

Using the K2 DXE IF Buffer Amp as a Panadapter Using the SDRPlay RSP2 and HDSDR Software.

One of the more useful options for installing the DXE IF Buffer Amp in your K2 is to use the IF output to feed an SDR radio or a conversion platform like the LP-Pan, which will provide the I/Q signals for use with a soundcard, to view the IF spectrum on your PC screen with your favorite SDR software. The following describes my venture into a project of this type.



DXE IF Buffer Amp Board

I loved building my K2 many years ago and still really enjoy operating this fine rig. For a more than 20-year-old design, the receiver is still top notch and it is still a pleasure to operate. Although, it does not contain many of the bells and whistles found in the more modern designs especially in the SDR arena. One of the functions of today's SDR based rigs I miss with my K2 is a panadapter.

This document describes my setup using my K2 with the DXE IF Buffer Amp installed, feeding the IF to a SDRPlay RSP2. The output of the RSP2 is then fed to a very good SDR program called HDSDR. HDSDR is freeware and can be downloaded from their website: <http://www.hdsdr.de/index.html>.

HDSDR is able to use Omni-Rig for rig control. This will give you point and click operation so that you can view a spectrum of signals and pick the one you are interested in and select it. This will tune the K2 to the frequency you selected.

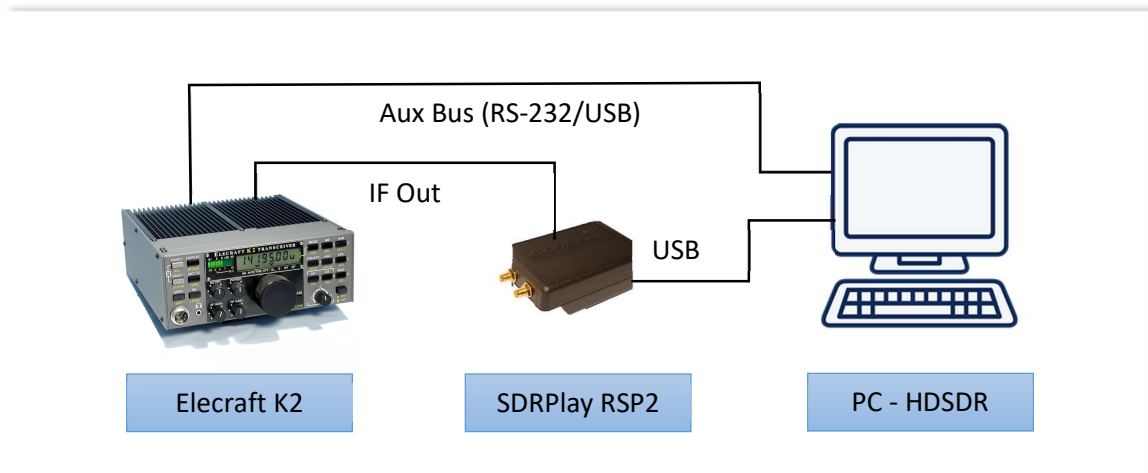
There are many options in the HDSDR application. So, explanation of everything available will be task left to the user. Alan, G4ZFQ has a very detailed site on using HDSDR on multiple SDR platforms and rigs found here: <https://sites.google.com/site/g4zfqradio/installing-and-using-hdsdr?authuser=0> He specifically has a section dedicated to setting up HDSDR for use as a panadapter using a conventional transceiver: <https://sites.google.com/site/g4zfqradio/hdsdr-if-pano>

Specifically, I set out to setup the K2 with a panadapter in the classic sense with very tight integration. i.e., having the HDSDR interface control the K2 and vice versa and still have the ability to use the K2 for audio output, crystal filtering etc. There is also a way to simply use the K2 as an IF front end and use HDSDR with its fully capable DSP and audio functions for all filtering and audio etc. This is an excellent way to configure HDSDR as a second receiver for the K2. Tuning of HDSDR is independent of the K2 in this configuration and would allow monitoring a signal separate from the TX frequency on the K2 VFO. This allows split operation without placing the K2 in split mode.

