Softrock Lite II Project

Home Bill of Materials Power Supply Local Oscillator Divider Operational Amplifiers Band Pass Filter Mixer External Connections Comments Acronyms Inventory Revisions as of 10/7/2010 Components By Stage WB5RVZ Main Website

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Project Introduction

General

This set of builders notes is replaces and supercedes the notes for the original SR Lite II design, now documenting a combined kit with all of the components required to do any of the five available options (post 1 Jun1 2010). The original design's schematic dates back to December 2009. The current design's schematic is depicted in the Schematic Section, below.

The Softrock Lite II, the sequel to the SR Lite V6.2 series , provides an economical entry-level kit for the ham or SWL who wants to experiment with Software Defined Radio (SDR).

The Lite II circuit board size is 2.5 inches by 0.9 inches. All SMT components are mounted on the bottom of the board .

Ordering Information

Prices and availability of the kit are found at the Softrock Ordering Website.

This kit was originally offered in several versions, corresponding to bands of interest. It has, since, changed over to the Combined Lite II. This "combined" kit will include all components needed to build the kit as a 160m, 80m, 40m, 30m, or 20m receiver. The 15m option is no longer offered. The builder can decide which kit to build at commencement of the build; the parts for any of the options are included in the shipment. The Combined Lite II kit will be priced at $20 plus $1 for US postage or $2 for DX postage.

As of 11 June, 2010, the options in this series will include:

40m kit option (the example used herein)

- 40m kit will tune the following ranges:
- 40m when used with a soundcard that samples at 48 kHz - 7.032 to 7.08 MHz
- 40m when used with a soundcard that samples at 96 kHz - 7.008 to 7.104 MHz

- 80m kit option
  - 80m kit will tune the following range:
  - 80m when used with a soundcard that samples at 48 kHz - 3.49825 to 3.54625 MHz
  - 80m when used with a soundcard that samples at 96 kHz - 3.47425 to 3.57025 MHz
- 160m kit option
  - 160m kit will tune the following range:

  - 160m when used with a soundcard that samples at 48 kHz - 1.819 to 1.867 MHz
  - 160m when used with a soundcard that samples at 96 kHz - 1.795 to 1.891 MHz

- 30m kit option
  - 30m kit will tune the following range:
  - 30m when used with a soundcard that samples at 48 kHz - 10.100 to 10.148 MHz
  - 30m when used with a soundcard that samples at 96kHz - 10.076 to 10.172 MHz

- 20m kit option
  - 20m kit will tune the following range:
  - 20m when used with a soundcard that samples at 48 kHz - slightly below 14.024 to 14.070 MHz
  - 20m when used with a soundcard that samples at 96 kHz - slightly below 14.00 to 14.094 MHz

The 30m and 20m kits will all make use of 1/3 sub- harmonic sampling.

Prices for any one of the above kits are found at the Softrock Ordering site.

Original Versions of SR Lite II

Before the current Combined SRLite II, the SR Lite II came in six versions corresponding to the 160, 80, 40, 30, 20, and 15m bands. These versions were described in the common schematic, which had a table of band-specific component values. The changes from that schematic to the current version are summarized below:

- Drop 15m option
- X1 now 14.089MHz for 80m.
- C8/C9 no longer band-specific; now 390 pF
- R7/R8 no longer band-specific; now 4.99k
- R5 and R6 are now band-specific (49.9Ω on 160, 80, 40; 10Ω on 30, 20)
- Toroids all go to T30-6
- New L1 and T1 winding info for all (all have same uH as original versions, except 30m T1, which goes to 0.18 uH)
- U4 no longer band-specific - it is LT6231 in all options

Original SR Lite II Builders Notes

The original notes were compiled into a PDF file by Philippe F6CZV for those who are still working with the original, now superceded SR Lite (non-combined) kit. Please note that the design of that original kit and the currently offered (from KB9YIG) kit is quite different. Don't get them confused!

Note: 8.215 MHz SoftRock Lite II for K3 IF application

Tony also offers a version of the Softrock Lite II kit that provides panadaptor capability on a K3 by tapping into the IF.

The SoftRock operates with the crystal frequency divided by 4. The SoftRock center frequency will be about 8.191 MHz and when used with a soundcard that can sample at 96 kHz will give IF band coverage from 8.143 MHz to 8.239 MHz where the K3 IF center is 8.215 MHz.

The kit is built very much like this kit, with the exception of the following changes:

- C10 100pF
- C11 not used
- L1 34T of #30 on a T25-2 core (4.0 uH)
- T1 9T of #30 on primary and 5T of #30 in each of the two secondary windings "bifilar" over the top of the primary on a T25-2 core (0.25 uH on primary)
- C3 = 100 pF
- C4 = 1500 pF
- Crystal X1 is 32.768 MHz

Theory of Operation

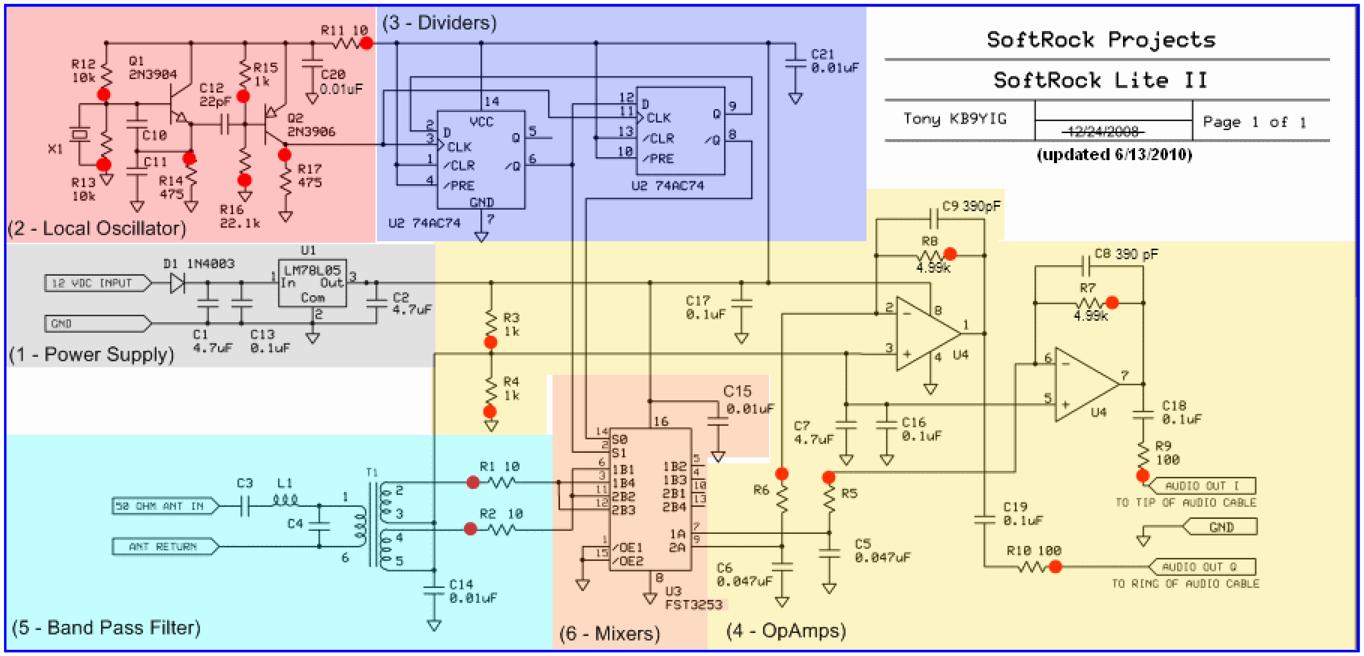
Many thanks to Jan G0BBL and Tony KB9YIG for their input to this and the stages' theoretical discussions.

- This receiver is patterned on the classic "direct conversion" receiver, in that it mixes incoming RF down to audio frequencies by, in effect, beating the RF against a Local oscillator such that the mixer products are in the sub 100 kHz range.
- Unlike the traditional DC receiver, the SDR does not "tune" the local oscillator's frequency to beat up against a desired RF signal. Instead, the local oscillator is at a fixed frequency.
- As a result, the (baseband) mixer products can vary in frequency from zero to +/- some theoretically high super-audio frequency. In fact, the practical limit is one-half the soundcard's maximum sampling rate.
- The "tuning" (and demodulation and AFC and other neat radio things) happen in the software part of the Software Defined Radio. It is the magic of Software that makes for the extraordinarily high selectivity in the direct conversion hardware (which is notorious for great sensitivity but terrible selectivity).
- The software requires the mixer's baseband products to be provided to the PC as two separate signals, each identical to the other, except that they are 90 degrees apart in phase ("in quadrature"). The SR Lite II achieves this by dividing the local oscillator's frequency by 4 (with attendant phase shifts to achieve quadrature).
- The output of the divider chain is two signals, I (In-Phase) and Q (Quadrature), identical in all respects but phase i.e., they are "in quadrature").
- RF from the antenna is bandpass-filtered for the band that is specific to the kit.
- The two quadrature signals from the Divider stage are fed into the mixer stage, which mixes the bandpass-filtered RF down to two baseband signals that are also in quadrature and otherwise identical to each other.
- These two signals are provided to an amplifier stage where they are amplified and low-pass filtered to levels acceptable to the PC's soundcard stereo line-in inputs.
- A soundcard which can sample 48 kHz, can digitize an incoming "chunk" of baseband signals from 0 to 24 kHz. Such a soundcard, using its stereo line-in inputs for the I and Q signals, will yield an effective bandwidth of 48 kHz: 24 kHz above the center frequency and 24 kHz below the center frequency. The SDR software in the PC manipulates the digitized I and Q signals to deliver, demodulate, condition, and filter signals within this 48 kHz spectrum. Soundcards capable of higher sampling rates (e.g. 96 kHz or 192 kHz) will yield proportionately wider bandwidth, provided their internal audio filters do not cut off the higher audio frequencies.
- Mike Collins KF4BQ (whose photos of the completed board are found further on in this page) has performed extensive tests on this receiver and has found it to be an exceptionally powerful receiver. Considering the cost, nothing out there can beat it!

(go directly to build notes)

Project Schematic

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



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

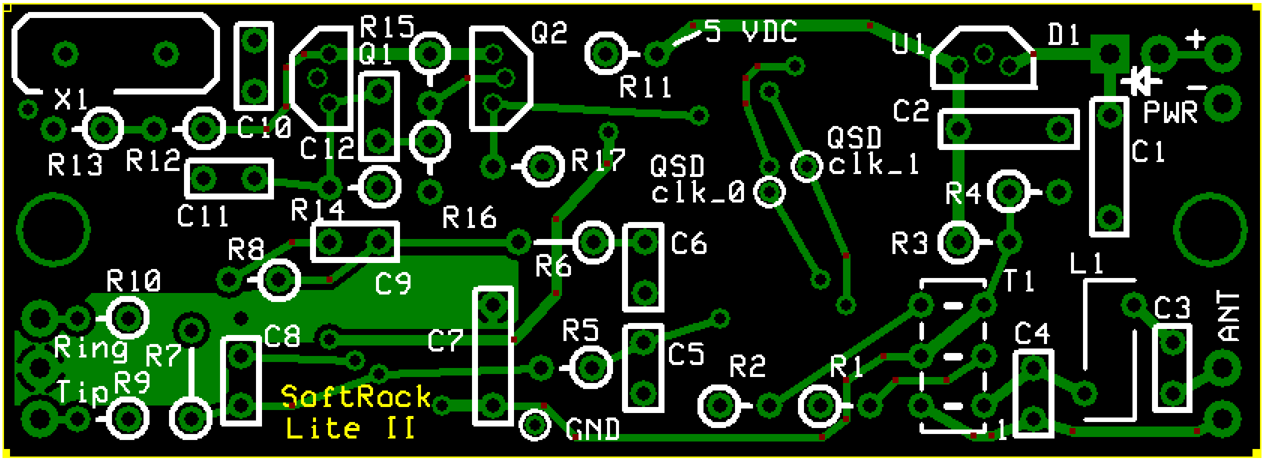
(go directly to build notes)

Project Bill of Materials

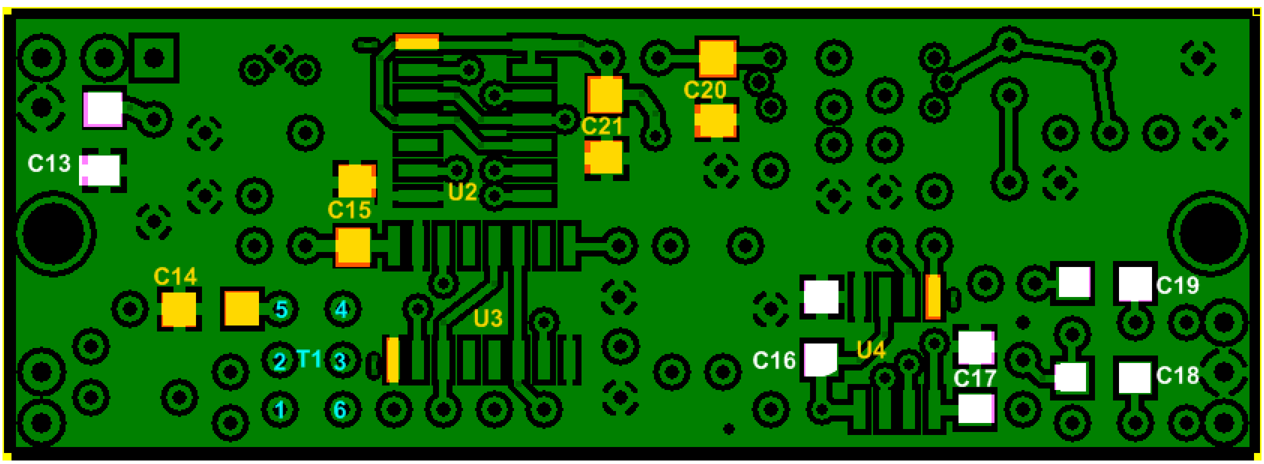
See Project Bill of Materials

Project Expert's (terse) Build Notes

Board Top



Board Bottom



Summary (Experts') Build Notes

(Tony Parks can build this kit in about 3 hours!)

10 June 2010: The latest schematic from Tony is available at this link. This schematic combines the schematics for the various options into a single schematic.

- Conduct BOM inventory. Note: the inventory covers all options, so there will be parts left over at the end of the build. Also note that some items in the inventory are expected to be builder-furnished (e.g., hookup wire, power cables, etc.
- Install all SMT Caps (bottomside)
- Install SMT ICs (bottomside). Note: you should install the 16 pin U3 BEFORE installing the 14 pin U2.

- Install 17 topside resistors. Note R5 and R6 are band-specific
- Install 12 topside ceramic capacitors (6 of which are band-specific)
- Install topside Semiconductors and IC (U1, D1, Q1, Q2)
- Install topside band-specific crystal and grounding lead
- Install and wind topside band-specific inductors (L1 and T1)
- Make external connections
- load and run Rocky and test the radio

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 Local Oscillator Stage
- Build and Test the Divider Stage
- Build and Test the Operational Amplifiers Stage
- Build and Test the Band Pass Filter Stage
- Build and Test the Mixer Stage
- Build and Test the External Connections 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.

Project 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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Softrock Lite II 01_Power Supply

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Power Supply Introduction

General

In this first (and following) stages, the builder should remember that one of the most common causes of errors is soldering. It pays to review materials on soldering, get help from Elmers, or whatever you can do to make your solder joints as clean and properly conductive as possible!

The second most common cause of errors is installation of the WRONG component and/or installing the component in the wrong ORIENTATION. The old rule of "measure twice, cut once" clearly applies to this project. Be especially careful and beware that it is very easy to install the wrong resistor depending entirely in color codes. While color codes are helpful in initially sorting resistors out, it is imperative that you validate that you have the correct resistor by double checking with your ohmmeter. While the ohmmeter reading will never be the exact value, for most of the resistors in this kit, the ohmmeter will get you to within 1% (a very few some are within 5%) of the stated value

The remaining one-tenth of one percent of the causes of errors is the defective component - most suspect the component immediately; the intelligent rarely look first at possible component failure.

