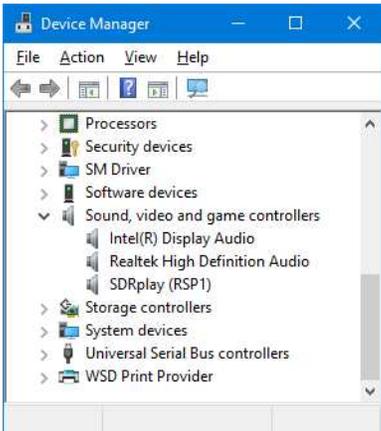
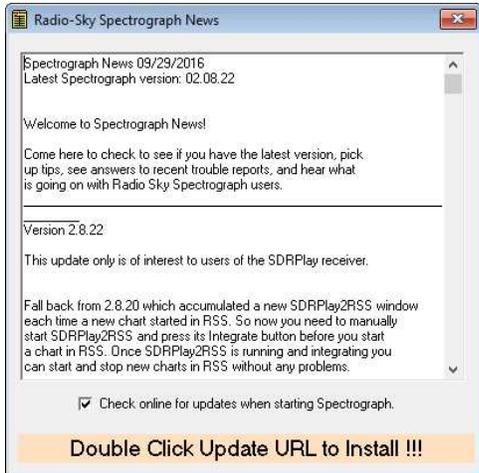


Installing SDRPlay RSP with SDRPlay2RSS and Radio-Sky Spectrograph

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Note: The following instructions are meant to help users get started with the RSP and are not meant to provide settings that are optimum for any particular type of radio astronomy observing.

1. Install the SDRUno software application from the SDRPlay website: <http://www.sdrplay.com/start-here/>
 - a. Register your RSP and download SDRUno
 - i. Follow all instructions on the above webpage to install and run SDRUno
 - ii. Be sure to select the SDRUno option when asked what software you wish to use
 - iii. Be sure the RSP is not connected to the PC
 - iv. If you do not heed the above three pieces of advice you most likely will run into compatibility problems and then be pecked to death by ducks
 - b. SDRUno will install the necessary drivers for the receiver and direct you to connect the receiver to a PC USB port (do not use a hub), allowing you to confirm receiver operation with SDRUno
 - c. You can check that the PC recognizes the RSP. Go to Device Manager, scroll down to *Sound, video and game controllers* and expand it. If the RSP has been recognized it will be shown as SDRPlay (RSP1) or SDRPlay (RSP2) depending on your model (see image right)
 - d. After confirmation of receiver operation per SDRPlay, close SDRUno. It is no longer needed except possibly for troubleshooting if you run into problems later. Never try to run two applications at the same time that need to access the RSP
2. Install the Radio-Sky Spectrograph (RSS) software from the Radio-Sky website: http://jupiter.wcc.hawaii.edu/spectrograph_software.htm
 - a. Open the downloaded file but do not install in the default Program Files folder; instead, use something like c:\Tools\Spectrograph\

 - b. In a new or existing installation, open RSS and update it. In a new installation use the procedures in the window that pops up when it starts (see image right). In an existing installation or if you do not see the pop-up, click Help – Check for Updates and install the update. Always uses the latest available version

 - c. The current version of RSS includes and automatically installs the SDRPlay2RSS software tool
 - d. After approximately April 2017, both RSP1 and RSP2 are supported by RSS and SDRPlay2RSS
3. Open Radio-Sky Spectrograph
 - a. In RSS select the Identity / Antenna menu and fill in the details for your observatory
 - b. In RSS select the Color – Load Color File menu and load the AJ4CO color file
 - c. Leave RSS open; additional changes will be made later
 - d. Note: In later versions of RSS, the SDRPlay2RSS tool functions have been automated but I have found that following the procedures below prevents crashes and gives the most reliable results

4. RSP connections
 - a. The RSP already should be connected to a PC USB port per 1. above
 - b. Connect the antenna to the RSP RF input if not already connected
5. Setup the SDRPlay2RSS tool. The following will get you started but it is not a complete setup of all the features in the tool. Other feature setups are required if you wish to customize your installation to, for example, save the data directly from SDRPlay2RSS to a file and not send to RSS

