Ensemble RX II LF/HF RX Home

Current as of 3/22/2011

Home Bill of Materials Power Supply USB Power Supply Local Oscillator and Control Quadrature Clock Generator Auto Band Pass Filters Quadrature Sampling Detector Operational Amplifiers Comments Acronyms Inventory Revisions as of ~~11/30/2010~~ Components By Stage WB5RVZ Main Website

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LF/HF RX Home Introduction

General

The Ensemble RX LF/HF kit and its 4.5: X 2" board representing the culmination of a long line of Softrock SDR receivers from Tony Parks, KB9YIG. The line began with the Softrock 40 RX and went through several iterations of receivers. The most recent receiver was the All-band HF receiver with anautomatically switched bandpass filter. This current kit is a refinement on that kit and further streamlines the kitting process for Tony Parks, the designer and supplier.

HF Option

The Ensemble RX LF/HF kit provides coverage of HF ham bands from 160-10m, in four different optional "super bands" (each with underlap and overlap within the parameters of the associated bandpass filter):

1. Band 0: 160m - Continuous coverage from 1.8 to 2.0 MHz
2. Band 1: 80m and 40m - Continuous coverage from 3.5 to 7.3 MHz
3. Band 2: 30m, 20m, and 17m - Continuous coverage from 10.1 to 18.168 MHz
4. Band 3: 15m, 12m, and 10m - Continuous coverage from 21.0 to 29.7 MHz

LF Option

The Ensemble RX LF/HF kit provides the option of coverage of LF frequencies from approximately 160-10m, in four different optional "super bands" (each with underlap and overlap within the parameters of the associated bandpass filter):

1. Band 0: 1000m - Continuous coverage from 180 kHz to 480 kHz
2. Band 1: 500m - Continuous coverage from 400 kHz to 800 kHz
3. Band 2: 250m - Continuous coverage from 800 kHz to 1.6 MHz
4. Band 3: 160m - Continuous coverage from 1.6 MHz to 3.0 MHz

The band coverage is via 4 switchable "bands" ("superbands"). Band switching is performed under program control, in conjunction with programmatic control of the receive frequency. This control is provided by an Atmel ATTiny85 micro-controller, acting as a USB device to control the Si570 programmable oscillator and automatically switch to the appropriate band (0-3) as the frequency changes.

As a welcome improvement over other models, this kit provides pcb-right-angle jacks for all external connections: Antenna, USB from the PC, I/Q output to the PC, and Power to the Board. Thus, once built, the kit can be placed in a suitable enclosure and handled thereafter as a "blackbox peripheral" to the PC.

The design of the Ensemble RX is very similar to the receiver design of its sibling Ensemble RXTX. The major difference is the greater band coverage of the Ensemble RX kit (roughly 4 "superbands" on the RX vs. 1 "superband" on the RXTX).

This kit is an excellent value for both the licensed amateur and the SWL who is comfortable with building electronics kits. The skill level and experience requirements are medium-level because of the small size of the components, the requirement to be able to solder SMT parts, and the requirement to wind and install inductors. Thousands of builders have proven this is not an insurmountable set of requirements. If you are new at this, you should try one of Tony's sub $20 monobander RX kits as a "starter/learner" kit.

Several hams have provided interesting/informative galleries of photos as they have followed these build notes:

- Ulf, K1ULF

Recommended Enclosure

Tom KM5KH offers a very nice

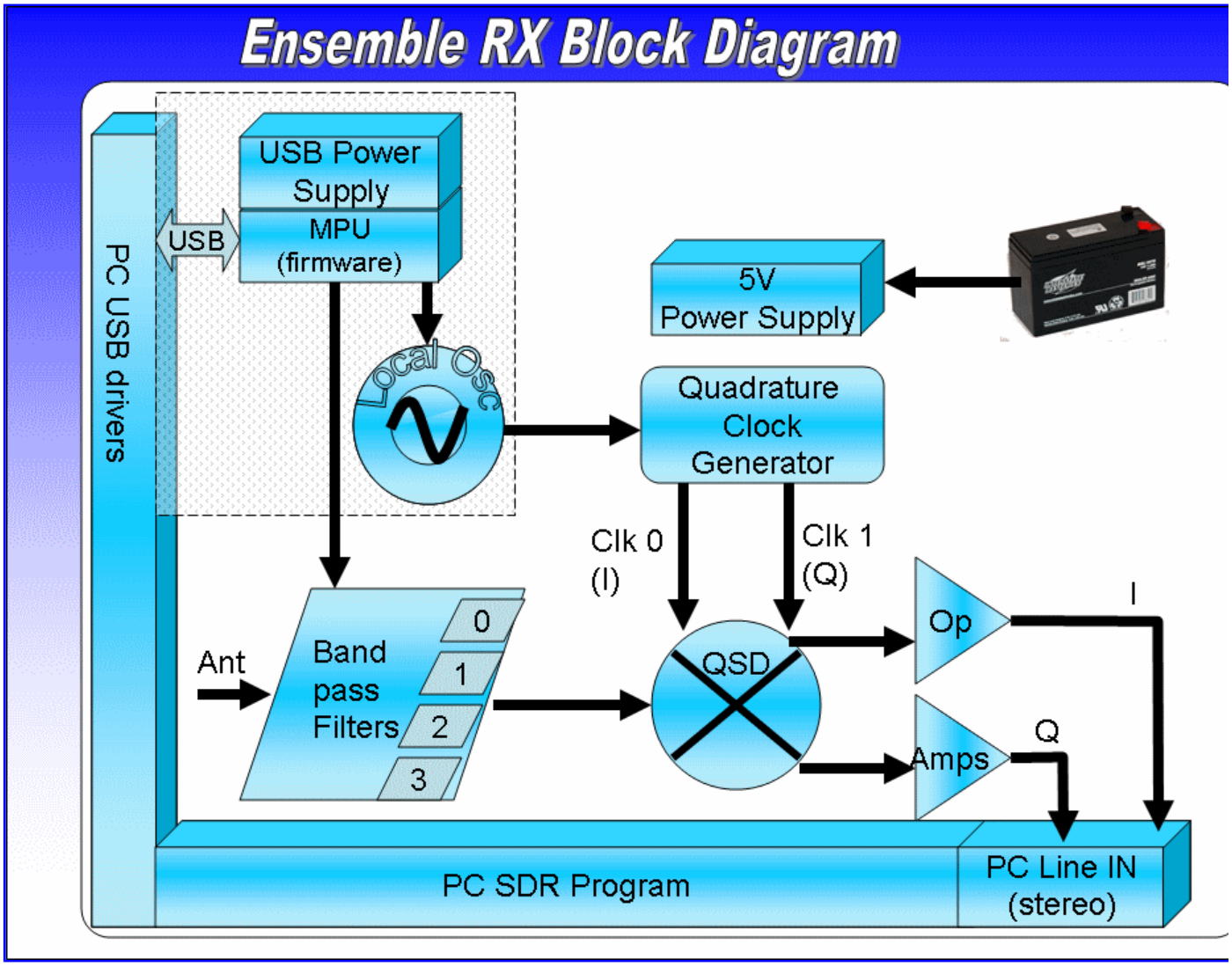
enclosure for the Ensemble RX line.

Theory of Operation

Basic Theory

For a very readable (if somewhat dated) presentation of the fundamentals of SDR receivers, see the presentation by Bob, G8VOI..

Block Diagram



This receiver implements a quadrature sampling detector to produce low frequency I and Q signals for input to the stereo line in inputs of a PC sound card. The I and Q signals are the product of the quadrature sampling detector (QSD) stage, in which bandpass filtered "chunks" of RF are mixed with quadrature clock signals to produce the down-converted I and Q signals. These products (the I and Q pairs) are identical to each other in all respects except phase, where they are 90 degrees apart.

The I/Q products of the QSD ("mixer"), when input to the appropriate SDR program through the PC's STEREO line-in soundcard input, result in a spectrum display on the PC which will show signals arrayed around a "center frequency". This "center frequency" is the frequency of the I/Q outputs from the Quadrature Clock Generators. The bandwidth of the signals either side of the center frequency will be approximately equal to the sampling rate of the PC's sound card. Thus, if the local oscillator is tuned to produce 28.4 MHz to the Quadrature Clock Generators, they will output two signals (I and Q clocks) at 7.1MHz (the "center frequency"). If the PC's sound card has a 48 kHz sampling rate, then the SDR program can translate the QSD's I/Q outputs into a chunk of spectrum that is 24 kHz either side of the center frequency of 7.1 MHz: i.e, 7.076 - 7.124 MHz. If the LF Option is built (by eliminating the HF Jumper and installing the second 74AC74 IC to allow for a divide-by-16), the center frequency resulting from a local oscillator frequency of 3.5 MHz (the lowest for the Si570) will be approximately 218 kHz.

As the user tunes the receiver, varying the frequency of the local oscillator, the micro-controller tracks the frequency and switches the appropriate bandpass filter into the RF chain. The SDR program's display will update to show the new center frequency and

adjust the scale to reflect the current +/- bandwidth around that center frequency. At all times, the operator can see all signals that are within this movable "window" (whose total width is 48, 96, or 192 kHz, depending upon the sampling rate of the PC's soundcard).

The receiver is controlled via a USB connection from the PC. This USB connection provides a "USB 5V" bus for the local oscillator and micro-controller. A separate 3.3 V voltage regulator on the 5 USB 5 volt bus provides power to the programmable oscillator, the Si570.

The RX has an Atmel ATTiny85 micro-controller unit which, acting as a USB device, and on the "USB 5V" rail, controls the frequency output of the programmable local oscillator (Si570) and provides two switching signals which can be used to select one of four filter banks in the band pass filter

The output of the local oscillator is at a frequency which is 4 times the desired center frequency of the receiver and is consumed in the Quadrature Clock Generators.

The Quadrature Clock Generators divides the local oscillator frequency by 4 (or, for the LF option, by 16) to produce two clock signals - QSE Clk 0 and QSE Clk 1 - which will be used to clock the QSD stage. These I and Q clock signals are identical in all respects but phase (they are in quadrature - 90 degrees phase separation).

Rf at the antenna jack is filtered through the Bandpass Filter Stage, where one of four "chunks" of the HF (or LF) band is selected by the micro-controller, based upon the tuning of the programmable Local Oscillator. The filtered RF is passed as input to the QSD Stage.

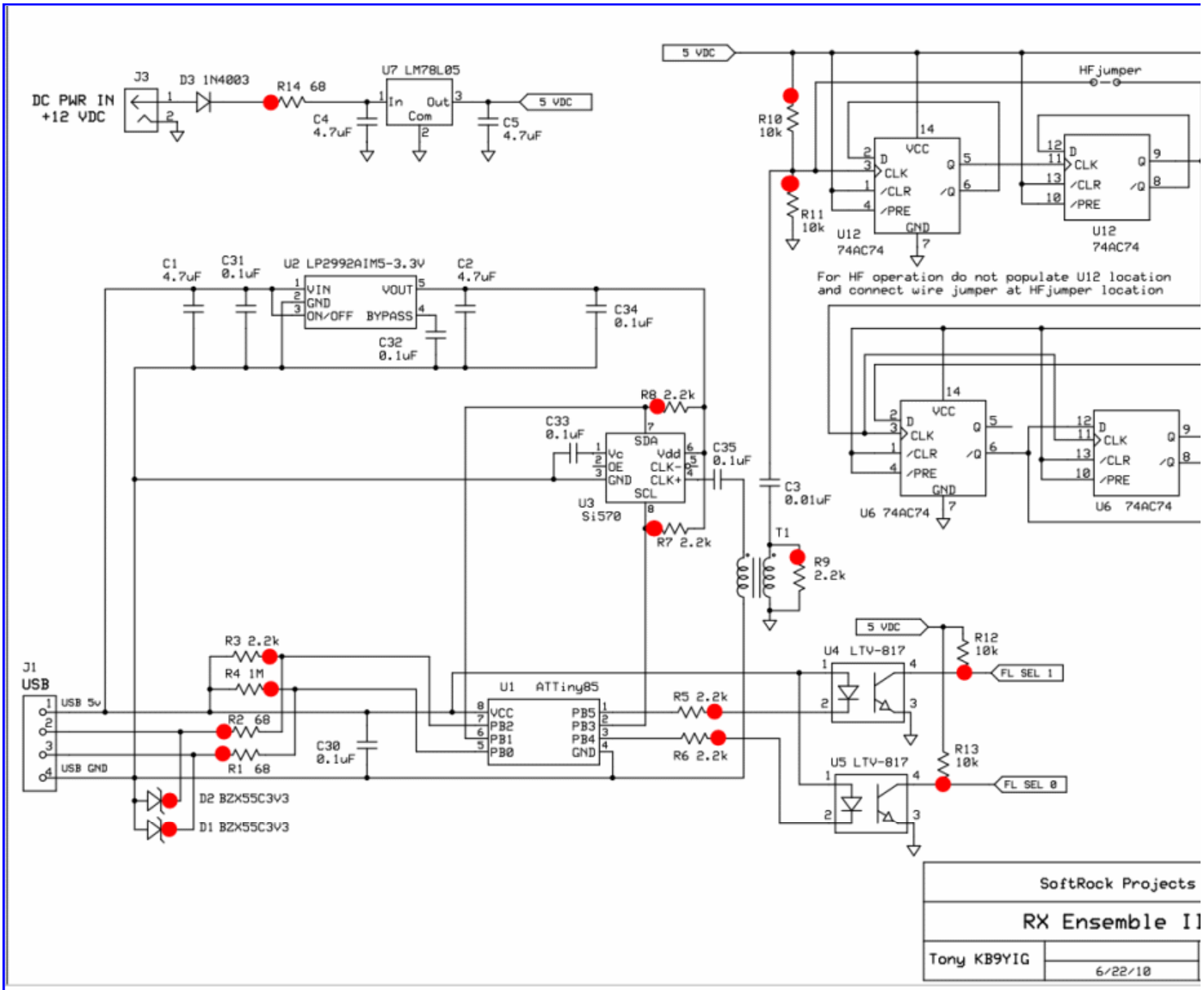
The Quadrature Sampling Detector (QSD) Stage acts very similar to a mixer. It incorporates a high-speed switch that is clocked by the two QSD clock signals from the Quadrature Clock Generators and switches the incoming RF into a RC sampling network. The result is two outputs at low frequency and also in quadrature, which are the down-converted, baseband analogs of the incoming RF signals.

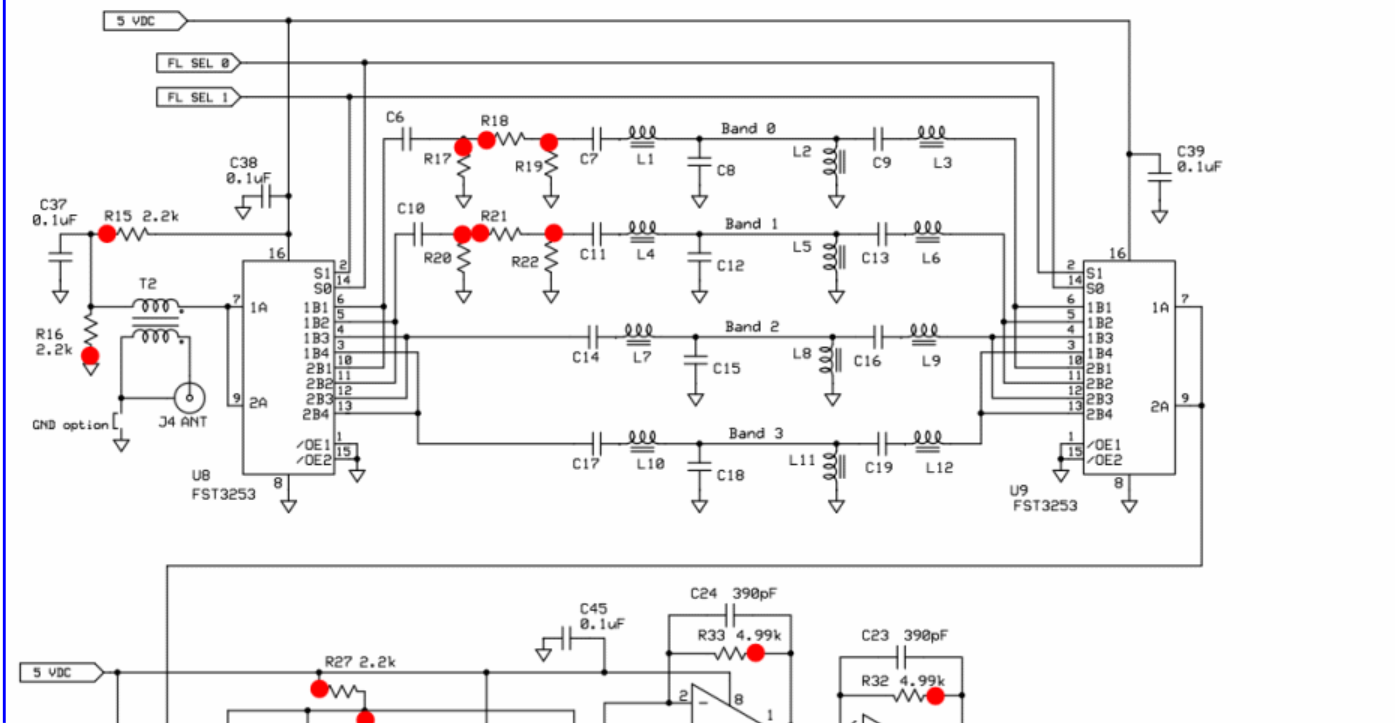
The outputs of the QSD stage are then fed into a pair of high gain Operational Amplifiers to produce the I and Q baseband signals which will be input to the PC soundcard's stereo Line In.

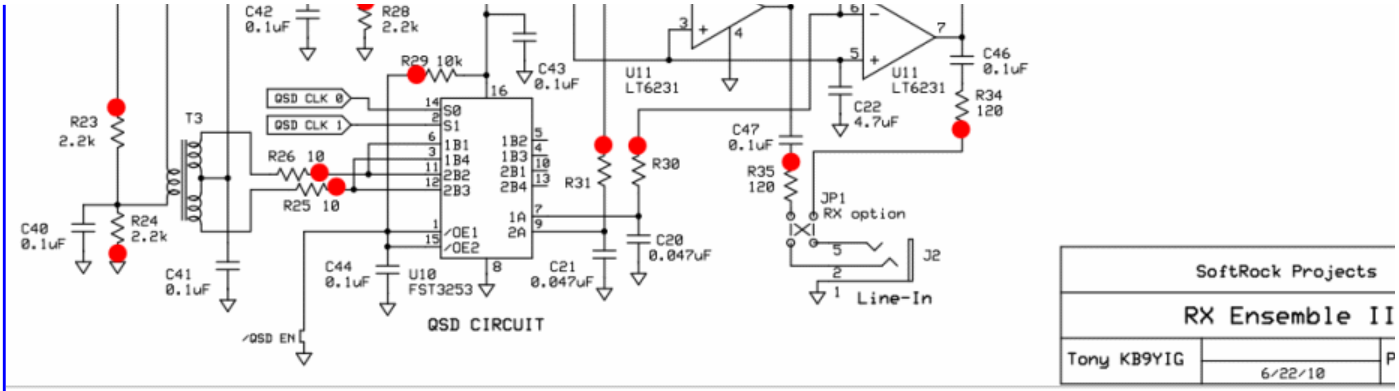
(go directly to build notes)

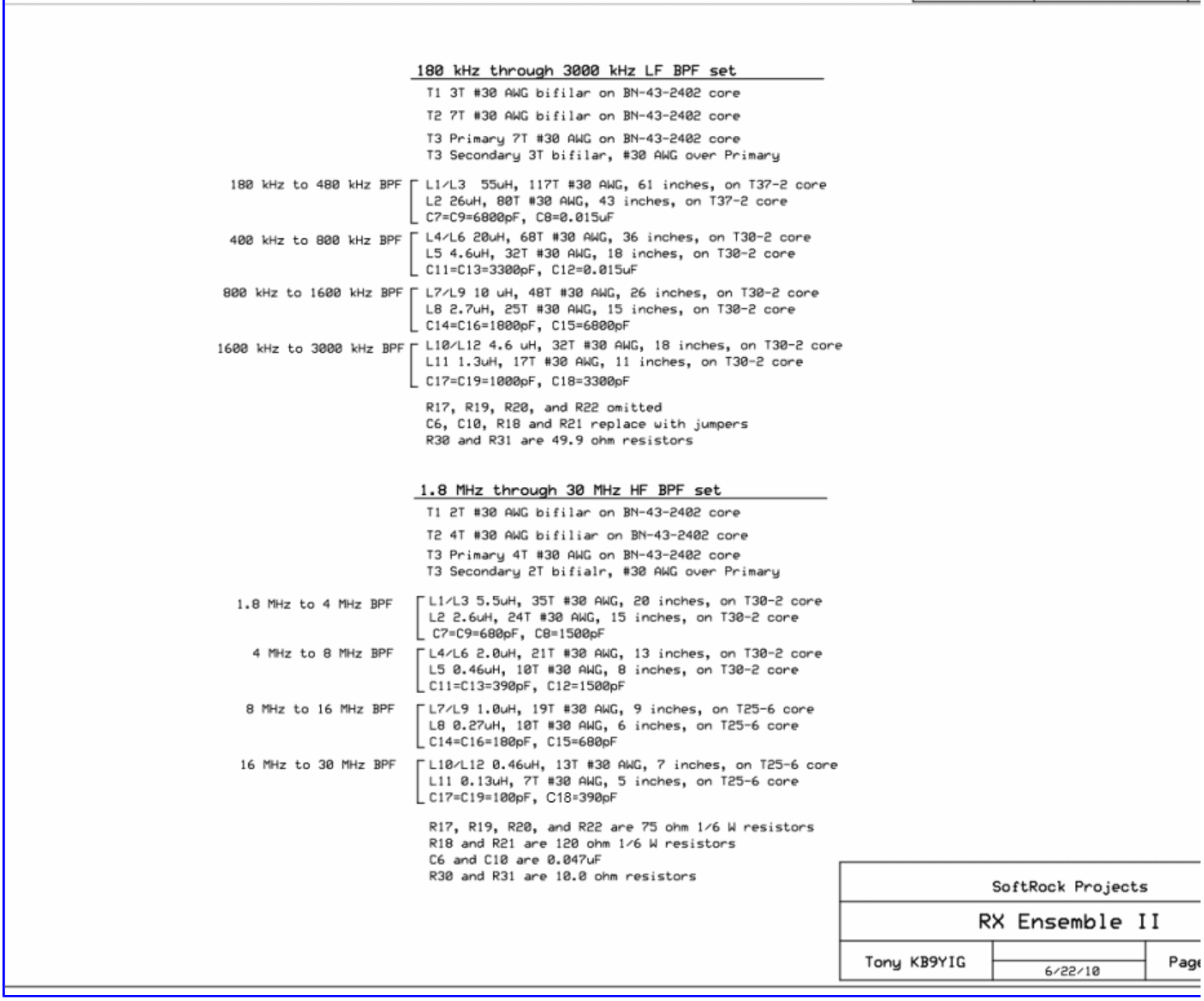
LF/HF RX Home Schematic

(Resistor testpoints (hairpin, top, or left-hand lead), as physically installed on the board, are marked in the schematic with red dots)


DC PWR IN
+12 VDC
J3
D3 1N4003
R14 68
U7 LM78L05
In
Out
Com
5 VDC
C4
4.7uF
C5
4.7uF
R10
10k
R11
10k
HFjumper
U12
74AC74
For HF operation do not populate U12 location
and connect wire jumper at HFjumper location
C1
4.7uF
C31
0.1uF
U2 LP2992AIM5-3.3V
VIN
VOUT
GND
ON/OFF
BYPASS
C2
4.7uF
C32
0.1uF
C34
0.1uF
R8 2.2k
C33
0.1uF
SDA
Vc
OE
GND
Vdd
CLK-
CLK+
SCL
U3
Si570
C35
0.1uF
C3
0.01uF
R7 2.2k
T1
R9
2.2k
U6 74AC74
J1
USB
USB 5v
USB GND
R3 2.2k
R4 1M
R2 68
R1 68
C30
0.1uF
D2 BZX55C3V3
D1 BZX55C3V3
U1 ATTiny85
VCC
PB2
PB1
PB0
PB5
PB3
PB4
GND
R5 2.2k
R6 2.2k
U4 LTV-817
U5 LTV-817
R12
10k
R13
10k
FL SEL 1
FL SEL 0
SoftRock Projects
RX Ensemble II
Tony KB9YIG
6/22/10


5 VDC
FL SEL 0
FL SEL 1
C38
0.1uF
C37
0.1uF
R15 2.2k
T2
R16
2.2k
GND option
J4 ANT
U8
FST3253
C6
R18
R17
R19
C7
L1
C8
Band 0
L2
C9
L3
C10
R21
R20
R22
C11
L4
C12
Band 1
L5
C13
L6
Band 2
C14
L7
C15
L8
C16
L9
Band 3
C17
L10
C18
L11
C19
L12
C39
0.1uF
U9
FST3253
C45
0.1uF
C24 390pF
R33 4.99k
C23 390pF
R32 4.99k
R27 2.2k





(above schematic has clickable areas that can be used for navigation)

(go directly to build notes)

LF/HF RX Home Bill of Materials

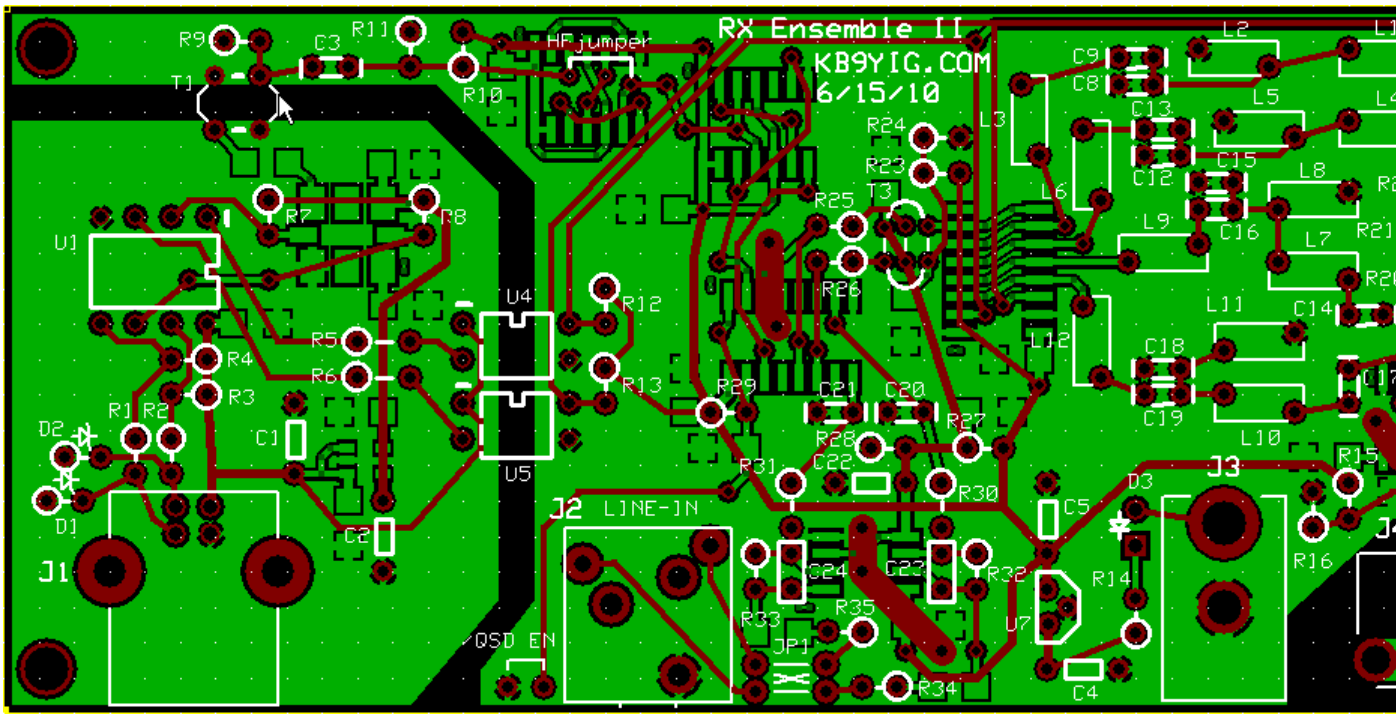
See Project Bill of Materials

LF/HF RX Home Expert's (terse) Build Notes

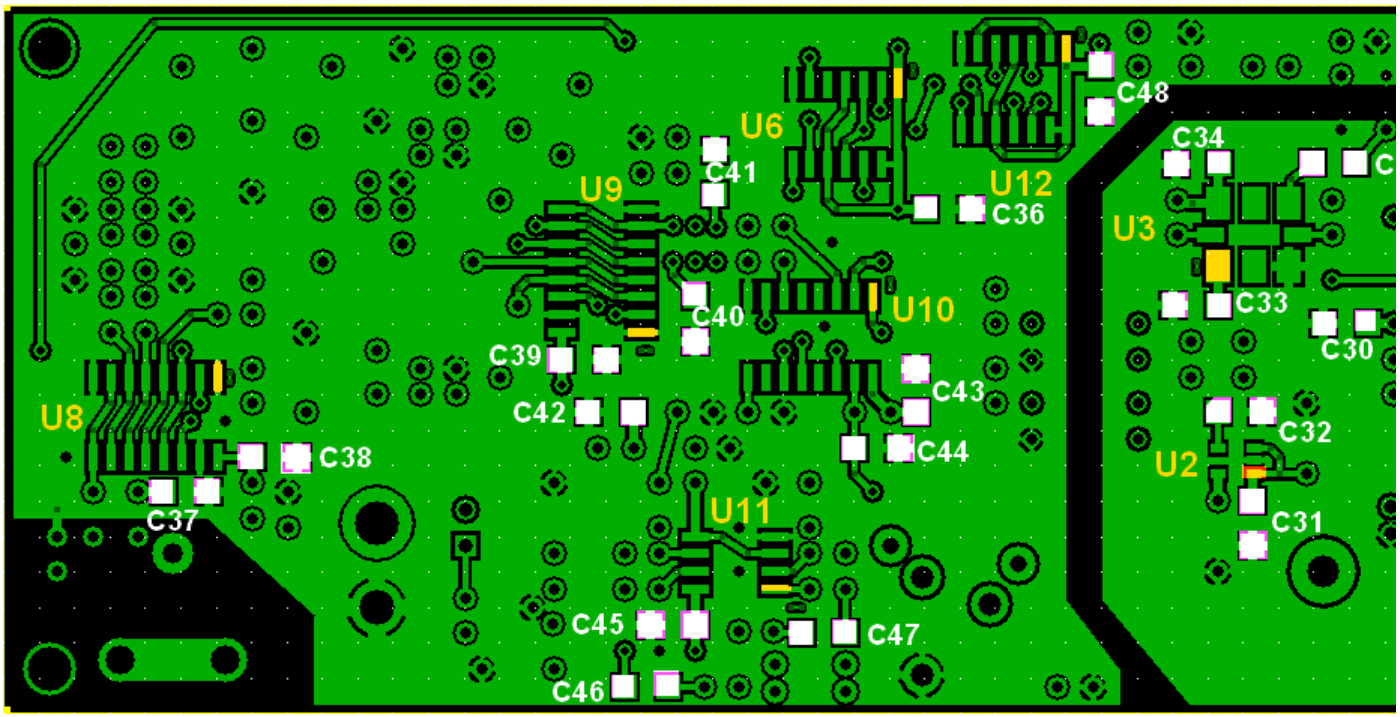
- Review schematics: sheet1 and sheet 2
- Build USB Side

- Build Auto BPFs
- Build QSD Clocks, Mixers, and OpAmps
- Operate Radio

Board Top



Board Bottom



(Note: 0.1 uF SMT caps are mounted to the WHITE pads; 0.01 uF caps mount to YELLOW cap pads - do not conuse these with the yellow identification of the "1" pins for the ICs.)

Project Detailed Build Notes

For the non-expert builders among us, this site takes you through a stage-by-stage build of the kit. Each stage is self-contained and outlines the steps to build and test the stage. This ensures that you will have a much better chance of success once you reach the last step, since you will have successfully built and tested each preceding stage before moving on to the next stage.

Each stage is listed below, in build order, and you can link to it by clicking on its name below (or in the header and/or footer of each web page).

- Inventory the Bill of Materials
- Build and Test the Power Supply Stage
- Build and Test the USB Power Supply Stage
- Build and Test the Local Oscillator and Control Stage
- Build and Test the Quadrature Clock Generator Stage
- Build and Test the Auto Band Pass Filters Stage
- Build and Test the Quadrature Sampling Detector Stage
- Build and Test the Operational Amplifiers Stage

Background Info

Tools

Winding Inductors

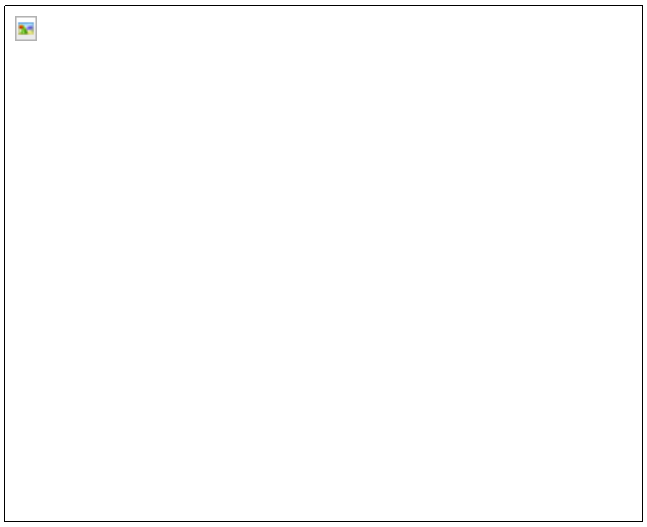
To learn how to wind coils and transformers, please read the

- tips from the experts and then
- view the excellent videos on KC0WOXs Website
- or take a read of Dinesh's VU2FD guidelines.
- You can review the common construction techniques for inductors for details on deciphering the winding specifications, core specifications,and construction of toroidal and binocular inductors.

Soldering

If you are not experienced at soldering (and even if you are somewhat experienced at soldering), refer to Tom N0SS's excellent tutorial on basic soldering techniques.

The video below describes techniques for soldering SOIC 14 (and 16 and 8) SMDs



View the above in full-screen mode on Youtube.

For the more adventurous, there is a process using solder paste and an electric oven called the reflow process, which can be used to install all the SMT chips to one side of the PC Board. This is documented by Guenael Jouchet in the following Youtube segment:

- Read the Primer on SMT Soldering at the Sparkfun site. It is a very good read and it speaks great truths. Then take the time to watch the video tutorial on soldering an SOIC SMD IC.
- Solder Stations. Don't skimp here. Soldering deficiencies account for 80 percent of the problems surfaced in troubleshooting. It is preferable to have an ESD-safe station, with a grounded tip. A couple of good stations that are relatively inexpensive are:
  - 

    Velleman VTSS5U 50W Solder Station (approx $20 at Frys) (See BGMicro for Spare Tips)
  - 

    Haakko 936 ESD Solder Station (under $100)

ESD Protection

You may wish to review the message topic beginning at Message 43554 for a common-sense discussion on ESD.

- Avoid carpets in cool, dry areas.
- Leave PC cards and memory modules in their anti-static packaging until ready to be installed.
- Dissipate static electricity before handling any system components (PC cards, memory modules) by touching a grounded metal object, such as the system unit unpainted metal chassis.
- If possible, use antistatic devices, such as wrist straps and antistatic mats (see Radio Shack's Set for $25 or the JameCo AntiStatic mat for $15)).
- Always hold a PC card or memory module by its edges. Avoid touching the contacts and components on the memory module.
- Before removing chips from insulator, put on the wrist strap connected to the ESD mat. All work with CMOS chips should be done with the wrist strap on.
- As an added precaution before first touching a chip, you should touch a finger to a grounded metal surface.
- If using a DMM, its outside should be in contact with the ground of the ESD mat, and both leads shorted to this ground before use.
- See the review of ESD Precautions at this link.

