HF BPF Project

Project Introduction

General

This kit is a daughter board, designed by Jan G0BBL and Tony KB9YIG, that provides four electronically switched band-pass filters for the Softrock Lite + Xtall V9.0 RX, replacing the single-band daughter board in the original design.

The kit can be built in two different "flavors", each providing four switchable bands:

- Option 1: A 160 - 10m version (see main schematic, below), and
- Option 2: A 80-10m + 6m version (see inset in lower left corner of schematic below)

The kit will ship with parts that enable the builder to decide what bands (which "flavor") he/she desires. The board itself works for both option 1 and option 2. The differences are in the components for the first 2 bands (Caps C07 - C12 and coils L1 - L6.

The board can also be used with the earlier RXTX V6.3 and RX V8.3 kits. However, in those cases, the builder must supply the required +5 Vdc bus (and ground connection) to the HF-BPF board, there being no matching sockets therefor on the earlier boards.

If you use Rocky as your SDR, the project initially is manually switched, using two header pins and their associated jumpers.

Starting with v9.0 kits shipped after 21 Feb 2009, the USB interface microprocessor will be an ATTiny85 device with JanG0BBL's new enhanced features code. If there is interest in a programmed ATTiny85 device for an existing v9.0 receiver, contact Tony Parks and he will price the replacement device to cover device cost, PayPal loss and mailing cost.

PowerSDR and Winrad have enabled the programmatic switching of the board.

Included in the kit is a two pin socket section to interface with J3 on the RX v9.0 board. Wires need to be connected to the two jumper plug locations, (with the jumper plugs not used), on the switched BPF board to the two pin socket section. This then is the plug connection between the v9.0 board and the

electronically switched BPF board. An insulated sleeve may be put on the little plug to give it a more finished look and a mark may be added to indicate polarization.

Filter VNA Tests

Mike Collins KF4BQ tested (on 13 December 2008) the completed board and the results can be found at this link.

The latest schematics (1/12/2009) are at the following links:

- Option 1 - 1.5-30 MHz
- Option 2 - 3.5-30 MHz plus 6m

BF-BPF is Now in Production

Kit price for the electronically switched v9.0 BPF is $14 for US/Canada and $15 for DX where mailing costs are included in each kit price.

Theory of Operation

- The board gets its power and control signals, as well as inputs and outputs, from the appropriate points on the Softrock Lite + Xtall RX V9.0
- Control signals (two inputs that can each be "high" or "low", resulting in four possible combinations) are available at J3 on the V9.0 board and are provided to this board via a cable connection to the holes for P102.
- Power (regulated +5 Vdc) comes from the 3-pin J2 on the V9.0 board via P101
- The RF antenna inputs and the balanced RF outputs are facilitated via P100, which plugs into the V9.0 board's 9-pin J1.
- RF in and out are coupled via transformers. T1 couples RF from the antenna into U1, the first of two switching ICs. The second switch, using the same truth table, switches the appropriate bandpass filter circuit through to the output transformer, T2, and thence to the pins of P100 that feed the balanced signal to the V9.0 RX.
- Each switch has four outputs, one for each of the four bandpass filters implemented on the board. The switch routes the RF to the appropriate filter, based upon the levels present at S0 and S1 (which can be set via JP1 and JP2), according to the following truth table:

JP1 (S0)	JP2 (S1)	Band
jumpered	jumpered	1.8=4 MHz
open	jumpered	4-8 MHz
jumpered	open	8-16 MHz
open	open	16-30 MHz

