# AIRAURA X5

**Product Update Bulletin**

**Version 1.2.0 Software**

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Welcome to Version 1.2.0, the latest software for the AirAura X5 FM/HD Audio Processor.  This update includes numerous product improvements, enhancements, additions and refinements, as well as the incorporation of suggestions from the field. Thanks to our many early adopters as well as our beta testers for their valuable, and always considered, feedback!

Specifically:

- Enhancements to the built-in HD time alignment algorithm to enhance its performance with watermark-based ratings services.

- Refinements to our Limitless$^{©}$ FM clipper algorithm allowing even greater competitive loudness *and* clarity with no increase in distortion.

- Improvements to the 'front end' multiband automatic gain control and its built-in automatic tuning algorithms.

- A new Bass Processor with five different bass styles allowing virtually any character of on-air bass to be created.

- Refinements and additions to the user interface to permit deeper levels of creativity when developing presets or designing a specific on-air sound.

- Refinements to the extensive and built-in RDS/RDBS features.

- A new family of Factory Presets.

UPDATE OVERVIEW

The update process should take only a few minutes, and if possible should be performed with the X5 nearby.  We recommend creating a folder for the downloaded files - some users prefer the Windows desktop - to make finding the files easier.  The software update and all of its relevant files can be found online here:

https://bit.ly/2JBSHwd

All of the upgrades can be downloaded to the processor *without* taking it off the air, however once all downloads are complete the unit *must* be power-cycled once to bring all of the new features online.

From power up to the return of processed on-air audio is approximately <u>45 seconds</u>. The use of a backup processor is recommended if being off the air during that period is a no-no.

Note that remote operation of the processor, as well as its updating, <u>requires</u> the use of the Windows-based Remote GUI Application and it connects to the X5 over a standard Ethernet network. The Ethernet interface in the X5 is Auto-MDIX (Auto-MDIX network interfaces detect if a crossover cable is needed and then reconfigures itself to remove the need for one).

The following explains how to install the X5 Remote GUI Application, how to get it to communicate with the X5, and finally, how to use the GUI Application to download the new software and presets to the X5 hardware.
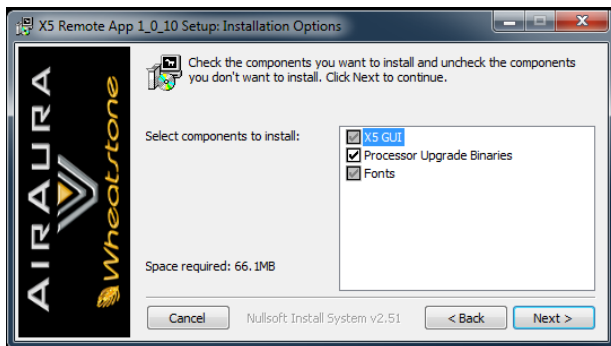
<u>INSTALLING THE GUI APPLICATION</u>

In the folder where the files were downloaded is a file called X5_RemoteApp_1.2.0.exe. Double click the file name to start the installation. NOTE: if you have a previous version of the X5 GUI installed on the target PC make sure that it is NOT running.

When the installation starts the following window will appear. Click the checkbox near bottom left to accept the terms of the License Agreement and then click Next.
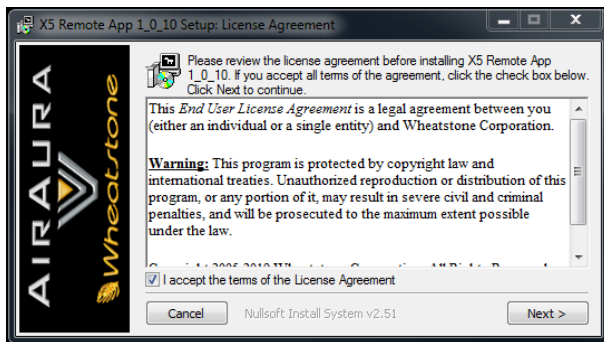
The next dialog will show the options to be installed. Leave all options as they appear and again click Next.



