

PFR-3B Portable Field Radio



Figure 1

Specifications:

Bands : 40 meters, 30 meters and 20 meters
Tuning range: Full band coverage
DDS VFO with 50 Hz slow tuning rate and 200 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:
Display on, 47 ma
Display off, 34 ma

Transmitter:
5 watts at 12.0 volts, all bands +/- 10%
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 B mode iambic keyer
Two (2) 63 character keyer memories.

Coax or balanced line output
Built in SWR indicator and 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

Pacific Antenna
www.qrpkits.com

Manual Revised: February 24, 2016

Assembly notes:

- There is no need to print out the whole assembly manual which would use up a lot of ink. Hopefully you have a laptop or similar you can view these instructions on at the work bench.
- Do print the over all parts placement diagram to use as reference as you build. For experienced builders, that is likely all you'll need for most of the assembly.
- Pre-sorting the resistors and capacitors can speed up the assembly and reduce mistakes.
- Parts will be installed in order of height, starting with resistors. This way taller parts don't get in the way had they been installed first.
- The placement diagrams highlight the parts to be installed. To reduce clutter on the diagram, parts already installed or to be installed at a later step are not shown, with the exception of a few things for reference.
- Parts are numbered on the board starting at the lower right hand corner. Numbers run bottom to top, then right to left across the board.
- Missing or lost parts? Contact QRPKITS.com for replacements.

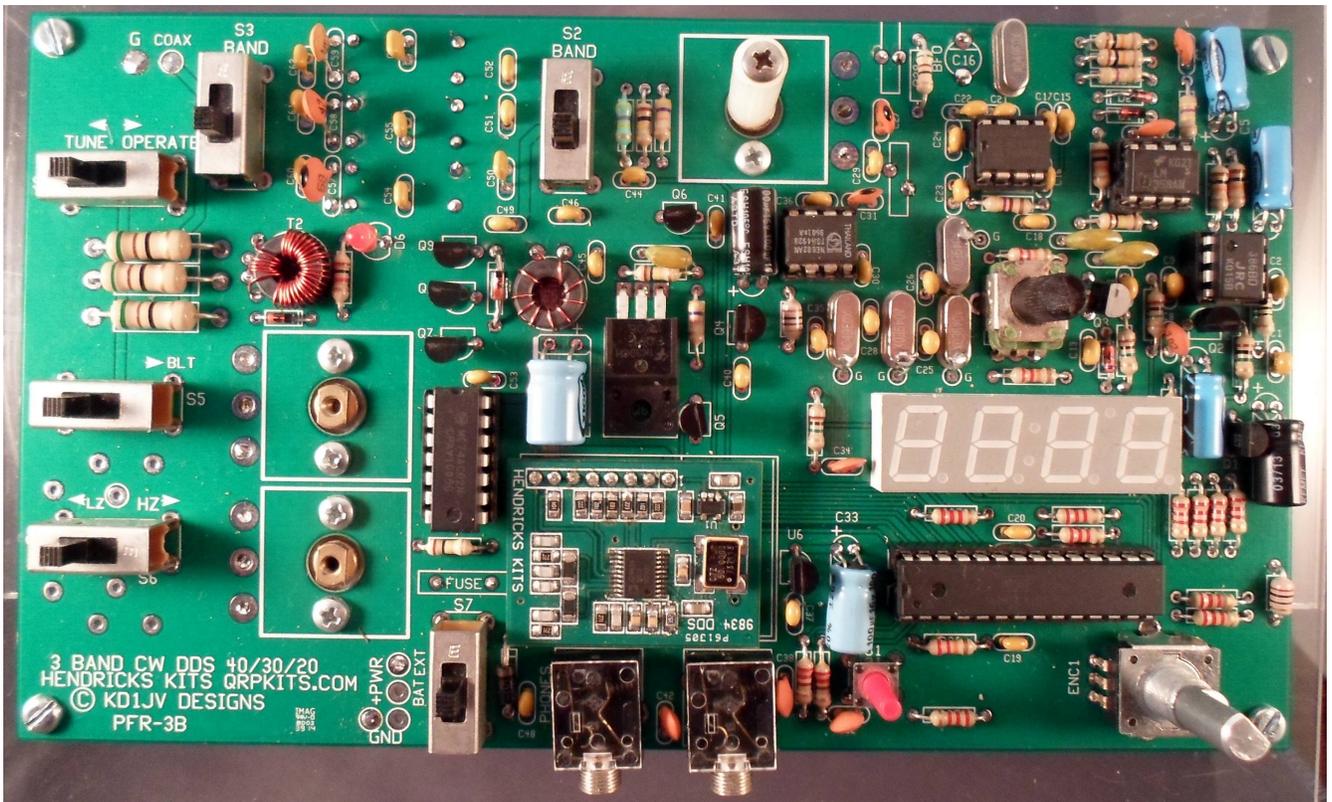
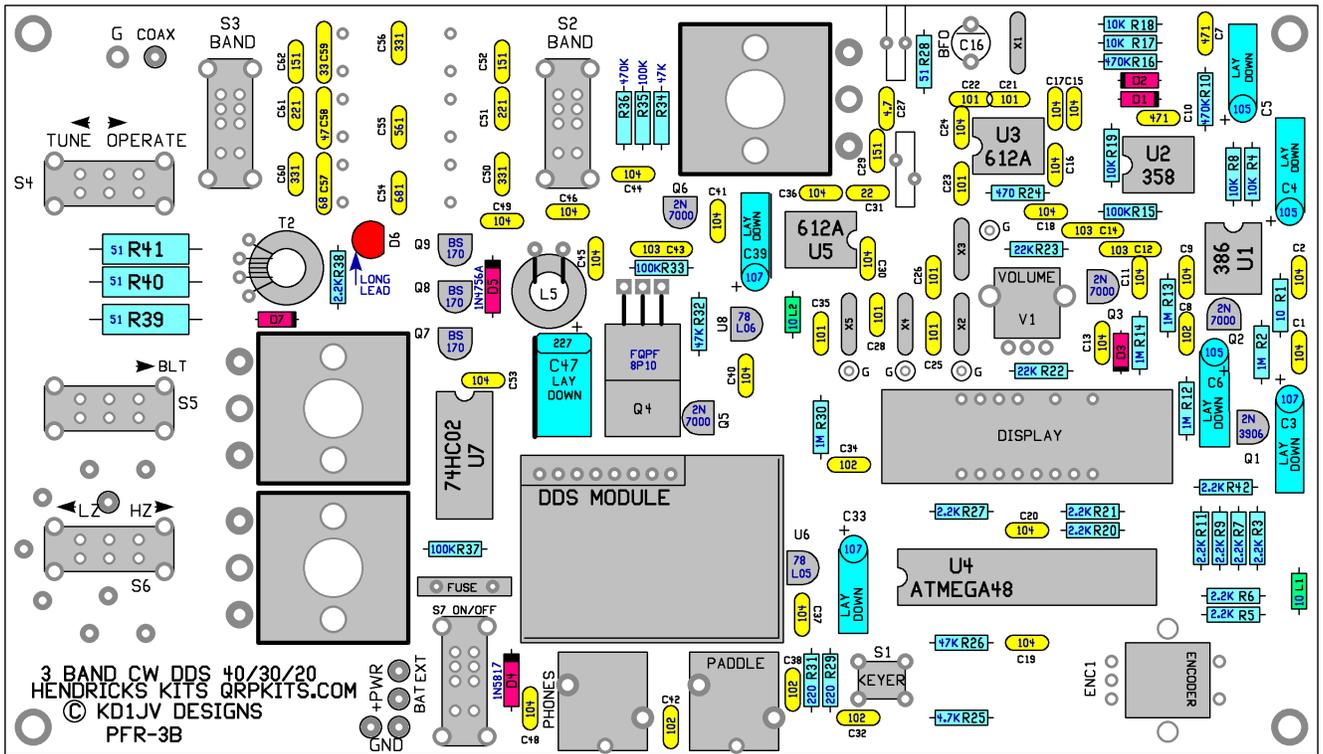
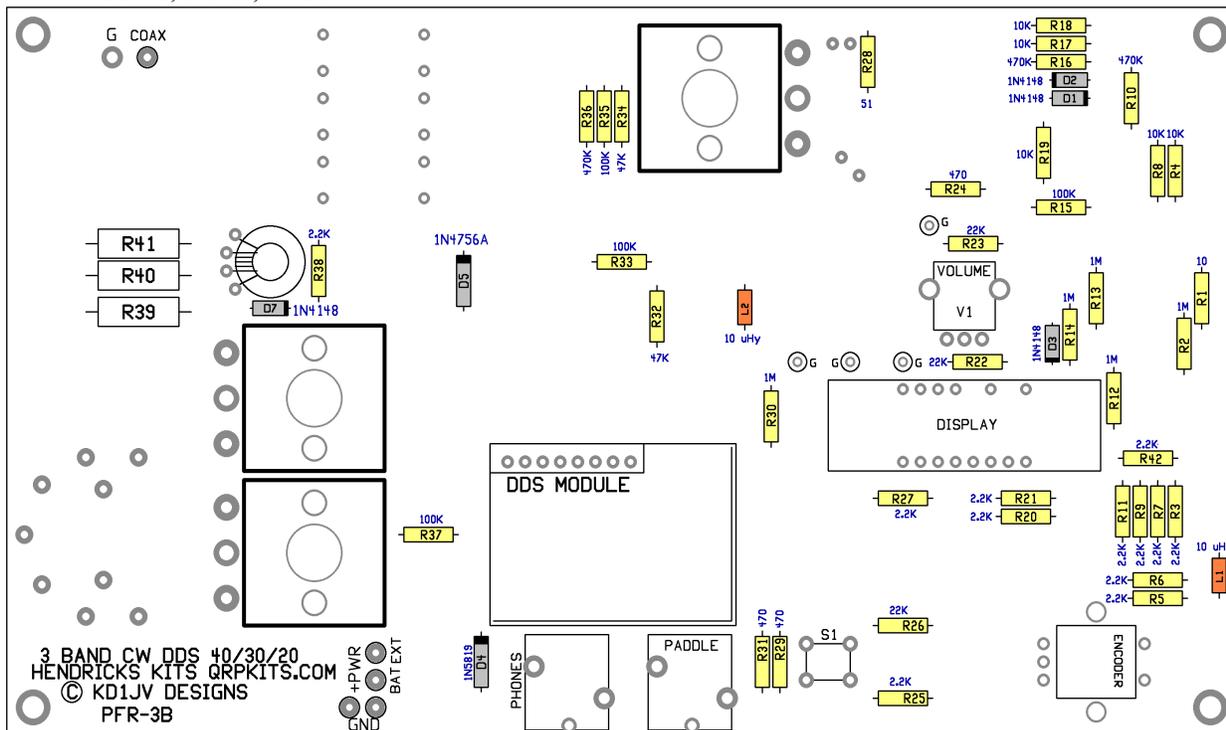