Theory of Operation

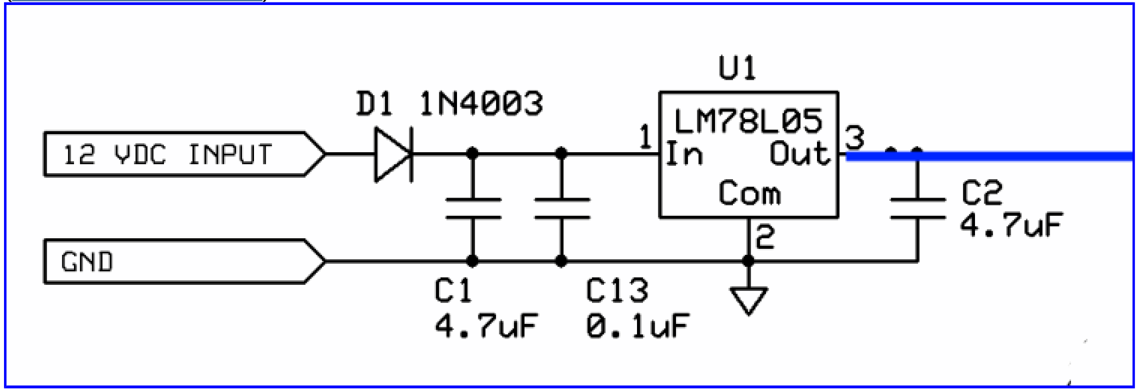
This stage provides the +5 volt power rail for the radio. The incoming voltage (from 9 - 12 Vdc) is regulated by U1 to a nominal 5 Vdc (4.5 - 5.1 Vdc range). D1 serves to protect the circuit from accidentally reversed polarity.

(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)



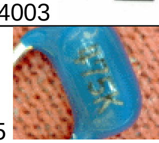
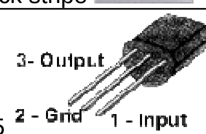
(above schematic has clickable areas that can be used for navigation)

(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)

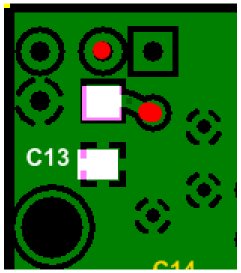
Check	Count	Component	Marking	Category
❑	1	1N4003	1N4003 	Axial
❑	2	4.7 uF 10% 16V X7R RAD	475 	Ceramic
❑	1	shunt wire (cut-off lead)		Cutoff
❑	1	0.1 uF	(smt) black stripe 	SMT 1206
❑	1	LM78L05 voltage regulator	LM78L05 	TO-92

Power Supply Summary Build Notes

- Install SMT cap
- Install topside components
- Install ground test loop
- Test the Stage

Power Supply Detailed Build Notes

Bottom of the Board



Install SMT cap

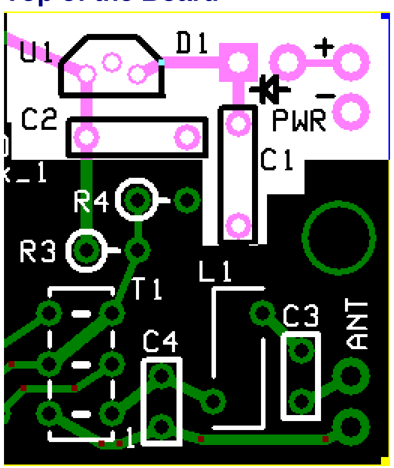
Install C13 SMT 0.1 uF cap

Take care to avoid solder "splashover" that could clog up the thru-holes above and to the right of C13 (see red dots in above graphic)

See hints on installing SMT Caps.

Check	Designation	Component	Marking	Category	Orientation	Notes
❏	C13	0.1 uF	(smt) black stripe 	SMT 1206	SMT	

Top of the Board

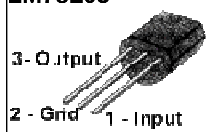
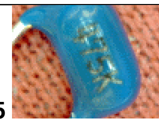
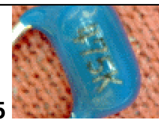


Install topside components

Install the two blue capacitors, U1, and D1. Install D1 such that the cathode end (the end with the band) is facing up and forms a hairpin. The hairpin lead will go into the square thru-hole (refer to the Completed Stage, Topside picture below).

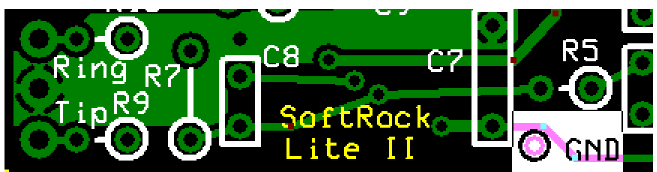
See hints on identifying and installing Ceramic Capacitors

Take care to correctly identify the Voltage regulator, U1. It is a TO92 package, as are the 2N390x transistors. Some have had the misfortune of installing one of the 2N390x transistors in this stage, with strange results.

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	U1	LM78L05 voltage regulator	LM78L05 	TO-92		Take ESD precautions
❑	D1	1N4003	1N4003 	Axial	E-W	
❑	C01	4.7 uF 10% 16V X7R RAD	475 	Ceramic		
❑	C02	4.7 uF 10% 16V X7R RAD	475 	Ceramic		

Install ground test loop

Using a short length of cut-off resistor or capacitor lead, fashion a short wire loop and solder it to the "ground" hole, such that the loop is available on the topside to provide a ground point for tests.



Check	Designation	Component	Marking	Category	Orientation	Notes
❑	gnd	shunt wire (cut-off lead)		Cutoff		

Power Supply Testing

Visual Inspection

Test Setup

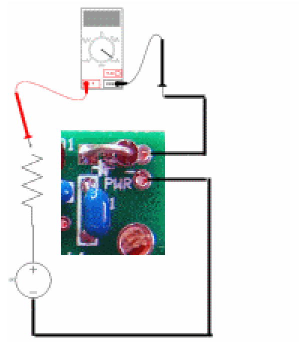
Using very good lighting and magnification, carefully inspect the solder joints to identify bridges, cold joints, or poor contacts.

Current Draw

Test Setup

Test for current draw in 2 ways:

- Use a 12 volt power supply
- In one test there is also a 1k resistor in the series "chain" as well.
- in the second test, the setup is the same except that the current-limiting resistor is removed



(measurements courtesy of Leonard KC0WOX)

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
With 1k limiting resistor	mA	< 9	4.1	
Without current limiting resistor	mA	3 - 6	4.4	

Voltage Test

Test Setup

Once the current draw test is successfully passed:

- Apply 12 Vdc (NO current limiting resistor) to the PWR + and - pads (upper right-hand corner of the board)
- Measure the voltage with respect to ground at the testpoints below

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
R11 hairpin (5 Vdc point)	Vdc	5	4.93	
D1 cathode (square hole)	Vdc	11-13	12.2	

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Softrock Lite II 02_Local Oscillator

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Local Oscillator Introduction

General

Note: The crystals included with the Lite II Combined kit are:

- ECS-73-18-4XEN a 7.3728 MHz crystal giving a 160m center frequency of about 1.843 MHz,
- ABLS-14.08919MHZ-10-J4Y a 14.089 MHz crystal giving an 80m center frequency of about 3.522 MHz,
- HC49US-28.224MABJ-UB a 28.224 MHz crystal giving a 40m center frequency of a bout 7.055 MHz,
- HC49US-13.500MABJ-UB a 13.5 MHz crystal giving a 1/3 sub-harmonic sampled 30m center frequency of about 10.125 MHz,
- 18.730 MHz crystal giving a 1/3 sub-harmonic sampled 20m center frequency of about 14.047 MHz.

Theory of Operation

The Local Oscillator stage implements a basic Colpitts Crystal Oscillator with a buffer stage to increase the signal level. The oscillator produces a signal that is at the crystal's specified fundamental frequency.

See the table in the lower right-hand corner of the schematic below for the frequencies produced by this stage, for the appropriate band/kit.

In reality, for each frequency the crystal circuit will oscillate at a slightly lower frequency (~ - 1 kHz), due to the capacitive divider (C10/C11) pulling the crystal down somewhat. The effect is more pronounced for the higher bands.

Sub-harmonic Sampling

Alan, G4ZFQ points out that on the 30m, 20m, 15m receivers, the Local Oscillator produces a signal that is 4/3 times the desired center frequency as opposed to the 4x the center frequency output for the lower band models.

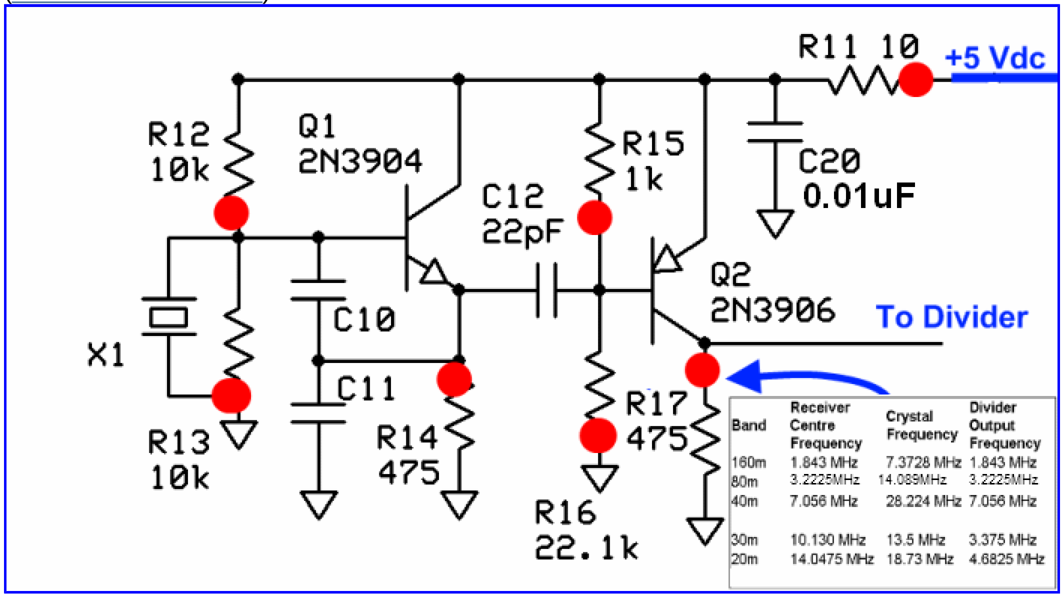
"Subharmonic" works like this:- The LO outputs a 13.5MHz signl that goes to the dividers /4, resulting in 1 3.375MHz square wave (rich in odd harmonics) being fed to the mixer. At the mixer, a strong 3rd harmonic is present on the clock inputs, along with the fundamental of 3.375 MHz. The 3.375 fundamental multiplied by 3 yields the third harmonic of 10.125MHZ. The Bandpass filter (BPF) performs the essential function of severely attenuating any signals centered around the 3.375MHz fundamental frequency and first harmonmic, but allows 30m signals centering around the third harmonic of the 3.375MHz LO output. The result is that the mixer is dealing with signals in the passband, centering on 10.125MHz, as though the dividers were passing a fundamental frequency of 10.125 to the mixer. BPFs are all that stop Softrocks from working on unwanted frequencies!

(go directly to build notes)

Local Oscillator 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)

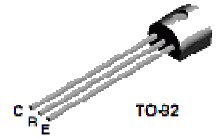
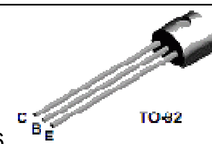
(go directly to build notes)

Local Oscillator Bill of Materials

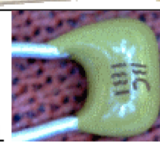
Stage Bill of Materials

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

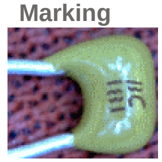
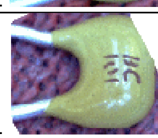
Check	Count	Component	Marking	Category
❏	1	1 k 1/4W 1%	br-blk-blk-br-br	1/4W
❏	2	10 k 1/4W 1%	br-blk-blk-r-br	1/4W
❏	1	10 ohm 1/4W 1%	br-blk-blk-gld-br	1/4W
❏	1	22.1 k 1/4W 1%	r-r-brn-r-br	1/4W
❏	2	475 1/4W 1%	y-v-grn-bl-br	1/4W
❏	1	22 pF 5%	 22J	Ceramic
❏	1	band-specific		misc
❏	1	band-specific		misc
❏	1	band-specific		misc

❏	1	0.01 uF	(smt) 	SMT 1206
❏	1	[2N3904 NPN Transistor]	2N3904 	TO-92
❏	1	[2N3906 PNP transistor]	2N3906 	TO-92

Band Specific Items for 160m Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❏	C10	330 pF 5%	331 	Ceramic			Local Oscillator
❏	C11	180 pF 5%	 181	Ceramic		Not used at all for 40m & 15m versions	Local Oscillator
❏	X1	7.3728 MHz	ECS-73-18-4XEN	Xtal			Local Oscillator

Band Specific Items for 80m Band

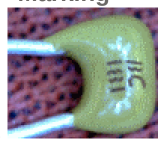
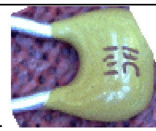
Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❏	C10	180 pF 5%	 181	Ceramic			Local Oscillator
❏	C11	100 pF 5%	 101	Ceramic		Not used at all for 40m & 15m versions	Local Oscillator
❏	X1	14.089 MHz	ABLS-14.08919MHZ-10-J4Y	Xtal		6_10_2010	Local Oscillator

Band Specific Items for 40m Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❏	C10	100 pF 5%	 101	Ceramic			Local Oscillator

❏	C11	unused capacitor		Unused		Not used at all for 40m & 15m versions	Local Oscillator
❏	X1	28.224 MHz	HC49US-28.224MABJ-UB	Xtal			Local Oscillator

Band Specific Items for 30m Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❏	C10	180 pF 5%	 181	Ceramic			Local Oscillator
❏	C11	100 pF 5%	 101	Ceramic		Not used at all for 40m & 15m versions	Local Oscillator
❏	X1	13.5 MHz	HC49US-13.500MABJ-UB	Xtal			Local Oscillator

Band Specific Items for 20m Band

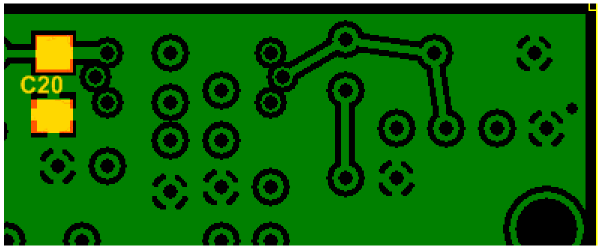
Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❏	C10	180 pF 5%	181 	Ceramic			Local Oscillator
❏	C11	100 pF 5%	101 	Ceramic		Not used at all for 40m & 15m versions	Local Oscillator
❏	X1	18.73 MHz	18.730 1108	Xtal			Local Oscillator

Local Oscillator Summary Build Notes

- Install SMT cap
- Install Crystal
- Install Ceramic Capacitors
- Install transistors
- Install Resistors
- Test the Stage

Local Oscillator Detailed Build Notes

Bottom of the Board

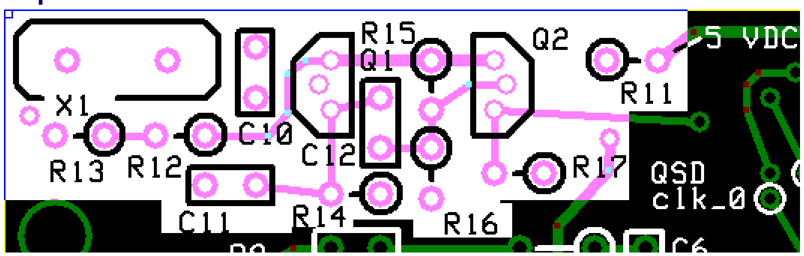


Install SMT cap

See hints on installing SMT Caps.

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	C20	0.01 uF	(smt) 	SMT 1206		

Top of the Board

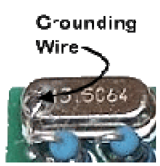


Install Crystal

See Band-specific Components chart for value.

Mount the HC49 crystal mounting in the upper left corner of the board, mounting it vertically to the board. A small plated-through hole in the lower left corner of the crystal mounting position provides a place for a grounding wire to be soldered to the metal crystal case. The grounding wire also provides additional mechanical support for the crystal.

Make sure the crystal is mounted slightly above the board. You can use a piece of cardboard or wire insulation between the bottom of the crystal and the board to get the desired standoff distance while mounting X1.



