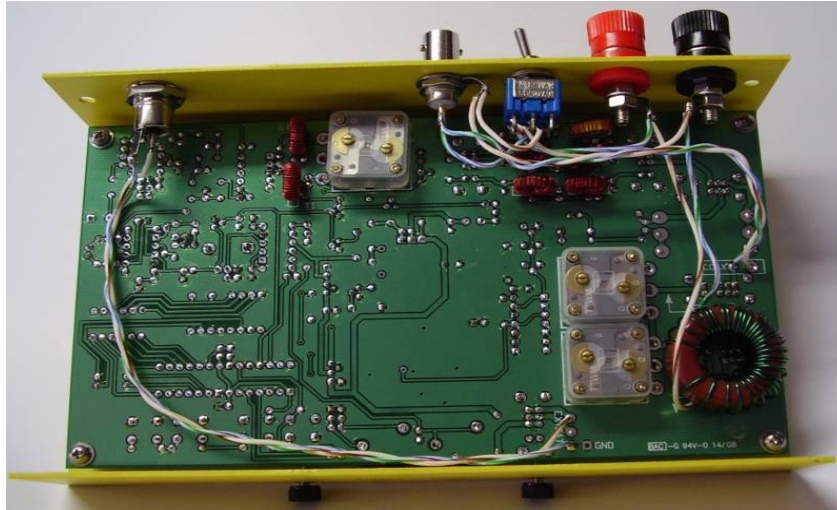
- Solder the end of a 4.5" length of hook up wire to each of the pads labeled "OUT" under T3. These wires attach to the bottom side of the board. Since T3 covers these holes, the solder connections are made from the top of the board.
- Tape the red acetate filter to the inside of the led window.
- Slide the board into the top piece of the cabinet at an angle with the phone jacks at the front of the board down. To ease mounting, place all slide switches to the center position. Be careful not to bend the SWR led.
- Center the phone/paddle jacks in the chassis holes, and secure the board with the 4-40 x 1/4" screws and lock washers.
- Attach the nylon spacers to the tuning caps with the screw and 2.5mm lock washer. A small drop of super glue into the screw hole on the tuning cap will help keep the screw from coming loose. (You may want to wait until you are sure you will not have to remove the board from the cabinet for some reason before gluing the screw in place)
- Push the brass knob extension all the way down onto the volume control and secure the knob with the set screw. (Personally, I prefer not to use a knob on the volume control, KD1JV)
- Place the three knobs on the tuning caps. Set the knob as low as it can go without rubbing against the cabinet
- Mount the two binding posts, DPDT toggle switch, Coax jack and external power jack to the rear of the cabinet.
- Wire up the binding posts, switch and coax jack as shown in the diagram below. The wires going from the coax jack back to the board should be tightly twisted together and take a direct path back to the pads on the circuit board. The red wire between binding post, switch and coax connector is optional.