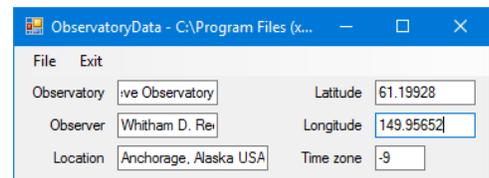
a. Navigate to the RSS installation folder used in 2. above and open the SDRPlay subfolder

b. Double-click SDRPlay2RSS.exe to open the tool (see image right)

c. In SDRPlay2RSS select File – Observatory Path and navigate to the folder you wish to use for storing your

observatory information; for example, `c:\Tools\Spectrograph\SDRPlay\`

d. In SDRPlay2RSS select File – Observatory. A window will open where you enter your observatory information (see image right). This information is essentially the same as you used for the RSS Identity but it is required separately for when SDRPlay2RSS saves data directly rather than sending to RSS.

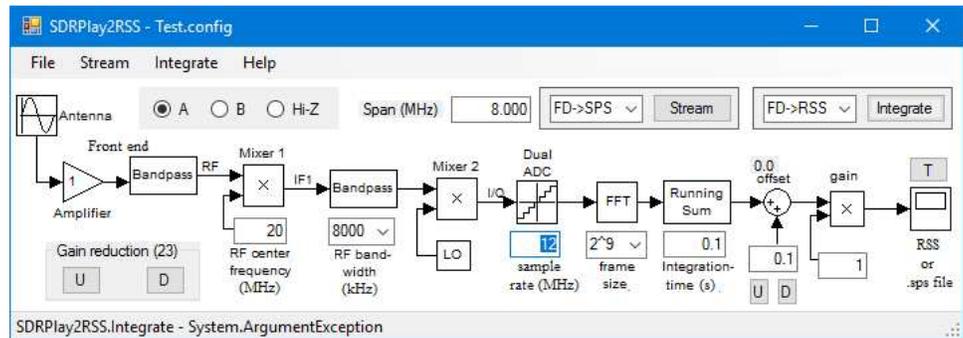


When finished, select File – Save as and give the Observatory file a name. Click the Save button and the file will be saved at the Path specified in c. above. You can have more than one Observatory and can load any one as desired. The latest Observatory also is saved as `ObservatoryLast.obs`

e. In SDRPlay2RSS, use these basic settings to get started (all settings can be changed later)

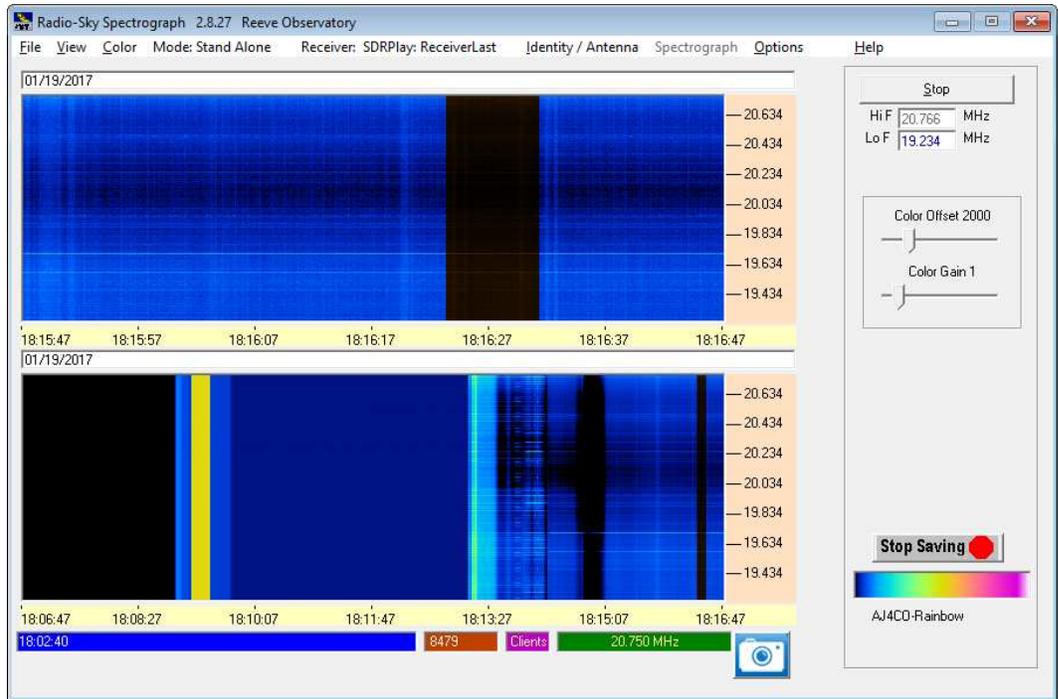
- i. Antenna radio buttons: The choices are A, B and HiZ. If you have the RSP1, select A (the default). If you have the RSP2 select A, B or HiZ corresponding to your antenna connection
- ii. Gain reduction: Set to 10 using the Up (U) and Down (D) buttons on the left
- iii. RF center frequency: Set to 20 MHz
- iv. RF bandwidth: To start out, set to 1536 kHz using the dropdown menu (most modern low-power PCs can handle this bandwidth); higher bandwidths require a more powerful PC
- v. Sample rate: Set to 2 MHz; sample rate must be higher than the RF bandwidth
- vi. Frame size: Set to 2^8 using the dropdown menu (see appendix for FFT calculations)
- vii. Integration time: Set to 0.1 s; the lower the integration time, the fast the scans in RSS
- viii. Color Offset increment: Set to 0.01 and the click the Up (U) or Down (D) buttons until the offset value shown above the adder symbol is 0.4 to 0.5; some users find that an offset of 0.0 (rather than 0.4 or 0.5) works best
- ix. Color Gain: To start out, set to 1; some users find that a gain of 1.5 works best
- x. FD>RSS: In the dropdown menu to left of the Integrate button in upper-right corner (this allows RSS to connect to SDRPlay2RSS and receive the FFT data)