Work Area

- You will need a well-lit work area and a minimum of 3X magnification (the author uses a cheap magnifying fluorescent light with a 3X lens. This is supplemented by a hand-held 10 X loupe - with light - for close-in inspection of solder joints and SMT installation.
- You should use a cookie sheet or baking pan (with four sides raised approximately a half an inch) for your actual work space. It is highly recommended for building on top of in order to catch stray parts, especially the tiny SMT chips which, once they are launched by an errant tweezer squeeze, are nigh on impossible to find if they are not caught on the cookie sheet.

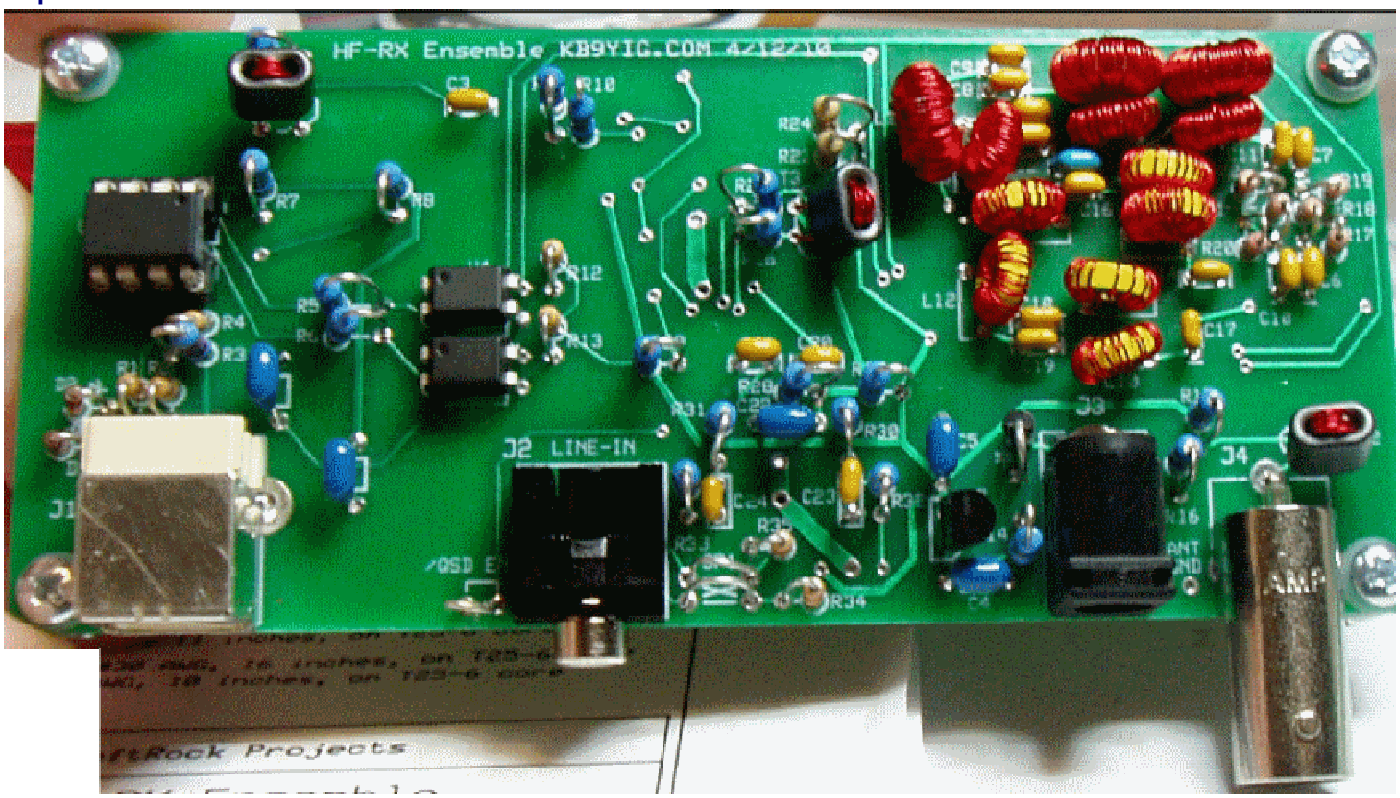
Misc Tools

- It is most important to solidly clamp the PCB in a holder when soldering. A "third-hand" (e.g., Panavise or the Hendricks kits PCB Vise) can hold your board while soldering. In a pinch, you can get by with a simple third-hand, alligator clip vise. Jan G0BBL suggests "A very cheap way is to screw a Large Document Clip to a woodblock which will clamp the side of a PCB."
- Magnifying Head Strap
- Tweezers (bent tip is preferable).
- A toothpick and some beeswax - these can be used to pickup SMT devices and hold them steady while soldering.
- Diagonal side cutters.
- Small, rounded jaw needle-nose pliers.
- Set of jewelers' screwdrivers
- An Exacto knife.
- Fine-grit emery paper.

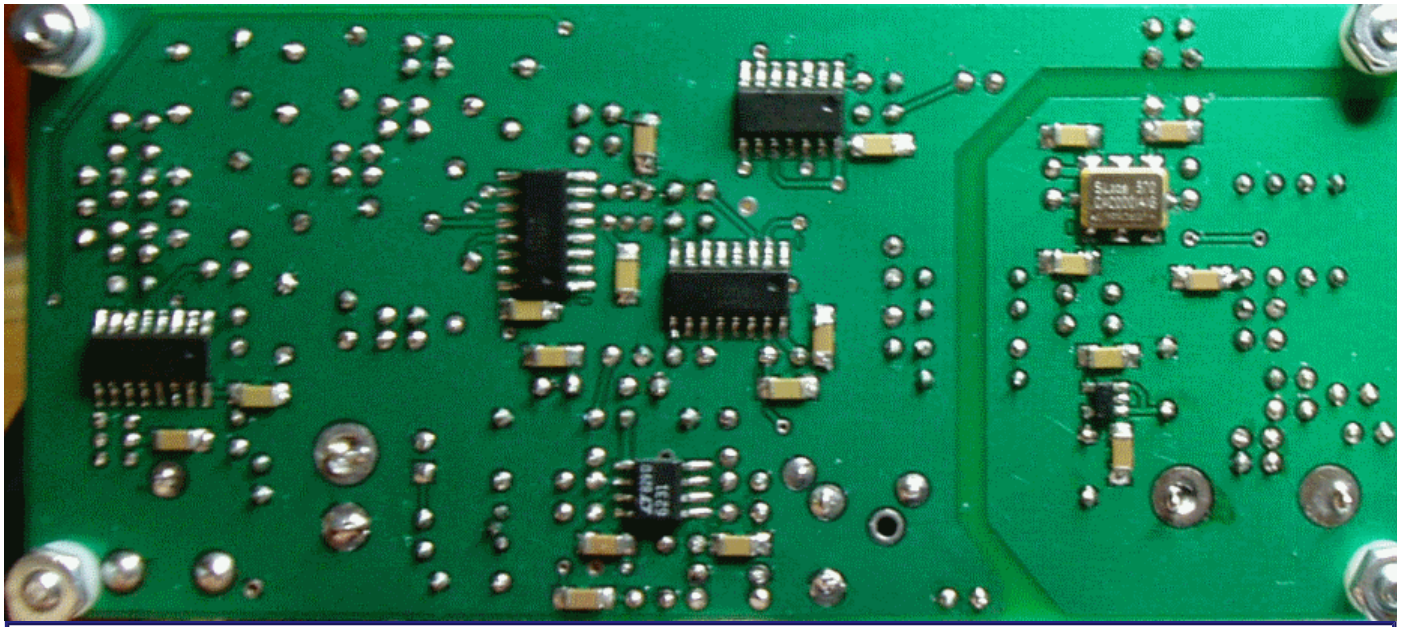
LF/HF RX Home Completed Stage

(These photos were of an earlier board design. It has changed since the author built the kit upon which these notes are based. The board layout graphics are, however, current.)

Top of the Board



Bottom of the Board



LF/HF RX Home Testing

Each stage will have a "Testing" Section, outlining one or more tests that, when successfully completed, provide you with the confidence and assurance that you are heading in the right direction towards a fully tested and built transceiver.

When you perform a test, you should always record the results of the test where indicated in the Testing section. This will make troubleshooting via the reflector much easier, since you will be communicating with the experts using a standard testing and measurement regime.

> *When comparing measurements to those published in these notes, the builder should be aware that actual and expected values could vary by as much as +/- 10%. The idea behind furnishing "expected/nominal" measurement values is to provide the builder with a good, "ballpark" number to determine whether or not the test has been successful. If the builder has*

concerns about his measurements, he should by all means pose those concerns as a query in the Softrock reflector so the experts can provide assistance.

It goes without saying that you should ALWAYS precede any tests with a very careful, minute inspection (using the best light and magnification available to you) to be sure all solder joints are clean and there are no solder bridges or cold joints.

This kit can be built and reliably tested using nothing more than a common multimeter. Tests assume that the builder has a decent digital multimeter of sufficiently high input impedance as to minimize circuit loading issues. Measurements will be taken of current draws, test point voltages, and resistances.

Most stages will have a current draw test, in which the builder tests the stage's current draw in two different ways:

- First, testing the draw through a current-limiting resistor
- Then, when that test is OK, removing the current-limiting resistor and measuring the real current draw.

Some tests will require you to use your ham radio to receive or generate a signal of a specified frequency in order to test transmitters, oscillators, dividers, and/or receivers.

Optional testing. If the builder has (access to) a dual channel oscilloscope, along with an audio signal generator and an RF signal generator, and feels the need to perform tests beyond the basic DMM tests, certain stages will include in their testing section some optional tests involving this advanced equipment.

The IQGen or DQ-Gen programs available free from Michael Keller, DL6IAK, can be used in a pinch to get the sound card to produce audio tones for injection into the circuit.

You can always use Rocky to generate I and Q signals for tests requiring these audio signals (this is the author's preferred way)

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Ensemble RX II Inventorys

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Component Inventory

This page provides a list of components and their maximum quantities to support your inventorying the kit as a whole. This is helpful for kits where the kit includes all parts necessary to build any particular band-specific option (there would, in such cases, likely be excess parts left over at the end of the build).
Once these quantities check out, you can sort the components out to their respective build stages.

Note: mag wire furnished with the kit is approximately 35 feet. Shunt wire for jumpers required may be obtained from cutoff leads.

Component Type	Category	Component	Qty
boardhdw	HDW	4 X #4-40 hdw (nut, bolt, washer, spacer)	1
Capacitor	Ceramic	0.01 uF (103)	1
Capacitor	Ceramic	0.015 uF 5% (153)	2
Capacitor	Ceramic	0.047 uF 5% (473)	4
Capacitor	Ceramic	100 pF 5% (101)	2
Capacitor	Ceramic	1000 pF 5% (102)	2
Capacitor	Ceramic	1500 pF 10% (152)	2
Capacitor	Ceramic	180 pF 5% (181)	2
Capacitor	Ceramic	1800 pF 5% (182)	2
Capacitor	Ceramic	3300 pF 5% (332)	3
Capacitor	Ceramic	390 pF 5% (391)	5
Capacitor	Ceramic	4.7 uF 10% 16V X7R RAD (475)	5
Capacitor	Ceramic	680 pF 5% (681)	3
Capacitor	Ceramic	6800 pF 5% (682)	3
Capacitor	SMT 1206	0.1 uF ((smt) black stripe)	20
connector	Jack	BNC Connector Male - PCB mount	1
connector	Jack-RA	3.5mm stereo jack - PCB mount (rt-angle)	1
connector	Jack-RA	DC Power Jack PCB Mount (rt-angle)	1
connector	Jack-RA	USB-B pcb jack (rt-angle)	1
connector	Plug	DC Power Plug 5.5/2.1mm Pos Ctr	1
Diode	Axial	1N4003 (1N4003)	1
Diode	Axial	BZX55C3V3 3.3V zener diode (BZX55C)	2
IC	DIP 8	ATtiny 85-20 PU w/V15.12 Firmware (AVR ATTINY85-20PU)	1
IC	DIP-4	LTV-817 Opto-Isolator (LTV 817)	2
IC	I2C	Si570 Programmable Oscillator (SiLabs 570)	1
IC	SOIC-14	74AC74 Dual D FF (74AC74)	2
IC	SOIC-16	FST3253 mux/demux switch (FST3253)	3
IC	SOIC-8	LT6231 dual op-amp (LT6231)	1
IC	SOT-23-5	LP2992AIM5-3.3V regulator (LFEA)	1
IC	TO-92	LM78L05 voltage regulator (LM78L05)	1
inductor	Binocular core	BN-43-2402 (no markings!) (none)	3
inductor	Toroid	T25-6 toroid core (yellow)	6
inductor	Toroid	T30-2 toroid core (red)	9
inductor	Toroid	T37-2 toroid core (red)	3
PCB	Main Board	Ensemble RX PCB (board)	1
Resistor	1/4W	10 ohm 1/4W 1% (br-blk-blk-gld-br)	4
Resistor	1/4W	4.99 k 1/4W 1% (y-w-w-br-br)	2
Resistor	1/4W	49.9 ohm 1% (yel-wht-wht-gld-brn)	2
Resistor	1/6W	1 M 1/6W 5% (brn-blk-grn-gld)	1
Resistor	1/6W	10 k 1/6W 5% (brn-blk-ora-gld)	5
Resistor	1/6W	120 1/6W 5% (brn-red-brn-gld)	4
Resistor	1/6W	2.2k 1/6W 5% (red-red-red-gld)	12
Resistor	1/6W	68 1/6W 5% (bl-gry-blk-gld)	3
Resistor	1/6W	75 1/6W 5% (vio-grn-blk-gld)	4
socket	Socket	8 pin dip socket	1
wire	Cutoff	shunt wire (cut-off lead)	6
wire	Magnetic	Magnetic Wire, enameled #30	2

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Ensemble RX II designations

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Component Designations By Stage

This page provides a list of component designations (e.g., R1, C1, L1, etc.) and the stage in which the component appears under the designation.
The page is sorted by stage, then by component. To find a component by its designation, just use your browser's "FIND ON PAGE" function.

Designation	Component	Stage
xtracap	0.1 uF (SMT 1206) - (smt) black stripe	Bill of Materials
magwire	Magnetic Wire, enameled #30 (Magnetic)	Bill of Materials
mtg_hdw	4 X #4-40 hdw (nut, bolt, washer, spacer) (HDW)	Power Supply
C04	4.7 uF 10% 16V X7R RAD (Ceramic) - 475	Power Supply
C05	4.7 uF 10% 16V X7R RAD (Ceramic) - 475	Power Supply
J03	DC Power Jack PCB Mount (rt-angle) (Jack-RA)	Power Supply
P1	DC Power Plug 5.5/2.1mm Pos Ctr (Plug)	Power Supply
D3	1N4003 (Axial) - 1N4003	Power Supply
U07	LM78L05 voltage regulator (TO-92) - LM78L05	Power Supply
PCB	Ensemble RX PCB (board) (Main Board)	Power Supply
R14	68 1/6W 5% (1/6W) - bl-gry-blk-gld	Power Supply
/QSD EN	shunt wire (cut-off lead) (Cutoff)	Power Supply
C01	4.7 uF 10% 16V X7R RAD (Ceramic) - 475	USB Power Supply
C02	4.7 uF 10% 16V X7R RAD (Ceramic) - 475	USB Power Supply
C31	0.1 uF (SMT 1206) - (smt) black stripe	USB Power Supply
C32	0.1 uF (SMT 1206) - (smt) black stripe	USB Power Supply
C34	0.1 uF (SMT 1206) - (smt) black stripe	USB Power Supply
J01	USB-B pcb jack (rt-angle) (Jack-RA)	USB Power Supply
U02	LP2992AIM5-3.3V regulator (SOT-23-5) - LFEA	USB Power Supply
T01	HF: 5.76uH: 2T(bi)T #30(8 (2x4)in) on BN43-2402 (xfrmr -) LF: 12.96uH: 3T(bi)T #30(10 (2x5)in) on BN43-2402 (xfrmr -)	Local Oscillator and Control
C03	0.01 uF (Ceramic) - 103	Local Oscillator and Control
C30	0.1 uF (SMT 1206) - (smt) black stripe	Local Oscillator and Control
C33	0.1 uF (SMT 1206) - (smt) black stripe	Local Oscillator and Control
C35	0.1 uF (SMT 1206) - (smt) black stripe	Local Oscillator and Control
D1	BZX55C3V3 3.3V zener diode (Axial) - BZX55C	Local Oscillator and Control
D2	BZX55C3V3 3.3V zener diode (Axial) - BZX55C	Local Oscillator and Control
U01	ATtiny 85-20 PU w/V15.12 Firmware (DIP 8) - AVR ATTINY85-20PU	Local Oscillator and Control
U04	LTV-817 Opto-Isolator (DIP-4) - LTV 817	Local Oscillator and Control
U05	LTV-817 Opto-Isolator (DIP-4) - LTV 817	Local Oscillator and Control
U03	Si570 Programmable Oscillator (I2C) - SiLabs 570	Local Oscillator and Control
T01-core	BN-43-2402 (no markings!) (Binocular core) - none	Local Oscillator and Control
R01	68 1/6W 5% (1/6W) - bl-gry-blk-gld	Local Oscillator and Control
R02	68 1/6W 5% (1/6W) - bl-gry-blk-gld	Local Oscillator and Control
R03	2.2k 1/6W 5% (1/6W) - red-red-red-gld	Local Oscillator and Control
R05	2.2k 1/6W 5% (1/6W) - red-red-red-gld	Local Oscillator and Control

R06	2.2k 1/6W 5% (1/6W) - red-red-red-gld	Local Oscillator and Control
R07	2.2k 1/6W 5% (1/6W) - red-red-red-gld	Local Oscillator and Control
R08	2.2k 1/6W 5% (1/6W) - red-red-red-gld	Local Oscillator and Control
R09	2.2k 1/6W 5% (1/6W) - red-red-red-gld	Local Oscillator and Control
R12	10 k 1/6W 5% (1/6W) - brn-blk-ora-gld	Local Oscillator and Control
R13	10 k 1/6W 5% (1/6W) - brn-blk-ora-gld	Local Oscillator and Control
R04	1 M 1/6W 5% (1/6W) - brn-blk-grn-gld	Local Oscillator and Control
SO1	8 pin dip socket (Socket)	Local Oscillator and Control
magwire	Magnetic Wire, enameled #30 (Magnetic)	Local Oscillator and Control
C48	HF: omit for this band (Omit -) LF: 0.1 uF (SMT 1206 - (smt) black stripe)	Quadrature Clock Generator
hf-jmp	HF: shunt wire (cut-off lead) (Cutoff -) LF: omit for this band (Omit -)	Quadrature Clock Generator
U12	HF: omit for this band (Omit -) LF: 74AC74 Dual D FF (SOIC-14 - 74AC74)	Quadrature Clock Generator
C36	0.1 uF (SMT 1206) - (smt) black stripe	Quadrature Clock Generator
U06	74AC74 Dual D FF (SOIC-14) - 74AC74	Quadrature Clock Generator
R10	10 k 1/6W 5% (1/6W) - brn-blk-ora-gld	Quadrature Clock Generator
R11	10 k 1/6W 5% (1/6W) - brn-blk-ora-gld	Quadrature Clock Generator
C06	HF: 0.047 uF 5% (Ceramic - 473) LF: shunt wire (cut-off lead) (Cutoff -)	Auto Band Pass Filters
C07	HF: 680 pF 5% (Ceramic - 681) LF: 6800 pF 5% (Ceramic - 682)	Auto Band Pass Filters
C08	HF: 1500 pF 10% (Ceramic - 152) LF: 0.015 uF 5% (Ceramic - 153)	Auto Band Pass Filters
C09	HF: 680 pF 5% (Ceramic - 681) LF: 6800 pF 5% (Ceramic - 682)	Auto Band Pass Filters
C10	HF: 0.047 uF 5% (Ceramic - 473) LF: shunt wire (cut-off lead) (Cutoff -)	Auto Band Pass Filters
C11	HF: 390 pF 5% (Ceramic - 391) LF: 3300 pF 5% (Ceramic - 332)	Auto Band Pass Filters
C12	HF: 1500 pF 10% (Ceramic - 152) LF: 0.015 uF 5% (Ceramic - 153)	Auto Band Pass Filters
C13	HF: 390 pF 5% (Ceramic - 391) LF: 3300 pF 5% (Ceramic - 332)	Auto Band Pass Filters
C14	HF: 180 pF 5% (Ceramic - 181) LF: 1800 pF 5% (Ceramic - 182)	Auto Band Pass Filters
C15	HF: 680 pF 5% (Ceramic - 681) LF: 6800 pF 5% (Ceramic - 682)	Auto Band Pass Filters
C16	HF: 180 pF 5% (Ceramic - 181) LF: 1800 pF 5% (Ceramic - 182)	Auto Band Pass Filters
C17	HF: 100 pF 5% (Ceramic - 101) LF: 1000 pF 5% (Ceramic - 102)	Auto Band Pass Filters
C18	HF: 390 pF 5% (Ceramic - 391) LF: 3300 pF 5% (Ceramic - 332)	Auto Band Pass Filters
C19	HF: 100 pF 5% (Ceramic - 101) LF: 1000 pF 5% (Ceramic - 102)	Auto Band Pass Filters
L01	HF: 5.5uH: 35T #30(20in) on T30-2(red) (coil - red) LF: 55uH: 117T #30(61in) on T37-2(red) (coil - red)	Auto Band Pass Filters
L01-core	HF: T30-2 toroid core (Toroid - red) LF: T37-2 toroid core (Toroid - red)	Auto Band Pass Filters
L02	HF: 2.6uH: 24T #30(15in) on T30-2(red) (coil - red) LF: 26uH: 80T #30(43in) on T37-2(red) (coil - red)	Auto Band Pass Filters
L02-core	HF: T30-2 toroid core (Toroid - red) LF: T37-2 toroid core (Toroid - red)	Auto Band Pass Filters

L03	HF: 5.5uH: 35T #30(20in) on T30-2(red) (coil - red) LF: 55uH: 117T #30(61in) on T37-2(red) (coil - red)	Auto Band Pass Filters
L03-core	HF: T30-2 toroid core (Toroid - red) LF: T37-2 toroid core (Toroid - red)	Auto Band Pass Filters
L04	HF: 2uH: 21T #30(13in) on T30-2(red) (Coil - red) LF: 20uH: 68T #30(36in) on T30-2(red) (coil - red)	Auto Band Pass Filters
L05	HF: 0.46uH: 10T #30(8in) on T30-2(red) (coil - red) LF: 4.6uH: 32T #30(18in) on T30-2(red) (coil - red)	Auto Band Pass Filters
L06	HF: 2uH: 21T #30(13in) on T30-2(red) (Coil - red) LF: 20uH: 68T #30(36in) on T30-2(red) (coil - red)	Auto Band Pass Filters
L07	HF: 1uH: 19T #30(9in) on T25-6(yel) (coil - yellow) LF: 10uH: 48T #30(26in) on T30-2(red) (coil - red)	Auto Band Pass Filters
L07-core	HF: T25-6 toroid core (Toroid - yellow) LF: T30-2 toroid core (Toroid - red)	Auto Band Pass Filters
L08	HF: 0.27 uH: 10T #30 (6") on T25-6 core (coil - yellow) LF: 2.7uH: 25T #30(15in) on T30-2(red) (coil - red)	Auto Band Pass Filters
L08-core	HF: T25-6 toroid core (Toroid - yellow) LF: T30-2 toroid core (Toroid - red)	Auto Band Pass Filters
L09	HF: 1uH: 19T #30(9in) on T25-6(yel) (coil - yellow) LF: 10uH: 48T #30(26in) on T30-2(red) (coil - red)	Auto Band Pass Filters
L09-core	HF: T25-6 toroid core (Toroid - yellow) LF: T30-2 toroid core (Toroid - red)	Auto Band Pass Filters
L10	HF: 0.46 uH: 13T #30 (7") on T25-6 core (coil - yellow) LF: 4.6uH: 32T #30(18in) on T30-2(red) (coil - red)	Auto Band Pass Filters
L10-core	HF: T25-6 toroid core (Toroid - yellow) LF: T30-2 toroid core (Toroid - red)	Auto Band Pass Filters
L11	HF: 0.13 uH: 7T #30 (5") on T25-6 core (coil - yellow) LF: 1.3uH: 17T #30(11in) on T30-2(red) (coil - red)	Auto Band Pass Filters
L11-core	HF: T25-6 toroid core (Toroid - yellow) LF: T30-2 toroid core (Toroid - red)	Auto Band Pass Filters
L12	HF: 0.46 uH: 13T #30 (7") on T25-6 core (coil - yellow) LF: 4.6uH: 32T #30(18in) on T30-2(red) (coil - red)	Auto Band Pass Filters
L12-core	HF: T25-6 toroid core (Toroid - yellow) LF: T30-2 toroid core (Toroid - red)	Auto Band Pass Filters
R17	HF: 75 1/6W 5% (1/6W - vio-grn-blk-gld) LF: omit for this band (Omit -)	Auto Band Pass Filters
R18	HF: 120 1/6W 5% (1/6W - brn-red-brn-gld) LF: shunt wire (cut-off lead) (Cutoff -)	Auto Band Pass Filters
R19	HF: 75 1/6W 5% (1/6W - vio-grn-blk-gld) LF: omit for this band (Omit -)	Auto Band Pass Filters
R20	HF: 75 1/6W 5% (1/6W - vio-grn-blk-gld) LF: omit for this band (Omit -)	Auto Band Pass Filters
R21	HF: 120 1/6W 5% (1/6W - brn-red-brn-gld) LF: shunt wire (cut-off lead) (Cutoff -)	Auto Band Pass Filters
R22	HF: 75 1/6W 5% (1/6W - vio-grn-blk-gld) LF: omit for this band (Omit -)	Auto Band Pass Filters
T02	HF: 23.04uH: 4T(bi)T #30(12 (2x6)in) on BN43-2402 (xfrmr -) LF: 70.56uH: 7T(bi)T #30(16 (2x8)in) on BN43-2402 (xfrmr -)	Auto Band Pass Filters
T03	HF: 23.04uH: 4T/2T(bi)T #30(12 (6/2x3)in) on BN43-2402 (xfrmr -) LF: 70.56uH: 7T/3T(bi)T #30(18 (8/2x5)in) on BN43-2402 (xfrmr -)	Auto Band Pass Filters
C37	0.1 uF (SMT 1206) - (smt) black stripe	Auto Band Pass Filters
C38	0.1 uF (SMT 1206) - (smt) black stripe	Auto Band Pass Filters
C39	0.1 uF (SMT 1206) - (smt) black stripe	Auto Band Pass Filters
C40	0.1 uF (SMT 1206) - (smt) black stripe	Auto Band Pass Filters
C41	0.1 uF (SMT 1206) - (smt) black stripe	Auto Band Pass Filters
C42	0.1 uF (SMT 1206) - (smt) black stripe	Auto Band Pass Filters
J04	BNC Connector Male - PCB mount (Jack)	Auto Band Pass Filters
U08	FST3253 mux/demux switch (SOIC-16) - FST3253	Auto Band Pass Filters
U09	FST3253 mux/demux switch (SOIC-16) - FST3253	Auto Band Pass Filters
T02-core	BN-43-2402 (no markings!) (Binocular core) - none	Auto Band Pass Filters
T03-core	BN-43-2402 (no markings!) (Binocular core) - none	Auto Band Pass Filters
L04-core	T30-2 toroid core (Toroid) - red	Auto Band Pass Filters
L05-core	T30-2 toroid core (Toroid) - red	Auto Band Pass Filters
L06-core	T30-2 toroid core (Toroid) - red	Auto Band Pass Filters

R25	10 ohm 1/4W 1% (1/4W) - br-blk-blk-gld-br	Auto Band Pass Filters
R26	10 ohm 1/4W 1% (1/4W) - br-blk-blk-gld-br	Auto Band Pass Filters
R15	2.2k 1/6W 5% (1/6W) - red-red-red-gld	Auto Band Pass Filters
R16	2.2k 1/6W 5% (1/6W) - red-red-red-gld	Auto Band Pass Filters
R23	2.2k 1/6W 5% (1/6W) - red-red-red-gld	Auto Band Pass Filters
R24	2.2k 1/6W 5% (1/6W) - red-red-red-gld	Auto Band Pass Filters
R27	2.2k 1/6W 5% (1/6W) - red-red-red-gld	Auto Band Pass Filters
R28	2.2k 1/6W 5% (1/6W) - red-red-red-gld	Auto Band Pass Filters
magwire_165in	Magnetic Wire, enameled #30 (Magnetic)	Auto Band Pass Filters
magwire_47in	Magnetic Wire, enameled #30 (Magnetic)	Auto Band Pass Filters
magwire_67in	Magnetic Wire, enameled #30 (Magnetic)	Auto Band Pass Filters
magwire_90in	Magnetic Wire, enameled #30 (Magnetic)	Auto Band Pass Filters
R30	HF: 10 ohm 1/4W 1% (1/4W - br-blk-blk-gld-br) LF: 49.9 ohm 1% (1/4W - yel-wht-wht-gld-brn)	Quadrature Sampling Detector
R31	HF: 10 ohm 1/4W 1% (1/4W - br-blk-blk-gld-br) LF: 49.9 ohm 1% (1/4W - yel-wht-wht-gld-brn)	Quadrature Sampling Detector
C20	0.047 uF 5% (Ceramic) - 473	Quadrature Sampling Detector
C21	0.047 uF 5% (Ceramic) - 473	Quadrature Sampling Detector
C43	0.1 uF (SMT 1206) - (smt) black stripe	Quadrature Sampling Detector
C44	0.1 uF (SMT 1206) - (smt) black stripe	Quadrature Sampling Detector
U10	FST3253 mux/demux switch (SOIC-16) - FST3253	Quadrature Sampling Detector
R29	10 k 1/6W 5% (1/6W) - brn-blk-ora-gld	Quadrature Sampling Detector
C23	390 pF 5% (Ceramic) - 391	Operational Amplifiers
C24	390 pF 5% (Ceramic) - 391	Operational Amplifiers
C22	4.7 uF 10% 16V X7R RAD (Ceramic) - 475	Operational Amplifiers
C45	0.1 uF (SMT 1206) - (smt) black stripe	Operational Amplifiers
C46	0.1 uF (SMT 1206) - (smt) black stripe	Operational Amplifiers
C47	0.1 uF (SMT 1206) - (smt) black stripe	Operational Amplifiers
J02	3.5mm stereo jack - PCB mount (rt-angle) (Jack-RA)	Operational Amplifiers
U11	LT6231 dual op-amp (SOIC-8) - LT6231	Operational Amplifiers
R32	4.99 k 1/4W 1% (1/4W) - y-w-w-br-br	Operational Amplifiers
R33	4.99 k 1/4W 1% (1/4W) - y-w-w-br-br	Operational Amplifiers
R34	120 1/6W 5% (1/6W) - brn-red-brn-gld	Operational Amplifiers
R35	120 1/6W 5% (1/6W) - brn-red-brn-gld	Operational Amplifiers
JP1A	shunt wire (cut-off lead) (Cutoff)	Operational Amplifiers
JP1B	shunt wire (cut-off lead) (Cutoff)	Operational Amplifiers

Home Bill of Materials Power Supply USB Power Supply Local Oscillator and Control Quadrature Clock Generator Auto Band Pass Filters Quadrature Sampling Detector Operational Amplifiers Comments Acronyms Inventory Revisions as of 11/30/2010 Components By Stage WB5RVZ Main Website

Ensemble RX II 01_Power Supply

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Power Supply Introduction

General

This stage supplies the "regular" 5 volt power rail, for powering the CMOS chips on the main part of the board.

Note: throughout these notes, they will refer to the board in terms of:

- Topside: the side where one can read the silk-screened component designations and outlines
- Bottomside: the reverse of topside, where the SMT components are installed
- Bottom or "bottom edge": the edge of the board where all of the connectors are located
- Top or "top edge": the edge of the board opposite of the bottom edge

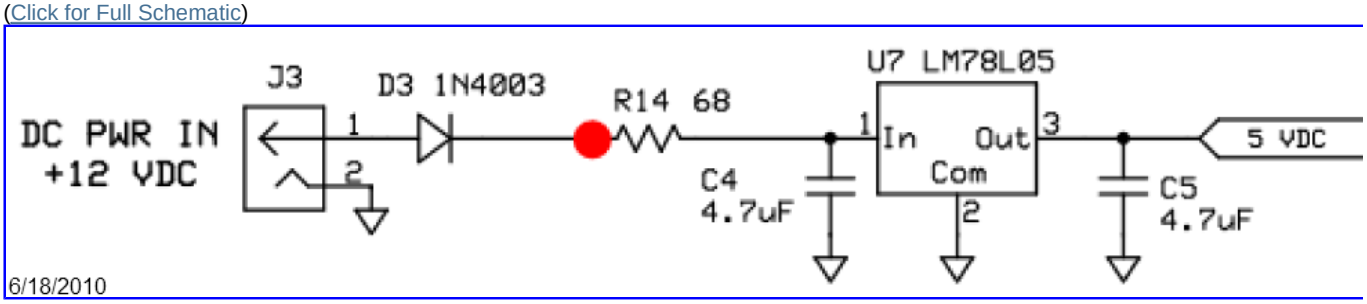
Unlkess otherwise noted, all photos/graphics of the board layout are displayed herein with the top edge UP.

(go directly to build notes)

Power Supply Schematic

(Resistor testpoints (hairpin, top, or left-hand lead), as physically installed on the board, are marked in the schematic with red dots)

(Click for Full Schematic)

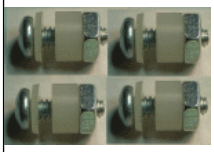


(go directly to build notes)

Power Supply Bill of Materials

Stage Bill of Materials

(resistor images and color codes courtesy of WIlfried, DL5SWB's R-Color Code program)

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	/QSD EN	shunt wire (cut-off lead)		Cutoff		(use for regular GND connection point)	Power Supply
❑	D3	1N4003	1N4003	Axial			Power Supply
❑	mtg_hdw	4 X #4-40 hdw (nut, bolt, washer, spacer)		HDW		Can install later. four each of 3/8 inch 4-40 Phillips head screws,4-40 nuts, 1/8 inch long #4 nylon spacer and #4 nylon washer	Power Supply
❑	PCB	Ensemble RX PCB (board)		Main Board			Power Supply
❑	R14	68 1/6W 5%	bl-gry-blk-gld 	1/6W	S-N		Power Supply

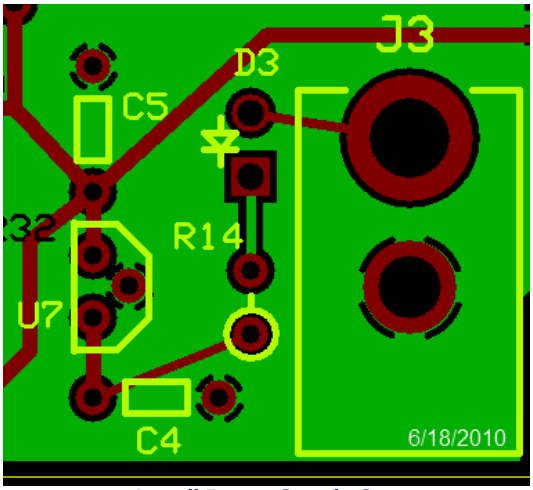
❑	U07	LM78L05 voltage regulator	LM78L05 	TO-92			Power Supply
❑	C04	4.7 uF 10% 16V X7R RAD	475 	Ceramic	horiz		Power Supply
❑	C05	4.7 uF 10% 16V X7R RAD	475 	Ceramic	vert		Power Supply
❑	J03	DC Power Jack PCB Mount (rt-angle)		Jack-RA			Power Supply
❑	P1	DC Power Plug 5.5/2.1mm Pos Ctr		Plug			Power Supply

Power Supply Summary Build Notes

- Install Power Supply Components
- Install /RX EN (Ground Point)
- Test the Stage

Power Supply Detailed Build Notes

Top of the Board



Install Power Supply Components

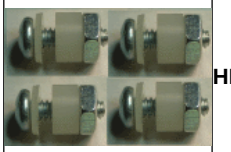
Install the Diode with the lead on the cathode (banded) end forming a hairpin lead and the anode end snugged up against the board.