The next popup dialog will ask where you'd like to install the GUI application.  The GUI application may be installed anywhere that's convenient (as long as it's local) though many users will want to install it in C:\Program Files(x86)\Wheatstone\X5.  Click the Install button when you are satisfied with the installation path.
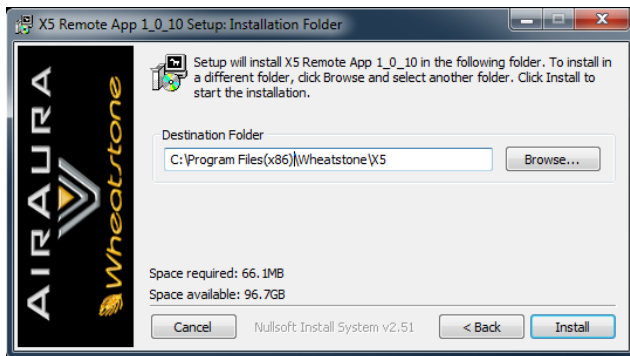


The last popup displays the update process as new files are being installed. Note that on a first GUI installation the process for 'fonts' can *appear* to be stalled as Windows registers them to the operating system - it will eventually show 'Completed'. The GUI may now be started using the Windows Start dialog, looking for the Wheatstone folder under All Programs and then clicking on the X5 Remote App icon.

Once the GUI app is up and running we need to tell it how to connect to the X5 hardware. To do that, click on the Devices button at the lower right corner of the GUI. The popup dialog will appear as follows, noting that there is already a device (mine!) - yours will be blank unless a previous X5 device and GUI were installed!
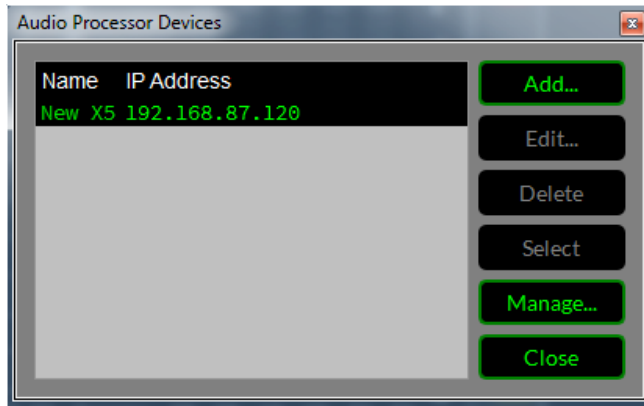


To Add a new device, click on the Add button which will open the following dialog.
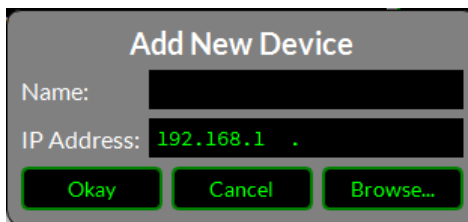


The X5 may be given a custom name, such as station calls, and the IP address field needs the IP address of the X5 coprocessor.  A quick  glance at the bottom of either front panel display will reveal the current IP address of the "Coproc".  Note also that X5 requires *three* dedicated network IP addresses and that the factory *default* IP address for the Coprocessor is 192.168.87.2.

Once the Coproc IP address is entered click Okay to close the dialog.

The last configuration step is to left click on the new device in the Audio Processor Devices dialog to highlight it, clicking the Select button to tell the GUI which X5 it should connect to (it can connect to any in the list) and then Closing the dialog.

**NOTE:**
**When entering IP addresses avoid the use of leading zeros. In other words, an address of 192.168.87.2 should be entered exactly like that, and not as 192.168.087.002.**

→ Next, if the X5 is on the IP address just configured...

→ And the host PC that the GUI application was installed on is within the same network address range...

→ And they are directly connected together with an Ethernet cable or wired through an Ethernet switch...

→ Clicking the Offline/Online button at the top middle of the GUI application should result in the status changing to Online.

→ And if the X5 already has audio present, active metering will be visible as below.

Online/Offline Button
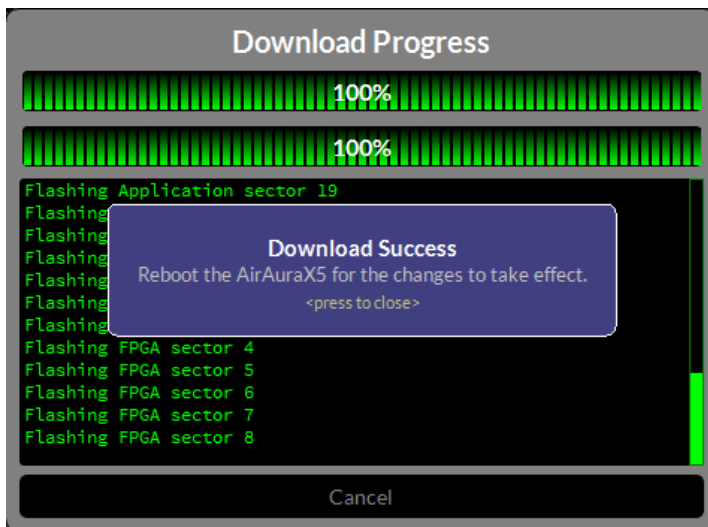
STEP  BY  STEP  UPGRADE  PROCEDURE

