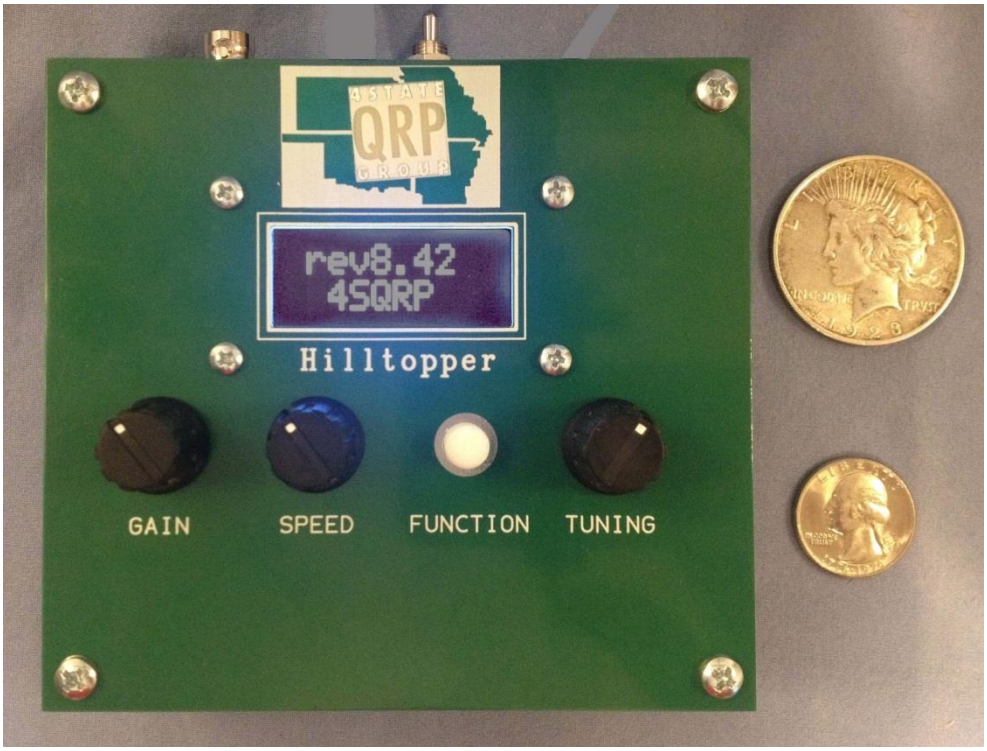
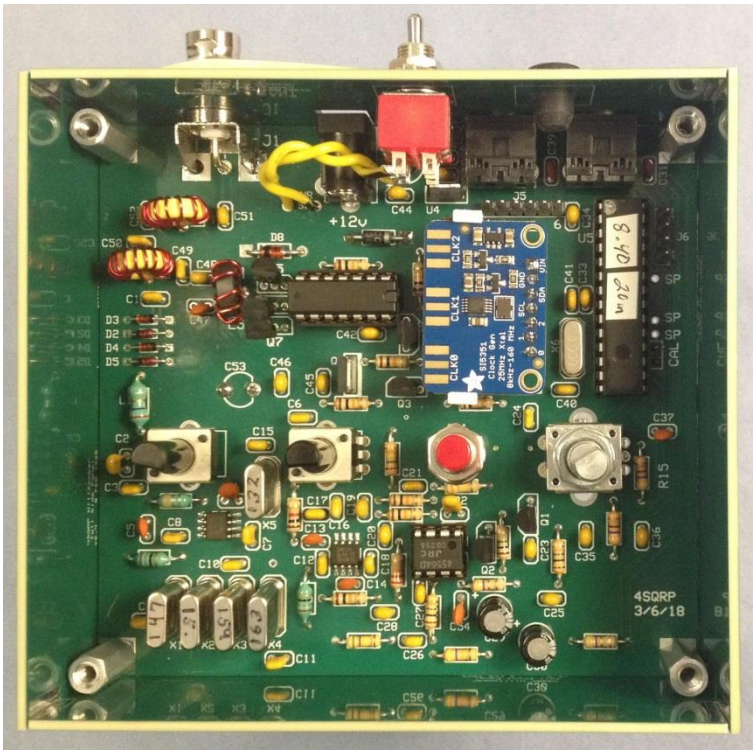
The Hilltopper TallBoy

Compact Monoband CW Transceiver with LCD Display

For 40m, 30m, 20m, 17m, or 15m

Offered by the 4-State QRP Group





Features:

Frequency coverages:

40m kit: 7.000 to 7.300 MHz
30m kit: 10.100 to 10.150 MHz
20m kit: 14.000 to 14.350 MHz
17m kit: 18.068 to 18.168 MHz
15m kit: 21.000 to 21.450 MHz
Receiver can tune beyond the band edges (Tx is inhibited)

Tuning: 20Hz / 100Hz / 1kHz / 10kHz steps
Transmitter power output: 5W nominal @13.8V
Current draw: ~ 80 mA Rx, < 700 mA Tx

Iambic keyer, selectable A/B mode, or Straight Key
On-the-fly CW speed control, 5-30 wpm,
Frequency readout: Audio Morse & LCD Display
Integrated packaging – minimal chassis wiring
Size: 4.4 x 3.4 x 2.3 inches, weight: ~11 oz
Alignment: One-time Frequency Calibration
One-time BFO trim cap adjustment
SMT Parts: 2 parts, SA612AD mixer, factory-installed

Description:

Receiver: The receiver is adapted from K1SWL's 'SW+' Series with minor modifications. The front-end circuitry was revised to replace the now-vanished 10.7 MHz IF transformers. The output of 1st mixer U1 is transformed to a 220 ohm value by L3/C8. The following crystal filter has a -3dB bandwidth of approximately 400 Hz. L4 and C12 step the impedance back up into the 2nd mixer U2. Trimmer capacitor C53 provides adjustment of the BFO frequency during the alignment process. The two op-amp stages following provide approximately 60 dB of audio gain. The final audio stage is configured as a bandpass filter centered on 800 Hz with a Q of 2. The receiver output is suitable for headphone use. A sidetone is injected into this final stage.

Transmitter: The transmitter strip closely resembles Steve Weber's (KD1JV) fine work. The frequency source for both transmitting and receiving is an Adafruit Si5351a programmable clock generator board. This board outputs 3 Vp-p square waves. The 'CLK1' signal is enabled (turned on) during Transmit directly at the operating frequency. The 'QSK' signal from U5 further 'gates' the CLK1 signal to eliminate a 'back-wave' between code elements. U7's three remaining gates are paralleled for higher current drive into the PA devices Q5-Q7. The low-pass filter design is based on a drain impedance of 10 ohms and was optimized using the ELSIE modelling application. The addition of C52, in parallel with L7, provides a notch to reduce the 2nd harmonic content to FCC-compliant levels.

Wave-shaping: Q4 is a P-channel enhancement mode MOSFET rated for 2A continuous duty -with proper heatsinking- and is turned on when Q3 is on, conducting current to ground. Capacitor C45 serves to make the supply voltage rise and fall linear. Rise time is 2 mS and fall time is 4 mS. Note: R17, R18 and R21 are 'insurance', ensuring that the PA stage and supply bias are firmly OFF during initial power-up.

MPU Controller: The controller IC is a 28-pin DIP IC, the Atmel ATmega328P, as used in the Arduino UNO. It relies on an external 16 MHz crystal (Y6) for its timing. The application firmware was written in the Arduino environment (more on this later). An on-board rotary encoder outputting 24 pulses-per-revolution provides a tuning function. The variable DC voltage provided by Speed potentiometer R16 is read by an A/D converter and scaled for Morse code timing. A pair of inputs are used for dot/dash paddles, and straight-key mode (usable for bug or cootie) is also available. The remainder of the I/O provides various control signals and a sidetone . There are a couple of unused I/O lines that could be utilized for future extra features.

Firmware: The *Hilltopper* firmware was written in Arduino's (mostly) C language, supported by its own compiler (the Arduino Integrated Development Environment or IDE). After power-up initialization, the main program runs in a fairly high-speed loop, awaiting keyer and pushbutton inputs. Encoder phase A is handled by a brief interrupt routine. That routine flags the presence of a new tuning input and reads phase B to determine its up/down tuning direction. Outputs 'A4' and 'A5' provide an I2C interface clock and serial data to the Si5351a board. During Receive operation, CLK0 is active, and its output provides the receiver's local oscillator (LO) injection, whose frequency equals the operating frequency plus the IF (high-side injection). During Transmit, CLK1 is active directly at the operating frequency. The changeover is a fairly slow process, requiring that a number of data bytes be sent to the Si5351a at a fairly low bit rate. To avoid having to keep switching back and forth between code elements, there's a 50 mS 'hang' time on key-up.
The *Hilltopper* firmware is open-source and can be downloaded from *https://4sqrp.groups.io/g/HilltopperKit* See the 'Files' section. Several builders have offered on that forum firmware updates that provide extra features.

Hilltopper TallBoy -- Bill of Materials, Sorted by Contents of the Individual Parts Bags

PARTS BAG 1

Qty.	Reference designator	Description	Markings, Comments
15	C19 ,C20, C23, C25, C28, C32, C33, C34, C35, C36, C42, C44, C45, C46, C48	0.1 µF ceramic capacitors	"104"

PARTS BAG 2

Qty.	Reference designator	Description	Markings, Comments
10	C4, C5, C13, C14, C31, C37, C38, C39, C47, C54	.01 µF ceramic capacitors	"103"

PARTS BAG 3

Qty.	Reference designator	Description	Markings, Comments
2	C40, C41	22 pF C0G capacitor	"220"
1	C24	470 pF C0G capacitor	"471"
1	C43	100 µF electrolytic capacitor	note +/- polarity
2	R14, R15	470 ohm	Yellow-violet-brown-gold
1	R18	10 K ohm	Brown-black-orange-gold
1	J2	2.1 x 5.5 mm coaxial DC jack - PC mounting	DC power input jack
1	X6	16.000 MHz HC-49/US crystal	U5 microprocessor clock
1	CAL	2-pin male right-angled header, 0.1" spacing	For the CAL header
1	CAL	2-pin female shorting jumper	Shorting jumper for CAL
1	--	28-pin DIP socket	for U5, may be in ESD Bag, with IC already in the socket

PARTS BAG 4

Qty.	Reference designator	Description	Markings, Comments
1	C26	820 pF C0G capacitor	"821"
1	C27	.0022 µF (2200 pF) C0G capacitor	"222"
2	C29, C30	100 µF electrolytic capacitor	note +/- polarity
2	R13, R23	4.7 ohm	Yellow-violet-gold-gold
1	R22	1.0 K ohm	Brown-black-red-gold
1	R11	10 K ohm	Brown-black-orange-gold
1	R8	47 K ohm	Yellow-violet-orange-gold
1	R4	150 K ohm	Brown-green-yellow-gold
1	R10	510 K ohm	Green-brown-yellow-gold
2	R7, R12	1.0 M ohm	Brown-black-green-gold
2	J3, J4	3.5 mm stereo jack - PC mounting	Headphones & Paddles
1	--	8-pin DIP socket	for U3, may be in ESD Bag with IC already in the socket

PARTS BAG 5

Qty.	Reference designator	Description	Markings, Comments
1	C15	10 pF C0G capacitor	“100” or “10J”
1	C16	47 pF C0G capacitor	“470” or “47J”
1	C17	68 pF C0G capacitor	“680” or “68J”
1	C22	220 pf C0G capacitor	“221”
1	C21	470 pF C0G capacitor	“471”
1	C18	.033 µF capacitor	“333”
1	C53	12-60 pF trimmer capacitor	brown plastic body
2	R2, R3	10 K ohm	Brown-black-orange-gold
1	R9	22 K ohm	Red-red-orange-gold
1	R5	330 K ohm	Orange-orange-yellow-gold
1	R6	1.0 M ohm	Brown-black-green-gold

PARTS BAG 6

Qty.	Reference designator	Description	Markings, Comments
1	C6	10 pF C0G capacitor	“100” or “10J”
3	C1, C8, C12	47 pF C0G capacitor	“470” or “47J”
3	C7, C9, C11	100 pF C0G capacitor	“101”
1	C10	150 pF C0G capacitor	“151”
2	L3, L4	18 µH molded inductor	brown-grey-black - gold or silver

PARTS BAG 7

Qty.	Reference designator	Description	Markings, Comments
4	R17, R19, R20, R21	10K ohm	Brown-black-orange-gold
1	J1	BNC jack, right-angle - PCB mounting	Antenna
1	--	14-pin DIP socket	for U7, may be in ESD Bag with IC already in the socket
1	J5 Serial Programming	6-pin vertical male header strip, 0.1”	
1	J6 I2C bus	4-pin vertical male header strip, 0.1”	to connect to LCD display
1	J7	4-pin vertical male header strip, 0.1”	for future accessory

CRYSTAL BAG

Qty.	Reference designator	Description	Markings, Comments
5	X1 - X5	5.185 MHz HC-49/US crystal	5.185, matched set, For BFO & IF filter

PC BOARD SECTIONS

Qty.	Reference designator	Description	Markings, Comments
1	--	Main Printed Circuit Board	4SQRP 3/6/18
1	--	Bottom cover for enclosure	Bottom Cover
1	--	Top cover for enclosure	Top Cover for 8x2 LCD Display
1	--	Rear panel for enclosure	Tall Rear Panel
1	--	Front panel for enclosure	Tall Front Panel
2	--	Side panels for enclosure	Tall Side Panel

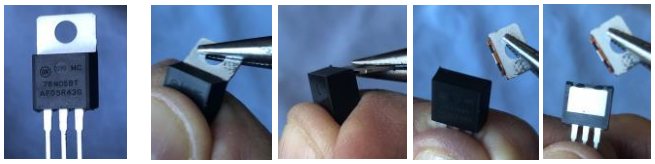
Anti-static (ESD) Bag

Qty.	Reference designator	Description	Markings, Comments
1	D1	1N5818 Schottky rectifier diode	black epoxy body
4	D2, D3, D4, D5	1N4148 small signal diode	glass body, small
2	D6, D7	BAT85 small signal Schottky diode	glass body, small
1	D8	1N4756 47 V 1 W Zener diode	glass body, larger than above
5	Q1, Q3, Q5, Q6, Q7	BS170 N-channel MOSFET **static sensitive**	TO-92 black epoxy package
1	Q2	J113 N-channel JFET	TO-92 black epoxy package
1	Q4	FQU8P10 or IRF9530 P-channel MOSFET **static sensitive**	FQU8P10 has small heat sink tab, IRF9530 has normal TO-220 tab
1	U3	NJM4556AD operational amplifier	8-pin DIP IC
1	U4	LM78M05 linear 5V regulator ****SEE BELOW****	May or may not have a heatsink tab
1	U5	ATmega328P **static sensitive**	28-pin DIP IC
1	U6	LM78L05 linear 5V regulator	TO-92 black epoxy package
1	U7	74AC08 quad AND **static sensitive**	14-pin DIP IC
1	LCD1	2 row x 8 character, I2C interfaced, LCD display	Assembly of two small PC boards
1	Clock generator	Si5351a clock generator module	Supplied with an 8-pin male header strip -- see Group 3 instructions

FINAL ASSEMBLY BAG

Qty.	Reference designator	Description	Markings, Comments
2	R1, R16	5 K potentiometer, PCB mount	"5K" or "502"
1	SW1	SPST momentary-ON pushbutton switch	FUNCTION switch
1	SW2	rotary encoder, with SPST pushbutton	TUNING control
1	--	SPST panel mount mini toggle switch	Rear panel power ON/OFF/ON
1 pc	--	Insulated hookup wire, 4 inches	for toggle switch
3	--	Knob	has slotted setscrew
4	--	#6 standoff, 5/8" unthreaded	between top cover & PCB
4	--	#6 standoff, 1/4" unthreaded	between bottom cover & PCB
4	--	#6-32 standoff, 5/8" F-F threaded	between top cover & PCB
4	--	#6-32 x 5/8" machine screw, Phillips pan head	To attach bottom cover
4	--	#6-32 x 1" machine screw, Phillips pan head	To attach top cover
4	--	#4-40 x 3/8" machine screw, Phillips pan head	For LCD mounting
1	--	3D printed shaft extender for rotary encoder	for SW2 (28.5mm long)
1	--	3D printed shaft Extender for PB switch	for SW1
2	--	3D printed shaft extender for potentiometers	for R1 and R16 (29.9mm long)
2	--	3D printed mounting bracket for LCD display	for LCD display
1	--	4-conductor 10 cm female-female ribbon cable	for LCD display
1	--	Silicone rubber plug for 1/4" hole	for rear panel unused hole

**** Important:** *If your 78M05 regulator (U4) has an extended heat sink tab as seen in the leftmost photo, remove it as depicted in the photo sequence: Hold the plastic body with your finger. Use a plier to gently bend the metal tab backwards and wiggle it back and forth a few times. It should snap off neatly as shown.*



MISCELANEOUS

Qty.	Reference designator	Description	Markings, Comments
2	U1, U2	SA612AD mixer 8-pin SOIC-8 IC	SMD parts pre-installed on PCB
1	--	optional - panel mount 3.5mm stereo jack	for serial data (not supplied with kit)

Band–Specific Band Packs – One Band Pack is supplied with each kit, for the band chosen

40 meter Band Pack -- assembly steps for 40m will be highlighted in this color

Qty.	Reference designator	Description	Markings, Comments
1	L1	10 µH molded inductor	brown-black-black - (gold or silver)
1	L2	6.8 µH molded inductor	blue gray gold - (gold or silver)
2	L6, L7	T37-2 iron powder toroid core (red)	see group 7 instructions
1	L5	FT37-43 ferrite toroid core (dark grey)	see group 7 instructions
1	C2	330 pF C0G capacitor	“331”
1	C3	100 pF C0G capacitor	“101”
1	C49	470 pF C0G capacitor	“471”
1	C50	820 pF C0G capacitor	“821”
1	C51	470 pF C0G capacitor	“471”
1	C52	100 pF C0G capacitor	“101”
1 pc	magnet wire	AWG 21 or AWG 22 enameled wire	used for winding L5
1 or 2 pcs	magnet wire	AWG 24 enameled wire (thinner than #22)	used for winding L6 and L7

30 meter Band Pack -- assembly steps for 30m will be highlighted in this color

Qty.	Reference designator	Description	Markings, Comments
1	L1	5.6 µH molded inductor	green-blue-gold - (gold or silver)
1	L2	4.7 µH molded inductor	yellow-violet-gold - (gold or silver)
1	L6	T37-6 iron powder toroid core (yellow)	See Group 7 instructions
1	L7	T37-2 iron powder toroid core (red)	See Group 7 instructions
1	L5	FT37-43 ferrite toroid core (dark grey)	see group 7 instructions
1	C2	220 pf C0G capacitor	“221” or ".00022"
1	C3	68 pf C0G capacitor	“680” or “68J”
1	C49	330 pf C0G capacitor	“331”
1	C50	680 pf C0G capacitor	“681”
1	C51	390 pf C0G capacitor	“391”
1	C52	68 pf C0G capacitor	“680” or “68J”
1 pc	magnet wire	AWG 21 or AWG 22 enameled wire	used for winding L5
1 or 2 pcs	magnet wire	AWG 24 enameled wire (thinner than #22)	used for winding L6 and L7

20 meter Band Pack -- assembly steps for 20m will be highlighted in this color

Qty.	Reference designator	Description	Markings, Comments
1	L1	2.7 µH molded inductor	red-violet-gold - (gold or silver)
1	L2	3.3 µH molded inductor	orange-orange-gold -(gold or silver)
2	L6 & L7	T37-6 iron powder toroid cores (yellow)	See Group 7 instructions
1	L5	FT37-43 ferrite toroid core (dark grey)	see group 7 instructions
1	C2	150 pF C0G capacitor	“151”
1	C3	47 pF C0G capacitor	“470” or “47J”
1	C49	220 pF C0G capacitor	“221”
1	C50	470 pF C0G capacitor	“471”
1	C51	270 pF C0G capacitor	“271”
1	C52	56 pF C0G capacitor	“560” or “56J”
1 pc	magnet wire	AWG 21 or AWG 22 enameled wire	used for winding L5
1 or 2 pcs	magnet wire	AWG 24 enameled wire (thinner than #22)	used for winding L6 and L7

17 meter Band Pack -- assembly steps for 17m will be highlighted in this color

Qty.	Reference designator	Description	Markings, Comments
1	L1	1.5 µH molded inductor	brown-green-gold - (gold or silver)
1	L2	2.7 µH molded inductor	red-violet-gold - (gold or silver)
2	L6 & L7	T37-6 iron powder toroid cores (yellow)	See Group 7 instructions
1	L5	FT37-43 ferrite toroid core (dark grey)	see group 7 instructions
1	C2	120 pF C0G capacitor	"121"
1	C3	39 pF C0G capacitor	"390" or "39J"
1	C49	160 pF C0G capacitor	"161" may have axial leads
1	C50	390 pF C0G capacitor	"391"
1	C51	220 pF C0G capacitor	"221"
1	C52	39 pF C0G capacitor	"390" or "39J"
1 c	magnet wire	AWG 21 or AWG 22 enameled wire	used for winding L5
1 or 2 pcs	magnet wire	AWG 24 enameled wire (thinner than #22)	used for winding L6 and L7

15 meter Band Pack -- assembly steps for 15m will be highlighted in this color

Qty.	Reference designator	Description	Markings, Comments
1	L1	1.2 µH molded inductor	brown-red-gold - (gold or silver)
1	L2	2.2 µH molded inductor	red-red-gold - (gold or silver)
2	L6 & L7	T37-6 iron powder toroid cores (yellow)	See Group 7 instructions
1	L5	FT37-43 ferrite toroid core (dark grey)	see group 7 instructions
1	C2	100 pF C0G capacitor	"101"
1	C3	33 pF C0G capacitor	"330" or "33J"
1	C49	130 pF C0G capacitor	"131"
1	C50	360 pF C0G capacitor	"361"
1	C51	200 pF C0G capacitor	"201"
1	C52	36 pF C0G capacitor	"360" or "36J"
1 pc	magnet wire	AWG 21 or AWG 22 enameled wire	used for winding L5
1 or 2 pcs	magnet wire	AWG 24 enameled wire (thinner than #22)	used for winding L6 and L7

Assembly- general notes:

A number of components are polarity-sensitive: all of the semiconductor devices – transistors, diodes, and ICs …. as well as the three electrolytic capacitors. The trimmer capacitor C53 is NOT actually polarized, but there is a preferred direction of installation that makes BFO alignment easier by having the adjustment screw grounded via the pin on the round side of the trimmer. That way a metal tool won't affect the tuning.

Anti-static precautions. Semiconductors, especially CMOS and MOSFET devices, can be susceptible to damage from electrostatic discharge (ESD). Don't remove them from their protective packaging or antistatic foam until you are ready to install them. Be sure to touch a grounded object before handling semiconductors, and be sure that your soldering tools are ESD safe. The soldering iron should have a grounded tip.

