

Add a band scope, DSP IF filtering, IF shift and DSP demodulation to your boat anchor receiver, for less than \$20.

By Andrew Barron ZL3DW. (March 2007)

This article describes my recent experiments with Software Defined Radio and the SoftRock 6.2 Lite developed by Tony Parks KB9YIG. Since I started this project there has been a recent RadCom article which describes a similar experiment using an FT-1000 transceiver. Personally I am not brave enough to do surgery on my main station transceiver, but I had an older transceiver gathering dust in the garage that was ideal for this project.

The SoftRock kitset is sold as an entry-level introduction to the world of software defined radio. The kits are sold as receivers capable of tuning across a small part of a selected ham band. There are SoftRock kits available for the 160m, 80m, 40m, 30m, 20m and 10m bands. The SoftRock kit translates the RF frequency down to "I" and "Q" audio signals, which are fed into the PC soundcard. Filtering and demodulation is done by software in your PC.

The receivers cover about a 44kHz segment of the selected band. With a high end PC soundcard, capable of A-D conversion at 96kHz, the bandwidth can increase to approximately 98kHz. A nice thing is that there is a lot of "open source" free SDR receiver software available on the Internet. This is not shareware there is no fee to pay or registration required.



On reading about the SoftRock kits I reasoned that if I could set the device to work at the centre of the 9MHz 1st IF in my FT-301 receiver, I would be able to tune to any frequency and still get the advantages of the SDR software. This would effectively add IF DSP filtering, band scope and demodulation to the old receiver. These are features usually only found in the latest top of the range transceivers.

I sent a query off to Tony Parks and said that I would like to buy a SoftRock kitset for a 9MHz IF or failing that I would buy the 30m version and change the crystal. Tony replied immediately and sold me a 9MHz kitset for \$US12 including postage. This is incredible value for money. The pcb is high quality with silk screening and plated through holes. There are five integrated circuits and all of the other parts. Please note that this kitset is not for novices, there are 4 smd integrated circuits and 10 smd capacitors plus an inductor and transformer to be wound on tiny toroid cores. You need good eyesight, I ended up using hobby glasses on top of my normal glasses, most amusing to the family. You also need a temperature controlled soldering iron with a fairly fine tip. I had never used smd devices before and was a bit worried, but in the end I had no problems. I also used an anti-static wrist strap, although I do not know if the chips are static sensitive. Good lighting and a very careful approach are recommended. Another point worth noting is that there were no assembly instructions provided, just a brief note showing the components that differ on the 9MHz version from a standard kit. This is not a problem as the building instructions, parts list, schematic and pcb layout are all available on the Internet. There is also the SoftRock-40 users group on Yahoo. Experimenters are requested to use the Yahoo users group to ask questions rather than overloading Tony Parks with FAQ. I am also happy to give assistance.

The SoftRock board includes a 5V voltage regulator so the kitset can run on the same supply as the receiver. In the 9MHz version a 12MHz oscillator is divided by 4 to produce two 3MHz square wave clock signals with one clock delayed by 90 degrees. SoftRock kits on bands below 20m usually have oscillators either 4 or 8 times the clock frequency, which is normally the same as the centre frequency of the receiver. In the 20m version and my 9MHz special, the clock is 1/3 of the centre frequency. This is called 1/3 undersampling.

The SoftRock board down converts and quadrature samples the RF signal applied to it. The RF input signal, in my case the 9MHz 1st IF signal, is fed through an LC filter into a transformer wound on a small toroid core. The transformer has a 4+4 turn bifilar wound centre tap secondary. The two out of phase RF signals and two clock signals are fed into a FST3253 video multiplex switch, which together with the op amps and software in the PC form a Tayloe detector. Output samples are at 0°, 90°, 180° and 270° relative to the input signal. The two outputs of the FST3253 are integrated by two op amps to form audio "I" and "Q" "baseband" signals, which are, connected to the soundcard stereo inputs. The "I" and "Q" outputs both carry all of the signals in the passband, but the phase of the signals is different. Either signal can be demodulated by the SDR software, but the clever noise filtering and image rejection is only effective when the software is able to use both the I and Q signals.

The really clever stuff happens in the software. There are several compatible SDR programs listed below. Rocky is the simplest application, SD radio is good as well. The most complex is the Flex Radio "Power SDR V1.8.0", which is the software used with the SDR-1000 radio. It is the only application to offer an auto notch filter and dual in band receiver demod. You can have the two receiver outputs mixed or one on the left channel and the other on the right. My personal favourite is WinRad V1.24 which has a great user interface and features simultaneous spectrum and waterfall displays both across the entire 44kHz spectrum and across the selected bandwidth.

