The 'Old Friend'

Direct-conversion Transceiver

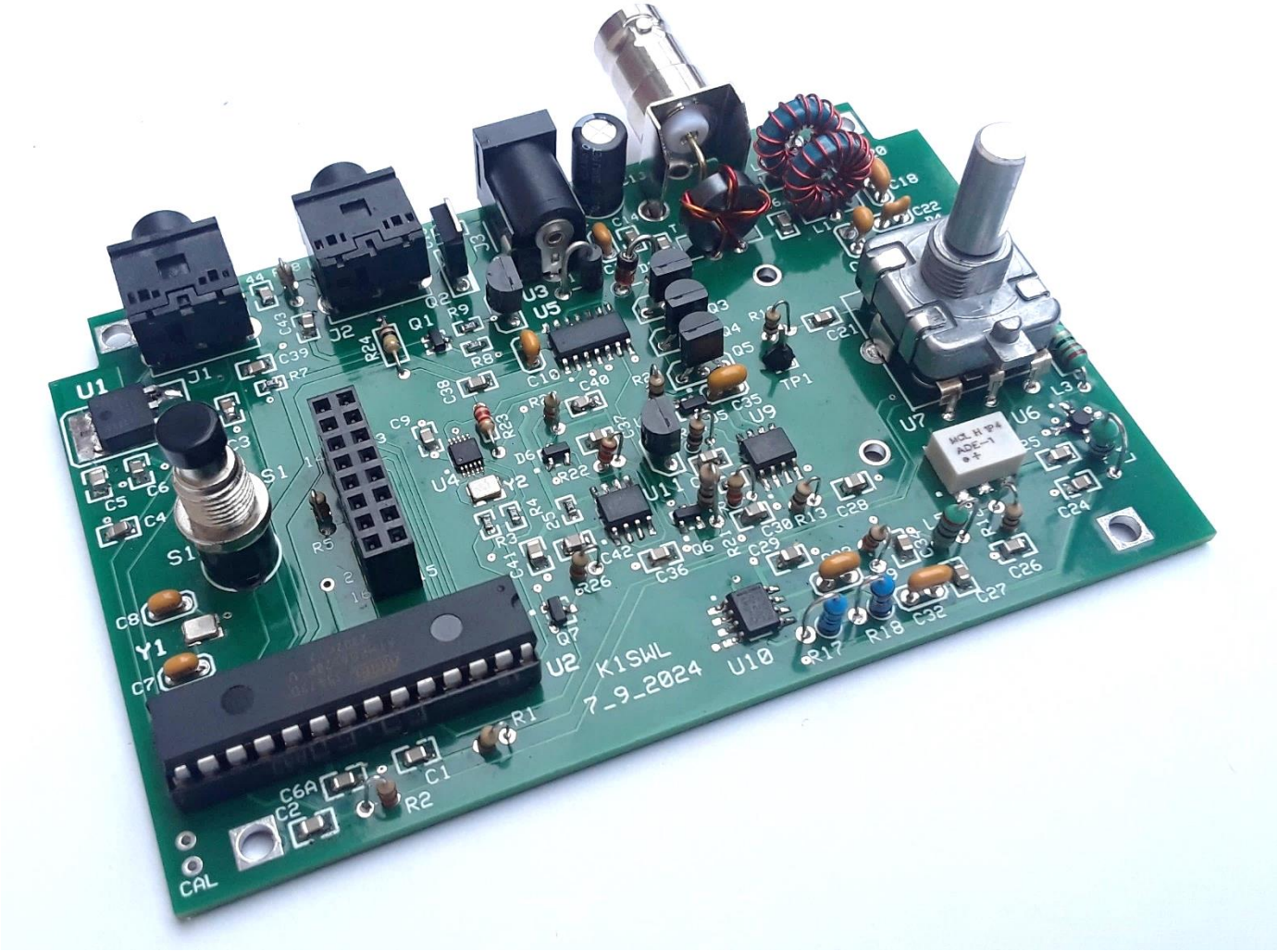
A single-board, 6-watt, CW transceiver
for use on 80, 40, 30, 20, 15 or 10 meters

by Dave Benson, K1SWL

ASSEMBLY & OPERATING MANUAL

February 2025

Produced by Midnight Design Solutions



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INTRODUCTION

The **OLD FRIEND Transceiver™** is a single-board, 6 Watt Direct-Conversion Transceiver specifically designed for CW operation. The **OLD FRIEND ('OF')** is capable of transmitting and receiving on the 80m, 40m, 30m, or 20m bands.

This project pays homage to our early days in QRP. For homebrewers, a functioning D-C rig was a real accomplishment in those days. The Old Friend incorporates newer technology in the form of digitally-controlled tuning and an LCD readout and includes both Iambic Keyer and Straight Key functionality. The OF further features good audio quality by virtue of its 'relaxed' approach to audio filtering.

Important Note 1: If there is not already a jumper wire attached to the bottom of your PCB, be sure to see Appendix 9.

Important Note 2: If you ordered an Old Friend Enclosure Kit, be sure to see Appendix 10 for assembly instructions.

SPECIFICATIONS

Frequency coverage:

OF-80 board: 3.500 MHz to 3. 650 MHz

OF-40 board: 7.000 MHz to 7.150 MHz

OF-30 board: 10.100 MHz to 10.150 MHz

OF-20 board: 14.000 MHz to 14.150 MHz

OF-15 board: 21.000 MHz to 21.200 MHz

OF-10 board: 28.000 MHz to 28.300 MHz

Transmit:

6 Watts nominal, complies with FCC Spectral Purity requirements

Keyer: Iambic Mode B, adjustable 5-40 WPM, non-volatile paddle reverse.

Straight Key: Automatic on Power-up with 2-pin plug. 20 ms debounce

Receive: MDS of -97 dBm

Frequency Calibration: One-time

Adjustments: None

Controls:
- "Tune/Speed": Tuning achieved in course frequency adjustments (by fast dial turns) or in finer adjustments (by slower dial turns). Function pushbutton initiates CW speed adjustments, whereupon adjustment times out after 2-sec pause.
- Function: Short press - Initiates CW speed adjustment with Tune control
  Long press – Initiates key-down 'tuning function' for 5 sec, then exits
- Audio level: Shottky diode-pair automatically soft-limits audio to comfortable volume

DC Power: 11-14V @ 135ma (Rx), 1A (Tx), center-positive 2.1mm/5.5mm 'barrel' plug

Kits: Currently available for 80m, 40m, 30m 20m, 15 or 10m.

PCB dimensions: 4.25" x 2.80"

Components:

- All through-hole parts, controls, display and connectors supplied for user assembly
- 53 surface mount parts, all pre-installed on the pc board

Enclosure Kits: Separately (optionally) available.

Enclosure Dimensions: 4.74" x 3.69" x 1.24", excluding protrusions. The OF enclosure based around a modified Hammond enclosure with a custom top cover and necessary hardware. *A tuning knob is included.*

PREPARATION FOR ASSEMBLY

Take a moment to carefully read this section, as it provides good "starting point" guidance that can be of great help in building the Old Friend.

Tools & Supplies:

You'll need the following tools and supplies for assembling the OF:

[ ] Soldering iron – 25 to 60W, preferably thermostatically controlled

[ ] Fine 60/40 (Pb/Sn) rosin core solder

[ ] Diagonal cutters

[ ] Needle-nose pliers

[ ] Small flat- blade screwdriver

[ ] Adhesive (Scotch®) tape

[ ] (Helpful) Close-up glasses or magnifier

[ ] Operational Needs: Power supply, antenna, keyer or Straight Key, headphones

General Assembly Notes:

- **A number of components are polarity-sensitive.** This includes all semiconductor devices and diodes, and the electrolytic capacitor. All but the electrolytic cap is provided in antistatic envelopes or on antistatic foam.
- **Components these days are tiny!** In sunlight, one can read their printed values with +3.0 reading glasses. Most of the time, though, builders can benefit from using a 10-power eye loupe (costing about $3-4 from DigiKey).
- **Assembly sequence**: These assembly instructions provide a step-by-step guide to successful construction of the OF. It is recommended that you follow the **six** grouped assembly sequences in order.
- **Schematic and Component Placement diagrams** are provided in Appendices 2 and 3, respectively. It is highly recommended to print a copy of this manual for reference during construction. As you build, you can check off each construction step as you complete them in order.
- **Further details** may be found in the grouped assembly sequences.

Parts Organization:

- Take some time to organize the parts provided and check them against the Parts List shown in Appendix 1. You may want to organize parts in a muffin tin or insert them into a sheet of Styrofoam® to keep them from disappearing. Especially if you have a cat.
- To minimize the chance of static damage, keep ICs and semiconductors in the anti-static package until you're ready to install them. As a practical matter, you don't need an antistatic mat or ESD wrist strap. **Note:** You should try to avoid setting these components down on paper. Shuffling on carpet (for instance) is probably a poor idea.

- Now would be a good time to inventory the parts on against the Parts List shown later in this manual in Appendix 1. If parts are missing in your kit, send an email to n2apb@MidnightDesignSolutions.com and I will promptly provide shortages.

Old Friend Parts Kit:

Round 2 (and beyond) kitting runs of the Old Friend consist of a carefully-developed set of Parts Cards and Parts Bags using a technique developed over time by the **"Midnight Elf", Larry K3PEG.** Larry meticulously produced each of the cards and bags in this kit at the northern branch of Midnight Design.

