FlexRadio Systems®
Software Defined Radios

FLEX-6000 SIGNATURE SERIES

SMARTSDR SOFTWARE USER GUIDE

Version *1.11.12*

7 September 2017

FlexRadio Systems®
Software Defined Radios

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1   HOW TO REQUEST TECHNICAL SUPPORT AND ASSISTANCE

If you encounter any issues installing or operating SmartSDR for Windows with a FlexRadio Systems Signature Series software defined radio, please use our on-line Community (https://community.flexradio.com/) to find information about SmartSDR and the FLEX-6000 radios. If you need assistance using the Community, please refer to the community topic "How to use the FlexRadio Systems Support Community".

If you are unable to find an existing answer to your issue on the Community, please contact FlexRadio Systems technical support by opening a HelpDesk support ticket on-line at https://helpdesk.flexradio.com/

For details on how to submit a HelpDesk support ticket, please refer to the following URL: https://helpdesk.flexradio.com/hc/en-us/articles/202118688-How-to-Submit-a-Request-for-Technical-Support.

Hours of Operation: Our Technical Support engineers are available Monday-Friday from 9:00am-5:30pm Central Time. If you contact Support after business hours, on a holiday or weekend, we will respond to your request for assistance during regular business hours in the order the tickets were received.

2 KEY CONTACTS

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HelpDesk: https://helpdesk.flexradio.com

User Support: https://community.flexradio.com

Outside of the USA

Please contact your local distributor. See www.flexradio.com/distributors .

www.flexradio.com

3   INSTALLING SMARTSDR FOR WINDOWS APPLICATION ON YOUR PC

The SmartSDR for Windows application is the software used to interface with the FLEX-6000 radio hardware for viewing RF spectrum and controlling the radio. It must be installed on a Windows PC before you can start using your FLEX-6000.

3.1   RECOMMENDATIONS AND REQUIREMENTS

The minimum required CPU for SmartSDR is an Intel i3 2100T or an AMD Athlon Phenom II or greater. Lesser processors may not perform adequately when displaying multiple or full screen spectrum displays. However, for the optimal user experience, as most users run multiple applications along with SmartSDR for Windows such as loggers and digital mode programs, a quad-core CPU or greater is highly recommended.

3.2   MINIMUM WINDOWS AND .NET REQUIREMENTS

SmartSDR is a Windows .NET Framework application designed to operate on Windows Vista, Windows 7, Windows 8.x and Windows 10. The .NET Framework 4.0 Client Profile is required.

The minimum version of Windows supported by SmartSDR v1.2.0 and greater is Windows Vista Service Pack 2 (SP2). The SmartSDR Installer will automatically detect your current Windows version and will notify you if it does not meet the minimum operating system requirements. SmartSDR can be installed on Windows XP SP3 PC with a warning that Windows XP is no longer supported by Microsoft or FlexRadio Systems. *Upgrading XP to a Microsoft supported operating systems is highly recommended.* If your Windows XP PC has not been upgraded to SP3, you must do so before installing SmartSDR for Windows.

If you need to install SP3 for Windows XP, install it before installing the .NET Framework 4.0 Client Profile. The easiest method for obtaining it is to use the Windows Update service. An optional update method is to download the SP3 update software via the Internet directly from Microsoft using this web link:

http://www.microsoft.com/en-us/download/details.aspx?id=24

Note: This is a very large download (approximately 316 MB) which may take over an hour to download using slower Internet connections.

If you need to install the .NET Framework 4.0 Client Profile, the CD based SmartSDR for Windows Installer will automatically install it from the SmartSDR Installation CD. If you are not using the installation CD, the installer will attempt to download the necessary software from the Internet. Alternately, you can download it directly from Microsoft using this web link BEFORE installing SmartSDR for Windows.

http://www.microsoft.com/en-us/download/details.aspx?id=17113.

Please run Microsoft Update after installing the .NET Framework 4.0 Client Profile to get all the required patches and security updates.

3.3   INSTALLING THE SOFTWARE

If you are installing SmartSDR for Windows from the CD, place it in your CD drive and close the drive door. The SmartSDR software installer will automatically begin. If you are installing SmartSDR for Windows from the installer downloaded from the Internet, double click on the SmartSDR installer (SmartSDR_v1.x.x_Installer.exe) to begin.

3.3.1   Step 1. Pre-Installation Tasks

The first thing the SmartSDR software installer will do is determine if your PC's operating system and installed .NET version meets the minimum requirements. If your Windows XP PC does not have the required .NET Framework 4.0 Client Profile software loaded, the following Setup Pre-Install screen will be displayed.
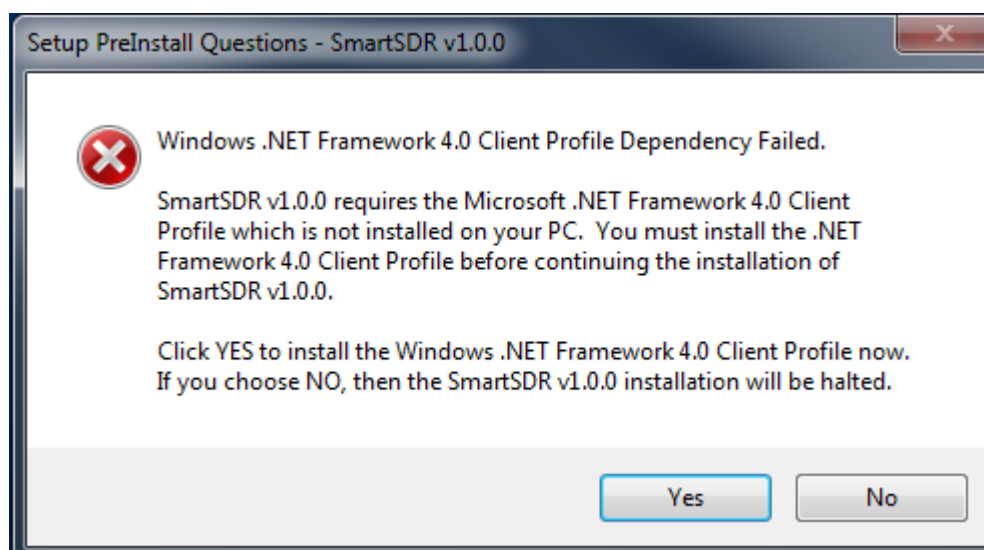
If you see this screen, click **YES** to install the .NET Framework 4.0 Client Profile software or click on NO to stop installing SmartSDR for Windows. If you are installing from the SmartSDR for Windows CD, and select **YES**, the following screen will be displayed.
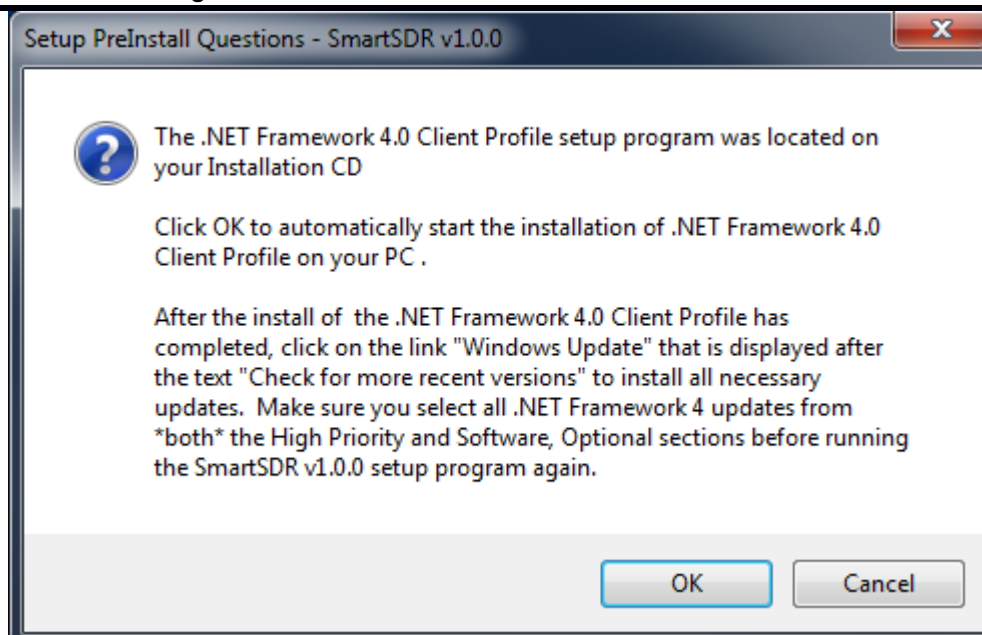
Click **OK** to begin the .NET Framework 4.0 Client Profile software install or click on CANCEL to stop installing SmartSDR for Windows.

If you choose not to install SmartSDR for Windows to install the .NET Framework 4.0 Client Profile, the following screen will be displayed.
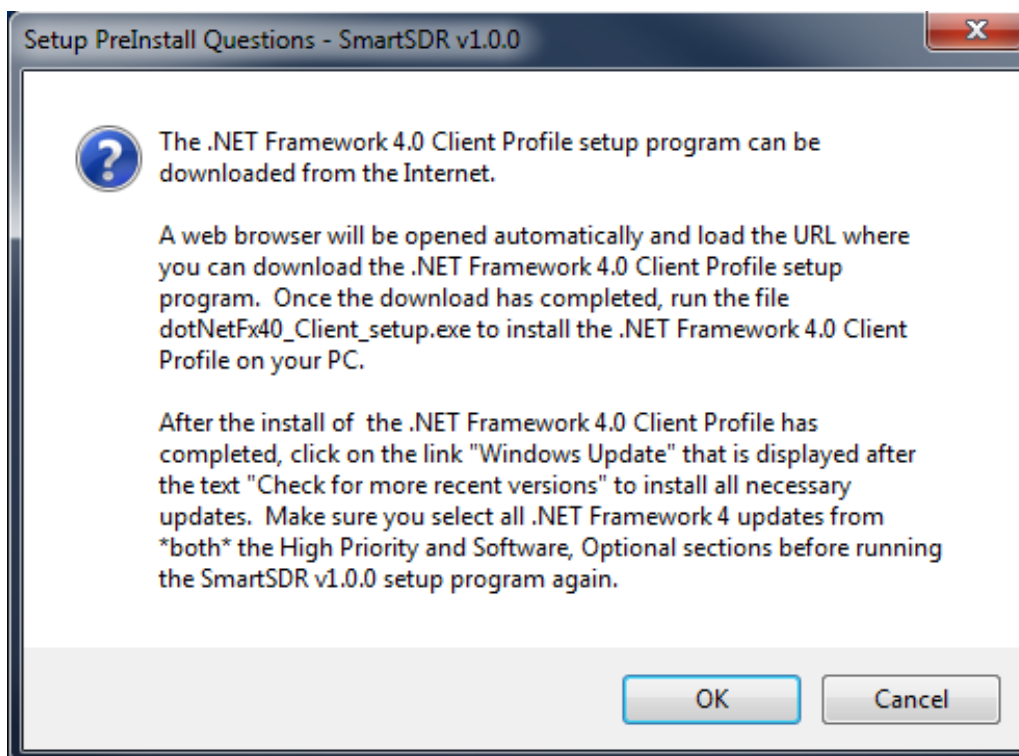
Click on **OK** to open a web browser and download the .NET Framework 4.0 Client Profile software from the Internet or click on CANCEL to stop installing SmartSDR for Windows.

3.3.2 Step 2. Installing SmartSDR for Windows

The first screen displayed is the <u>Welcome to the SmartSDR Setup Wizard</u> as shown below.

Click **NEXT** to continue.

The <u>SmartSDR for Windows End User's License Agreement</u> screen is displayed as shown below.

To accept the license agreement, click on the "**I accept the agreement**" radio button and then click **NEXT**.

The Select Destination Location screen is displayed as shown below. It is recommended that you use the default installation location, as it will use the Windows recommended location for the application files. You may however choose an alternate location.
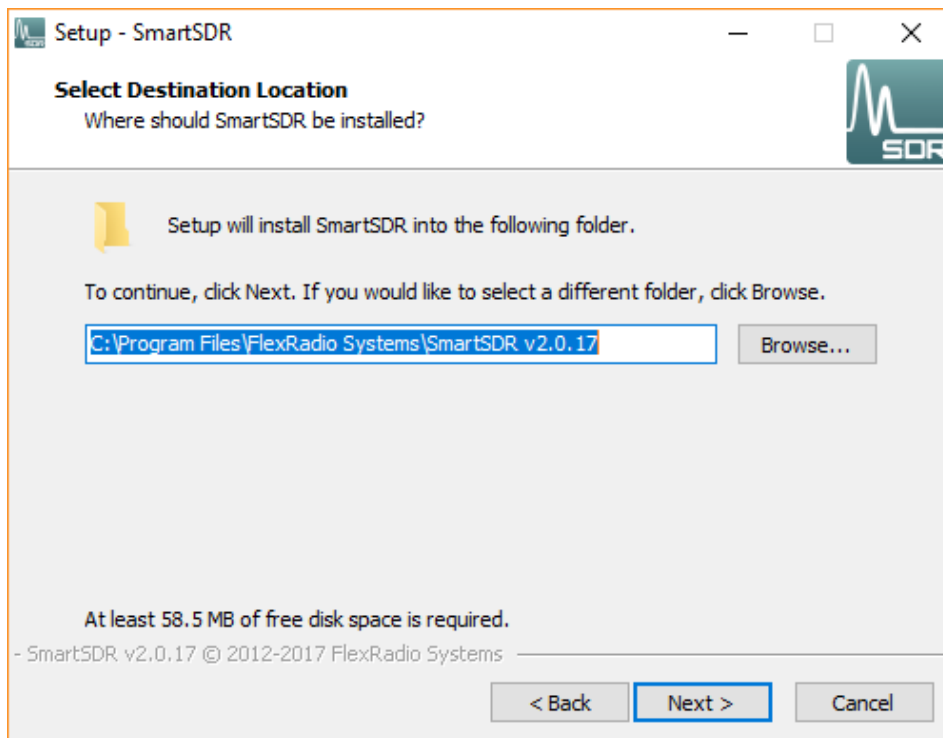
Once you have decided on the installation location for SmartSDR for Windows, click **NEXT** to continue.

The Select Components screen is displayed as shown below; additional components may be displayed. The DAX and SmartSDR CAT applications are optional components which are installed by default. If the DAX application files are installed (DAX sound drivers), the installer will prompt to reboot the system at the end of the installation.
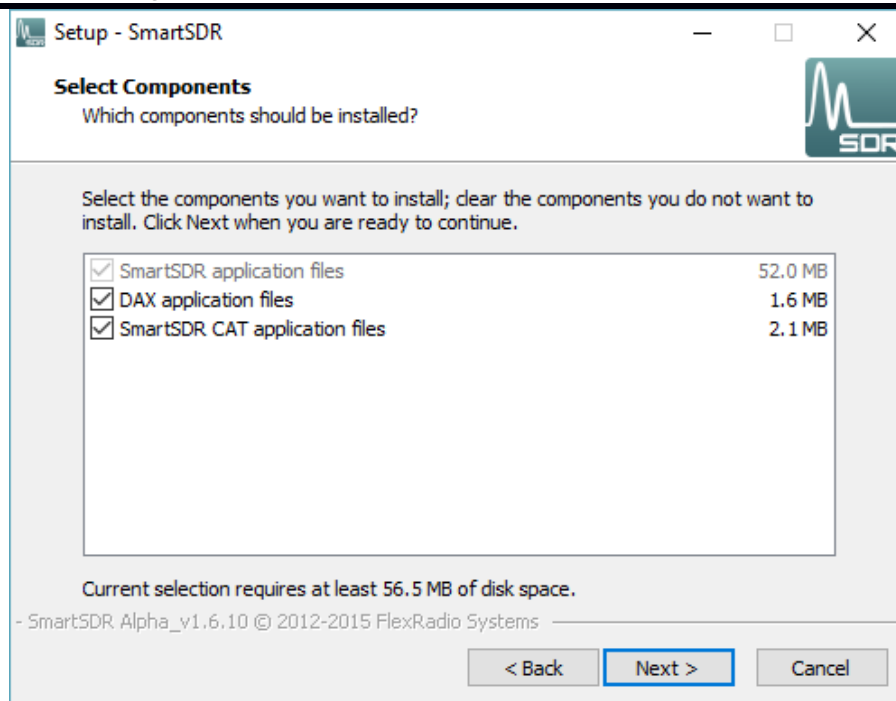
Click **NEXT** to continue.

The Select Additional Tasks screen is displayed as shown below. It is recommended that you leave the "Create a desktop icon" option checked to provide a convenient way of starting SmartSDR for Windows from your Windows Desktop.
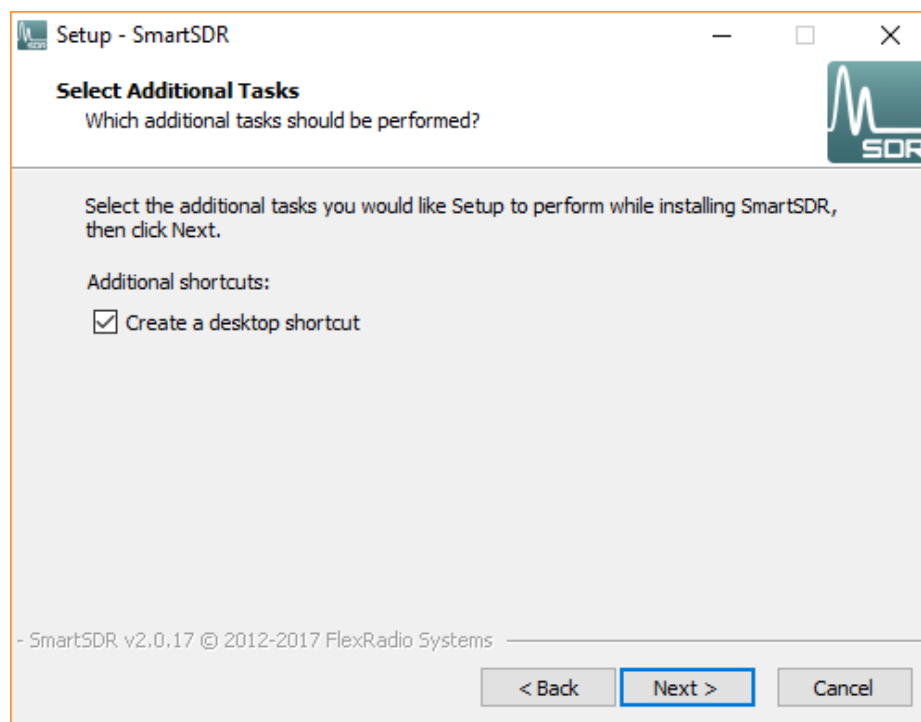
Click **NEXT** to continue.

The Ready to Install screen is displayed as shown below.
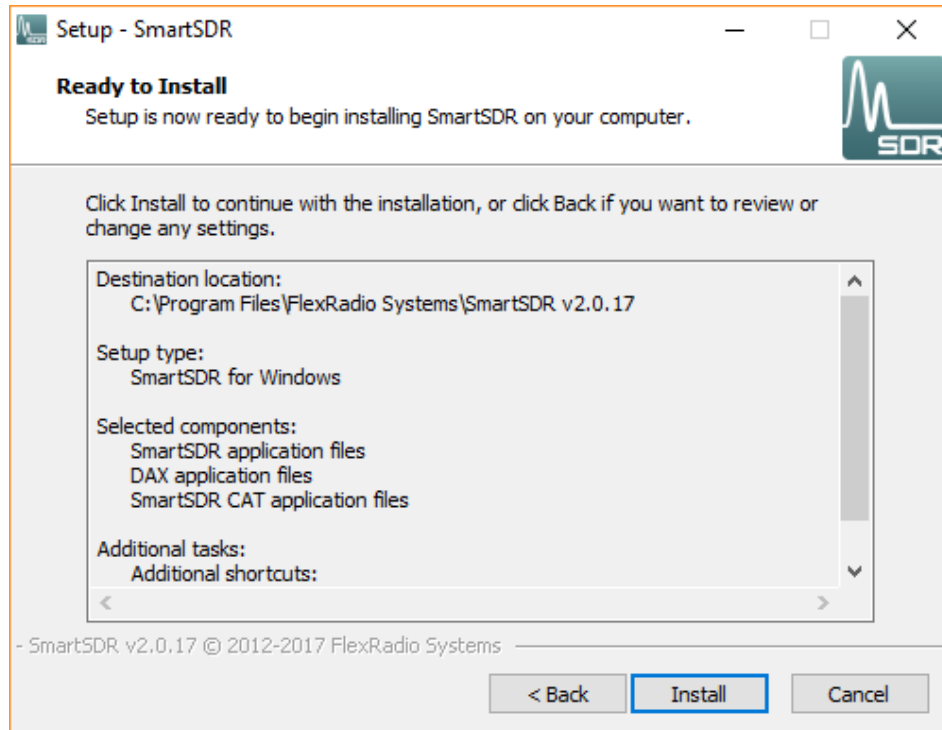
Click **NEXT** to continue.

The Installing screen will be displayed showing the files being loaded
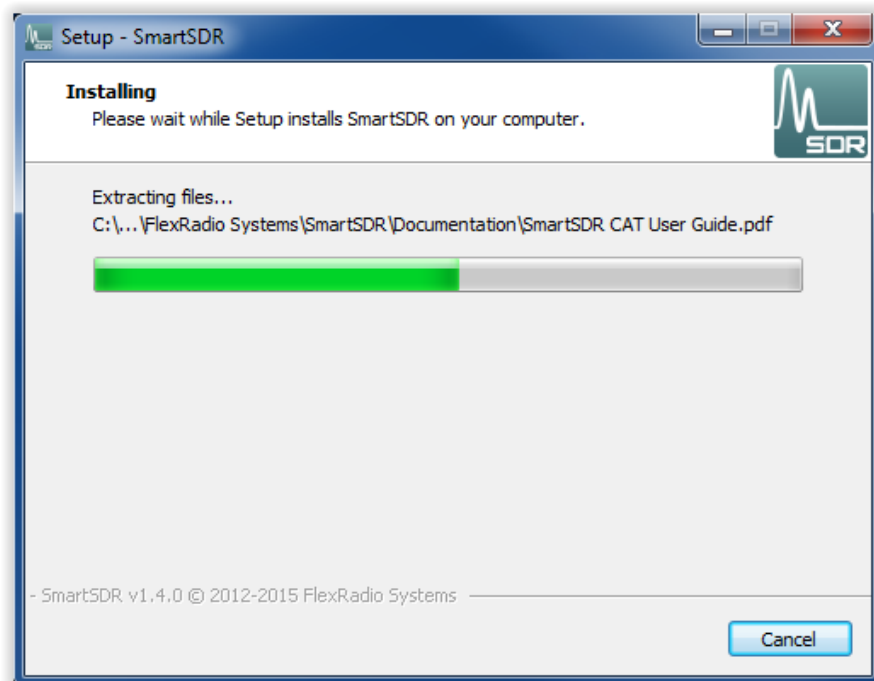
After the application files have been installed, additional drivers will be installed as shown below.
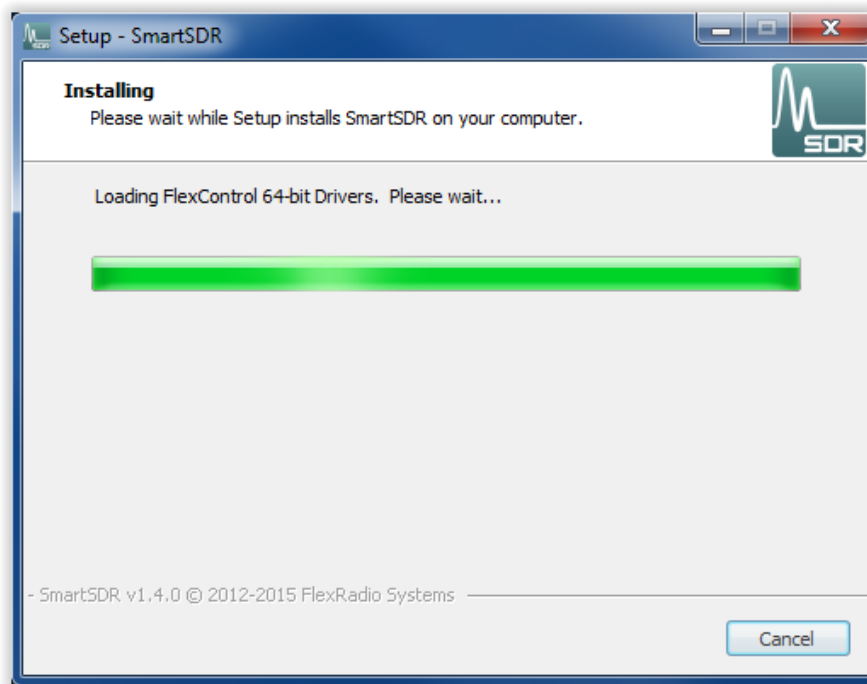
After a few moments, the <u>Completing the SmartSDR Setup Wizard</u> screen will be displayed as shown below. It is *highly* recommended that you review the SmartSDR for **Windows Release Notes** as they contain important information regarding the features and operation for this specific release of SmartSDR for Windows. Check the "**View the Release Notes (requires a PDF reader)**" option to display the SmartSDR for Windows Release Notes after SmartSDR installer has completed the software install.

For a complete listing of all changes in SmartSDR, check the **"View the changelog"** option.

If you want to start the SmartSDR for Windows application after the SmartSDR installer has completed, leave the "**Launch SmartSDR**" option checked.

Click **FINISH** when you have made your selections.

Note: If hardware or virtual hardware drivers were loaded as part of the installation process, the above screen will not be displayed. You will be prompted to reboot your computer to ensure that the newly installed drivers have been properly installed and initialized. If prompted, reboot your PC before connecting to a Signature Series radio.

4   CONNECTING TO A RADIO

When SmartSDR starts, a dialog box is displayed showing any radios found in your local network. SmartSDR locates these radios using a network broadcast protocol that is limited to the local subnet of your network. If your radio is turned on and is connected to your local network, it should appear in the dialog as shown below:
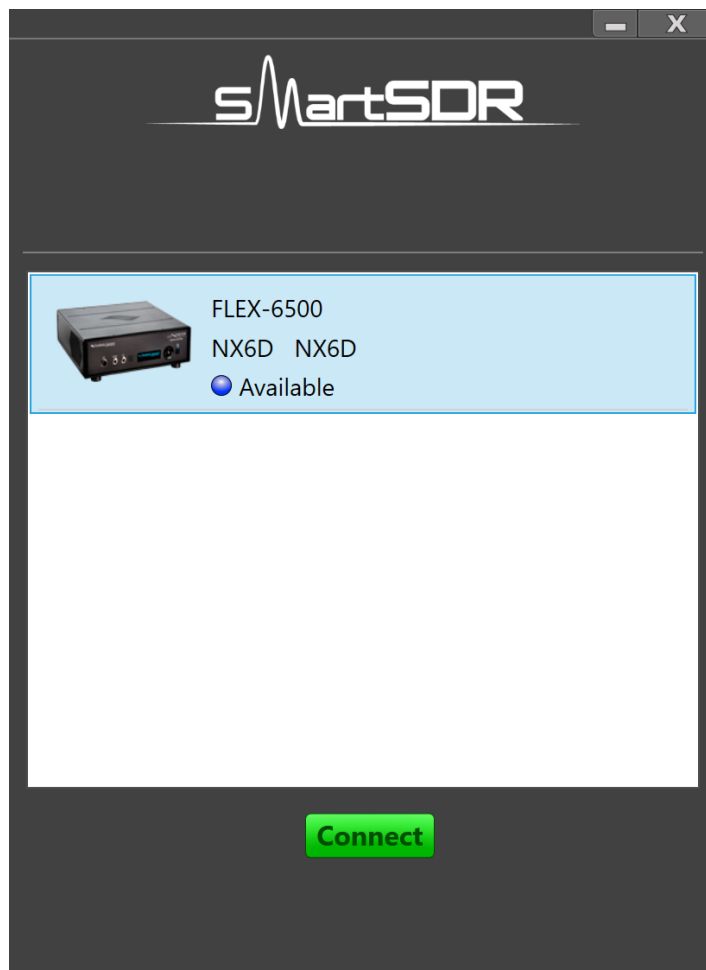
To start SmartSDR, double click the radio in the Radios area of the dialog box or click the radio once and then press the CONNECT button that appears at the bottom of the screen. "Available" indicates that you may connect to the radio.

If the radio is in use on another computer or is connected to a third-party application that provides radio GUI functions, you will see "In Use" and the IP address or computer name that is using the radio:
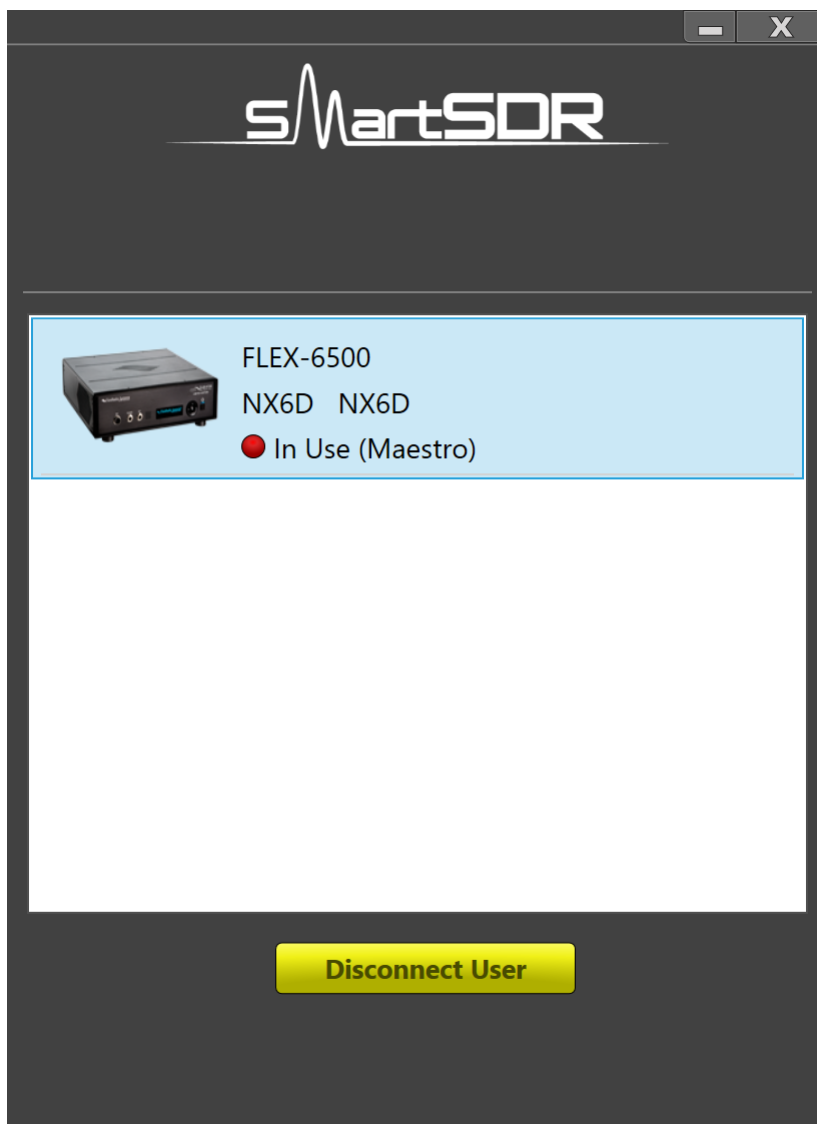
To connect to a radio that is in use by another client, select the radio by clicking on it. A **Disconnect User** button will appear. Click this button to disconnect the other client. The radio will then be available for use.

5 HOW TO UPDATE THE RADIO FIRMWARE

In the event the installed radio firmware version is not compatible with the active version of SmartSDR, a firmware update will be required. You will notice that there is a yellow indicator ● Update followed by the text "Update" in the box where your radio is listed. You will also notice text requiring you to update your radio before you can proceed. To resolve this discrepancy, click Update . If the version of the firmware that is being installed is newer than the installed version, the update process will begin.
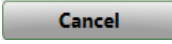
Once the process has started you will see a progress bar showing the approximate completion status. Upon completion of the update you will see ● Available appear next to the radio in the list box. Firmware updates usually complete in a few minutes. If the progress bar goes all the way to the right and stops, and the update does not complete within a few minutes, restart the radio and SmartSDR and try again.

Note: Some firmware updates make changes to the radio's processor that regulates its internal temperature. When this happens, the radio's fans will run at full speed as a safety precaution until the update is finished. This and other unusual occurrences during firmware updates should not be considered problems unless they persist after the update is complete.

5.1 DOWNGRADING THE FIRMWARE

If the active version of SmartSDR requires an older radio firmware version, a pop up window will be shown to verify that this is being done intentionally.
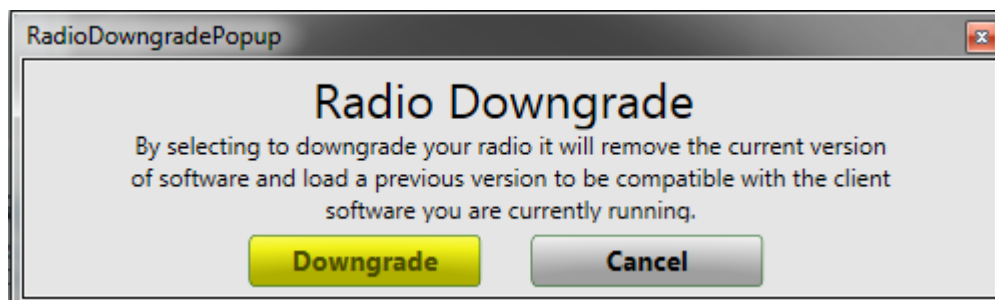
Clicking Downgrade button will remove the current version of the firmware and install an older version that is compatible with the version of SmartSDR you are running. Click Cancel to maintain the existing version of the firmware.

Note: If you were not intending to downgrade the radio, check to make sure that you are running the correct version of SmartSDR.

Once the process has started you will see a progress bar showing the approximate completion status. Upon completion of the update you will see ● Available appear next to the radio in the list box. Firmware updates usually complete in a few minutes. If the progress bar goes all the way to the right and stops, and the update does not complete within a few minutes, restart the radio and SmartSDR and try again.

6 HOW TO DETERMINE THE IP ADDRESS OF THE RADIO AND THE SOFTWARE VERSION NUMBERS

Bring up the Radio Setup Panel by clicking the "Settings" drop-down menu at the top left of SmartSDR. Then select "Radio Setup".
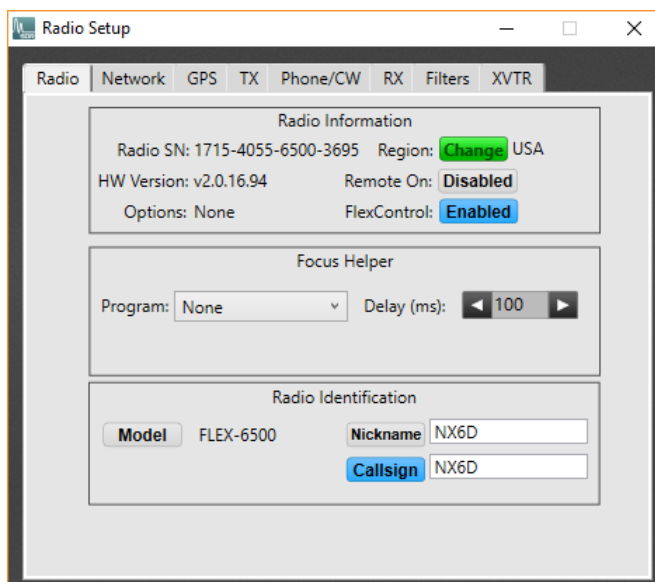
Located in the "Radio" tab is basic information about the selected radio. Radio Hardware version refers to the version of SmartSDR that is running and the associated radio firmware.

Located in the "Network" tab is information about the Flex 6000 Series radio, including the IP address used by the radio.
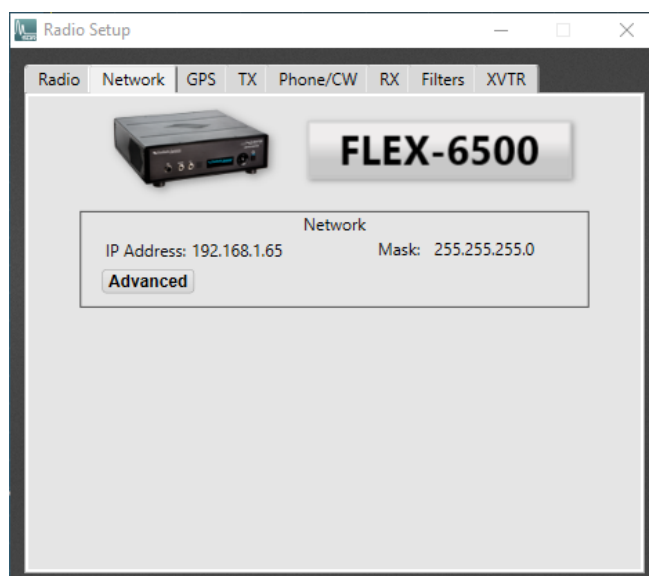
7 SMARTSDR OVERVIEW

7.1 THEORY OF OPERATION

SmartSDR is a software system designed to run on radios such as the FLEX-6000 Signature Series. SmartSDR has been designed from the start to work on hardware platforms that perform wide-band sampling of the RF spectrum. How is wide-band sampling different from other radios?

In superheterodyne (also called "superhet" or "multiconversion") radio systems, a series of down-conversions using local oscillators is performed on the RF input ultimately resulting in a baseband signal. This signal is generally only a few kilohertz wide and is ready to be demodulated and presented to the operator in the form of audio. In a superheterodyne architecture, generally only a single receiver is available at a time and the receiver has limited bandwidth.

In a wide-band sampling radio, a large portion of the spectrum is sampled (turned into digital information) all at once. This sampling provides the basis for the use of several analysis tools and receivers in the spectrum simultaneously, all from the one hardware sampler.

7.2 KEY SMARTSDR COMPONENTS

7.2.1 Spectral Capture Unit (SCU)

Because the notion of a receiver is firmly established in both the amateur community and possibly the rest of the world, it seemed inappropriate to describe the functionality of a wide-band sampling system simply as a "receiver". Instead, in the SmartSDR world there are one or more "Spectral Capture Units", or SCUs, that are responsible for the collection of wide-band data from the RF spectrum. The SCU components are: an antenna input, an optional set of receive preselectors, and an analog-to-digital converter (ADC). Each SCU in the radio system can be connected to only a single antenna at a time, but due to the sampling architecture it may support any number of receivers and spectrum displays. The SCU enables listening to multiple bands at the same time on the same antenna. A hardware platform with multiple SCUs such as the FLEX-6700 allows for monitoring multiple bands on different antennas or the ability to perform more complex noise mitigation techniques that are available in multi-antenna systems.

7.2.2 Slice Receiver

SmartSDR can create many receivers out of the data collected from the SCU. How does this work? The characteristics of the SCU sampled data stream vary by radio model, but is typically 1-4Gbps of data that contains all activity across a large section of the RF spectrum. In the FLEX-6700, for example, an SCU tuned to the HF band collects every signal present in the spectrum from 0-73MHZ! This data is not directly observable or understandable by an operator, so several tools exist for understanding and using the SCU data, the first of which is the Slice Receiver. Each Slice Receiver is tuned to a specific frequency just as a Variable Frequency Oscillator (VFO) would be in a traditional radio. The Slice Receiver then takes this more manageable amount of data (typically describing 10-20kHz of the band) and performs operations to output the signals required by the operator.

For example, in the case of a single sideband receiver, the Slice Receiver will demodulate the upper (or lower) sideband of the data collected, will filter it according to the receiver filter settings, may perform noise mitigation techniques on the data and then ultimately passes it to an audio system to become sound for the operator. Because the source of the Slice Receiver data is always the SCU

data and each Slice Receiver uses the same techniques to demodulate, filter and convert the signal into audio, each Slice Receiver shares the same base performance as the other Slice Receivers. For the operator, this means that access to two or more receivers with the same top performance may be used interchangeably without concern for differing performance characteristics of each receiver often found in superheterodyne receivers.

7.2.3 Panadapter

The Panadapter uses the data available from the SCU and turns it into a visual representation of the radio frequency spectrum. The Panadapter display, pictured below, shows the level of signals present across a specific region of the spectrum just as a spectrum analyzer would. The higher the white line appears in the display, the stronger the signal is in that part of the band. A scale for the absolute signal level in dBm (decibels above or below one milliwatt) is provided on the right-hand side of the display. This allows the operator to quickly identify signals of interest where the operator can focus his/her efforts.

Each Panadapter is derived from the data from a single SCU so it is possible in multiple-SCU radios to show two different Panadapters tuned to the same region of the spectrum, each with data from a different SCU and ultimately a different antenna. The Panadapter shows the current state of the spectrum and can be adjusted to show various widths of spectrum. A Panadapter can be seen below:
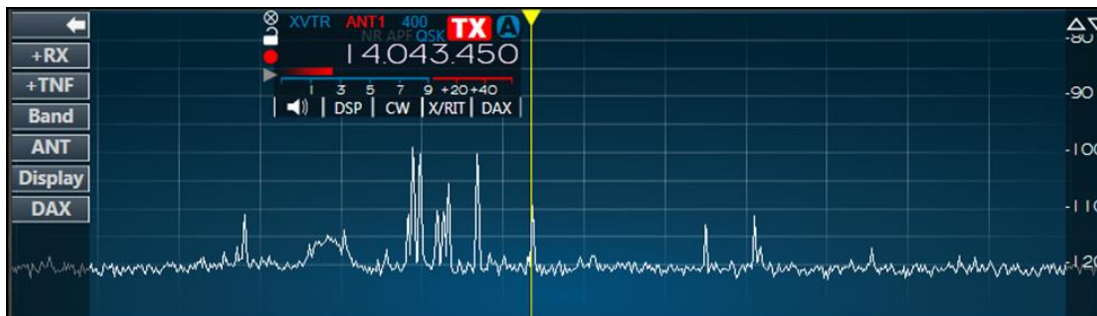
7.2.4 Waterfall

The Waterfall uses the same data from the SCU as the Panadapter and turns it into a time-based visual representation of the spectrum. In the Waterfall, intensity of signal is represented by a change in color in a similar way as water density is shown in weather radar. The vertical position in the Waterfall represents the time that the information on the spectrum was obtained. The Waterfall owes its name to the way that it continually moves downward like a Waterfall as time passes. The Waterfall can be useful for understanding how signals are distributed in the spectrum over time, locating where stations have recently transmitted and even locating "holes" where operation will not interfere with other stations. A Waterfall can be seen below:
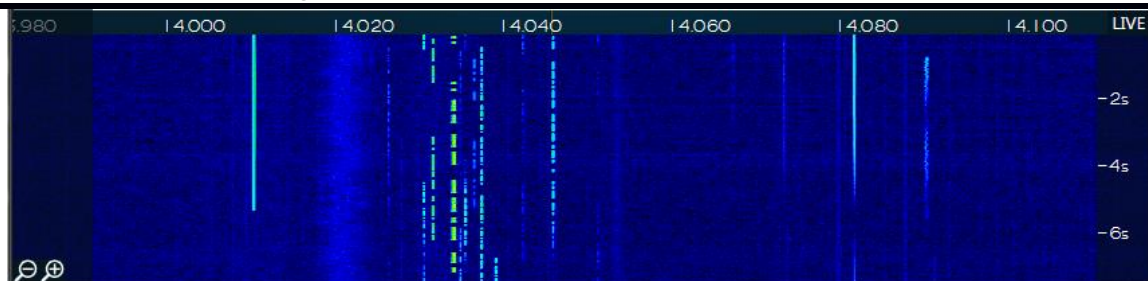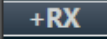
7.2.5 Panafall

The Panafall display is simply a Panadapter and a Waterfall that are joined such that the horizontal axis has the same frequency location. In this way, the Panadapter portion of the display will show the current state of the spectrum and the Waterfall portion will show a historical perspective.
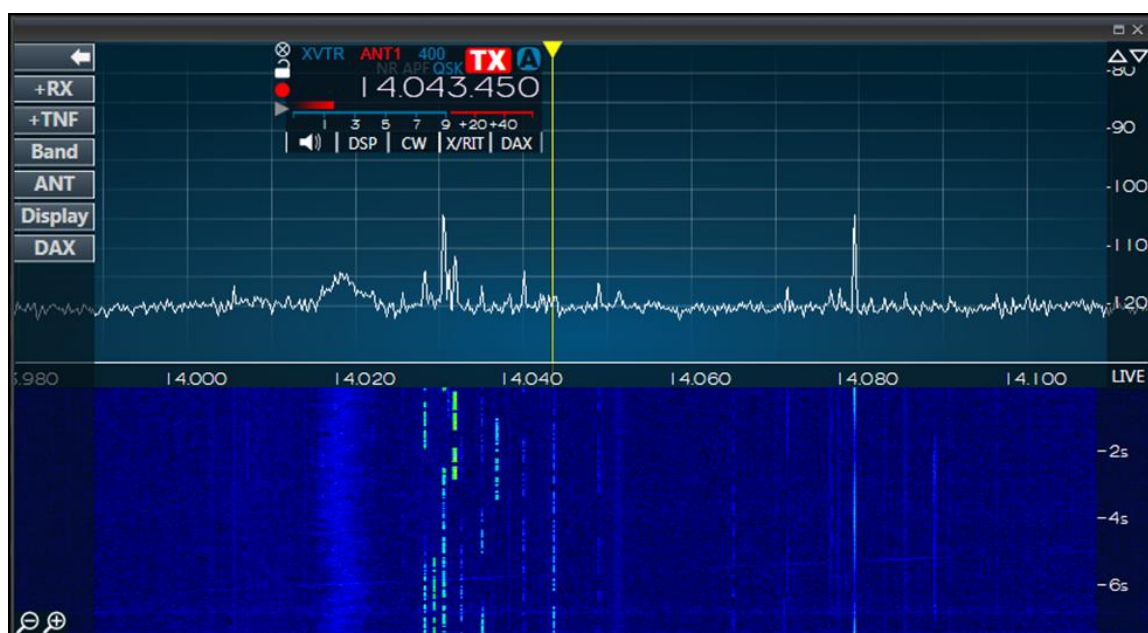
8   HOW TO OPERATE A SLICE RECEIVER

8.1   HOW TO CREATE AND DESTROY A SLICE RECEIVER

To add a Slice Receiver, click the +RX button in the Panadapter menu on the left side of the Panadapter. This action will place an additional Slice Receiver resource inside the corresponding Panadapter. A Slice Receiver will be created in the center of the Panadapter if none exist. If a Slice Receiver is already present in the Panadapter, the new Slice Receiver will be created with the same basic characteristics (mode, DSP settings, etc.) as the active or closest Slice Receiver to the center of the Panadapter with a mode specific frequency offset.