Understanding capacitor markings. Capacitors these days are tiny!
In strong light I can just read about their printed values with my trifocals. But most of the time I use a dual lens magnifier, 5x or 10x (~ $4-5 from DigiKey). Likewise, the adjustment slot on trimmer capacitor C53 is tiny as well. An eyeglass repair kit ($2 at discount stores) has just the right teensy screwdriver.

The small monolithic ceramic capacitors of values greater than 100 pF will almost always be marked with a three-digit number. The first two digits are a numeric value, and the third is a power-of-ten multiplier, to yield a result that is in units of pF.
e.g. "104" => 1 0 x 10^4 => 100,000 pF = 0.10 µF "391" => 3 9 x 10^1 => 390 pF

Smaller values may use the three digit form, *e.g.* "680" => 6 8 x 10^0 => 68 pF, or may give the actual value with two digits, as in "47J" where the "47 is the value in pF and the "J" is a type code that means it's a C0G/NP0 type cap. Really small ones can explicitly show the decimal point: "7.5J" => 7.5 pF, 'J' for C0G/NP0 type

Understanding inductor markings. The molded inductors (L1 and L2) look much like resistors but are generally slightly larger in diameter and often have a green body. They are marked with color bands that have the same meaning as resistor bands, but stand for units of micro-henries (µH). There may be additional bands, of various colors depending on manufacturer.

Example: L1 for 20 meters is 2.7 µH. It will be marked red-violet-gold-gold
"red" stands for "2" , "violet" for "7" The first "gold" stands for "x 10^{-1}" The final "gold" stands for 5% tolerance
So 2 7 x 10^{-1} => 27 x 0.1 = 2.7 µH, with +/- 5% tolerance
or another example, yellow-violet-black-silver => 4 7 x 10^0 = 47 µH 10% tolerance

Lead forming. If you have a lead-bending tool, the resistors, molded inductors, and the larger diodes should have their leads formed for 0.4 inch spacing. The small diodes need 0.3 inch spacing, which may be too small for most simple lead bending tools.

Be particularly careful forming the glass diode and molded inductor leads, as the connection from the component to the lead wire is delicate. The molded inductors are wound with very fine wire that can break if stressed, so bend the leads very gently and carefully. Use 0.4 inch on your lead bending tool. You might want to test their DC resistance with an ohmmeter after bending the leads and before soldering. They should have less than 10 ohms resistance. Anything bigger means a likely broken wire.

Component Value Identification. The entries in the Bill of Materials, and the assembly steps themselves, will specify what the expected markings on the components should be.
Channeling Norm, the carpenter…. ***Check twice, solder once***.

Component Orientations. Resistors and most capacitors are not polarized and may be installed in either orientation. But careful builders usually adopt a preferred orientation that will make it easier to check components later if necessary. For example:

For resistors orient them so that the color bands read in order from left-to-right, or from bottom-to-top.

For capacitors, be mindful of what other components are, or soon will be, nearby. Orient the capacitor so that its markings are least likely to be obscured by other components or the chassis walls.

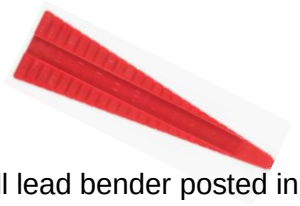
BEFORE YOU START

Before getting started with building the *Hilltopper*, take some time to organize and familiarize yourself with the parts provided and check them against the Parts List. Building over a cookie sheet is recommended to minimize parts being lost. To prevent static damage, it is recommended that the ICs and other semiconductors not be removed from their anti-static packaging until you are ready to install them. The ICs may be provided in the parts bag already plugged into their respective sockets. If so, you don't have to remove them, just solder the socket with the chip in place.

If parts are missing in your kit, send an email to the *Hilltopper* kitter listed at 4SQRP.com. He will promptly provide replacements.

It is helpful to collect the necessary tools and supplies before beginning. These include:

* Soldering iron – 20 to 30 W, ESD safe , and preferably thermostatically
* Fine gauge 60/40 or 63/37 rosin core solder (recommend 63/37 0.031" or 0.025")
* Diagonal flush cutters
* Safety glasses to guard against escaping bits of nipped wire ends
* Needle-nose pliers
* Small flat blade and Phillips screwdrivers
* Magnifier, 5x to 10x
* Masking tape
* Fine file or emery board, and some fine sandpaper
* Some #64 rubber bands (1/4" x 3") and some round toothpicks
* A lead bending tool (pictured) is a useful aid
  If you have access to 3D printing, there is a design file for a small lead bender posted in the Files area of the Hilltopper email group.



Schematic and Component Placement diagrams are provided as part of the documentation package. It is highly recommended to print a copy for reference during construction. As you build, you can check off each construction step as you complete them in order. When you think you are done, you can check the list to verify that all of the parts have been installed.

Some builders use a highlighter to mark off parts on the schematic as they build. Aside from the additional insurance that nothing is missed, it helps to build an understanding of where the parts are used and what they do in the circuit.

The values of several components depend on the specific band for which your kit it being built. The applicable sections of the **Bill of Materials**, and the steps in the **Assembly Sequence** that involve those components are flagged by color coded highlighted headings *Can you figure out how the colors were chosen?* If you are working from a printed paper copy of this manual, and especially if it is a black and white copy, it would be helpful to use a highlighter pen to mark those sections that pertain only to your band.

The enclosure front, rear, and side panels have already been separated from larger PCB sections. They are included in the "Final" parts bag. The rough edges where the pieces were snapped apart should be lightly sanded until they are smooth. Place the sandpaper on a smooth flat surface, hold the panel perpendicular to the surface, and make a few passes across the sandpaper.
Be careful to avoid stray fiberglass slivers until the edges are smooth.

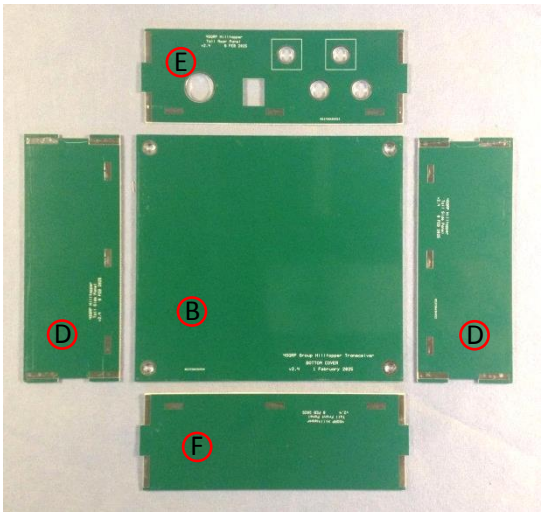
Further details may be found in the grouped assembly sequences. ***Let's get started!***
Online Support: Search for 'Groups.io' on your browser and register to use their free service. Find *4SQRP.groups.io* and register to join. Once approved, find the *Hilltopper* Kit subgroup and register for it as well. These are group e-mail reflectors and they support images and other file types.

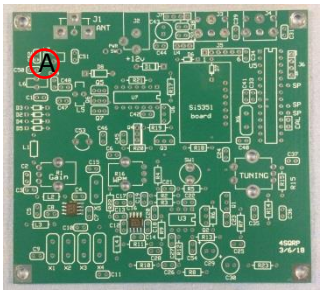
Dry Fitting" the Enclosure

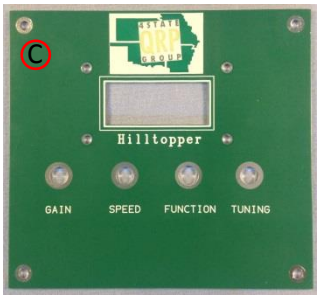
It's a good idea the do a practice run assembling the Hilltopper's enclosure. It's made of several precision cut pieces of circuit board material that fit together closely. Temporarily putting it all together without doing any irreversible steps, like soldering, will save possible confusion or hard-to-correct errors at the end of construction – when you'll be eager to get your radio on the air.

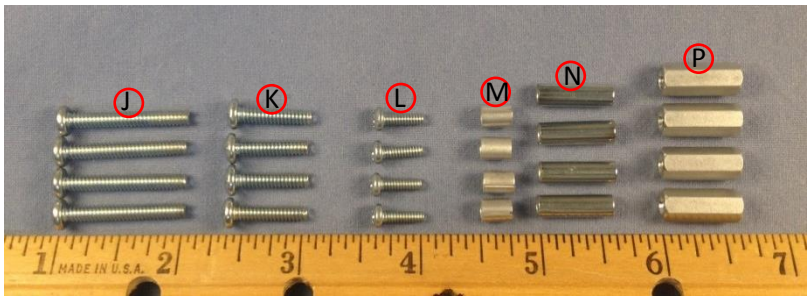
Locate these items, many will be in the "Final Assembly" parts bag :

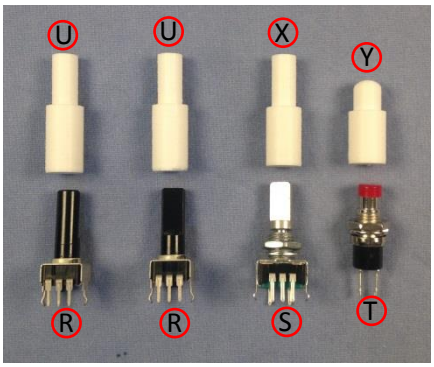
- Ⓐ Main printed circuit board
- Ⓑ Enclosure bottom cover
- Ⓒ Enclosure top cover
- Ⓓ Enclosure left and right side panels (2 - identical)
- Ⓔ Enclosure rear panel
- Ⓕ Enclosure front panel
- Ⓖ LCD display module (in the Antistatic bag)
- Ⓗ LCD display mounting brackets (2 ea, plastic 3D printed)
- Ⓙ 6-32 x 1" pan-head machine screws (4)
- Ⓚ 6-32 x 5/8" pan head machine screws (4)
- Ⓛ 4-40 x 1/2" pan head machine screws (4)
- Ⓜ #6 x 1/4" unthreaded standoffs (4)
- Ⓝ #6 x 5/8" unthreaded standoffs (4)
- Ⓟ #6-32 x 5/8" female threaded standoffs (4)
- Ⓡ PC mount potentiometers (2)
- Ⓢ PC mount rotary encoder
- Ⓣ PC mount SPST pushbutton switch
- Ⓤ Plastic 3D printed potentiometer shaft extenders (2)
- Ⓧ Plastic 3D printed encoder shaft extender (shorter than above)
- Ⓨ Plastic 3D printed pushbutton extender (domed top)

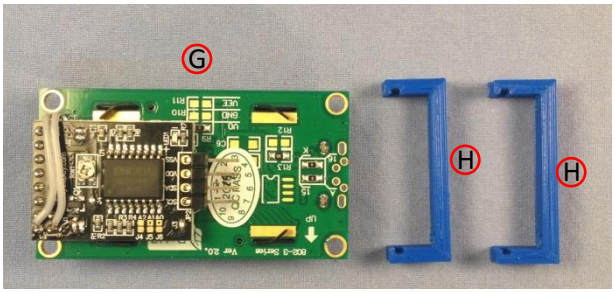


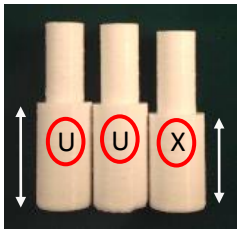












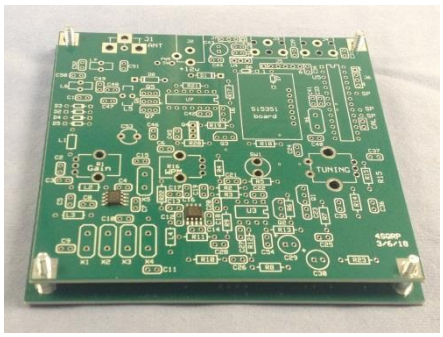
Note that the two potentiometer extenders **U** on the left are slightly taller (29.9mm) than the encoder extender **X** at right (28.5mm) but the real giveaway is the lower height of the shoulder on the lower part of the encoder extender shaft.

THIS IS A TRIAL RUN……. DO NOT SOLDER ANYTHING AT THIS TIME.
TIGHTEN THE SCREWS ONLY JUST ENOUGH TO HOLD THE SECTIONS TOGETHER.

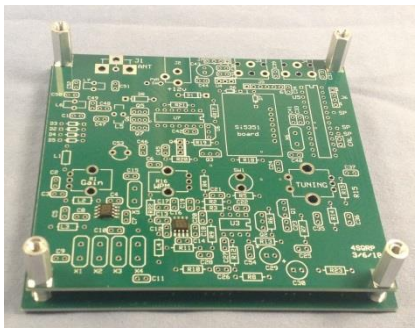
1. Begin the “stackup” by inserting four #6-32 x 5/8” machine screws up from the bottom of the bottom panel. Note the orientation of the bottom panel. Use the silkscreened legend as a reference.

2. Add a 1 /4” unthreaded standoff to each screw

3. Drop the main PC board on top of the standoffs. Observe the orientation of the board.



4. Thread a #6-32 threaded spacer onto each of the screws

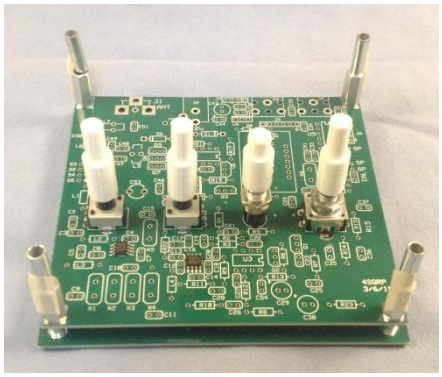


5. Insert two potentiometers, the pushbutton switch, and the rotary encoder into their mounting holes in the PC board. Be sure each is inserted as far as it will go and is plumb and square. The base of the PB switch will not quite be touching the PC board.

6. Add the plastic extenders to each of the controls. The extender for the encoder is slightly shorter than the two for the potentiometers.

Your plastic parts may be different colors than those pictured.

7. Use some bits of tape to temporarily hold a #6 x 5/8” unthreaded standoff on top of each of the threaded standoffs

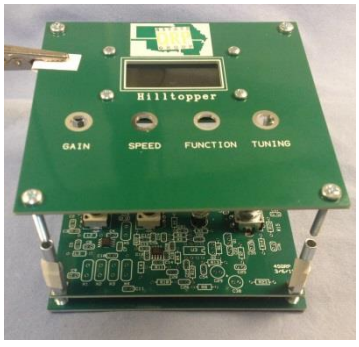


8. Slip the two plastic brackets onto the LCD display module and position it on the underside of the top cover as shown.

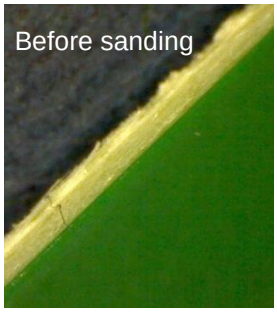
Observe the orientation of the LCD module and the panel. The brackets have a closed-end slot and will only slide on one way.

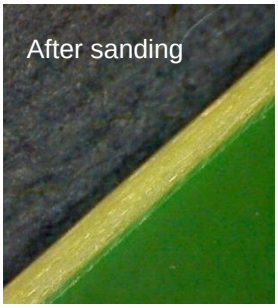
9. Use four #4-40 x 3/8” screws to secure the LCD brackets to the top cover. DO NOT OVERTIGHTEN the screws. It’s easy to strip threads in plastic

10. Drop a #6-32 x 1” screw into the holes at each corner of the top cover. Line up the screws with the unthreaded standoffs that you taped in pace earlier and drop the screws into place, threading them into the threaded standoffs.

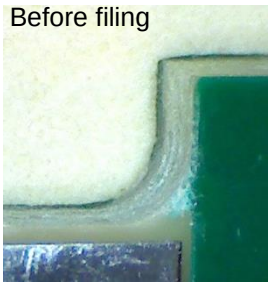


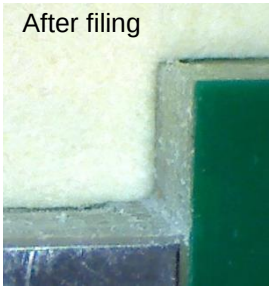
The front/rear/side panels of the enclosure are manufactured in pairs, with a shallow V-groove milled so they can be snapped apart into individual pieces. That does leave a slightly rough edge, as shown in the magnified photos at right. A couple of passes over some fine sandpaper will clean up that edge. Just lay some fine sandpaper on a smooth, flat surface. Hold the board perpendicular to the paper and make a few gentle passes. Be careful while handling the “undressed” board to avoid picking up any little fiberglass slivers.



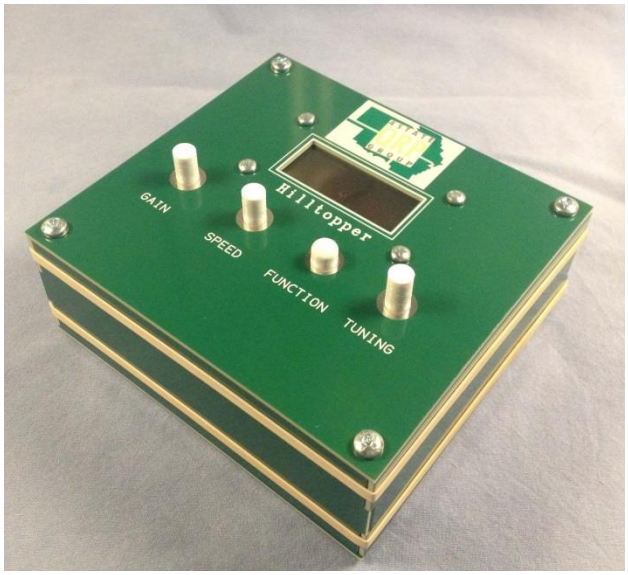


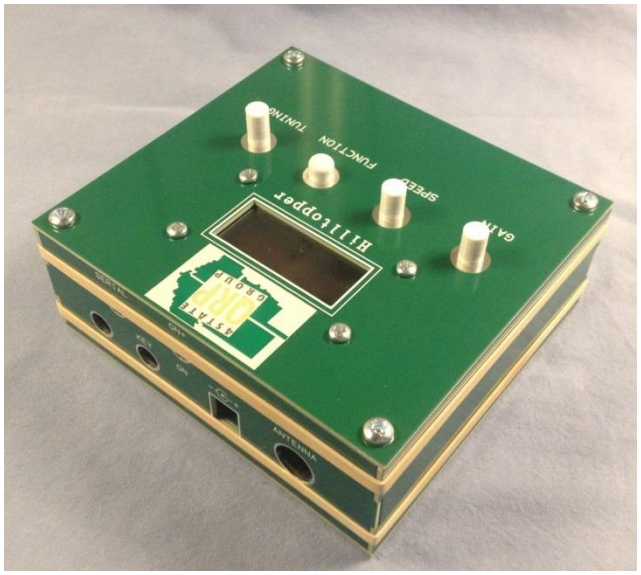
Also, the factory trimming and profiling of the edges of the panels is done with a round bit, so there is always a little inner radius left after the cut. The fit of the tabs and notches is sufficiently close that even that small radius can affect the fit. A few strokes with a square-profile needle file (*e.g.* Harbor Freight set) cleans that up nicely and helps make a neat fit.





11. Slip the front, rear, and side panels between the top and bottom covers and hold them in place with a couple of rubber bands. Each panel is identified with a silkscreened legend on the inside surface. The two side panels are identical (there is no “handedness”) The outside top edges of the side panels are identified by a double white line. The front panel is blank on the outside. The tabs on the front and rear panels fit into notches in the side panels. You should end up with an assembly like this:





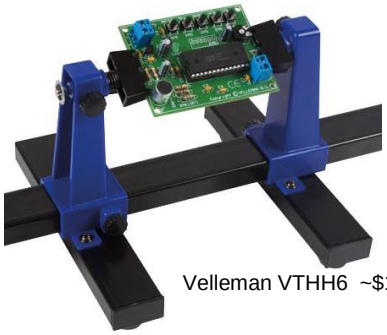
Verify that the control shafts turn without binding and that the pushbutton switch operates smoothly. You can now disassemble the enclosure and set the panels and hardware aside until the final assembly steps. If you wish you may leave the display attached to the top cover.

You probably noticed that the milled edges of the enclosure panels are lighter in color than the surfaces. That’s because the green solder mask applied to the flat surfaces is milled off in the trimming process. If you like, a green Sharpie® marker can be used to color the edges. Should you slip and get some ink on a surface, nail polish remover (acetone) will clean it off.

For the next steps in assembly you will need the main circuit board and the parts bags. Bags marked 1 through 7 correspond to those numbered assembly groups. There is also an Antistatic bag that contains the semiconductors that are used in more than one group. Five matched quartz crystals (used in Groups 5 and 6) are in a separate bag, and the Final Bag contains hardware and miscellaneous items. The “Band Pack,” marked with the ham band for your kit, contains all of the band-specific components.

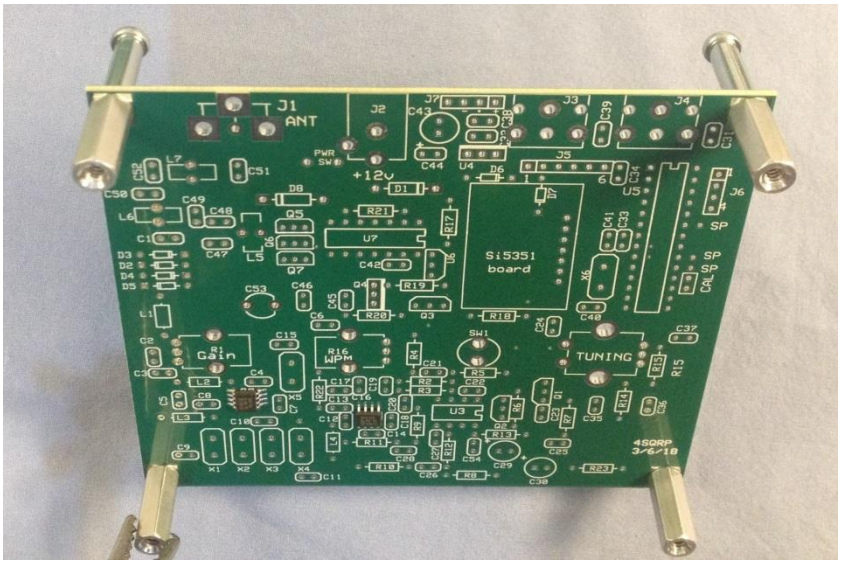
Circuit board assembly

If you are fortunate enough to have one of those nifty circuit board vises to hold your PC board while populating it, congratulations! You can skip the rest of this hint! The photo shows one of several versions you can find.



Velleman VTHH6 ~$15

You can use the 5/8" standoffs and the 1" screws to add some temporary "legs" to your PC board. Fit them up as shown in the photo, with threaded standoffs on one side and unthreaded standoffs on the other, fastened together with the 1" screws. When you flip your board over for soldering you'll have a stable platform.



Assembly Sequences:

On the following pages you'll find seven carefully thought out, grouped assembly sequences.