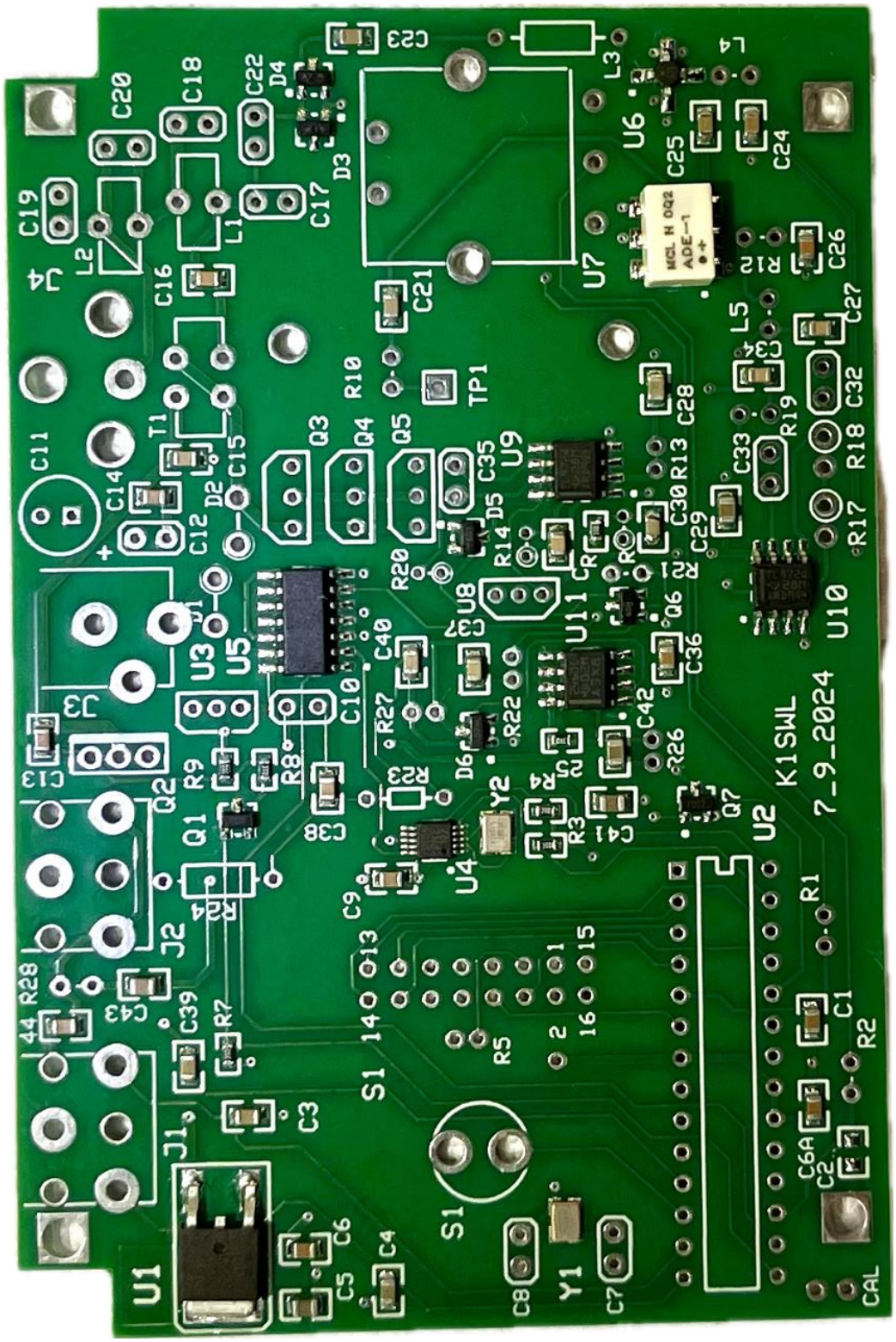
Pictured left-to-right above is …

- Printed Circuit Board (PCB) with installed SMT components;
- Loose Parts Bag #1: jacks, pushbutton, DIP socket, etc;
- Semiconductors (Anti-static bag);
- Blue wire: for a user modification to the pcb, described herein;
- Loose Parts Bag #2: LCD, Encoder, BNC
- (Bag Label)
- Resistors Card
- Band-specific Parts Card: This one shown is for 40m
- Capacitor Card

A detailed parts list is found in Appendix 1.

PC Board:

The Old Friend Printed Circuit Board contains pre-attached Surface Mount Devices. *Handle with anti-static care!*



GROUP 1 ASSEMBLY: Board Power

Refer to the diagram "Group 1 Component Placement" on the next page for reference to the location of components being installed here.

NOTE: The location of components installed in this assembly group are shown with a colored dot.

[ ] D1: To install diode D1 (black body) vertically, bend the lead on the BANDED end of the 1N5818 so the component forms a 'hairpin' shape. Install the component with the body of the component oriented as shown in the photo. D1 is found in the Semiconductor Bag.

The silkscreen symbol ○– indicates that a component's lead is formed into a hairpin prior to installation. See the photo on the right. The straight component lead gets inserted to the center of the circular silkscreen designator- the rightmost of the two component holes. The lead that is bent over is inserted into the left-hand hole.

[ ] C10, C12: Install these two capacitors marked '104' from the Capacitor Card at the locations shown.

[ ] J3: Install DC power connector J3. It may be helpful to tape it down before turning the board over to solder. If there's a plastic post on the bottom side of the connector, cut it off and discard it.

[ ] U3: Install the 78L05 3-pin IC (U3), matching its orientation to that of the silkscreen outline.

[ ] U8: Install the second 3-pin 78L05 regulator at U8, again matching its orientation to that of the silkscreen outline.

[ ] C11: Install the 16V 100 uF electrolytic cap at C11. This capacitor is polarity-sensitive. The longer lead must be installed nearest the '+' sign on the silkscreen legend. Double-check to ensure that the negative side of the capacitor (marked with a vertical band on the side of the capacitor) is facing the back edge of the printed-circuit board.

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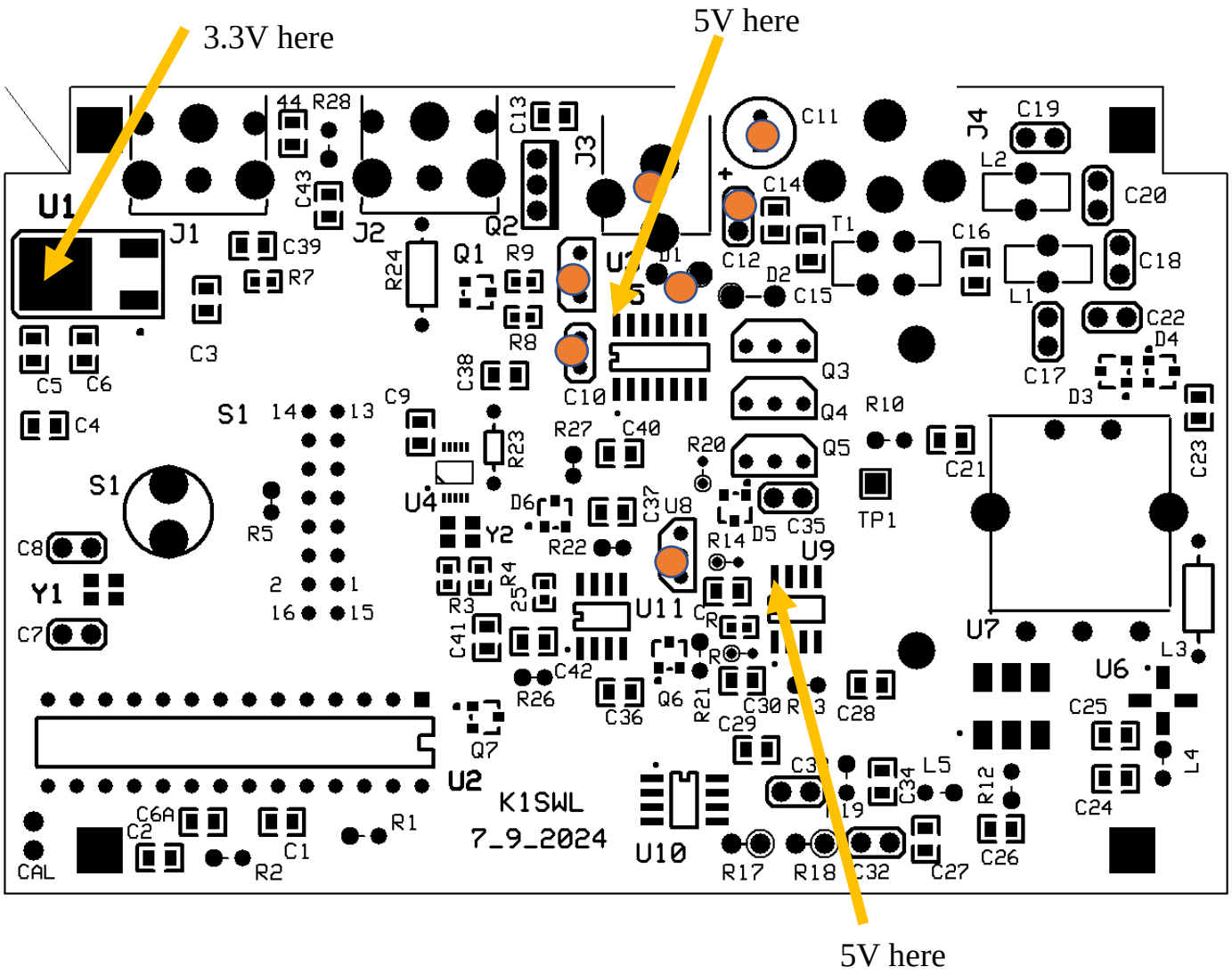
***TEST #1*: Basic Power**

- *Apply 12V power through jack J3. (The center pin is positive.)*
- *With your multimeter ground clip attached to any of the board mounting holes, measure for 5+/- 0.3 V DC at pin 8 (upper left corner of the U9 pin socket.*
- *Next measure for 5 volts at pin 14 of U5.*
- *Then measure for 3.3V at the large pad on the left end of U1.*
- *Do not proceed until you see these voltages, as the rest of the components depend on these voltages for proper operation.*
- *Remove power before proceeding to the next assembly group.*

Group 1 Component Placement



GROUP 2 ASSEMBLY: Audio Amplifier

This assembly group installs the Final Audio stage components as shown in the diagram on the next page.

[ ] IC Socket: Install the 28-pin DIP IC socket (from the Loose Parts #1 Bag) at the lower left corner of the board as shown. Ensure that the 'notch' at one end of the socket faces as shown in the illustration. *It's not necessary technically, but we'll guide you in orienting the IC in a later step.* You can tape the socket down on the top side of the board to hold it in place before soldering. Ensure that all socket leads protrude through the board before soldering. It's helpful to solder just two of opposite corner-pins and check to make sure the sockets are solidly seated on top of the board. Retouch as needed.

[ ] R28: Install 4.7-ohm resistor R28 (yellow-violet-gold-gold) at the location shown to the left of J2. This and most other resistor leads are formed into a 'hairpin' for upright mounting. Either installation polarity is OK unless noted otherwise.

[ ] J2: Install a 3.5mm audio connector at J2**.** You can tape the socket down on the top side of the board to hold it in place before soldering.

[ ] R24: Install a 100K ohm resistor (brown-black-yellow-gold) as shown in the diagram on the next page**. Note**: This resistor is installed 'laying down'.