As with any integration project involving multiple pieces, there are a number of compromises, tweaks, adjustments and plain experimentation involved in getting something useful for operation. HDSDR for instance, is a very good generic software front end for many SDR rigs on the market. With this said, there is nothing specific in the interface or underlying integration with regards to the K2. Therefore, there are a number of tweaks and adjustments to get this integration working properly with the K2.

The Basic Setup Concept

The integration consists of connecting the IF output of the K2 to the SDRPlay RSP2, setting up Omni-Rig for use with controlling the K2 and then setting up HDSDR to use the input from the RSP2 as well as



Basic Setup Connections Between the K2, RSP2 and Windows PC

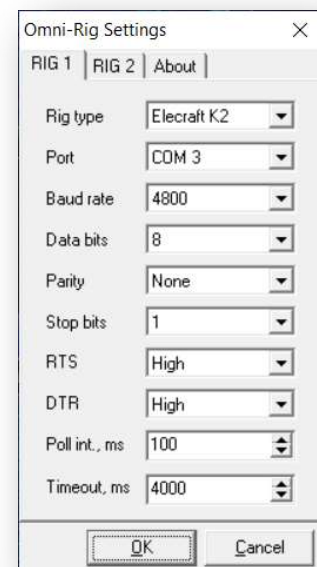
utilizing Omni-Rig to control the K2. You may access the Omni-Rig setup via HDSDR and use the following parameters to setup the communication with your K2. Obviously, you will want to select the COM port that your K2 is connected. Remember that the K2 will only work with 4800 baud. I changed the polling interval to 100ms from the default of 500ms. I found that the tuning was a little more responsive.

The K2 Mixing Scheme

One of the first things to consider when using HDSDR to control the K2 is dealing with the mixing scheme used in the K2. For 160m through 17m, the K2 uses a high-side injection mixing method. For 15m and up, it uses a low-side injection method. This was to allow a VCO range of around 24MHz to cover all bands. What that means is if you setup HDSDR to work properly on 160m – 17m, the spectrum will be reversed when working with 15m – 10m. Fortunately, HDSDR does provide a convenient method to reverse the spectrum when a specified frequency is reached.

K2 Mode Differences in HDSDR

HDSDR allows you to specify frequency offsets to adjust aligning the spectrum display to the VFO reading on the K2 in the RF Front-End Configuration Dialog (Show below). The offset will have to be calculated for each mode used by the K2. I have derived a way to calculate these offsets which will be covered in detail later in this document. For now, suffice it to say that there will be a positive offset and negative offset for each mode depending on side band orientation. The SSB modes of USB and LSB operate normally and act as you would think they should. For reasons that so far, I'm unaware of, the offsets for the CW modes of CW_U and CW_L seem to be the opposite as they relate to the K2 CW



Omni-Rig Settings Dialog

modes of CW-Reverse and CW-Normal. Even when using the HSDR menu option to swap CW and CW-R in Omni-Rig, this apparently does not apply to the mode offsets. Checking the options to swap CW and CW-R in Omni-Rig does provide for consistent tuning across all bands, even when tuning 15m-10m.

K2 IF Shift Between Modes and Filters

Based on the mode type and filter width, each will cause the K2 to shift the IF slightly to compensate for how the filter is adjusted internally to the K2. While HSDR allows specifying offsets for each mode, it does not provide the ability to do this for each filter used in the K2 (FL-1 through FL-4). You will want to pick the filter you would like to search with and specify the offsets for that filter.

I have the KSB2 SSB module installed in my K2. I use the OP1 filter (2.4KHz SSB crystal filter) for each mode (CW, SSB & RTTY) supported in the K2. Using the same filter for each mode allows you to specify the same IF entry in the HSDR setup for using the OP1 filter as well as provide a set of offsets for each mode. This again, will be covered later in detail. Also covered later in detail will be a spreadsheet that I designed to calculate the IF entry and mode offsets per filter (FL-1 – FL-4) for the K2.

Calculating the Mode Offsets for the K2

After using the method documented on Alan's, G4ZFQ website for calibrating the offsets used per mode using a standard signal like WWV and the documented IF of 4.915 Mhz for the K2, it occurred to me that there might be a mathematical way to determine these offsets. I determined that after the filters are properly aligned using the CAL FIL routine on the K2, the BFO frequencies used to set those filters could be used to calculate the correctly shifted IF-frequency as well as the symmetrical offsets for each mode. Since each filter, if adjusted properly, should represent a mirrored presentation for each sideband of each mode, we should be able to calculate the IF frequency as the mean average of the two BFO frequencies representing the upper sideband and lower sideband.

