AUDIOARTS

LiON

(The Little Processor That Roars®)

**FM + HD
Five-Band Processor
Plus Multipath Controller**

User Reference Manual

Revision 07.20.23

Software Versions 1.2.0 and Higher

Designed and manufactured in the USA by Wheatstone Corporation
600 Industrial Drive, New Bern, North Carolina, 28562
+1 (252) 638-7000

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Federal Communications Commission (FCC)

Declaration of Conformity

The following information refers to the **Audioarts LiON FM/HD Audio Processor**.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna.

Increase the separation between the equipment and receiver.

Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Consult our technical support department for help.

Wheatstone and Audioarts are not responsible for any radio or television interference caused by using other than recommended cables and connectors or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications will void the user's authority to operate the equipment as well as void its warranty.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Responsible Party:
Wheatstone Corporation
600 Industrial Drive
New Bern, NC 28562
Email: techsupport@wheatstone.com

Warranty Statement

Limited Warranty by Wheatstone Corporation

1. All equipment sold and shipped to final destinations within the USA and its possessions warranted for one (1) full year from the date of purchase against defects in material and workmanship. All equipment sold and shipped to final destinations outside the U.S.A. and its possessions warranted for one (1) full year from the date of purchase against defects in material and workmanship.

    All repairs to maintain the unit at original specification will be made at no charge to the original purchaser, except for shipping and insurance costs to be prepaid by the owner to the factory in the event the unit cannot be serviced by an authorized Wheatstone Corporation dealer.

2. This Warranty is subject to the following restrictions and conditions:
    a. The owner must have registered the product at Wheatstone's official web site; or at the time of servicing the owner must provide proof of purchase from an authorized Wheatstone Corporation sales engineer, distributor or dealer.
    b. This Warranty is valid for the original purchaser on the unit. Parts used for replacement are warranted for the remainder of the original warranty period. Repair or replacement is in the discretion of Wheatstone Corporation and is the exclusive remedy hereunder.
    c. This Warranty DOES NOT apply to damage or defects resulting from abuse, careless use, misuse, improper installation, electrical spikes or surges, or alteration, repair, or service of the unit or equipment by anyone other than Wheatstone Corporation or its authorized dealer.
    d. This Warranty is void if the serial number has been removed, altered or defaced.
    e. This Warranty DOES NOT cover loss or damage, direct or indirect, arising out of the use or inability to use this unit or for shipping or transportation to any dealer.
    f. Wheatstone Corporation reserves the right to modify or change any unit in whole or in part at any time prior to return delivery in order to incorporate electronic or mechanical improvements deemed appropriate by the Wheatstone Corporation but without incurring any responsibility for modifications or changes of any unit previously delivered or to supply any new equipment in accordance with any earlier specifications.
    g. THERE ARE NO OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IF FOR ANY REASON ANY IMPLIED OR STATUTORY WARRANTY CANNOT BE DISCLAIMED, THEY ARE LIMITED TO THIRTY (30) DAYS FROM THE DATE OF PURCHASE. WHEATSTONE COPORATION IS NOT RESPONSIBLE FOR ELECTRICAL DAMAGE, LOSS OF USE, INCONVENIENCE, DAMAGE TO OTHER PROPERTY, OR ANY OTHER INCIDENTAL OR CONSEQUENTIAL, WHETHER DIRECT OR INDIRECT, AND WHETHER ARISING IN CONTRACT, TORT, OR OTHERWISE. NO REPRESENTATIVES, DEALERS, OR WHEATSTONE PERSONNEL ARE AUTHORIZED TO MAKE ANY WARRANTIES, REPRESENTATIONS, OR GUARANTIES OTHER THAN THOSE EXPRESSLY STATED HEREIN.

SAFETY INSTRUCTIONS

- **Heat**
  This product must be situated away from heat sources and high heat generating equipment.

- **Ventilation**
  This product does not have ventilation holes or slots in its enclosure. Cooling is via natural convection from its high emissivity flat black finish.

- **Water and Moisture**
  Do not use this product near water.

- **Power Sources**
  The device must be operated from the power source listed in its specifications and on the rear panel label. If you are not sure of the type of power supplied to your facility, consult your local electrical supplier of a qualified electrician.

- **Grounding and Polarization**
  This product is equipped with a polarized AC plug with integral safety ground pin. Do not defeat the ground safety ground in any manner.

- **Power Cord Protection**
  Power supply cords should be routed in a manner to make them unlikely to be pinched or punctured by any object.

- **Lightning**
  For added protection from lighting induced transients a well-qualified surge protector and proper grounding is recommended. In high radio frequency energy environments additional filtering on the I/O leads may be necessary in order to result in proper operation in those environments.

- **Servicing**
  Refer all servicing of the product to Wheatstone Corporation or their authorized and designated repair facility. Unauthorized service of the product may void the product warranty.

A Brief History of Audioarts and
Wheatstone Audio Processors

Wheatstone was originally founded as Audioarts Engineering and spent its early years designing custom audio processing and mixing products for the music and entertainment industries. An Audioarts product's high quality, exacting attention to detail, and unsurpassed audio performance and reliability drove an ever-increasing demand for a wider variety of its products.

Audioarts products are designed and manufactured by its parent company, Wheatstone Corporation, and are designed and built to the same rigorously high standards. Research and development, manufacturing, testing, and quality control are all accomplished in Wheatstone's large state-of-the-art facility in the historic city of New Bern, North Carolina.

Our design and manufacturing processes operate together to retain complete control over all facets of product creation. From the birth of a product idea to the shipping of the finished product to customers, everything happens in house. Further, by not relying on any offshore manufacturing Wheatstone remains true to its pledge of "Made in the USA".

A dozen experts with deep experience in Digital Signal Processing, broadcast audio and other highly technical engineering disciplines make up our audio processing team. Led by audio processing specialist and broadcast engineering veteran Jeff Keith, the team combines their creative skills to design and build audio processors that achieve a higher standard for on air sound quality.

Wheatstone has invented many new and unique audio processing algorithms to help on-air broadcasts sound better and push audio processor performance to new and higher levels. We created the first program density aware AGC, the first audio limiter to employ the science of human psychoacoustics to mask its operation (our patented 31-band limiter) and our patented method for ensuring that a station's HD time alignment is perfect, and stays there.

Each Wheatstone Audio Processor can be remotely controlled by a Windows® software-based Graphical User Interface. In addition, carefully crafted factory presets ensure that our audio processors can be placed into use quickly, in any size market, and with a minimum of effort – a PhD in audio processing is *not* required!

With thousands of our audio processors now in the field we cordially invite you to take a look at our new LiON… *"the little processor that roars"*.

INTRODUCTION

Audioarts LiON FM/HD+ audio processor is the first product to offer highly advanced on-air audio processing *and* a dual processing path in a half-rack sized package. It not only incorporates some of our most advanced audio processing algorithms, it also combines myriad ways to put them to use.

The FM processing system includes a five band AGC with a windowed leveler, a five-band limiter and a distortion-cancelled clipper. The stereo generator provides a single analog composite output on a rear panel BNC connector. It can also, and simultaneously provide, digital composite multiplex over AES on a male XLR connector using our Baseband192® technology.

The stereo generator is also equipped with a full-featured RDS/RBDS encoder which may be operated in static mode, or may receive dynamic information from any broadcast automation system via the UECP protocol.

The HD+ processing path can optionally include the five-band AGC and limiters, just the windowed leveler output, or even the unprocessed audio input if desired. The HD+ processing also includes a BS.1770-compliant automatic loudness controller with a settable LUFS target and full metering of short and long term loudness.

The Input Audio Source may be analog left/right, AES3 digital, or WheatnetIP with automatic fallback to a secondary audio input should the primary audio source fail. If failover to the backup source occurs and the primary source comes back up later, LiON will automatically switch back over to the primary audio source.

Several dozen Factory Presets are included for getting users up and running quickly. Those, or customer generated presets, may be automatically put on air via the full featured clock-based Preset Scheduler.

The analog and digital (AES3) outputs may be selected to output either the processed FM signal or the HD+ processing. De-emphasis options are provided for whenever the outputs need to carry the processed FM audio and provide a 'flat response' audio output.

LiON's FM stereo multiplex and HD audio outputs may also be sent over a network to our SystemLink® decoder with the FM and HD audio remaining in perfect sync.

LiON's analog and digital audio inputs and outputs are available on separate RJ-45 jacks which follow standard StudioHub pin assignments. Any compatible RJ to XLR breakout cables may be used for external devices only equipped with XLR-style connectors.

Rack Mounting

Lion can optionally be mounted into an industry standard 19" equipment rack and will require one rack unit (RU) of vertical space. If using only two rack screws always use the *bottom* two screws to prevent twisting of the front panel and other undue forces from harming the processor chassis.

LiON does not need and does not have ventilation holes. Cooling is accomplished via the high emissivity of its black extruded aluminum enclosure.

LiON may be mounted between other devices in the equipment rack; however, in accordance with good engineering practice it should not be mounted directly above devices that generate a significant amount of heat (such as power amplifiers or power supplies). If such a location is unavoidable it is advisable to utilize an extra 1RU blank rack panel between LiON and devices immediately above or below it.

GENERAL ADVISORIES

LiON's enclosure usually does not need to be opened in the field. There are no user-serviceable parts inside.

LiON's power supply operates at voltages well above the incoming AC line potential and pose a hazardous, if not potentially lethal, risk.

Special tools, software, and fixtures are required for service.

Please don't shower with LiON. It is not compatible with water.

As with all computers and mission-critical broadcast equipment, LiON should always receive its AC power from an Uninterruptable Power Supply (UPS) and be protected with a suitably rated surge protector.

LiON must be returned to Wheatstone Corporation under a Return Authorization in the unlikely event that repair is necessary.

If you hear LiON roar, it's because it's supposed to.

LiON requires a Return Authorization should it need to be returned to the factory for repair. Contact our Technical Support department via:

➢ Telephone: +1 252-638-7000 Monday through Friday 8:30am to 5:30pm ET.

➢ Our online Support Web Portal: https://shorturl.at/gow29

➢ Via email: techsupport@wheatstone.com.

LiON Installation Tips

Grounding:

➢ Establish a low impedance common ground in the broadcast facility and try to route all equipment grounds to that point – this is what's known as a 'star' ground.

➢ Always use ground conductors with the largest possible surface area and keep ground leads as short as possible.

➢ LiON's ground reference is its chassis which should have a connection to station ground. This is especially important when LiON is operating in a high RF environment and helps minimize differential voltages between the processor's chassis and other pieces of gear and the rack that it is mounted in.

Surge Protection:

➢ Always place surge protection circuits as close as possible to the device being protected.

➢ AC power line surge protection should manage transients to keep *instantaneous* potential differences between power line hot, neutral, AC grounding conductor and the station ground and processor chassis as low as possible.

➢ Measures should be taken to keep the instantaneous potential difference between the audio cable shields and the processor chassis as low as possible, particularly when LiON is located within an electrically hostile environment such as the station's transmitter site.

UPS/Power Conditioning:

➢ Choose the best power conditioning/UPS units that your budget will allow, focusing on its features, options, and performance. Some questions to ask while shopping:

➢ Will the UPS behave properly when AC power is not exactly 60Hz, such as when the facility is on backup generator?

➢ If the UPS has built-in surge protection, what kind of surge capability does it have and where are those surges directed to?

➢ Is the UPS equipped with remote monitoring capability?

➢ Does the UPS have onboard monitoring and alarms to signal problems such as low batteries and primary power outages?

Analog Audio Input Connections:

Balanced audio input sources are recommended and should <u>always</u> be connected to LiON using standard two-conductor shielded audio cable such as Belden 8451 or 9451.

Unbalanced input audio connections are not recommended, however should they be needed, connections between the unbalanced source output and LiON's input should be connected as follows: the unbalanced source's "hot" should connect to LiON's "Hi" input (XLR pin2) and the unbalanced source's shield connected to LiON's "Lo" input (XLR pin-3).

In certain circumstances grounding the shield conductor *also* at LiON's input (XLR pin-1) may also be needed to reduce noise and hum.

If RF interference is an issue, the floating and ungrounded far end of the audio cable shield can be *experimentally* bypassed to RF ground via a 0.01uF, 250V AC rated capacitor.

The purpose of using a capacitor rather than a direct 'wire' connection to ground is to prevent a *power-line frequency* ground loop (hum). The capacitor's relatively low capacitance presents a *high impedance* at power line frequencies but a *low impedance* path for RF currents in both the AM and FM broadcast bands.

Note that sometimes grounding the far end of the cable shield in this manner makes the problem worse, but the only way to find out if it helps is to try it. Here are some suitably rated capacitors:

Brand	Capacitor Ratings	Manufacturer's Part Number
TDK	10,000pF, 250VAC, +/-20%	CS17-F2GA103MYGS
Murata	10,000pF, 250VAC, +/-20%	DE2F3KH103MA3B
Panasonic	10,000pF, 440VAC, +/-20%	ECK-ATS103MF
AVX	10,000pF, 250VAC, +/-20%	65N103MBLCP

LiON's analog and digital audio inputs and outputs are via RJ-45 connectors and are interfaced using StudioHub compatible pigtails so some 'creativity' might be needed to devise a method for connecting a cable shield to ground through a capacitor.

For RF interference mitigation snap-on torroidal cores can be installed on the StudioHub wires rather than performing surgery on its molded XLR connectors. If so, the snap-on cores should be made of Manganese Zinc (MnZn) and/or Nickel Zinc (NiZn).

MnZn has good attenuation properties at low broadcast frequencies such as the AM broadcast band, and NiZn has properties better suited to the FM broadcast band. It may not hurt to use both types, nor will it hurt to use more than one of each type on the same cable, keeping them as close as possible to the rear panel of LiON. Looping the wire through the core more than once will also increase a core's effectiveness.

Analog Audio Output Connections:

Balanced audio loads are always recommended and should be connected to LiON's outputs using standard two-conductor shielded audio cable such as Belden 8451 or 9451.

Unbalanced audio loads should be avoided, but if they can't they should be connected using shielded two conductor cable such as Belden 8451 or 9451, just as if connecting a balanced source.

LiON is equipped with an active balanced output driver stage that behaves like a transformer and the correct wiring method may be different than expected.

The unbalanced load's "Hi" lead should be connected to LiON's output XLR Pin 2 ("Hi") or StudioHub pins 1 or 3.

The unbalanced load's shield should be connected to LiON's output XLR Pin 3 ("Lo") or StudioHub pins 2 or 6.

To enable LiON's balanced output amplifier to operate correctly when driving an unbalanced load it is recommended that LiON's XLR output Pin 1 (ground/shield) also be connected to Pin 3 ("Lo") at the LiON end of the cable and not at the far end.

> ➢ *Do not connect the XLR Pin 1 and Pin 3 conductors together at the far end of the cable. Doing so can introduce external noise and crosstalk on the output amplifier's 'load sense' lead which is XLR Pin 3 whenever Pin 2 is being used as the "Hot."*

As in the input case, if RF interference is an issue the far (floating) end of the cable shield can be experimentally bypassed to RF ground through a 10,000pF AC rated capacitor to see if it helps. Please refer to the table in the Analog Input Connections section above for capacitors known to be suitable for the task.

Digital Audio Connections:

For digital audio connections always use a good quality balanced digital audio cable (or twisted pair Category 5E/6 Network cable) having a characteristic impedance of 110 ohms.

The cable should be shielded where possible and in the case of multi-pair cable, each pair should be individually shielded. Foil shielding is recommended for permanent installations and a cable with foil shield plus an overall braid should be used in applications where frequent flexing of cables will occur.

Generic audio cable such as Belden 8451 and 9451 *may* be used for interconnecting AES3 digital audio devices *as long as the cable is short*. The actual cable length that will work satisfactorily is determined by many factors; the error correction and jitter tolerance of the AES3 receiver in the equipment being fed, the characteristics of the digital cable driver, and the characteristics of the specific cable being used and the cable's length.

Generic analog audio cables typically have higher capacitance than digital cable and high capacitance cables can impair the ability of the AES3 receiver to recover the digital signal without errors. Increased jitter, dropouts, or no audio at all can be an indication of an improper cable type or a digital cable that is simply too long.

Where to install LiON

The best location to install LiON is always at the transmitter site. The primary benefit of a transmitter site installation is availability of LiON's built-in stereo generator and MPX processing, much tighter control of modulation peaks, and more competitive loudness.

A transmitter site location allows the use of LiON's oversampled composite processor which can create additional loudness without the audible grunge and spectral garbage that analog composite clippers create.

With the advent of Wheatstone's Baseband192® technology the promise of an all digital air chain that is as loud as and cleaner than analog composite is a reality. Users have the option of deploying LiON using either traditional analog MPX, or MPX over AES with a suitably equipped exciter.

We recommend that whenever there is a choice between using an exciter's composite MPX, AES over MPX option, or AES3 left/right input, LiON should be interfaced to the transmitter using either the exciter's MPX over AES, or its analog composite MPX input.

The exciter's AES3 digital left/right input may be 'clean' and it may be 'digital,' but it also precludes the ability to gain additional loudness through the use of LiON's oversampled composite clipper. Also, depending on several factors including the sample rates being used, an FM exciter's AES digital left/right inputs typically exhibit inferior infrasonic frequency response and peak control compared to its composite MPX input.

When LiON is located at the studio and an STL is being used to send the program material to the transmitter site there are several issues to consider:

Digital STL:

There are two general categories of Digital STL's on the market – those with codec-based audio compression and those using uncompressed linear audio.

When a digital STL employs codec-based audio compression LiON should be located at the transmitter site, placing it *after* the codec. This is because most codecs will sound far

better when presented with *unprocessed* studio audio instead of highly processed and pre-emphasized audio from an FM on-air processor's output.

Further, the encoding schemes used in such STL's usually cannot accurately pass the well-defined peak levels created by LiON and will create a modulation (loudness) disadvantage.

Installing LiON at the studio end of a "compressed" STL brings with it at least two caveats:

➢ LiON's stereo generator and composite clipper are not available. Many digital exciters offer stereo generator and composite clipper functions but their clippers have historically been quite crude and spectrally 'dirty'. Exciter-hosted composite clippers are usually not the optimum choice when the ultimate in sound quality is the goal.

➢ Compressed STL's do not perform well when presented with competitively processed audio, especially when that audio has been pre-emphasized.

Codecs do their magic by examining the incoming audio for opportunities to remove content that shouldn't be audible to the average human ear. When densely processed audio is presented to a codec there are fewer opportunities to remove redundant audio information and then *mask* that removal from our hearing, resulting in the commonly known codec artifacts such as swishing and a metallic texture to the audio.

When handling heavily processed (limited dynamic range) material, codec operation can be much more obvious – even to the point of being objectionable – than when the processing is located *after* the codec where the masked artifacts are only occasionally and, usually, minimally unmasked by processing gain.

TIP: If using the LiON at the studio be certain that any clippers or pre-emphasis in the transmitter site's stereo generator are calibrated properly and complement the settings in LiON. There can be gross distortion and large and unpredictable modulation overshoots if pre-emphasis is *also* enabled in the transmitter.

Analog Left/Right STL:

Older analog discrete left/right channel STL's can suffer from the inability to control audio peaks because of inadequate bandwidth in their IF circuits or poor low frequency and phase performance. Also, individual left/right STL's rarely have identical group delay which will adversely affect stereo separation. Such STL's can also suffer from AFC bounce when handling highly processed low frequency material, robbing modulation and reducing on-air loudness.

Composite Analog STL:

A high quality analog composite STL has many advantages over an analog left/right STL and will typically have broader audio bandwidth and better audio performance than a discrete analog STL. Most also have the capability to add subcarriers for SCA and RDS along with the composite audio. That means that subcarrier generators may be located at the studio which, along with the audio processor, makes for a very convenient setup.

When the system includes a modern composite STL and a properly engineered point-to-point RF path, the on-air audio can be nearly indistinguishable from that using a digital STL.

Analog Phone Lines:

Discrete left/right analog 'phone line' STL's are not recommended because of the inability of most Telco service providers to meet the tight frequency response and phase matching requirements of a stereo audio pair. Furthermore, in many locales wideband analog audio circuits are unavailable or their cost prohibitive. On the other hand, if the 'wired' STL is a dedicated (and equalized if necessary) pair of circuits under the station's complete control, it might be acceptable.

Where Should Pre-Emphasis Go?

Pre-emphasis should *always* be applied by the FM audio processor and *never* by the FM exciter. Modern FM audio processors are equipped with highly refined and very sophisticated technology to manage the myriad challenges posed by FM pre-emphasis and can provide very tight modulation control with very low perceived distortion. No FM exciters have this technology.

To summarize, the overall best location for the audio processor is at the transmitter site.

Ratings Encoders:

Lab testing and field experience has shown that all of our on-air audio processors, including LiON, favorably pass the data watermarking technology used in the Nielsen and Kantar rating services and regardless of the aggressiveness of the audio processing performed.

AC Power Considerations

To enhance long-term reliability LiON does not have a power off/on switch. *All* power switches notoriously become intermittent over time and without regular use.

LiON accepts AC line input voltages between 100 and 240 VAC, 50 or 60Hz, and its power consumption is less than 20VA.

Although aggressive AC input filtering is utilized on LiON's AC power input, it is always advisable to use external surge protection and an uninterruptible power supply (UPS) where possible. This is especially true where the AC power quality can be in question, such as at a remote transmitter site.

Power conditioning, surge suppression, and even power backup devices are wise investments when using sensitive modern electronic devices. LiON is, after all, a highly specialized "computer."

The use of a UPS will also protect LiON from very short duration power interruptions which might otherwise signal it to reboot. When LiON powers up or reboots there is a loss of audio for approximately 35 seconds.

Rear Panel Connections

The image below shows the rear panel of LiON and the location of various connectors associated with installation:

LiON Rear Panel Connections from left to right:

Connector Type	Function and Notes
RJ-45	Left/Right analog audio input – StudioHub wiring standard
RJ-45	Left/Right analog audio output – StudioHub wiring standard
BNC Female	Processed stereo MPX output
BNC Female	SCA/Subcarrier Input
RJ-45	Left/Right digital audio input – StudioHub wiring standard
RJ-45	Left/Right digital audio output – StudioHub wiring standard
RJ-45	100BaseT Network connection
IEC C-14 male	100-240VAC power input – internally fused

Audio Inputs:

LiON accepts three types of audio input sources:

> ➢ Balanced analog line level left/right audio;

> ➢ Digital AES3-compliant left/right audio with sample rates between 32kHz and 96kHz;

> ➢ WheatnetIP via its 100BaseT Ethernet connection to a WheatnetIP audio network.

Input audio can be applied to any or all inputs simultaneously. Automatic audio failover from analog to digital or vice versa is supported.

Automatic failover from AES3 or WheatnetIP to analog is instantaneous and based on invalid or missing bits in the AES3 stream <u>or</u> after 30 seconds of "silence" on both channels (audio level below -42dBFS).

Automatic failover from analog to AES3 or WheatnetIP is based on silence sense and in response to audio on both channels being below -42dBFS for more than 30 seconds.

Input failover capability is not available between the AES3 and WheatnetIP inputs.