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	D3	1N4003	1N4003 	Axial		
❑	PCB	Ensemble RX PCB (board)		Main Board		
❑	R14	68 1/6W 5%	bl-gry-blk-gld 	1/6W	S-N	
❑	U07	LM78L05 voltage regulator	LM78L05 	TO-92		Take ESD precautions

❑	C04	4.7 uF 10% 16V X7R RAD	475 	Ceramic	horiz	
❑	C05	4.7 uF 10% 16V X7R RAD	475 	Ceramic	vert	
❑	J03	DC Power Jack PCB Mount (rt-angle)		Jack-RA		
❑	P1	DC Power Plug 5.5/2.1mm Pos Ctr		Plug		

Install /RX EN (Ground Point)

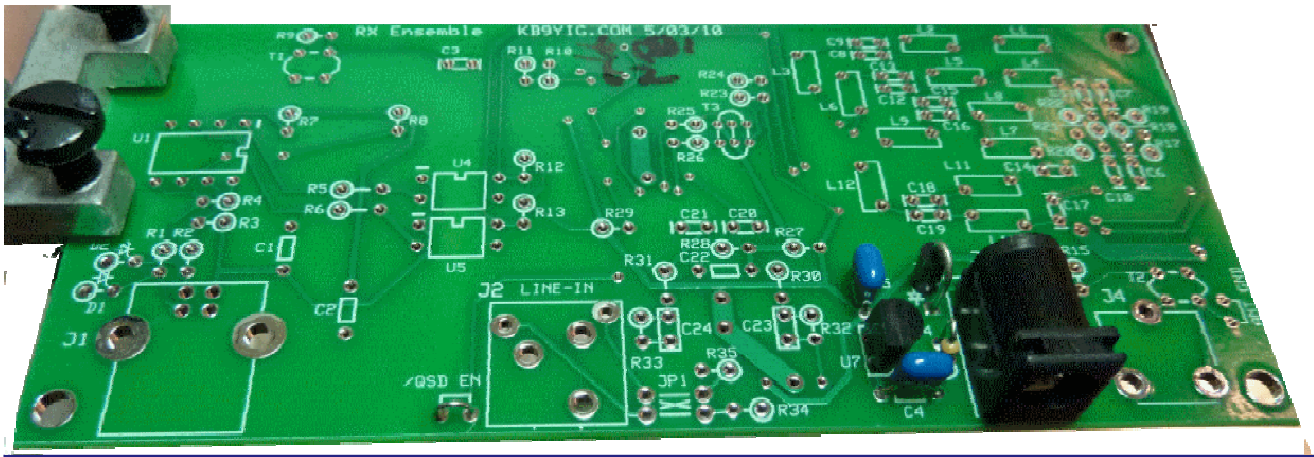
Use a good strong piece of wire, as this will be used as a ground connection point for a number of tests throughout the build.

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	/QSD EN	shunt wire (cut-off lead)		Cutoff		(use for regular GND connection point)
❑	mtg_hdw	4 X #4-40 hdw (nut, bolt, washer, spacer)		HDW		Can install later. four each of 3/8 inch 4-40 Phillips head screws,4-40 nuts, 1/8 inch long #4 nylon spacer and #4 nylon washer

Power Supply Completed Stage

(These photos were of an earlier board design. It has changed since the author built the kit upon which these notes are based. The board layout graphics are, however, current.)

Top of the Board



Power Supply Testing

Current Draw

Test Setup

Measure the resistance (after the input diode) on the power input to ensure there is no short circuit. Measurement can be taken from the hairpin of D3 and the "/QSD EN" ground wire and should read in the Megohm range.

If the measured input resistance is within reason, measure the current draw with your mA meter inserted in series into the positive power lead.

Test Measurements

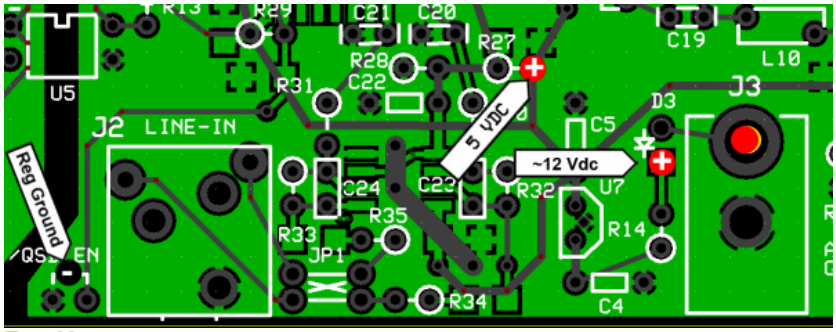
Testpoint	Units	Nominal Value	Author's	Yours
D3 hairpin lead (WRT GND - "/QSD EN")	ohms	> 1M	7 M and rising	
Current Draw	mA	< 8	4.3	

Voltage Test

Test Setup

With 12 V dc applied to the board (author's gel cell was at 12.89 Vdc), measure the voltage after D3 and measure the output of U7 (the 5 Vdc rail)

Measurements are with respect to (WRT) the regular ground plane (i.e., the non-USB side) of the board.



Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
At Cathode of D3 (WRT regular ground)	Vdc	.6V less than input	12.3	
At hole for R27 hairpin lead (WRT regular ground)	Vdc	5	4.92	

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Ensemble RX II 02_USB Power Supply

Home Bill of Materials Power Supply USB Power Supply Local Oscillator and Control Quadrature Clock Generator Auto Band Pass Filters Quadrature Sampling Detector Operational Amplifiers Comments Acronyms Inventory Revisions as of 11/30/2010 Components By Stage WB5RVZ Main Website

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USB Power Supply Introduction

General

This stage installs the power supplies for the USB section of the board. This section is galvanically isolated from the rest of the board, with its own ground plane (the "USB ground"). Voltages measured in this stage are measured with respect to (WRT) this ground and NOT the "regular ground" of the rest of the board. To paraphrase a famous city's motto, "What happens in USB stays in USB!"

This stage installs the USB connection (with its 5 V bus) and the (very tiny) 3.3V regulator whch translates the USB 5 volts to 3.3V for the Si570 of the next stage..

This stage will present the most difficult SMT soldering challenge to the builder; that voltage regulator is, indeed, tiny! The builder should undertake this stage BEFORE that third cup of coffee and take great pains to avoid launching the little chip off into space (never to be retrieved!)

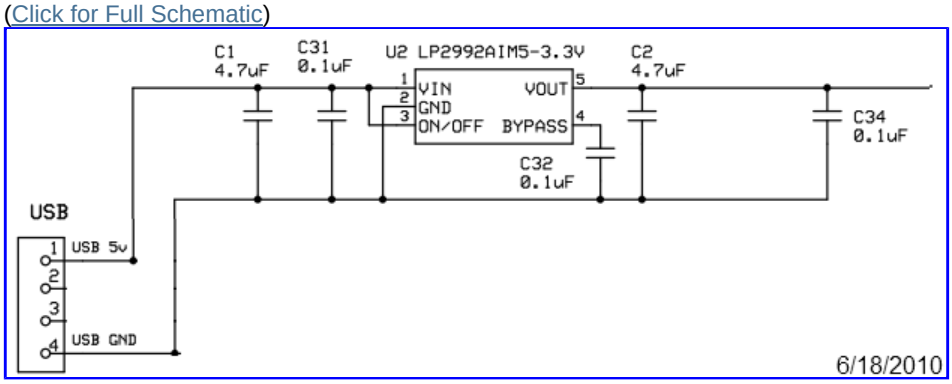
The 3.3V regulator is, indeed, very tiny. It is found in a rolled up and stapled bottom portion of an antistatic bag. You have to look very closely to find it. You do not want to do, as the author did, toss the chip out with the little rolled up bag!

(go directly to build notes)

USB Power Supply Schematic

(Resistor testpoints (hairpin, top, or left-hand lead), as physically installed on the board, are marked in the schematic with red dots)

(Click for Full Schematic)

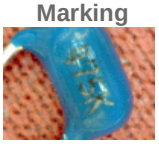
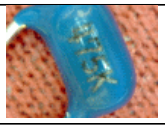


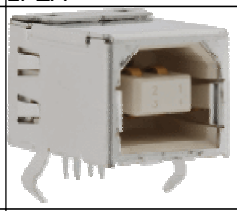
(go directly to build notes)

USB Power Supply Bill of Materials

Stage Bill of Materials

(resistor images and color codes courtesy of WIlfried, DL5SWB's R-Color Code program)

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	C01	4.7 uF 10% 16V X7R RAD	475 	Ceramic	vert		USB Power Supply
❑	C02	4.7 uF 10% 16V X7R RAD	475 	Ceramic	vert		USB Power Supply

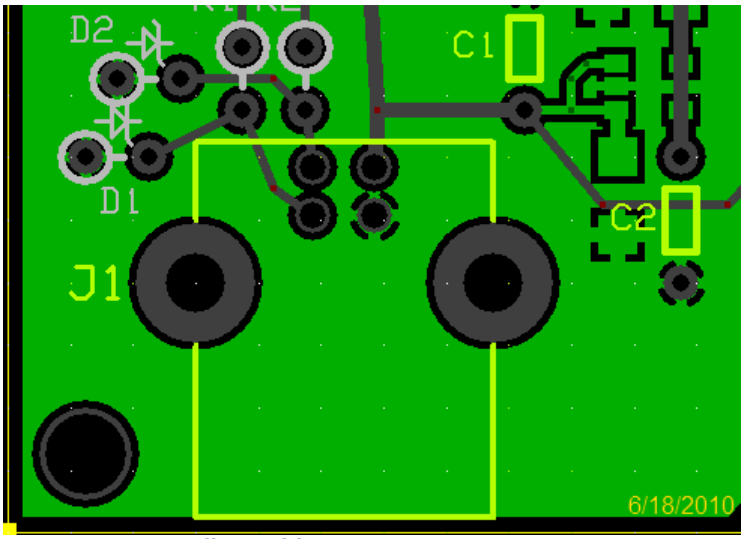
❑	U02	LP2992AIM5-3.3V regulator	 LFEA	SOT-23-5			USB Power Supply
❑	J01	USB-B pcb jack (rt -angle)		Jack-RA			USB Power Supply
❑	C34	0.1 uF	(smt) black stripe 	SMT 1206	white pads		USB Power Supply
❑	C32	0.1 uF	(smt) black stripe 	SMT 1206	white pads		USB Power Supply
❑	C31	0.1 uF	(smt) black stripe 	SMT 1206	white pads		USB Power Supply

USB Power Supply Summary Build Notes

- Install Topside Components
- Install Bottomside Components
- Test the Stage

USB Power Supply Detailed Build Notes

Top of the Board

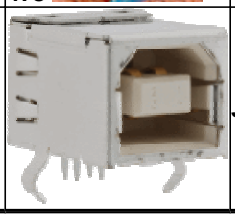


Install Topside Components

You will want to install the topside capacitors (at least) prior to attempting to solder the SMT parts on the underside (there are holes for the ceramic caps which could accidentally be clogged up if you begin with the SMT parts.

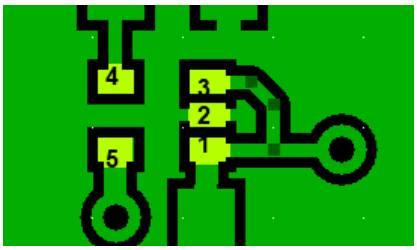
The 3.3V regulator is, indeed, very tiny. It is found in a rolled up and stapled bottom portion of an antistatic bag. You have to look very closely to find it. You do not want to do, as the author did, inadvertently toss the chip out with the little rolled up bag!

Due to some problems with recent lots of Si570 devices, Tony has had to pre-mount the Si570s and test them in circuit before sending the kit out. The circuit boards sent out with the Si570 already mounted have a cut in the trace between the 3.3 volt regulator output and the Si570. This is so that the 3.3 volt supply may be verified to be regulating properly before subjecting the Si570 to an over voltage condition. The cut needs to be bridged by scraping the ends of the trace each side of the cut and then soldering in a short wire to bridge the cut!

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	C01	4.7 uF 10% 16V X7R RAD	475 	Ceramic	vert	
❑	C02	4.7 uF 10% 16V X7R RAD	475 	Ceramic	vert	
❑	J01	USB-B pcb jack (rt-angle)		Jack-RA		

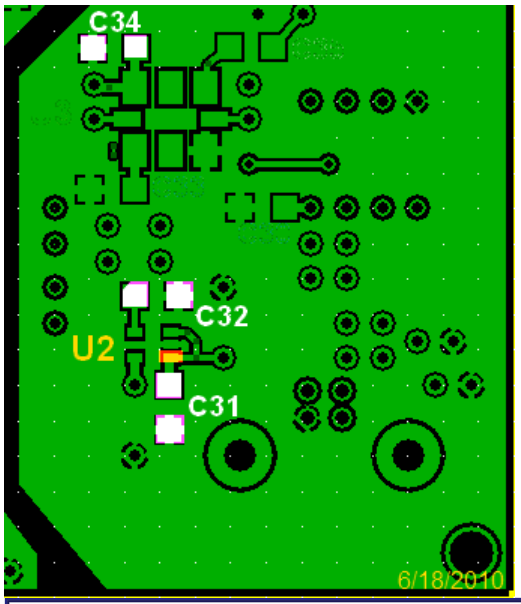
Install Bottomside Components

Pay careful attention to the 3.3V regulator. Pins 1 and 3 are at 5V; pin 2 is at ground and nestled snugly between pins 1 and 3.



Check	Designation	Component	Marking	Category	Orientation	Notes
❑	U02	LP2992AIM5-3.3V regulator	LFEA 	SOT-23-5		Take ESD precautions
❑	C34	0.1 uF	(smt) black stripe 	SMT 1206	white pads	
❑	C32	0.1 uF	(smt) black stripe 	SMT 1206	white pads	
❑	C31	0.1 uF	(smt) black stripe 	SMT 1206	white pads	

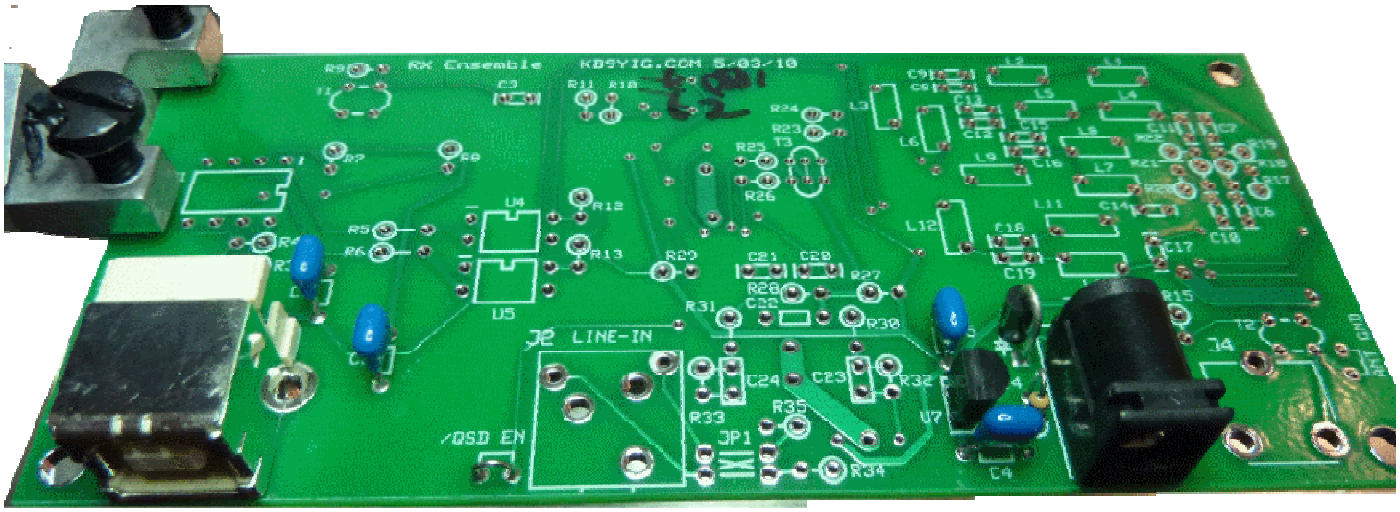
Bottom of the Board



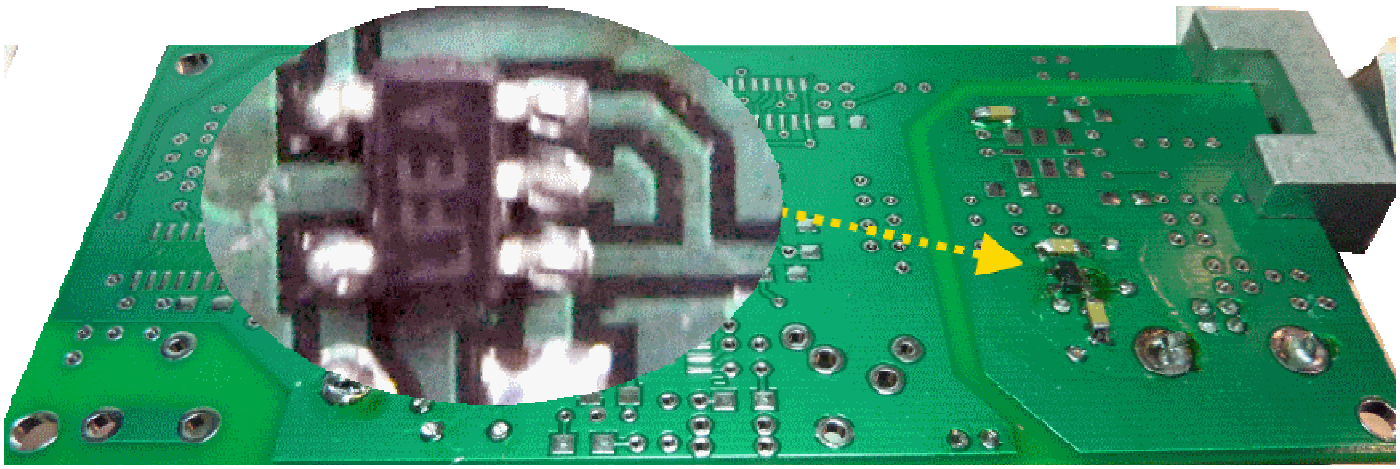
USB Power Supply Completed Stage

(These photos were of an earlier board design. It has changed since the author built the kit upon which these notes are based. The board layout graphics are, however, current.)

Top of the Board



Bottom of the Board

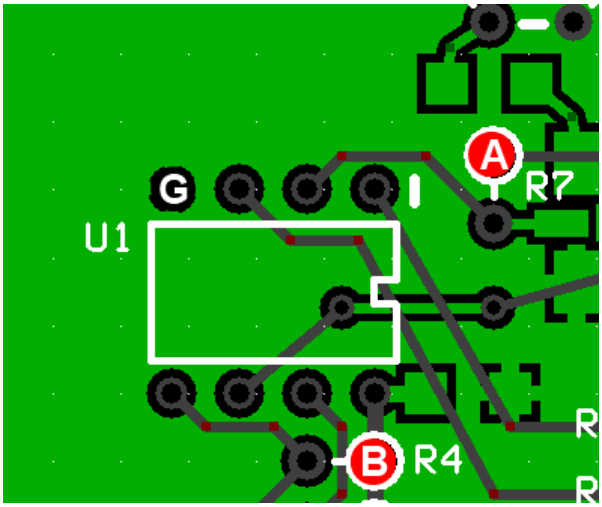


USB Power Supply Testing

Test Resistances

Test Setup

Measure resistances on the power rails to be sure there are no short circuits.



Test Measurements

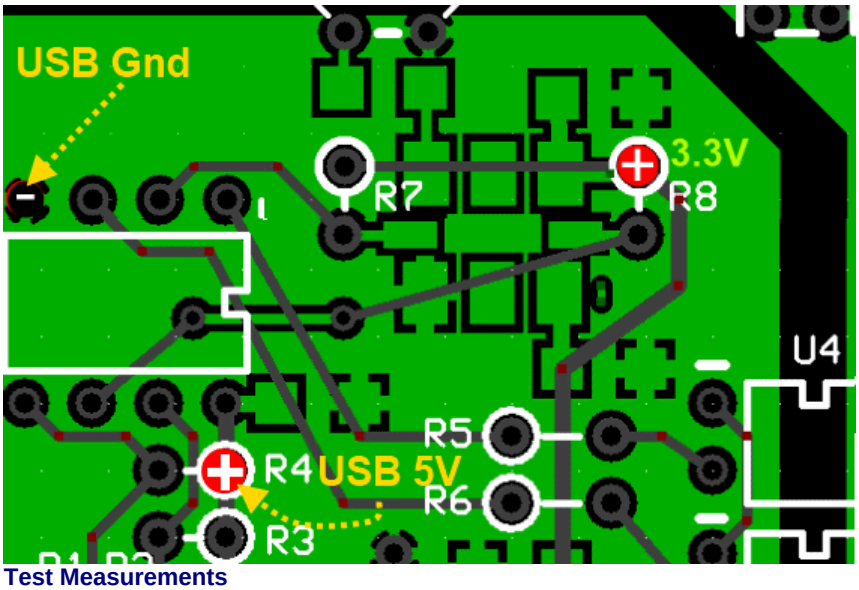
Testpoint	Units	Nominal Value	Author's	Yours
(A) 3.3V rail: R7 barrel to USB Grnd (G)	ohms	>100k	130k	
(B) USB 5V rail: R4 barrel to USB Ground (G)	ohms	> 1M	7M and rising	

Voltage Test

Test Setup

Connect the USB cable to the PC and to the board.

Measure the USB voltages (with respect to the USB ground) at the point indicated on the graphic



Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
3.3V point (WRT USB Ground)	Vdc	3.3	3.29	
USB 5V (WRT USB Ground)	Vdc	5	5.02	

Home Bill of Materials Power Supply USB Power Supply Local Oscillator and Control Quadrature Clock Generator Auto Band Pass Filters Quadrature Sampling Detector Operational Amplifiers Comments Acronyms Inventory Revisions as of 11/30/2010 Components By Stage WB5RVZ Main Website

Ensemble RX II 03_Local Oscillator and Control

Home Bill of Materials Power Supply USB Power Supply Local Oscillator and Control Quadrature Clock Generator Auto Band Pass Filters Quadrature Sampling Detector Operational Amplifiers Comments Acronyms Inventory Revisions as of 11/30/2010 Components By Stage WB5RVZ Main Website

Search: Search selected SDR sites

Local Oscillator and Control Introduction

General

This stage completes the component installation for the isolated USB ground plane and implements:

- the microcontroller and
- the local oscillator functionality.

The microcontroller implements a USB device which can control frequency of the programmable oscillator (Si570) and provides programmatic band-select switching signals to select from among bands 0, 1, 2, and 3. These bands are "super bands" which, depending upon the builder's choice of options, provide coverage of the traditional HF bands or a set of HF bands plus 6m.

It is important to remember that the Local Oscillator does not output at the desired center frequency for your band; it produces an output at a frequency that is:

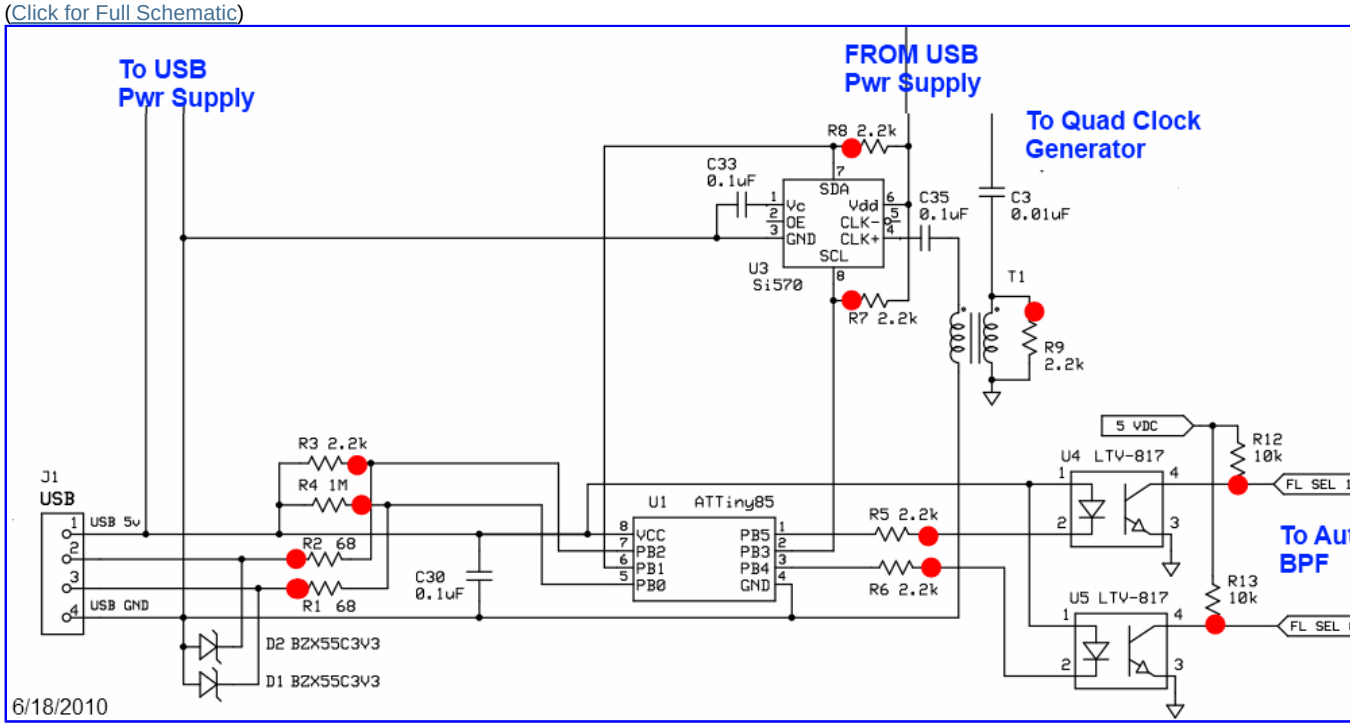
- *For the HF option, 4 times the desired center frequency*
- *For the LF optikon, 16 times the desired center frequency*

(go directly to build notes)

Local Oscillator and Control Schematic

(Resistor testpoints (hairpin, top, or left-hand lead), as physically installed on the board, are marked in the schematic with red dots)

(Click for Full Schematic)



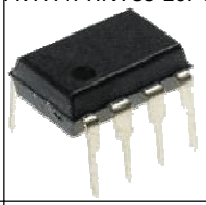
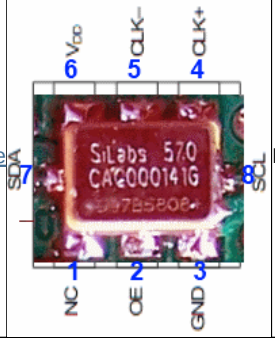
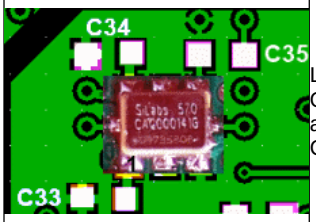
(above schematic has clickable areas that can be used for navigation)

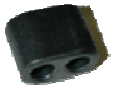
(go directly to build notes)

Local Oscillator and Control Bill of Materials

Stage Bill of Materials

(resistor images and color codes courtesy of Wilfried, DL5SWB's R-Color Code program)

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	D1	BZX55C3V3 3.3V zener diode	BZX55C	Axial		The band end of the diode is the hairpin lead - see board layout	Local Oscillator and Control
❑	D2	BZX55C3V3 3.3V zener diode	BZX55C	Axial		The band end of the diode is the hairpin lead - see board layout	Local Oscillator and Control
❑	magwire	Magnetic Wire, enameled #30		Magnetic		(total of 30 ft. provided in kit)	Local Oscillator and Control
❑	SO1	8 pin dip socket		Socket		for ATTiny85	Local Oscillator and Control
❑	U01	ATtiny 85-20 PU w/V15.12 Firmware	AVR ATTINY85-20PU 	DIP 8	(dimple in upper right)		Local Oscillator and Control
❑	U03	Si570 Programmable Oscillator	SiLabs 570 	I2C			Local Oscillator and Control
❑	U04	LTV-817 Opto-Isolator	LTV 817 	DIP-4	(dimple in upper left)		Local Oscillator and Control
❑	U05	LTV-817 Opto-Isolator	LTV 817 	DIP-4	(dimple in upper left)		Local Oscillator and Control
❑	C03	0.01 uF	103 	Ceramic	horiz		Local Oscillator and Control
❑	C30	0.1 uF	(smt) black stripe 	SMT 1206	white pads		Local Oscillator and Control
❑	C33	0.1 uF	(smt) black stripe 	SMT 1206	white pads		Local Oscillator and Control
❑	C35	0.1 uF	(smt) black stripe 	SMT 1206	white pads		Local Oscillator and Control
❑	R01	68 1/6W 5%	bl-gry-blk-gld 	1/6W	N-S		Local Oscillator and Control
❑	R02	68 1/6W 5%	bl-gry-blk-gld 	1/6W	N-S		Local Oscillator and Control
❑	R03	2.2k 1/6W 5%	red-red-red-gld 	1/6W	E-W		Local Oscillator and Control

❑	R05	2.2k 1/6W 5%	red-red-red-gld	1/6W	W-E		Local Oscillator and Control
❑	R06	2.2k 1/6W 5%	red-red-red-gld	1/6W	W-E		Local Oscillator and Control
❑	R07	2.2k 1/6W 5%	red-red-red-gld	1/6W	N-S		Local Oscillator and Control
❑	R08	2.2k 1/6W 5%	red-red-red-gld	1/6W	N-S		Local Oscillator and Control
❑	R09	2.2k 1/6W 5%	red-red-red-gld	1/6W	W-E	chenged from 221	Local Oscillator and Control
❑	R12	10 k 1/6W 5%	brn-blk-ora-gld	1/6W	N-S		Local Oscillator and Control
❑	R13	10 k 1/6W 5%	brn-blk-ora-gld	1/6W	N-S		Local Oscillator and Control
❑	R04	1 M 1/6W 5%	brn-blk-grn-gld	1/6W	E-W		Local Oscillator and Control
❑	T01-core	BN-43-2402 (no markings!)	none 	Binocular core			Local Oscillator and Control
❑	T01	band-specific		misc		change from 3Ttrifilar	Local Oscillator and Control

Band Specific Items for HF Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	T01	5.76uH: 2T(bi)T #30(8 (2x4)in) on BN43-2402		xfrmr		change from 3Ttrifilar	Local Oscillator and Control

Band Specific Items for LF Band

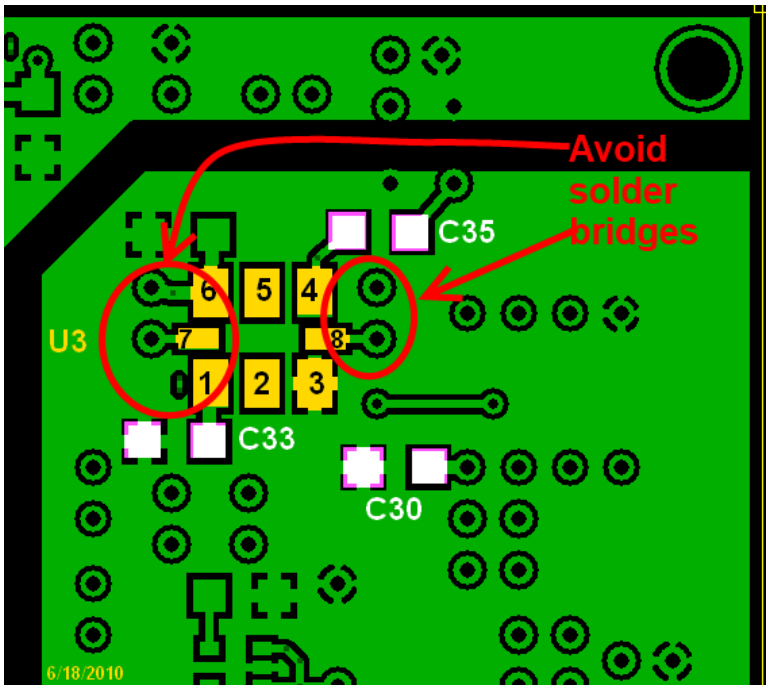
Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	T01	12.96uH: 3T(bi)T #30(10 (2x5)in) on BN43-2402		xfrmr		change from 3Ttrifilar	Local Oscillator and Control

Local Oscillator and Control Summary Build Notes

- Install Protective Topside Parts
- Install Bottomside Components
- Wind and Install T1
- Install Topside Ics
- Install Remainder of Topside Components
- Download and Install Required Software
- Configure Si570 for LF Option
- Test the Stage

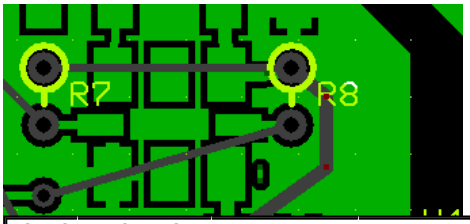
Local Oscillator and Control Detailed Build Notes

Bottom of the Board



Install Protective Topside Parts

Install these resistors first, so as to protet against solder splashover at pins 4 and 8 off the Si570 (see below)



Check	Designation	Component	Marking	Category	Orientation	Notes
☐	R07	2.2k 1/6W 5%	red-red-red-gld	1/6W	N-S	
☐	R08	2.2k 1/6W 5%	red-red-red-gld	1/6W	N-S	

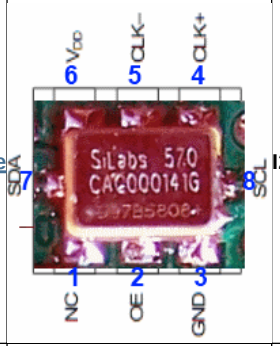
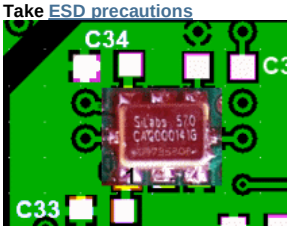
Install Bottomside Components

Watch out when installing C35 to avoid solder splashover into the adjacent holes for the T1 primary windings.

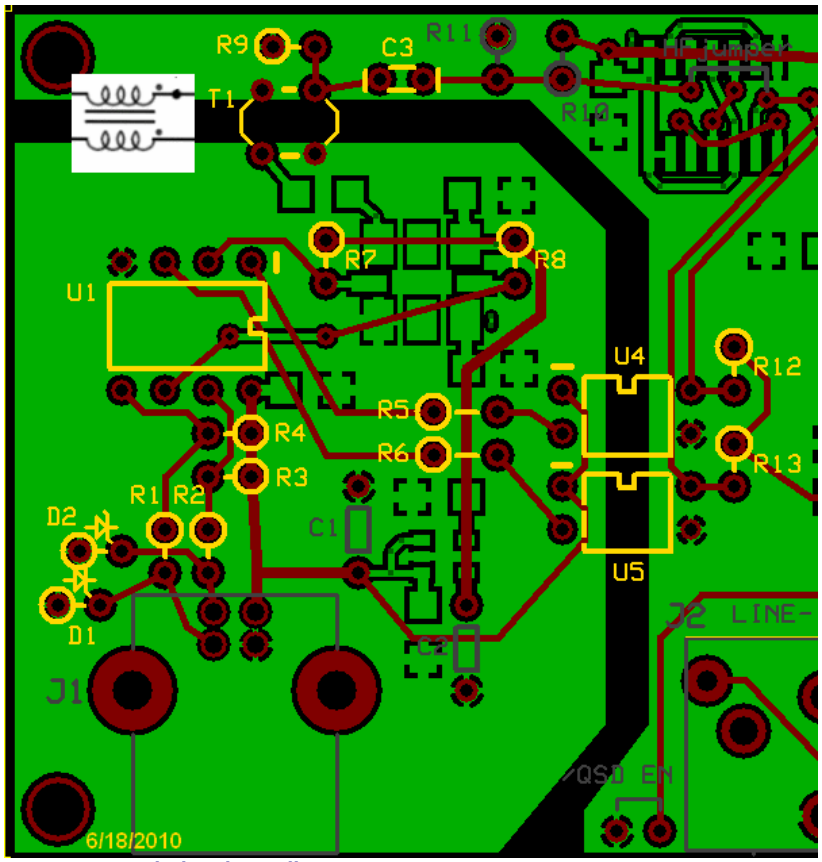
Note the orientation photo for the Si570 and install with correct orientation.