As an example, on my K2, to determine the IF frequency and offsets for the SSB mode, I look up the USB and LSB BFO frequencies using the CAL FIL routine. In my case, my USB BFO frequency is 4,916,280 Hz and LSB is 4,913,620. The difference between those two frequencies is 2,660 Hz – divide that by 2 for the offset of 1,330 Hz. Adding this offset to the LSB frequency (or subtracting from the USB frequency) provides us with the true IF frequency of 4,914,950 Hz. Then applying the offset of 1,330 Hz to the LSB mode and -1,330 Hz to the USB mode will sync HSDR's spectrum frequency to the K2 VFO.

AM	FM	LSB	USB	CW_U	CW_L	DIG_U	DIG_L
0	0	1330	-1330	830	-830	-1330	1330

HSDR RF Front-End Configuration Dialog

For SSB mode:

(USB BFO frequency – LSB BFO frequency) / 2 = filter offset

LSB BFO frequency + filter offset = True SSB IF frequency

(4,916,280 – 4,913,620) / 2 = 1,330

4,913,620 + 1,330 = 4,914,950 (4,924,950 Hz adjusting for the Global Offset in HDSDR discussed below)

When using these calculations and entering the calculated IF frequency and USB/LSB offsets in the HDSDR RF Front-End Configuration dialog, the HDSDR spectrum and K2 VFO are in dead sync when using LSB or USB SSB modes.

Since I am using the same filter (OP1) for the CW and RTTY filters, the same calculation can be used for both and obtain the same sync. The CW offsets are calculated a little differently in that the K2 shifts the IF by the sidetone frequency. In my case, I have a sidetone frequency of 500 Hz. Therefore, an additional 500 Hz needs to be subtracted from the offset to account for this.

Below is the spreadsheet output used to calculate the HDSDR IF and mode offsets for all four of my filters I have setup on my K2. Again, only one filter's calculations can be used at a time in HDSDR. There is no provision to enter the data for all four filters. I am currently using FL1 (which is set for OP1). Although, you could enter the offsets for a different filter for a given mode as long as the IF frequency is also changed when using that filter. i.e., You would rather use a narrower filter when surfing CW frequencies. You could enter the offset for CW mode for FL-2 (700 Hz width), you would then have to set the IF Frequency to 4,913,805 Hz (4,923,805 Hz adjusting for the Global Offset in HDSDR discussed below) when using this filter for CW surfing.

I chose to use OP1 (2.4 KHz) as my main surfing filter so that I don't have to adjust anything in the HDSDR RF Front-End dialog. I am fortunate to have the KDSP2 module installed and when using the audio off of the K2, I can use the set of four audio filters to narrow things down without having to use the crystal filters. Using the crystal filters with K2 audio would require adjustments in the RF Front-End dialog. If you are using HDSDR to provide audio output, you can certainly use the fine DSP processing available through HDSDR to adjust things to your ear. Of course, if you are in noisy or close-in-signal type environment, using the native K2 crystal filters to eliminate noise or QRM may well be a better option. Obviously, there are pluses and minuses to each method depending on how you are operating.