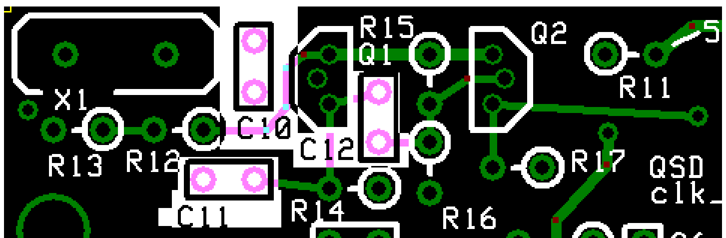
Check	Designation	Component	Marking	Category	Orientation	Notes

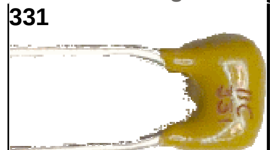
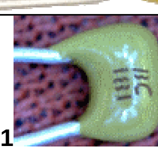
<table>
<tr><td>❏</td><td>X1</td><td>band-specific</td><td><table><tr><th>Band</th><th>Component</th><th>Marking</th></tr><tr><td>160m</td><td>7.3728 MHz (Xtal)</td><td>ECS-73-18-4XEN</td></tr><tr><td>80m</td><td>14.089 MHz (Xtal)</td><td>ABLS-14.08919MHZ-10-J4Y</td></tr><tr><td>40m</td><td>28.224 MHz (Xtal)</td><td>HC49US-28.224MABJ-UB</td></tr><tr><td>30m</td><td>13.5 MHz (Xtal)</td><td>HC49US-13.500MABJ-UB</td></tr><tr><td>20m</td><td>18.73 MHz (Xtal)</td><td>18.730 1108</td></tr></table></td><td>misc</td><td></td><td></td></tr>
</table>

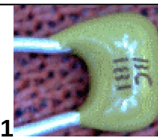
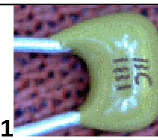
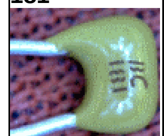
Install Ceramic Capacitors

See Band-specific Capacitors chart for value.

See hints on identifying and installing Ceramic Capacitors.



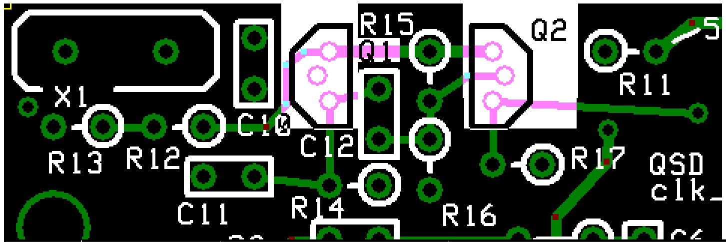
<table>
<tr><th>Check</th><th>Designation</th><th>Component</th><th>Marking</th><th>Category</th><th>Orientation</th><th>Notes</th></tr>
<tr><td>❏</td><td>C12</td><td>22 pF 5%</td><td>
22J</td><td>Ceramic</td><td></td><td></td></tr>
<tr><td>❏</td><td>C10</td><td>band-specific</td><td><table><tr><th>Band</th><th>Component</th><th>Marking</th></tr><tr><td>160m</td><td>330 pF 5% (Ceramic)</td><td>331
</td></tr><tr><td>80m</td><td>180 pF 5% (Ceramic)</td><td>
181</td></tr></table></td><td>misc</td><td></td><td></td></tr>
</table>

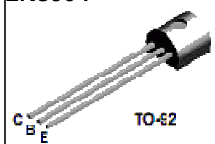
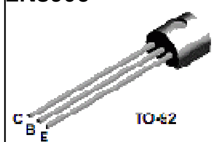
<table>
<tr><td></td><td></td><td></td><td><table>
<tr><td>40m</td><td>100 pF 5% (Ceramic)</td><td>101 </td></tr>
<tr><td>30m</td><td>180 pF 5% (Ceramic)</td><td>181 </td></tr>
<tr><td>20m</td><td>180 pF 5% (Ceramic)</td><td>181 </td></tr>
</table></td><td></td><td></td><td></td></tr>
<tr><td>❏</td><td>C11</td><td>band-specific</td><td><table>
<tr><th>Band</th><th>Component</th><th>Marking</th></tr>
<tr><td>160m</td><td>180 pF 5% (Ceramic)</td><td>181 </td></tr>
<tr><td>80m</td><td>100 pF 5% (Ceramic)</td><td>101 </td></tr>
<tr><td>40m</td><td>unused capacitor (Unused)</td><td></td></tr>
<tr><td>30m</td><td>100 pF 5% (Ceramic)</td><td>101 </td></tr>
<tr><td>20m</td><td>100 pF 5% (Ceramic)</td><td>101 </td></tr>
</table></td><td>misc</td><td></td><td>Not used at all for 40m & 15m versions</td></tr>
</table>

Install transistors

Mount the two transistors being careful to orient them according to the pattern in the silkscreen.

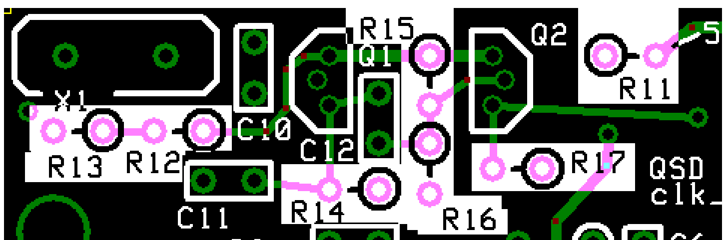
Take care not to get 2N3904 and 2N3906 mixed up. Carefully check the last digit.



Check	Designation	Component	Marking	Category	Orientation	Notes
❏	Q1	2N3904 NPN Transistor	2N3904 	TO-92		
❏	Q2	2N3906 PNP transistor	2N3906 	TO-92		

Install Resistors

See hints on installing and orienting resistors



Check	Designation	Component	Marking	Category	Orientation	Notes
❏	R11	10 ohm 1/4W 1%	br-blk-blk-gld-br 	1/4W	W-E	
❏	R14	475 1/4W 1%	y-v-grn-bl-br 	1/4W	E-W	
❏	R17	475 1/4W 1%	y-v-grn-bl-br 	1/4W	E-W	
❏	R15	1 k 1/4W 1%	br-blk-blk-br-br 	1/4W	N-S	
❏	R12	10 k 1/4W 1%	br-blk-blk-r-br 	1/4W	E-W	
❏	R13	10 k 1/4W 1%	br-blk-blk-r-br 	1/4W	E-W	
❏	R16	22.1 k 1/4W 1%	r-r-brn-r-br 	1/4W	N-S	

Local Oscillator Testing

Visual Check

Test Setup

Using very good lighting and magnification, carefully inspect the solder joints to identify bridges, cold joints, or poor contacts.

Current Draw

Test Setup

- connect a 1k ohm resistor in series with the positive power lead
- apply 12 Vdc and measure the current draw with the limiting resistor in place
- remove the current limiting resistor
- apply 12 Vdc and measure the current draw without the limiting resistor

(measurements courtesy of Leonard KC0WOX)

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
With the 1k limiting resistor	mA	< 9	7.3	______
Without current limiting resistor	mA	< 20	14.1	______

Voltage Tests

Test Setup

- Power the board
- Measure the testpoint voltages with respect to ground

Note that some of the voltages measured may have ac components, which, depending upon your DMM, may average in with the dc voltages to produce higher apparent dc voltages than theory would suggest.

Author measured the dc voltage at R17 using a scope and got ~2.6 Vdc. Per Alan, G4ZFQ, This voltage (at R17) is not critical and can vary a lot, partly depending on the crystal. The important thing is that the LO's RF output is a good healthy signal and is detectable on an external RX (or counter or scope).

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
R11 hairpin	Vdc	4.5 - 5	4.9	______
R15 hairpin	Vdc	< R11 hairpin	4.7	______
R12 hairpin	Vdc	< 2.5	2.3	______
R17 hairpin	Vdc	> 2.0	4.2	______

LO Output Test

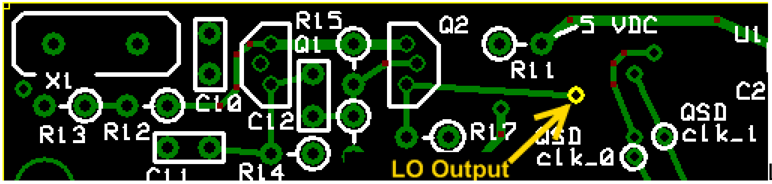
Test Setup

- On the 3 lower bands, the frequency of the LO’s output should be 4 times the desired center frequency e.g., 28.224 MHz for a desired center frequency of 7.056 MHz).
- If your kit is the 30m, 20m, or 15m kit, this is a little different. The higher band SoftRock Lite kits use 1/3 sub-harmonic sampling to give receive function. The center frequency is approximately 3 * XtalFrequency / 4 in MHz. The loss in sensitivity associated with the 1/3 sub-harmonic sampling, about 3 or 4 dB, is made up by 5x gain, (compared to the lower band SoftRock Lite kits), in the I / Q audio stage where a low-noise LT6231 op-amp is used in lieu of the TVL2462CD opamps
- The crystal frequency is band-specific, as follows:

Designation	Band	Frequency
X1	160m	7.3728 MHz

X1	80m	14.06 MHz
X1	40m	28.224 MHz
X1	30m	13.5 MHz
X1	20m	18.73 MHz
X1	15m	28.06 MHz

- You can use a ham receiver tuned to the appropriate crystal frequency. You should hear the LO's frequency.
- Scope measurements may be taken IF you have a high quality, calibrated scope with correctly compensated probes
- Note: 1/3 sub-harmonic sampling does reverse the spectrum. Changing the audio cable connections to the SoftRock Lite circuit board from tip to ring and ring to tip will correct the reversed spectrum so that the SDR software works the same for the higher band receivers as with the lower band receivers. (See Cecil K5NWA'a explanation of the sub-harmonic sampling in his message on the Yahoo Softrock group.



LO Output Test"

Home Bill of Materials Power Supply Local Oscillator Divider Operational Amplifiers Band Pass Filter Mixer External Connections Comments
Acronyms Inventory Revisions as of 10/7/2010 Components By Stage WB5RVZ Main Website

Softrock Lite II 03_Divider

Search: Search selected SDR sites

Divider Introduction

General

This stage will actually involve installing the remainder of the bottom-side SMT capacitors. In addition to the remaining SMT capacitors, you will also install two of the three bottom-side ICs:

- the Divider IC (U2), and
- the Mixer IC (U3)

Normally, the Mixer chip (U3) would be addressed in a separate "Mixer" Stage. However, due to the close proximity of the pads for the two Ics, U2 and U3, you will install it in this "Dividers" Stage.

The tests for U3 will be postponed until the "Mixer" Stage.

.

Theory of Operation

The dividers accept as input the output of the local oscillator and divide that down to two signals that are ¼ the input frequency and in quadrature (90 ° out of phase with each other).

U2 is wired as a divide-by-4 synchroneous divider, clocked by the output from the Local Oscillator. Synchroneous clocking means that all stages switch at the same time, potentially offering a reduction of noise generated during switching.

The divider provides two LO outputs which clock Mixer, U3. Proper Operation of the Dividers may be monitored on a CW or SSB receiver tuned to Divider Output Frequency listed in the table below.

Band	Divider Output Freq
160m	1.843 MHz
80m	3.525 MHz
40m	7.056 MHz
30m	3.375 MHz
20m	4.6825 MHz
15m	7.015 MHz

Note 1: A beat note should be heard when the antenna lead connected to a CW or SSB Receiver - tuned to Divider Output Frequency, is held near U2 on the SR Lite II PCB.

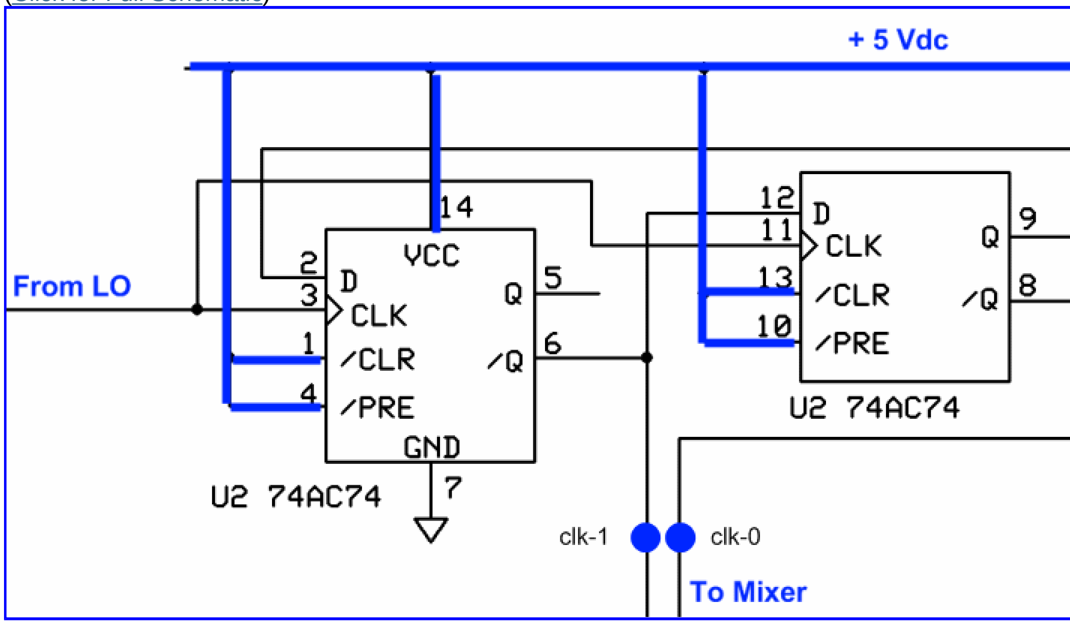
Note 2: All frequencies may be slightly below those stated in the table because of the loading capacitance is a little higher than specified for the nominal frequency of the Crystals supplied.

(go directly to build notes)

Divider 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)



Band	LO	Center	Clk
160	7.3728	1.843	1.843
80	14.06	3.515	3.515
40	28.224	7.056	7.056
30	13.5	10.125	3.375
20	18.73	14.0475	4.6825
15	28.06	21.045	7.015

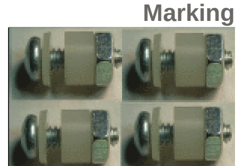
(above schematic has clickable areas that can be used for navigation)

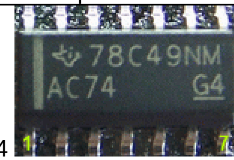
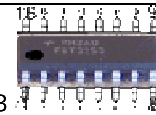
(go directly to build notes)

Divider Bill of Materials

Stage Bill of Materials

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

Check	Count	Component	Marking	Category
❏	2	4 X #4-40 hdw (nut, bolt, washer, spacer)		HDW
❏	3	0.01 uF	(smt) 	SMT 1206

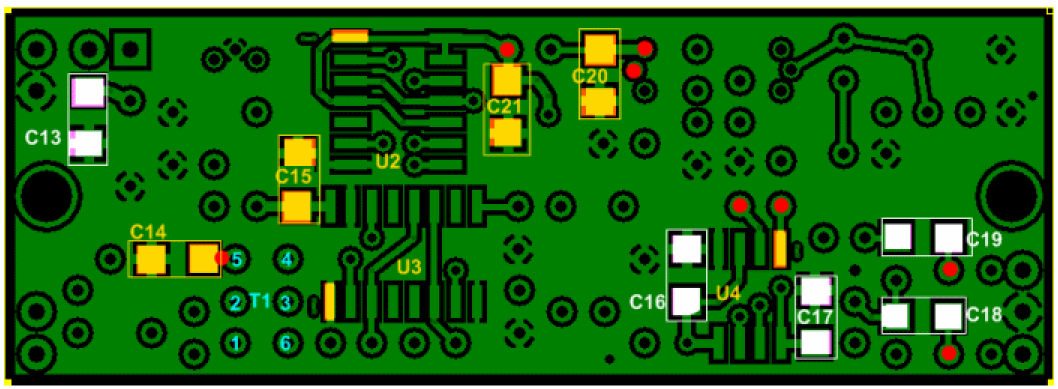
❑	4	0.1 uF	(smt) black stripe 	SMT 1206
❑	1	74AC74 Dual D FF	74AC74 	SOIC-14
❑	1	FST3253 mux/demux switch	FST3253 	SOIC-16

Divider Summary Build Notes

- Install remainder of the SMT Capacitors
- Install U3
- Install U2
- Install Hardware
- Test the Stage

Divider Detailed Build Notes

Bottom of the Board



Install remainder of the SMT Capacitors

We will use this stage to go ahead and install all of the remaining SMT bypass capacitors.

See hints on installing SMT Caps.

The pads for the 0.1 uF capacitors are highlighted in white on the board shown above. These capacitors are in carrier strips marked with a black stripe.

The yellow markings pertain to the 0.01 uF capacitors.

