Table of Contents

Builder's Procedures

Introduction

Congratulations. You are about to get in on the ground floor of the next big thing in ham radio – Software Defined Radio. You have successfully registered for the Buildathon to be held on 11 July 2009 at Carrollton Public Library, Hebron Branch 4220 North Jose Lane Carrollton, TX.

The procedures in this document are provided to you to enable you to get the most out of the Buildathon experience and minimize potentially wasted time at the actual event.

You will receive your Softrock SR Lite 20m RX kit a minimum of 2 weeks before the event. With your kit in hand, there are a few tasks you should perform before showing up for the Buildathon. These will be outlined later in this document. Additionally, we will explain to you how the procedures during the actual event will work, so that you can get right to the building as soon as the event begins.

Preparatory tasks - Required

Prior to showing up at the event, you will be expected to complete the inventory and organization of your kit's Bill of Materials. Optionally, you can also begin and even complete one of the more time-consuming tasks in the overall build, the winding of the two inductors used in the RX's band pass filter.

Inventorying the Bill of Materials (BOM)

The Buildathon committee has prepared a set of BOM inventory sheets for you to use in inventorying and organizing the components in the Bill of Materials. The most important part is getting the passive components (resistors and capacitors) and certain of the active components inventoried, identified as to component values, prepared for installation, and affixed to the provided inventory sheets.

Inventory Sheets

We have prepared a BOM inventory sheet for each of the six primary stages of the build project. The package is in a .PDF file that can be downloaded from: http://www.wb5rvz.com/sdr/buildathon/StagesBOMsComponentsOrganizers.pdf Each sheet lists and provides space for affixing the components that are required for that stage.

Organizing the Components by Stage of the Build

The process is as follows:

(1) Lay out the inventory BOM sheets on a table
(2) **Begin with the 17 resistors** in the kit envelope. For each resistor:
    a. Bend the resistor leads into a hairpin (for tips on "hairpinning" a resistor, see: Resistor Mounting Techniques (http://www.wb5rvz.com/sdr/common/Common_Component_Mounting.htm#resistors)
    b. Using a DMM, determine the resistance
    c. Find an available line in one of the BOM sheets that calls for that resistance value (note that most of the resistors are 1% tolerance resistors; the tinier resistors are 5% tolerance) Do not be surprised to find the DMM does not show, for example, exactly 1000 ohms for a 1K resistor.
    d. Using masking tape, affix the "hairpinned" resistor to the sheet on the line corresponding to its value
    e. Repeat for each resistor
    f. When you run out of resistors, you should also have run out of empty resistor lines on all of the BOM sheets.
(3) **Next, organize the 12 ceramic capacitors**. For each capacitor:
    a. Identify the capacitor value by reading the code (you will probably need a magnifying glass or loupe and good light to read many of these).
    see: http://www.wb5rvz.com/sdr/common/Common_Component_Mounting.htm#ceramics
    b. Find an empty line for the ceramic capacitor with the corresponding marking. Note: There are lines on the BOM for the tiny SMT capacitors. Do not confuse them.
    c. Affix the ceramic capacitor with a bit of masking tape to the corresponding line on the BOM sheet.
    d. Repeat for each ceramic capacitor.
    e. As in the resistors, when you run out of ceramic capacitors, you should also have run out of empty ceramic capacitor lines on all of the BOM sheets.
(4) **Next, Organize the 2 transistors**.
    a. They are in TO-92 cases and, again, you will need good magnification and light to identify them.
    b. Note that they look identical, save for a single digit in the identifying code. One is a **2N3904**; the other is a **2N3906.** Also note that there is, in the anti-static envelope for the ICs, a LM78L05 Voltage regulator (U1) that very closely resembles these two transistors.
    c. These will be affixed to one of the two lines (Q1 and Q2) on the Local Oscillator Stage's BOM sheet.
(5) **Next, find the diode D1** (1N4003) in the kit envelope and affix it to the D1 line on the Power Supply BOM sheet.
(6) **Next, find the Crystal** in the kit envelope. It will have markings indicating that it is an 18.730 MHz crystal. Affix it with a bit of masking tape to the Local Oscillator BOM sheet on the "X1" line.

