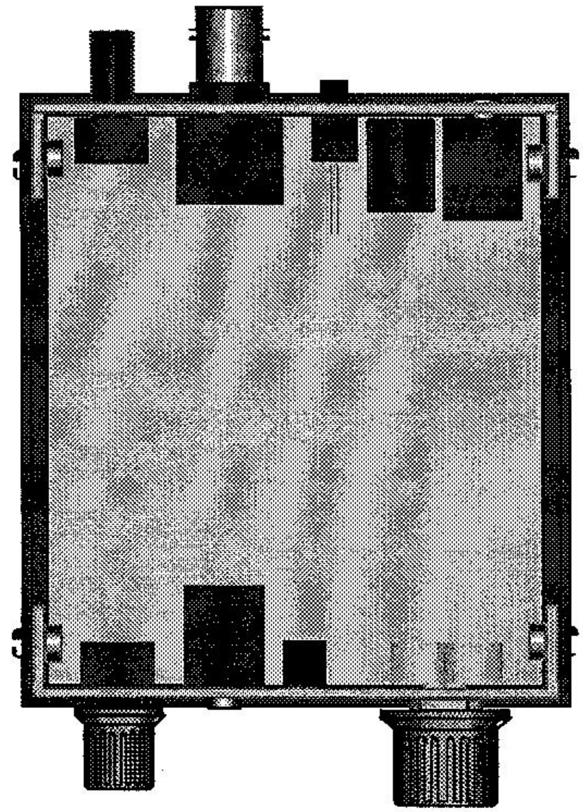
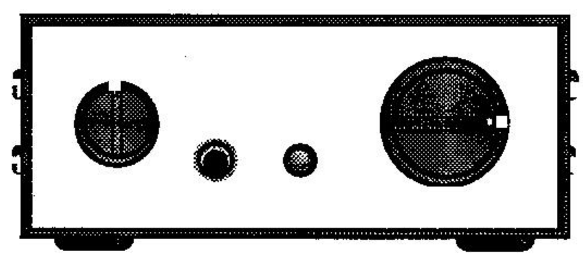


SST CW Transceiver

Assembly And Operating Manual



Wilderness Radio

P.O. Box 734, Los Altos, CA 94023-0734
(650) 494-3806

Printed on recycled paper

Contents

Introduction

The SST--or *Simple Superhet Transceiver*--is a compact, high-performance CW rig that covers a portion of 40, 30, or 20 meters. The SST's simplicity makes it one of the easiest-to-build QRP transceiver kits available, yet it provides excellent receiver performance and about 2 watts of output power on transmit. The SST also has several features that will appeal to outdoor operating enthusiasts:

- It's less than half the size of many other single-band transceivers.
- A VXO (variable crystal oscillator) provides excellent stability in varying temperatures. The VXO's 10 to 20kHz tuning range includes the portion of each band most often used by QRP (low power) stations.
- The efficient design permits optional operation from an *internal* 9V battery. A slide switch is used for power so the unit won't get turned on accidentally.
- Connection points are provided for the Wilderness Radio KC1 keyer/frequency counter, eliminating the need for an external keyer. The KC1's Morse-output counter is useful in many operating situations.

Add fold-up headphones, a 1/4-wave wire antenna, and a miniature keyer paddle, and you'll have a complete station that weighs about one pound!

We hope you enjoy building and operating the SST, and that the rig will facilitate your exploration of low-power, portable communications.

73,

Bob Dyer, KD6VIO
Wayne Burdick, N6KR

Wilderness Radio's Kit Policy

1. Unbuilt kits may be returned within 30 days for a full refund, less a 15% restocking fee. Customer must pay cost of shipping the kit to Wilderness Radio.

2. Missing or defective parts will be replaced free of charge within 30 days.

3. If--after your best efforts--the kit still does not work properly, we will repair it for a fixed fee of $50 plus $5 for return shipping. The kit must be in good condition; damaged kits may not be repairable. Customer must pay cost of shipping the kit to Wilderness Radio.

4. Technical support is available by phone Monday through Friday, 10 a.m. to 5 p.m. Pacific time at (650) 494-3806. Send written inquiries to: Wilderness Radio, P.O. Box 734, Los Altos, CA 94023-0734

Specifications

Numeric values given are typical; your results will be somewhat different. Unless otherwise noted, measurements were made with a 13.8V supply and 50Ω load at the antenna.

General

Size:	1.5" (H) x 3.4" (W) x 3.7" (D)
Cabinet:	Unfinished, .050" aluminum
Voltage Requirements:	9 to 16VDC[1]
Current, Receive:	15 mA (23mA w/KC1 keyer/counter)
Current , Transmit:	225-250mA at 2.0 watts 100-150mA at 1.0 watts

Frequency Range[2]:

Band	Using D4B	Using D4A
40m	7.030- 7.040	7.035- 7.045
40m Novice	7.105- 7.115	7.110- 7.120
30m	10.095-10.110	10.105-10.120
20m	14.040-14.055	14.050-14.060

VXO Drift:	100Hz total from cold start at 65°F
VXO Dial calibration:	Supplied by builder (optional)

Transmitter

Output:	0 to 2.0W, adjustable (0.5 - 1.0W typical @ 9V)
Final Amp efficiency:	65 - 75%
Load Tolerance:	brief operation into high SWR
Transmit offset:	400-800 Hz
T-R (transmit-receive) delay:	< 50 milliseconds

Receiver

Min. discernible signal (MDS):	-135dBm
Selectivity:	200 to 400Hz @ -6dB
I.F.:	Approx. 4Mhz; 3-pole Cohn crystal filter
Audio output impedance:	8Ω or higher (headphones or speaker) **(Stereo headphone plug required--see Operation)**

[1] Operation below 10V requires the use of a different voltage regulator (see **Modifications**).
[2] Two different varactor diodes, D4A (MV209) and D4B (MVAM108), are supplied with the kit. Either or both may be used. Actual frequency ranges may be different from those shown.

Preparation for Assembly

☑ **As you complete each step, put a mark in the check-off box as shown here.**

Component Identification

☐ Take a moment to familiarize yourself with the parts list (Appendix A). Components are listed alphabetically by the letters in their *reference designators* (e.g., "R" for resistor). Pages 1 and 2 of the parts list show the components common to all versions of the SST. Page 3 has four sections, one for each SST band.

☐ To avoid confusion during assembly, you may wish to highlight the appropriate section on page 3 of the parts list.

☐ To help identify parts, the parts list includes drawings of most components, capacitor markings (in quotes), and color code bands. If you aren't familiar with component markings, please read the ***Capacitor Markings*** and ***Color Code*** sections, below.

☐ Using the parts list, identify all components in the kit. If anything is missing or damaged, call or write to Wilderness Radio immediately.

Capacitor Markings

All of the capacitors in the kit can easily be identified by their drawings and descriptions in the parts list. However, you may find it helpful to understand the markings of small capacitors.

Small (< 1000 pF) disc ceramic capacitors are usually marked with 1, 2, or 3 digits and no decimal point. If 1 or 2 digits are used, that is the value in pF (picofarads). If there are 3 digits, the third digit is *usually* a multiplier. For example, a capacitor marked "151" would be 150pF (15 with a multiplier of 10 to the first power). Similarly, "330" would be 33 pF, and "102" would be 1000 pF.

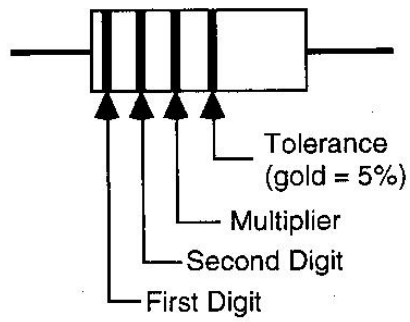
Occasionally, disc capacitors use "0" as a decimal place holder rather than a multiplier, so that "330" might actually mean 330 pF, not 33 pF. Markings shown in the parts list should clear up any confusion.