f. In SDRPlay2RSS press the Integrate button. After a short delay it will turn Yellow and the status bar at the bottom-left of the window will show *Integrating ...* At this time, RSS is ready to connect to SDRPlay2RSS

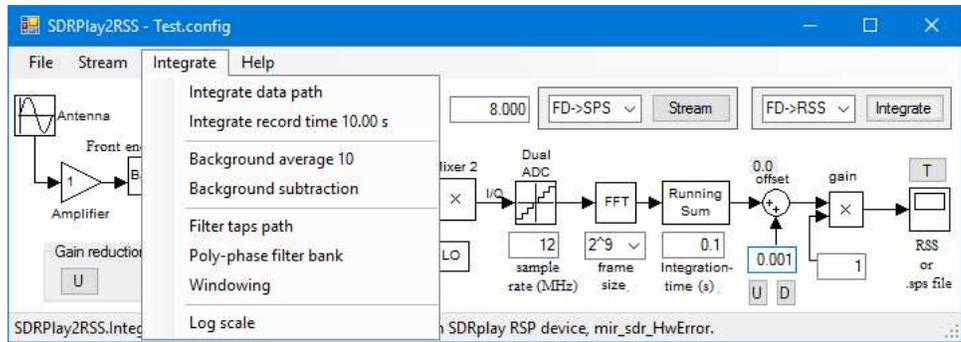


6. In RSS, click the Start button on the upper-right side of the window. The spectrum windows will become active and start scrolling from right-to-left
 - a. The vertical size of the RSS spectrum windows will change to suit the frequency range selected by the SDRPlay2RSS RF bandwidth, Sample rate and Frame size. The Hi F and Lo F fields on RSS will display the actual range. For example, if the RF center frequency is 20 MHz and the RF bandwidth is 1536 kHz (768 kHz each side of center frequency), the displayed range will be approximately $20\,000\text{ kHz} - 768\text{ kHz} = 19\,232\text{ kHz}$ (19.232 MHz) to $20\,000\text{ kHz} + 768\text{ kHz} = 20\,768\text{ kHz}$ (20.768 MHz). The actual range will be slightly smaller because of the way the FFT channels are calculated and displayed
 - b. If the scrolling display is black with no features, adjust the Color Offset and Color Gain in SDRPlay2RSS in small increments to obtain a display with a dark blue background. Spurs (horizontal lines) should be visible. Note that depending on the version, the Color Offset and Color Gain controls in RSS may do nothing when it is collecting data from SDRPlay2RSS. The color settings are obtained from SDRPlay2RSS and can be changed on the fly (see next item).
 - c. Certain settings in SDRPlay2RSSs can be changed on the fly while the Integrate button is active (Yellow) and others can be changed only after deactivating the Integrate button (White). If the Integrate button is deactivated, RSS should automatically Stop. After making changes reactivate the Integrate button and reStart RSS. Read the SDRPlay2RSS Help in the RSS Help menu to determine what functions require deactivation and what functions can be changed on the fly
 - d. I avoid clicking the Integrate button to deactivate SDRPlay2RSS without first clicking the Stop button in RSS. For the most reliable operation, I use the following protocol:
 - i. To open applications and start collecting data:
 1. Open SDRPlay2RSS
 2. Change settings as desired in SDRPlay2RSS
 3. Click the Integrate button in SDRPlay2RSS and wait until it turns Yellow
 4. Open RSS
 5. Check that Receiver is set to SDRPlay
 6. Click the Start button in RSS
 - ii. To stop collecting data and close applications:
 1. Click the Stop button in RSS
 2. Close RSS
 3. Click the Integrate button in SDRPlay2RSS and wait until it turns White
 4. Close SDRPlay2RSS
 - e. You can now use RSS to save data and images, export data to a Comma Separate Variable file for reading in Excel and run a timed observations, among many other things

