Integrating a USB-SDR Radio into Ham Station Operation

Several features already built into my ham radio station have made it easier to fully integrate a SDR into normal ham station operation. You don’t have to have all these in place, except for good RF grounding practices needed any time connections are made from your ham radio to your computer. But the changes discussed below do make the using the SDR as a band scope with my HF transceiver a seamless operation.

Initial testing/operation of the NooElec up converter and SDR lying open at the back of my transceiver indicated no need for additional RF shielding. This statement should be prefaced with the fact that proper grounding of the computer and ham radio system are already in place. The packaging arrangement shown below is primarily for mechanical protection and enclosing anything subject to inadvertent electrical shorts and, making connection to the ham station antenna system. I have kept ferrite beads on all wiring to minimize stray common mode currents.

**Item #1: Antenna Switch**
The first item that influenced how I added the SDR, is the use of an antenna switch between my antenna tuner and the transceiver antenna connection as the final barrier for lightning protection for my HF radio. That switch is the basis of how the SDR is mechanically mounted and connected to the antenna feed for the SDR. The aluminum box mounted below the antenna switch contains the NooElec HF up converter and protective relay needed to disconnect the SDR on transmit, and delay transmit enable until the relay is fully in the SDR disconnect state. The USB-SDR was left outside the box, since it does dissipate a small amount of heat and really needs no additional packaging.
The RF connection is simply a "tee" connection in parallel with my ham transceiver antenna input through a DPDT relay with suitable dielectric and contact spacing for the 100watts of RF, configured to break the connection to the up converter upon transmit. Previous testing showed no ill effects (noise, or loss of signal) of paralleling the two receivers on the same antenna.

**Item #2: Transmit Inhibit/Delay Function**
The second modification facilitating the SDR receiver addition, is a transmit inhibit feature added to the antenna switch, using the OMNI-VI transmitter out/enable circuit to prevent keying the transmitter into a dead short when the antenna switch is not in the proper position. With the SDR addition, the micro switch transmit enable wiring was connected to the other side of the relay DPDT contacts, allowing the relay armature swing time to insert a 25ms time delay between transmitter key/unkey and SDR disconnect/connect cycle. This ensures the SDR is not exposed to direct transmitter output during transitions from receive to transmit. The up converter SMA connector output and the converter bypass switch are visible on the back of the box.
Details of Construction

Interior View - NooElec Converter, DPDT Relay, +5VDC Power connection to Card
Most HF transceivers come equipped with the necessary outputs similar to the OMNI to safely connect an outboard linear RF Amplifier; that is the Transmit Out/Transmit Enable connections (to permit outboard equipment to insert additional transition time between PTT and actual transmitter power up, PTT controlled relay dry contacts (OMNI Relay Output connection shown above) to power up outboard equipment on transmit, and lastly a convenient Aux 13.5VDC power source for outboard relays, etc.

Relay Choice based on Suitable Dielectric Strength Rating, Size, DPDT Contacts

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One caveat with the NooElec surface mount card: I unfortunately discovered that the micro-USB connector on the card suffers the classic lack of a good solder bond between the connector mechanical support tabs and the card, as the connector broke off after connecting/disconnecting the USB cable a few times.

The white encircled area above shows where the micro-USB connector was located. Fortunately +5VDC and Ground pin-through holes are provided and clearly marked. The enlarged photo below more clearly shows the proper locations for soldering a micro USB cable directly to the card. Standard insulation color coding of the USB conductors are: +5VDC (Red), Ground (Black), Turquoise and White (Data). Only the power and ground need be connected.

It is not uncommon for surface mount PCBs that have connectors soldered on as part of the surface mount solder process to have problems since the larger connector mechanical tabs require more heat and time to have good solder wetting than the component J leads. I had the same failure in one of my laptop SO-DIMM memory sockets.

D.C. Eddleman, KR4UB
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Fortunately right next to the USB connector mounting location, ground and +5V pin through hole connection points are conveniently located on the PCB, so I simply cut the connector off the USB cable and soldered the power leads in the pin through holes. I didn't like the way the micro USB connector stuck out to the side the PCB anyway.