Be very careful when soldering the SMT capacitors, so as to avoid solder "splashover" that could clog the thru-holes for components installed later on in the project. The holes that are "at risk" are marked with a red dot on the above graphic. You might want to plug them up temporarily with a fine-pointed toothpick when soldering in their vicinity. The at-risk holes are associated with the following capacitors:

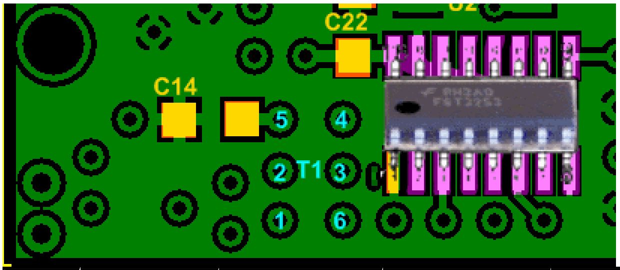
- ***C14 (the T1 secondary hole to the right of the cap)***
- ***C18 (R9's barrel hole at the bottom right of the cap)***
- ***C19 (R10's barrel hole at the bottom right of the cap)***
- ***C21 (R11's hairpin hole above the cap)***

Check	Designation	Component	Marking	Category	Orientation	Notes
❏	C14	0.01 uF	(smt) 	SMT 1206		
❏	C21	0.01 uF	(smt) 	SMT 1206		
❏	C15	0.01 uF	(smt) 	SMT 1206		
❏	C16	0.1 uF	(smt) black stripe 	SMT 1206		
❏	C17	0.1 uF	(smt) black stripe 	SMT 1206		
❏	C18	0.1 uF	(smt) black stripe 	SMT 1206		
❏	C19	0.1 uF	(smt) black stripe 	SMT 1206		

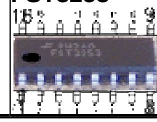
Install U3

You should install the 16 pin Mixer chip (U3) BEFORE installing the 14 pin divider chip (U2), due to layout considerations which could complicate the soldering of the Ics. The mixer will be tested in a [later stage](#).

See [hints on installing SMT ICs.](#)



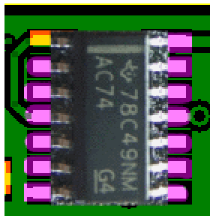
Check	Designation	Component	Marking	Category	Orientation	Notes

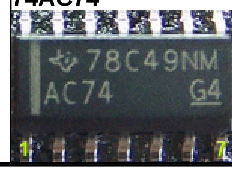
❏	U3	FST3253 mux/demux switch	FST3253 	SOIC-16		Take ESD precautions

Install U2

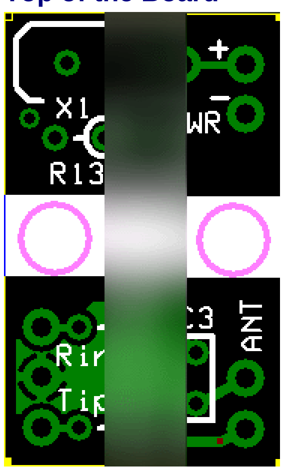
Install 74AC74 (U2) on the SOIC-14 pads on the bottom side of the board. Take ESD precautions

See hints on installing SMT ICs.



Check	Designation	Component	Marking	Category	Orientation	Notes
❏	U2	74AC74 Dual D FF	74AC74 	SOIC-14		Take ESD precautions

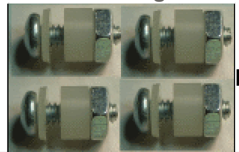
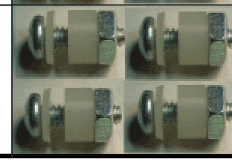
Top of the Board



Install Hardware

At this point you may install the two mounting screws and their associated hardware.

Install them with the screw head on the topside, then the board, then the spacer, then the washer, and finally the nut.

Check	Designation	Component	Marking	Category	Orientation	Notes
❏	**hdw1**	**4 X #4-40 hdw (nut, bolt, washer, spacer)**		**HDW**		
❏	**hdw2**	**4 X #4-40 hdw (nut, bolt, washer, spacer)**		**HDW**		

Divider Testing

Visual Check

Test Setup

Using very good lighting and magnification, carefully inspect the solder joints to identify bridges, cold joints, or poor contacts.

Pay especial attention to the joints on the divider IC pins. If necessary, touch up the joints with your iron and/or some flux. Wick up any excess.

(measurements courtesy of Leonard KC0WOX)

Current Draw

Test Setup

- connect a **100 ohm** resistor in series with the positive power lead
  - apply 12 Vdc and measure the current draw with the limiting resistor in place
  - remove the current limiting resistor
  - apply 12 Vdc and measure the current draw without the limiting resistor

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
With the **100 ohm** current-limiting resistor	mA	< 20	18.0	
Without current limiting resistor	mA	< 25	18.1	

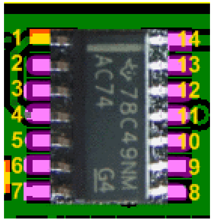
Voltage Tests

Test Setup

Measure the voltages with respect to ground for each of the pins of U2. Take care to measure at the actual IC pin rather than the pad, so as to ensure you are measuring the PIN voltage

expected voltages are indicated in the table below:

- 5 V (range of 4.5 - 5.4)
- 2.5 V (approx 50% of the 5V rail value)



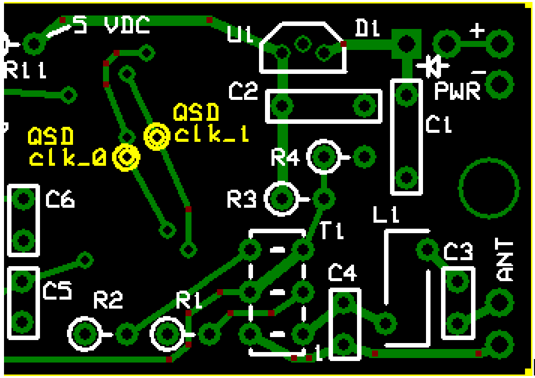
Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
Pin 1	Vdc	5	4.9	
Pin 2	Vdc	2.5	2.48	
Pin 3	Vdc	3.5 - 4.5	4.1	
Pin 4	Vdc	5	4.9	
Pin 6	Vdc	2.5	2.47	
Pin 7	Vdc	0	0	
Pin 8	Vdc	2.5	2.48	
Pin 9	Vdc	2.5	2.48	
Pin 10	Vdc	5	4.9	
Pin 11	Vdc	3.5 - 4.5	4.1	
Pin 12	Vdc	2.5	2.47	
Pin 13	Vdc	5	4.9	
Pin 14	Vdc	5	4.9	

Divider Output

Test Setup

- The divider provides the QSD clocking signals for the mixer stage, with the frequency determined by the band for your kit. The bands and their QSD clocking frequencies are:
  - 160m: 1.8432 MHz
  - 80m: 3.515 MHz
  - 40m: 7.056 MHz
  - 30m: 3.375 MHz (the mixer will actually use the 3rd harmonic, 10.125 MHz)
  - 20m: 4.6825 MHz (the mixer will actually use the 3rd harmonic, 14.0475 MHz)
  - 15m: 7.015 MHz (the mixer will actually use the 3rd harmonic, 21.045 MHz)
  - The divider divides the LO frequency by 4, producing 2 frequencies that are at ¼ of the LO frequency and are 90° out of phase with each other.
  - Using a ham receiver, dial up the QSD clocking frequency for the band in question and couple a wire from its antenna to point "QSD Clk 0" and then point "QSD Clk1" on the graphic below. You should hear the signal in the receiver.



Divider Output"

Mixer Test

Test Setup

The Mixer installation will be tested in a later stage. In the meantime, just carefully examine the soldering and placement of the IC using good magnification and light.

Home Bill of Materials Power Supply Local Oscillator Divider Operational Amplifiers Band Pass Filter Mixer External Connections Comments
Acronyms Inventory Revisions as of 10/7/2010 Components By Stage WB5RVZ Main Website

Softrock Lite II 04_Operational Amplifiers

Search: Search selected SDR sites

Operational Amplifiers Introduction

Theory of Operation

The low-level In-Phase (I) and Quadrature (Q) IF signals from the Mixer are sampled over capacitors C5 and C6 (in the Mixer stage).

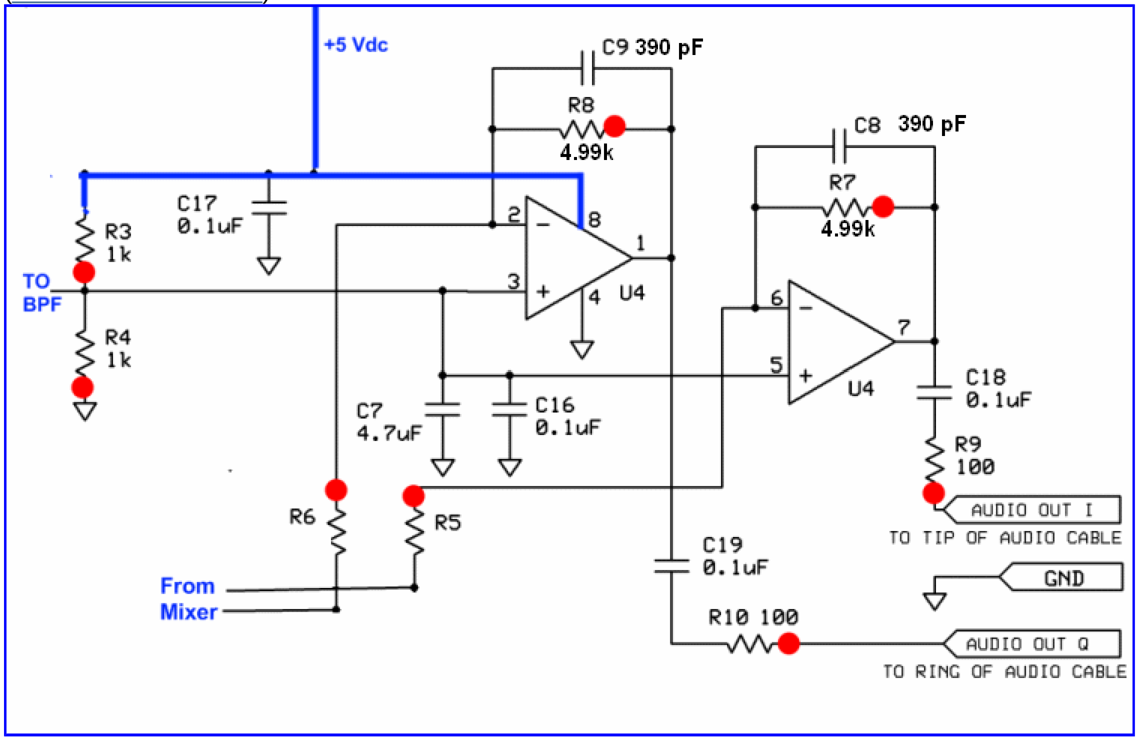
The Opamp amplifies the I and Q signals by about 500 times.

(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)



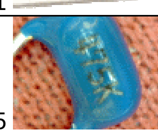
(above schematic has clickable areas that can be used for navigation)

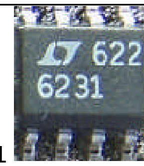
(go directly to build notes)

Operational Amplifiers Bill of Materials

Stage Bill of Materials

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

Check	Count	Component	Marking	Category
❏	2	1 k 1/4W 1%	br-blk-blk-br-br 	1/4W
❏	2	4.99 k 1/4W 1%	y-w-w-br-br 	1/4W
❏	2	100 1/6W 5%	br-blk-br-gld 	1/6W
❏	2	390 pF 5%	 391	Ceramic
❏	1	4.7 uF 10% 16V X7R RAD	475 	Ceramic

❏	2	band-specific		misc
❏	1	LT6231 dual op-amp	LT6231 	SOIC-8

Band Specific Items for 160m Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❏	R05	49.9 ohm 1%	yel-wht-wht-gld-brn	1/4W	E-W		Operational Amplifiers
❏	R06	49.9 ohm 1%	yel-wht-wht-gld-brn	1/4W	E-W		Operational Amplifiers

Band Specific Items for 80m Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❏	R05	49.9 ohm 1%	yel-wht-wht-gld-brn	1/4W	E-W		Operational Amplifiers
❏	R06	49.9 ohm 1%	yel-wht-wht-gld-brn	1/4W	E-W		Operational Amplifiers

Band Specific Items for 40m Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❏	R05	49.9 ohm 1%	yel-wht-wht-gld-brn	1/4W	E-W		Operational Amplifiers
❏	R06	49.9 ohm 1%	yel-wht-wht-gld-brn	1/4W	E-W		Operational Amplifiers

Band Specific Items for 30m Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❏	R05	10 ohm 1/4W 1%	br-blk-blk-gld-br	1/4W	E-W		Operational Amplifiers
❏	R06	10 ohm 1/4W 1%	br-blk-blk-gld-br	1/4W	E-W		Operational Amplifiers

Band Specific Items for 20m Band

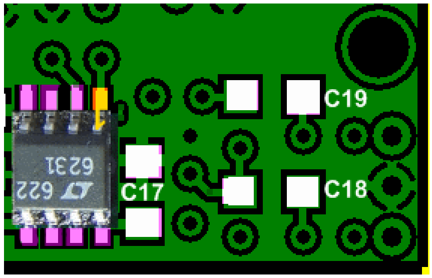
Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❏	R05	10 ohm 1/4W 1%	br-blk-blk-gld-br	1/4W	E-W		Operational Amplifiers
❏	R06	10 ohm 1/4W 1%	br-blk-blk-gld-br	1/4W	E-W		Operational Amplifiers

Operational Amplifiers Summary Build Notes

- Install OpAmp
- Install band-specific components
- Install remaining components
- Test the Stage

Operational Amplifiers Detailed Build Notes

Bottom of the Board

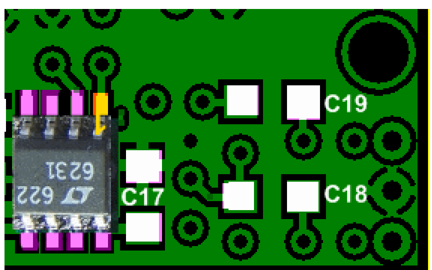


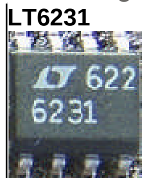
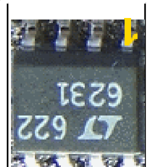
Install OpAmp

Install the LT6231 operational amplifier to the bottomside of the board.

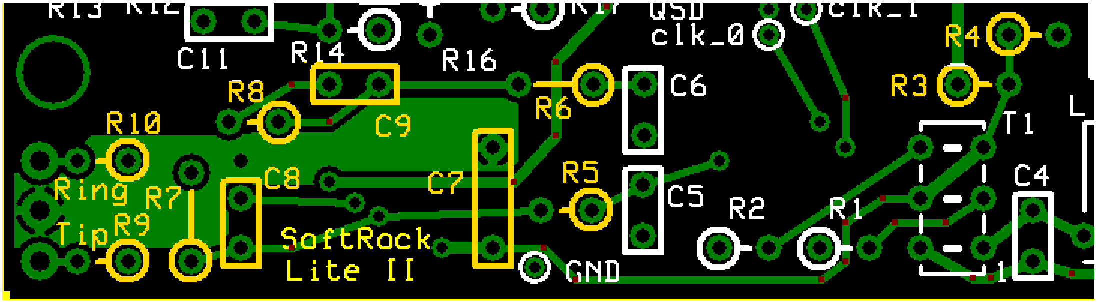
See hints on installing SMT ICs.

- **Orient U4 on its pads so that the pin 1 corner of the IC matches the small “1" (it also looks like a “0”) mark in the copper on the bottom side of the board. In general, pin 1 of an SOIC packaged IC is in the lower left corner of the package when the printing on the package top reads upright, from left to right.**
- **Tack-solder one corner pin of U4 and reheat the tacked pin as necessary to line up U4 on its pads properly.**
- **Double-check the orientation of U4 and the line up of the IC on its pads with magnification and good lighting. You do NOT want to install U4 oriented incorrectly. If all is well, carefully solder the rest of the leads to their pads.**



Check	Designation	Component	Marking	Category	Orientation	Notes
❏	U4	LT6231 dual op-amp	LT6231 	SOIC-8		Take ESD precautions

Top of the Board



Install band-specific components

Install the band-specific capacitors and resistors.

See band-specific chart for values

See hints on orienting and installing resistors.

See hints on identifying and installing ceramic caps.