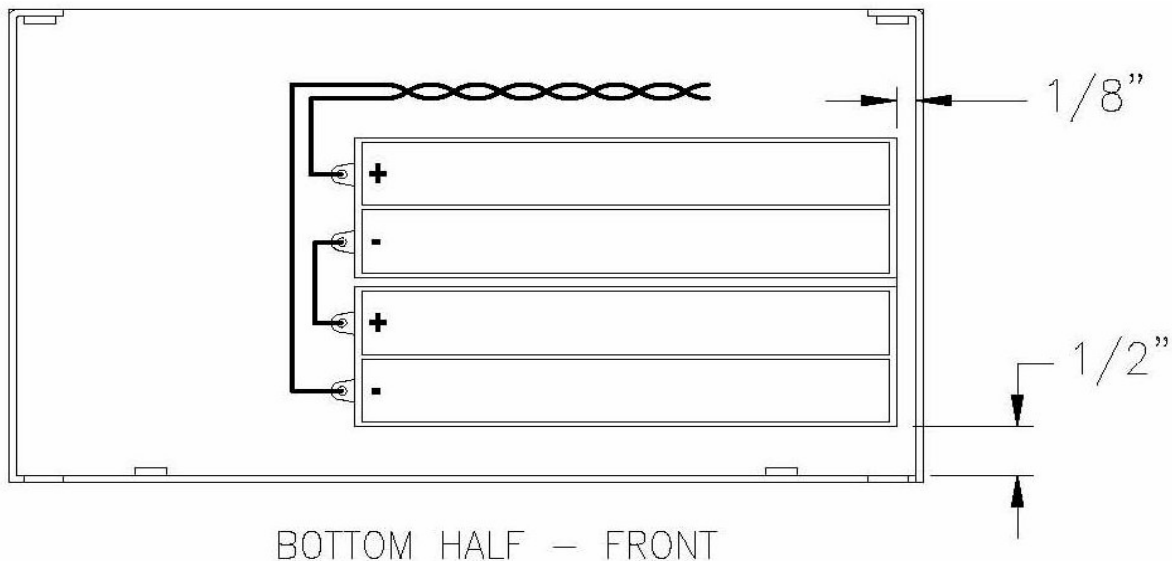
- Twist two 8" lengths of hook up wire together.
- Solder to external power jack
- Solder the other end to the EXT and GND pads next to the On/Off switch
- The wire for connecting to the power jack to the board should be routed along the outside edge of the board.

Once the wiring from the board to the rear panel is completed it is still possible to remove the board from the cabinet but it is a little tricky to do. Remove the mounting screws and gently push the board towards the rear of the case to free the phone jacks from the holes in the front of the case. Then gently angle the board up. When remounting the board, the main problem might be getting the SWR LED to line back up with the hole.

Photo of final panel wiring



Battery holder mounting:



Mount battery holder to bottom of cabinet as shown below. These are attached to the bottom side of the cabinet with double sided tape, which is already attached to the bottom of the holders. Leave a small space between the sides of the battery holders as when the batteries are installed it will billow out the sides a little. Connect wires to the battery holder terminals as shown the diagram below. Be quick about soldering the wires, as the plastic will melt if you leave the iron on too long. Wire the [+] terminal to pad labeled "BAT" next to power switch and the [-] terminal to the pad labeled "GND"

Fuses:

There are no fuses built into the rig but it is a good idea to add one. A fuse could prevent damage to your power supply or even a fire if something should go wrong. For the external supply, use a power cord with an in-line fuse holder and use a 1.5 or 2 amp fuse. Adding a fuse to the battery pack is a bit more of a problem. A 2AG sized fuse holder could be added to the bottom half of the cabinet just above the battery pack and located so it sits between the power jack and receiver input coils.

Operation:

Power supply:

The PFR-3 rig should be powered by no more than about 12 volts and no less than 8 volts. Maximum supply current at full transmitter output is typically less than 800 ma. **If a 13.8 volt bench supply is used to power the rig, two silicon rectifier diodes should be added in series with the positive supply lead to drop the voltage down closer to 12 volts.** This will ensure the rig does not put out more than about 5 watts. 5 watt output at 12 volts was chosen as this is the typical voltage a gel-cell battery settles down to after it has been removed from its charger. Below 8 volts, the 6 volt regulator for the receiver will start to lose regulation. Since transmit power output is dependent on supply voltage, a variable supply is a handy way to adjust the power output level. At the minimum supply voltage of 8 volts, the transmitter will deliver about 2 watts output. Transmitter current will also be reduced at lower supply voltages, extending battery life.

Power switch:

The power switch has three positions. OFF, Internal (battery) power and External power.

When the rig is first turned on, the display will show all "8"s for a second. This is the segment display test. Then the display will indicate the currently selected band, "20", "30" or "40". The band numbers will be displayed for a couple of seconds, then the display will change to show the operating frequency. Since only four digits are available, only the 100 kHz to 100 Hz digits are displayed. MHz digits are implied by the currently selected band. The initial operating frequencies loaded when the rig is powered on or the band is changed are 7.030,000 MHz for 40 meters, 10.110,000 MHz for 30 meters and 14.060,000 MHz for 20 meters.