Audio Outputs

Outputs for the FM and/or HD audio paths are available as:

> ➢ Balanced analog left/right stereo, pre-emphasized.

> ➢ Balanced analog left/right stereo, de-emphasized according to the pre-emphasis in use.

> ➢ AES3 digital left/right stereo, de-emphasized according to the pre-emphasis in use.

> ➢ AES3 digital FM composite (Baseband192®) connected to compatible FM transmitter or exciter*

> ➢ Unbalanced FM composite stereo on one BNC female connector.

> ➢ Left/right audio via a WheatnetIP audio network.

*The AES digital output connector is switchable between left/right stereo and digital composite (Baseband192®). Note also that the Baseband192® MPX signal is not available

or routable within a WheatnetIP network due to the high sample rate and special data formatting.

Network Connections

LiON can connect to a network or PC/laptop over wired Ethernet via the 100Base-T Ethernet port on the rear panel. The port is Auto-MDIX and therefore supports either straight through or crossover cables. The wired Ethernet interface can support multiple and simultaneous connections to remote LiON GUIs.

Factory Processing Presets

LiON comes equipped with several dozen factory presets and can hold 100 presets in its onboard memory. Customer-created presets can be saved within LiON's onboard memory until all 100 preset storage slots are full. An unlimited number of presets may be stored on the PC hosting the Windows-based remote control GUI software.

It may take several seconds for a new preset's settings to fully settle in so it is important to remember this when switching between presets and judging the resulting on-air sound.

If a Factory or User preset is recalled and not modified, the preset name will be displayed in green text in the GUI's Current Preset window. If changes are made the color of the preset name will change to red. If/when those settings are then saved back to LiON the preset name assigned when the settings were saved will appear in the Current Preset window in green text.

Factory presets can be adjusted and saved to a new preset name in order to create a new custom on-air sound.

Note that factory presets are write-protected and changes made to them cannot be written back over the original preset's memory location.

Factory presets that have been modified are considered by the system to be 'user' presets and therefore must be saved in a new preset storage slot.

Our advice is to explore all of the factory presets and then pick the preset that is the *closest* to your desired on-air sound *texture* (not necessarily loudness).

If changes are necessary we recommend making no more than two or three adjustments at a time and then listening for a while before deciding more changes are necessary.

A broadcast audio consultant friend of ours who has many decades of field experience with all kinds of on-air processors and program formats offers this advice:

"Tweak small, Listen large"

LiON SIGNAL FLOW

The diagram below shows the overall signal flow inside the LiON processor including the output signal switching and source select switching for the input of the HD+ processing path.
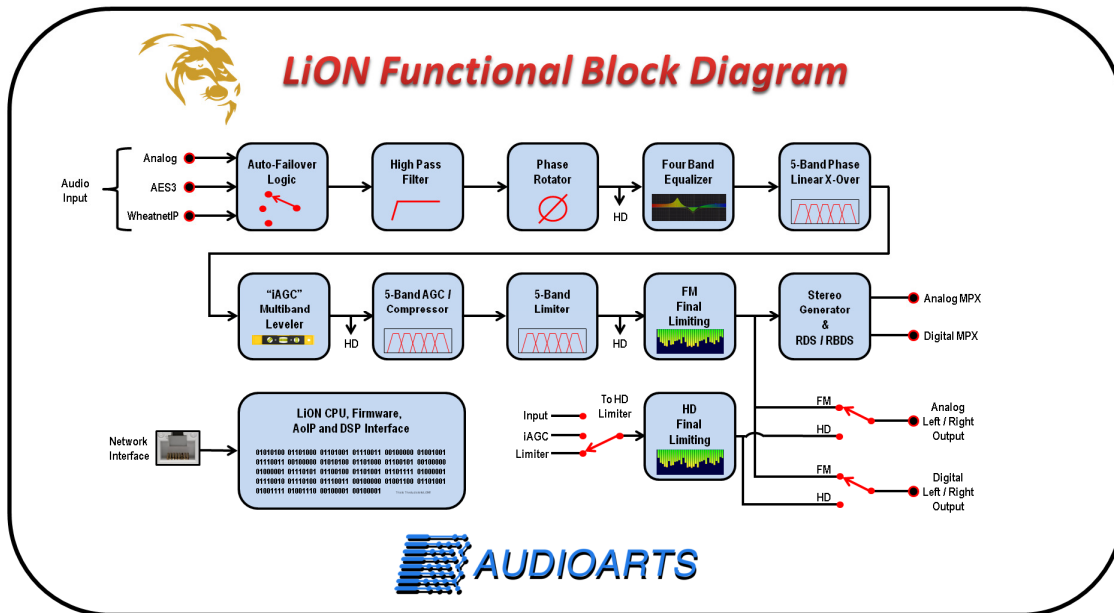
FRONT PANEL OVERVIEW

LiON's front panel is equipped with a rotary encoder with push switch, an illuminated "Back" button for use when navigating the front panel menu structure, and a 128x128 pixel organic LED (OLED) for displaying the menu. The name of the current preset and the processing gain reduction and input/output metering is always displayed on the Home screen.

There is also a "Link" LED located to the right of and below the rotary encoder for status and the state of any network connections present.

LED STATE	
Off	No Ethernet network connection is present
Red	On briefly during power up while the operating system loads
Green	On steady if an active network connection is present

Note: the Link LED does *not* blink during network data transmissions but remains solid green.
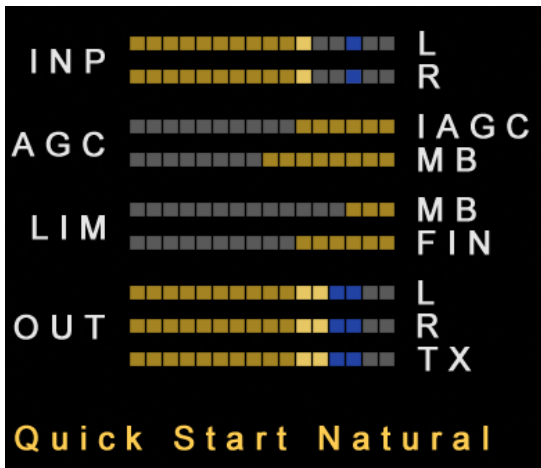
Navigating the front panel is user-friendly.

When the menu tree is not in use and has timed out a Home screen (shown at left) will be visible with the processing activity, input/output levels and the name of the current preset being shown.

Turning the rotary encoder, activating its push switch, or pressing the Back button will cause the Home screen to be replaced by a menu tree (shown on next page) displaying the various options and settings which are available for adjustment.

Scrolling through the front panel menu is done via the rotary encoder. Selecting the option to investigate or modify is accomplished by pressing the encoder's push switch an item is highlighted.

Navigating out of the selected option and back into the overall menu tree is done using the "Back" button. Two pushes of the Back button will exit out to the Home screen.

Front Panel Security: At the bottom of the menu tree is an option called Access which allows the user to lock the front panel and prevent access to anything but the Home screen and the password entry dialog.

We've used a four-digit numerical passcode to create a one in ten thousand chance of someone simply guessing the passcode. Note also that the front panel is not 'locked out' if more than a certain number of passcode guesses have been attempted. Even an extremely lucky person would need some time to hit on the one correct code out of the 10,000 possible choices.

If the front panel passcode is not known or has been forgotten, Audioarts customer support can instruct you on how to get it unlocked; there is no general 'reset' code.

Contact Wheatstone Customer support if passcode assistance is required:

Email techsupport@wheatstone.com or call us at +1 252-638-7000.

LiON FRONT PANEL MENU TREE

LiON Front Panel Menu Tree

```
── PRESETS ──────── Preset List

── INPUT ────────── Source ──┬── Analog
                             ├── Digital ── AES
                             ├── Digital ── WNIP
                             ├── Analog Gain
                             └── Digital Gain

── PRE-EMPH [PreEmp] ────────┬── Flat
                             ├── 50uS
                             └── 75uS

── SOUND ───────┬── Texture ──┬── Drive ──────────── Edit  -5 to +5
                │             ├── Density ────────── Edit  -5 to +5
                │             ├── Loudness ───────── Edit  -5 to +5
                │             └── Save Preset [Save Pst] ── Edit  Name (8 char max)
                │
                └── Eq ───────┬── Low EQ ─────────── Edit  -5 to +5
                              ├── Warm EQ ────────── Edit  -5 to +5
                              ├── High EQ ────────── Edit  -5 to +5
                              └── Save Preset [Save Pst] ── Edit  Name (8 char max)

── OUTPUTS ──────┬── TX Out [Tx Lvl] ─────────── Edit  TX Level dB
                 ├── Pilot Inj ────────────────── Edit  Pilot Inj %
                 ├── Dig Out ──────────────────── Edit  Digital Level dBFS
                 ├── 192 Out ──────────────────── Edit  MPX192 Level
                 └── Analog Out ───────────────── Edit  Analog Level

── NETWORK ──────┬── IP Address [IP Addr] ─────── Edit  IP Address
                 ├── Subnet Mask [Sub Msk] ────── Edit  Subnet Mask
                 ├── Gateway ──────────────────── Edit  Gateway
                 └── MAC Address [MAC Addr] ───── (scroll down to view)

── VERSION ──────┬── SW: xx.xx.xx
                 ├── HW: xx.xx.xx
                 ├── DSP: xx.xx.xx
                 ├── WS1 xxxx
                 └── WS2 xxxx

── ACCESS ───────┬── Lock
                 ├── Unlock
                 └── Change PW? [Chg PW] ──┬── N
                                           └── Y ──┬── Old PW:
                                                   ├── New PW:
── EXIT                                            └── Save
```

As an example for how the menu navigation works, scroll down the menu items to find the **IP Address** entry and then press the jog wheel. Now, each press of the jog wheel will select a different octet of the four octets of the IP address. While a particular octet is selected, turning the jog wheel will increment or decrement the values. When the correct value is found, press the jog wheel to select it and the cursor will go to the next octet. Once there, turn the jog wheel to select the correct value, and so on. The same procedure is used to modify any numerical value within the menu.

Functionally, the front panel and its menu are limited to basic setup such as the network configuration, input audio source selection, output level adjustments and basic processing tuning, all things typically addressed during initial LiON setup.

For deeper and complete access to *every* control that the LiON offers we strongly recommend using the software GUI application. The GUI interface is quite comprehensive and also allows LiON to be remotely controlled from anywhere in the world. The following discussion will explain each item of the front panel menu tree.

PRESETS:

Selecting this item allows scrolling through the several dozen Factory Presets. The list can be simply scrolled to see what's available and a preset from the list may be placed on-air by pressing the rotary encoder wheel to activate the Take option while the desired preset is highlighted.

Important Note: *Always allow a selected preset to 'settle in' for a few seconds before deciding how it sounds. Due to the intelligence built into LiON's algorithms it must learn about the incoming program content while applying the preset-selected processing style. Note also that switching between presets can sometimes cause a brief glitch in the audio due to the new preset switching in or out styles of processing needed by the preset being recalled.*

INPUT:

This selection allows the audio input source to be selected and the input gains separately adjusted for the analog and digital inputs. Under normal circumstances the input level controls should be left at their zero settings to ensure enough headroom inside LiON's internal signal chain.

PRE-EMPH:

This selection is used to apply the correct amount of FM pre-emphasis for the region in which LiON will be used on the air.

In some markets in the US we've noted that FM stations will select the 50µS when 75µS is the standard. Selecting 50µS instead causes 3dB less pre-emphasis which then does two things:

> ➢ It eases the amount of work the processor's FM clipper needs to do to in order control high frequencies and audio peaks.

> ➢ Because US-based FM receivers will still apply 75uS *de-emphasis*, the processed audio will be 'softer' on the ears, a sometimes useful processing trick for female-targeted program formats.

There is no right or wrong – set pre-emphasis for what is appropriate for *your* format and *your* market's radio listeners.

SOUND

This section of the menu allows the user to modify how a preset sounds with two main sections available, Texture and EQ.

Texture

Allows the Drive, Density and Loudness to be modified in ways that a processing expert would do it using the 'back door' controls we use when making Factory Presets. Adjusting each of these options moves a series of background adjustments in order to achieve a new sound. Each control will be described in turn.

Drive: adjusts how much *work* the AGC and Limiter sections will be doing. Settings with positive numbers mean "more" and those with negative numbers mean "less". The Drive control is always adjusted to taste.

Density: adjusts how *fast* the AGC and Limiter sections do their work. Positive numbers mean the processing works "faster" and negative numbers mean it works "slower". Like the Drive control, the Density control is adjusted to taste, noting that negative settings will sound more relaxed.

Loudness: adjusts the drive to the final FM clipper and to a lesser degree the MPX clipper as well. Higher positive numbers mean "more" loudness and negative numbers mean "less". This control is adjusted to satisfy competitive market conditions, noting that any clipper driven too hard can create undesired distortion.

Save Preset: this option allows saving the current settings as a preset, and when selected, a prompt will appear for a new preset name. Once the preset is saved it becomes the currently running preset on the air.

NOTE: *If the source preset was a Factory preset, modified, and then saved, it will be saved as the original Factory preset's name in the lowest numbered and available preset slot.*

EQ

Allows tailoring of LiON's low, mid and high frequency spectral energy as follows:

Low: allows tailoring of very low frequencies such as those below 100 Hz which can be useful for adjusting bass punch. As in the Texture menus, positive numbers mean 'more' and negative numbers mean 'less'.

Warm: allows tailoring of the audio spectrum around 300-500 Hz. Increasing the Warmth setting can add a sense of fullness to the audio, while reducing it can open up the separation between lows and highs creating a more open sound.

An excessive Warmth setting can cause the sound to be 'tubby' and should be avoided. Just like the Texture menus, positive numbers mean 'more' and negative numbers mean 'less'.

High: allows custom adjustments to the very high frequencies above 8-10 kHz, commonly known as 'sparkle'. Like the Texture menus, positive numbers mean 'more' and negative numbers mean 'less'.

Be aware that FM pre-emphasis already challenges the final peak processing in most FM on-air processors and LiON is no exception. A little high frequency EQ boost goes a l-o-n-g way.

Save Preset: this option allows saving the current settings as a preset, and when selected, a prompt will appear for a new preset name. Once the preset is saved it becomes the currently running preset on the air.

NOTE: *If the source preset was a Factory preset, was modified, and was then saved, it will be saved with the original Factory preset's <u>name</u> and in the lowest numbered and available preset slot.*

OUTPUTS

This menu section allows level adjustments of the various audio outputs, including setting the 19 kHz stereo pilot injection of the stereo generator.

TX Out: allows adjustment of the analog composite output from the stereo generator. Note that when the composite output level is changed, so too is the stereo pilot level because the 19 kHz pilot signal *is* a component of the overall stereo composite multiplex signal.

Pilot Inj: allows trimming of the 19 kHz stereo pilot signal. Normally this control will be set between 8% and 10% and after the TX Out level has been set. Because the stereo pilot adds to modulation, some iteration between TX Out and Pilot Inj may be necessary to set both levels accurately.

Dig Out: allows the output level in dBFS of the AES3 digital left/right output to be set, whether being fed from the FM processing or the HD+ audio chain.

192 Out: allows the output level of the digital stereo multiplex signal (Baseband192®) to be set as required to match input calibration of the transmitter.

Analog Out: allows the output level of the analog left/right output to be set, whether being fed from the FM processing or the HD+ audio chain.

NETWORK

The Network menu permits changing LiON's network configuration from its factory default IP address in order to match the customer's network.

IP Address: here an IP address is entered in four three-digit octets corresponding to the customer's network address range. The factory default IP address is 192.168.87.230.

Subnet Mask: like the IP address, the subnet mask is entered as four three-digit octets corresponding to the network mask appropriate for the customers network configuration. The factory default is 255.255.255.0.

Gateway: the gateway address is entered as four three-digit octets corresponding to the network gateway in use by the customer's network. The factory default network mask is 192.168.87.1

MAC Address: every networked device is assigned its own unique twelve digit MAC (Media Control Access) identification. Because Ethernet switches and Internet routers do their routing using MAC addresses there should never be other devices with the same MAC address on the network. The first few digits of a MAC address usually identify the manufacturer or entity that assigned the MAC address.

VERSION

The Version dialog displays the currently installed software, hardware (firmware) and DSP code running on the unit. In addition, there are two diagnostic flags, WS1 and WS2 which are zero in normal operation and may show a diagnostic code if an issue arises inside the software or hardware. Our technical support department may ask for any WS1 or WS2 codes if trouble is reported with a unit.

ACCESS

LiON's front panel may be locked to prevent unauthorized access to its settings. When the front panel is locked the display is restricted to showing only the metering and the option to unlock it. We use a four digit passcode to provide 10,000 possible access codes.

Lock: This option is available when the front panel is not already locked. When this option is selected the user will be prompted for a four digit passcode. That passcode will then be entered twice, once for its assignment, and then again for confirmation. If the two codes match, the front panel will lock.

Unlock: When the front panel is locked and this option is selected the user will be prompted for the correct unlock passcode. Once the correct passcode has been entered the user will also be asked if he wishes to change the passcode, and if so, the same sequence for initial locking will occur, passcode assignment and passcode confirmation.

If no other action is desired the Back button will exit this menu and the front panel will be unlocked.

Change PW?: During the unlock process described above is an option for assigning a new passcode. Changing the passcode is like assigning a first passcode. The two passcodes must match or the user will be prompted to reenter a code that does.

Removing a Passcode: At the end of the Change PW? dialog is an option to remove the passcode. Because the front panel has already been unlocked in order to arrive at this option, no passcode is required in order to remove security; just acknowledge the "Are You Sure" question and the front panel will have no security.

EXIT

Selecting this option will exit the menu structure and go back to showing the meters. Note that the meter screen is never hidden.

**Installing the Windows®-based LiON Graphical User Interface Software**

Next we will be discussing the features and operation of the PC-based software GUI application, starting first with GUI installation on the host PC and followed by configuring the GUI to communicate with the LION hardware.

Scanning the QR code supplied inside the LiON shipping box will open a URL where the most current GUI software and this manual can be downloaded.

First locate the file called "Lion_RemoteApp_x_xx_x.exe where the x's show the version of GUI software to be installed. Double clicking the exe file will start the installation. Once the installation starts, a popup dialog will ask to accept the terms of the license agreement.
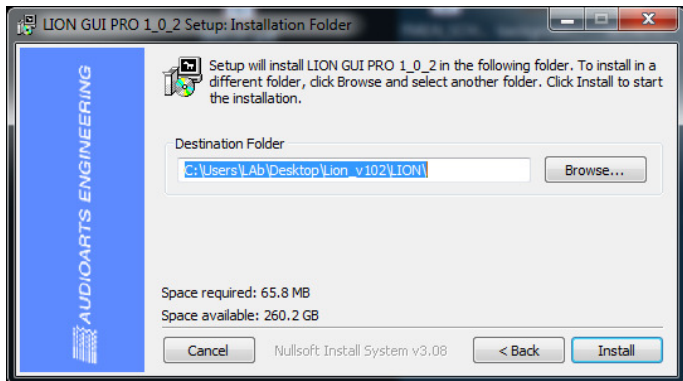

Click the "I Accept…" box checked in the image at left and then click Next to continue the installation.
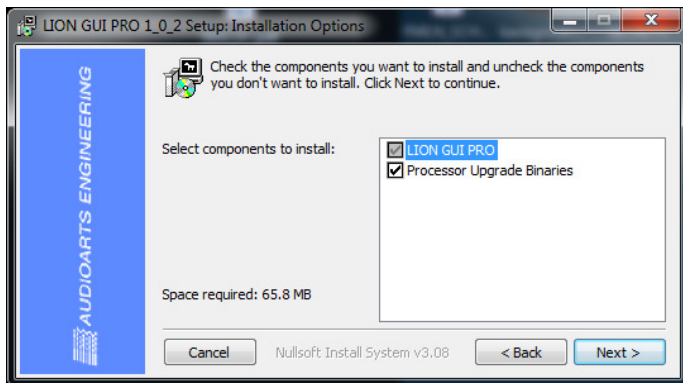
The next popup allows you to select the components to be installed. Both items will be checked and installed by default.

We recommend leaving the settings as they are and continue the installation by clicking the Next button.

On most PC's the default GUI installation will be here:

C:\Program Files (x86)
\Audioarts
\Lion

The application may be installed in any other location if desired, including an aptly-named folder on the Windows desktop.

Once the installation has finished the GUI application may be started by navigating to the Windows All Programs dialog, scrolling to locate the Audioarts entry, opening that, and clicking on the entry for the Lion Remote App.

During opening of the GUI application Windows may pop up a message asking for permission to allow the GUI access through the Windows firewall. This is normal and you should click on Allow Access which will allow program startup to continue. If Cancel is clicked instead GUI startup will be cancelled.

Next we will configure the GUI application to communicate with the LION hardware by first opening the Devices dialog by clicking its button, circled in the image below.
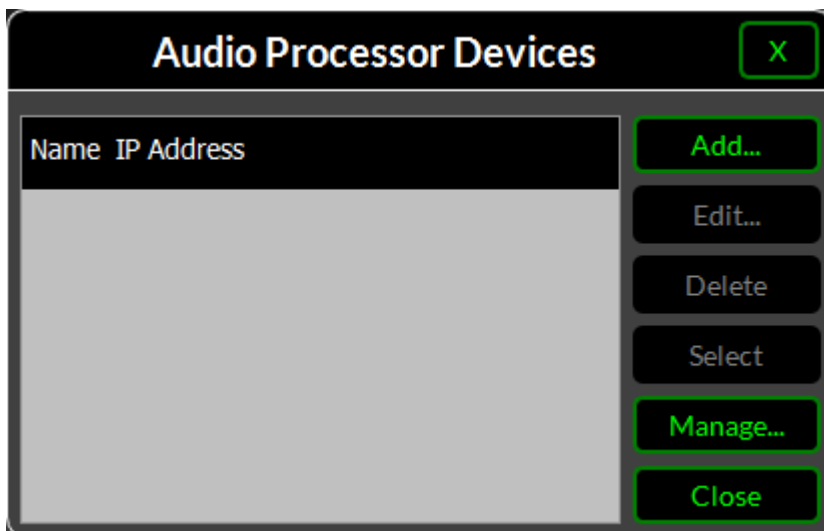
Here we will add the IP address and device name of the LiON you wish to control by clicking the Add button to open the configuration dialog.