When you have utilized all your available Slice Receiver resources, the Add Slice Receiver button will be dimmed indicating that the action is no longer available. It will return to an available state once a Slice Receiver is closed.

If your cursor is already in the position in the display where you would like to create a receiver, you may right-click the Panadapter revealing a pop-up menu which will allow creation of a Slice Receiver at your current position.
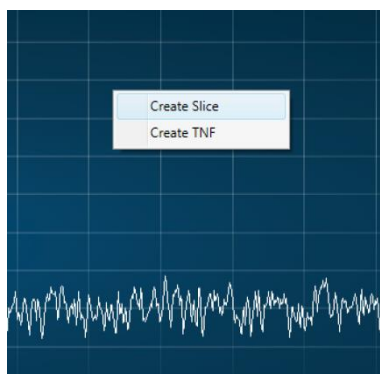
When a Slice Receiver is within the bounds of a Panadapter, the Close Button will remove the slice from the Panadapter. It will no longer be available for reception or transmission of audio.

Note: If the removed Slice Receiver was enabled for transmission, the radio will be unable to transmit until another Slice Receiver is selected for transmission.

If a slice has moved off-screen outside the bounds of a Panadapter, the Slice Receiver display will change to indicate where the slice is tuned relative to the Panadapter. Double clicking on the indicator will center the slice in the Panadapter display. The indicator also will show if the transmitter is enabled in the off-screen slice.

An off-screen slice can be closed by right-clicking on the off-screen indicator and selecting "Close Slice" or moved on-screen by selecting "Move Slice here" as shown below:
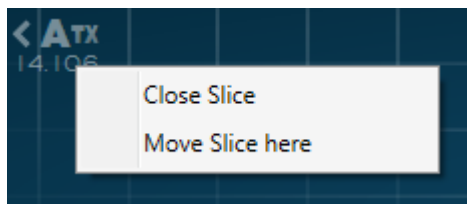
If a Slice Receiver moves too far beyond the bounds of the Panadapter, it will be put into a detached state and will no longer produce audio. Moving the slice back into the bounds of the Panadapter will put the Slice Receiver back into a normal state which produces audio. The bounds of the Panadapter are determined by the radio hardware, and vary by radio model.

8.2   HOW TO TUNE A SLICE RECEIVER

Drag Tuning: Drag Tuning is one of the more common tuning methods. By placing the cursor over the Receive Filter (lighter blue area of the Slice Receiver) or the carrier (the vertical yellow or red line of the Slice Receiver), the cursor will change to a small hand icon. Clicking and dragging when the hand icon appears will change the frequency of the slice up or down in frequency as the Panadapter remains stationary. This tuning will occur in increments of the currently selected step size. Once the slice reaches the edge of the Panadapter the slice will stop and the Panadapter will begin to move behind the slice. This is called Pan Edge Tuning and allows for rapid tuning above or below the Panadapter's current frequency range.

Click Tuning: Double clicking anywhere in the Panadapter grid will initiate a Click Tune. Click tune will move the active or closest slice to the frequency where the mouse pointer is located.

Direct Frequency Entry: Direct Frequency entry for any Slice Receiver is a tuning option. Simply highlight the slice frequency display using the mouse and type in the frequency from the keyboard in megahertz using a single separator specific to your country (for the US it is a period, for other countries it may be a comma). For example, entering "14.0705" will tune to 14.070.500. You can also enter some frequency ranges using kilohertz, but the data entered is limited to 4 or 5 digits and you cannot use a country specific separator. For example, entering "7250" will tune the Slice Receiver to 7.250.000 megahertz.

Mouse Wheel Tuning: Mouse scroll wheel tuning is available when an active slice is selected and the mouse is focused on, and within the boundaries of, SmartSDR.

FlexControl Tuning: FlexControl tuning will tune the active slice regardless of the mouse focus when the tuning of the VFO is assigned to the FlexControl knob.

Tune Step Size: The amount of frequency change caused by one tuning action on the FlexControl, mouse scroll wheel or by dragging is determined by the active slice Tune Step Size. Tune Step Size is mode group specific and can be set by the user using the Step Size adjustment on the active slice Widget. The FlexControl utilizes an accelerated tuning feature that will tune larger frequency steps when the knob is rotated more quickly.

8.3 MAKING A SLICE RECEIVER ACTIVE

A Slice Receiver consists of a center Carrier Frequency displayed by a solid yellow or red vertical bar. A yellow bar indicates the slice is "Active," indicating that this is the slice that you are currently manipulating. An active slice will have the focus of tuning devices such as the mouse wheel and the FlexControl. You can toggle the active slice by clicking anywhere on an available slice's filter display. When a new Slice Receiver is selected as the active slice, the old active slice will become inactive and its carrier line will change to the red color. There can only be one active slice under tuning device control at a time in SmartSDR.

8.4 HOW TO CHANGE THE DEMODULATION MODE
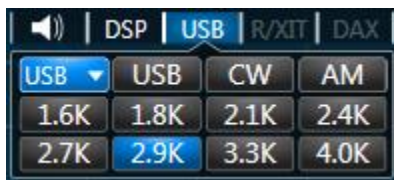
 The Mode Menu button on the Slice Flag displays the mode that is currently selected. Inside the menu there is a mode drop down menu and three quick select modes. To change the quick select modes to a different mode, use a right click to expose a drop-down menu of available modes. Beneath the mode select buttons are the mode specific Filter Presets.

The position of the Receive Filter relative to the Carrier Frequency will correspond to the conventions of the current mode. A Receive Filter to the right of the Carrier indicates Upper Sideband mode. A Receive Filter to the left indicates Lower Sideband mode. A Receive Filter that spans both the left and right of the Carrier will indicate a double sideband mode.

8.5 HOW TO ADJUST THE SPEAKER AND HEADPHONE VOLUME OF A SLICE RECEIVER
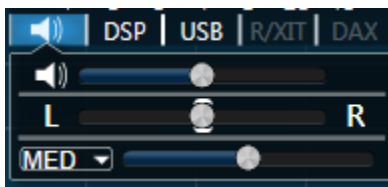
Clicking on the slice Audio menu button will expose the slice specific audio controls. Right clicking on the slice Audio menu button offers a shortcut for muting or un-muting the audio without having to enter the menu. The slice Audio Menu includes a Mute button and volume slider to adjust the audio level of the slice, and a Left and Right balance button and slider to adjust the

balance between left and right channels for headsets or speakers. The Automatic Gain Control (AGC) drop-down menu **MED ▼** allows the user to select Fast, Medium, Slow and Off AGC settings. The slider to the right of the AGC drop-down controls AGC Threshold. See section **11.1** for detailed information about the use of the AGC.

8.6   HOW TO CHANGE THE RX FILTER OF A SLICE RECEIVER

Surrounding the Carrier Frequency bar, a Slice Receiver will be a blue Receive Filter bar which represents the filtered receive audio. The portion of spectrum that is highlighted by the Receive Filter bar will be output as audio.

The Receive Filter width can be adjusted manually by hovering the mouse over the edge of the bar to get the <-> cursor. Clicking and dragging will expand or reduce the bandwidth of the filter.
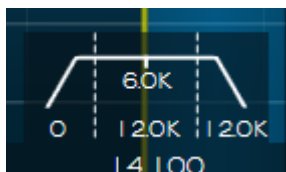
The Filter Control Widget is used to adjust the high cut and low cut of the Receive Filter. To initiate the Filter Control Widget, hover your mouse over the Carrier Frequency just above the horizontal axis Frequency bar. This will cause the Filter Control Widget to appear. Within the widget there are three sections separated by dotted lines.

If you hover your mouse over the left section a left Control arrow will appear. Clicking and dragging left or right will adjust the low cut of the filter and will be displayed as the left side of the Receive Filter moving left or right. The value at the bottom of the widget displays the separation from the carrier frequency.

The center section adjusts both the high cut and low cut of the filter simultaneously. Hovering over the center section causes a four-way arrow to appear. Clicking and dragging up and down from within this section will decrease/increase the low cut while increasing the high cut of the filter effectively making the Receive Filter bar wider. Clicking and dragging left and right will move the Receive Filter bar left and right relative to the Carrier Frequency.

If you hover your mouse over the right section a right Control arrow will appear. Clicking and dragging left or right will adjust the high cut of the filter and will display as the right side of the Receive Filter moving left or right. The value at the bottom of the widget displays the separation from the carrier frequency.

8.7 RECORDING AND PLAYBACK OF SLICE RECEIVER AUDIO

Slice receivers may be recorded and the recording played back over the air using the Quick Record/Playback feature of SmartSDR. To the left of each Slice Receiver flag are both a record (red circle) and play button (green triangle).

On startup, there is no recorded audio in the playback buffer and so the play button will be disabled (greyed out). To record audio from the Slice Receiver, press the record button (red circle) once. While recording, the record button will animate a repeated pulse.

Recording will continue until the record button is pressed again or until two minutes have passed. Recording will include any received audio while in receive mode and any transmit audio when the radio switches to transmit mode. Once the recording is stopped, the record button will return to a solid red circle and the play button (green triangle) will be active:
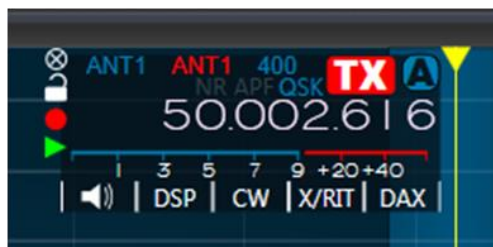
To playback the audio, press the play button. If the play button is pressed while the radio is in receive mode, the playback audio will be routed to the speakers and headphones. If play is pressed while the radio is in transmit mode, the audio recording will also play through the transmitter.

To stop playing audio, press the play button a second time or wait for the recorded audio to finish playing.

To record or play again, press the appropriate button. Only one audio recording per Slice Receiver is saved. The audio played during transmit can originate in any Slice Receiver regardless of whether the Slice Receiver that recorded the audio is the Slice Receiver now transmitting. For example, you may record audio using Slice Receiver A and then playback that audio over the air using Slice Receiver B. To do this, make Slice Receiver B the transmitter by selecting it using the red TX selection to the left of the letter B. Press the MOX button, PTT on the microphone, footswitch or other PTT source and then press the play button on Slice Receiver A.

9   HOW TO OPERATE THE PANADAPTER / WATERFALL

9.1   HOW TO CREATE / DESTROY A PANADAPTER / WATERFALL

On the lower tool bar of SmartSDR there is a button to create a new Panadapter and Waterfall . This control will add another Panadapter to the Main Window. The control will be a dark shade of grey when you have used all the available Panadapter resources.
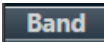
Clicking the Close button will remove the Panadapter and any Slices that are displayed in the Panadapter. When this occurs, you will not be able to use the Slice resources until they are recreated in another Panadapter.

9.2   HOW TO CHANGE THE PANADAPTER FREQUENCY (TUNE)

Each Panadapter can perform a pan function to adjust the frequency range that is displayed. Clicking and dragging within the Panadapter grid will reorient the frequencies being viewed on the Panadapter in the direction that your mouse is moving. By moving your mouse to the right, you will display lower frequencies and vice-versa.

The Band menu button in the Panadapter menu will expose the Band Menu. Selecting a band from this list will adjust the Panadapter to display all or part of the corresponding amateur radio band. Selecting band buttons allows for rapid switching between views of the amateur radio bands. Clicking the Band menu button again collapses the menu. Clicking on the XVTR button in the lower right swaps the buttons to a list of XVTR bands. Click the HF button to swap back.

<->

When switching between bands, if any Slice Receivers are defined in the Panadapter, these are removed. If Slice Receivers were present in the new band the last time the band was active in the radio, they will be recreated. If no Slice Receivers were present, none are created.

9.3   HOW TO ZOOM A PANADAPTER

Each Panadapter has a zoom range up to a maximum of 14 MHz for the FLEX-6500 and FLEX-6700 or 7 MHz for the FLEX-6300 down to a minimum of 1.5 kHz in bandwidth for the FLEX-6700 and 6kHz in bandwidth for the FLEX-6500 and FLEX-6300. There are multiple methods for adjusting the zoom of the Panadapter.

Use the plus and minus magnifying glass buttons located in the bottom left corner of the Panadapter for rapid zooming. Zooming out (-) will double the bandwidth presented in the Panadapter while zooming in (+) will halve the bandwidth. The frequency at the center of the Panadapter will remain the same after each change in bandwidth.

For more precise control of the zoom, click and drag anywhere on the frequency labels located at the bottom of the Panadapter.

Dragging the frequency labels to the right zoom in, dragging to the left zooms out. With this method, the frequency at the point where your mouse was located when clicked will remain stationary in the Panadapter.

When zooming out of a Panadapter there are certain points where the amount of data needed to create the display needs to be doubled. As this occurs more noise will be included in the FFT bins comprising the display which will cause a noticeable increase in the noise floor. The reverse occurs when zooming in on a Panadapter. Each time one of these thresholds is crossed, either zooming in or out, the noise floor will increase or decrease by about 3 dB. After zooming out to a certain point, the hardware will switch to wideband mode, which causes the radio to open the Bandpass Filters to their maximum bandwidth. When this occurs, any Panadapters using that antenna will display in the top right corner to indicate that they are in wideband mode.

Note: The FLEX-6300 is always in WIDE mode and will not show this indicator.

Just to the left of the WIDE indicator is an indicator that shows if the preamplifier is active and if so, at what level. A complete description of the preamplifier control can be found starting in section **23.11**.

To the left of the preamplifier indicator is an indicator for whether the Panadapter is on a Transverter (XVTR) band. A complete description of how to setup for XVTR operation can be found in section 24.

9.4   HOW TO CHANGE THE SIGNAL MAGNITUDE SCALE OF A PANADAPTER

Each Panadapter will allow you to adjust the maximum and minimum amplitude displayed. Clicking the up or down arrows displayed in the top right corner of the Panadapter will increase or decrease respectively the maximum amplitude displayed in 10 dB increments. You may also adjust the minimum amplitude by clicking and dragging the vertical axis. This will effectively adjust where the noise floor is positioned within the Panadapter.

The vertical scale is calibrated in dBm, showing the signal strength as measured at the antenna terminal.

9.5   ADJUSTING THE PANADAPTER AND WATERFALL CONTROLS

Display menu button [Display] on the Panadapter menu will expose the display controls. A horizontal line separates Panadapter controls (top) from Waterfall controls (bottom).
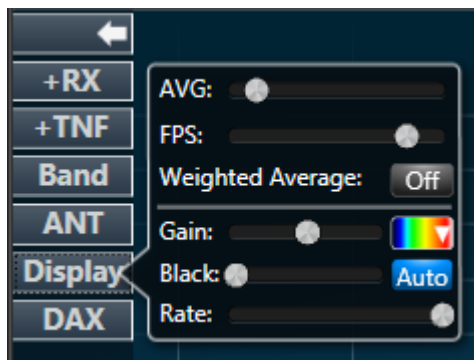
The FPS slider controls the rate that the Frequency Spectrum is drawn on the Panadapter, in frames per second. Lowering the FPS control has several effects:

It lowers the rate at which both the Panadapter and the Waterfall are updated

It lowers the network bandwidth of data sent from the radio to SmartSDR, which may be important in situations of limited network bandwidth

As the rate of update is lowered, the extra data not displayed is averaged and so the variance of the data is lowered, making both the Panadapter and the Waterfall smoother

If you prefer a faster updating display, but a more averaged or smoother one, adjust the FPS setting for the update speed you prefer and then raise the AVG (averaging) control. The AVG control increases the number of frames that are averaged, lowering the variance and smoothing the display.

The final Panadapter control, Weighted Average, emphasizes signals that are increasing in amplitude over ones that are declining. This tends to continue to show locations where signals have been and show a more precise view of their full amplitude when they first appear.

Below the line at the center of the control are the Waterfall controls.

The Gain, Black and Auto controls work together to adjust how different signal levels are displayed in the Waterfall. The Black control sets the level below which all pixels will render as black. In other words, it sets the level at which signals are no longer of interest. The Auto control will automatically set the black level to just below the noise as band conditions, preamplifier changes or antenna changes alter the noise floor. To enable auto-black, click the Auto button so that it is blue.

The Gain control adjusts how rapidly the Waterfall will advance through the color spectrum for minimal changes in signal level. Lowering the gain gives the Waterfall a broader dynamic range, but lessens its ability to show small variations in signals. Raising the gain lowers the dynamic range, but provides more detail in the variations in smaller signals' magnitudes.

The rate control adjusts how fast the Waterfall will advance on the screen. At the lowest setting, many minutes of data can be displayed. At its highest setting, the Waterfall displays a rapidly changing spectrum in the most detail.

In most cases Auto Black properly adjusts the background color or black level for the display's zoom factor and the relative noise floor of the band you are viewing. You can however, manually adjust the Waterfall display's setting to allow for the display of weak signals at or near the noise floor. If the black level is set too low, many of the "in the noise" FFT bins will always be zero, regardless of the display gain setting. To achieve an ideal setting for the Waterfall black level, do the following:

Turn the display gain level to maximum

Adjust the Waterfall black level to a point where the Waterfall is primarily white, but there are approximately 2-5% black areas displayed.

Turn the display gain down until the background is deep blue.

This ensures that small signals in the noise will be easily seen.

9.6   HOW TO CHANGE THE SIZE AND POSITION OF MULTIPLE PANADAPTERS

Clicking the Maximize button will prioritize the arrangement of the Panadapter at the top of the display. Once a Panadapter is maximized a grey horizontal separator will appear between the maximized Panadapter and any other Panadapters that are open at the time. Clicking and dragging this horizontal separator will increase or decrease the size of the maximized Panadapter. The non-maximized Panadapters will adjust to fill the remaining available space. To return to the standard view click the next to the close button. A maximum of three Panadapters can be maximized simultaneously.
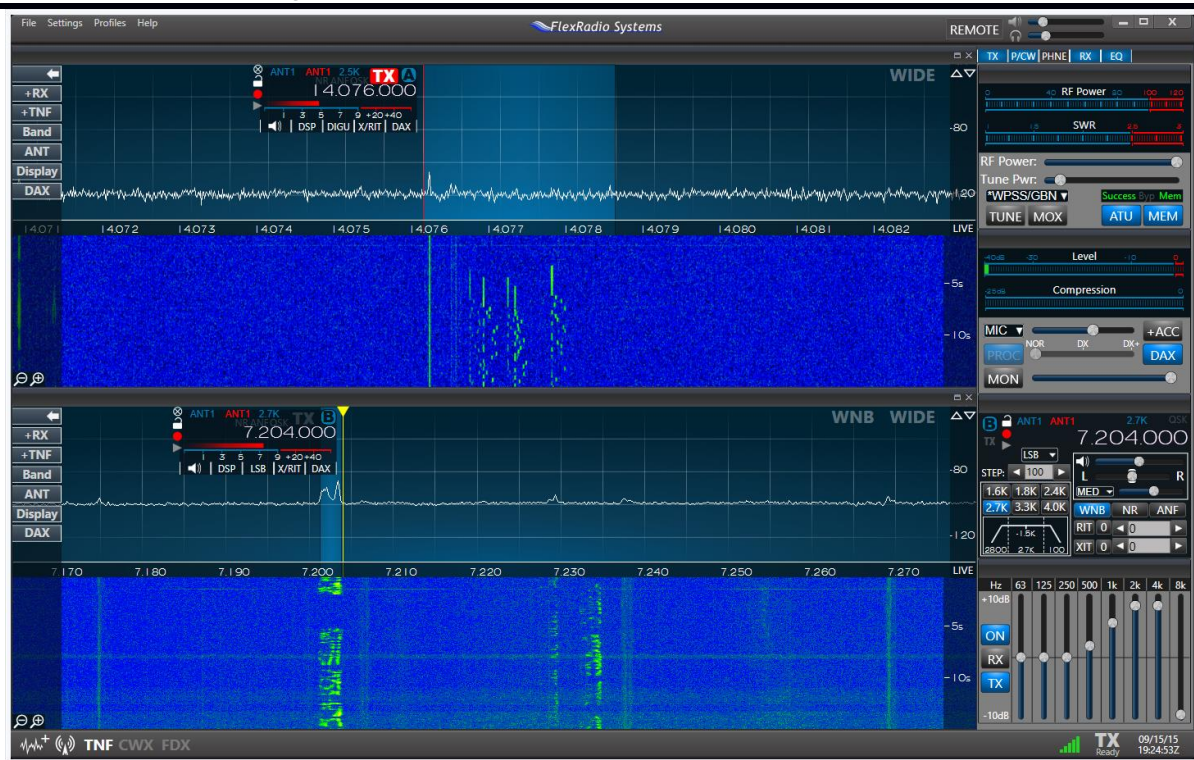
When multiple Panadapters are open, clicking on the main bar and dragging its position will rearrange the Panadapter windows.
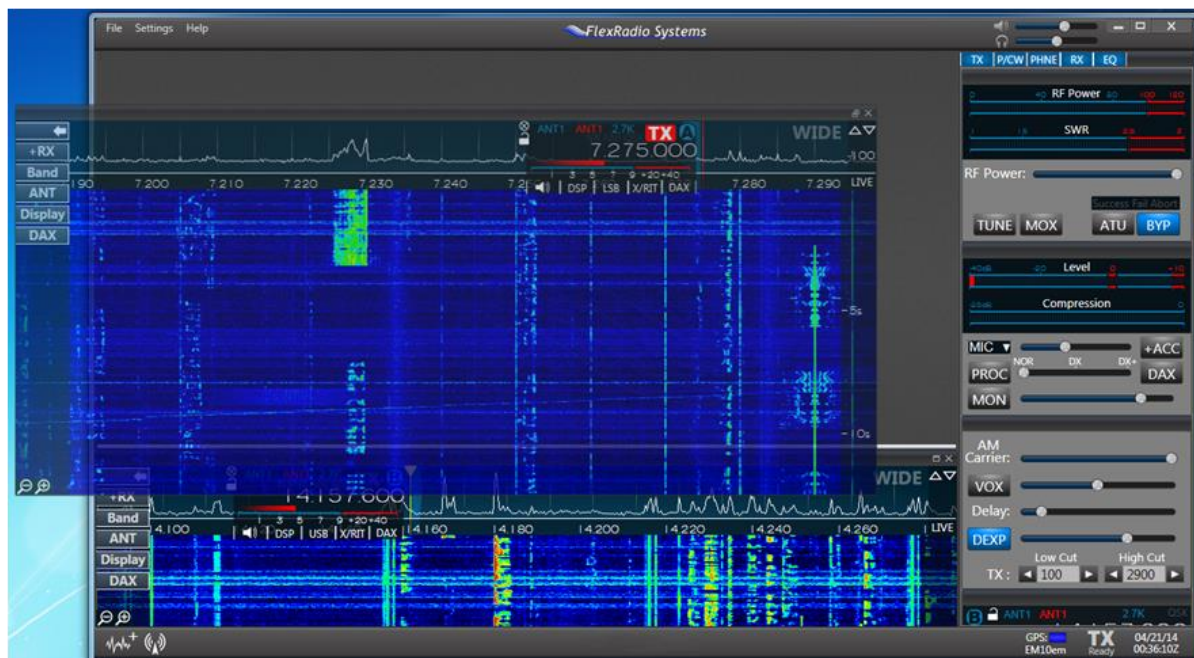
10 NOISE MITIGATION IN SMARTSDR

To properly utilize the DSP noise reduction features of SmartSDR, it is important to understand the type of noise causing interference.   There is no single solution for noise mitigation since different types of noise require different algorithms.   There are two primary types of noise that can be minimized using DSP techniques: white noise and impulse noise.

White noise is defined as random or uncorrelated noise with a uniform frequency spectrum over a wide range of frequencies. The sound of rain is an example of white noise. Three techniques are best used to improve signal to noise ratio in the presence of white noise:

- Reduced filter bandwidth
- Optimized AGC threshold (AGC-T) setting
- DSP Noise Reduction (NR)

Reducing filter bandwidth and optimizing the AGC threshold can significantly improve SNR without adding distortion or "coloring" the signal so long as the desired signal is not at the antenna noise floor.   However, DSP noise reduction (NR) can provide significant intelligibility improvement on weak signals which may be near or below the antenna noise floor.

Impulse noise is a category of noise that includes almost instantaneous impulse-like sharp sounds generated by voltage spikes from arcing power lines, automotive ignition systems, electric fences, etc. Impulse noise can raise the wide band noise floor received at the antenna by tens of dB and thus completely mask signals that would otherwise be readable.

Traditionally, "noise blankers" have been utilized to mitigate this type of impulse noise. These techniques detect the noise pulses and literally turn off the receiver during the time of the impulse. The problem with traditional noise blanking techniques is that they have no way to tell strong signals on the band from impulse noise and can thus "mix" impulses with the strong signals to cause unwanted interference.   SmartSDR incorporates a new Wideband Noise Blanking (WNB) algorithm that can differentiate between modulated signals and impulse noise, virtually eliminating the "mixing" problem found in traditional blankers. This WNB algorithm operates in real time over the entire Spectral Capture Unit (SCU) bandwidth to detect and replace impulses with an estimate of the desired signal.

11 HOW TO CONFIGURE NOISE MITIGATION

The FLEX-6000 has several digital-signal-processing functions that enhance reception in noisy environments.

11.1 AGC THRESHOLD

Automatic Gain Control (AGC) is a feature which automatically adjusts the Slice Receiver's audio gain (volume) based on the strength of signals in the receiver's passband filter. The goal of AGC is to amplify weak signals and attenuate strong signals so that they all lie within a comfortable listening range.

The receiver Automatic Gain Control Threshold (AGC-T) can be adjusted for optimum performance in noisy or quiet environments. The AGC-T sets the maximum gain applied under any circumstances. Since the noise floor is relatively constant on a given band at a given time, the AGC can be adjusted using the threshold control so that the AGC never applies gain to noise, but it will apply gain to signals just out of the noise. In doing so, the AGC can *reduce* the level of noise you hear and help signals pop out of the noise.

The AGC system in SmartSDR is a dual track system, meaning that it can track both slow and fast increases in signal strength, making appropriate gain correction decisions in the presence of each. The speed of the AGC (FAST, MED, SLOW) determines how quickly or slowly the AGC recovers after attenuating a strong signal. You can easily hear this by tuning to a CW signal and going through the three settings. On FAST with a strong signal you can hear the gain pump up and down while on SLOW it recovers after a longer pause once the signal stops. When the signal stops, you will hear the noise floor increase as the gain returns.

How to Set AGC for Different Operating Conditions

If you are listening to a loud voice signal, AGC SLOW will resist increasing the gain between syllables and therefore reject most of the noise which is at a level far below the signal. FAST and MED provide faster levels of recovery for situations when you want the system to more closely follow the dominant signal in the passband. Any time you have a very strong signal that causes the gain in the AGC to be reduced, you could experience a loss of gain to a weak signal you are listening to. The filter passband edges, which are continuously adjustable, and TNFs can be used to eliminate signals that might interfere with AGC operation.

The operator might prefer to use SLOW settings when rag chewing in a high signal to noise environment where there isn't much QRN and the noise floor is stable. This keeps the gain at more of a constant level that is less distracting. If the operator is trying to pull a weak CW signal out of the noise, they may prefer to use FAST mode to quickly ensure that the long-term average of the noise floor doesn't overcome the signal and prevent it from being heard. MEDium is a reasonable compromise.

When AGC is set to OFF, a *fixed* amount of gain determined by the AGC-T setting will be applied to both fast and slow signals regardless of their level. The more you adjust the AGC-T to the right, the more gain is applied and the louder the signal *and noise* will be. The benefits of increasing SNR with AGC are lost in this mode. Another disadvantage of turning AGC off is that the operator must adjust the 'RF Gain' manually to avoid distortion due to overload by strong signals.

Operating with AGC turned OFF may desired by operators who want to avoid having a strong signal drive a weak nearby signal into the noise floor resulting from AGC audio attenuation, such as when operating digital modes.

To adjust the AGC Threshold, tune to a quiet spot between stations. Starting with the AGC-T at a high value adjust the AGC-T slider to the left (lower gain values) until the background noise just begins to decrease. This is the AGC-T "sweet spot" or the "knee" of the AGC algorithm. Depending on band conditions, if the AGC-T is set below 50, you may have to compensate for the loss in audio gain (volume) by increasing the Slice or master AF volume to a higher value. When you get the knee and AF volume adjustment correct for the band conditions, it will keep the volume of strong signals constant which will allow weaker signals to be heard even with AGC in FAST mode. Thus AGC-T is one of the most important adjustments, and often overlooked, to achieve the maximum weak signal receive performance out of the FLEX- 6000 series SDRs.

The Automatic Gain Control Threshold (AGC-T) adjustments are located with the slice audio controls; it is the bottom control in the audio panel. Each Slice Receiver can have its own settings for the AGC timing and threshold.

The drop-down control sets the attack/release time for the AGC. You can choose FAST, MEDium, SLOW or OFF.

11.2 DSP NOISE MITIGATION FEATURES

The DSP control panel in the slice flag contains the enable buttons and threshold adjustments for the Wideband Noise Blanker, Slice Specific Noise Blanker, Noise Reduction, and Automatic Notch Filter. The midrange settings of the threshold controls are good starting points for adjustments.

11.3 WIDEBAND NOISE BLANKER (WNB)

The Wideband Noise Blanker (WNB) is used to combat fast rise time pulse-type noise such as power line hash and car ignitions. To enable the Wideband Noise Blanker, click the WNB button, then adjust the threshold control for the best noise suppression. In general, the default setting is adequate, but depending on the noise characteristics, some adjustment can help. The WNB Threshold control adjusts the level at which a sample is considered to be impulse noise. The general rule of thumb for this adjustment is to use the lowest level that is effective. For large impulse noise (meaning the noise floor jumps are large) a lower level should be used. If the impulse noise is causing only small jumps in the noise floor, a higher level can be used.

Large signals, both in the passband and around it, can result in distorted audio if the WNB threshold control is set too high.

Since the Wideband Noise Blanker operates at the SCU level rather than at the Slice level easy detection of wideband correlated noise pulses is possible. The algorithm employs an automatic slider normalization function to make the WNB work consistently on different bandwidths and signal levels. This unique architecture allows pulse removal with far less distortion than many traditional noise blankers.

Given the wideband nature of this feature, the threshold slider in the GUI controls an entire SCU, which may have several Panadapters and/or slice receivers attached to it. For convenience, the slider control is available in each slice and each Panadapter. Adjusting any one of them adjusts for an entire SCU, and all related slider controls are updated. Enabling and disabling the WNB function is available separately for each Panadapter. All Slices present on a Panadapter inherit the same value for the WNB enable and level.

When the WNB detects a significant change in signal level or bandwidth, it attempts to normalize the slider value. During this time, blanking will be momentarily bypassed, and the WNB indicator in the Panadapter will start to flash (blink). Once a suitable normalized slider range has been re-established, the noise blanking action will resume, and the WNB indicator will return to a solid color.

It is possible for certain WNB level settings to cause distortion with certain types of signals. For example, in the proximity of very large signals, noise may become worse with aggressive settings of WNB. If this is the case, either lower the WNB level setting, or disable WNB on that Panadapter.

11.4 SLICE SPECIFIC NOISE BLANKER (NB)

The Slice Specific Noise Blanker (NB) is used to combat fast rise time pulse-type noise such as power line hash and car ignitions, on a Slice Receiver basis. To enable the Noise Blanker, click the NB button, then adjust the threshold control for the best noise suppression. In general, the default setting is adequate, but depending on the noise characteristics, some adjustment can help. The NB Threshold control adjusts the level at which a sample is considered to be impulse noise. The general rule of thumb for this adjustment is to use the lowest level that is effective. For large impulse noise (meaning the noise floor jumps are large) a lower level should be used. If the impulse noise is causing only small jumps in the noise floor, a higher level can be used.

Unlike the Wideband Noise Blanker, the Slice Specific Noise Blanker algorithm considers only 24kHz of the RF spectrum, centered on the Slice Receiver's tuned frequency, not the entire SCU RF spectrum, as is the case with WNB. The NB algorithm complements the WNB algorithm and may be used with or without WNB. It may more effective than WNB, less effective or have no effect on specific examples of impulse noise.

The Slice Specific Noise Blanker may be turned on or off and adjusted for each Slice Receiver.

11.5 NOISE REDUCTION (NR)

The Noise Reduction processor (NR) will reduce random ("white") noise making signals more readable which are buried in the noise. It is best to adjust the AGC threshold first, and then enable the Noise Reduction.

The Noise Reduction algorithm uses a correlation based adaptive filter. Noise Reduction increases correlation between input and output with the assumption that noise is uncorrelated and should be canceled out. The threshold adjustment controls the adaptation rate of the filter, so in the case of Noise Reduction, there will be very little audible change while adjusting the threshold unless the noise is changing rapidly or dramatically. The most aggressive settings of Noise Reduction increase the signal to noise ratio but will tend to "color" the signal. The slider should be set for the optimal tradeoff between signal to noise ratio and minimal distortion of the desired signal.

11.6 AUTOMATIC NOTCH FILTER (ANF)

The Automatic Notch Filter algorithm uses a correlation based adaptive filter. The Automatic Notch Filter decreases correlation of the input and output since a constant tone is highly correlated and should be canceled out. The threshold adjustment controls the adaptation rate of the filter. If a loud tone is present and you move the receive filter around it, you should hear the tone get canceled at different rates depending on the threshold control setting.

12 HOW TO USE TRACKING NOTCH FILTERS (TNF)
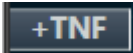
12.1 TRACKING NOTCH FILTER THEORY

With the notch filters found on most receivers, the notch removes an audio frequency after the AGC. When you hear a carrier in the middle of a sideband transmission, you can enable the notch and adjust it to remove the objectionable carrier. The weakness of this type of filter is apparent when the dial frequency is changed. Since the notch is on an audio frequency offset, as the dial frequency is changed the audio frequency of the undesirable frequency is changed and it falls out of the notch, requiring a readjustment of the notch.

With the Tracking Notch Filter™ (TNF), once the frequency has been notched the filter remembers the RF frequency of the objectionable signal. When the dial frequency is changed, the filter is automatically adjusted to maintain the notch on the objectionable frequency. With SmartSDR, you can create many Tracking Notch Filters to notch out local problem carriers or birdies across all bands covered by SmartSDR. The TNFs may be temporary, for only the current session, or they may be remembered permanently.

Note: Individual TNFs are disabled when in the audio passband of a Slice Receiver that is configured for demodulating FM. Because of the frequency dependent nature of FM, a "notch" in the FM passband severely distorts the demodulation.

12.2 CREATING AND ADJUSTING A TRACKING NOTCH FILTER

To create a TNF, click the ⬛ +TNF button on the left side of the Panadapter. This will create a TNF in the center of the Panadapter. You can also right click in the Panadapter or Waterfall on the frequency where you would like the TNF created and select "Create TNF."
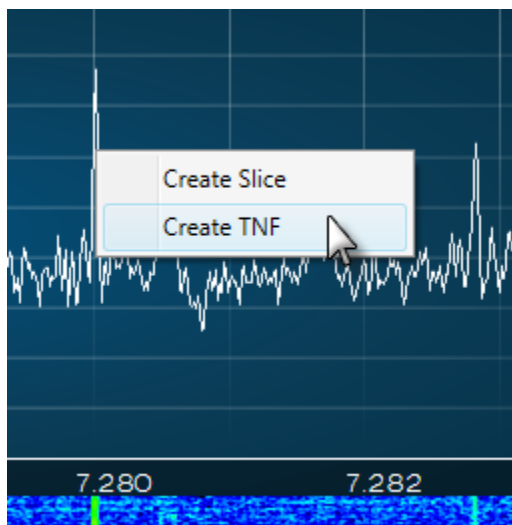
The Tracking Notch Filter will be created on the frequency where the right-click occurred. A TNF will be shown by a greenish vertical line with diagonal yellow stripes.
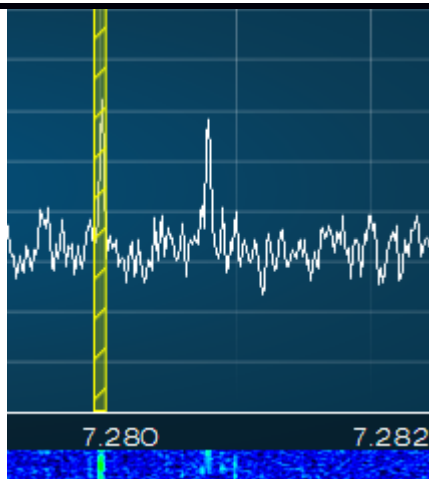
Once the TNF is created, the TNF may be remembered, deleted or adjusted by right-clicking on the TNF again:
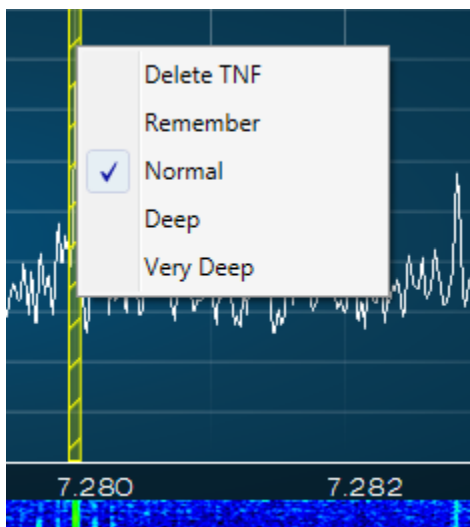
To see details on the current TNF or change its frequency or width, hover your cursor over the TNF. The cursor will change to a 4-way directional cursor and details about the TNF will appear in a callout:
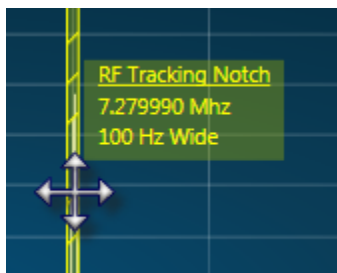
To increase the width of the TNF, left-click and then move the cursor up-and-down. To adjust the frequency of the TNF, slide side-to-side.

12.3 TURNING ALL TRACKING NOTCH FILTERS ON OR OFF

To disable all TNFs at the same time, click on the TNF icon in the bar at the bottom on SmartSDR:
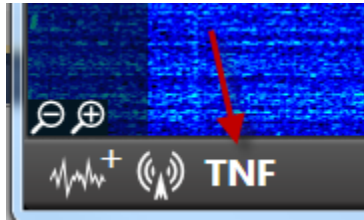
When all TNFs are disabled, the TNF icon will "gray out" as shown below. To re-enable all TNFs, just click on the button again.
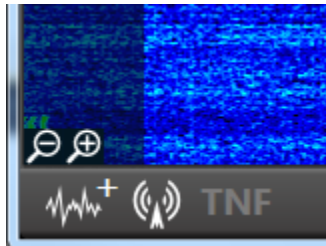
13 HOW TO CUSTOMIZE THE FLEXCONTROL INTERFACE

The FlexControl interface provides a handy physical knob and a set of buttons that can be programmed to perform selected operations in SmartSDR.

13.1 HOW TO CUSTOMIZE THE FLEXCONTROL INTERFACE

From the "Settings" drop-down menu at the top of SmartSDR, select the "FlexControl" option.
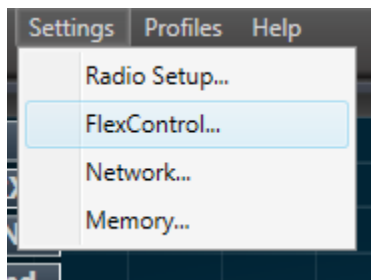
This will bring up the simple mode FlexControl panel.

The panel resembles the physical appearance of the actual FlexControl to make the programming experience more intuitive. Each of the buttons has a corresponding drop-down menu that allows the user to modify its function.

The different options include:

- Tune Slice – When enabled, the knob will tune the active slice
- RIT (Receive Incremental Tuning) – When enabled, the knob will tune the RIT of the active slice. Double clicking the button will zero the RIT setting.
- XIT (Transmit Incremental Tuning) – When enabled, the knob will tune the XIT of the active slice. Double clicking the button will zero the XIT setting.
- Slice AF – When enabled, the knob will adjust the volume of the active slice
- Master AF – When enabled, the knob will adjust the master volume control
- AGCT (Automatic Gain Control Threshold) – When enabled, the knob will adjust the AGCT of the active slice.
- Change Active Slice – When enabled, this option will sequentially step through all defined Slice Receivers making each one the active slice.
- MOX – When enabled, pressing this button will key the transmitter
- RF Power – When enabled, the knob will set the RF Power output from 0-100.
- CW Speed – When enabled, the knob will set the CW Speed in WPM.
- CWX Macros [1 -12] – When selected, pressing the button will send the selected CWX Macro
- None – no option is assigned to the button

13.2 OPERATING THE FLEXCONTROL

Once you have assigned a control function to a button or the knob, pressing the appropriate AUX button will assign that function to the knob control. As an example, using the image above, AUX1 is assigned to RIT. Pressing AUX1, will cause the LED under AUX1 to illuminate and when you rotate the knob, it will change the RIT offset. Pressing down on the knob will reassign the knob back to tuning the active slice.

XIT/RIT Control Functions:

In addition to changing the XIT/RIT offsets using the knob control when the respective assigned AUX button is pressed once, if you double click the AUX button assigned to RIT or XIT the offset will reset to 0 Hz.