Power save mode:

After about 5 minutes of no switch activity the rig will go into a power save mode by blanking the display and the processor is put to sleep. The decimal point will stay on to indicate that the rig still has power applied. This will reduce the supply current from about 47 ma to 34 ma. Not a huge current savings, but if the rig is being run on batteries every ma counts. The rig will "wake up" if any switch (other than Band) or the paddle is used.

Selecting operating band:

Two slide switches are used to select the operating band. **Both switches MUST be in the same band position for proper operation.** The band switch located near the top, center of the cabinet tells the processor which band you want to use and will indicate the selected band on the display for a second when the band is changed or on power up, as noted above. The switch located near the top, left of the cabinet is used to connect the output of the low pass filter to the antenna. If the two band switches are not in sync, there will be no signals in the receiver and the transmitter might be damaged if you transmit at this time. If you change bands and then return to a previously used band, the frequency the rig was tuned to on that band will be restored. This feature could be handy if your jumping between bands in a contest. Operating frequencies are lost when power is turned off and the rig will load the default frequencies again on power up.

After you change bands, you must re-peak the receiver input with the Rx peak control.

Tuning:

Tuning is done with two push button switches. These switches are operated best by "clicking" them to the side, rather than pushing straight down. Tuning steps are in 50 Hz increments. A momentary click of the switch will change the frequency by 50 Hz. Since the display only has 100 Hz resolution, it will take two clicks of the switch to see a change of frequency on the display. Holding one of the tuning switches closed for longer than about one (1) second will start an auto tune mode, where the frequency will change in 100 Hz steps at a rate of about 10 steps per second, so long as the switch is held closed. When the switch is released, normal 50 Hz "one click" tuning is restored.

Note: If you are in the fast tuning mode and quickly change tuning directions, the tuning may continue the direction that it was in. This is because there is a slight delay between releasing the switch and the processor detecting that a different switch has been closed.

Tuning limits:

Tuning is restricted to be within the currently selected ham band. This is to prevent out of band transmission. Full band coverage is available. 7.000,000 to 7.300,000 on 40, 10.100,000 to 10.150,000 on 30 and 14.000,000 to 14.350,000 on 20. Even though you can tune into the phone band, SSB signals will not be intelligible due to narrow CW filter.

RIT (receiver incremental tuning)

Clicking the RIT switch will activate RIT. The left most decimal point on the display will light when you are in RIT mode. When in RIT mode, the receive frequency is changed by the tuning switches and the transmit frequency stays where it was when RIT was activated. Clicking the RIT switch again will exit RIT mode and restore the original receive frequency. If RIT is on when the band is changed RIT will be automatically turned off.

DFE mode (direct frequency entry)

This mode allows you to go directly to a specific frequency by entering it in with the paddle. Clicking and holding closed the RIT switch for longer than one (1) second will activate this mode. The display will change to display [- - -] when DFE mode is enabled. Enter the frequency you wish to go to, starting with the 100 kHz digit and finishing with the 100 Hz digit. As each digit is entered, it will be shown on the display and shift from right to left as additional digits are entered. If a number is not recognized, a “?” will be sent by the side tone. Once the 100 Hz digit is entered, the rig will re-tune to that frequency provided it is within the normal tuning limits of the current band. If it is outside the band, the frequency at which the rig was tuned to when DFE was enabled will be restored and DFE mode exited. If you make a mistake or wish to exit the DFE mode at anytime before the 100 Hz digit is entered, you can escape by clicking any of the switches.

Note: DFE mode is not available in straight key mode or if RIT is on.