Add New Device [X]

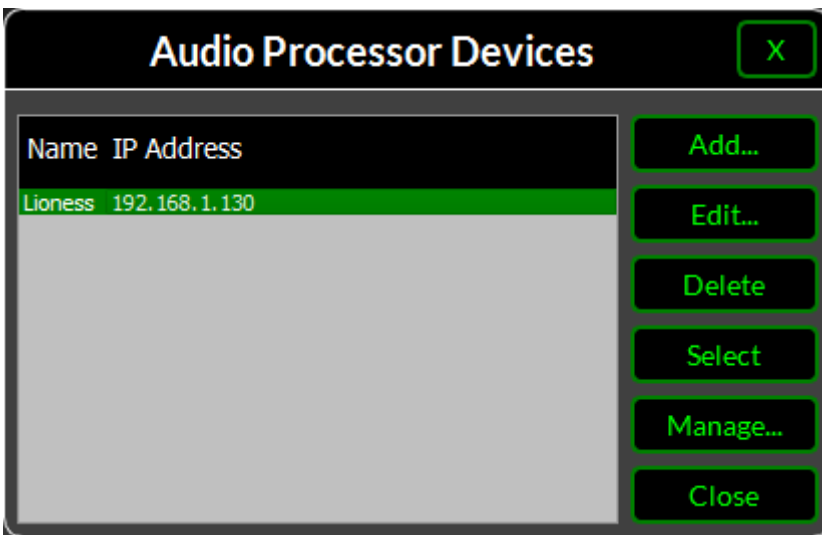Name: Lioness

IP Address: 192.168.1 .130

Okay   Cancel   Browse...
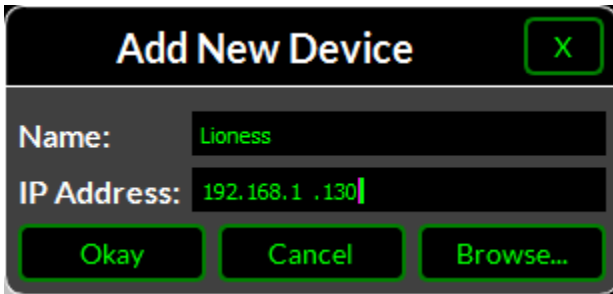
Each LiON can have its own device name, and there is no limit for how many Lions can be set up to be controlled with the same GUI (of course, one at a time!).

Here we've called our Lion "Lioness" and told the GUI that Lioness's hardware IP address is 192.168.1.130. Click Okay and the dialog will close.

Audio Processor Devices [X]

Name IP Address

Lioness 192.168.1.130

Add...
Edit...
Delete
Select
Manage...
Close

Next we'll tell the GUI which Lion we want to communicate with by highlighting Lioness (single left mouse click) and then clicking on the Select button.

When that is done the Audio Processor Devices dialog will close and the GUI is ready to communicate with the Lion hardware.

Ensure the Lion is powered up and a valid Ethernet connection is present on its rear panel. Note also that the Lion's IP address and the IP address of the PC that is running the GUI software must be able to communicate with each other over the same network if it is a *local network* with no special port forwarding in use.

Windows Laptop Advisory:

It has been noted, and going all the way back to the days of Windows XP, that laptops running a Windows operating system that are also equipped with a built-in wireless interface will almost without exception attempt to communicate with wired network devices using the wireless interface instead. This of course cannot possibly work. Therefore to ensure communication with wired network devices it is virtually always necessary to <u>disable</u> the PCs wireless device in order to force Windows to use the wired network interface instead.

To put the GUI online to the Lion hardware click on the button to the left of the Status window shown at upper right.

Once the GUI is online and communicating with Lion the Status will change to "Online" and the name of the current running preset will be shown in the "Current Preset" window.

Also at this time all metering will become active and show the current state of audio input and output levels as well as multiband gain reduction if the iAGC/Comp or Limiters screens are currently visible.

An Important Note about Audio Levels:

The Input and Output metering is calibrated in dBFS, decibels Full Scale (digital)). Because the <u>output</u> metering is *after* final peak limiting, processing prevents the output levels and therefore the metering from *exceeding* 0dBFS. The appearance of a full scale reading on any output meter *does not* indicate an 'out of bits' condition.

Unlike the output meters which might show as high as 0dBFS with no ill effects, pegging the *Input* meters means you are 'out of bits' and not much sounds worse than clipping in the digital domain!

Normal input levels should frequently peak around -12dBFS and perhaps no higher than around -8dBFS. Correct levels can be set using the GUI controls on the Input page, discussed next.

GUI Navigation Buttons
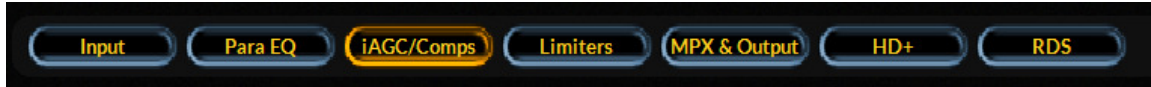
Above is shown the set of buttons which allow each page of the GUI to be shown. The currently selected page is shown as the button highlighted (iAGC/Comps above). Clicking on each button will change the page currently being viewed to the one selected by a left mouse click.

INPUT

Audio Source

Three types of input audio sources may be used via two categories of input audio signals; Analog and Digital.

Analog: allows LiON to accept conventional analog balanced left/right audio signals on its rear panel ANALOG In RJ-45 connector.

Digital: allows LiON to accept either conventional AES3 digital left/right audio, or left right digital audio via a WheatnetIP network.

Input Failsafe: Automatic input failover is available between the analog and digital audio inputs and input audio can be applied to all inputs simultaneously. WheatnetIP and AES3 digital cannot failover over from each other.

Automatic audio failover from analog to digital or vice versa is supported. Automatic failover from AES3 or WheatnetIP to analog is instantaneous and based on invalid or missing bits in the AES3 stream or after 30 seconds of "silence" on both channels (audio level below -42dBFS).

Automatic failover from analog to AES3 or WheatnetIP is based on silence sense and in response to audio on both channels being below -42dBFS for more than 30 seconds.

Analog Gain: Allows a +12/-12dB adjustment of the analog audio level being applied to LiON's processing. Normally this control should be left at zero, with any necessary audio level adjustments being made at the audio source.

Digital Gain: Allows a +12/-12dB adjustment of the digital audio level being applied to LiON's processing, whether from the AES3 or WheatnetIP inputs. Normally this control should be left at zero, with any necessary audio level adjustments being made at the audio source.

Left/Right Balance: Allows a +12/-12dB adjustment of the left/right channel balance prior to audio being applied to LiON's processing. Normally this control should left at zero, with any necessary audio level balance adjustments made instead at the audio source.

Left/Right Mode: This control allows both left and right channels of LiON's processing to be fed from both channels (stereo), just the left channel, just the right channel, or with the stereo input audio mixed down to mono.

In normal operation this control should be in the Stereo position, the other modes being for testing or special circumstances where one channel of the input audio is missing for some reason.

Phase Rotator: The task of a phase rotator is to make extremely asymmetrical audio signals, like human voice and certain musical instruments, more symmetrical without upsetting how it they sound. Phase rotators are especially useful in FM on-air audio processing because unlike AM, FM is a symmetrical medium where positive and negative modulation should be equal under all program conditions.

When illuminated, LiON's phase rotator is in circuit and active.

 Asymmetrical Voice

 Symmetrical Voice
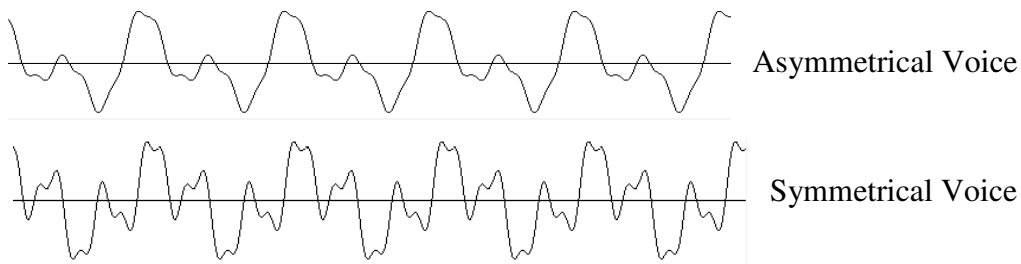
HPF Freq: HPF stands for High Pass Filter and a high pass filter's job is to remove frequency components *below* a certain frequency. The reason we want to remove low frequencies, in particular very low frequencies, is that they can bring undesirable effects:

- ➢ typically contain no useful program information
- ➢ often cannot be reproduced on listeners' radios
- ➢ often contain undesirable non-audio signals such as rumble
- ➢ may cause phase locked loops in FM exciters or STLs to unlock

LiON's high pass filters can be set to reject frequencies below 60Hz in 10Hz steps down to 20Hz. In normal FM broadcasting a good high pass filter setting is 20Hz or 30Hz.

HPF enable: When illuminated LiON's high pass filter is in circuit and actively removing frequencies below the HPF Freq setting.

Input Settings Change With Presets: When LiON saves a preset all settings are saved, not just those related to sound, but also the settings related to which input source is being used, etc. When illuminated, the Input Settings Change With Presets function will recall all of the settings saved with the preset, except those related to outputs (covered later).

CAUTION: *If a preset was made using the analog input and now LiON is using the digital input, the station will lose on-air audio if Input Settings Change With Presets is selected when taking that preset because it will cause the input source to switch to analog. If no analog source is present loss of audio will occur.*

This function can be quite useful, however, if a station wants to change input source settings using presets. Just be aware of how the function behaves.

NOTE: LiON's Factory Presets were created using the <u>analog</u> input mode.

Para EQ (Equalizer)

LiON is equipped with a four-band equalizer section situated in front of the multiband processing, including the windowed leveler *i*AGC.

There are two shelving EQ sections (low and high) along with two fully parametric equalizers that have adjustable frequency, boost and bandwidth (Q) controls.

BW (Octaves)	Q
2.0	0.667
1.0	1.414
2/3 (0.66666)	2.145
1/2 (0.50000)	2.871
1/3 (0.33333)	4.318
1/6 (0.16666)	8.651
1/10 (0.10000)	14.242
1/30 (0.03000)	43.280

Recall that filter Bandwidth and Q are related as shown at left.

At left are the controls associated with LiON's equalizer section.

Note that the controls are grouped according the 'band' that they operate within.

The two fully parametric equalizer sections are unique, however, in that they may be tuned to operate on *any* portion of the audio spectrum between 20 Hz and 20 kHz.

EQ Enabled: When illuminated the equalizer section is in circuit and active. If any control within the equalizer section has been adjusted to alter any portion of the audio spectrum, when the section is enable those adjustments take effect immediately.

Lo Shelf Section
Boost/Cut: The Boost/Cut control adjusts the Lo Shelf equalization over a +/-14dB range. Note that a boost or cut of just 3dB increases or decreases the acoustical *power* of the frequencies being controlled by a factor of *two*.

Frequency: Lion's Lo Shelf equalizer frequency range is 20Hz to 500Hz. Slight boosts (~3dB) around 50-70Hz can increase the sense of bass punch on the air. Remember that some portion of the station's listening audience listens on radios that cannot even reproduce bass energy 'down there'. Most table radios (for instance) do don't much below around 100Hz. Most car radios fare better, but getting below around 50Hz isn't something they're good at unless equipped with a subwoofer.

Para #1 and Para #2:   These are LiON's two fully parametric equalizer sections. Each may be tuned over the range of 20Hz to 20kHz, have boost/cut capability of +/-14dB, and may have their bandwidths set according to the amount of frequency spectrum desired to be affected by their settings.

Hi Shelf Section
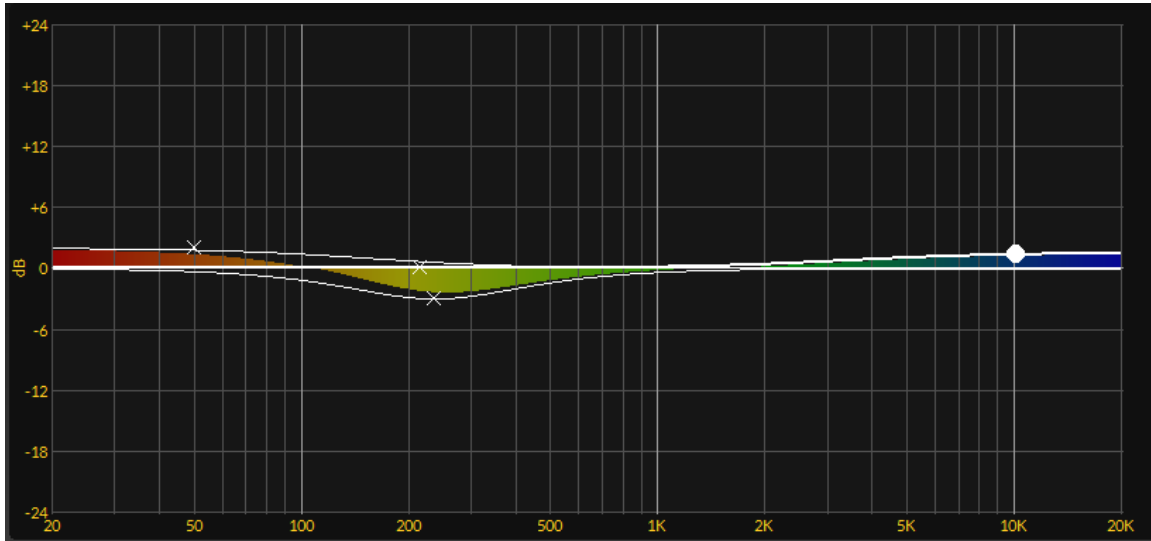**Boost/Cut:**   The Boost/Cut control adjusts the Hi Shelf equalization over a +/-14dB range. Note that a boost or cut of just 3dB increases or decreases the acoustical *power* of the frequencies being controlled by a factor of *two*.

Frequency: Lion's Hi Shelf equalizer frequency range is 2kHz to 20kHz. Slight boosts (<3dB) around 10kHz can add a sense if 'air' to the audio, noting that a little goes a long way.

EQ Graphical Area: Shown below is LiON's equalizer spectral display showing where, and by how much, frequencies with the audio spectrum are being modified.

The graphic below corresponds to the equalizer controls shown on the previous page where we've:

- added a 2dB boost at 50Hz to add a little more bass punch
- pulled down the energy in the spectrum around 240Hz by 3dB to decrease 'muddiness'
- added a little 'air' to the broadcast using a 1.5dB boost at 10.1kHz

iAGC/Comps (intelligent AGC and compressors)
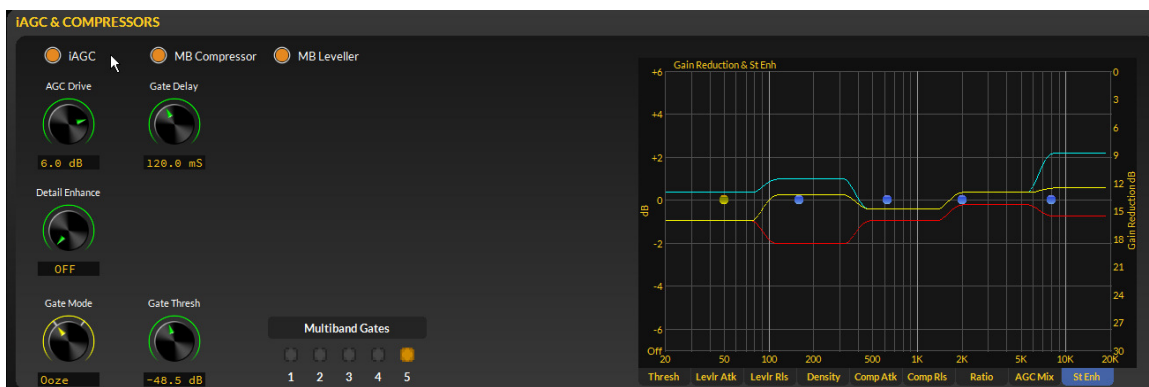
LiON is equipped with a sophisticated multiband gain control system that automatically adjusts itself as the incoming program content changes to ensure a consistent on air spectral balance. There are three primary sections to this first stage of dynamics processing:

iAGC (intelligent AGC):   this stage is responsible for measuring and analyzing the incoming program content and adjusting the 'feed' to the following processing to provide them a consistent spectral balance. The iAGC behaves as an automatic equalizer to ensure good spectral consistency on the air.

There are no user controls for the iAGC section such as Drive, Threshold, and such. Everything it does and reacts to is controlled by its internal programming and built in intelligence.

When the iAGC is enabled its indicator will be illuminated and the stage is in circuit and active.

MB Compressor: The MB (multiband) compressor is a relatively quick-acting dynamics section that serves to 'fill in' the audio in order to provide a consistent level of loudness on the air. Its operation is smooth and unobtrusive and works with the MB (multiband) Leveler to provide a consistent loudness on the air. When the MB Compressor is enabled its indicator will be illuminated and the stage is in circuit and active.

The MB compressor may operate in three modes starting with all sections enabled:

iAGC In, MB Compressor In, MB Leveler In – in this mode the iAGC is controlling the long term spectral balance, the MB Leveler is controlling the medium term spectral balance and levels, and the Compressors are providing some 'fill' to maintain consistent loudness levels for the short term. While in this mode the Compressors cannot add more gain than that of the MB Leveler. In other words, they can decrease the gain in a band, but when the compressors release their gain cannot go higher than the current band gain of the MB Leveler. This behavior prevents unnecessary density buildup which then aids long-term listening by not 'over processing' in the multiband section.

iAGC Out, MB Compressor In, MB Leveler In – in this mode the iAGC is disabled, removing the automatic spectral balance afforded by that section. The MB Leveler and Compressors then take on the task of level and spectral balance control. Again, while the MB Leveler is enabled the Compressors are not permitted to add more gain than the current per-band state of the MB Leveler. They can decrease band audio levels below that of the MB Leveler, but cannot increase them.

iAGC Out, MB Leveler Out, MB Compressor In – in this mode the multiband compressor is acting alone as the sole controlling mechanism for spectral balance and short term level control. The audio will be denser due to the compressor's shorter time constants, and the multiband compressor's output levels will be less consistent without the MB Leveler being active. Usually when operated this way the goal is to provide very little in the way of long-term gain control, focusing more on the short term. Loudness will not be consistent when operated in this mode.

MB Leveler: The MB (multiband) leveler is a relatively slow-acting dynamics section that serves to keep consistent medium to long term loudness on the air. Its operation is smooth and unobtrusive and works with the MB (multiband) Compressor and/or iAGC and Leveler to provide a consistent loudness on the air. When the MB Leveler is enabled its indicator will be illuminated and the stage is in circuit and active.

AGC Drive: The AGC Drive control sets how much work the multiband section does as the incoming audio levels and spectral balance change. Higher drive levels force deeper gain reduction in the MB Leveler and MB Compressor, while lower drive levels reduce the overall amount of gain reduction. This setting will change with different presets and may be modified to change the amount of work the multiband leveler and compressor are doing.

Note that the AGC Drive control has no effect on the operation of the iAGC which is looking at and analyzing only LiON's input audio.

Gate Delay: The multiband section has built in gating which will freeze the gain control action if the incoming audio levels fall below the Gate Thresh setting, explain next. The Gate Delay is adjustable between 50mS and 500mS (milliseconds) and serves to prevent the gating circuitry from freezing a band's gain release until the Gate Delay timer times out.

The purpose of delaying the gating action is to allow a partial gain reduction release when the audio falls below the gating threshold which has the following effects:

- During a speech only programming it helps keep the multiband section's output level more consistent by bringing up, slightly, the gain before a band actually enters the gated phase.

- If the Gate Threshold is set rather high and the Gate Delay set to about 300mS (the syllabic rate) the resulting audio will sound more relaxed, even though aggressively processed, due to the short pauses of level recovery which our ears perceive as more natural dynamics. Set correctly, the Gate Threshold and Gate Delay can add a sense of openness and dynamics to otherwise heavily processed audio which can aid long term listening without sacrificing loudness.

Gate Thresh: The Gate Thresh(old) control sets the level at which falling incoming audio levels cause a band to enter its gated state and its gain is frozen.

The Gate Thresh control has a range of -20dBFS to -70dBFS, plus an Off position which completely disables the gating function. Normally the Gate Threshold will end up around -40dBFS or so with normal audio input levels to LiON.

Gate Mode: The Gate Mode control modifies the behavior of the gating circuit to give it a 'Hold" mode where gain is frozen when audio falls below the gate threshold, and also

an "Ooze" mode which allows the multiband gains to very slowly increase over time even though the gating circuit is activated.

The Hold and Ooze modes are used to modify how the multiband section behaves when audio levels falls below the gating threshold. Like extending the Gate delay, the Ooze mode can be useful for talk formats as long as there are no long pauses to allow the gains to increase to the point of bringing up noise or background effects from the studio room.

The Ooze mode is often preferred for very competitive formats where the desire is for the audio levels to never, ever, fall, no matter what. Ooze mode is much more effective (musically) then relying on very fast time constants in the Leveler to keep levels always up. Using Ooze rather than quick time constants usually just sounds better.

Detail Enhance: The Detail Enhance control is part of a processing algorithm that serves to relax certain portions of processing which allows subtle details often hidden by the processing to come forward. The control is calibrated in percent, from Off to 100% and is adjusted to taste.

Multiband Gates: These are "LED" indicators which show the state of each band's gating circuit. A band is gated when the indicator is on, and ungated when it is off. Under normal programming it is normal for the indicators to be flashing and not constantly on or off.

Gain Reduction Graphics: To the right of the iAGC and Compressor controls is a graphical area showing, among other things, the amount of each band's iAGC, Leveler, and Compressor gain reduction.
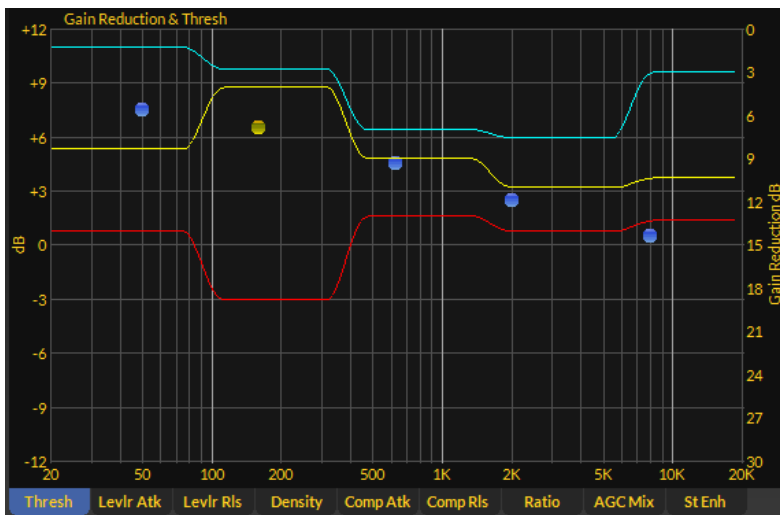

Each processing type has a different colored set of lines indicating the amount of work being done.

➢ The light blue lines show the action of the multiband compressors. The further down the display, the more gain reduction being accomplished by the compressors.

➢ The yellow lines show the action of the multiband leveler, and like the compressors, the further down the display they are the more work is being done by the leveler.

➢ The red lines show the action of the iAGC section's automatic equalizer which is ahead of all other processing.