(7) **Next, verify that you have the SMT capacitor chips**. They will be found on tape strips in the kit bag. They do not need to be affixed to any BOM sheets. There are two different values represented:

   a. 0.1 uF caps (in a strip with a black stripe marked on it)  . Visually verify that you have 6 chips in the strip (Tony includes 6, even though the design only calls for 5 – you are entitled to one free "throwaway")

   b. 0.01 uF caps (in a clear strip)  . Verify that there are 5 chips in the strip. Again you actually get a free "throwaway". (You should be so lucky with the ICs!)

(8) **Finally, verify that you have the 4 ICs** in the ESD envelope within the kit envelope. Do NOT unstaple and unwrap the ESD envelope. We'll do that at the actual event.

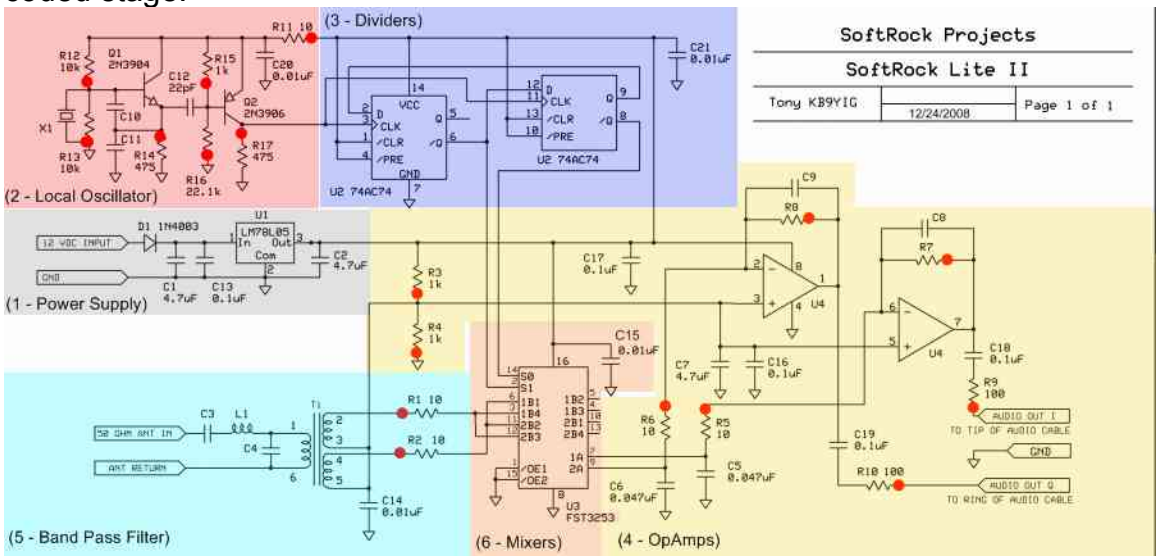
Preparatory Tasks – Study

Build Notes

Once you have your components organized by build stage, you should devote some time to review of the actual build instructions (see:

http://wb5rvz.com/sdr/sr_lite_ii/).

First, just browse through the introduction page, followed by the pages for the individual build stages.
You can also browse the stages via the overall schematic, clicking on each color-coded stage.



You must print out the notes for each stage and bring these with you to the event. If this is an issue, contact Robby WB5RVZ (rrrobson@gmail.com).

Construction tips

Next, review the Common Component Mounting Instructions page, which provides valuable tips on handling typical construction/build issues. See:

http://www.wb5rvz.com/sdr/common/Common_Component_Mounting.htm

Pay particular attention to the videos on SMT soldering in the SMT sections of the Common Component Mounting Instructions page. Many builders worry excessively about this subject unnecessarily. It is really not a challenging area. See:

- SMT Capacitors: http://www.wb5rvz.com/sdr/common/Common_Component_Mounting.htm#chips
- SMT ICs: http://www.wb5rvz.com/sdr/common/Common_Component_Mounting.htm#ics

Preparatory Tasks – Optional

If you review the instructions for the Band Pass Filter (BPF) stage, you will see that it calls for winding two toroids. The first is a simple coil (L1); the second is a bifilar transformer (T1).