MENU switch (Keyer functions) :

The MENU switch is used to access various keyer functions. Which function is selected is determined by how long the switch is held closed. Keyer functions are selected in this order: send message, change keyer speed, TUNE mode, enter messages and select iambic A or B mode of operation. **Note: When in straight key mode, none of the MENU switch functions are available, with the exception of sending keyer message 1, assuming a message is already stored in that location.**

Sending a Message:

Two, 63 character (including word spaces) Morse messages can be stored in memory. One of these messages can be sent by first clicking and releasing the KEYSER switch and then tapping the DOT paddle to send message one, or tapping the DASH paddle to send message two. This must be done within 1 second of releasing the switch or the change code speed mode will be activated. Once a message has started sending, it can be terminated by closing the DOT paddle. If a character is being sent at the time of dot or dash closure, it must be held closed until that character has finished being sent.

When in straight key mode, only message 1 is available, as the DASH input is always grounded by the straight key plug.

Changing keyer code speed:

If sending a message has not been selected using the paddle after clicking and releasing the MENU switch, speed change mode will be activated. The current code speed is shown on the display as [C xx], where xx is the current speed. Keyer speed is changed by closing either the DOT paddle to increase speed or closing the DASH paddle to decrease speed. The selected speed is shown on the display. Once the desired speed is indicated on the display, release the paddle and wait about two (2) seconds and speed select mode is automatically exited.

Tune Mode:

This mode is used if you have an automatic antenna tuner which needs to see a steady carrier for a few seconds to operate. For manual tuners, it is easier and less stressful on the PA to simply send a string of dots as you fiddle with the tuner.

To enable **tune mode**, click and hold close the MENU switch until the letter “T” is annunciated by the side tone and release the switch. When you then release the MENU switch, the display will blank and a character which resembles a lower case “t” will appear on the left most digit. The transmitter can now be keyed by closing and holding closed either the dot or dash paddle. When you wish to return the rig to normal operation, click any of the switches.

Storing a message:

Holding closed the MENU switch for four (4) seconds will activate the message entry mode. Release the switch when the letter “M” is annunciated by the side tone, which occurs after the tune mode letter “T” has been annunciated. The receiver is then muted and you can now start to enter your message by using the paddle. If you accidentally activate this mode and do not wish to enter a message, click the MENU switch to abort before touching the paddle. The Letter “X” will be annunciated and the rig will go back to normal operation. There is no visual indication that message entry mode is active.

Up to 63 characters (including word spaces) may be entered. If you exceed this limit, the letters “EM” will be annunciated by the side tone and you will have to start again. Note that “ideal” letter and word timing is used to determine letter element

groups and word groups. Of these two, the letter timing is most critical. If do not pause long enough before starting a new letter, a letter space will not be detected. If you pause too long, it will be interpreted as a word space. It may take some practice to enter a message correctly. I ensure a word space is inserted, it is best to pause somewhat longer than you normally would between word letter groups.

When you have finished entering the message, click the MENU switch. The message you have entered will be sent by the side tone so you can check the accuracy of the message. If it sounds good, store it by closing either the DOT or DASH paddle. DOT will store it into message location 1 and DASH into location 2. If you wish to redo the message, click the KEYSER switch again. "EM" will be annunciated by the side tone and you can now re-enter the message.

Selecting Iambic A or B modes.

Iambic A mode is the default keyer mode. To switch to B mode or back to A mode, hold the MENU switch closed for about four (4) seconds until the letter A or b appears on the display (b looks like a 6 on the display) then release the switch. The letter which appears on the display will be the mode the keyer will be set to when you release the switch. The Morse letter "A" or "B" is also annunciated by the side tone.

The difference between A and B modes:

In A mode, if both paddles are closed at the same time, alternating code elements are sent. If you close the dash paddle first and then hold both the dash and dot paddle closed, the keyer will send dah-dit-dah-dit-dah so long as the paddles are held closed. When the paddles are released, the keyer will simply stop sending at the end of the code element which might be being sent at the time the paddles are released, if any.