Pay close attention to the pins 4 , 7, and 8, as their footprint is quite small relative to the other pads. The very tight space around those pins and the multiple contacts in close proximity can easily lead to frustrating solder bridges.

Check	Designation	Component	Marking	Category	Orientation	Notes

❑	U03	Si570 Programmable Oscillator	SiLabs 570 	I2C		Take ESD precautions 
❑	C30	0.1 uF	(smt) black stripe	SMT 1206	white pads	
❑	C33	0.1 uF	(smt) black stripe	SMT 1206	white pads	
❑	C35	0.1 uF	(smt) black stripe	SMT 1206	white pads	

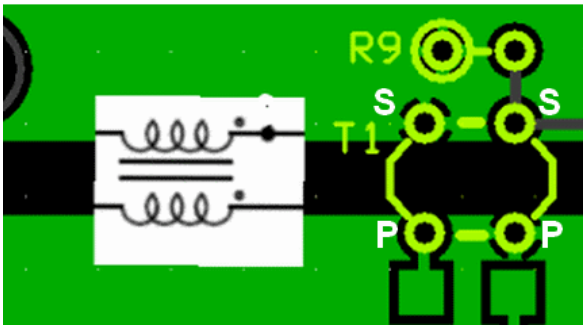
Top of the Board



Wind and Install T1

You should take two 5" strands of #30 wire and twist them together ("bifilar") so you get around 3 twists to the inch. Using the resultant bifilar strand, thread it through the binocular core for two turns. Remember a turn is a trip that:
(1) starts at a particular hole
(2) goes into that hole and out of the other end
(3) goes into the hole nthat is across from the hole out of which it just exited, and
(4) Comes out of the hole at the opposite end and across from the original entry hole.
Do that series twice with the twisted pair and you have a transformer with two windings (each winding corresponding to one of the two twisted single wires).
Each winding (primary and secondary) is two turns. Since the windings are identical in length and number of turns, you can arbitratily pick either one as the primary, with the remaining winding serving as the secondary winding.

(Hont: use an ohmmeter (or other continuity checker) to identify which wire-ends go together to make the ends of a winding.



If you are unfamiliar with winding and installing inductors, you may want to refer to the WB5RVZ construction hints for coils (toroidal) and transformers (toroidal and binocular). Click here for details on identifying toroid cores.

Decoding the trqansformer specifications:

Transformers' windings are specified using the pattern "nnT/wXmmT" or "wXmmT/nnT", where:

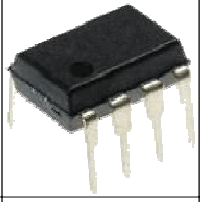
- **"nn" is the number of turns in the single winding**
- **"mm" is the number of turns in the multiple windings**
- **"w" = the number of multiple windings (e.g., 2 = bifilar; 3 = trifilar, etc.)**

Thus, e.g., "18T/2x9T bifilar #30" means, using #30 wire, produce a single 18 turn primary winding and two 9-turn secondary windings; "2x9T bifilar/ 18T #30" means, using #30 wire, produce two 9-turn primary windings and a single 18 turn secondary winding.

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	magwire	Magnetic Wire, enameled #30		Magnetic		(total of 30 ft. provided in kit)
❑	T01	band-specific	Band / Component / Marking HF: 5.76uH: 2T (bi)T #30(8 (2x4)in) on BN43-2402 (xfrmr)  LF: 12.96uH: 3T(bi)T #30 (10 (2x5)in) on BN43-2402 (xfrmr) 	misc		change from 3Ttrifilar

Install Topside Ics

Double check the orientation on the two optoisolators. They should be oriented so that their "dimple" is in the upper left-hand corner.

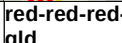
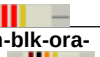
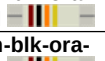
Check	Designation	Component	Marking	Category	Orientation	Notes
❑	SO1	8 pin dip socket		Socket		for ATTiny85
❑	U01	ATtiny 85-20 PU w/V15.12 Firmware	AVR ATTINY85-20PU 	DIP 8	(dimple in upper right)	Take ESD precautions
❑	U04	LTV-817 Opto-Isolator	LTV 817 	DIP-4	(dimple in upper left)	Take ESD precautions

❑	U05	LTV-817 Opto-Isolator	LTV 817 	DIP-4	(dimple in upper left)	Take ESD precautions

Install Remainder of Topside Components

Careful installing the resistors and diodes clustered near the USB connector area. Builders have been known to insert these into the wrong holes. Review the board layout and the orientation column below to double check the orientation.

The body of each zener is to be located above the silkscreen circles for D1 and D2 on the board with the diodes mounted standing perpendicular to the board in a hairpin fashion. The banded end of each diode is then at the lead of the diode that loops back to the circuit board.

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	D1	BZX55C3V3 3.3V zener diode	BZX55C	Axial		The band end of the diode is the hairpin lead - see board layout
❑	D2	BZX55C3V3 3.3V zener diode	BZX55C	Axial		The band end of the diode is the hairpin lead - see board layout
❑	C03	0.01 uF	103 	Ceramic	horiz	
❑	R01	68 1/6W 5%	bl-gry-blk-gld 	1/6W	N-S	
❑	R02	68 1/6W 5%	bl-gry-blk-gld 	1/6W	N-S	
❑	R03	2.2k 1/6W 5%	red-red-red-gld 	1/6W	E-W	
❑	R05	2.2k 1/6W 5%	red-red-red-gld 	1/6W	W-E	
❑	R06	2.2k 1/6W 5%	red-red-red-gld 	1/6W	W-E	
❑	R09	2.2k 1/6W 5%	red-red-red-gld 	1/6W	W-E	chenged from 221
❑	R12	10 k 1/6W 5%	brn-blk-ora-gld 	1/6W	N-S	
❑	R13	10 k 1/6W 5%	brn-blk-ora-gld 	1/6W	N-S	
❑	R04	1 M 1/6W 5%	brn-blk-grn-gld 	1/6W	E-W	

Download and Install Required Software

All of the latest versions of essential firmware configuration programs, USB driver and their associated documentation can be obtained from Fred PE0FKO's website:

- **USB driver: (search for "Download Firmware source and .hex files")**
- **CFGSR program: (search for "Download")**
- **Documentation**

In order to test (and later, operate) your rig, you must download and install required software (SDR programs and Dynamic Link Libraries, along with hardware drivers. The actual steps and programs may vary, depending upon your computer's windows operating system version (XP, Vista, or Windows 7) and architecture CPU/memory (32 bit or 64 bit).

The following links are provided and, as of 7/8/2010, are current:

Software	Role/Purpose	Download Link	Notes
CFGSR	Configure/Control Ensemble microcontroller	download	
SRDLL	dll for Softrock controllers (resides in same folder as CFGSR)	download	

USB driver(s)	drivers for ATTiny85 USB	download	Zip file with 32 and 64 bit drivers*.
HDSDR	Simple SDR (RX only) Program (based upon original Winrad)	download	
Rocky	Simple SDR (RX/TX) Program (see note below)	download	
(Windows XP) PowerSDR-IQ V1.12.20	Version of FlexRadio's PowerSDR tailored for I/Q Soundcard-based SDRs	download	Has Si570 Control Capability
(Windows 7, Vista) PowerSDR-IQ V1.19.3.15	Version of FlexRadio's PowerSDR tailored for I/Q Soundcard-based SDRs	download	Has Si570 Control Capability (Please see Christos' message 43204 on the Yahoo Reflector)

Note: Rocky latest version is 3.6. Operates fine on Windows XP; in later Windows versions, Rocky will operate, but only recognizes USB soundcards. Has RXTX for CW and PSK31; RX only for SSB.

***Note on installing PE0-FKO's USB Drivers: Fred's website has an excellent step-by-step guide to instaling the USB driver.**

Install Driver

The correct procedure is to download the driver and put it in a suitable folder, then plug in the USB lead, Windows should detect new hardware has been found and you need to manually point it to the folder containing the drive. It should then install correctly. Certainly does on Win2000 and XP. On Vista or Windows 7, there used to be some issues with driver signing. There have been messages on the forum describing methods of working around these issues. One such solution is addressed in the author's MOBO4.3 builders notes.

LibUSB - "Unknown Device" Error

Others have experienced the dreaded "Unknown Device" problem upon plugging in the USB cable after having installed the LibUsb driver. This "unknown device" problem (and a remedy for those who are using Logitech cordless mouse and/or various wireless internet connection adaptors) are discussed in message #45071 and Message #47755 on the Yahoo Softrock40 Group

Install/Run CFGSR ("ConFiGureSoftRock")

Once the driver is installed, if you run 'CFGSR' that will either automatically 'open' the firmware, or if not, you need to go to the 'USB' tab and select it from the list displayed in the bottom box. Which way depends on if you have 'CFGSR' set up to auto connect on program start or not.

For further discussions of the software side of SDR and soundcard issues, see Alan G4ZFQ's pages.

Test Local Oscillator

You can use 'CFGSR' to exercise the Si570 using the 'Tune' tab that makes it into a 'VFO'. Just a case of setting the frequency, and the Si570 should output a signal at 4 times the frequency displayed on the main display on the screen. The 'Test' tab can also be used to look at all the various Si570 registers etc, but probably unnecessary as if you can hear or measure the Si570 output frequency, you know it is working.

Configure Si570 for LF Option

For the LF version, it will be essential to change the firmware configuration to successfully operate that version. Tthe default values are only suitable for the 'normal' HF version.

Changes needed are (using CFGSR.exe):

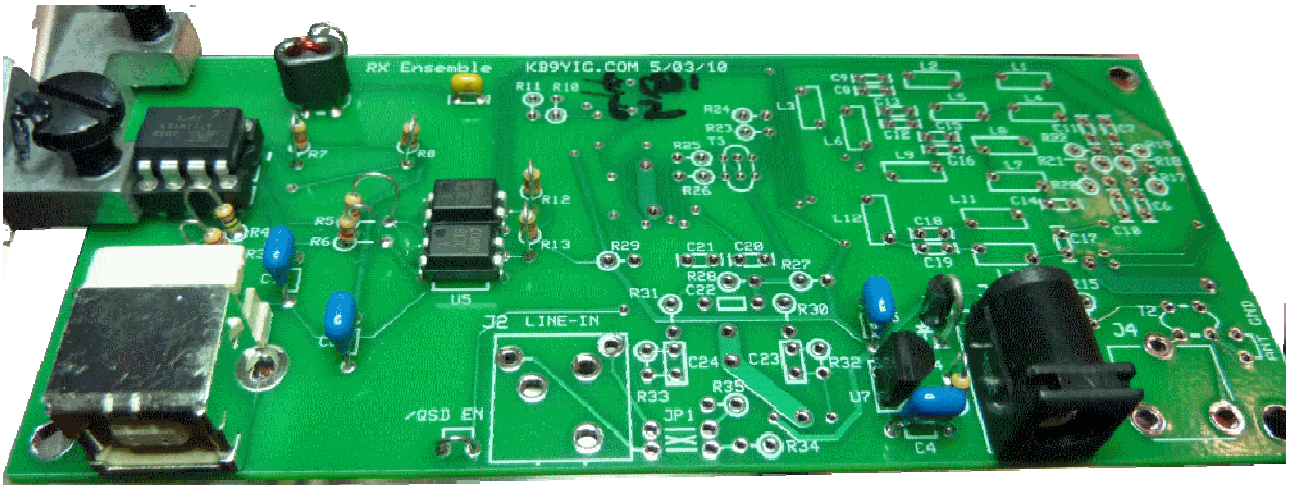
- **Si570 tab**
  set the minimum device frequency to 3MHz (default 6MHz). Although the Si570 will not run below 3.5MHz, the box only accepts integer values
- **LO tab**
  need to change the 'LO:Total' multiply for bands 0 - 3 from the default x4 to x16
- **ABPF tab**
  need to change the filter cross over points to 0.4, 0.8 and 1.6MHz

(TX to Bob G8VOI for the instructions on how to configure the Ensemble RX II Local Oscilklator for LF operation.)

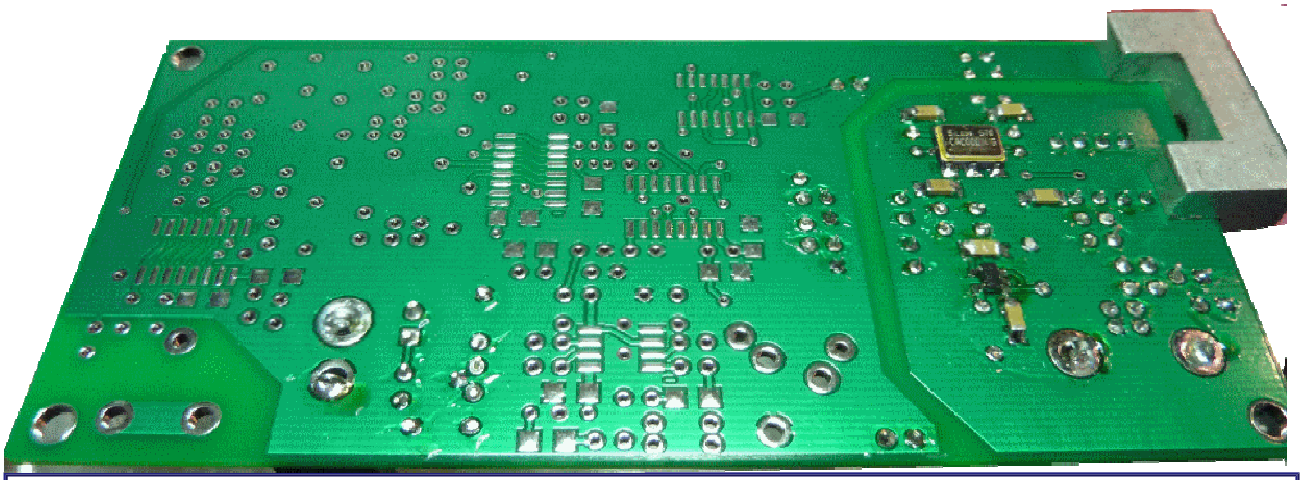
Local Oscillator and Control Completed Stage

(These photos were of an earlier board design. It has changed since the author built the kit upon which these notes are based. The board layout graphics are, however, current.)

Top of the Board



Bottom of the Board



Local Oscillator and Control Testing

Current Draw

Test Setup

Power up the regular circuit side of the board

Measure the current draw on the 12 V power lead (WITHOUT the USB plugged in)

Plug in the USB cable and keep 12V power to the main circuit

Measure the current draw on the 12 V power lead (WITH the USB plugged in). You should get a slightly higher current draw.

Test Measurements

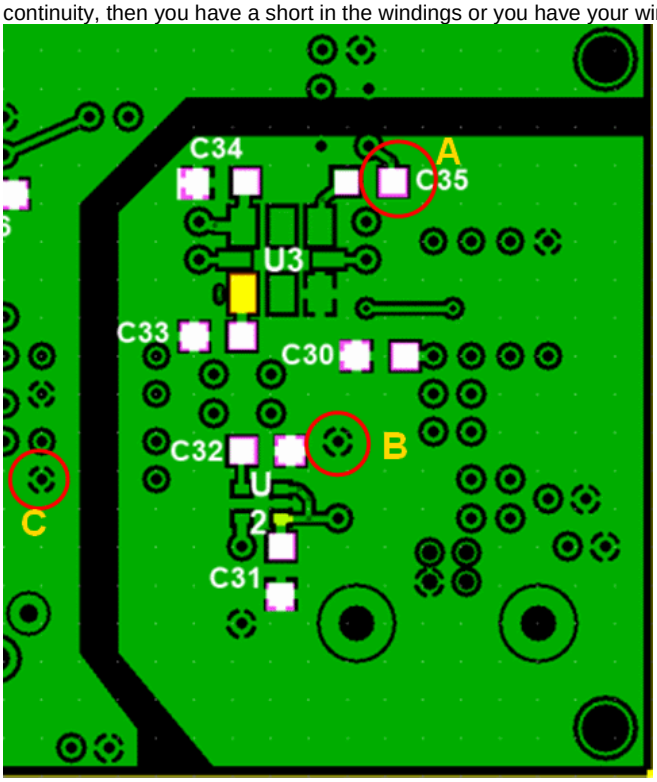
Testpoint	Units	Nominal Value	Author's	Yours
Current Draw - NO USB	mA	< 8	4.3	
Current Draw - USB plugged in	mA	< 9	5.3	

Test T1 Windings

Test Setup

Using an ohmmeter, check for continuity between the right-hand pad for C35 (point marked "A") and the USB ground (point marked "B"). You should get continuity (~ 0 ohms). Then, check for continuity (~ 0 ohms) between the right-hand pad of C35 (point marked "A") and the regular ground (point marked "C"). You should NOT get continuity; if you do get

continuity, then you have a short in the windings or you have your windings crossed.



Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
"A" to "B"	ohms	~0		
"A" to "C"	ohms	~ infinity		

LO Stage Outputs

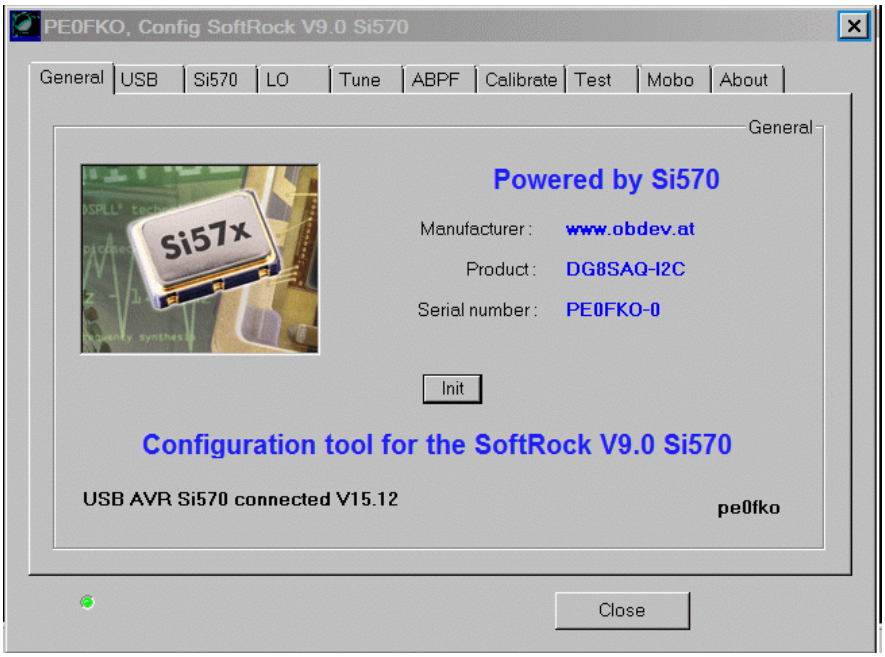
Test Setup

Here we want to measure the output (4x center frequency for dividers). It is measured WRT (regular) ground (at the R9 hairpion lead).

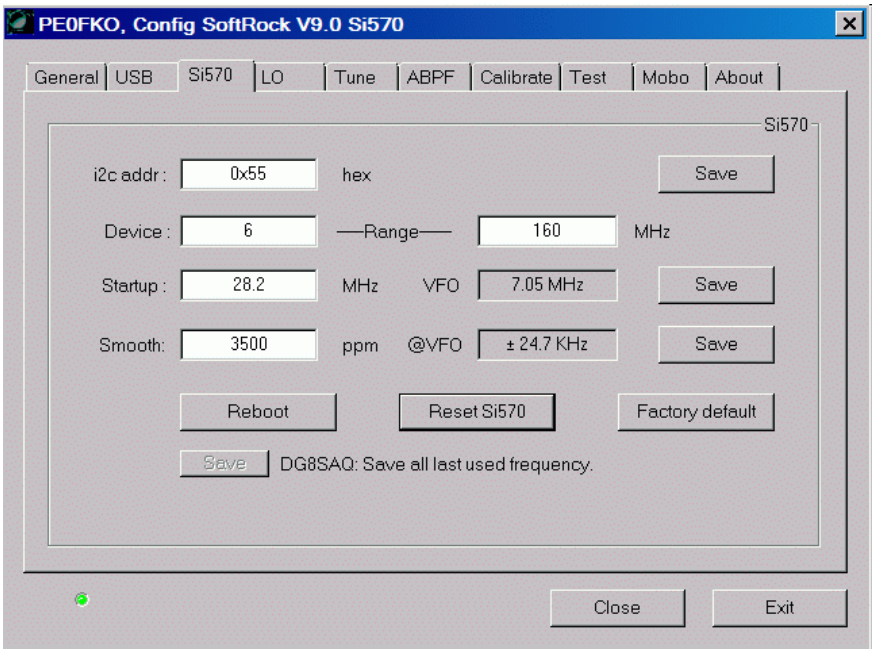
Setup

Be sure all software and drivers, etc., have been installed. Connect the USB jack via USB cable to the PC. You should hear the "BoopBoop" sound the PC makes when it recognizes a device (the Ensemble) has been attached to a USB port..

Next, run CFGSR.exe and you should get the following screen:



Then, check out the "Si570" tab. It should look like this:

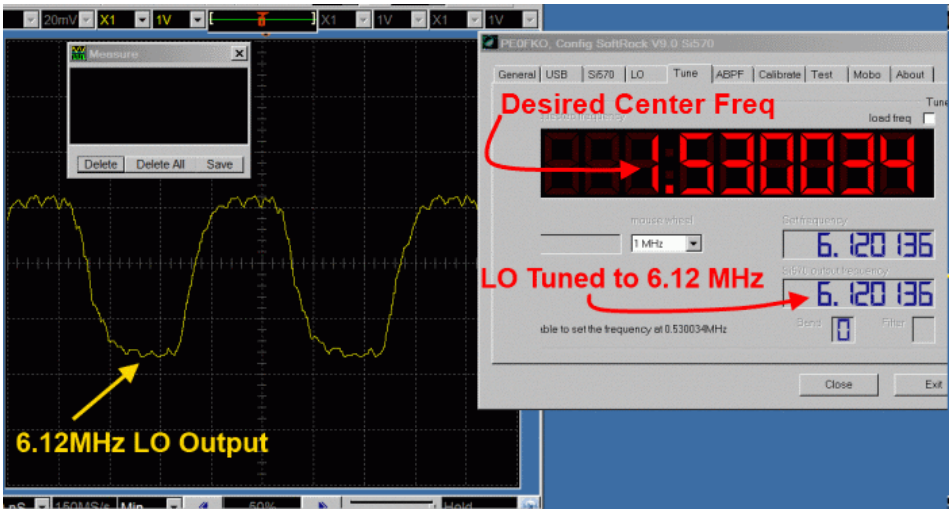


Note that the Local Oscillator's outputs are measured with respect to the analog ground plane, NOT with respect to the galvanically isolated USB groundplane. The /QSD EN shunt is a good point for this ground connection.

Using the CFGSR Software (at the "Tune" tab), test scenarios for setting the center frequency (remember, the Si570 produces a signal that is 4 times the desired center frequency).

Measure the output at the hairpin lead of R9.

Below is an example of tuning the Si570 in CFGSR, selecting a center frerquency of 1.53 MHz (with an Si570 output frequency of 4x, or 6.12MHz. (Pay no attention to the lousy oscilloscope behind the curtains - the output is really a square wave, but the scope is a cheap USB scope that doesn't sample HF square waves very well.)



You can place your mouse on the frequency in the center frequency field and turn your mouse wheel. The center frequency will increase or decrease and the LO Output frequency (4x) will increase or decrease at a rate 4 times that of the center frequency.

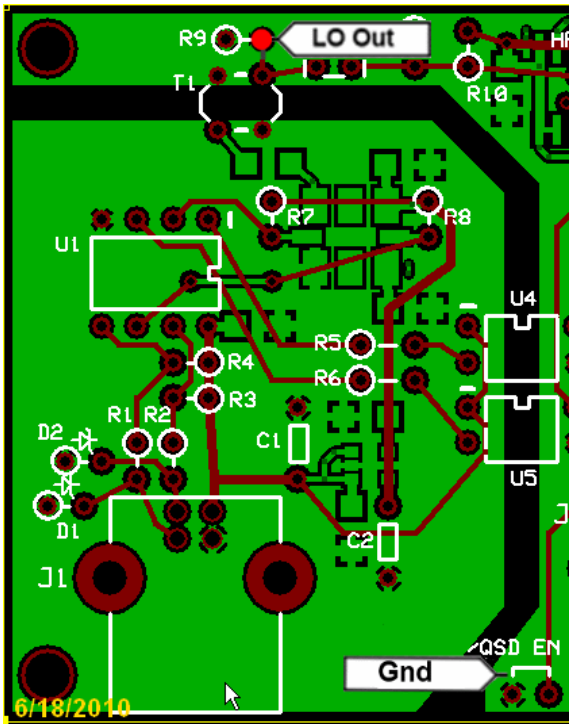
John, KB6QL, discovered this trick for those with no scope, counter, or HF radio to use in testing LO output:

"Turns out that local oscillator can be tuned for a frequency that is in the FM band. So, as a quick and dirty, I got out my little MP3 player-cum-FM-radio and tuned it to that frequency and let the headset cord/ant drape over the RX. It gave me full quieting. Then I switched the RX to another frequency and the quieting was gone."

Troubleshooting Hints

Si570 Does Not Respond to Control Signals

Soldering on the Si570 is the most usual problem with lack of control, providing the USB is properly recognised.



Validate Filter Selection Outputs

Test Setup

Start up CFSR again and tune the local oscillator through four frequencies (each being in the middle of one of the bands):

1. 2MHz
2. 6MHz
3. 12MHz
4. 24MHz

Measure the voltages at "FL SEL 0" (R13 hairpin) and "FL SEL 1" (R12 hairpin) with respect to regular ground

(The high/low values at R12 and R13 are used in the ABPF switching truth table, shown in the Automatic Band Pass Filter stage's introductory paragraphs.

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
R12 (for 2 MHz band 0)	Vdc	0	100 mV	
R12 (for 6 MHz band 1)	Vdc	0	100 mV	
R12 (for 12 MHz band 2)	Vdc	5	4.92	
R12 (for 24 MHz band 3)	Vdc	5	4.92	
R13 (for 2 MHz band 0)	Vdc	0	100 mV	
R13 (for 6 MHz band 1)	Vdc	5	4.92	
R13 (for 12 MHz band 2)	Vdc	0	100 mV	
R13 (for 24 MHz band 3)	Vdc	5	4.92	

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Ensemble RX II 04_Quadrature Clock Generator

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Quadrature Clock Generator Introduction

General

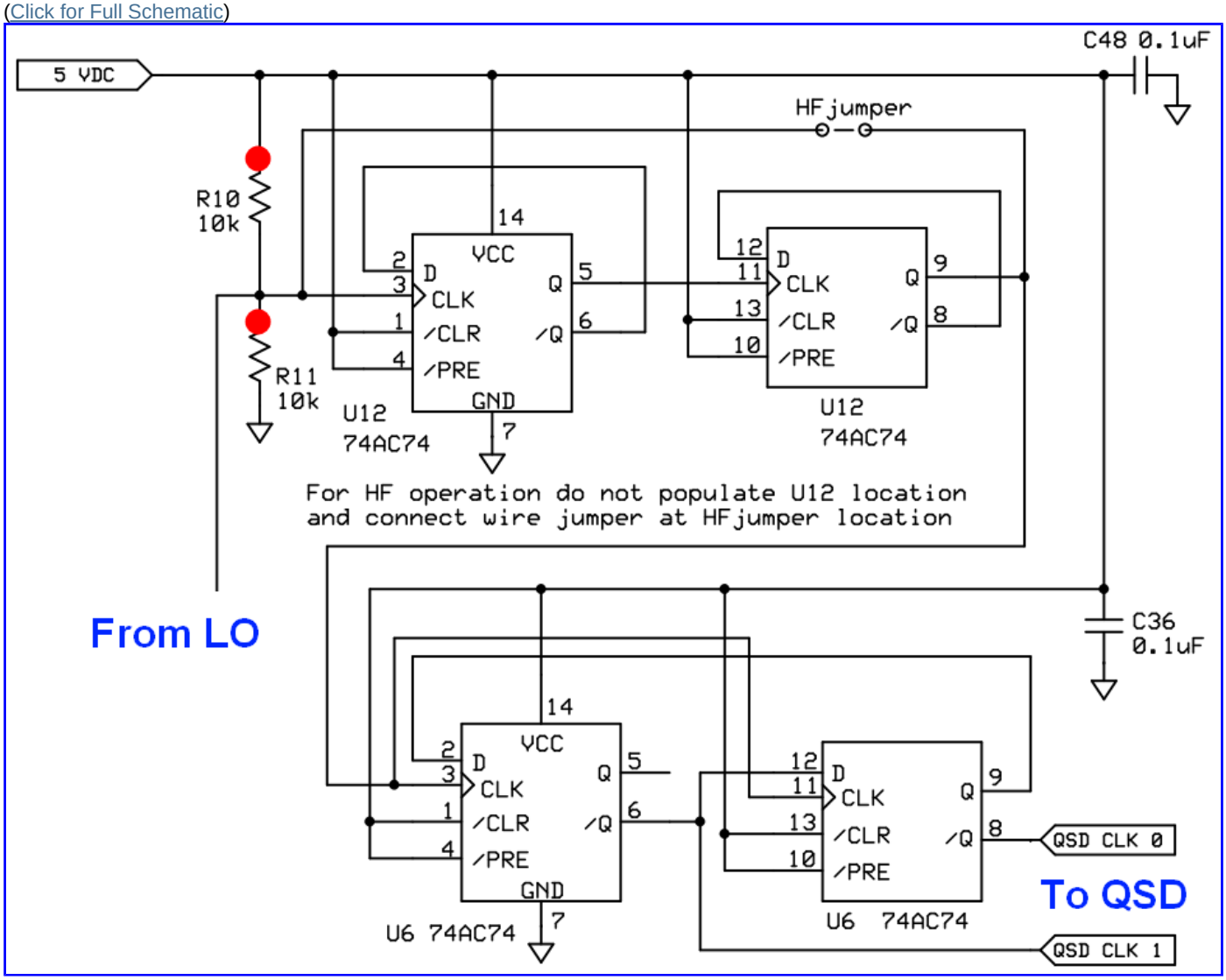
This stage divides the local oscillator output by 4 and shifts the phase of the dividend signals such that they are now one-fourth the LO frequency and 90 degrees separated in phase (i.e., in quadrature). Both signals are identical in all regards except phase. They will be used to clock the switch used in the Quadrature Sampling Detector (QSD) stage.

(go directly to build notes)

Quadrature Clock Generator Schematic

(Resistor testpoints (hairpin, top, or left-hand lead), as physically installed on the board, are marked in the schematic with red dots)

(Click for Full Schematic)



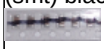
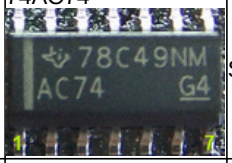
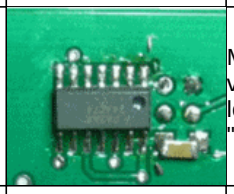
(above schematic has clickable areas that can be used for navigation)

(go directly to build notes)

Quadrature Clock Generator Bill of Materials

Stage Bill of Materials

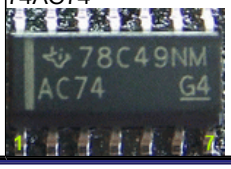
(resistor images and color codes courtesy of WIlfried, DL5SWB's R-Color Code program)

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	C48	band-specific		misc			Quadrature Clock Generator
❑	hf-jmp	band-specific		misc			Quadrature Clock Generator
❑	C36	0.1 uF	(smt) black stripe 	SMT 1206	yellow pads		Quadrature Clock Generator
❑	R10	10 k 1/6W 5%	brn-blk-ora-gld 	1/6W	S-N		Quadrature Clock Generator
❑	R11	10 k 1/6W 5%	brn-blk-ora-gld 	1/6W	N-S		Quadrature Clock Generator
❑	U06	74AC74 Dual D FF	74AC74 	SOIC-14		Markings vary - look for "AC74"	Quadrature Clock Generator
❑	U12	band-specific		misc			Quadrature Clock Generator

Band Specific Items for HF Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	C48	omit for this band		Omit			Quadrature Clock Generator
❑	hf-jmp	shunt wire (cut-off lead)		Cutoff			Quadrature Clock Generator
❑	U12	omit for this band		Omit			Quadrature Clock Generator

Band Specific Items for LF Band

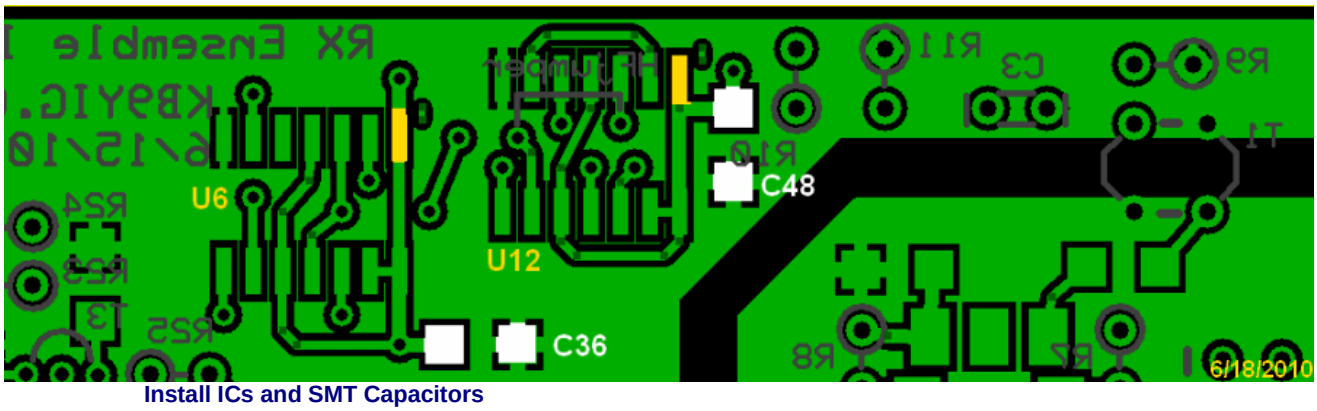
Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	C48	0.1 uF	(smt) black stripe 	SMT 1206			Quadrature Clock Generator
❑	hf-jmp	omit for this band		Omit			Quadrature Clock Generator
❑	U12	74AC74 Dual D FF	74AC74 	SOIC-14			Quadrature Clock Generator

Quadrature Clock Generator Summary Build Notes

- Install Voltage Divider Resistors
- Install ICs and SMT Capacitors
- Install HF Jumper
- Test the Stage

Quadrature Clock Generator Detailed Build Notes

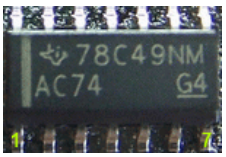
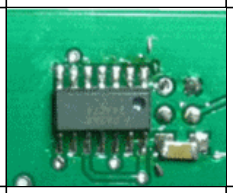
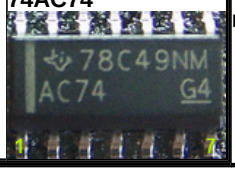
Bottom of the Board



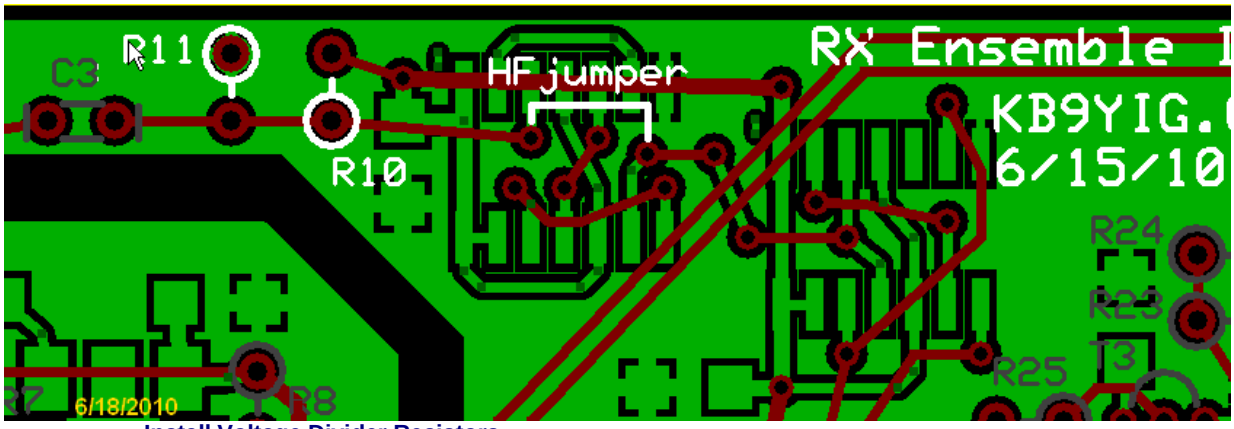
Install ICs and SMT Capacitors

Here, you will install U6 (to get a divide-by-4) and, if building the LF option, U12 (to get a divide-by-16); also installed will be the appropriate SMT bypass capacitors.