Along the bottom of the gain reduction graphical area is a set of tabs which lead to adjustment pages for the multiband processing as show below. Each will be described in turn.
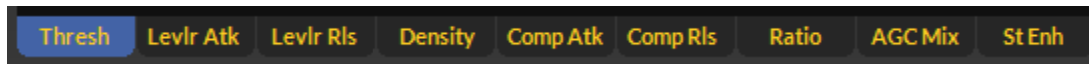
Before we get to explaining each of the tabs, we first need to help you understand how adjustments are made on all nine of the graphical screens.
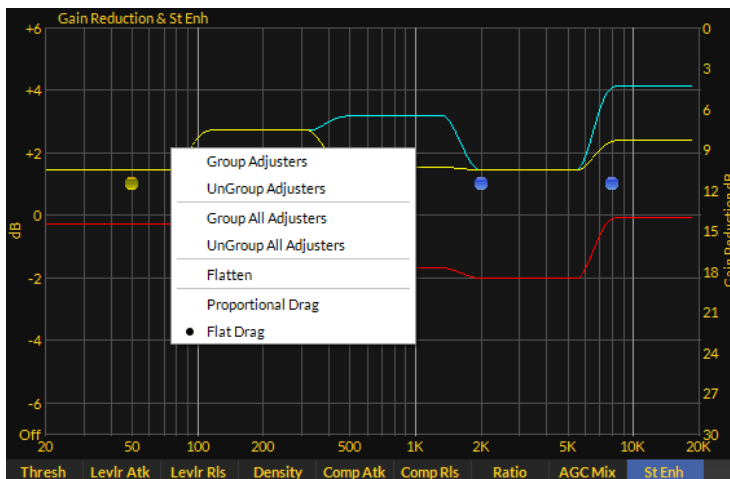
Once again, take another look at the screen at left and notice the five blue dots…

Each processing band owns a dot, and they are shown from left to right for bands one through band five.

Each dot can act like a little 'hand to move a band's parameters up and down, and here's how.

If you right click on the graphical area (like we did when we made this screen shot) you'll see a dropdown menu with some options:

➢ Group Adjusters
➢ Ungroup Adjusters
➢ Group All Adjusters
➢ Ungroup All Adjusters
➢ Flatten
➢ Proportional Drag
➢ Flat Drag

What do these options do?

By default, all adjusters (the blue dots) are grouped, that is they are coupled to each other so that if you grab one with the mouse (single left click and hold) and then slide the mouse up and down, all the blue dots move up and down together.

If you double click a blue dot, it will turn red to indicate that it has been selected, after which it may be moved individually to anywhere along the vertical scale by sliding it with the mouse.

If you now double click another blue dot somewhere on the line, it too will turn red and be able to be individually adjusted.

If you move the mouse to a point between the two dots selected in the above steps, right click the mouse and select UnGroup Adjusters, all the points in between the first two dots will turn red and can be individually adjusted up or down.

If you place the mouse over the graphical area, right click again, and this time select Group Adjusters the dots between the first two that you highlighted will turn back to blue. If you then grab the line between those dots with the mouse (left click and drag) you can move the entire line connecting the two highlighted end dots up and down, with other dots remaining anchored in place. Cool, eh?

Right clicking on the graphical area and selecting Group All Adjusters turns all dots back to blue where they can be adjusted as a whole. Conversely, right clicking and selecting UnGroup All Adjusters turns all blue dots red, meaning they can now each be individually adjusted.

The Flatten option, although next in the list, is best explained last.

Okay, highlight a single dot again… any dot will do. Then right click the graphical area and select Proportional Drag. Now left click the line to the left or right of the dot you just highlighted and drag it up or down. See how the line behaves? It pivots at the point where you highlighted the dot, and bends at the point where you grabbed it with the mouse. Virtually any curve can be created by following these steps.

Now right click again and this time select Flat Drag. Grab the line again, anywhere (left click and drag) and move it up and down. See how the line pivots at the highlighted point but remains flat above or below as you raise and lower it back to where it was?

But how to make it all flat again without having to move every single point back? Easy!

Right click on the graphical area again and select Flatten. If there were any points still highlighted red you'll want to first click Group All Adjusters option before you select

Flatten in order to turn them back to blue. When you then click Flatten the line will return back to flat and you may move the whole thing up and down again with the mouse, this time as a whole.

To review:

Group Adjusters: gangs the blue dots between two highlighted orange points into a commonly behaving entity.

UnGroup Adjusters: disconnects any blue dots that were grouped by Group Adjusters.

Group All Adjusters: gangs all the dots, turning them blue, regardless of their previous highlighted state.

UnGroup All Adjusters: un-gangs all the adjustment dots, turning them red, regardless of any previous highlighting.

Flatten: removes any variance between adjacent dots not horizontal to each other.

Proportional Drag: allows the dragging of adjustment dots to create slopes.

Flat Drag: allows the dragging of all the dots together in a Flat orientation.

One more thing…as you slide the mouse cursor across the graphical area you'll notice a blue dot change to yellow, a color change that indicates that you have 'selected' that dot for adjustment.

The Thresh Tab
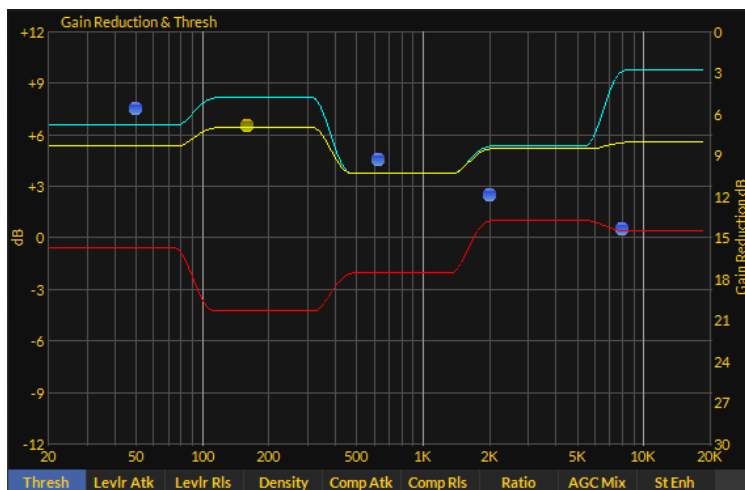
The dots controlled by the Thresh parameter adjust the Leveler and Compressor thresholds together.

Pulling the dots down lowers the threshold (more processing), while raising them causes less.

Each band can be adjusted +/-12dB from nominal.

There are two primary effects which will occur as the threshold is varied:

➢ As a threshold is raised, output from the band being adjusted will increase because less processing is occurring in that band. This will result in more drive to the corresponding multiband limiter band later in LiON's processing chain.

➢ As a threshold is lowered, output from the band being adjusted will decrease because more processing is occurring in that band. This will result in less drive to the corresponding multiband limiter band later in LiON's processing chain.

Keep in mind that the Thresh controls, or any of the other controls available on the nine tabs below the graphical area, do not affect the behavior of the iAGC. Only the MB Leveler and MB Compressor are affected by the 'dot' controls.

The Levlr Atk Tab
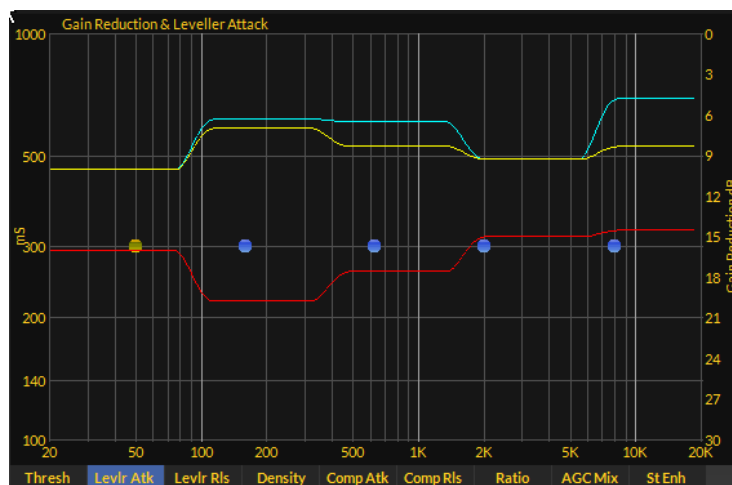
The dots controlled by the LvLr Atk parameter adjust the Leveler attack times. Pulling the dots down speeds up the attack time (more audible processing), while raising them slows the attack time.

Each band can be adjusted between 100mS and 1,000mS (one second).

The Leveler section is primarily responsible for managing medium term dynamics and levels on a multiband basis. Each of the five band's Attack Times may be adjusted, individually or together, using the 'dot navigation' methods described previously. Fast attack times cause it to react more quickly to increases in the incoming audio levels while slower attack times case the opposite effect. Slower attack times are generally perceived as sounding more dynamic.
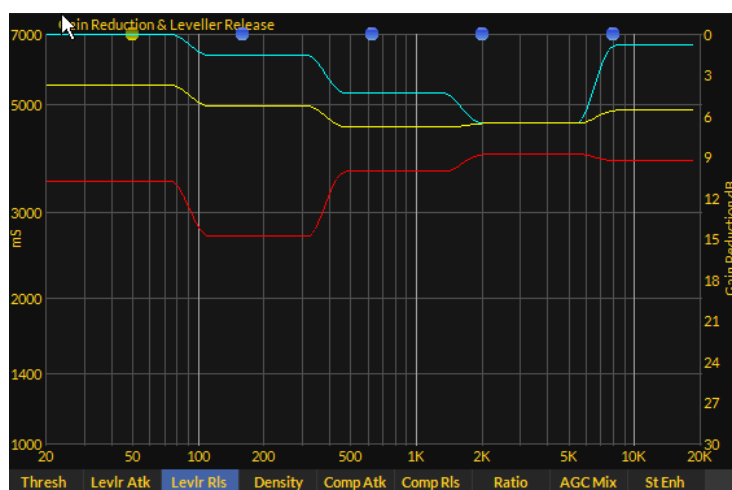
The Levlr Rls Tab

The dots controlled by the LvLr Rls parameter adjust the Leveler release times. Pulling the dots down speeds up the release time (more audible processing), while raising them slows the release time.

Each band can be adjusted between 1,000mS (one

second) and 7,000mS (seven seconds).

The Leveler section is primarily responsible for managing medium term dynamics and levels on a multiband basis. Each of the five band's Release Times may be adjusted, individually or together, using the 'dot navigation' methods described previously. Fast release times cause it to react more quickly to decreases in the incoming audio levels while slower release times case the opposite effect. Slower release times are generally perceived as sounding more dynamic.

The Density Tab
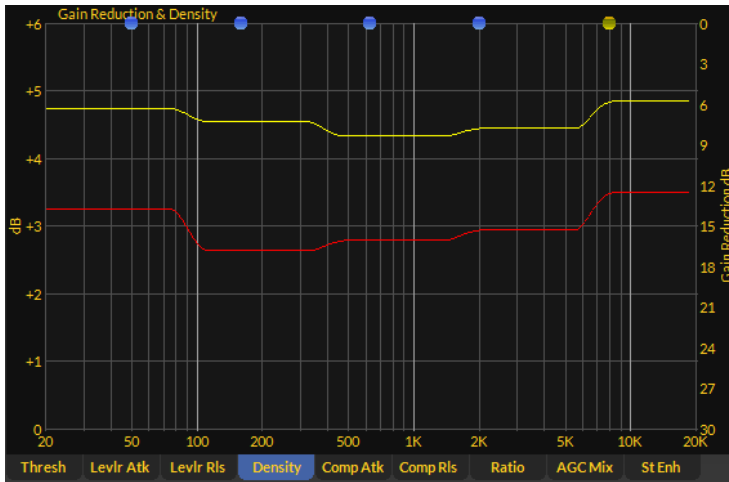
The dots for the Density parameter adjust the ratio of Leveler to Compressor processing. Pulling the dots down causes more Leveling (less audible processing), while raising them causes more Compression.

Each band can be adjusted between 0dB and +6dB with higher dB numbers resulting in more audible compression.

The Density controls are primarily responsible for managing the audibility of compression and/or gain control. Each of the five band's Density controls may be adjusted, individually or together, using the 'dot navigation' methods described previously.

Higher Density settings increase the audibility of processing for short term level changes and can add some 'excitement' to the audio if not taken to the extreme. Some of LiON's Factory presets, such as those for the Oldies and Classic Hits formats, utilize higher Density settings to achieve exactly that effect for more closely emulating the sound of on-air audio processors of that era.
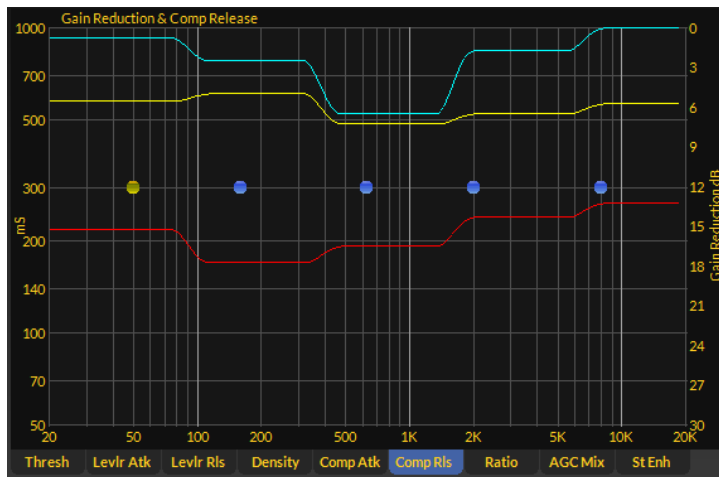
The Comp Atk Tab
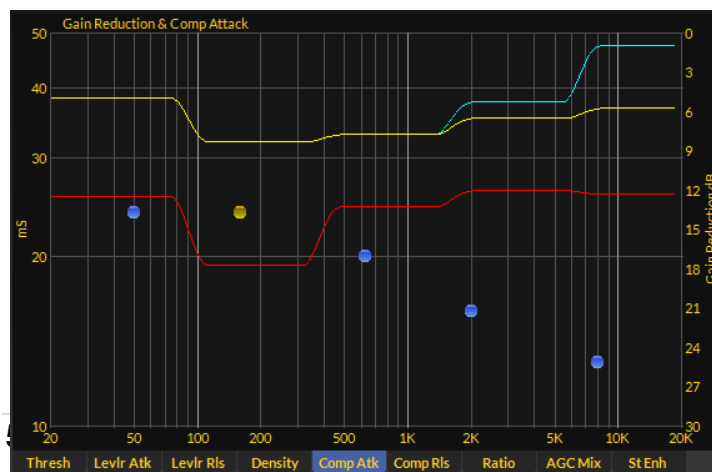
The dots for the Comp Atk parameter adjust the attack time of the compressors. Pulling the dots down causes more compression (more audible processing), while raising them causes less.

Each band can be adjusted between 10mS and 50mS (milliseconds) higher numbers being slower.

The Comp Atk controls are primarily responsible for managing the short term level changes required to keep the multiband output levels under control.. Each of the five band's Comp Atk controls may be adjusted, individually or together, using the 'dot navigation' methods described previously.

Higher Comp Atk settings (slower) decrease the audibility of processing for short term level changes but will also allow shorter duration peaks to 'escape', adding back a sense of dynamics to processed audio. Care must be taken for very long attack though times however as audio energy not controlled by the faster compressors will end up driving the multiband limiter later in LiON's processing chain harder which will undo any dynamics enhancement afforded by long compressor attack time.

The Comp Rls Tab

The dots for the Comp Rls parameter adjust the release time of the compressors. Pulling the dots down causes faster release times and more audible processing, while raising the dots causes less.

Each band can be adjusted between 50mS and 1,000mS (milliseconds) higher numbers being slower.

The Comp Rls controls are primarily responsible for managing the short term level changes required to keep the multiband output levels under control. Each of the five band's Comp Rls controls may be adjusted, individually or together, using the 'dot navigation' methods described previously.

Higher Comp Rls settings (slower) decreases the audibility of processing for short term level changes and will sound more dynamic on the air. Unlike using longer compressor attack times, longer compressor release times do not drive LiON's multiband limiter any harder.

Lower Comp Rls settings (faster) will increase the audibility of processing and used in combination with the Density settings can add a sense of excitement to the broadcast. Some of LiON's Factory presets, such as those for the Oldies and Classic Hits formats, utilize higher Comp Rls in combination with higher Density settings to achieve exactly that effect for more closely emulating the sound of on-air audio processors of that era.

The Ratio Tab
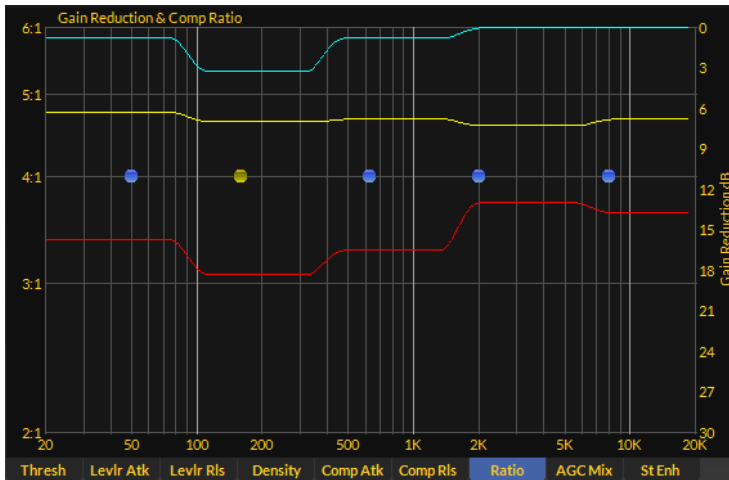
The dots for the Ratio parameter adjust the compression ratio of the leveler and compressors.

Pulling the dots down lowers the ratio (less processing), while raising the dots causes more.

Each band can be adjusted between 2:1 and 6:1 compression ratio.
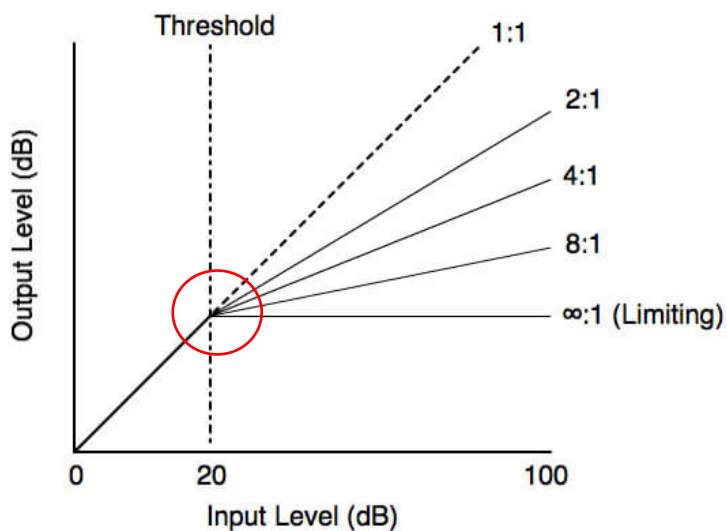
In audio, compression ratio is generally defined as the amount of output signal increase for every dB of input signal increase.

For instance, a compression ratio of 4:1 means that for every 4dB of input level increase, the output only increases by 1dB. A high compression ratio such as 20:1 could be used as a limiter.

In a compressor, the output level will increase perfectly in sync with the input level <u>until</u> the compression threshold is reached, after which the output level will change as a function of the compression ratio.

The compressor threshold is sometimes also called the 'rotation point' because that is where the straight line input/output level relationship deviates according to the compression ratio. In the above graphic showing various compression ratios between 1:1 and 20:1 the rotation point has been circled in red.

There are behavioral variations in some compressors where the rotation point isn't abrupt, but slowly morphs from a linear behavior to the compression ratio. That behavior

is usually called 'soft knee' because of how it appears when graphed. LiON utilizes soft knee compression because it sounds more musical and friendly to the ear.

The AGC Mix Tab
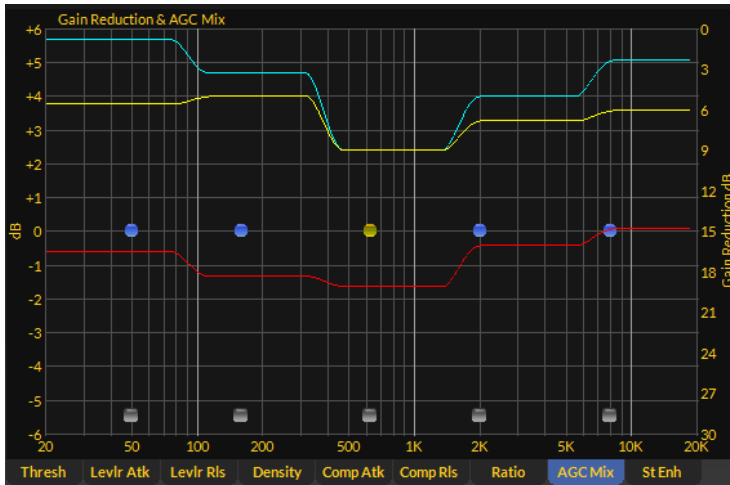
The dots for the AGC Mix parameter adjust the output levels of the individual bands.

Pulling the dots down lowers the output level of a band while raising them causes a higher output level.

Each band can be adjusted +/- 6dB from nominal.

The AGC Mix controls are primarily responsible for establishing the post AGC and Compressor spectral balance and also the amount of drive to the final five-band limiter.

In most Factory presets the Mix controls will be at their center, or 0dB position. They may be adjusted up or down to taste, noting that a 3dB change in mix level represents a change of 2X if increased, or 0.5X if decreased, in *acoustical* power from a band.

The St Enh (Stereo Enhance) Tab
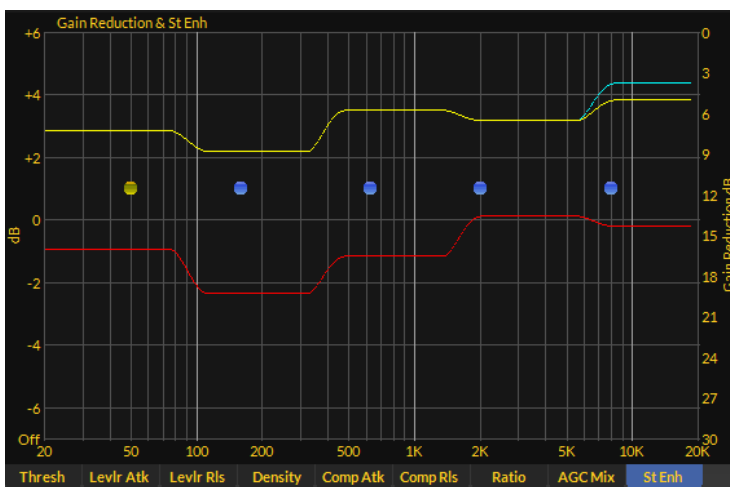
The dots for the St Enh parameter adjust the L-R audio level of an individual band.

Pulling the dots down lowers the stereo effect from the chosen band while raising the dots increases it.

Each band can be adjusted +/- 6dB from nominal, including an 'Off' setting (band in mono).

The use of stereo enhancement in FM broadcast is a balancing act for several reasons, some of them having to do with the behavior of modern DSP-based radios.

➢ Increasing the L-R modulation level mathematically reduces the L+R (mono) signal component which is of course the station's 'loudness' when decoded on a

mono radio. Note that this effect is <u>not</u> dependent on any particular radio, whether it's an antique or DSP-based, but is a result of vector addition in the math domain.