You don't have to follow them. *Land of the Free, etc.*
But if you're blazing your own trail, you'd best be numbered *Among the Brave.*

***Caution*: There are two component installations, both in Group 3, where the order really does matter.**

*Diode D7, which goes **UNDERNEATH** the Si5351a board.*
*Install it **BEFORE** you add the Si5351a board.*
But if you forget, don't panic, you can install D7 on the bottom side of the PC board.

The **CAL** 2-pin right-angle male header is to be installed on the bottom side of the main PC board. It cannot be installed until **AFTER** the U5 socket has been soldered in place.

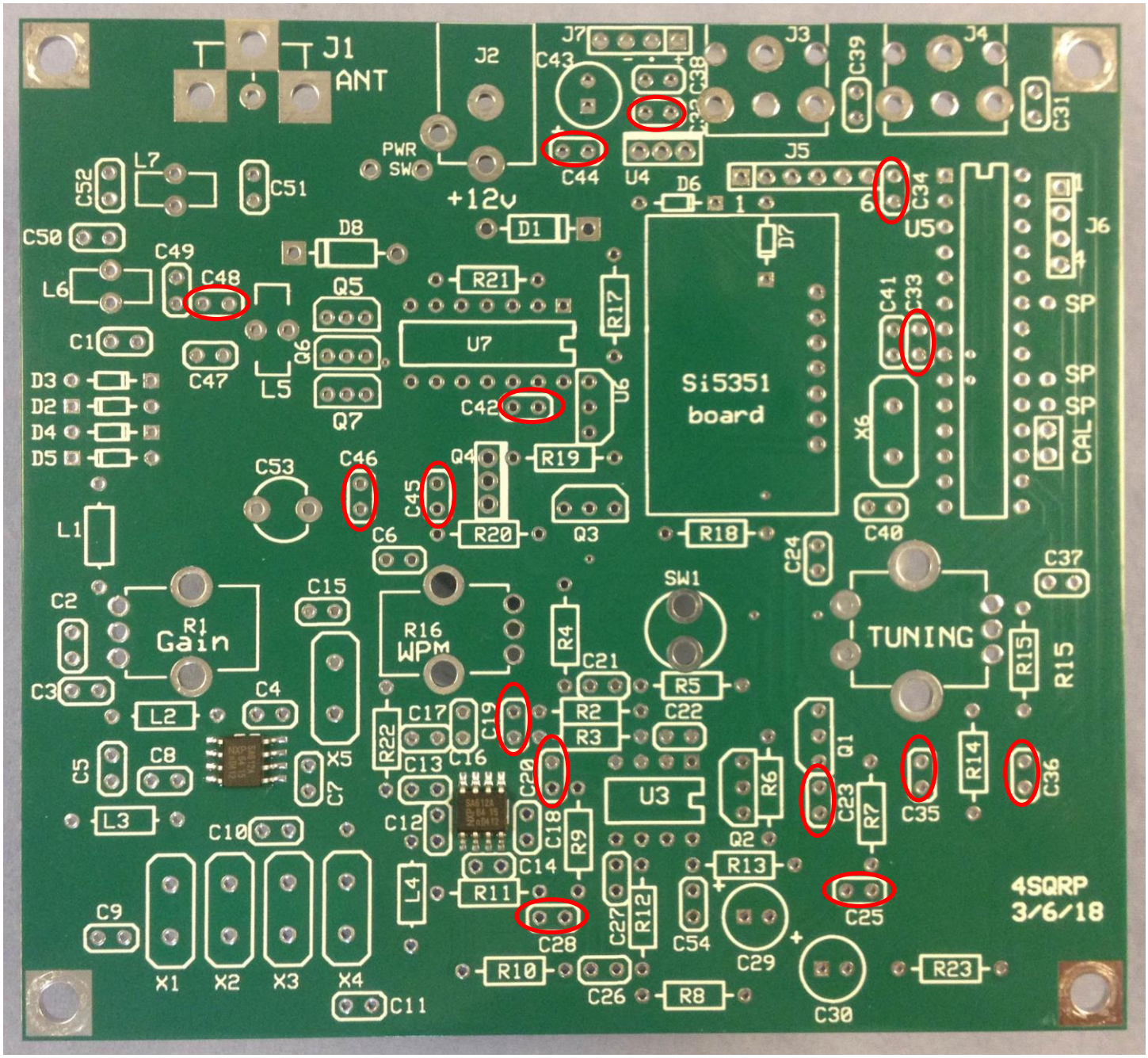
It's also important to ensure that the on-board connectors and controls are installed "square and plumb" to the PC board surface. Always solder just one pin of a control or connector, then check its alignment before soldering the remaining pins.

GROUP 1 ASSEMBLY:

☐ Install all (total of 15) of the 0.1 µF ceramic capacitors from Bag 1. These are marked '104' on one side. Restrain each capacitor by spreading the leads apart on the underside of the board until you can solder it. *I typically insert 3 or 4 components at a time, then solder each and clip off the excess lead length.* Locations are highlighted below for these components:

C19, C20, C23, C25, C28, C32*, C33, C34, C35, C36, C42, C44*, C45, C46, C48

** C44 is NOT polarized. The + sign near its outline applies to the adjacent part, C43*
The silkscreened ID for C32 is partially obscured. It's the circled part just below C38.

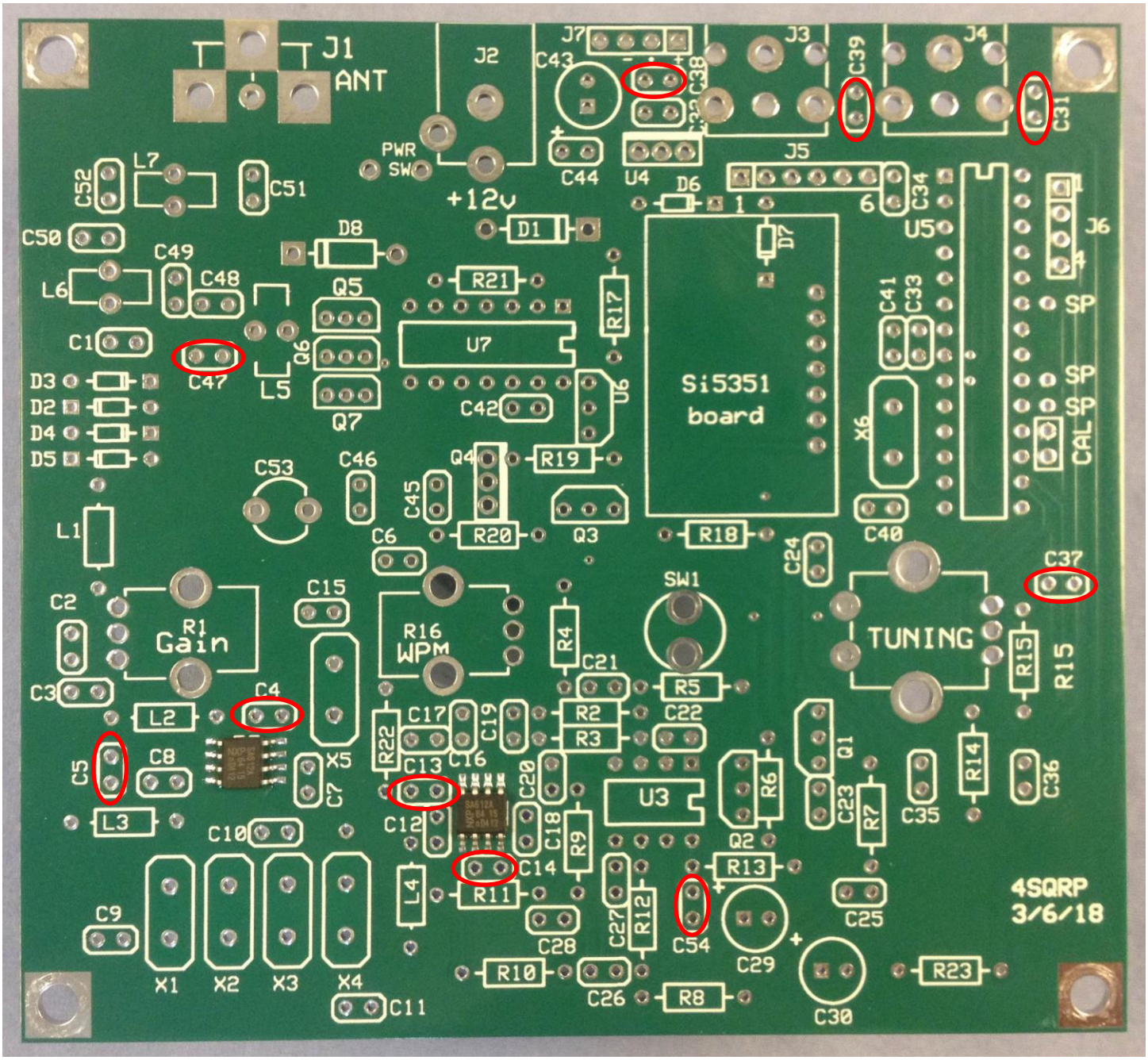


GROUP 2 ASSEMBLY:

☐ Install all (total of 10) of the 0.01 µF capacitors from Bag 2. These are marked '103' on one side. Restrain each capacitor by spreading the leads apart on the underside of the board until you can solder it.
I typically insert 3 or 4 components, then solder each and clip off the excess lead length.
Locations are highlighted below for these components:

C4, C5, C13, C14, C31, C37, C38*, C39, C47, C54*

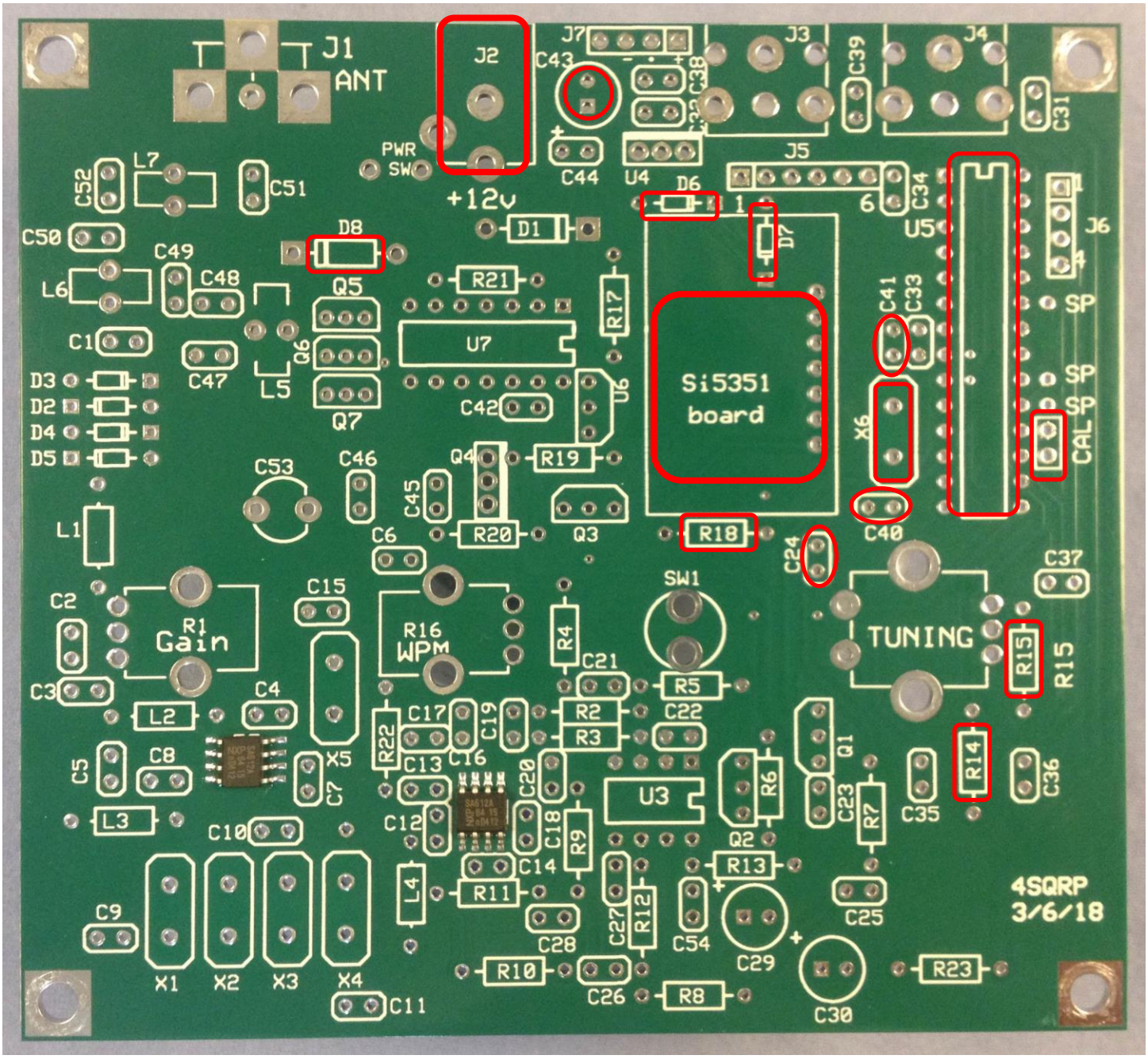
** C38 is NOT polarized. The + and – signs near the C38 outline refer to the header J7*
Likewise, C54 is NOT polarized. The nearby + sign refers to C29

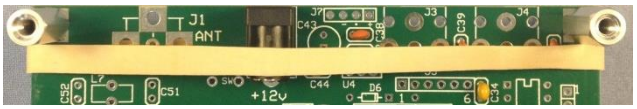


GROUP 3 ASSEMBLY:

The following components will be installed in this assembly group. In addition to those in Bag 3, some parts are in the ESD Bag, along with some other parts to be used in future steps. A detailed assembly step-by-step sequence follows this illustration.

J2, D1, D6, D7, C43, C40, C41, X6, R18, R14, R15, C24, 5351a board, U5, **CAL** header





- ☐ Install coaxial DC power connector J2. Use a ¼-inch wide rubber band (see image above) around the PC board to hold the connector in place temporarily
  Solder only one lead at first. Flip the board back right-side-up and check to ensure that the connector is aligned squarely on the board and is seated flush against the surface. Reheat the connection if needed to align the connector properly. Once the alignment is confirmed, solder the remaining leads.

□ Install power polarity protection diode D1 (1N5818) and bias diodes D6 and D7 (BAT85). Be sure to match the banded end of the diodes to that shown on the illustration.

D7 must be installed before the Si5351 board (below) is installed.

Note: the PC board pads for the small glass diodes D6 and D7 are spaced 0.3 inches, which is too small for most lead bending tools. Be careful when forming the leads, and don't force the parts into the holes. They should slip in smoothly.

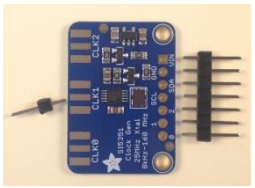
□ Install 100 µF electrolytic cap C43. This part is polarity sensitive. The longer lead (+ side) goes into the square pad. Install so the white band on the case (- side) faces the rear of the board. *This also corresponds to the shorter wire lead.*

□ Install 22 pF ceramic capacitors C40 and C41 (marked '22J' or '220')

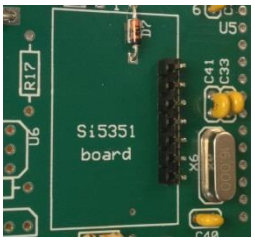
□ Install X6 (16.00 MHz crystal). *I use a narrow (0.1") strip of paper under the crystal can to hold the crystal just slightly above the board. Once at least one of the leads is soldered, the paper is removed. If the paper gets stuck and won't slide out, or leaves a paper shard under the crystal, no harm will result.*

□ Install resistor R18 (10K ohm, brown-black-orange-gold)
□ Install resistors R14 and R15 (470 Ω, yellow-violet-brown-gold).
□ Install capacitor C24 - 470 pF (marked '471')

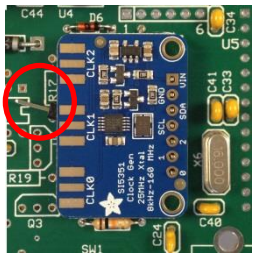
Some experienced builders have opted to socket the 5351 module. There are pros and cons. A socketed connection will not be as reliable as a properly soldered connection. But if the 5351 module should ever need replacing, a socket makes that a trivial task. **Appendix A** *in this manual gives some details about how to use a socket, without interfering with clearance between the 5351 and the LCD display.*



□ Prepare to install the Si5351 module. Touch a grounded object, then open the bag containing the module. You'll find an 8-pin male header strip packed with the 5351. The 5351 module only has 7 pads for the header strip. Snap one pin off the 8-pin header, but keep it handy. You'll need it in just a bit.



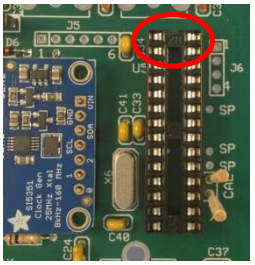
□ Drop the now 7-pin header into the main PC board, inside the outline of the 5351 module. ***Insert the LONG PINS DOWN into the PC board***. The plastic spacer strip and the short pins should be on the top of the main PC board, as in the photo. You can use a bit of tape to hold the strip in place so you can flip the board over for soldering. Solder only one pin on the bottom side of the PC board, then check that the header is seated flush and square on the main PC board. If the alignment is good, solder the remaining pins. Clip off the excess pin length below the main PC board.



□ Position the 5351 module over the short pins of the header strip, component side up as shown in the photo. Use the extra cut-off pin as a temporary spacer under the left edge of the module (circled in red) so that it will be sitting level, just above the main PC board. Solder one pin to the 5351 module, then check that it is straight and square, then solder the remaining pins, and discard the cut-off pin.

□ Install the 28-pin IC socket at U5. If the IC is already plugged in, touch a grounded object before handling it. Leave it plugged in and solder the socket with the IC. The notch at one end of the socket (circled in red) faces the rear of the board as shown on the silkscreened outline. Make sure all the pins are inserted through the board. Solder two pins – at diagonally opposite corners. Check that the socket is seated flush against the PCB. Re-heat and press it into place if needed, then solder the remaining pins. Double check that all 28 are soldered.

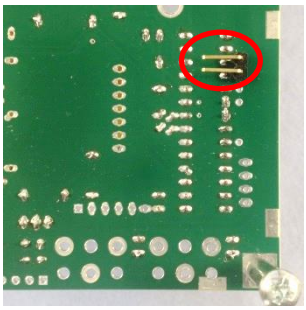
If you accidentally install it backwards- leave it! The socket itself is not polarity-sensitive. You can just plug the in the IC in the correct orientation.



□ If it wasn't already plugged in, install 28-pin IC U5 (ATmega328P). Note: this band-specific part (firmware must match the band) is located in the ESD bag, not the Band Pack.This IC device is polarity-sensitive and static-sensitive. Touch a grounded object before handling it.

The dot and/or notch at one end of the device must face the back of the board. You will need to bend the IC pins gently inward to mate with the socket. The best approach is push the IC down on a hard surface to bend one 14-pin row at a time evenly. **Inspect that all 28 leads are seated into the socket.**

*The photo of the 28-pin socket installation (previous page) included two pieces of toothpick pushed into the holes of the **CAL** header. This to help locate those two holes on the bottom side of the PC board.*

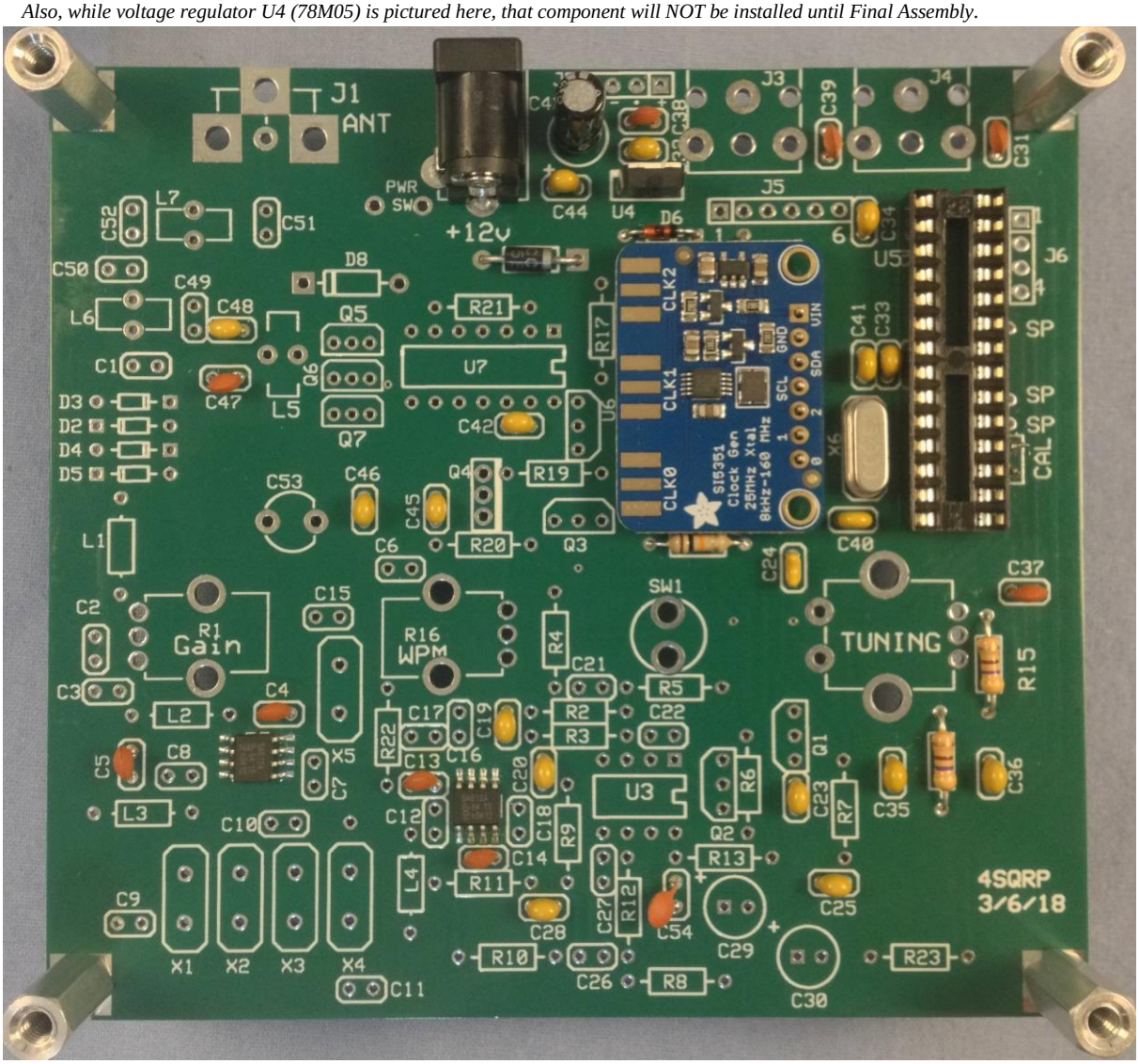


□ Install the 2-pin male header ON THE BOTTOM of the PC board - under the location marked on top as **CAL.** See the photo for location and orientation (red circle) Be sure the long pins are parallel with the PC board surface and do not tilt down toward the U5 pins. Solder on the top side of the PC board. Set the mating 2-pin female jumper aside until construction is complete.