In B mode, alternating code elements are also sent when both paddles are closed, but this time an extra and opposite code element will be tacked on the end of the string when the paddles are released. Therefore, to send a letter such as "K", you just have to close the dash paddle first, then close the dot paddle and release both paddles when the dot starts to be sent. dah-dit-dah will be automatically sent. In A mode to send this same letter you would have to keep the dash paddle closed until the second dash has started to be sent before releasing the paddles.

In B mode, the "both paddles closed" condition is sensed at the end of the inter-element space. Therefore, to insert an extra element, both paddles need to be held closed at least until the next to last element you want to send is has started. If the "both paddles closed" condition is sensed any earlier, it is nearly impossible to send a simple letter such as an "A" or "N" and not have a "R" or "K" be sent instead. Even so, it is easy to accidentally add an extra element if your not quick to release the paddles which makes B mode a bit difficult to get the hang of with out a lot of practice, especially at higher code speeds.

Both A and B modes have dot and dash memory while an element is being sent. So, if you tap the dot paddle while a dash is being sent, the dot will be sent after the dash is finished and vice-a-versa.

Straight key mode:

If a monaural plug is in the paddle jack at power up (the sleeve grounds the dash input pin), the rig will power up in straight key mode. This allows using either a straight key or external keyer. While in straight key mode, none of the keyer switch functions will be available. If a message has been previously stored in the keyer memories, only memory location 1 will be available, (tap the straight key closed with in 1 second of clicking the keyer switch) as this is selected with the dot input pin, now controlled by the straight key.

Using the SWR bridge and BLT tuner:

Note that S7, S8 and S9 are three position switches but only two positions are used. The two positions to the left are the same.

TUNE / OPRT SWITCH:

Sliding S7 to the TUNE position switches in the SWR bridge. The LED will now indicate the relative amount of SWR. The brighter the LED, the higher the SWR is. When the LED is not lit or is very dim indicates 1:1 SWR.

COAX / BLT SWITCH

S8 is used to switch between a direct coax connection to the BNC jack or the BLT (balanced line tuner). The Coax position is of course used if you are using a resonate, coax feed antenna or an external tuner. The BLT position is used when the built in tuner is desired and is normally used with ladder line feed antennas, but can also be used for end feed antennas or possibly matching coax feed antennas which need a little tweaking.

Using the BLT:

Note: The handle of the switch on the rear panel should be slanted towards the coax jack when using either a balanced line on the binding posts or just a coax feed antenna.

Before transmitting, adjust the TUNE and LOAD capacitors for best band noise or signal strength. Now switch from Operate to Tune mode with S7. Now transmit a string of dits or dahs and fine tune the TUNE and LOAD capacitors so that the SWR LED gets very dim. This of course, is easier said than done. The tuning is very sharp and if you tune too fast you will never see the LED get dim. A further complication is the Load and Tune controls are interactive.

First slowly adjust the LOAD until you see even the slightest dimming of the LED. Now adjust the TUNE and see if you can make it even dimmer. Go back to LOAD and see if this will dim the LED farther. If no farther improvement can be made, advance the TUNE slightly (try clockwise first) which will make the LED brighter again, then try the LOAD. Working back and forth a few time between the Tune and Load controls should enable you to make the LED become very dim or go out completely. In most cases when using a ladder line feed antenna, you will use the HI-Z setting of the BLT. In some cases, you may only be able to find a match using the Low-Z setting.

Once you find the match, you might want to mark the positions of the controls on the panel using some stick on dots. This will speed up retuning after switching bands.

Using the BLT with end feed wire antennas or coax.

Switching the handle of the rear panel switch so it faces the binding posts will ground the black balanced line binding post and connect the Red post to the coax jack. End feed wire antennas can now be connected to the Red binding post and a counter pose to the Black post. Use the High Z position of S9 if the wire is near a 1/2 wave in length. Use the Low Z position if the wire is near a 1/4 wave or less in length. The Low Z position is also used when using the BLT to match a coax feed antenna.

Using a speaker instead of headphones:

The amount of current the audio amplifier can deliver to a speaker is limited by the current available from the 78L06 regulator. A small, efficient speaker at low or modest volume should be alright. However, it would be a good idea to use an amplified speaker such as those used for PC sound, as this would keep the load on the PFR audio amplifier to a minimum.