[ ] R22: Install a 2.2K ohm resistor (red-red-red-gold) as shown in the diagram on the next page**.**

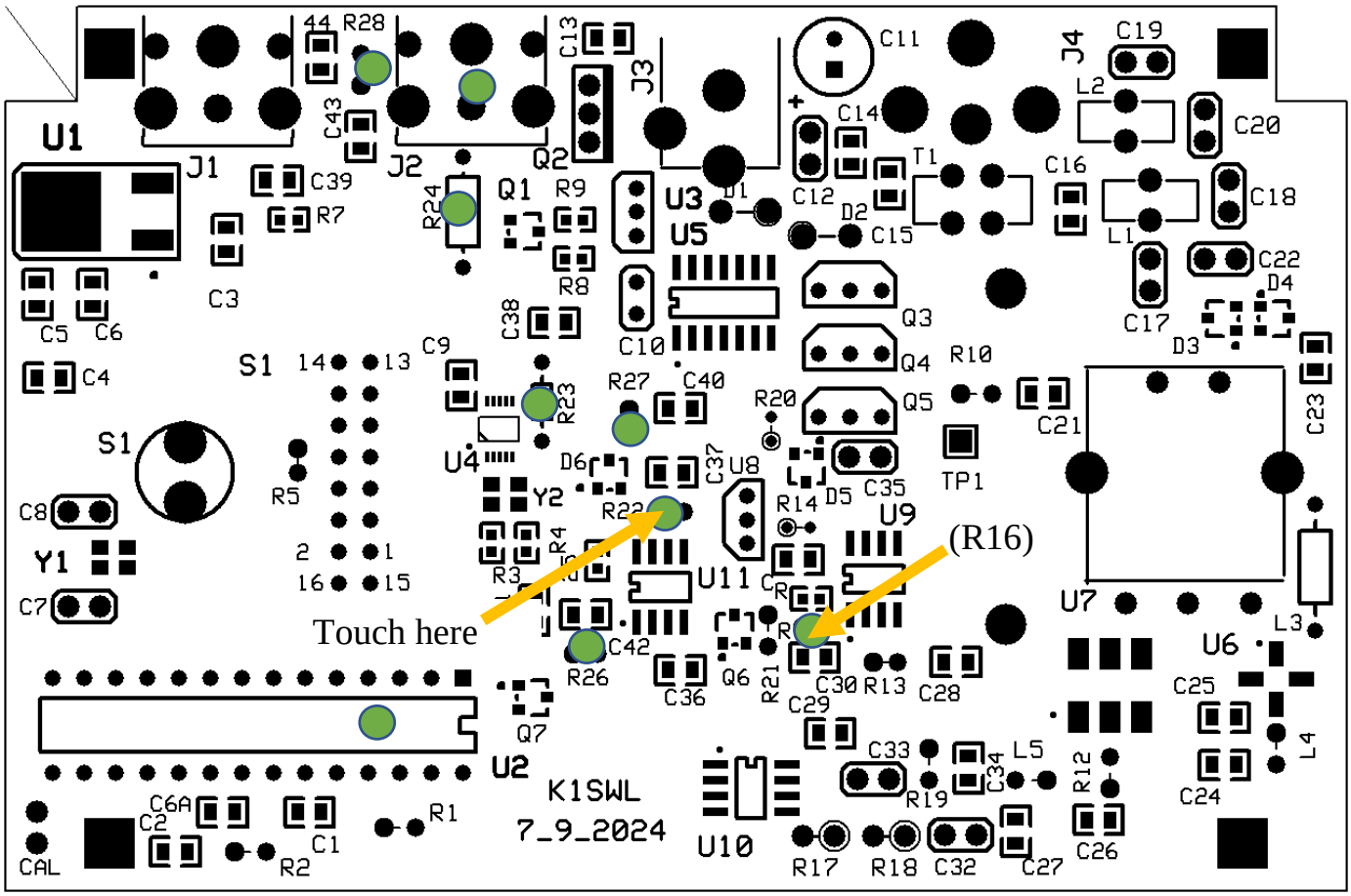
[ ] R23: Install a 2.2K ohm resistor (red-red-red-gold) as shown in the diagram on the next page**. Note**: This resistor is installed 'laying down'.

[ ] R16, R26, R27 Install 22K ohm resistors (red-red-orange-gold) as shown in the diagram on the next page**.** R16 is located immediately behind capacitor C30.

***TEST #2:* Audio final Amplifier**

- *Connect headphones via connector J2.*
- *Connect DC power via connector J3.*
- *While listening in headphones, touch a fingertip to the wire loop on resistor R22.*
- *Success criterion: Hum is audible.*
- *(Remove headphones and DC power before proceeding to the next assembly group.)*

Group 2 Component Placement



GROUP 3 ASSEMBLY: RF signal and Sidetone

This assembly group installs the controller IC (U2) and related components and verifies critical portions of Old Friend operation.

[ ] C7, C8 Install the two 22pF capacitors (marked 22J or 220) from the R-C bag as shown in the figure on the following page.

[ ] R1, R2, R5: Install 1k resistors R1,R2 and R5 (brn-blk-red-gold) as shown in the figure on the following page.

[ ] J1: Install the remaining 3.5mm connector at J1 (upper left corner of board).

[ ] R10: Install a 51-ohm resistor (green-brown-black-gold) at R10 as shown in the figure on the following page.

[ ] TP1: Install a single-pin header at the location shown on the following page. This small piece is found in the hardware bag. Caution: Use a minimum of heat when soldering. It's fairly easy to melt TP1's plastic sleeve with excessive heart. Note: if you plan to take this signal off for measurement purposes and typically use clip leads, you can omit this installation step. Instead- you'll clip onto resistor R10.

[ ] Integrated Circuit U2: Install 28-pin IC U2 (ATMega328P-PU). This pre-programmed device is polarity-sensitive. The dot and/or notch at one end of the device must face to the right. You'll probably need to bend the IC pins gently inward to mate with the socket. The best approach is to push the IC down on each side separately using a hard surface to bend one 14-pin row at a time. Once you've installed the IC, ensure that all leads are seated in the socket.

TEST #3: RF signal and Sidetone

- *Install Paddles or Straight Key at connector J1. Install headphones at connector J2.*
- *Apply DC power to connector J3.*
- ***Test 3.1*** *Upon closing the keyer paddles or straight key, verify the presence of sidetone in the headphones.*
- ***Test 3.2*** *Connect a clip lead to R10 (or female jumper wire to TP1) to bring off a signal there.* ***Verify*** *the presence of the following signal there: 80m 3561 kHz. 40m: 7031 kHz 30m: 10107 kHz 20m: 14041kHz 15m: 21031 kHz 10m: 28031 kHz. Any of the following tools can be used: A* ***frequency counter****. A* ***digital oscilloscope*** *with frequency readout. Your '****big rig'****.*

The exact frequency doesn't matter- you're verifying its presence. The Calibration procedure (Appendix 4) is performed later to correct this.

- *(Remove all connections to the board.)*

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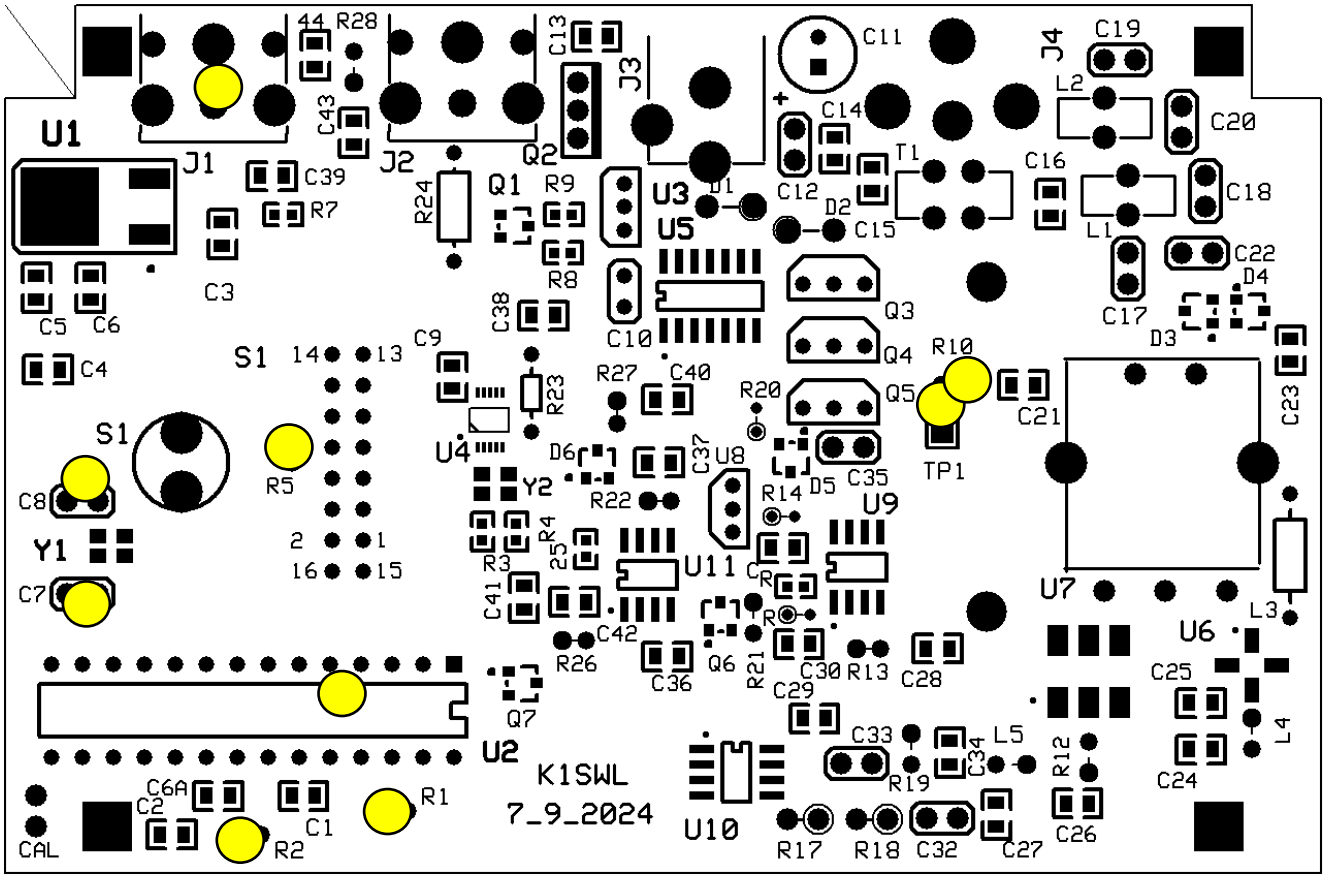
Group 3 Component Placement



GROUP 4 ASSEMBLY: Audio Active Filter and DC Biases

This assembly group installs the OF's remaining audio components. *See next page for component placement, as indicated by **blue** dots.*

[ ] R12,R13 (51 ohms): Install 51-ohm resistors (green-brown-black-gold) at R12 and R13 as shown at right.