*P.S. the two pins on U5 just below the **CAL** header that look like they are shorted together with a solder bridge….*
They are supposed to be!

Now that you've finished Group 3 Assembly, your Hilltopper board should look like this:

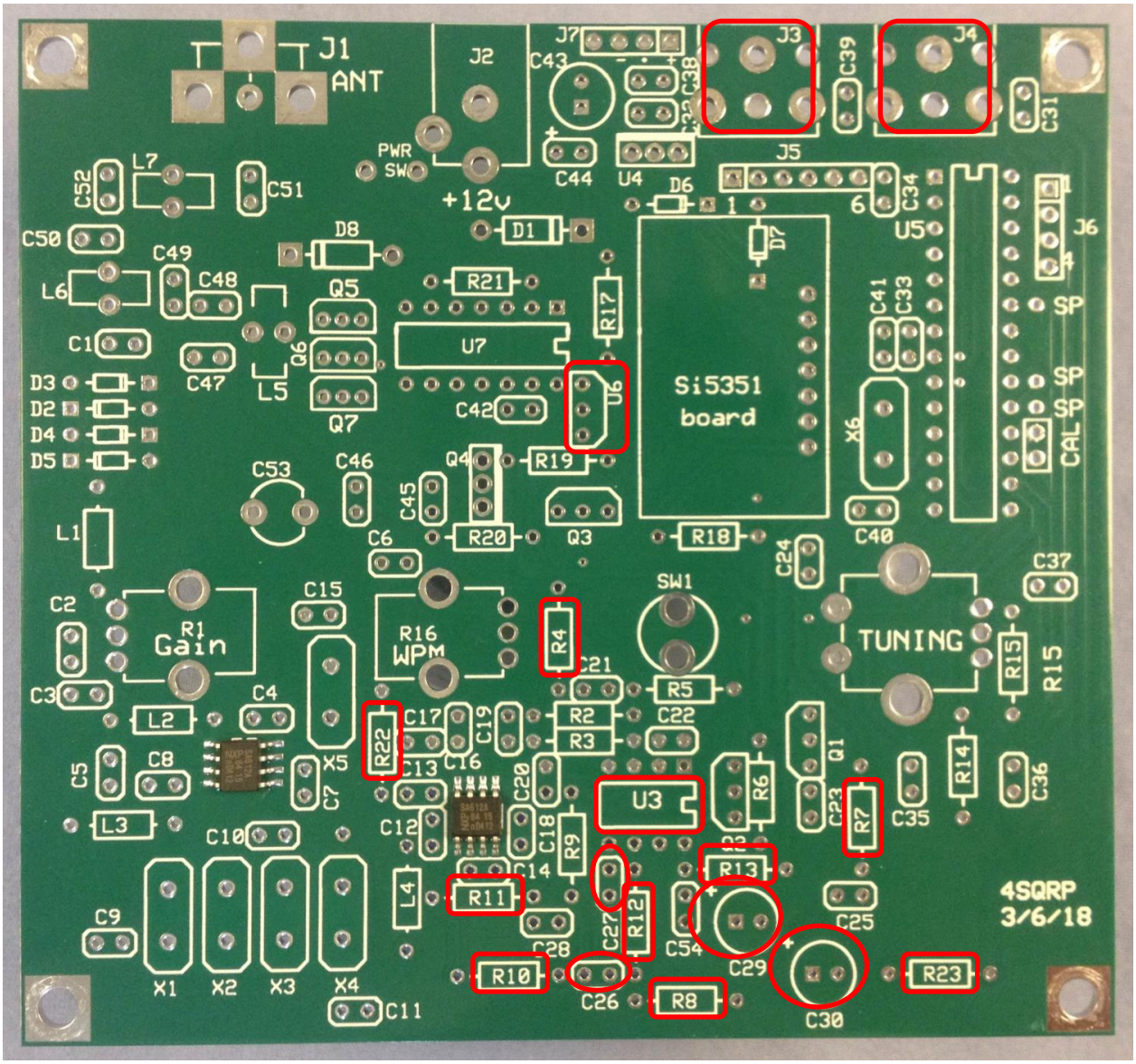
This photo was taken before the pins of the 5351 module had been soldered, and before the U5 IC chip had been inserted into its socket. Also, while voltage regulator U4 (78M05) is pictured here, that component will NOT be installed until Final Assembly.



GROUP 4 ASSEMBLY:

The components listed below will be installed, from Bag 4 and the Antistatic Bag. A detailed assembly sequence follows the illustration.

J3, J4, U6, R4, R22, R11, R10, U3, C27, C26, R7, R12, R13, R23, R8, C29, C30

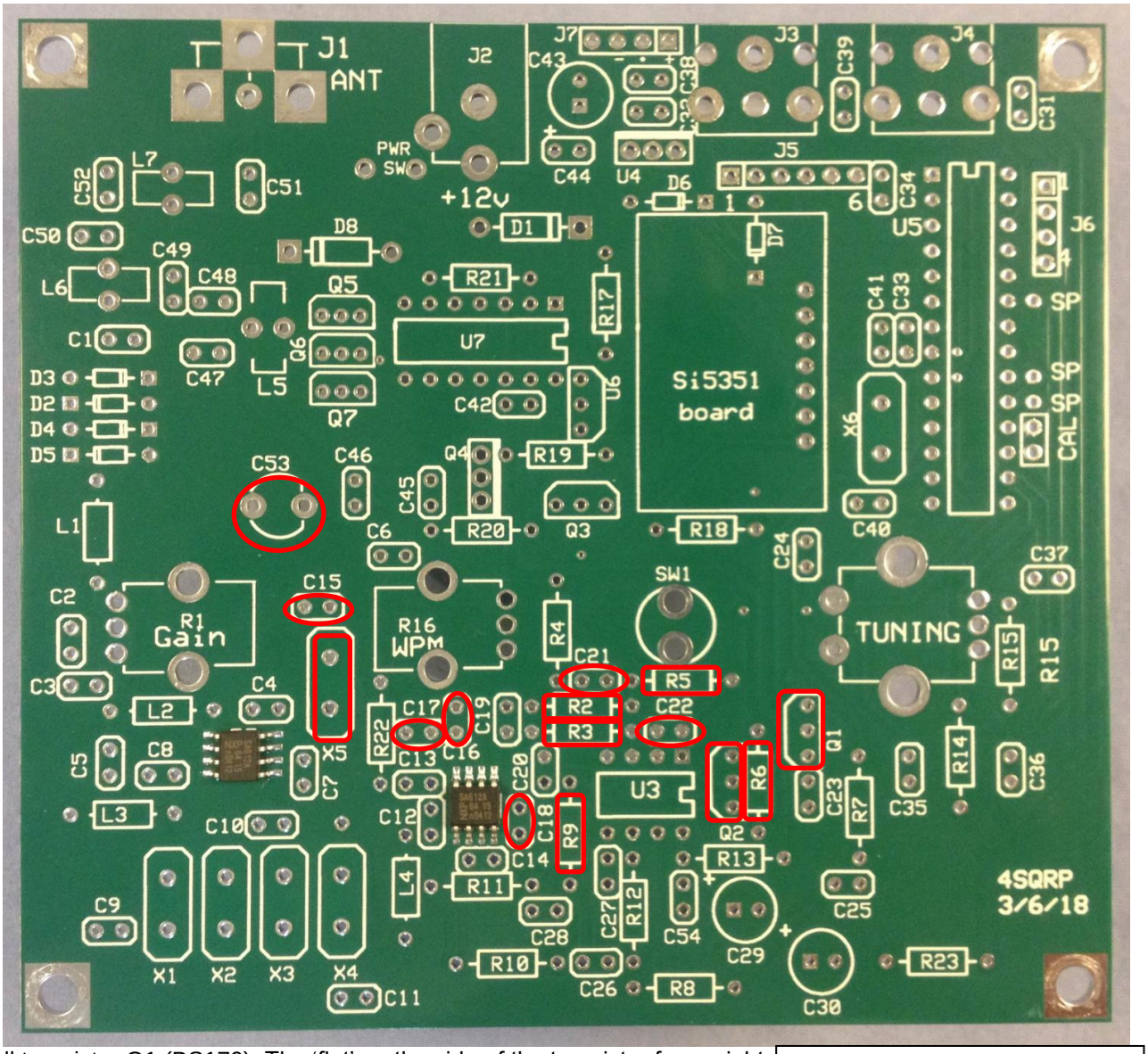


- ☐ Install J3 and J4, the 3-conductor stereo jacks, be sure they are seated flush and square. Solder 1 pin, check, finish.
- ☐ Install U6 (78L05). Observe proper orientation on the board. Flat side to the left.
- ☐ Install resistor R4 – 150K ohm (brown-green-yellow-gold)
- ☐ Install resistor R22 - 1K ohm (brown-black-red-gold)
- ☐ Install resistor R11 – 10K ohm (brown-black-orange-gold)
- ☐ Install resistor R10 – 510K ohm (green-brown-yellow-gold)
- ☐ Install the 8-pin DIP IC socket at U3. Its IC chip may be plugged in. The notched end of the socket faces to the right.
- ☐ Install the NJM4556AD IC at U3. This part is polarity-sensitive. ***The notch/dot on the IC faces to the right.***
- ☐ Install capacitor C27 (.0022 uF, '222')
- ☐ Install capacitor C26 (820 pF, '821')
- ☐ Install resistors R7 and R12 (1M ohm, brown-black-green-gold)
- ☐ Install resistors R13 and R23 (4.7 ohm yellow-violet-gold-gold) *Be careful not to mix up these with R8, below*
- ☐ Install resistor R8 (47K ohm yellow-violet-orange-gold)
- ☐ Install 100 µF electrolytic caps C29 and C30. Observe polarity. The longer wire leads (+leads) go to the square pads, which are the left-hand pads in the capacitor outlines. The reference + signs are at the upper left of each outline.

GROUP 5 ASSEMBLY:

Components listed below will be installed, from Bag 5 and the ESD Bag. Aassembly sequence follows the illustration

Q1, Q2, R6, R5, C21, C22, R2, R3, R9, C18, C16, C17, X5, C15, C53

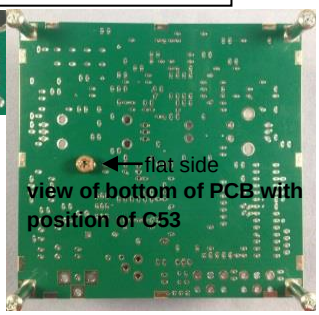


- ☐ Install transistor Q1 (BS170). The 'flat' on the side of the transistor faces right.
- ☐ Install transistor Q2 (J113). The 'flat' on the side of the transistor faces right.

Q1 and Q2 look nearly identical. Carefully check the imprinted markings.

- ☐ Install resistor R6 - 1M ohm (Brown-black-green-gold)
- ☐ Install resistor R5 - 330K ohm (Orange-orange-yellow -gold)
- ☐ Install capacitor C21 - 470 pF (marked '471')
- ☐ Install capacitor C22 - 220 pF (marked '221')
- ☐ Install resistors R2 & R3 - 10K ohm (Brown-black-orange-gold)
- ☐ Install resistor R9 - 22K ohm (Red-red-orange-gold)
- ☐ Install capacitor C18 - 0.033 uF (marked '333')
- ☐ Install capacitor C16 - 47 pF (marked '470' or '47J')
- ☐ Install capacitor C17 - 68 pF (marked '68J' or '680')

X1 – X5 have been selected as a matched set. The set measured here had a spread of only 32 Hz. But, if you have the ability to accurately measure crystals, select the LOWEST frequency for X5.

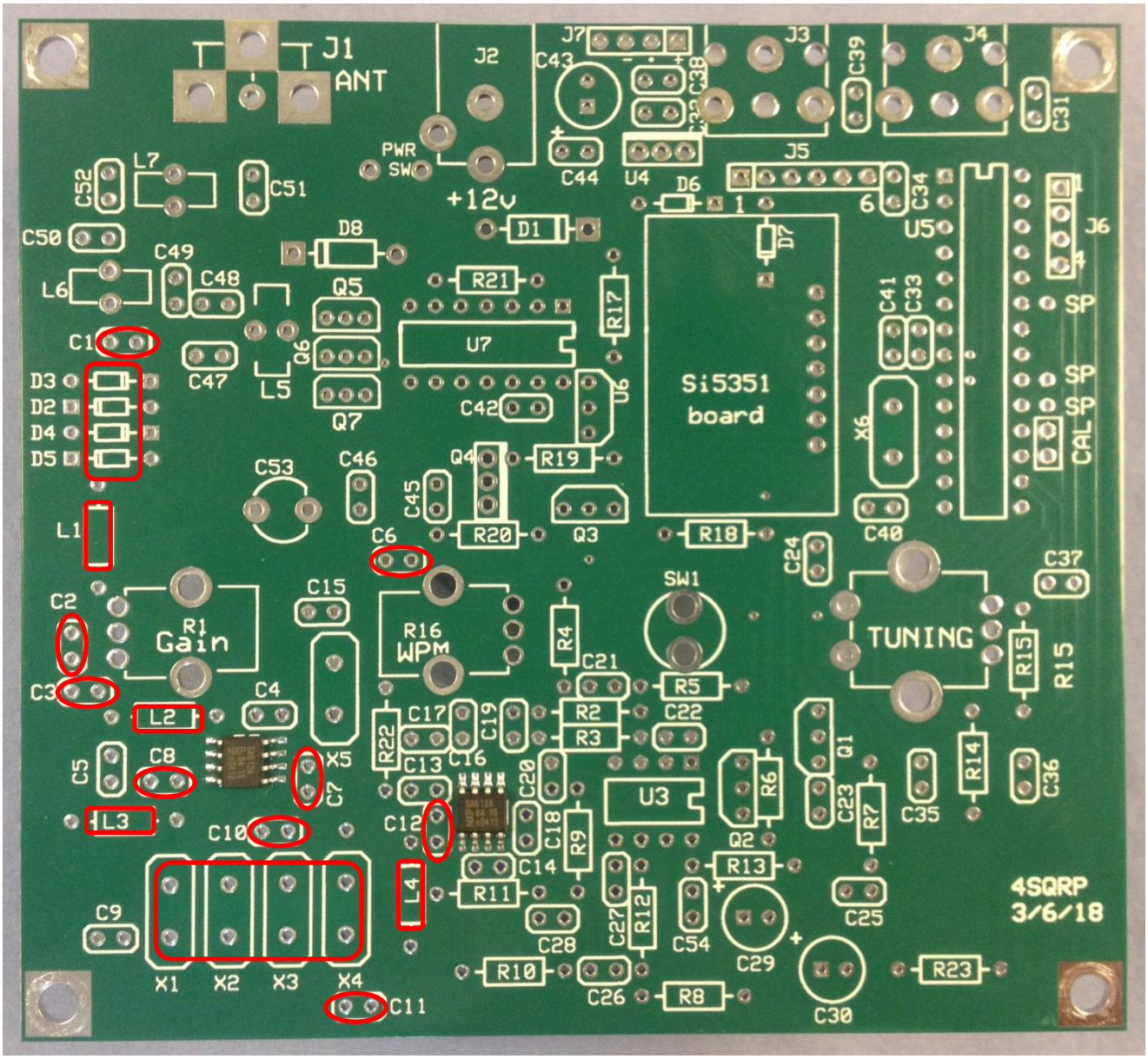


- ☐ Install crystal X5 – 5.185 MHz One of a matched set of 5 crystals. It's interchangeable within the group.
- ☐ Install capacitor C15 - 10 pF (marked '100' or '10J')
- ☐ Install - **ON THE BOTTOM OF THE BOARD** - trimmer capacitor C53, 12-60 pF (brown body). A toothpick in the hole in the flat side of the outline on top locates the holes below. Solder C53's pins on top, with the flat side as pictured.

GROUP 6 ASSEMBLY:

Components listed below will be installed. From Bag 6, the Band Pack, the ESD Bag, and the Crystal Bag. A detailed assembly sequence follows the illustration.

C1, C8, C12, C3, C6, L1, L2, C10, C2, C7, C9, C11, L3, L4, X1, X2, X3, X4, D2, D3, D4, D5



□ Install capacitors C1 (Band Pack), plus C8 and C12 (Bag 6) - 47 pF (marked ‘47J’or ‘470’).

□ **15m - Install capacitor C3 –** (Band Pack) – 33 pF (marked “330” or “33J” **OR**
□ **17m - Install capacitor C3 –** (Band Pack) – 39 pF (marked “390” or “39J” **OR**
□ **20m - Install capacitor C3 –** (Band Pack) – 47 pF (marked ‘47J’or ‘470’) **OR**
□ **30m - Install capacitor C3 –** (Band Pack) – 68pf - (marked ‘68J or 680’) **OR**
□ **40m - Install capacitor C3 –** (Band Pack) – 100pf - (marked ‘101’).

□ Install capacitor C6 - 10 pF (marked ‘10J’or ‘100’).

The molded inductors L1 and L2 look much like resistors but are generally slightly larger in diameter and often have a green body. They are marked with color bands that have the same meaning as resistor bands, but stand for units of micro-henries (µH). There may be additional bands, of various colors depending on manufacturer.

Example: L1 for 20 meters is 2.7 µH. It will be marked red-violet-gold-gold
"red" stands for "2" , "violet" for "7" The first "gold" stands for "x 10^{-1}" The final "gold" stands for 5% tolerance
So 2 7 x 10^{-1} = 27 x 0.1 = 2.7 µH, with +/- 5% tolerance
These molded inductors are wound with very fine wire that can break if stressed, so bend the leads very gently and carefully. Use 0.4 inch on your lead bending tool. You might want to test their DC resistance with an ohmmeter after bending the leads and before soldering. They should have less than 10 ohms resistance. Anything bigger means a likely broken wire.

In the event the part supplied has a larger than usual body that prevents the leads from being bent normally to the 0.4" spacing it is OK to gently curve the leads so they will fit. Don't worry if this leaves the part slightly above the board surface.

• 15m - Install molded inductor L1 – (Band Pack) 1.2 µH brown-red-gold-gold
• 15m - Install molded inductor L2 – (Band Pack) 2.2 µH red-red-gold-gold

• 17m - Install molded inductor L1 – (Band Pack) 1.5 µH brown-green-gold-gold
• 17m - Install molded inductor L2 – (Band Pack) 2.7 µH red-violet-gold-gold

• 20m - Install molded inductor L1 – (Band Pack) 2.7 µH red-violet-gold-gold
• 20m - Install molded inductor L2 – (Band Pack) 3.3 µH orange-orange-gold-gold

• 30m - Install molded inductor L1 – (Band Pack) 5.6 µH green-blue-gold-gold
• 30m -Install molded inductor L2 – (Band Pack) 4.7 µH yellow-violet-gold-gold

• 40m - Install molded inductor L1 – (Band Pack) 10 µH brown-black-black-gold
• 40m - Install molded inductor L2 – (Band Pack) 6.8 µH blue-grey-gold-gold

• Install capacitor C10 - 150 pF (marked '151').

• 15m - Install capacitor C2 – (Band Pack) - 100 pF (marked "101") OR
• 17m - Install capacitor C2 – (Band Pack) - 120 pF (marked "121") OR
• 20m - Install capacitor C2 – (Band Pack) - 150 pF (marked '151') OR
• 30m - Install capacitor C2 – (Band Pack) - 220 pF (marked '221') OR
• 40m - Install capacitor C2 – (Band Pack) - 330 pF (marked '331').

• Install capacitors C7, C9 and C11 - 100 pF (marked '101').

• Install RF chokes L3 and L4 - 18 µh, brown-grey-black-gold bands.

• Install crystals X1 through X4 – 5.185 MHz. As in the group 3 assembly, a narrow (0.1") strip of paper temporarily stands the crystals slightly above the board.

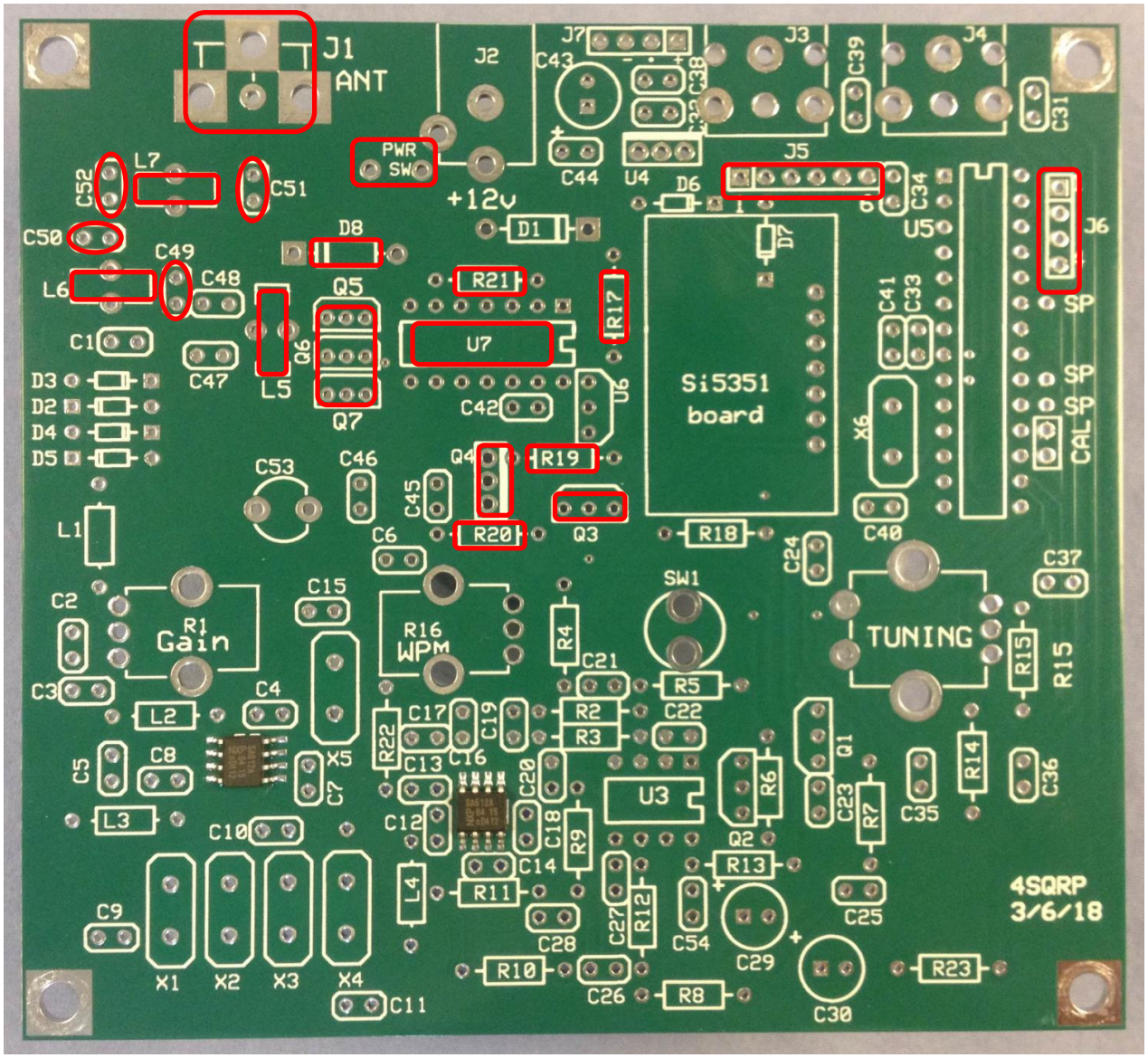
• Install diodes D2 through D5 - 1N4148. Be to match the banded end of each diode to the banded marking on the circuit board component outline. ***Note: D3 and D4 bands point to the right, D2 and D5 bands to the left.***

Note: the PC board pads for D2 - D5 are spaced 0.3 inches, which is too small for most lead bending tools. Be careful when forming the leads, and don't force the parts into the holes. They should slip in smoothly.