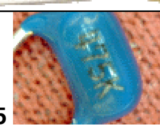
Check	Designation	Component	Marking: Band	Marking: Component	Marking: Marking	Category	Orientation	Notes
❏	R05	band-specific	160m	49.9 ohm 1% (1/4W)	yel-wht-wht-gld-brn	misc	E-W	
			80m	49.9 ohm 1% (1/4W)	yel-wht-wht-gld-brn			
			40m	49.9 ohm 1% (1/4W)	yel-wht-wht-gld-brn			
			30m	10 ohm 1/4W 1% (1/4W)	br-blk-blk-gld-br			
			20m	10 ohm 1/4W 1% (1/4W)	br-blk-blk-gld-br			
❏	R06	band-specific	160m	49.9 ohm 1% (1/4W)	yel-wht-wht-gld-brn	misc	E-W	
			80m	49.9 ohm 1% (1/4W)	yel-wht-wht-gld-			

		brn
40m	49.9 ohm 1% (1/4W)	yel-wht-wht-gld-brn
30m	10 ohm 1/4W 1% (1/4W)	br-blk-blk-gld-br
20m	10 ohm 1/4W 1% (1/4W)	br-blk-blk-gld-br

Install remaining components

See hints on orienting and installing resistors.

See hints on identifying and installing ceramic caps.

Check	Designation	Component	Marking	Category	Orientation	Notes
❑	C08	390 pF 5%	391 	Ceramic		
❑	C09	390 pF 5%	391 	Ceramic		
❑	C07	4.7 uF 10% 16V X7R RAD	 475	Ceramic		
❑	R07	4.99 k 1/4W 1%	y-w-w-br-br	1/4W	S-N	
❑	R03	1 k 1/4W 1%	br-blk-blk-br-br	1/4W	W-E	
❑	R08	4.99 k 1/4W 1%	y-w-w-br-br	1/4W	E-W	
❑	R04	1 k 1/4W 1%	br-blk-blk-br-br	1/4W	W-E	
❑	R09	100 1/6W 5%	br-blk-br-gld	1/6W	E-W	
❑	R10	100 1/6W 5%	br-blk-br-gld	1/6W	E-W	

Operational Amplifiers Testing

Warning

Test Setup

Take appropriate ESD precautions in these tests, since you will be working around the sensitive OpAmp IC

Visual Check

Test Setup

Using very good lighting and magnification, carefully inspect the solder joints to identify bridges, cold joints, or poor contacts.

Pay especial attention to the joints on the OpAmp IC pins. If necessary, touch up the joints with your iron and/or some flux. Wick up any excess.

Current Draw

Test Setup

- In each test, the ammeter must be placed in series between the positive lead of the power source and the board's positive power-in "+" terminal.
- In one test there is also a **100 ohm** resistor in the series "chain" as well.
- in the second test, the setup is the same except that the current-liminting resistor is removed

Apply 12 Vdc to the board for this test

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
With **100 ohm** current-limiting resistor	mA	< 30	26.6	
Without current limiting resistor	mA	< 30	26.9	

Voltage Tests

Test Setup

Measure the voltages with respect to ground for each of the pins of U4. Tage care to measure at the actual IC pin rather than the pad, so as to ensure you are measuring the PIN voltage

expected voltages are indicated in the table below:

- 5 V (range of 4.5 - 5.4)
- 2.5 V (approx 50% of the 5V rail value)

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
Pin 1	Vdc	2.5	2.46	
Pin 2	Vdc	2.5	2.46	
Pin 3	Vdc	2.5	2.46	
Pin 4	Vdc	0	0	
Pin 5	Vdc	2.5	2.46	
Pin 6	Vdc	2.5	2.46	

Pin 7	Vdc	2.5	2.46	
Pin 8	Vdc	5	4.94	

Functional Test

Test Setup

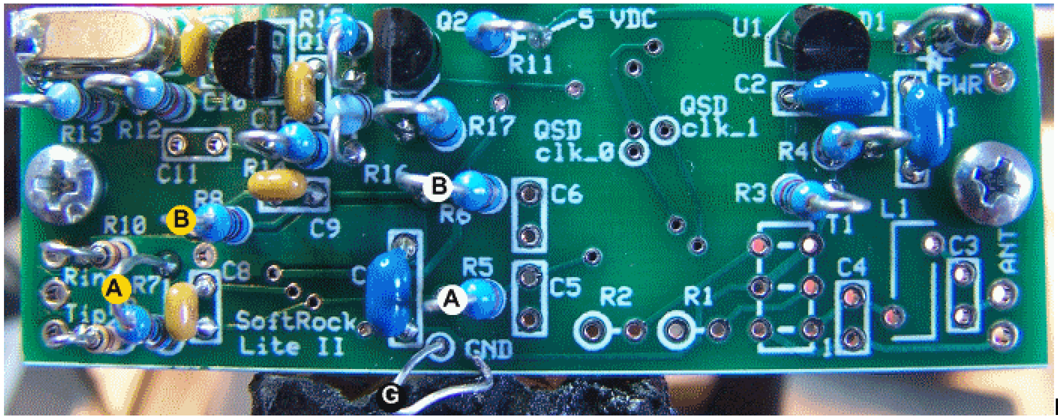
You will test the DC gain of each of the op-amps by connecting resistors R_B from each op-amp inverting input to circuit ground. Introducing the "bridging" resistor R_B will result in a test current equal to 2.5 / R_t which will be balanced by the current fed back from each op-amp's output through each feedback resistor, R_F (i.e., R7 or R8). Each op-amp output will increase in voltage by 2.5 * R_F/ R_B from the nominal DC level of 2.5 volts.

The value of the "bridging" resistor (R_B) is 10 kΩ:

- **Test the First OpAmp**
  Power up the circuit and measure the voltage at pin 1 of the op-amp (hairpin of R8). It should be ~2.5 Vdc
- Power off and use clip leads to connect R_B between the hairpin of R6 and circuit ground. (This provides an input resistance(R_i) of 10 kΩ
- Power up and measure the output voltage at the hairpin of the feedback resistor R8. You should get:, with R_B=10 kΩ and R8=4.99 kΩ: ~3.75 Vdc.
- Remove R_B and the output voltage at R8 should go back to ~2.5 Vdc.
- **Test the Second OpAmp**
  Power up the circuit and measure the voltage at pin 7 of the op-amp (hairpin of R7). It should be ~2.5 Vdc
- Power off and use clip leads to connect R_B between the hairpin of R5 and circuit ground. (This provides an input resistance(R_i) of 10 kΩ
- Power up and measure the output voltage at the hairpin of the feedback resistor R7. You should get, with R_B=10 kΩ and R7=4.99 kΩ: ~3.75 Vdc.
- Remove R_B and the output voltage at R7 should go back to ~2.5 Vdc.

The diagram below shows the test points. The yellow dots show the output voltage measurement points. The white points show the bridging resistor connection points (connect the bridging resistor R_B between the ground and a white point). To measure the voltage at yellow point "A", use white point "A" for the bridge; same with points "B".

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



Functional Test"

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
R7 (yellow "A")- unbridged	Vdc	2.5	2.48	______
R8 (yellow "B") - unbridged	Vdc	2.5	2.46	______
R7 (yellow "A") bridging white "A" to ground	Vdc	3.75	3.72	______
R8 (yellow "B") bridging white "B" to ground	Vdc	3.75	3.69	______

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Softrock Lite II 05_Band Pass Filter

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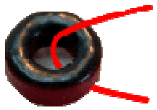
Band Pass Filter Introduction

General

 Remember, when winding toroidal inductors, a single pass through the core counts as 1 turn. You might want to review Leonard KC0WOX's excellent 10-minute video on winding toroidal coils and transformers.

Also, please refer to the common component mounting instructions for toroids

Theory of Operation

The purpose of this stage is to pass the Radio Frequency signals within the receiver band to the mixer stage and to attenuate unwanted signals which are within the designed passband for the filter.

This attenuation is especially important, since it permits the $\frac{1}{3}$ harmonic sampling in the mixer for the higher bands. Without that attenuation, for example, the 20m kit would be responding to signals in the region of 4.6825 MHz rather than to the designed response in the region of the 3rd harmonic of 14.0475 MHz!

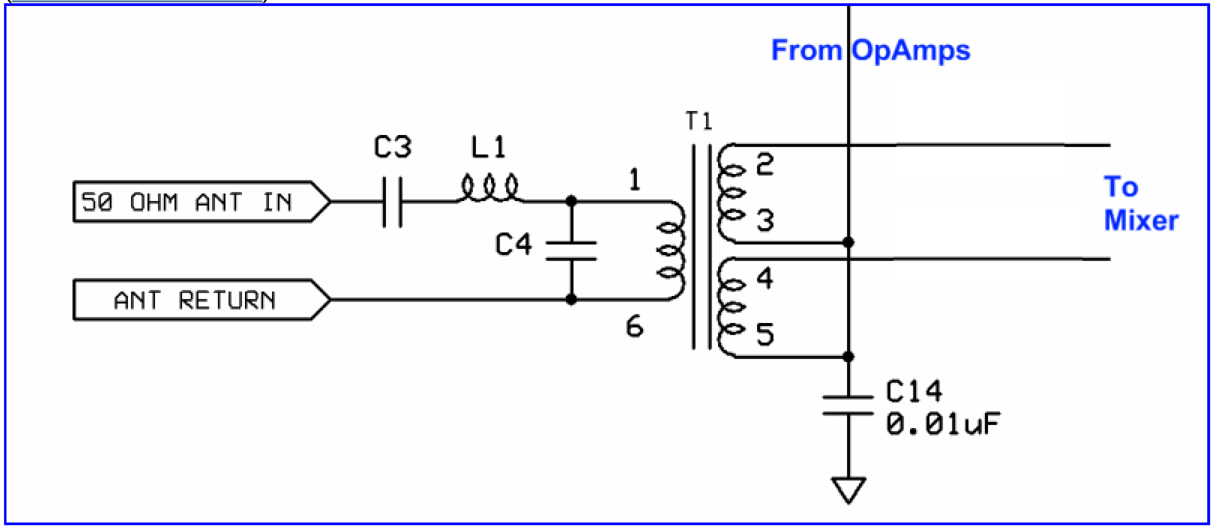
For further information on the subharmonic sampling effect, refer to this topic on the Yahoo Reflector.

(go directly to build notes)

Band Pass Filter 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)



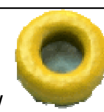
(above schematic has clickable areas that can be used for navigation)

(go directly to build notes)

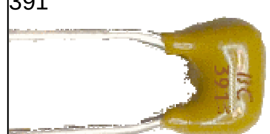
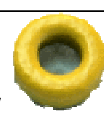
Band Pass Filter Bill of Materials

Stage Bill of Materials

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

Check	Count	Component	Marking	Category
❏	4	band-specific		misc
❏	2	T30-6 toroid core	 yellow	Toroid

Band Specific Items for 160m Band

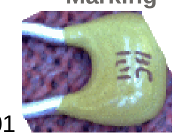
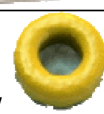
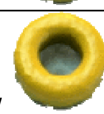
Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❏	C03	390 pF 5%	391 	Ceramic			Band Pass Filter
❏	C04	5600 pF 5%	562	Ceramic			Band Pass Filter
❏	L1	19.6 uH 74T #30 on T30-6 (yellow) (38")	 yellow	Coil		38"	Band Pass Filter

❑	T1	1.4 uH 20T/10T bifilar #30 on T30-6 (yellow) (13")	yellow 	Xfrmr			Band Pass Filter

Band Specific Items for 80m Band

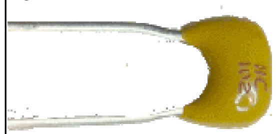
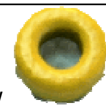
Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	C03	220 pF 5%	221 	Ceramic			Band Pass Filter
❑	C04	3300 pF 5%	332	Ceramic			Band Pass Filter
❑	L1	9.1 uH 50T #30 on T30 -6 (yellow) (26")	yellow 	Coil		26"	Band Pass Filter
❑	T1	0.73 uH 14T/7T bifilar #30 on T30-6 (yellow) (10")	yellow 	Xfrmr			Band Pass Filter

Band Specific Items for 40m Band

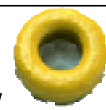
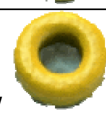
Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	C03	100 pF 5%	101 	Ceramic			Band Pass Filter
❑	C04	1500 pF 10%	152 	Ceramic			Band Pass Filter
❑	L1	5.0 uH 37T #30 on T30 -6 (yellow) (20")	yellow 	Coil		20"	Band Pass Filter
❑	T1	0.35 uH 10T/5T bifilar #30 on T30-6 (yellow) (8")	yellow 	Xfrmr			Band Pass Filter

Band Specific Items for 30m Band

Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❑	C03	68 pf 5%	68J	Ceramic			Band Pass Filter

❏	C04	1000 pF 5%	102 	Ceramic			Band Pass Filter
❏	L1	3.5 uH 31T #30 on T30-6 (yellow) (17")	 yellow	Coil		17"	Band Pass Filter
❏	T1	0.18 uH 8T/4T bifilar #30 on T30-6 (yellow) (7")	 yellow	Xfrmr			Band Pass Filter

Band Specific Items for 20m Band

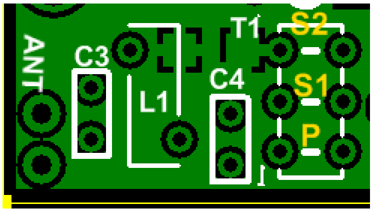
Check	Designation	Component	Marking	Category	Orientation	Notes	Circuit
❏	C03	47 pF 5%	47J	Ceramic			Band Pass Filter
❏	C04	680 pF 5%	681 	Ceramic			Band Pass Filter
❏	L1	2.5 uH 26T #30 on T30-6 (yellow) (15")	 yellow	Coil		15"	Band Pass Filter
❏	T1	0.18 uH 8T/4T bifilar #30 on T30-6 (yellow) (7")	 yellow	Xfrmr			Band Pass Filter

Band Pass Filter Summary Build Notes

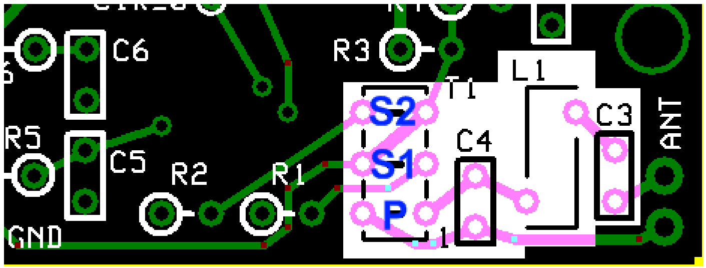
- Install Band-specific Capacitors
- Wind and Install Band-specific L1
- Wind and Install band-specific T1
- Test the Stage

Band Pass Filter Detailed Build Notes

Bottom of the Board



Top of the Board

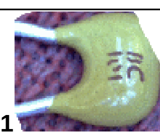


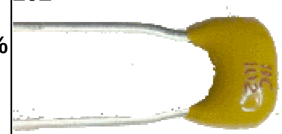
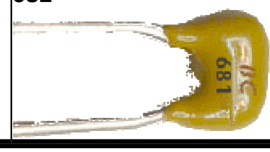
Install Band-specific Capacitors

Install the band-specific capacitors, C3 and C4.

See band-specific chart for values

See hints on identifying and installing Ceramic Capacitors.

Check	Designation	Component	Marking: Band	Marking: Component	Marking: Marking	Category	Orientation	Notes
❏	C03	band-specific	160m	390 pF 5% (Ceramic)	391 	misc		
			80m	220 pF 5% (Ceramic)	221 			
			40m	100 pF 5% (Ceramic)	 101			
			30m	68 pf 5% (Ceramic)	68J			

<table>
<tr><td></td><td></td><td></td><td><table><tr><td>20m</td><td>47 pF 5% (Ceramic)</td><td>47J</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td>❑</td><td>C04</td><td>band-specific</td><td><table>
<tr><th>Band</th><th>Component</th><th>Marking</th></tr>
<tr><td>160m</td><td>5600 pF 5% (Ceramic)</td><td>562</td></tr>
<tr><td>80m</td><td>3300 pF 5% (Ceramic)</td><td>332</td></tr>
<tr><td>40m</td><td>1500 pF 10% (Ceramic)</td><td>152
</td></tr>
<tr><td>30m</td><td>1000 pF 5% (Ceramic)</td><td>102
</td></tr>
<tr><td>20m</td><td>680 pF 5% (Ceramic)</td><td>681
</td></tr>
</table></td><td>misc</td><td></td><td></td></tr>
</table>

Wind and Install Band-specific L1

Install the band-specific coil, L1.