Disc or film capacitors with values over 1000pF may use a decimal point in the value, such as .001 or .02. This is the value in microfarads (µF).

Color Code

Color codes are used on both resistors and RF chokes. The drawing below shows how to read the color bands on resistors. The markings on RF chokes will be explained in a subsequent section.

Resistor Color Code



Color	Digit	Multiplier
Black	0	x 1
Brown	1	x 10
Red	2	x 100
Orange	3	x 1K
Yellow	4	x 10K
Green	5	x 100K
Blue	6	x 1M
Violet	7	
Gray	8	
White	9	

Assembly Tips

Tools

- Use a pencil-type soldering iron of 15 to 25 watts with a fine tip--one that's designed for integrated circuit work. Do not use a soldering gun, or an iron with a large, flat tip. Excess heat will damage pads and traces on the PC board.

- Solder containing 2% silver is preferred (Mouser Electronics[3] #533-0415 or equiv.).

Component Installation and Soldering

[3]Mouser's phone number is 1-800-346-6873.

• Install all of the components in each group as described, then check your work before soldering. This may save you the trouble of removing a part that was soldered in the wrong place.

• Use good lighting to avoid confusing color bands on resistors. If you're unsure of a resistor's color bands, check the value with an ohmmeter.

• As you install each component with long leads, seat it flush against the PC board, then bend the leads at about a 45° angle. After installing each component with long leads, cut the leads off to a length of about 1/16". The short leads on components such as ICs (integrated circuits) and connectors need not be trimmed.

• Sockets are not recommended for the ICs or transistors, since they may be unreliable in the presence of vibration or temperature variation.

Component Removal

The SST PC board is double-sided with **plated-through holes**. This results in a very clean layout, but also makes component removal more difficult than it is from single-sided boards. If you need to remove a component, 3/32" or 1/8" wide desoldering braid (also called *solder-wick*) works well. **Do Not** use Archer or other cheap brands of desoldering braid; it may wick solder very poorly. Use a professional brand such as Ungar-Wick.

If a component can't be removed with wick or a solder sucker, try using long-nose pliers on one side and soldering iron on the other. Use only the amount of heat necessary. Remove any remaining solder from the hole with solder wick.

Assembly

PC board assembly begins with low-profile components--e.g., resistors and diodes--and works up to the higher-profile parts. This keeps the board stable as you turn it over each time to solder.

Install and solder each component (or group of components) in the order given below. Part locations can be identified from the outlines and reference designators on the PC board. There is also a component location drawing (Appendix B).

Resistors, Diodes, and RF Chokes

☐ On page two of the parts list, locate the first fixed resistor listed (R10). To find where it goes, look for a small rectangular outline on the PC board with the label "R10."

☐ Install R10 so that it is seated flush with the top of the board, then bend and clip the leads on the bottom of the board as described previously. Do not solder this resistor until the remaining fixed resistors have been installed.

☐ Install the remaining fixed resistors, double-checking the color code. (If you have trouble seeing the color bands, ask someone to identify the resistors for you.) The resistors should all be oriented in one direction for ease of reading the color codes later: the first significant-digit band should be towards the left or top.

☐ Install trimmer potentiometer R12. Be sure to orient R12 in the direction indicated by its PC board outline.

☐ Solder all of the fixed resistors and the trimmer potentiometer.

☐ Install D1, D5, and D6 (page 1 of the parts list). These diodes must be installed with the cathode end--the end with the widest band--oriented in the same direction as the banded end of their PC board outlines.

☐ The SST's frequency coverage is different for the two different varactor diodes, D4A and D4B, as shown in the **Specifications** section. Choose one of these diodes and save the other one for possible future use. (You can optionally use both diodes in conjunction with a miniature front panel switch. Refer to **Modifications** for details. The switch is not supplied with the kit.)

☐ Install D4A or D4B (see above), which has a flat-sided package like a transistor. Install the diode according to its PC board outline.

☐ Install diode D2 in the same fashion.

☐ Install diode D3 (red LED) so that the LED lens hangs over the front edge of the PC board. Make sure it is flush with the PC board as you solder.

☐ Solder all of the diodes.

☐ Install all of the RF chokes ("RFC") except RFC5, which is a toroidal choke that you'll install later. Note that there are RF chokes listed on both pages 2 and 3 of the parts list. The color code on each choke represents the value in microhenries (µH). The largest color dot is the multiplier, where black = x1. For example, brown-green-black is 15µH. Gold is a multiplier of 0.1, so an RF choke with colors green-blue-gold would be 5.6µH.

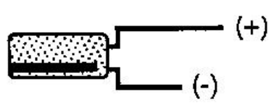
☐ Solder the RF chokes.

Capacitors

☐ Install all of the disc and film capacitors, which appear on pages 1 and 3 of the parts list. These capacitors are easily damaged; be careful when handling the leads.

☐ Solder all of the disc and film capacitors.

☐ Next, install the electrolytic capacitors. All of the electrolytics are polarized as shown in the drawing below. Be sure that the (+) lead is installed in the (+) hole in the board--the one with the **square** pad. The (+) lead is usually longer than the (-) lead. The (-) lead is usually indicated on the body of the capacitor with a black band. Refer to the component placement drawing, Appendix B, to verify the orientation of electrolytic capacitors.

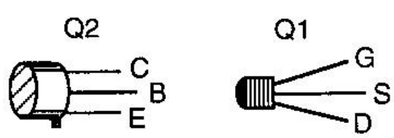


☐ Solder all of the electrolytic capacitors.

☐ Next, install trimmer capacitors C1 and C28. Orient the trimmers as they appear on their PC board outlines, then solder.

Transistors, ICs, and Crystals

Base diagrams for Q1 and Q2 are shown below for reference:



☐ Locate the final amplifier transistor, Q2. If Q2 is supplied in a small envelope, discard any extra hardware or oval plastic spacer you may find inside.

☐ Q2 may come fitted with an oval, aluminum heatsink, which must be removed. **Remove and discard** this heatsink, being careful not to damage the leads of the transistor as you pull it off.

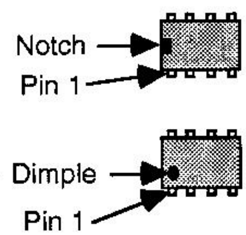
☐ Install Q2, pressing it down so that it is about 1/16" above the PC board. Solder Q2.

☐ **Carefully press the finned heat sink onto Q2, spreading the heatsink open slightly with a flat-blade screwdriver so that it goes on easily. Don't force it--you could damage the transistor.** Once the heat sink is installed, make sure it isn't touching any of the surrounding components.

☐ Install the remaining transistor, Q1. Align the flat side of the transistor with its PC board outline. It must sit about 1/8" above the board; don't force it the way down. Solder Q1.

☐ Install U6. This is a flat-sided unit like a plastic transistor; install it as indicated on its PC board outline. Solder U6.

☐ Install all of the remaining ICs. These ICs are 8-pin DIPs (dual-inline packages). Since there are no sockets used, be careful to install the ICs correctly. **The notched and/or dimpled end of each IC must be aligned with the notched end of its PC board outline as shown in the following drawing.**



☐ Solder all of the 8-pin ICs.

☐ Install all six crystals (shown on page 3 of the parts list). **Note that X6 has a different frequency from the others.** Make sure that the crystals are seated correctly--perpendicular to the board--then solder.