GROUP 7 ASSEMBLY:

Components listed below will be installed, from Bag 7 and the ESD Bag. A detailed assembly sequence follows the illustration.

R17, R19, R20, R21, Q4, U7, Q3, Q5, Q6, Q7, D8, C49, L5, L6, L7, C50, C51, C52, J1, J5, J6



- □ Install R17, R19, R20 and R21 - 10K ohm (brown-black-orange-gold).
- □ Install Q4 - FQU8P10 or IRF9530 ORIENTATION: *Ensure that the heat-sink 'flat' is to the right, as shown*.
- □ Install a 14-pin IC socket at U7 – ORIENTATION: *The notch on the socket faces to the right, as shown.*
- □ Adjust the lead spacing on U7 - 74AC08 as needed, if it wasn't already plugged in.
  Now install U7 - 74AC08 ORIENTATION: *the dot/notch on the IC body faces to the right*
- □ Install transistors Q3, Q5, Q6, and Q7, (all BS170) ORIENTATION: the flat sides of the components should match the longer flat sides on the PCB outlines.
- □ Install Diode D8 (1N4756) 0.4" lead spacing , ORIENTATION: *banded end towards the left*
- □ **15m** - Install capacitor C49 (Band Pack) – 130 pF (marked '131') **OR**
- □ **17m** - Install capacitor C49 (Band Pack) – 160 pF (marked '111') **OR**
- □ **20m** - Install capacitor C49 (Band Pack) - 220 pF (marked '221') **OR**
- □ **30m** - Install capacitor C49 (Band Pack) - 330 pF (marked '331') **OR**
- □ **40m** - Install capacitor C49 (Band Pack) - 470 pF (marked '471')

For the 17 meter Bandpack, C49 may be supplied as an axial leaded part. If so, bend the leads into a hairpin loop and install the part vertically on the PC board.

□ In the Band Pack, locate the piece of #21 or #22 wire (thicker than the #24) and the FT37-43 (dark grey) ferrite toroid core. Use a piece about 8" long.
Wind 8 turns, distributed over the full core circumference to form the RF choke, L5.
Trim excess lead length to about 3/8" (1 cm).
Using a small knife, gently scrape the insulation from the protruding leads.
(*The insulation will NOT melt when you apply a soldering iron*)

□ Install and solder L5. Pull the leads so the toroid is tight to the PC board.
A properly-wound toroid looks like the top photo at right. Note:

(*bad bad ugly toroid!*)

Each time the wire goes through the hole it counts as one turn.
Double check your work.
• The winding is evenly-spaced around the core as shown at top right
Regardless of the number of turns, distribute the turns over the core.
• The leads are scraped clean prior to installation, all the way to the core's body
• The windings are tight. I pull the wire taut after each turn comes up over the outer edge of the core.

• *and please*… no scrambled turns! Beware 

□ **15m** - Using a 10" piece of the #24 (thinner) magnet wire, wind 9 turns on a T37-6 (yellow) toroid (Band Pack). Spread out the turns. Prepare the leads as above and install at L6.
□ **15m** - Using a 10" piece of the #24 (thinner) magnet wire, wind 11 turns on the remaining T37-6 (yellow) toroid (Band Pack). Spread out the turns. Prepare the leads as above and install at L7.

□ **17m** - Using a 10" piece of the #24 (thinner) magnet wire, wind 11 turns on a T37-6 (yellow) toroid (Band Pack). Spread out the turns. Prepare the leads as above and install at L6.
□ **17m** - Using a 10" piece of the #24 (thinner) magnet wire, wind 12 turns on the remaining T37-6 (yellow) toroid (Band Pack). Spread out the turns. Prepare the leads as above and install at L7

□ **20m** - Using a 11" piece of the #24 (thinner) magnet wire, wind 12 turns on a T37-6 (yellow) toroid (Band Pack). Spread out the turns. Prepare the leads as above and install at L6.
□ **20m** - Using a 12" piece of the #24 (thinner) magnet wire, wind 14 turns on the remaining T37-6 (yellow) toroid (Band Pack). Spread out the turns. Prepare the leads as above and install at L7.

□ **30m** - Using a 12" piece of the #21 or #24 (thinner) magnet wire, wind 14 turns on the T37-6 (yellow) toroid (Band Pack). Spread out the turns. Prepare the leads as above and install at L6.
□ **30m** - Using a 12" piece of the #24 (thinner) magnet wire, wind 14 turns on the T37-2 (red) iron powder) toroid (Band Pack). Spread out the turns. Prepare the leads as above and install at L7.

□ **40m** - Using a 13" piece of the #24 (thinner) magnet wire, wind 16 turns on a T37-2 (red) toroid (Band Pack). Spread out the turns. Prepare the leads as above and install at L6.
□ **40m** - Using a 14" piece of the #24 (thinner) magnet wire, wind 19 turns on the remaining T37-2 (red) toroid (Band Pack). Spread out the turns. Prepare the leads as above and install at L7.

Some math … the wire length needed to wind N turns on a T37 size toroid, allowing 1.5" leads each end, is about:
L = N(0.53) + 3 *in inches*

□ **15m** - Install capacitor C50 (Band Pack) - 360 pF (marked '361) **OR**
□ **15m** - Install capacitor C50 (Band Pack) - 390 pF (marked '391) **OR**
□ **20m** - Install capacitor C50 (Band Pack) - 470 pF (marked '471') **OR**
□ **30m** - Install capacitor C50 (Band Pack) - 680 pF (marked '681') **OR**
□ **40m** - Install capacitor C50 (Band Pack) - 820 pF (marked '821').

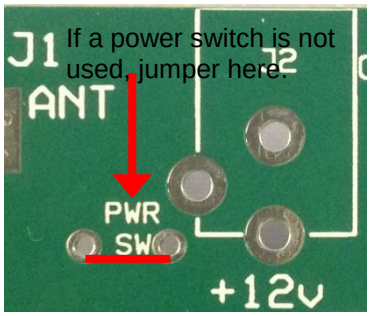
□ **15m** - Install capacitor C51 (Band Pack) - 200 pF (marked '221') **OR**
□ **17m** - Install capacitor C51 (Band Pack) - 220 pF (marked '221') **OR**
□ **20m** - Install capacitor C51 (Band Pack) - 270 pF (marked '271') **OR**
□ **30m** - Install capacitor C51 (Band Pack) - 390 pF (marked '391') **OR**
□ **40m** - Install capacitor C51 (Band Pack) - 470 pF (marked '471').

□ **15m** - Install capacitor C52 (Band Pack) – 36 pF (marked "360" or "36J") **OR**
□ **17m** - Install capacitor C52 (Band Pack) – 39 pF (marked "390" or "39J") **OR**
□ **20m** - Install capacitor C52 (Band Pack) - 56 pF (marked '560' or '56J') **OR**
□ **30m** - Install capacitor C52 (Band Pack) - 68 pF (marked '680' or '68J') **OR**
□ **40m** - Install capacitor C52 (Band Pack) - 100 pF (marked '101'').

□ Install the BNC bulkhead jack, J1. Roughen the jack's plating with a file or sandpaper for a good solder joint. There's a lot of thermal mass on those ground lugs. You don't need a bigger iron, but it will take more time to heat up the lugs and pads.

□ Install two male header strips – J5 (6 pins) and J6 (4 pins). **DO NOT** install a 4-pin header at J7 at this time. Insert the short pins though the PC board. Use a bit of tape to hold them in place while you solder only one pin on each header. Turn the board over and check that the headers are straight, square, and plumb. Reheat and adjust as needed. Then solder the remaining pins. The J7 header may or may not be needed for a future accessory.

This most recent run of circuit boards added a pair of pads that can be used to connect an optional power ON/OFF switch. A DPDT miniature short-lever toggle switch is provided in the kit. Some builders my prefer to omit the power switch, or even to use it for a different purpose.



Examine your board just to the right of the BNC jack (J1). If you see two pads labelled "PWR SW" you have one of the new boards

□ If you do **NOT** plan to use the supplied DPDT switch for a power OFF/ON function, use a discarded component lead to make a jumper across the "PWR" pads indicated in red in the image below. Your transceiver will then be powered up as soon as you plug a live +12V source into the DC power jack.

If you **WILL** be using the switch for power ON/OFF, it will be connected to the "PWR SW" pads during the "Final Assembly" sequence. **DO NOT** put a wire jumper there at this time.

There are three unconnected pads, near U5, labelled "SP" for "spare." These pads are connected to Input/Output pins on the microprocessor which are not being used by the current firmware. The two near CAL are digital I/O, while the one near J6 can be digital or analog I/O. They are available for use by user-written firmware that might add additional features

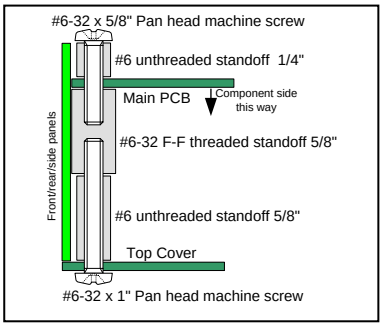
Other than those spare pads, the only things left unconnected at this time should be:

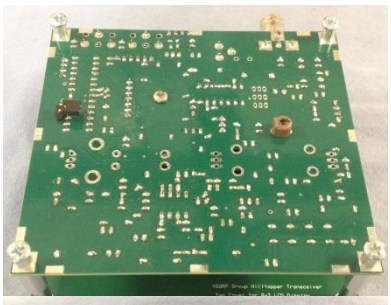
GAIN control - 5K potentiometer R1 – (installed during Final Assembly)
SPEED control - 5K potentiometer R16 – (installed during Final Assembly)
FUNCTION pushbutton switch - SW1 -– (installed during Final Assembly)
TUNING control - rotary encoder -– (installed during Final Assembly)
The J7 header strip – will not be installed
And, possibly the PWR SW pads – awaiting wired connection to the rear panel switch (Final Assembly)

***** This completes assembly of the main circuit board *****

Final assembly:

Think back to the “dry fit” of the enclosure that you did earlier. You are now going to rebuild that assembly, but in a slightly different sequence, upside down as in the drawing, and without the bottom cover. This will allow you to have access to the solder pads you will use to permanently connect the main PC board to the front, rear, and side panels. It’s alright if you still have the LCD display attached to the top cover, but now is the time to remove the plastic protective film on the face of the display if you haven’t done so already.





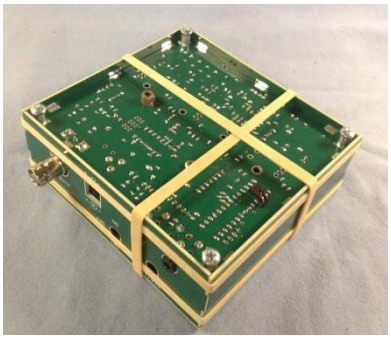
- □ Start with the top cover face down on a paper towel or soft cloth to prevent scratches. Assemble the 1” screws, 5/8” unthreaded standoffs, and 5/8” threaded standoffs at each corner as shown in the photo.

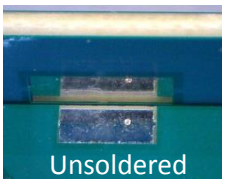
- □ Place the main PC board on top of the stack, component side down, and +board-mounted connectors to the back edge as in the photo. You’ll notice that the pads for transistors Q5, Q6, and Q7 are unsoldered. These photos were taken before those parts had been mounted. Your board will have them.

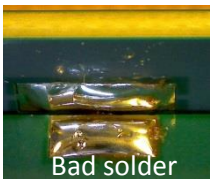
- □ Grab some rubber bands and add the front, rear, and side panels just as you did before. Now the BNC and stereo connector jacks should line up with, and protrude through, their cutouts in the rear panel. The power jack will be flush with the inner surface of the rear panel.

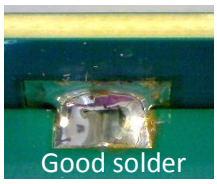
  The silkscreen printing on the inner surface of the front, rear, and side panels will be upside down when they are in proper position.

Examine the bottom of the PC board. You’ll see a series of twelve rectangular solder pads around the perimeter (bottom photo). Each one should line up adjacent to a matching pad on a front, rear, or side panel. There should be no more than a tiny gap in the corner between the matching pads. These pads are thermally isolated from the ground planes, so when you solder, the heat will be mostly contained within the small area of the pads. A soldering iron tip held in the corner touching both matching pads should head the two pads and allow you to form a smooth solder fillet that will solidly join them, mechanically and electrically. DO NOT yield to the temptation to grab a hotter, higher power iron. The same iron you used for the components will do fine. The photos below show how a proper solder fillet should appear.





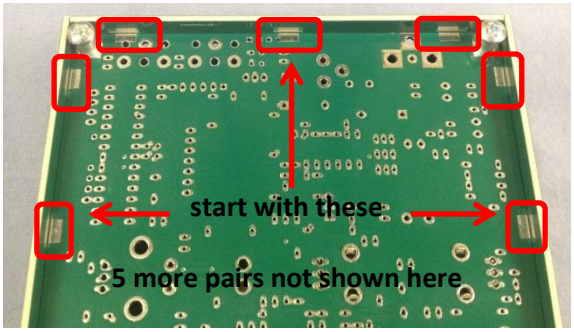




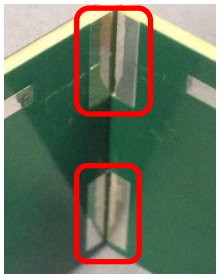
- □ Inspect the alignment of the front, rear, and side panels with the top cover and the main PC board. Make sure the corners are square and only a tiny gap exists. Snug up the screws. Press the front, rear, and side panels down firmly against the top cover. When you are satisfied that the alignment is good, solder only the middle pair of pads where the rear panel joins the PC board.

- □ Inspect the alignment again. If you have to, you can use solder wick or a solder sucker to free the PCB and adjust the fit.
  If the fit is good, continue soldering just the center pairs of pads, doing one panel at a time, and inspecting again after each one is soldered.

- □ Once all four sides have the middle pair of pads soldered, and they’ve passed your inspection for alignment and fit, proceed to solder the remaining eight pairs of pads.



You will notice that there is another collection of those rectangular solder pads at the corners where the front, rear, and side panels join. Soldering those points gives further stiffening to the enclosure. There are pad pairs both above and below the main PC board. You'll have to temporarily remove a screw and standoff to gain access to solder these pads.



□ If you are happy with the alignment of the panels so far, proceed to solder these four pairs of pads on the underside of the PC board. Do one corner at a time. Inspect the alignment after each corner. Replace the hardware each time you've soldered a corner, to keep things snug.

□ Once the four corners below the bottom of the PC board are soldered the enclosure should be pretty sturdy. Now remove the top cover and repeat the process for the four sets of corner pads above the PC board. Set the top cover aside for the moment.

□ Install the controls as you did during the dry fit: 5K potentiometers R1 and R16 (marked "502"), pushbutton switch SW1 and the rotary encoder (listed as SW2). Make sure each one is pressed flush against the PC board and that it is square and plumb to the board. Slip the plastic extenders onto the controls just as you did for the initial dry fit. Remember that the encoder's extender is slightly shorter than the ones for the potentiometers. Temporarily fit the top cover in place with "barely tight" screws to ensure the controls will align with holes. Turn unit over and solder ONE PIN ONLY on each component.

Note concerning pushbutton SW1: WB6ZFG has suggested an alternative mounting for SW1. He used the lockwasher and nut to secure the switch to the top panel and made wire connections to the pads on the PC board. He observed that this arrangement gave better tactile feedback than the plastic extender and had the advantage of not exerting downward stress on the PC board when the switch is pressed.

It's perfectly alright to use this method. The only downside is having to remove the nut if the top cover needs to be removed. But since the CAL and BFO adjustments are on the bottom of the PCB there will be little need to remove the top cover one the rig is in operation. A suggestion is to use relatively stiff solid wire to connect the switch to the board. Solder wires to the switch, mount the switch to the top cover, and attach the top cover to the enclosure, fishing the wires through the PCB holes. Then solder the wires to the PC board. The stiff wire leads will help hold the switch in position when the top cover is reinstalled.

□ Check the alignment with the top cover once again. If necessary, remove the top cover, reheat, and reposition components. Once you are satisfied that all are square and plumb, and the shafts turn freely without binding, solder the remaining pins. Remove the top cover once again and set it aside.

□ If you have decided to use the supplied DPDT toggle switch as a power ON/OFF control, install it now. A short length of #22 stranded, insulated hookup (yellow) wire is provided in the kit.

At this point you should perform a "dry-fit" of the voltage regulator, U4 (78M05 – in the ESD Bag) and the DPDT toggle switch.

Temporarily mount the toggle switch on the rear panel as shown in the photo (but without any wire leads attached yet) using the supplied hardware. Put the lockwasher inside the panel, and the indexing washer outside. You can either nip off the little indexing tab that isn't needed, or put the washer on with the tab facing outwards. Finish with the two nuts on the outside. Insert the 78M05 voltage regulator into its PCD pads. The face with the printed markings should face towards the 5351 module.

Verify that the jack J3 does not interfere with the body of U4. You may need to lean U4 forward to keep it from touching J3. Also verify that the lugs of the toggle switch are not interfering with U4. If all appears satisfactory, remove U4 and set it aside for the moment while you proceed with wiring the switch.

□ For ease of handling, temporarily remove the switch from the rear panel. Cut two 2 ¼" pieces of the insulated hookup wire and strip about 3/16" insulation from each end. On one of the pieces, use a bit of tape or a marking pen to identify both ends, so you can tell the wires apart after you've twisted them together. Solder one end of each wire to the lugs of the switch as shown in the photo. Be sure to dress the wires sideways away from the switch as in the photo. Otherwise they may touch components behind the rear panel. Twist the wires together a few times.

□ Note the orientation of the switch lugs and wires as shown in the photo. This will make the switch operation conform to the labels on the rear panel. "UP" toggle will be "ON" and "MIDDLE" or "DOWN" toggle will be "OFF."

- □ Insert the switch into the hole on the rear panel labelled ON and OFF. Put the lockwasher inside the panel, and the indexing washer outside. You can either nip off the little indexing tab that isn't needed, or put the washer on with the tab facing outwards. Finish with the two nuts. Snug up the first one, then thread the second one as a jam-nut.

- □ Insert the wire from the middle lug of the switch (note the black marks in the photo) into the right-hand pad (closest to the power jack) of the "PWR SW" pair and solder it on the bottom side of the board. In the same fashion, solder the other wire to the left-hand pad. Set the switch to the OFF (middle) position.

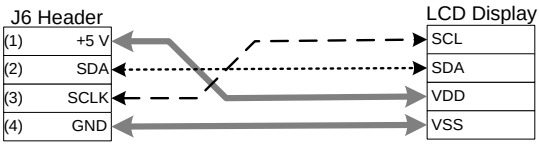
- □ Now, in the same manner as when you performed the dry-fit, re-install U4, remembering that the face with the markings goes towards the 5351 module. If it once more has good clearance from J3 and the toggle switch, solder its three pins.

- □ If you had removed the display from the top cover after the initial "dry fit" you can reinstall it now in the same fashion. Make sure the protective plastic film has been removed from the face of the LCD.

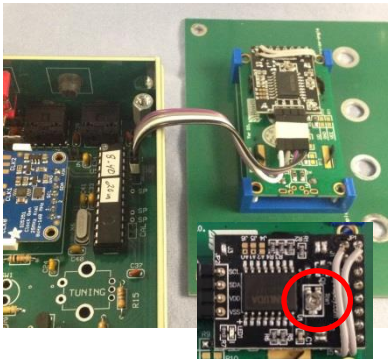
- □ Double check the orientation of the display so it will read right-side-up. Snug up the screws if necessary. ***DO NOT OVERTIGHTEN THE #4-40 SCREWS***. Threads in plastic will strip easily.

You will now prepare a Dupont style ribbon cable to connect the LCD to the main PC board. A 10cm (~3") cable is in the Final Bag.
The order of the signals at the pins of J6 are not the same as that at the header pins on the LCD display board. You will have to transpose the leads to match up the signals. The drawing below shows how the two ends of the ribbon cable should be arranged. The signal names at either end correspond to the labels used on the display board and on the Hilltopper schematic diagram. You should leave the wires in their natural order at the J6 end, and make the transpositions at the LCD end.

Notice in the photo of the actual cable that the wires are each of a different color. Your set will most likely be different colors than that in the sample photo. If you can print a copy of this page, you can write into the chart's blank spaces the actual colors that should be arranged at each end of your cable. Use a thin strip of tape to hold the plastic shells together in proper order at each end.



- □ Lay out the top cover and the Hilltopper chassis as shown. Plug one end of the 4-wire ribbon cable onto the 4-pin header on the little "backpack" I2C adapter attached to the display. Plug the other end onto the J6 header. You may have to make folds in the cable when you put the top cover into position. Double check that the wires are in correct sequence at each end.

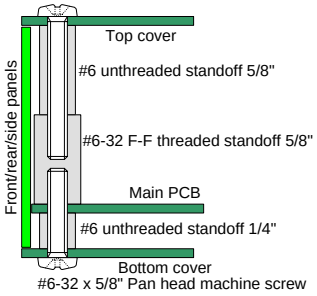


- □ There is a tiny potentiometer on the LCD board (red circle) that controls the contrast of the display. Use your jeweler's slotted screwdriver to set it fully clockwise for the moment. This will ensure that the display is visible initially, You can readjust it to your preference later.

- □ Put the control shaft extenders back onto their respective controls. Remember the extender for the encoder is a bit shorter than the other two as seen in the photo below. Make a few emery board strokes to clean up any roughness on the plastic shafts.

*Another hint for getting those unthreaded standoffs to stay put while installing the top cover. I cut some round toothpicks in half and stuck one piece (fat side down) into each **threaded** standoff. Then I slipped the unthreaded standoffs over the toothpicks. Next I dropped the top cover over the exposed toothpicks. Line up the control shaft extenders through their holes. Doing one corner at a time I carefully pulled out the toothpicks and put the 1" screws in their place. The weight of the top cover kept the standoffs captive.*

□ Replace the top cover with its standoffs. The drawing at right is a reminder of the order of the standoffs and screws. Note how the top/rear/side panels fit between the top and bottom covers, with the covers overhanging the sides.