HDSDR K2 Panadapter Offset Calculator

Enter frequencies in the white cells from your K2 CAL FIL entries

Mode	FL1	FL2	FL3	FL4
SSB	OP1	2.20 KHz	2.00 KHz	1.80 KHz
LSB	4,913,620	4,913,960	4,913,720	4,913,490
USB	4,916,280	4,916,000	4,915,830	4,915,600
Difference	2,660	2,040	2,110	2,110
HDSDR Setting				
IF	4,924,950	4,924,980	4,924,775	4,924,545
LSB Offset	1,330	1,020	1,055	1,055
USB Offset	-1,330	-1,020	-1,055	-1,055
RTTY	OP1	1.00 KHz	0.70 KHz	0.40 KHz
RTTY	4,913,620	4,912,940	4,912,820	4,912,750
RTTY-R	4,916,280	4,914,900	4,914,800	4,914,730
Difference	2,660	1,960	1,980	1,980
HDSDR Setting				
IF	4,924,950	4,923,920	4,923,810	4,923,740
DIG_L Offset	1,330	980	990	990
DIG_U Offset	-1,330	-980	-990	-990
CW	OP1	0.70 KHz	0.40 KHz	0.20 KHz
CW	4,913,620	4,913,310	4,913,250	4,913,220
CW-R	4,916,280	4,914,300	4,914,240	4,914,210
Difference	2,660	990	990	990
HDSDR Setting				
IF	4,924,950	4,923,805	4,923,745	4,923,715
CW_U Offset ¹	830	-5	-5	-5
CW_L Offset ¹	-830	5	5	5
K2 CW Sidetone	500			
HDSDR Global Offset	10000	*Added to median IF above to compensate the offest		
Note: ¹	HDSDR CW_L and CW_U seem to be reversed.			
	CW_U corresponds to K2 CW Normal.			
	CW_L corresponds to K2 CW Reverse			

The Calculations

The formula for the K2 modes SSB, LSB and USB (HSDR LSB and USB) and RTTY, R and R-reverse (HSDR DIG_L and DIG_U) are identical since both modes are 0Hz based. Using the BFO frequencies for each sideband:

$$(SSB, USB Freq - SSB, LSB Freq) / 2 = \text{Offset Freq for each sideband}$$

$$\text{i.e. } (4916280 - 4913620) / 2 = 1330$$

$$\text{IF Frequency} = 4914950 \text{ (before Global Offset adjustment)}$$

$$\text{HSDR LSB Offset} = 1330 \text{ HSDR USB Offset} = -1330$$

For digital modes:

$$(RTTY, R-R \text{ (reverse) Freq} - RTTY, R Freq) / 2 = \text{Offset Freq for each sideband}$$

$$\text{i.e. } (4916280 - 4913620) / 2 = 1330$$

$$\text{IF Frequency} = 4914950 \text{ (before Global Offset adjustment)}$$

$$\text{HSDR DIG_L Offset} = 1330 \text{ HSDR DIG_U Offset} = -1330$$

For K2 CW modes, the IF is further shifted by the sidetone frequency. Therefore, the sidetone frequency must be subtracted from the end result offset. And because HSDR appears to use the opposite side band in the application of the offset, the signs have to be reversed:

$$((CW, C-R \text{ (reverse) Freq} - CW, C Freq) / 2) - \text{Sidetone Freq} = \text{Offset Freq for each sideband}$$