13.3 TROUBLESHOOTING ISSUES WITH THE FLEXCONTROL

If the Windows system running SmartSDR cannot detect a FlexControl connected to it, the following screen is displayed:

If you have your FlexControl physically connected to your PC and you receive the *FlexControl not detected* message, the problem may be caused by one of the following:

1.) **The FlexControl Drivers did not load properly** – The FlexControl drivers are installed when SmartSDR for Windows is installed. Under certain rare circumstances, Windows permissions issues may prevent the driver from installing properly. Uninstalling and reinstalling SmartSDR may solve the problem. If the problem persists, please open a HelpDesk support ticket so that a technical support engineer can attempt a manual load of the drivers.
2.) **Serial port conflict** – The FlexControl emulates a serial port via a USB connection which is dynamically assigned a com port number by Windows. Occasionally Windows fails to recognize

existing com ports if they are virtual, such as the ones created by SmartSDR CAT. When this happens, Windows can accidently assign the FlexControl to a com port that is already in use, resulting in both the FlexControl and the applications connected to the virtual com port to stop working. Manually assigning the FlexControl a com port in a range well beyond what the virtual com ports are using usually solves the problem. For more information on how to change the com port assignment for the FlexControl, please refer to the FlexRadio HelpDesk Help Center article How to Change the Com Port Assignment for a FlexControl.

14 HOW TO USE PROFILES

Profiles allow the user to name and save the state of the radio and recall it later. Profiles can even be exported and restored on another FLEX-6000 Series radio. This facilitates convenient backup of radio configurations and helps IT managers of DXpeditions or contest super-stations test configurations and then install or restore them at a site. Individual operators can also save their favorite settings and then, after others have operated, restore the state of the radio. [Note: Graphical User Interface layout settings are not currently stored but may be included in a future version of SmartSDR.]

There are three types of profiles: GLOBAL, TRANSMIT and MIC. Global profiles store the state of the radio including the Panadapters and Slices that are open, the mode associated with each slice and all the settings for noise blankers, AGC, filters, etc. Transmit profiles save the transmitter power level, tune power level, transverter power level and the various transmitter delay parameters. MIC profiles save a configuration for a specific microphone or audio source, including the TX filter settings, the MIC selection and level and the DEXP, PROC, DAX, VOX and EQ settings.

Profiles are far superior to traditional "band stacking" in that you can save as many different configurations as desired and give them a meaningful name for recall.

14.1 MIC PROFILES

MIC profiles manage a set of radio parameters associated with microphones and other audio sources. These include TX filter settings, MIC selection and level, and DEXP, PROC, DAX and VOX settings. A complete list of the parameters is provided in section 15.

The MIC profile can be selected using the Profile Manager, or by selecting it from the drop-down menu which is located just above the MIC gain slider in the P/CW panel.

MIC profiles can be associated with the mode of a Slice Receiver. The MIC profile in effect at any point in time is determined by the mode of the transmit slice, or by a Global profile. Many Slice Receivers may exist, set to different modes, but only one controls the transmitter and that slice determines the MIC profile that is invoked in the radio.

A MIC profile is associated or "linked" with a demodulation mode by selecting a profile from the drop-down menu in the P/CW panel while the desired mode is selected in the *transmit* slice. When a new MIC profile is created, it is associated with a mode in the same way. Note that the modes that can be associated with a MIC profile are SSB, Digital, FM, AM, RTTY and Waveforms.

To associating a MIC profile with a mode, modes groups are used. LSB and USB are a single mode group (SSB), as are DIGU and DIGL (Digital), FM, NFM and DFM (FM) and AM and SAM (AM). RTTY and each Waveform installed in the radio are treated as a separate mode.

To associate or link a Mic profile to a mode group, set the transmit slice to the mode you wish to link. Then load or save a Mic profile while the transmit slice is in that mode. From then on, whenever the transmit slice is set to that mode the linked Mic profile will be loaded. For example:

1. Slice A – Mode is USB
2. Load **Default FHM-1** Mic profile. (This Mic profile is now linked to the USB/LSB mode group)

3. Change Slice A to SAM (This loads the default linked MIC profile *Default*)
4. Load **Default PR781** Mic profile. (This Mic profile is now linked to the AM/SAM mode group)
5. Change Slice A to LSB or USB. (This loads the **Default FHM-1 Mic** profile)
6. Change Slice A to AM or SAM. (This loads the **Default PF781** Mic profile).

When any value associated with the selected MIC profile is changed but not saved, an asterisk (*) will appear before the profile's name in the drop-down menu. If a different profile is selected, either by use of the drop-down menu or by selecting a different transmit mode, the changes will be lost if not saved before change the MIC profile. Use the Profile Manager (section 0) to save changes to either the existing profile or a new profile.

MIC profiles are band-independent. A MIC profile that is associated with a mode will invoke the same values in any band in which it is used.

NOTE: If a MIC profile is modified, the change will affect all MODES and Global profiles with which the MIC profile is associated.

14.2 TRANSMIT PROFILES

Transmit profiles manage the transmitter power and interlock settings. The power settings are saved by band, while the interlock settings apply to all bands. The power settings include the transmitter power level, tune power level, ALC, and transverter tune and power levels. The interlock settings include the TX Delay, PTT Timeout, and the controls for the various transmitter engaged signals. A complete list of the settings is provided in section 15.

NOTE: Power settings are saved for every band in a Transmit profile. To save the appropriate power settings set a slice as the TX Slice. Tune to every band you want to save a power setting for and change the setting. After this is done save the Transmit profile.

The Transmit profile can be selected with the Profile Manager, or by selecting it from the drop-down menu which is located just above the TUNE and MOX buttons in the TX panel.

Transmit profiles are linked to the TX Antenna setting in the transmit slice. When the antenna used by the transmit slice is changed, the Transmit profile associated with the new antenna selection is invoked. For example:

1. Slice A is the transmit slice. TX ANT is **ANT1**
2. Slice B is **NOT** the transmit slice. TX ANT is **ANT2**
3. Load **SO2R_TX1** Transmit profile. (This Transmit profile is now automatically linked to ANT1)
4. Set Slice B as the transmit slice.
5. Load **SO2R_TX2** Transmit profile. (This Transmit profile is now automatically linked to ANT2)
6. Set Slice A as the transmit slice. (This loads the **SO2R_TX1** Transmit profile)
7. Change Slice A TX ANT to **ANT2.** (This loads the **SO2R_TX2** Transmit profile)

To associate a Transmit profile with a TX antenna, select the TX Antenna you wish to associate in the transmit slice, then load or save a Transmit profile using the Profile Manager, or select an existing Transmit profile using the drop-down menu.

Each Transmit profile saves a set of power settings, one setting for each band. To save power settings for each band, select the Transmit profile from the drop-down menu, then tune to each band and adjust the power settings. As the adjustments are made, an asterisk should appear before the Transmit profile name in the drop-down menu, indicating that the Transmit profile has been modified. When all bands of interest have been set, save the modified Transmit profile using the Profile Manager.

NOTE: If a Transmit profile is modified, the change will affect all Global profiles with which the Transmit profile is associated.

14.3 GLOBAL PROFILES

Global profiles manage the state of panadapters and slice receivers and the layout of these components on the SmartSDR display. Panadapter settings saved in Global profiles include the number and location of panadapters on the SmartSDR display, frequency ranges, bandwidth and scaling and display parameters. Slice Receiver parameters include the frequency, mode, MIC profile, RX and TX filter settings, DAX channel, audio gain and many others. See section **15** for details.

In addition, Global profiles also record the linking of each TX Antenna in each slice to a Transmit profile, and each Slice Receiver's mode. Invoking a Global profile therefore creates a set of panadapters and slices, selects a slice to control the transmitter, then invokes the Transmit profile indicated by the selected TX antenna and the MIC profile. Selection of a different slice to control the transmitter may change the selected Transmit and MIC profiles. Similarly, changes to the selected TX antenna or mode within the transmit slice may change the selected Transmit or MIC profiles.

To create or save a Global profile, configure all panadapters and slice receivers to the desired settings. TX Antennas and modes should be set to the desired values. Each TX Antenna that will be used in the Global profile should be selected and then linked to a Transmit profile by selecting the profile in the drop-down menu. Select the mode and MIC profile in each slice receiver. When these adjustments are complete, save the Global profile using the Profile Manager.

Note that changes made to panadapters and slices are not automatically saved to a loaded Global profile. Changes to existing Global profiles can only be made by manually re-saving the profile using the Profile Manager.

14.4 SAVING AND DELETING PROFILES

From the "Profiles" drop-down select the option "Save Global Profile", "Save Transmit Profile" or "Save MIC Profile".
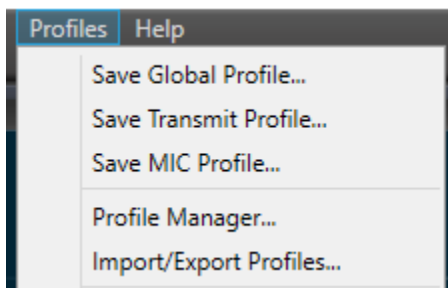
This will bring up one of the following Profile Manager Windows:
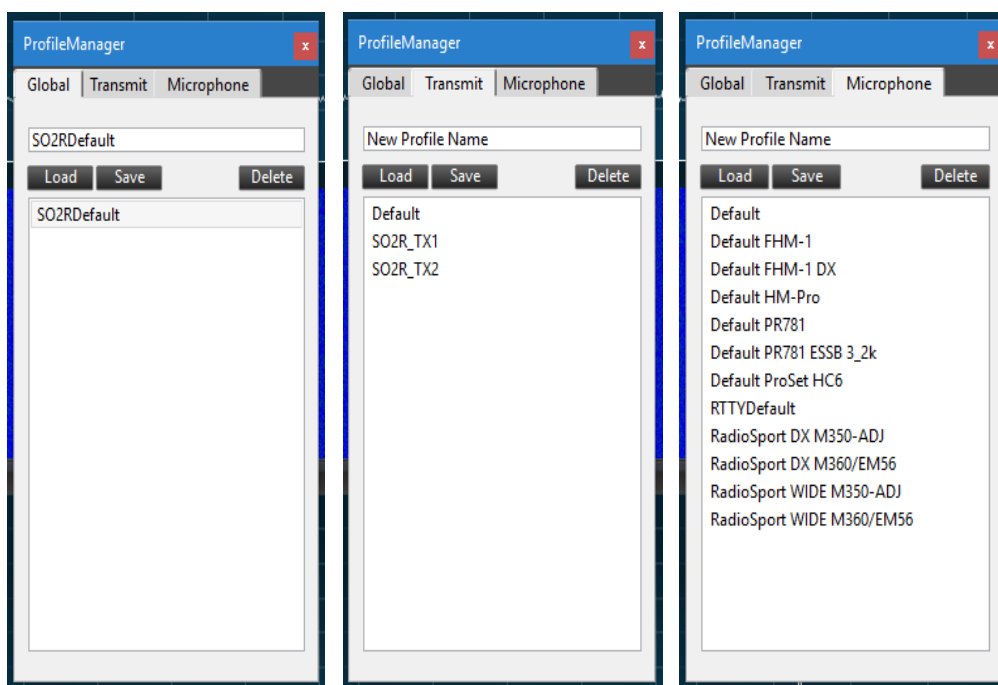
There are three tabs at the top of the window. The tab that is selected will correspond to the menu option the user selected. Type the desired profile name into the text box at the top that says, "New Profile Name" and click save or hit the Enter key on the keyboard to save a new profile. Saving a Global profile saves the Panadapter settings, the CWX settings, and the Slice Receiver configuration. Saving a Transmit or MIC profile will save only the settings related to the transmitter or microphone. See section **15** for details.

Note: When creating a new global profile, it must have a TX and MIC profile associated with it. At the time the new global profile is saved, if there isn't a TX or MIC profile associated with the global profile, new TX and MIC profiles are created having the same profile name as the global profile.

Take care when creating a new MIC profile to ensure that the Slice Receiver that is selected to control the transmitter also selects the mode to be associated with the new MIC profile. If this is not the case, the new MIC profile may become associated with the wrong mode.

To creating a MIC profile, LSB and USB are a single mode (SSB), as are DIGU and DIGL (Digital), FM, NFM and DFM (FM) and AM and SAM (AM). Each Waveform installed in the radio is treated as a separate mode.

To delete a profile, select the appropriate profile name and click the delete button.

Note: Performing a database reset from the front panel of the radio will delete all non-default profiles. It is recommended that you export your profiles with all options selected before performing a database reset.

14.5 LOADING PROFILES

To load a profile from the Profile Manager Window, select the desired profile and click load or simply double click the profile name.

Global profiles can be quickly loaded from the "Profiles" drop-down menu. The saved profiles will show up under the "Import/Export Profiles…" selection.
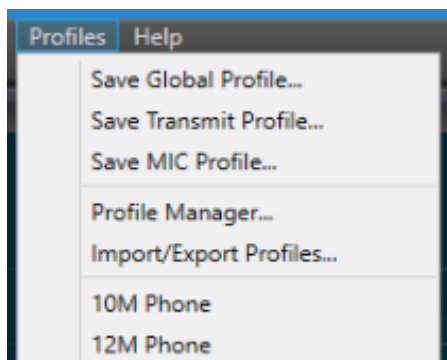
Transmit profiles can be quickly selected from the drop-down menu on the Transmit Panel above the "Tune" and "MOX" button, as shown below:
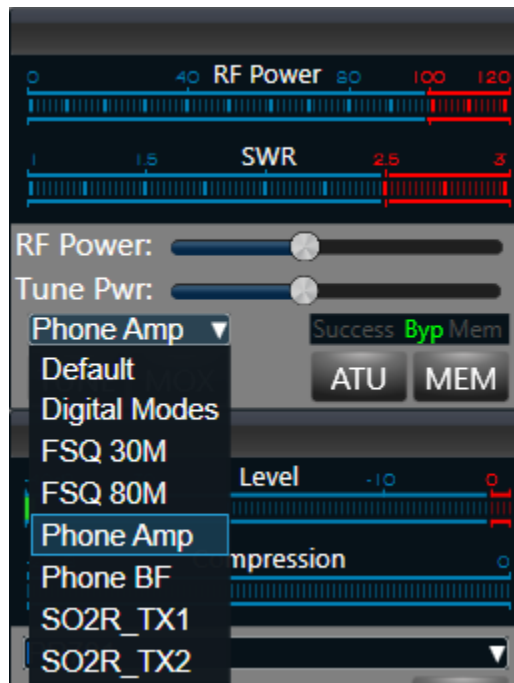
MIC profiles can be quickly selected from the drop-down menu on the P/CW Panel above the MIC gain slider, as shown below:
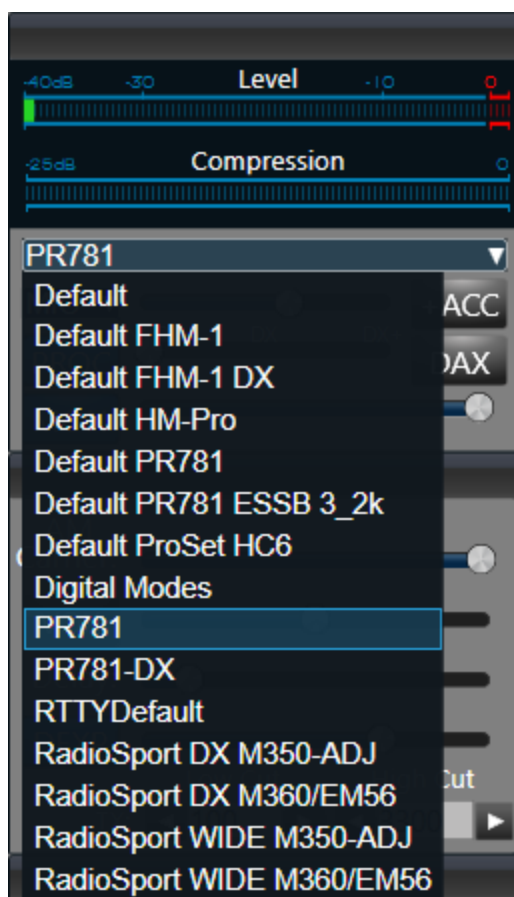
The user can leave the Profile Manager open to the side of the SmartSDR window and instantly switch configurations by double clicking the desired profile.

Note: You can load profiles created by different FLEX-6000 models without any adverse interactions. If the target radio model does not have the same resources as the source radio, such as the number of available Panadapters and Slices, the target radio's resources and capabilities will take precedence.

14.6 DEFAULT PROFILES

Several default profiles are included in the radio software. These profiles provide a basic level operation for the radio and are listed in the illustrations in section 0 above.

A default global profile, *SO2RDefault*, provides an example setup of the radio for SO2R operation (see section **30.3.1**). The default Transmit profiles provide common transmitter settings for "barefoot" operation. The default MIC profiles provide example values for microphone level, transmit filters, DEXP settings, voice processor settings, equalization settings and other settings for several popular microphones and headsets.

Default profiles can be modified or deleted from the radio using the Profile Manager, but will be restored if the radio is reset to the factory defaults (see section **32**).

Note: Default profiles can be modified, but the modifications cannot be saved using the default profile name. A new profile name must be entered.

14.7 COMPARING PROFILES AND PERSISTENCE

Profiles are different from persistence. As described above, profiles are a way to manually save and restore a complete radio configuration and then return to that configuration later. Profiles require action on your part to both save and restore, but are a very quick way to put the radio in exactly the state you want.

Persistence, always enabled on your Signature Series radio, remembers settings from band to band without your direct action so that when you return to a band your settings are restored. For example, if you are operating on 20m and set the output power to 60W, then go to 10m and set the output power to 100W and then go back to 20m, persistence will return your 20m power to 60W. Resetting the radio to the factory settings (see section **32**) will clear the persistence settings.

Persistence remembers many settings as shown in the following table:

Radio	
PTT Timeout	Show mic meter in receive
TX1/2/3/Acc enabled and delay	Show transmit signals in Waterfall
TXREQ enabled and polarity (RCA & ACC)	DAX transmit enabled
Speaker volume and mute	Hardware ALC enabled
Headphone volume and mute	Transmit inhibit setting
Remote audio enabled	VOX Level and hang time
Processor enabled and setting	Raw I/Q mode enabled
Selected microphone	Transmit filter passband (low, high)
CW/CWX Keyer speed	AM Carrier Level
CW/CWX breakin delay	CW Sideband (CWL or CWU)
CW Pitch	CW Iambic mode / straight key
CW Monitor enabled / level / pan	CW/CWX synchronize settings enable
SSB monitor enabled / level / pan	Reference calibration offset

Mode	
Selected microphone	

Microphone	
Bias enabled	Level
Boost enabled	Compander settings
Accessory Mix enabled	

Slice	
Frequency	AGC Mode
Filter limits	AGC-Threshold / AGC Off Level
Mode (USB, CW, etc.)	Mute state
RX Antenna	Audio level, pan
TX Antenna	WNB, NR, ANF, APF states and levels
TX state (is this the transmit slice?)	Diversity state / Slice
DAX channel	FM tone mode
Squelch settings (for FM)	FM repeater offset

Panadapter	
Center Frequency and Bandwidth	DAX I/Q Channel
RX Antenna and Loop settings	Display frames per second
Preamplifier setting	Display averaging settings
Display min/max dBm	

Waterfall	
Auto-black enable and level	Gradient selection
Scroll speed (line duration)	Color gain

15 IMPORTING AND EXPORTING RADIO SETTINGS

From the "Profiles" drop-down menu select "Import/Export Profiles"
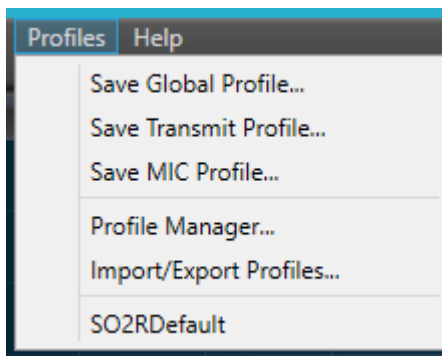
This will bring up the Import/Export window:
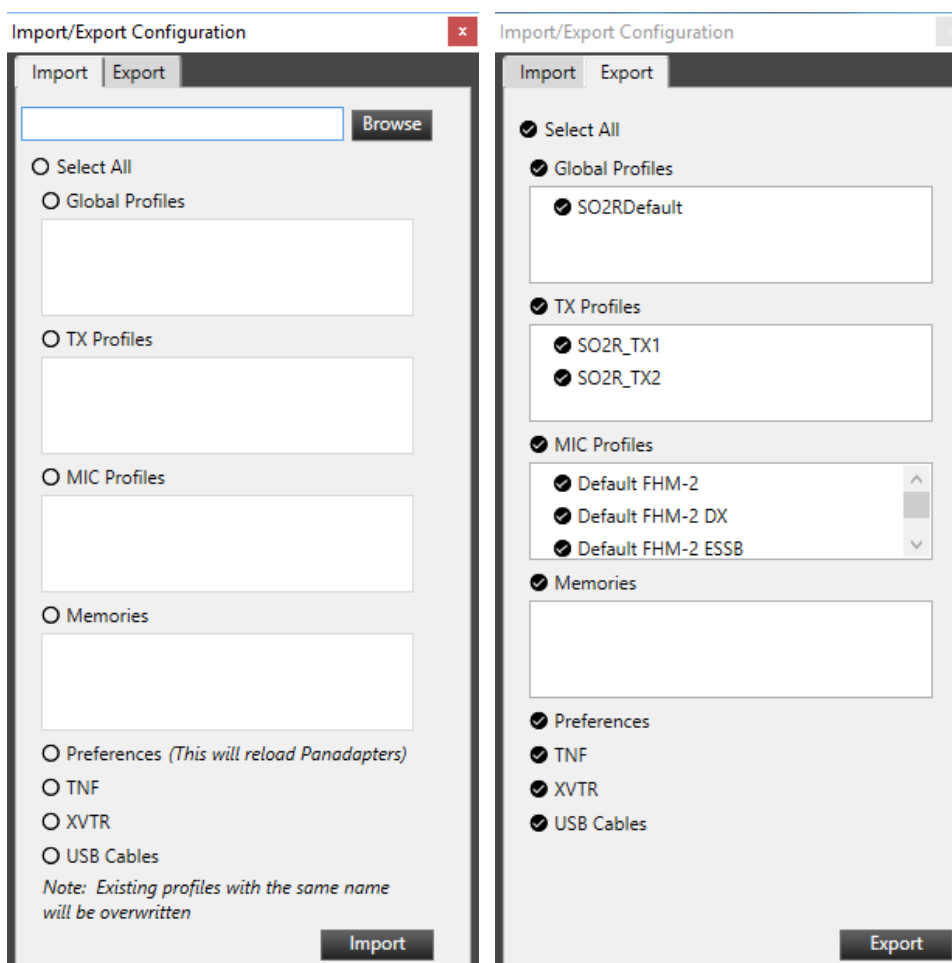
Select the appropriate tab for import or export controls. The "Browse" button on the Import tab will bring up a Windows Explorer window that can be directed to the file to import. The user can

check the items that they wish to import/export by clicking on one of the circles ○ next to the setting.

The available options are:

- Global Profiles (Basic radio state settings, see below)
- TX Profiles (Phone transmit settings, see below)
- MIC Profiles
- Memories (Frequency memories)
- Preferences (Slice and Band persistence. See section **14.7**)
- TNF (Saved or permanent tracking notch filter parameters)
- XVTR (Transverter band settings)
- USB Cables

When an option is selected, a checkbox will display inside the circle. Checking/unchecking the circle next to *Select All* will select/deselect all the options. Click "Import" or "Export" to complete the operation. Clicking "Export" will prompt the user to save the file to a specified location.

Importing profiles adds user defined Global, Transmit and MIC profiles to the profiles in the radio at the time of import. If an imported profile has the same name as a profile already in the radio, the imported profile will replace the profile in the radio. This is also true for default profiles.

Default profiles can be modified by the user and exported using the tools described above. Resetting the radio to "factory state" (see section **32**) will remove all user defined profiles and install the default profiles. However, the default profiles may then be overwritten by importing previously exported profiles. If this behavior is not desired, then delete the modified default profiles, export all profiles and settings, perform a "factory reset" of the radio, and then import all profiles and settings. The radio's profiles and settings will be restored and the default profiles will be restored to the "factory" values.

NOTE: When importing preferences, existing preferences may conflict with the current state of the radio. To avoid a situation where the current state of the radio would overwrite the preferences just imported, all resources such as Panadapters, Slices, etc. will be closed during an import of preferences and then will be reopened after the import. Some settings may change in favor of the imported preferences.

Global Profile Fields			
PANADAPTER	**CWX**	**SLICE**	**Global**
Center Frequency	CWX Macro 1	Frequency	RX EQ Enable
XVTR Frequency	CWX Macro 2	XVTR Frequency	RX EQ Levels (all frequencies)
XVTR Key	CWX Macro 3	XVTR Key	Full Duplex ON/OFF
Bandwidth	CWX Macro 4	Diversity	
RX Antenna	CWX Macro 5	Mode	
Loop A Enabled	CWX Macro 6	RX Filter Low	
Loop B Enabled	CWX Macro 7	RX Filter High	
RF Gain	CWX Macro 8	RX Ant	
Min dBm	CWX Macro 9	TX Ant	
max dBm	CWX Macro 10	Parent Panadapter	
FPS	CWX Macro 11	Is this the TX Slice	
Averaging ON/OFF	CWX Macro 12	DAX Channel	
Weighted average ON/OFF		Is muted?	
DAX IQ Channel		Audio Gain	
Waterfall black level		Audio Pan	
Waterfall color gain		Is locked?	
Waterfall line duration level		AGC Mode	
Waterfall autoblack ON/OFF		AGC Threshold	
Waterfall gradient		AGC Off Level	
Waterfall Type		NR Enabled	
Show TX in Waterfall		NR Level	
		NB Enabled	
		NB Level	
		ANF Enabled	
		ANF Level	
		APF Enabled	
		APF Level	
		Squelch Enabled	
		Squelch Level	
		FM Tone Mode	
		FM Tone Value	
		FM Repeater Offset	
		TX Offset Frequency	
		FM Repeater Offset Direction	
		Diversity Child AGC Mode	
		Diversity Child AGC Level	
		Diversity Child Audio Gain	
		Diversity Child RX Ant	

MIC Profile Fields
TX Filter Low
TX Filter High
Mic Selection
Mic Level
Mic Boost
Mic Bias On/Off
DEXP Enable
DEXP Level
PROC Enable
PROC Level
Monitor Enable
Monitor Level
Monitor Pan (L/R)
DAX Input Enable
VOX Enable
VOX Level
VOX Delay
Show MIC Meter in RX Enable
AM Carrier Level
TX EQ Enable
TX EQ Levels (all frequencies)

TX Profile Fields	
Interlock	**Power**
TX Delay	Hardware ALC Enabled
PTT Timeout	Tune Level
PTT Inhibit	Power Level
ACC TX Request Enable	XVTR Tune Level
RCA TX Request Enable	XVTR Power Level
ACC Polarity	
RCA Polarity	
ACC TX Relay Enable	
ACC TX Relay Delay	
TX Relay 1 Enable	
TX Relay 1 Delay	
TX Relay 2 Enable	
TX Relay 2 Delay	
TX Relay 3 Enable	
TX Relay 3 Delay	

16 HOW TO OPERATE LAN REMOTE

SmartSDR for Windows can be operationally "decoupled" from the radio hardware by playing Slice Receiver audio through the default PC speakers (playback device) and using the default PC microphone (recording device) to make phone QSOs. This feature, known as LAN Remote, streams compressed audio over the IP connection between the radio and the SmartSDR client on the PC, eliminating the need for the speakers and microphone to be directly connected to the radio hardware.

To provide diagnostic capabilities for LAN Remote, two features were added to SmartSDR. The Network Quality Monitor and Audio Streaming Monitor provide a visual indication of a network's capability to adequately stream audio to the PC, which is essential when using a wireless link between the client PC and the radio hardware.

LAN Remote use a compressed audio format suitable for transmission over the local area network. Compression is accomplished with the Opus codec. Opus is an audio coding format developed by the Internet Engineering Task Force (IETF) and has been standardized in RFC 6716. Although technically lossy, Opus provides excellent fidelity with minimal bandwidth usage.

16.1 PLAYING SLICE AUDIO USING THE DEFAULT PLAYBACK DEVICE

As noted above, LAN Remote uses the Windows default Playback and Recording sound devices. Clicking on the REMOTE button located in the top bar of the SmartSDR console enables streaming of slice audio from the radio to your computer's default playback device (speakers or headphone).

When remote audio streaming is enabled the REMOTE button will be highlighted.

Hovering your mouse cursor over the REMOTE button will trigger a tool-tip that shows which sound device will be used when you press the remote button.

Depending on the order that audio devices have been added to your PC, the device you wish to use for playback might not be selected as the default.

Note: When the DAX audio drivers were installed on your PC, Windows may have reassigned the default sound device to one of the DAX audio devices. This will result in the REMOTE button being grayed-out since a DAX device cannot be used as a sound device for LAN Remote operation. See section 16.3 for instructions for reconfiguring the default audio devices.

16.2 TRANSMITTING USING THE DEFAULT RECORDING DEVICE

To transmit using a microphone connected to the PC you will need to select the PC option from the MIC input menu. This will automatically select the Windows default recording device for your MIC input.
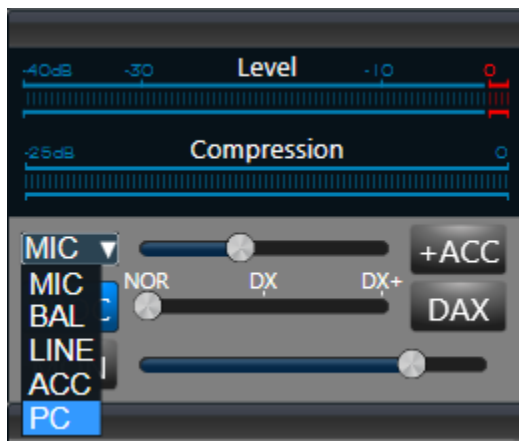
Transmit can be triggered using the MOX button on the transmit panel or using VOX, or any PTT input.

16.3 CONFIGURING THE DEFAULT WINDOWS SOUND DEVICES

As noted above, LAN Remote uses the Windows default Playback and Recording sound devices for the remote audio and PC mic audio I/O selections.   In general, on Windows 7, Windows 8.x and Windows 10 PCs, when plugging a headset into a sound card or USB based audio device into a PC, Windows will automatically designate the newly inserted device as the default sound device, and after a short time will activate it, making LAN Remote a "plug-n-play" feature. For example, your speakers will be deactivated while you have your USB headset plugged in.

However, there are cases when you may need to manually set the appropriate sound device as the default.   Please refer to the HelpDesk article How To Set The Windows Default Playback & Recording Audio Device (https://helpdesk.flexradio.com/hc/en-us/articles/203731345-How-To-Set-The-Windows-Default-Playback-Recording-Audio-Device) for a detailed explanation how to accomplish this task.

The following is an example of setting the default Playback device for a Windows 7, 8.x or 10 PC. To start, right-click on the speaker icon in the system tray and select Playback Devices as shown below:
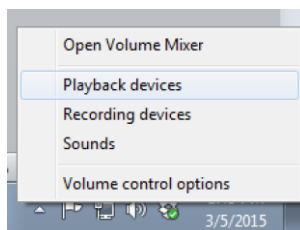
After selecting Playback Devices, Windows will display a window like this:
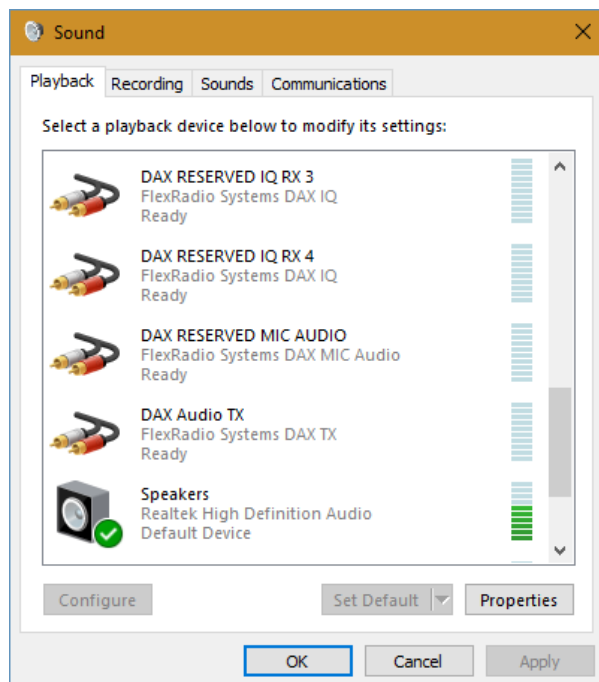
To choose a device to be the default, right-click on the device and select "Set as Default Device." On Windows 7, 8.x and 10, a green checkbox icon will be placed on the device as shown above. If you have a DAX channel selected, the REMOTE icon will be grayed-out indicating that LAN Remote will not work with a DAX device selected.

If you also wish to use a microphone on your PC as a source of audio to be transmitted, you should click on the Recording tab and ensure that the default selection for the microphone is the microphone you wish to use.

16.4 PTT OVERRIDE WHEN OPERATING LAN REMOTE

When operating in a non-DIGx mode, using a hardware PTT such as the RCA PTT input on the back panel or the front panel microphone, local activation of the PTT will override the Remote PTT. This feature allows the user at the radio to override the Remote input with a PTT switch connected directly to the radio.

16.5 OPERATING CW WHEN USING LAN REMOTE

When operating in CW mode while LAN Remote is enabled, the CW must be sent with either a key or paddles directly connected to the radio or by using CWX or Maestro. At present, there is no feature to attach a key or paddles to the PC to operate CW remotely.

Note: CW sidetone is only available when using CWX if LAN Remote is enabled

16.6 MONITORING REMOTE AUDIO AND NETWORK PERFORMANCE

There are two ways to monitor the performance of the network while using LAN Remote. The first is with a convenient Network Health Indicator display in the lower right of the SmartSDR display. The second is a detailed Network Diagnostics display.

16.6.1 Network Health Indicator

The network health indicator is a quick way to determine if your network connection is performing well enough to properly operate your radio for both remote and local modes of operation. As shown below, the indicator is a series of "bars", usually green, indicating error free streaming at a sufficient rate.
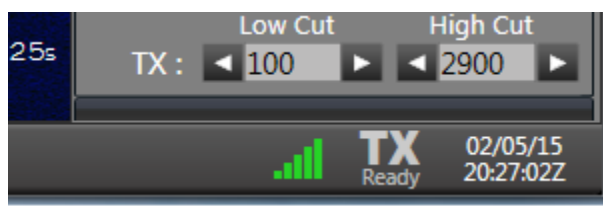
If network errors do occur, the number of illuminated bars in the indicator will decrease as shown in the following series of images. If the indicator is green, the radio should perform properly. If the indicator changes to yellow, occasional audio dropouts and screen freezes may occur, but the radio will continue to operate. Once the health indicator drops to red bars or no bars, the link is not reliable enough to maintain communications.

16.6.2 Network Diagnostics

When LAN issues occur with SmartSDR, it is useful to have additional details to aid in diagnosing the problem. A Network Diagnostics feature provides this information. To access this information, click on "Network" under the settings drop-down menu or click on the Network Health Indicator bar graph.
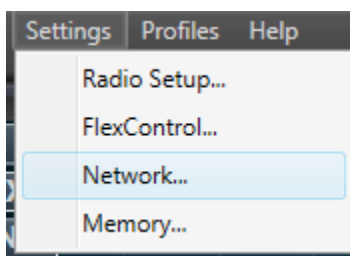
The Network Diagnostics window shows several different types of diagnostic data. There is a **Network Status** indicator that describes a summary of the quality of your network connection.

Latency (RTT) is the round-trip time in milliseconds for a keepalive packet to be sent between SmartSDR and the radio hardware. A lower number indicates better network quality. On a LAN, Latency (RTT) should be no more than a few milliseconds and should not very greatly. For a wireless network link, this number may be much higher and can vary depending on factors inherent to wireless network links such as signal attenuation and multipath reflections. **Max Latency (RTT)** is the greatest observed value of Latency (RTT). If this number is much higher than the real-time Latency (RTT) values, this indicates a network link that has a lot of quality variability, which in general is not desirable.

The **Remote RX** and **TX Rates** are the rates, in kilobits per second, of LAN Remote receive and transmit audio. If you are not using the LAN Remote feature, these values will be zero.

Additionally, there is a listing of the number of dropped packets and the total number of data packets sent between the radio and the client since the Network Diagnostic data has been reset or since SmartSDR started. On a healthy LAN connection with sufficient bandwidth, you should not experience any dropped packets. When using a wireless network connection, dropped packets cannot be avoided and you may observe the occasional dropped packet. However, if you observe a rising number of dropped packets, greater than 0.10% after the radio has been running for several minutes, this is an indication that your network is not sufficient to provide error free operation. You can reset this count by right-clicking on this screen and selecting RESET.
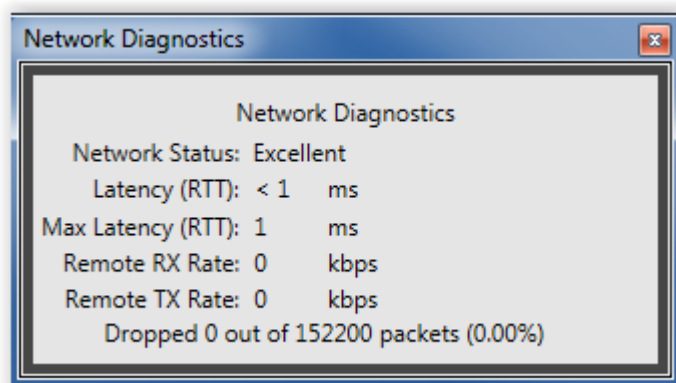
17 HOW TO OPERATE CW MODE

To use SmartSDR in CW mode, select CW in the slice control panel. This will bring up the CW specific controls in the transmit panel, and show the narrower CW receive filter presets.

The CW display is slightly different from the SSB display. In CW mode, the slice carrier indicator line is in the center of the receiver passband. This coincides with the CW carrier frequency. It shows exactly the location of your transmitted carrier. The pitch of received CW signals depends on the value of the Pitch control in the CW Transmit Control Panel (see section **33.7.2**) and the distance of the CW carrier from the tuned frequency.

17.1 HOW TO OPERATE CW IN SPLIT MODE

Many DXpeditions prefer to operate in split mode, where they transmit on one frequency, but listen on another, up or down a few kilohertz. To do this in SmartSDR, add a second Slice Receiver to the Panadapter to use as your secondary frequency. To add a slice, click the [+RX] button on the left side of the screen. Your Panadapter display should look like this:
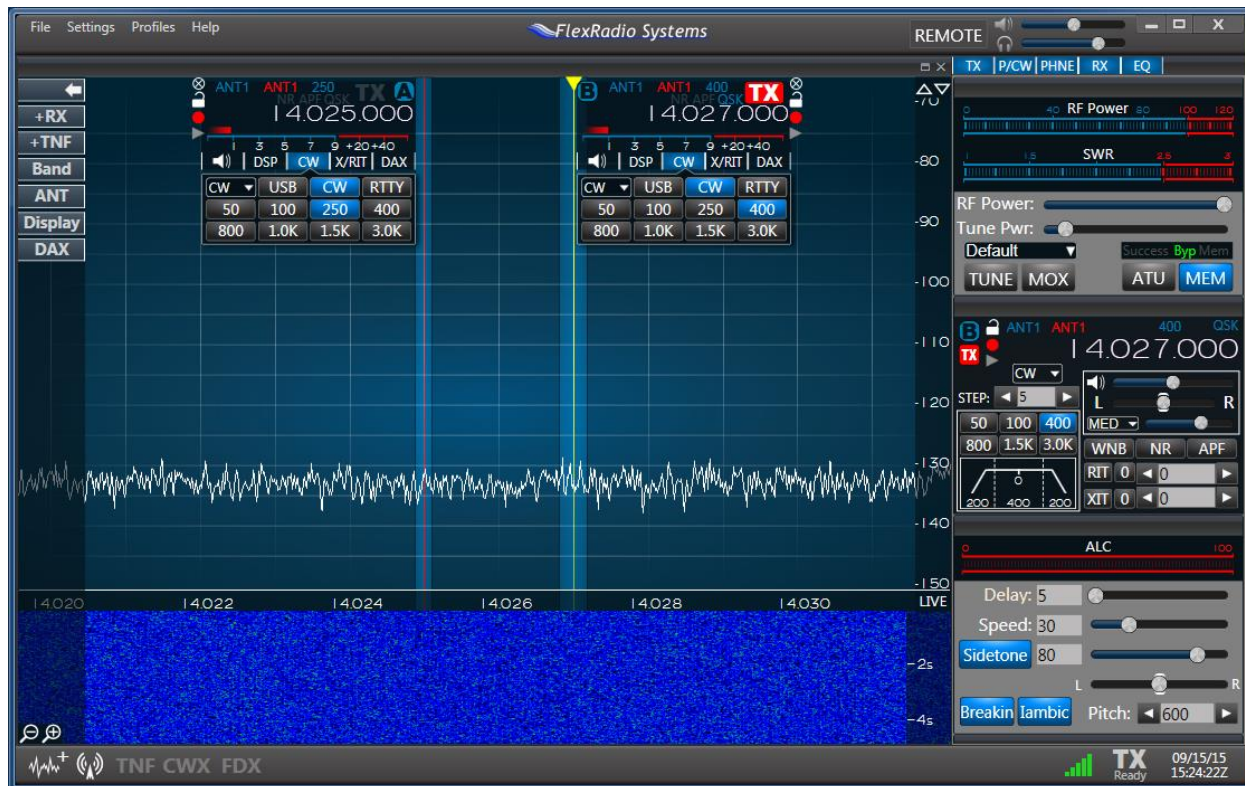
Slice Receiver A should be tuned to the DX station's transmitting frequency. Slice Receiver B should be selected as the active slice so you can tune your transmitter to the DX station's listening frequency. Select TX enable on slice B so your transmitter will follow.

If you prefer, you can use the slice audio controls to pan the slice audio so one receiver is in your left ear and the other is in your right ear. A single click on the L or R will move the control one step to the left or right. If the control is in the center, clicking on the R will move the control all the way to the right. Clicking on the L will move the control back to the center. Clicking on the L again will move the control all the way to the left.

17.2 CW TRANSMITTING

To transmit in CW mode using the keyer built-into the Flex-6000 radio, you will need either a straight key or an iambic paddle. Refer to the FLEX-6000 Hardware Reference Manual for wiring instructions.
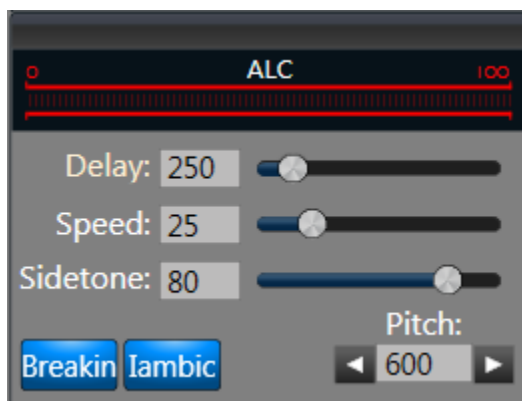
To use a straight key, uncheck the IAMBIC control in the CW transmit panel. The BREAKIN control allows automatic PTT when the key is pressed. The Delay slider sets the PTT hold time for break-in in milliseconds. It can be set anywhere from zero (full QSK), to 2000 milliseconds (2 seconds). See section **33.7.2** for details about these controls.