With the GUI application online and talking to the X5 hardware, right click anywhere in the GUI and select the 'Hardware/Update Co-processor...' option. A dialog will open showing several folders along with a file having a .vbn extension.

Select the .vbn file and click the Open button at lower right. A new dialog will ask for verification of the download. Click Yes.
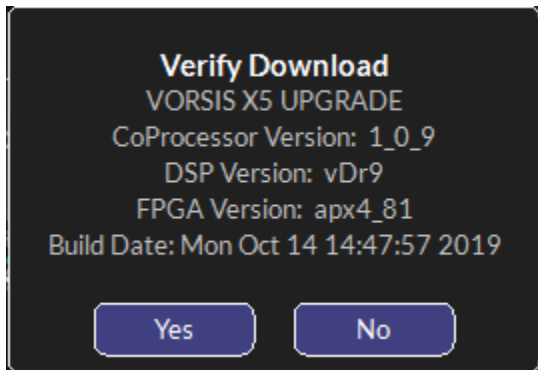


(the versions shown in your dialog will be newer than what is shown at left)

A Download Progress window will open while the update is in progress, followed by a Download Success notification.



The X5 has just received a new operating system, DSP code and FPGA images. A reboot (later!) will be required to bring all of these new features online.

Next we will update the left and right front panel displays, noting that each side has its own dual core i.MX6 1GHz CPU and "GUI IP" network address...

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With the GUI application still online and talking to the X5 hardware, right click anywhere in the GUI and select the 'Hardware/Update Left Front Panel...' option. A dialog will open showing the Host IP address of the left front panel and it should already know and list which "LBN" file it needs to download. Click the Start button at the bottom of the dialog to start the download.

If you happen to be near the X5 and are watching it, you'll notice that the left front panel will exit its application when the update download starts and it will restart itself when the download is finished and the new files have been written to memory. When the download is finished a "Success" message will be shown on the PC GUI.

The right front panel is updated in a similar way using the right click, 'Hardware/Update Right Front Panel...' dialog. Just as the left display did during its update process, the right side will terminate its application and automatically restart at the end of the update process.

We will install the new Factory Presets next, but first we need to power cycle the X5 so that all the new code is online, running, and ready for the new presets. Please allow 45 seconds for on-air audio to return after AC power is reapplied.

INSTALLING NEW FACTORY PRESETS

**IMPORTANT NOTE:**

*Factory presets (and customer created presets, too) depend heavily on the firmware and DSP versions they were created with for proper operation and sound. Mixing old presets and new firmware/DSP versions (or vice versa) may cause unpredictable results and is not recommended.*

The first step is to open the Library dialog at the right side of the X5 GUI application by clicking on the Library button.
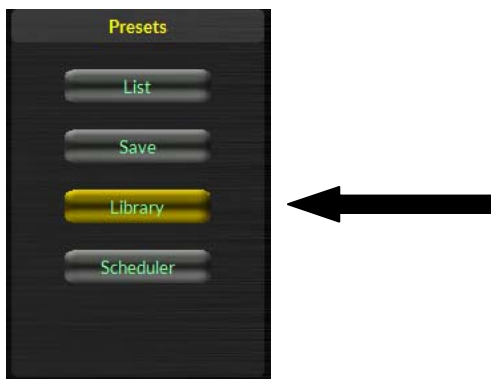
When the Library dialog opens the following Preset Library window will appear, noting that the presets *currently* on your X5 will be different than those shown below.