**Considerations in Dealing with Audio from both the SDR and the Ham Station Transceiver**

The SDR addition with the SDRSharp software provides a panoramic spectrum view with the ability to see activity across an entire selected ham band. After listening to a station on the SDR, I simply tune the OMNI to that frequency and can begin transmission to make a contact.

I don’t know how and if modern ham transceivers with dual receive function permit simultaneous audio out of both receivers, but for me, this being the first experience with it, I find it can be quite confusing as to what signal is coming from where.

**Item #3: Ham Station Receive Audio Connection to Computer Sound Card**

The third modification provides a logical way (to me anyway) to deal with the dual receive audio. The OMNI receiver audio is fed into the computer sound card line input, done originally for the audio spectrum analyzer software I use. With the SDR audio in the computer as wave audio output, the computer sound volume controls shown below can be used for example put the OMNI audio on one side of the headset and the SDR audio on the other side, making it easier listen to both receivers while zeroing in the OMNI in on the same signal heard on the SDR. The OMNI-VI transceiver audio is controlled by the Input Volume Sliders and the SDR audio is controlled by the Wave Volume Sliders.

**Same Solution for yet Another Problem**

Feeding both the OMNI audio and SDR audio through the computer also solves another nuisance problem that would be present if not done.

That is, any DSP processor adds noticeable delay as part of the signal processing. If the OMNI transceiver audio is listened to direct from the radio, along with the SDR audio, the delay difference between the two signals is considerable and very annoying. However, by feeding the OMNI audio through the computer sound card, the delay introduced there pretty well matches up with the SDR signal delay, bringing both signals pretty much in time sync. There is a very small amount of delay difference between the two, making for a slight echo in the sound, but not objectionable to the point of being unusable.

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**Item #4 Relay to Mute Computer Sound Card Output when Transmitting**
The forth modification is the use of a separate relay I added sometime back in the computer to mixer/headset circuit, that mutes all computer audio (including SDR) in my headset when I key the transmitter.

**Problem #1**
It seems that even with proper grounding, computer sound cards in the presence of strong RF, are inclined to generate noise in the audio output, even without input cables connected to the sound card. I originally experienced this problem during VHF transmissions to local repeaters, even before there were any connections from the ham radio to the adjacent computer system.

**Problem #2**
With the SDR addition and tuned to the same frequencies, without some method the mute the output during transmission, you are going to hear your transmitted voice audio, delayed in time by the SDR. This can be very annoying and disorienting. If you ever experienced this back in the days of analog long distance telephone circuits or satellite telephone calls, when the echo suppression failed to activate, you know just how disorienting this can be in trying to talk.

The computer audio mute on transmit relay solves both of these problems.

**Item #5 Proper Ham Station Grounding**
The fifth and probably most important modification that facilitated the installation of the SDR is an effective grounding system not only for the ham station itself, but extended to the attached computer system. Without this, RF issues between the transceiver and attached computer are likely to occur. Braid ground strapping originating from my ground rod system, parallels the entry of all my antenna leads and bonds to the tuner, transceiver, the chassis of the outboard audio mixer/amplifier for speaker/headset audio, and finally to the chassis of the attached computer. I also use a top quality audio ground loop isolation transformer in the audio path from the transceiver to the computer sound card input/output.

**Source for the NooElec Up Converter:**

http://www.nooelec.com/store/software-defined-radio/ham-it-up-v1-0-rf-upconverter-for-software-defined-radio.html - .USO_GPK86Jo

**Source for the TV28T v2 DVB-T USB Stick (R820T) w/ Antenna and Remote Control**

http://www.nooelec.com/store/software-defined-radio/sdr-receivers/tv28tv2.html - .USO-wPK86Jo

**Source for Additional SMA Connectors and Cables you may need**

http://www.amazon.com/gp/product/B007PPZU44/ref=oh_details_o02_s00_i00?ie=UTF8&psc=1
http://www.amazon.com/gp/product/B007PPHUO2/ref=oh_details_o02_s00_i02?ie=UTF8&psc=1
http://www.amazon.com/Gino-Male-Coaxial-Adapter-Connector/dp/B007POCTTA/ref=pd_rhf_pe_p_t_2_2RJ1