[ ] R14,R19 (1K): Install 1K-ohm resistors (brown-black-red-gold) at R14 and R19 as shown at right.

[ ] R17 (86.6K): Install the 86.6K-ohm resistor (blue body, brown-red- grey-grey-tan) at R17 as shown at right.

[ ] R18 (150K): Install the 150K-ohm resistor (blue body, brown-orange-black-yellow-brown) at R18 as shown at right.

[ ] R20 (100K): Install a 100K-ohm resistor (brown-black-yellow-gold) at R20 as shown at right.

[ ] R21 (1M): Install a 1M-ohm resistor (brown-black-green-gold) at R21 as shown at right.

[ ] C32 (1200pF): Install the 1200pF capacitor ('122') at C32 as shown at right.

[ ] C33 (1500pF): Install the 1500pF capacitor ('152') at C33 as shown at right.

[ ] C35 (2200pF): Install the 2200pF capacitor ('222') at C35 as shown at right.

Test 4: Audio Amplifier and DC biases

When this assembly group is complete, the Audio amplifier chain is functional.

[ ] Connect headphones at J2.

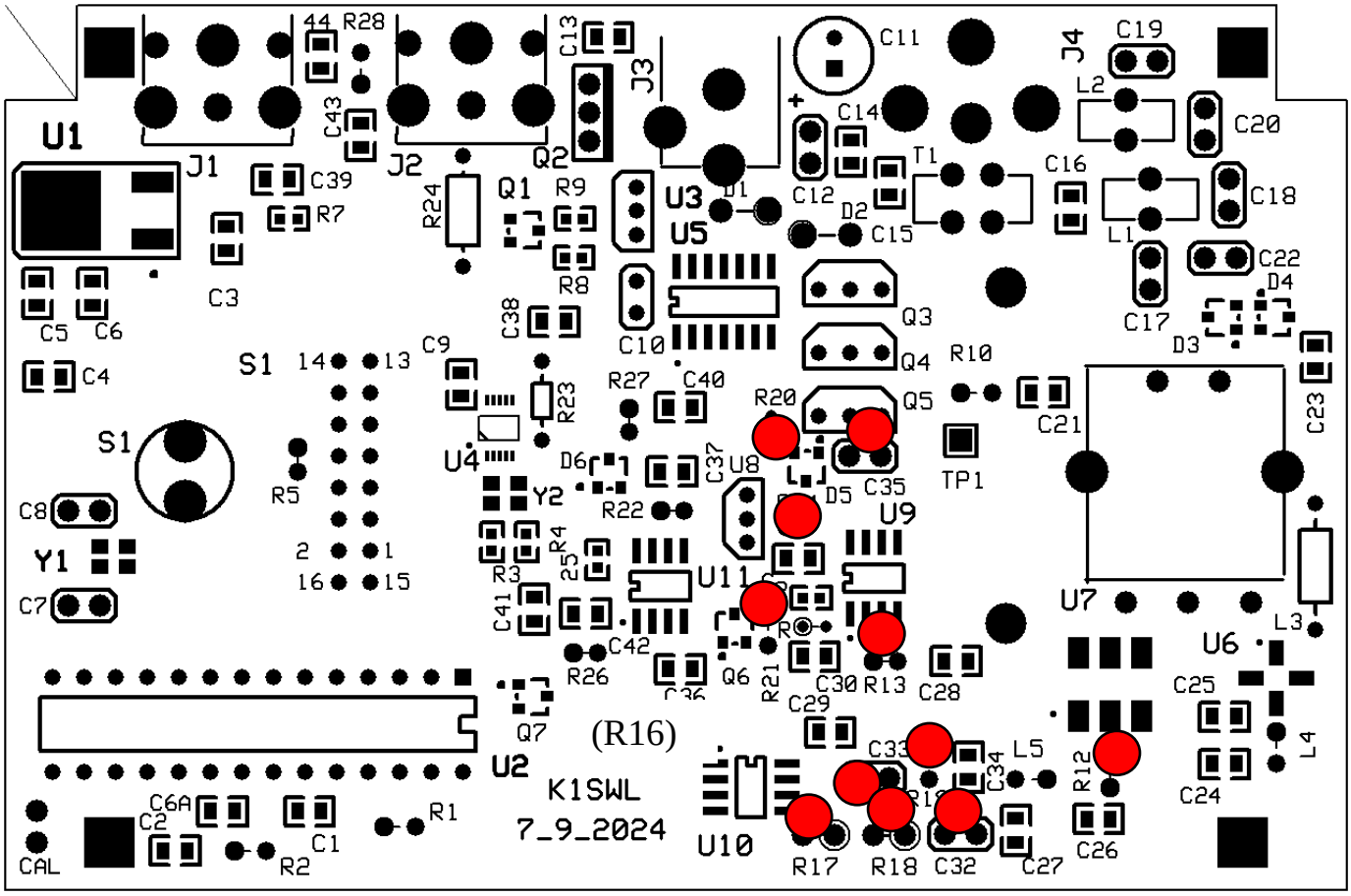
[ ] Connect DC power at J3.

[ ] Touching R18's wire loop should cause a loud hum in the headphones .

(Remove DC power and headphones.)

Here we are- becalmed in the Sargasso Sea of assembly. The next Assembly group's much more fulfilling.

Group 4 Component Placement



GROUP 5 ASSEMBLY: Transmitter strip

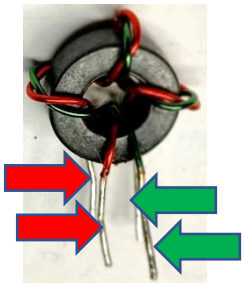
This assembly group installs the transmitter components. See the next page for component placements.

[ ] T1 (Toroid FT37-43): Wind **4 turns** of the supplied **#24 red/green** twisted-pair wire on the **FT37-43 toroid form** (gray, 0.37"-diameter). Take extra care to avoid scrambled turns. Prepare the leads as described next.

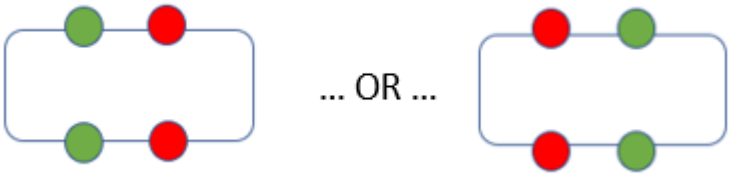
[ ] T1 Lead preparation: Trim the leads on each end of the twisted pair to a length of 3/8" (1cm). Separate the wires.

[ ] T1 wire stripping: With your soldering iron, load its tip with a generous bead of solder. Apply this bead to a wire tip until the insulation melts. *This may take as much as 10 seconds.* Work your way along each wire, repeating until all 4 wires show clean tinning up to the toroid body itself.

Two leads of a given color must be arranged to one side of the finished toroid. The two remaining leads must be grouped to the other side of the toroid. This is illustrated in the photo to the right.



Now, install the toroid at T1 in either orientation as shown below. Seat it fully- but not forcefully- on the board before soldering.



[ ] L1 (**T37 Toroid**): Cut a 12" length of the supplied **#26 red magnet wire** and wind the number of turns specified for your band in Appendix 8**. Caution: circle the table values for your band on that page and cross out the unneeded tables.** ***Too easy to get off-track otherwise.*** Heat-strip the leads as before and install at L1. **See Appendix 7 for guidance on winding toroids.**

[ ] L2 (**T37 Toroid**): Cut a 12" length of the supplied **#26 red magnet wire** and wind the number of turns specified for your band in Appendix 8 and install at L2.

[ ] BNC (J4): Install the BNC connector at J4 Solder all connections. The two 'press-fit' leads are not used electrically but they provide mechanical stability

[ ] C17: Install capacitor C17. Its value may be found in Appendix 8 for your band. The same caution about using the correct table values apply to C17 through C20.

[ ] C18: Install capacitor C18. Its value may be found in Appendix 8 for your band.

[ ] C19: Install capacitor C19. Its value may be found in Appendix 8 for your band.

[ ] C20: Install capacitor C20. Its value may be found in Appendix 8 for your band.

[ ] D2: Install diode D2 (glass body) in the lefthand hole of the pair and the wire loop into the righthand hole. **The banded side of the diode body** (the cathode) is **oriented at the top with the wire that loops over-and-down**.

[ ] Q2: Install semiconductor Q2 (3 leads, tab at top) at the location shown at right. **Ensure that the tab on the device is oriented to the right as shown before soldering.**

[ ] Q3,Q4,Q5: Install semiconductors Q3-Q5 (3 leads marked ' ') at the locations shown below. **Ensure that the 'flat' on each device is oriented as shown.**