Also, since the PFR does not have AGC, be careful when using in-the-ear "ear bud" type headphones. Turn the volume control down when tuning across the band so that if you run across a strong station, it does not blow your ears off!

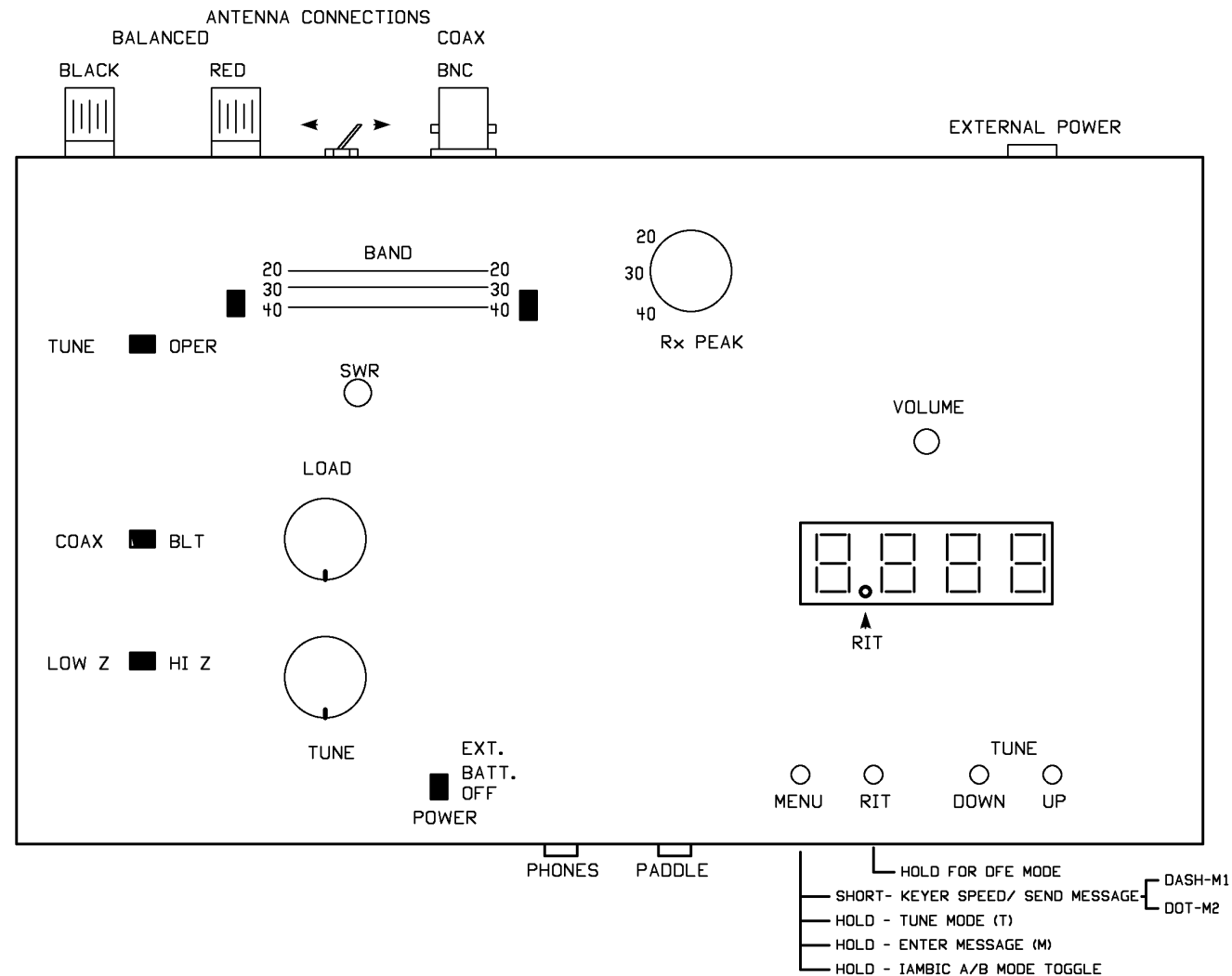
Paddle wiring:

The paddle jack uses "standard" wiring:

Tip is Dot
Ring is Dash
Sleeve is ground

There is no paddle sense reverse built into the firmware.