Those who would like to get a big jump on the process may wish to consider winding at least the coil (L1). This will allow you to get a feel for the winding process. The more adventurous may want to try and wind the Transformer (T1) either just doing the primary winding in advance or going whole hog and winding the primary and the (bifilar) Secondaries in advance. Tinning and trimming can wait until the actual event.

If you do not feel you can accomplish this beforehand, not to worry; there will be a special "inductors station" at the event, with Elmers who have been there and done that on hand to help you.

We will also have spare toroids, solder special strippable magnet wire, and special color-coded bifilar magnet wire.

If you choose to tackle one or more of these tasks in advance of the event, and we recommend you try to, the pertinent information follows (contact Robby WB5RVZ if you would prefer to use the special wires).

L1 Coil – 30 turns (14") #30 wire, T25-6 Core

Peel off about 14 inches of the provided #30 magnet wire and wind 30 turns onto one of the yellow Toroids provided in the kit envelope. *ANY pass through the center of the toroid counts as one turn.*

For winding techniques, please refer to the toroid winding hints at:
http://www.wb5rvz.com/sdr/common/Common_Component_Mounting.htm#toroid_coils

Leave the leads on the finished coil such that you have at least one-half inch of free lead on either end of the winding.

T1 Bifilar Transformer – 8-turn primary, 4-turn Secondaries, T25-6 Core

T1 is a Toroidal bifilar transformer with one primary winding and two secondary windings. The term "bifilar" refers to the fact that the secondary windings are made by twisting together two lengths of wire such that, when wound, each length of wire represents the beginning and ending of one of the secondary windings. (Robby WB5RVZ has special

color-coded bifilar wire available should you wish to use it for your T1 secondaries).

You may want to review the T1 Winding Tutorial for detailed instructions on winding T1 for the kit.

When winding this type of transformer, you will end up with 6 leads (2 for the single primary and 2 for each of the two Secondaries). It is very important to "tag" these leads so that you can correctly identify them when installing the transformer onto the board. Bits of colored insulation can be used.

Refer to the tips above for guidance on winding Toroidal transformers:
http://www.wb5rvz.com/sdr/common/Common_Component_Mounting.htm#toroid_coils

You will need to first wind the primary winding:

- Peel off about 6" of #30 wire and wind an 8 turn primary onto the remaining yellow toroid. Wind it so that the windings are evenly spaced over 85% of the circumference of the coil.
- Identify the primary leads so (later) you will be able to readily pick them out of the finished transformer (which will end up with 6 leads altogether).
- Peel off another 6" of #30 wire, fold it over in half to form a pair of wires 3 inches long, and twist it so you get about 3 twists per inch.
- Wind the twisted cable over the primary turns, beginning where the primary began, winding 4 turns in the same direction as the primary was wound, and ending where the primary winding ended.

Preparatory Tasks – Builder Station Infrastructure

When you registered for the event, you stipulated that you planned to bring certain or all of the equipment/tools necessary to set up your builder's station at the event. You should have these packed and ready for the event.

Below is the listing of the (types of) items that make up a builder's station, along with recommended sources should you need to obtain them. For some items, multiple possibilities are listed, representing a range of cost and features. If the builder had absolutely none of the tools needed, they could tool-up for just around $50.00.

Item	Cost	Source	Notes
Uncoated Cookie Sheet – *NOT non-stick* (e.g., E-Z Baker Cookie Pan)	$1.00	Dollar Tree Store (next to Harbor Freight), stock no 80T-DT	work surface: important for ESD protection and protection against lost