Figure 3

Table 1: Parts list

	QTY	VALUE		QTY	VALUE	
	1	10 ohms	Brown, black, black, gold	1	4.7 p NPO	Disk, brown, black dot on top edge
	1	51 ohms	Green, brown, black, gold	1	22 p NPO	Disk, brown, black dot on top edge
	3	470 ohms	Yellow, violet, brown, gold	1	33 p NPO	Disk, brown, black dot on top edge
	12	2.2 K, 1%	Red, red, red, gold	1	47 p C0G	
	5	10 K	Brown, black, orange, gold	1	68 p NPO	Disk, brown, black dot on top edge
	3	22 K	Red, red, orange, gold	7	100 p NPO	Disk, brown, black dot on top edge
	2	47 K	Yellow, violet, orange, gold	3	150 p C0G	Mono, yellow
	4	100 K	Brown, black, yellow, gold	2	220 p C0G	Mono, yellow
	3	470 K	Yellow, violet, yellow, gold	3	330 p C0G	Mono, yellow
	5	1 MEG	Brown, black, green, gold	1	560 p C0G	Mono, yellow
	3	51 ohm 2W	Green, brown, black, gold	1	680 p C0G	Mono, yellow
	1	10K audio	Vertical PCB mount	2	470 p DISK	Disk, brown
	2	10 uhy rfc	Brown, black, black, gold	5	.001 ufd disk	Disk, brown
	2	SA612AN	8 pin DIP IC	23	0.1 ufd X7R	Mono, yellow
	1	LM358N	8 pin DIP IC	3	0.01 ufd film	Film
	1	LM386N	8 pin DIP IC	1	30 p trimmer	Green
	1	74HC02N	14 pin DIP IC (74AC02 may be supplied)	3	Polyvaricons	Polyvaricon capacitors
	1	ATMEGA48	28 pin DIP IC	3	Polyvaricon hardware	Screws and standoffs
				3	1 ufd / 50V	Aluminum electrolytic
	1	78L05	TO-92 5V reg	3	100 ufd /16V or 25V	Aluminum electrolytic
	1	78L06	TO-92 6V reg	1	220 ufd /16V or 25V	Aluminum electrolytic
				4	8 pin DIP sockets	
	1	2N3906	PNP TO-92 plastic	1	14 pin DIP socket	
	4	2N7000	TO-92 plastic N MOSFET	1	28 pin DIP socket	
	3	BS170	TO-92 plastic N MOSFET	2	FT37-43 Toroid	Ferrite core, gray or black
	1	FQP8P10	TO-220 plastic P MOSFET	6	T37-2 Toroid	Powdered iron toroid (red)
	1	1N4756A	Larger glass diode, 47V 1W zener	2	T37-6 Toroid	Powdered iron toroid (yellow)
	1	1N5817	Plastic diode shottky rectifier, 1A	1	T106-2 Red	Powdered iron toroid (red)
	4	1N4148	Glass diode	1	12mm mechanical	Encoder, w/switch, vertical mount
	1	DDS module	Built and tested.	1	6mmx13mm tack	Push button switch, NO
	1	8 pin header strip	Header for dds board	3	DPDT slide switch	
	1	4 dig LED	4 digit multiplexed display module	3	DP3T slide switch	
	1	Super bright	Red LED (clear package)	1	DPDT toggle switch	
	5	4.9152 MHz Crystals	Crystals HU-49US, matched	2	Stereo jacks	3 pin (no switch)
	1	0.9 A hold, 1.8A trip	PTC resetable fuse	5	Knobs	4 small, 1 medium
	1	Power jack	2.1 mm pin	4	4 cell AA battery	2x2 holders and double sided tape
	1	BNC jack	Panel mount BNC with hardware	1	Red filter	
	2	Binding posts	1 Red, 1 Black	1	PC board	
	1	5 feet	#24 hook up wire.	4	4-40 x 1/4" screws	Socket with black plastic caps
	1	5 feet	#26 magnet wire	4	#4 lock washers	Star washers
	1	12 feet	#28 magnet wire	4	4-40 x 1/4" screws	Phillips pan head screws
	4	Rubber feet	Feet for case	1	Case	Yellow case for PFR-3B