$$\text{i.e. } ((4916280 - 4913620) / 2) - 500 = 830$$

$$\text{IF Frequency} = 4914950 \text{ (before Global Offset adjustment)}$$

$$\text{HSDR CW_L Offset} = -830 \text{ HSDR CW_U Offset} = 830$$

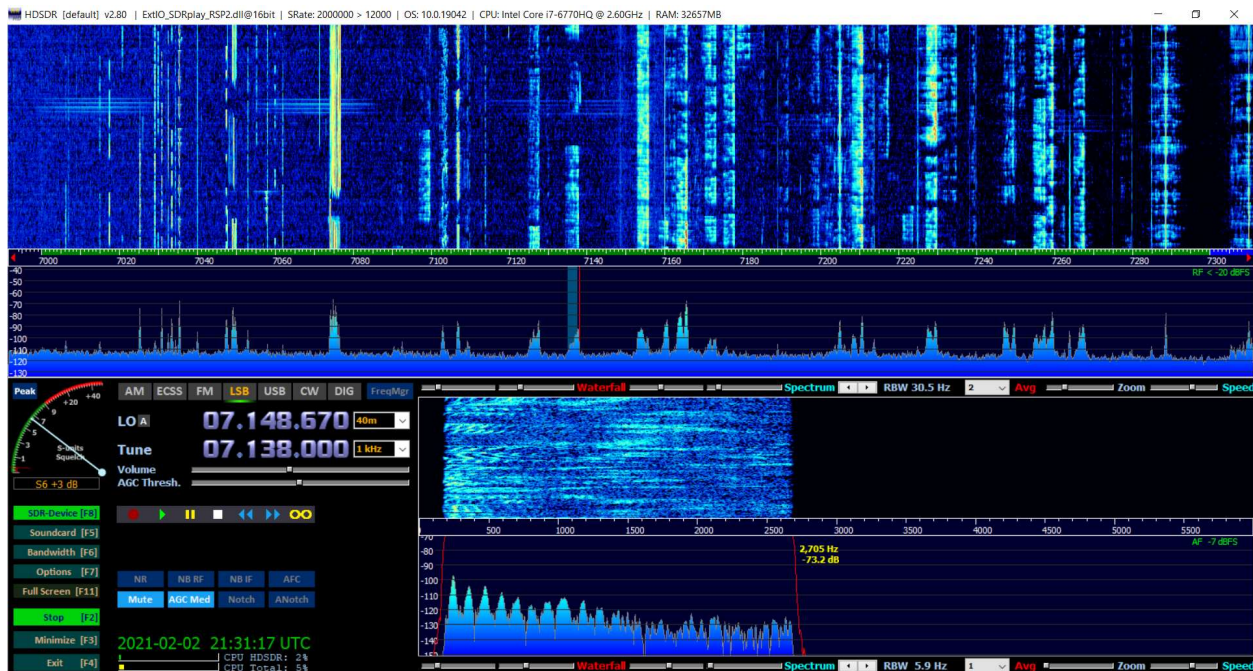
As there is no AM or FM mode in the K2, those offsets can remain 0. HSDR will switch to those modulation methods, but the K2 will remain in the last mode selected.

HSDR Global Offset

Next to the IF Frequency entry in the RF Front-end Configuration dialog, is an entry marked Global Offset. Providing a value other than 0 will avoid the noise that is often associated with the SDR's center frequency (which is technically DC). On my RSP2, the noise is not very noticeable on the noisier low bands, but on the quieter upper bands, it is quite noticeable. I selected 10,000 Hz as my offset to put it outside the audio range of any filters used in this setup. Sometimes there is a very small spike of noise

visible 10 KHz from my tuned frequency. The offset can be larger to push it outside the spectrum as long as the IF Bandwidth used by the SDR can support where you put it.

This value also has to be accounted for when calculating the IF Frequency as noted above. In the example above for SSB the calculated IF Frequency is 4,914,950 Hz. The Global Offset will then need to be added to the IF Frequency in order to line up the HDSDR spectrum frequency and the K2 VFO. The end result would be IF of 4914950 + 10000 Global Offset for a total of 4924950.



HDSDR with full 300 KHz of 40m displayed.

My Recommended HDSDR Setup as a Panadapter for the K2

I have pretty much touched upon most of my setup of HDSDR for use with my K2 as a panadapter. But I will provide a set of screen shots here for simple reference in setting things up. You will need a number of software modules to download and install. They are as follows:

SDRPlay Software

You can download the appropriate software for your RSP model from SDRPlay's site here:

<https://www.sdrplay.com/downloads/>

Here you will find a number of SDR programs available for the RSP model you have including a link to HDSDR.

HDSDR provides SDR vendors an interface to create an I/O DLL to be used with HDSDR to allow vendor specific setup of the SDR rig. So, you will not only want to download HDSDR, but the EXTIO Plugins as well. You will then be prompted by HDSDR to place the appropriate DLL for your RSP model in the HDSDR operating directory. It will automatically load this DLL so that you can make adjustments to the setup of your SDR.

HDSDR Software

As noted above, you can get to the HDSDR download via the SDRPlay download site. But you can also access it directly here:

<http://www.hdsdr.de/index.html>

I am using the original version of Omni-Rig here that supports two rigs. So I downloaded the version of HDSDR that works with that particular version. If you choose to use the newer Omni-Rig version that supports up to four rigs (different author) then you will want to download the HDSDR version compatible with that version.

Omni-Rig Software

As mentioned above, I use the original version of Omni-Rig that supports two rigs. It can be downloaded here:

<http://dxatlas.com/Download.asp>

Scroll down on that page and download the Omni-Rig program along with the INI files. The INI files provide the translation of commands used in Omni-Rig to control the K2. When setting up your K2 with Omni-Rig, you will find a rig entry for Elecraft K2 that you will use.