U6 is required for both HF and LF options; U12 is only needed for the LF option. Watch out for the potential to install U6 in the wrong set of pads!

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	C48	band-specific	Band: HF — Component: omit for this band (Omit); Band: LF — Component: 0.1 uF (SMT 1206) — Marking: (smt) black stripe 	misc		
❑	C36	0.1 uF	(smt) black stripe 	SMT 1206	yellow pads	
❑	U06	74AC74 Dual D FF	74AC74 	SOIC-14		Take [p] precau Markii vary - for "A
❑	U12	band-specific	Band: HF — Component: omit for this band (Omit); Band: LF — Component: 74AC74 Dual D FF (SOIC-14) — Marking: 74AC74 	misc		

Top of the Board



Install Voltage Divider Resistors

Pay careful attention to the orientation (S-N and N-S, respectively) of R10 and R11. Some builders have inadvertently installed these with a horizontal orientation rather than a vertical orientation.

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	R10	10 k 1/6W 5%	brn-blk-ora-gld	1/6W	S-N	
❑	R11	10 k 1/6W 5%	brn-blk-ora-gld	1/6W	N-S	

Install HF Jumper

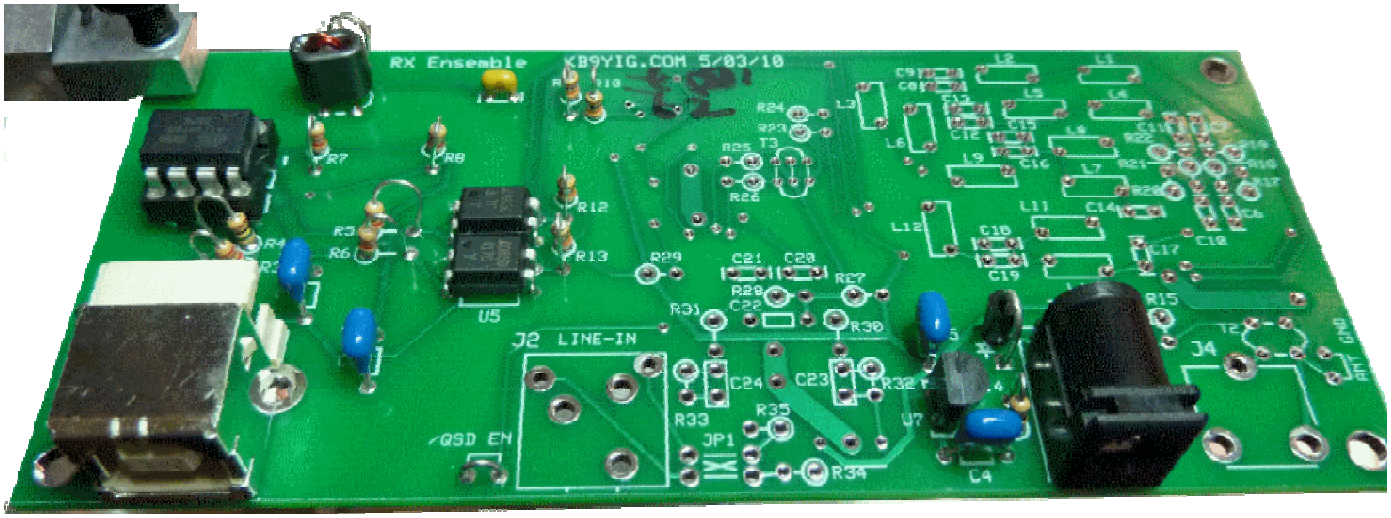
If building the HF option, omit U12 and Install the jumper wire to bypass U12 with the LO signal

Check	Designation	Component	Marking			Category	Orientation	Notes
			Band	Component	Marking			
❑	hf-jmp	band-specific	HF	shunt wire (cut-off lead) (Cutoff)		misc		
			LF	omit for this band (Omit)				

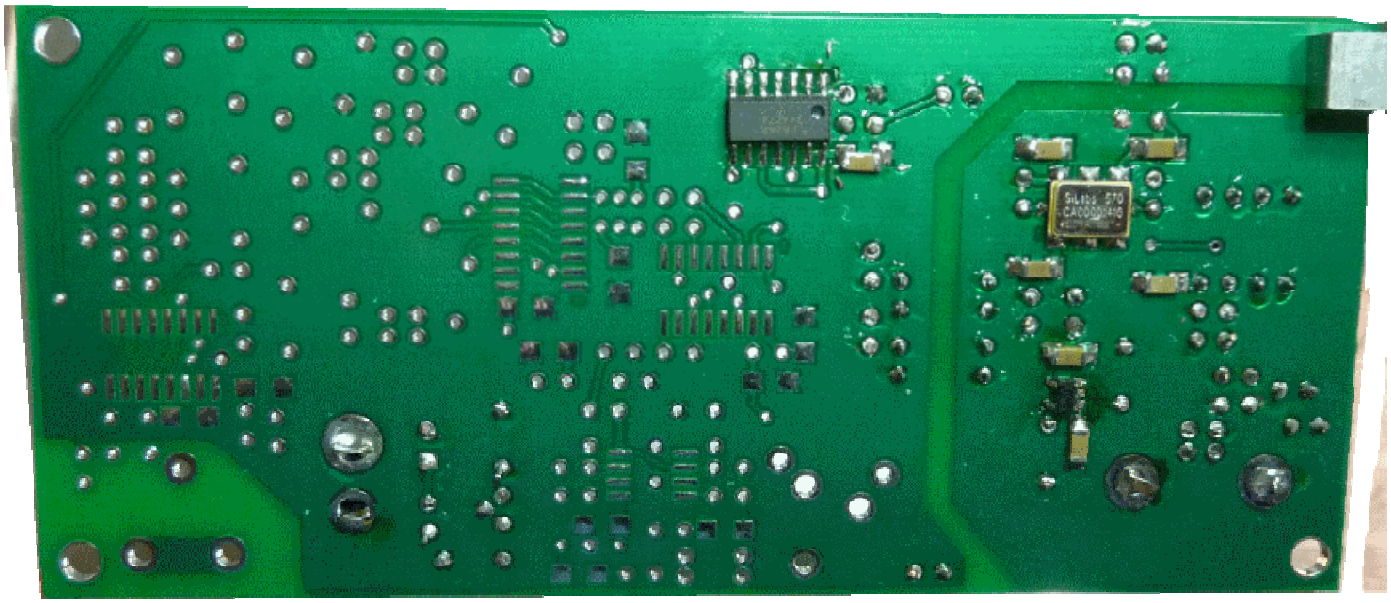
Quadrature Clock Generator Completed Stage

(These photos were of an earlier board design. It has changed since the author built the kit upon which these notes are based. The board layout graphics are, however, current.)

Top of the Board



Bottom of the Board



Quadrature Clock Generator Testing

Current Draw

Test Setup

With both the USB cable and the power cable plugged in, measure the current draw in the positive power lead.

Measure the current draw with just the 12V power.

Note: the current draw will be slightly higher if you installed U12 as part of an LF option build

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
Current draw WITH USB	mA	< 18	9.8	
Current draw NO USB	mA	< 20	13.7	

Test Voltage Divider

Test Setup

When performing the following tests, you must apply [pwer to the board AND plug in the USB cable. Otherwise, results will not be as expected.

Plug in USB and power the board.

Measure the voltage on the R11 hairpin; you should see 50% of the %v rail voltage.

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
R11 hairpin (WRT regular gnd)	V dc	2.5	2.46	

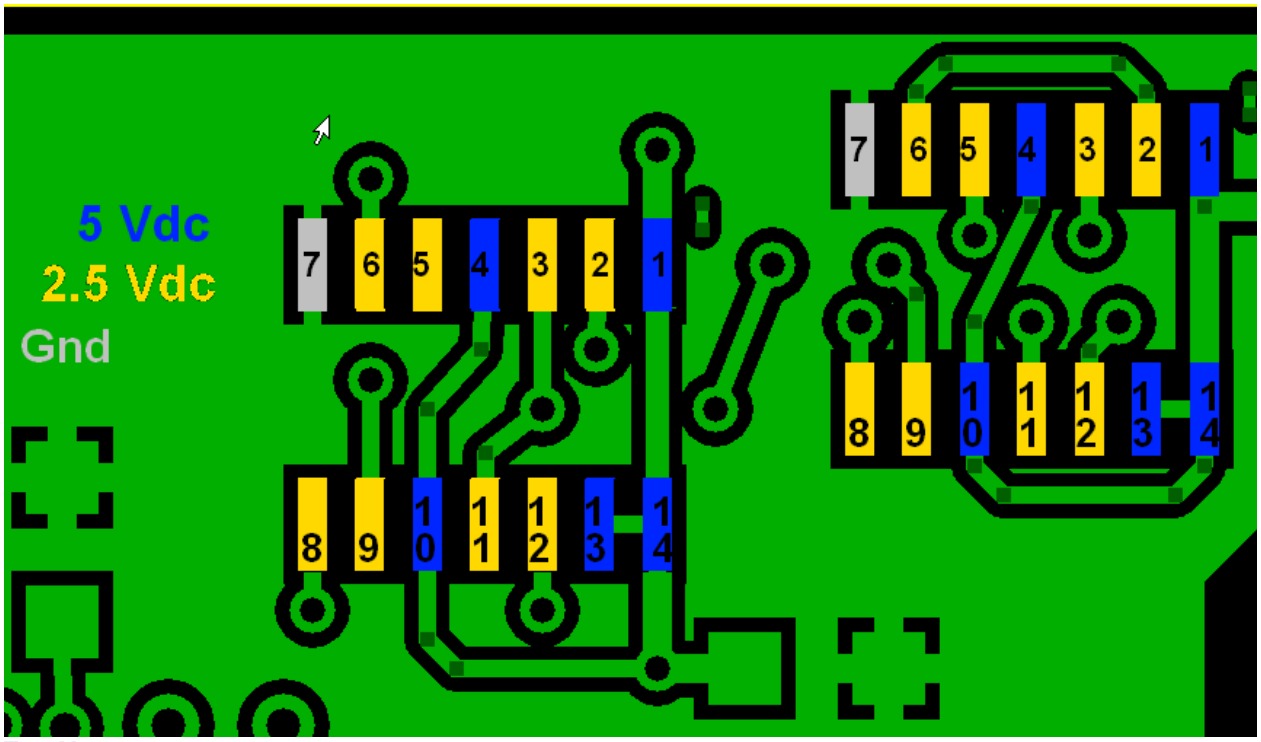
Divider Pin Voltages

Test Setup

Power USB and 12V. Then measure the voltages on the pins (and, separately, on the pads) of U6 (74AC74). Refer to the color codes on the graphic for the voltages.

Pins 3 and 11 will not show exactly 2.5Vdc because they have the additional AC component of the local oscillator signal from C3.

If you are building the LF option, you should perform this test on both U12 and U6; otherwise, just test U6.



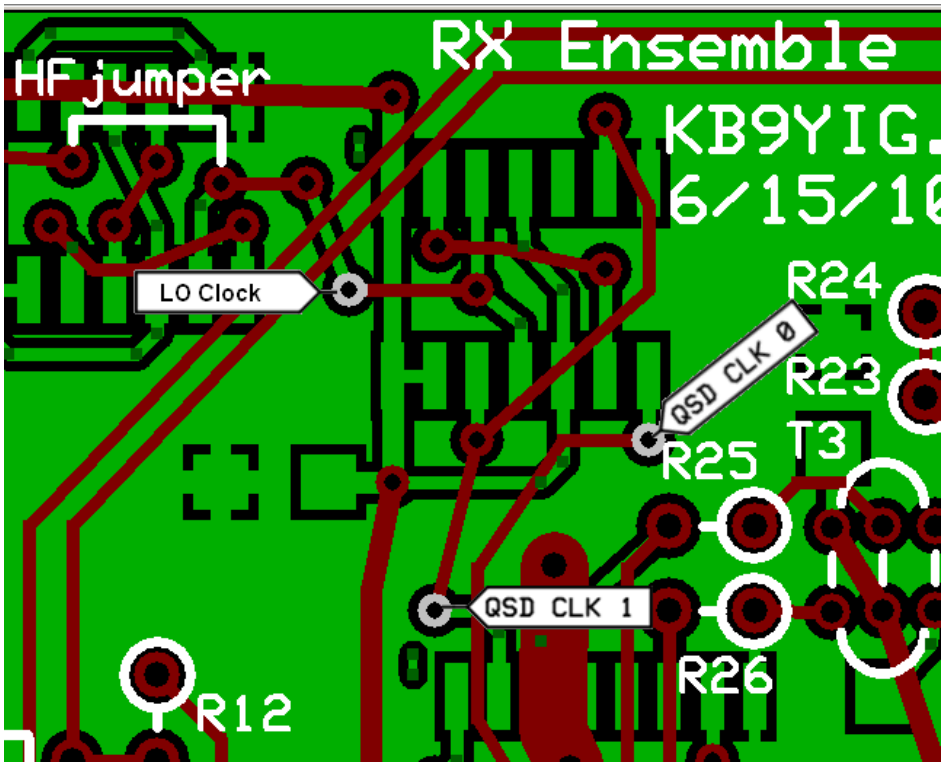
Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
Pin 1	Vdc	5	4.92	
Pin 2	Vdc	2.5	2.45	
Pin 3	Vdc	2 to 3	2.46	
Pin 4	Vdc	5	4.92	
Pin 5	Vdc	2.5	2.45	
Pin 6	Vdc	2.5	2.45	
Pin 7	Vdc	0 (GND)	0	
Pin 8	Vdc	2.5	2.45	
Pin 9	Vdc	2.5	2.45	
Pin 10	Vdc	5	4.92	
Pin 11	Vdc	2.5	2.46	
Pin 12	Vdc	2 - 3	2.45	
Pin 13	Vdc	5	4.92	
Pin 14	Vdc	5	4.92	

Quadrature Colck Generated Waveforms

Test Setup

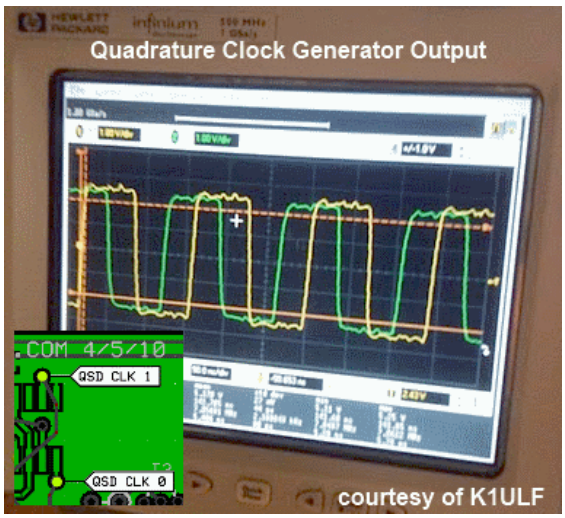
Set your board up to oscillate at a selected center frequency, e.g., 7.100 MHz.



If you have a dual trace scope available, probe the two "QSD CLK (n)" test points and you should get a waveform similar to the one shown here.

The testpoint marked "LO Clock" will provide the Si570's output frequency or, in the case of the LF option, that frequency divided by 4 (courtesy of U12).

Your mileage may vary, depending upon the desired center frequency you select and the quality of your scope (some scopes tend to have issues with these square waves - still, the scope should show two waveforms in quadrature at the desired center frequency).



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Ensemble RX II 05_Auto Band Pass Filters

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Auto Band Pass Filters Introduction

General

This stage implements the automatic bandpass filtering circuit. The circuit uses two quad multiplexer switches to switch one of four bandpass filters into the QSD input. The filters provide continuous coverage, in four "chunks", from 1.8MHa through 30 MHz in the HF option and 0.180 MHz to 3.0 MHz in the LF option (with some under and overlaps).

Switching is automatic, via the two binary signals, "FL SEL 0" and "FL SEL 1". The ATTiny 85 Microcontroller has a built-in band plan (which the user can adjust, using the facilities in the CFGSR program) which associates any output frequency of the Local Oscillator to the most appropriate filter and issues the corresponding bits to "FL SEL 0" and "FL SEL 1", per the following truth table:

Filter Selection Truth Table

(Frequencies in the Low/High columns are given for the HF option, with the frequencies for the LF option shown inside of parentheses)

Sel 1 (R12)	Sel 0 (R13)	Band	Low HF (LF) MHz	High HF (LF) MHz
L	L	0	1 (0.180)	4 (0.480)
L	H	1	4 (0.400)	8 (0.800)
H	L	2	8 (0.800)	16 (1.6)
H	H	3	16 (1.6)	30 (3.0)

(SEL-0 is at the hairpin lead of R13; SEL-1 is at the hairpin lead of R12)

These notes detail the construction of each of the four bandpass filters, with a simple continuity test at the end of each filter's construction to verify soldering of the leads of the coils.

If you are unfamiliar with toroid and binocular inductor construction, please see the WB5RVZ Construction hints for inductors.

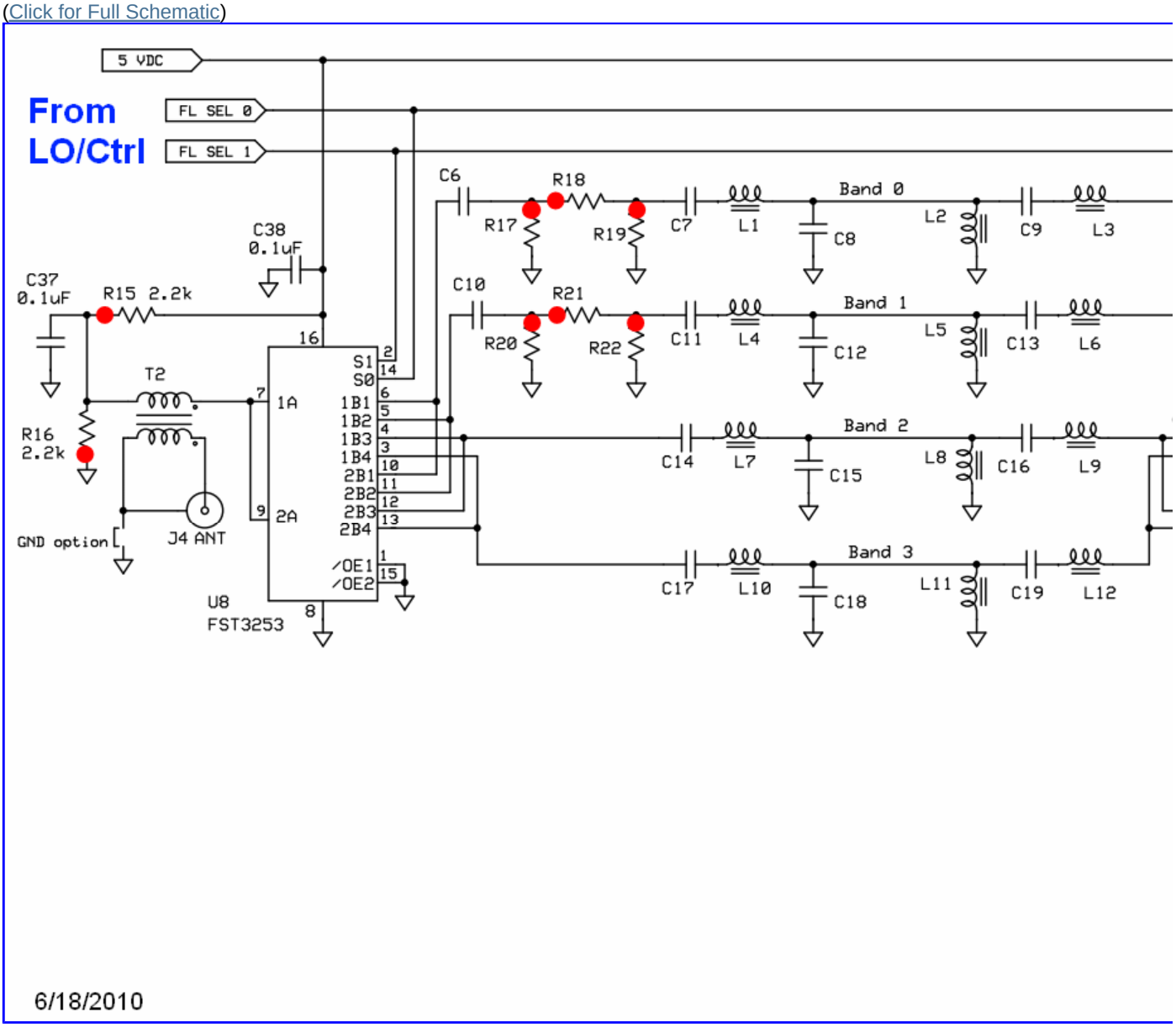
(Note: completed photos of this and the next stage were, unfortunately not taken at stage-end. The completed photos shown are from the final stage, with the uninstalled sections photoshopped out. Apologies.)

(go directly to build notes)

Auto Band Pass Filters Schematic

(Resistor testpoints (hairpin, top, or left-hand lead), as physically installed on the board, are marked in the schematic with red dots)

(Click for Full Schematic)



(above schematic has clickable areas that can be used for navigation)

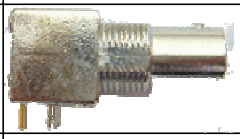
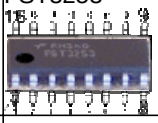
(go directly to build notes)

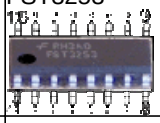
Auto Band Pass Filters Bill of Materials

Stage Bill of Materials

(resistor images and color codes courtesy of WIlfried, DL5SWB's R-Color Code program)

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	magwire_165in	Magnetic Wire, enameled #30		Magnetic		50 inches #30	Auto Band Pass Filters
❑	magwire_47in	Magnetic Wire, enameled #30		Magnetic		19 inches #24	Auto Band Pass Filters
❑	magwire_67in	Magnetic Wire, enameled #30		Magnetic		24 inches #24	Auto Band Pass Filters

❑	magwire_90in	Magnetic Wire, enameled #30		Magnetic		24 inches #30	Auto Band Pass Filters
❑	R23	2.2k 1/6W 5%	red-red-red-gld 	1/6W	W-E		Auto Band Pass Filters
❑	J04	BNC Connector Male - PCB mount		Jack			Auto Band Pass Filters
❑	L01	band-specific		misc			Auto Band Pass Filters
❑	L01-core	band-specific		misc			Auto Band Pass Filters
❑	L04-core	T30-2 toroid core	red 	Toroid			Auto Band Pass Filters
❑	L07	band-specific		misc			Auto Band Pass Filters
❑	L07-core	band-specific		misc			Auto Band Pass Filters
❑	L10	band-specific		misc			Auto Band Pass Filters
❑	L10-core	band-specific		misc			Auto Band Pass Filters
❑	T02	band-specific		misc			Auto Band Pass Filters
❑	U08	FST3253 mux/demux switch	FST3253 	SOIC-16			Auto Band Pass Filters
❑	L02	band-specific		misc			Auto Band Pass Filters
❑	L02-core	band-specific		misc			Auto Band Pass Filters
❑	L05	band-specific		misc			Auto Band Pass Filters
❑	L05-core	T30-2 toroid core	red 	Toroid			Auto Band Pass Filters
❑	L08	band-specific		misc			Auto Band

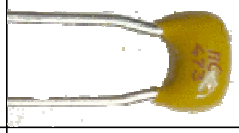
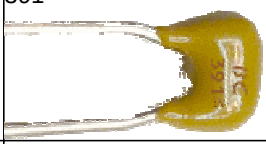
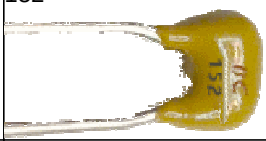
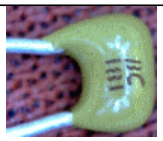
							Pass Filters
❑	L08-core	band-specific		misc			Auto Band Pass Filters
❑	L11	band-specific		misc			Auto Band Pass Filters
❑	L11-core	band-specific		misc			Auto Band Pass Filters
❑	T02-core	BN-43-2402 (no markings!)	none 	Binocular core			Auto Band Pass Filters
❑	U09	FST3253 mux/demux switch	FST3253 	SOIC-16			Auto Band Pass Filters
❑	L03	band-specific		misc			Auto Band Pass Filters
❑	L03-core	band-specific		misc			Auto Band Pass Filters
❑	L04	band-specific		misc			Auto Band Pass Filters
❑	L06	band-specific		misc			Auto Band Pass Filters
❑	L06-core	T30-2 toroid core	red 	Toroid			Auto Band Pass Filters
❑	L09	band-specific		misc			Auto Band Pass Filters
❑	L09-core	band-specific		misc			Auto Band Pass Filters
❑	L12	band-specific		misc			Auto Band Pass Filters
❑	L12-core	band-specific		misc			Auto Band Pass Filters
❑	T03	band-specific		misc			Auto Band Pass Filters
❑	C37	0.1 uF	(smt) black stripe 	SMT 1206	white pads		Auto Band Pass Filters
❑	C06	band-specific		misc	vert	(jumper for LF)	Auto Band

							Pass Filters
❑	C10	band-specific		misc	vert	(jumper for LF)	Auto Band Pass Filters
❑	C14	band-specific		misc	horiz		Auto Band Pass Filters
❑	C17	band-specific		misc	vert		Auto Band Pass Filters
❑	T03-core	BN-43-2402 (no markings!)	none 	Binocular core			Auto Band Pass Filters
❑	C38	0.1 uF	(smt) black stripe 	SMT 1206	yellow pads		Auto Band Pass Filters
❑	C07	band-specific		misc	vert		Auto Band Pass Filters
❑	C11	band-specific		misc	vert		Auto Band Pass Filters
❑	C15	band-specific		misc	horiz		Auto Band Pass Filters
❑	C18	band-specific		misc	horiz		Auto Band Pass Filters
❑	C39	0.1 uF	(smt) black stripe 	SMT 1206	yellow pads		Auto Band Pass Filters
❑	R15	2.2k 1/6W 5%	red-red-red-gld 	1/6W	N-S		Auto Band Pass Filters
❑	C08	band-specific		misc	horiz		Auto Band Pass Filters
❑	C12	band-specific		misc	horiz		Auto Band Pass Filters
❑	C16	band-specific		misc	horiz		Auto Band Pass Filters
❑	C19	band-specific		misc	horiz		Auto Band Pass Filters
❑	C40	0.1 uF	(smt) black stripe 	SMT 1206	yellow pads		Auto Band Pass Filters
❑	R16	2.2k 1/6W 5%	red-red-red-gld	1/6W	N-S		Auto Band

							Pass Filters
❑	C09	band-specific		misc	horiz		Auto Band Pass Filters
❑	C13	band-specific		misc	horiz		Auto Band Pass Filters
❑	C41	0.1 uF	(smt) black stripe 	SMT 1206	white pads		Auto Band Pass Filters
❑	R24	2.2k 1/6W 5%	red-red-red-gld 	1/6W	W-E		Auto Band Pass Filters
❑	R17	band-specific		misc	S-N		Auto Band Pass Filters
❑	R20	band-specific		misc	S-N		Auto Band Pass Filters
❑	C42	0.1 uF	(smt) black stripe 	SMT 1206	yellow pads		Auto Band Pass Filters
❑	R25	10 ohm 1/4W 1%	br-blk-blk-gld-br 	1/4W	E-W		Auto Band Pass Filters
❑	R18	band-specific		misc	N-S	(jumper for LF)	Auto Band Pass Filters
❑	R21	band-specific		misc	N-S	(jumper for LF)	Auto Band Pass Filters
❑	R26	10 ohm 1/4W 1%	br-blk-blk-gld-br 	1/4W	E-W		Auto Band Pass Filters
❑	R19	band-specific		misc	E-W		Auto Band Pass Filters
❑	R22	band-specific		misc	W-E		Auto Band Pass Filters
❑	R27	2.2k 1/6W 5%	red-red-red-gld 	1/6W			Auto Band Pass Filters
❑	R28	2.2k 1/6W 5%	red-red-red-gld 	1/6W			Auto Band Pass Filters

Band Specific Items for HF Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit

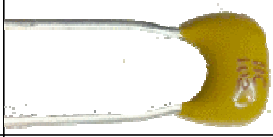
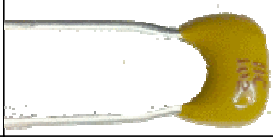
❑	C06	0.047 uF 5%	473 	Ceramic	vert	(jumper for LF)	Auto Band Pass Filters
❑	C07	680 pF 5%	681 	Ceramic	vert		Auto Band Pass Filters
❑	C08	1500 pF 10%	152 	Ceramic	horiz		Auto Band Pass Filters
❑	C09	680 pF 5%	681 	Ceramic	horiz		Auto Band Pass Filters
❑	C10	0.047 uF 5%	473 	Ceramic	vert	(jumper for LF)	Auto Band Pass Filters
❑	C11	390 pF 5%	391 	Ceramic	vert		Auto Band Pass Filters
❑	C12	1500 pF 10%	152 	Ceramic	horiz		Auto Band Pass Filters
❑	C13	390 pF 5%	391 	Ceramic	horiz		Auto Band Pass Filters
❑	C14	180 pF 5%	 181	Ceramic	horiz		Auto Band Pass Filters
❑	C15	680 pF 5%	681 	Ceramic	horiz		Auto Band Pass Filters
❑	C16	180 pF 5%	 181	Ceramic	horiz		Auto Band Pass Filters
❑	C17	100 pF 5%	 101	Ceramic	vert		Auto Band Pass Filters

❑	C18	390 pF 5%	391 	Ceramic	horiz		Auto Band Pass Filters
❑	C19	100 pF 5%	101 	Ceramic	horiz		Auto Band Pass Filters
❑	L01	5.5uH: 35T #30 (20in) on T30-2 (red)	red 	coil			Auto Band Pass Filters
❑	L01-core	T30-2 toroid core	red 	Toroid			Auto Band Pass Filters
❑	L02	2.6uH: 24T #30 (15in) on T30-2 (red)	red 	coil			Auto Band Pass Filters
❑	L02-core	T30-2 toroid core	red 	Toroid			Auto Band Pass Filters
❑	L03	5.5uH: 35T #30 (20in) on T30-2 (red)	red 	coil			Auto Band Pass Filters
❑	L03-core	T30-2 toroid core	red 	Toroid			Auto Band Pass Filters
❑	L04	2uH: 21T #30 (13in) on T30-2 (red)	red 	Coil			Auto Band Pass Filters
❑	L05	0.46uH: 10T #30 (8in) on T30-2 (red)	red 	coil			Auto Band Pass Filters
❑	L06	2uH: 21T #30 (13in) on T30-2 (red)	red 	Coil			Auto Band Pass Filters
❑	L07	1uH: 19T #30(9in) on T25-6(yel)	yellow 	coil			Auto Band Pass Filters
❑	L07-core	T25-6 toroid core	yellow 	Toroid			Auto Band Pass Filters
❑	L08	0.27 uH: 10T #30 (6") on T25-6 core	yellow 	coil			Auto Band Pass Filters
❑	L08-core	T25-6 toroid core	yellow 	Toroid			Auto Band Pass Filters
❑	L09	1uH: 19T #30(9in) on T25-6(yel)	yellow 	coil			Auto Band Pass Filters

❑	L09-core	T25-6 toroid core	yellow 	Toroid			Auto Band Pass Filters
❑	L10	0.46 uH: 13T #30 (7") on T25-6 core	yellow 	coil			Auto Band Pass Filters
❑	L10-core	T25-6 toroid core	yellow 	Toroid			Auto Band Pass Filters
❑	L11	0.13 uH: 7T #30 (5") on T25-6 core	yellow 	coil			Auto Band Pass Filters
❑	L11-core	T25-6 toroid core	yellow 	Toroid			Auto Band Pass Filters
❑	L12	0.46 uH: 13T #30 (7") on T25-6 core	yellow 	coil			Auto Band Pass Filters
❑	L12-core	T25-6 toroid core	yellow 	Toroid			Auto Band Pass Filters
❑	R17	75 1/6W 5%	vio-grn-blk-gld 	1/6W	S-N		Auto Band Pass Filters
❑	R18	120 1/6W 5%	brn-red-brn-gld 	1/6W	N-S	(jumper for LF)	Auto Band Pass Filters
❑	R19	75 1/6W 5%	vio-grn-blk-gld 	1/6W	E-W		Auto Band Pass Filters
❑	R20	75 1/6W 5%	vio-grn-blk-gld 	1/6W	S-N		Auto Band Pass Filters
❑	R21	120 1/6W 5%	brn-red-brn-gld 	1/6W	N-S	(jumper for LF)	Auto Band Pass Filters
❑	R22	75 1/6W 5%	vio-grn-blk-gld 	1/6W	W-E		Auto Band Pass Filters
❑	T02	23.04uH: 4T(bi)T #30(12 (2x6)in) on BN43-2402		xfrmr			Auto Band Pass Filters
❑	T03	23.04uH: 4T/2T (bi)T #30(12 (6/2x3)in) on BN43-2402		xfrmr			Auto Band Pass Filters

Band Specific Items for LF Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	C06	shunt wire (cut-off lead)		Cutoff	vert	(jumper for LF)	Auto Band Pass Filters
❑	C07	6800 pF 5%	682	Ceramic	vert		Auto Band

							Pass Filters
❑	C08	0.015 uF 5%	153	Ceramic	horiz		Auto Band Pass Filters
❑	C09	6800 pF 5%	682	Ceramic	horiz		Auto Band Pass Filters
❑	C10	shunt wire (cut-off lead)		Cutoff	vert	(jumper for LF)	Auto Band Pass Filters
❑	C11	3300 pF 5%	332	Ceramic	vert		Auto Band Pass Filters
❑	C12	0.015 uF 5%	153	Ceramic	horiz		Auto Band Pass Filters
❑	C13	3300 pF 5%	332	Ceramic	horiz		Auto Band Pass Filters
❑	C14	1800 pF 5%	182	Ceramic	horiz		Auto Band Pass Filters
❑	C15	6800 pF 5%	682	Ceramic	horiz		Auto Band Pass Filters
❑	C16	1800 pF 5%	182	Ceramic	horiz		Auto Band Pass Filters
❑	C17	1000 pF 5%	102 	Ceramic	vert		Auto Band Pass Filters
❑	C18	3300 pF 5%	332	Ceramic	horiz		Auto Band Pass Filters
❑	C19	1000 pF 5%	102 	Ceramic	horiz		Auto Band Pass Filters
❑	L01	55uH: 117T #30 (61in) on T37-2 (red)	 red	coil			Auto Band Pass Filters
❑	L01-core	T37-2 toroid core	 red	Toroid			Auto Band Pass Filters
❑	L02	26uH: 80T #30 (43in) on T37-2 (red)	 red	coil			Auto Band Pass Filters