Figure 4: Resistors, diodes, RFCs

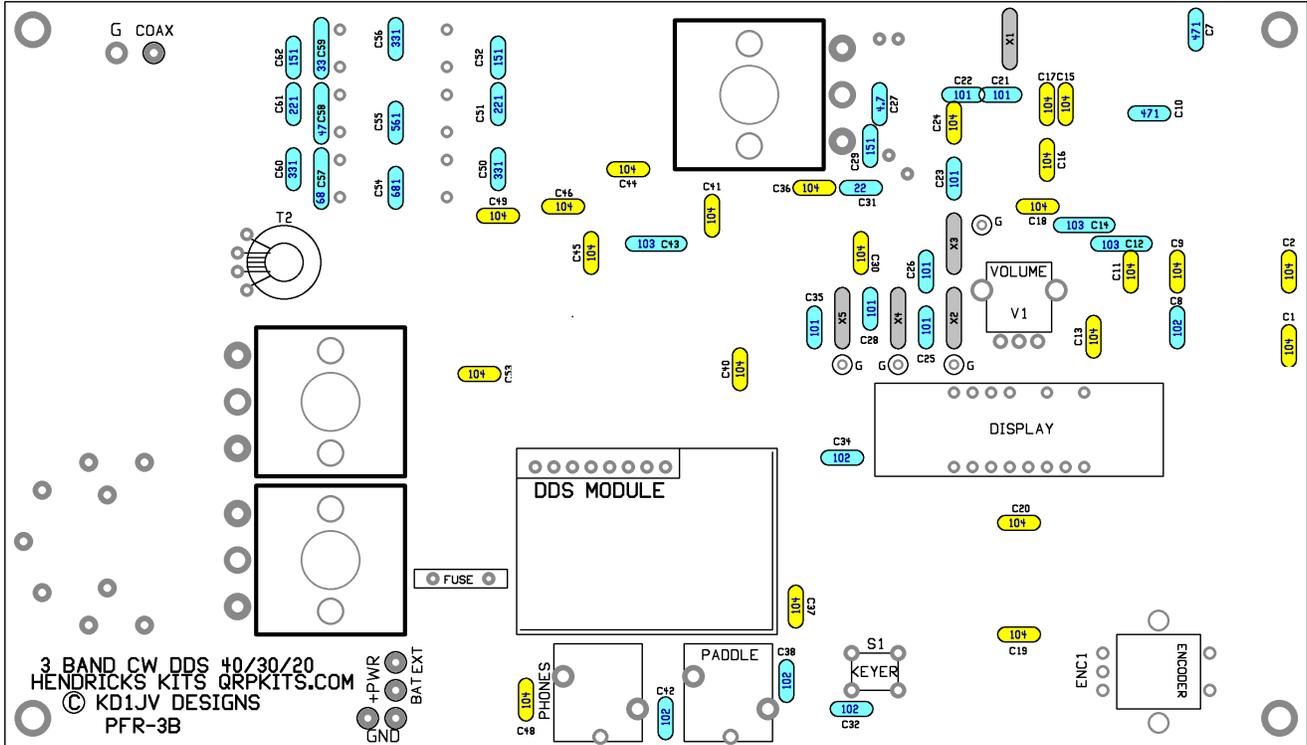


R1	10 OHMS	BRN/BLK/BLK/GLD	R25	2.2 K	RED/RED/RED/GLD
R2	1 MEG	BRN/BLK/GRN/GLD	R26	22 K	RED/RED/ORG/GLD
R3	2.2 K	RED/RED/RED/GLD	R27	2.2 K	RED/RED/RED/GLD
R4	10 K	BRN/BLK/ORG/GLD	R28	51 OHMS	GRN/BRN/BLK/GLD
R5	2.2 K	RED/RED/RED/GLD	R29	470 OHMS	YEL/VOL/BRN/GLD
R6	2.2 K	RED/RED/RED/GLD	R30	1 MEG	BRN/BLK/GRN/GLD
R7	2.2 K	RED/RED/RED/GLD	R31	470 OHMS	YEL/BLK/BRN/GLD
R8	10 K	BRN/BLK/ORG/GLD	R32	47 K	YEL/VOL/ORG/GLD
R9	2.2 K	RED/RED/RED/GLD	R33	100 K	BRN/BLK/YEL/GLD
R10	470 K	YEL/VOL/YEL/GLD	R34	47 K	YEL/VOL/ORG/GLD
R11	2.2 K	RED/RED/RED/GLD	R35	100 K	BRN/BLK/YEL/GLD
R12	1 MEG	BRN/BLK/GRN/GLD	R36	470 K	YEL/VOL/YEL/GLD
R13	1 MEG	BRN/BLK/GRN/GLD	R37	100 K	BRN/BLK/YEL/GLD
R14	1 MEG	BRN/BLK/GRN/GLD	R38	2.2 K	RED/RED/RED/GLD
R15	100 K	BRN/BLK/YEL/GLD	R39	51	INSTALL LATER
R16	470 K	YEL/VOL/YEL/GLD	R40	51	INSTALL LATER
R17	10 K	BRN/BLK/ORG/GLD	R41	51	INSTALL LATER
R18	10 K	BRN/BLK/ORG/GLD	R42	2.2 K	RED/RED/RED/GLD
R19	10 K	BRN/BLK/ORG/GLD	D1	1N4148	SMALL, GLASS
R20	2.2 K	RED/RED/RED/GLD	D2	1N4148	
R21	2.2 K	RED/RED/RED/GLD	D3, D7	1N4148	
R22	22 K	RED/RED/ORG/GLD	D4	1N5817	LARGE, BLACK PLASTIC
R23	22 K	RED/RED/ORG/GLD	D5	1N4756A	LARGE GLASS
R24	470 ohms	YEL/VOL/BRN/GLD	L1	10 uHY	BRN/BLK/BLK/GLD
			L2	10 uHY	BRN/BLK/BLK/GLD

Table 2

Figure 5: Capacitors

Since there are a lot of 0.1 ufd caps, these are highlighted in yellow. The rest of the assorted values are in light blue. We will also install the crystals, highlighted in gray, and are mounted first. Solder a lead clipping from the hole next to the crystal labeled "G" to the top of the crystal can to ground it. X1 is not grounded.



3 BAND CW DDS 40/30/20
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X1-5	CRYSTALS jumper case to gnd	C21	101 (100 pfd)	C42	102 (.001 ufd) DISK
C1	104 (0.1 ufd)	C22	101 (100 pfd)	C43	103 (.01 ufd) FILM
C2	104 (0.1 ufd)	C23	101 (100 pfd)	C44	104 (0.1 ufd)
C3	Electrolytic install later	C24	104 (0.1 ufd)	C45	104 (0.1 ufd)
C4	Electrolytic install later	C25	101 (100 pfd)	C46	104 (0.1 ufd)
C5	Electrolytic install later	C26	101 (100 pfd)	C47	Electrolytic install later
C6	Electrolytic install later	C27	4.7 pfd DISK	C48	104 (0.1 ufd)
C7	471 (470p) DISK	C28	101 (100 pfd)	C49	104 (0.1 ufd)
C8	102 (.001 ufd) DISK	C29	151 (150pfd)	C50	331 (330 pfd)
C9	104 (0.1 ufd)	C30	104 (0.1 ufd)	C51	221 (220 pfd)
C10	471 (470p) DISK	C31	22 pfd DISK	C52	151 (150 pfd)
C11	104 (0.1 ufd)	C32	102 (.001 ufd) DISK	C53	104 (0.1 ufd)
C12	103 (.01 ufd) FILM	C33	Electrolytic install later	C54	681 (680 pfd)
C13	104 (0.1 ufd)	C34	102 (.001 ufd) DISK	C55	561 (560 pfd)
C14	103 (.01 ufd) FILM	C35	101 (100 pfd)	C56	331 (330 pfd)
C15	104 (0.1 ufd)	C36	104 (0.1 ufd)	C57	68 pfd
C16	104 (0.1 ufd)	C37	104 (0.1 ufd)	C58	47 pfd
C17	104 (0.1 ufd)	C38	102 (.001 ufd) DISK	C59	33 pfd
C18	104 (0.1 ufd)	C39	Electrolytic install later	C60	331 (330 pfd)
C19	104 (0.1 ufd)	C40	104 (0.1 ufd)	C61	221 (220 pfd)
C20	104 (0.1 ufd)	C41	104 (0.1 ufd)	C62	151 (150 pfd)