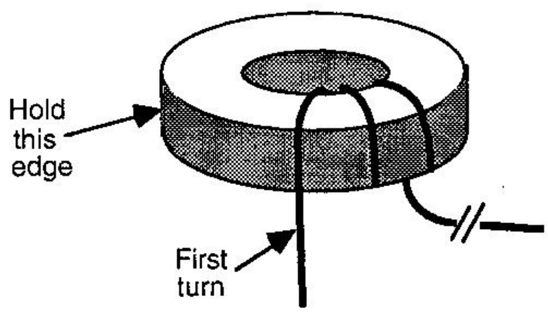
☐ The cases of crystal X1 through X3 should be grounded to reduce "blow-by" from very loud signals, i.e., signal leakage around the crystal filter. There is a ground pad near each crystal for this purpose. Use a very short length of wire soldered directly to each crystal can, as close as possible to the ground pad.

Toroid Tutorial

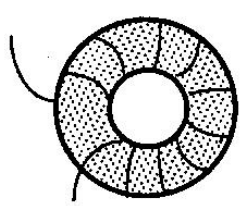
If you've never wound a toroidal inductor before, here are some things to keep in mind. Read through this section once before trying your hand at one of the easiest to wind toroids, L2.

• Always begin winding toroids as shown: grip the core on its left side, pass the first turn over the top, then pull all the wire through, winding from left to right. Be very careful not to kink the wire.

• Since each pass through the core counts as one turn, the toroid shown has 3 turns on it so far. The remaining wire to be wound on the core continues off to the right.



• After winding, the turns should be spaced roughly even around most of the core, leaving a small gap between the first and last turns as shown below. (The number of turns shown in the drawing is different from the actual number of turns used.)



Toroid Winding and Installation

☐ Locate toroid L2 on page three of the parts list. The **Part Number** column specifies the toroid core type, in this case a red T37-2 core. The "37" in the part number means 0.37 inches in diameter, and the "-2" is a specific type of iron-powder core material which is color-coded red.

☐ Wind L2 as described above. The parts list specifies the number of turns (for example, "18T" means 18 turns), wire gauge (#28 enamel), and the length of wire required in inches. The enamel wire used to wind the toroids is provided in the kit.

☐ After winding L2, cut its leads to about 1/2 inch long, then use a match or cigarette lighter to remove the insulation from the ends of the leads (to within about 1/8" of the toroid body). About 5 to 10 seconds on each lead should do it, or you can place the leads close together and burn the insulation off of both at once.

☐ Remove any remaining enamel coating from the wire using medium-grit sandpaper. (Don't sand it down too thin, since this will weaken the wire.) Tin the leads with solder.

☐ Install L2 vertically, as indicated by the PC board outline. Keep the toroid pressed up against the board and gently pull the leads taut on the other side.

☐ After pulling the leads through, make sure you can see *bare wire* where the lead intersects the pad on the bottom of the board. Don't pull the lead through so far that the *insulated* part of the lead is seen protruding from the pad.

☐ Trim the leads and bend them down onto the pads, then solder. If you burned off, sanded and tinned the leads properly, the solder will cleanly stick to the leads. As a check, use an ohmmeter to measure from one pad to the other. There should be continuity through the toroid (nearly zero ohms) if you have two good solder joints.

☐ Wind and install L3 and L1 in the same manner as L2, using the number of turns specified in the parts list.

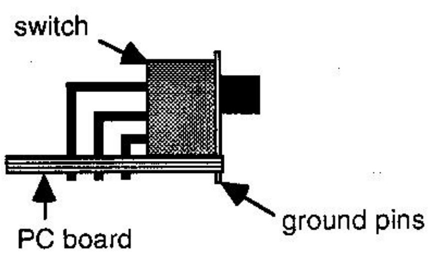
☐ Wind and install RFC5 (page 2 of the parts list). Note that this toroid uses a black core, and may also have an orange dot.

Controls, Connectors, and Panels

☐ Install 1/8" jacks J3 and J4. Bend the leads slightly to hold the jacks in place. Solder, holding the connectors flush with the PC board.

☐ Install the antenna jack, J2. Make sure the jack is flush with the PC board while soldering.

☐ Install slide switch S1 so it is flush with the PC board as shown below. S1 has two ground pins that must be pressed into two holes that are right at the edge of the PC board. These holes may have some burring, which can be removed with a small screwdriver or pocket knife. Be sure that the ground pins on the switch are fully pressed into these holes, or the switch may not be flush with the PC board.



☐ Remove the small metal tab (near the shaft) of the large potentiometer, R4. When you install R4, press it down into its PC board holes as far as it will go without forcing it. Solder R4.

☐ Install the two small potentiometers, R1 and R3. They have different values, so be careful not to swap them. Be sure that the potentiometers remain flush with the board as you solder.

☐ Install the rear panel onto the shafts of the rear panel controls. Secure the rear panel to the PC board assembly using the provided control nuts and washers.

☐ Install the front panel onto the shafts of the front panel controls. Secure the front panel to the PC board assembly using the provided control nuts and washers.

☐ Install J1 on the PC board. You'll need to hold J1 flush against the board as you solder. One way to do this is to tack-solder one pin first, then re-heat the joint as you press the connector down onto the board.

Final Assembly

☐ Do a final inspection for cold solder joints, solder splashes, shorts, and broken component leads. This could save you from a protracted troubleshooting session.

☐ Attach the large knob to the VFO pot (R4) and the small knob to the AF GAIN control (R3).

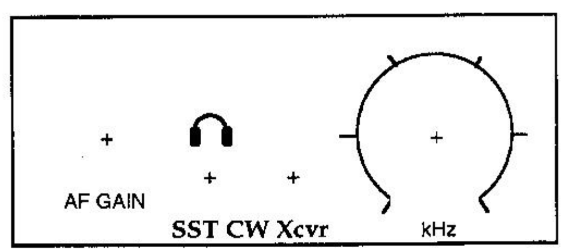
☐ Install the bottom cover, securing it to the PC board with four 4-40 x 1/4" screws. The top cover can be installed after alignment.

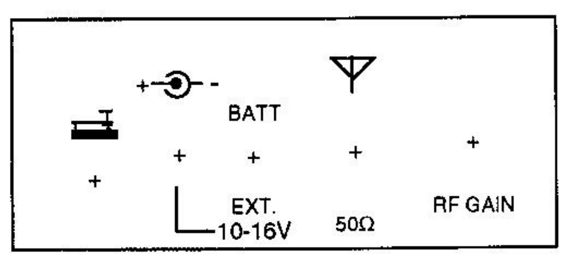
☐ Stick on the four rubber feet, approximately 1/4" from each corner of the bottom cover.

☐ You should now have the following items left over: P1 (mating connector for J1), one varactor diode, four 4-40 x 1/4" screws, and the top cover. If there's anything else left over, check for uninstalled components on the PC board.

☐ Paint and labeling are optional. Labeling can be done by hand using dry transfers, available at art supply stores. Alternatively, you can use the front and back label artwork below, which is 1:1. It can copied onto transparency material, then glued to the panel.

☐ If desired, you can calibrate the VXO dial using a frequency counter or another transceiver.





Alignment and Test

If you have any difficulty with the procedure below, refer to the **Troubleshooting** section.

Initial Test

Before beginning alignment, follow these steps:

1. Make sure S1 (power) is in the OFF position (UP). Note: **If you're using an internal 9V battery, then the OFF position is DOWN. Refer to Modifications.**

2. Connect a 50Ω, 2-watt (minimum) dummy load to the antenna jack.

3. Connect a well-regulated and filtered 10 to 16V DC power supply (or battery) capable of supplying 300mA to J1. If you're using a power supply, set it for 13 to 14V. Then turn on the power supply and S1. If any component is warm to the touch or you see or smell smoke, turn S1 OFF immediately, disconnect the power supply, and turn to the **Troubleshooting** section.

4. If you have a milliameter, connect it in series with the supply and note the current reading, which should be approximately 14-17mA. If the reading differs by more than a few mA from this value, chances are you have a short or open or a bad component. Note: adding a KC1 increases current drain to about 23mA; see **Modifications.**

Receiver Alignment

1. Connect a pair of headphones or a speaker to J4. **You must use stereo headphones,** or make an adapter to convert from mono to stereo. Sensitive, Walkman-style headphones with either in-ear buds or full-cover ear pieces are strongly recommended.