			components
ESD Solder Station	$19.99	Frys #4825190,	Velleman VTSS5U
DMM	$4.99	Harbor Freight 92020-1VGA	Check for on-sale (has been seen on sale for $1.99)
3rd Hand Capability			
○ **3rd Hand**	$5.99	Harbor Freight 65779-2VGA	(3rd hand with magnification and light)
○ **Panavise, Jr**.,	$24.95	Frys 1917851	(preferred possibility for 3rd hand capability)
○ "**Mini Vise**"	$3.49	Velleman VTTV3, Tanners	(another possibility for 3rd hand capability)
Light/Magnification			
○ **Lighted, Magnifier Headband**	$9.99	Harbor Freight 95890-5VGA	One way for lighting AND magnification
○ **Desktop lighted magnifier**	$5.99	Harbor Freight 96358-1VGA	Another way for lighting and magnification
○ **Desktop Magnifying Lamp**	$17.99	Harbor Freight 97448-2VGA	Recommended way for light and magnification
○ **Desktop Magnifying Lamp**	$19.99	Office Max #21661881,	Catalina Full Spectrum Flip Task Lamp
Eye Loupe SET	$2.97	Harbor Freight 47995-2VGA	For super fine inspection (up to 10X) of tiny components, completed work
Tweezers	$4.99	Harbor Freight 93598-4VGA	A set of tweezers
Diagonal Cutters	$6.59	Radio Shack 64-2951	Kronus 4.5" diag cutters
Wire Strippers	5.99	Radio Shack 64-2979	Kronus™ Adjustable Wire Stripper
Diag Cutter/Stripper Combo	$5.99	Combo: Harbor Freight, #97871-2VGA	Combo dikes and wire stripper
9V Battery		Anywhere	
9V Snap Lead	4/$1.00	Tanners	Club has extras
3.5 mm Stereo cable & plug (or panel jack)	$1.49 (or $0.69)	Tanners	Builder's choice: cable and plug or panel jack. Club has extras of each
PC w/SDR Software (Optional)	n/a	Builder	Builder's laptop PC loaded with Rocky or Winrad SDR Software
Multiple Outlet Power Strip	$3.99	Builder; Harbor Freight 91334-3VGA	Required
# Uncoated Cookie Sheet –NOT non-stick	$1.00	Dollar General Store (next to Harbor Freight)	work surface: important for ESD protection and protection against lost

			components.
Baking Pan 18" x 26"	$8.77	Sams Club #127108	The $1.00 one works, but is a little cramped for space. (Sams also has a half-sized 18x13 for $5.12)
Safety.	$0.99	Harbor **Glasses**Freight ITEM 99762-0VGA	Better to be safe than sorry. Hot solder blobs can wreak havoc in your eyes
Grounding wire	~$1.00	Builder (make one from a three-prong plug and a single wire to bring the ground connection out to an alligator clip to clip to the cookie sheet)	If you are not using a anti-static mat, this is highly recommended as an ESD safety measure.

PC and Software

Optionally, the builder is encouraged to bring their PC (laptop preferred) with one or both of the free SDR programs (Rocky, Winrad) pre-loaded on it. The software can be obtained from the developers' sites, as follows:

- Rocky: http://www.dxatlas.com/Rocky/
- Winrad: http://www.winrad.org/

The PC should have a soundcard capable of stereo input (line in or mic), since an SDR must be able to handle the separate and independent "I" and "Q" audio signals from the RX board. Note: Rocky, under the Vista operating system, only works with an external USB soundcard. Winrad can work with the on-board soundcard under all Windows Operating Systems.

The Final Test Station at the event will have a PC with SDR capability available.

Buildathon Procedures/Process

Builder Stations

At the actual event, you will be assigned to a builder station, where you can lay out your tools, etc., and perform most of your construction tasks. If we have more builders than soldering irons, we will try to pair up left-handed and right-handed builders to facilitate sharing of a single iron.

Your registration form outlined the items (tools, supplies, etc.) that each builder is asked to bring to the event with them. See also above table.

It is highly recommended that the builder brings a multi-outlet extension cord (or surge suppressor/power strip) to the build because there will be excessive competition for available outlets.

Elmer Stations

In addition to the builder stations, we will have centrally located *Elmer stations*, where Elmers and special equipment and tools will be provided for shared use as each builder encounters task(s) that require these facilities or help.

Smoke Test Station

You will visit this station frequently. Each stage of the build ends with a series of tests. The first test is a "Smoke Test" to check the current draw of the rig up to that point, initially limited by a current limiting resistor, and then unlimited. This station provides a simple test harness with battery, snap leads, and mA meter. You will plug your rig's power snap leads into the test harness and quickly run the two tests, recording the results of each on your copy of the instruction sheets.