Table 3

Figure 6: Most everything else

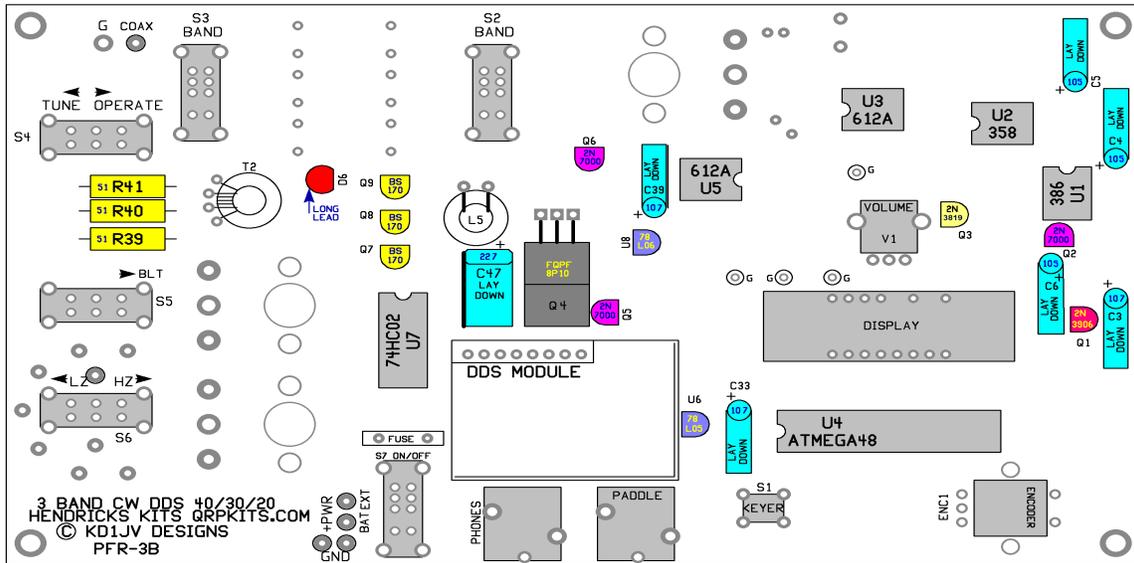


Table 4: Parts should be installed in the order in which they are listed in the table below.

LED Display	This will go in only one way as there are two missing pins and corresponding pads.
U4, 28 pin DIP socket	When installing sockets, double check the leads to make sure none of them are folded over under the socket. This is very hard to fix once you start soldering!
U7, 14 pin dip socket	
U1, U2, U3, U5, 8 pin	
Phone and paddle jacks	Make sure they are set flush to the board.
R39, R40 and R41	51 ohm, 2 watt resistors Green/Brown/Black/gold
Q1	2N3906
Q2, Q3, Q5, Q6	2N7000
Q7, Q8, Q9	BS170
Q4 FQP8P10	FQP8P10, TO-220 Mosfet
U6	78L05 Check the number very carefully so as not to mix up with U8
U8	78L06
	The electrolytic caps are installed laying flat to the board. The value indicated on the diagram is in pfd. 105 = 1,000,000 pfd = 1 ufd
C4, C5, C6 (105)	1 ufd Aluminum Electrolytic. Long lead is plus, black stripe on can is negative.
C3, C33, C39 (107)	100 ufd Aluminum Electrolytic
C47 (227)	220 ufd Aluminum Electrolytic
	When installing the switches, make sure the switch is set square to the board before soldering more then one pin! If the switch is tilted, it may not fit into the slot in the enclosure.
S4, S5, S6	DPDT slide switch
S2, S3, S7	DP3T slide switch
S1	Long handled Tactile push button switch
ENC1	Mechanical rotary encoder.
V1	10K variable resistor.
D6	LED Space off board 1/4" to bottom of the LED.

Figure 7: Parts mounted on bottom of board

Several parts mount on the bottom of the board. These are the variable capacitors, the toroid coils, the BFO trimmer and the resettable fuse.

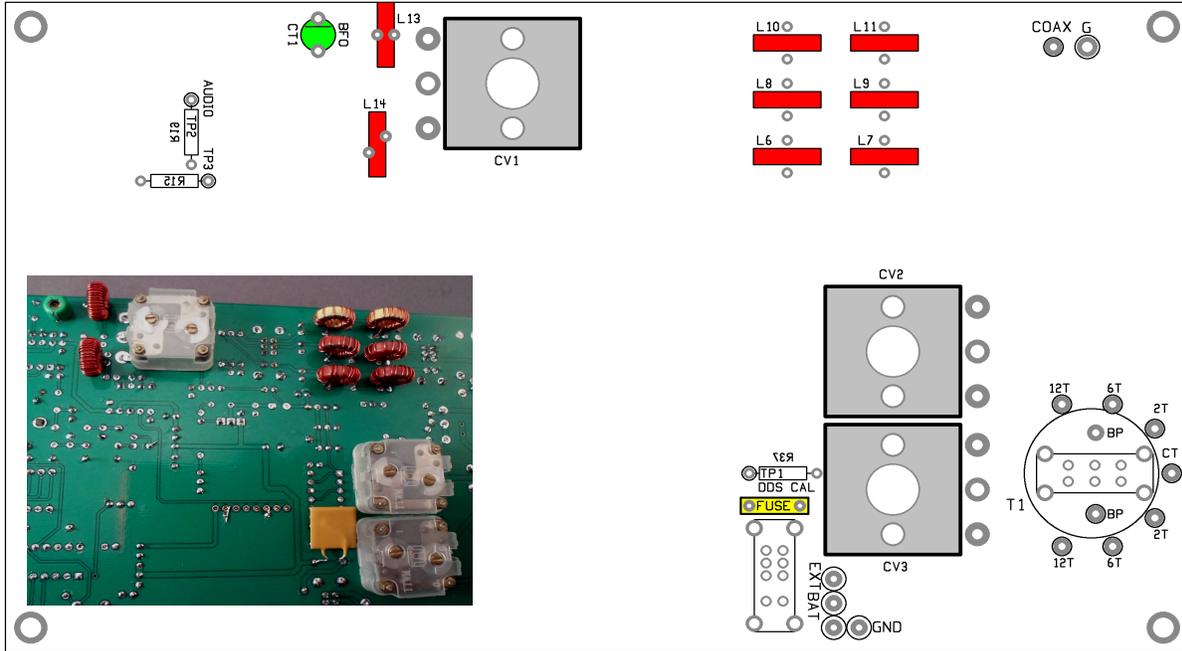


Table 5

CV1, 2, 3	Mount these three variable caps to the bottom of the board, using the short screws supplied.
CT1	BFO trimmer. Make sure the flat side of the cap faces the line in the part outline, towards the top edge of the board.
Fuse	The outline is shown on the top side, but is mounted on the bottom.