PFR front panel controls and rear panel connectors.



Troubleshooting:

With careful assembly, your PRF-3 kit should work right off. Unfortunately, this is not always the case and some troubleshooting will be required. This job goes a lot quicker if you have a signal generator, Oscilloscope and frequency counter, but alas, most of you will only have a DVM to work with.

The most common reason a kit does not work is because of assembly errors, the most common being soldering issues. Soldering issues include missing solder connections, solder shorts between pads which are not connected together, not using enough heat in places so solder only sticks to a component lead and does not flow into the solder pad and not properly tinning magnet wire leads so there is no continuity through a coil. Less common but still something to look for is miss-placed parts. It is often easy to miss-read the color codes on resistors, especially those with similar colors, but in a different order.

The above problems can often be found with a simple but careful visual inspection of the board. It does help to have an idea of which general area the problem maybe in as to narrow down the search.

Bad parts:

All new, prime parts are supplied with the kit. It is very, very unlikely any were bad prior to installation. Unless the part was physically damaged during assembly, it is safe to assume the part is good. However, some parts, in particular, the 2N7000 and BS170 MOSFETs can be damaged by static while handling and soldering. Some of the ICs can be damaged if they are installed backwards in the socket and power applied. However, since the regulators which supply voltage to the ICs have limited current capability and have over current shut down, it is quite likely the IC will survive being installed backwards.

Troubleshooting steps: Divide and conquer

The best way to find out what doesn't work is to first find out what does work. The first step is to make sure proper power supply voltages are present. If the output of a regulator is lower than it should be and/or the package is getting hot, something is dragging the output down. This could be caused by one of the aluminum electrolytic capacitors being installed backwards, a solder short or an IC plugged in up side down.

The next step is to check the voltages on the IC pins. If one or more of these voltages are off significantly, it may not mean the IC is bad, but something is affecting the voltage on that pin. Before asking for a replacement part, check the parts connected to those pins and of course, the soldering in that area.

If you still have a problem, its time to start tracing the signal paths. For the receiver, it is easiest the start with the output and work towards the input. For the transmitter, start at the input and work towards the output.

Group 1, the processor and display:

There is very little go wrong here. If the processor is getting it's +5 supply, it should work. Although there could be problems with things connected to the various input and output pins which will affect it's operation. If there is a missing segment or digit on the display, it is likely there is a missing solder connection or short. The same is true if a paddle or the switches don't work or there is a "stuck switch" problem.

Group 2, the receiver:

The audio stages are very easy to test. You should hear some "hiss" when the volume control is turned all the way up and you should hear the side tone when using the paddles. You should be able to hear 60 cycle hum if you touch pins 4 and 5 of U2 with your fingers. If you hear the side tone but not any hiss or hum which touching pins 4 and 5 of U2, the mute switch Q4 might be shorted out. If the voltages on pins 3 and 5 of U3 are not correct, C24 might be in backwards or the R7 and R12 values interchanged.

The crystal filter and U2 product detector/ BFO oscillator is tested when using the DDS offset calibration mode. There is little to go wrong here other than soldering problems.

Still no luck getting the rig to work?

We will try to first help you via email. Sometimes we can nail the problem right off, but often it can be of no real help. We can't look over your shoulder to see whats going on and we're not psychic! Often, we can't do much more than repeat what has already been said in the above troubleshooting guide. To be of help we need as much information as possible about the problem. Simply saying that it does not work is of little use.