2. Connect an antenna to J2. If possible, use a known-good antenna that is matched at the intended operating frequency. At minimum, use a wire whose length in feet is equal to about 234/F (MHz), connected directly to the center pin of J2. The SST receiver will perform poorly without a good antenna.

3. Turn the RF gain control (R1) fully clockwise (as viewed from the rear panel).

4. Turn on power using S1, and adjust the audio output level using R3 until you can hear some noise in the headphones.

5. Using a small tuning tool or jeweler's screwdriver (preferably with an insulated handle), adjust C1 for maximum atmospheric noise.

6. If possible, locate a weak on-air signal and fine-tune C1 as needed for maximum signal.

7. If you don't hear any noise, or if the pitch of received signals seems to high or too low, refer to **Troubleshooting.**

Transmitter Alignment

1. Set R12 to maximum (fully clockwise).

2. Re-connect the 50Ω dummy load to J2. If an inline watt meter or SWR bridge is available, connect it in series with the dummy load. Alternatively, you can use a DMM and RF probe to check the output at J2, or use a ham-band receiver with an S-meter.

3. Connect a key or keyer to J3.

4. Key the transmitter for brief periods (maximum of 3 seconds at a time) and adjust C28 for maximum signal strength on the meter or external receiver. If there is no apparent power output, see **Troubleshooting**.

5. Adjust R12 for the desired output level. The maximum output should be between 1.8 and 3.0 watts. A power output setting of 0.5 watts or higher is recommended for best transmitted signal purity.

6. The transmit monitor tone should be plainly audible in the headphones when you key the transmitter. If you cannot hear the transmit monitor tone, or if it is too low or too high in pitch, refer to **Troubleshooting.**

Operation

Front Panel Controls

AF Gain: The AF gain control, R3, will typically be set at 12 o'clock with ear-bud type 'phones, higher with less sensitive types. This control affects gain for both received signals and the transmit monitor tone. R3 should not require frequent adjustment, thanks to the AGC circuit.

Headphone Jack: J4 is intended to be used with very sensitive, 8 to 32Ω*stereo* headphones. Use a mono-to-stereo adapter with mono headphones.

Signal LED: The signal LED, D3, flashes in proportion to the strength of received signals. On transmit, the LED may also flash, but *not* in proportion to the power output level.

VXO: The VXO (variable-crystal oscillator) control, R4, covers as much as 20 kHz depending on the band. You can increase the VXO range by switching in a second varactor diode or crystal. VXO range will be somewhat less if you operate from 9V. (See **Modifications.**)

Rear-Panel Controls

RF Gain: RF gain control R1 will normally be set to maximum (fully clockwise as viewed from the rear panel). You may need to turn the RF gain down if signal levels are extremely high, particularly on 30 and 40 meters when strong AM short-wave broadcast interference is present. Note that R1 must be turned almost fully counter-clockwise before it begins to reduce receiver gain.

Antenna Jack: Always use a well-matched, 50Ω antenna at J2. If you have any doubts, use an SWR bridge and, if necessary, an antenna tuner. It is possible to damage the output transistor of the SST if you operate it into a poorly matched load for an extended period.

Power Jack : The SST requires 10 to 16 VDC at J1 (or an internal, 9V battery and appropriate modifications). Transmit current will rarely be over 350mA. Transmit power output will be proportionally lower with lower supply voltage.

On-Off Switch: S1 is a double-throw switch, allowing the SST to be powered from either an external power supply (via J1) or by an internal battery. If you're using J1, **DOWN** is ON. With an internal battery connected to the topmost lead of S1, UP is ON. S1 is a break-before-make switch, so you can safely use both a battery and an external supply if desired.

Key Jack: You can use a hand key or any type of "key-to-ground" keyer at J3. Most keyers, including the Wilderness Radio KC1, have an output of this kind.

Operating Tips

Operating QRP: Experienced QRPers usually spend much more time listening than transmitting. This is especially important for portable operation, since the life of your batteries is inversely proportional to how much transmitting you do. However, don't be afraid to call "CQ QRP" on a seemingly dead band; someone has to open it! If you've never operated QRP, there are many good books on the subject to help you get started.

Transmit Monitor Tone: The SST doesn't have a side tone oscillator. Instead, the signal you hear when you key the transmitter is the output signal itself, being picked up by the receiver and reduced to a comfortable volume. Because of this, you can tell what pitch to listen to as you tune in other stations: just occasionally check the pitch of the transmit monitor signal. The sound of the transmit monitor tone will vary somewhat depending on whether the cover is on or off, how well the antenna is matched, and what supply voltage you're using.

Receiver Overload: If the band is very noisy or you hear very loud stations, turn the RF gain control down. The SST uses an NE602 as the receive mixer, providing excellent sensitivity and low current drain, but it can get overloaded by very large signals.

Sharp Filtering: The narrow crystal filter in the SST does an excellent job of helping fish weak signals out of the noise--in fact it's so sharp that you may need to tune more slowly than you're used to. The filter also does a good job of reducing the noise itself. For example, wideband, random noise will be about 10 to 20dB lower in amplitude with the SST than with a rig using a 3kHz-wide sideband filter.

Troubleshooting

1. If you have a problem that you can *see* or *smell*, turn off power immediately.

2. The most common problems with the SST are listed in the chart below. If none of these match your symptoms, continue with the *General Troubleshooting Procedure.*

Symptom	Cause/Solution
No audio output.	Use 8 to 32Ω *stereo* headphones. If mono, you must use mono-to-stereo adapter.
Can't peak receiver input tuned circuit (C1).	D1 in backwards; wrong value at RFC1; R1 and R3 swapped.
Receiver sensitivity seems low.	Use more sensitive headphones. Re-peak C1. Try widening xtal filter (use 68pF at C6 and C9, and 180pF at C7 and C8).
No received signal, and/or VXO doesn't change frequency when tuning R4.	D2 and D4 may be swapped; X6 may be swapped with one of X1 through X5
Received signal pitch is too high or too low.	Change the value of C10. You may wish to replace C10 with a 50-pF trimmer capacitor.
Transmit monitor pitch is too low or too high.	Change the value of C24. You may wish to replace C24 with a 50-pF trimmer capacitor.
Key clicks heard in headphones when transmitting	Install a .01uF disc capacitor across pins 1 and 2 of key jack (J3)
No transmit power output.	C28 not peaked; Drive control set too low; D5 and D6 swapped; U4 or U5 installed backwards.
Low transmit power output (< 1.5W @ 12V or < 2.0W @ 14V)	If C28 peaks but power still seems low, reduce R10 to 120 or 150Ω.
Sidetone sounds noisy in headphones when transmitting. Worse when using an antenna than when using a dummy load.	RF may be getting into the headphone cable. Solder a .001 to .002µF capacitor from the wiper of R3 to ground using short leads.

General Troubleshooting Procedure

1. Inspect the PC board for solder bridges, cold or non-existent solder joints, incorrectly-installed parts (backwards or wrong part), broken parts, and open circuit traces. **The most likely problem, by far, is a poorly-stripped lead on a toroid. Also likely is an incorrect resistor, capacitor , or RF choke value.**

2. Double-check your test setup. Often you can trace a problem to a bad scope probe, intermittent clip lead, incorrect power supply voltage, etc.

3. Try signal tracing to locate where the signal is getting lost (see below). Unless otherwise noted, measurements were taken with a high-impedance DMM set to DC Volts and an RF probe. (See any edition of the ARRL Handbook for RF probe circuits and construction details.)