Winding the toroids:

The wire needs to be wound snug to the core. A loose, sloppy winding job will result in poor performance. A turn is each time the wire passes through the center of the core. Miss counting and having an extra turn is a common mistake and will result in low power output.

Make sure you tin the wire leads before trying to solder the wire to the board! And make sure you don't pull the wire through the pad past the tinned area of the lead. You can tin with your iron with a blob of solder at the tip.

Table 6a: L6 – L14

L6	18 turns #28 (11") on T37-2, Red core	40M
L7	21 turns #28 (12.5") on T37-2, Red core	40M
L8	13 turns #28 (9") on T37-2, Red core	30M
L9	18 turns #28 (11") on T37-2, Red core	30M
L10	14 turns #28 (9") on T37-6, Yellow core	20M
L11	18 turns #28 (11") on T37-6, Yellow core	20M
L13	40 turns #28 (22") on T37-2, Red core	Rx in
L14	40 turns #28 (22") on T37-2, Red core	Rx in

Table 6b: L5 and T2 – These mount to the top of the board.

L5	8 turns #28 (5") on FT37-43, black core
T2	25 turns #28 (15") on FT37-43, black core. 5 turns #28 (3") for primary. First wind the 25-turn secondary. Then wind the 5-turn primary, in the space between the wire ends of the 25-turn secondary. The 5T primary wires go to 2 center pads of the outline, secondary wires to 2 outside pads.

Winding and mounting of T1:

- Cut a 24" (2 foot) length of the # 26 wire.
- Wind 12 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 bottom of core. Wind the rest of the turns in a counter clock wise direction, passing the long end of the wire down into the core from the top. 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. Space the turns so that they cover about 1/2 of the core. See photos at bottom of this page.
- Pull the 6th turn on the outside of the core (counting from the left hand starting end) slightly away from the middle, outside edge of the core.
- Scrape away the insulation on the wire of this 6th turn, near the middle of the core.
- Cut a 2" length of the # 26 wire and tin one end.
- Attach this wire to the 6th 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 an 18" length of the # 26 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 each side of the tap. It is easiest the start the winding of these turns from the center tap of the first winding.
- Now cut an 8" length of the # 26 wire and wind 1 turns on each 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.
- Before mounting T1 to the board, solder in the wires which will connect to the binding posts into the holes labeled "BP". (4.5" long) These wire will pass through the center of the core. If the wires are not installed now, it is difficult to do once T1 is mounted in place.
- The core is mounted to the bottom of the board, the wires are soldered from the top. Suspend the core slightly off the bottom of the board so the wires do not touch the ends of the switch mounted above it. The thick magnet wire is difficult to tin properly, verify connections were made with an ohm meter.

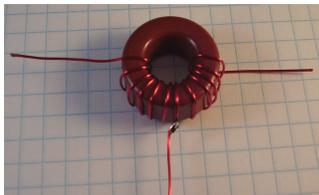


Figure 8a: Primary winding of T1 with center tap



Figure 8b: T1 with HI-Z and LOW-Z winding

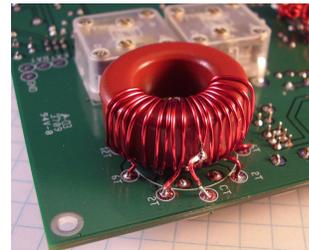


Figure 8c

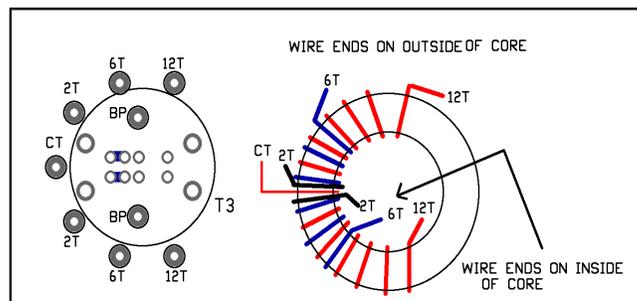


Figure 9: Winding T1

DDS Module:

The final step is to install the DDS module. This gets soldered in place as there isn't enough "head room" for a socket. The module is installed on the top side of the board and can only go in one way. Once soldered in place, clip the SIP pins flush to the board. If they are not trimmed back, they may short to the batteries in the internal battery pack.

Testing and calibration:

The board is now complete except for installing the ICs. Give the BFO trimmer (CT1) 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.

If you have some 1/2" 4-40 screws and nuts or threaded spacers, put these in the four corner mounting holes to rise the board off your bench. Otherwise, clean the work space of wire clippings and solder blobs. Wire up the power jack and BNC jack to the board. Wrap a piece of tape around the leads of the power connector so there isn't a chance the B+ can short to something on the board as you flop it around to work on.

Initial tests:

Connect a 9 to 12 volt power source to the board and use the power switch on the board to turn it on.

- Check for proper voltages from the regulators. There should be +5 volts on pin 14 of U7 and +6 volts on pin 8 of U5.
- If the voltages are correct, disconnect power and install the MEGA48 processor into the U4 socket.
- Power up the board again and the power up sequence should be seen on the display. 1) all segments light for a second, 2) 40, 30 or 20 will be shown depending on which band the band select switch is set to and then 3) the initial operating frequency.
- You can now test the tuning and Menu switch for proper operation. Refer to the operating instructions.
- Remove power again and install the rest of the ICs.
- U1, LM386 / U2, LM358 / U3, SA612A / U5, SA612A / U7, 74AC02 or 74HC02
- Connect an antenna to the BNC jack and restore power.
- You should now be able peak the receiver input tuning and to hear stations. (Attach the nylon spacer shaft extender to the variable cap to make it easier to adjust.)

Transmitter testing:

Turn the power off and then disconnect the antenna and connect up a suitable QRP power meter and dummy load. Make sure the TUNE / Operate switch is in the Operate position and the coax / BLT switch is in the Coax position.

Plug in a paddle or straight key. If using a paddle, you can hold the dash paddle closed when turning the power on to set the rig to straight key mode. Then the dot paddle will key the transmitter on and off.

You can now turn the power back on and key the transmitter. Power output depends on supply voltage. With a 9.0 V supply, power out should be about 2.5 watts on all bands. With 12.0 V supply power out should be between 4.5 and 5 watts on all bands.

Tweaking power output:

Power output is affected by the spacing of the turns on the input side coil for the low pass filter. This would be L6, L8 or L10 for 40, 30 and 20 respectively. If power output is too high, move some of the turns closer together. If it is too low, spread the turns out as best can be done. If the power out is much lower than expected, this is usually due to have an extra turn on the core or a very loosely wound one. Although some times the problem is simply a power meter which is not very accurate at these power levels.

SWR bridge testing:

Set the TUNE / Operate switch to TUNE, disconnect the dummy load and transmit. The LED should light brightly. Now reconnect the dummy load and transmit again. The LED should be off or very dim.

BLT testing:

The Balance Line Tuner is more easily tested once the board is wired up into the enclosure, but you can do that now if you like. If there is a problem it will be easier to fix with the board out of the case.

First install the wires to the board to the output of T1 which will connect to the binding posts. Now connect the BNC jack to these wires. It doesn't matter which one is ground. Attach the shaft extenders and knobs to the variable caps to make then easier to adjust.

Connect your dummy load and also your power meter if you like. Set the Tune/operate switch to Tune and the Coax/BLT switch to BLT. Set the Hi Z/ Low Z switch to Low Z.