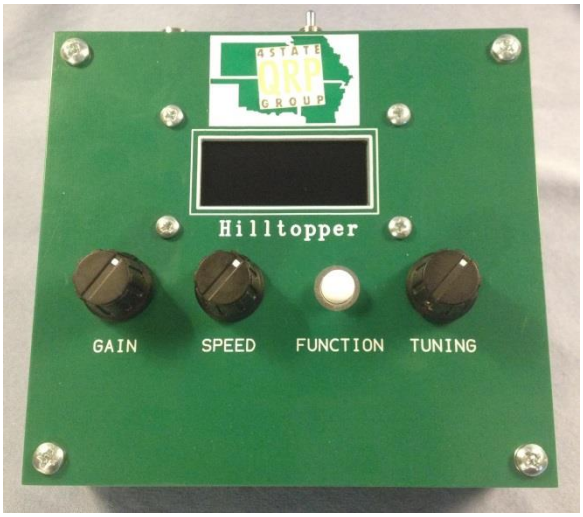
□ Now add the bottom cover. With the unit upside down, rest it on something so controls are held above the work surface, set a 1/4" unthreaded spacer over each hole (probably don't need the toothpick trick fir these short ones). Carefully lay the cover on, then put the remaining ⅝" screws through the holes and spacers. Use a screwdriver, ***first turning counter-clockwise*** until you feel the screw seat itself into the threaded spacer, and then turn clockwise to tighten.

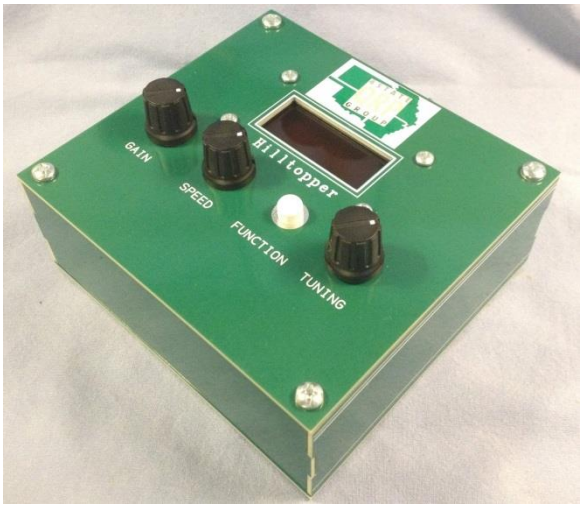
□ Install knobs (Final Bag) on the three controls, using a small screwdriver on the slotted setscrews. Space the knobs slightly above the panel to prevent rubbing. The tuning knob must be mounted just high enough to allow the pushbutton switch on the rotary encoder to function when the knob is pressed down.

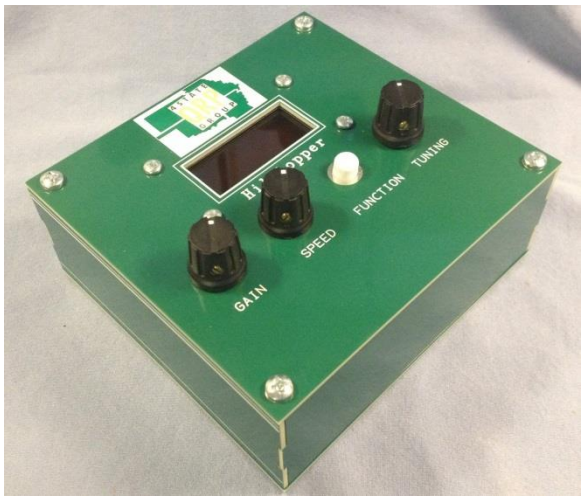
You'll find that the shaft extenders exhibit some "looseness" on the control shafts. This doesn't affect operation, and the extenders cannot fall off the shafts when the top cover is in place. Resist the temptation to reach for the epoxy and glue the extenders onto the shafts. If you do, the chances are good that you'll end up with the extenders rubbing against the sides of the holes. The looseness ensures free rotation.

□ Use the little black rubber hole plug (Final Bag) to fill the unused hole in the rear panel.

Your radio ought to look like this:







*** * * *** ***This completes assembly of the kit*** *** * * ***

Continue to initial power-up checks, calibration, and BFO alignment.

Initial Power-Up Checks

For the initial checks you'll need a few items:

A 50 Ω, non reactive Dummy Load, rated 5W or more.
If you don't have a dummy load (well… Get one! *http://www.4sqrp.com/4SDL.php*)
you can connect the radio to a **MATCHED ANTENNA**
NEVER, EVER operate the radio without a reasonably matched antenna, or a dummy load connected.

A power source providing 11 – 13.8 VDC, with current capacity of about 1 ampere.
If you have a power supply with a current limiting feature, that would be great.
Set the current limit to about 200 mA at first.

A power cord terminated with a 2.1 x 5.5 mm coaxial DC power plug.

Low impedance headphones or earbuds.

A straight key or set of paddles
Paddles should have a 1/8" (3.5mm) stereo plug: tip => dit, ring => dah, sleeve => GND
Straight key should have a 1/8" (3.5mm) mono plug: tip => key, sleeve => GND
It is possible to use a straight key with a stereo plug. Details in the operating instructions.

(optional): DC voltmeter, RF power meter or SWR meter.

Verify that the **CAL** shorting jumper (bottom of the PC board) had been removed.

Be sure the radio's power switch (if used) is set to the **OFF** (middle) postion.

Connect your dummy load or matched antenna
NEVER, EVER operate the radio without a reasonably matched antenna, or a dummy load connected.

Do not connect a key or paddles at this time.

Connect the DC power source.
If the voltage and/or current limit are adjustable, set a reduced "check out" voltage ~11V, current limit ~200 mA.

Turn the power switch to the ON (up) position.
If you hear Snap, Crackle, or Pop, see puffs of smoke or sparks, or smell nasty odors…
TURN IT BACK OFF RIGHT NOW! You will soon embark upon a "valuable learning experience"

Presuming the power-up was uneventful, you should within a few seconds see the LCD light up with a sign-on message that gives the version number of the installed firmware (at this writing, most recent is v8.69) a prompt for straight key setting, then transitions in a few more seconds to a frequency display. The frequency shown will be the default startup for your band.

Rotate the **TUNING** control back and forth. The displayed frequency should change up and down.
Rotate the **SPEED** control. A speed in WPM should briefly flash on the display, then revert to frequency

Turn the **GAIN** control fully clockwise (maximum gain) and plug in your headphones or earbuds.
You should hear some background hiss, or band noise or even signals if an antenna is connected.

If all the above were satisfactory, turn the power OFF, or disconnect the power source.

Plug in your key or paddles

Connect your RF power meter or SWR meter (and dummy load if the meter doesn't include one).

If the power supply has current limiting, reset it to about 1 ampere.

Turn the power ON or reconnect the power source (be alert again for those bad things).

Tap the key or paddle and check that there is an indication of some RF power output (< 4W at this reduced voltage)

All good so far? Great! Shut everything down and prepare to perform the calibration and BFO alignment.

ALIGNMENT:
There are only two steps in the alignment process. The frequency calibration is performed first.

1) Frequency Calibration – so you transmit on the frequency the dial displays
2) BFO pitch adjustment – so you can match the op at the other end of your QSO

Frequency Calibration:
The Si5351 DDS board uses a standard-quality SMD crystal as its reference clock. Without calibration your operating frequency may be off by a kHz or more at the band on which your kit operates. You should achieve frequency accuracy with a few tens of Hz after calibration.

PROCEDURE:

1) Tune your 'big rig' to the Hilltopper's startup frequency: 21060 kHz, 18096 kHz, 14060 kHz, 10112 kHz, or 7030 kHz, depending on the Hilltopper's operating band.
2) Remove the Hilltopper's bottom cover, but use a couple of the screws and standoffs at opposite corners to fasten the top cover so it won't fall loose.
3) Install the 2-pin **CAL** shorting jumper onto the right-angled header pins.
4) Connect a 50-ohm load to J1. A matched antenna is OK. **DON'T POWER UP WITHOUT IT !**
5) Apply 10-14V DC power to the *Hilltopper*

Upon power-up, whenever the **CAL** jumper is in place, the display will go through the normal start-up screens, then show the **CAL** mode and the default starting frequency for the band. The Hilltopper will now generate a continuous, low-level signal, but strong enough to be picked up with your "big rig." Set your big rig to CW mode, with the widest filter, and set its frequency to the same as that displayed on the Hilltopper. Rotate the Hilltopper's **TUNING** control up or down (the Hilltopper's displayed frequency will **NOT** change) until you hear the tone in your big rig and its pitch matches the Hilltopper's sidetone pitch. Initially you may be as much as a couple of kHz off – outside your big rig's filter passband – tune the big rig around for the signal, then walk it back to the default frequency.

Frequency counter method: Touch a frequency counter probe to the CLK1 pad on the 5351 module (ground pads are on either side) and apply D-C power to the rig. Adjust the tuning control as above until the counter reads the same frequency as the

When you are satisfied the tuning is close enough, press the **FUNCTION** button. The Hilltopper will drop out of **CAL** mode and show you the new calibration factor (may be positive or negative) that it will save to its internal EEPROM. That value will be retrieved on each subsequent power up.

Next you'll see a prompt concerning adjustment of the IF frequency. The rig's default IF center frequency will be displayed as an 8 digit number that represents tenths (not tens) of Hz. The frequency is actually saved in the rig's EEPROM memory as hundredths of Hz. The value in the photo should be interpreted as 5186100.00 Hz (5186.10000 kHz).

It's a good idea to write that value down in your build notes or on a piece of tape stuck on the inside of the bottom cover. For the time being, ignore this prompt and just **TAP** the **FUNCTION** button to skip the procedure. Greater details are in the BFO alignment section that follows.

Following the next on-screen prompt, power down the Hilltopper, remove the **CAL** jumper (save it in case you want to repeat the process), and power up again. The newly determined calibration factor will be fetched from memory, and the rig is ready for operation.

IMPORTANT: After calibration, remember to disconnect DC power, then remove the jumper at the **CAL** location. When you restore DC power the *Hilltopper* will resume normal operating mode.

BFO Pitch adjustment: (do this only AFTER the frequency calibration above):

The quick method:

Tune in a CW station and adjust trim cap C53 using a teensy screwdriver. You're looking for maximum signal strength at the same pitch as the sidetone (800 Hz). It's a 2-handed operation, since you also need to work the tuning knob.

The better method:

Power up the *Hilltopper* and leave it set at its starting frequency. Set your big rig to the same band and frequency, and send a string of dots with your big rig (lowest possible power, preferably to dummy load, please!). Adjust trimmer capacitor C53 so that the received pitch in the *Hilltopper* matches your big rig's sidetone pitch.

Replace the bottom cover.

What if you can't adjust the pitch enough to match the sidetone?

The *Hilltopper's* firmware presumes a nominal value for the center of the crystal filter's passband. It's possible that a given batch of crystals, even though closely matched to one another, may be so far away from that nominal value that the trimmer capacitor's range (about +/- 350 Hz) is inadequate to properly set the BFO pitch.

That's when you can make use of the IF Adjustment feature briefly noted above in the frequency calibration procedure.

Power down the *Hilltopper* and put the **CAL** jumper back in place. Power up again and wait until the **CAL** prompt appears.
TAP the **FUNCTION** button to skip the **CAL** portion and proceed to the IF adjustment.

Make sure to write down the frequency shown initially, just in case a complete do-over becomes necessary. You can always reset to this initial default and begin again.

The receiver will be active during this procedure, tuned to the default startup frequency for the band. So you'll be able to hear the change as you make the adjustments.

If your previous best efforts to adjust the trimmer still left the pitch too HIGH, you will need to INCREASE the IF frequency.
Conversely, if the pitch remained too LOW, then DECREASE the IF frequency.

Turning the **TUNING** control can adjust the IF frequency up or down in steps of 10 Hz. Remember that the display is to the nearest 0.1 Hz. The object is to get close enough to the proper pitch that the trimmer can make the final fine adjustments.

Before you begin the adjustments it's a good idea to set the trimmer near the middle of its range. That will give you a fine tuning range of better than +/- 300 Hz after you've finished the coarse setting.

Proceed to move the IF setting as needed, up or down, until you feel like you are "close enough." At any time during this process you can tweak the trimmer to see how close you are.

When you are happy with the result, write down the new value for reference, then **TAP** the **FUNCTION** button to save it and exit the procedure.

Remember to power down and remove the **CAL** jumper.

* ***Congratulations, you're done!*** *

Should you need help troubleshooting a problem, join the Hilltopper Support email group: https://4sqrp.groups.io/g/HilltopperKit *and put out a call. There are many skilled and experienced builders who will be happy to offer advice and counsel.*

Operation, Using rev8.68 (and later) Firmware

Be sure to also read the operating instructions, in APPENDIX E, for the basic Hilltopper functions.

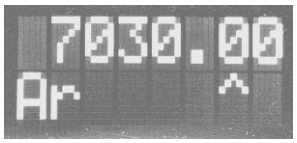
Each time power is applied, the firmware scans the I2C data bus to determine whether an LCD interface is present and responding to commands.
If an LCD device is not found the Morse message "**NO LCD**" is sounded and the *Hilltopper* will operate in its original non-display fashion. There will be Morse announcements of the firmware version number (e.g., rev8r44") the band of operation (e.g., "40m") whether RIT or XIT are currently available (e.g., **RIT** or **XIT**) and, finally, the starting frequency (e.g., "0r30" which would mean 7030.0 kHz for a 40m kit). The *Hilltoppe*r will then function the same as one with the version 6.xx firmware described earlier in the manual.

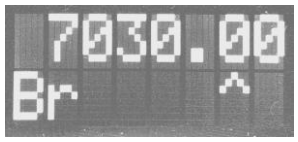
If, however, an active LCD device is discovered, many of the Morse announcements will be supressed in favor of the visual display. The following describes the format of the information that will be available on the display.

This is the sign-on splash screen showing the version number of the installed firmware. Options such as keyer mode, paddle reversal, and straight key mode can be selected at power up by a pressing certain controls while power is being applied. At the release of this manual, firmware enhancements had reached rev8.68.

Following the firmware version screen, this prompt will remind you that if you press and hold a connected straight key, or either paddle of an iambic paddle set, the internal keyer will change to straight key mode until the next power up cycle. Press it at the prompt and keep it pressed until you see the bottom frequency display with **SK** (below) appear.

Below are the basic displays of frequency, tuning step size, and keyer mode. The up-pointer shows which decimal place is currently being affected by the **TUNING** control. Here the step size is 100 Hz (TAP the **TUNING** pushbutton to change step size). The "**An**" means iambic ***mode* A** for the keyer, with **n***ormal* paddle wiring (dits for the righthand thumb). The other possibilities, shown below, are "**Ar**" for *mode* **A r***eversed* paddles, and "**Bn**" or **Br**" for *mode* **B n***ormal* or **r***eversed*.





Basic frequency display, but now the "**SK**" indicates operating in straight key mode. Straight Key was selected as described above and with more detail later in this section. Note: the tuning step size has been changed to 1 kHz.

Receive Incremental Tuning (RIT) and Transmit Incremental Tuning (XIT)
The Hilltopper can provide either RIT or XIT, but not both at the same time. A LONG PRESS (greater than 5 seconds) of the **TUNING** pushbutton will toggle back and forth between the two features. Just as described in the APPENDIX, a sequence of "beeps" and "boops" signal which feature is available for use. The feature is toggled on/off by a SHORT PRESS (greater than 1 second, less than 5 seconds) of the **TUNING** pushbutton.

Whenever either RIT or XIT is turned on, there is an option to have a display with the top line for frequency and the bottom line for status, or a display with two lines for frequency. The actual receive frequency is always shown on the top line, regardless of which display option is in use. At left, RIT has been turned on. Note that the decimal point has been replaced by "r" to indicate that RIT is active. The default display is one line for frequency and one line for status. Single frequency display with RIT turned on. The "r" replaces the decimal point as a reminder that RIT is active. The displayed frequency is the actual receiving (possibly RIT shifted) frequency. The transmit frequency is the same as it was when RIT was turned on.

When RIT is on, a short TAP of the **FUNCTION** pushbutton toggles between the above single line frequency display and a dual frequency display. The decimal point in the top line is "r" to indicate the display of the receive frequency. The decimal point in the bottom line is "x" to indicate the transmit frequency. Since RIT is on, only the receive frequency (top line) will be affected by the TUNING control. An underline cursor in the top line shows which digit (10 Hz digit here) is being varied by the **TUNING** control.

Just as in the rev6.xx firmware described in the APPENDIX, you'll know whether the rig has RIT or XIT available any time you HOLD the **TUNING** pushbutton to toggle on the feature on/off. The single or double "boobeep(s)" will signal which feature: RIT ON is signaled by a *boobeep* sound (an up-chirp), RIT OFF is signaled by *beeboop* (a down-chirp).
XIT ON/OFF is signaled by doubled up or down-chirps (*boobeep-boobeep* or *beeboop-beeboop*)

XIT/RIT availability toggles back and forth with a LONG PRESS (greater than 5 s) press of the **TUNING** pushbutton.

At left, XIT has been turned on. Note that the decimal point has been replaced by an "x" with a bar over the top to indicate that XIT is active. The default display is one line for frequency and one line for status. With this display option, turning the **TUNING** control will not change the displayed frequency, because the control is now shifting the transmit frequency. *Remember that the top line always displays the actual receive frequency.* A couple of seconds after any motion of the **TUNING** control, a Morse announcement will tell how many XIT tuning steps (held fixed at 100 Hz per step) the transmit frequency is offset from receive. For example: "U3" for three steps (300 Hz) up, or "D6" for six steps (600Hz) down.

A short TAP of the **FUNCTION** pushbutton toggles between the above single line frequency display and the dual frequency display. The decimal point in the top line is "r" to indicate the display of the receive frequency. The decimal point in the bottom line is "x" to indicate the transmit frequency. Since XIT is on, only the transmit frequency (bottom line) will be affected by the **TUNING** control. An underline cursor in the bottom line shows which digit (always the 100 Hz digit with XIT) is being varied by the **TUNING** control. *In XIT the tuning step size is held fixed at 100 Hz per step.*

Regardless of what frequency display format is active, whenever you turn the **SPEED** control the selected keyer speed will flash on the bottom line just long enough to read it before reverting to the currently active frequency display.

If the *Hilltopper* is operating in straight key mode (SK) and the key is pressed for more than 5 seconds the rig will go into TIMEOUT! to protect the finals from a "stuck key" condition. A TAP of the **FUNCTION** pushbutton will clear the timeout and restore normal operation.

Out-of-band Transmit Protection

Each time the *Hilltopper's* transmitting frequency is changed, whether by the main tuning control or an XIT adjustment, the resulting frequency is compared against the upper and lower limits of the band (the full band, not just the usual CW portion).

If the new frequency is beyond a band edge, the transmit frequency will not be changed, and a warning message is displayed. The warning disappears if tuned back within the band limits. The receive frequency will not be limited, however, so the rig can receive outside the band. It won't be "General Coverage Receive" by any means, but a few hundred kHz above and below should be possible.

Paddle Reverse and Iambic Mode A/B Selection

Apply DC power to the *Hilltopper* while PRESSING AND HOLDING the **FUNCTION** pushbutton switch. Hold the button until you you see **Pdl Rev ?** on the LCD or hear **R?** in Morse on the sidetone. Then release the button and tap either paddle within 2 seconds to reverse the paddles. (Do nothing and there's no swap)

Next, you'll see **Mode B?** on the LCD or hear **B?** in Morse. Tap either paddle within 2 seconds to choose Mode B (Do nothing, and Mode A is selected*)* (Most operators prefer Mode A) You'll then hear an 'A' or 'B' to confirm your selection and you'll see the keyer mode on the LCD frequency display Your selections are saved in non-volatile EEPROM memory and the *Hilltopper* will proceed to normal operation. The LCD also shows which mode is in operation.

Straight Key mode

Method 1. Upon power-up, the *Hilltopper* firmware checks the state of the **RING** (middle) connection on the keyer jack. If a "mono" (2-conductor) plug is used, the **SLEEVE** portion of the plug contacts the RING terminal of the jack, and that connection is grounded. The *Hilltopper* senses that condition and automatically follows the straight key or external keyer input. The iambic paddle function will be disabled. The LCD will show **SK.**
To return to iambic keying, power down, remove the mono plug, and power up again.

Method 2. In the revised rev 8.4x and later firmware the *Hilltopper* will test both the **RING** and **TIP** terminals of the stereo paddle jack. If either terminal is detected as being grounded at power up the rig will operate in straight key mode. On the LCD you will first see the firmware version number displayed, followed by -**HLD4SK-** (**H**o**LD** for **St**raight **K**ey) then finally the frequency display. So if paddles are plugged in, hold either paddle closed during power up to start up in straight key mode. Or, if you have used a stereo plug on your straight key (connected to **TIP** and **SLEEVE**) hold the key closed during power up. You can release the key or paddle when you see the frequency display on the LCD or hear the frequency being announced in Morse. The LCD will show **SK.**

This provision makes it convenient to connect paddles and straight key in parallel to a single stereo plug. Paddles will connect to **TIP**, **RING** & **SLEEVE**, and straight key to **TIP** & **SLEEVE**.

A new feature in rev8.50 and later is a quick way to switch back and forth between straight key and keyer without having to cycle power. While operating in keyer mode, turn the **SPEED** control to minimum (fully counterclockwise ~5 wpm). The rig will change to straight key (**SK** will show in the LCD display) and remain in that mode until the **SPEED** is bumped up. You can wire your key in parallel with your paddles. Connect the key between **SLEEVE** (GND) and the **TIP** terminal. Since the **SPEED** setting also controls the speed of Morse info messages, and 5 wpm is way too slow for that, they will be sent at 12 wpm or the current setting of the **SPEED** control, whichever is faster.