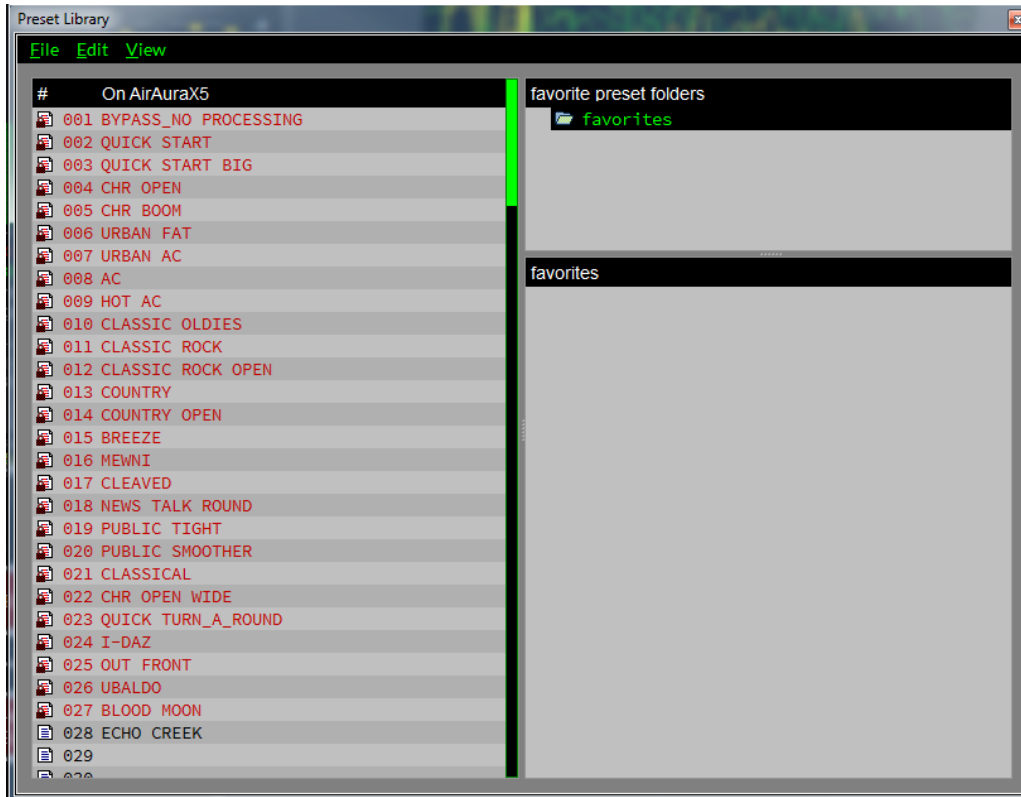
There are two 'panes' in the Preset Library dialog, each with a different purpose:

→        The Left pane shows presets that are currently installed on the X5 <u>hardware</u>.

→        The right pane shows presets stored locally <u>on the PC running the GUI application</u>.

In Wheatstone audio processors presets are stored in numbered 'slots'. In the case of the X5 there are 160 'slots' available for preset storage. Factory presets usually start in the ninth slot with Bypass No Processing in slot 009 and the first on-air preset in Slot 010.

To install the new Factory Preset Package, right click on any preset slot in the left pane and select the 'Install Factory Presets' option from the drop down list.  A new window will open allowing you to navigate to the location of the Factory Preset Package previously downloaded. The file will have a .fpp extension.

Highlight the .fpp filename and click the Open button at the bottom right corner of the dialog whereupon you'll be greeted with the following dialog. Click Yes to continue...

**Install Factory Preset Package**
Are you sure you want to install new factory presets?

Yes    No
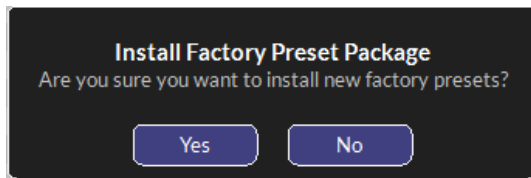
While the preset install process is running previously stored presets will be *overwritten* with the new Factory presets. When the update process is finished all dialog boxes will close, leaving Preset Library dialog open.

You may now select a new Factory preset to put on the air - we suggest trying Quick Start first. Within the Preset *Library* dialog this is done by left clicking the preset and then right clicking on the Take option. Conversely, if the GUI's 'Preset List' dialog was open instead, double clicking the preset will 'Take' it and put it on the air.

A QUICK NOTE ABOUT HOW OUR PRESET 'TAKE' FUNCTION WORKS

Since day one, Wheatstone digital audio processors have utilized what we call *parameter slewing* when new presets are brought on line; processing parameters are slewed from their old settings to their new values over a period of several seconds as the new preset's parameters are loaded to DSP.

The purpose of slewing is to prevent pops, clicks and other jarring sounds as a new preset is taking effect, and this behavior is by design. In our opinion the process of changing presets should be as gentle and unobtrusive as possible, especially when the Preset Scheduler is being tasked with changing presets based on day parting or other events that have been created using the X5's Preset Scheduler feature.