17.3 USING THE BUILT-IN KEYER

The radio has a built-in iambic keyer that can be used either as iambic "A" or iambic "B". Controls for the keyer are found on the Phone/CW tab of the Radio Setup panel. See section **31.7** for details about these controls.
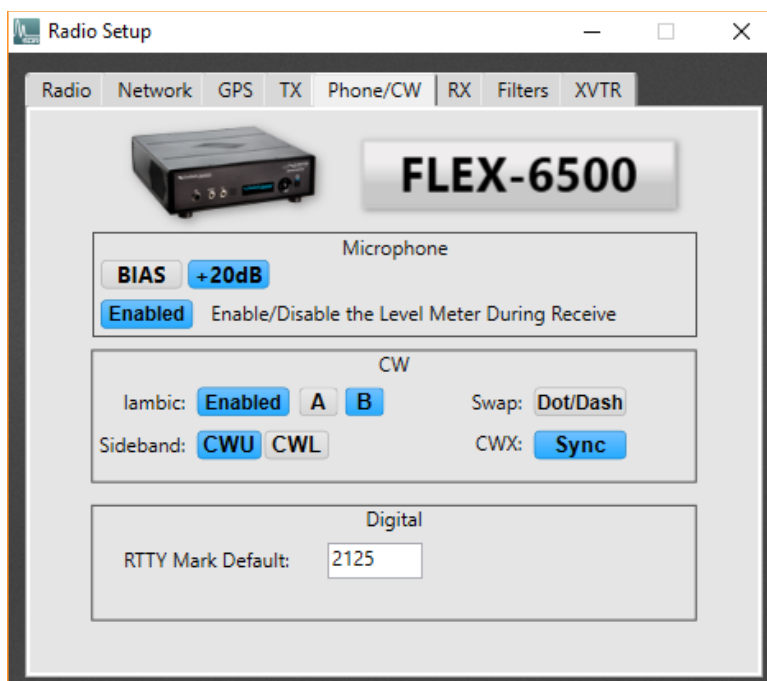
The keyer speed can be set between 5 and 100 WPM using the Speed control in the CW transmit panel. The IAMBIC selector must be enabled to use the built-in keyer. The Sidetone control will increase or decrease the sidetone volume in the speakers and headphones.
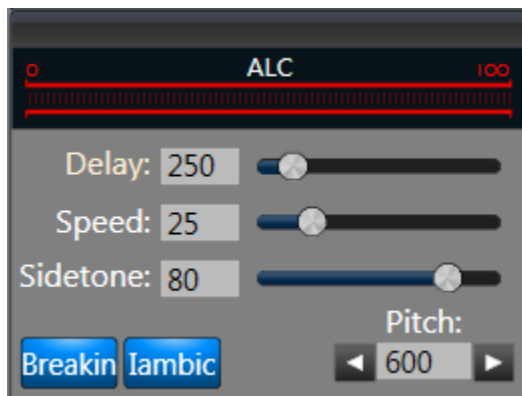
17.4 HOW TO OPERATE QRQ (HIGH SPEED) CW WITH QSK

All FLEX-6000s are capable of full QSK operation. To achieve the full benefit of QSK, the delay control on the CW Transmit Control Panel must be set to zero. This will allow the transmit/receive switching to occur immediately upon release of the key. In QSK mode the FLEX-6000s use a very fast reed relay for CW T/R switching, but at higher CW speeds, above 30 WPM, better inter-element receiving results are obtained by using one antenna for transmit and a different antenna for receive. Refer to the antenna selection instructions for information on how to configure separate transmit and receive antennas. Full break QRQ is only available in the FLEX-6700 model.

17.5 HOW TO CONNECT AN EXTERNAL KEYER USING THE FSK/KEY INPUT ON THE ACCESSORY CONNECTOR

In CW mode, the FSK/Key input on the rear panel accessory connector (pin 4) can be used as a straight key input. This is useful if you wish to attach an external keyer, such as a K1EL WinKeyer, microHAM microKEYER, or another contest-oriented interface. This input is always active, and is not affected by the FLEX-6000 internal keyer settings. It's therefore possible to use both the external keyer, and the internal keyer at the same time.

18 HOW TO OPERATE SINGLE SIDEBAND MODE (SSB)

To use SmartSDR in SSB mode, select either USB or LSB in the slice mode select control panel. This will bring up the SSB specific controls in the transmit panel, and show the receive filter presets. The image above shows the Slice Receiver in USB mode. Conventional USB or LSB settings are automatically selected for each band when the band selection panel is used.

To select the opposite SSB mode, click on the mode indicator as shown above. In this example, LSB can then be selected from the drop-down menu to the left of the USB indicator.

In SSB modes, the slice carrier indicator line will be located to the left of the receiver passband for USB and to the right for LSB. It shows exactly the location of your transmitted SSB suppressed carrier frequency. If the slice is the active slice, the carrier indicator line will be displayed in yellow with a triangular arrow at the top. All other Slices are displayed with no arrow and have red carrier indicators.

18.1 HOW TO SELECT THE SSB RX FILTER BANDWIDTH
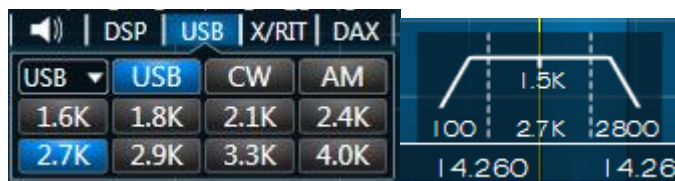
Standard SSB receive filter bandwidths from 1.6K to 4.0K can be selected from the drop-down panel under the mode selection button as shown below. Custom bandwidths can be adjusted either by

clicking and dragging the side of the filter display on the Panadapter or by using the filter control enabled by hovering the mouse at the bottom of the carrier indicator.

18.2 HOW TO OPERATE SSB IN SPLIT MODE

Many DXpeditions prefer to operate in split mode, where they transmit on one frequency, but listen on another, up or down a few kilohertz. To do this in SmartSDR, you must add a second Slice Receiver to the Panadapter to use as your secondary frequency. To add a slice, click the +RX button on the left side of the screen. Your Panadapter display should look like this:

Slice Receiver A should be tuned to the DX station's transmitting frequency. Slice Receiver B should be selected as the active slice so you can tune your transmitter to the DX station's listening frequency. Click on TX on slice B so your transmitter will follow the active slice.

If you prefer, you can use the slice audio controls to pan the slice audio so one receiver is in your left ear and the other is in your right ear.

18.3 HOW TO CONFIGURE THE AUDIO CONTROLS FOR PHONE MODES
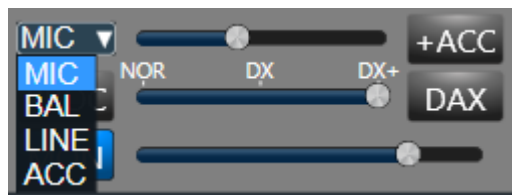
Connect a suitable microphone to the 8-pin front panel connector or to the balanced microphone input following the instructions provided in the FLEX-6000 Hardware Reference Manual. In the transmitter control panel, select "MIC" for the front panel microphone. Select "LINE" or "BAL" for the rear panel balanced microphone input (FLEX-6700 and FLEX-6500 only).

See section **27.2.6, DAX TX Channel and Microphone Interaction** for information about coordinating DAX TX channel usage with microphones.

NOTE: If the DAX button above has been selected and PTT is initiated through CAT, audio will be used from the DAX source rather than the currently selected microphone input. If, however, a microphone PTT is depressed, the selected microphone will be used for input. This allows the operator to switch between a digital audio source and voice audio quickly.

NOTE: When PTT is depressed while the PC is the selected microphone, the PC microphone will not be used as the source of microphone input. This allows a local microphone to always override a remote PC. To use the PC microphone, the MOX button must always be used as the PTT control.

18.3.1 Setting the Transmit Filter Bandwidth
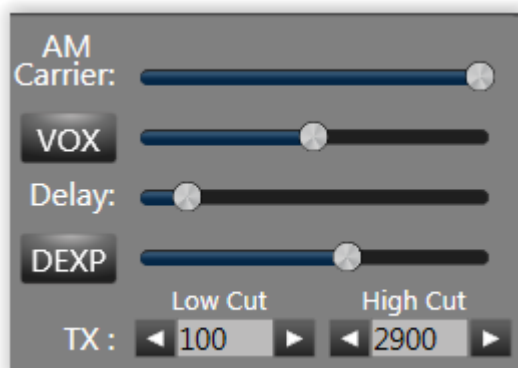
The transmit bandwidth of a single sideband is determined by the **Low Cut** and **High Cut** bandwidth controls found on the Transmit Control panel. The bandwidth is adjustable up to 10 KHz in 50 Hz steps. The transmit bandwidth is double for symmetric sideband modes such as AM.
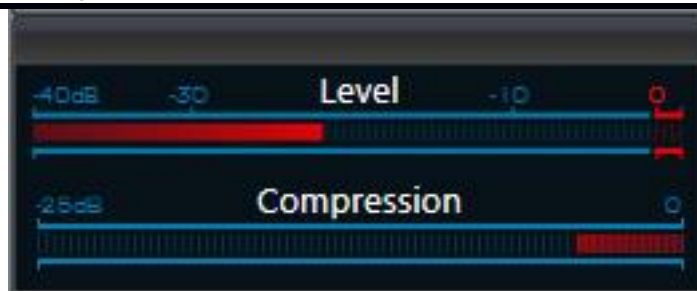
There are two indicator components of the microphone or input Level meter that show the actual audio input level. The leftmost component is a solid bar indicating the average input level and the smaller box-like component farther to the right of the average input level bar is the peak level indicator. The Level meter indicator bars also utilize three colors to visually indicate the input level range. Signals up to -10 dB are shown in green. Signals levels between from -10 and 0 dB are shown in yellow. Any signal level that is greater than 0 dB is shown in red.

When setting up your microphone audio for optimal modulation, adjust the input gain so that the peak level indicator is peaking just BELOW the 0 dB on voice peaks. It is very important that your peak level indicator never exceed 0 dB and turn red at any time. A red peak level indicator indicates over-driven or "clipped" input audio levels resulting in audio distortion. The input ALC is active, but excessive input signal levels may result in input signals that can exceed 0 dB. If you see the peak level indicator turn red at any time, turn down the audio input level until you no longer see the peak level indicator turn read.

The compression meter indicates the amount of compression provided by the speech processor based on the PROC setting and the input gain level. This meter is informational only and is not used in setting microphone levels.

18.3.2 Operating the Speech Processor

The speech processor implements the W9GR Controlled Envelope Single Sideband (CESSB) peak limiting algorithm in SSB, AM and FM modes. The controls are highlighted below in the red square. The processor may be on or off and has three different settings when enabled. In the NOR or normal setting, the processor provides minimal additional gain and simply prevents audio peaks from clipping or producing power greater than the set level. In the DX setting, more gain is provided to the audio to increase the overall sideband envelope which results in a stronger signal that may be more readily heard at a distance. The DX+ setting adds even more gain increasing your talk power or "punch" without incurring significant audio distortion. DX+ is most effective if you increase the low-cut TX filter to between 200-400 Hz to concentrate your talk power in the audio frequency range that has the greatest intelligibility.
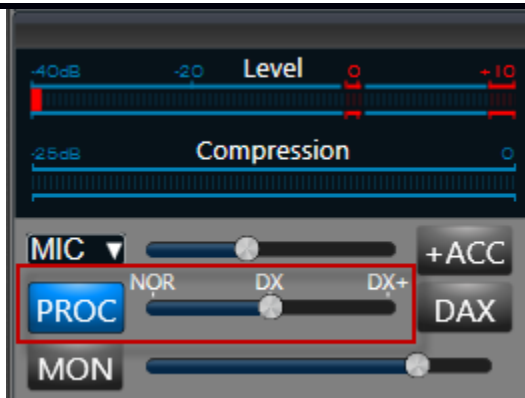
The recommended setting is to leave the speech processor enabled and in the NORmal or DX position.

18.3.3 How to Configure the Equalizer (EQ)
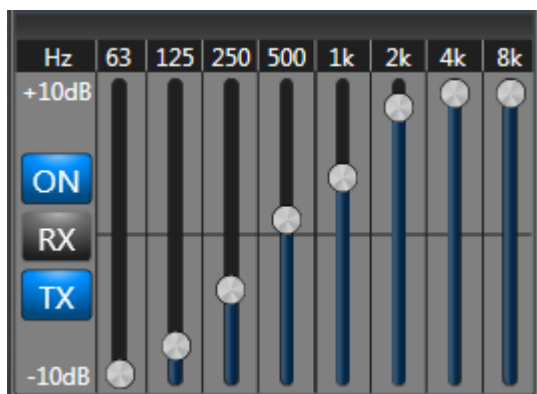
The Transmit Equalizer control panel is illustrated above with the TX and ON buttons highlighted. With these buttons selected, the graphic equalizer can be optimized for different microphones and operating styles such as DX, contesting and ESSB. The sliders provide a +/- 10 dB adjustment range over eight octaves. The settings shown above provide very good audio quality for many dynamic microphones.

In a similar fashion, the Receive Equalizer is enabled with the RX and ON buttons. With these buttons selected, the graphic equalizer can be optimized for different listening conditions and operating styles. The sliders provide a +/- 10 dB adjustment range over eight octaves.

18.3.4 How to Configure VOX
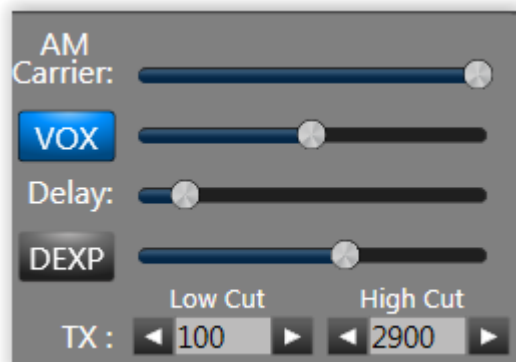
Press the [VOX] button to enable voice operated transmit operation and adjust the VOX gain slider to adjust the VOX sensitivity.   Sensitivity should be adjusted to the minimum that allows reliable keying by the voice without keying from other room noises. **VOX Delay** sets the hang time before the transmitter unkeys after you stop speaking. The delay should be set to be comfortable for the style of operation desired. See section **27.2.6**, **DAX TX Channel and Microphone Interaction** for details concerning the interaction of VOX and the DAX TX channel.

18.3.5 Monitor Mode Operation
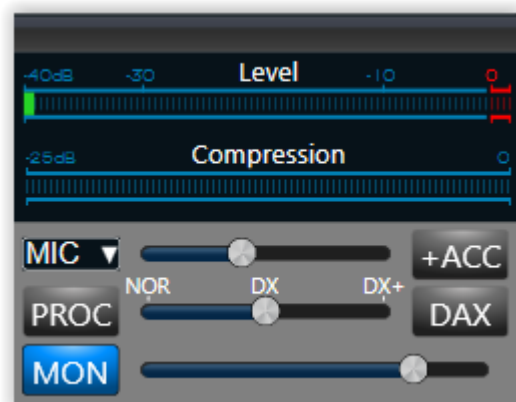
Monitor mode is enabled by engaging the MON button so that the monitor level may be controlled by the adjacent slider.

The MON feature allows for monitoring of the processed audio *prior* to the final brick wall filtering and ALC limiting, compression and equalization, allowing the operator to listen to the transmitted audio in "real time" with minimal latency or delay. However, since the monitor audio bypasses the signal processing stages, the audio heard in the monitor is not the same as what is being transmitted and therefore is not suitable for determining the over the air quality of your transmitted signal.

18.3.6 How to Configure the Downward Expander (DEXP)
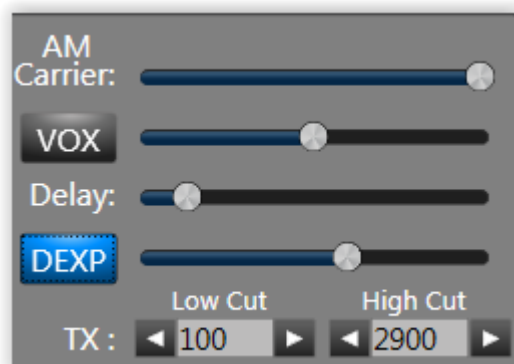
The Downward Expander reduces the microphone input gain during the quiet periods between spoken words, eliminating extraneous background noise. This improves the apparent signal to noise ratio of your transmitted audio by "soft gating" ambient room noise between words.

To adjust the DEXP, Enable DEXP and move the DEXP Threshold slider to 0. While transmitting, and listening with MON without speaking, adjust the DEXP Threshold until you can no longer hear the background or ambient noise at your operating position. In most cases a DEXP threshold level of 60-70 should be sufficient.

18.4 MONITORING YOUR TRANSMITTED AUDIO

The Quick Record and Playback feature in SmartSDR can be used to monitor your transmitted audio. The audio recorded in this manner represents transmitted audio using all the enabled signal processing features so that adjustments can be made to optimize your transmitted audio.

- Connect your radio to a dummy load and switch the transmit antenna to the appropriate antenna connector or turn down the power output to 1W (a setting of 0W will not transmit any audio)
- Click MOX or press PTT to enabled the transmitter
- Click the RECORD icon (red dot) on the slice that has the transmitter enabled. It will flash when recording.

- Talk normally into the microphone.
- When done, click the RECORD icon to stop recording. The PLAY icon (green triangle) will illuminate.
- Click the PLAY icon to play back the transmitted audio.

See section **8.7** for complete details on the usage of this feature. Also, see section **28** for a description of the DAX MIC Stream.

18.5 RECOMMENDED AUDIO ADJUSTMENT STEPS FOR PHONE MODES

Use of a second receiver to monitor your transmitted audio in real time is the preferred method for making the adjustments listed below. Otherwise, use the Quick Record and Playback procedure described above for monitoring your transmitted audio and making the following adjustments.

- Select the desired microphone input from the drop-down menu in the P/CW panel.
- Select the desired transmit filter width on the Setup/Voice (PHNE) panel.
- Turn the speech processor off by pressing the PROC button in the P/CW panel so that it is not highlighted.
- Adjust the TX Equalizer to compensate for the microphone and operating conditions. The default setting is a good starting point for most microphones. The TX EQ is located after the processor in the signal chain so it should typically be adjusted prior to engaging the processor. Minor adjustments can be done after engaging the processor but care is needed to avoid excessive peaks.
- Speak into the microphone at the loudest voice level you would normally use.
- Adjust the microphone gain control so that the peak indicator hovers near 0 VU on the Level meter. **Most microphones will require the +20 dB gain preamp to be enabled** on the Radio Setup / Phone panel.
- Turn on the speech processor with the PROC button. The adjacent slider sets the Compression setting. In most cases use the NORM (normal) setting. Selecting DX and DX+ adds additional compression without distorting the audio.
- Readjust the transmit equalizer to optimize the audio for your voice characteristics, the desired operating style and microphone response once PROC is enabled.
- Enable the DEXP, setting it for your operating position's ambient background noise. Ideally any device that generates background noise should be on so that the DEXP is optimally configured.
- If VOX operation is desired, enable the VOX button and adjust VOX gain/delay for proper operation.

The settings described above are included in MIC profiles. After the controls are adjusted, their settings can be saved for future use by storing a MIC profile. See section **14.4 Saving and Deleting Profiles**.

19 HOW TO OPERATE AM AND SAM MODES

To operate in Amplitude Modulation (AM) or Synchronous AM (SAM) mode, select AM or SAM on the Slice Receiver's mode drop down menu. In selective fading conditions SAM mode may provide better detection of AM signals. The receiver's preset AM filter is selected on the drop-down menu along with the mode selection. The carrier frequency indicator is shown at the center of the filter passband.

Note: The filter bandwidth may be adjusted on either side by dragging the side of the filter with the mouse. This allows asymmetrical filter settings to eliminate heterodyne carriers or other interference on one side of the desired signal.
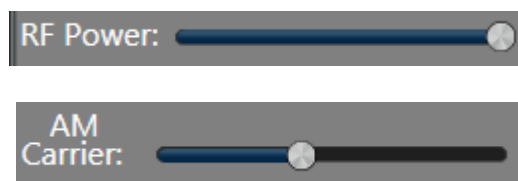
The AM Carrier control allows the carrier level to be set while maintaining a constant overall PEP output of the transmitter. With the AM Carrier control set to maximum, standard 25% carrier operation is provided. When both the RF Power and AM Carrier controls are set to maximum, the carrier level will be approximately 25W and PEP output will be approximately 100W. Reducing the RF Power control will reduce the carrier level and PEP in proportion. By reducing the AM Carrier level, the percentage of carrier relative to total PEP can be reduced to increase talk power in the AM sidebands. This is called Reduced Carrier AM.

20 HOW TO OPERATE FM MODE

The FM (frequency modulation) feature provides three modes of FM operation: Narrow FM (NFM), Wide FM (FM) and Digital FM (DFM).

Wide FM is the standard FM mode used by commercial radio stations and provides 5kHz deviation FM modulation and demodulation with pre-emphasis and de-emphasis, CTCSS tone encoding and memories.

NFM is the same basic mode, but with a 2.5kHz deviation for narrower channel spacing.

DFM is a digital FM mode providing 5kHz of deviation, but no pre-emphasis and de-emphasis. This mode can be used for modulation of digital data that prefers a flat bandpass such as 9600 baud packet data.

When an FM mode is selected, the DSP button in the slice flag is replaced with an options button, OPT. Pressing the OPT button will reveal the FM specific settings, as shown below.
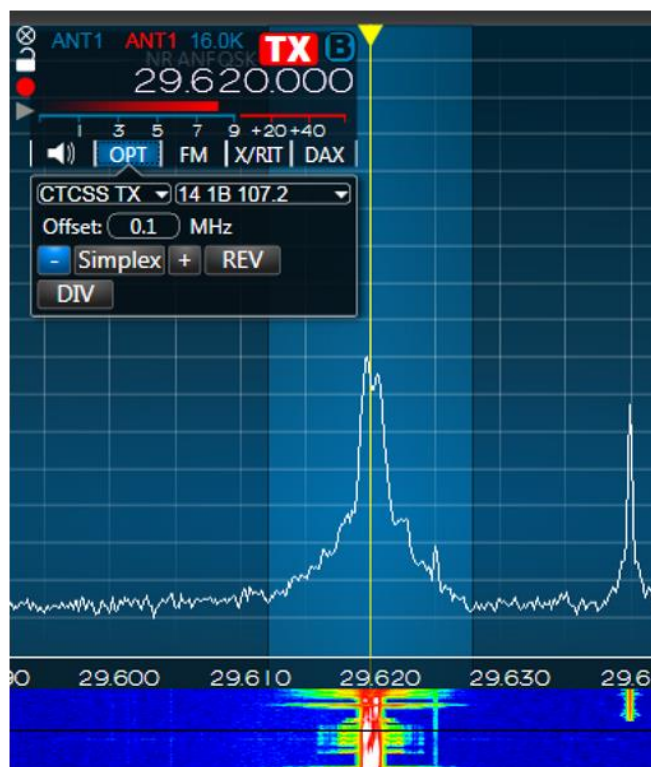
20.1 OPERATING FM REPEATERS

From upper right to lower left, the first drop down menu in the FM options menu allows selection of CTCSS tone for transmit and the tone value. The Offset control selects the frequency offset or "split" in MHz for repeater operation. The repeater controls, "-", "Simplex", and "+" set the repeater offset direction or enables simplex mode (no offset). The REV button enables a quick frequency change to the repeater split or transmit frequency.

20.2 OPERATING FM REPEATERS (EU ONLY)

Repeaters in the UK and much of Europe may require an access tone to switch the transmitter from standby to ready for use. Commonly, this is a 1750 Hz tone of one half of a second or less.

For FLEX Signature Series SDRs that are configured to operate in Europe, a 1750 Hz manual tone burst option is provided to open repeaters. To use this option, key the radio, *left click and hold* the **1750** button for 0.5 seconds, then unkey the radio.

20.3 MEMORY CHANNELS

FM as well as any other mode memories can be stored in the Memory form accessible from the Settings...Memory... menu in SmartSDR. The memory form, as shown below, stores the memory frequency along with other settings such as the mode, CTCSS tone, etc.

Group	Owner	Frequency	Name	Mode	Step	FM TX Offset Dir	Repeater Offset	Tone Mode	Tone Value	Squelch	Squelch Level	RF Power	RX Filter Low	RX Filter High	RTTY Mark	RTTY Shift	DIGL Offset	DIGU Offset
10m	N5AC	28.620.000	KQ2H	FM	10000	Down	0.1	CTCSS_TX	107.2	☑	50	100	-8000	8000	2125	170	2213	1500
10m	N5AC	29.600.000		FM	100000	Simplex	0	Off	107.2	☑	50	100	-8000	8000	2125	170	2210	1500
	AB5ED	14.080.000		RTTY	100000	Simplex	0.1	Off	107.2	☑	50	100	-8000	8000	2125	170	2210	1500

The memory form also allows individuals to create lists that can be shared with others. For example, your local club may produce a list of frequencies all with a common "group" name. Then this group of channels can be independently exported and imported back into SmartSDR. The memory specific import/export function supports the CSV format to allow for external editing or production using an existing database program.

Clicking on the column headings will sort the table by that column. Shift + Click will add a secondary sort. For example, the table could be sorted by Mode and then by Frequency.

The order of the column display can be re-arranged by clicking and dragging the column headings.

The columns are defined as follows:

- **Owner** - This is important for importing files and is typically the callsign of the person creating the memory. This will be populated automatically when creating a new memory if a callsign has been entered in SmartSDR.
- **Group** - Also important for importing. The combination of Owner/Group identifies a set for import. When importing, the existing Owner/Group memories will be removed prior to importing the new fields. This makes it easy for a user to keep a master list of memories and distribute them and not have to worry about merging existing old data - initially blank
- **Freq** - The frequency to tune the slice when selecting the memory.   This will initially be set to the Active Slice frequency when adding a memory.
- **Name** - A unique name for this memory - Initially blank.
- **Mode** - The Modulation/Demodulation mode for the slice (e.g. USB, CW, FM, etc.). Initially set to the Active Slice mode.
- **OffsetDirection** - If in FM mode, this sets the direction for the repeater transmitter offset. Options are Down, Simplex and Up. Initially this will be set to the matching setting in the Active Slice.
- **RepeatersOffset** - The offset in MHz. Initially this will be set to the matching setting in the Active Slice.
- **ToneMode** - In FM transmit, this can be set to Off or CTCSS TX for PL tones. Initially this will be set to the matching setting in the Active Slice.
- **ToneValue** - The tone value in Hz to use for CTCSS TX
- **Squelch** – Turns FM Squelch on or off.
- **Squelch Value** – The Squelch threshold value.
- **RF Power** - The power setting from 0-100 to use for this memory.
- **RXFilterLow** - The Receive Filter Low Cut in Hz
- **RXFilterHigh** - the Receive Filter High Cut in Hz
- **RTTY Mark** - The mark frequency when using RTTY mode
- **RTTY Shift -** The shift frequency when using RTTY mode
- **DIGL Offset -** The offset when using DIGL mode
- **DIGU Offset -** The offset when using DIGU mode

21 HOW TO OPERATE DIVERSITY RECEPTION (FLEX-6700 ONLY)

Diversity Reception is a powerful method for improving the reliability of a message signal by using two or more communication channels with different characteristics. Diversity is very useful for aid reception in weak and fading (QSB) signal conditions. With optimally configured antennas, weak signal QSB copy can be improved up to 75%.

Two common diversity methods are space and polarization. Both methods use separate antennas to receive different versions of the same signal. The FLEX-6700 incorporates two fully independent Spectral Capture Units (SCUs) that allow two separate antennas to be simultaneously digitized. The analog to digital converters (ADCs) on the respective SCUs are driven from a single clock source to provide stable synchronous reception.

Note: Since the FLEX-6500 and FLEX-6300 use a single SCU, they are not capable of diversity reception.

For best results, antennas should be de-correlated in some way so that fading on one antenna is likely to be seen as increased signal strength on the other antenna. De-correlation can be accomplished by using different types of antennas (dipole and vertical), using the same type antenna at wide spacing (e.g. multiple wavelengths), or using the same antenna with different polarizations (horizontal and vertical or right and left). The more de-correlated the antennas the better but even small amounts can be beneficial. One interesting example of the application of circular polarization diversity on HF is discussed in the December 2010 *QST* article, "Gimme an X, Gimme an O, What's that Spell? – Radio."

The diversity implementation provided in SmartSDR is intended for use only with headphones. Two Slice Receivers attached to separate antennas are automatically routed to the left and right ears so that the brain can provide discrimination between the signals. The reason speakers are not used is that they allow the signals to combine in the space between the speakers to cause undesirable peaks and nulls in the sound. For example, slice A could be set to RXA and slice B to RXB.

To enable diversity, click the DIV button in the slice Audio drop down menu as shown below. This will create a diversity slave slice locked to the same frequency as the master slice of the diversity pair.
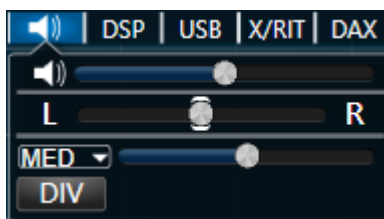
As seen in the screen shot below after diversity has been enabled, a weak SSB signal has been tuned on slice A attached to ANT1 and the slaved diversity slice B on ANT2 locked to the same frequency as slice A.

Note: The RXA, RXB, and XVTR ports are also available for receiver inputs.

SmartSDR automatically sets the slice audio faders to place the two antennas in the left and right ears respectively. Your brain does the rest. Remember that the sound will be very different from normal reception since you are literally listening in "stereo" to the same signal on two different antennas.

22 HOW TO OPERATE THE ATU

The antenna tuning unit (ATU) is a device in the RF signal path between the transmitter and its antenna to improve power transfer between them by transforming the impedance at the antenna feed output at the transmitter to a value compatible with the transceiver's power amplifier. An ATU is useful when the antenna's feedline impedance is unknown, complex, or otherwise different from the transceiver. It's important to remember that the ATU has no effect on the actual SWR of the antenna and feedline. It does however change the impedance presented to the transmitter from the ATU.

Note that the radio software automatically folds back transmitter power so that the power reflected by the antenna and tuner system does not exceed 25 watts. This feature protects the Power Amplifier, but should not be relied upon when operating with a mismatched antenna. Use of the ATU or an external tuner is recommended to match the transmitter to the antenna and minimized power reflected to the Power Amplifier.

The FLEX-6000 ATU is a standard feature of the FLEX-6700 and FLEX-6500 and an option for the FLEX-6300. The operation of the ATU is controlled by the SmartSDR software.

22.1 MODES OF OPERATION

There are two modes of ATU operation; manual and memory. In manual mode, the user initiates an ATU tune operation to attempt find a better match between the PA and the antenna system, but the inductance (L) and capacitance (C) values are not retained and the ATU will revert to bypass mode if the frequency or band is changed. Memory mode is an extension to Manual mode where the L/C values are retained and automatically used when the frequency of the transmit slice is within the ATU Match Frequency Range.

What constitutes a successful ATU match? The ATU will try to impedance match the load to as close to a 1.1:1 SWR as possible. If the ATU measures an SWR of 1.1:1 or better to at the beginning of the matching process, SmartSDR will leave the ATU in bypass and report Success.
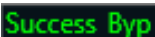
A successful ATU on 6m occurs when the SWR is improved from the initial SWR determined in the bypass state and is better than 2.32:1. For non-6m operation, a successful ATU match is one where the SWR is improved from bypass SWR reading and is better than 1.7:1.

The ATU will stay enabled but the ATU status indicator will not report Success if the SWR improved from bypass but does not meet the above SWR criteria. If the resulting SWR after an ATU tuning operation is not better than when in Bypass and the above SWR criteria is not met, the ATU goes into Bypass (ATU button is not illuminated) and ATU status indicator does not report Success.

ATU Match Frequency Range – After the ATU has found a successful match, the inductance (L) and capacitance (C) values are valid for a 200 kHz frequency span centered at the frequency the ATU tuning operation was initiated, or +/- 100 KHz. Once you tune the frequency of the transmit slice beyond that range, the ATU will be put into Bypass mode. The only exception is if there is another previously saved ATU memory frequency contained within that ATU Match Frequency Range and you have ATU memories enabled.

22.1.1 Manual Mode

To operate the ATU in manual mode without saving the ATU L/C values, make sure the MEM (ATU Memory) button is unlit by clicking on it (ATU memories are enabled by default).

Press the button to initiate an ATU tuning operation. The ATU will set the power output to approximately 2W on 6m and 10W on all other bands during the tuning operation. The ATU will tune until it either achieves a successful impedance match as shown by the indicator, leaving the button illuminated indicating that the ATU is engaged or the ATU cannot achieve a successful match, shown by the indicator leaving the button unlit indicating that the ATU is not engaged (in Bypass mode).   Note that if the ATU determines that being in Bypass provides the best match, this is a successful ATU operation.

Pressing the button while in Bypass mode, will initiate a new ATU tuning operation.

Tuning the transmit slice to a frequency outside of the ATU Match Frequency Range or to a different band will disable the ATU putting it into Bypass mode.

If the ATU is not able to provide a better impedance match and the SWR of the antenna system in Bypass is greater than maximum SWR threshold, neither the ATU and MEM buttons will be illuminated and the ATU status indicators will display Byp (Bypass) as shown here:

22.1.2 Memory Mode

The Antenna Tuning Unit (ATU) has been enhanced to store and recall L/C values for frequency ranges per antenna port automatically. This feature is known as ATU Memories.

When the user initiates a manual mode ATU tune operation, a successful result can be either a better match was not found resulting in the ATU being in Bypass mode or that the ATU is inline, presenting a better impedance match to the transmitter. If the MEM (Memory) option was selected before the ATU tune operation, the result of the ATU tune operation will be stored in a persistence database otherwise known as a memory and recalled anytime the transmit slice is configured for that transmit antenna port (ANT-1 or ANT-2) and ATU match frequency range. The ATU Memory feature eliminates the need to manually retune the ATU to find a match when changing frequencies if the new frequency range in question already has an associated ATU memory.

The enable ATU Memory mode, click on the button.   It will be illuminated when ATU memory mode is active.

Once ATU Memories are active, perform an ATU tuning operation as described above. If the ATU could provide a better match than in bypass mode, both the ATU and MEM buttons will be illuminated and the ATU status indicators will display Success and Mem as shown here:

If the ATU cannot find a better match and the SWR when in bypass mode is below the maximum SWR threshold, only the MEM button will be illuminated and the ATU status indicators will display Success, Byp and Mem as shown here:

After a successful ATU tuning operation, either finding a match or being in bypass, if you tune the frequency of the transmit slice outside of the ATU Match Frequency Range, the ATU will either use an existing ATU memory for the new frequency range, or the ATU will go into Bypass mode with the MEM status indicator being unlit indicating there is no ATU memory for this frequency as shown below:

At this point, clicking the ATU button will initiate an ATU tune operation and the resulting ATU values will be stored in an ATU memory.

At any time, you can initiate an ATU tuning operation by simply clicking on the ATU button and the resulting ATU values will be stored in an ATU memory regardless if an existing ATU memory exists of not.

Also, for high Q antennas that have a very narrow low SWR range, ATU memories can be saved every 10 kHz for a very granular ATU memory profile for that antenna.

Clearing ATU Memories – ATU memories can be easily cleared by placing your mouse cursor over either the ![ATU] button and clicking the right mouse button to display the ATU context menu. Select the option <u>Clear ATU Memories</u> and all previously stored ATU memories will be cleared.
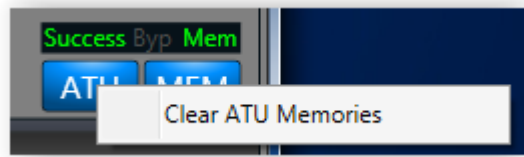
Performing a Reset to Factory Defaults on the FLEX-6000 will also clear all ATU memories.

23 HOW TO CONFIGURE ANTENNAS

23.1 GETTING STARTED

When SmartSDR starts for the first time, it loads a single Panadapter and Slice Receiver with Antenna 1 (ANT1) selected by default. Transceiver operation is then functional on ANT1 with no further setup or adjustment required.

23.2 SELECTING THE RECEIVE ANTENNA FOR A PANADAPTER WITHOUT SLICE RECEIVERS
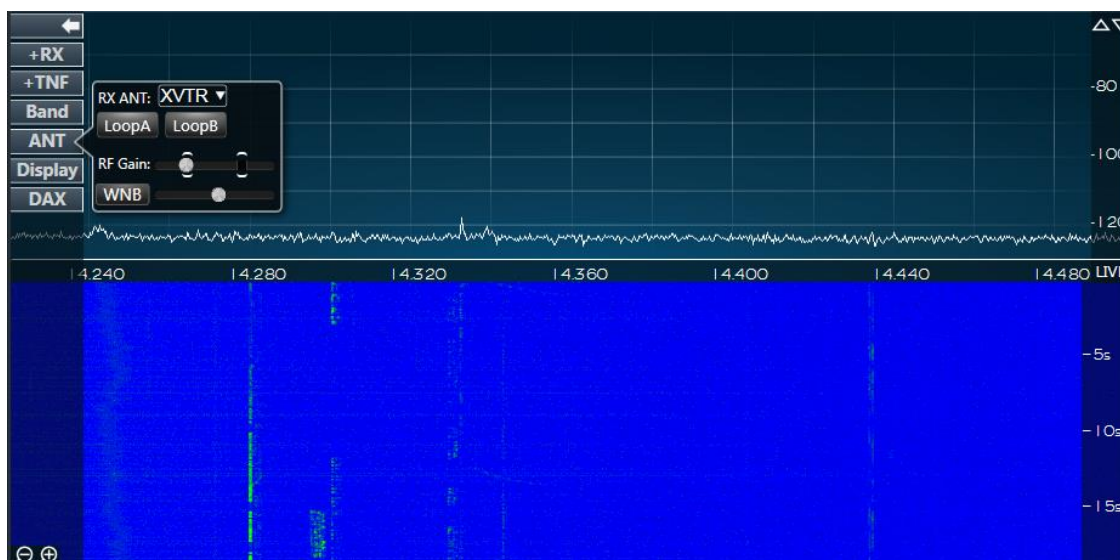
The image above shows a single Panadapter with no active Slice Receivers. The Panadapter receive antenna is selected on the ANT pop out menu on the left side of each Panadapter. LoopA or LoopB (Not available on FLEX-6300) may be selected along with the RF Gain for the associated Panadapter.

23.3 USING THE PANADAPTER ANT POP-OUT MENU
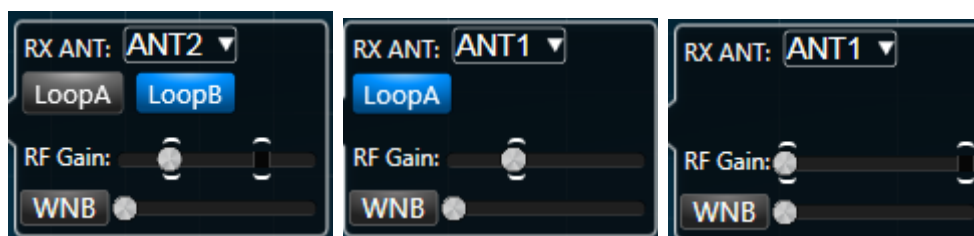
The ANT pop-out menu provides receive antenna selection, RF Gain control for the FLEX-6700 (left image), FLEX-6500 (center image) and FLEX-6300 (right image), and Wideband Noise Blanker control. Changing the configuration in this menu affects the receiving setup for all Slices located on its Panadapter. Changing the receiving antenna on any slice within the Panadapter changes the configuration for its Panadapter and all Slices located within.

FLEX-6700

FLEX-6500

FLEX-6300

The Slice Receiver flags allow drop down selection and annunciation of the receive antenna selected for its Panadapter and all respective Slices located therein. The upper flag shown above shows the options allowed on a FLEX-6700, the center flag shows those available on the FLEX-6500 and the lower flag shows the FLEX-6300. The RX B input selection is available only on the FLEX-6700 since only it contains the necessary two SCUs.

Loop selection is controlled only from the Panadapter ANT menu but is indicated under the receive antenna selector on each slice flag. The LoopA annunciator can be seen under ANT1 in the slice A flag shown above. When shown, the RX A loop is active and connected to ANT1.

The Wideband Noise Blanker (WNB) can be controlled from the ANT pop-out menu. Given the wideband nature of this feature, the threshold slider in the GUI controls an entire SCU, which may have several Panadapters and/or Slice Receivers attached to it. For convenience, the slider control is available in each slice and each Panadapter. Adjusting any one of them adjusts for an entire SCU, and all related slider controls are updated. Enabling and disabling the WNB function is available

separately for each Panadapter. All Slices present on a Panadapter inherit the same value for the WNB enable and level. See section **11.3**, **Wideband Noise Blanker (WNB)** for details on the use of the Wideband Noise Blanker.

23.4 SELECTING THE TRANSMIT ANTENNA FOR A SLICE RECEIVER

The transmit antenna for each slice is selected from the red drop-down menu shown on slice A above. The transmit antenna selector offers the same ANT1, ANT2, and XVTR options on both the FLEX-6500 and FLEX-6700 models. Each slice may have its own designated transmit antenna that is activated by the large red TX button to the left of its slice letter (e.g. slice A in above).

23.5 ANTENNA OPTIONS FOR PIN DIODE QSK OPERATION

Full QSK operation with reception between individual elements is supported on a single transceiver antenna at speeds up to 30 WPM. *QRQ QSK is supported at 100+ WPM when a separate receive antenna is used on RX A, RX B or XVTR.* The QSK annunciator located to the left of the TX selector button on each flag indicates that QSK is operational in the selected mode. QSK is not supported with a separate receive antenna set to either ANT1 or ANT2.

23.6 USING A COMMON RECEIVE ANTENNA WITH SEPARATE TRANSMIT ANTENNAS

The image above illustrates two Panadapters on a single receive antenna (ANT1) but using separate transmit antennas on ANT1 and ANT2 respectively. Slice A and B both have ANT1 selected for reception. Slice A has ANT1 selected as the TX antenna and slice B has ANT2 selected as the TX antenna. Clicking on the TX indicator for the slice changes the TX indicator to red and activates the respective slice as the transmitter with its TX antenna.

23.7 USING TWO TRANSCEIVE ANTENNAS ON THE FLEX-6700

In the image above, slice A is set to receive and transmit on ANT1. Slice B is set to receive and transmit on ANT2. The slice B is selected as the active transmit frequency of 7.033 MHz on ANT2 as

indicated by the red TX button. To move the transmit frequency to 14.225 MHz on ANT1, simply click the TX button on slice A.

23.8 USING A DEDICATED RECEIVE ANTENNA

The image above shows slice A using a dedicated receive antenna on RX A while transmitting on ANT1. The FLEX-6700/6700R models have the option of using separate receive antennas on RX A and RX B. The FLEX-6500 has only the RX A option. The FLEX-6300, FLEX-6500 and FLEX-6700 all have the option of receiving from the XVTR port. *The XVTR port is not recommended as a receive antenna port if an external preamp is used on its antenna. Accidental transmission on the XVTR port could put up to +10 dBm of reverse power into the connected preamp.*

23.9 RECEIVE ONLY ANTENNA OPERATION

In the image above a FLEX-6700 is configured so that slice A receive antenna is set to RX A and slice B to RX B. ANT1 is selected as the transmit antenna for slice A and ANT2 for slice B. This configuration allows separate receive antennas on the two independent SCUs. This configuration is not available on the single SCU FLEX-6500 or FLEX-6300. Slice A is selected as the transmit frequency. To change the transmitter to slice B, simply click its TX button.

23.10   ANTENNA SELECTION FOR TRANSVERTER OPERATION
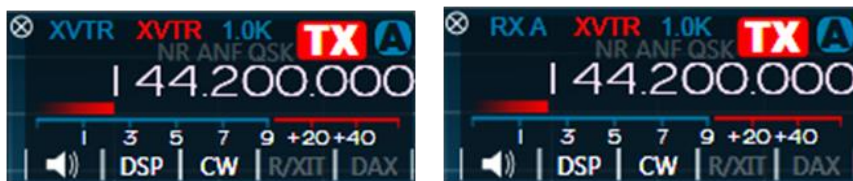
The left slice flag above shows XVTR selected for both receive and transmit antennas. This provides conventional transverter port transceiver operation.   In the slice flag on the right, split transmit/receive transverter operation is configured in which RX A is set as the receive antenna and XVTR as the transmit antenna.

23.11   USING THE RECEIVE RF GAIN/PREAMPLIFIERS

Each Signal Capture Unit (SCU) in the FLEX-6000 includes a preamplifier with adjustable gain. The RF gain selector is in the ANT menu on the left side of the screen.

The FLEX-6300 can be set to 0dB (default) and +20dB

Note: Since the FLEX-6300 always operates in wide band mode, the preamplifier incorporates a tapered gain with -3db cutoff located at ~14 MHz. This technique is optimized so that preamp gain and an improved noise figure is provided above 14 MHz, and the gain is tapered below 14 MHz to offset the rising noise levels below 14 MHz. At very low frequencies the preamp will function as an attenuator when enabled.

The FLEX-6500 can be set to -10dB, 0dB (default), +10dB and +20dB.

The FLEX-6700 can be set to -10dB, 0dB (default), +10dB, +20dB, +30dB and +40dB.

Note: In some cases, the preamp of the FLEX-6700 may overload at the 20dB setting but not at the 30dB setting with the same input signal. This is caused by differences in the hardware implementation of the two preamp settings. If the 20dB setting is overloading, the 30dB setting should be tried before changing to the 10dB setting.