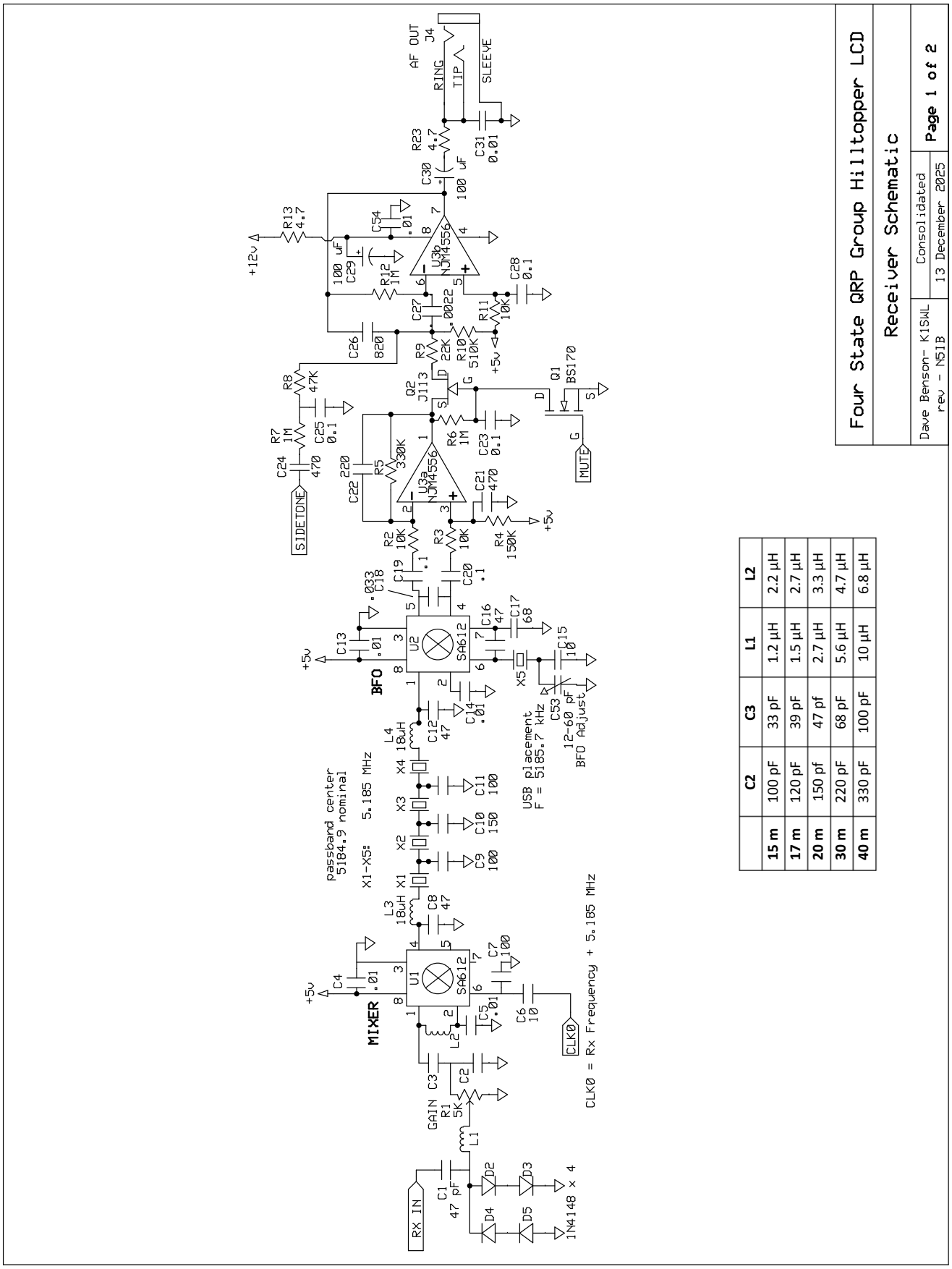
If you had selected straight key mode during the power-up process, that choice overrides the above feature and the radio will ignore the **SPEED** control and stay in straight key mode until the next power cycle.

Alternate Startup Frequency:

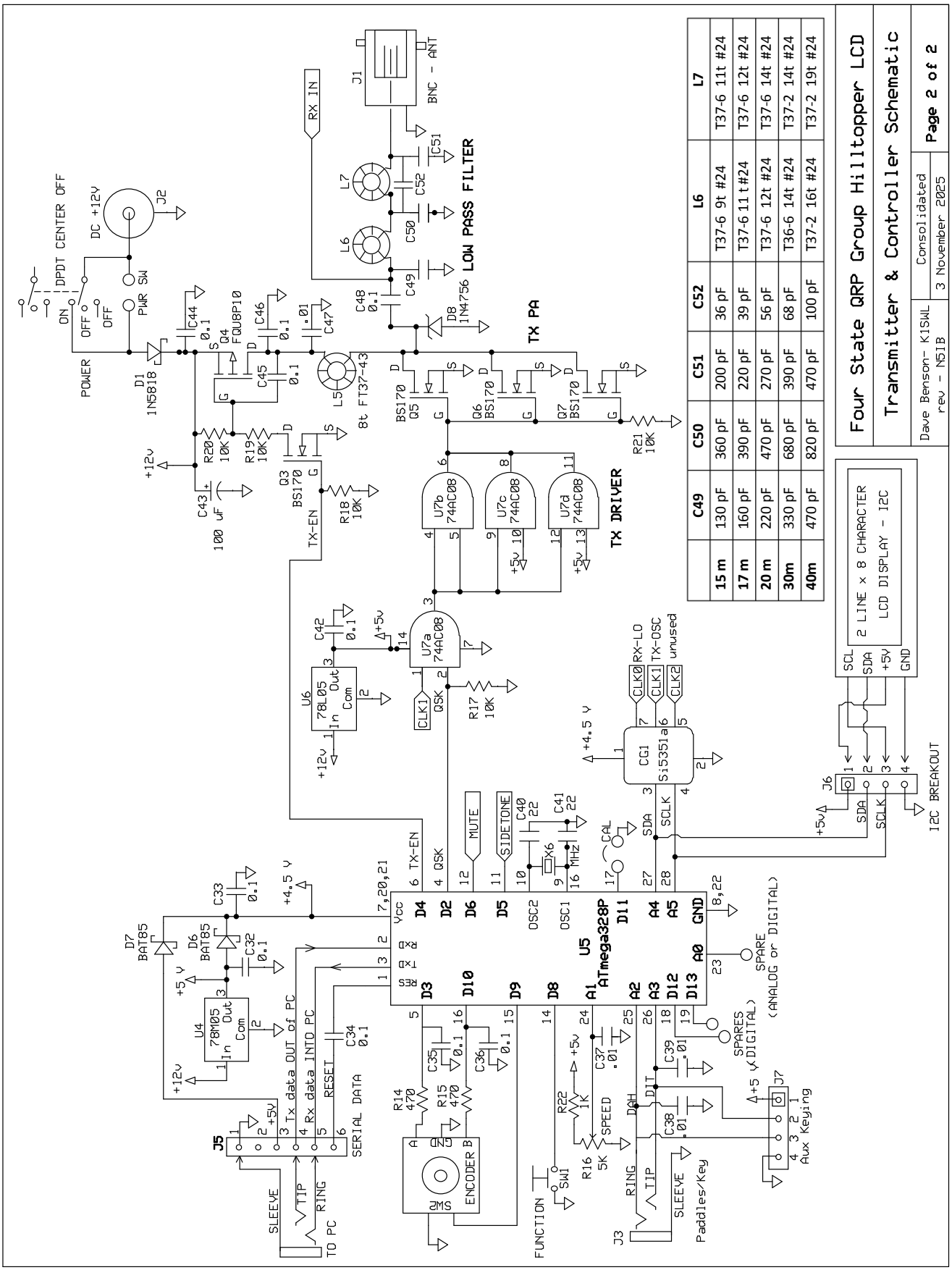
The Hilltopper normally powers up with the frequency set to a popular QRP operating frequency on the given band. But pressing the **TUNING** switch down while applying DC power to the *Hilltopper* yields an alternate startup frequency. Hold the press until the frequency display appears:

15 m – 21030.0 kHz
17 m – 18130.0 kHz
20 m - 14030.0 kHz
30 m – 10122.0 kHz
40m – 7122.0 kHz.

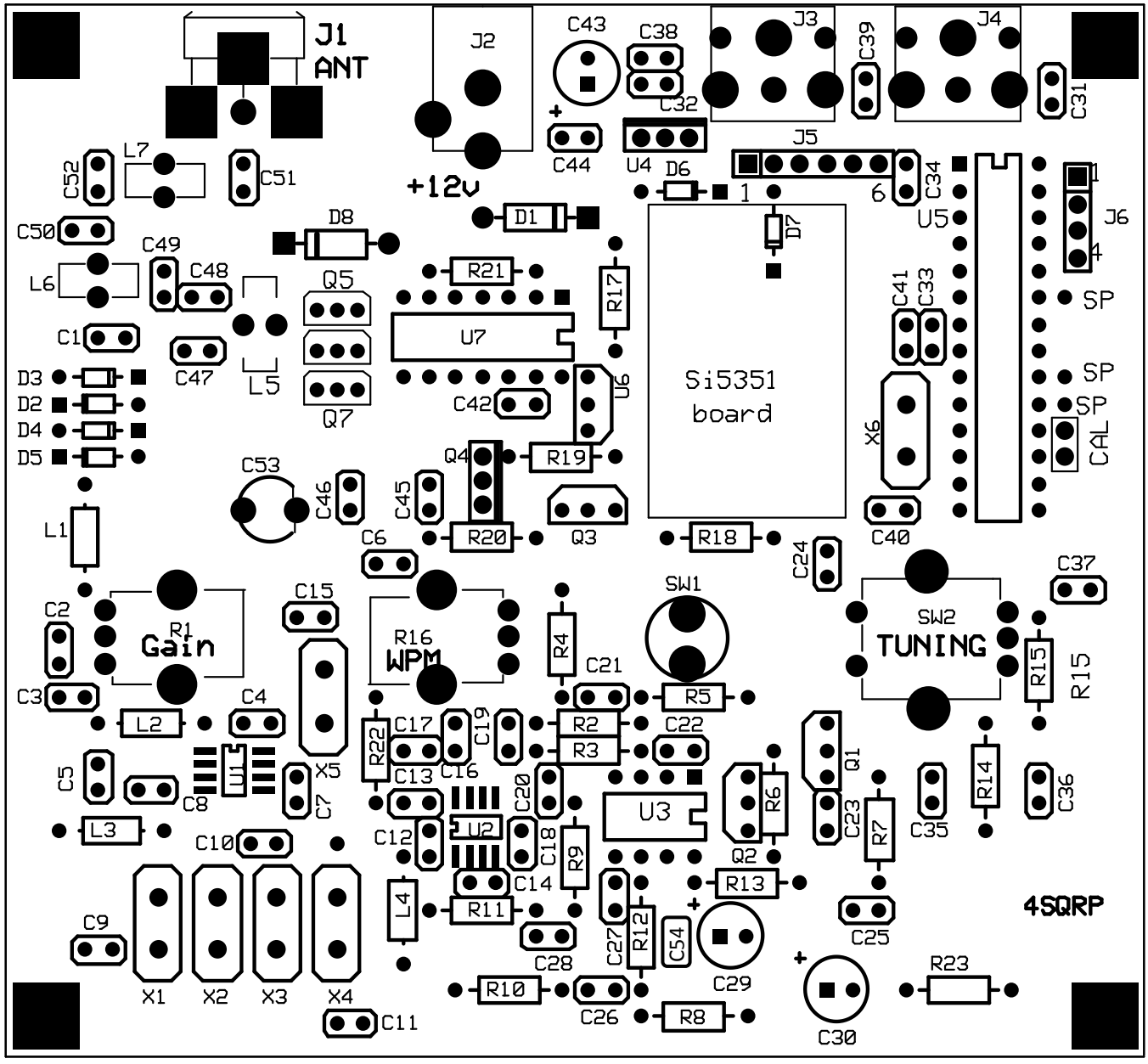
This saves some knob-twisting to get to another QRP watering hole on the band.

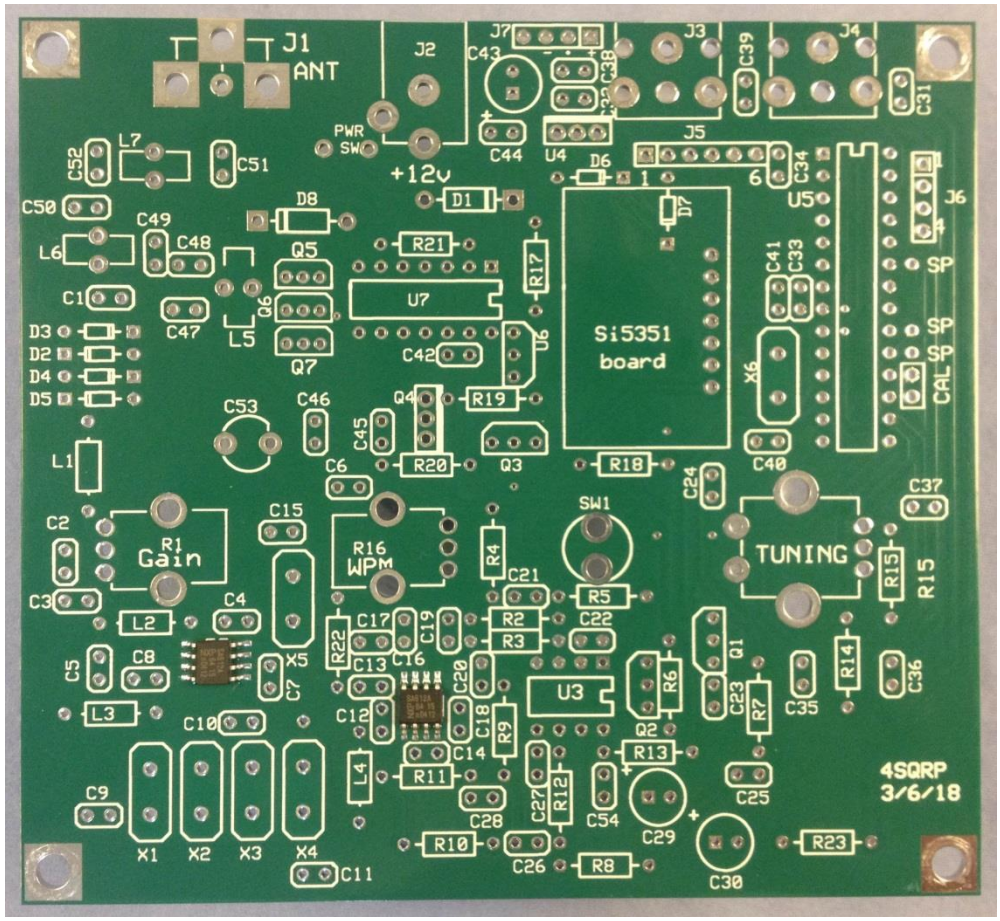


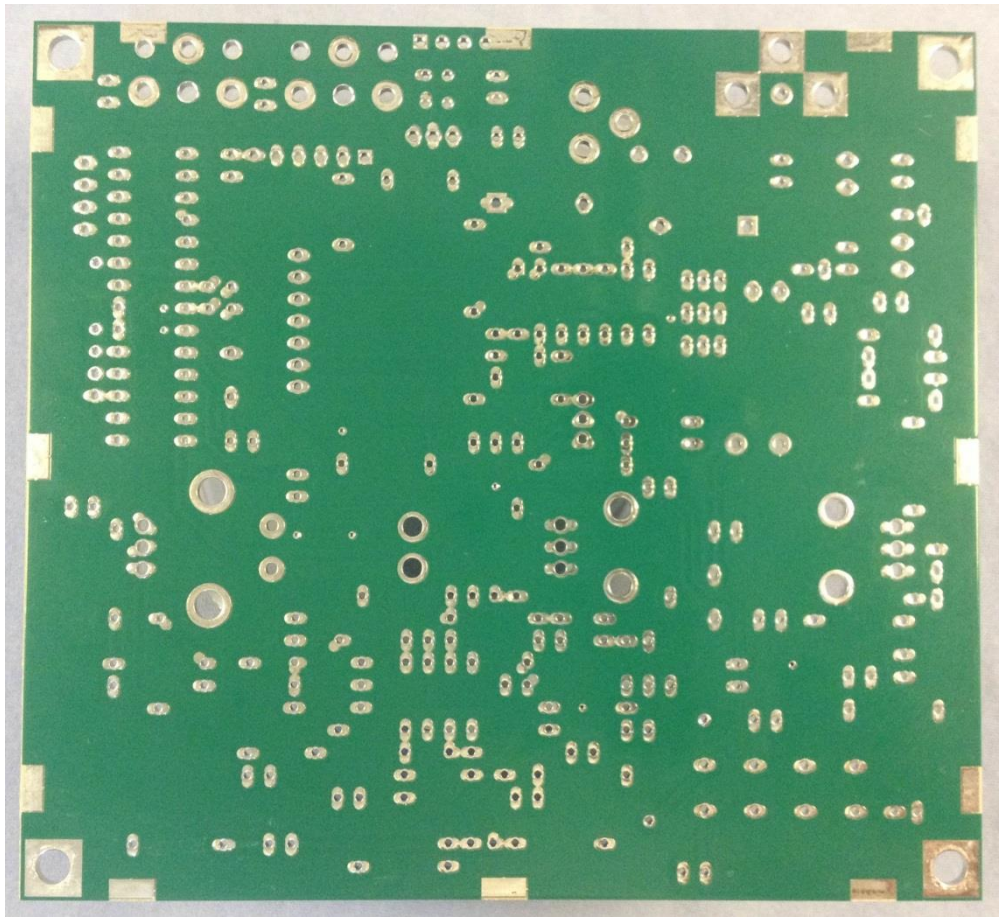
	C2	C3	L1	L2
15 m	100 pF	33 pF	1.2 µH	2.2 µH
17 m	120 pF	39 pF	1.5 µH	2.7 µH
20 m	150 pf	47 pf	2.7 µH	3.3 µH
30 m	220 pF	68 pF	5.6 µH	4.7 µH
40 m	330 pF	100 pF	10 µH	6.8 µH



	C49	C50	C51	C52	L6	L7
15 m	130 pF	360 pF	200 pF	36 pF	T37-6 9t #24	T37-6 11t #24
17 m	160 pF	390 pF	220 pF	39 pF	T37-6 11t #24	T37-6 12t #24
20 m	220 pF	470 pF	270 pF	56 pF	T37-6 12t #24	T37-6 14t #24
30m	330 pF	680 pF	390 pF	68 pF	T36-6 14t #24	T37-2 14t #24
40m	470 pF	820 pF	470 pF	100 pF	T37-2 16t #24	T37-2 19t #24

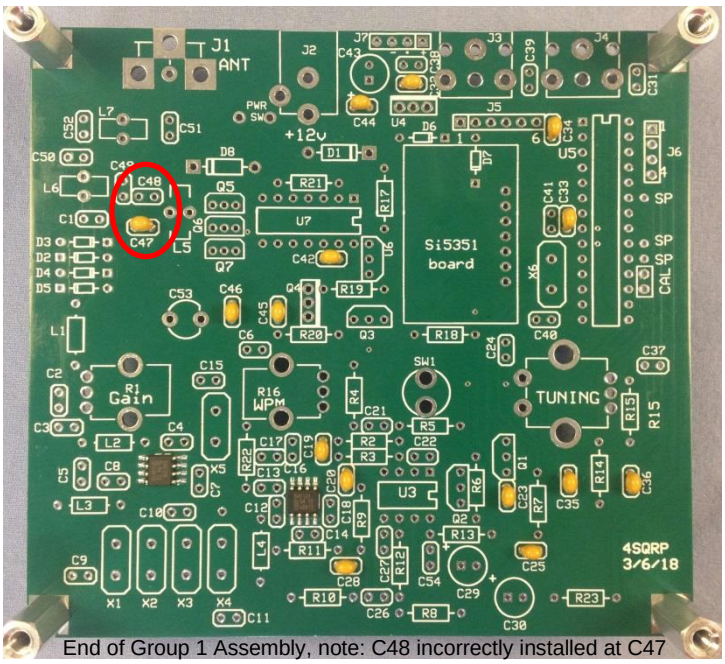

J1
ANT
J2
+12v
C43
C38
J3
J4
C39
C31
C32
J5
C44
U4
D6
C34
U5
J6
L7
C52
C51
C50
D8
D1
D7
C49
C48
L6
Q5
R21
R17
U7
C41
C33
SP
C1
D3
D2
D4
D5
C47
L5
Q7
C42
U6
Si5351
board
SP
SP
CAL
X6
C53
C46
C45
Q4
R19
C40
L1
C6
R20
Q3
R18
C24
C37
C2
R1
Gain
C15
R16
WPM
SW1
SW2
TUNING
R15
R15
C3
L2
C4
R4
C21
R5
C17
C19
R2
C22
R22
R3
C5
C13
C16
C20
Q1
C23
R14
C36
C8
U1
X5
C7
U2
U3
R6
R7
C35
L3
C10
C12
C18
R9
Q2
C14
R13
4SQRP
L4
R11
C27
R12
C54
C25
C9
C28
C29
R23
X1
X2
X3
X4
C11
R10
C26
R8
C30


J1
ANT
J2
PWR
SW
+12v
J7
J3
J4
J5
J6
C43
C44
U4
D6
D1
D8
D7
U5
C52
L7
C51
C50
C49
C48
L6
Q5
Q6
Q7
L5
C1
C47
D3
D2
D4
D5
R21
U7
R17
C42
U6
Si5351
board
X6
C41
C33
C34
C31
SP
SP
SP
CAL
C53
C46
C45
Q4
R19
R20
Q3
R18
C40
C24
C37
L1
C6
SW1
C2
R1
Gain
C15
R16
WPM
R4
C21
TUNING
R15
C3
L2
C4
R5
R2
R3
C22
C17
C19
R22
C13
C16
C20
U3
Q1
R6
C23
R7
C35
R14
C36
C5
C8
X5
C7
L3
C12
C18
R9
Q2
R13
C10
C14
R11
L4
C27
R12
C54
C29
C25
4SQRP
3/6/18
C9
C28
C30
R23
X1
X2
X3
X4
C11
C26
R8
R10

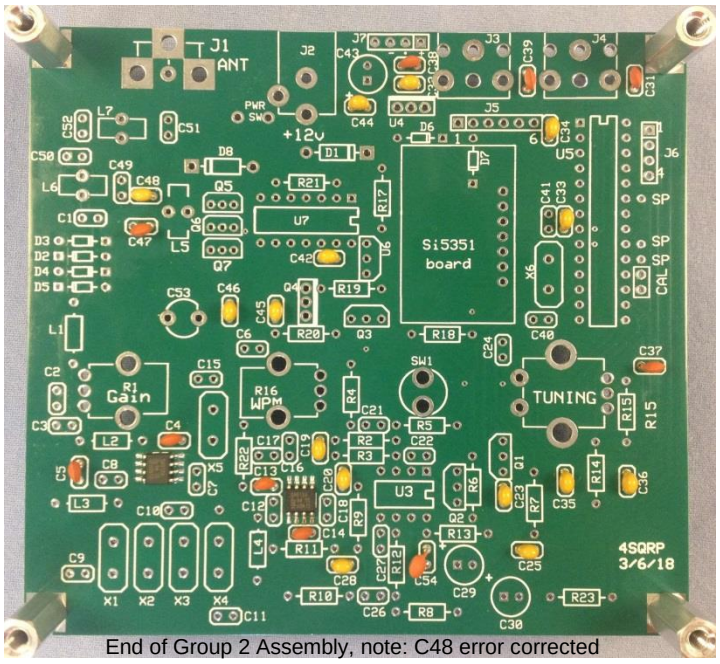


APPENDIX A – Assembly Group Photos

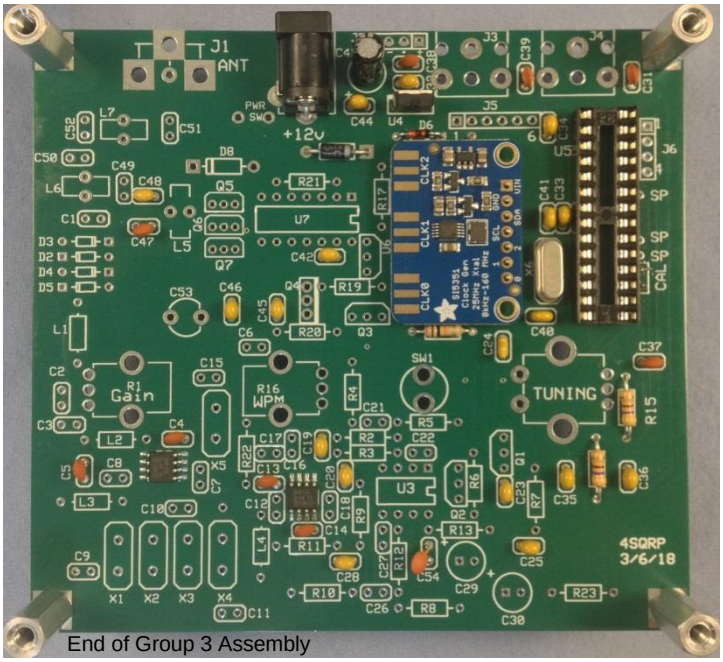
To allow for additional photography, insertion of the U5 IC chip, and final soldering of the 5351 module have not yet been performed.