➢ Increasing the L-R modulation causes receiver stereo blend effects to be more pronounced and often to the point of being annoying to listeners.

➢ Increasing the L-R signal <u>does not</u> *cause* multipath. It simply makes it much more audible when stereo receivers blend to mono.

➢ Increasing the L-R modulation – to excess – can cause the 'hole in the middle' effect on stereo recordings.

➢ Increasing the L-R modulation can cause the stereo difference information to mask content such as song vocals which were recorded equally in both channels, pushing the vocal performer to the background.

If desired, LiON's stereo enhancement *can* be freely used in combination with its stereo generator's 'Multipath Limiter' to help mitigate the effects caused by such enhancement, and without harming a listener's stereo experience. We'll be covering the theory and operation of the Multipath Limiter later in the Stereo Generator portion of this manual.

It is worth noting, too, that a large amount of electrical stereo separation does not necessarily increase our perception of *acoustical* separation, in fact quite the opposite is true. As the graph below shows, 'most' listeners only require about 20dB of *electrical* stereo separation to believe that what they are hearing is truly separate left and right channels.
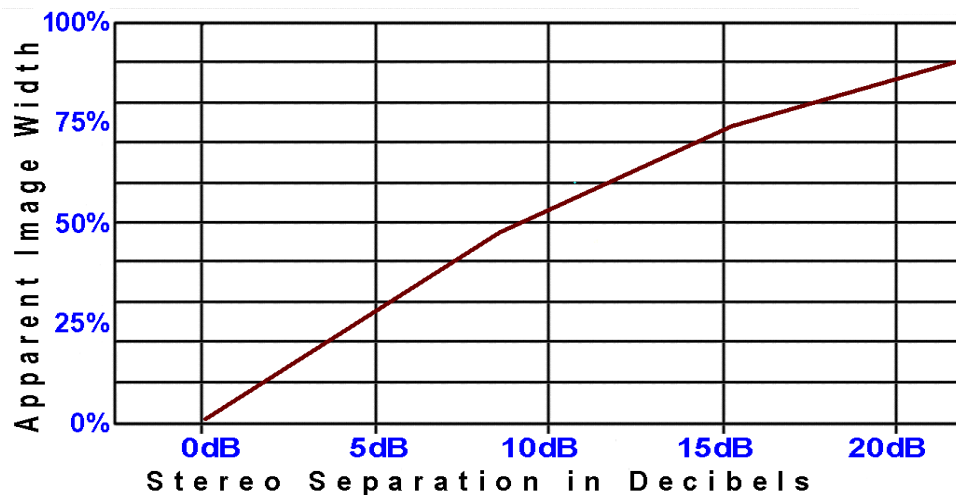
Credit: J.R Stuart, "The Psychoacoustics of Multichannel Audio", *AES Conference:* March 1996, pp 7, Figure 16.

What this implies, and what has been proven in actual practice in the field, is that you can use LiON's multiband stereo enhancement to tailor the spectral balance of the stereo L-R difference signal in any artistic way you choose, and then use LiON's Multipath Limiter to dynamically reduce the overall 'electrical' separation to make radio blending less audible, and without undoing or destroying your creative special mix of L-R enhancement.

LIMITERS
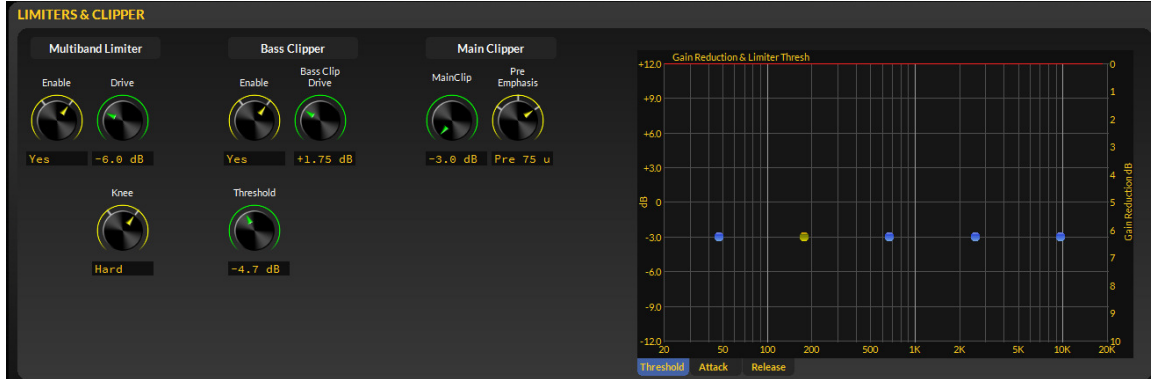
LiON is equipped with a five band limiter which follows the five band iAGC, Leveler, and Compressor which precedes it. The limiter shares the same five frequency bands which were created by the five band crossover prior to the iAGC, Leveler, and Compressor.

Multiband Limiter Enable: This control allows the Multiband Limiter to be switched in or out. In Factory Presets the Multiband Limiter is typically enabled.

Switching the limiter out removes its influence over the audio coming from the multiband iAGC, Leveler and Compressor, and leaves all remaining energy and peak control the LiON's final clipper. For some formats this may be okay, but for most our recommendation is to leave the multiband limiter enabled.

Multiband Limiter Drive: This control sets how hard the multiband limiters will be driven and is the primary control for determining short term audio density and loudness. In most Factory Presets the multiband limiter drive is set to perform a minimal amount of short term limiting, the possible exception being the presets for oldies and classic hits where the extra density serves to replicate the sound of on-air processing from the era when that music was played on the radio.

Multiband Knee: LiON's limiters can operate in Hard or Soft Knee mode if desired. Recall that LiON's compressors utilize soft knee compression because it sounds more musical. The difference between hard and soft knee is represented by the graphic below.
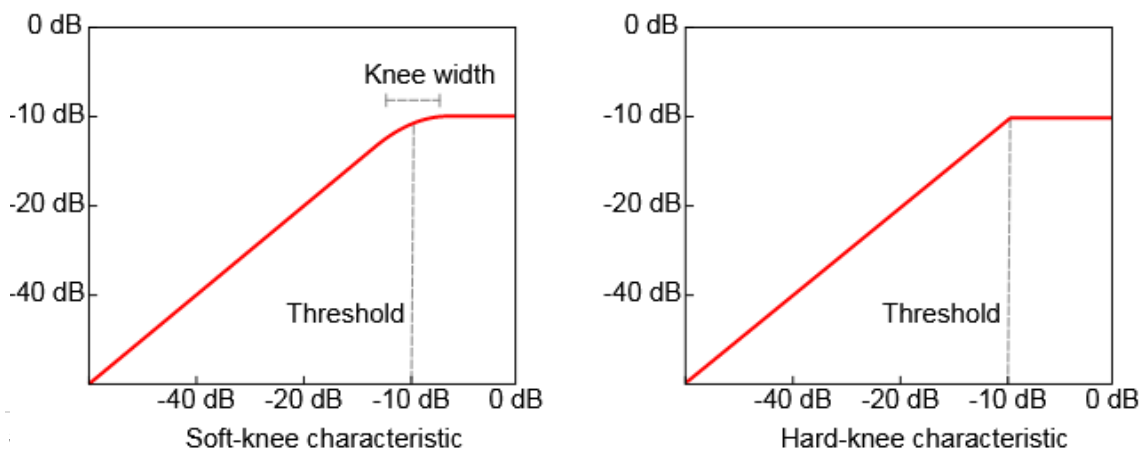
In Hard Knee mode the limiters begin to limit as soon as the limiter threshold is reached.

In Soft Knee mode there is a gentle transition from linear to limiting which then 'softens' the audible effect of limiting as the audio levels cross the limit threshold.

When Soft Knee is in use it will be noticed that the limiters behave as though the limit threshold has been lowered, and if you look at the graph above you'll notice that is exactly what is happening – limiting is starting to occur as the audio level is getting *near* the threshold and not when it has *reached* it. Most of LiON's Factory Presets use the Hard Knee mode which provides a better defined threshold of limiting.

Bass Clipper Enable: LiON's Bass Clipper prevents very low frequencies from reaching the main clipper threshold which then greatly reduces the effects of intermodulation distortion. How the bass clipper prevents this type of distortion can be explained by the following graphic and explanation.
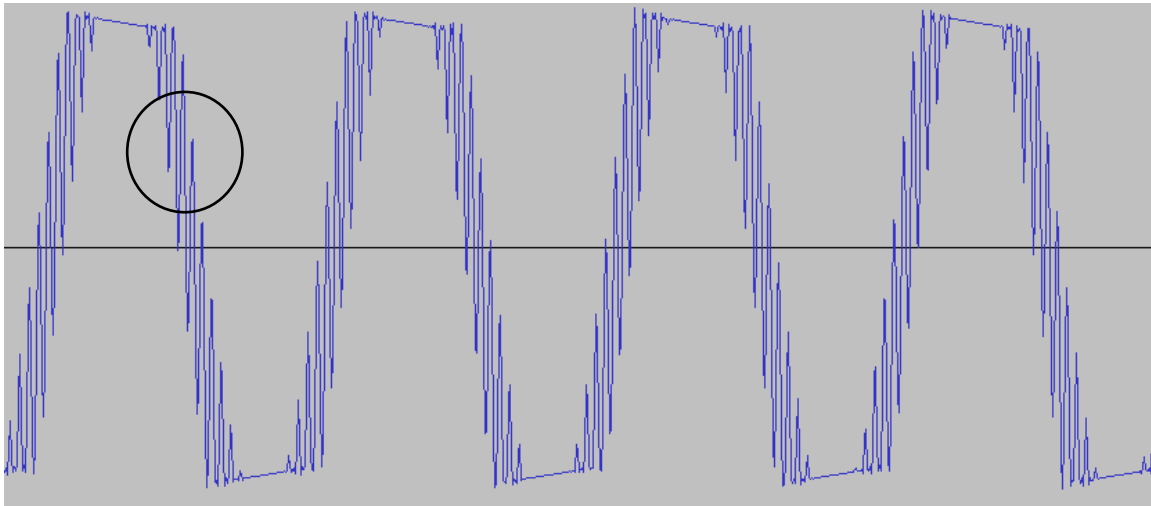
In the above graphic of a real audio waveform, the bass and high frequencies have been allowed to reach and exceed the main clipper threshold. The high frequencies (circled) are then 'cut off' at the top and bottom of the bass waveform whenever bass notes exceed the clipper threshold.

Each time the bass notes come in and out clipping, the high frequencies cut off and then reappear at the bass note's frequency, resulting in the high frequencies sounding like they're "garbling". The low frequency bass notes are now modulating the high frequencies, which is the precise definition of intermodulation distortion.

A bass clipper *prevents* this phenomenon by making sure that the bass frequencies can never reach the main clipper's threshold. A side effect of the bass clipper, because clipping a signal increases its RMS energy, is an increase of bass's acoustical energy, even though the *peak* level of the bass is now *lower* than it originally was.

Bass Clip Drive: The Bass Clip Drive control sets how hard the bass clipper is driven and can be adjusted over a 6dB range. Driving the bass clipper harder has several effects:

➢ It increases the RMS energy of bass *without* increasing its peak level. Bass sounds louder without boosting its level.

➢ It increases the duty cycle of bass clipping which, when taken to the extreme, can create something called "bass sustain" which may have been absent in the original program content. Bass sustain causes bass notes to last longer, and because of the bass clipper action, adds some harmonic content that can help make up for a small speaker's lack of deep bass reproduction.

➢

Bass Clipper Threshold: This is a "Danger Will Robinson" control, but is included in the set of GUI controls in order to allow users to tailor bass exactly how they want it. The control is 'dangerous' because when set too high allows the bass clipper threshold to approach that of the main clipper. That means that under certain circumstances intermodulation distortion, the very thing the bass clipper was designed to prevent, can *still* occur. Be careful using Bass Clipper Threshold settings above about -2dB.

Main Clipper Drive: Along with the Multiband Limiter Drive, it and the Main Clipper Drive are the "loud" controls. LiON's main clipper is quite forgiving, however as is the case with all peak controllers using clippers, at some point when driven too hard, distortion will become apparent.

The best way to set the Main Clipper Drive control when adjust many other controls to achieve a certain texture or sound is to start by turning it down to -3dB. Then turn your monitor up to compensate while tweaking any other controls.

Once you have the density, spectral balance and texture all adjusted to where you want it, only then should you start increasing the Main Clipper Drive. Adjust to taste to achieve either your competitive loudness target, or the point where there is too much distortion.

Keep in mind that FM peak clippers have a tremendous job to do, and to do it gracefully and without you noticing the work it is doing means that it has to do several *very* important things *extremely* well:

➢ Control audio peaks to constrain modulation to within the legal limits.

➢ Manage FM pre-emphasis in a way that doesn't cause dulling, swishing, smearing, or other nasty artifacts of high frequency control.

➢ Maintain near perfect protection of the FM stereo pilot at 19kHz.

➢ Prevent the generation of out of band signals which might interfere with stations on adjacent frequencies.

> ➢ Protect the integrity of the stereo baseband signals in order to achieve great stereo performance when receivers are located in weak signal areas.

It is often assumed that at least some of the above is the responsibility of the stereo generator and its filtering. But great performance for the stereo generator actually *starts* back in the left/right audio domain where the main peak clipper actually operates.

Main Clipper Pre-Emphasis: There are three options for pre-emphasis; Off, 50μS and 75μS. Off is used for testing, 50μS is used in most of Europe, and 75μS is used in North America and various other countries around the world.

To the right of the Limiters and Clipper controls is a graphical area similar to the one used in the iAGC, Leveler, and Compressor processing section. Beneath the graph are three choices accessible by clicking on its tab; Threshold, Attack and Release. Each will be explained in turn.

Threshold:
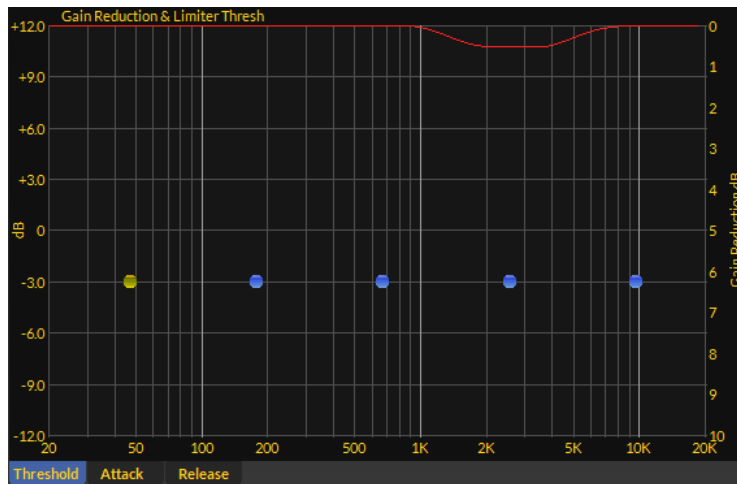
The blue dots on the Threshold tab control the limiter thresholds for each of the five limiter bands.

Moving dots up increases the threshold (less limiting), moving them down lowers the threshold (more limiting).

There is a +/-12dB adjustment range to allow a wide range of operational options.

Unlike the Leveler and Compressor threshold which are very 'gentle' by comparison the Limiter threshold are quite sensitive. Recall that a 3dB change is equivalent to a doubling (or halving) of acoustical energy.

Because the multiband limiter is the 'last line of defense' prior to the main clipper, each of the limiter thresholds plays a large and important role in controlling clipper-induced distortion. Making *small* adjustments followed by *large* listening is highly recommended when adjusting limiter thresholds.

Attack:
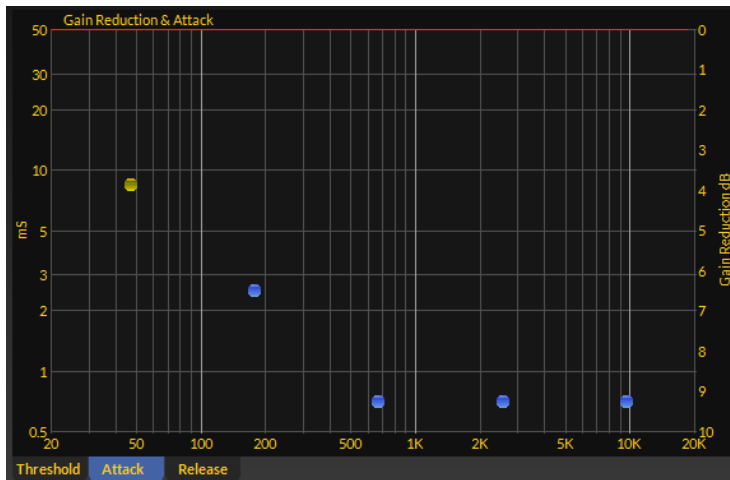
Limiter attack times are adjusted using the blue dots.

Higher settings are slower attack times while lower settings are faster. Limiter attack times are adjustable between 0.5 and 50mS (milliseconds).

Limiter attack times are not as sensitive as the limiter thresholds but still play a big part in how the audio sounds prior to the main clipper. Something to keep in mind about attack times is the time it takes for certain frequencies of musical notes to go through a complete cycle. The following is what we mean by that…

All audio waveforms, including all sounds made in nature, are nothing more than a collection of sine waves of various frequencies and amplitudes. When it comes to limiter attack times it's helpful to think about how fast a particular frequency "happens". Take for instance the lowest frequency bass guitar note at 41.20Hz shown as its waveform, below.
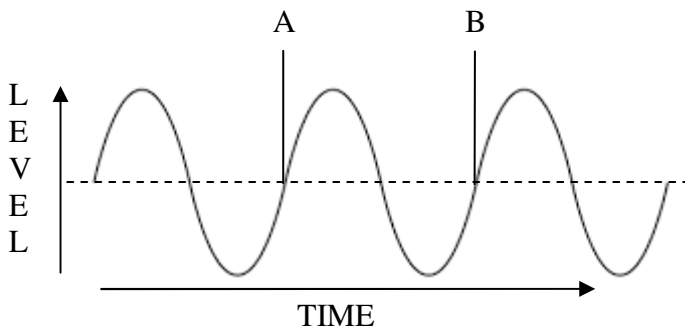
Between points A and B is one complete cycle of the bass guitar's lowest note which takes 24.27 milliseconds to make one complete cycle. If we wanted to peak limit this signal, how fast of an attack time would the limiter need?

It takes about one fourth of the 24.27 milliseconds for the waveform to reach its first peak, which is around 6 milliseconds and a good peak limiter with a high ratio can safely and fully limit this bass waveform to keep it from exceeding whatever the threshold is.

Release:
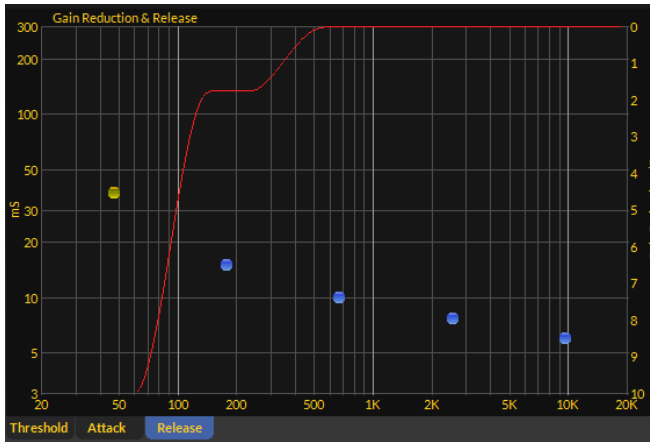
Limiter release times are adjusted using the blue dots just like in the other graphical areas.

Higher settings are slower release times and lower settings are faster.

Limiter release times can be critical for distortion control, and setting them too fast can partially undo the control afforded by the threshold and attack times.

Further, one must be careful to not set release times so fast that the limiter's gain trajectory 'follows' the waveform through its cycle. If this happens, severe distortion resembling clipping can occur, most particularly at very low frequencies.

Let's use again our prior graphical example of a bass guitar's lowest string at a frequency of around 41Hz and its period of about 24 milliseconds.
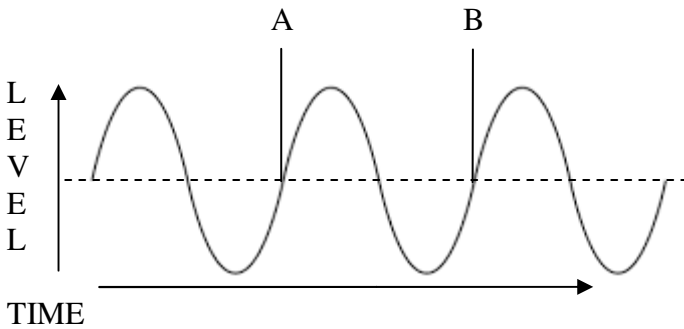
Just from the numbers alone we can see that a release time of 24 milliseconds would likely do exactly what we caution against; limiter gain trying to precisely follow the *envelope* of the waveform between points A and B. So, what to do?

Our recommendation is to use limiter release times that approximate perhaps 10 to 20 cycles of the lowest frequency within a particular band. For instance, good multiband limiter release times on a per-band basis might look like this:

Band #	Minimum Release Time	Optimum Release Time
1	80 milliseconds (mS)	170 to 330 milliseconds (mS)
2	50 milliseconds (mS)	85 to 170 milliseconds (mS)
3	30 milliseconds (mS)	55 to 85 milliseconds (mS)
4	20 milliseconds (mS)	35 to 55 milliseconds (mS)
5	10 milliseconds (mS)	15 to 35 milliseconds (mS)

The above values are *recommended* starting points and deviations may be acceptable under certain program and processing goal conditions. Your ears should always be the judge!

Before leaving the Multiband Limiter section and moving on, it's important to mention that the limiter's job is to prevent certain waveforms from undergoing excessive clipping within the final clipper. Remember that the clipper's job is to clip peaks, but if the limiter has removed them, what's left for the clipper to do? Well, here we are back at the subject of limiter Attack time again!

Our ears are forgiving when it comes to short duration clipping. It is perfectly acceptable, or even desired, that the limiters purposely 'let through' some short duration peaks that can be clipped without us noticing that it happened. As a very loose rule of thumb, our ears usually don't notice clipping of a waveform if it lasts less than about ten milliseconds, and that's the magic of a distortion-controlled peak clipper like LiON's. We can purposely let the clipper take care of 'purposeful' limiter overshoots which not only opens up the audio to make it less squashed, it also adds back in a sense of dynamics and punch that pure limiting removes. Your ears are always the best judge of processing effects and its artifacts!

MPX & OUTPUT

The MPX & Output page of the GUI provides all of the controls for multiplex processing, stereo generation, multipath limiting, ITU BS.412 MPX power regulation, and others.