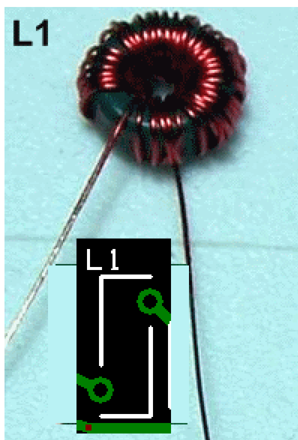
Also, please refer to the common component mounting instructions for toroids

Band-Specific Details
L1, for all bands, uses #30 wire and T30-6 toroid core. Turn counts, wire lengths, and inductance per band are shown in the table below:

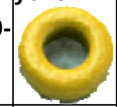
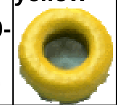
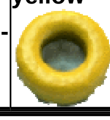
Band	Core	Length	Turns	µH
160m	T30-6 (yellow)	38"	74	19.6
80m	T30-6 (yellow)	26"	50	9.1
40m	T30-6 (yellow)	20"	37	5.0
30m	T30-6 (yellow)	17"	31	3.5
20m	T30-6 (yellow)	15"	26	2.5

- **BOM Notation**
  Wind the band-specific number of turns of #30 wire onto the band-specific toroidal core. E.G., "9.1 uH 50T #30 on T30-6 (yellow) (26")" means use 26 inches of #30 wire to wind 50 turns onto a T30-6 toroid
- **Turn Counting**
  Each pass through the center of the core is counted as a turn when winding the inductor.

- **Do you Run Out of Toroid Before You Run Out of Turns?**
  Occasionally, you may find that there is not enough room on the toroid toplace all of the windings without having to go back and add a layer of winding. Tony Parks suggests that you overlap some turns as you put on windings around the circumference of the core so that all turns are on the core by the time you get back to the start end of the winding. This should have negligible effect on the coil's performance in the radio.
- **Coil Orientation**
  L1 is mounted vertically and supported by its leads.
- **Lead Preparation**
  Be sure to remove the enamel coating on the wire before attempting to solder an inductor lead to its associated mounting hole. There are two different approaches to removing the enamel and tinning the leads:
  - **The enamel coating on the #30 wire provided in the kit does not heat strip very well but may be stripped by use of a small folded over piece of Emory paper where the lead is pulled through two facing surfaces of the Emory paper multiple times to sand off the enamel coating on the wire end. Then you can run each lead through a blob of solder on the hot iron tip to tin it.**
  - **If you have some solder flux (I use the paste kind), you can slather each lead with flux paste and then run each lead through a hot blob of solder to clean and tin the tip. You may have to repeat the process a couple of times to get all the gunk off of the lead. It produces a well-tinned lead with non of the trauma inherent in stripping the enamel with sandpaper or exacto knife.**



Check	Designation	Component	Marking			Category	Orientation	Notes
			Band	Component	Marking			
❏	L1	band-specific	160m	19.6 uH 74T #30 on T30-6 (yellow) (38") (Coil)	yellow 	misc		

80m	9.1 uH 50T #30 on T30-6 (yellow) (26") (Coil)	yellow 
40m	5.0 uH 37T #30 on T30-6 (yellow) (20") (Coil)	yellow 
30m	3.5 uH 31T #30 on T30-6 (yellow) (17") (Coil)	yellow 
20m	2.5 uH 26T #30 on T30-6 (yellow) (15") (Coil)	yellow 

Wind and Install band-specific T1

> ***If T1 is not wired correctly to the six holes on the Lite circuit board it can result in very low receiver sensitivity. You should carefully read this section and study the photo below showing how to mount the transformer.***

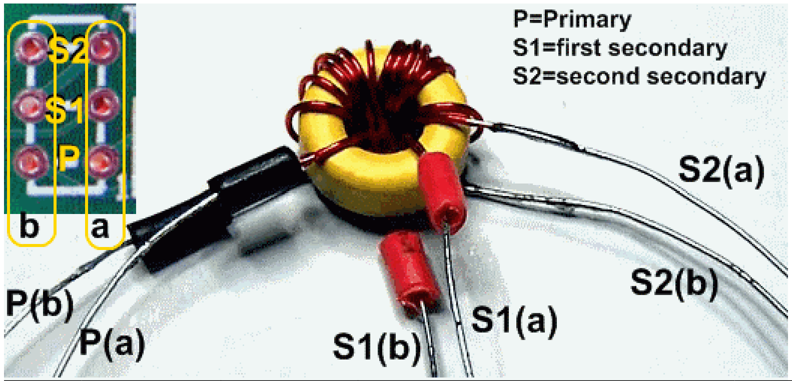
Also, please refer to the common component mounting instructions for toroids and detailed instructions for T1 in the 20m SR Lite II kit. These resources should help the first-time transformer/coil builder past any concerns in that area.

- **Band-Specific Transformer Details**
  The transformer is wound with a primary winding and two secondary windings. The two secondary windings are created by folding the specified length of wire over double ("bifilar") and winding the doubled wire the required number of (secondary) turns. See table below for Core, Length, Turns, and Primary Inductance info. ("Turns 10/5" Means primary is 10 turns and secondaries are 5 turns bifilar):

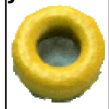
Band	Core	Length	Turns(p/s)	µH(p)
160m	T30-6 (yellow)	13"	20/10	1.4
80m	T30-6 (yellow)	10"	14/7	0.73
40m	T30-6 (yellow)	8"	10/5	0.35
30m	T30-6 (yellow)	7"	8/4	0.18
20m	T30-6 (yellow)	7"	8/4	0.18

- **BOM Notation**
  The winding details will be in the form: "nnT/2 x mmT bifilar #30" on Txx-x (LL")". This translates to:
  - **Using a toroid Txx-x and LL inches of #30 wire, wind a primary with nn turns**
  - **then, using the same length of #30 wire folded in half, wind the 2 secondaries on top of the primary for mm turns**

- **Primary Winding**
  The primary winding is of the band-specific number of turns. Wind the primary winding with the specified number of turns of #30 AWG enameled wire so that the primary winding starts and ends at about the same point on the core and is uniformly spread around the core.
- **Secondary Windings**
  The secondary uses lengths of #30 wire, twisted together into a bifilar pair that has approximately 2-3 twists per inch and is wound over the primary, using the band-specific number of turns.Wind the secondary windings, in the same direction as the primary, with the windings starting and ending just slightly clockwise around the core from where the primary winding starts and ends.
- **ID and Tag the Winding Leads**
  After striping and tinning each transformer lead at about 1/8 of an inch from the core, determine the two pairs of leads of each of the secondary windings by use of an ohmmeter. I like to use short lengths of insulation from hookup wire to identify two of the 3 sets of leads in these transformers.
- **Transformer Orientation**
  (Refer to the graphic, below): Correct wiring is with leads from one side (the "a" side) of the core going to a group of three holes and the leads from the other side (the "b" side) of the core going to the other group of three holes as shown below.
- Note the photo below shows the holes for the primary ("P") and each of the two secondary ("S") leads, with the "a" and "b" designating from which side of the core the particular winding's lead should go.
- for example:
  - The primary winding's "b" lead would go into the left-hand "P" hole
  - The primary winding's "a" lead would go into the right-hand "P" hole
  - The first secondary winding's "b" lead would go into the left-hand "S" hole in the middle row of winding holes
  - The first secondary winding's "a" lead would go into the right-hand "S" hole in the middle row of winding holes
  - and so on …
- Be careful when threading the leads through the holes to avoid their getting tangled up with nearby components!



Check	Designation	Component	Marking	Category	Orientation	Notes

<table>
<tr>
<td>❏</td>
<td>T1</td>
<td>band-specific</td>
<td>
<table>
<tr><th>Band</th><th>Component</th><th>Marking</th></tr>
<tr><td>160m</td><td>1.4 uH
20T/10T
bifilar #30
on T30-6
(yellow)
(13")
(Xfrmr)</td><td>yellow
</td></tr>
<tr><td>80m</td><td>0.73 uH
14T/7T
bifilar #30
on T30-6
(yellow)
(10")
(Xfrmr)</td><td>yellow
</td></tr>
<tr><td>40m</td><td>0.35 uH
10T/5T
bifilar #30
on T30-6
(yellow)
(8") (Xfrmr)</td><td>yellow
</td></tr>
<tr><td>30m</td><td>0.18 uH
8T/4T
bifilar #30
on T30-6
(yellow)
(7") (Xfrmr)</td><td>yellow
</td></tr>
<tr><td>20m</td><td>0.18 uH
8T/4T
bifilar #30
on T30-6
(yellow)
(7") (Xfrmr)</td><td>yellow
</td></tr>
</table>
</td>
<td></td>
<td>misc</td>
<td></td>
<td></td>
</tr>
</table>

Band Pass Filter Testing

Visual Check

Test Setup

Using very good lighting and magnification, carefully inspect the solder joints to identify bridges, cold joints, or poor contacts.

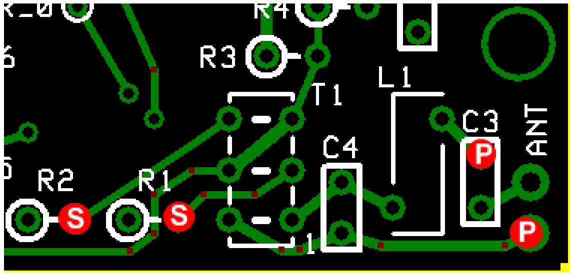
Pay especial attention to the joints on the transformer. Bad solder joints in this stage will have an extreme effect on the sensitivity of the receiver.

Inductor Continuity Tests (NO power)

Test Setup

This tests the continuity through L1 and the T1 primary winding, using testpoints (red dot with letter "P") that test the continuity from connected pads. This helps check the soldering of the leads by placing the probes at points that are connected to the actual solder joint.

Similarly, the secondary windings of T1 are tested for continuity, using the secondary testpoints (red dots with the letter "S").



Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
Point "P" to point "P"	ohm	0	0	______
Point "S" to point "S"	ohm	0	0	______

Voltage Tests

Test Setup

Apply power and measure the voltages WRT (with respect to ground).

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
R1 hairpin (hole)	Vdc	~2.5	2.47	______
R2 hairpin (hole)	Vdc	~2.5	2.47	______

Resistance Tests (no power)

Test Setup

Remove power from the board and measure the resistance with respect to ground for the T1 secondaries in situ.

Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
R1 hairpin (hole)	ohms	~800	803	______
R2 hairpin (hole)	ohms	~800	803	______

Phasing Test (NO power)

Test Setup

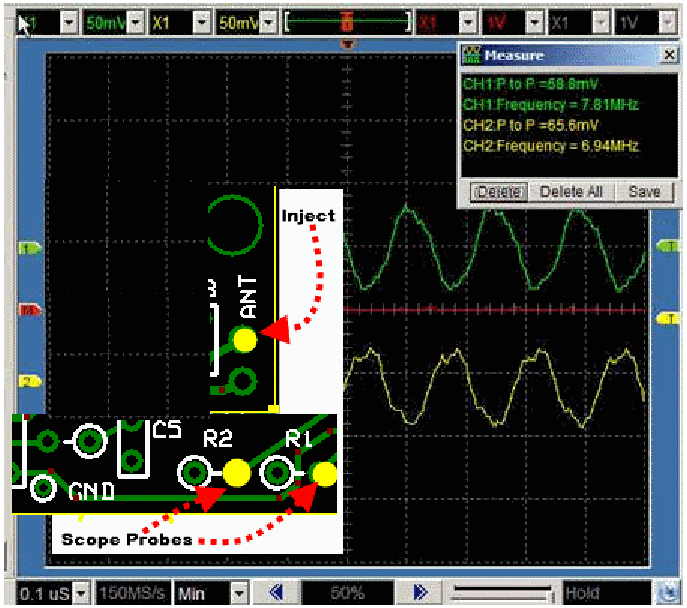
Optional Test - assuming you have a dual channel scope and an RF source that can output a signal close to the band-specific center frequency.

- Conduct this test with the power OFF
- Connect a ~2 volt p-p signal source at around the center frequency into the ANT-IN and RET pads.
- Set up the scope for triggering on Channel 1

.

- Connect the scope probes to the R1 and R2 hairpins (holes) and the ground clips to ground.
- You should have a pair of equal amplitude, opposite phase signals displayed. If they are in phase, you probably aren't triggering the scope on channel 1. If either one is missing, double check the solder connections for T1.

- Thanks to Leonard KC0WOX for this test



Home Bill of Materials Power Supply Local Oscillator Divider Operational Amplifiers Band Pass Filter Mixer External Connections Comments
Acronyms Inventory Revisions as of 10/7/2010 Components By Stage WB5RVZ Main Website

Softrock Lite II 06_Mixer

Home   Bill of Materials   Power Supply   Local Oscillator   Divider   Operational Amplifiers   Band Pass Filter   Mixer   External Connections   Comments   Acronyms   Inventory   Revisions as of 10/7/2010   Components By Stage   WB5RVZ Main Website

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Mixer Introduction

General

From the builder's standpoint, the Mixer stage consists solely of the installation of the input resistors (R1 and R2) and the integrating capacitors, C5 and C6. The installation of the IC, U3, was performed in the Dividers Stage.

Theory of Operation

The RF input signal, filtered by the BPF is applied in antiphase to the inputs 1B and 2B of the Mixer U3.

The two LO signals from the Divider Stage operate the switches which connect R1 to C5 and connects R2 to C6 during the first clock cycle.

When the LO Clock changes 90 degrees later, the connections reverse: R1 now connects to C6 (Q) and R2 connects to C5 (I).

This switching sequence then repeats itself.

The resulting RF input signal is sampled over capacitors C5 and C6 as the Intermediate Frequency (IF)

On the lower bands (160m, 80m, and 40m) the dividers are clocked at the desired center frequency, which is in the pass band for the incoming RF.

On the higher bands, the situation in the Softrocl RX is a little different. The clocking frequency is at the one-third sub harmonic of the desired center frequency and is NOT within the passband of the incoming RF.

For example, consider the 20m RX:

- For 20m, the dividers are clocked at about 18.73 MHz and their output QSD clock is 18.73 MHz / 4 = 4.682 MHz
- The third harmonic of that clock frequency is 3 * 4.682 = 14.047 MHz.
- The 20m signals in the BPF's passband will be sampled at that 3rd harmonic; however, the sampling will not yield as strong an I/Q pair as does the sampling technique used in the lower bands. Hence, the higher gain OpAmps for the higher band kits.
- It is like looking at a rotating wheel with a strobe flashing once for every three revolutions of the wheel. The rotation speed of the wheel is down converted but the image is not as bright as it would be if you flashed the strobe at the rotation speed of the wheel.

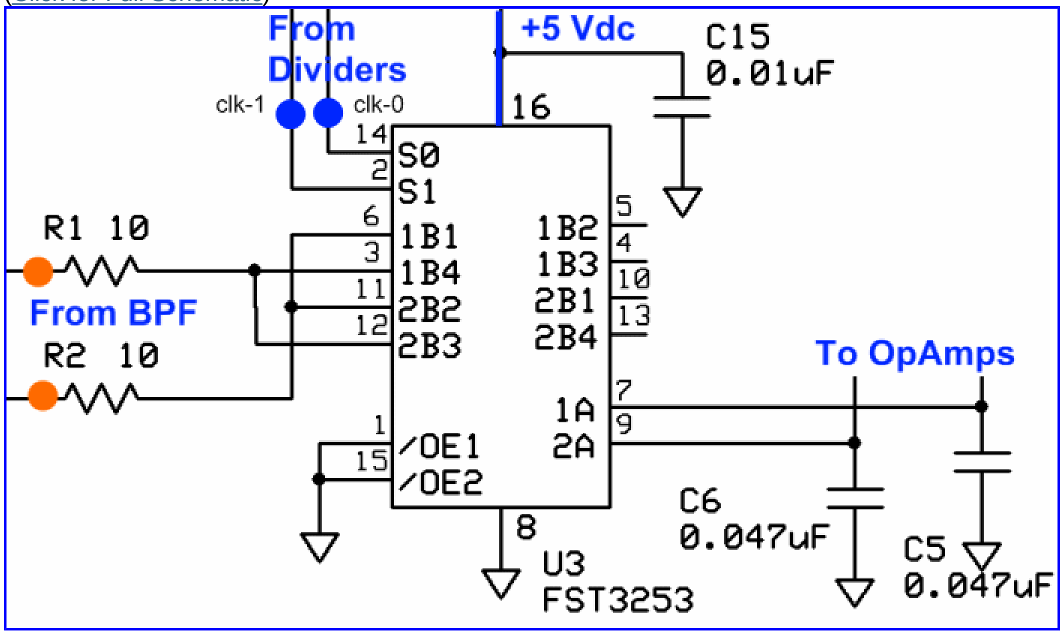
If you are interested, you might want to review the "Tayloe Mixer" operation. While the Softrock mixer is not a pure Tayloe mixer, the theoretical discussion on Taylo mixers helps with understanding how this process works.