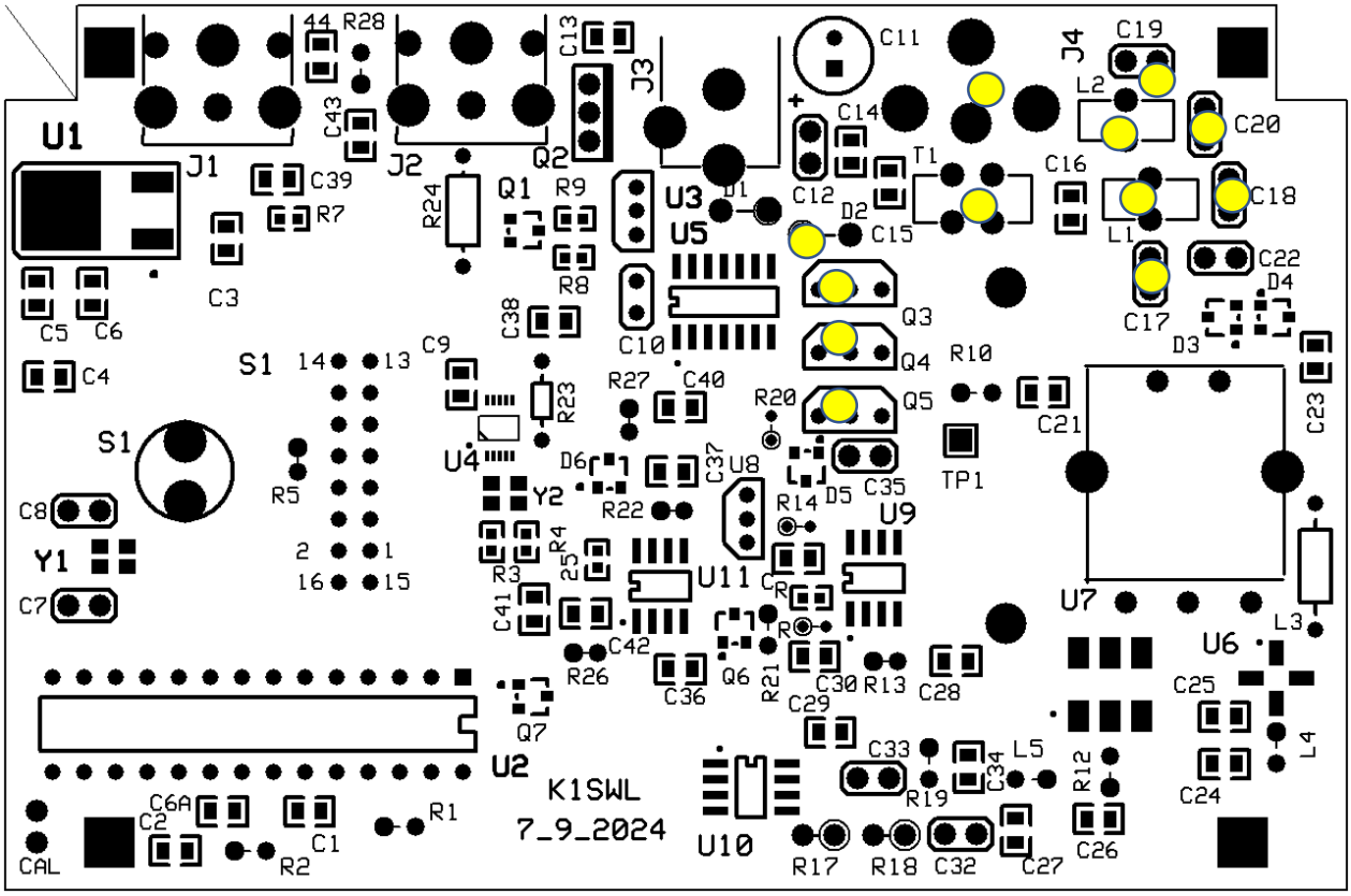
TEST #5: ***the Transmitter Strip***

Connect Keyer paddles or a Straight key to J1. Connect a 50-ohm nominal dummy load/wattmeter to the BNC connector (J4). Apply 12V DC power via J3.

Upon key-down, you should see 6 Watts nominal at the wattmeter.

No wattmeter? No problem. On an oscilloscope, 5 Watts out corresponds to approximately 48 Volts peak-to-peak into a 50-ohm load.

Group 5 Component Placement



GROUP 6 ASSEMBLY: Receiver and final Assembly

[ ] C22: Install capacitor C22. Its value may be found in Appendix 8 under the applicable 'Band-Pak' for your band.

[ ] L3,L4,L5: Install these 3 RF Chokes. Their values may be found in Appendix 8.

TEST #6.1: ***The Receiver***

Install headphone at J2 and connect DC power via J3.

Touch a small screwdriver to the center conductor of BNC connector J4. You should hear a rise in the receiver noise.

(Disconnect headphones and DC power.)

We recommend cleaning the flux residue from the underside of the circuit board. You may use cotton swabs dipped in acetone (a hardware store item). It does a great job removing the flux. *Do not use nail polish remover for this job as it may contain oil or other ingredients.*

Final Assembly:

[ ] ENCODER: Install the rotary encoder at the right side of the board. **Be sure to seat it firmly and fully on the printed circuit board before soldering.** If it's 'canted' when a top cover is added at a later date, it will prove difficult to realign later.

[ ] 16-PIN SOCKET: Install this socket behind the Controller IC (U2). This will be a force-fit. Take care to press down firmly so that the socket seats at right angles to the printed circuit board. *"Use the Force, Luke"* necessary to seat the socket fully down on the board. Update: Effective with boards marked 12/29/2024, brute force is no longer necessary. *You're welcome.*

[ ] PUSHBUTTON SWITCH: Install this component to the left of the 16-pin socket. Again, it's important to ensure that this switch stands vertical. You should be able to solder just one lead to hold it in place before soldering the second one. With this component, it's possible to make minor adjustments after the fact.

[ ] LCD: Remove the LCD assembly from its Anti-Static packaging. Install this component on the 16-pin socket installed earlier. Doublecheck to ensure that the 16 LCD pins are all plugged into the socket- and not off by one row or column.

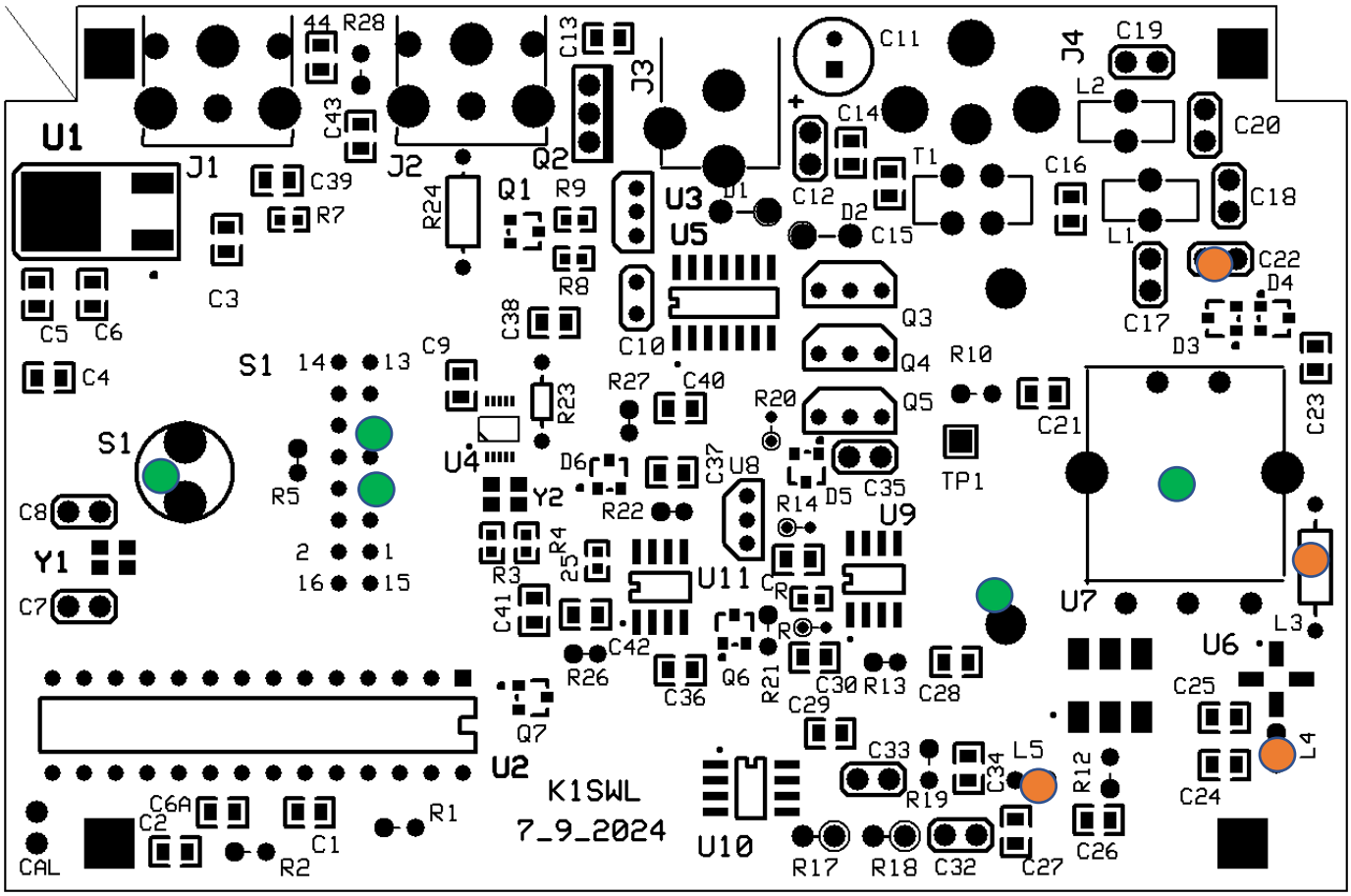
Test #6.2 Final Testing

Apply DC power via connect J3.

Verify that the LCD illuminates and displays the startup frequency for your band.

Rotate the rotary encoder both clockwise and counterclockwise. The frequency display reflects the inputs from the encoder- tuning both up and down in frequency.