Conversely, and because of this behavior, taking a new preset won't necessarily make its difference *immediately* apparent on the air. Instead, the newly selected preset will 'settle in' over a period of several seconds as the new processing parameters become active and begin to effect how the audio processing behaves and sounds.

**Please keep this behavior in mind when trying different presets in succession! Immediately judging a preset's sound mere milliseconds after selecting it will *always* provide false impressions of how the preset actually sounds on the air - until all of its parameters have finally settled in.**

MISCELLANEOUS NOTES

**Automatic Time Alignment Drift:** It has been noted by those working in the industry that certain automatic HD time alignment error <u>measuring</u> devices 'drift' and often require rebooting in order to perform accurate long-term time alignment error measurements.

Is this true? In a word, yes!

Like the AirAura X5, every diversity delay error <u>measurement</u> device has (must have!) an iBiquity-licensed FM/HD receiver inside it and during the X5 development phase when we asked iBiquity Research & Development about the reports of so-called drift, here is what they said:

*"... audio alignment drift in a receiver is due to the internal timing tracking of the HD Radio demodulator which must dynamically adapt the audio samples extracted from HD Radio signal to the hardware clock of the local receiver board. The severity of drift depends on the tolerance of the clock oscillator on the receiver board and varies depending on the precise receiver architecture. To be safe, we recommend a receiver reboot about once a day."*

It is important to recognize that consumer radios have this issue too! However, every time the receiver is power cycled (car started up), blends to analog and back to digital, or is changed to a different station, the HD section of the receiver is reset. Only in 24/7/365 applications associated with dedicated devices performing automatic alignment measurement is the 'drift' cumulative over a long enough period of time to become problematic.

So, every day at 2:00am X5 system clock time, whether locally set, synchronized to NTP, or not set at all, the right front panel of the X5 automatically shuts down and restarts.

Why?

The X5's right front panel hosts the FM/HD receiver controller and our time alignment measurement algorithm and 'rebooting' returns both to a fresh initial state once every 24 hours. This action provides 100% assurance that there is <u>never</u> any 'drift' in *our* alignment or measurement scheme.

The daily automatic restart cannot be defeated, nor is there any jump in diversity delay or interruption of on-air FM or HD audio when the restart occurs.

Speaking of the front panel's automatic daily reboot, should there ever be a need to reboot *just* the front panel displays it can be done *without* taking the station off the air like a full X5 power cycle would!
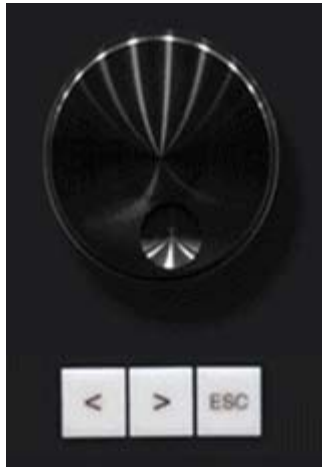


Press and release the encoder knob
AND
the middle button at the same time.

**Automatic Time Alignment Correction Rate:**

There are five Delay Correct Speeds for the automatic HD time alignment error correction algorithm and its control is located within the Delay and Test tab of the GUI's MPX & Output page. While the algorithm continuously *measures* FM/HD diversity delay error, it loops through and performs the *correction* phase only about once per second.

*Fastest:*    An error in delay is adjusted by 80% of whatever the error (or remaining error) is during each pass through the algorithm until the remaining error is one sample. The last correction step is one sample.

*Fast:*    An error in delay is adjusted by 40% of whatever the error (or remaining error) is during each pass through the algorithm until the remaining error is one sample. The last correction step is one sample.

*Normal:*    An error in delay is adjusted by 20% of whatever the error (or remaining error) is during each pass through the algorithm until the remaining error is one sample. The last correction step is one sample.

*Slow:*    An error in delay is adjusted by 10% of whatever the error (or remaining error) is during each pass through the algorithm until the remaining error is one sample. The last correction step is one sample.

*Slowest:*    An error in delay is adjusted by 100% of the error or a <u>maximum</u> of five samples during each pass through the algorithm until the remaining error is one sample. The last correction step is one sample.

**NOTE:**    The 'Slowest' speed setting is *specifically* designed to prevent corruption of watermark-based ratings technology by keeping the correction rate less than that which is known to cause watermark decoders to get 'confused'.