❑	L02-core	T37-2 toroid core	red 	Toroid			Auto Band Pass Filters
❑	L03	55uH: 117T #30 (61in) on T37-2 (red)	red 	coil			Auto Band Pass Filters
❑	L03-core	T37-2 toroid core	red 	Toroid			Auto Band Pass Filters
❑	L04	20uH: 68T #30 (36in) on T30-2 (red)	red 	coil			Auto Band Pass Filters
❑	L05	4.6uH: 32T #30 (18in) on T30-2 (red)	red 	coil			Auto Band Pass Filters
❑	L06	20uH: 68T #30 (36in) on T30-2 (red)	red 	coil			Auto Band Pass Filters
❑	L07	10uH: 48T #30 (26in) on T30-2 (red)	red 	coil			Auto Band Pass Filters
❑	L07-core	T30-2 toroid core	red 	Toroid			Auto Band Pass Filters
❑	L08	2.7uH: 25T #30 (15in) on T30-2 (red)	red 	coil			Auto Band Pass Filters
❑	L08-core	T30-2 toroid core	red 	Toroid			Auto Band Pass Filters
❑	L09	10uH: 48T #30 (26in) on T30-2 (red)	red 	coil			Auto Band Pass Filters
❑	L09-core	T30-2 toroid core	red 	Toroid			Auto Band Pass Filters
❑	L10	4.6uH: 32T #30 (18in) on T30-2 (red)	red 	coil			Auto Band Pass Filters
❑	L10-core	T30-2 toroid core	red 	Toroid			Auto Band Pass Filters
❑	L11	1.3uH: 17T #30 (11in) on T30-2 (red)	red 	coil			Auto Band Pass Filters
❑	L11-core	T30-2 toroid core	red 	Toroid			Auto Band Pass Filters
❑	L12	4.6uH: 32T #30 (18in) on T30-2 (red)	red 	coil			Auto Band Pass Filters

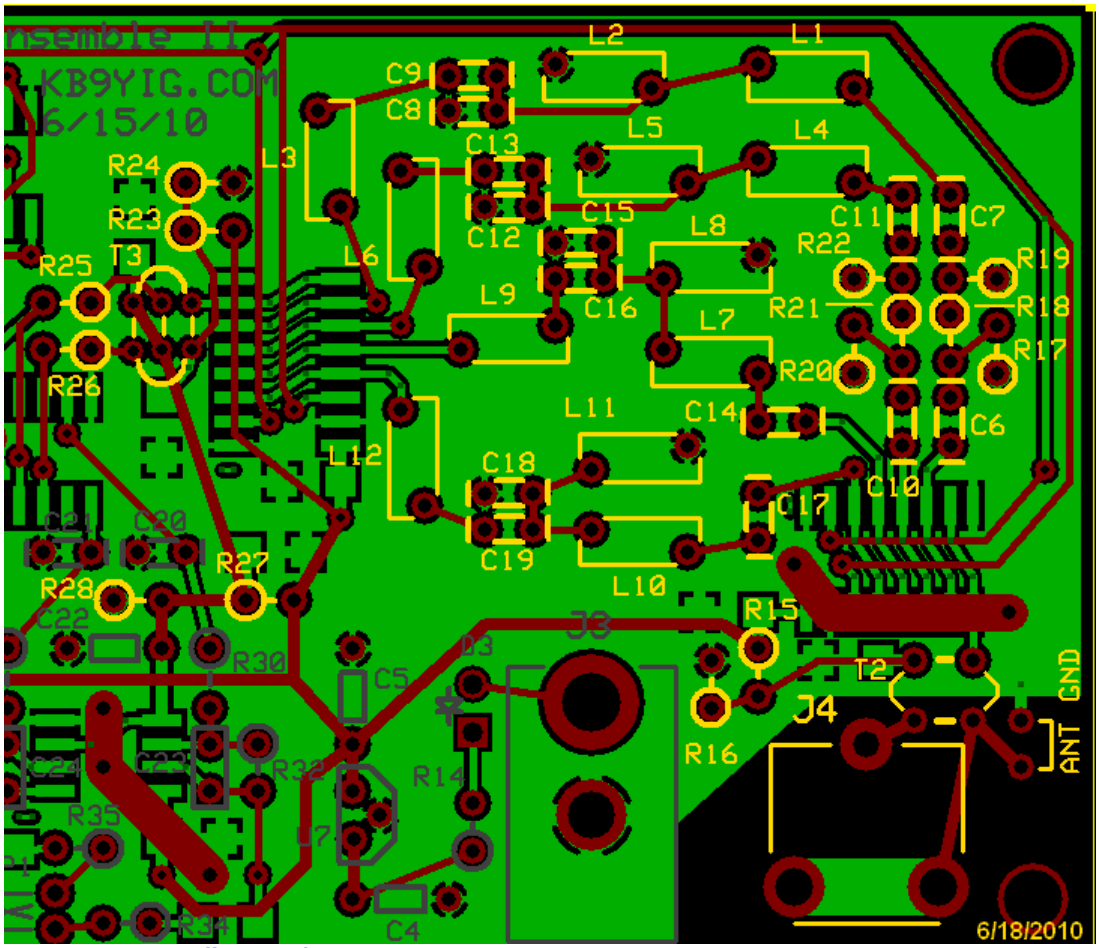
❑	L12-core	T30-2 toroid core	red 	Toroid			Auto Band Pass Filters
❑	R17	omit for this band		Omit	S-N		Auto Band Pass Filters
❑	R18	shunt wire (cut-off lead)		Cutoff	N-S	(jumper for LF)	Auto Band Pass Filters
❑	R19	omit for this band		Omit	E-W		Auto Band Pass Filters
❑	R20	omit for this band		Omit	S-N		Auto Band Pass Filters
❑	R21	shunt wire (cut-off lead)		Cutoff	N-S	(jumper for LF)	Auto Band Pass Filters
❑	R22	omit for this band		Omit	W-E		Auto Band Pass Filters
❑	T02	70.56uH: 7T(bi)T #30(16 (2x8)in) on BN43-2402		xfrmr			Auto Band Pass Filters
❑	T03	70.56uH: 7T/3T (bi)T #30(18 (8/2x5)in) on BN43-2402		xfrmr			Auto Band Pass Filters

Auto Band Pass Filters Summary Build Notes

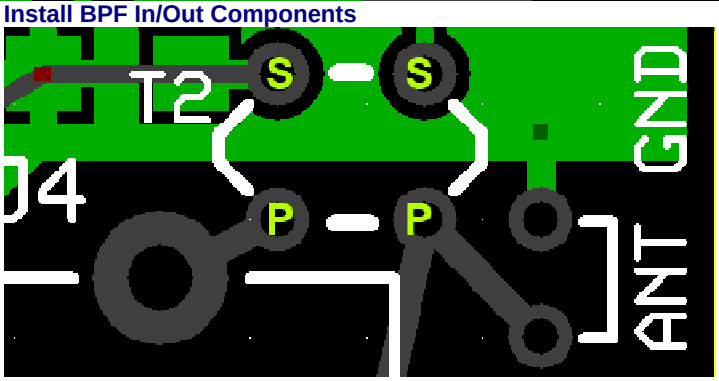
- Install BPF In/Out Components
- Install and Continuity Test the Band 0 BPF
- Install the Band 0 Inductors
- Install the Band 0 Static Components
- Install and Continuity Test the Band 1 BPF
- Install the Band 1 Inductors
- Install the Band 1 Static Components
- Install and Continuity Test the Band 2 BPF
- Install the Band 2 Inductors
- Install the Band 2 Static Components
- Install and Continuity Test the Band 3 BPF
- Install the Band 3 Inductors
- Install the Band 3 Static Components
- Install Bottomside Components
- Install Antenna Jack
- Test the Stage

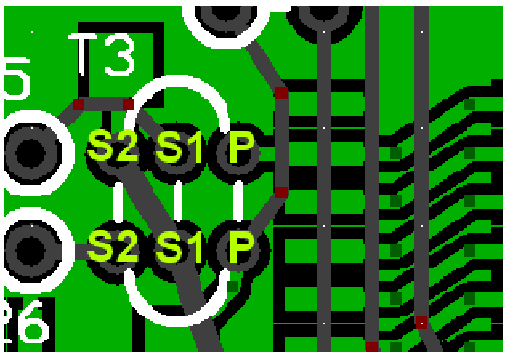
Auto Band Pass Filters Detailed Build Notes

Top of the Board

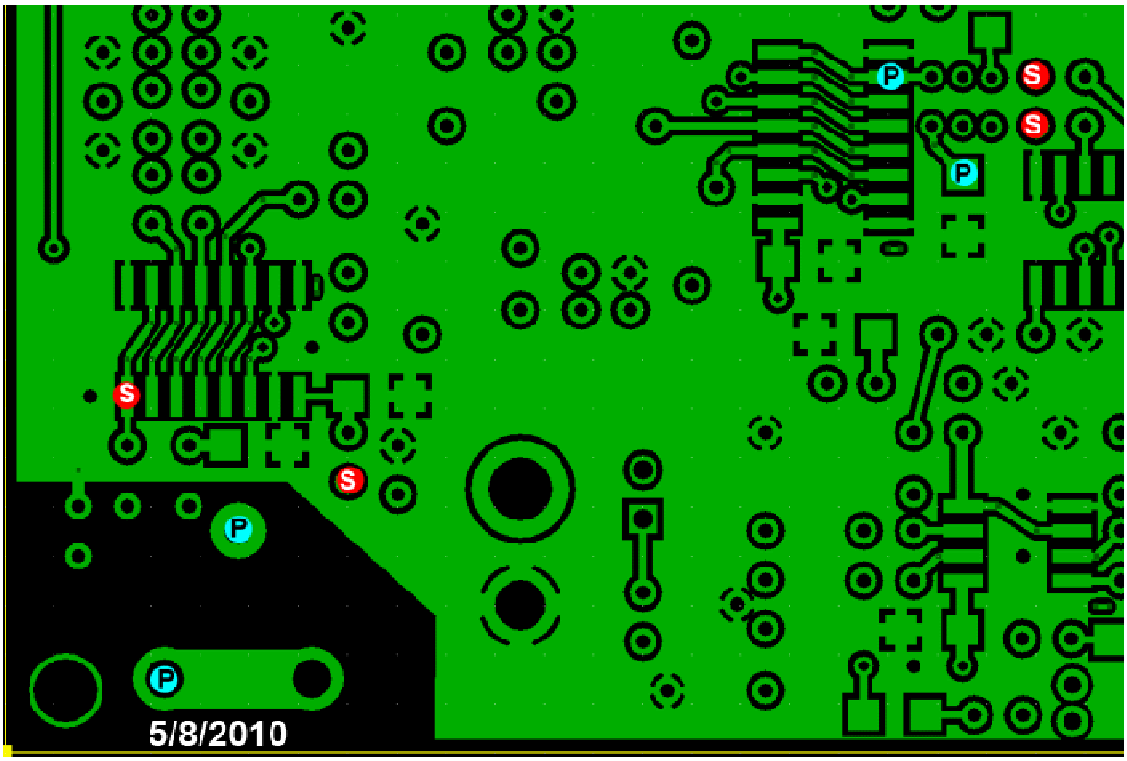


Install BPF In/Out Components





Includes winding and installing the two binocular transformers, T2 and T3.



The T3 secondary windings are connected by a trace on the board such that the secondary winding ends not connected together are 180 degrees phase different. Only one secondary winding is connected through the QSD switches of U10 at any instant of time resulting in signal integration on capacitors C20 and C21. T3 also provides a 4:1 Z transformation from the BPF to the QSD circuit.

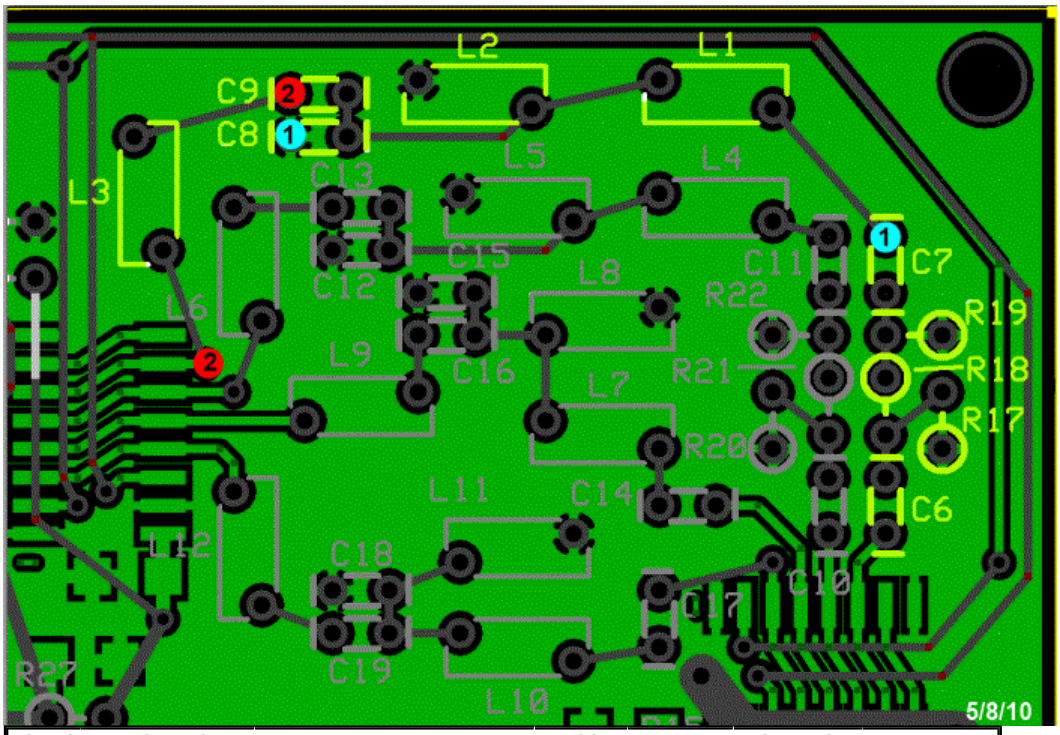
Once the transformers are wound and installed, you should turn the board over and run continuity tests on the primary and secondary windings, per the above diagram

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	R23	2.2k 1/6W 5%	red-red-red-gld	1/6W	W-E	
❑	T02	band-specific	Band: HF — Component: 23.04uH: 4T(bi)T #30 (12 (2x6)in) on BN43-2402 (xfrmr) — Marking:  Band: LF — Component: 70.56uH: 7T(bi)T #30 (16 (2x8)in) on BN43-2402 (xfrmr) — Marking: 	misc		
❑	T03	band-specific	Band: HF — Component: 23.04uH: 4T/2T(bi)T #30(12 (6/2x3)in) on BN43-2402 (xfrmr) — Marking:  Band: LF — Component: 70.56uH: 7T/3T(bi)T #30(18 (8/2x5)in) on BN43-2402 (xfrmr) — Marking: 	misc		

❑	R15	2.2k 1/6W 5%	red-red-red-gld	1/6W	N-S	
❑	R16	2.2k 1/6W 5%	red-red-red-gld	1/6W	N-S	
❑	R24	2.2k 1/6W 5%	red-red-red-gld	1/6W	W-E	
❑	R25	10 ohm 1/4W 1%	br-blk-blk-gld-br	1/4W	E-W	
❑	R26	10 ohm 1/4W 1%	br-blk-blk-gld-br	1/4W	E-W	
❑	R27	2.2k 1/6W 5%	red-red-red-gld	1/6W		
❑	R28	2.2k 1/6W 5%	red-red-red-gld	1/6W		

Install and Continuity Test the Band 0 BPF

In this step and the two steps following it, you will build the bandpass filter for the band 0 passband.



Check	Designation	Component	Marking	Category	Orientation	Notes
❑	magwire_165in	Magnetic Wire, enameled #30		Magnetic		50 inches #30

Install the Band 0 Inductors

First, you want to wind and install the coils and then continuity test them. The continuity test checks for continuity between the points labeled "1" and then tests the continuity between the points labeled "2". Wherever possible, the test points have been assigned to vias removed from but electrically connected to the coils' vias, so as to give a good test of the soldering.

If you are unfamiliar with winding and installing inductors, you may want to refer to the WB5RVZ construction hints for coils (toroidal) and transformers (toroidal and binocular). Click here for details on identifying toroid cores.

Decoding the trqansformer specifications:

Transformers' windings are specified using the pattern "nnT/wXmmT" or "wXmmT/nnT", where:

- **"nn" is the number of turns in the single winding**
- **"mm" is the number of turns in the multiple windings**

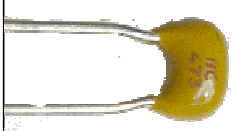
- **"w" = the number of multiple windings (e.g., 2 = bifilar; 3 = trifilar, etc.)**

Thus, e.g., "18T/2x9T bifilar #30" means, using #30 wire, produce a single 18 turn primary winding and two 9-turn secondary windings; "2x9T bifilar/ 18T #30" means, using #30 wire, produce two 9-turn primary windings and a single 18 turn secondary winding.

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	L01	band-specific	Band: HF — Component: 5.5uH: 35T #30(20in) on T30-2 (red) (coil) — Marking: red  ; Band: LF — Component: 55uH: 117T #30(61in) on T37-2 (red) (coil) — Marking: red 	misc		
❑	L01-core	band-specific		misc		
❑	L02	band-specific	Band: HF — Component: 2.6uH: 24T #30(15in) on T30-2 (red) (coil) — Marking: red  ; Band: LF — Component: 26uH: 80T #30(43in) on T37-2 (red) (coil) — Marking: red 	misc		
❑	L02-core	band-specific		misc		
❑	L03	band-specific	Band: HF — Component: 5.5uH: 35T #30(20in) on T30-2 (red) (coil) — Marking: red  ; Band: LF — Component: 55uH: 117T #30(61in) on T37-2 (red) (coil) — Marking: red 	misc		
❑	L03-core	band-specific		misc		

Install the Band 0 Static Components

Once you have successfully verified continuity, you can proceed to install the remaining parts for the passband.

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	C06	band-specific	Band: HF — Component: 0.047 uF 5% (Ceramic) — Marking: 473  ; Band: LF — Component: shunt wire (cut-off lead) (Cutoff)	misc	vert	(jumper for LF)
❑	C07	band-specific	Band Component Marking	misc	vert	

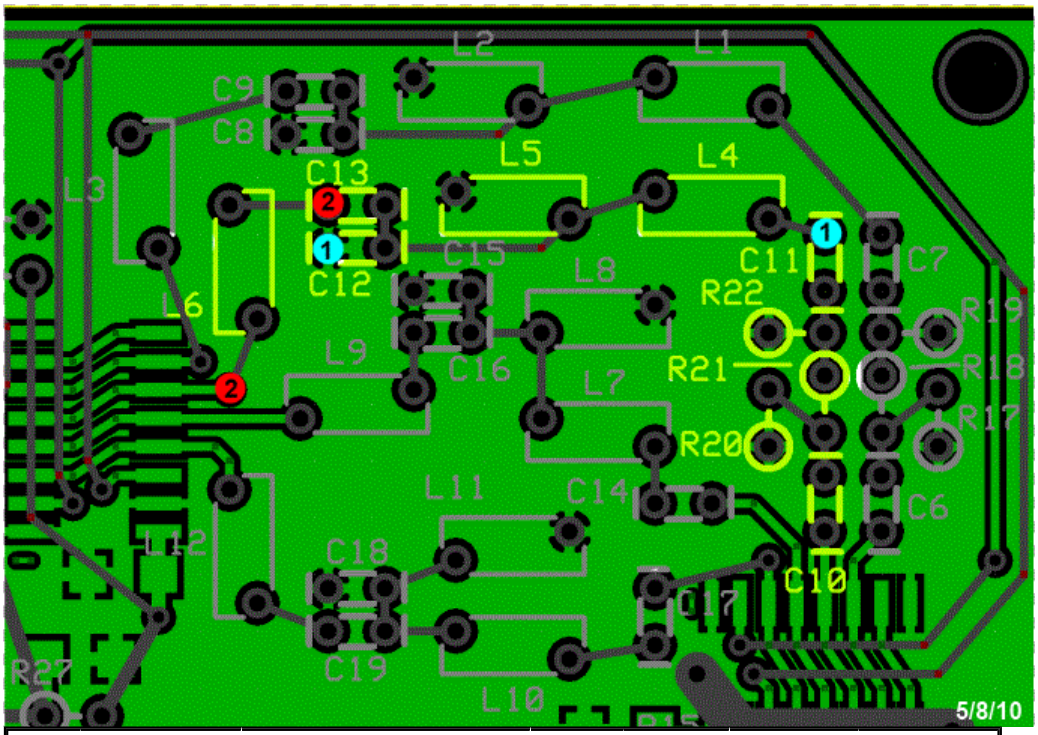
			HF	680 pF 5% (Ceramic)	681 			
			LF	6800 pF 5% (Ceramic)	682			
❑	C08	band-specific	Band HF	Component 1500 pF 10% (Ceramic)	Marking 152 	misc	horiz	
			LF	0.015 uF 5% (Ceramic)	153			
❑	C09	band-specific	Band HF	Component 680 pF 5% (Ceramic)	Marking 681 	misc	horiz	
			LF	6800 pF 5% (Ceramic)	682			
❑	R17	band-specific	Band HF	Component 75 1/6W 5% (1/6W)	Marking vio-grn-blk-gld 	misc	S-N	
			LF	omit for this band (Omit)				
❑	R18	band-specific	Band HF	Component 120 1/6W 5% (1/6W)	Marking brn-red-brn-gld 	misc	N-S	(jumper for LF)
			LF	shunt wire (cut-off lead) (Cutoff)				
❑	R19	band-specific	Band HF	Component 75 1/6W 5% (1/6W)	Marking vio-grn-blk-gld 	misc	E-W	
			LF	omit for this band (Omit)				

Install and Continuity Test the Band 1 BPF

In this step and the two steps following it, you will build the bandpass filter for the band 1 passband.

First, you want to wind and install the coils and then continuity test them. The continuity test checks for continuity between the points labeled "1" and then tests the continuity between the points labeled "2". Wherever possible, the test points have been assigned to vias removed from but electrically connected to the coils' vias, so as to give a good test of the soldering.

Once you have successfully verified continuity, you can proceed to install the remaining parts for the passband.



Check	Designation	Component	Marking	Category	Orientation	Notes
❑	magwire_90in	Magnetic Wire, enameled #30		Magnetic		24 inches #30

Install the Band 1 Inductors

First, you want to wind and install the coils and then continuity test them. The continuity test checks for continuity between the points labeled "1" and then tests the continuity between the points labeled "2". Wherever possible, the test points have been assigned to vias removed from but electrically connected to the coils' vias, so as to give a good test of the soldering.

If you are unfamiliar with winding and installing inductors, you may want to refer to the WB5RVZ construction hints for coils (toroidal) and transformers (toroidal and binocular). Click here for details on identifying toroid cores.

Decoding the trqansformer specifications:

Transformers' windings are specified using the pattern "nnT/wXmmT" or "wXmmT/nnT", where:

- **"nn" is the number of turns in the single winding**
- **"mm" is the number of turns in the multiple windings**
- **"w" = the number of multiple windings (e.g., 2 = bifilar; 3 = trifilar, etc.)**

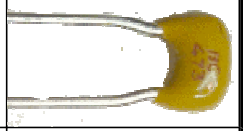
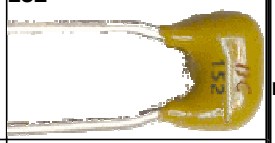
Thus, e.g., "18T/2x9T bifilar #30" means, using #30 wire, produce a single 18 turn primary winding and two 9-turn secondary windings; "2x9T bifilar/ 18T #30" means, using #30 wire, produce two 9-turn primary windings and a single 18 turn secondary winding.

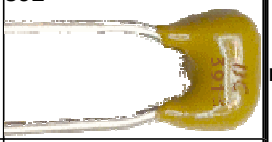
Check	Designation	Component	Marking			Category	Orientation	Notes
			Band	Component	Marking			
❑	L05	band-specific	HF	0.46uH: 10T #30 (8in) on T30-2(red) (coil)	red 	misc		
			LF	4.6uH: 32T #30(18in) on T30-2 (red) (coil)	red 			

❑	L04	band-specific	Band	Component	Marking	misc		
			HF	2uH: 21T #30(13in) on T30-2 (red) (Coil)	red 			
			LF	20uH: 68T #30(36in) on T30-2 (red) (coil)	red 			
❑	L06	band-specific	Band	Component	Marking	misc		
			HF	2uH: 21T #30(13in) on T30-2 (red) (Coil)	red 			
			LF	20uH: 68T #30(36in) on T30-2 (red) (coil)	red 			

Install the Band 1 Static Components

Once you have successfully verified continuity, you can proceed to install the remaining parts for the passband.

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	C10	band-specific	Band: HF — Component: 0.047 uF 5% (Ceramic) — Marking: 473  Band: LF — Component: shunt wire (cut-off lead) (Cutoff)	misc	vert	(jumper for LF)
❑	C11	band-specific	Band: HF — Component: 390 pF 5% (Ceramic) — Marking: 391  Band: LF — Component: 3300 pF 5% (Ceramic) — Marking: 332	misc	vert	
❑	C12	band-specific	Band: HF — Component: 1500 pF 10% (Ceramic) — Marking: 152  Band: LF — Component: 0.015 uF 5% (Ceramic) — Marking: 153	misc	horiz	

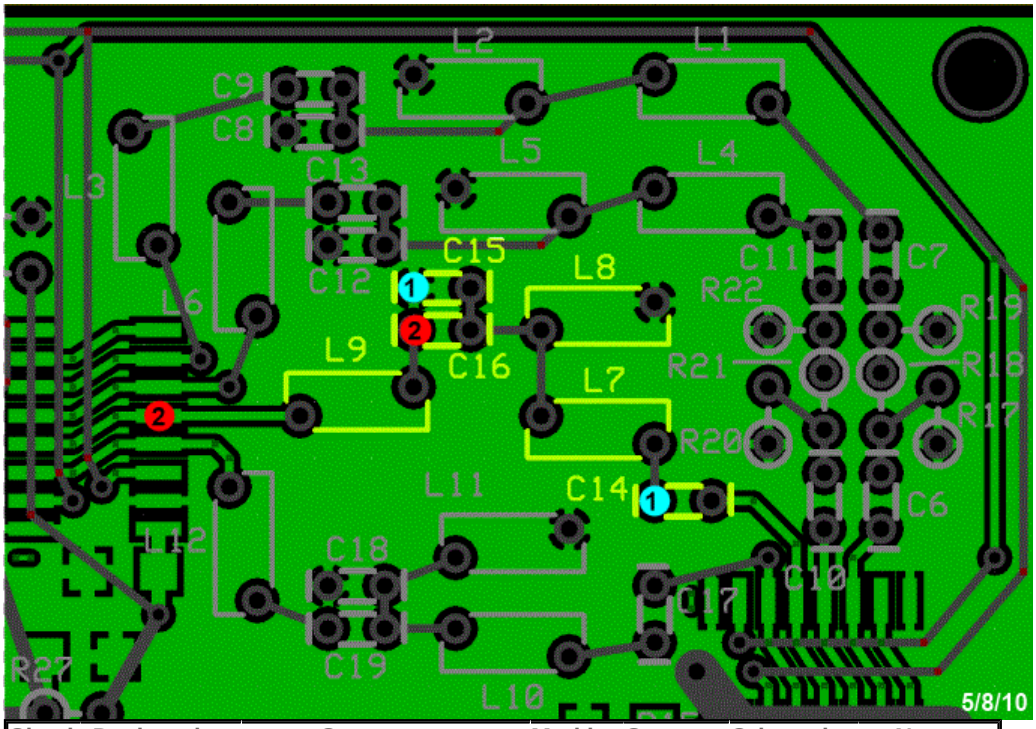
❑	C13	band-specific	Band / Component / Marking HF: 390 pF 5% (Ceramic) — 391  LF: 3300 pF 5% (Ceramic) — 332		misc	horiz	
❑	R20	band-specific	Band / Component / Marking HF: 75 1/6W 5% (1/6W) — vio-grn-blk-gld  LF: omit for this band (Omit)		misc	S-N	
❑	R21	band-specific	Band / Component / Marking HF: 120 1/6W 5% (1/6W) — brn-red-brn-gld  LF: shunt wire (cut-off lead) (Cutoff)		misc	N-S	(jumper for LF)
❑	R22	band-specific	Band / Component / Marking HF: 75 1/6W 5% (1/6W) — vio-grn-blk-gld  LF: omit for this band (Omit)		misc	W-E	

Install and Continuity Test the Band 2 BPF

In this step and the two steps following it, you will build the bandpass filter for the band 2 passband.

First, you want to wind and install the coils and then continuity test them. The continuity test checks for continuity between the points labeled "1" and then tests the continuity between the points labeled "2". Wherever possible, the test points have been assigned to vias removed from but electrically connected to the coils' vias, so as to give a good test of the soldering.

Once you have successfully verified continuity, you can proceed to install the remaining parts for the passband.



Check	Designation	Component	Marking	Category	Orientation	Notes
❑	magwire_67in	Magnetic Wire, enameled #30		Magnetic		24 inches #24

Install the Band 2 Inductors

First, you want to wind and install the coils and then continuity test them. The continuity test checks for continuity between the points labeled "1" and then tests the continuity between the points labeled "2". Wherever possible, the test points have been assigned to vias removed from but electrically connected to the coils' vias, so as to give a good test of the soldering.

If you are unfamiliar with winding and installing inductors, you may want to refer to the WB5RVZ construction hints for coils (toroidal) and transformers (toroidal and binocular). Click here for details on identifying toroid cores.

Decoding the trqansformer specifications:

Transformers' windings are specified using the pattern "nnT/wXmmT" or "wXmmT/nnT", where:

- **"nn" is the number of turns in the single winding**
- **"mm" is the number of turns in the multiple windings**
- **"w" = the number of multiple windings (e.g., 2 = bifilar; 3 = trifilar, etc.)**

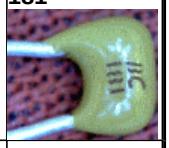
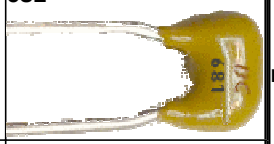
Thus, e.g., "18T/2x9T bifilar #30" means, using #30 wire, produce a single 18 turn primary winding and two 9-turn secondary windings; "2x9T bifilar/ 18T #30" means, using #30 wire, produce two 9-turn primary windings and a single 18 turn secondary winding.

Check	Designation	Component	Marking		Category	Orientation	Notes
			Band	Component Marking			
❑	L07	band-specific	HF	1uH: 19T #30(9in) on T25-6(yel) (coil) yellow 	misc		
			LF	10uH: 48T #30(26in) on T30-2 (red) (coil) red 			
❑	L07-core	band-specific			misc		

❑	L08	band-specific	Band / Component / Marking HF: 0.27 uH: 10T #30 (6") on T25-6 core (coil) — yellow  LF: 2.7uH: 25T #30(15in) on T30-2 (red) (coil) — red 	misc	
❑	L08-core	band-specific		misc	
❑	L09	band-specific	Band / Component / Marking HF: 1uH: 19T #30(9in) on T25-6(yel) (coil) — yellow  LF: 10uH: 48T #30(26in) on T30-2 (red) (coil) — red 	misc	
❑	L09-core	band-specific		misc	

Install the Band 2 Static Components

Once you have successfully verified continuity, you can proceed to install the remaining parts for the passband.

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	C14	band-specific	Band / Component / Marking HF: 180 pF 5% (Ceramic) — 181  LF: 1800 pF 5% (Ceramic) — 182	misc	horiz	
❑	C15	band-specific	Band / Component / Marking HF: 680 pF 5% (Ceramic) — 681  LF: 6800 pF 5% (Ceramic) — 682	misc	horiz	
❑	C16	band-specific	Band / Component / Marking HF: 180 pF 5% (Ceramic) — 181  LF: 1800 pF 5% (Ceramic) — 182	misc	horiz	

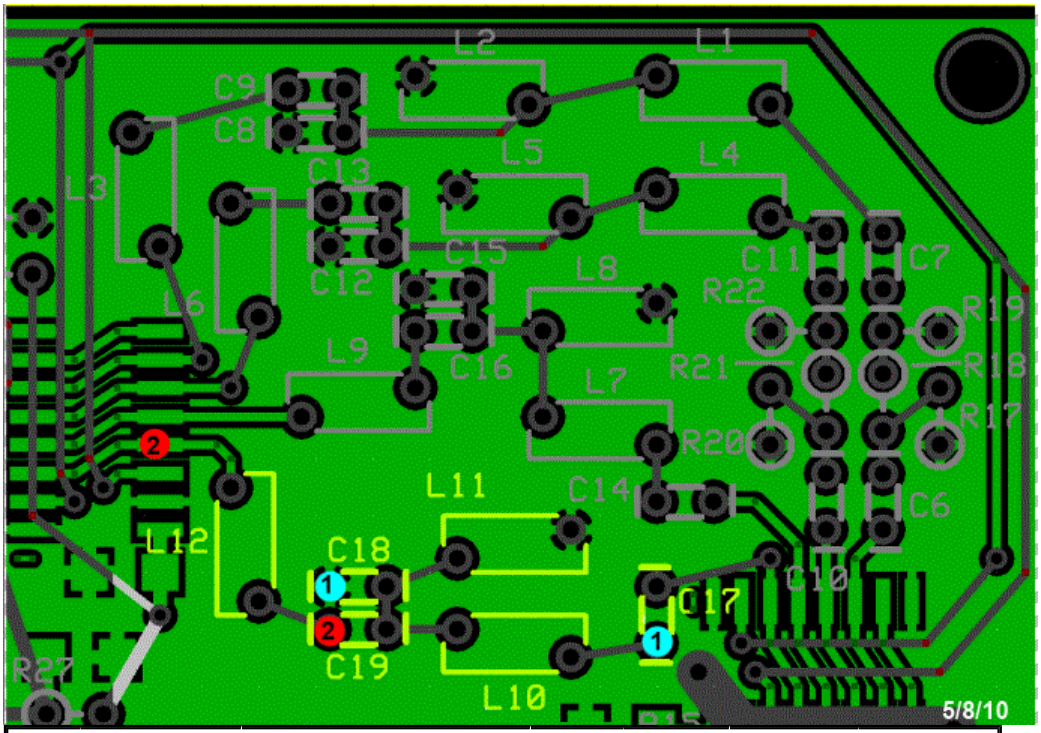
Install and Continuity Test the Band 3 BPF

In this step and the two steps following it, you will build the bandpass filter for the band 3 passband.

First, you want to wind and install the coils and then continuity test them. The continuity test checks for continuity between the points labeled "1" and then tests the continuity between the points labeled "2".

Wherever possible, the test points have been assigned to vias removed from but electrically connected to the coils' vias, so as to give a good test of the soldering.

Once you have successfully verified continuity, you can proceed to install the remaining parts for the passband.



Check	Designation	Component	Marking	Category	Orientation	Notes
❑	magwire_47in	Magnetic Wire, enameled #30		Magnetic		19 inches #24

Install the Band 3 Inductors

First, you want to wind and install the coils and then continuity test them. The continuity test checks for continuity between the points labeled "1" and then tests the continuity between the points labeled "2". Wherever possible, the test points have been assigned to vias removed from but electrically connected to the coils' vias, so as to give a good test of the soldering.

If you are unfamiliar with winding and installing inductors, you may want to refer to the WB5RVZ construction hints for coils (toroidal) and transformers (toroidal and binocular). Click here for details on identifying toroid cores.

Decoding the trqansformer specifications:

Transformers' windings are specified using the pattern "nnT/wXmmT" or "wXmmT/nnT", where:

- **"nn" is the number of turns in the single winding**
- **"mm" is the number of turns in the multiple windings**
- **"w" = the number of multiple windings (e.g., 2 = bifilar; 3 = trifilar, etc.)**

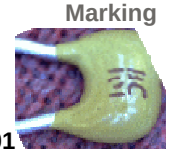
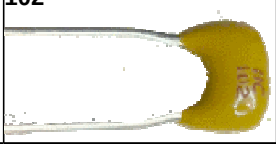
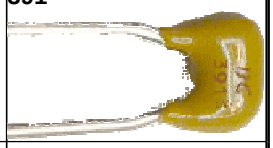
Thus, e.g., "18T/2x9T bifilar #30" means, using #30 wire, produce a single 18 turn primary winding and two 9-turn secondary windings; "2x9T bifilar/ 18T #30" means, using #30 wire, produce two 9-turn primary windings and a single 18 turn secondary winding.