Group 6 Component Placement

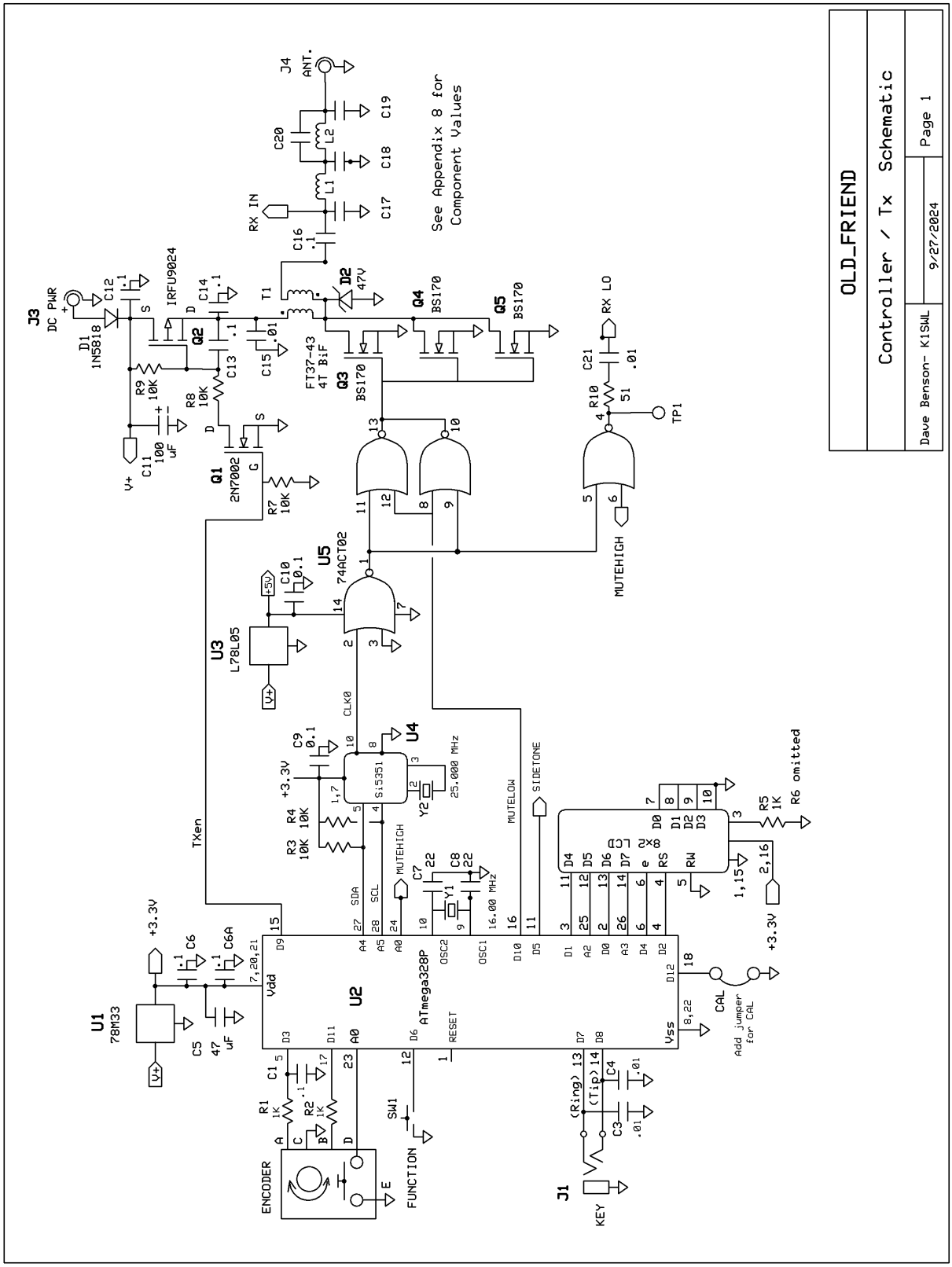


APPENDIX 1: Parts List for the Old Friend

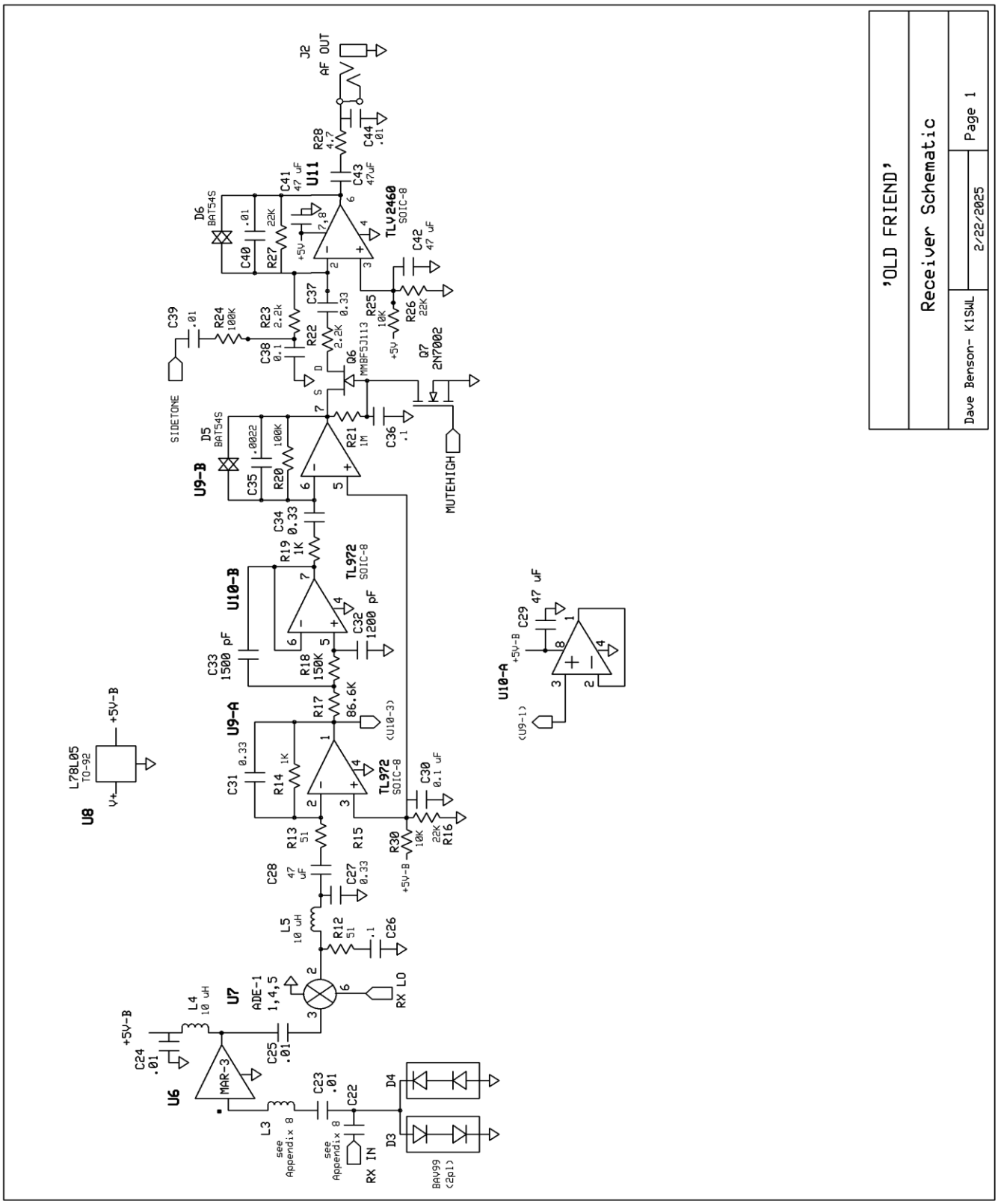
	OLD FRIEND BOM as of 08-NOV-2024 **FACTORY-INSTALLED SMDs**			
Qty	**Ref. Des**	**Value**	**Package**	**Markings/Identification**
11/12	C1,C2, C6,C6A,C9,C13,C14,	.1 uF	0805	
	C16,C26,C30,C36,C38			
	(C2 is installed on boards marked 12/29/2024 and later)			
10	C3,C4,C15,C21,C23,C24,C25, C39,C40,C44	.01 uF	0805	
6	C5,C28, C29,C41,	47 uf 6V	0805	
	C42,C43			
4	C27,C31,C34,C37	0.33 uF	0805	
2	D3,D4	BAV99	SOT-23	
2	D5,D6	BAT54S	SOT-23	
2	Q1,Q7	2N7002	SOT-23	
7	R3,R4,R7-R9,R15,R25	10k ohm	0603	
1	Q6	MMBFJ113	SOT-23	
1	U1	78M33	TO-252	
1	U4	Si5351	MSOP-10	
1	U5	74ACT02	SOIC-14	
1	U6	MAR-3SM+		
1	U7	ADE-1+	SMD-6	
2	U9,U10	TL972	SOIC-8	
1	U11	TLV2460	SOIC-8	
1	Y1	16MHz	SMD-4	
1	Y2	25MHz	SMD-4	
	CAPACITOR PARTS CARD			
2	C10,C12	.1 uF	.100" l.s.	'104'
2	C7,C8	22 pF C0G	.100" l.s.	'22J'
1	C11	100 uF 16V	.100" l.s.	'16V 100uF'
1	C33	1500 pF	.100" l.s.	'152'
1	C32	1200 pF	.100" l.s.	'122'
1	C35	.0022 uF	.100" l.s.	'222'
	SEMICONDUCTOR BAG			
1	D1	1N5818	axial	Black body
1	D2	47V Zener	axial	Clear body
1	Q2	IRFU9024	I-PAK	3 leads, metal tab
3	Q3-Q5	BS170	TO-92	'BS170'
2	U3,U8	L78L05	TO-92	AS78L05Z

	RESISTOR BAG			
1	R28	4.7 ohms	1/4W 5%	Yellow-violet-gold-gold
3	R10,R12,R13	51 ohm	1/8W 5%	Grn-brown-black-gold
5	R1,R2,R5,R14,R19	1k	1/8W 5%	Brn-black-red-gold
2	R22,R23	2.2K	1/8W 5%	Red-red-red-gold
3	R16,R26,R27	22k ohm	1/8W 5%	Red-red-orange-gold
2	R20,R24	100k	1/8W 5%	Brn-blacl-yellow-gold
1	R21	1M	1/8W 5%	Brn-blacl-green-gold
1	R17	86.6K	axial	brown-red- grey-grey-tan)
1	R18	150K	axial	brn-orange-black-yellow-brn
	LOOSE PARTS BAG #1			
1	16-pin 2-row header	female socket		2-row housing, 16 pins
1	28-pin DIP socket			Black 28-pin housing
1	FT37-43 toroid	T1		0.37”/1cm dk. grey ring
1	Momentary switch			Pushbutton
1	J3	power		DC power jack
2	J1,J3	3.5mm TRS		3.5mm stereo connect
1	36" length #26 magnet wire			
1	4" length red/grn pair wire			
1	Single-pin post	TP1		
	LOOSE PARTS BAG #2			
1	LCD 8X2 BuyDisplay.com			LCD- in Anti-static envelope
1	Encoder	PEC16R		Rotary control w/ shaft
1	J4	BNC		BNC connector
	BAND-SPECIFIC COMPONENTS			
	See Appendix 8			