A maximum correction rate was researched by the engineering department of a large radio broadcast group and empirically determined to be no more than seven samples per second. We therefore chose five samples per second as our Slowest correction rate to safely err on the conservative side.

The X5's delay error measurement *accuracy* is +/- 1 digital sample or +/-22.675 <u>microseconds</u>. When the Automatic Correction Control Style is set to 'AutoAdj.' any delay error within the

transmission system contributed by anything *after* the X5 will be servo'd out to continuously maintain the above stated accuracy over *any* length of time.

It is normal to see a +/- 1 sample 'bobble' or correction as the algorithm looks at aired program material and sees the expected differences in FM and HD audio. This behavior does <u>not</u> affect overall time alignment or receiver blend quality.

**FM/HD Receiver Chipset Headroom?**

During beta testing a few questions arose from users in the field about our FM/HD receiver chipset's modulation headroom. Extremely competitive stations (often choosing to ignore the legal modulation limit) wondered if the FM/HD tuner chipset we used in the X5 could tolerate, shall we say, gross overmodulation in the station's quest to be the loudest thing on the planet.

The answer is mostly yes.

While (everyone's) HD receiver runs out of free lunch (and bits!) at 0dBFS, the FM analog side of our FM/HD receiver was carefully designed with enough headroom to accommodate up to 157% modulation to ensure our delay measurement and analysis algorithm could perform well in any *typical* installation.

So modulate away, but be forewarned! With analog modulation like that loudness jumps during analog to HD blend is going to be um, annoying...

**RDS Functions**

**R**adio **D**ata **S**ystem is an international standard protocol which allows the broadcaster to embed text and other metadata into the FM signal.  FM radios which receive this signal are able to decode this metadata, and either display it as text or act upon it in other ways.  The RDS standard is documented in IEC-62106 (2009).  The North American variant, called RBDS, is documented in NRSC-4-B (2011).  The AirAura X5 is compliant with both standards.

**Basic Settings**

RDS must be configured first before it is enabled.  Fortunately this is fairly quick and easy to do.

Select the RDS screen and go to the Basic Settings panel.  Do not enable RDS yet but set the RDS Level knob to 5.0% until you have configured everything else.

Dial in your Country Code (CC).  If your country is not listed, choose the Manual Entry setting, then enter the value in the CC field.

Enter your Extended Country Code (ECC).  A complete list of Country Codes and Extended Country Codes is provided at the end of this chapter.

Enter your station's broadcast frequency.

Enable Clock Time (CT) messages if you have an internet connection to an NTP server and have enabled the X5 to use NTP. See the GUI's System screen under the Miscellaneous category near the lower right side of the interface for the NTP settings, noting that for NTP time to work the X5 <u>must</u> be able to either see the public Internet, <u>or</u> be pointed to an internal NTP server on the local network.

**A Word about Data Sets**

The Basic Settings we have just configured apply to all RDS messaging.  The remaining information that RDS can carry is arranged in Data Sets, of which there are a maximum of 128, and of which only one is active at any given time.  You do not have to use all 128 Data Sets, but you will use at least one.  Data Sets are one way of changing the public "face" – the metadata messaging – of your station from hour to hour, day to day, or week to week.

When setting parameters in the Static Settings and ID Settings panels, pay attention to the fact that the change you are making applies only to one Data Set, which is the one selected by the "Viewing Data Set" knob in each of these two panels.

Data Sets may be switched dynamically during a broadcast, in order to switch the IDs and messaging encoded in the RDS stream.  Several ways to do this are discussed later in this chapter.

**Static Settings**

As the name suggests, the Static Settings do not, as a general rule, change very often, so you might think of them as "default settings" which describe the majority of your station's programming.

Program Type (PTY) is a subject category like "talk", "news," or "sports".  Note that the knob values are divided into two sets.  The RBDS categories in the <u>second</u> half of the knob rotation are appropriate for stations in North America, while the RDS categories in the <u>first</u> half of knob rotation should be used in the rest of the world.

Dynamic Program Type Indicator (PTYI) is a flag that tells the receiver whether your Program Type will change periodically, or remain fixed.

Traffic Advisory (TA) is a flag which indicates that your station is currently broadcasting motor vehicle traffic information, e.g. accidents, congestion, road closures, recommended detours, etc.

Traffic Program (TP) is a flag which indicates that your station does normally carry traffic reports (although not necessarily at the moment).