Receiver

a. VXO output at Q1-source should be 200 to 400 mVrms.

b. BFO at U2, pin 6: about 100 to 300mV rms.

c. Use a fine-point metallic tool to do "qualitative signal tracing." *With your hand contacting the blade,* touch the tool to pins 2 and 3 of U3--you should hear the same amount of hum (a lot!) on each pin. Now work backwards to see where you're losing it: touch the tool to pins 4 and 5 of U2, then pin 1 of U2, and finally the left side of RFC7. If you can still hear loud noises when you touch RFC7, the likely culprit is the crystal filter or first mixer.

Transmitter (key down, drive set to maximum)

a. If you don't hear any transmit monitor tone when you key the rig, look for a problem in the transmit mixer stage. Try the voltage checks in Table 1.

b. Driver output at Q2 base: over 0.7V rms.

c. Power output at Q2 collector: 12 to 15V rms.

d. Output at antenna jack: 10V rms.

e. If power amp collector efficiency seems low (less than 60%), double-check the components in the low-pass filter, PA, and buffer/driver stages.

DC Voltage Chart

These readings were taken with a DMM (30V DC scale) with the (-) probe at ground, under the following conditions: power supply = 13.8V; 8V regulator at U6; dummy load connected to J4; transmit output 2 watts; RF gain = MAX; AF gain = MIN. In general, you should expect your readings to be within about 5 to 10% of these.

SST DC Voltages, All Active Devices. Voltages marked with an asterisk (*) cannot be measured because of loading by the DMM probe.

Pin#	Rcv	Xmit	Pin#	Rcv	Xmit
U1-1	1.4	-0.5	U4-1	> 8.0	1.7
U1-2	1.4	-0.9	U4-2	> 8.0	1.7
U1-3	0	0	U4-3	> 8.0	0.3
U1-4	6.8	8.0	U4-4	> 8.0	6.8
U1-5	6.8	7.8	U4-5	> 8.0	6.8
U1-6	7.9	7.9	U4-6	> 8.0	7.9
U1-7	7.2	7.4	U4-7	> 8.0	7.5
U1-8	8.0	8.0	U4-8	> 8.0	8.0
U2-1	*	*	U5-1	0	0
U2-2	1.4	1.3	U5-2	> 8.0	7.0
U2-3	0	0	U5-3	> 8.0	6.9
U2-4	6.8	7.4	U5-4	> 8.0	0.30
U2-5	6.9	7.4	U5-5	0	0
U2-6	8.0	7.8	U5-6	> 8.0	7.2
U2-7	7.6	7.6	U5-7	13.8	13.7
U2-8	8.0	8.0	U5-8	0	0
U3-1	*	*	U6 in	13.8	13.7
U3-2	0	*	U6 out	8.0	8.0
U3-3	0	*	U6 gnd	0	0
U3-4	0	0	Q1-G	0	0
U3-5	4.1	4.1	Q1-S	0.9	0.9
U3-6	8.0	8.0	Q1-D	8.0	8.0
U3-7	4.0	4.0	Q2-E	0	0
U3-8	*	*	Q2-B	0	*
			Q2-C	13.8	*

Circuit Details

Design Overview

The SST uses essentially the same set of functional blocks as the NorCal 40A and similar CW transceivers (see schematic, Appendix C). However, the SST design is optimized for minimal parts count, so some of its circuitry is quite different.

Like the NorCal 40A, the SST's receiver section has an I.F. (intermediate frequency) filter, but no I.F. amplifier. Since the receive mixer has considerable gain, I.F. gain is not really necessary. Nor is an I.F. amplifier required for attenuation. Instead, the SST's AGC (automatic gain control) circuit works by reducing the bias on the NE602 product detector.

The transmitter has its own mixer and crystal oscillator. This means that what you hear when you key the rig is the actual transmitted signal, not a sidetone oscillator. The usual buffer and driver stages have been replaced by a video op-amp, but the final amplifier stage is conventional.

A varactor-tuned VXO rounds out the major functional blocks. On each band, both the VXO and I.F. use common microprocessor crystal frequencies. Since the SST is a single conversion rig, when receiving at 7.040MHz the math is: 11.040 (VXO) - 7.040 (RF) = 4.000 (IF). On transmit the rig subtracts the transmit oscillator from the VXO to get to 40 meters: 11.040 - 4.000 = 7.040.

Receiver

Starting in the upper left-hand corner of the schematic, you'll notice that the receiver input filter has only one tuned circuit--C1/RFC1. A single tuned circuit is all that's needed to remove the image response (I.F. + VXO), because the image is *above* the operating frequency and is attenuated somewhat by the low-pass filter. Receive mixer U1 then subtracts the RF input signal from the VXO to obtain the I.F.

The SST's input circuit is unusual in that C1 is *series-resonant* with RFC1 at the operating frequency. This provides a good match to the low-pass filter. The other end of the series-tuned circuit is terminated at AC ground by C3, so the load for C1/RFC1 is really U1, via C2. C3 also holds U1 pin 2 at AC ground, which is necessary when the NE602 is used single-ended.

RF gain control R1 is used to reduce the amplitude of the signal at U1 pin 1. Thanks to the isolation provided by C2, R1 will not have a significant detuning effect on C1/RFC1.

Switching diode D1 and PIN diode D2 are used for receiver RF limiting on transmit. Both are at reverse or zero bias during receive, so neither has an effect an effect on the received signal. As soon as the transmitter is keyed, D1's cathode is pulled down to ground, which causes three things to happen: (1) the positive half-cycles from the final amp output are shunted to ground, making C1 appear as part of the low-pass filter and effectively removing RFC1 from the circuit; (2) the DC bias on pin 2 of U1 goes well below 1.4V, unbalancing the mixer and cutting off the received signal; (3) D2 becomes forward biased, removing any remnant of the transmit signal seen on pin 1 of U1.

A three-crystal I.F. filter follows mixer U1. The filter provides excellent selectivity, thanks to the low I.F. C6/RFC6 and RFC7/C9 transform the high impedances of U1 and U2 down to about 100 ohms to provide a good match to the crystal filter.

U2 is the product detector and BFO (beat-frequency oscillator). It subtracts the I.F. signal from that of its on-chip oscillator to arrive at an audio signal. X4, the BFO crystal, is tuned to a frequency that is just above the I.F. by approximately 500 to 600Hz. The output of U2 is amplified to headphone level by audio amp U3. C16 and R2 form a feedback network that improves U3's gain at 500 to 600Hz.

D3 is the AGC detector. One end of D3 is connected to DC ground by R3, and the other end sits at about 1.4VDC due to the internal bias circuitry of U2. D3 requires about 1.7 volts to become forward biased, so it has no effect when only small signals are present. At an AF output level of around 0.6Vp-p, D3 starts to conduct on the negative half-cycles of audio, which reduces the bias on U2. This is an unconventional use of the NE602, but it provides good AGC range with minimal components. C39 sets the AGC time constant, and also removes any audio component from the signal applied to U2. RFC2 holds pin 1 at the same DC voltage as pin 2, thus keeping the mixer balanced and reducing distortion.

D3 is visible through a hole on the front panel, so as it conducts it also serves as a signal indicator.

VXO and Transmitter Circuits

Q1 is the VXO, which is varactor tuned. The two varactor diodes supplied with the kit provide different tuning ranges because their voltage vs. capacitance curves are quite different. RFC3 must be low-Q for best range. The value of RFC3 is fairly critical; if it is too high, the oscillator will have excessive drift and its output voltage will vary widely over its tuning range.

The LT1252, U5, is an inexpensive video amplifier IC, with nearly flat frequency response up to 50MHz in low-gain configurations. Its output impedance is about 75 ohms, providing a good match to final amplifier Q2. R10/R11 form a gain-setting divider. The LT1252 can swing about 8V peak-to-peak when running on 12V. No transmit keying transistor is used; instead, the ground pins of the transmit mixer and the video amp are pulled low on transmit.