23.12 SETTING THE RF GAIN/PREAMPLIFIERS

Each Signal Capture Unit (SCU) in the FLEX-6000 includes a preamplifier with adjustable gain. The RF gain selector is in the ANT menu on the left side of the screen. The gain range is selectable in 10 dB steps from -10 dB to +40 dB on the FLEX-6700, -10 dB to +20 dB on the FLEX-6500 and 0dB to +20dB on the FLEX-6300. The default setting is 0 dB. For typical HF operation below 12M, the 0 dB setting provides the highest dynamic range and is recommended for most locations. Even in quiet rural locations, gain is not needed or desired unless a low gain/low noise antenna is utilized.

The best way to determine the amount of gain needed for a given antenna and band condition is to disconnect the antenna and measure the receiver noise floor with the Slice's dBm meter. Hover the mouse pointer over the S meter to enable the pop up dBm meter indicator. Next, connect the antenna. If the band noise measurement without a signal present in the passband is 8 dB or more than that with no antenna, additional gain is not needed. If a directional antenna is used, it should be pointed toward the band opening for this measurement because noise propagates with the opening.

Note: Although the RF gain slider is present in every Panadapter, the setting controls the RF preamplifier associated with SCU. If you adjust the preamp settings for one Panadapter, all other Panadapters associated with that SCU will also be changed since the change is made to the SCU. On a FLEX-6700, this is equivalent to making the change on a "per antenna" basis. In the case of the FLEX-6500 and FLEX-6300 with a single SCU, the preamplifier settings affect all Panadapters and receivers.

The preamp indicator in the upper right corner of the Panadapter will be lit whenever the preamp/attenuator is turned on for the band. It will show the requested gain for a FLEX-6500 or FLEX-6700 (such as +20dB). On the 6300, the preamp provides different levels of gain by frequency. If there is a net +5dB or better gain, the indicator will show PRE. If there is a net -5dB or less gain (attenuation) then the indicator will read ATTN. If it is in-between these two values, it will read ---- to indicate that the preamp is on, but not providing much change in the band of interest. This means that on a 6300 one Panadapter could indicate PRE and the other ATTN.
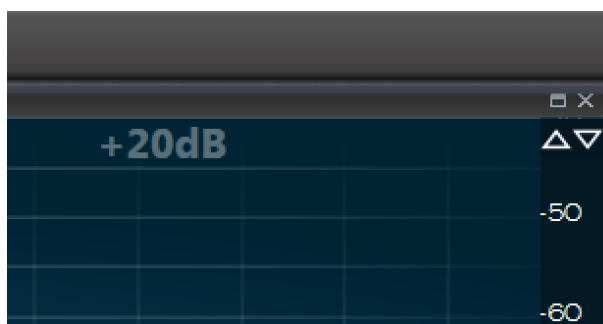
23.13   ANTENNA CONFIGURATION BASIC TERMS AND RULES

For more advanced antenna configurations, it is helpful to define terms used to describe the FLEX-6000 Signature Series architecture and the rules associated with its configuration.

- A Spectral Capture Unit (SCU) is a direct sampling, wideband digitizer that captures the entire RF spectrum within its input filter limits.
- The FLEX-6700/6700R models contain two fully equivalent but independent SCUs. The FLEX-6500 and FLEX-6300 contain a single SCU.
- The FLEX-6700/6700R models can simultaneously digitize two antennas, one for each SCU, while the FLEX-6500 and FLEX-6300 digitize a single antenna.
- Each Panadapter spectral display requires selection of an associated receive antenna. The default association for the first Panadapter is ANT1.
- One or more Slice Receivers may be placed on one or more Panadapters.
- Multiple Slices and Panadapters can share a single receive antenna.
- SmartSDR v1.2 allows up to eight Panadapters and eight Slice Receivers on the FLEX-6700/6700R models and up to four Panadapters and four Slice Receivers on the FLEX-6500. The FLEX-6300 allows up to two Panadapters and two Slice Receivers.
- All Slices placed on a Panadapter must use the same receive antenna as the Panadapter. Changing the receive antenna for a single slice will change the receive antenna for its host Panadapter and all Slices within.
- The FLEX-6700/6700R models allow simultaneous reception from two receive antennas. The FLEX-6500 and FLEX-6300 operates from a single receive antenna.
- The receive RF Gain control located on the Panadapter ANT pop out menu is tied to its respective SCU/ receive antenna combination.
- Transmit antenna selection is completely independent of the receive antenna. Only one transmit slice can be active at one time.
- The transmit slice is selected by clicking on the large "TX" button on the slice flag, which will illuminate the button in red.
- ANT1 and ANT2 ports allow transmission at 100W on 160m through 6m amateur bands. The XVTR port allows continuous coverage low power (+10 dBm max) transverter IF from 100 KHz to 165 MHz.
- Each slice can have its own transmit antenna selection, which may be the same as or different from the assigned receive antenna.
- Each SCU on the FLEX-6700 has the option of a dedicated receive only antenna designated RX A and RX B respectively. These inputs are hard wired to their respective SCU and may not be switched between SCUs.

   Note: This does not preclude using RX A with ANT2 or RX B with ANT1.

- The single SCU on the FLEX-6500 has the option of the dedicated receive only antenna input RX A.
- LoopA and LoopB on the FLEX-6500 and FLEX-6700 are provided to allow connection of external preamplifiers or preselectors. The internal relay switching is identical to RX A and RX B respectively. However, LoopA and LoopB is a logical designation that assumes that their input is from one or both of ANT1 and ANT2. This means that a preamplifier installed in LoopA will be functional if either LoopA or RX A are selected. Logically RX A will assume a receive-only antenna connected to RX A and LoopA will assume that a device is connected between RX A IN and RX A OUT.

- The XVTR input/output port may be used on the FLEX-6300, FLEX-6500 and FLEX-6700 as another receive only input or may be used as a transverter transmit or common receive port. RX A and/or RX B on may be used for split transmit receive operation when selected as the receive antenna and XVTR as the transmit antenna.
- PIN diode silent CW QSK operation on ANT1 and ANT2 require that both receive and transmit be on the same antenna or that a dedicated receive only antenna be used on RX A, RX B, or XVTR. If ANT1 and ANT2 are used separately as receive and transmit antennas, the transmitter reverts to mechanical relay TR switching. Each slice has a QSK annunciator that indicates when PIN diode TR switching is engaged.

24 HOW TO CONFIGURE TRANSVERTERS

To configure transverters, first bring up the transverter configuration panel in SmartSDR by clicking Settings… Radio Setup… and the selecting the XVTR tab. The radio setup panel should look like this:

To add a transverter band, click the plus (+) tab. A new transverter band tab will show up which has blanks that need to be filled in with information about your transverter. The first blank holds the name of the transverter or transverter band. Generally, you would enter something like "1296" for 1296MHz or "10G" for 10.368GHz, but you may enter any 4-character descriptor for the band that suits you. Next, the RF frequency in MHz is entered followed by the IF frequency in MHz. This is followed by any error in your local oscillator, a maximum output power from the radio and then any IF gain in your transverter. Here's a detailed description of each field and what you would input or see in the field:

Name: holds the name of the transverter, generally a reference to the RF frequency of the transverter. This name must be 4-characters or less. The name will be displayed in the Panadapter during transverter use as a reminder that RF will be passing through the transverter. The name is also used on the transverter band selection panel discussed later.

RF Freq (MHz): the output RF frequency of your transverter. This is the frequency that the final antenna will work on. Note that the RF frequency and the IF frequency are directly related by the LO frequency. You must enter an RF frequency that will be directly translated to the IF frequency. For example, if you enter "1296" for a 1296 to 28MHz transverter, you must enter "28" in the IF frequency. Do not use "1296.1" for one and "28.0" for the other unless this is the way your transverter is configured. If you have any doubts, be sure that the LO frequency calculated by SmartSDR matches the LO frequency of your transverter.

IF Freq (MHz): the IF frequency that corresponds to the RF frequency previously entered. Currently SmartSDR only understands high-side injection so the IF frequency must be below the LO frequency of your transverter.

LO freq (MHz): the calculated value of the local oscillator in your transverter. This number should match the transverter manufacturer's specifications. If it does not, check the RF and IF entries again and make corrections.

LO error (Hz): If your radio's local oscillator is off-frequency by a known amount, enter that amount here and SmartSDR will make the proper adjustments to properly read transmit and receive frequencies in SmartSDR. If you are using a GPS or 10MHz locked transverter, this number should be set to zero.

RX Only: Enable this if you do not want to transmit through your transverter. It will lock-out the transmit capabilities in SmartSDR.

Max Power (dBm): Enter the IF input power level to the transverter to achieve maximum output power of the transverter. This will limit the output power that SmartSDR allows to be provided to the transverter. This value may be up to +15dBm for IF frequencies below 80MHz and up to +8dBm for IF frequencies above 135MHz (default: 0dBm). The value set in this field, should match the power output when the RF Power slider is set to 100. The lower end (values near 1 on the RF Power slider) will be approximately 20dB lower than the Max Power setting.

Note: This power range may be different than using the IF frequency directly (i.e. not using the XVTR RF frequency).

RX Gain (dB): this field is optional, but will correct the receive signal level reading in the Panadapter and Slice Receivers. To properly set this, you should enter the IF gain for the transverter. If you do not know this value, ask your transverter manufacturer. If you do not have this number available, it may still be calculated by inputting a known value signal into the transverter, reading the receive level in SmartSDR and then adjusting the RX Gain until the values are equal.

Below you can see a completed transverter setup form with a single band entered:

The green "Valid" indicates that SmartSDR has enough information to use the transverter.

When operating in a Transverter band the Transverter name will appear in the top right corner of the Panadapter as shown below:
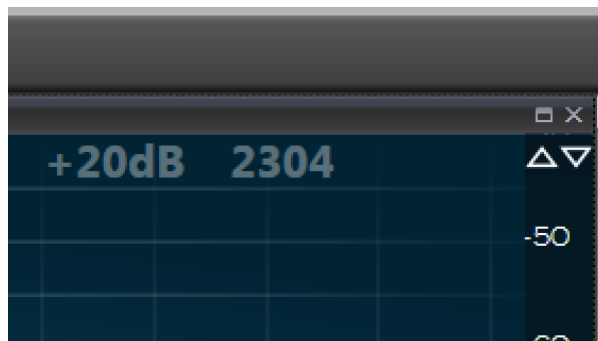
24.1 USING A TRANSVERTER

There are two ways to tune to a transverter. The first way is to use the band select panel in the Panadapter (shown below). To get to the transverter band panel, first select Band in the Panadapter and then click the XVTR button at the lower right of the panel of buttons that appears. Next select the transverter band you wish to use. The buttons in the panel use the name of each transverter specified in the transverter setup form.
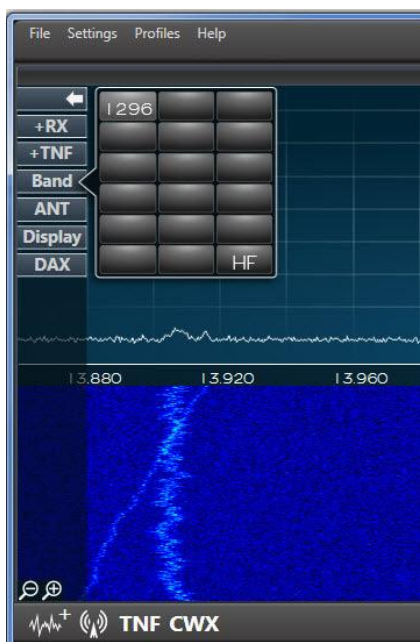
When the band button for a transverter is clicked, the radio will change the frequency of the Panadapter to the transverter frequency. Below you can see that we are now on 1296.0MHz and there is now a band indicator in the upper left of the Panadapter that indicates that we are on the 1296 transverter.

The FLEX-6000 is receiving on the IF frequency and performing a frequency translation in the slice and the Panadapter to indicate the frequency being listened to.

If you have more than one transverter on the same band, you can name them differently and then access them with different transverter buttons. Each transverter band behaves just like an HF band in that it remembers settings used for that band. If you were to QSY (change frequency) to 1296.1, SmartSDR will remember that this is the last frequency used on the 1296 transverter band. All other features of SmartSDR including multiple Slices, wide bandwidth views of the spectrum, etc. are all available on the transverter band.

To return to an HF band, simply enter the HF frequency that you wish to QSY to or select the band with an HF band button.

The second way to select a transverter band is to directly enter the frequency of the desired operation into the Slice Receiver. For example, entering "1296." (don't forget the decimal point to tell SmartSDR that we want to go to 1296MHz) will move the Panadapter and slice to 1296MHz.

24.2 MULTIPLE COPIES OF A BAND

In some situations, it may be desirable to have multiple copies of a signal frequency in the radio. For example, if you have a high power 144 to 28MHz transverter in use on a FLEX-6700, the radio will not definitively know whether to tune to the internal 144MHz band or to the external transverter. This ambiguity is resolved in two ways: First, if the band is selected using the band buttons, the radio will always know which band to switch to. If direct frequency entry is used, the following rules are used to select the band of operation:

- If the Panadapter is currently in a band that would match the entered frequency, SmartSDR remains on the current band.
- The most recently used band that matches the frequency entered will be selected.

Example:

- The current Panadapter is tuned to 50.125MHz
- There is an external 144 to 28MHz transverter on a FLEX-6700 with an internal 2m band
- The most recently used 144MHz band is the external 144-28MHz transverter
- A direct frequency entry of "144.2" is typed
- The radio will select the external 144-28MHz transverter and tune to 144.200MHz
- The Panadapter will clearly indicate the selected band by placing a "144" (or whatever name was given to the transverter band) in the upper right of the Panadapter If this is not the desired result -- if you intended to switch to the internal 2m band, just use the Band selection to switch to this band in the Panadapter. At this point, the radio will switch to the correct band and it will become the "favorite" band next time a direct frequency is entered.

24.3 TRANSVERTER POWER SETTINGS

The operation of the RF power slider in SmartSDR is set by the Max Power setting in the transverter setup. Setting the RF power slider to 100 will set the power to the Max Power setting. The zero setting will shut off all RF power from the transverter port. A setting of 1 would be 20dB below the max power. For example, if a Max Power setting of +5dBm was set in the settings, the slider "0" position will be no power, "1" will be +5dBm - 20dB = -15dBm. The 50% setting on the slider will be +5dBm - 10dB = -5dBm.

24.4 TRANSMITTING ON A TRANSVERTER

When transmissions occur on the transverter, the radio will reconfigure internal relays to connect the exciter in the FLEX-6000 to the XVTR port on the radio. If a split IF is in use, the RXA or RXB port may continue to be used for receiving if your transverter continues to provide receive RF (check with transverter manufacturer).

When a common IF transverter is used, the XVTR port normally being used for transmit will be switched away from the FLEX-6000 SCU and connected to the exciter. As a side-effect, the relay may connect the SCU to one of the HF antenna ports which causes the Panadapter to show HF signals in the HF IF band in addition to the transverter band when transmitting.

In addition, when transmitting on a split IF transverter configuration, because the transverter RF output is low power it will not be dramatically visible on the transverter Panadapter like it is shown when transmitting on HF at high power.

Both conditions during transmit can be quite confusing as they do not accurately represent the transmitting state of the radio properly. For this reason, the Panadapter will pause when using IF transverters while transmitting.

24.5 WEAK SIGNAL CONSIDERATIONS

When using SmartSDR for weak signal operations, three kinds of receivers will be in use: Panadapters, Waterfalls and Slice Receivers. The noise floor of the Panadapter may be changed to facilitate seeing signals that are weaker than the "noise floor." Amateurs generally refer to the noise floor as the noise floor in a 500Hz bandwidth receiver. For a SmartSDR Panadapter, the receiver is variable width for a single "bin" or pixel in your display. The further you zoom in the Panadapter, the lower the bin size in use and the lower the noise floor. The processing gain achieved in this way is 3dB for each reduction in the bandwidth of a bin by two --- or each time the magnifying glass '-' is depressed.

On a FLEX-6700 fully zoomed in, the bin size will be 1.5Hz. This represents a 25dB gain over the 500Hz noise floor. The Waterfall and Panadapter both derive data from the same receiver so for best weak signal viewing, zoom the Panadapter to one of the last few zoom levels. On a FLEX-6500 or FLEX-6300, the minimum bin size is 5.9Hz.

The noise floor of the Slice Receiver is independent of the Panadapter and is adjustable by adjusting the filter width of the Slice Receiver. Your ears and brain provide their own type of processing gain and so the Slice Receiver should be adjusted for best listening experience. In general, the AGC-T should be set to a low value for best listening on transverted bands. In other words, it should be adjusted for a relatively quiet receiver.

25 HOW TO CONNECT AN EXTERNAL AMPLIFIER

The FLEX-6000 has hardware interfaces for connecting an external power amplifier. There are four PTT outputs on the FLEX-6700 and FLEX-6500 and two outputs on the FLEX-6300, each with independently configurable time delays, a transmit hold-off input for amplifiers that have QSK hold-off outputs, and a standard zero to negative four Volt hardware ALC input. SmartSDR controls the configuration for these interfaces using the TRANSMIT tab in the Radio Setup menu. (Left: FLEX-6700/6500 Right: FLEX-6300)
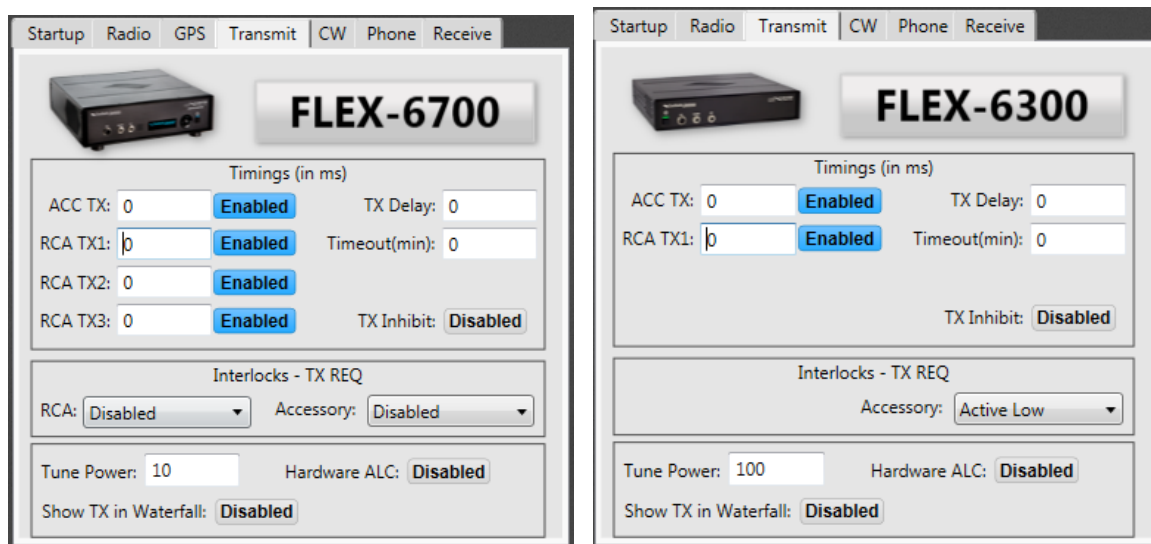
On the FLEX-6700 and FLEX-6500 there are four PTT outputs. Three are RCA jacks on the rear panel, labeled TX1, TX2, and TX3. The FLEX-6300 has one RCA jack labeled TX. On each of the radios there is an output on Pin 11 of the Accessory connector on the rear panel as well. These outputs are isolated, and each one can have a specific delay. Some users will want to utilize the delay settings to sequence switch external equipment.

For external amplifier use, the delay should be set to zero for any output that keys the external amplifier. This will insure the relay will follow the PTT signal exactly.

The TX Delay setting can be used if the external amplifier has slow T/R relays and requires a longer time between PTT and RF Emission. Unless you are noticing problems with the radio emitting RF before the amplifier has switched to transmit position, you should leave the TX Delay set to zero.

The TX Delay will have a negative impact on QSK operation and other timing specific digital modes. If the intent is to operate QSK then Delay should be set to zero.

The Interlocks settings are used for amplifiers that have a hold-off output for QSK CW. There are two interlock inputs. One is an RCA jack on the rear panel, and the other is Pin 13 of the Accessory connector on the rear panel. On the FLEX-6300 this is only available on the Accessory connector

If your amplifier does not have one of these outputs, or you do not use it in your station, leave these settings disabled. If you need to use the hold-off, select Active High or Active Low to enable the interlock and set the proper polarity of the signal provided by the amplifier.

26 USB CABLES

26.1 USB CABLES OVERVIEW

The USB Cables feature provides a means to control external devices such as amplifiers, antenna controllers, and tuners via USB to Serial data cables connected to the USB ports on the back panel of the radio. Band data generated by SmartSDR appear on the cable in a form acceptable to the external device.

This feature is limited to FTDI USB cables which contain embedded circuitry that translates the USB signals and protocol to one of several serial or parallel data protocols. In some cases, data flow is bidirectional with a wide selection of speeds and signaling levels.

FlexRadio carries two FTDI cables that can be used to interface with many devices:

- FTDI USB to Serial Port Cable DB9M (UT232R-200). For most configurations, only Pins 2, 3, and 5 will be used.
- FTDI C232HM (C232HM-EDHSL-0). This parallel data cable has an output of 10 pins that can be used for interfacing to other devices in BIT and BCD modes (described below).

The cable that is used to interface with an external device will vary for each device. One of the above cables may be sufficient for operation in many cases, while for other devices a proprietary cable or custom-made cable may also be needed. Detailed information for many commonly used devices is provided in the **USB Cables Interface Guide** available in the **Downloads** section of the FlexRadio Systems website.

Three main types of cables are supported, CAT, BIT and BCD, described below. In addition, a preconfigured cable type is provided for Down East Microwave 2 and 4-meter Low Drive Power Amplifiers: See http://www.downeastmicrowave.com/product-p/2mldpa.htm for more information.

26.2 CABLE MANAGEMENT

USB Cables are managed through the **USB Cables** window found in the **Settings** -> **USB Cables** menu:
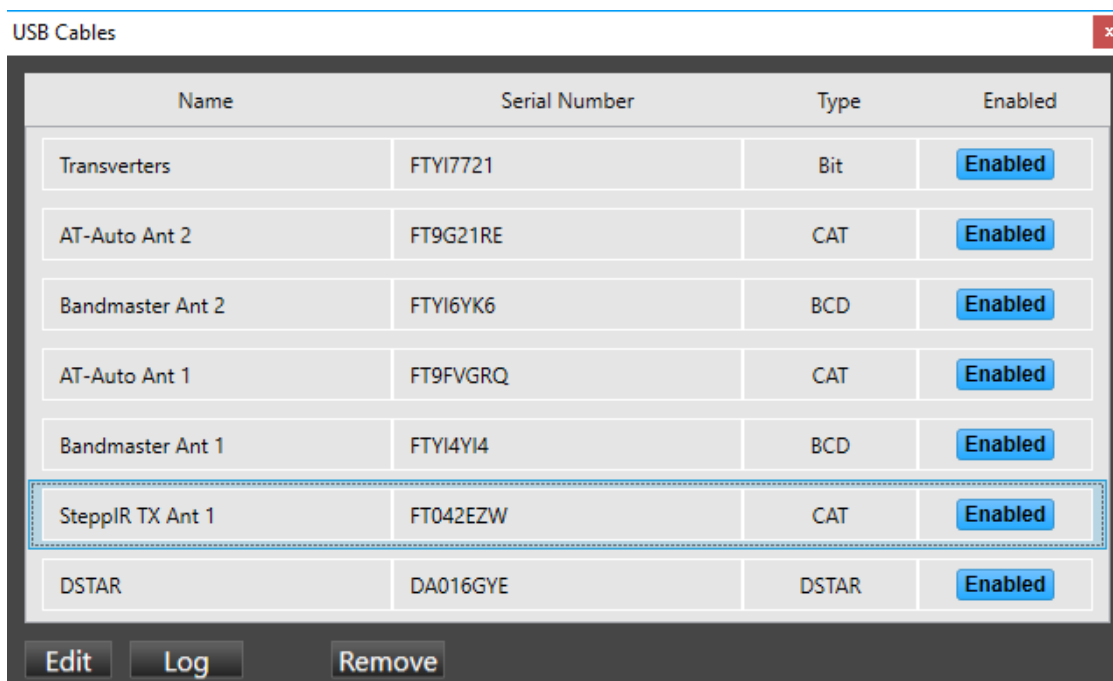
Using the **USB Cables** window, cables can be selected, activated and deactivated, modified, logged and removed. The fields in the window are:

- **Name** – The name given to the USB Cable. Newly installed cables get a default name. The name can be changed with the **Edit** command.
- **Serial Number** – The serial number of the USB Cable, read from the FTDI chip embedded in the cable.
- **Type** – The type of the USB Cable. This field is limited to one of the following:
  - CAT
  - BIT
  - BCD
  - LDPA
- **Enabled** – Enables or disables the USB Cable.

The **Edit**, **Log** and **Remove** buttons perform a function on a selected cable. Clicking **Edit** opens a window that allows the user to edit the settings of the selected cable. Clicking **Log** opens a window that enables logging for a cable. Logging allows the user to see and monitor all traffic going across the cable. For BIT and BCD cables the log indicates the bits written to a cable as a hexadecimal number. Clicking **Remove** removes the cable from SmartSDR management. Note that cables can be removed only when they are unplugged.

26.2.1 CAT Cables

CAT cables are serial data communication cables on which a small subset of the CAT command set is implemented. Most of the functions implemented on these cables are frequency reporting functions. Each cable has an associated source device in the radio which supplies the frequency information communicated across the cable.
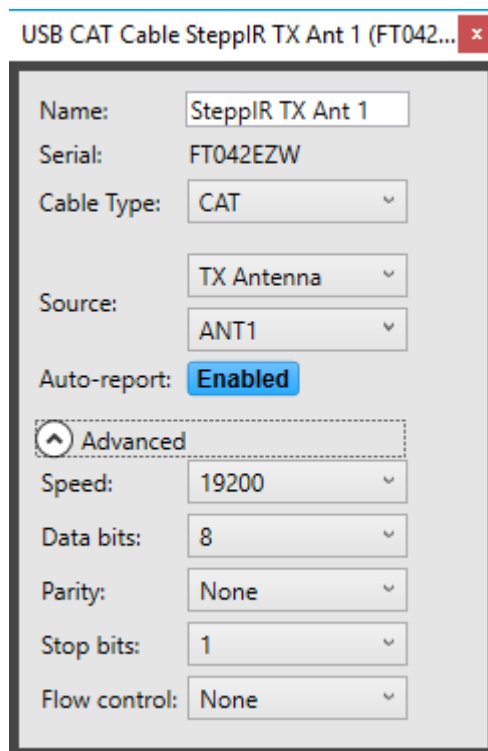
The sources are:

- **TX Slice** - The cable will report the frequency of the slice receiver that holds the Transmit Indicator.
- **Active Slice** - The cable will report the frequency of the active slice receiver (the slice that has the yellow cursor).
- **TX Panadapter** - The cable will report the center frequency of the panadapter that contains the transmit slice
- **Specific Slice** - The cable will report the frequency of the specified slice (A, B, C, D, E, F, G, H)
- **RX Antenna** - The cable will report the frequency of the specified receive antenna (ANT1, ANT2, XVTR, RXA, RXB). Note: If multiple slices are on the same RX Antenna then the frequency of the last tuned slice will be reported.
- **TX Antenna** - The cable will report the frequency of the specified transmit antenna (ANT1, ANT2, XVTR). Note: This frequency is only changed/reported when the TX Slice is connected to the specified antenna.

The **Advanced** menu provides configuration for link speed, number of data bits, parity, stop bits and flow control.

The CAT commands supported on CAT cables are:

- **FA** and **ZZFA**: Report the source frequency, **Get/Read Only**
- **FB** and **ZZFB**: Report the source frequency, **Get/Read Only.** FA and FB report the same information.
- **FR:** Reports which slice is the receiver (0 or 1) which corresponds to the slice that does NOT control the transmitter.
- **FT:** Report or set the transmit slice.
- **SP:** Report the split mode status, or enter split mode.
- **SB:** Report the status of a "sub-band receiver". This command will report "SB0" when a single SCU is in use, or "SB1" when more than one SCU is in use.
- **IF** and **ZZIF**: Report the source frequency as well as mode and other parameters, **Get/Read Only**
- **AI** and **ZZAI**: Set 'auto-report' enabled/disabled
    - o   If **Auto-report** is FALSE, then the external device must poll by sending a command through the USB Cable. If **Auto-report** is TRUE, then anytime the source frequency changes it is automatically sent on the CAT cable
- **PC**: Set and get the current power level

26.2.2 BIT Cables

BIT cables provide a means to map the tuned frequency of the radio to a set of individual signals/wires at the end of the cable. These cables are designed to control external devices when the radio is tuned to specific bands or frequency ranges, and for external keying or sequencing that is triggered when the transmitter becomes active.

The signal that appears on each bit/pin of a BIT cable is configured by use of the controls in the **USB Cables** menu:

- **Pin** – Enables/disables each pin/bit individually
- **Polarity** - Controls whether the pin/bit is high or low when triggered
- **Source** - Determines which source is used as the frequency check for this bit/pin. The sources are the same as for the **CAT** cables, listed above.
- **Trigger** - Determines the band/frequency range that the source must be within for this bit/pin to be active.
- **PTT** - When set, the pin/bit will become active only when the radio is in transmit and the source frequency is within the output band/frequency range. Individual pin/bit PTT and TX Delays can be set and will be used by the radio when keyed.

26.2.3 BCD Cables

BCD cables provide a means to map the tuned frequency of the radio to a 4 or 5-bit Binary Coded Decimal output representing specific bands.

The BCD signal that appears on the cable is configured by use of the controls in the **USB Cables** menu:
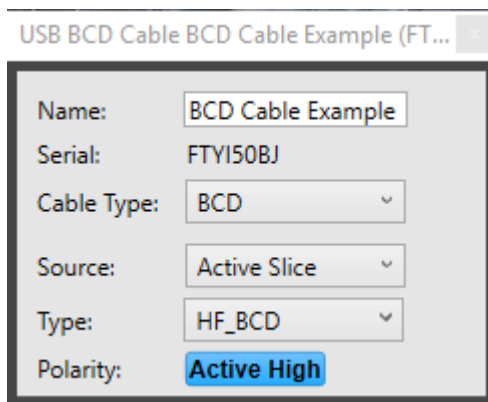
- **Source** - Determines which source is used as the frequency check. The sources are the same as for the **CAT** cables, listed above.
- **Type** – Specifies which of several available BCD mappings are generated by the cable:
  - **HF_BCD** - Yaesu/Elecraft BCD band output
  - **VHF_BCD** - Like HF_BCD but for VHF and higher bands
  - **HF_VHF_BCD** - Combined HF and VHF output

BCD Output					
Band	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
160	0	0	0	0	1
80	0	0	0	1	0
60	0	0	0	0	0
40	0	0	0	1	1
30	0	0	1	0	0
20	0	0	1	0	1
17	0	0	1	1	0
15	0	0	1	1	1
12	0	1	0	0	0
10	0	1	0	0	1
6	0	1	0	1	0
2	0	1	0	1	1
432	0	1	1	0	0

VHF VBCD Output					
Band	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
6	0	0	0	0	1
2	0	0	0	1	0
222	0	0	0	1	1
432	0	0	1	0	0
902	0	0	1	0	1
1296	0	0	1	1	0
2304	0	0	1	1	1
3456	0	1	0	0	0
5760	0	1	0	0	1
10368	0	1	0	1	0
24048	0	1	0	1	1
47088	0	1	1	0	0
4	0	1	1	0	1

HF + VHF Output					
Band	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
160	0	0	0	0	1
80	0	0	0	1	0
60	0	0	0	0	0
40	0	0	0	1	1
30	0	0	1	0	0
20	0	0	1	0	1
17	0	0	1	1	0
15	0	0	1	1	1
12	0	1	0	0	0
10	0	1	0	0	1
6	1	0	0	0	1
2	1	0	0	1	0
222	1	0	0	1	1
432	1	0	1	0	0
902	1	0	1	0	1
1296	1	0	1	1	0
2304	1	0	1	1	1
3456	1	1	0	0	0
5760	1	1	0	0	1
10368	1	1	0	1	0
24048	1	1	0	1	1
47088	1	1	1	0	0
4	1	1	1	0	1

26.2.4 LDPA Cables

Control cables for Low Drive Power Amplifiers for the 2 and 4 meter bands produced by Down East Microwave Inc. are supported by the LDPA option in the **USB Cables** menu. The functions supported by the amplifiers are determined by the manufacturer, so the options for this type of cable are limited to selecting the model of the amplifier and turning the pre-amplifier on and off. As with all USB cables, the entire cable can be enabled or disabled.

27 HOW TO OPERATE IN DIGITAL MODES

In the initial versions of SmartSDR, configuring a FLEX-6000 for operating digital modes was essentially the same as most analog/DSP radios; an analog audio interface is connected from the radio mic and speaker to a PC sound card.   However, with the introduction of DAX (Digital Audio eXchange), audio can be transferred from the radio to third-party sound card based applications without the need for a radio-to-PC audio interface or a physical sound card in the PC. Using DAX is the preferred method for operating digital modes with the FLEX-6000.

This procedure assumes that you have a working knowledge of operating digital modes with your favorite sound card based digital mode program and will not delve into the details of configuring specific third-party digital mode programs. For the examples in this procedure, Fldigi v3.20.x will be used.

27.1 STEPS FOR ENABLING DIGITAL MODE OPERATION

- Using the DAX interface for audio transfer
- Using a PC sound card for audio transfer (option, not preferred)
- Enabling SmartSDR CAT
- Configuring a PTT interface
- Configuring the third-party digital mode application

27.2 USING DAX FOR OPERATING DIGITAL MODES

DAX or Digital Audio eXchange is a standalone radio client application that facilitates the exchange several kHz of audio data from a Slice Receiver with third-party programs on your PC by emulating a sound card interface. It is designed to provide you with the audio from a Slice Receiver so the limits on the Slice Receiver bandpass filter will set the limits on this audio passband. The Audio support is bi-directional meaning you can both RX and TX. DAX supports up to 8 channels in the radio.

27.2.1 Connecting to the FLEX-6000 via DAX

To use DAX, there are two separate components; the DAX Control Panel which is a standalone application and configuring a slice in SmartSDR to pass audio to DAX via a DAX Channel or configuring a Panadapter to pass wide band IQ audio via an DAXIQ Channel to the PC emulating a Windows sound device (sound card).

### 27.2.2 SmartSDR for Windows Configuration with DAX Audio

Set DAX Audio Channel on Slice

First select one of the DAX channels in SmartSDR on a Slice Receiver. Each channel can be selected on only one Slice Receiver. The radio prevents selection of multiple Slices per channel. The selection is made in the DAX panel and associated drop-down menu:

Set DAX Audio Source

If you intend to use DAX audio for transmit, select DAX as the input source for the audio in SmartSDR
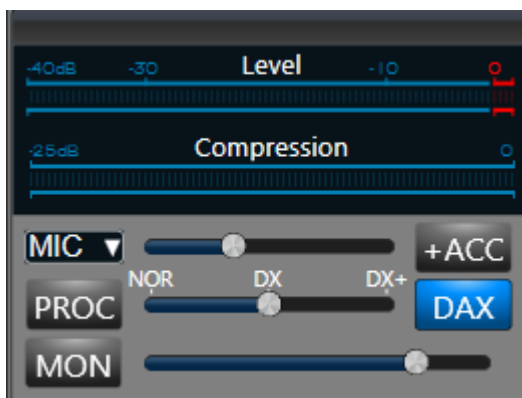
Enabling the MON (monitor) will allow you to listen to the transmitted signals via a DAX.

Note: The previous audio input source that you had selected in the drop-down box for audio will be used in situations where you initiate PTT with the front MIC or RCA jack on the back of the radio and you are in SSB, AM, FM or SAM mode.

27.2.3 DAX Control Panel Setup

The DAX control panel application starts automatically when Windows starts. Its icon should be found in the task bar. The control panel can be started and stopped in the conventional way, but note that if the application is stopped while the radio is running, DAX channels connected to other applications will be disconnected.

The DAX control panel is divided into four main sections. The top section contains controls for the TX channel, the second section has controls the MIC Stream, the third section has controls the RX channels and the bottom section has controls for the DAX IQ channels. The number of controls available is dependent on the model of the radio as shown in the chart below:

Radio Model	DAX Audio Channels	DAX IQ Channels
FLEX-6700 / FLEX-6700R	8	4
FLEX-6500	4	4
FLEX-6300	2	2

The software enables the first N of the DAX audio and DAXIQ channels where N is determined by the radio model, as shown above. Eight DAX channels and four DAXIQ channels are shown in drop down menus and in the DAX Control Panel, but only the first two or four of those channels will be usable with Flex 6300 and Flex 6500 model radios.

Each of the DAX Audio channels has several controls. The first control is the enable button in the upper left of each channel. This button and the line of text below it control and display the state of each DAX channel. The channel button will generally be grey and the text below will indicate that the channel is "Off." A channel that is off will not request audio from the radio and will not stream any data to digital programs. To enable a DAX channel, press the channel button. The button should change color to blue and the status line should change to "Streaming."

If there is any reason that data cannot be streamed from the radio to the PC, the DAX channel number will be either red or yellow, and the problem will be indicated in the status line below. Status messages and the action required to fix the issue are shown in the table below:

Channel Indicator	Status Message	Issue / Corrective Action
	Disabled	The DAX channel has not yet been enabled. To enable, press the DAX channel button
	No Slice	A slice has not been assigned to the DAX channel in SmartSDR. Pick a slice in SmartSDR to stream audio to the channel by selecting the DAX channel in the slice flag.
	No Data	The setup in SmartSDR and the DAX Control Panel are correct, but no data is being received from the radio. This could be a firewall issue in Windows or a setup issue in Windows. Check these items and if all else fails, try restarting SmartSDR and/or the radio
or	Not Connected	The DAX Control Panel is unable to connect to the radio. Ensure the radio is turned on and the LED on the front of the radio is solid green or blue. Check firewall settings in Windows to ensure DAX can communicate with the radio. Ensure the radio and computer are on the same TCP/IP subnet. Ensure that the Windows firewall or any third-party firewall is not blocking access.
	Driver Error	DAX is unable to connect to the DAX RESERVED audio channels in Windows. Open the sound settings control in Windows and ensure that no audio devices are connected to these channels. The DAX Control Panel must be restarted after a driver error.
	Streaming	DAX is connected to the radio and streaming data to an audio sound card in Windows. There are no setup errors.

More data on the nature of the problem and the status of the DAX channel can be found by hovering the mouse over either the DAX channel number or the status message in DAX. A ToolTip box will appear with a more detailed status message and suggestions for corrective action as shown below:
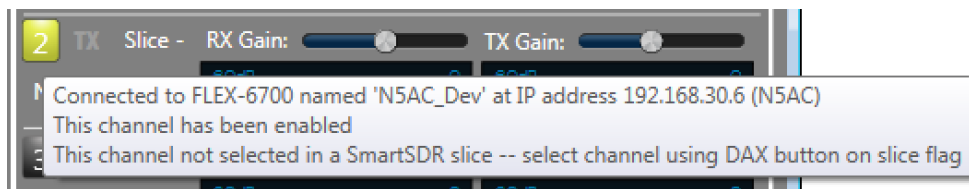
In this case, the No Slice status was present and the last line of the ToolTip box suggests selecting a DAX channel for a slice.
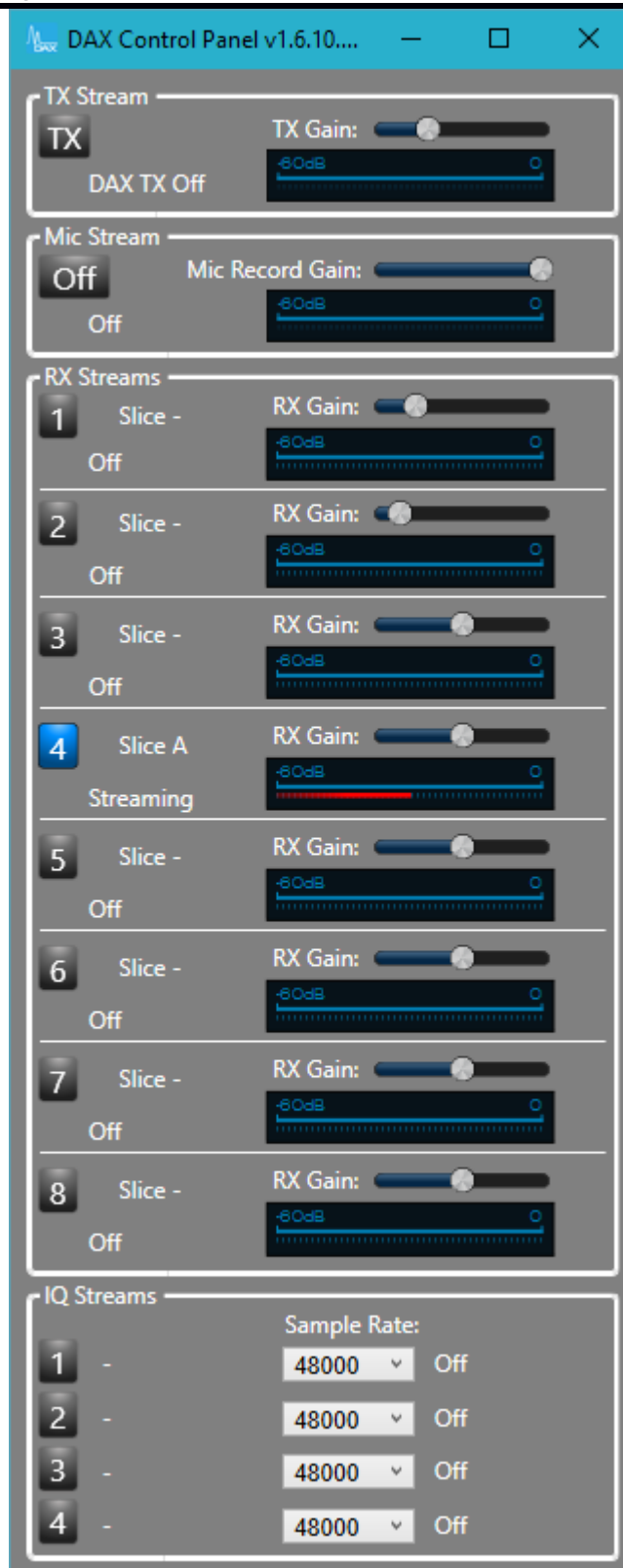
When a DAX Channel is set for a Slice Receiver, the DAX Control Panel(s) connected to the radio will also show the Slice Receiver that is connected to the DAX Channel as confirmation. When transmit is initiated by a digital mode program through CAT or other means, SmartSDR must decide which audio stream to send.   First, the Slice Receiver that has been designated the transmitter in

SmartSDR (red TX button on the Slice Receiver flag is illuminated) will be the Slice Receiver transmitting, as usual. If the DAX button is enabled in SmartSDR (in the transmit control panel), DAX will use the DAX source for the transmit audio. If a single DAX Control Panel is active and a single PC is being used, the transmit audio will come from the digital mode program connected to the DAX TX audio sound card.

DAX will allow multiple PCs to use the same DAX channel(s). For example, you could use two PCs to listen to the same frequency with different decoding programs. If more than one PC is used on the same DAX channel, the TX selection in the DAX Control Panel will determine which PC will be the source of the transmit audio. If you select TX in one DAX control panel for a given DAX Channel, all other PCs will be deselected as the transmit audio source.

You can also see the data rate from the radio to the computer and the level being received from the radio listed in kbps while transmitting. Use the sliders to set audio levels while keeping the peaks ~6 dB below the maximum.

The DAX control panel retains a memory of its position and size on the desktop. If it is visible when Windows or the control panel is shut down, it will be visible when Windows or the control panel is restarted. Similarly, if it was minimized, it will be restored in minimized state.

27.2.4 DAX Channels to Sound Device Mappings

There is a four-to-one mapping between DAX channels and the sound devices that are available on your PC.   Each DAX channel consists of an RX or receive audio link or conduit. There is one TX or transmit audio link as only one Slice Receiver can be transmitting at any point in time. Each link or conduit has two endpoints; a *reserved* endpoint that connects only to the radio and an *audio* endpoint that is connected to the digital modem program running on the PC. So, for each DAX Audio channel, you will see two RX sound cards and two TX sound cards.