Refer to the operating instructions later in the manual for how to use the BLT. Tuning is very touchy and it takes some practice. Doing this now into a dummy load is a good way to not only verify operation, but to get that practice.

If you compare the power out between direct and via the BLT, you will notice a few 100 mW loss in power while using the BLT.

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 by a few 100 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 to ensure 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 for the proper offset to match the audio band pass filter.

NOTE: If you do not have the equipment to do the frequency and offset calibration, these steps may be skipped, leaving the default values in place. You will need to "click through" to the BFO setting part of the calibration to set the BFO trimmer cap. This is done by first entering the calibration mode as described below and clicking the MENU switch once to get to the Offset and BFO adjustment step.

Entering Calibration modes:

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

Reference frequency calibration:

Connect a frequency counter to the TP1 test point at R37. Use the tuning knob to adjust the frequency to exactly 10.000,000 MHz. Once adjusted, click the MENU switch to advance to the IF offset and BFO trimmer adjustment.

IF offset adjust and BFO trimmer set:

Once the MENU switch has been clicked, the LED display now reads [CAL.o].

If you do not have an Oscilloscope, do not make any adjustments to the IF offset frequency and just go do the BFO adjustment.

Connect an Oscilloscope to Pin 7 of U2. You will see the audio beat note on this pin.

Tune through the pass band of the crystal filter using the tuning encoder. 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 knob 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 BFO beat note. Reduce the volume to ensure the AGC circuit is not active. Adjust the BFO trimmer cap CT1 for a peak in the volume, which should occur at about 600 Hz. For best results, an Oscilloscope connected to the headphone jack should be used.

Problems?

Refer to the trouble shooting guide at the end of the manual. For technical help, email the designer at Steve.kd1jv@gmail.com. If the problem can not be resolved by email, a repair service is available for a small, nominal fee.

Wiring the board into the enclosure.

1. Remove the shaft extender(s) from the variable cap(s).
2. Before mounting the board, solder the wires which will connect from T1 to the binding posts to the board.
3. Secure the red LED filter over the display opening inside the enclosure, using clear shipping tape.
4. Mount the board into the top of the enclosure, using the four 4-40 1/4" screws and lock washers. The board needs to be angled and wiggled a little to get ends of the paddle and headphone jack to snap into the holes on the front side of the case.

5. Install the power jack, binding posts, DPDT toggle switch and BNC jack to the rear panel. Wire as shown below. Power jack wiring should be routed "the long way" directly across the board from the jack and then along the front edge of the enclosure.

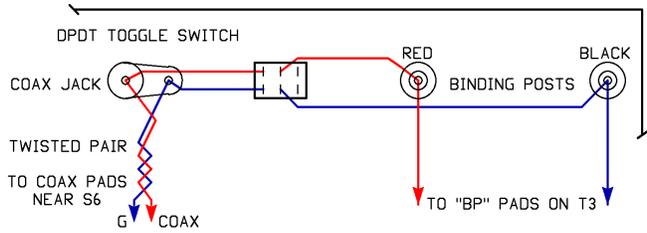


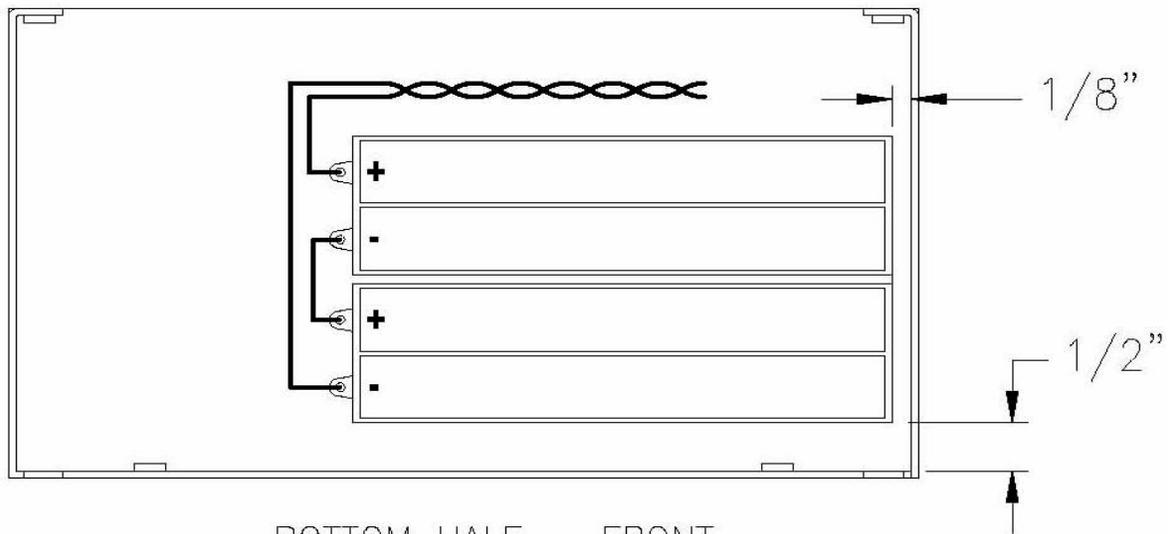
Figure 10a



Figure 10b

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. Make sure you identify the front of the cabinet piece correctly. Leave a small space between the sides of the battery holders as when the batteries are installed they will billow out the sides a little. Connect the 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"



BOTTOM HALF — FRONT

Figure 11

Operation

Power supply:

The PFR-3B 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 few seconds. 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 another 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 when 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. Once on, the last used frequency for each band is restored when changing between bands.

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 of course, no transmitter output. Although transmitting with improper switch settings will not damage the transmitter, it is not recommended to do so.

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

Tuning:

Tuning is done with the tuning knob. Tuning steps are in 50 Hz increments. Each detent will change the frequency by 50 Hz. Since the display only has 100 Hz resolution, it will take two clicks of the encoder to see a change of frequency on the display.

Changing tuning rate:

The tuning rate can be toggled between normal 50 Hz rate and a fast tune rate of 200 Hz by pushing and holding down the tuning knob for longer than 1 second. The letter "F" will be annunciated if the 200 Hz rate is toggled on or "S" for the normal rate of 50 Hz.

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, the SSB signals will not be intelligible due to narrow CW filter.

Volume control and AGC:

The PFR-3B incorporates an audio derived AGC circuit on the audio output amplifier. This helps to limit the volume when a strong station is encountered. This limits the signal to 1.2V p-p or about 11 mW into a 16 ohm load. However, this is still enough to result in a very loud volume when using efficient "ear bud" type

headphones so it is wise to turn the volume down before scanning the band. You will also want to keep the volume turned down enough to keep the AGC from activating in the first place.

RIT (receiver incremental tuning)

Momentarily pushing the Tuning knob for less than 1 second will activate RIT.

The display will change to display [r -0.0]

The 'r' indicates RIT mode is active and -0.0 shows the displacement from the transmit frequency, up to + or - 9.9 kHz.

Checking Rx frequency without exiting RIT mode:

Clicking the MENU switch will toggle the receive frequency back to being equal to the transmit frequency. The display will change to [= 0.0] and the tuning is locked out in this mode. You can however transmit.

MENU switch:

The MENU switch is used to access various functions, mostly related to the keyer 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.

Menu functions are selected by a repeated "click and release" of the MENU switch. To activate a function, simply stop clicking the switch when the desired function is displayed.

Functions are selected in the following order:
(note, decimal point is always on)

Code speed: Display [C 2.0]
"Tune" mode: Display [t .] Side tone : "T"
DFE mode: Display [---.] Side tone : "D"
Enter message Display [--.] Side tone : "M"

Changing keyer code speed:

The current code speed is shown on the display as [C x.x], where x.x is the current speed. Ignore the decimal point. The Keyer speed is changed by using the tuning knob. Turn clockwise to increase speed, counterclockwise to decrease speed. Once the desired speed is selected, exit by clicking the MENU switch.