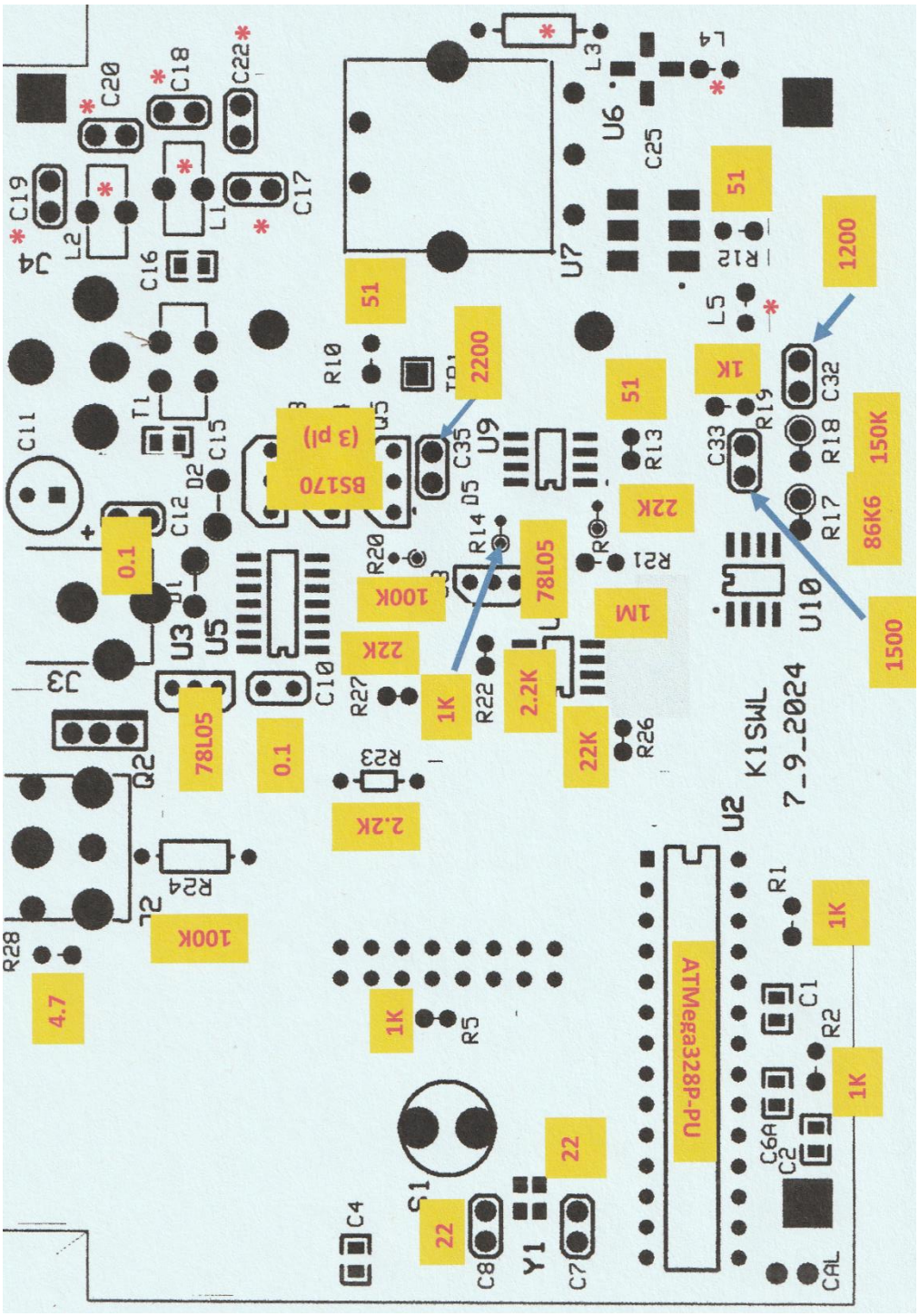
APPENDIX 2a: Old Friend TX Schematic (1 of 2)



APPENDIX 2b: Old Friend RX Schematic (2 of 2)



APPENDIX 3: Parts Layout



- This figure shows component values for the through-hole parts
- Component values marked with '*' are found in Appendix 8.

APPENDIX 4: Calibration procedure

There's not much to it!

The OLD Friend has a simple procedure for Calibrating its operating frequency. This is needed because of the manufacturing tolerances in the 25 MHz crystal that's the Master clock reference for the Si5351 clock generator.

[ ] CAL jumper: You'll find two pads labeled 'CAL' at the extreme lower left corner of the board. Jumper these two pads with a short length of resistor lead . (Hopefully left over from OLD Friend assembly.)

[ ] Test Point: Connect a jumper wire to R10 or TP1 (specified in Group 3 Assembly) for signal measurement.

[ ] DC power: Apply DC power via connector J3.

[ ] Calibration display: The Calibration frequency appears on the top line of the LCD. The word 'CAL' appears on the lower line of the LCD.

[ ] Test equipment: Use a frequency counter or digital oscilloscope connected via the test point above to measure frequency. (Lacking any of this equipment, you can listen on your big rig tuned to the CAL display frequency and tuning the OF for zero-beat using USB or LSB mode.

[ ] Frequency adjustment: The OF's rotary encoder is rotated to change frequency. **Note that the OF's Display does not change**. Allow 2 seconds after each adjustment for test equipment to catch up with the new frequency. Adjust until the measured frequency matches that on the OF display.

The adjustment resolution is 20 Hz. Although it'd be tempting to adjust with finer resolution, the 25 MHz crystal will cause as much as 40 Hz of drift from a cold start. A good idea to let the CAL procedure run for 5 minutes to eliminate some of this warmup drift.

[ ] Exiting CAL: Snip the short wire loop at the board lower-left CAL location. The correction factor is saved to non-vol memory. The DC power can now be removed. The correction factor is retrieved on subsequent applications of DC power.

[ ] Cycle Power: ***One last step***- remove and then restore DC power via connector J3. This sets the receiver frequency to its expected value.

Note*: In normal operation (i.e., not in CAL), frequency readings at R10/TP1 are 800 Hz higher than the operating frequency. This is because the local oscillator frequency has the 800 Hz T/R offset added to it.*

APPENDIX 5: Operation Guide

Station Equipment:

Power Supply – Use a sufficiently capable supply to power the Old Friend. Oftentimes, ac adapters (e.g., 'wall-warts') do not have good regulation at their current rating, and the transmitted signal will suffer if there is low voltage or AC ripple.

Antenna – The Old Friend expects a 50-ohm load at the BNC jack. Use a tuned antenna or a pre- antenna tuner (ATU). The Old Friend does contain a measure of SWR protection.

Headphones: The Old Friend is designed to drive Low-impedance headphones. I'm partial to the Panasonic 'closed' style phones. You want the ones without a built-in microphone. If you have phones with a 4-conductor (TRRS) plug, there are adaptors available online. This may-or may not- be an issue for you. *There are two competing standards for 4-pin audio connectors at work here!*

Operating the Old Friend:

The first thing you'll notice is that you hear a given signal equally well on both sides of zero beat. When tuning in a station to call them, tune in from the **HIGH** frequency side. The Old Friend has a dual tuning rate: 20 Hz steps for a slow rotation of the tuning knob… and 100 Hz steps for faster excursions with the tuning.

There are two options for keying the rig:

A set of keyer paddles and 3-pin plug may be connected to J1 at any time. The Old Friend generates **mode B Iambic keying over a range of 5 to 40 WPM**. *[Version 1 software provided mode A Iambic keying.]*

A straight key and 2-pin plug connected **BEFORE** applying power brings up **Straight Key operation**. There's a 5-second timeout on key closures to guard against overheating mishaps.

'Function' Pushbutton Use …

- **When in Keyer Mode**: A brief (<500 ms) closure on that pushbutton changes the LCD frequency readout to CW Speed in WPM. Turning the "Tune/Speed" control will increase or decrease Speed. Operation reverts to Frequency readout after 2 seconds without control movement. *[In version 1 software, instead of using the Tune/Speed control to change CW speed, closures on the dot and dash paddles accomplished this at approximately 6 WPM per second. Operation reverts to Frequency readout after 1.5 seconds without paddle closures.]*
- A long (>500 ms) closures puts the Old Friend in tune-up mode- 5 seconds of steady RF power out for antenna tuning purposes. If you accidently start this, a tap on either paddle aborts the sequence.
- Paddle reverse: Holding the pushbutton down while applying DC power reverses the Dot and Dash paddles.
- **When in Straight Key Mode:** A long (>500 ms) closures puts the Old Friend in tuneup mode- 5 seconds of steady RF power out for antenna tuning purposes. A tap of the key aborts the sequence.

Frequency Presets *[a version 3 feature]…*

When tapping the "Tune/Speed" control pushbutton, the operating frequency is sequentially placed to one of four convenient "preset" positions in the band to allow for quick and convenient frequency navigation. Typically those four

Preset values in each band are: (1) the Low end; (2) the QRP/POTA watering hole; (3) the old "Novice" segment; and (4) the high end. The presets are arranged such that Preset 4 wraps back around to Preset 1.

APPENDIX 6: Theory of Operation

Receiver: The receiver input is supplied from a connection ('Rx IN') on the Drain side of the low-pass filter. The combination of C22 and L3 provides a fairly broad peak at the band of interest for a measure of selectivity.
Audio gain is provided by both sections of U9 and an additional 20 dB of voltage gain at the audio final (U11).
The audio final was selected for its rail-to-rail operation and a maximum output current of 80 mA. Audio gain control is provided by D6- a Schottky diode pair, ensuring that a painful audio transient won't reach your ears. At normal signals levels, it's a fairly 'soft' limiter. The active filter stage at U10 bears mention. This was a balancing act between sharp filter rolloff and good audio fidelity. I opted for fidelity.

Transmitter: The frequency source for both transmitting and receiving is a Silicon Labs Si5351 (U4). This IC outputs a 3V square wave (hi-Z load) at the operating frequency in Transmit. Its output in Receive is at a frequency 800 Hz higher to provide the offset for working another station. This offset is also the sidetone frequency.

The Si5351 output is split into two paths for Transmit and Receive purposes. They're mutually exclusive- only one is on at any time. The Receive path drives an ADE-1 diode-ring mixer, which in turn is fed by a MAR-3 MMIC. It provides about 12 dB of gain ahead of that mixer. The Transmit path parallels several gates of a 74ACT02 to provide sufficient drive to a trio of BS170 MOSFETs.

The PA stage collector impedance is designed for 12.5 ohms. The output low-pass filter provides an impedance-step-up to 50 ohms in addition to cleaning up the collector waveform. Capacitor C20 provides a notch in the filter's 2nd harmonic response. This allows the relatively simple low-pass filter to meet FCC/EU standards for spectral purity.

Logic: The controller IC (U2) is an ATMega328P-PU clocked at 16 MHz by Y1 and associated capacitors. Upon application of power, the PIC initializes the Si5351 clock generator and illuminates the LCD screen with the startup frequency. It interrogates the paddle/key inputs on a one-time basis to establish the operating mode. A number of parameters are stored to non-vol memory to restore operation at the same settings after power is cycled. The tuning function (via a rotary encoder) is supported by an interrupt service routine which flags newly-arrived encoder pulses and their sense (tune up or down).

Upon receipt of a paddle closure, the logic branches to timing routines which generate dot and dash timing as well as other signals used for T-R sequencing. For Straight key mode, the transmitter output largely follows the key-down times from a key. Both keyer and straight key modes are restricted to 5 second key-down intervals to protect against PA overheating.

APPENDIX 7: Winding Toroids

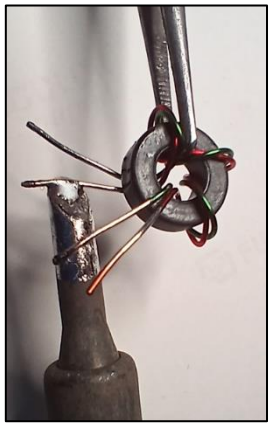
A properly-wound toroid is shown at right.