How does it work? In one word it is "awesome". My FT-301 does not have a narrow cw filter so when I tuned to the low end of 40m during a recent cw contest I could hear at least 20 cw QSOs at once. With the SDR running I could set the filter as narrow as 100Hz, auto peak each cw signal, and listen to perfect clean signals. Each cw signal can be selected by mouse clicking on the waterfall display and the cw audio tone can be set to any frequency you like. The digital filters are fully adjustable from 5kHz to less than 100Hz and are razor sharp. In WinRad the filter shape on the display is the actual filter shape produced by the software, not just a graphic representation. SSB signals with an interfering signal or another QSO too close can have the offending signal removed with "pin point" accuracy due to the waterfall display. Using Power SDR the auto-notch removes a spurie or offending carrier completely but leaves it on the waterfall display, which is a bit uncanny because you can see it but not hear it. When tuned to a PSK31 signal and feeding the output audio via "Virtual Audio Cable" to MixW the signal to noise can be improved dramatically.

If you are interested in getting a taste of Software Defined Radio (SDR) without investing in the SoftRock kitset, you can download sample wave files, which run in a loop. Several of the SDR receiver programs can

I was particularly interested in disabling the AGC function of the receiver, because AGC pumping is a major failing of the AF DSP in my FT-847 transceiver. AGC pumping is the situation that arises when a strong signal in the receiver's IF passband reduces the receiver sensitivity, suppressing the weaker wanted signal. This is very common problem when working PSK31 DX. It occurs every time a VK opens up 200Hz up the band. The AF DSP will remove the VK from the audio so it can't be seen on the waterfall display but the big signal desensitises the receiver and the wanted DX fades away. With IF DSP, the filtering removes the strong signal before the AGC circuit so the weak signal is unaffected.



sdorf.net SDR-SoftRock-05.html

I decided to use some of the receiver's gain to boost the signal so I moved my IF take off to the last point where the full 8MHz wide spectrum was available. This turned out to be the IF Filter board. There is no CW filter fitted on my FT-301 so I wired the SoftRock to the tag where it would be connected if it were present. I removed a jumper, which had been fitted so that CW could be copied via the SSB crystal filter. Now the SoftRock had tons of signal and I could select normal USB, LSB or SDR (CW switch setting). This has the advantage that the Yaesu receiver gets no input to the second IF when SDR is selected, which means that the AGC keeps the front end at full sensitivity. The RF gain control is still in circuit if I need to manually turn down the RF level.

There are plenty of places where I could have mounted the small SoftRock board within the Yaesu rig. I decided that since I was connecting into the IF filter board that I would mount it there. There was not enough room so I removed the AM crystal filter. This disables AM reception on the receiver but of course it is still available via the SDR receiver. Since the Yaesu can only receive ham bands the loss of AM is not a big concern to me. I can always reinstall the filter if I remove the SoftRock pcb. The Yaesu can still receive USB and LSB, which is handy for tuning across the band to look for activity. Once signals are found I can switch to the SDR (CW) position and use the SDR features.

Overall it has been a very interesting and inexpensive project. I still have the problem of receiving on the FT-301 and wanting to transmit on the FT-847. I will have to arrange a way to use the FT-301 for PSK transmit. The problem is netting the transmit frequency to the same frequency as the PSK receive which could be anywhere within +-22kHz of the displayed centre frequency. Normally it is just a matter of sending PSK at

the same audio frequency as received but in this case the relationship between the transmitter RF frequency and the receiver RF frequency has been changed completely. The Yaesu transceiver uses a 9MHz IF on transmit as well, so there is the possibility of adding SDR transmit modulation. But that is another story.

Resources:

A view of the of the earlier v6.0 SoftRock may be seen at <http://ewjt.com/kd5tfd/sdr1k-notebook/sr40/sr6-production/index.html> which gives a good idea of the general look of the SoftRock Lite board except the Lite is a square board.

German language (use Translate function) <http://dj9cs.raisdorf.net/SDR-SoftRock-05.html> Has the SoftRock V6.2 Lite files. The download files are all in English.

HamSDR.com public download area has SoftRock V6.0 files. <http://www.hamsdr.com/dnld.aspx>

The software may be download at no cost with a number of programs available that will play the SoftRock receiver. Please see:

Flex Software < <http://www.flex-radio.com/> >

Rocky Software < <http://www.dxatlas.com/rocky/> >

KGKSDR Software < <http://www.m0kgk.co.uk/sdr/index.php> >

SDRadio Software < <http://digilander.libero.it/i2phd/sdradio/index.html> >

Winrad Software < <http://digilander.libero.it/i2phd/winrad/index.html> >

Documentation to build the kit may be downloaded from files area of <http://groups.yahoo.com/group/softrock40/> You will have to register at the website to download the documents for the kit.

Orders will be accepted by PayPal to user name raparks@ctcisp.com This seems to be the easiest way to buy a SoftRock 6.2 Lite kit. Tony will also accept money orders but these are more expensive than the kitset.