R12 does triple duty as the load for the LT1252, protection for Q2 on negative half-cycles, and the drive level control. D6 provides some protection for Q2 when the SWR is high.

Modifications

This section describes modifications to the SST that some builders may want to try. To make this a bit easier, the PC board has labeled pads for a number of useful signal lines (listed below). The actual labels used on the PC board are shown in parentheses.

8VDC ("8V")	Near U2
12VDC ("V+")	Near S1
VXO out ("CTR")	Near U1, pin 7
A.F. input ("A")	Near U3
Keyline ("K")	Near J3
Ground ("G")	Near U1, J3, or R4
Rcvr RF in ("RF")	Near J2
Noise blnkr in ("NB")	Near U1

KC1 Keyer/Frequency Counter

The KC1 keyer/frequency counter board is only 2.5" by 0.8", and will fit on the top cover of the SST. It provides an iambic keyer with nonvolatile message buffers, as well as a "displayless" frequency counter: instead of a display, the KC1 uses Morse-code audio output to report your operating frequency as 3 digits. Here's how to build the KC1 into the SST:

1. Follow the assembly instructions in the KC1 manual, with one exception: the 3.3K resistor (R3) must be replaced with 470 or 560Ω. This increases the KC1's RF amplifier gain so it can reliably count the SST's low-level VXO signal.

2. The best location for the KC1 is along the left edge of the top cover, so that the KC1 board sits directly above the crystal filter (X1, X2, and X3 on the SST). Orient the KC1 board so that the speed control is near the front of the box.

3. To increase the amplitude of the VXO signal, you must put a 15k resistor between pins 7 and 3 of U1 on the back of the SST PC board. The KC1 will not work properly without this modification.

4. Use the connection points listed below between the KC1 and the SST. Keep all leads short, and avoid running lines close to the final amplifier, Q2, or any components near it. The extra parts needed, CV and RA, can be mounted on the back of the SST PC board.

KC1	SST
V+ ("+")	pad labeled "8V"
Ground ("GND")	pad labeled "G" near U1
Keyline ("K")	pad labeled "K"
VFO ("V") (via CV)	CV = 100pF; connect CV to pad labeled "CTR"
AF Output ("AF")	pad labeled "A" near U3; RA = 180k; no CA

5. Use the following KC1 configuration: SideTone OFF; Weight 4; QSK 1; Mute 1. The VFO offset command depends on the band: 40 meters, "O3A001"; 40 meter novice, "O3A069"; 30 meters, "O3A807"; 20 meters, "O3A069".

6. A keyer paddle jack can be installed directly above the key jack (J3), or you can cut all traces to J3 and re-wire it as a keyer jack.

7. If the KC1's audio output is too high or too low, increase or decrease (respectively) the size of RA.

Increasing VXO Tuning Range

There are a number of ways to increase the SST's VXO tuning range:

1. *Increase the size of RFC3.* The highest standard-value RF choke that works reliably has already been chosen, so your best bet is to add a second RF choke in series with the first. Start with 1.0µH, and watch for signs of instability (drift or loss of VXO signal amplitude). If you go too far, VXO temperature stability may suffer. You may also find it more difficult to tune in stations.

2. *Use both varactor diodes supplied with the kit.* You can add a miniature SPDT switch to the front panel to select one of the two varactors. Use the shortest possible leads to the PC board.

3. *Add a second identical VXO crystal in parallel with the first.* Depending on the actual frequency and type of crystal you use, range may increase by as much as a factor of 4! In some cases, the second crystal can cause problems, such as drop-outs in part of the range and parasitic oscillation. You may also have to considerably reduce size of RFC3.

4. *Switch between two crystals.* You'll probably have to custom-order a crystal for the range of interest.

5. *Insert a small-value capacitor (1 to 3pF) between the VXO crystal and the gate of Q1.* This may increase VXO range at the high-frequency end. If you use this method, be sure to re-check VXO output and stability over the full tuning range.

Improving VXO Tuning Linearity

VXO linearity can be improved by connecting a resistor between the wiper and 8V end of R4. If you're using the MVAM108 at D4, try a 3.3K resistor. For the MV209, try 18K. You may have to experiment to find the best value.

9-Volt Operation

A 9-volt battery will fit inside the SST, even if you also have built-in a KC1 as described above. A 9V alkaline battery will not last very long (perhaps an hour), so a lithium battery is recommended. To use a 9V battery, follow these steps:

1. Replace the 8V regulator, U6, with a 5V or 6V unit (78L05 or 78L06), or roll your own 7V, low-dropout regulator (e.g., using the National Semiconductor LP2952). The higher the regulated voltage, the better your VXO range will be. *Make sure that the battery voltage never drops too low on key-down for the regulator you use.* A 9V lithium battery may drop to 8V on key-down when new, and it will drop lower as the battery is drained.

2. Connect the positive battery terminal to the upper-most pin of S1. The UP position of S1 is then the ON position for battery operation, and DOWN will still connect the external supply via J1. If you're also using a KC1, connect its "V+" pin to this same point. (The KC1's 5V regulator will not function correctly running from less than 7V.)

3. Reduce the transmit power output as necessary to meet the battery's upper current drain limit. That means 0.5W to 1W with a 9V lithium battery. Power level can easily be set using R12.

4. If you use a *rechargeable* 9V battery, you may be able to trickle-charge it from the external supply. This will be highly dependent on the battery type, so consult the manufacturer.

Noise Blanker

If you have a really bad case of A.C. line noise, you can install a Wilderness BuzzNot noise blanker in the SST. The "RF" pad on the SST's PC board can be connected to the BuzzNot's input pin. The BuzzNot output should be connected to the "NB" pad on the SST through a .01µF capacitor. (You may have to re-peak C1 on the SST after the installation.) Finally, you'll need a miniature 10k potentiometer on the front or rear panel to control the noise blanker gain, or at least an on-off switch.

Widening the Crystal Filter

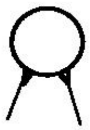
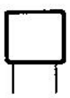
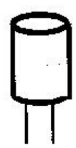
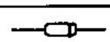
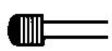
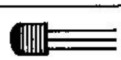
The SST's crystal filter bandwidth is quite narrow. If you prefer a wider filter, use 68pF at C6 and C9, and 180pF at C7 and C8. In addition to increasing the filter bandwidth, this modification may increase receiver audio output by 1 or 2 dB.

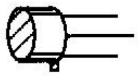
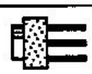
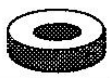
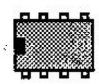
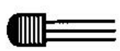
Increasing Power Output

You may be able to increase transmitter output by decreasing the value of R10 to as low as 120Ω. There are also some transistors available that have higher gain than the 2N3553 (Q2), for example the ECG-341 or MRF237. **Note: The MRF237 has its collector and emitter leads reversed with respect to other NPN transistors. The ECG-341 is specified as having this same package, but we have not tested the ECG-341 in the SST. Both the MRF237 and ECG-341 may be available only as surplus parts.**

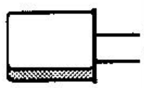
One final trick for increasing output power is to connect an RF choke between Q2's base and ground. On 20 meters, a good starting point would be 6.8µH.