- **Each time the wire goes through the hole it counts as a turn**
- **The windings are tight**. Pull the wire taut after each turn comes over the outer edge of the core.

and please… no scrambled turns!

- **Doublecheck the turns count.** *I do this by bumping a fingernail over each turn*. When the number of turns is correct, cut the leads to a length of 3/8" (1cm).

- **Strip the leads** by scraping with a small knife to remove the insulation. It should also be possible to heat-strip the leads. This is described for the T1 component in Group 5 Assembly.
- **Try using a single-edge safety razor blade** to scrape one or more sides of the wires all the way up to the toroid's body before tinning them. Removing some of the insulating coating will aid heat transfer to the wire from the soldering iron.
- T1 will get very hot while you're tinning its leads, so use tweezers to hold T1 rather than using your fingers.



- Use a large iron tip to tin the leads. It will hold a large pool of hot solder.
- EZ-strip enameled wires coating burns off at around 155 degs C (311 degs F). Set your iron's temperature higher than that temperature point.
- Note: The burned off coating creates a mess on both the wire and soldering iron tip. Clean the iron's tip often, and ensure you scrape away any crud from the wires after tinning them.
- If you tin toroid wires this way you'll have good solder connections to the pcb and avoid problems,
- **Once the leads are prepared, make sure the turns are evenly spaced on the toroid form**. *If the leads are bunched together, the inductance will be too high. This typically results in low power output.*

APPENDIX 8: BAND-SPECIFIC Component Values

80 Meters:

Reference Desig.	Description	Color/ marking	Number of turns
L1	T37-1 Toroid	Blue/grey	16
L2	T37-1 Toroid	Blue/grey	14
L3,L4,L5	22 uH RF choke	Red-red-blk-gold	-
C17	820 pF	'821'	-
C18	1500 pF	'152'	-
C19	820 pF	'821'	-
C20	220 pF	'221'	-
C22	82 pF	'82J'	-

40 Meters

Reference Desig.	Description	Color/ marking	Number of turns
L1	T37-2 Toroid	Red	18
L2	T37-2 Toroid	Red	17
L3,L4,L5	10 uH RF choke	Brown-blk-blk-gold	-
C17	470 pF	'471'	-
C18	820 pF	'821'	-
C19	470 pF	'471'	-
C20	100 pF	'101'	-
C22	47 pF	'47J'	-

30 Meters

Reference Desig.	Description	Color/ marking	Number of turns
L1	T37-2 toroid	Red	16
L2	T37-2 toroid	Red	14
L3,L4,L5	6.8 uH RF choke	Blue-grey-gold-gold	-
C17	330 pF	'331'	-
C18	560 pF	'561'	-
C19	330 pF	'331'	-
C20	68 pF	'68J'	-
C22	36 pF	'36J' or '360'	-

20 Meters

Reference Desig.	Description	Color/ marking	Number of turns
L1	T37-6 toroid	Yellow	15
L2	T37-6 toroid	Yellow	13
L3,L4,L5	4.7 uH RF choke	Ylw-violet-gold-gold	-
C17	220 pF	'221'	-
C18	390 pF	'391'	-
C19	220 pF	'221'	-
C20	68 pF	'68J'	-
C22	27 pF	'27J'	-

15 Meters

Reference Desig.	Description	Color/ marking	Number of turns
L1	T37-6 toroid	yellow	12
L2	T37-17	Blue/yellow	14
L3,L4,L5	2.7 uH RF choke	Red-violet-gold-gold	-
C17	150 pF	'151'	-
C18	270 pF	'271'	-
C19	150 pF	'151'	-
C20	39 pF	'39J'	-
C22	20 pF	Install as 'hairpin'	-

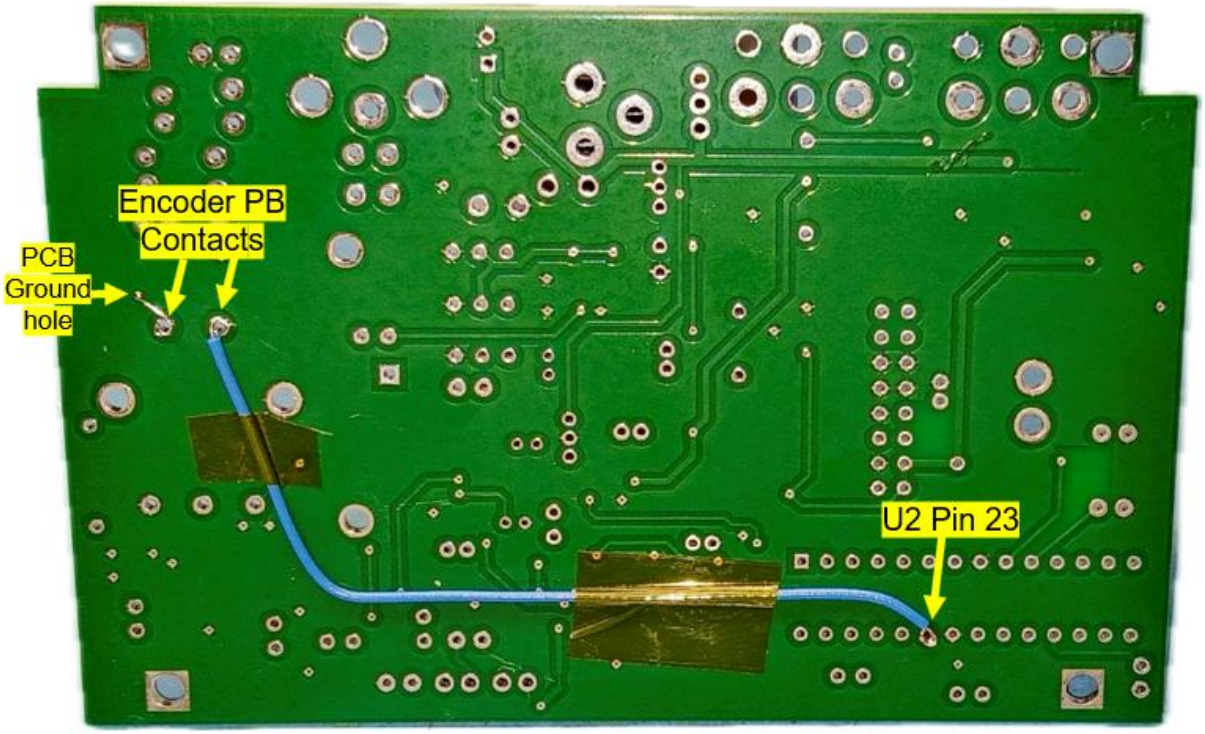
10 Meters

Reference Desig.	Description	Color/ marking	Number of turns
L1	T37-17 toroid	Blue/Yellow	13
L2	T37-17 toroid	Blue/Yellow	12
L3,L4,L5	2.2 uH RF choke	Red-red-gold-gold	-
C17	120 pF	'121'	-
C18	220 pF	'221'	-
C19	120 pF	'121'	-
C20	27 pF	'27J'	-
C22	12 pF	'12J'	-

APPENDIX 9: PCB MODIFCATION FOR ENCODER PUSHBUTTON

In order to use the "Frequency Presets" feature, two "extra" wires are needed on the bottom of the PCB that connect the pushbutton contacts of the "Tune/Speed" encoder to the microcontroller U2. **NOTE: These wires are already present on PC boards provides in some kits – please check the bottom of your board before proceeding with this guidance.**

If you have determined that your board does **not** have the blue wire already attached as shown below, you will need to do it yourself … *and it's easy!* One wire is a longer insulated wire (provided herein), reaching from one of the PB contacts of the rotary encoder over to U2 pin 23, and the other is a shorter 'scrap' wire connecting the other PB contact to a nearby ground thru-hole in the PCB. Photos of these connections are shown below …



APPENDIX 10: ASSEMBLING THE ENCLOSURE

The **Old Friend Enclosure Kit** is very easy to put together.

Parts supplied with the Enclosure Kit include:

(1) Red cover
(1) Plastic shell, Hammond #1591-G, pre-drilled
(2) Knob
(4) 5/8" #2 threaded aluminum spacers
(8) #2-56 black nylon screws
(4) #4 black aluminum sheet metal screws
(4) Rubber feet

Step 1: Attach the Cover to the top of the PCB assembly using the four aluminum spacers and the eight (8) black nylon screws. (A small-blade jeweler's screwdriver works great for these 'unusual' Phillips-head screws.)

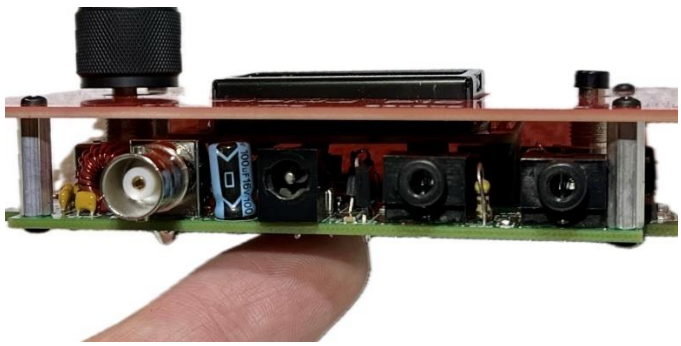
Step 2: Using your thumb (or worst-case, a sharp blade or file), clear the pre-drilled holes of the plastic shell of any residual plastic debris from the drilling operation. Most shells are fairly clean already and will just require a quick scrape with your thumbnail to make the edges smooth.

Step 3: Insert the cover-and-PCB assembly into the plastic shell, being careful to align the PCB's connectors optimally to the holes in the shell. NOTE: Due to drilling tolerances, you might wish to 'fine tune' the positioning of the PCB connectors against the holes by loosening the #2 black nylon screws on the top cover and 'slide' the PCB assembly as-needed. Tighten the screws when an optimal fit is found.

Step 4: Screw the top cover into the four corner posts of the plastic shell using the #4 black sheet metal screws.

Step 5: Using an appropriate hex-Allen wrench, screw the knob onto the shaft of rotary encoder. Be sure leave some vertical room for the knob to be depressed enough to actuate the encoder's built-in pushbutton. (You'll hear and feel a slight 'click' when this happens.)

Step 5: Attach the four rubber feet to the bottom of the plastic shell.



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Jan 13, 2025 Initial release of single 'combined' manual. Added band suppport for 15m and 10m.
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