If all else fails, a repair service is available for a flat \$35.00 fee. If you want the rig to be insured on return shipping, add another \$5.00. DX stations will also have to add extra funds to cover air mail postage. It would be helpful if a short note explaining what kind of problem your having is included. We will try to repair and return the rig as quickly as possible, but it could take a few weeks in some cases, depending on other work loads from the day job.

Send the rig with a check or MO for the repair fee to:

Steven Weber, KD1JV
Steve's Electronics
633 Champlain St
Berlin, NH 03570

IC pin voltage charts: Small deviations from listed voltages acceptable due to DVM and voltage regulator tolerances

IC U1, U2 SA612 mixer

Pin 1	1.4 V	IN
Pin 2	1.4 V	IN
Pin 3	0 V	GND
Pin 4	3.8 V	OUT
Pin 5	3.8 V	OUT
Pin 6	5.9 V	OSC
Pin 7	5.4 V	OSC
Pin 8	6.0 V	V+

IC U3 LM358 op amp

Pin 1	3.0 V	OUT
Pin 2	3.0 V	- IN
Pin 3	3.0 V	+ IN
Pin 4	0 V	GND
Pin 5	3.0 V	+ IN
Pin 6	3.0 V	- IN
Pin 7	3.0 V	OUT
Pin 8	6.0 V	V+

IC U4 LM386 audio amp

Pin 1	1.25 V	feedback
Pin 2	0 V	- IN
Pin 3	0 V	+ IN
Pin 4	0 V	GND
Pin 5	2.9 V	OUT
Pin 6	6.0 V	V+
Pin 7	3.0 V	Bypass
Pin 8	1.25 V	feedback

Note: LED display driver pin voltage vary with digits displayed so typical voltages not shown

IC U6 MEGA 48 MPU processor

	Rx	Tx	Pin function
Pin 1	5.0 V	5.0V	reset
Pin 2	5.0 V	5.0 V	DDS CLK
Pin 3	5.0 V	5.0 V	DDS EN
Pin 4	5.0 V	0 V	Paddle DOT in
Pin 5	5.0 V	0 V	Paddle DASH in
Pin 6	-----	-----	Digit 3
Pin 7	5.0 V	5.0 V	Vcc
Pin 8	0 V	0 V	GND
Pin 9	-----	-----	Decimal point
Pin 10	-----	-----	"d" segment
Pin 11	-----	-----	Digit 1
Pin 12	-----	-----	Digit 2
Pin 13	-----	-----	Digit 4
Pin 14	-----	-----	"e" segment
Pin 15	-----	-----	"f" segment
Pin 16	-----	-----	"b" segment
Pin 17	-----	-----	"g" segment
Pin 18	-----	-----	"a" segment
Pin 19	-----	-----	"e" segment
Pin 20	5.0 V	5.0 V	AVcc
Pin 21	5.0 V	5.0 V	Aref
Pin 22	0 V	0 V	GND
Pin 23	5.0 V	5.0 V	A/D switch input
Pin 24	2.5/1.5/.22	Same	A/D Band input
Pin 25	0 V	5.0 V	MUTE out
Pin 26	0 or 5 V	2.5 V	Side tone out
Pin 27	0 V	5.0 V	Tx enable
Pin 28	5 or 0 V	5 or 0 V	DDS Data

IC U8 74HC02 NOR GATE

	Rx	Tx	
Pin 1	0 V	5V square wave	out
Pin 2	0 V	0 V	in
Pin 3	3.5V	3.5V square wave	in
Pin 4	5V	5V	out
Pin 5	0V	0V	in
Pin 6	0V	0V	in
Pin 7	0V	0V	GND
Pin 8	0V	0V	in
Pin 9	0V	0V	in
Pin 10	5V	5V	out
Pin 11	3.5V	3.5V square wave	in
Pin 12	0V	0V	in
Pin 13	0V	5V square wave	out
Pin 14	5.0 V	5.0V	Vcc

Pins 1 and 13 will measure about 2.5 volts with DVM when transmitting steady carrier.

Receiver audio