We will start with the Process & SCA tab of that page and cover each control in turn.
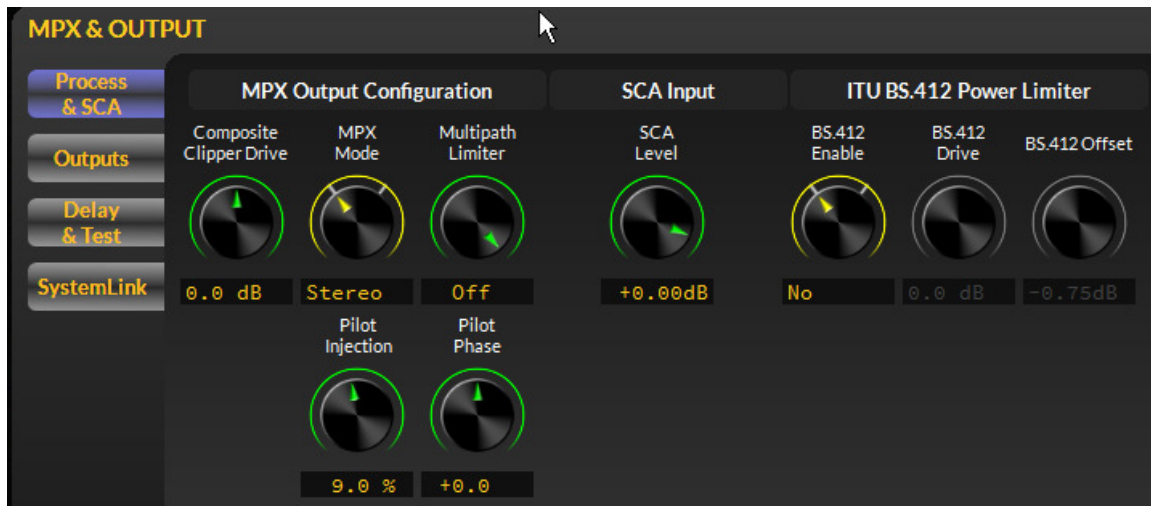
Composite Clipper Drive: The composite clipper drive sets how much, if any, clipping will occur in the stereo multiplex domain. A small amount of MPX clipping after all of the previous processing has been done can add a little more loudness on the dial and many FM stations use it to gain just a little more competitive advantage.

MPX clipping, just like any other form of clipping, can be taken to excess and in the stereo MPX domain it is easy to overdo things. While a little MPX clipping adds a little more loudness, too much MPX clipping can destroy the fragile MPX spectrum and make it difficult for some stereo radios to decode, especially in areas where the station has weak coverage.

MPX Mode: The MPX Mode switch selects whether the stereo generator is running in stereo or mono. When in mono the stereo generator will turn off the 19kHz stereo pilot and shut down the generator of the double sideband suppressed carrier L-R signal centered at 38kHz.

Pilot Injection: This control sets the amount of 19kHz stereo pilot injection. Usually the control is set between 8% and 10%, noting that the 19kHz pilot level *does vary* as the MPX output level control is adjusted because the stereo pilot is a component part of the signal whose level is being adjusted.

The control is adjustable between 0% and 20% to accommodate a wide range of situations in the field.

Pilot Phase: Normally, and with most transmitters and transmission systems the pilot phase control is set to zero. However, if the transmitter that LiON is connected to is feeding an antenna system with poor RF bandwidth or a multi-station combiner whose group delay is substandard, adjustment of the pilot phase might be necessary in order to achieve good stereo separation.

The reason for the existence of the pilot phase control is that transmission systems like those described above can upset the phase relationship between the stereo pilot at 19kHz and the 38kHz subcarrier around which the L-R stereo information is modulated. If the 19kHz stereo pilot and 38kHz subcarrier don't cross zero at the same instant, transmitter stereo separation is poorer than it could be and stereo radios out in the field cannot fix it.
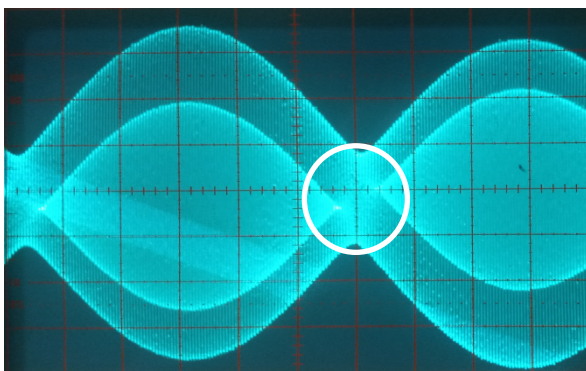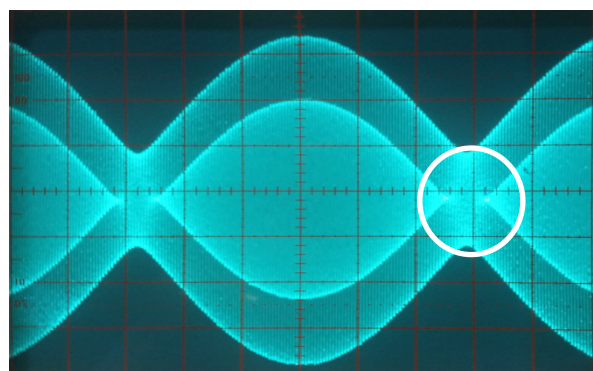
| **Poor Pilot Phase** | **Proper Pilot Phase** |

The oscilloscope photographs above are examples of poor (left) and proper (right) 19kHz pilot phase. Inside the circled areas are what to look for if adjusting the pilot phase is required. The 'points' in the center of each waveform should be directly across from each

other, just as they are in the right hand image. The 'points' being directly across from each other tells us that the 19kHz stereo pilot and the 38kHz stereo subcarrier are in perfect phase.

To generate this waveform on an oscilloscope, set it up to monitor the MPX output, select the Factory BYPASS preset on LiON, and with the LiON stereo generator in Stereo mode, feed the left and right inputs with a low frequency sine wave with one channel out of phase. That will create a pure L-R signal and make the 19kHz pilot/38lHz subcarrier phase relationships quite visible on the oscilloscope.

NOTE: Be certain to utilize DC coupling on the oscilloscope input!

If the 'points' on the waveform are out of line as they are in the left hand picture, adjust LiON's Pilot Phase control until they are in as good alignment as can be achieved within the range of the Pilot Phase control.

SCA Input, SCA Level: LiON is equipped with a rear panel BNC female connector which may be used for insertion of a subcarrier into the overall MPX baseband signal. This input can be used for any subcarrier frequency between 57kHz and 80kHz.

The level control has a 90dB adjustment range, -80dB to +10dB. External subcarrier generators will usually require an SCA Level setting between -10dB and +10dB. The -80dB setting is provided in the event it is desired to completely shut down the SCA Input.

ITU BS.412 Power Controller
LiON is equipped with an MPX Power Controller which is fully compliant with the European Union's ITU BS.412 stereo modulation standards. LiON is provided with three controls which govern the controller's behavior.

NOTE: Engaging the MPX Power Controller when it is not needed can cause up to a 5dB loss of on-air loudness. Do not engage the controller unless your country requires its use!

BS.412 Enable: This control enables and disables the MPX Power Controller.

BS.412 Drive: This control allows the user to adjust the amount of drive to the controller to make up for program formats that may be using very little processing. Adding some extra drive helps the controller maintain a more consistent MPX power level.

BS.412 Offset: This control permits the use to make adjustment to the MPX Power target and has a range of -1dB to +3dB allowing adjustment to meet whatever regulatory requirements the customer's country requires..

A one hour example of LiON's MPX Power management capability is demonstrated in the graphic below.
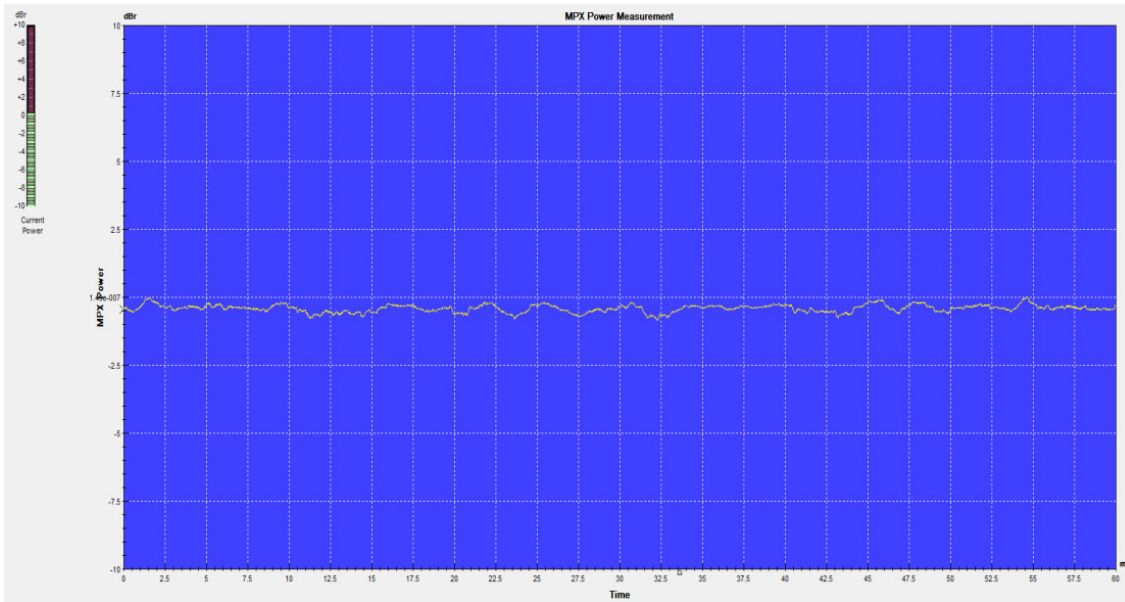
In the hour-long test performed to create the graph above MPX Power was held to within 1dB of the 0dB target level and never exceeded it.

Outputs

LiON is equipped with multiple audio outputs arranged in a flexible method for choosing which audio signals exit which rear panel connectors. Each output type has its own high resolution level control.

Analog Level: The Analog Output control has an adjustment range of -48dB to 0dB and in 0.1dB steps. The analog output is normally from the pre-emphasized FM final peak clipper and is available on LiON's rear panel RJ-45 Analog Out connector.

Analog HD Delay: When required the analog output may be taken from LiON's built in HD diversity delay to put it in sync with the processed MPX output. The default mode for Analog HD Delay is "Out".

Analog De-Emphasis: If the analog output is not feeding an FM transmitter or other medium requiring FM pre-emphasis, the analog output audio may be de-emphasized by setting the Analog De-Emphasis mode to its "Yes" setting.

Digital Level: This control adjusts the audio output level of the AES output signal whether it's left/right processed audio, or the Baseband192® (BB-192) digital FM multiplex signal. Like the analog output level, the digital level control has an adjustment range of -48dB to 0dB.

Digital HD Delay: When required the AES3 digital output may be taken from LiON's built in HD diversity delay to put it in sync with the processed MPX output. The default mode for Digital HD Delay is "Out".

Digital Type: LiON's digital output may be selected to be processed left/right AES-3, or Baseband192® digital multiplex when the control is set to the BB-192 position.

Digital De-Emphasis: If the digital output is not feeding an FM transmitter or other medium requiring FM pre-emphasis, the digital output audio may be de-emphasized by setting the Digital De-Emphasis mode to its "Yes" setting. Note that the Digital De-Emphasis mode has no effect when the digital output type is set to BB-192.

Sample Rate: The digital output, and only when it is in AES mode, may be set to 44.1kHz or 48kHz. When the Digital Type is set to BB-192 the output sample rate is always 192kHz.

MPX Output: This control adjusts the output level of the stereo multiplex signal appearing on LiON's rear panel MPX Out female BNC connector. The output level is adjustable over a -24.00dB to +3.00dB range with steps of 0.05dB allowing very fine adjustment of the stations modulation level.

Output Settings Change With Preset Takes: One of LiON's most flexible features is the ability to cause its input or output settings to follow whatever is stored in a preset. When the feature is enabled (dot is filled with color) taking a preset will recall all output-related settings along with the settings pertaining to the processing functions.

The Output Follow Presets feature is useful for scenarios like when a station transmits mono programming (such as a talk show) and turns off the stereo pilot because it can help with reception in weak signal areas.

Saving a preset with the stereo pilot disabled also makes it available when the station wishes to transmit in mono without having to manually switch off the pilot. In this case LiON's Preset Scheduler (covered later) can make the "pilot off" process automatic and based on day and time of day, if desired.

Delay and Test

LiON includes a sine wave test oscillator, adjustable in frequency and in level, and because it can generate tones up to 80kHz makes it suitable for checking the frequency response of entire the FM transmission system.

Tone Enable: Turns the test tone on or off. When in the On state normal programming is replaced by the test tone which is *only* output on the rear panel MPX Out BNC connector.

Tone Level: This control adjusts the output level of the test tone generator in 1% steps allowing for very fine adjustment of the resulting MPX modulation.

Tone Frequency: The tone generator is capable of generating low distortion sine wave tones between 50Hz and 80kHz.

Also included is a Bessel frequency of 31.250kHz which when used with a suitable RF spectrum analyzer can be used to verify the accuracy of the stations modulation monitor.

Using the Bessel frequency and the "Tone Level" control (adjustable in 1% steps), MPX modulation is adjusted until the spectrum analyzer shows the <u>first</u> complete sideband null which then represents *precisely* 75kHz deviation (100% modulation).

Diversity Delay: LiON is equipped with HD diversity delay with a maximum delay of ten seconds and adjustable in two digital sample (41.6µS) steps.

There are two displays showing the amount of delay currently in use, Seconds and Samples, as well as three controls for setting the desired amount of diversity delay; Seconds, Milliseconds, and Microseconds.

Each slider can be slid back and forth using a mouse left-click and drag motion or the mouse scroll wheel, if equipped. Fine delay adjustments may be made using the mouse scroll wheel and keyboard keys.
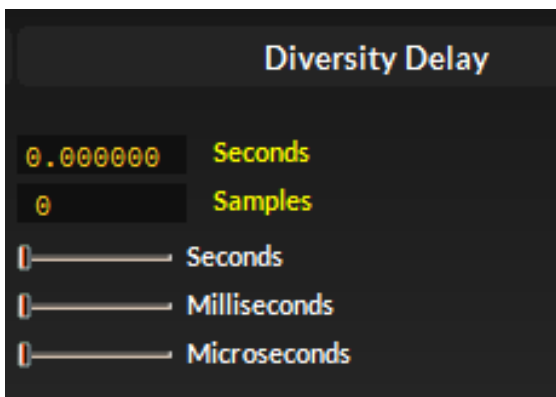
Coarse adjustments may be made while holding down the keyboard **SHIFT** key while scrolling settings with a mouse wheel.

Alternately, fine adjustments may be made in the same way but by holding down the keyboard's **ALT** key instead.
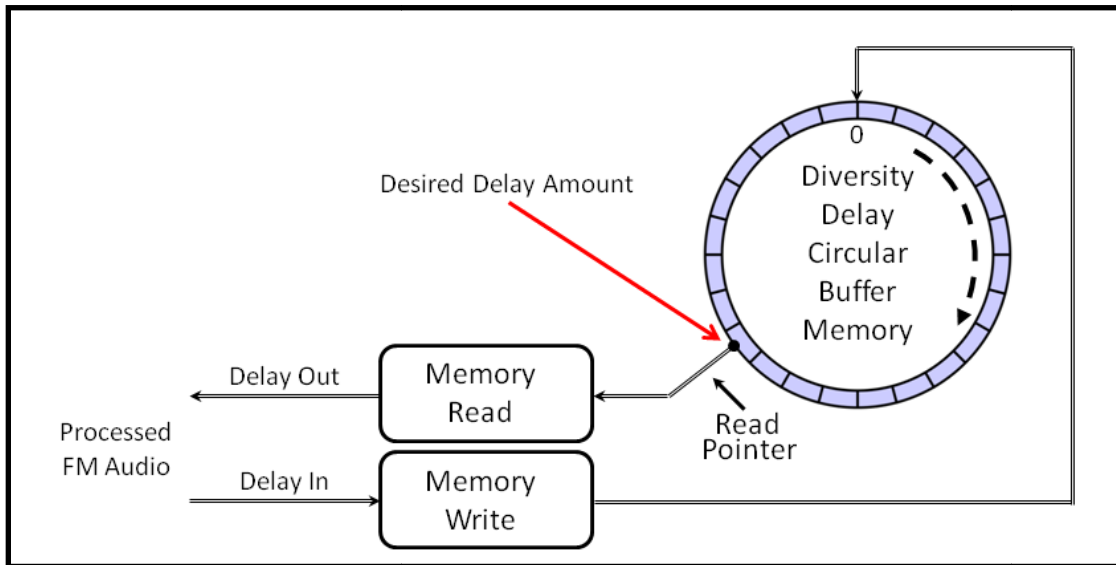
It is important to mention that diversity delay in on-air processors, and for certain our own on-air processors, doesn't 'wander around'.

If it *could* wander around and it did, the delay wouldn't slowly be getting out of sync... It would be *randomly* jumping around inside the full ten seconds of delay and causing *very* noticeable jumps in the station's on-air audio.

The diversity delay remains where it has been manually set. If FM analog and HD audio are getting out of sync, something else, somewhere else, in the audio chain is causing it.

HD+

LiON is equipped with a fully featured HD+ audio processing section which may be used not only for feeding a station's HD signal, but is also extremely competent for processing audio for streaming.

LiON's HD+ audio processing may be fed from three possible audio sources using the Source control, explained next.

Input: In this mode the HD+ audio processing is being fed from the audio occurring after the high-pass filter and phase rotator and before any other form of processing. Because that audio is prior to LiON's four band equalizer in the main FM signal path, LiON has its own identical equalizer, covered later. This mode is useful for purest applications where no other processing, other than that afforded by the HD+ section, is desired.

*i*AGC: In this mode the audio source for the HD+ audio processing is after the *i*AGC in the main FM signal path. The *i*AGC is then feeding the HD+ section a more consistent spectral balance so its behavior will be a bit different, mostly in how the HD+ section's AGC behaves. Overall, audio levels exiting the HD+ section will be more consistent in level and spectral balance than in the "Input" mode case.

All: In this mode LiON's HD+ section is receiving audio from all of the FM processing chain up to and prior to the FM left/right peak clippers. Audio out of the HD+ section in this mode will be very consistent, both in level and spectral balance and is useful for when stations desire to more closely match the sound of their HD channel or Internet stream to that of their FM on-air audio.

Trim: Allows a +/-6dB left/right channel balance adjustment which is usually most useful whenever the HD+ section is accepting input audio in the Input source mode.

Look Ahead Limiter
LiON's HD+ limiter features a true lookahead function which allows it to anticipate, and then react to audio peaks in a way that prevents them from exceeding the currently set limiter threshold.

Threshold: The HD+ limiter threshold may be adjusted over a 3dB range from -3dBFS to 0dBFS. In most applications a limiter threshold of about 1dB below 0dBFS, or -1dB, is recommended.

Knee: This control changes the limiter between hard and soft knee limiting.
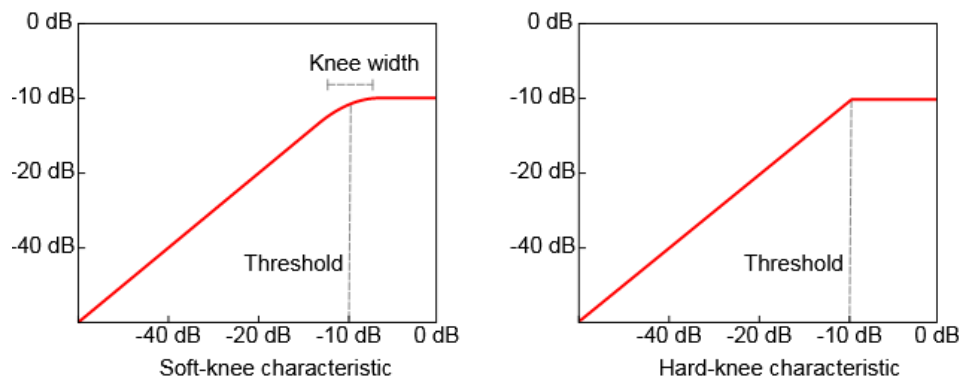
A soft knee characteristic causes limiting to occur over a broader portion of the gain control curve, called the knee width, as the limit threshold is approached. Conversely, a

hard knee characteristic causes limiting to occur immediately when the limit threshold is reached.

A soft knee is preferable over hard in some programming situations and your ears should be your guide. In LiON's HD+ limiter the knee width is fixed at 3dB when in the Soft mode.

L/R Coupling: The L/R Coupling control is responsible for setting how much the left and right limiters track each other under dynamic conditions and coupling can be varied from zero to 12dB.

At a setting of zero both limiter channels will track in their gain reductions and will follow the channel with the highest peak levels.

At the other extreme is a setting of 12dB where neither channel will track the other unless the gain reduction difference is 12dB or greater – the left and right limiters are essentially operating independently.

There is a potential downside to operating with the limiters fully uncoupled, stereo image shift. This can happen because on transients and when the limiter reduces the gain of the channel with the higher peak level, it causes the stereo image to instantaneously shift towards the channel with the *lower* peak level.

An artifact like that can sound quite unnatural to someone with classical music training or interest, and a good tradeoff is to set the L/R Coupling at about 3dB.

AGC On/Off: The HD+ section's AGC is a two-band design which aids spectral balance management, especially when the input source is set to Input. When engaged it helps the BS.1770 loudness controller maintain a consistent loudness level even though the controller is capable of doing so on its own.

If the AGC is switched to Off the Leveler AGC gain reduction meter will slowly return (up to) to zero and if the loudness controller is On, it would do more work to control loudness.

Attack: This control sets the speed at which the HD+ AGC section chases increasing audio levels in order to bring them back in check. The control has an adjustment range of 50mS to 250mS with settings between 70mS and 150mS being useful with generating processing artifacts.

Release: This control sets the speed at which the AGC section chases the incoming audio levels as they decrease. The control has an adjustment range of 100mS to 1,000mS (one second) with settings between 300mS and 1,000mS being useful for most formats.

The graphic below shows how the gain will change during the AGC's attack and release conditions.
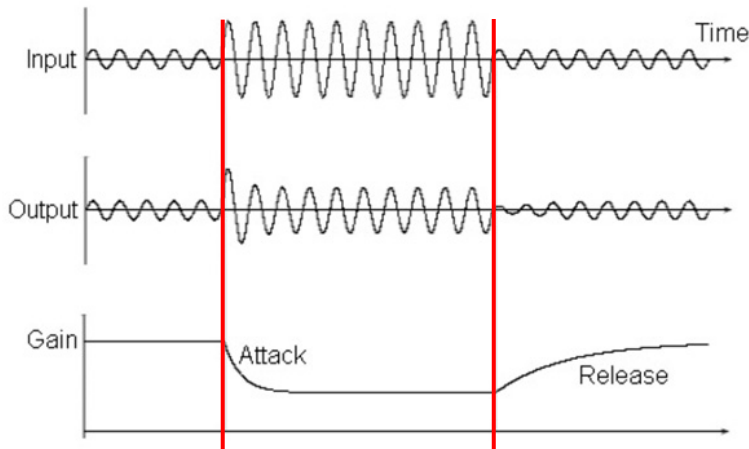
AGC Backoff: In order to control short-term dynamics the leveler is also equipped with a side chain compressor. The AGC Backoff control allows the AGC to briefly 'step aside' during faster audio transients and let the compressor do more work without the AGC (which takes longer to recover) having to do all of the necessary gain reduction.