Music/Speech (MS) is a flag which indicates the predominant type of programming your station broadcasts.

Two settings are largely deprecated in current RDS practice (and ignored by most receivers), but they are provided for backwards compatibility.  Mono/Stereo is a flag which indicates whether your program is broadcast in mono or stereo.  Compression is a flag which indicates whether your signal is compressed.

**ID Settings**

Program ID (PI) is a crucial part of your station's RDS messaging and you should take care to set it correctly.  The Generate PI Code dialog, which is opened by pressing the "Generate PID" button, can help in this regard.  In North America, the PI code is generated from the station's call sign (3 or 4 letters).  In the rest of the world, PI codes are assigned by regional broadcast authorities, but they may also be formulated from a combination of the Country Code, a Regional Coverage code, and a Reference Number.  LPFM stations use a PI code generated from the Country Code and a flag indicating whether or not your program is broadcast on alternate

frequencies.  In any case, your PI code should be unique, and should not overlap with any other transmitters in your geographical location.

Program Service (PS) is an 8-character text string (including spaces) which identifies your station.  Examples might be "103.5 FM," "The Jet," or "Radio 1."  Most receivers display this text prominently.

Radio Text (RT) is a 64-character text string (including spaces) which can carry any message you desire.  It is up to a listener's receiver how or even if to display this message – when it is shown, it is often displayed in a smaller font than the PS message, and it is often scrolled by the receiver inside a "window" of less width than the entire message can fit.

Alternate Frequencies (AF) is a space-separated list of frequencies which carry the same program as your main tuning frequency.  The AF list is used by more sophisticated receivers to automatically switch to an alternate frequency when you are listening to the radio in a vehicle which is moving out of the reception area of the station you are currently listening to.

Again, when setting all of these parameters, pay attention to which Data Set you are altering.

At this point the RDS encoder has the minimal amount of information it needs, and you could go back to the Basic Settings page and enable it. If you have means to monitor the RDS injection you can use it to set the desired injection level. If not, leaving the RDS level control set to 5.0% should work fine in the majority of installations.

**Data Sets, Again**

The Data Sets panel displays a summary of all the settings in each of your data sets.  You may copy values from one Data Set to another, save all Data Sets to a file, restore all Data Sets from a file, and activate a Data Set.

The columns display, left to right, the Program ID (normally this should be the same for ALL Data Sets), Program Type, Dynamic Program Type Indicator, Traffic Announcement, Traffic Program, Music/Speech, Stereo/Mono, Compression, Alternate Frequencies, Program Service Name and Radio Text.

**Automation**

We finally come to the fun stuff!

You *could* set all of the values discussed above, for one Data Set, and just let that run: never changing your message, never displaying artist and title info for your listeners, never texting clues for a call-in contest to your audience.  Alternatively, you *could* try to do all of that in real-

time by opening the AirAura X5 GUI, going to the RDS screen, and typing away. That would work, but you'd be very busy.

Or you can automate. There are three ways to do this: with UECP messages (transmitted via UDP), with plain text messages (transmitted via UDP), and with the X5's Scheduler function. These methods may be used independently or simultaneously, in any combination.

The Automation Settings panel displays controls for four "Units" which receive messages on the selected UDP network port. There are also four different message formats which may be received. Two of these are UECP, and two are plain text.

**Universal Encoder Communication Protocol**

UECP (often pronounced "you-sep") is described by the RDS Forum Technical Specification SPB 490 (2010). In the strict interpretation of the protocol, each message is bounded by special start and stop bits, there is a CRC word, and a requirement that certain byte patterns in the message be escaped. It's very technical, and that's why we call it **UECP Strict**.

A Unit which receives a Strict message has to "unpack" it – it has to strip off the start and stop bits, check and remove the CRC, and translate the escape characters. The message in this form we call **UECP Unpacked**, and this is the format that many automation systems transmit.

Incoming UECP messages have a four-tiered addressing scheme. The top level is the UECP Site Address, which is a number in the range 1-1023. A Site corresponds to a transmitter location or a broadcast facility. The next level is the UECP Encoder Address, which is a number in the range 1-63, and which differentiates multiple Encoders at one Site. Next is the Data Set Number (DSN), a number in the range 1-253 (corresponding to the 253 Data Sets available for storing metadata). Finally there is the Program Service Number (PSN), which is a number in the range 1-255.