Appendix A: SST Parts List   Rev. C March 30, 1998

Drawing	Ref.	Description, markings ("")	Part Number	Source	Qty
	C2,C21,C26,C29	CAP,DISC,5pF,10% ("5")	140-CD50S2-005J	MOUSER	4
	C10	CAP,DISC,22pF,5% ("22")	P4044A-ND	DIGIKEY	1
	C4,C24	CAP,DISC,56pF,5% ("56")	P4453A-ND	DIGIKEY	2
	C6,C9,C19,C20	CAP,NPO DISC,100pF,5% ("101" or "100")	P4456A-ND	DIGIKEY	4
	C7,C8,C11,C25	CAP,DISC,270pF,5% ("271" or "270")	P4029-ND	DIGIKEY	4
	C30	CAP,DISC,820pF,5% ("821" or "820")	P4035-ND	DIGIKEY	1
	C3,C5,C22	CAP,FILM,.01µF,20%,25V ("103" or ".01")	P4513-ND	DIGIKEY	3
	C14,C16,C23, C31,C32,C33	CAP,FILM,.022µF,20%,25V ("223" or ".022")	P4517-ND	DIGIKEY	6
	C12,C13	CAP,FILM,0.1µF,100V ("104" or ".1")	P4525-ND	DIGIKEY	2
	C15,C40	CAP,ELEC,2.2µF,25V ("2.2µF")	140-XRL25V2.2	MOUSER	2
	C17,C18,C38	CAP,ELEC,100µF, 25V ("100µF")	140-XRL25V100	MOUSER	3
	C39	CAP,ELEC,470µF,10V ("470µF")	140-XRL10V470	MOUSER	1
	C1,C28	CAP,VARIABLE,8-50pF	24AA024	MOUSER	2
	D1	DIODE,SWITCHING	1N914 or1N4148	DIGIKEY	1
	D6	DIODE,ZENER,43V,1W	333-1N4755A	MOUSER	1
	D5	DIODE,SHOTTKY	1N5817GICT-ND	DIGIKEY	1
	D2	DIODE, PIN	MPN3700	Wilderness	1
	D4A (see text)	DIODE,VARACTOR, 10-50pF cap.	MV209	Wilderness	1
	D4B (see text)	DIODE,VARACTOR, 40-700pF cap.	MVAM108	Wilderness	1
	D3	LED,RED,RIGHT-ANGLE MOUNT	512-MV67539.MP6 (Alt: Digikey L20311-ND)	MOUSER	1
	J3,J4	JACK,3.5MM,STEREO,PC-MT, WITH SPST SWITCH	161-3500	MOUSER	2
	J2	JACK,BNC,PC-MOUNT	177-3138	MOUSER	1
	J1	JACK, DC POWER, 2.1mm DIA.	16PJ031	MOUSER	1
	P1 (MATING PLUG FOR J1)	PLUG,DC POWER,2.1mm DIA.	1710-2131	MOUSER	1
	Q1	TRANS,JFET,TO-92 CASE	J310	Wilderness	1

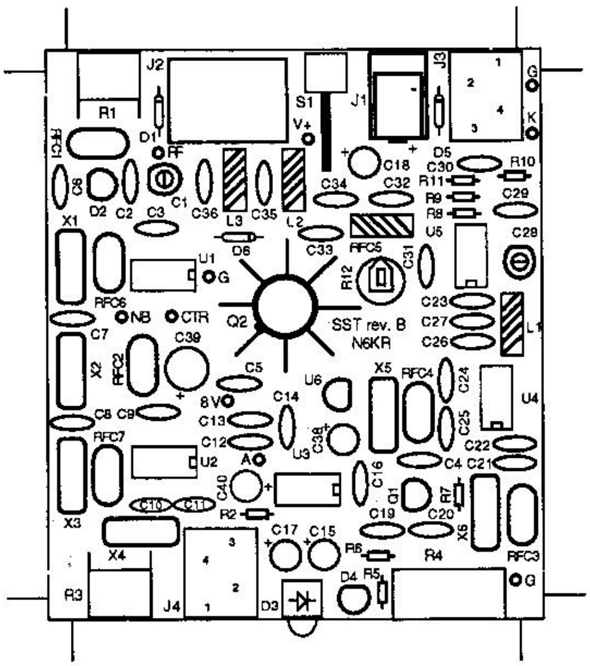
	Q2	TRANS,NPN,TO-5 CASE	2N3553 (alternate: 2SC799)	Wilderness	1
	R10	RES,180Ω,1/8W,5% (brn-gray-brn)	180EBK-ND	DIGIKEY	1
	R7	RES,330Ω,1/8W,5% (org-org-brn)	330EBK-ND	DIGIKEY	1
	R11	RES,620Ω,1/8W,5% (blue-red-brn)	620EBK-ND	DIGIKEY	1
	R2	RES,1.8K,1/8W,5% (brn-gray-red)	1.8KEBK-ND	DIGIKEY	1
	R8,R9	RES,10K,1/8W,5% (brn-blk-org)	10KEBK-ND	DIGIKEY	2
	R5,R6	RES,100K,1/8W,5% (brn-blk-yel)	100KEBK-ND	DIGIKEY	2
	R12	RES,TRIMMER,100Ω	36C12-ND	DIGIKEY	1
	R3	RES,RIGHT ANGLE TRIM w/SHAFT,1K	317-2091-1K	MOUSER	1
	R1	RES,RIGHT ANGLE TRIM w/SHAFT,5K	317-2091-5K	MOUSER	1
	R4	RES,PANEL MOUNT POT,10K	31CW401	MOUSER	1
	RFC6,RFC7	IND,CHOKE,12μH (brn-red-blk)	43LR125	MOUSER	2
	RFC4	IND,CHOKE,22μH (red-red-blk)	43LR225	MOUSER	1
	RFC2	IND,CHOKE,1mH (brn-blk-red)	43LR103	MOUSER	1
	RFC5	IND,TOROIDAL CHOKE,8T #28 (5")	FT37-43 (black)	AMIDON	1
	S1	SWITCH, SPDT SLIDE, PC-MOUNT	102-1271	MOUSER	1
	U3	IC,AF AMP	LM386N-1 (alt: -4)	DIGIKEY	1
	U1,U2,U4	IC,MIXER/OSC	SA/NE602AN (alt: SA/NE612AN)	Wilderness	3
	U5	IC,VIDEO AMPLIFIER	LT1252CN8-ND	DIGIKEY	1
	U6	IC,VOLTAGE REG.,8V,TO-92	AN78L08	DIGIKEY	1
	MISC	CABINET, UNFINISHED	n/a	Wilderness	1
	MISC	ASSEMBLY & OPERATION MANUAL	n/a	Wilderness	1
	MISC	PC BOARD	n/a	Wilderness	1
	MISC	FOOT, RUBBER	517-SJ-5012BK	DIGIKEY	4
	MISC	HEATSINK, STAR, 0.75" DIA.	33HS502	MOUSER	1
	MISC	KNOB, 0.60" (AF GAIN)	450-2034	MOUSER	1
	MISC	KNOB, 0.80" (VXO)	450-2035	MOUSER	1
	MISC	SCREW, 1/4" x 4-40 PANHEAD PHIL.	n/a	Wilderness	8
	MISC	WIRE,#28 ENAMEL	n/a	Wilderness	8 ft.