The AGC Backoff control allows one to set, or divide up, the amount of work done by the AGC and side chain compressor. With the control set at zero the AGC is always in charge, but as the control is set to increasingly positive numbers the AGC will 'step aside' on short term dynamics and allow the compressor to do more work. The acoustical effect is a slightly denser sound whenever the backoff control is above its zero setting.

BS.1770 Loudness Controller

LiON's HD+ section includes a comprehensive loudness controller which is compliant with the International Telecommunication Union regulation ITU-R BS.1770. The HD+ sections current output loudness is displayed on four GUI-based bargraphs representing 400mS, 3 second, 10 Second and 30 Second integrations as well as a loudness target meter.

BS1770 Target: The Target control sets the long-term loudness target goal and the algorithm will monitor the resulting loudness in real time to ensure that the loudness goal is maintained.

Auto Target: Enables or disables the automatic loudness feature. When On the algorithm is actively managing the HD+ section's output loudness over time to ensure the target is reached and maintained. When Off the loudness controller is disabled.

Meter Range: Changes the scaling for the four GUI-based bargraphs. In the 0-20 position the bargraphs have a display range of 0 LUFS to -20 LUFS and when the meter rang is set to the 0-40 range the bargraph meters display 0 LUFS to -40 LUFS.

dBLU: When elected the large digital loudness meter displays the current loudness.

Long Term Avg: When selected, the large digital meter will display the long term average loudness over time on a rolling minute by minute basis with the elapsed measurement time shown by "Over Last X Minutes" below the large digital display.

On each minute the displayed value will update to show how the loudness has varied over the displayed elapsed time. In other words, the Long Term Average being displayed is a rolling average over the period of time that the long term average measurements have been taking place.

The Long Term Average meter may be Run, Reset, or Paused by using the buttons below the large digital display of loudness. An illuminated button indicates the current state of the loudness measurement process.

EQUALIZER

The HD+ section is equipped with a second instance of the four band equalizer that is present in the FM processing chain and operates in exactly the same manner.

There are two shelving EQ sections (low and high) along with two fully parametric equalizers that have adjustable frequency, boost and bandwidth (Q) controls.

BW (Octaves)	Q
2.0	0.667
1.0	1.414
2/3 (0.66666)	2.145
1/2 (0.50000)	2.871
1/3 (0.33333)	4.318
1/6 (0.16666)	8.651
1/10 (0.10000)	14.242
1/30 (0.03000)	43.280

Recall that filter Bandwidth and Q are related as shown at left.

A more detailed discussion of Q and bandwidth can be found here:

https://shorturl.at/kuQX9

At left are the controls associated with LiON's equalizer section.

Note that the controls are grouped according the 'band' that they operate within.

The two fully parametric equalizer sections are unique, however, in that they may be tuned to operate on *any* portion of the audio spectrum between 20 Hz and 20 kHz.

EQ Enabled: When illuminated the equalizer section is in circuit and active and if any control within the equalizer section is adjusted those adjustments take effect immediately.

Lo Shelf Section
Boost/Cut: The Boost/Cut control adjusts the Lo Shelf equalization over a +/-14dB range. Note that a boost or cut of just 3dB increases or decreases the acoustical *power* of the frequencies being controlled by a factor of *two*.

Frequency: The HD+ section's Lo Shelf equalizer frequency range is 20Hz to 500Hz. Slight boosts (~3dB) around 50-70Hz can increase the sense of bass punch on the station's HD channel or web stream.

Some portion of the station's listening audience listens on devices that may not be able to reproduce bass energy 'down there' and most don't reproduce much below around 80-100Hz unless equipped with a subwoofer.

Para #1 and Para #2:   These are the HD+ section's two fully parametric equalizer sections. Each may be tuned over the range of 20Hz to 20kHz, have boost/cut capability of +/-14dB, and may have their bandwidths set according to the amount of frequency spectrum desired to be affected by their settings.

Hi Shelf Section
Boost/Cut: The Boost/Cut control adjusts the Hi Shelf equalization over a +/-14dB range. Note that a boost or cut of just 3dB increases or decreases the acoustical *power* of the frequencies being controlled by a factor of *two*.

Frequency: The Hi Shelf equalizer frequency range is 2kHz to 20kHz. Slight boosts (<3dB) around 10kHz can add a sense if 'air' to the audio, noting that a little goes a long way.

EQ Graphical Area: Shown below is LiON's equalizer spectral display showing where, and by how much, frequencies with the audio spectrum are being modified.

The graphic below corresponds to the equalizer controls shown on the previous page where we've:

- added a 2dB boost at 50Hz to add a little more bass punch
- pulled down the energy in the spectrum around 240Hz by 3dB to decrease 'muddiness'
- added a little 'air' to the broadcast using a 1.5dB boost at 10.1kHz

HD channels and web streams are a bit more forgiving when it comes to equalization but are still must be taken, especially at high frequencies when codecs with low bitrates are in use.

OUTPUT

On the Output page of the HD+ section are choices for which of LiON's audio outputs carries which processed audio signal, FM or HD+.

Normally upon the first startup of LiON this GUI page will look mostly blank because by default LiON's analog and digital outputs are carrying processed FM audio along with a messages in orange text at the top of the GUI stating: "Analog Outputs Assigned to FM" and "Digital Outputs Assigned to FM".

To send the HD+ processed audio out of LiON's analog outputs select the "HD+ to Analog Outputs" button at the lower left corner of the upper GUI panel.

Upon doing so the controls for that output will appear and we also now have HD+ left/right audio coming out of LiON's analog output.

Level: Sets the HD+ audio output level of the rear panel analog output RJ-45.

De-Emphasis: Selects whether or not FM de-emphasis is applied to the analog output. De-emphasis will only be necessary if the HD+ processing section is receiving its audio from the "All" input mode because that audio is post FM left/right clipper and has been pre-emphasized.

Likewise we can send the HD+ processed audio to the digital output by selecting the "HD+ to Digital Outputs" button at the lower left order of the upper GUI panel and upon doing so the controls for that output will appear. Now we have HD+ audio coming out of LiON's digital output, too.
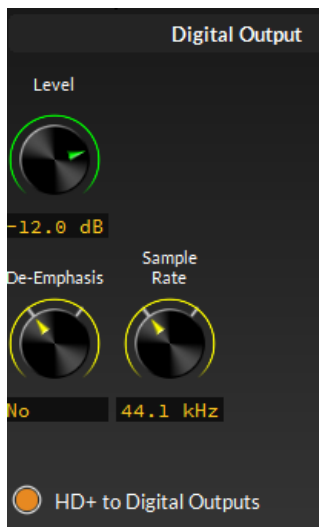
Once again we have Level controls and De-emphasis selections, but now we also have a Sample Rate selection too which can be set to 44.1kHz or 48kHz as needed for the application.

These controls operate exactly like those for the analog output and if audio to the HD+ section is coming from the "All" input mode, the De-emphasis mode set to Yes will likely be required for situations where pre-emphasized audio is not desired.

SCHEDULER
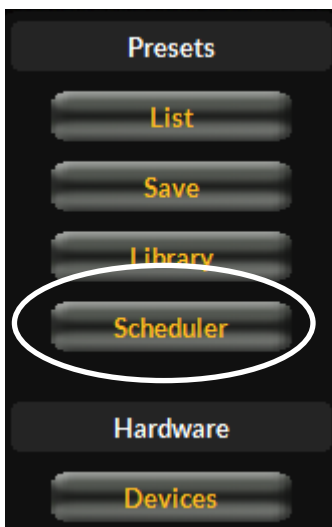
LiON has a built in, clock-based scheduler which can be used to automatically put presets on the air as some desired date and time, but is also integrated with LiON's RDS encoder for switching RDS Datasets according to a time and date schedule.

Click the Scheduler button in the lower left corner of the GUI to open the schedule page.
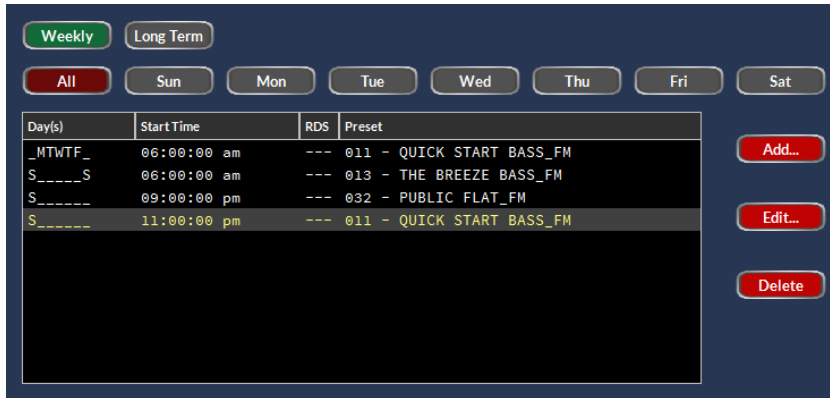
Scheduled events are added to the schedule by clicking the Add button.

The **Weekly** Event Scheduler window will open as shown below (see Long Term later).
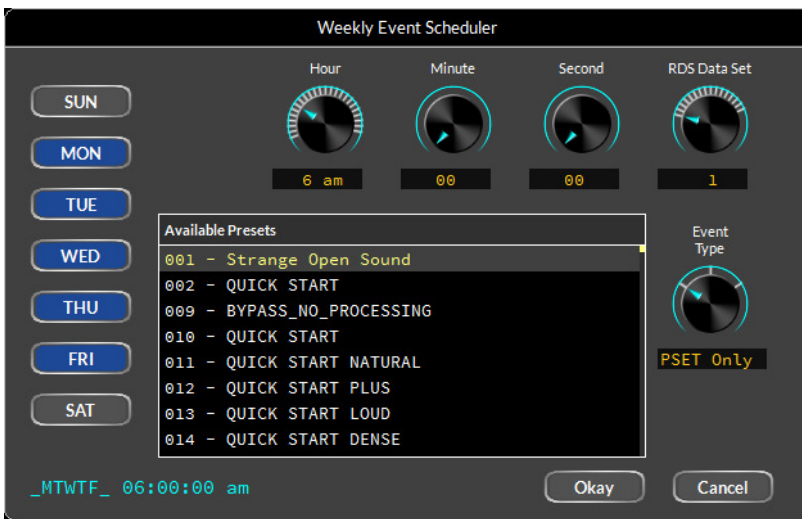
Here events may be scheduled to change presets only, RDS Data Sets only, or presets and RDS Datasets at the same time.

Events may be scheduled by any day of the week or several days, or all days if desired.

In the above image we've scheduled some preset changes to use for our example.

Long Term Scheduler Events
Along with the Weekly scheduler LiON also has a Long Term scheduling function as well which can be used to change presets well in the future.
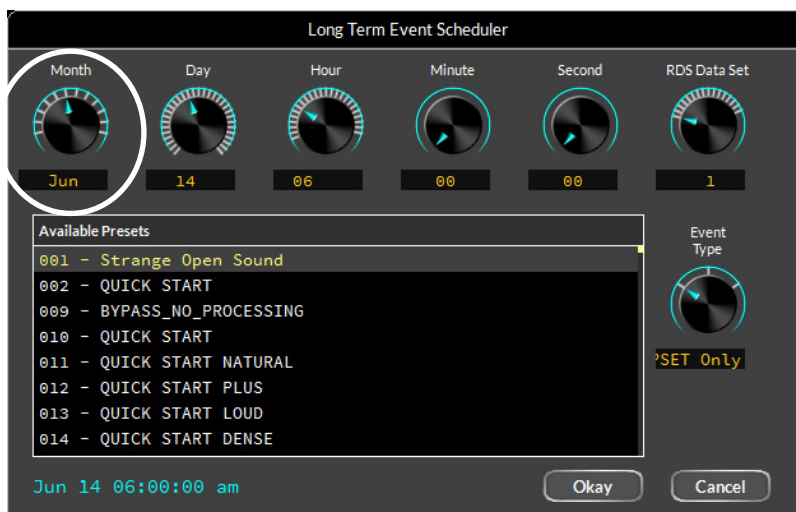
Unlike the Weekly scheduler the Long Term scheduler also includes a *Month* parameter.

One of the common uses for the Long Term scheduler is pre-scheduling a preset change to be used for music over the holidays and it can be set up well in advance. In fact, you could set it up in June, walk away, and when it was time for that preset to be on the air, bingo, it's on, and nobody had to do or touch anything.

Of course there's always a nefarious use for technology like this and one that comes to mind is someone who planned to leave a station in the next month or so and under not such a good set of circumstances…

In an "I'll show you" moment, a preset was secretly scheduled and a few days later and after that person was long gone from the company – and in the middle of the station's morning show no less – LiON's Bypass/No Processing preset went on the air! Yes. It happened! ☺

Editing Events: In both the Weekly and Long Term Schedulers, events can be edited or deleted at will using the Edit button after a scheduled event has been highlighted within the main Scheduler window. There is no separate event save option. Once the event has been edited and the Edit window closed, the event has been saved.

Deleting Events: A scheduled event can easily be deleted by selecting it in the main Scheduler window and then clicking the Delete button.

Important: there is no Yes/No or Confirm pop-up question when *deleting* an event. When the Delete button is clicked, the event is permanently removed.

SYSTEM SCREEN

The final page of LiON's GUI interface is the System screen. We'll cover each item shown from left to right.

CoProcessor Version
LiON relies on several different types of software in order to do all of its magic. There is code for the FPGA (Field Programmable Gate Array), the DSP (Digital Signal Processor), and Software which is what ties all of it together into a working LiON.

The Built date shows the date and time when the bundle of software currently running on LiON was packaged up into an 'rbn' file. An rbn file is an encrypted combination of all of the above versions which makes upgrading LiON in the field simple for a user – there is only *one* upgrade file to contend with and it will update everything. If for instance the FPGA code hasn't changed, uploading the rbn file to the hardware will overlay a new and fresh copy of the same version of FPGA code, just in case.

GUI Version
The GUI Version field shows the version of the GUI that is currently connected to LiON. In most cases the GUI Version and the Co-Processor *software* versions will and should match.

NIC Address
The NIC (Network Interface Card) Address is the IP address of the PC that is currently running the GUI. Sometimes it is necessary to explicitly tell the GUI where the PC is, and for that we've provided the "SET" function which when pressed, automagically does just that.

Status
Under the Status column LiON displays to the GUI and end user various data that it knows about itself. This column provides a lot of helpful information that can be useful for troubleshooting.

Temperature
LiON has a built in temperature sensor on its internal main CPU board which keeps track of the operating temperature in degrees Centigrade. Normally LiON's internal temperature will be somewhere between room temperature (~22C) and in the 40's, depending on the physical environment that LiON is operating within.

If the internal temperature reaches 50C or higher the temperature readout will turn red to indicate that "hey, things are getting hot in here!" No immediate harm will come to LiON if operated at elevated temperatures, however long-term reliability may suffer.

Date and Time
LiON also has a built-in real time clock (RTC) that keeps the Scheduler functions operating correctly. Keep in mind however that LiON will maintain its timekeeping for *short* duration power outages (a few seconds) but because it has no internal backup battery correct time will be lost for power interruptions that last longer.

Why is there no battery backup for the RTC? So you won't have to worry about changing it when it stops working and/or losing your schedules without knowing you lost them because the battery died and no one noticed!

CoProc IP
LiON has its own user assigned network IP address which is used by the GUI to know where on the network LiON lives.

IP addresses are like house numbers on your street. You might live on Main Street (the station's network) but unless you give someone your house address (LiON's IP address) they (the GUI) won't know which house (LiON) is yours!

CoProc MAC
Every networked device is assigned a unique 12-digit number at 'birth' that identifies it to other devices on the network such as Ethernet switches and routers. In fact, Ethernet switches and routers communicate with devices on the network not by their IP addresses, but by their MAC addresses.

In the System Page image LiON's MAC address is shown as: 80:E4:DA:00:89:A7. If you look up that MAC address on the Internet you'll find that it has been assigned to Wheatstone Corporation (us) and belongs to a range of about one million MAC addresses assigned to us between 80:E4:DA:00:00:00 and 80:E4:DA:0F:FF:FF.

WNIP Host Blade
When LiON is part of a WheatnetIP network and has been assigned a Host Blade the host Blade IP address will be shown. Here, and because Host Blade IDs usually start at 100, our Host Blade ID is the number 51.

WNIP Sample Rate
When LiON is attached to a WheatnetIP network the sample rate of the system it's connected to will be shown here.
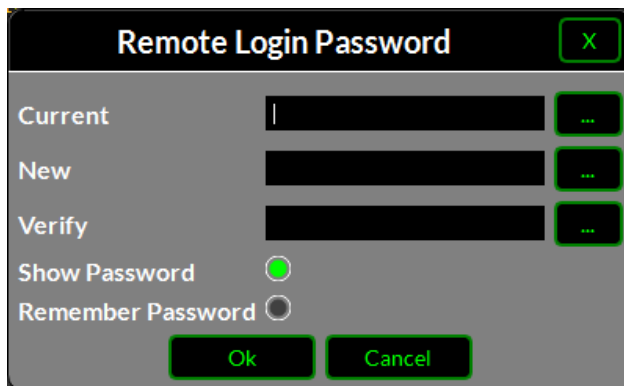
SECURITY

LiON is equipped with a multi-layer security system which, when enabled, can be used to prevent unauthorized access to the LiON hardware or remote access via the GUI software.

Remote Login
If a Remote Login password is enabled whenever a remote GUI attempts to connect to the LiON hardware a password prompt will appear and unless the correct password is entered, LiON's hardware will refuse the connection.

Clicking on the Remote Login button will open the following dialog.

The Current Password field is only used if you wish to change or remove an existing password.

To change an existing password, enter it in the Current field, followed by entering the new password in the New and Verify fields.

If the Show Password option is enabled (highlighted), the passwords will be visible as they are entered.

If the Remember Password option is enabled (highlighted) the GUI will write the password to a hidden file on the PC running the GUI, and the password will be *automatically* entered the next time the GUI attempts a remote connection to LiON's hardware.

To remove a password, simply enter the current password followed by blank fields for those for New and Verify.

When all edits are completed in this dialog clicking the Ok button will cause LiON to store the information.

If the password is lost, Audioarts technical support can help gain access again noting that there is *no* master password *nor* is there a factory default command.

Front Panel
LiON's front panel has built in security which, unlike the Remote Login which can use alphanumeric characters, the front panel is limited to four numerical digits (0-9) which allows 10,000 possible lock/unlock codes.

The front panel access code can be set using either LiON's front panel or through the GUI's Front Panel security button.
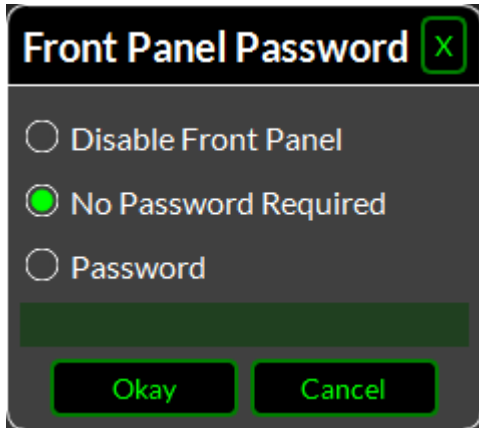
It is also possible to make LiON's front panel completely restricted by choosing the Disable Front Panel option. When this option is chosen, LiON will only display metering. There will be no option to gain entry using a front panel passcode.

To undo the disable front panel option or to delete an existing passcode, select the No Password Required option. When this option is in effect the front panel is wide open with no security.

If the Password option is chosen the shaded bar below Password will turn black and allow up to four numbers to be assigned as the front panel passcode. When Okay is clicked the dialog will close and all front panel passcode changes will immediately go into effect.

GUI Access
This option allows you to set a security code that can lock the GUI controls completely out, or simply restrict making control settings changes or saving a preset (preset recall is not affected).
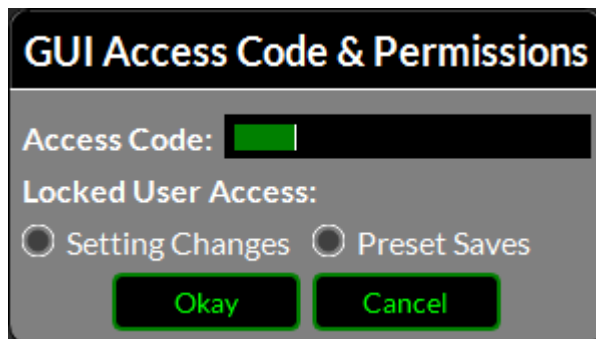
The access code dialog accepts four numerical digits, just like LiON's front panel.

If an access code is not assigned to Settings Changes and/or Preset Saves, those functions will not be restricted, however GUI Lock, covered next, will now function.

GUI Lock
The GUI Lock feature enables the user to completely lock the GUI, and by locked we mean preventing access to *everything* except being able to *view* the GUI metering and the various GUI pages related to processing and other functions. Functions other than viewing will remain restricted until the correct passcode is entered in the GUI Access dialog.

Set Time

LiON"s Real Time Clock may be set three different ways, Manually, Using the GUI's host PC's clock, or via SNTP (Simple Network Time Protocol).

Manually

Using the Manual adjustment dialog all parameters pertaining to date, time, hour format and UTC offset may be applied.

The graphic at left shows the controls available within the Manual adjustment style.

PC Clock

Using the PC Clock dialog allows the selection of the 12 or 24 hour format.

When Okay is clicked the GUI and the LiON hardware will be sent the current time according to the local time on the PC.

The graphic at left shows the controls available within the PC Clock adjustment style.

SNTP
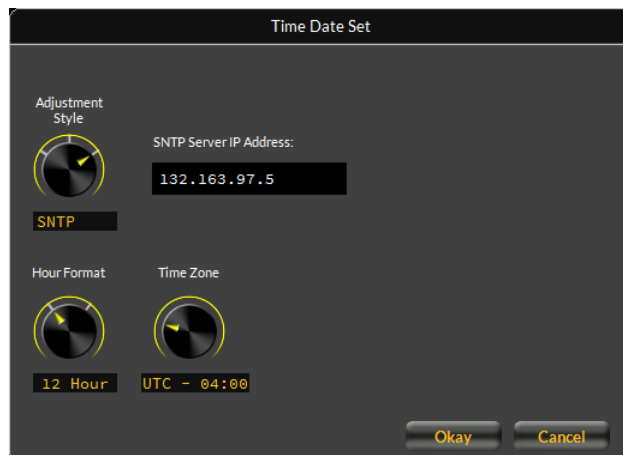
Using the SNTP option allows the setting of the time server's IP address as well as 12/24 hour format and UTC Time Zone offset.

In the image at left we're using the time server at Ntp-wwv.nist.gov to grab the current time and keep LiON's RTC in sync.