Let's assume we're looking at DAX Channel #1. You will see:

- DAX AUDIO RX 1
- DAX RESERVED AUDIO RX 1

In addition, you will see the shared DAX transmit channel:

- DAX AUDIO TX
- DAX RESERVED AUDIO TX

You will connect your 3rd party software to the DAX AUDIO RX/TX sound cards. **The ones marked RESERVED are for internal use in the software so you should never connect to them.**

27.2.5 DAX TX Channel Switching

The DAX system implements a single dynamically switched transmit channel. There is no DAX TX channel number. Since only one Slice Receiver can be enabled to operate the transmitter at any given time, DAX automatically switches the DAX TX channel to the enabled Slice Receiver. To transmit audio supplied by the DAX TX channel, the channel must be enabled in the DAX control panel, and DAX must be selected as the input source in the P/CW panel.

Numerous digital modem programs can be configured to transmit via the shared DAX TX channel. At any point in time, at most one of these programs will be transmitting, and if all the criteria mentioned above are met, the DAX TX channel will be connected to that program.

27.2.6 DAX TX Channel and Microphone Interaction

When the DAX TX Channel has been selected to provide audio for the transmitter (DAX button in the transmit control panel), the radio will still accept audio from the selected microphone if the DAX TX stream contains no data. As soon as data appears, the DAX TX channel becomes the transmitted audio.

This feature is provided to support voice keyer configurations. The user can enable both the DAX TX channel and a microphone and use the microphone normally if the voice keyer program is not sending a message. When a voice keyer message is desired, the associated program simply plays the audio into the DAX TX channel and the transmitter automatically switches to it, overriding the microphone.

In a similar fashion, VOX can be triggered from either the DAX TX channel or the selected microphone audio. If the DAX TX channel information is above the VOX triggering level, DAX will key the radio.

27.2.7 DAXIQ Configuration

The second type of DAX channel, listed in the lower portion of the DAX Control Panel is the DAXIQ channel, of which there are four (all four may not be implemented on all radios). Each of these channels will stream wide-band IQ data to a client program. This allows decoding of multiple signals across large swaths of the amateur bands. The data provided in a DAXIQ channel is "raw I/Q" which has no demodulation, AGC, etc. applied to it. This is like getting a RAW file, instead of a JPG, out of a digital camera.

Set the DAXIQ Channel on a Panadapter

First select one of the four DAXIQ channels from the DAX menu on the Panadapter. Each channel can be selected on only one Panadapter. The radio prevents selection of multiple Panadapters per channel.
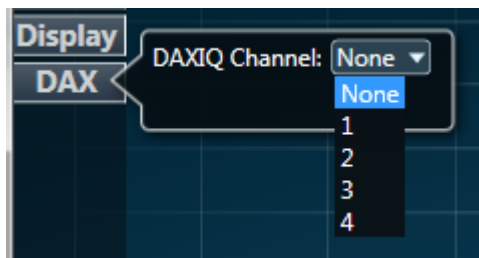
Set DAXIQ Stream in DAX Control Panel

On the DAX Control Panel, enable the stream that corresponds to the channel set in the SmartSDR Panadapter by clicking on the number. When enabled, the button will change to blue. Here you also can see the center frequency of the Panadapter and the Streaming status.
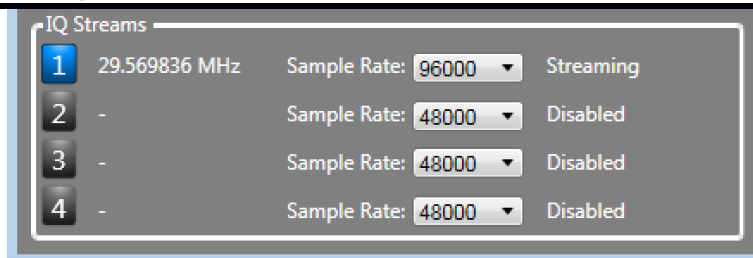
The DAX IQ channels have similar status states as the DAX Audio channels. A complete accounting of each state and the possible resolutions are detailed in the table below:

Channel Indicator	Status Message	Issue / Corrective Action
1	Disabled	The DAX IQ channel has not yet been enabled. To enable, press the DAX IQ channel button
1	No Panadapter	A Panadapter has not been assigned to the DAX IQ channel in SmartSDR. Pick a Slice in SmartSDR to stream audio to the channel by selecting the DAX channel in the Panadapter DAX IQ settings.
1	No Data	The setup in SmartSDR and the DAX Control Panel are correct, but no data is being received from the radio. This could be a firewall issue in Windows or a setup issue in Windows. Check these items and if all else fails, try restarting SmartSDR and/or the radio
1	Busy	Only one computer at a time can be receiving DAX IQ data. The Busy indicator shows that another computer is receiving this DAX IQ channel. To correct, disable the DAX IQ channel on the other computer and the busy condition on this computer will automatically resolve
1 or 1	Not Connected	The DAX Control Panel is unable to connect to the radio. Ensure the radio is turned on and the LED on the front of the radio is solid green or blue. Check firewall settings in Windows to ensure DAX can communicate with the radio. Ensure the radio and computer are on the same TCP/IP subnet. Ensure that the Windows firewall or any third-party firewall is not blocking access.
1	Driver Error	DAX is unable to connect to the DAX RESERVED audio channels in Windows. Open the sound settings control in Windows and ensure that no audio devices are connected to these channels. The DAX Control Panel must be restarted after a driver error.
1	Streaming	DAX is connected to the radio and streaming data to an audio sound card in Windows. There are no setup errors.

27.3 USING A SOUND CARD FOR OPERATING DIGITAL MODES

As mentioned above, the FLEX-6000 can operate digital modes in a legacy manner using an analog interface to connect to a PC sound card. Unless a physical audio interface is required, such as when

using a PACTOR modem, the preferred method of operating digital modes is to use DAX for audio transfer.

The disadvantages of a separate sound card are the additional hardware, the quality of the signal digitization (or lack thereof), and the additional wired connections between the radio and the PC that can cause audio ground loops and provide ingress points for RFI.

27.3.1 Connecting the FLEX-6000 to a Sound Card via the ACC Connector

There are several audio inputs and outputs on the FLEX-6000 that can be used for connecting the radio hardware to a PC sound card. Please refer to the FLEX-6000 Hardware Reference Manual for a detailed description and location of the following audio inputs and outputs.

The basic audio schematic is used to connect a FLEX-6000 to a PC sound card:

- PC Sound Card Mic / Line In <---> FLEX-6000 Audio Output
- PC Sound Card Line Out / Speaker Out <---> FLEX-6000 Audio Input

FLEX-6000 Inputs:

- Front Mic Connector [MIC] (8-pin Foster)
- Rear Balanced Input [BAL] (3-pin XLR)
- Rear Line Input [LINE] (1/4" TRS connector)
- Rear Accessory input [ACC] (15-pin D-sub connector)

FLEX-6000 Outputs:

- Front Headphone connector (1/4" TRS connector)
- Rear Powered Speaker connector (1/8" TRS connector)
- Rear Accessory output (15-pin D-sub connector)

The audio input and output you choose is mostly a matter of your operating preferences. For example, if you also operate phone modes, you may not want to constantly disconnect your microphone and speakers to facilitate the connection to the PC sound card, so you may want to use the Accessory connector for both the audio input and output. In the following example, the left channel audio output on the Accessory connector is used to facilitate both the input and output audio connections to the PC sound card. A detailed pinout of the ACC connector's audio connections can be found in the FLEX-6000 Hardware Reference Manual.

When connecting the FLEX-6000 to a PC sound card, connect one of the FLEX-6000 inputs to the LINE OUT on the sound card and one of the FLEX-6000 outputs to the MIC or LINE IN on the sound card.

27.3.2 SmartSDR for Windows Configuration with a Sound Card Interface

As noted above, we have connected the FLEX-6000's audio input and output via the **ACC Connector** to a PC sound card. In this example, we will be using an Edirol FA-66 sound card, but any PC sound card is usable for operating digital modes.

27.3.3 Slice Receiver Setup

Create or modify a Slice Receiver for operating digital modes. Since all the audio from all Slice Receivers is mixed together in the audio output, it is best to only have one Slice Receiver defined so that you do not have to worry about muting the audio for other Slice Receivers.

Change the Demodulation mode to DIGU or DIGL. DIGU (upper sideband) is the ASFK demodulation mode most commonly used for digital mode operation.

Verify that the Audio Pan control is in the center position. To ensure that audio will be sent to the sound card, make sure that the Pan audio control is in the center position. (See the Slice Receiver control panel image below.
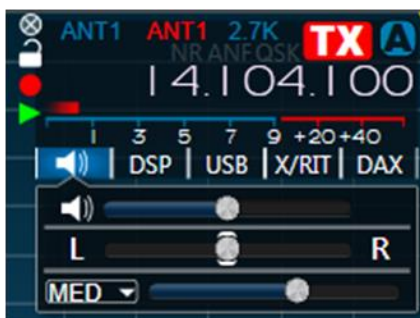
27.3.4 SmartSDR Audio Output Configuration

The audio outputs of all Slices are constantly being sent out the audio outputs unless you have explicitly muted the output.

The audio output gain level is adjusted by two different controls; the master audio gain and the slice audio gain.

If using the **ACC** or **Powered Speaker** audio output on the FLEX-6000, the **Speaker Master Gain** slider (the top most slider shown in the image below) is used to adjust the audio output being sent to the PC sound card. Consequently, if you have connected the headphone jack to the PC sound card, you will use the **Headphone Master Gain** slider to adjust the audio output being sent to the PC sound card.

27.3.5 SmartSDR Audio Input Configuration

As noted previously, the audio input on the ACC Connector is being used for this example.

- **Select the ACC input from the Audio Input drop-down box selection**. In the Transmit control panel, select the ACC input. When this option is selected the **+ACC** button will illuminate.
- **Turn off all audio processing**. Click on the **PROC** and **EQ ON** buttons until they both are not illuminated.
- **Turn off VOX**. Click on the **VOX** button until it is no longer illuminated. The SmartSDR Transmit Control Panel should like the following image below.
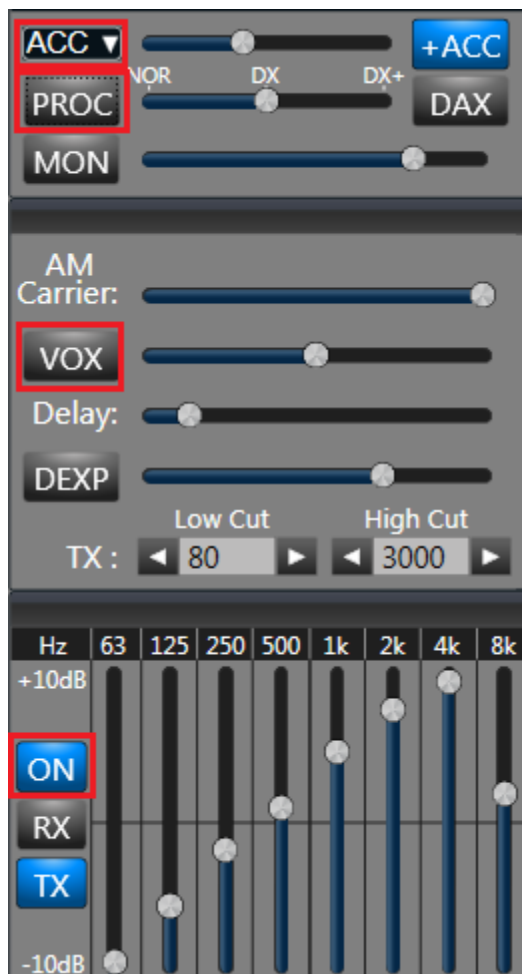
When using the ACC audio input, which is set at a fixed gain level, the adjustment input must be done on the Windows sound card audio control panel or by using controls in the digital mode program itself if they exist. The more common method of adjusting the input gain is by using the Windows audio Control panel.

27.4 ENABLING THE SMARTSDR CAT INTERFACE

SmartSDR CAT is a FLEX-6000 client application that translates serial port CAT commands into FLEX-6000 "FlexLib" commands and is included with SmartSDR for Windows. It must be configured before setting up your digital mode configuration. Please refer to the SmartSDR CAT Software User's Guide for detained instructions for installing SmartSDR CAT.

After SmartSDR CAT is installed, note the virtual server port number assigned to your FLEX-6000. The default FlexRadio virtual com port is COM4 and will be used in this setup procedure.

27.5 CONFIGURING A PTT (KEYING) INTERFACE

To key the radio for transmitting digital modes either a CAT connection or serial port PTT interface can be used. The most common method is to use CAT commands to key and un-key the radio, but either a physical or virtual serial port can be used as well.

For this procedure, SmartSDR CAT will be used to key and un-key the radio via the SmartSDR CAT protocol. SmartSDR CAT will also properly translate Kenwood CAT commands too. Please refer to the SmartSDR CAT Software User's Guide for additional information regarding the CAT protocol.

27.5.1 PTT Override when Operating Digital Modes

When operating in a non DIGx mode, using a hardware PTT such as the RCA PTT input on the back panel will override the input of DAX. This feature allows the user to override the DAX input with a PTT switch connected directly to the radio. Also, see section **27.2.6**, **DAX TX Channel and Microphone Interaction** for additional information about coordinating the use of microphones and the DAX TX channel.

27.6 CONFIGURING THIRD-PARTY DIGITAL MODE PROGRAMS

Below are instructions for configuring third-party digital mode programs for use with FLEX-6000.

27.6.1 Setting up Fldigi

With most digital mode programs, you must configure the audio setup and CAT. Fldigi is no different. For this example, CAT will be configured first and then the audio setup.

*NOTE: For the remainder of this example it is assumed that you have Fldigi installed on your computer. The download URL is: http://www.w1hkj.com/download.html*

The **SmartSDR-SliceA.xml** RigCAT file is also needed. It can be downloaded by doing a right click and a "save as" on it from http://www.w1hkj.com/xmlarchives.html

Please review the Fldigi user documentation for installation instructions.

27.6.1.1   Fldigi RigCAT Configuration Steps

- Start Fldigi and open the **Configure** Menu
- Select the **Rig Control** menu option
- Click on the **RigCAT** tab
- Check the **Use RigCAT** checkbox
- Click on the **Open** button and select the **SmartSDR-SliceA.xml** file downloaded previously.
- In the **Device** drop down, select the FlexRadio virtual com port associated with your FLEX-6000. In this example, it is **COM4** the default FlexRadio virtual com port.
- Change the **Baud Rate** to **9600**
- Change the **Stopbits** to **1**
- Make sure the **CAT command for PTT** option is checked
- Click on the **Initialize** button to make the connection to the FLEX-6000. If the connection is successful, the **QSY** button on the bottom right hand side of the Fldigi console will no longer be grayed-out and the frequency readout for slice A will be shown above the mode and Filter buttons on the Fldigi console.
- Click on the **SAVE** button to save the configuration changes
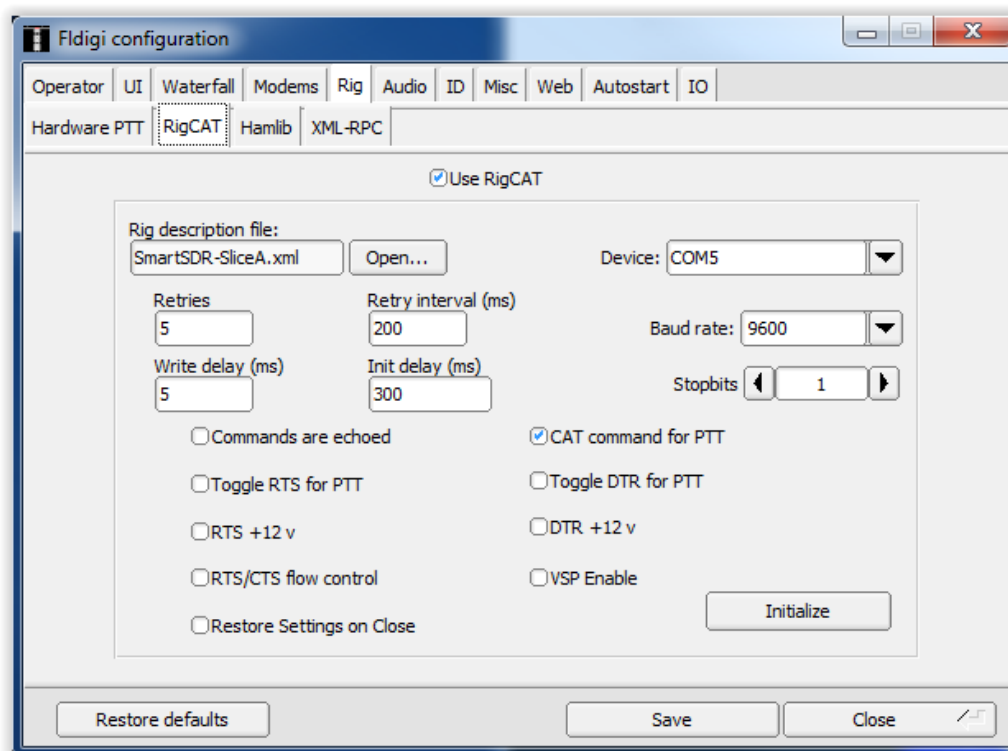
27.6.1.2   Fldigi Audio Configuration Steps

- Start Fldigi and open the **Configure** Menu
- Select the **Sound Card** menu option
- Click on the **Devices** tab
- Check the **PortAudio** option
- In the **Capture** drop-down box, select the PC sound card **INPUT** interface
- In the **Playback** drop-down box, select the PC sound card **OUTPUT** interface

- Click on the **SAVE** button to save the configuration changes

Shown below is an example of the Fldigi Sound Card Configuration for DAX

Setting up FLDIGI to use DAX audio channels is done in the Fldigi configuration panel. Click Configure, Sound Card and the Audio Tab to bring up the sound card selection page. Using the PortAudio option, click the capture and playback selection boxes to choose the DAX channels you want to use
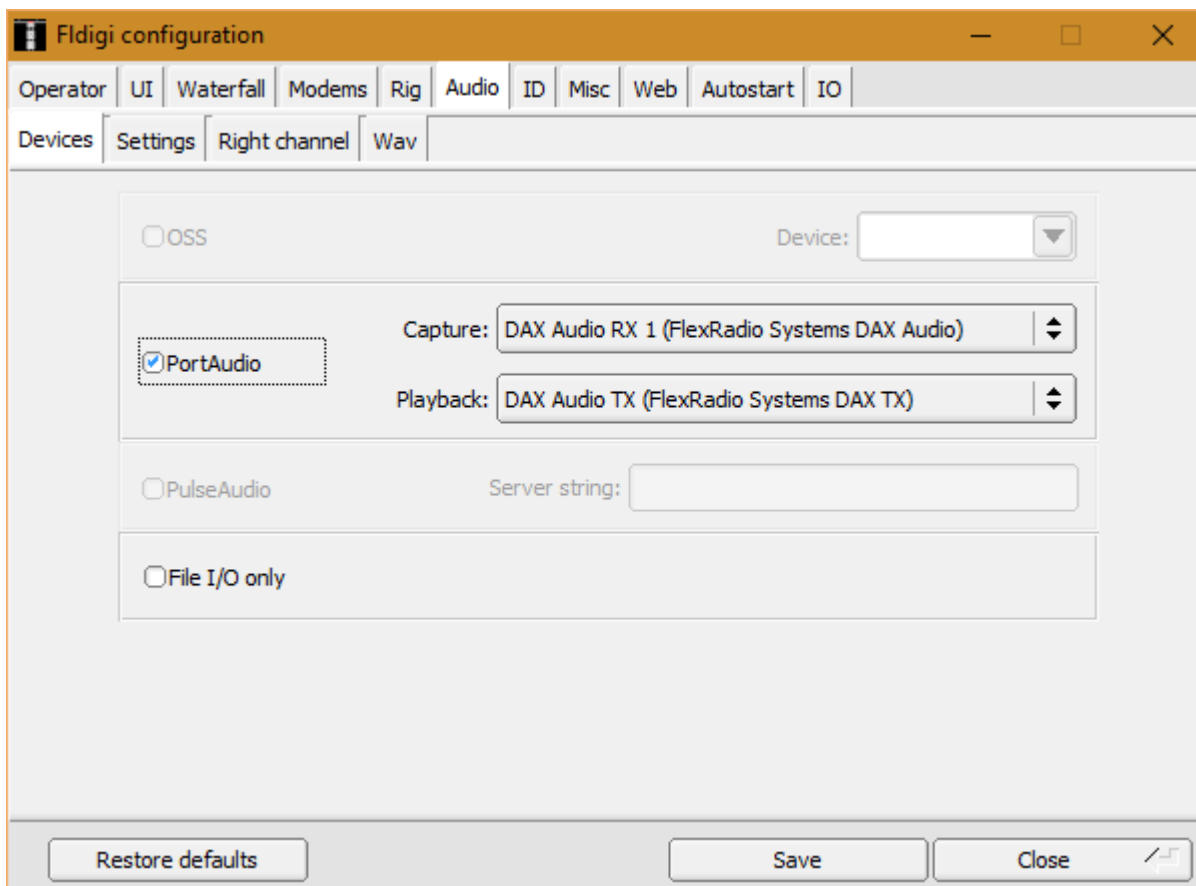
Adjusting the Audio Gain Levels – DAX

For the transmit level setting, adjust the DAX TX Gain slider until the peak hold bar registers below 0 dB on the SmartSDR for Windows Audio Input Level meter to achieve the power output reasonable and customary for the digital mode you are operating.
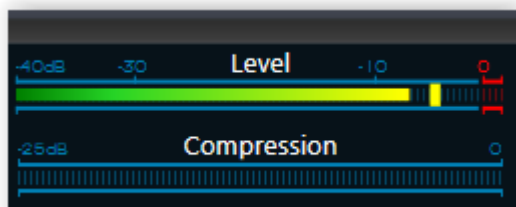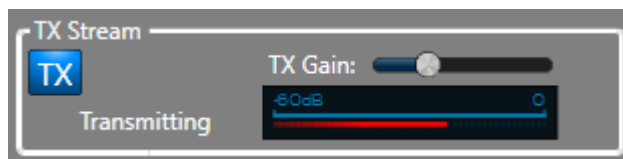
Shown below is an example of the Fldigi Sound Card Configuration with a Physical Sound Card
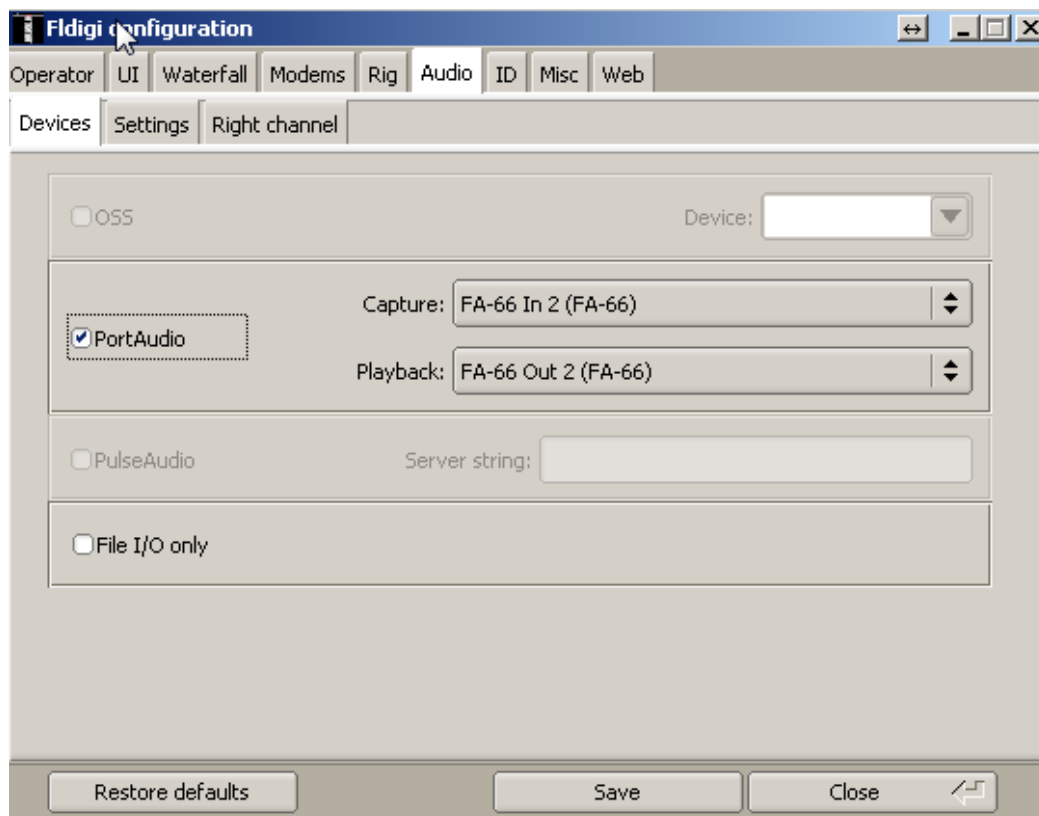
Adjusting the Audio Gain Levels – PC Sound Card

As noted previously set the input and output gain controls using the Windows Audio Control panel for the PC sound card.

For the transmit level setting, adjust the digital mode program's output gain until the peak hold bar registers *below* 0 dB on the SmartSDR for Windows Audio Input Level meter as shown below.
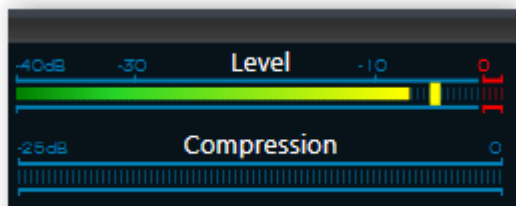
27.7 RTTY MODE

RTTY mode is a variant of DIGL mode, provided to facilitate tuning, click tuning and reporting of RTTY Mark frequency via CAT or the FlexLib API. In RTTY mode two fields appear in the DSP drop down menu in place of the APF/ANF sliders. These are the RTTY Mark and RTTY Shift values:

These values default to 2125 and 170 Hz respectively for operating at 45.5 baud, the standard for HF. The RTTY Mark is an IF shift of the Slice Receiver indicated frequency which allows click tuning and spot frequency reporting to third-party programs that expect the reported frequency to be the RTTY Mark frequency. For click tuning, place your mouse cursor on the Mark frequency (higher of the two tones) and double click. To the user, the IF shift at the RTTY Mark frequency is transparent since the slice seems to be tuned to the RTTY Mark.

The Slice Receiver filter is also IF shifted and the default filter presets (shown below) are centered between the RTTY Mark and Space frequencies.

27.8 DIGI MODE AUDIO OFFSETS

When operating the radio in DIGU or DIGL mode a receive filter Offset control is available in the DSP tab of the Slice Receiver. This control allows the operator to set the audio offset in Hertz of the center of the receiver's bandpass preset filters. When click tuning a Slice Receiver with an Offset set to a non-zero value, the Slice Receiver's frequency will be adjusted so that the center of the receiver's bandpass filter will be tuned to the frequency that was click tuned. The default offset for DIGU is 1500Hz and the default for DIGL is 2210 Hz.
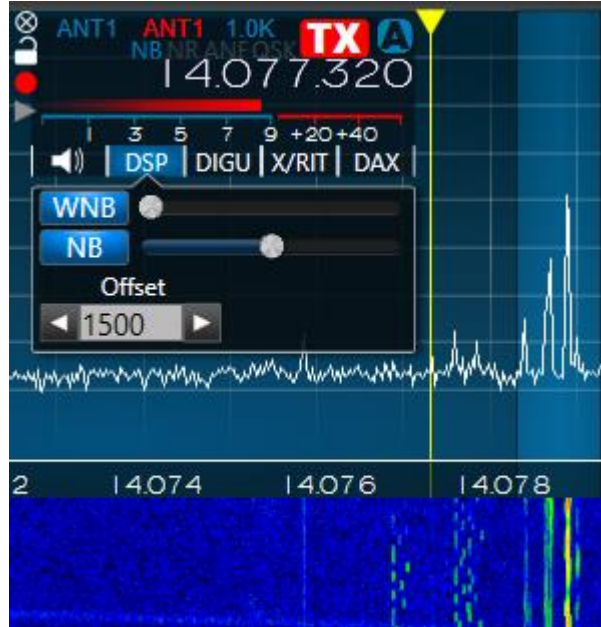
This feature allows the operator to configure a narrow filter in DIGU or DIGL mode, then conveniently drop it over a signal of interest by simply double clicking on the signal.

28 HOW TO EXPORT TRANSMITTED AUDIO

SmartSDR provides a means to export digitized audio that appears at the transmitter's input. This audio is exported to the DAX MIC channel where it can be connected to any program that opens a sound card device.

The DAX MIC channel is controlled by the Mic Stream section of the Dax Control Panel:
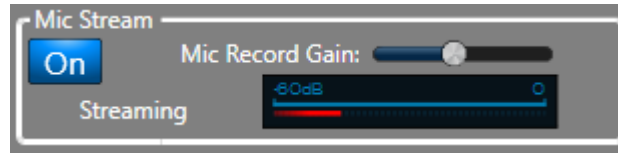
The MIC stream is enabled and disabled by clicking the button in the upper left corner. The gain is controlled with the slider.

The DAX MIC channel is supplied by the audio source that has been selected in the P/CW panel. When the microphone or balanced input is selected, the audio received by the radio is digitized and sent to the DAX MIC channel while the channel is enabled. When one of the other audio sources is selected in the P/CW panel (e.g. LINE, ACC, PC) the audio is digitized and sent to the DAX MIC channel only when the transmitter is active.

Audio is sampled and digitized before the Equalization and Processing steps are performed, so it reflects the audio as presented to the radio. Since the DAX system runs independently of SmartSDR, the audio connected to the DAX MIC stream is available from the stream even if SmartSDR is not running.

29 HOW TO OPERATE USING WAVEFORMS

29.1 WHAT IS A WAVEFORM MODULE?

A Waveform Module or "waveform plug-in" adds signaling or mode capability to a FLEX-6000 Signature Series radio. Waveform Modules are installed and run *inside* the radio without any outside computer software, adding a new mode or capability into the FLEX-6000. Waveform Modules are tightly integrated with the radio stream and control data and don't rely on extra accessories or software, such as sound cards, patch cables, virtual sound cards, serial ports, CAT or DAX to operate.

Waveform Modules that can be run without an external GUI effectively extend the waveforms into the remote realm -- if you create a digital voice waveform and load it in the radio, this can be used from the GUI when the radio is remote without any extra effort. Radio operators must decide about how much trouble they want to go through to use a new mode today. The objective of waveform is to make this decision easier because once loaded, the mode becomes part of the radio's normal mode list. No external software is required.

Waveform Modules may be implemented for signaling and digital modes such as RTTY and PSK-31 extending the capability of the radio. Waveform Modules also allow a user with appropriate programming skills to add modes or functionality to the FLEX-6000, by using a defined, open API (Application Programming Interface). If you are interested in writing your own Waveform Module, please refer to the documentation for the Waveform SDK (Software Development Kit). The open API allows full control of the radio, including filters, frequencies, transmit control, and access to both pre and post demodulation receive and both pre and post modulation transmit streams. Or, in other words, access to audio in and out, as well as baseband transmit and receive signals, in both the real and complex I-Q domains.

All available waveforms and their "How To" guides are available at:

http://www.flexradio.com/smartsdr/waveform/

29.2 INSTALLING AND REMOVING A WAVEFORM MODULE

SmartSDR for Windows must already be installed on your Windows computer, prior to installing the Waveform application. The installation is a two-step process. First the waveform package installer is run to install a waveform specific GUI program (this is waveform dependent and a GUI may not be included with all waveforms) and stores the waveform plug-in on your computer. Then SmartSDR is run and used to install the waveform plug-in from the Windows computer into the target FLEX-6000. Second, the waveform plug-in is installed in the FLEX-6000.

The Waveform Installer, which is a Windows executable, can be downloaded from the FlexRadio web site and placed anywhere convenient, such as your desktop. Double click on the installer to begin the waveform installation. It will install the Waveform GUI application (if any) and install the radio waveform plugin in the standard Waveform folder.

After the waveform installer has been run, power up the FLEX-6000, start SmartSDR for Windows and connect to your radio. Once it has connected, open the "Files" menu and select "Waveform"

to open the **WaveForm Manager**. If no previous waveforms have been installed, the WaveformManager window will be empty as shown below.
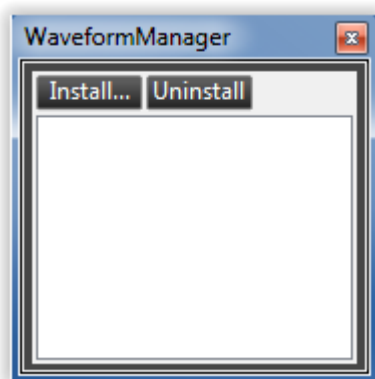
Press the "Install…" button, to bring up the Windows Explorer file select window for Waveforms. Select a waveform plug-in to install into the FLEX-6000.
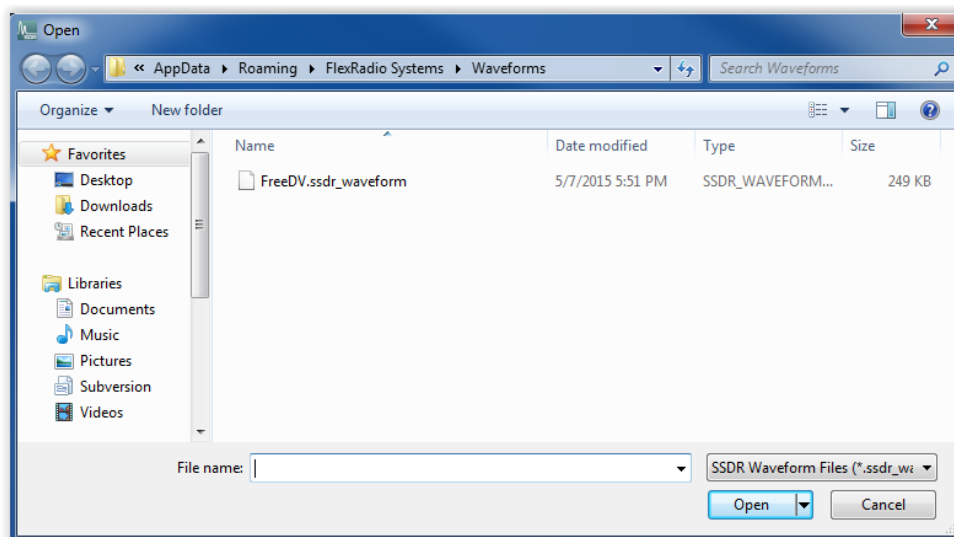
For this example, the name of the waveform plug-in file is "*FreeDV.ssdr_waveform*." Double click on the entry with this name, or single click and press the "Open" button. "FreeDV v1.0.3" should now be installed in the WaveformManager window as shown below. Close the WaveformManager window when done.
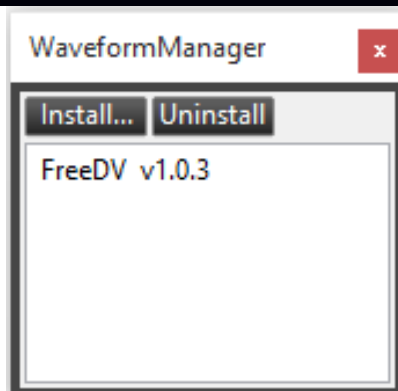
The Waveform Application is now installed in both the Windows computer and the radio. Any Waveform modules may be uninstalled by opening the window above and selecting the module for removal, then pressing the "Uninstall" button.

To uninstall a Waveform, open the Waveform Manager, select the appropriate wave form and click on the Uninstall button.

Δ – Resetting the radio data base will erase any Waveform modules installed inside the radio. The original copy is still stored in the SmartSDR application in the Windows control computer, and can easily be re-installed into the radio by opening the File/Waveform/Installer-Window and repeating the installation step above.

29.3 OPERATING A WAVEFORM MODULE

The Waveform Module extends the capability of the radio by adding additional modes. When installed, an additional mode button may appear alongside the existing mode buttons, such as the case of FreeDV/CODEC2 adding a mode button labeled FDV alongside USB, LSB, FM, etc. Some Waveform applications will not require any further controls or displays other than the mode button. If additional GUI capability is needed, it will generally appear in a separate window. So, general operation of the radio in the new added mode should be like existing operation. Instructions on how to operate any added user interface (GUI) will be included as part of the module specific documentation included as part of the module distribution.

Δ – The Waveform module adds an extra signal processing load on the radio. It is possible that running a radio at or close to maximum processing capability and then adding a Waveform module load could degrade the overall performance of the radio. In this case, it may be necessary to reduce the total number of open receiver Slices, until the performance is acceptable.

30 HOW TO OPERATE IN FULL DUPLEX (FDX) MODE

All FLEX-6000 Signature Series Transceivers are inherently capable of full duplex operation. In normal simplex operation, all Slice Receivers are muted when transmitting. When Full Duplex (FDX) is enabled, the transmitting Slice Receiver is muted along with all other Slice Receivers on the same antenna. Receivers located on *different antennas* from the transmitter are not muted during transmission.

FDX is only possible if the two (or more) Slice Receivers are using separate physically isolated antennas. Since at least two receivers are used, two or more frequencies may be heard simultaneously when in receive. When the radio is switched to transmit, the transmitting Slice Receiver will no longer emit receive audio, but the other receivers will continue to receive.

The transmitting Slice Receiver is muted primarily because it contains a delayed version of the radio's transmit signal. This delayed transmit signal results in operator confusion if heard at the same time transmit audio is being produced. If hearing this signal is the desired goal, another Slice Receiver may be placed on the same frequency as the transmit slice. This receiver will not be muted and delayed transmit audio can be heard if the receiver's receiving antenna is different from the transmit antenna.

30.1 FDX REQUIREMENTS

To use FDX mode, the following requirements must be met:

- The transmitting antenna and receive antenna must be different
- The transmitting Slice Receiver and receiving Slice Receivers must be different (two or more receivers must be used)
- The radio must be placed into FDX mode
- The signal level of the received transmit signal coming into the receive antenna must be below the overload threshold of the Spectral Capture Unit (SCU, details below)

The first three steps involve setting up the radio properly, but the fourth step requires understanding your antenna system and signal level environment in detail by performing the necessary calculations to ensure proper operation. A detailed explanation of this and working examples are provided below.

30.2 FDX APPLICATIONS

There are two initial applications of FDX mode:

- FLEX-6700 Single Operator Two Radio (SO2R) operation
- Full Duplex amateur satellite operation using appropriate transverters

SO2R mode is used by single operator contesters to boost scores by listening on two bands simultaneously and alternating the transmit band, interleaving listening and transmitting tasks. As always, consult the contest rules for any requirements or restrictions on operating in this manner. With SmartSDR v1.5 and greater, SO2R operation is only possible on the FLEX-6700. A future add-on hardware product will enable SO2R operation on both the FLEX-6500 and FLEX-6300.

30.3 FDX CAPABILITIES BY RADIO MODEL

The capabilities and rules for FDX operation vary by model as defined by its respective hardware capabilities. Specifics for each model are as follows.

30.3.1 FLEX-6700 SO2R Operation

The FLEX-6700 incorporates two independent, full performance Spectral Capture Units (SCUs), each with their own band pass filter preselectors. This means that the FLEX-6700 can simultaneously receive on two separate antennas. With FDX engaged, it is possible to listen on one antenna/band while transmitting on another - given sufficient antenna isolation is provided.

Alternately, RX A, RX B, or XVTR may be used as receive only ports. The internal preselectors on the FLEX-6700 provide a minimum of 20 dB band to band rejection. With antenna isolation of at least 40 dB, cross band SO2R operation without external filtering is practical. For high power operation and sites with less antenna isolation, external transmit band pass filters must be added to increase isolation.

Please refer to the SO2R Mode with N1MM for the FLEX-6700 How to Guide for step-by-step setup instructions for operating a FLEX-6700 with N1MM in SO2R mode.

A default Global profile, *SO2RDefault*, is provides a starting point for configuring the radio for SO2R operation.

The image below illustrates an example SO2R configuration using the FLEX-6700.
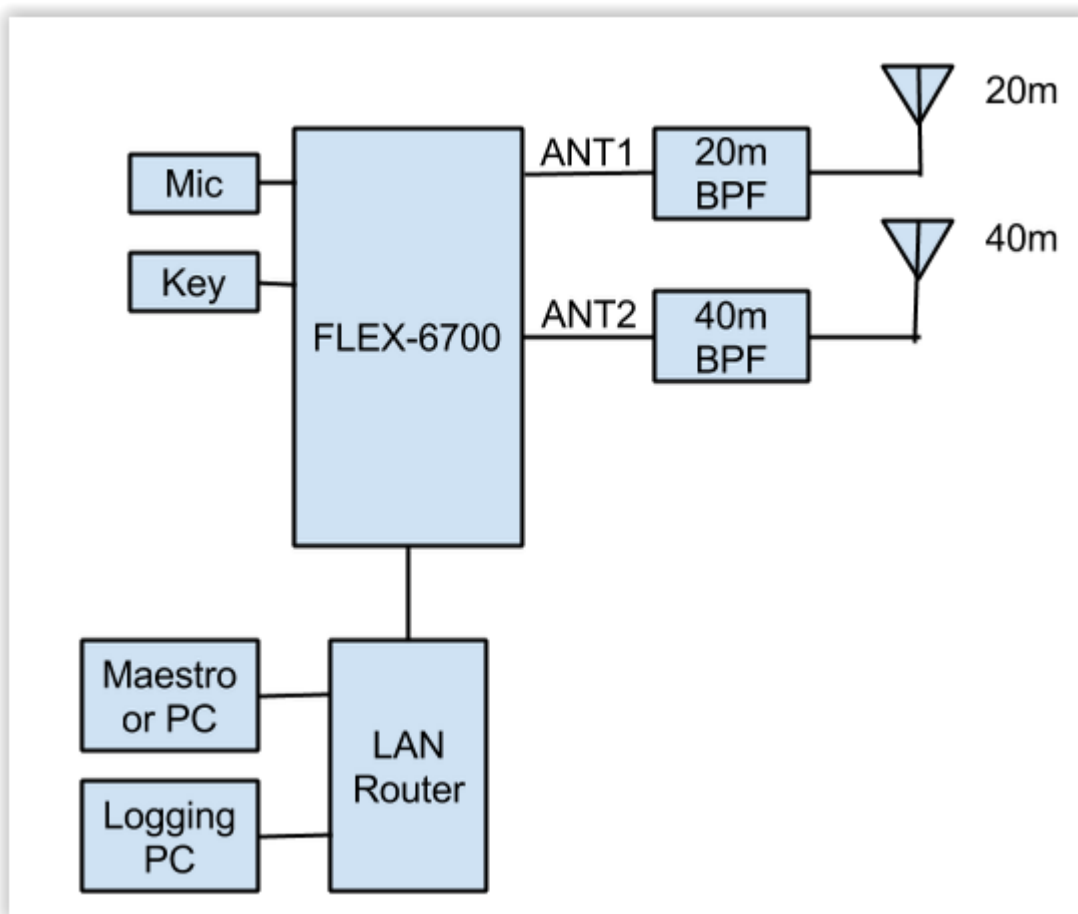
30.3.2 FLEX-6300 and FLEX-6500 Full Duplex

Both the FLEX-6300 and FLEX-6500 models are enabled for full duplex operation using XVTR as a receive only port so long as at least 70 dB of port to port isolation is provided for a 100W station. This may be provided through a combination of antenna isolation and external band pass filtering for cross band operation. RX A may alternately be used on the FLEX-6500. This feature can also be used for satellite operation with suitable transverter support.

30.4 SCU OVERLOAD FUNDAMENTALS

All radios are susceptible to overload. Overload conditions caused by a signal level that is too high can result in compromised performance, the inability to receive or even receiver damage. An understanding of how overload occurs and methods to avoid it is required for proper operation of a radio in full duplex mode.

The Spectral Capture Units (SCU) in the FLEX-6000 transceivers contain three primary component blocks:

- Preselection band filters (except in FLEX-6300)
- A preamplifier / attenuator
- A high-performance analog to digital converter (ADC) also known as a digitizer

Each of these blocks plays a role in receiver performance and must be considered when planning full duplex operation.

30.4.1 Preselection Band Filter Block

Preselection band filters, when present and active, can reduce out of band signal levels by 20dB or more. Preselection band filters are enabled by default in the FLEX-6500 and FLEX-6700 any time the radio is not in the WIDE mode. An indicator in the upper right corner of the panadapter will show when the radio is in the WIDE mode and preselectors are not enabled. The FLEX-6300 is always in WIDE mode since it does not have preselection band filters, but this is not indicated in the panadapter.