(go directly to build notes)

Mixer 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)

Mixer Bill of Materials

Stage Bill of Materials

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

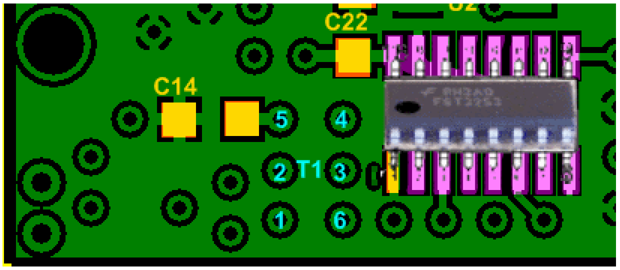
Check	Count	Component	Marking	Category
❏	2	10 ohm 1/4W 1%	br-blk-blk-gld-br 	1/4W
❏	2	0.047 uF 5%	 473	Ceramic

Mixer Summary Build Notes

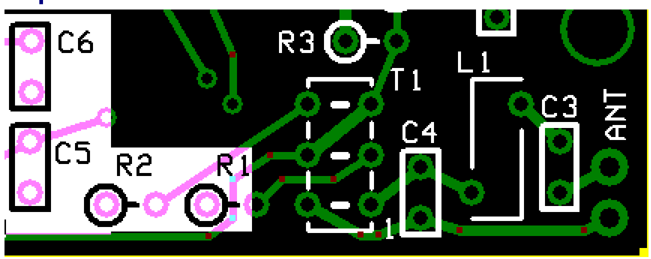
- Install Topside Components
- Test the Stage

Mixer Detailed Build Notes

Bottom of the Board



Top of the Board



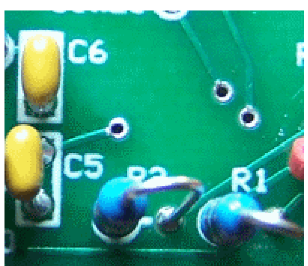
Install Topside Components

Install R1 and R2

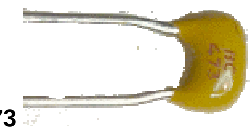
See hints on orienting and installing resistorss.

Install integrating capacitors, C5 and C6

See hints on identifying and installing Ceramic Capacitors.



Check	Designation	Component	Marking	Category	Orientation	Notes
❑	R01	10 ohm 1/4W 1%	br-blk-blk-gld-br	1/4W	W-E	

❑	**R02**	**10 ohm 1/4W 1%**	**br-blk-blk-gld-br** 	**1/4W**	**W-E**	
❑	**C05**	**0.047 uF 5%**	 **473**	**Ceramic**	**vert**	
❑	**C06**	**0.047 uF 5%**	 **473**	**Ceramic**	**vert**	

Mixer Testing

Warning

Test Setup

Take appropriate ESD precautions in these tests, since you will be working around the very sensitive mixer IC

Visual Inspection

Test Setup

Using very good lighting and magnification, carefully inspect the solder joints to identify bridges, cold joints, or poor contacts.

Pay especial attention to the joints on the Mixer IC pins. If necessary, touch up the joints with your iron and/or some flux. Wick up any excess.

Current Draw

Test Setup

- In each test, the ammeter must be placed in series between the positive lead of the power source and the board's positive power-in "+" terminal.
- In one test there is also a 100 ohm resistor in the series "chain" as well.
- in the second test, the setup is the same except that the 100 ohm current-limiting resistor is removed
- The mixer stage should not appreciably change the current draw from preceding stages.

Apply 12 Vdc to the board for this test

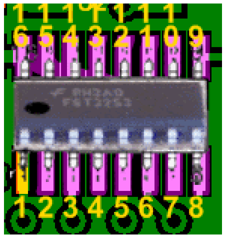
Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
With the **100** ohm current limiting resistor	mA	< 30	26.1	______
Without the current limiting resistor	mA	< 30	26.4	______

Voltage Tests

Test Setup

Power up the board and measure the pin voltages with respect to ground (on the pins, not the pads) of U3, per the table below



Test Measurements

Testpoint	Units	Nominal Value	Author's	Yours
Pin 14 (QSD clk_0 on topside)	Vdc	2.5	2.47	________
Pin 2 (QSD clk_1 on topsode)	Vdc	2.5	2.47	________
Pins 3 & 12	Vdc	2.3 - 2.5	2.44	________
Pins 6 & 11	Vdc	2.3 - 2.5	2.44	________
Pin 7 (1A)	Vdc	2.3 - 2.5	2.44	________
Pin 9 (2A)	Vdc	2.3 - 2.5	2.44	________
Pin 16	Vdc	5	4.94	________
Pin 8	Vdc	0	0	________
Pins 1 & 15	Vdc	0	0	________

Home Bill of Materials Power Supply Local Oscillator Divider Operational Amplifiers Band Pass Filter Mixer External Connections Comments
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Softrock Lite II 07_External Connections

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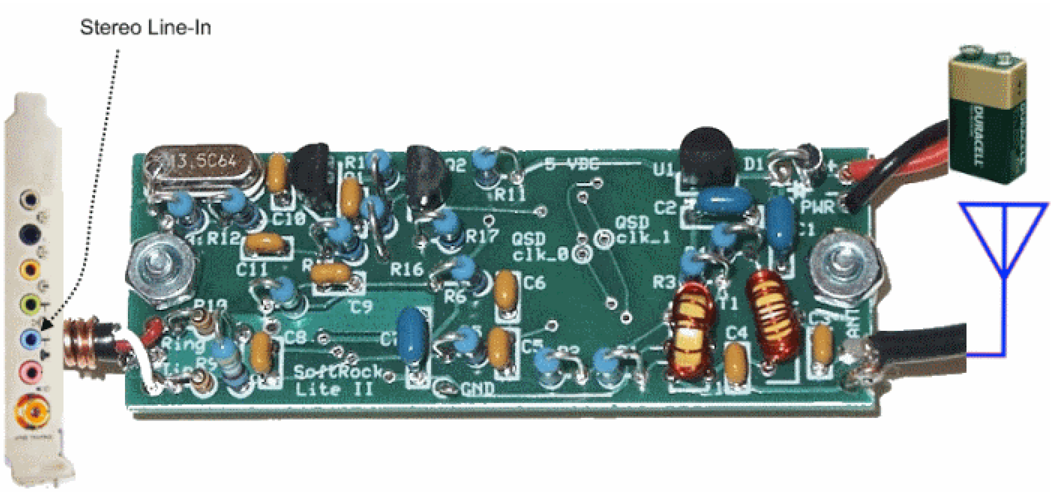
External Connections Introduction

General

The final stage involves connecting the RX to the outside world. Specifically, we need to provide for:

- Power - the power leads can connect to a well filtered, regulated DC source fromn 9 to 13 Vdc.
- RF - need to connect the antenna and antenna return terminals to a 50 ohm antenna tuned for the specified band
- I/Q Output - connect the I and Q audio outputs of the RX into the PC via the stereo input of its sound-card. Normally, this will connect to the stereo "line-in" jack; depending upon the PC/Laptop, you might need to use the stereo "MIC" jack.



Ground Loops

If your display shows numerous peaks/spikes up and down the spectrum, these are likely caused by ground loops (since the spectrum is a display of I and Q signals in the audio/near-audio range).

Doug, WA3DSP, advises:

The SoftRock boards have a number of places where you could create a ground loop. The antenna should not be one of them as long as you isolate BOTH sides of the connection. In other words do not use a shell grounded BNC or other coax fitting on a metal chassis. I use an isolated shell BNC. The power connection is another place where a ground loop could take place. Of course running on a battery would eliminate that as would powering from a wall transformer.

The only two things left are the audio connections and the USB connection, if you use it. Both are grounded at the computer so in most cases a ground loop would not happen here.

So first make sure you antenna and power to the Softrock card are isolated. You don't need USB to receive so you could disconnect that. Then you would only have one grounded connection to the card and if you are still having problems it might be something else.

Alan, G4ZFQ, puts it this way:

"Ground loop" says it all. The RX must be connected to the computer by just one ground. The PSU is a common reason, somtimes the antenna. There is no simple answer, as you indicate, different setups seem to have different answers. It should be posssible to greatly reduce the problem but experimenting is the only real answer. Check what is grounded and try disconnecting duplicated ones. Multiple connectionas between the SDR and computer may be acceptable if they are run together. Bad audio cables picking up external noise is another thing to look for.

(go directly to build notes) (go directly to build notes)

External Connections Bill of Materials

Stage Bill of Materials

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

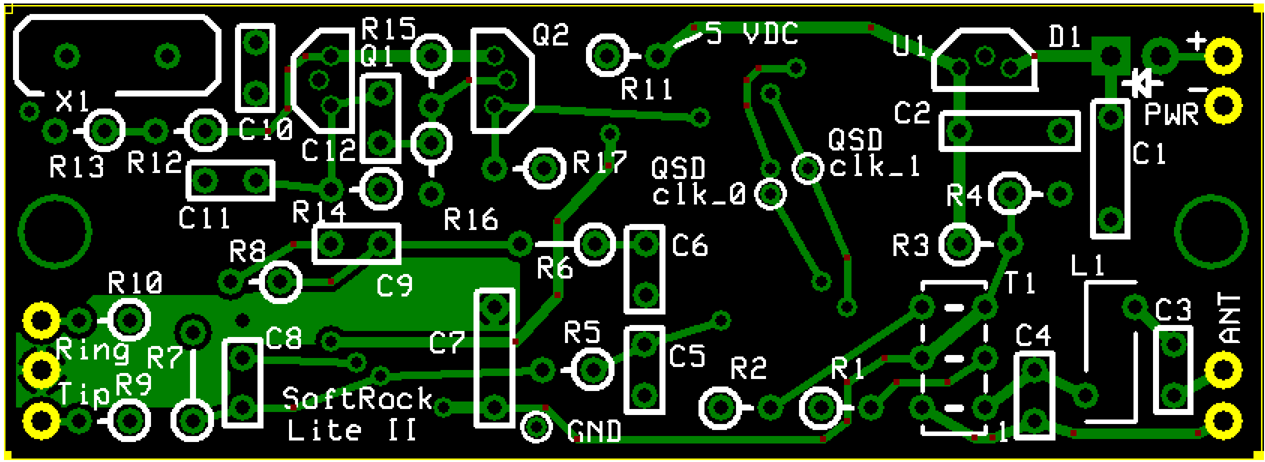
Check	Count	Component	Marking	Category
❏	1	2 conductor shielded audio cable		Cable
❏	1	antenna COAX		Cable
❏	1	power leads		Cable

External Connections Summary Build Notes

- Install Power Connection
- Install I/Q Audio Cable Connection
- Install Antenna Connection
- Test the Stage

External Connections Detailed Build Notes

Top of the Board

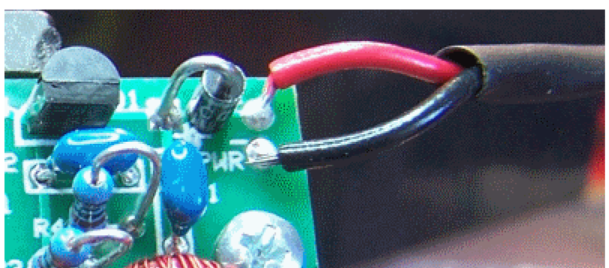


Install Power Connection

Install the power leads (nominally red for positive and black for negative) to the PWR + and PWR - holes on the upper right-hand side of the board

Use the power jack or plug appropriate to your situation

If at all possible, when initially testing the rig, it would be a good idea to use a battery or gel cell for the power supply. This minimizes the potential (pun intended) for ground loops (see discussion in Introduction section above). Later, you can introduce a mains-powered supply and, if that introduces ground loops, then you can make decisions from that point.



Check	Designation	Component	Marking	Category	Orientation	Notes
❑	pwr	power leads		Cable		not furnished with the kit

Install I/Q Audio Cable Connection

Cable

A stereo audio cable may be connected at this time to the board at the three plated through-holes along the lower left edge of the board near the lower left corner.

- **Strain Relief**
  Use a short piece of #22 bus wire to connect the middle plated through-hole (ground) to the shield (barrel) of the cable and wrap the end of the bus wire around the outside of the cable several turns for strain relief of the cable.
- **Cable Installation**
  - **Notefor the 30m. 20m, and 15m RX kits**
    1/3 sub-harmonic sampling does reverse the spectrum. Changing the audio cable connections to the SoftRock Lite circuit board from tip to ring and ring to tip will correct the reversed spectrum so that the SDR software works the same for the higher band receivers as with the lower band receivers.
  - For the lower band units, the tip of the stereo cable plug connects to the plated through-hole that is marked "Tip" on the board. It is the "I" signal. Reverse this for the higher band units.
  - For the lower band units, the ring of the stereo cable plug connects to the plated through-hole marked "Ring" and is the "Q" signal. Reverse this for the higher band units.

Alternate Connection - Stereo Jack

Some builders might prefer to implement the I/Q Audio connection using a 1/8" stereo mini-jack instead of a stereo cable terminated with a 1/8" stereo plug. Either approach works and is pretty much up to the individual builder and his/her approach to packaging the finished board.

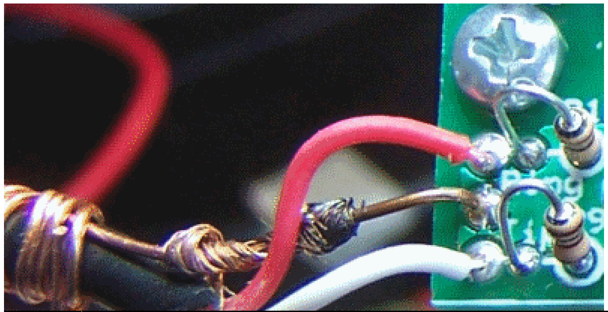
Troubleshooting Large differences in I and Q Output

The receiver should provide nearly identical I and Q signals (other than phase). If there are significant differences in the gain of each OpAmp output, you may want to look at the following before concluding that the IC is bad:

Things that could affect gain--

1. The feedback resistors (R7 and R8) are poorly soldered or of the wrong value(s)
2. Incorrectly wound transformer in the BPF.
3. Incorrect resistors (10 ohm) at both the input and output of the QSD.
4. Incorrect filter capacitor(s) on the output of the QSD.

(tx to Milt W8NUE)



Check	Designation	Component	Marking	Category	Orientation	Notes

❏	audio	2 conductor shielded audio cable		Cable		not furnished with the kit

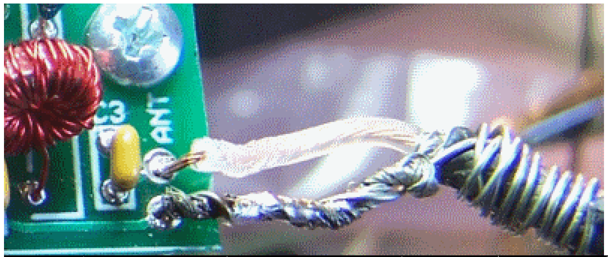
Install Antenna Connection

- **Antenna Impedance**
  It is extremely important to use an antenna with as close a match as possible to 50 ohms impedance. The radio's sensitivity is predicated on a 50 ohm antenna input.
- **Coax**
  Connect a length of 50 ohm coax to the antenna connection on the right edge of the board near the lower right corner. RG-174 is a good fit for this tiny board.
    - **The lower of the two plated through-holes is the antenna RTN connection to the coax shield**
    - **The upper plated through-hole is the coax center conductor connection (ANT IN).**
- **Not Grounded!**
  Note that this connection is isolated from circuit ground.

You may want to review the series of messages on this subJect in the Softrock 40 Yahoo Group.

Additionally, you should review the materials on the Clifton Labs website concerning the use of an antenna isolation transformer

Finally, regarding the "floating antenna RET" connection, review the messages in this topic where the builder was getting no signal and the cause was the improper ANT RET connection.



Check	Designation	Component	Marking	Category	Orientation	Notes
❏	ant	antenna COAX		Cable		not furnished with the kit

External Connections Testing

Final Test

Test Setup

Once external connections are installed, you are ready to take the radio for a spin. This final test will use Rocky as the SDR Software.