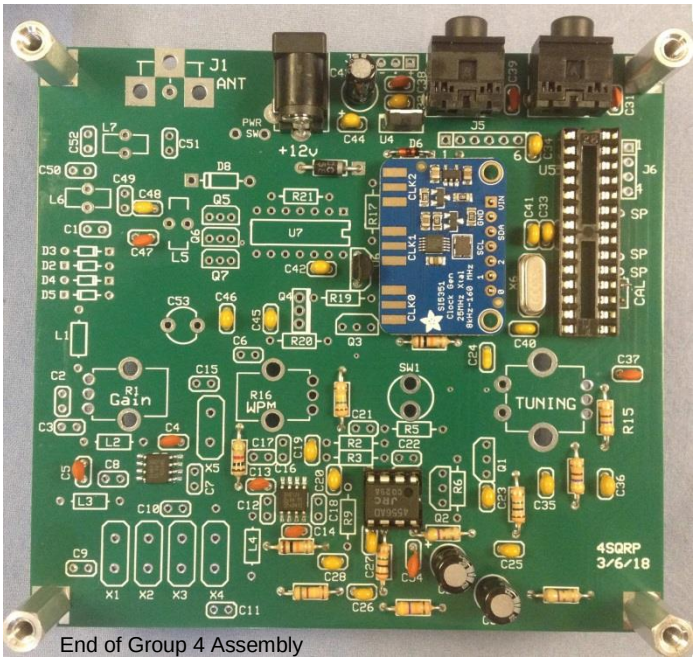
End of Group 1 Assembly, note: C48 incorrectly installed at C47



End of Group 2 Assembly, note: C48 error corrected



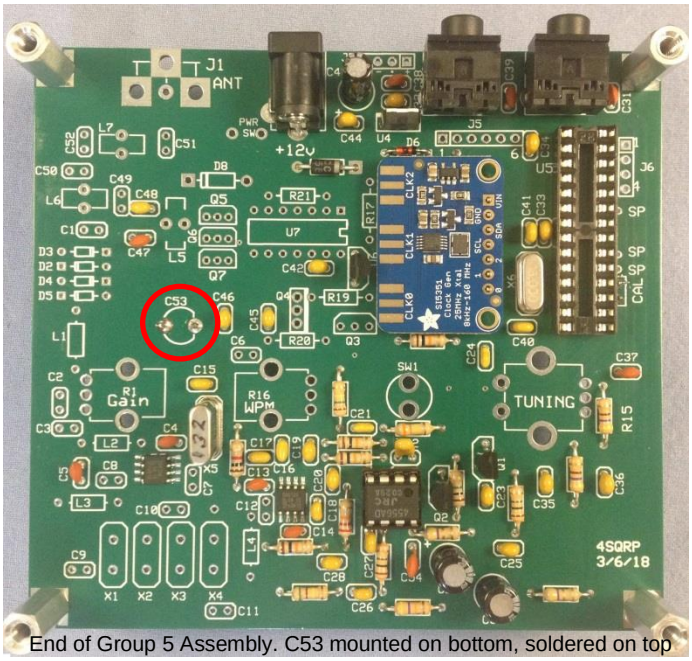
End of Group 3 Assembly



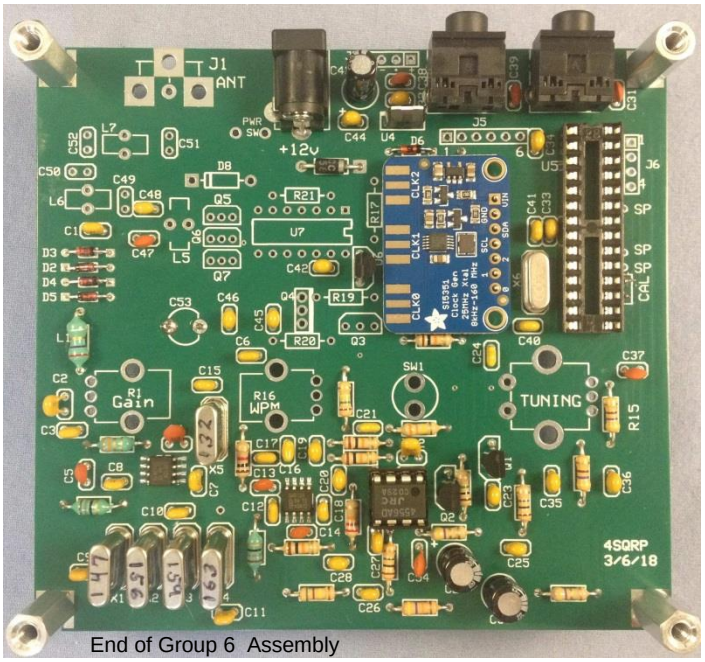
End of Group 4 Assembly

APPENDIX A – Assembly Group Photos, continued

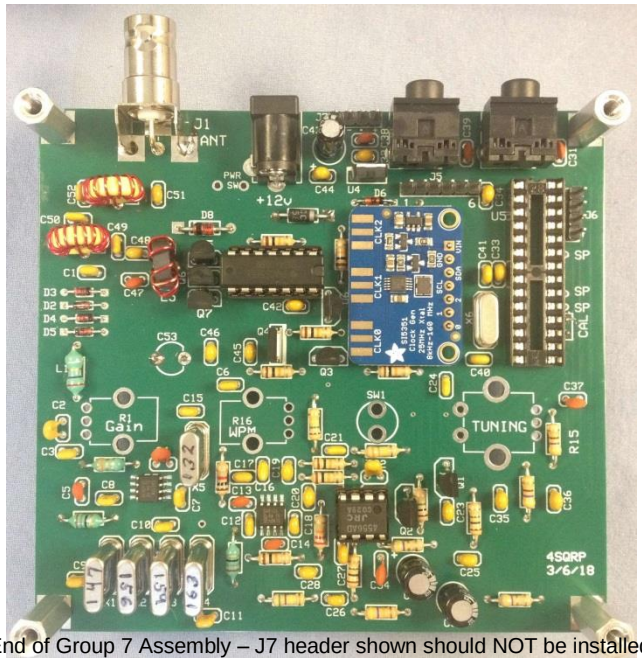
To allow for additional photography, insertion of the U5 IC chip, and final soldering of the 5351 module have not yet been performed until Final Assembly
The 4-pin header strip at J7 is shown installed in the Group 7 photo, but it was decided, subsequent to the photo, to omit it from the board.



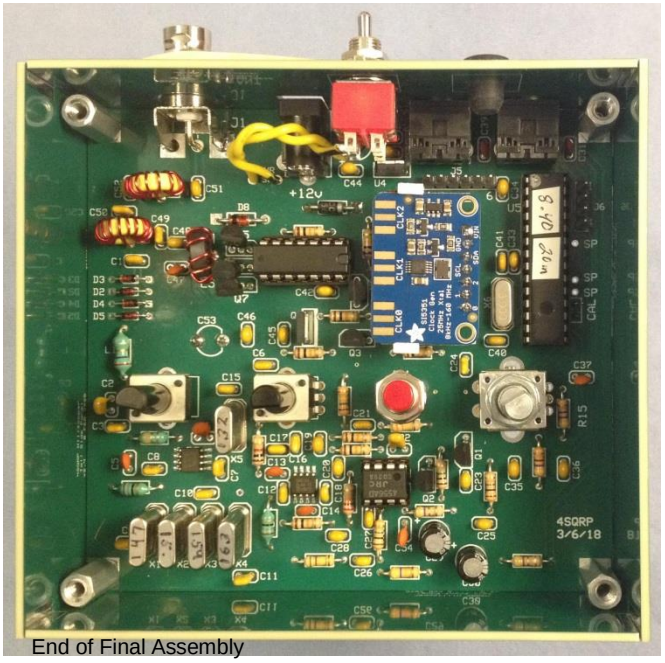
End of Group 5 Assembly. C53 mounted on bottom, soldered on top



End of Group 6 Assembly



End of Group 7 Assembly – J7 header shown should NOT be installed



End of Final Assembly

APPENDIX B – Socketing the 5351 Module

It is possible to use a socket to install the 5351 Clock Generator module. **The option is for experienced builders, as it involves drilling a hole in the main PC board.** While it is, of couse, much more convenient to drill the hole in an unpopulated PC board, it's not difficult to accomplish after some or all board assembly has been completed.

The materials needed are:

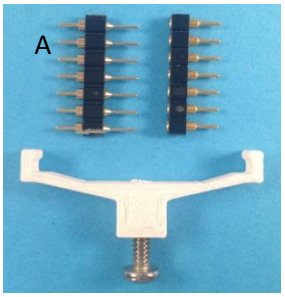
- Round-pin machined pin and socket strips, one 7-pin female and one 7-pin male strip, recommend the gold plated variety
- #4-40 x ¼" pan-head machine screw
- 3D printed plastic bracket
- #30 or 1/8" drill bit
- 1/16" or smaller drill bit

The round-pin socket and pin strip are needed because the usual 0.025" square post headers and sockets would stand too tall, and the module would interfere with the LCD display board on the underside of the top cover.

A design file for the 3D printed bracket can be found in the Files Area of the Hilltopper e-mail Group. Or a call out on the Group will most likely turn up a volunteer who'll print one for you.

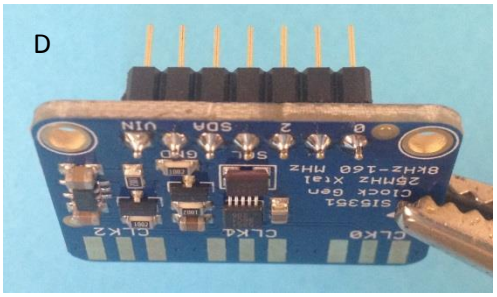
There is only ground plane in the region around the hole, top and bottom, so no damage will be done to the board by drilling a small hole there.

Follow the photos.



A. Shown are the round pins (left) and sockets (right), the 3D printed mounting bracket, and the 4-40 X 1/4" screw. The sockets will be soldered to the PC board, and the pins to the 5351 module. Notice that the set of pins to the right are longer than the ones on the other side of the plastic spacer. The longer pins will plug into the sockets.

B. Drill the hole for a "free fit" of a #4-40 machine screw. That's a #30 drill in the numbered set, or you can use a 1/8" if you don't have numbered drills. Mark the center for drilling just above the dot of the "i" in "Si5351" – where the black dot has been drawn. It's a good idea to use a smaller drill to make a pilot indentation – 1/16" or smaller is good. De-burr the edges top and bottom when done.



C. The hole has been drilled and deburred, and the socket strip has been installed and soldered to the PC board.

D. The strip of round pins has been solderd to the 5351 module. Note that the long pins and the plastic spacer are on the side of the module opposite the components.

E. Bottom view of the installed pins and the 3D printed plastic bracket. The hole in the bracket must be tapped to receive #4-40 threads.

F. The 5351 module mounted and plugged into the socket strip on the main PC board. The screw secures the plastic bracket from below the main PC board.

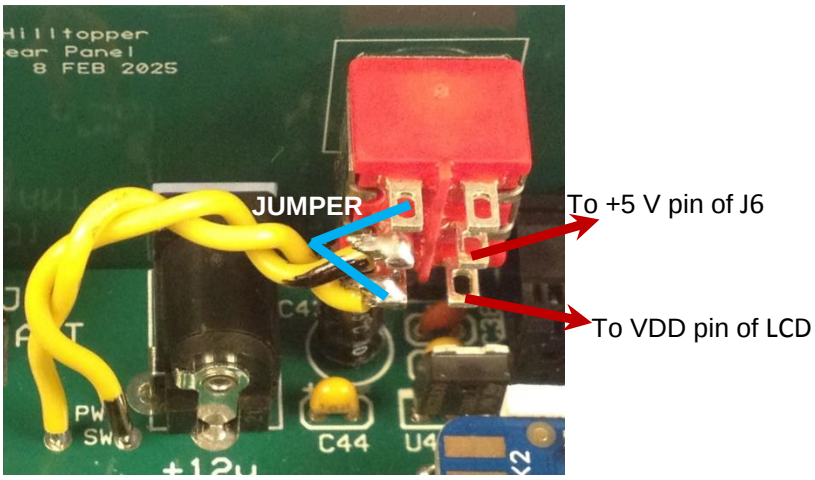
APPENDIX C – Other Uses for the DPDT Toggle Switch

The power ON/OFF switch provided in the Hilltopper kit is a DPDT (ON-OFF-ON) style, but only a SPST action is required for that function. The other pole of the switch is available for other tasks a builder may wish.

As an example, suppose it was desired to conserve battery capacity during portable operations by turning off the LCD display. The unused pole of the switch could be wired so as to control the +5 V supply to the LCD module.

If, when powering up, the Hilltopper is unable to detect an operating LCD display device, the firmware will revert to operation with Morse annunciation of frequency and other operating information. About 25 mA of battery current would be saved.

To accomplish this action the +5 V lead in the ribbon cable from J6 to the LCD must be cut and connected to the unused pole of the switch as shown below. A jumper must also be added from the top to bottom lug of the pole already in use for main power ON/OFF. The photo below shows the connections.



The switch operation will now be:

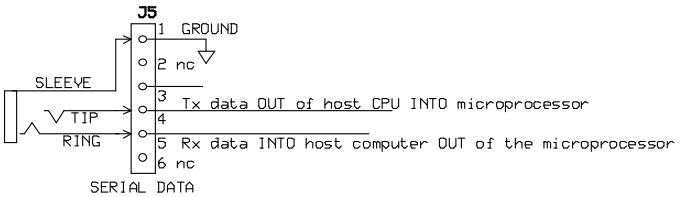
UP position	Main power is ON, with LCD display enabled
Center position	All power is OFF
DOWN position	Main power is ON, LCD is OFF

APPENDIX D – Connecting a Stereo Jack to the J5 Serial Data Header

To utilize the serial communications capability of the microprocessor, connect a 3-conductor (TRS style) 3.5 mm (1/8”) stereo jack to the J5 header as shown below. The convention used here is:

Tip ➔ **T**ransmit data **TO** the microprocessor’s RxD input
Ring ➔ **R**eceive data **FROM** the microprocessor’s TxD output
Sleeve ➔ GROUND

Serial communications could be use for computer control of the radio (CAT). This is not implememted in the basic firmware loaded into the microprocessor, but other builders have suggested firmware modifications to provide it.



The serial data connection can also be used to upload new firmware to the micrprocessor.

APPENDIX E - Operation of non-LCD firmware rev6.xx:

Your LCD equipped Hilltopper retains some of the operating procedures of the older, non-display kits. And if you ever wish to disconnect the LCD (maybe preserving battery capacity on a long POTA/SOTA excursion) the rig will automatically sense the absence of the LCD and revert to the "non-display" operating mode discussed below.

Upon applying DC power (no CAL jumper) to the *Hilltopper*, you'll hear in your headphones several Morse announcements:

1) the firmware version number, *eg.* "v 6 r 6 0" for rev 6.60 firmware. This should match a label on U5.
2) either "RIT" or "XIT" to indicate which feature is currently available for use (more on that later)
3) the ham band for which the firmware is prepared, *eg.* "4 o m" for 40 meters
   This confirms that your kit has the correct firmware installed to operate the band for which it was built
4) the starting frequency
   - 15 m kit: "6 o r o" this shorthand indicates the starting frequency is 21**060.0** kHz
   - 20 m kit: "6 o r o" for 14**060.0** kHz
   - 30 m kit: "1 1 2 r o" for 10**112.0** kHz
   - 17 m kit "9 6 r 0" for 180**96.0** kHz
   - 15 m kit: "3 o r o" for 7**030.0** kHz

After the Morse announcements are finished the receiver will be un-muted and, if an antenna is connected, you should hear normal band noise and/or signals.

Frequency Readout:

Tap the **FUNCTION** switch briefly (less than ½ sec) to hear your current frequency. You'll always hear the tens of kHz and the kHz digits, followed by the "r" for the decimal, then the tenths of kHz. If the hundreds of kHz is a zero, that leading zero will be omitted. Otherwise it will be sounded as well (*e.g.* 1 2 2 r 5 if you were on 7122.5 kHz)

Examples: 21074.3 kHz => "7 4 r 3" 21122.0 kHz => "1 2 2 r 3" 21005.7 kHz => "o 5 r 7"

Be aware that if your tuning step size (see below) is selected as 20 Hz, it may take several clicks of the **TUNING** knob before the Morse readout indicates a frequency change in the 100s of Hz digit.

The readout is at the same speed as your keyer speed setting.

Tuning step size:

Briefly pressing the **TUNING** knob cycles the step size from 1 kHz to 100Hz to 20Hz. The power-up default is the 100 Hz step size. You'll hear one or more beeps to confirm a change in step size:

1 beep => smallest step, 2 beeps => medium step, 3 beeps => largest step

RIT and XIT:

The *Hilltopper* can operate with Receiver Incremental Tuning (RIT) or Transmitter Incremental Tuning (XIT), but not both at the same time.

Use RIT if the station you are working is a little off your operating frequency.

Use XIT to "work split" when calling stations that are listening up or down from their transmitting frequency (*great for the QRP Foxhunts!*).

The feature that was last used will be saved in EEPROM and announced at the next power up.

When RIT is ON, the Morse frequency announcement will be your *transmitting* frequency.
When XIT is ON, the Morse will announce your *receiving* frequency.

When XIT is ON, you'll want to know how far away from your receiving frequency you are transmitting. While XIT is ON, each time you turn the **TUNING** knob one or more clicks, about 1.5 seconds after the last click you'll hear a Morse announcement such as "U 3" which means 3 tuning steps above your receiver frequency, or "D 5" for 5 steps below your receive spot.

The XIT tuning step size is held fixed at 100 Hz per step and cannot be changed. This prevents you from getting too far afield without realizing it. The band edges are checked whenever the transmitting frequency is changed, either in normal operation or in XIT, to protect you from getting out of band.

Switching between RIT/XIT availability: To switch features, press and hold the TUNING control for a "long press" of about 10 seconds, then release. You'll hear a Morse announcement "OK RIT" or "OK XIT" to confirm the feature that is now available. If you hear a rude, buzzing sound (a "raspberry") the switch was not successful.
Once RIT or XIT is made available, you can turn its operation ON or OFF by pressing the TUNING control for about 1 second, then releasing.

RIT ON is signaled by a "boobeep" sound (an up-chirp), RIT OFF is signaled by "beeboop" (a down-chirp).
XIT ON/OFF is signaled by doubled up or down-chirps (boobeep-boobeep or beeboop-beeboop)

If you ever are unsure whether RIT or XIT is the available feature, just do the 1 second press of **TUNING**. The single or doubled beeps will let you know which one is in play.

You can only switch between RIT and XIT availability when the current feature is turned OFF. If you try to make the change while either RIT or XIT is ON, you'll get the "raspberry" for your sins.

TUNE Mode
Push and hold the **FUNCTION** pushbutton for at least one second, then release the button. The sidetone and transmitter output turn on to allow adjustment of antenna tuners, etc. It stays in TUNE mode until:

- 5 seconds has elapsed *OR* either keyer paddle is tapped

Paddle Reverse and Iambic Mode A/B Selection
Apply DC power to the *Hilltopper* while PRESSING AND HOLDING the **FUNCTION** pushbutton switch. Release the button when you hear **R ?.** Tap either key paddle within 2 seconds to reverse the paddles. (*Do nothing and there's no swap*.) Next, you'll hear **B ?.** Tap either key paddle within 2 seconds to choose Mode B. *Do nothing, and Mode A is selected.* (Most operators prefer Mode A) You'll then hear an 'A' or 'B' to confirm your selection. Your selections are saved in non-volatile EEPROM memory and the *Hilltopper* will proceed to normal operation.

Straight Key mode:
Method 1. Upon power-up, the *Hilltopper* firmware checks the state of the RING (middle) connection on the keyer jack. If a "mono" (2-conductor) plug is used to connect a straight key, the SLEEVE portion of the plug contacts the RING terminal of the jack, and that connection is grounded. The *Hilltopper* senses that condition and automatically follows the straight key or external keyer input. The iambic paddle function will be disabled. To return to iambic keying, power down, remove the mono plug, and power up again.

Method 2. In the revised firmware the *Hilltopper* will test both the RING and TIP terminals of the stereo paddle jack.
If either terminal is detected as being grounded at power up the rig will operate in straight key mode. So if either paddles or a straight key are plugged in using a stereo plug, hold the straight key or one of the paddles closed during power up to start up in straight key mode. You can release the key or paddle when you hear the frequency being announced in Morse. This provision makes it convenient to connect paddles and straight key in parallel to a single stereo plug. Paddles will connect to TIP-RING-SLEEVE, and straight key to TIP-SLEEVE.

***Straight key 'timeout'*:** After 5 seconds key-down, the transmitter output shuts off. Tap the **FUNCTION** switch briefly to restore normal operation. The TUNE function works in straight key mode but returns to normal operation without operator action. The timeout provision is meant to protect the PA devices from a 'stuck key' situation.

Alternate Startup Frequency:
Holding the **TUNING** switch down while applying DC power to the *Hilltopper* yields an alternate startup frequency.
15 m – 21030.0 kHz 17 m – 18130.0 kHz 20 m - 14030.0 kHz 30 m – 10122.0 kHz 40m – 7122.0 kHz.
This saves a lot of knob-twisting.

APPENDIX F

If you've read this manual all the way here, CONGRATULATIONS. Number yourself as *Among the Few*.

Here's an image that might pique your interest.

Subscribe, and make an enquiry on the Hilltopper email Group

https://4sqrp.groups.io/g/HilltopperKit

for some details.

Builder's Notes: _____

Acknowledgements:

Thanks to Steve Weber- KD1JV whose SOTA POP design influenced the design of the transmitter section. He also graciously provided open-source firmware…… which I proceeded to mangle for this project.

Thanks also to David Cripe- NMOS- who played an invaluable role with enclosure layout, technical liason with 4SQRP, and provided advice with component selection.

Dave Benson, K1SWL 14Nov. 2017