For the purposes of calculations, assume a 20dB reduction in out-of-band signals when the preselection band filters are enabled.

Example 1: FLEX-6500 with two Slice Receivers on 20m in a single panadapter. Both receivers are set to listen on RXA and transmit on ANT1. The WIDE indicator is not present in the panadapter. In this case, the preselector filter for 20m is enabled, but the receiver and transmitter are on the same band. The preselector will not reduce the transmit signal (it is in-band) and no 20dB reduction in signal can be used for calculations.

Example 2: FLEX-6500 with two Slice Receivers, one on 20m, one on 40m in two panadapters. Both Slice Receivers are set to receive on RXA and transmit on RXB. Because two different bands are received on the same antenna, WIDE mode is indicated in both panadapters. Preselection band filters are not used and a 20dB reduction in signal cannot be used for calculations.

Example 3: FLEX-6700 with two Slice Receivers, one listening on 20m and one on 40m in two panadapters. Slice A is set to receive on RXA and transmit on ANT1. Slice B is set to receive on RXB and transmit on ANT1. Neither panadapters indicate WIDE. In this case, preselection band filters are enabled on both bands and a 20dB reduction can be used in calculations.

30.4.2 Preamplifier / Attenuator Block

The preamplifier / attenuator block can raise or reduce signals before they are sampled in the ADC block. The overload limit of the SCU is reduced by any gain that is added by the preamplifier. For example, if 10dB of gain is selected using the preamplifier selection under the antenna controls in the panadapter, this 10dB addition must be factored into the overload calculations. The same holds for other amplification levels: if +20dB or +30dB are selected, the respective value must be added to overload calculations. You should only use pre-amplification when necessary and only what is required to raise the noise level in the receiver by 8-10dB over the noise level when the antenna is disconnected.

The preamplifier has protection circuitry to prevent damage above levels of +10dBm. This protection circuitry will cause distortion in received signals if the level exceeds 10dBm. For this reason, pre-amplification should not be used when the input signal level will meet or exceed +10dBm. When performing all testing of a full duplex configuration, it is highly recommended that the preamplifier be disengaged until it can be determined that the power level from the transmitter will not reach +10dBm in any operating scenario.

30.4.3 High-Performance Analog to Digital Converter Block (ADC)

The ADC block, or digitizer, converts the received signals into digital data. All ADCs have overload points and damage points, but there is some variability in overload symptoms. With the FLEX-6000 Signature Series radios, the ADC overload point varies from +7dBm (FLEX-6300) to +9dBm (FLEX-6500 and FLEX-6700). This overload point is a "soft overload" meaning that at this point the receiver will begin to show a performance drop. The ADC generally functions better with increasing signal levels up to this point. At the soft overload point, the receiver will begin to develop spurs that will appear in the panadapter and these spurs will grow as power is increased. A digital overload point will be reached around +12dBm, but varying by receiver, at which point the receiver will cease to function normally, producing substantial distortion in received signals and rendering reception difficult.

At levels above +15dBm, the ADC can be damaged so the FLEX-6000 contains circuitry to disengage the ADC from the SCU. While circuitry should protect the radio from a damaging signal, it is highly recommended that station configuration be designed such that signal levels above the soft overload point are prevented from entering the antenna connector of the radio. FlexRadio Systems assumes no responsibility for damage incurred from high signal levels entering the receiver.

30.5 FULL DUPLEX ANTENNA ISOLATION REQUIREMENTS

For successful FDX operation, it is essential to understand and plan for sufficient transmit to receive antenna isolation to prevent receiver overload and/or damage. The FLEX-6000 FDX Power Calculation Worksheet can aid in the calculation of antenna isolation and power levels that are suitable for a specific station.

The FLEX-6000 Signature Series transceivers are designed to disconnect the receiver from the antenna when signal levels are +18 dBm to +22 dBm depending on frequency. The front-end protection circuits will begin to engage at approximately +15 dBm. Front-end overload of the SCU will occur with a single tone in the range of +8 dBm with the preamp off. Increasing the preamp gain will lower the overload point by the amount of the added gain.

To provide suitable headroom to prevent SCU overload, we recommend that transmit to received signal strength be limited to a worst case of -20 dBm or lower at the antenna input. With 20 dB of preamp gain, this would provide a single tone input of 0 dBm to the A/D converter leaving about 8 dB of headroom. More isolation is better.

One of the best resources for information on achieving antenna isolation is:

"Managing Interstation Interference, Revised Second Edition" by George Cutsogeorge, W2VJN.

31 RADIO SETUP

31.1 INTRODUCTION

The Radio Setup menu, located in the Settings menu of the main SmartSDR window, is used to configure various settings of the radio.

31.2 CONFIGURING A RADIO

To configure a radio, select the radio you wish to connect to from the SmartSDR start screen. Once selected, the radio will be highlighted in blue. Double click the radio to start it. Open the Settings menu from the main window menu list. Use the tabs toward the top of the window to navigate to the different areas for configuration.
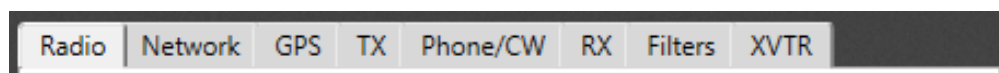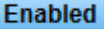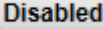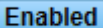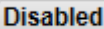

31.3 RADIO TAB
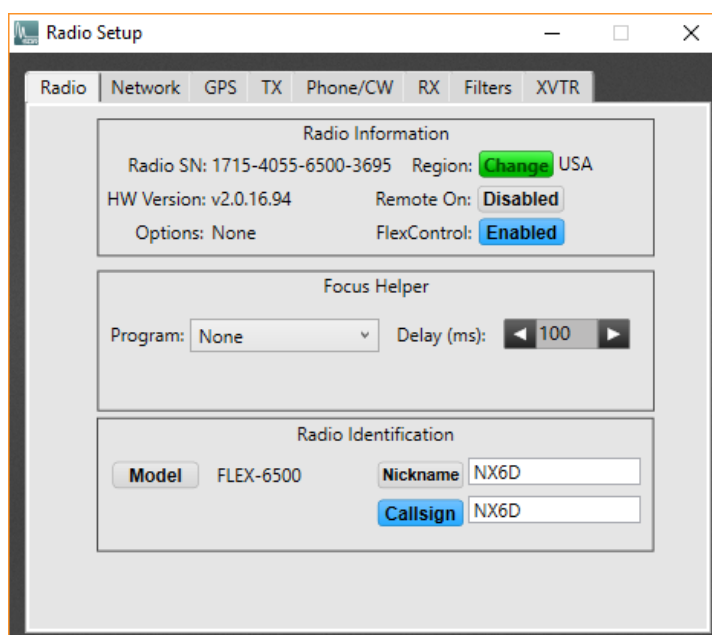
Located in the "Radio" tab is basic information about the selected radio. The tab contains the radio serial number, installed options and hardware version. Radio Hardware version refers to the software and firmware that is loaded into the radio itself.

The "Region" indicator which displays the country for which the radios transmit capabilities are based. The **Change** button will open an explorer window to select a TURF file for changing the region. (A TURF file is supplied by FlexRadio Systems or the international distributor where the radio was purchased) Navigate to the TURF file and click "Open". The radio will automatically update the radio to the new region.

There is an option to enable/disable the FlexControl by clicking the ![Enabled]. When blue the FlexControl is enabled, when grey ![Disabled] the FlexControl is disabled and will no longer control SmartSDR.

Next is the Remote On enable/disable control ![Enabled]. When blue Remote On is enabled, when grey ![Disabled] remote on is disabled. To operate remote on, with the radio off, if you close the rear RCA connector continuously, it will power on the radio. Open the RCA contact and the radio will power off.

The next section contains controls for adjusting focus integration controls. This allows the user to pass the mouse and keyboard focus back to the third-party program of their choice. Currently N1MM, N3FJP, WriteLog and Win-Test have all been tested and preset in SmartSDR. An "Other" setting is also included to enable use with other logging programs not formally supported.
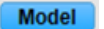
The delay control adjusts the wait time for SmartSDR to pass the focus back to the selected program.

When a preset application is selected in the drop-down menu, a textbox becomes available to adjust the UDP Port which is the receiving port for the application. Modification of the selected application's configuration file is required and both must agree with the port number entered.

UDP Port: 12060

When "Other" is selected from the drop-down menu then a textbox becomes available to adjust the name of the window that will be receiving the focus.

In the Radio Identification section, there are three modes for identifying your radio in the OLED display on the front panel of some radio models, Nickname, Callsign and Model. After entering a Nickname or Callsign, clicking the buttons beside the text will cause the corresponding information to appear on the front of the radio. When the selected option is active the button beside it will illuminate blue. For example, the Model button ![Model] is enabled displaying "FLEX-6700" on the OLED display.

31.4 NETWORK TAB

The network tab offers information and settings related to the radio's network connection.
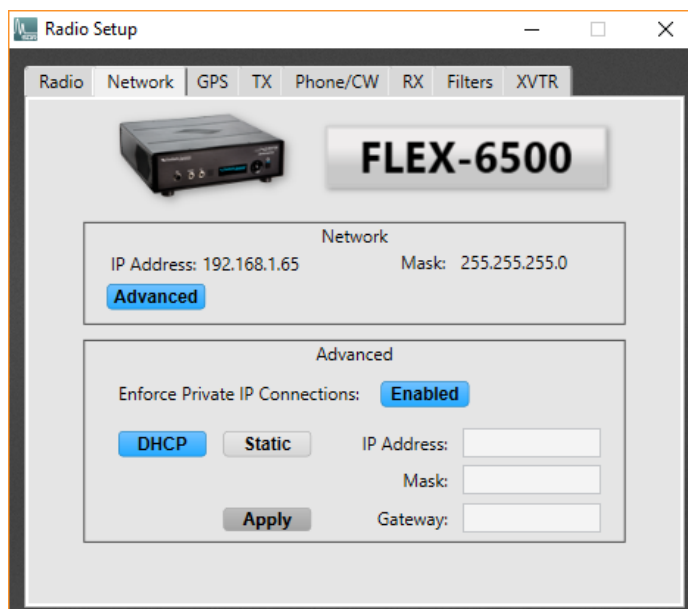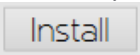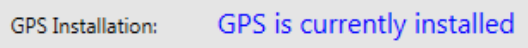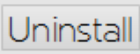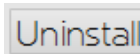
The Network tab contains the IP address and sub-net mask in use by the radio.

Pressing the **Advanced** button reveals controls that allow the user to assign a fixed IP address to the radio. Press the **Static** button then enter the desired IP address, sub-net mask and gateway address. Press **Apply**. The radio will reboot. SmartSDR will lose its connection to the radio and will return to the Startup screen. The radio can be returned to dynamic IP address assignment by use of the **DHCP** button.

The **Enforce Private IP Connections** button enables and disables a network security feature. When enabled, only private network IP addresses may connect to the radio when the radio is connected to a private network. These are the 10.0.0.0 - 10.255.255.255, 172.16.0.0 - 172.31.255.255 and 192.168.0.0 - 192.168.255.255 address blocks. When disabled, any address may connect.

31.5 GPS TAB

(Only available on the FLEX-6700 and FLEX-6500) The "GPS" tab has the option to Install or Uninstall a GPS module in the software. If your radio has a GPS module installed from the factory, this process should already be complete. If you are installing the GPS module after the fact you will need to click [Install] to test for the GPS and enable the GPS functionality. If the installation has been successful, you will see: GPS Installation: GPS is currently installed toward the top of the panel. When removing the GPS or if you would like to bypass the GPS you will click [Uninstall] to disable GPS functionality.

If no GPS device is present in the radio, the [Install] and [Uninstall] buttons have no effect.

The lower portion of the GPS tab displays information collected from the GPS module. This information includes:

- Latitude
- Longitude
- Grid Square
- Altitude
- Sat Tracked - Number of Satellites being tracked by the GPS
- Sat Visible - Total number of satellites that should be visible to the GPS currently
- Speed - Speed of your radio in knots along the surface of the Earth
- Freq Error - Average error in the frequency of the 10MHz output from the GPS. If you multiply this number by your current frequency, it is the GPS's report of how far off frequency you could be.
- Status - Displays the status of the GPS Module. One of six modes will be displayed:
- Not Present
- Holdover
- Locking
- Locked
- Holdphase
- Warm up
- UTC Time

31.6 TX TAB

The "Transmit" tab offers adjustments for Timings as well as Interlocks.

The "Timings" section has adjustments for RCA TX1, TX2 and TX3 (Only TX1 on FLEX-6300) as well as the Accessory TX, TX Delay and TX Timeout. Each of these controls is measured in Milliseconds (MS). Each of the TX1, 2, 3 timings act independently and start measuring from the moment a microphone PTT switch is depressed, a CW paddle is keyed, etc. RF is transmitted as soon as the largest of the TX1, 2, 3, and ACC_TX delays have elapsed if TX Delay is set to zero. Otherwise TX Delay value is added to the maximum of TX1, 2, 3 and ACC_TX. The user can also enable/disable the TX Inhibit by clicking on the **Disabled** button. TX Inhibit is used to disable the ability to transmit completely and should be used when you want to ensure that the radio will not transmit at all.

The "Interlocks" section offers three setting for RCA TX and Accessory TX: Disabled, Active High and Active Low. The FLEX-6300 does not have interlock settings for RCA. In the Disabled position, the connector or accessory pin will not perform any function. In the Active Low setting, transmit will be prevented if the connector/pin are driven to ground. In the Active High setting, transmit will be prevented if the connector/pin are "high" or driven to some voltage level above ~1.5V.

To interlock two FLEX-6000s for Multi/2 operation, for example, the following actions should be performed:

1. Run an RCA cable from TX1 (or TX2 or TX3) of radio #1 to the TXREQ connector on radio #2
2. Run an RCA cable from TX1 (or TX2 or TX3) of radio #2 to the TXREQ connector on radio #1
3. Enable the respective TX1/2/3 outputs by clicking the Disabled button for the appropriate TX1/2/3 output on each radio in the transmit tab (enable the output for the port you are using in steps 1 and 2)
4. Enable the interlock on both radios by selecting Active Low in the Interlocks – TX REQ section for the RCA cable
5. Test to ensure proper operation: ensure that radio #2 cannot transmit while #1 is transmitting and vice versa. When testing, use the information below to ensure proper operation

When the interlock is active, meaning the radio will not transmit even though actions that would normally cause the radio to transmit (PTT is pressed, the CW paddles are being keyed, CAT is attempting to transmit, etc.), the radio will:

1. Change the color of the LED on the front panel of the radio from green (receive) to red (transmit).
2. All relays in the radio will engage to start transmission
3. PA finals in the radio will be biased for transmit
4. The waterfall will indicate that the radio is in transmit
5. If in CW, sidetone will be heard as if the radio is transmitting
6. But NO power will emanate from the radio meaning the power meter will show no power out, the panadapter will show no power out and the TX indicator at the lower right of SmartSDR will not change to a red TX

The indicator in the lower right corner of SmartSDR will always indicate the reason that the radio will not transmit and why:
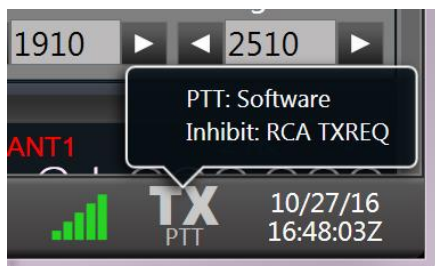
This shows that transmit is being inhibited by the RCA TXREQ line on the rear of the radio. Once the TXREQ line is cleared, the indicator will revert to a normal transmit indicator:
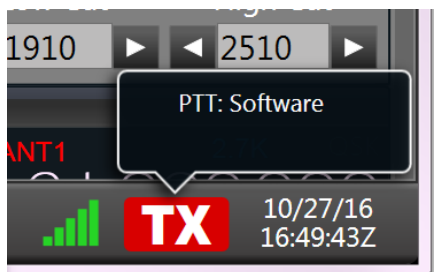
The "Max Power" text box allows the user to manually set the radio's maximum output power on ANT1 and ANT2, when using the PA. This control sets the maximum value of the RF Power slider on the RF Power / ATU Control Panel (section 33.7.1). Transmit power set by third party programs will be limited to this value.

The user can also enable/disable the Hardware ALC by clicking on **Disabled** . When blue **Enabled** Hardware ALC is enabled, when grey it is Disabled.

Δ – Please note this input is provided as a safety measure for external amplifiers. It is NOT meant to be used in regular operation as an active power control input or to modify the "attack" of an

external amplifier. Almost all modern HF amplifier manufacturers discourage the use of ALC in normal operation. In fact, many amplifiers do not have ALC implemented.

The software is set to not show your transmit signal on the Waterfall by default so that the Waterfall does not display data that may not be useful to the user. Instead it will display a single white line while in transmit. When enabled, The Show TX in Waterfall setting will cause the Waterfall to show the data of your transmission.

31.7 PHONE/CW TAB
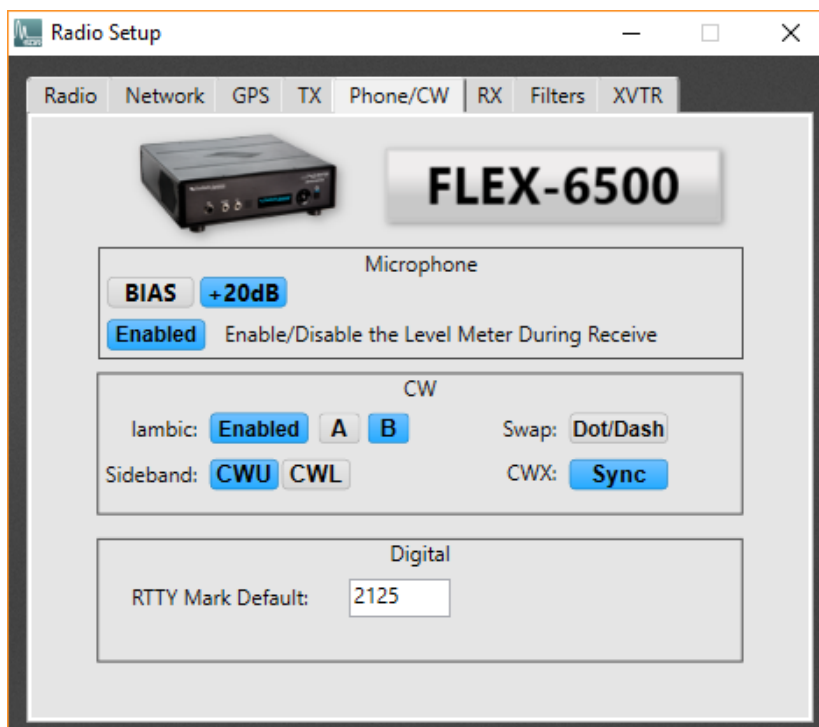
BIAS button: Clicking this button will enable the +5 VDC microphone BIAS voltage on the MIC connector. Enable the BIAS only if the microphone being used requires the +5 VDC voltage to operate, such as microphones with condenser elements.

+20dB button: Clicking this button will enable the +20 dB gain microphone preamp.

Note: The +20 dB microphone preamp option should always be enabled whenever a microphone is directly connected the FLEX-6000. This option is not available when LINE is selected as the audio input.

Disable/Enable Mic Meter button: Enables or disables the Mic Meter during receive.

Buttons are found on the Phone/CW tab to toggle Iambic mode and paddle swap for dot/dash. Iambic can be enabled or disabled in either mode A or mode B configurations. Blue signifies selected mode .

There are two settings for the Key configuration, Dot/Dash and Dash/Dot. Dot/Dash indicates the left paddle is the dot and the right is the dash. When Dash/Dot is selected, the button will highlight blue **Dash/Dot**

There is also a selection for upper (CWU) or lower sideband (CWL) for CW Operation. **CWU CWL** CWL and CWU alter tone pitch with tune direction in a similar way to upper and lower sideband decoding.

31.8 RX TAB

The receive tab has selections for Frequency Offset to adjust for the error in the local oscillator.
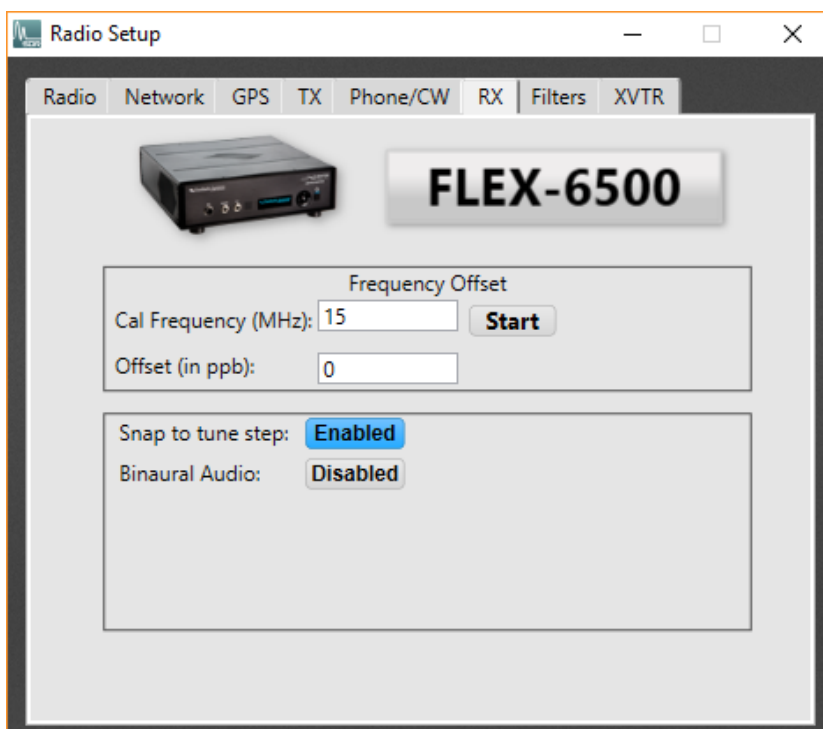
Calibration Frequency: This is the frequency of the source that you are using for the calibration.

Start: Initiates the automatic estimation of the offset based your calibration frequency.

Offset: Resulting offset in parts per billion. This box can also be manually entered.

NOTE: When running the frequency calibration, the radio uses Slice A and ANT-1 regardless of the radio's slice/antenna configuration.

Snap to Tune Step: This feature will allow the user to adjust whether features like Drag Tune or Click Tune will snap (or round the frequency) to the closest tune step size. For example, if your tune step is set to 10Hz then the Slice Receiver will snap to every round 10 Hz (i.e. 14.100.000, 14.100.010, 14.100.020) increment regardless of the tuning method when tuning outside of the Slice Receiver passband. When this feature is disabled it will allow the receiver to be tuned in 1 Hz steps.

Binaural Audio: Enabling this global option will produce a virtual 3D spatial depth of field listening sensation by shifting the phase of the recovered audio relative to one channel of the speakers or headphones. The effect may enhance weak signal reception.

31.9 FILTERS TAB
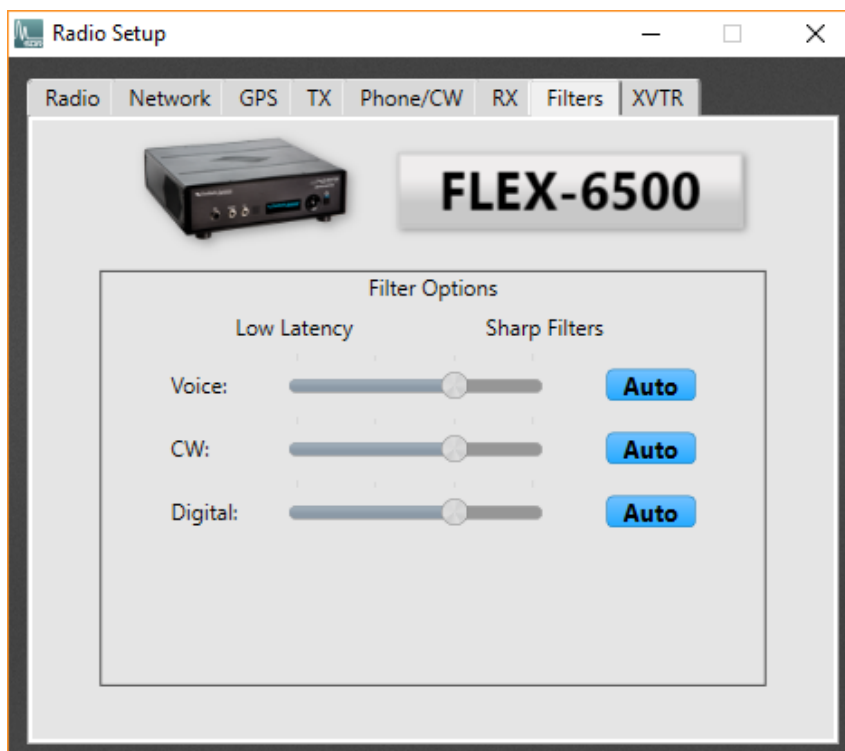
The three sliders in the **Filters** tab control the RX filter sharpness/latency for the three mode groups, **Voice** (USB/LSB/AM/SAM/FM), **CW** and **Digital** (DIGU, DIGL, DFM, RTTY). The processing time, or latency, of the digital RX filters increases as the slider is moved to the right. Sharper filters require more processing time. In applications requiring fast turnaround of signals (e.g. certain contest environments), faster filtering of the received signal may be more desirable than adjacent signal rejection.
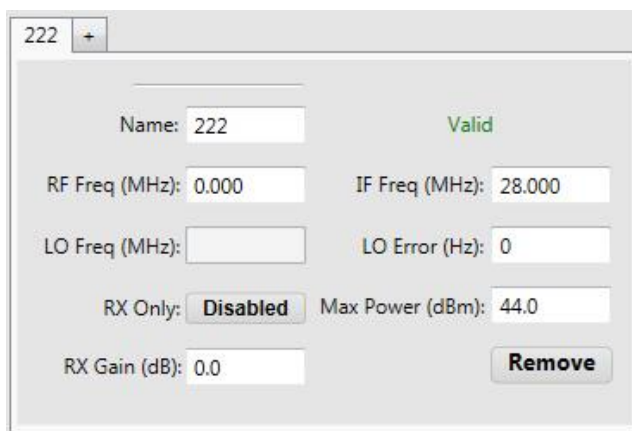
When **Auto** is selected for a mode group, the sharpness of the filter depends on the bandwidth of the filter. In general, the filter gets sharper, but slower, as the bandwidth narrows. In the following, Level 0 is the lowest latency (least sharp) and Level 3 is the highest latency (most sharp).

- DIGU/DIGL
    - Bandwidth from zero to 500 Hz: Level 3
    - Bandwidth from 500 to 1000 Hz: Level 2
    - Bandwidth from 1000 to 2000 Hz: Level 1
    - Bandwidth from 2000 to 10000 Hz: Level 0
- RTTY
    - Bandwidth from zero to 400 Hz: Level 3
    - Bandwidth from 400 to 1000 Hz: Level 2
    - Bandwidth from 1000 to 1200 Hz: Level 0
- CW

- o Bandwidth from zero to 400 Hz: Level 3
        - o Bandwidth from 400 to 1000 Hz: Level 2
        - o Bandwidth from 1000 to 1500 Hz: Level 1
        - o Bandwidth from 1500 to 10000 Hz: Level 0
    - USB/LSB/AM/SAM
        - o Level 3 for all bandwidths
    - FM/NFM/DFM
        - o Level 0 for all bandwidths

All TX filtering is performed with low latency (less sharp) filters, but SmartSDR will sharpen the TX filters as necessary to prevent any signal being emitted outside of the lower limit set by the **Lo Cut** control. See section **33.7.4**, **Voice Mode Panel** for more information.

31.10   XVTR TAB

The XVTR Tab allows the user to set up transverter bands for the FLEX-6000. Clicking the '+' will create a new tab for a new transverter band. Refer to the section How to Configure Transverters for detailed information on configuring transverters.

32 RESTORING TO FACTORY DEFAULTS

Restoring the radio to factory defaults will clear any installed waveform modules, persistence and profile data in the radio and return it back to its original state.   Default profiles are restored if they had been deleted. It is recommended that you make a backup of your Global, Transmit and MIC profiles before resetting the radio back to factory defaults.

NOTE: This should only be used as a last resort. If you are having trouble with your radio, please submit a HelpDesk support request.

FLEX-6700 and FLEX-6500 Reset Procedure

With the radio powered off, press and hold down the "OK" button on the front panel of the radio. Momentarily press and release the power button to power on the radio. Continue holding in the OK button until the front display counts down to 0, the power LED starts blinking white and the "CALIBRATING…" message is displayed, then release the OK button. Allow the radio to continue booting normally.

FLEX-6300 Reset Procedure

With the radio powered off, press and hold down the power button until the Power LED blinks white, then release the power button. Allow the radio to continue booting normally.

33 MAIN WINDOW

33.1 INTRODUCTION

The Main Window of SmartSDR is where the primary operation of the radio will occur. Inside this window there is a Top Menu Bar, Bottom Menu Bar, and Tiles.

33.2 UPPER MENU BAR

Located in the top menu bar are a series of drop down menus "File", "Settings" and "Help". You will also find the "REMOTE" button as well as volume controls for speaker and headphone volume.

33.2.1 Menus
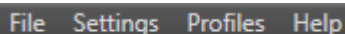
- The *File* menu contains the following selections:
  - *Exit* – SmartSDR disconnects from the radio and terminates
  - *Waveforms* – Opens the Waveform Manager (see section **29**)
- The *Settings* menu contains the following selections:
  - *Radio Setup* - Opens the Radio Setup window for connecting and configuring radios. See section **31**.
  - *FlexControl* – Opens the FlexControl Setup window for configuring the functions of the FlexControl. See section **13**.
  - *Network* – Opens the Network Diagnostics window. See section **16.6.2**.
  - *Memory* – Opens the Memory Channels window. See section **20.3**.
  - *USB Cables* – Opens the USB Cables windows. See section **26**.
- The *Profiles* menu contains the controls for using Profiles. See section **14**
- The *Help* menu contains the following selections:
  - Help Desk - Launches the default web browser and navigates to the FlexRadio help desk web site (https://helpdesk.flexradio.com).
  - *Community* – Launches the default web browser and navigates to the FlexRadio user community (https://community.flexradio.com/home).
  - *Tutorial* – Opens the "Tips and Tricks" tutorial window which provides helpful hints on how to operate SmartSDR. Here FlexRadio users can post questions/answers, ideas, problems and praise so that other users can comment and help one another.

33.2.2 Volume Controls

In this section, there are two rows of controls. The first row controls the speaker volume for the radio's powered speakers. By clicking you will mute the audio of any speakers connected to the PWR SPKR plug. After muting, the icon will show a red circle with a cross through it . Located to

the right of this button is the Speaker Volume slider [slider image]. Adjusting the silver circle to the left or to the right will decrease or increase respectively your speaker volume. The Headphone Volume controls behave the same way as the [icon] icon will display [icon] when muted. Likewise, with the Headphone Volume slider [slider image] will adjust the volume of any headphones connected to the radio.

33.3 LOWER MENU BAR

[image: Lower menu bar showing TNF CWX FDX, TX indicator, and 09/03/15 19:31:20Z]

Located in the Lower Menu bar you will find a series of controls for initiating items within SmartSDR. You will also find a Transmit indicator and a Date/Time indicator.

33.3.1 Application Launcher

In the application launcher, you will find a series of controls which will initiate applications within the SmartSDR infrastructure.

The first control [icon] will add another Panadapter to the Main Window. This control will turn to a dark shade of grey when you have used up the available Panadapter resources.

The second control [icon] will launch or hide the Transmit Control Panel. This panel will appear vertically on the right side of the Main Window of SmartSDR. Once the Transmit Panel is opened it can be closed by clicking the icon again.

The third control [TNF icon] will globally toggle on and off the Tracking Notch Filters that have been placed. When disabled, the TNF(s) will turn to a shade of white on the Panadapter.

The fourth control [CWX icon] will launch or hide the CWX panel. This panel will appear vertically on the left side of the Main Window of SmartSDR. Once the CWX Panel is opened it can be closed by clicking the icon again

The fifth control [FDX icon] will enable and disable Full Duplex (FDX) mode.

33.3.2 GPS Indicator

[image: GPS indicator showing "GPS:" with blue box and "XXXXXX"]

- FLASHING YELLOW = GPS in warm up
- SOLID YELLOW = GPS in holdover (lost satellites)
- SHORT FLASH BLUE = GPS locking
- LONG FLASH BLUE = GPS in hold phase mode

- SOLID BLUE = GPS locked
- SOLID AMBER = Radio off, GPS powered for stability

33.3.3 Transmit Indicator

The Transmit indicator ![TX Ready] is designed to inform the user of the current state of the radio transmitter. The smaller text below the "TX" describes the status of the transmitter.
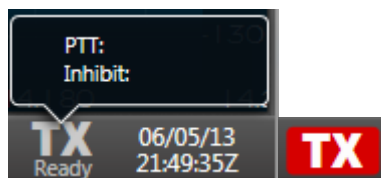
33.3.4 Date/Time Indicator
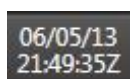
The Date/Time Indicator gathers data from your computer's clock. Today's date is listed on the first line and the current time in Greenwich Mean Time (GMT) on a 24-hour scale is on the second line.

33.4 ORGANIZATION AND ARRANGEMENT

This section describes the organization and arrangement of the Main Window of SmartSDR. This will include the organization of the Tiles within the window as they resize and reorder with user input.

33.5 PANAFALL (PANADAPTER/WATERFALL)
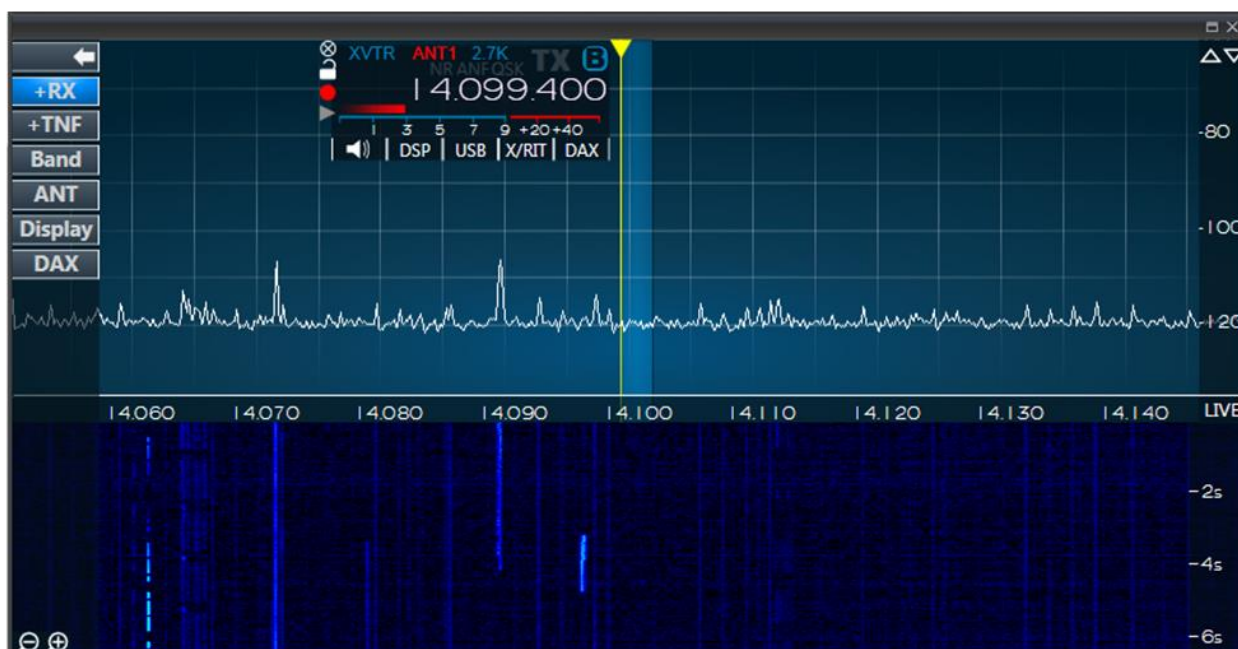
33.5.1 Panadapter Definition

A Panadapter is a visual spectrum display of radio frequencies (RF). Frequency is listed along the horizontal axis from lower to higher frequency, from left to right, measured in Megahertz (MHz). Amplitude is shown on the vertical axis measured in decibels (dB). The moving white line represents RF coming into the radio. The Panadapter is where most radio operation will occur. The FLEX-6000 series radios can display multiple Panadapters simultaneously each with their own frequency and bandwidth.

33.5.2 Waterfall Definition
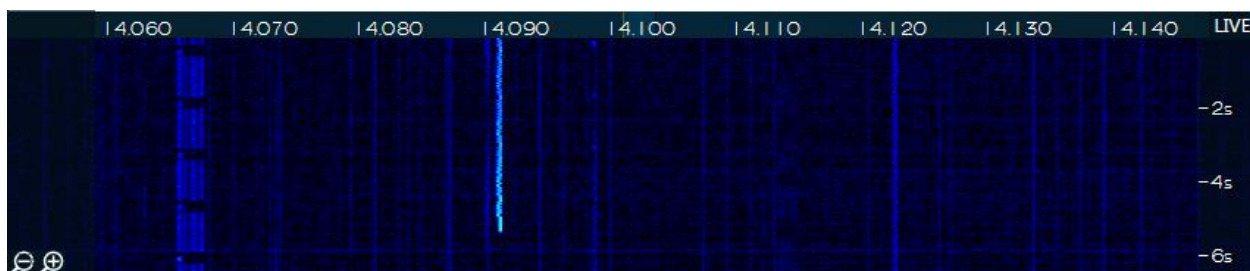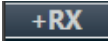
A Waterfall is a historical representation of the frequency data over time. Frequency is listed along the horizontal axis from lower to higher frequency, from left to right, measured in Megahertz (MHz). Time is listed on the vertical axis where the most recent data is at the top and the oldest data is on the bottom.
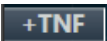
33.5.3 Panadapter Menu

In this section, there are a series of menu options that control various functions of the Panadapter. These controls are located on the left side of the Panadapter.

Hide Menu button will collapse the Panadapter menu so that it is no longer obstructing the view of the Panadapter. When clicked, it will appear with an arrow pointing to the right . Clicking the button again will expand the menu back to its default state.

Add Slice Receiver button **+RX** will place an additional Slice Receiver resource inside the Panadapter. When you have utilized all your available Slice Receiver resources the Add Slice Receiver button will turn to a dark shade of grey indicating that the action is no longer available. It will return to an available state once a Slice Receiver is closed.

Add Tracking Notch Filter button **+TNF** will place a TNF in the center of your slice filter. If no slice is available, the TNF will be placed at the center of the Panadapter.

Band menu button **Band** will expose the Band Menu. Selecting a band from this list will adjust the Panadapter display to within the correlating amateur radio band. One band can be selected at a time and allows for rapid switching between views of the amateur radio bands. Clicking the Band menu button again will collapse the menu.

When switching between bands, if any Slice Receivers were left on the old frequency, these are removed and one new one will be added. If no Slice Receivers were present, one will not be added at the new frequency.

Antenna menu button will expose antenna selection options.
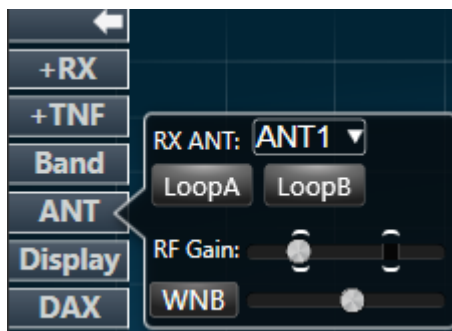
The RX ANT drop down menu allows you to select the antenna that you would like to use for receiving within this Panadapter. This will dictate which antenna is supplying the RF for the frequency display as well as the receive audio for the Slice Receivers within the Panadapter.

The Loop buttons will toggle on (Blue) and off (Grey) the LoopA or LoopB ports. The FLEX-6500 only has one loop option while the FLEX-6300 does not have a loop option.

RF Gain adjusts the preamps of the FLEX-6000. The FLEX-6700 has two stages of hardware preamps which allow a total of six Preamp settings in 10dB steps (-10, 0, +10, +20, +30, +40). The FLEX-6500 has one hardware preamp and 3 preamp settings while the FLEX-6300 has one hardware preamp and 2 preamp settings. In most scenarios, the preamp should be left in the default setting for optimal operation. In a few rare situations (e.g. extremely low RF noise floor, use of a low gain receive antenna), you may get an improvement in signal to noise ratio by turning the preamp up. Even rarer, if you have extremely strong signals, you may decrease the preamp setting to keep from overloading the radio's RF front end.

Display menu button on the Panadapter menu will expose display controls. A horizontal line separates Panadapter controls (top) from Waterfall controls (bottom).
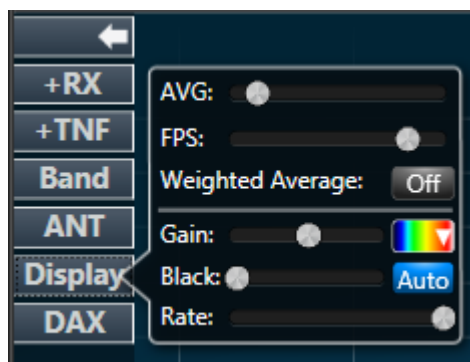
The FPS slider controls the Frames Per Second that the Frequency Line is drawn at. Lowering the FPS control has several effects:

- It lowers the rate at which both the Panadapter and the Waterfall are updated

- It lowers the network bandwidth of data sent from the radio to the client (important in situations where you may have limited bandwidth)
- As the rate of update is lowered, the extra data not displayed is averaged and so the variance of the data is lowered, making both the Panadapter and the Waterfall smoother

If you prefer a faster updating display, but a more averaged or smoother one, adjust the FPS setting for the update speed you prefer and then raise the AVG (averaging) control. The AVG control increases the number of frames that are averaged, lowering the variance and smoothing the display.

The final Panadapter control, Weighted Average, emphasizes signals that are increasing in amplitude over ones that are declining. This tends to continue to show locations where signals have been and show a more precise view of their full amplitude when they first appear.

Below the line at the center of the control are the Waterfall controls.

The Gain, Black and Auto controls work together to adjust how different signal levels are displayed in the Waterfall. The Black control sets the level below which all pixels will render as black. In other words, it sets the level at which signals are no longer of interest. The Auto control will automatically set the black level to just below the noise as band conditions, preamplifier changes or antenna changes alter the noise floor. To enable auto-black, click the Auto button so that it is blue.

The Gain control adjusts how rapidly the Waterfall will advance through the color spectrum for minimal changes in signal level. Adjusting gain low gives the Waterfall a broader dynamic range, but lessens its ability to show small variations signals. Raising the gain lowers the dynamic range, but provides more detail in the variances in smaller signals' magnitudes.

The DAX menu button DAX will expose the DAX controls.
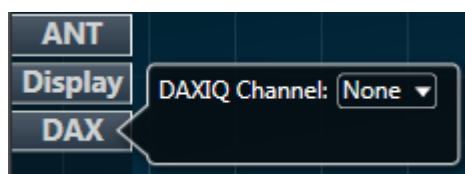
The DAXIQ Channel drop-down menu allows the user to select the DAXIQ channel (1-4) that will stream the IQ from the Panadapter.
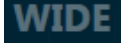
33.5.4 Horizontal Zoom

Each Panadapter has a zoom range up to a maximum of 14 MHz in bandwidth displayed at one time on the FLEX-6500 and FLEX-6700 and up to 7 MHz on the FLEX-6300. There are multiple methods for adjusting the zoom of the Panadapter.

- The first is by the plus and minus buttons zoom located in the bottom left corner of the Panadapter and is used for rapid zooming. Zooming out (-) will double the bandwidth presented in the Panadapter while zooming in (+) will cut the bandwidth in half. The

frequency at the center of the Panadapter will remain the same after clicking a zoom button.

- The second method is a click and drag method using the horizontal axis for more precise zooming. The click and drag method will zoom in by dragging to the right and vice-versa. With this method, the frequency at the point where your mouse was located at the click event will remain stationary in the Panadapter.