Software Installation

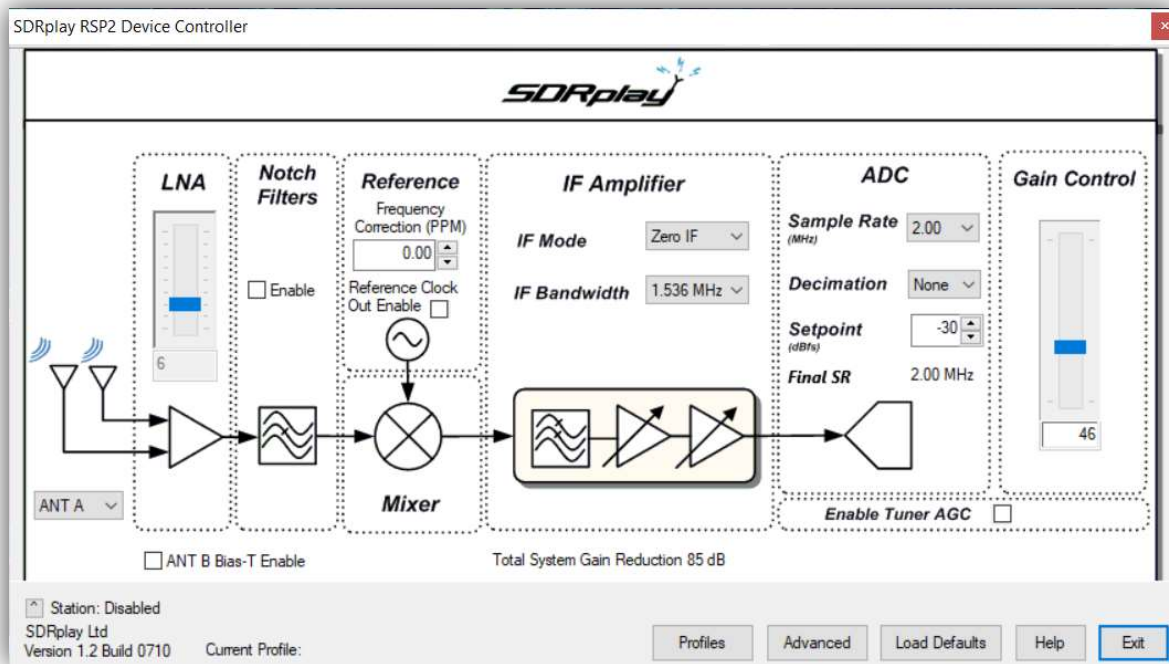
I will not go into how to install all of the various software components in this document. It is fairly self-explanatory and is covered in other documents including the referenced HDSDR installation site by Alan, G4ZFQ here: <https://sites.google.com/site/g4zfqradio/installing-and-using-hdsdr?authuser=0>

My Setup

After installation of all of the noted software components and the hardware has been cabled properly, you are now ready to setup HDSDR and sub-components for use with the K2. Run HDSDR and setup each component to get things running. Here is how I currently have things setup here in my station:

SDR-Device

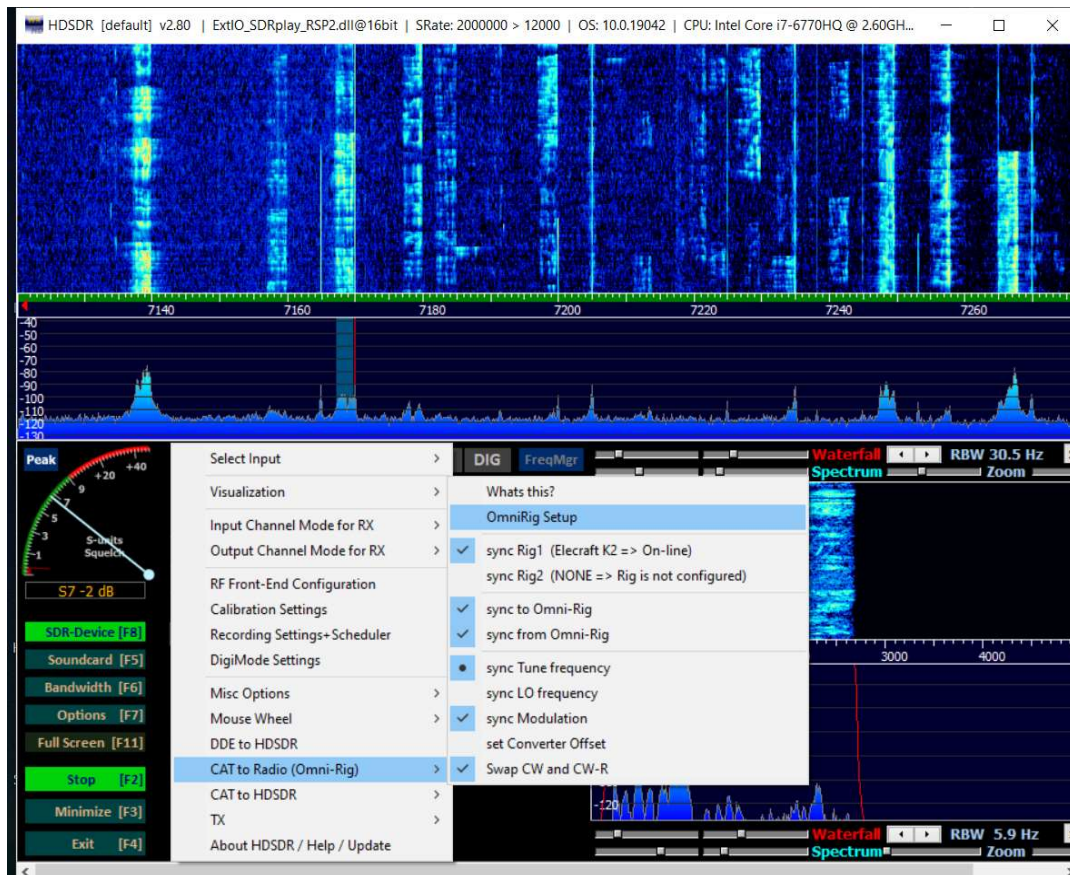
Pressing F8 or clicking the SDR-Device button will bring up the SDR Rig Setup dialog:



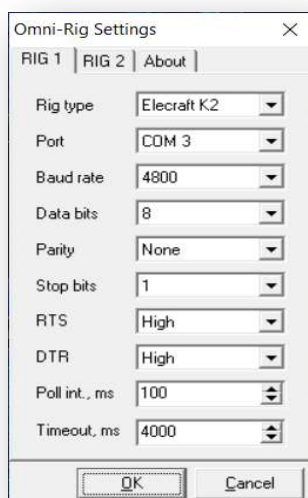
As you can see, I am using the RSP2 device as noted at the top of the dialog. This dialog may look a little different depending on you model of SDR. I am feeding the IF Output of the K2 into the Antenna A port on my RSP2. So, I have that selected (lower left). I pretty much left everything set for the default operation. Periodically if the bands become really noisy, the ADC can become overloaded and I will adjust the LNA or Gain Control down to prevent overloading.

Omni-Rig

Press F7 or select Options and then select **CAT to Radio (Omni-Rig)** and then **Omni-Rig Setup**. Also note the other menu items checked on this menu.



This will bring up the Omni-Rig rig setup dialog:



Omni-Rig Settings Dialog

I selected Elecraft K2 as the rig type. COM3 is my port, yours may be different. And don't forget that the K2 can only communicate with a maximum baud rate of 4800.

I also set my Polling Interval for 100ms as opposed to the 500ms default as it made the tuning response a little better.

HDSDR RF Front-End Configuration

This dialog is where most of your setup will occur for working with the K2. After you calculate your IF Frequency and offset for use with HDSDR this is where you will enter them. Here is what mine look like. Again, these will very well be different for your K2 settings.