A Few Words About The Coils from Jan G0BBL

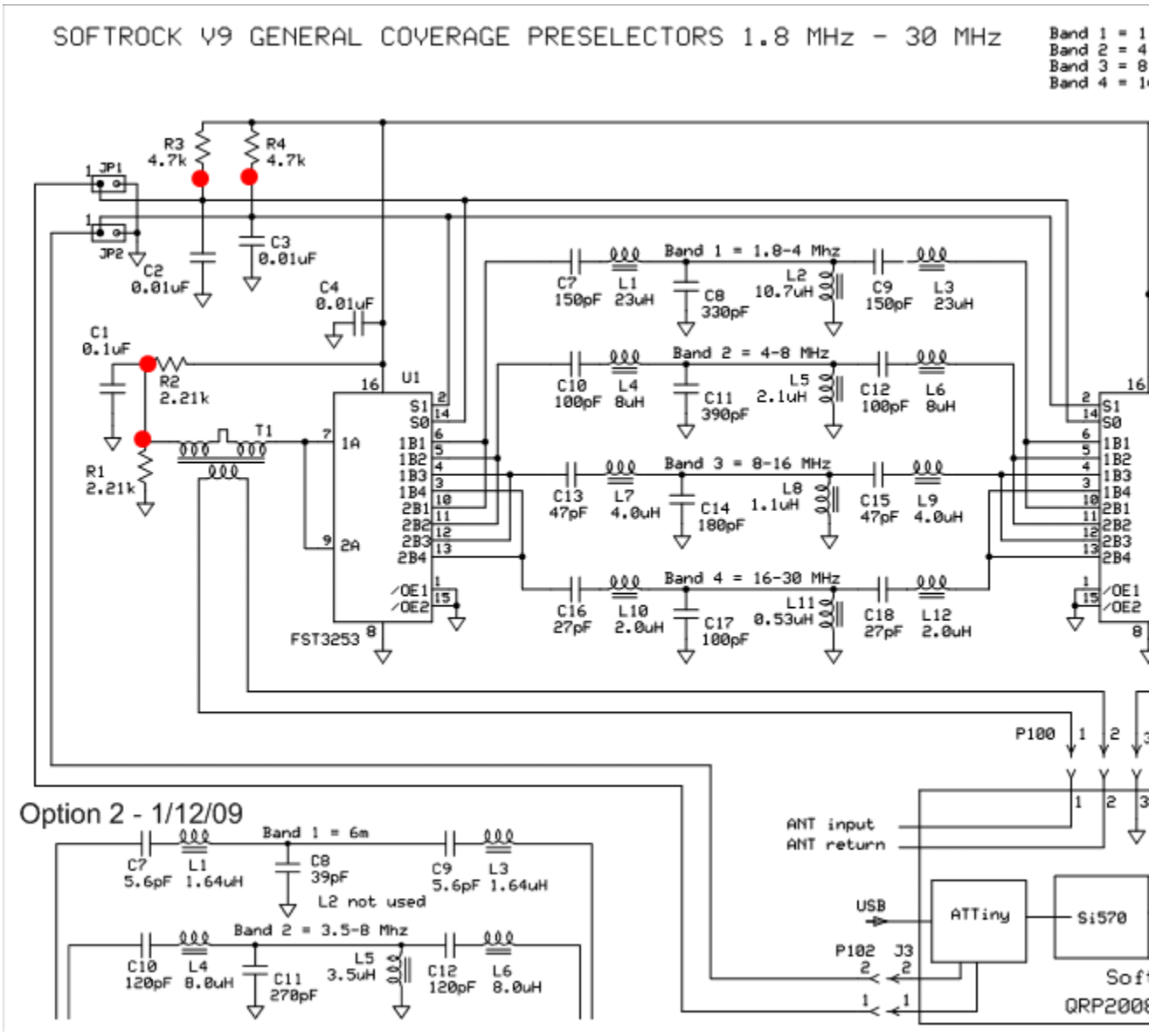
Turn Counts and Inductances

- Coil winding data is based on the manufacturer's data used in the toroid calculators that are avaiable. If you do NOT have an Inductance meter, then please use these values.
- In practice the value of the toroids will be slightly HIGHER than the design value. This has been confirmed by a number of amateurs. However as it is much EASIER to take off a turn then to ADD turns, I have suggested to Tony and Robby to use the TOROID calculator data instead of the original values which I provided (obtained by measuring coils used in prototype)
- Bodo DJ9CS and Mike W1USN checked their winding data and also suggested to use the data from the Toroid calculator. Please note that the value of the core AL may vary by +/- 10% as has been mentioned elsewhere.

- **Critical Coils**
  - From experience the inductance of the Centre (center, for the colonials) Coil (ie L2. L5,. L8 and L11) is critical for setting the Centre Frequency of the BPF concerned. If you are sure that a BPF is too low in frequency then you may take the effort to take a turn off the centre inductor.
  - If you have a band which is completely out then closely check the ceramic capacitors. A hairline crack may indicate the capacitor is faulty. For this reason I would suggest to mount C's about 3mm (1/8") away from the PCB. Capacitors generally will NOT survive desoldering so do not reuse caps.