In an incoming UECP message, each of these addresses may be set to the special value 0. In the Site Address, it means "all sites." In the Encoder Address, it means "all encoders." In the DSN field, it means "current data set." The PSN field is an exception: it *must* be set to 0 or the AirAura X5 will ignore the message.

In the Automation Settings panel, set your UECP Site Address if you have one, or set it to 0 if not. Likewise with the UECP Encoder Address.

The AirAura X5 implements the following UECP commands:

| | | |
|---|---|---|
| 01 | PI | Set Program ID code |
| 02 | PS | Set Program Service Name |
| 03 | TA/TP | Set Traffic Advisory/Program flags |
| 04 | DI/PTYI | Set values for Dynamic PTY, Stereo/Mono and Compressed flags |
| 05 | MS | Set Music/Speech flag |
| 06 | PIN | Set Program Item Number, the start time of the current program |
| 07 | PTY | Set Program Type code |
| 13 | AF | Set Alternate Frequencies |
| 1C | DataSetSelect | Set current Data Set |
| 3E | PTYN | Set Program Type Name, an 8-character string which extends PTY |
| 24 | FreeFormat | Transmit arbitrary RDS message using raw data blocks passed in |
| 25 | IH | Transmit In-House RDS message |
| 2B | EWS | Transmit Emergency Warning System message |
| 30 | TMC | Transmit Traffic Message Channel ODA message |
| 40 | ODA Configure | Transmit ODA configuration message, transmit short ODA |
| 42 | ODA FreeFormat | Transmit free format ODA message |
| 46 | ODA Data | Transmit ODA message |

## Plain Text

Plain text messages received by the AirAura X5 may be routed to either PS (Program Service) or RT (Radio Text), depending on the Unit's Format setting. These messages affect only the current data set, and neither value is saved (for example, if you switch to a different Data Set after receiving these message, then their values are lost). A PS text string longer than eight characters will be displayed in chunk-wise scrolling fashion. An RT string longer than 64 characters is truncated. Both PS and RT text strings are displayed verbatim.

## The Scheduler

The X5's Preset Scheduler can also be used to activate different RDS Data Sets at pre-determined times, either weekly/daily/hourly or as a one-shot event on a particular date. Scheduled events may include processing preset changes as well as RDS Data Set changes. Opening the X5's Scheduler dialog on the lower right side of the GUI will display the options that are available, noting the three Event Types available: PSET(preset) Only, RDS Only, and PSET & RDS.

Here is how the Weekly Event Scheduler dialog appears when open.
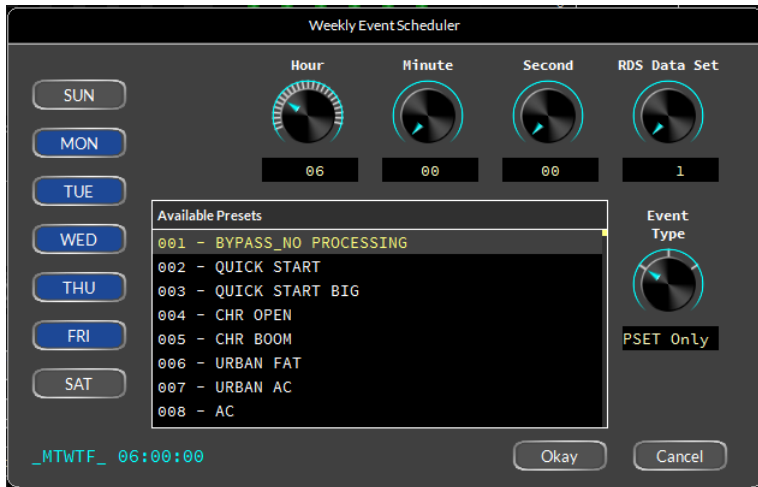


## RDS Level

As mentioned previously, the RDS Level control on the RDS Basic Settings tab sets the amount of injection (modulation) that the RDS subcarrier contributes to the station's overall modulation level.

Note that because the RDS subcarrier and its sidebands aren't correlated with the program audio (they are wildly dissimilar signals!) increasing the RDS Level by, for instance, 2% won't necessarily increase the overall peak modulation level by that same 2%.

Also note that the station's absolute peak modulation as measured by a modulation monitor will appear to wander around by a percent or two as program energy and RDS subcarrier sideband components naturally add and subtract in an uncorrelated manner. Further, the stereo pilot and RDS subcarrier are NOT clipped by the MPX clipper causing the absolute peak modulation level to be somewhat indeterminate (but harmless).