Tune Mode:

This mode is used if you want to key a steady carrier for measuring power output or when adjusting the antenna tuner. However if you just need to tweak the tuner, it is quicker 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 release the MENU switch twice until the letter "T" is announced by the side tone and something which looks like a "t" is displayed. 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 the MENU switch.

NOTE: there is a minor bug in this routine. The first time you key the transmitter, the side tone starts but the transmitter doesn't produce any output. Release the paddle and key it again and it will start to work properly.

DFE mode (direct frequency entry)

This mode allows you to go directly to a specific frequency by entering it in with the paddle. This is useful if you want to make large frequency shifts, which might otherwise take a lot of tuning knob twisting.

To enter DFE mode, click and release the MENU switch three times. The display will change to [- - -.] and the letter "D" will be announced by the side tone.

Enter the desired frequency, 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 announced 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 the MENU switch.

Note: DFE mode is not available if RIT is on.

Storing a message:

Click and release the MENU switch 4 times to enter the Message store mode. The display will show [--.] and the letter "M" will be annunciated by the side tone. 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.

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. To ensure a word space is inserted, it is best to pause somewhat longer than you normally would between word letter groups. Many people run their letters and words together by not leaving enough space between letter element groups. If your message come out gibberish, you have that problem.

When you have finished entering the message, click the MENU switch. The message you have entered will be annunciated 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. DASH will store it into message location 1 and DOT into location 2. If you wish to redo the message, click the MENU switch again. "EM" will be annunciated by the side tone and you can now re-enter the message.

Sending a message:

To transmit one of the two messages, click and hold close the MENU switch, then tap the dash paddle to send message 1, or the Dot paddle to send message 2, then release the MENU switch.

If a message has not yet been stored, releasing the MENU switch will activate the change code speed mode.

Once started, a message can be terminated by closing the DOT or DASH paddle. The paddles are tested in between the transmission of characters, so hold the paddle closed long enough to be sensed.

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:

TUNE / OPER SWITCH:

Sliding TUNE / OPER witch 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

The COAX / BLT switch 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.

Balanced / unbalanced switch:

The toggle switch on the rear panel is used to switch between balanced and unbalanced feed lines. Use the unbalanced mode when matching to a coax feed line or matching directly to an end feed antenna wire.

- When the handle of the toggle switch faces the binding posts, the BNC jack is connected to the output of

the BLT and one side of the BLT output winding is grounded.

- **Note:** The handle of the switch on the rear panel should be facing towards the coax jack when using either a balanced line on the binding posts or a coax feed antenna which is not using the tuner.

Using the BLT:

Learning to use the tuner takes some practice. The best way to practice and to learn how to operate the tuner is by transmitting into a dummy load. Once you do find a match, if you mark the knob settings on the case you will find these settings will repeat very closely for a wide range of loads and will provide a good starting point. Set the knobs on the capacitor shafts to point towards the center of the case as they are rotated. This gives you the space to add the dial markings. Use different color markers for each band. If you don't want to do this directly on the case, use a piece of heavy paper like from an index card and then laminate it.

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 readjust 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.

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 S6. if the wire is near a 1/2 wave in length. Use the Low Z position if the wire is near a ¼ wave or less in length. The Low Z position is also used when using the BLT to match a coax feed antenna.

Fuses:

A solid state, self-resting fuse is built into the circuit. This fuse will trip if the current exceeds 1.5A. This is enough to prevent a fire or damage to your power supply if a serious short develops inside the rig. However, it is still a good idea to have a 1 A, fast blow fuse in the power supply cord.

Paddle wiring:

The paddle jack uses "standard" wiring.

Tip is Dot.

Ring is Dash.

Sleeve is ground.

Straight key:

Use a mono plug or ground the ring of a stereo plug.

There is no paddle-sense reverse built into the firmware.

Troubleshooting:

More often than not, any trouble with the board not working is inevitably tracked down to soldering issues, so this is the first thing to look for. Looking at the solder pads at the TOP of the board can be helpful. If the hole around a part lead isn't full of solder, it probably isn't soldered on the bottom. Solder can stick to the lead and look soldered, but didn't actually flow into the hole.

Another common issue is the tinning of the magnet wire used to wind the toroids. Even if you pre-tinned the wire, sometimes it gets pulled through the pad past the tinned area. Use an ohm meter to verify continuity through the coil.

Less common are misplaced parts. Resistors are most susceptible to ending up in the wrong place if the color code is misread.

Even rarer are bad parts. IC's almost never go bad these days and most will survive being powered up if they were installed backwards. The 2N700 and BS170 MOSFETs are static sensitive, so it is possible for these to be damaged by handling, but again is rare.

If you can't spot the problem visually, time to break out the test equipment. For most of you, that will be a DVM, but it's a lot quicker if you have a signal generator and Scope available.

Turning on the Offset cal mode effectively turns the DDS module into a signal generator at the IF frequency and can be used to troubleshoot all the receiver stages except for the first mixer signal input. If you can hear the beat note in the Cal mode, you know everything from the input of the first mixer (U5) to the headphones is working and your problem is in the input filter or QSK switch.

The transmitter is as simple as it gets and rarely has problems, other than low power out which is always related to the output filter. If there is no power output, make sure the connections to L5 are good and that Q4 is turning on (and off!).

The IC voltage tables below might help in determining a problem area. These voltages can vary +/- 0.25 volts; depending on the voltage output of the regulators and possible loading by your voltmeter. Don't be concerned unless the voltage is way off.

Table 7a:
U3,U5 SA612 mixer

Pin 1	1.4 V	IN
Pin 2	1.4 V	IN
Pin 3	0 V	GND
Pin 4	5.0 V	OUT
Pin 5	5.0 V	OUT
Pin 6	5.9 V	OSC
Pin 7	5.4 V	OSC
Pin 8	6.0 V	V+