SMT Solder Station

This station – manned by Elmers who have SMT experience - will have an area with a high quality, ESD-protected, temperature controlled iron, solder wick, excellent magnification, and bright light. Each builder has the option of coming to this station to mount their SMT ICs capacitor chips should be mounted at the builder's station).

Op Amp Test Station

Not really a formal "station", this is simply an area where the builder can borrow the resistors and clip leads called for in the functional test at the end of the OpAmp Stage.

Inductors Station

This station – again, manned by Elmers – will be available to builders when they are winding and tinning their inductors (L1 and T1). It will have tools to measure out the wire lengths, hold the tiny toroids while winding, extra magnet wire, extra toroids, and lead tinning tools and supplies. Elmers will be able to measure the coil's inductance and to show the builder how to mount the coil and transformer.

Frequency Test Station

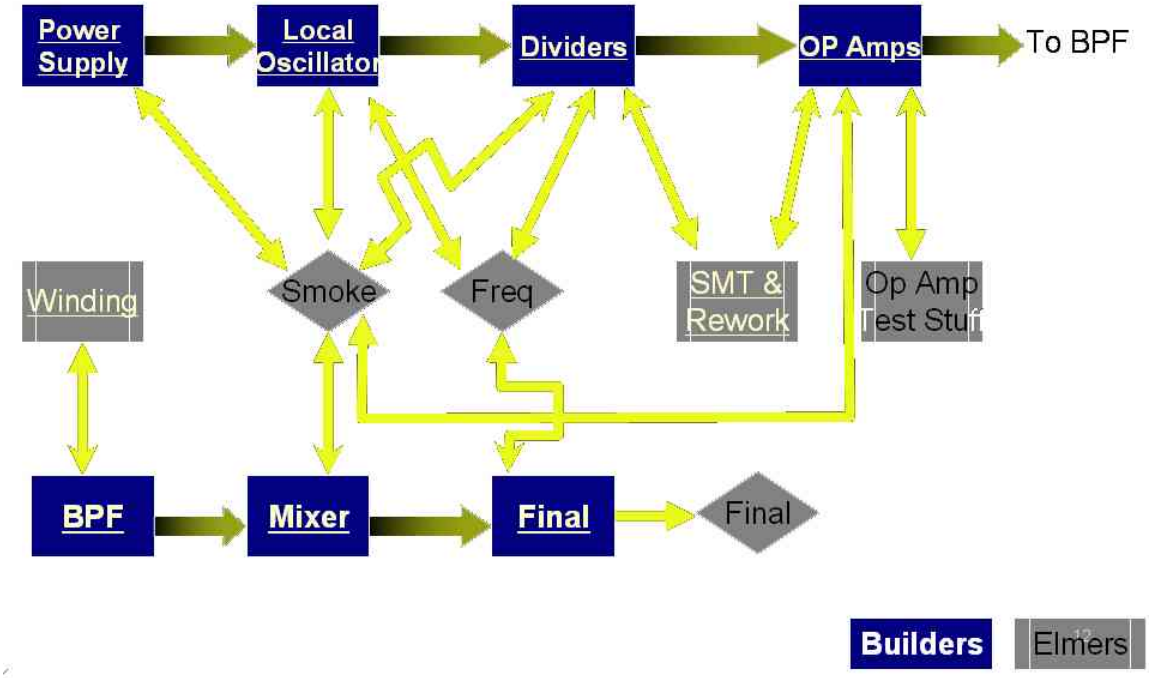
This station will have Elmers and special equipment (frequency counter, oscilloscope, RF and AF signal generators) to assist in testing stages such as the Local Oscillator stage, the Dividers stage, the BPF stage, and the final assemblies. While the kits are designed to be built requiring nothing more than a DMM for test equipment, these additional test facilities help give the builder a sense of confidence in their progress through the build. "Seeing is believing!"

Final Test Station

This is where the rubber meets the road. Here, the builder can hook up their completed kit to power, PC, and antenna and see the receiver actually work to bring in signals and display them on the PC's screen (and speakers).