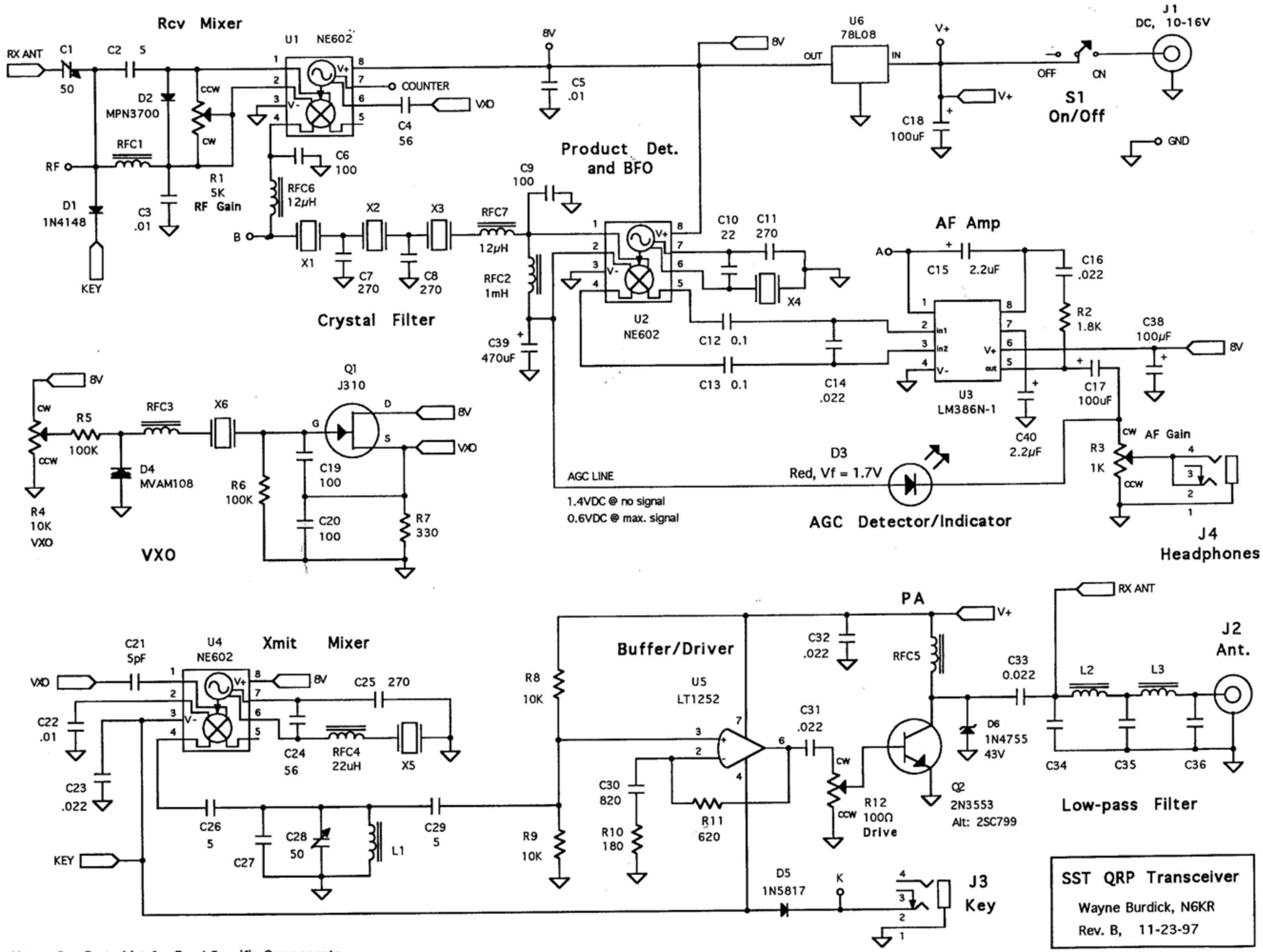
Components for Individual Bands

		40 Meters/General			
	C27	CAP,DISC,100pF,5% ("101" or "100")	P4456A-ND	DIGIKEY	1
	C34,C36	CAP,DISC,330pF,5% ("331" or "330")	P4030A-ND	DIGIKEY	2
	C35	CAP,DISC,820pF,5% ("821" or "820")	P4035A-ND	DIGIKEY	1
	L1	IND,TOROID,3.4µH,28T #28 (16")	T37-2 CORE (red)	AMIDON	1
	L2,L3	IND,TOROID,1.3µH,18T #28 (12")	T37-2 CORE (red)	AMIDON	2
	RFC1, RFC3	IND,CHOKE,15µH (brn-grn-blk)	43LR155	MOUSER	2
	X1-5	CRYSTAL, 4.0 MHz, HC-49 (matched)	CTX006-ND	DIGIKEY	5
	X6	CRYSTAL, 11.046 MHz, HC-49	X025-ND	DIGIKEY	1
		40 Meters/Novice			
	C27	CAP,DISC,100pF,5% ("101" or "100")	P4456A-ND	DIGIKEY	1
	C34,C36	CAP,DISC,330pF,5% ("331" or "330")	P4030A-ND	DIGIKEY	2
	C35	CAP,DISC,820pF,5% ("821" or "820")	P4035A-ND	DIGIKEY	1
	L1	IND,TOROID,3.2µH,28T #28 (16")	T37-2 CORE (red)	AMIDON	1
	L2,L3	IND,TOROID,1.3µH,18T #28 (12")	T37-2 CORE (red)	AMIDON	2
	RFC1,RFC3	IND,CHOKE,15µH (brn-grn-blk)	43LR155	MOUSER	2
	X1-5	CRYSTAL,3.932 MHz, HC-49 (matched)	X013-ND	DIGIKEY	5
	X6	CRYSTAL,11.046 MHz, HC-49	X025-ND	DIGIKEY	1
		30 Meters			
	C27	CAP,DISC,68pF,5% ("68")	P4022A-ND	DIGIKEY	1
	C34,C36	CAP,DISC,270pF,5% ("271" or "270")	P4029A-ND	DIGIKEY	2
	C35	CAP,DISC,560pF,5% ("561" or "560")	P4033A-ND	DIGIKEY	1
	L1	IND,TOROID,2.3µH,23T #28 (12")	T37-2 CORE (red)	AMIDON	1
	L2,L3	IND,TOROID,0.8µH,14T #28 (7")	T37-2 CORE (red)	AMIDON	2
	RFC1,RFC3	IND,CHOKE,12µH (brn-red-blk)	43LR125	MOUSER	2
	X1-5	CRYSTAL,4.194 MHz, HC-49 (matched)	X007-ND	DIGIKEY	5
	X6	CRYSTAL,14.318 MHz, HC-49	CTX088-ND	DIGIKEY	1
		20 Meters			
	C27	CAP,DISC,47pF,5% ("47")	P4020A-ND	DIGIKEY	1
	C34,C36	CAP,DISC,180pF,5% ("181" or "180")	P4027A-ND	DIGIKEY	2
	C35	CAP,DISC,390pF,5% ("391" or "390")	P4031A-ND	DIGIKEY	1
	L1	IND,TOROID,1.6µH,19T #28 (10")	T37-2 CORE (red)	AMIDON	1
	L2,L3	IND,TOROID,0.6µH,12T #28 (6")	T37-2 CORE (red)	AMIDON	2
	RFC1,RFC3	IND,CHOKE,5.6µH (grn-blue-gold)	43LR566	MOUSER	2
	X1-5	CRYSTAL,3.932 MHz, HC-49 (matched)	X013-ND	DIGIKEY	5
	X6	CRYSTAL,18.0 MHz, HC-49	X144-ND	DIGIKEY	1

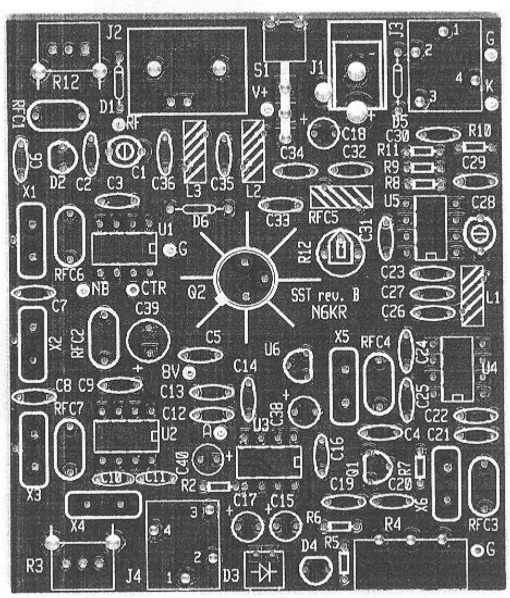
Appendix B, SST Component Placement Drawing

W. Burdick, 12-8-97





Note: See Parts List for Band-Specific Components


SST rev. B
N6KR