Check	Designation	Component	Marking			Category	Orientation	Notes
			Band	Component Marking				
❑	L10	band-specific	HF	0.46 uH: 13T #30 (7") on T25-	yellow 	misc		

				6 core (coil)				
			LF	4.6uH: 32T #30(18in) on T30-2 (red) (coil)	red 			
❑	L10-core	band-specific				misc		
❑	L11	band-specific	Band	Component	Marking	misc		
			HF	0.13 uH: 7T #30 (5") on T25-6 core (coil)	yellow 			
			LF	1.3uH: 17T #30(11in) on T30-2 (red) (coil)	red 			
❑	L11-core	band-specific				misc		
❑	L12	band-specific	Band	Component	Marking	misc		
			HF	0.46 uH: 13T #30 (7") on T25-6 core (coil)	yellow 			
			LF	4.6uH: 32T #30(18in) on T30-2 (red) (coil)	red 			
❑	L12-core	band-specific				misc		

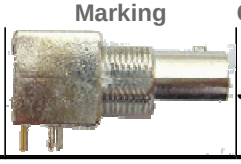
Install the Band 3 Static Components

Once you have successfully verified continuity, you can proceed to install the remaining parts for the passband.

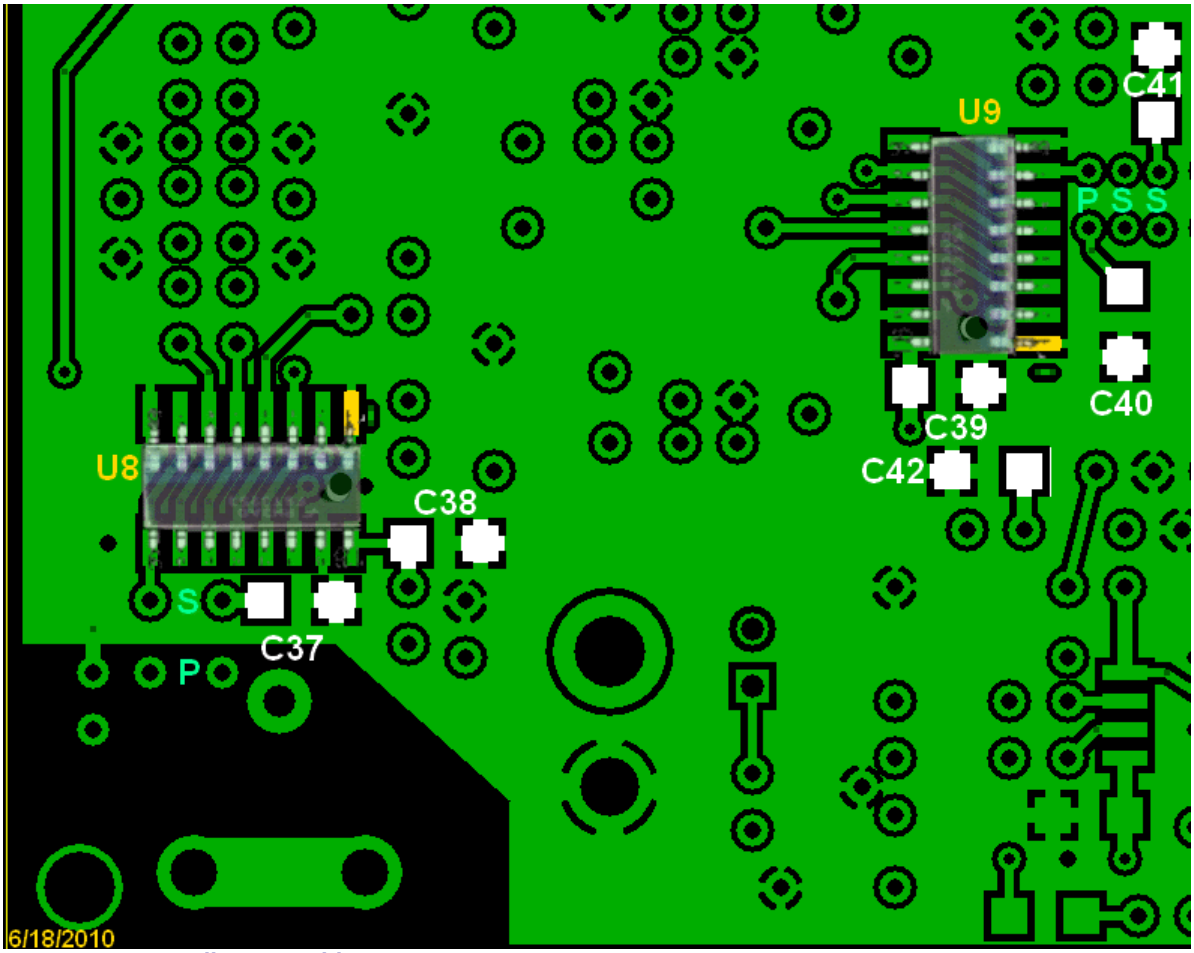
Check	Designation	Component	Marking			Category	Orientation	Notes
			Band	Component	Marking			
❑	C17	band-specific	HF	100 pF 5% (Ceramic)	101 	misc	vert	
			LF	1000 pF 5% (Ceramic)	102 			
❑	C18	band-specific	Band	Component	Marking	misc	horiz	
			HF	390 pF 5% (Ceramic)	391 			
			LF	3300 pF 5% (Ceramic)	332			
❑	C19	band-specific	Band	Component	Marking	misc	horiz	

			HF	100 pF 5% (Ceramic)	 101				
			LF	1000 pF 5% (Ceramic)	102 				

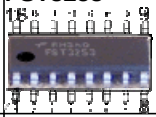
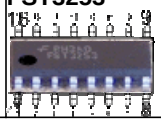
Install Antenna Jack

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	J04	BNC Connector Male - PCB mount		Jack		

Bottom of the Board



Install Bottomside Components

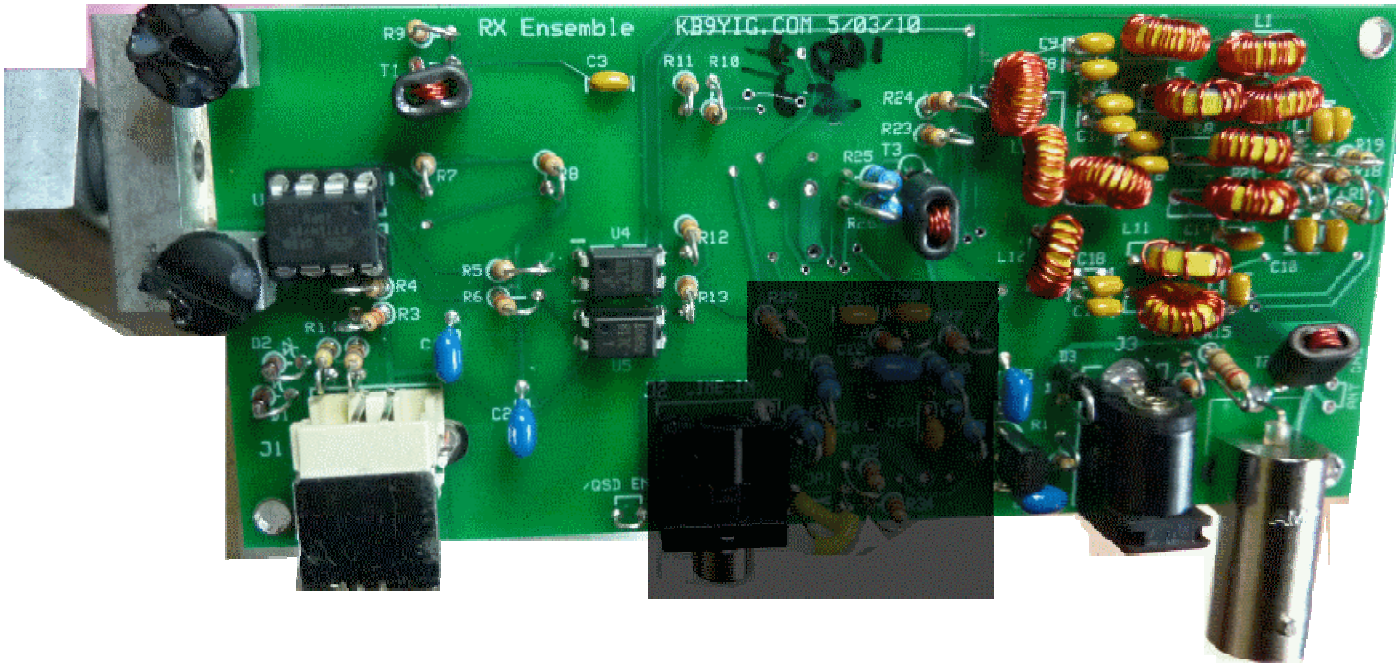
Check	Designation	Component	Marking	Category	Orientation	Notes
❑	U08	FST3253 mux/demux switch	FST3253 	SOIC-16		Take ESD precautions
❑	U09	FST3253 mux/demux switch	FST3253 	SOIC-16		Take ESD precautions

❑	C37	0.1 uF	(smt) black stripe	SMT 1206	white pads	
❑	C38	0.1 uF	(smt) black stripe	SMT 1206	yellow pads	
❑	C39	0.1 uF	(smt) black stripe	SMT 1206	yellow pads	
❑	C40	0.1 uF	(smt) black stripe	SMT 1206	yellow pads	
❑	C41	0.1 uF	(smt) black stripe	SMT 1206	white pads	
❑	C42	0.1 uF	(smt) black stripe	SMT 1206	yellow pads	

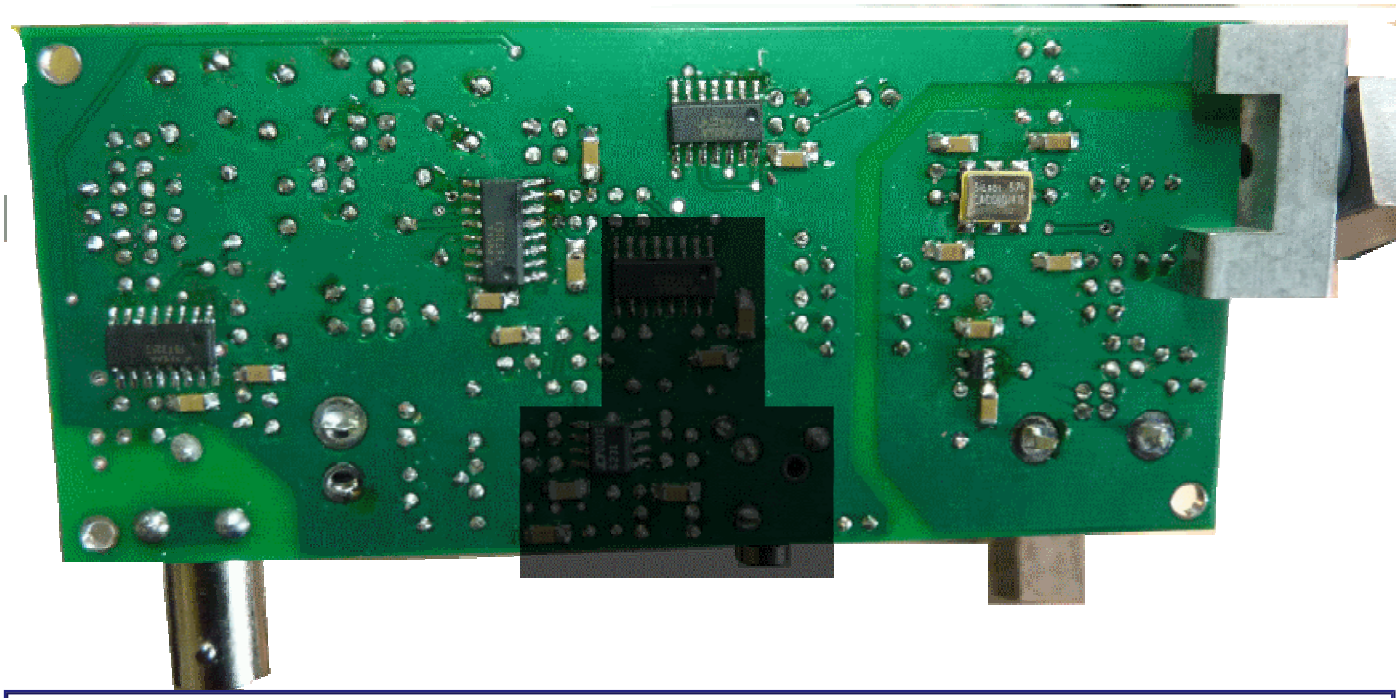
Auto Band Pass Filters Completed Stage

(These photos were of an earlier board design. It has changed since the author built the kit upon which these notes are based. The board layout graphics are, however, current.)

Top of the Board



Bottom of the Board

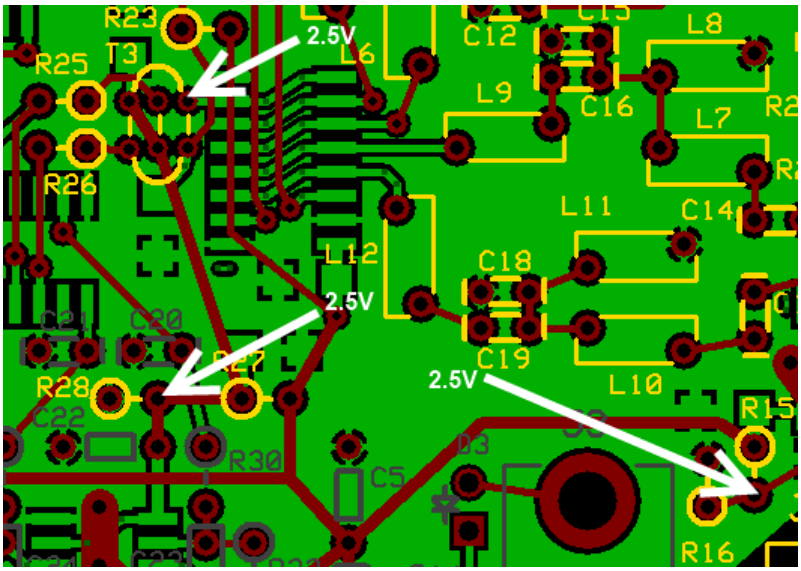


Auto Band Pass Filters Testing

Voltage Divider Tests

Test Setup

With Power and USB connected, test the output of the three voltage dividers in this stage. Each should yield approximately one-half the voltage on the 5V rail. If they do not, check to be certain that the resistors are all 2.2K (red -red-red-gld).



Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
R15 Hairpin lead (R15/R15 voltage divider)	V dc	2.5	2.47	
Either of the Primary leads of T3 (R23/R24 voltage divider)	V dc	2.5	2.47	
R28 Hairpin lead (R27/R28 voltage divider)	V dc	2.5	2.47	

Pin Voltages on the Ics

Test Setup

Run the Filter Selection Test from the LO and Control Stage, only instead of measuring the voltages at the hairpin leads of R12 and R13, measure the voltages at the 2 and 14 PINS (not the pads) of U8 and U9. This will validate that the pins were correctly soldered to the pads and are getting the switching signals.

Perform the tests below for each of U8 and U9

If you are building the LF option, you will need to changet the frequencies to ones that are within the pass band of each filter:

Band	Midband (kHz)
Band 0	330
Band 1	600
Band 2	1200
Band 3	2300

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
LO=2 MHz (band 0) - Test pin 2 (FL SEL 1)	V dc	0	100 mV	
LO=2 MHz (band 0) - Test pin 14 (FL SEL 0)	V dc	0	100 mV	
LO=6 MHz (band 1) - Test pin 2 (FL SEL 1)	V dc	0	100 mV	
LO=6 MHz (band 1) - Test pin 14 (FL SEL 0)	V dc	5	4.92	
LO=12 MHz (band 2) - Test pin 2 (FL SEL 1)	V dc	5	4.92	
LO=12 MHz (band 2) - Test pin 14 (FL SEL 0)	V dc	0	100 mV	
LO=24 MHz (band 3) - Test pin 2 (FL SEL 1)	V dc	5	4.92	
LO=24 MHz (band 3) - Test pin 14 (FL SEL 0)	V dc	5	4.92	

(Optional) RF Test

Test Setup

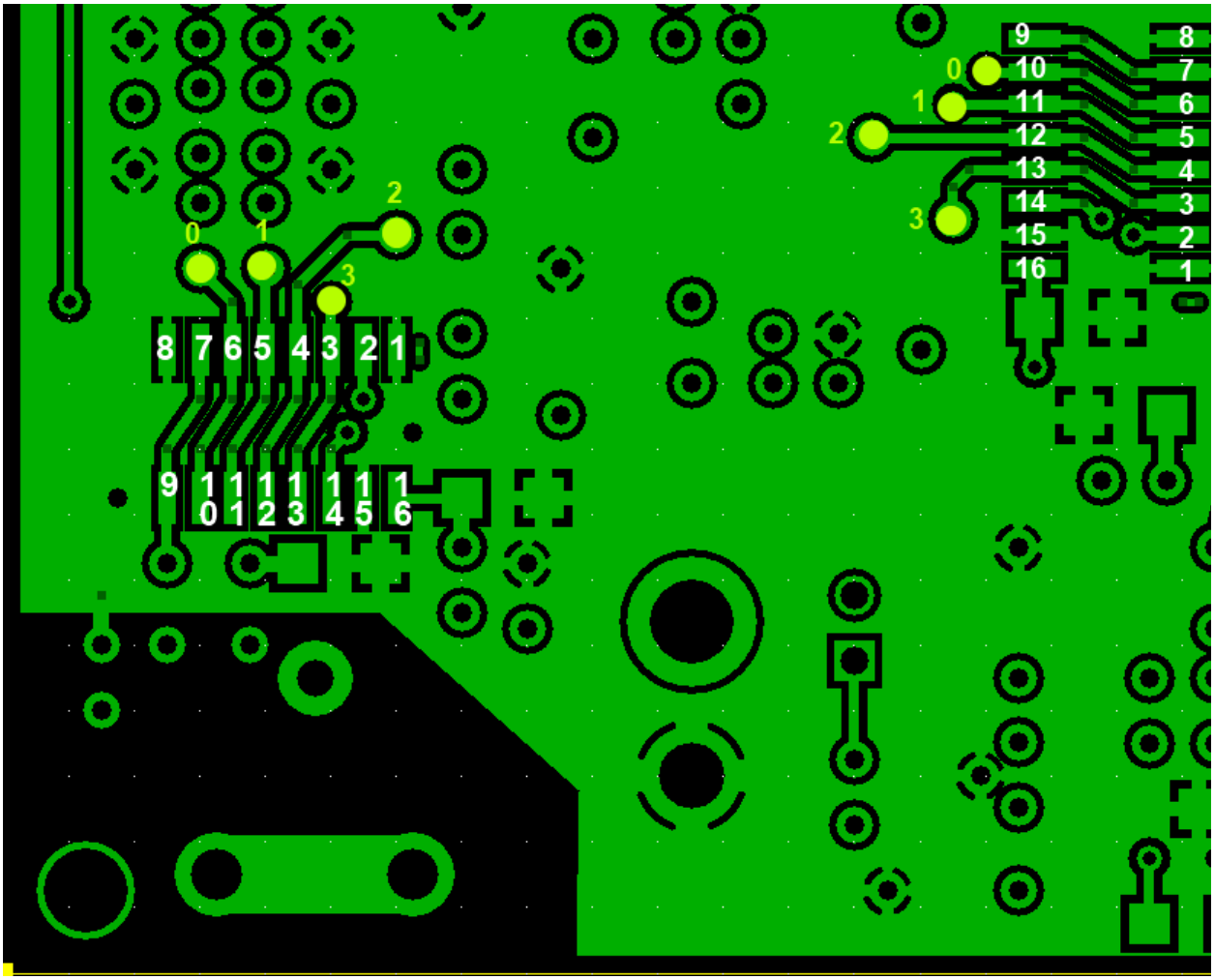
If you have a scope and a signal source (or an RF probe and a signal source)

Inject an RF signal of around 50-100 mV at the antenna jack, determine which band should switch for that RF signal, and probe the pins of U8 and U9 which should be switched to that signal:

Band	Switched Pins
Band 0 (1-4 MHz)	6 & 10
Band 1 (4-8 MHz)	5 & 11
Band 2 (8-16 MHz)	4 & 12
Band 3 (16-30 MHz)	3 & 13

Adjust the frequencies above if you are building the LF kit

Your scope should show the signal at the switched pins and not at any of the other pins.



Home Bill of Materials Power Supply USB Power Supply Local Oscillator and Control Quadrature Clock Generator Auto Band Pass Filters Quadrature Sampling Detector Operational Amplifiers Comments Acronyms Inventory Revisions as of 11/30/2010 Components By Stage WB5RVZ Main Website

Ensemble RX II 06_Quadrature Sampling Detector

Home Bill of Materials Power Supply USB Power Supply Local Oscillator and Control Quadrature Clock Generator Auto Band Pass Filters Quadrature Sampling Detector Operational Amplifiers Comments Acronyms Inventory Revisions as of 11/30/2010 Components By Stage WB5RVZ Main Website

Search: Search selected SDR sites

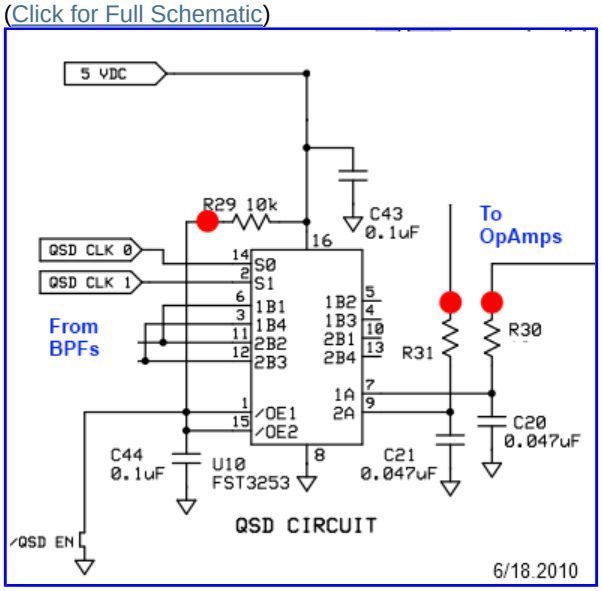
Quadrature Sampling Detector Introduction

(go directly to build notes)

Quadrature Sampling Detector Schematic

(Resistor testpoints (hairpin, top, or left-hand lead), as physically installed on the board, are marked in the schematic with red dots)

(Click for Full Schematic)



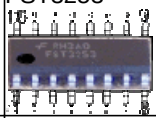
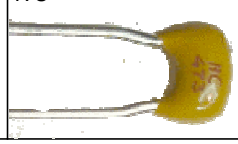
(above schematic has clickable areas that can be used for navigation)

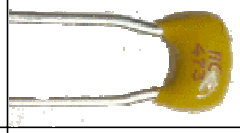
(go directly to build notes)

Quadrature Sampling Detector Bill of Materials

Stage Bill of Materials

(resistor images and color codes courtesy of WIlfried, DL5SWB's R-Color Code program)

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	R30	band-specific		misc	N-S		Quadrature Sampling Detector
❑	R31	band-specific		misc	N-S		Quadrature Sampling Detector
❑	U10	FST3253 mux/demux switch	FST3253 	SOIC-16			Quadrature Sampling Detector
❑	C20	0.047 uF 5%	473 	Ceramic	horiz		Quadrature Sampling Detector

❑	C21	0.047 uF 5%	473 	Ceramic	horiz		Quadrature Sampling Detector
❑	C43	0.1 uF	(smt) black stripe 	SMT 1206	white pads		Quadrature Sampling Detector
❑	C44	0.1 uF	(smt) black stripe 	SMT 1206	white pads		Quadrature Sampling Detector
❑	R29	10 k 1/6W 5%	brn-blk-ora-gld 	1/6W	W-E	was R27	Quadrature Sampling Detector

Band Specific Items for HF Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	R30	10 ohm 1/4W 1%	br-blk-blk-gld-br 	1/4W	N-S		Quadrature Sampling Detector
❑	R31	10 ohm 1/4W 1%	br-blk-blk-gld-br 	1/4W	N-S		Quadrature Sampling Detector

Band Specific Items for LF Band

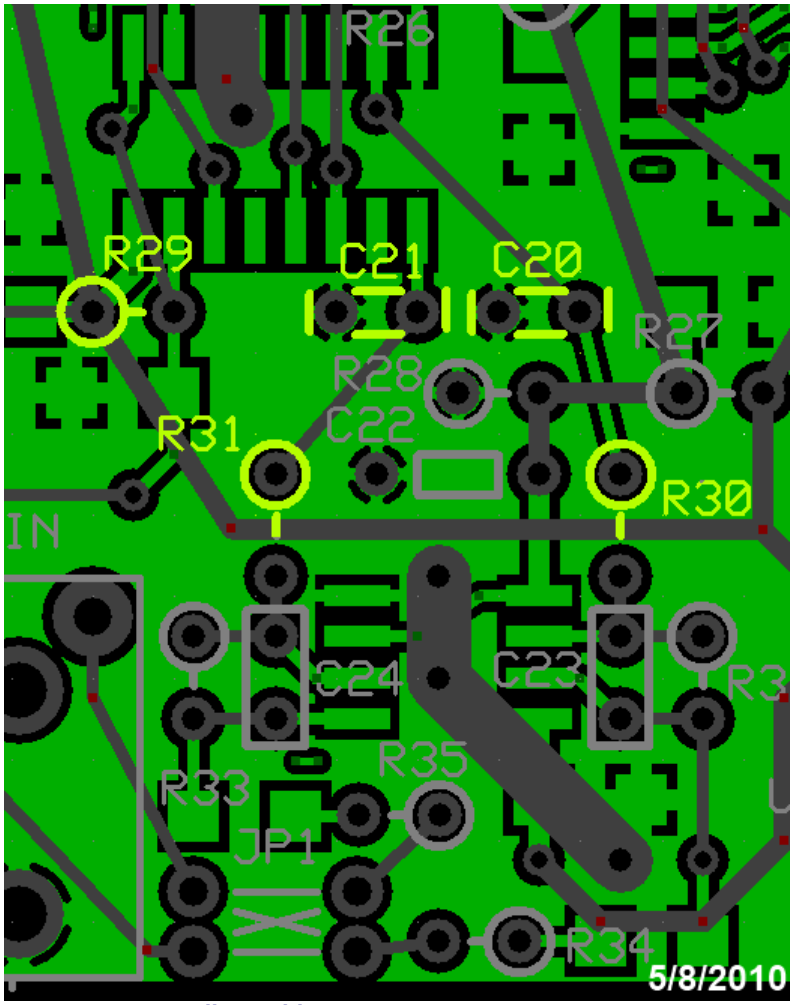
Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	R30	49.9 ohm 1%	yel-wht-wht-gld-brn 	1/4W	N-S		Quadrature Sampling Detector
❑	R31	49.9 ohm 1%	yel-wht-wht-gld-brn 	1/4W	N-S		Quadrature Sampling Detector

Quadrature Sampling Detector Summary Build Notes

- Install Bottomside Components
- Install Topside Components
- Test the Stage

Quadrature Sampling Detector Detailed Build Notes

Top of the Board

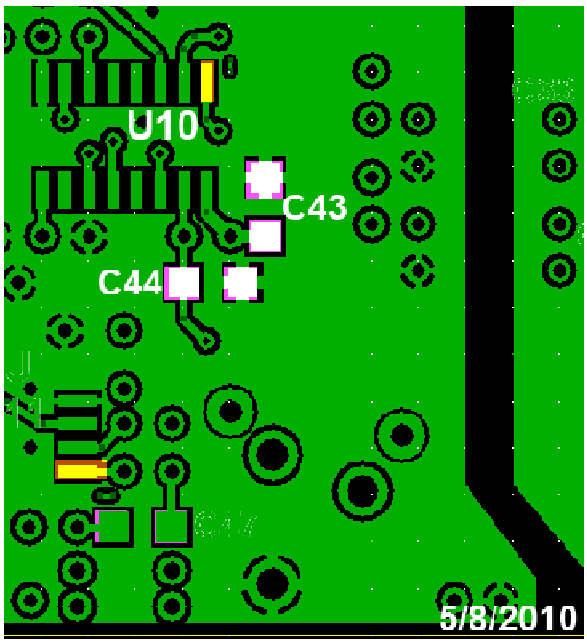


Install Topside Components

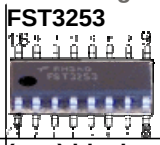
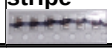
Check	Designation	Component	Marking	Category	Orientation	Notes
❑	R30	band-specific	Band: HF — Component: 10 ohm 1/4W 1% (1/4W) — Marking: br-blk-blk-gld-br; Band: LF — Component: 49.9 ohm 1% (1/4W) — Marking: yel-wht-wht-gld-brn	misc	N-S	
❑	R31	band-specific	Band: HF — Component: 10 ohm 1/4W 1% (1/4W) — Marking: br-blk-blk-gld-br; Band: LF — Component: 49.9 ohm 1% (1/4W) — Marking: yel-wht-wht-gld-brn	misc	N-S	
❑	C20	0.047 uF 5%	 473	Ceramic	horiz	

❑	C21	0.047 uF 5%	 473	Ceramic	horiz	
❑	R29	10 k 1/6W 5%	brn-blk-ora-gld 	1/6W	W-E	was R27

Bottom of the Board



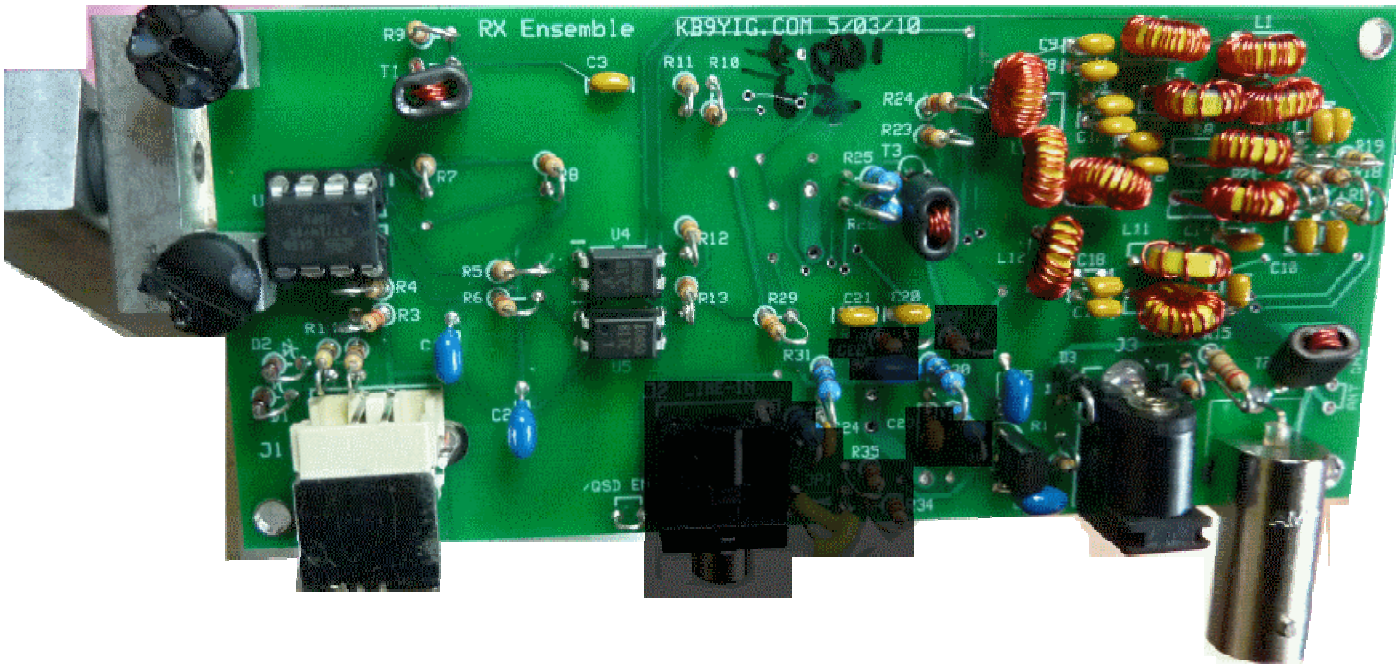
Install Bottomside Components

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	U10	FST3253 mux/demux switch	FST3253 	SOIC-16		Take ESD precautions
❑	C43	0.1 uF	(smt) black stripe 	SMT 1206	white pads	
❑	C44	0.1 uF	(smt) black stripe 	SMT 1206	white pads	

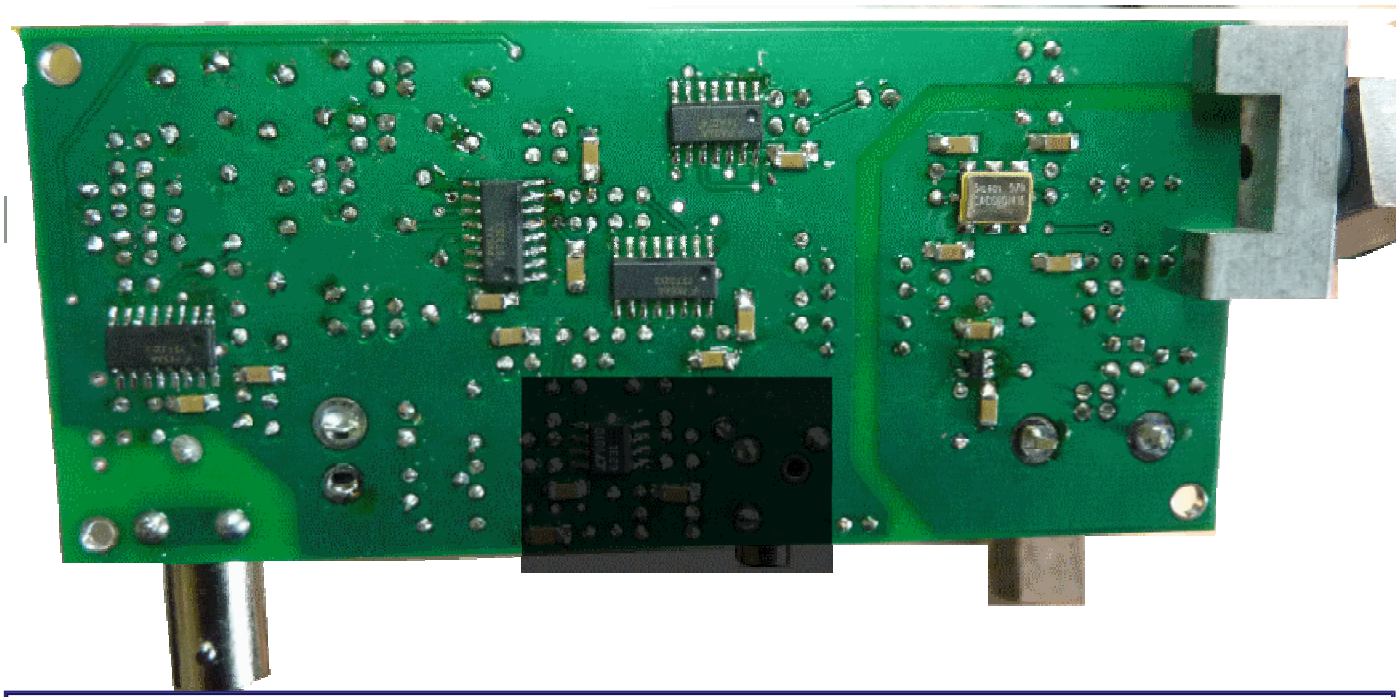
Quadrature Sampling Detector Completed Stage

(These photos were of an earlier board design. It has changed since the author built the kit upon which these notes are based. The board layout graphics are, however, current.)