Construction Map

The builder will follow this process (as documented in the builder's notes) during the actual event.



Build and Test the Power Supply

This stage starts the builder off gently. No real challenges here. One IC (the voltage regulator in a TO-92 package must be carefully removed from the protective ESD envelope – using ESD precautions – and installed on the board. There is one SMT capacitor chip to be installed on the underside, to get the builder's SMT feet wetted.

At stage end, the builder goes to the Smoke Test station, then returns to use their DMM to perform the other tests.

Build and test the Local Oscillator Stage

Another non-challenging stage, the LO stage has the builder stuffing lots of parts onto the board (transistors, resistors, capacitors), plus another SMT capacitor chip (getting to be an old hand now). You will want to install the Power leads for the board at this stage (the instructions have you waiting until the last stage, but the Smoke Test station needs these leads installed right away).

At stage end, another trip to the smoke test station. The major test will be at the Frequency Test station, to see the 18.730 MHz LO signal at the stage's output.

Build and Test the Dividers Stage

This stage will likely be accomplished at the SMT Station, although a good deal can be accomplished at the builder's station. It is nearly all SMT. The first portion (recommended to be performed at the builder's station) is to install the rest of the SMT capacitor chips (at the builder's station). This is followed by installation of two of the three SMT ICs: the Divider and the Mixer. These must be removed from the protective ESD envelope, using ESD precautions. Most builders will likely want to perform these tasks at the SMT station.

At stage end, there is the usual visit to the Smoke Test station. There are some DMM voltage tests that can be done at the builder's station. Finally the builder may want to visit the frequency test station to see the frequency and waveforms at the output of the dividers stage.

Build and Test the Operational Amplifiers Stage

This stage involves more topside board stuffing and the installation of the last SMT IC at the bottom of the board. ESD precautions are called for in the latter step. The builder should by this point have acquired the confidence to install the final SMT IC at their builder station (although it is OK to visit the SMT station if you feel you need that).

At stage end, there is the usual Smoke Test. There is a special functional test for this stage that involves some clip leads and resistors performed at the Op-Amp Test Station.

Build and Test the Band Pass Filter (BPF) Stage

This stage is all about inductors. There are a couple of capacitors to stuff, but the real action is in winding and stuffing the inductors. If you have already pre-wound the inductors, then all you need to do at the inductor station is tin the leads, trim them, identify them, and take them back to your builder station to stuff them (Elmer can show you how on the transformer). If not, you can wind them at your station or at the inductor station.

At the stage end there are continuity tests on the windings and an optional test at the Frequency Test Station to check the transformer's performance. Surprise! No Smoke Test!

Build and Test the Mixer Stage

Not much action here. This adds a couple of topside components and then you run some voltage tests. With the exception of the usual Smoke Test, all the action is at your builder station.

Make the External Connections and Operate the RX

Your radio is almost ready at this stage. Two external connections (audio and antenna) are added to the board and you take it to the Final test station to hook it up to a PC and antenna and listen to/watch those signals come in.

Appendix A – Elmer Station Infrastructure

Item	Qty	Notes	Station	Provider
Label Maker & labels	1	(for each builder to label equipment)	All	KC5SFB
Various Extension cords, power strips	**6**		All	each Elmer
20m Antenna	1	tuned to 14.06 MHz, Z=50 ohms	final	AE5BK
9V battery	1		final	WB5RVZ
Antenna Analyzer (optional)	1	(tuning antenna)	final	AE5BK
Antenna connector with clip leads	1	(with adaptors for bnc/uhf)	final	WB5RVZ
male-to-male stereo cable with 1/8" stereo plugs	1	(where builder used a Jack for IQ Output)	final	WB5RVZ
PC or Laptop with Rocky software loaded	1	(SDR)	final	AE5BK
Signal Generator	1	capable of outputting/sweeping 14.06 MHZ test signal	final	N5TCG
USB Soundcard that accepts stereo inputs	1	(if PC has no stereo input)	final	AE5BK
Dual Trace Oscilloscope 50 MHz with 2 probes	1		freq	
Frequency Counter with range to 20MHz with leads	1		freq	N5TCG
Vise or 3rd hand	1	(hold board under test)	freq	WB5RVZ
15' hank of color coded thermaleze bifilar wire	1		inductors	WB5RVZ
25W soldering iron	1		inductors	WB5RVZ
black and yellow wire insulation	1	(cut into 1/8" bits to serve as identifying "sleeves" for leads)	inductors	WB5RVZ
diagonal cutters	1		inductors	WB5RVZ
DMM	1	(identification of secondary leads)	inductors	WB5RVZ
Irwin Clamps	**4**		inductors	WB5RVZ (4)
jar of paste flux	1	(for tinning)	inductors	WB5RVZ
LC Meter	1	(measuring coil inductance)	inductors	WB5RVZ
PC microscope	1	(for verifying turn count)	inductors	WB5RVZ
PC or laptop with microscope software loaded	1		inductors	WB5RVZ
Spare T25-6 toroid cores	**25**		inductors	WB5RVZ 25)