RF front-end frequency options

SDR hardware coupling

☐ SDR hardware connected to antenna (default)

☒ SDR on IF output, which is controlled by by Omni-Rig1

Sync Mode

☒ Full sync in both directions

☐ Independent Tune in HDSDR

☐ Independent Tune, but sync on external change

☐ Full sync, except LO

IF-frequency: [Hz]

Global Offset: [Hz]

Additional Offset per Mode in Hz

AM	FM	LSB	USB	CW_U	CW_L	DIG_U	DIG_L
0	0	1330	-1330	830	-830	-1330	1330

☐ Mirror RF Spectrum in general

☒ Mirror RF Spectrum for Tune >= kHz

☒ operate CW in lower sideband (LSB)

☒ Swap CW and CWR for Omni-Rig

☐ SDR hardware on Down/Up-Converter

LO Frequency of Down/Up-Converter in Hz:

☐ SDR hardware in undersampling mode

Samplerate of Analog-Digital Converter in Hz:

HDSDR RF Front-End Configuration Dialog

For setting things up for HDSDR use as a panadapter for the K2 with syncing of all changes with either HDSDR or the K2, the **SDR on IF output** option is selected and Omni-Rig is also selected as the control for the K2. Then choose **Full sync in both directions** so that whether tuning, selecting modes etc. is done by HDSDR or the rig itself, both will sync with each other.

Other important settings in this dialog are checking the box for **Mirror RF Spectrum for Tune >=**. Then set the value for 20 MHz (20,000 KHz). This will reverse the spectrum when tuning bands 15m-10m due to the noted change from the K2 high-side injection to low-side injection mixing scheme.

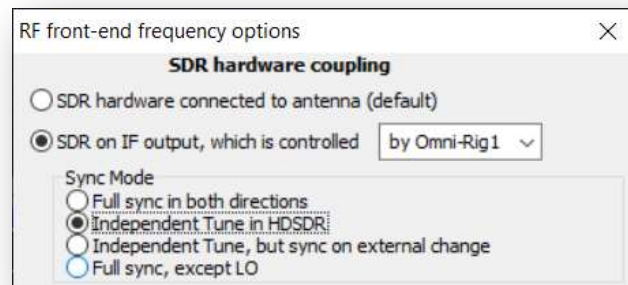
Checking the boxes for **operate CW in lower sideband (LSB)** and **Swap CW and CWR for Omni-Rig** was found to keep the tuning of CW signals consistent between the lower and upper bands when the mixing scheme changes.

To adjust these settings for use with the upper bands of 15m-10m when low-side injection is used, you must remember to reverse the signs of the Global Offset and the Additional Offset per Mode

AM	FM	LSB	USB	CW_U	CW_L	DIG_U	DIG_L
0	0	-1330	1330	-830	830	1330	-1330

And if you want to run HDSDR as a second receiver for the K2, then you will want to check the ***Independent Tune in HDSDR*** or ***Independent Tune, but sync on external change***.

This will leave the K2 VFO fixed and let you tune around the spectrum independent of the K2 VFO and listen to signals via HDSDR. The ***sync on external change*** option will sync HDSDR back up with the K2 VFO.



This is an excellent way to run split without putting the K2 into split mode. Simply leave the K2 VFO on the TX frequency and search for the RX using the HDSDR panadapter.

Conclusion

With these setups, adjustment, tweaks, and the installation of the DXE IF Buffer Amp in a K2, you can obtain a pretty powerful panadapter capability not to mention a second receiver for the K2. And all at a fairly low cost. As SDRPlay introduces newer models, older RSP1, RSP1A and RSP2 rigs are showing up on the used market for really nice prices. These older versions may not have all of the options of the newer models, but they are not needed for this simple application. HDSDR is very robust and leaves a fairly light footprint on the PC for what it is doing. And the price is right for this type of application.

Caveats

It would be nice to have an option in HDSDR to allow switching of the signs of the offsets when mirroring the spectrum while working 15m-10m. Although, switching the signs is not difficult, it does have to be remembered when operating on those bands and it is just inconvenient.

If you choose to use a different filter in the K2 besides the default like I have setup for FL-1, remembering to enter the proper IF frequency and offsets is again somewhat inconvenient.

When fully synced, when mouse clicking on a desired frequency, the whole RF spectrum on HDSDR slides in order to place the newly selected frequency where the old one was. I have a feeling that this is a loop situation created by Omni-Rig issuing commands to the K2 and getting a reply that causes HDSDR to make changes on its side, thus causing another reply to the K2. This is not a problem when using independent tuning. You can set up a spectrum window of your liking and tune around in it without moving the spectrum window. This is very nice when operating split and/or chasing DX.

There are a couple of other minor things, but those above are the most inconvenient to work around.