f. In the screenshot right, I played with the Color Gain and Color Offset controls in SDRPlay2RSS and also connected a short whip antenna to the RSP RF input, all while RSS was running



7. The SDRPlay2RSS Integrate menu has Background average and Background subtraction settings that affect how data is displayed in RSS (see image right). The Integrate menu also has other controls that affect the data and these can be experimented with as desired



8. If everything works okay, you can experiment with a wider bandwidth in the RF Bandwidth dropdown menu in SDRPlay2RSS. The maximum RF Bandwidth setting is 8 MHz. Set Sample rate > RF Bandwidth

Appendix ~ FFT Calculations

The center frequency, frequency span and other parameters are set in SDRPlay2RSS. Radio-Sky Spectrograph then displays the range of frequencies (low and high frequencies) and resolution determined by these settings.

The Fast Fourier Transform (FFT) splits the receiver continuum into frequency bins or channels. Each bin has a bandwidth determined by the FFT *frame size* or length N and RF *sample rate* f_s such that *channel width* or *channel spacing* $f_{Channel} = f_s / N$. For example, if in SDRPlay2RSS the RF sample rate $f_s = 2$ MHz and the frame size $= 2^8$ ($2^8 = 256$), then the channel width $f_{Channel} = f_s / N = 2 \cdot 10^6 / 256 = 7812.5$ Hz

The total number of channels $n_{Channels}$ displayed and saved by Radio-Sky Spectrograph depends on the frequency span f_{Span} where $n_{Channels} = N \cdot f_{Span} / f_s$. The frequency span f_{Span} is the same as the RF Bandwidth setting in SDRPlay2RSS. If the RF Bandwidth = 1536 kHz (1.536 MHz) and using the same settings in the example above, then the number of channels $n_{Channels} = N \cdot f_{Span} / f_s = 256 \cdot 1.536 \cdot 10^6 / 2 \cdot 10^6 = 197$. The channels will be spaced at 7.8 kHz intervals, thus providing 7.8 kHz resolution as determined above.

The frequencies displayed by Radio-Sky Spectrograph are determined by the center frequency f_c and the RF bandwidth. The RSS high and low frequencies are determined from $f_c \pm f_{Span} / 2$. For example, if the center frequency $f_c = 20.5$ MHz and RF Bandwidth = 1.536 MHz (as in above example),

$$\text{Low frequency } F_{Lo}: 20.5 - 1.536/2 = 19.732 \text{ MHz}$$

$$\text{High frequency } F_{Hi}: 20.5 + 1.536/2 = 21.268 \text{ MHz}$$

The spans available in the RSP-1 are limited to certain values, so Radio-Sky Spectrograph cannot display arbitrary low and high frequencies. Also, the Frame Size in SDRPlay2RSS must be set in multiples of 2, so the number of channels is limited to certain discrete values.

Document information

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