spool of #30 thernmaleze magnet wire	1		inductors	WB5RVZ
spool of 63/37 solder .032"	1	(for tinning)	inductors	WB5RVZ
Tweezers	1		inductors	WB5RVZ
UNCOATED cookie sheet	1	(for tinning)	inductors	WB5RVZ
wooden skewers	**6**		inductors	WB5RVZ (6)
10k resistors with clip leads on each end	**4**	"bridging resistor	opamp	WB5RVZ
9V battery	1	to power board under test	opamp	WB5RVZ
DMM	1	to measure op amp voltage output. COM lead should be cliplead.	opamp	WB5RVZ
ground wire	1	(for grounding cookie sheeet)	opamp	WB5RVZ
UNCOATED cookie sheet	1	(ESD protection)	opamp	WB5RVZ
9V snap leads	**6**	(spares)	rework	WB5RVZ (6)
anti-static mat with wrist strap	1		rework	WB5RVZ
combo lamp/magnifier (bright lamp)	1		rework	WB5RVZ
DMM	1		rework	WB5RVZ
flux removal spray/solution	1		rework	KB5SFB
ground wire	1	(for grounding cookie sheeet)	rework	WB5RVZ
hot air gun	1		rework	WB5RVZ
Junque box/Spare parts	1	(resistors, capacitors, LM78L05; 2N3904;2N3906)	rework	WB5RVZ
Panavise Jr	1		rework	WB5RVZ
RG-174 coiax 8'	1		rework	WB5RVZ
stereo 1/8" jacks	**5**	(spares)	rework	WB5RVZ (5)
stereo cables w/1.8" plug	**5**	(spares)	rework	WB5RVZ (5)
Temperature-controlled, grounded tip solder station with .032 or smaller tip	1	(fine tip .032" or finer)	rework	WB5RVZ
Tweezers	1		rework	WB5RVZ
UNCOATED cookie sheet	1	(ESD protection)	rework	WB5RVZ
9V battery	**2**	(a spare is recommended)	smoke	WB5RVZ (2)
DMM	1	measures mA current draw	smoke	WB5RVZ
ground wire	1	(for grounding cookie sheeet)	smoke	WB5RVZ
Smoke-test Harness	1	(see below)	smoke	WB5RVZ
UNCOATED cookie sheet	1	(ESD protection)	smoke	WB5RVZ

10X loupe or hand magnifier	1		smt	WB5RVZ
anti-static mat with wrist strap	**2**		smt	KD5YPB, KB5SFB
combo lamp/magnifier (bright lamp)	**2**		smt	W5SVG, KD5YPB
fine solder wick	1	(for grounding cookie sheeet)	smt	WB5RVZ
ground wire	1	(for grounding cookie sheeet)	smt	WB5RVZ
Panavise Jr.	**2**		smt	W5SVG, KD5YPB
solder sucker	1		smt	WB5RVZ
spool of .015" 63/37 solder	1		smt	WB5RVZ
Temperature-controlled, grounded tip solder station with .032 or smaller tip	**2**	(fine tip .032" or finer)	smt	WB5RVZ (2)
Tweezwea, fine	**2**		smt	WB5RVZ (2)
UNCOATED cookie sheet	1	(ESD protection)	smt	WB5RVZ