Top of the Board



Bottom of the Board



Quadrature Sampling Detector Testing

IC Pin Voltages

Test Setup

Test Notes

It has been observed before that some digital meters are affected by the square wave signals on IC pins and do not always read correctly. The readings you get should approximate 2.5V . The best instrument may be a good oscilloscope. Just be prepared to see slightly different readings on pins 10-13 and 3-6, depending on your DMM (mine is not the best!)

Just for a little background information, most of the voltages on U10 pins are derived from the potential divider formed by R27/28 (tested in the Auto Bandpass Filter Stage). If in doubt you can always measure the junction of those two and should get 2.5v as they are equal values across the 5v rail. If one or both were the wrong value, that point would

be significantly different. The 2.5v is passed through T3 to the input pins of the multiplexer, and appear on the output pins when the appropriate switch is enabled. Other pins have clock waveforms present, which are relying on the averaging effects of the measuring instrument to give an approximate reading of 2.5v, but this can vary tremendously.

Conduct the Test

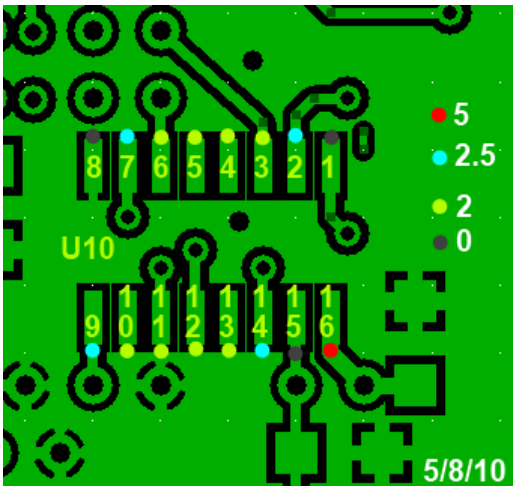
Power the board, connect USB to PC

Voltages are measured WRT (regular) ground (/QSD EN shunt)

Bob G8VOI provided thius note concerning these voltages:

Measure pin voltages

It is best to test for these voltages at the actual pins (not the pads), thereby ensuring correct soldering of the pins to the pads.



Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
Pins 1 and 15 (gnd)	V dc	0	0	_____
Pins 10, 11, 12, and 13 (40% of 5V rail)	V dc	2.5	2.1	_____
Pins 3, 4, 5, and 6 (40% of 5V rail)	V dc	2.5	2.1	_____
Pins 7 and 9 (1/2 of 5V rail)	V dc	2.5	2.5	_____
Pins 2 and 14 (1/2 of 5V rail)	V dc	2.5	2.5	_____
Pin 8 (gnd)	V dc	0	0	_____
Pin 16 (5 V rail)	V dc	5	5	_____

(Optional) QSD Output Test

Test Setup

Power up the board and connect the USB cable

Run CFGSR.exe and dial in a desired center frequency

Inject an RF signal at approximately 10 kHz below the dialed in center frequency

Probe the hairpin leads of R30 and R31 with your dual channel scope

Depending upon your scope's sensitivity, you should see two 10 kHz signals in quadrature.

As you vary the injected signal to move it above the center frequency, you should see the quadrature signals change frequency and, at crossover, switch the leading and lagging positions.

Home Bill of Materials Power Supply USB Power Supply Local Oscillator and Control Quadrature Clock Generator Auto Band Pass Filters Quadrature Sampling Detector Operational Amplifiers Comments Acronyms Inventory Revisions as of 11/30/2010 Components By Stage WB5RVZ Main Website

Ensemble RX II 07_Operational Amplifiers

Home Bill of Materials Power Supply USB Power Supply Local Oscillator and Control Quadrature Clock Generator Auto Band Pass Filters Quadrature Sampling Detector Operational Amplifiers Comments Acronyms Inventory Revisions as of 11/30/2010 Components By Stage WB5RVZ Main Website

Search: Search selected SDR sites

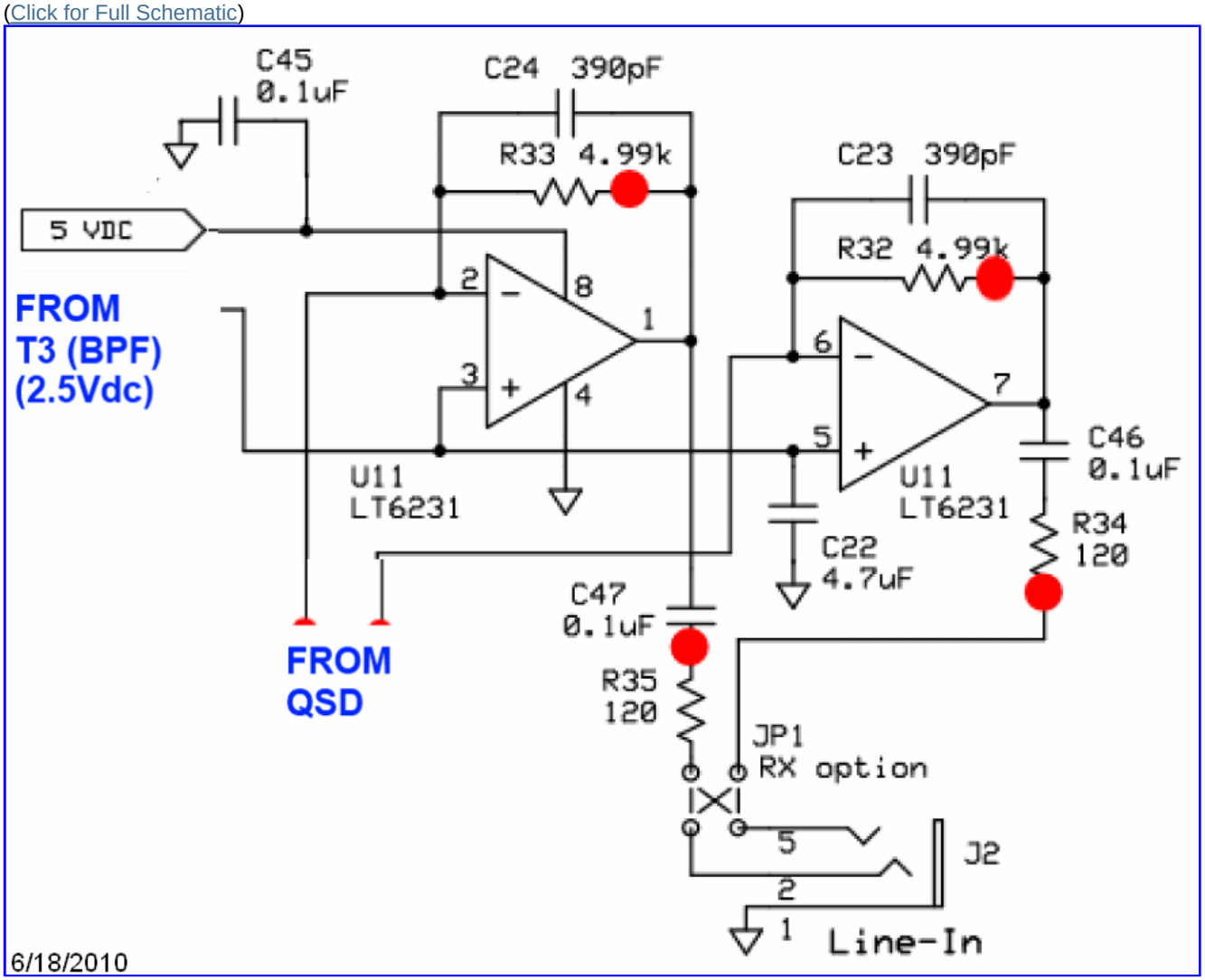
Operational Amplifiers Introduction

(go directly to build notes)

Operational Amplifiers Schematic

(Resistor testpoints (hairpin, top, or left-hand lead), as physically installed on the board, are marked in the schematic with red dots)

(Click for Full Schematic)



(above schematic has clickable areas that can be used for navigation)

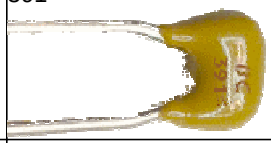
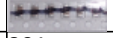
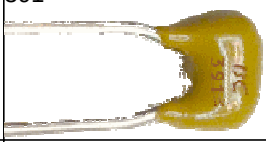
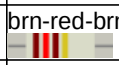
(go directly to build notes)

Operational Amplifiers Bill of Materials

Stage Bill of Materials

(resistor images and color codes courtesy of WIlfried, DL5SWB's R-Color Code program)

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit

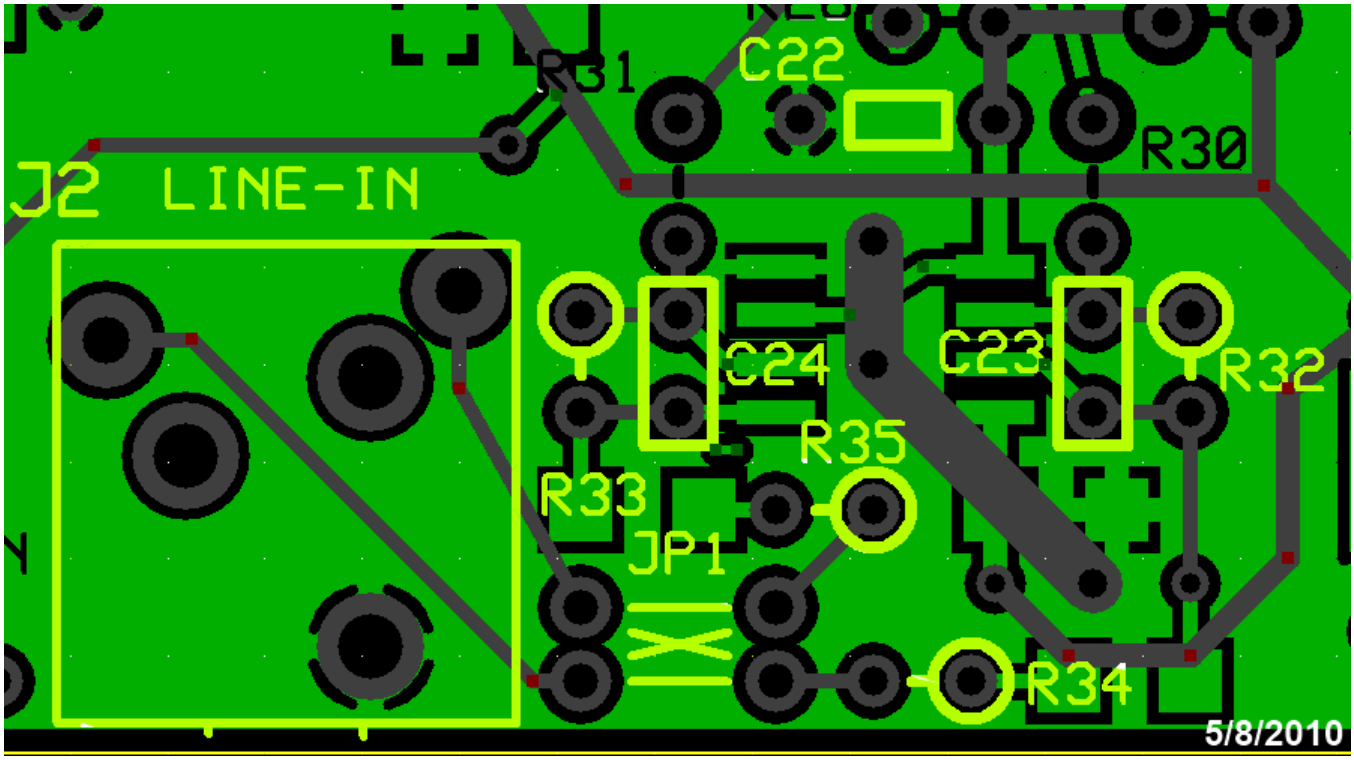
❑	C22	4.7 uF 10% 16V X7R RAD	475 	Ceramic	horiz		Operational Amplifiers
❑	U11	LT6231 dual op-amp	LT6231 	SOIC-8	(or LT6221)		Operational Amplifiers
❑	C24	390 pF 5%	391 	Ceramic	vert		Operational Amplifiers
❑	C45	0.1 uF	(smt) black stripe 	SMT 1206	white pads		Operational Amplifiers
❑	C23	390 pF 5%	391 	Ceramic	vert		Operational Amplifiers
❑	C46	0.1 uF	(smt) black stripe 	SMT 1206	white pads		Operational Amplifiers
❑	C47	0.1 uF	(smt) black stripe 	SMT 1206			Operational Amplifiers
❑	R32	4.99 k 1/4W 1%	y-w-w-br-br 	1/4W	N-S		Operational Amplifiers
❑	R33	4.99 k 1/4W 1%	y-w-w-br-br 	1/4W	N-S		Operational Amplifiers
❑	R34	120 1/6W 5%	brn-red-brn-gld 	1/6W	E-W		Operational Amplifiers
❑	R35	120 1/6W 5%	brn-red-brn-gld 	1/6W	E-W		Operational Amplifiers
❑	JP1A	shunt wire (cut-off lead)		Cutoff			Operational Amplifiers
❑	JP1B	shunt wire (cut-off lead)		Cutoff			Operational Amplifiers
❑	J02	3.5mm stereo jack - PCB mount (rt-angle)		Jack-RA			Operational Amplifiers

Operational Amplifiers Summary Build Notes

- Install Bottomside Parts
- Install Topside Parts
- Test the Stage

Operational Amplifiers Detailed Build Notes

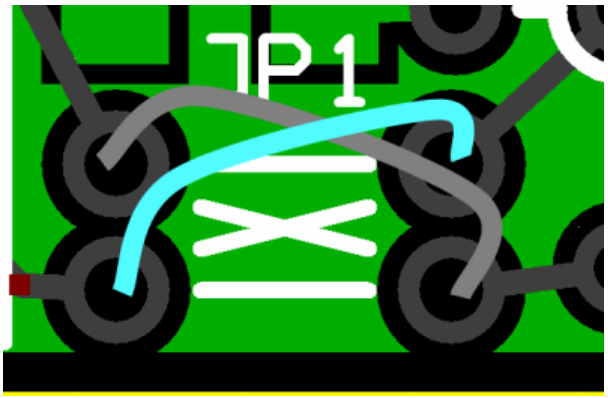
Top of the Board

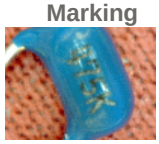


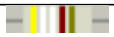
Install Topside Parts

Careful - there are 1/6W and 1/4W resistors in this step.

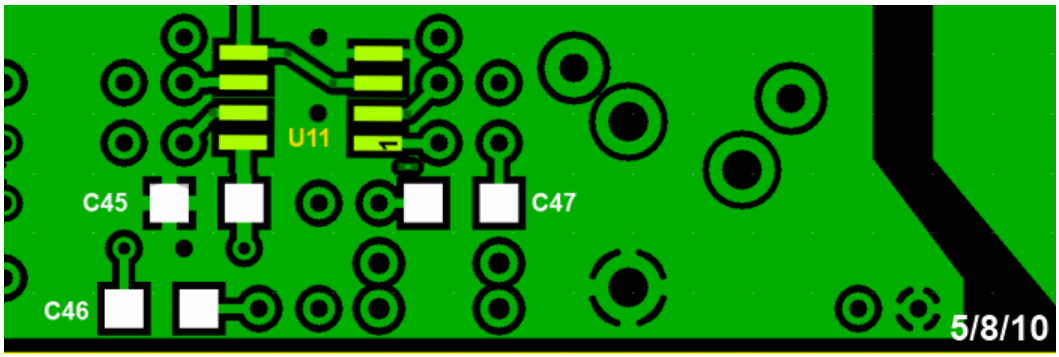
When installing the jumpers to the line-in jack, the builder is advised to install them crosswise (i.e., in the "X" pattern), rather than straight (in the parallel pattern), using insulated hookup wire to avoid shorts. This will make the receiver adaptable to all currently published SDR software. While the outputs would appear reversed to Rocky and Winrad, those two programs have a programmatic "switch I and Q lines" setting that can compensate. The PSDR versions do not have such a setting.



Check	Designation	Component	Marking	Category	Orientation	Notes
❑	C22	4.7 uF 10% 16V X7R RAD	475 	Ceramic	horiz	

❑	C24	390 pF 5%	391 	Ceramic	vert	
❑	C23	390 pF 5%	391 	Ceramic	vert	
❑	R32	4.99 k 1/4W 1%	y-w-w-br-br 	1/4W	N-S	
❑	R33	4.99 k 1/4W 1%	y-w-w-br-br 	1/4W	N-S	
❑	R34	120 1/6W 5%	brn-red-brn-gld 	1/6W	E-W	
❑	R35	120 1/6W 5%	brn-red-brn-gld 	1/6W	E-W	
❑	JP1A	shunt wire (cut-off lead)		Cutoff		
❑	JP1B	shunt wire (cut-off lead)		Cutoff		
❑	J02	3.5mm stereo jack - PCB mount (rt-angle)		Jack-RA		

Bottom of the Board



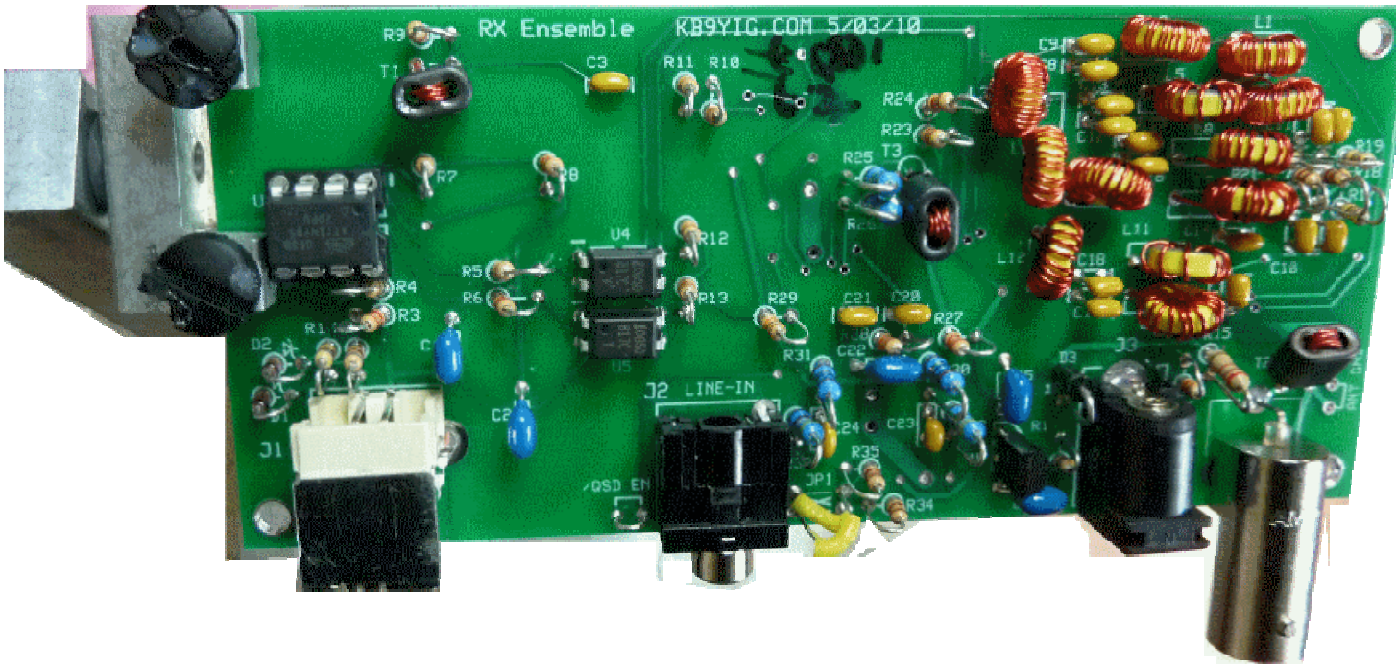
Install Bottomside Parts

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	U11	LT6231 dual op-amp	LT6231 	SOIC-8	(or LT6221)	Take ESD precautions
❑	C45	0.1 uF	(smt) black stripe	SMT 1206	white pads	
❑	C46	0.1 uF	(smt) black stripe	SMT 1206	white pads	
❑	C47	0.1 uF	(smt) black stripe 	SMT 1206		

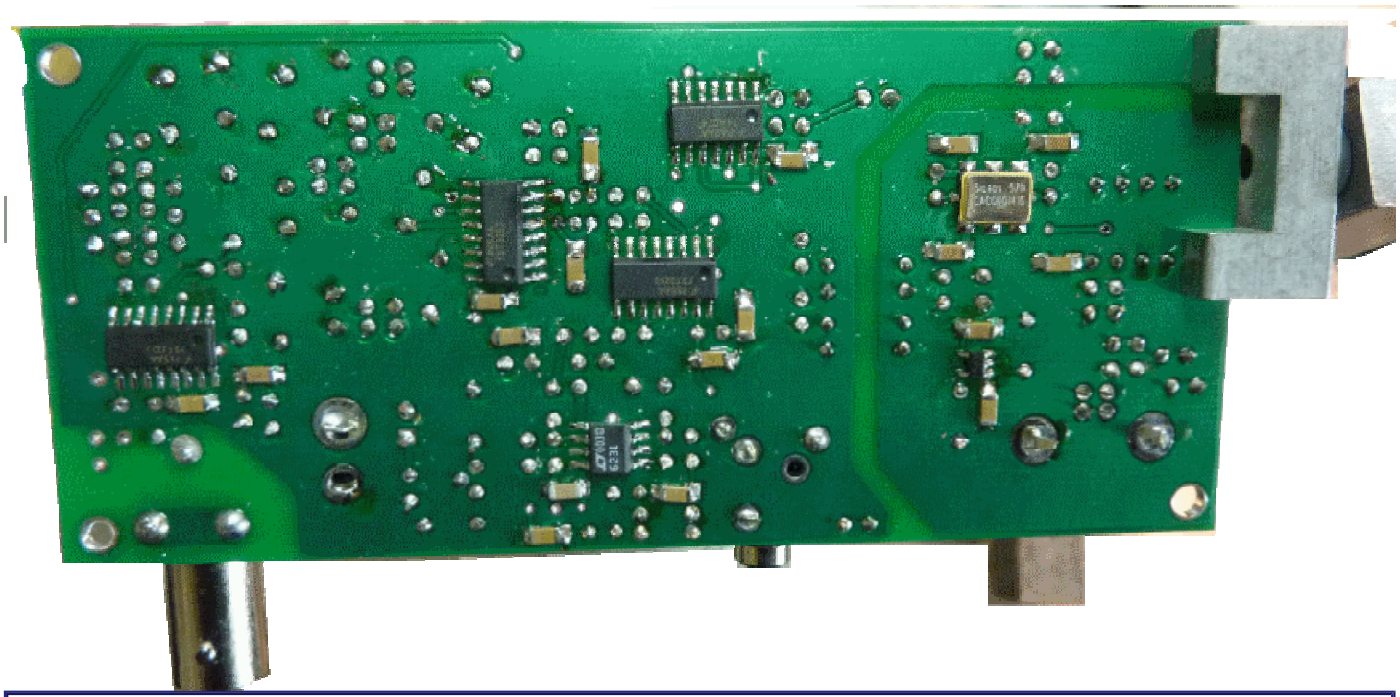
Operational Amplifiers Completed Stage

(These photos were of an earlier board design. It has changed since the author built the kit upon which these notes are based. The board layout graphics are, however, current.)

Top of the Board



Bottom of the Board



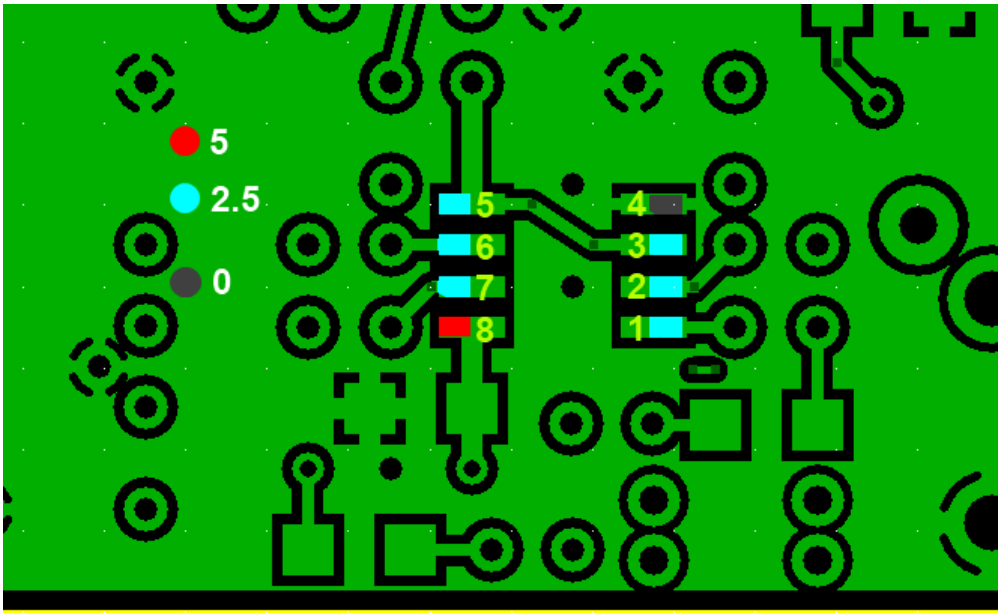
Operational Amplifiers Testing

Pin Voltage Tests

Test Setup

Test pin voltages WRT regular ground, as per graphic

As usual, if you are having any problems with this stage, be sure to measure the pin voltages two ways: first, measure each pin at the pin itself (on the IC). Then take a second measurement at the pin pad (on the board). If those two measurements do NOT agree, you very likely have a soldering issue.



Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
Pin 1 (50% of 5V rail)	V dc	2.5	2.45	
Pin 2 (50% of 5V rail)	V dc	2.5	2.43	
Pin 3 (50% of 5V rail)	V dc	2.5	2.43	
Pin 4 (gnd)	V dc	0	0	
Pin 5 (50% of 5V rail)	V dc	2.5	2.43	
Pin 6 (50% of 5V rail)	V dc	2.5	2.43	
Pin 7 (50% of 5V rail)	V dc	2.5	2.46	
Pin 8 (5V rail)	V dc	5	4.92	

Functional Test

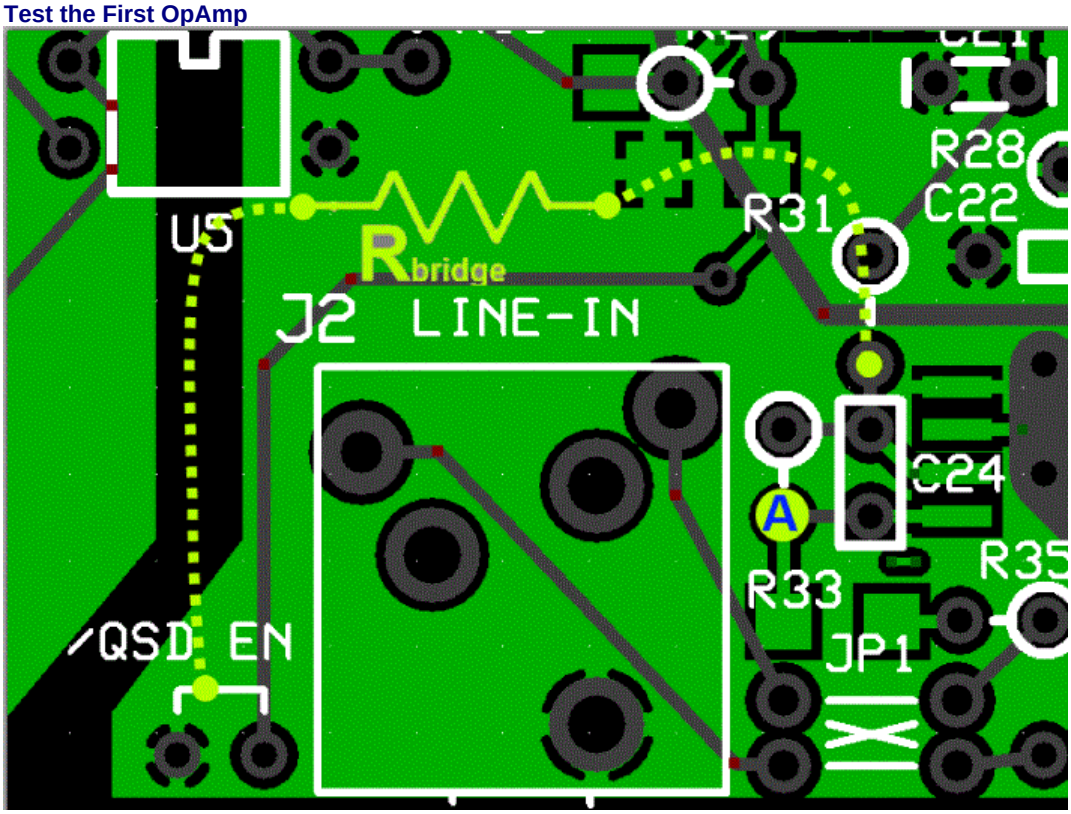
Test Setup

Test Setup

In this test, you will test the DC gain of each of the op-amps by connecting a bridging resistor R_b from each op-amp inverting input to circuit regular ground. Introducing the "bridging" resistor R_b will result in a test current equal to 2.5 / R_t, which will be balanced by the current fed back from each op-amp's output through each feedback resistor, R_f (i.e., R33 or R32). Each op-amp output will increase in voltage by 2.5 * R_f/ R_b from the nominal DC level of 2.5 volts.

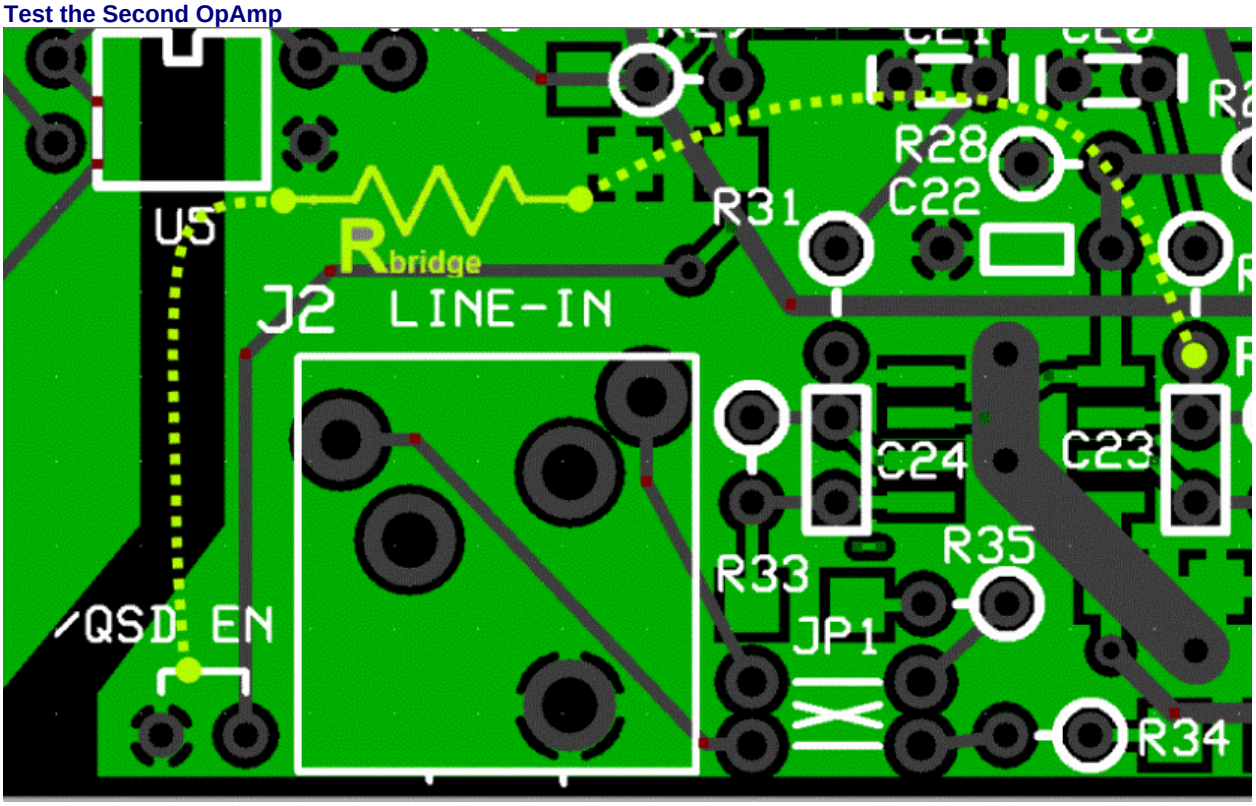
You will need to obtain a 10k resistor from your junk box or other source for this test.

Test the First OpAmp



1. Power up the circuit and measure the voltage at pin 1 of the op-amp (hairpin of R33). It should be ~2.5 Vdc
2. Power off and use clip leads to connect R_b between the hairpin of R31 and circuit ground. This provides an input resistance(R_i) of 10 kΩ, to the op-amp.
3. Power up and measure the output voltage (WRT regular ground) at the hairpin of the feedback resistor R33. You should get ~3.75 Vdc at R33 hairpin.
4. Remove R_b and the output voltage at R33 should go back to ~2.5 Vdc.

Test the Second OpAmp



1. Power up the circuit and measure the voltage at pin 1 of the op-amp (hairpin of R32). It should be ~2.5 Vdc

2. Power off and use clip leads to connect R_b between the hairpin of R30 and circuit ground. This provides an input resistance(R_i) 10 kΩ, to the op-amp.
3. Power up and measure the output voltage (WRT regular ground) at the hairpin of the feedback resistor R32. You should get: ~3.75 Vdc at R32 hairpin.
4. Remove R_b and the output voltage at R32 should go back to ~2.5 Vdc.

The diagram below shows the test points. The yellow dots show the R_b connection points for each "side" of the opamps. The dots marked "A" and "B" show the measurement points for the output voltages for Each "side" of the OpAmps.

An Excel spreadsheet with a calculator for this test is available for you to plug in your bridging resistor ohms (R_t) and your pin 1 or pin 7 normal voltages (E_{bias}) and predict the expected voltage when bridged (E_{out}).

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
"A" (hairpin lead of R33 (NOT bridged)	V dc	2.5	2.45	
"A" (hairpin lead of R33 (bridged)	V dc	3.75	3.66	
"B" (hairpin lead of R32 (NOT bridged)	V dc	2.5	2.46	
"B" (hairpin lead of R32 (bridged)	V dc	3.75	3.68	

RX Test

Test Setup

Prepare an SDR program for RX (author recommends Rocky for the Windows XP crowd; WinradHD for other Windows OS). This usually involves downloading and installing the program; selecting the desired soundcard for the (STEREO) input of the I and Q signals from the board; and connecting the board to the soundcard with a stereo cable with 1/8" stereo plugs on either end..

Once the SDR program is ready, connect the USB cable from your PC to the board, connect the 12V power to the board, and connect a 50 ohm antenna to J4.

Start the SDR program and adjust the LO frequency to the desired center frequency. You should see signals in the displayed spectrum. If there is a contest going on at test time, you will be even more impressed with the RX.!

Note: for either SDR program to work with the Ensemble RX, you MUST have installed the driver (libusb) for the Microcontroller's USB functionality. For WinradHD, you will also need to have downloaded and saved in the same directory as WinradHD, the EXTIO_Si570.dll file.

If you are seeing perfect mirror inages of the signals either side of the center frequency, you should review the information in the Image Rejection Hints page.

> *If you installed the I/Q jumpers as suggested, you will need (in Rocky and/or Winrad) to switch the I and Q inputs to get signals properlay arrayed on the correct "side" of the center frequency.*

Note that there is an optional grounding via for the return side of the antenna connection. Normally, you would want to ground this to regular circuit ground. However, if you encounter significant ground loop problems, you may want to un-ground the antenna shield side.