Project Schematic

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

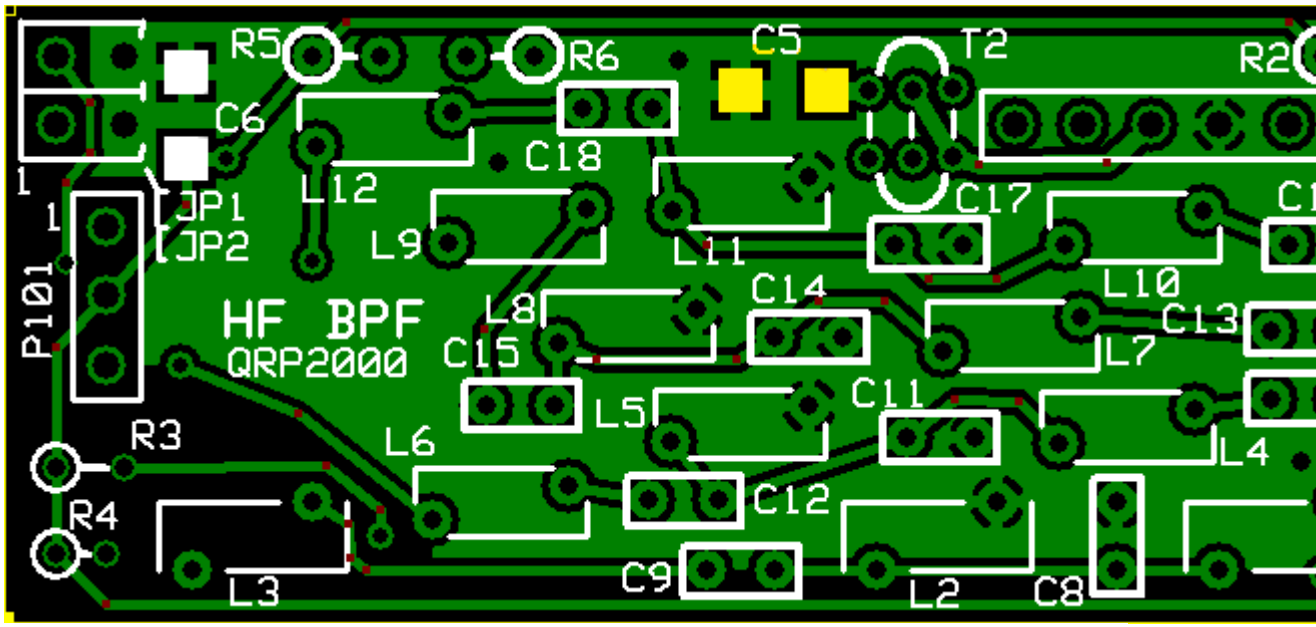


Project Bill of Materials

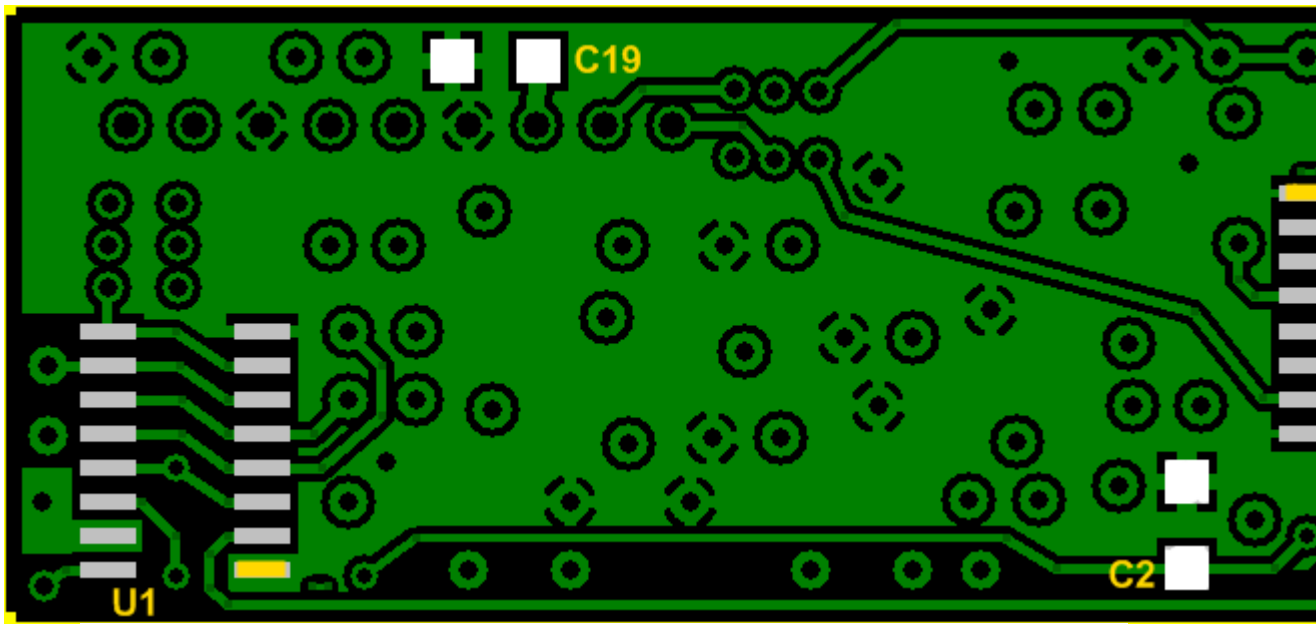
See Project Bill of Materials

Project Expert's (terse) Build Notes

Board Top



Board Bottom



- Install all SMT and SOIC components to the bottom of the board, then the top of the board
- Wind and install the transformers
- Wind and install the Coils
- Install the ceramic capacitors
- Install the resistors
- Install the jumpers and connectors

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 Busses and Rails Stage
- Build and Test the Switches Stage
- Build and Test the Transformers Stage
- Build and Test the Band 1: 1.8-4 MHz Stage
- Build and Test the Band 2: 4-8 MHz Stage
- Build and Test the Band 3: 8-16 MHz Stage
- Build and Test the Band 4: 16-30 MHz Stage
- Build and Test the Band1a 6m Stage
- Build and Test the Band2a 3.5-8 MHz 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.