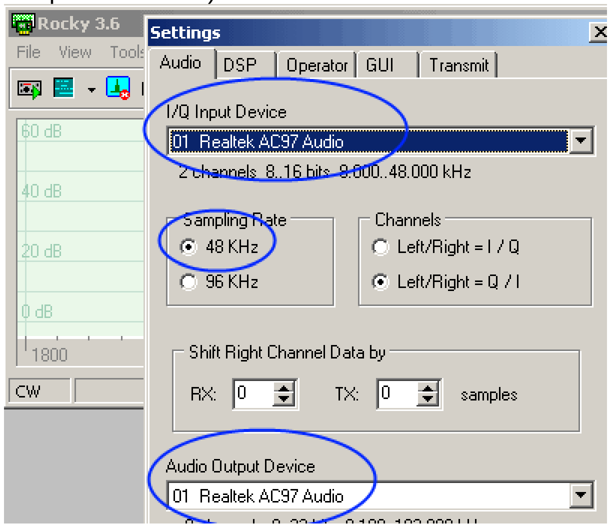
For further discussions of the software side of SDR and soundcard issues, see Alan G4ZFQ's pages.

This test assumes you have the following:

- A Windows Computer on which Rocky has been installed.
  Note: in Windows Vista, Rocky cannot "see" the on-board soundcard; Rocky can, however, "see" any external USB soundcard connected to a Vista computer.
- A sound card with a **stereo** input ("mic" or "Line-In")
  Note: some laptops, unfortunately, lack a true stereo input connection (either no line-in jack or just a "mic" that is mono only).
- An antenna (the better the impedance match to 50 ohms, the better the reception)

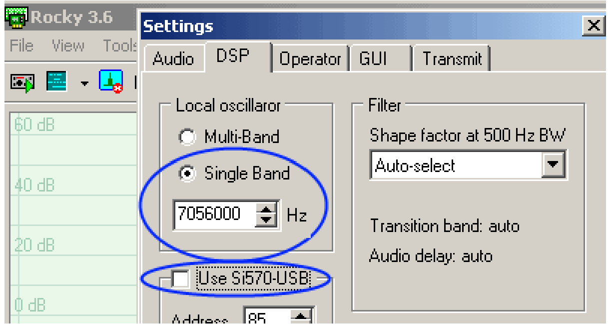
Setup the Radio and the PC

- Plug the audio output cable into the "mic" or "Line-In" input on the PC's sound card.
- Connect the antenna cable to your antenna (you can use a simple wire antenna, but the reception will be poor).
- Run the Rocky SDR program
- Select your soundcard in Rocky (`View -> Settings -> (click on the "Audio" tab)`)
  Normally, you will have a single soundcard, your on-board card, and that will be the default setting for both the "I/Q Input Device" and the "Audio Output Device". The default sampling rate is 48 kHz (you should be so lucky to have a card that samples at 96 kHz!)



- Set Rocky/s center frequency to the value (in Hz) corresponding to your kit:
  - 160m: 1.8432 MHz (1843200 Hz)
  - 80m: 3.515 MHz (3515000 Hz)
  - 40m: 7.056 MHz (7056000 Hz)
  - 30m: 10.125 MHz (10125000 Hz)
  - 20m: 14.0475 MHz (14047500 Hz)
  - 15m: 21.045 MHz (21045000 Hz)

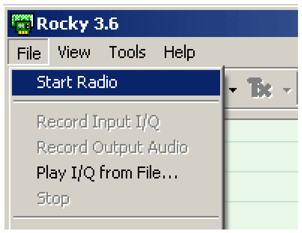
Enter the appropriate center frequency **in Hz**(`View -> Settings -> (click on the "DSP" tab)`)
Example, here, uses 40m rig's center frequency of 7.056 MHz:



It's alive, alive I tell you!

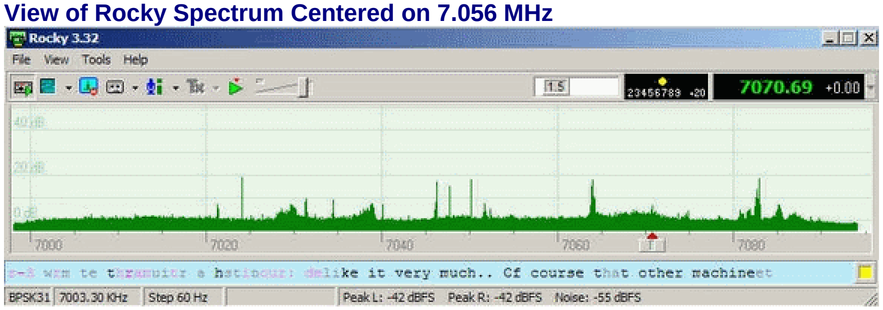
- Apply power to the receiver
- If not already done, Run Rocky and start the Rocky "radio"

  (`File > Start Radio` - click on "Start Radio")



You should see something like the following on the Rocky screen (depending upon your antenna, band conditions, and time of day):

View of Rocky Spectrum Centered on 7.056 MHz



If you see an unwanted "mirror image" of the desired signal, you may want to check out the image rejection hints on this website.

Softrock Lite II Inventorys

Home Bill of Materials Power Supply Local Oscillator Divider Operational Amplifiers Band Pass Filter Mixer External Connections Comments Acronyms Inventory Revisions as of 10/7/2010 Components By Stage WB5RVZ Main Website

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.

Component Type	Category	Component	Qty
boardhdw	HDW	4 X #4-40 hdw (nut, bolt, washer, spacer)	2
Capacitor	Ceramic	0.047 uF 5% (473)	2
Capacitor	Ceramic	100 pF 5% (101)	2
Capacitor	Ceramic	1000 pF 5% (102)	1
Capacitor	Ceramic	1500 pF 10% (152)	1
Capacitor	Ceramic	180 pF 5% (181)	1
Capacitor	Ceramic	22 pF 5% (22J)	1
Capacitor	Ceramic	220 pF 5% (221)	1
Capacitor	Ceramic	330 pF 5% (331)	1
Capacitor	Ceramic	3300 pF 5% (332)	1
Capacitor	Ceramic	390 pF 5% (391)	3
Capacitor	Ceramic	4.7 uF 10% 16V X7R RAD (475)	3
Capacitor	Ceramic	47 pF 5% (47J)	1
Capacitor	Ceramic	5600 pF 5% (562)	1
Capacitor	Ceramic	68 pf 5% (68J)	1
Capacitor	Ceramic	680 pF 5% (681)	1
Capacitor	SMT 1206	0.01 uF ((smt))	4
Capacitor	SMT 1206	0.1 uF ((smt) black stripe)	5
Capacitor	Unused	unused capacitor	1
connector	Cable	2 conductor shielded audio cable	1
connector	Cable	antenna COAX	1
connector	Cable	power leads	1
Diode	Axial	1N4003 (1N4003)	1
IC	SOIC-14	74AC74 Dual D FF (74AC74)	1
IC	SOIC-16	FST3253 mux/demux switch (FST3253)	1
IC	SOIC-8	LT6231 dual op-amp (LT6231)	1
IC	TO-92	LM78L05 voltage regulator (LM78L05)	1
inductor	Toroid	T30-6 toroid core (yellow)	2
Resistor	1/4W	1 k 1/4W 1% (br-blk-blk-br-br)	3
Resistor	1/4W	10 k 1/4W 1% (br-blk-blk-r-br)	2
Resistor	1/4W	10 ohm 1/4W 1% (br-blk-blk-gld-br)	5
Resistor	1/4W	22.1 k 1/4W 1% (r-r-brn-r-br)	1
Resistor	1/4W	4.99 k 1/4W 1% (y-w-w-br-br)	2
Resistor	1/4W	475 1/4W 1% (y-v-grn-bl-br)	2

Resistor	1/4W	49.9 ohm 1% (yel-wht-wht-gld-brn)	3
Resistor	1/6W	100 1/6W 5% (br-blk-br-gld)	2
Transistor	TO-92	2N3904 NPN Transistor (2N3904)	1
Transistor	TO-92	2N3906 PNP transistor (2N3906)	1
wire	Cutoff	shunt wire (cut-off lead)	1
Xtal	Xtal	13.5 MHz (HC49US-13.500MABJ-UB)	1
Xtal	Xtal	14.089 MHz (ABLS-14.08919MHZ-10-J4Y)	1
Xtal	Xtal	18.73 MHz (18.730 1108)	1
Xtal	Xtal	28.224 MHz (HC49US-28.224MABJ-UB)	1
Xtal	Xtal	7.3728 MHz (ECS-73-18-4XEN)	1

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Softrock Lite II designations

Home Bill of Materials Power Supply Local Oscillator Divider Operational Amplifiers Band Pass Filter Mixer External Connections Comments Acronyms Inventory Revisions as of 10/7/2010 Components By Stage WB5RVZ Main Website

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
C01	4.7 uF 10% 16V X7R RAD (Ceramic) - 475	Power Supply
C02	4.7 uF 10% 16V X7R RAD (Ceramic) - 475	Power Supply
C13	0.1 uF (SMT 1206) - (smt) black stripe	Power Supply
D1	1N4003 (Axial) - 1N4003	Power Supply
U1	LM78L05 voltage regulator (TO-92) - LM78L05	Power Supply
gnd	shunt wire (cut-off lead) (Cutoff)	Power Supply
C10	160m: 330 pF 5% (Ceramic - 331) 80m: 180 pF 5% (Ceramic - 181) 40m: 100 pF 5% (Ceramic - 101) 30m: 180 pF 5% (Ceramic - 181) 20m: 180 pF 5% (Ceramic - 181)	Local Oscillator
C11	160m: 180 pF 5% (Ceramic - 181) 80m: 100 pF 5% (Ceramic - 101) 40m: unused capacitor (Unused -) 30m: 100 pF 5% (Ceramic - 101) 20m: 100 pF 5% (Ceramic - 101)	Local Oscillator
X1	160m: 7.3728 MHz (Xtal - ECS-73-18-4XEN) 80m: 14.089 MHz (Xtal - ABLS-14.08919MHZ-10-J4Y) 40m: 28.224 MHz (Xtal - HC49US-28.224MABJ-UB) 30m: 13.5 MHz (Xtal - HC49US-13.500MABJ-UB) 20m: 18.73 MHz (Xtal - 18.730 1108)	Local Oscillator
C12	22 pF 5% (Ceramic) - 22J	Local Oscillator
C20	0.01 uF (SMT 1206) - (smt)	Local Oscillator
R11	10 ohm 1/4W 1% (1/4W) - br-blk-blk-gld-br	Local Oscillator
R14	475 1/4W 1% (1/4W) - y-v-grn-bl-br	Local Oscillator
R17	475 1/4W 1% (1/4W) - y-v-grn-bl-br	Local Oscillator
R15	1 k 1/4W 1% (1/4W) - br-blk-blk-br-br	Local Oscillator
R12	10 k 1/4W 1% (1/4W) - br-blk-blk-r-br	Local Oscillator
R13	10 k 1/4W 1% (1/4W) - br-blk-blk-r-br	Local Oscillator
R16	22.1 k 1/4W 1% (1/4W) - r-r-brn-r-br	Local Oscillator
Q1	2N3904 NPN Transistor (TO-92) - 2N3904	Local Oscillator
Q2	2N3906 PNP transistor (TO-92) - 2N3906	Local Oscillator
hdw1	4 X #4-40 hdw (nut, bolt, washer, spacer) (HDW)	Divider
hdw2	4 X #4-40 hdw (nut, bolt, washer, spacer) (HDW)	Divider
C14	0.01 uF (SMT 1206) - (smt)	Divider

C15	0.01 uF (SMT 1206) - (smt)	Divider
C21	0.01 uF (SMT 1206) - (smt)	Divider
C16	0.1 uF (SMT 1206) - (smt) black stripe	Divider
C17	0.1 uF (SMT 1206) - (smt) black stripe	Divider
C18	0.1 uF (SMT 1206) - (smt) black stripe	Divider
C19	0.1 uF (SMT 1206) - (smt) black stripe	Divider
U2	74AC74 Dual D FF (SOIC-14) - 74AC74	Divider
U3	FST3253 mux/demux switch (SOIC-16) - FST3253	Divider
R05	160m: 49.9 ohm 1% (1/4W - yel-wht-wht-gld-brn) 80m: 49.9 ohm 1% (1/4W - yel-wht-wht-gld-brn) 40m: 49.9 ohm 1% (1/4W - yel-wht-wht-gld-brn) 30m: 10 ohm 1/4W 1% (1/4W - br-blk-blk-gld-br) 20m: 10 ohm 1/4W 1% (1/4W - br-blk-blk-gld-br)	Operational Amplifiers
R06	160m: 49.9 ohm 1% (1/4W - yel-wht-wht-gld-brn) 80m: 49.9 ohm 1% (1/4W - yel-wht-wht-gld-brn) 40m: 49.9 ohm 1% (1/4W - yel-wht-wht-gld-brn) 30m: 10 ohm 1/4W 1% (1/4W - br-blk-blk-gld-br) 20m: 10 ohm 1/4W 1% (1/4W - br-blk-blk-gld-br)	Operational Amplifiers
C08	390 pF 5% (Ceramic) - 391	Operational Amplifiers
C09	390 pF 5% (Ceramic) - 391	Operational Amplifiers
C07	4.7 uF 10% 16V X7R RAD (Ceramic) - 475	Operational Amplifiers
U4	LT6231 dual op-amp (SOIC-8) - LT6231	Operational Amplifiers
R03	1 k 1/4W 1% (1/4W) - br-blk-blk-br-br	Operational Amplifiers
R04	1 k 1/4W 1% (1/4W) - br-blk-blk-br-br	Operational Amplifiers
R07	4.99 k 1/4W 1% (1/4W) - y-w-w-br-br	Operational Amplifiers
R08	4.99 k 1/4W 1% (1/4W) - y-w-w-br-br	Operational Amplifiers
R09	100 1/6W 5% (1/6W) - br-blk-br-gld	Operational Amplifiers
R10	100 1/6W 5% (1/6W) - br-blk-br-gld	Operational Amplifiers
C03	160m: 390 pF 5% (Ceramic - 391) 80m: 220 pF 5% (Ceramic - 221) 40m: 100 pF 5% (Ceramic - 101) 30m: 68 pf 5% (Ceramic - 68J) 20m: 47 pF 5% (Ceramic - 47J)	Band Pass Filter
C04	160m: 5600 pF 5% (Ceramic - 562) 80m: 3300 pF 5% (Ceramic - 332) 40m: 1500 pF 10% (Ceramic - 152) 30m: 1000 pF 5% (Ceramic - 102) 20m: 680 pF 5% (Ceramic - 681)	Band Pass Filter
L1	160m: 19.6 uH 74T #30 on T30-6 (yellow) (38") (Coil - yellow) 80m: 9.1 uH 50T #30 on T30-6 (yellow) (26") (Coil - yellow) 40m: 5.0 uH 37T #30 on T30-6 (yellow) (20") (Coil - yellow)	Band Pass Filter

	30m: 3.5 uH 31T #30 on T30-6 (yellow) (17") (Coil - yellow) 20m: 2.5 uH 26T #30 on T30-6 (yellow) (15") (Coil - yellow)	
T1	160m: 1.4 uH 20T/10T bifilar #30 on T30-6 (yellow) (13") (Xfrmr - yellow) 80m: 0.73 uH 14T/7T bifilar #30 on T30-6 (yellow) (10") (Xfrmr - yellow) 40m: 0.35 uH 10T/5T bifilar #30 on T30-6 (yellow) (8") (Xfrmr - yellow) 30m: 0.18 uH 8T/4T bifilar #30 on T30-6 (yellow) (7") (Xfrmr - yellow) 20m: 0.18 uH 8T/4T bifilar #30 on T30-6 (yellow) (7") (Xfrmr - yellow)	Band Pass Filter
L1-core	T30-6 toroid core (Toroid) - yellow	Band Pass Filter
T1-core	T30-6 toroid core (Toroid) - yellow	Band Pass Filter
C05	0.047 uF 5% (Ceramic) - 473	Mixer
C06	0.047 uF 5% (Ceramic) - 473	Mixer
R01	10 ohm 1/4W 1% (1/4W) - br-blk-blk-gld-br	Mixer
R02	10 ohm 1/4W 1% (1/4W) - br-blk-blk-gld-br	Mixer
ant	antenna COAX (Cable)	External Connections
audio	2 conductor shielded audio cable (Cable)	External Connections
pwr	power leads (Cable)	External Connections

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