Table 7c:
IC U1 LM386 audio

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

Table 7d:
IC U7 74HC02 NOR GATE

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

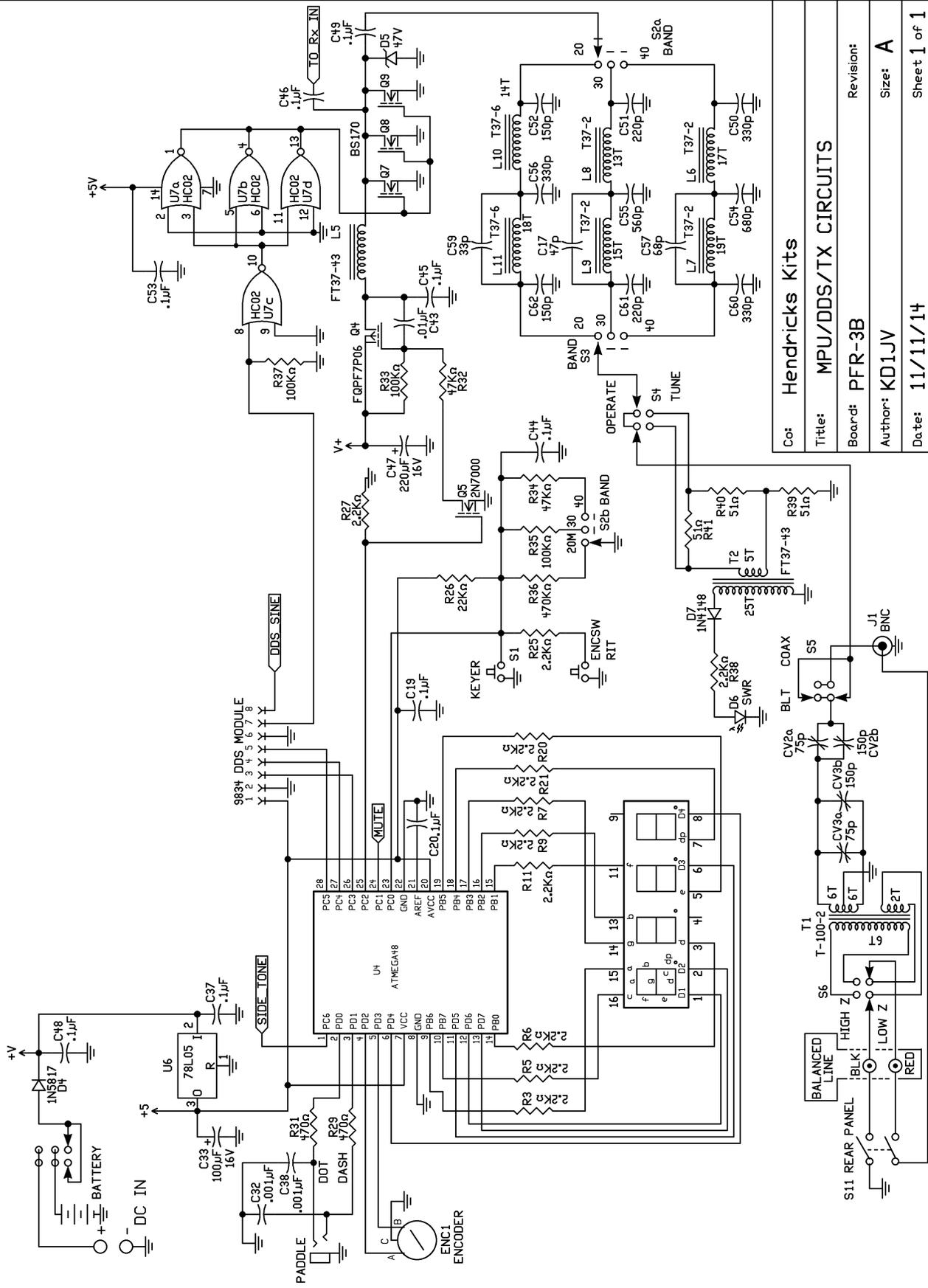
Pins 1, 4 and 13 will measure about 2.5 volts with most DVM's when transmitting steady carrier. In and out pins have square wave signal when transmitting.

Table 7b:
IC U2 LM358 op amp

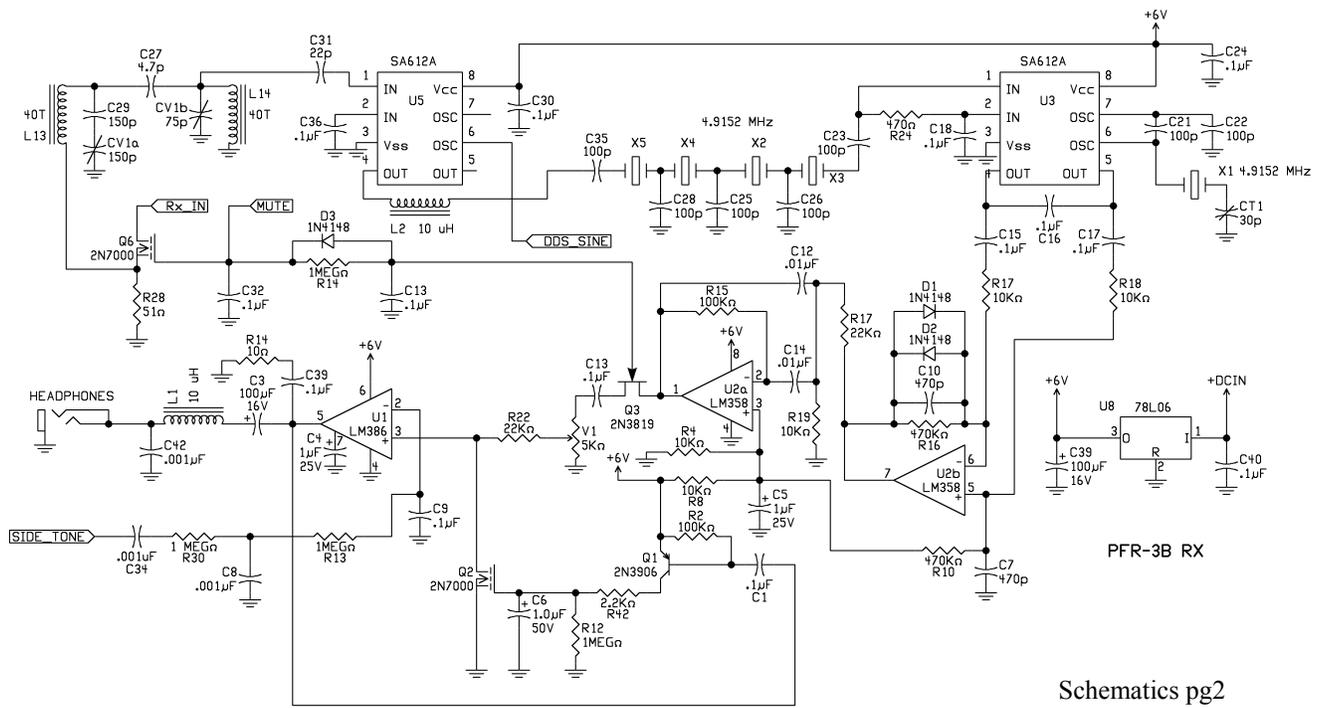
Pin 1	3.0 V	OUT
Pin 2	3.0 V	- IN
Pin 3	3.0 V	+ IN
Pin 4	0 V	GND
Pin 5	3.0 V	+ IN
Pin 6	3.0 V	- IN
Pin 7	3.0 V	OUT
Pin 8	6.0 V	V+

Table 7e:
IC U4 MEGA 48 MPU processor

	Rx	Tx	Pin function
Pin 1	5 or 0	2.5 V	Side tone
Pin 2	5.0 V	0 V	Paddle DOT in
Pin 3	5.0 V	0 V	Paddle DASH in
Pin 4	5 V	5 V	encoder
Pin 5	5 V	5 V	encoder
Pin 6	-----	-----	Digit 4
Pin 7	5.0 V	5.0 V	Vcc
Pin 8	0 V	0 V	GND
Pin 9	-----	-----	"a" segment
Pin 10	-----	-----	"c" segment
Pin 11	-----	-----	Digit 3
Pin 12	-----	-----	Digit 1
Pin 13	-----	-----	Digit 2
Pin 14	-----	-----	"d" segment
Pin 15	-----	-----	"f" segment
Pin 16	-----	-----	"b" segment
Pin 17	-----	-----	"g" segment
Pin 18	-----	-----	"dp" 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	3.4/4.0/ 4.7	40/30/20 band sw	A/D sw input
Pin 24	5V	0V	MUTE OUT
Pin 25	0 V	5.0 V	Tx enable
Pin 26	0 or 5		DDS clock
Pin 27	0 or 5		DDS data
Pin 28	5V	5V	DDS load



Co:	Hendricks Kits
Title:	MPU/DDS/TX CIRCUITS
Board:	PFR-3B
Author:	KD1JV
Date:	11/11/14
Revision:	
Size:	A
Sheet	1 of 1



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