When zooming out with a FLEX-6000 radio there are certain points where the size of the data used to create the display on the screen will need to be doubled. As this occurs there will be more noise considered while processing the display which will cause a noticeable increase in the noise floor. The reverse occurs when zooming in on a Panadapter. After zooming out to a certain point, the hardware will switch to wideband mode. When this occurs, any Panadapters that are affected by this change will display **WIDE** in the top right corner to indicate that it is in wideband mode. When in Wideband the radio will open the Bandpass Filters as wide as they can go for any Panadapters or Slice Receivers that are using that Antenna.

33.5.5 Vertical Zoom

Each Panadapter will allow you to adjust the maximum and minimum amplitude displayed. Clicking the up or down arrows displayed in the top right corner of the Panadapter will increase or decrease respectively the maximum amplitude displayed in 10 dB increments. You may also adjust the minimum amplitude by clicking and dragging the vertical axis. This will effectively adjust where the noise floor is positioned within the Panadapter.

33.5.6 Panning Method

Each Panadapter can perform a pan function to adjust the frequency range that is viewed. Clicking and dragging within the Panadapter grid will reorient the frequencies being viewed on the Panadapter in the direction that your mouse is moving. By moving your mouse to the right, you will display lower frequencies and vice-versa.

33.5.7 Waterfall Time Machine

SmartSDR keeps a copy of the last several minutes of the information that appeared in the waterfall. This information can be displayed by clicking in the time scale at the right edge of the waterfall, which changes the display to look like the image shown below. The UTC time at which the information was recorded is shown in right margin of the display. The stored waterfall information can be browsed by clicking in the time scale and dragging the display up and down.

While the stored information is being displayed, SmartSDR continues to record the live waterfall and add it to the top of the stored information. Depending on the amount of information stored, the oldest information at the bottom may be lost.

Return to the live waterfall by clicking on the button at the top right of the waterfall.
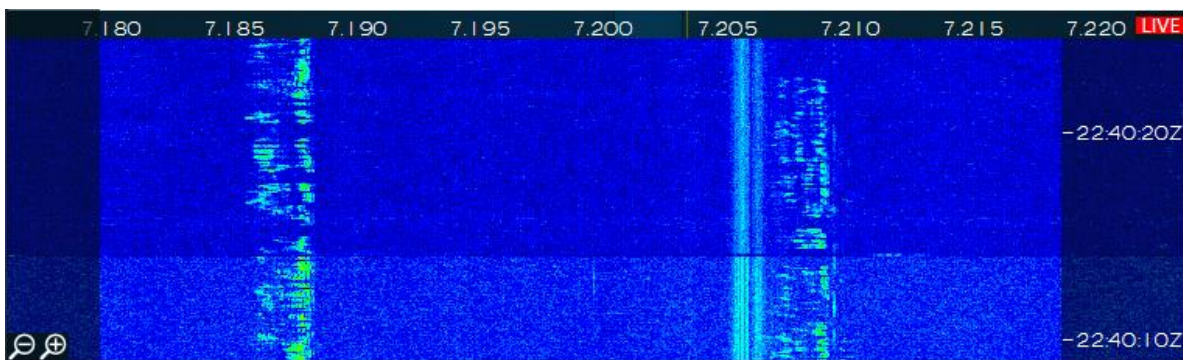
33.5.8 Close/Maximize/Rearrange

Clicking the Close button will remove the Panadapter and any Slices that are displayed in the Panadapter. Once this occurs you will not be able to use the Slice resources until they are recreated in a new Panadapter.

Clicking the Maximize button will prioritize the arrangement of the Panadapter at the top of the display. Once a Panadapter is maximized a grey horizontal separator will appear between the maximized Panadapter and any other Panadapters that are open at the time. Clicking and dragging this horizontal separator will increase or decrease the available size for the maximized Panadapter. The non-maximized Panadapters will adjust to fill the remaining available space. To return to the standard view click the next to the close button. You can have up to three maximized Panadapters at a time.
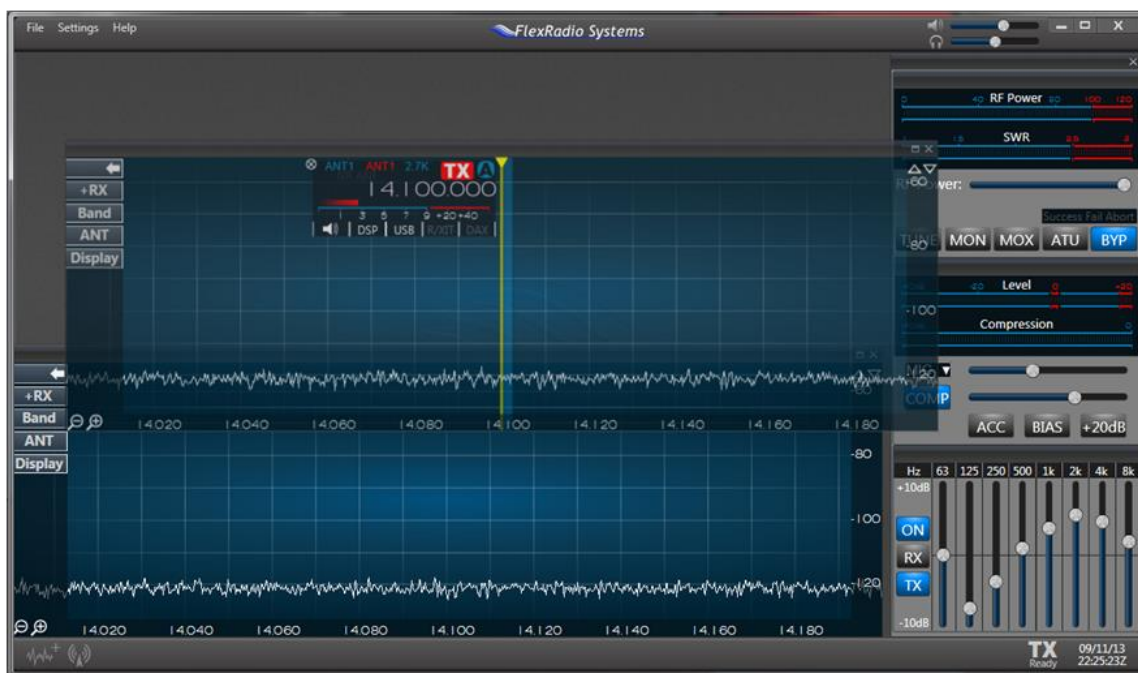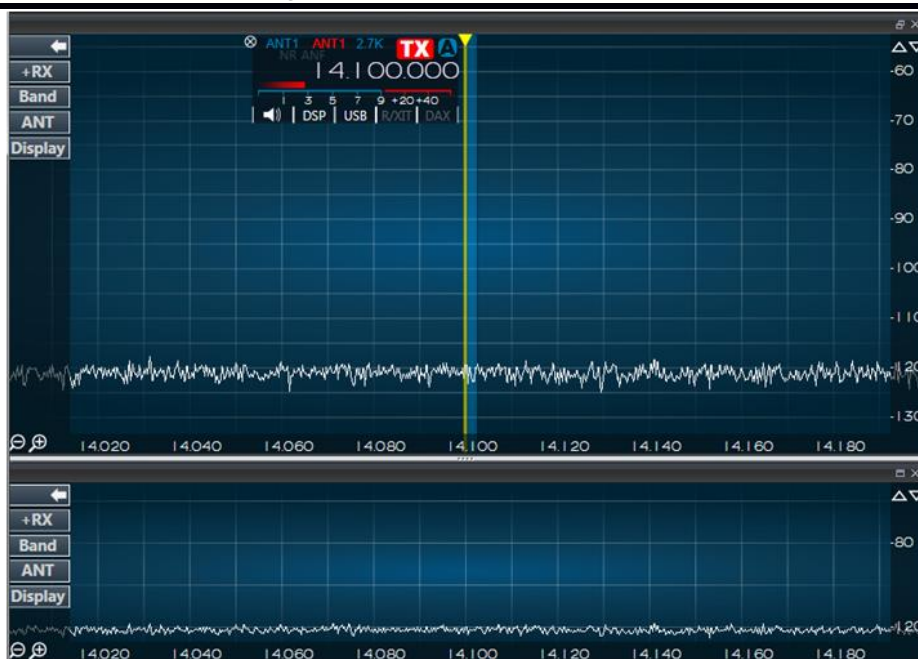
When multiple Panadapters are open, clicking on the main bar and dragging its position will rearrange the Panadapter windows.

33.6 SLICE RECEIVER

33.6.1 Definition

A Slice Receiver is a software resource which represents an independent, full performance, receiver. FLEX-6000 radios can have multiple Slices in operation at one time. A FLEX-6700 can operate up to eight Slices simultaneously while the FLEX-6500 can operate up to four and the FLEX-6300 can operate two. Each slice is designated by a letter indicator which increments with each additional slice.

33.6.2 Carrier Frequency

A slice consists of a center Carrier Frequency displayed by a solid yellow or red vertical bar. A yellow bar indicates the slice is "Active", suggesting that this is the slice that you are currently manipulating. An active slice will have the focus of tuning devices such as the mouse wheel and the FlexControl.

33.6.3 Receive Filter

Surrounding the Carrier Frequency bar will be a blue Receive Filter bar which represents the filtered receive audio. The portion of spectrum that is highlighted by the Receive Filter bar will be output as audio.

The position of the Receive Filter relative to the Carrier Frequency will correspond to what mode that you are in. A Receive Filter to the right of the Carrier indicates an Upper Sideband mode. A Receive Filter to the left indicates a Lower Sideband mode. A Receive Filter that spans both the left and right of the Carrier will indicate a double sideband mode.

The Receive Filter width can be adjusted manually by hovering the mouse over the edge of the bar to get the <-> cursor. Clicking and dragging will expand or reduce the size of the filter.

33.6.4 Dynamic Filter Depth

In most SDR systems, the number of filter taps employed to carry out the filtering task are set by a buffer size in the system. To change the filter tap depth, the system must be stopped before the adjustment can be made. As more taps are added, filtering is better but latency also increases. In SmartSDR, the number of filter taps employed changes based on the mode and filter width to achieve the best compromise between latency and filtering for the job. Ultimately, the filtering capability and the latency are a function of the total duration of samples inside the filter at any time. The table below shows based on mode and filter size how many samples are used in the filter. The more samples (and consequently time) inside the filter, the greater the filter and the higher the latency.

Mode	Filter Width	Filter time	Filtering	Latency
USB / LSB	Any	85ms	Excellent	Highest
CW	<= 400Hz	85ms	Excellent	Highest
	<= 1kHz	43ms	Very Good	Medium
	<= 1.5kHz	21ms	Good	Low
	> 1.5kHz	11ms	Good	Very Low
AM	Any	85ms	Excellent	Highest
FM	Any	11ms	Good	Very Low
DIGU / DIGL	<= 500Hz	85ms	Excellent	Highest
	<= 1kHz	43ms	Very Good	Medium
	<= 2kHz	21ms	Good	Low
	> 2kHz	11ms	Good	Very Low
Waveform Mode	Any	43ms	Very Good	Medium

When using low latency ARQ mode digital programs such as PACTOR, the recommendation is to use a filter width greater than 2kHz to avoid adding extra latency inside the radio to the demodulation time.

33.6.5 Filter Control Widget
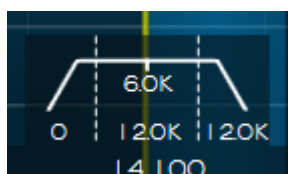
The Filter Control Widget is used to adjust the high cut and low cut of the Receive Filter. To initiate the Filter Control Widget, hover your mouse over the Carrier Frequency just above the horizontal

axis Frequency bar. This will cause the Filter Control Widget to appear. Within the control there are three sections separated by dotted lines.

- If you hover your mouse over the left section a left Control arrow will appear. Clicking and dragging left or right will adjust the low cut of the filter and will display as the left side of the Receive Filter moving left or right. The measurement at the bottom displays the separation from the carrier frequency.
- The center section adjusts both the high cut and low cut of the filter simultaneously. Hovering over the center section will display a four-way arrow. Clicking and dragging up and down from within this section will decrease/increase the low cut while increasing the high cut of the filter effectively making the Receive Filter bar wider. Clicking and dragging left and right will move the Receive Filter bar left and right relative to the Carrier Frequency.
- If you hover your mouse over the right section a right Control arrow will appear. Clicking and dragging left or right will adjust the high cut of the filter and will display as the right side of the Receive Filter moving left or right. The measurement at the bottom displays the separation from the carrier frequency.

33.6.6 Slice Flag
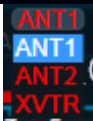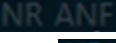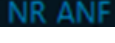
The Slice Flag contains all the controls and information related to the individual slice. The Flag will follow the slice for easy access.

- The Close Button ⊗ will remove the slice from the Panadapter and will no longer be accessible for receive or transmit audio.
- The Lock Slice button 🔓 will lock/unlock the slice tuning. When blue 🔒 slice tuning is disabled. This feature is useful to prevent accidental tuning.
- The Quick Record button 🔴 will record the receive or transmit audio of the respective Slice Receiver. When a file has been recorded the quick play button will change from Grey ▶ to Green ▶. Pressing the quick play button will play back the recorded audio. When the radio is in transmit mode, the recorded audio will be played through the transmitter.
- Receive Antenna drop-down is the far left blue drop-down. It allows for easy control over which antenna is being used for the receive audio. Changing the antenna on the Slice will change the antenna on the Panadapter menu and any other Slices within the Panadapter.

- Transmit Antenna drop-down is the red drop-down to the right of the receive antenna drop-down. It allows for easy control over which antenna is being used for the transmit audio. This selection is unique to the slice and changing it will not affect the Panadapter or other Slices.

- To the right of the transmit antenna drop-down is the Filter Bandwidth Annunciator . This displays the current bandwidth of the Receive Filter in KHz measurement.

- Following the Filter Bandwidth Annunciator is the Transmit Button which will toggle Transmit (TX) on and off for the individual slice. When transmit is enabled on the slice the button will highlight red . You can move the transmit capabilities between Slices by clicking the Transmit Button on another slice.

- When clicked, the slice Indicator will collapse the Slice Flag for an unobstructed view of the Panadapter. This is commonly used when a Panadapter has a small width and height dimension. When collapsed, you will see the Letter Indicator remain and a new TX Button appear . The TX button behaves the same way as the larger version .

- Below the Antenna Drop-down Menus there are three DSP (Digital Signal Processing) annunciators. When illuminated in blue it is indicating that the corresponding function is enabled. NR = Noise Reduction, ANF = Automatic Notch Filter.

- The indicator shows when you are in an arrangement that supports QSK operation. When illuminated in blue, you are in a supported setup.

- The Frequency Display consumes the largest portion of the Slice Flag. It represents the frequency of the Carrier of the individual slice. Clicking on this display will enable manual keyboard input of the desired frequency.

- The S-Meter shows the power within the Receive Filter as measured in S-Units (6 dB per S-Unit).

33.6.7 Slice Menus

In this section of the Slice Flag are a series of menus for adjusting the slice settings. Greyed out menus indicate menus that are not yet implemented.
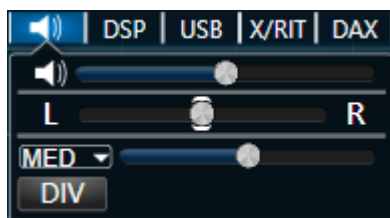
- Clicking on the Slice Audio menu button will expose the slice specific audio controls. Right clicking on the Slice Audio menu button offers a shortcut for muting audio without having

to enter the menu. The Slice Audio Menu includes a Mute button [speaker icon] and volume slider to adjust the audio level of the slice. A Left [L icon] and Right [R icon] balance button and slider to adjust the balance between left and right channels for headsets or speakers. Automatic Gain Control (AGC) drop-down menu [MED icon] allows the user to select Fast, Medium, Slow and Off AGC settings. Finally, the slider to the right of the AGC drop-down controls AGC Threshold.
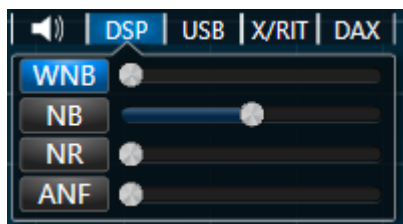
- The Digital Signal Processing (DSP) Menu contains Wideband Noise Blanker (WNB) On/Off and slider, Noise Reduction (NR) On/Off and slider, and Automatic Notch Filter (ANF) On/Off and slider. When these controls are enabled they will illuminate the annunciators on the Slice Flag in blue [NB NR ANF icon]. When the slice is in CW mode the ANF button and slider will switch to an APF button and slider. Clicking on the APF button will enable the Audio Peaking Filter. The slider will adjust the Audio Peaking Filter bandwidth. This function can be useful when trying to copy weak CW signals.

When operating a FLEX-6700 an additional control will appear to initiate Diversity Reception [DIV icon]. This will overlap two synchronized receivers on the same frequency which will operate on two different antennas for simple diversity reception. The slaved slice will have a Slice flag with reduced functionality. To hear the reception enhancement achieved using the diversity feature, you must listen using stereo headphones. Using stereo speakers can result in phasing nulls due to the lack of audio isolation between the left and right audio channels.
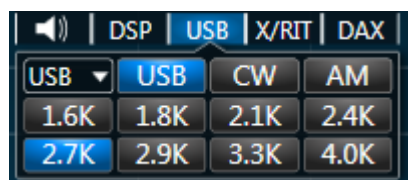
- The Mode Menu button displays the mode that is currently selected. Inside the menu there is a mode drop-down menu and three quick select modes. To change the quick select modes to a different mode, use a right click to expose a drop-down menu of available modes. Beneath the mode select buttons are the mode specific Filter Presets.

- The X/RIT Menu has controls for RIT and XIT. You can enable RIT or XIT by clicking the corresponding button. When enabled the button will turn blue. Modify the offset by clicking the right or left arrows or by typing in the text box. Click the [0] button to clear the offset. You can also control RIT and XIT on the FlexControl by clicking the AUX1 button to enable RIT and AUX3 for XIT. Double click the tuning knob to zero out the RIT/XIT. Double click the corresponding AUX button to disable RIT/XIT.
- When RIT/XIT is set to something other than 0 the slice's transmit filter bandwidth will be displayed on the Panadapter as a red bar. The bar is located behind the receive filter and will often overlap as shown below. Also, when RIT is adjusted a red dotted line will appear to show the original location of your receiver to where your slice will return upon zeroing out RIT.
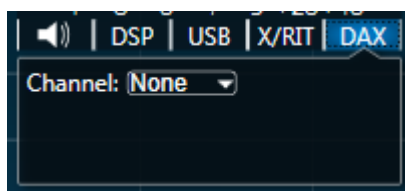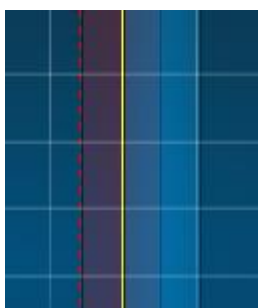
- In the DAX menu, there is a selection for your DAX Audio Channel.

33.7 SMARTSDR RADIO CONTROL PANEL

The SmartSDR Radio Control panel contains the controls and metering required for optimal FLEX-6000 RF transmission. The SmartSDR Radio Control Panel consists of five sub panels described below.

To display the Radio Control Panel, click on the Radio Control Panel icon in the lower left-corner of the SmartSDR application window. Clicking the icon again will remove the Radio Control Panel.

To open or close a subpanel click on the corresponding indicator at the top of the Radio Control Panel . When the button is illuminated in blue the subpanel is open and grey when closed

33.7.1 RF Power / ATU Control Panel
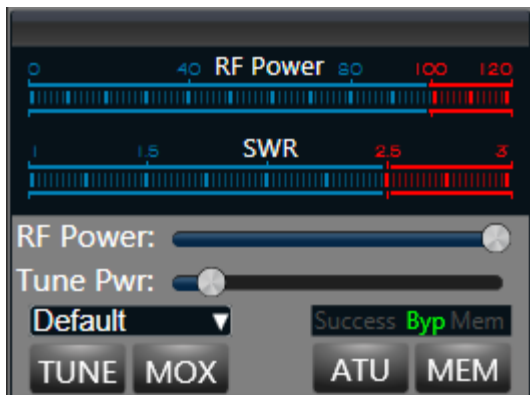
- **RF Power bar meter:** This meter is an indication of the peak RF power being transmitted
- **SWR bar meter:** While transmitting, the SWR meter will measure the ratio of peak voltage on the minimum amplitude of voltage of standing wave, or VSWR. This is an indication of the radiated RF power efficiency. The radio software automatically folds back transmitter power so that the power reflected by the antenna does not exceed 25 watts. This feature protects the Power Amplifier, but should not be relied upon when operating with a mismatched antenna.
- **RF Power slider control:** Moving the slider control to the right increases the RF power output. A value of 0 will not produce any RF output. The scale, from 0 – 100 approximates RF output wattage. If the Max Power in the Radio Setup->Transmit tab has been set for a value lower than 100, the slider will not progress beyond that limit.
- **Tune Pwr Slider:** The Tune Pwr (Power) slider control determines the power output level when TUNE is enabled. Moving the slider to the right increases the RF power output. A value of 0 will not produce any RF output. The scale, from 0 – 100 approximates RF output wattage.
- **Transmit Profile Drop-down:** This drop-down allows the user to quickly toggle between different Transmit profiles that have previously been created.
- **TUNE button:** Clicking this button will cause the transmitter to output a sinusoidal tone at low wattage (10 watts by default) for running external automatic antenna tuners and amplifiers. While TUNE is enabled, the output wattage can be adjusted using the RF Power slider control. When the TUNE button is the last to be pressed, the space bar can be used to toggle the TUNE state.
- **MOX button:** Clicking this button will key the transmitter. Clicking the MOX button while enabled will turn off or unkey the transmitter. When the MOX button is the last to be pressed, the space bar can be used to toggle the MOX state.
- **ATU button:** Clicking this button will initiate a tuning sequence by the internal Antenna Tuning Unit (ATU). If successful, the button will stay illuminated and the Success message will be displayed in the ATU Tune Operation Indicator. If the tuning operation fails to find a better impedance match, the ATU button will turn off, and either the Success or Byp message will appear in the ATU Tune Operation Indicator.

- **MEM button:** When illuminated, this button turns on the ATU memories.
- **ATU Tune Operation Indicator:** This annunciator display will indicate the result of an ATU tuning operation, where the possible outcomes are Success, Byp and Mem.

33.7.2 CW Transmit Control Panel
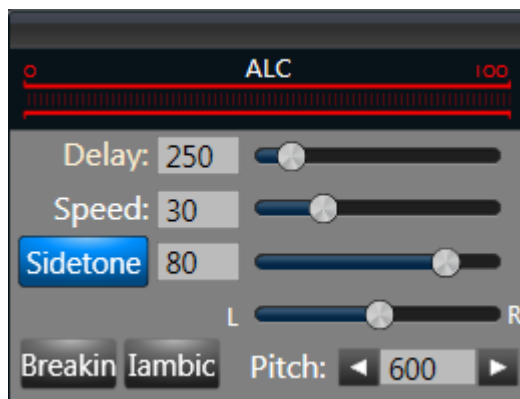
- **ALC bar meter**: This meter is an indication of the analog ALC hardware input levels provided by external power amplifiers. If there is ALC being displayed, the external power amplifier is notifying the exciter (FLEX-6000) to reduce the drive level.

  NOTE: When operating on Phone mode, if hardware ALC is indicated, the default RF Power and SWR meters will be momentarily hidden and the ALC meter displayed indicating a positive ALC condition exists.

- **Delay Slider:** Moving Delay slider control the slider control to the right increases the time delay in milliseconds (ms) between the end of a keying element and when the radio transitions from transmit to receive. This effectively controls the QSK characteristics of the radio, where a value of 0ms is full break. Increasing this value will allow different degrees of QSK (semi break), such as listening between letters or words while sending.
- **Speed slider:** Moving the slider control to the right increases keyer's word per minute (WPM) setting. Moving the slider control to the left decreases keyer's WPM setting.
- **Sidetone Button:** Enables or disables the CW Sidetone.
- **Sidetone Slider:** Adjusts the volume (or amplitude) of the CW note. Moving the slider control to the right increases the volume. Moving the slider control to the left decreases the volume.
- **Sidetone Pan Slider:** Moving the Sidetone Pan Slider will adjust the sidetone from left to right channel audio.
- **Breakin button** (ON by default): Clicking on this button will enable or turn on the transmitter by a key or paddle closure rather than using PTT
- **Iambic button** (ON by default): Clicking on this button will enable the Iambic keyer. Disable the Iambic keyer if using a straight key.
- **Pitch increment / decrement control:** Clicking on the < or > buttons will decrease or increase the CW pitch frequency (tone) in 50 Hz increments

33.7.3 Phone Transmit Control Panel
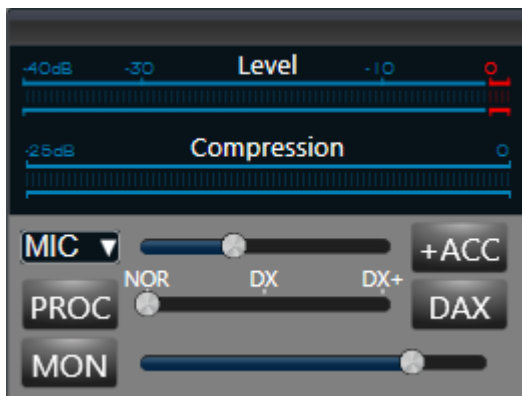
- **Level bar meter:** This meter shows the real-time audio input level in dB from the selected audio input. A peak level of approximately -10 dB is the optimal target for fully modulating the radio. Never exceed 0 dB.
- **Compression bar meter:** This meter shows the real-time level of compression being applied to the input signal when the speech processor (PROC) is enabled.
- **Audio Input drop down** (MIC is the default): Clicking on the drop-down box will display and allow for the selection of the primary audio input source. The audio input options are MIC (front panel 8-pin Foster connector), BAL (XLR balanced input) or LINE (TRS line level balanced audio input), ACCY (rear panel accessory connector and PC (uses the default Windows recording sound device). The audio inputs XLR and LINE are only available on the FLEX-6500 and FLEX-6700.
- **Audio Input Gain slider control** (to the left of the Audio Input drop down): Moving the slider control to the right increases the amount of transmitter audio gain and is shown by the Level bar meter. Moving the slider control to the left decreases the audio input gain.
- **ACC button:** Clicking this button will enable audio input and output on the ACC connector on the rear of the FLEX-6000 at the same time as a different primary audio source
- **DAX Button:** Clicking the DAX button will enable audio input from the Digital Audio eXchange (DAX) Transmit channel. See section **27.2.6**, **DAX TX Channel and Microphone Interaction** for more information on the coordination of DAX and microphones.
- **Processor (PROC) button:** Clicking on this button will enable the W9GR Controlled Envelope Single Sideband (CESSB) DSP algorithm resulting in additional talk power. The speech processor may be on or off and has three different settings when on. In the NOR or normal setting, the processor provides minimal additional gain and simply prevents audio peaks from clipping or producing power greater than the set level. In the DX setting, some compression is provided to the audio to increase the overall sideband envelope which results in a stronger signal that may be more readily heard at a distance. The DX+ setting adds even more compression increasing your talk power or "punch" without incurring significant audio distortion. DX+ is most effective if you increase the low cut TX filter to between 200-400 Hz to concentrate your talk power in the audio frequency range that has the greatest intelligibility. This feature is available only in SSB, AM and FM modes.
- **MON button:** Clicking this button will enable the audio input monitor while transmitting, allowing the operator to hear the audio signal being sent to the transmitter in real time.
- **MON Slider:** Moving the slider control to the right increases the monitor volume of the transmit audio. Moving the slider to the left decreases the monitor volume.

33.7.4 Voice Mode Panel
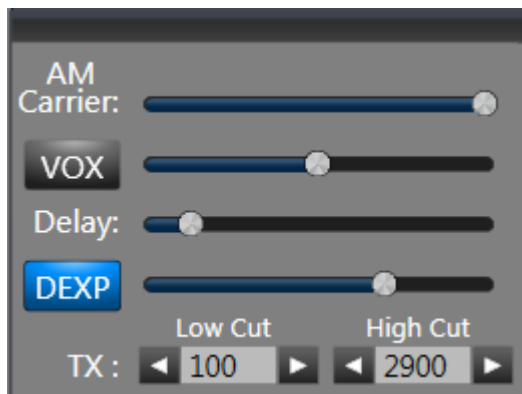
- **Carrier Slider:** adjusts the AM Carrier Level that is used by the radio. Sliding the control to the right will increase the carrier level while sliding to the left will decrease the level.
- **Voice-Operated Transmit (VOX) button**: When the VOX is on, the sound of your voice will automatically switch the transceiver into the transmit mode. When enabled the VOX button will illuminate blue.
- **VOX Level Slider:** will increase the audio level at which transmit is engaged when dragging the control to the right and decrease when dragging to the left.
- **Delay slider:** adjusts the delay between the end of the voice to when the radio switches back to receive mode. Sliding the control to the right will increase the delay while sliding to the left will decrease the delay.
- **Downward Expander (DEXP):** A downward expander variably attenuates the mic gain by a certain percentage below a gain threshold setting rather than gating it on and off. This results in filtering out background noise without the abrupt on/off or chattering of a noise gate. The effect of a downward expander is to increase the *apparent* dynamic range of the system by decreasing the gain during the relatively quiet times thereby moving the apparent noise floor downward.
- **TX Low Cut and High cut:** allows the user to set the low-end cutoff and the high-end cutoff of the transmit bandwidth. SmartSDR varies the sharpness, and therefore the latency, of the TX filter so that the lowest latency filter is used that is consistent with the **TX Low Cut** value. As the **Low Cut** value approaches zero, sharper but higher latency filters are used to assure that no signal is emitted outside of the set bandwidth.

33.7.5 Active Receiver Panel

The Active Receiver Panel mirrors the controls of the active receiver. For a list of the controls and their function see the Slice Flag Section of this manual. The tune step control is the only control that does not also reside on the Slice Flag [STEP: ◄ 100 ►]. You can adjust the size of your tune step by clicking the right or left arrows. A custom tune step size can be entered into the display field and enabled by pressing the <Enter> key. This will alter the step size of each click of the mouse wheel and FlexControl. It will also change the snap tune function for drag tuning and click tuning. When a slice is moved, it will automatically snap to the nearest round number at the chosen step size. This information is remembered on a per-slice basis.

33.7.6 Equalizer Panel
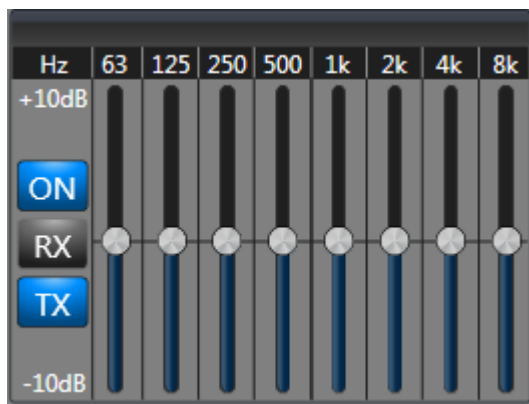
The Equalizer Panel allows the user to adjust the receive and transmit equalization for the radio. Toggle between Receive [RX] and Transmit [TX] by clicking on the corresponding button. The [ON] will enable (Illuminated Blue) or disable (Grey) the equalizer. The eight sliders will adjust the corresponding channel listed at the top of the panel. The slider allows for adjustments +/- 10 dB.

33.8 SMARTSDR CWX PANEL
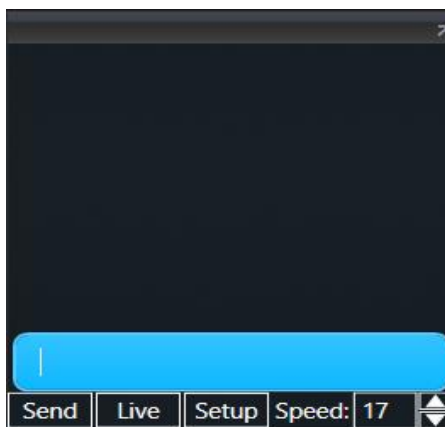
CWX is a keyboard entry method for CW operation. The user types a message into the blue text bubble to be sent by the radio. There are two methods of sending messages "Live" and "Standard"

- **Live mode** of operation is enabled when the Live button is highlighted in Red. [Live] While in live mode, text will be transmitted as the user types into the text bubble.

- In **Standard mode,** the text will not be transmitted until the user hits the "Send" button or presses the "Enter" key.
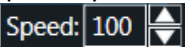
As text is transmitted the font color will change from black to white indicating that the transmission has occurred. The user can stop transmission at any point by pressing the "Escape" key on the keyboard or tapping your paddle or key.
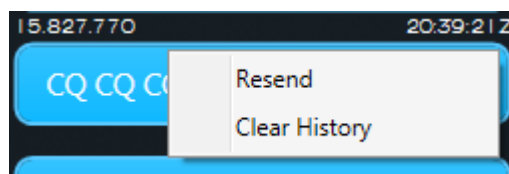
After a message has been sent the user can right click on the sent message to bring up a context menu that allows the user to resend the message or clear the history of the conversation.

CWX also supports several prosigns that can be entered in the CWX text bubble.

To insert Prosign BT use =
To insert Prosign AR use +
To insert Prosign KN use (
To insert Prosign BK use &
To insert Prosign SK use $

The user can quickly control the transmit speed by clicking the up down arrows next to the speed control or directly typing into the text box.

33.8.1 CWX Setup Panel

Clicking the "Setup" button will reveal the Setup Panel which contains a delay control 12 Hot Key presets for preset messages.

The "Delay" control adjusts how long after the end of a transmission until the radio will return to receive mode. This is measured in milliseconds. For QSK operation the Delay should be set to a low value while a high delay setting will keep the radio in transmit (keyed) between characters or words.

The Hot Key messages can be set by typing directly into the text boxes next to the F1 – F12 buttons. Once the message is set the user can press the corresponding F key on the keyboard or clicking the F button on the CWX Setup panel to automatically send the message. A Hot Key message can also be set from the CWX Text Bubble by pressing Ctrl+ F1 – F12 after text has been entered.

Delay: 5

F1	
F2	
F3	
F4	
F5	
F6	
F7	
F8	
F9	
F10	
F11	
F12	

CWX hot key messages are stored as part of Global profiles when the profile is saved. If a Global profile is loaded and there are no CWX hot key memories stored, the profile will not overwrite the current CWX hot key memories.

34 ERROR AND STATUS MESSAGES

Various error and status messages regarding the operational state you your radio may be displayed to inform you of conditions that require attention. The following section describes these messages. If any of these errors occur frequently, immediately contact FlexRadio Support by submitting a HelpDesk support ticket for assistance.

34.1 THERMAL OVER TEMPERATURE

If the temperature of the FPGA exceeds 122F (50C) the following fatal error message will be displayed and radio will become unresponsive, requiring a reboot of the radio to recover. An FPGA over temperature condition can be due to high ambient operating temperatures or insufficient cooling by the FPGA cooling fan.

34.2 REVERSE RF POWER DETECTED

When a large amount of RF power is detected coming into the receiver, the receiver will automatically be disconnected and the transmitter will be unkeyed. Review your radio setup.

34.3 IMPORT CONFIG FAILED

This message will appear if a profile configuration import has failed. If a configuration import fails multiple times, it may mean that the .ssdr_cfg file is corrupted.

34.4 INTERLOCK IS PREVENTING TRANSMISSION

This message means that there is a certain interlock condition that is preventing transmission. Details on this interlock condition can be found near the bottom left corner of SmartSDR.

34.5 TRANSMIT SLICE HAS NOT BEEN SELECTED

A transmit slice must be selected for the radio to transmit. To select a transmit slice, press the TX button on the Slice flag.

34.6 MAX POWER SET TOO LOW FOR ATU

This message indicates the Max Power setting for the radio is set too low for proper ATU operation. Refer to section 31.6 to increase this value.

35 TROUBLESHOOTING TIPS

If you encounter problems running SmartSDR for Windows, please use the following troubleshooting tips. If these tips do not solve the problem, please submit a HelpDesk support ticket for assistance from FlexRadio Systems.

35.1 FLEX-6000 DOES NOT SHOW UP IN THE RADIO CHOOSER

If the FLEX-6000 does not show up in the Radio Chooser, the most probable fault is network related. There are several network components that can be at fault.

35.1.1 Physical Layer Issues

After connecting your FLEX-6000 to a network router, an Ethernet switch or directly to your PC, check to make sure the FLEX-6000 is properly connected at the network physical layer.

Looking at the back of the FLEX-6000 at the Ethernet connection, below the connector on the left is the link state LED. It should be illuminated Yellow when the radio is powered on. If not, you do not have a physical layer connection and you should check or try the following:

- Make sure the Ethernet cable is plugged all the way in on both ends. A click should be heard when it is seated completely.
- Make sure the network router, PC or Ethernet switch is powered on before powering up the FLEX-6000.
- Most network routers and Ethernet switches will have their own link state LEDs associated with the port the FLEX-6000 is connected. Check to make sure the link state LED for the port connected to the FLEX-6000 is illuminated. If the port connected to the FLEX-6000 is blinking at a steady rate, this can indicate that the port is partitioned. Please refer to your network hardware manual for additional information
- Power cycle the FLEX-6000 to re-initialize the Ethernet port.

35.1.2 Firewalls Preventing Network Access from the FLEX-6000

The FLEX-6000 broadcasts a network discovery packet (message) that is received by SmartSDR for Windows. SmartSDR for Windows uses this information to populate the Radio Chooser. Therefore, if the FLEX-6000 is not displayed in the Radio Chooser or after connecting to a FLEX-6000 there is no spectrum displayed, one reason may be that a software firewall on your PC is preventing access. The SmartSDR for Windows Installer automatically modifies the Windows firewall to allow the FLEX-6000 discovery packet and other network traffic to pass properly, but does not modify third-party firewalls. A third-party firewall will most likely block access to the FLEX-6000. You may not be aware that secondary PC level firewalls are installed on your PC, so if you experience connectivity problems, this is the first thing to check.

Additionally, you may have a firewall running on a network router, which is referred to as a "hardware" firewall. It too can be improperly configured and may prevent network access between the FLEX-6000 and SmartSDR for Windows.

In these cases, the action to resolve this condition is to modify the third-party firewall software to allow access from any host on your local network to SmartSDR for Windows by allowing all TCP and UDP port access to SmartSDR for Windows.

If the installed third-party firewall is redundant, it may be disabled at your discretion. Please contact your firewall vendor for information regarding disabling or modifying the firewall for FLEX-6000 access.

35.1.3 MAC Address Filtering

Some hardware firewall / router / Wireless access point products have a feature that restricts access to the network based on the connected device's media access control (MAC) address. If this feature has been enabled, failure to add the FLEX-6000 to the permitted MAC address access control list will prevent the FLEX-6000 from showing up in the SmartSDR for Windows Radio Chooser control panel.

The MAC address of the FLEX-6000 can be determined from the Firewall's device list.

For hardware based firewalls, resetting it to factory defaults will usually resolve the misconfiguration that is preventing network access between the FLEX-6000 and SmartSDR for Windows.

35.2 DAX NOT BEHAVING AS EXPECTED

If a DAX channel is not behaving as expected, hover the mouse cursor over the channel button in the DAX Control Panel to view the diagnostic tooltip for the channel. If DAX is not working correctly, you may stop the DAX Control Panel and then restart it.

35.3 RADIO WILL NOT BOOT OR SMARTSDR-WIN WILL NOT COMPLETELY LOAD

If you get into a situation where the radio will not boot or the SmartSDR client will not load properly, please open a HelpDesk ticket to resolve this. Alternatively, you can reset the Persistence database by doing a Factory Reset. Before doing this procedure, it is recommended to export your current settings if possible using the Import/Export menu in the SmartSDR-Win client.

For the FLEX-6700/FLEX-6500/FLEX-6700R, while pressing and holding the OK button on the front of the radio momentarily press and release the radio's power button. You will see a radio console message that says "Reverting to factory settings" and a countdown timer starting at 5. Keep pressing the OK button until the display counts down to 0 and the Calibrating message is displayed and the LED changes color. For the FLEX-6300, simply hold the Power button while powering on for 5 seconds until the LED changes color.

35.4 FLEX-6000 FAILS TO UPGRADE TO A NEW VERSION OF FIRMWARE

If the FLEX-6000 fails to upgrade to a newer version of firmware, usually indicated by the power LED being illuminated purple for more than 5 minutes after starting the upgrade, this indicates that the initial step of transferring the new firmware to the radio is not working properly. If your radio was working properly with a previous version of SmartSDR, this may indicate that a program or software package on your PC is preventing the transfer of the new firmware to the radio.

Internet Security suites from manufacturers such as, but not limited to Norton, AVG or McAfee can interfere with the SmartSDR firmware update process and the continued proper operation of the radio. If you experience the behavior described above and you have an Internet Security suite installed, disable it completely before performing SmartSDR software updates.

35.5 FLEX-6000 NOT PERFORMING WELL AFTER AN UPGRADE TO A NEW VERSION OF FIRMWARE

If you observe unexpected behavior or your radio is not performing well immediately after an upgrade to a new version of SmartSDR, it is possible that not all the internal processors rebooted properly during the upgrade process. If this is the case, the first troubleshooting step is to "cold" boot the radio by turning the radio off using the power button. If the radio will not shut down, press and hold the power button until the radio turns off. Then remove all DC power from the radio for 10-15 seconds by unplugging the DC power cable. Replace the DC power cable and turn the radio back on. This will ensure a complete restart of all internal processors.

35.6 RF SPECTRUM NOT DISPLAYED PROPERLY AFTER SELECTING A FLEX-6000 OR AUDIO STUTTERING

After a FLEX-6000 has been selected, a default Panadapter is displayed showing active RF spectrum. If no spectrum is displayed, the display is not updating properly or remote audio is stuttering, there are several possibilities that could be causing the failure.

Low bandwidth connection between the FLEX-6000 and the PC running SmartSDR for Windows – If the PC running SmartSDR for Windows is connected to the FLEX-6000 via a wireless network connection, there is a possibility that a combination of low data streaming throughput and packet loss can result in a spectrum display that momentarily freezes or will not be displayed at all. If you experience this behavior, connect the FLEX-6000 directly to the PC via the Ethernet cable and reboot the radio when the PC is powered on. If the direct connect method resolves the problem, then the wireless network is not sufficient for connecting to the FLEX-6000.

Panadapter resource not available – If a Panadapter resource is not available in the radio, it is possible that the resource has been orphaned by an abnormal close of SmartSDR for Windows. In this case, power cycling the radio will free the locked Panadapter resource.

35.7 AMBER FRONT PANEL LIGHT STUCK ON

If the LED on the front panel of the radio stays amber after powering down the radio, the radio has been configured to hold power on a GPS device. This configuration can exist even if no GPS device is present. This situation can be corrected by uninstalling the GPS using the Uninstall button on the GPS tab in Radio Setup. See section **31.4** for details.

35.8 I PURCHASED A LICENSE, BUT IT DOESN'T SHOW UP IN THE RADIO.

If you have SmartSDR Version 2 running on your PC and your radio, and you purchased or are entitled to a Version 2 license but you continue to see the "License Required" message, this issue cannot be resolved by reinstalling any software.

A common cause of this problem is isolation of the radio from the Internet. The radio must be able to contact the FlexRadio server through the Internet to find and install the license. This step is done by the radio's firmware, not by the SmartSDR software running in a computer or in Maestro. The most common reason for the radio being isolated from the Internet is connecting the radio directly to the computer running SmartSDR with an ethernet wire. This configuration creates a "link-local" connection between the computer and the radio, which works fine for everyday use by SmartSDR, but it does not support Internet communication for the radio. The radio will not be able to connect to the FlexRadio server and install the license.

A simple solution is to disconnect the radio from the computer and reconnect the radio's ethernet wire directly to the local area network (LAN) router. Turn the radio on, let it run for a minute, turn it off and return the radio to its original location and wiring. The license should be installed.

If attaching the radio directly to the LAN is not a practical solution, and if the computer is connected to the Internet through a second network interface (usually a Wi-Fi connection to the LAN) another solution is to bridge the two network interfaces together in the computer so that the radio becomes part of the LAN. Instructions for doing this can be found at this HelpDesk Article. After making the changes described in the article and rebooting the computer and the radio, the radio should find and install the license within a few minutes.

If these suggestions don't solve the problem, open a HelpDesk support ticket.

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