Soldering

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

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View the above in full-screen mode on Youtube.

- 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:
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    Velleman VTSS5U 50W Solder Station (approx $20 at Frys)
  - 
    Harbor Freight ESD Solder Station (under $50)

ESD Protection

- 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

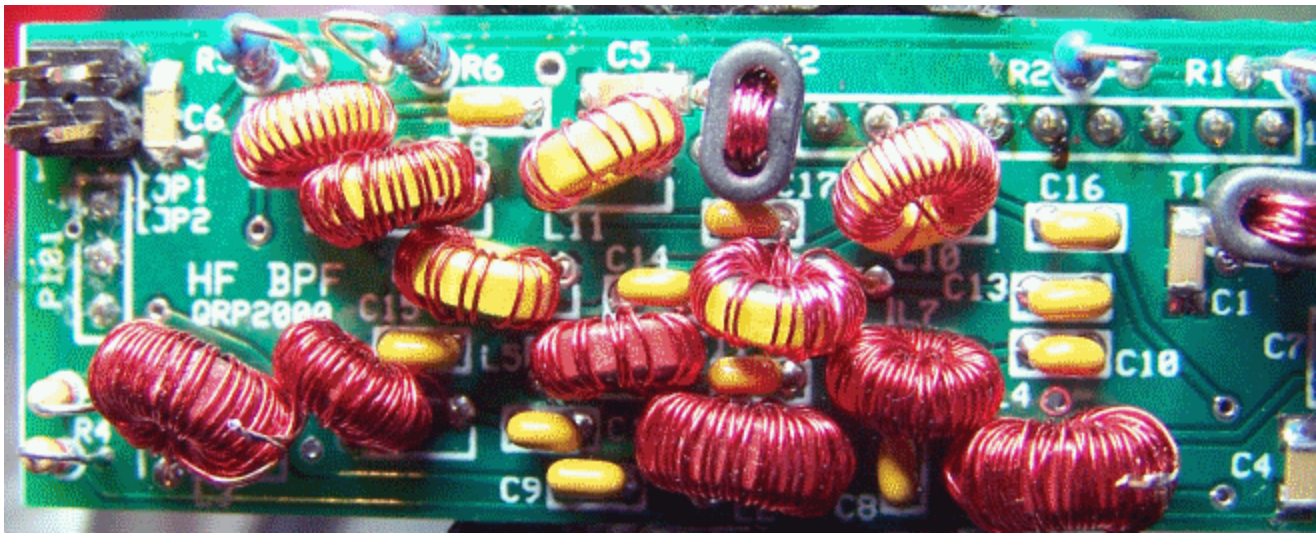
- You will need a well-lit work area and a minimum of 3X magnification (the author uses a cheap magnifying fluorescent light with a 3X lens. This is supplemented by a hand-held 10 X loupe - with light - for close-in inspection of solder joints and SMT installation.
- You should use a cookie sheet or 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 Completed Stage

Top of the Board



Bottom of the Board

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)