Input Settings Change With Presets
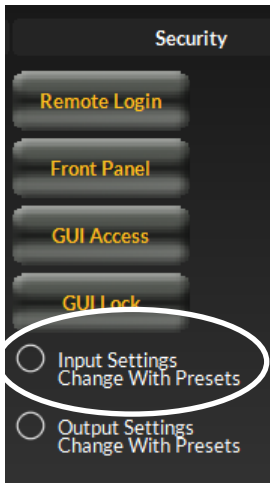
When this option is selected (highlighted) taking a preset will cause all *input* related settings to change according to what has been stored in that preset. Those include the input audio source, analog and digital input gains, the left/right mode, the phase rotator and the high pass filter settings.

One example usage for this feature is making taking a preset to change the input audio source, or the left/right mode, according to a desired daypart or programming need.

Output Settings Change With Presets
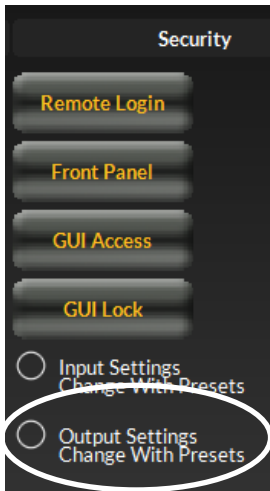
When this option is selected (highlighted) taking a preset will cause all *output* related settings to change according to what has been stored in that preset. Those include the output levels, stereo/mono mode and even modulation level.

Example usages for this feature are taking a preset to change the transmitted signal from stereo to mono, turning off the stereo pilot during mono programming, or even raising the station's modulation late on a Friday night to drive the competition's program director crazy over the weekend. It's happened ☺

FRONT PANEL METERING
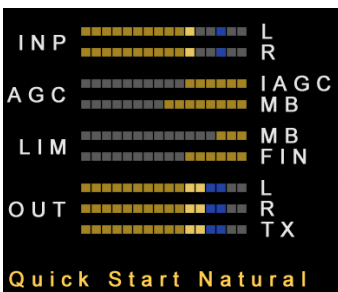
LiON's front panel and GUI interface include metering to show things such as input and output levels and the amount of work being done within various stages of its audio processing. We'll discuss the front panel metering first.

INP: The bars display the current left and right audio input levels being applied to LiON and are showing the audio levels after the Input Gain controls. Normally the meters should just 'tickle' the bottom-most bright yellow square with only an *occasional* peak

into the *first* blue square. The bars have no numerical scales – we'll be going bar color here!

AGC: The AGC bars show the amount of gain reduction occurring within the iAGC and the multiband AGC band with the highest current amount of gain reduction. Like the Input meters the AGC bars do not utilize numerical scales for the amount of gain reduction. Here, anything in the yellow is good and shows an appropriate amount of gain control occurring.

LIM: The LIM (limiter) bars will show the amount of gain reduction occurring in the multiband and final limiter, respectively. Normally the LIM bars will be showing less activity than the AGC bars, and sometimes, depending on the program content at the moment, might not show any gain reduction at all. This is normal.

OUT: There are three meter bars for the OUT metering. The topmost pair shows the left/right audio levels from the FM or HD+ processing section, whichever one happens to be feeding the AES3 *digital* output. The levels showing on the left/right (L/R) bars will correspond to the output level set by the digital output control in the FM section, or the digital output control in the HD+ section, again whichever one is feeding that particular output.

TX: The bottom OUT bar shows the presence of output level on the TX Out BNC on LiON's rear panel.

GUI METERING – FM PROCESSING

Unlike the front panel which doesn't have a whole lot of room to display a lot of meters, the GUI can display as many as we wish. And it does.
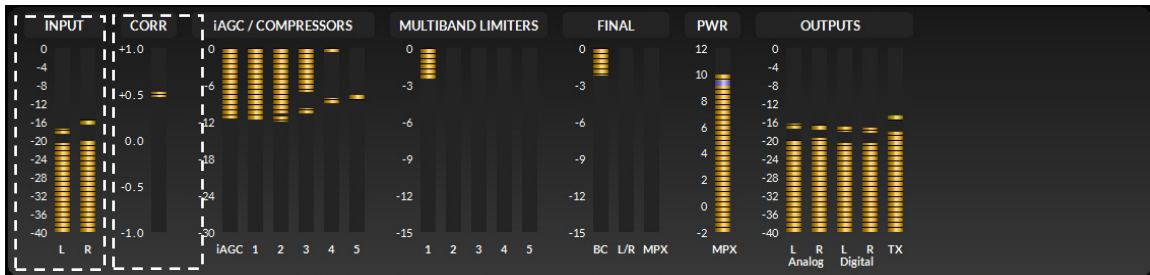
The above is how the metering looks when the HD+ GUI page is not active.

INPUT: These bars represent the current audio input levels to LiON regardless of which input audio source is in use. The scale represents levels in dBFS (decibels Full Scale digital) and normal input levels will be hovering between -20dBFS and -16dBFS with an *occasional* peak no higher than about -6dBFS and where the meters begin to show in blue.

CORR: LiON is equipped with a "correlation meter" which displays the amount of correlation (sameness) in the left and right audio channels.

Normal stereo signals will cause the CORR meter to be hovering above the 0.0 mark and program content with very wide stereo separation will cause the CORR meter to read even higher.

Mono program material containing minimal left/right phase and level errors will make the CORR meter read -1.0 or well below 0.0.

The CORR meter is measuring the input audio to LiON *prior* to the gain controls, the Left/Right Mode switch, and all processing and will therefore be immune to any adjustments made in those portions of the signal chain.

iAGC / COMPRESSORS: The next six meters are for displaying the amount of gain reduction (work) happening within the iAGC and five band leveler/compressor. The iAGC and each of the five bands has their own meter and can show gain reduction down to -30dB.

During normal operation and with most programming the iAGC meter will be hovering around -12dB or so, while gain reduction meters for compressor bands 1 through 5 will be showing between about -6dB and -18dB.
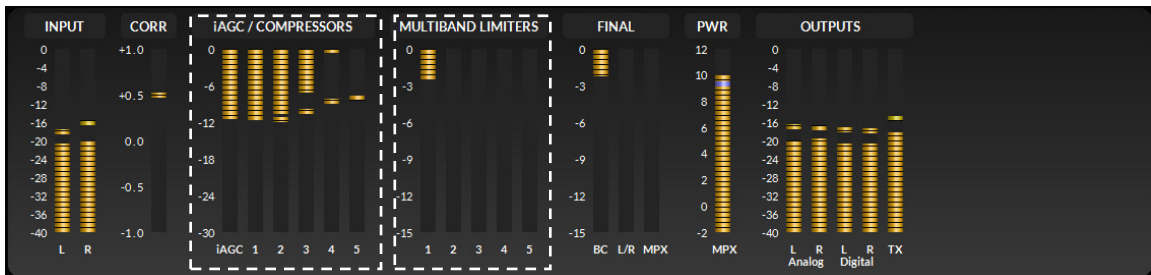
MULTIBAND LIMITERS: The next five meters are for displaying the amount of gain reduction (work) happening within the multiband limiters. These meters are scaled with a maximum gain reduction of 15dB. In normal operations and with most program content the limiters will be performing much less gain control so the limiter gain reduction scales are reduced accordingly.

During normal operation and with most programming the limiter meters will be showing occasional readings between -3dB and -6dB with an occasional higher excursion.

The amount of limiter drive and gain reduction has a strong correlation to on-air loudness though as with all good things, too much limiting can rapidly turn the resulting on-air audio into a wall of sound, something that's not recommend when long-term listenership is the goal of the station's format and management.
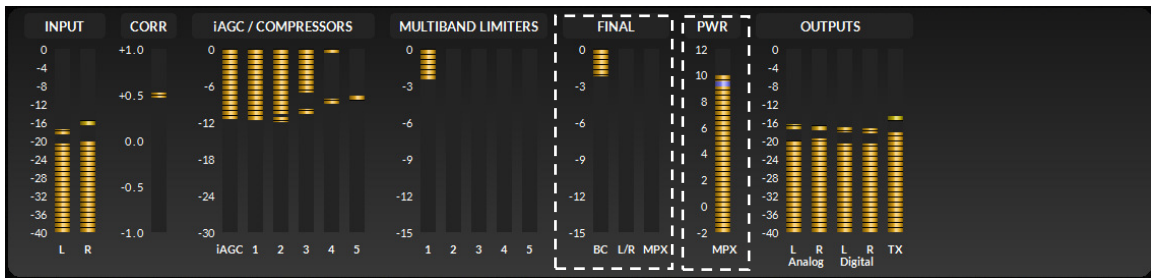
"FINAL" METERS: The next three meters show the amount of gain control occurring in the Bass Clipper, Main Clipper and MPX Clipper, respectively.

Each meter has a scale from 0 to -15dB and the *only* meter that should show a generous amount of gain reduction in normal operation is the "BC" meter whenever the program content being broadcast has a strong and prominent low end.

The L/R meter will show gain reduction values less than -6dB with most program content and will normally peak to around -3dB.

The MPX meter will normally show only a *very* small amount of gain reduction. The MPX meter displays the amount of work being done by the MPX clipper. Because the MPX clipper is *after* the L/R clipper and peak control has *already* been accomplished, a little bit of additional clipping, but now in the MPX domain, goes a <u>very</u> long way towards increasing on-air loudness.

Excessive clipping in the MPX domain (MPX meter peaking -2dB or more) can contaminate the MPX spectrum with clipping artifacts which can then make it difficult for stereo receivers to achieve stereo lock in weak signal areas and degrade RDS decoding as well.

PWR: The PWR meter displays the amount of multiplex power being generated by all of the preceding processing. LiON's algorithms are capable of generating a generous amount of MPX power (loudness). Under certain programming and processing circumstances LiON can easily match the MPX power generation capability of top of the line FM on-air processors costing several times more than LiON.

The PWR meter is also active when the BS.412 MPX Power Controller is active and accurately shows the current level of MPX power being genereted.

Note that BS.412 power control *and* its measurement occurs over a rolling one-minute average and that will make the PWR meter appear very sluggish (because it is!). It also means that adjustments to the processing *or* to the BS.412 MPX power in an effort to achieve a certain MPX power goal will require some time before a new value of MPX power shows up on the MPX meter.
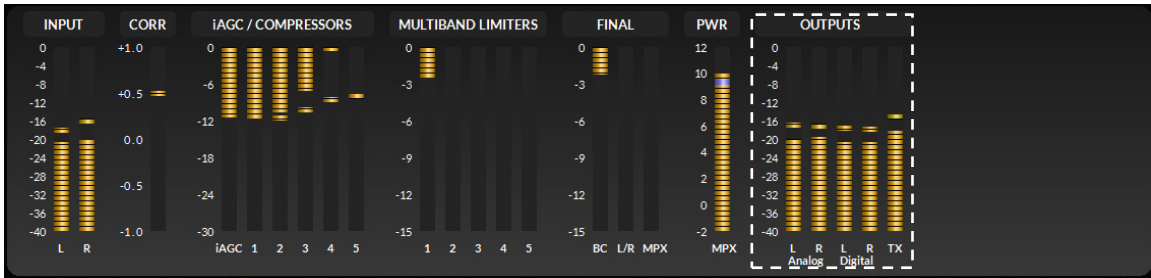
OUTPUTS: Next are four meters dedicated to displaying LiON's "FM" output levels, Analog L/R, Digital L/R and TX (MPX).

All four meters are calibrated in dBFS (decibels Full Scale) and are designed to indicate audio levels down to -40dBFS. Because the audio feeding the meters is processed and already have well defined peak levels there is no concern if a meter appears to be hitting the zero mark. We've left a bit of headroom in the digital domain (about 0.1dB) so it is impossible for an audio level hitting the zero on the meter from 'running out of bits'.

GUI METERING – HD PROCESSING

Like the metering for LiON's FM final processing, the HD+ section has its own metering which pops into view when the HD+ button at the top of the GUI is pressed.
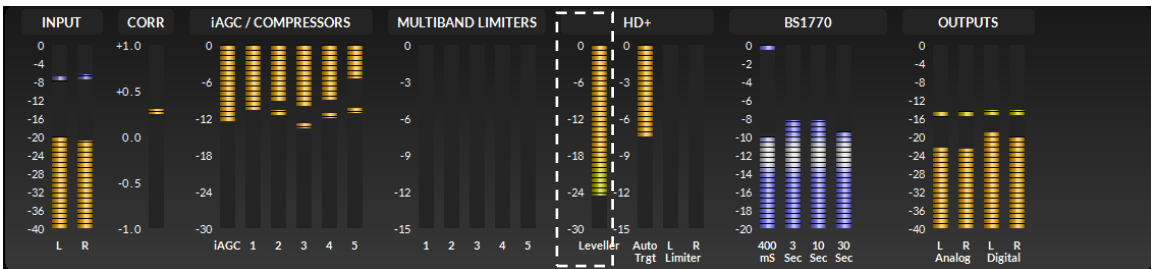
All of the processing metering up through the Multiband Limiters was covered in the FM Metering section since the multiband processing can be part of the HD+ processing when desired. The HD+ GUI mode reveals additional metering that is specific to that form of audio processing.

HD+ Leveler: The Leveler (AGC) meter displays the amount of gain reduction occurring at the 'front end' of the HD+ processing. The Leveler is always operating, even when the AGC On/Off control is set to the Off position; in the Off state audio is taken from the Leveler/AGC input rather than its output.

The Leveler meter has a range of 0 to -30dB and in normal operation and with program material will be showing values in the range of -12dB to -18dB. It will also vary to some degree based on where the audio for the HD+ section is coming from based on the setting of the "Source" control.
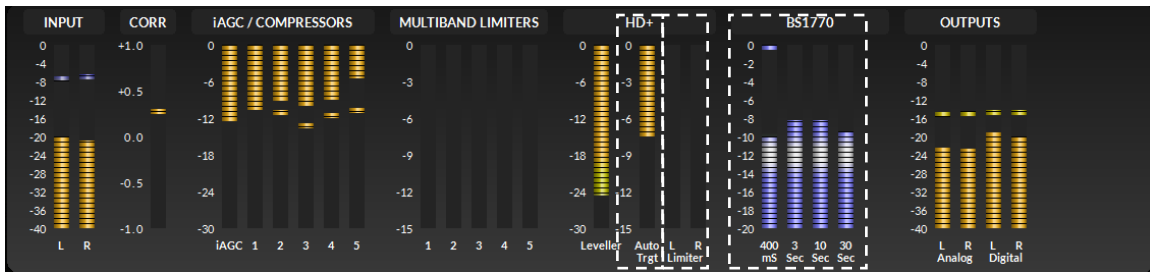
HD+ Auto Trgt: The Auto Trgt(Target) meter shows the amount of work being done to either increase or reduce the current loudness to the desired level. The meter has a display range of 0 to -15dB and in normal operation and with program material will be showing values in the range of -6dB to -12dB.

If the loudness value of the incoming and already processed audio suddenly increases or decreases, the AutoTrgt algorithm and its meter will reflect that it making quicker jumps to a new value of gain reduction in order to more quickly bring the loudness back within range.

HD+ L/R Limiter: The HD+ processing operates as two independent stereo channels with a variable degree of channel to channel coupling of gain reduction. As explained earlier in the section on HD+ processing, such coupling is not only desired, but recommended to prevent annoying stereo image shifts during gain reduction.

The Limiter meters share the same 0dB to -15dB scale of the Auto Trgt algorithm and in normal operation the indicated instantaneous gain reduction will be in the range of nothing, to perhaps less than -3dB.

BS1770: There are four meters associated with the BS1770 section and each will be described in turn:

> ➢ **400mS:** The 400mS meter displays two pieces of information; instantaneous loudness and the integrated loudness over a 400 millisecond rolling average.
>
> The instantaneous loudness is displayed as a single floating bar above the rest of the meter, and the 400mS value is shown as a solid bar. With normal processing and program content the instantaneous bar will hover near the top of the scale.
>
> ➢ **3 Sec:** The 3 Sec meter displays the integrated loudness over a rolling three second time period.
>
> ➢ **10 Sec:** The 10 Sec meter displays the integrated loudness over a rolling ten second time period.
>
> ➢ **30 Sec:** The 30 Sec meter displays the integrated loudness over a rolling ten second time period. The 30 second meter will typically be indicating a

loudness level similar to that of the BS177 target, if it has been set while the 'faster' meters will be showing quicker excursions of integrated loudness according to their own measurement time constants.

OUTPUTS: Like the meters for FM, the Analog and Digital meters for HD+ show the output levels in dBFS for the HD+ analog left/right or digital AES3 outputs should one or both of the rear panel outputs be assigned to the HD+ section.
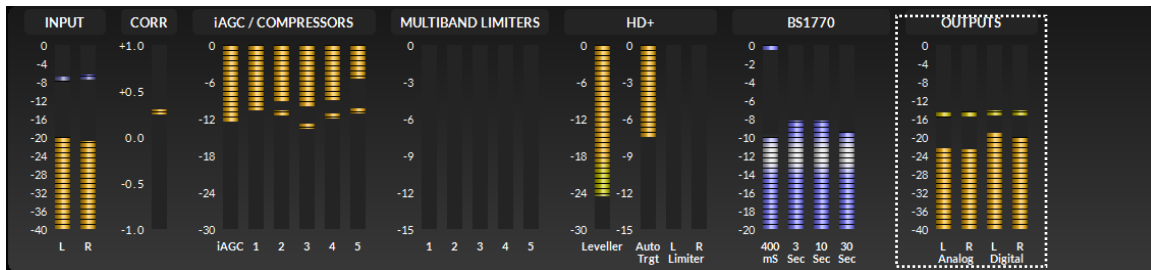
The output meters are calibrated in dBFS and like the Input meters, have a display range of 0dBFS to -40dBFS.

APPENDIX A

Common Audio Processing Terms and What They Mean

Background

When tasked with adjusting audio processing one is often faced with myriad meanings for the same sound descriptors. For instance, when the program director comments that it needs more "thump," what does he really mean?

➢ If he says that the audio is too "crunchy," what is he hearing?

➢ If he says that the competition is nice and "bright" and they have some nice "rumble," what exactly is that?

➢ Or what if he wants more bass and you add some bottom end but now he says "we sound too muddy"?

How do we untangle this mess and get to the bottom of what he really means?

There are many "audio" terms that have been invented over the years to describe the sound of audio processing while it's doing its work. In fact, ever since radio stations started employing circuits instead of humans to control the modulation of transmitters we've tried to come up with words to describe the audible effects of audio processing as far as what we hear.

Many of those terms were born out of simply trying to put into words the positive or negative artifacts of early compressors and limiters (thump, muddy, honk, tubby).

Still others were born later when EQ and different forms of 'enhancers' were added to station audio chains *and* its audio processors in order to modify certain parts of the frequency spectrum (rumble, punch for bass; bright, airy, open to describe presence and the high end).

The language of audio processing more often than not needs the benefit of an <u>interpreter</u>. Some oft-used terms can easily have multiple meanings and be confused with others. Making the problem worse, some of the terms we use might not be universally used, and nor do they describe very well what is actually *happening* to the audio.

For instance, one listener might feel the audio is "muddy" while another still might describe the sound as "warm." Which one is right? For starters, "muddy" is not usually used in a positive sense, while warm, on the other hand, often means the sound has a pleasing low end. See the confusion here?

The terms themselves, the ones that we use to describe sound, can be confusing enough. The real question becomes then, <u>what</u> do these terms really mean, and which knob on the processor do we turn if we want to change the sound?

In fact, here are some very common challenges:

➢ If the audio is too "muddy," do you turn up the high end, or do you reduce the low end?

➢ Which control is the right one if you wanted to bring up some low end "rumble" or "sub bass"?

➢ If the audio is "tinny," is the problem that there's too much energy up around 8,000Hz or is the problem actually further down in the spectrum?

We've created a graphic to try to bring some understanding to the more common terms we broadcasters use to describe sound, and where those sounds actually reside within the audio frequency spectrum. While creating an exhaustive list isn't impossible, it is well beyond the scope of what we're trying to accomplish here, so what we've done instead is compile the terms we most commonly hear customers use, and then lay them out in our graphic to help our users visualize what sounds actually live in what part of the audio spectrum that we hear.

Included in the chart below are the frequency ranges of the most common instruments heard in compilations played on the radio. The idea here is to marry musical instruments and the sounds they make with the terms we commonly use to describe how they sound.
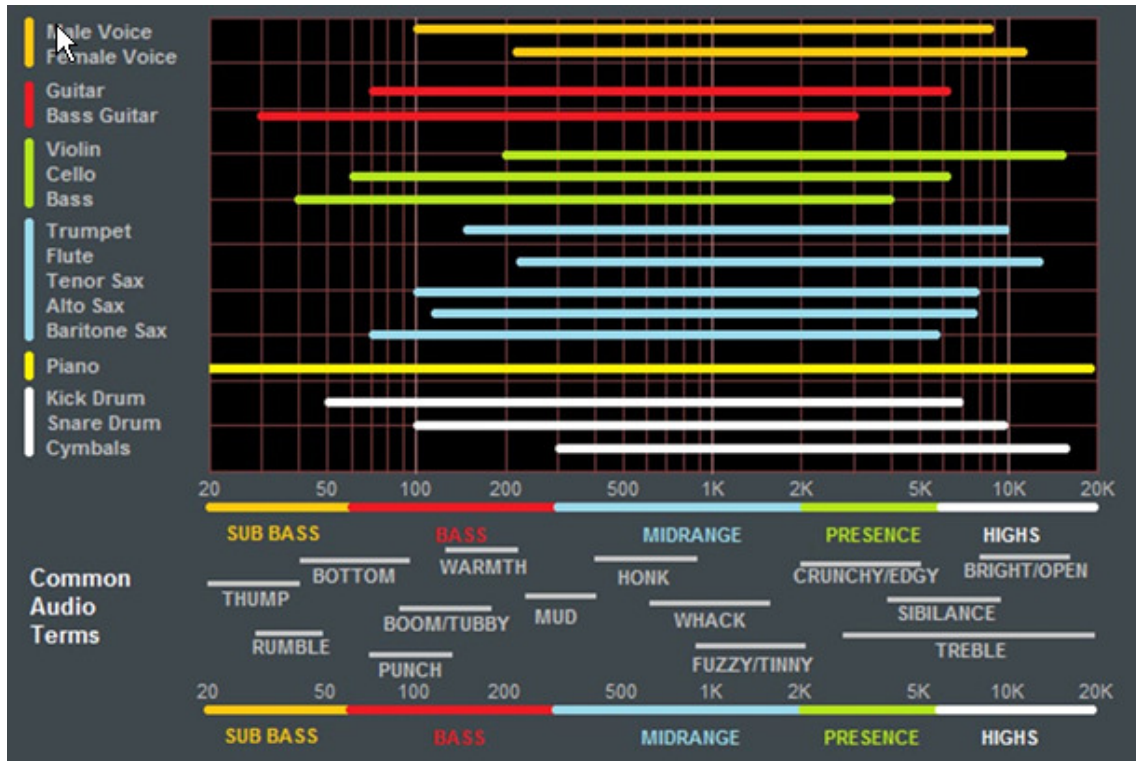
One good example might be the term "Honk," which coincidentally happens to be right in the middle of the frequency range created by *saxophones*. The goal here is to offer a better understanding of how to adjust an audio processor so that the "thump" you want will be the "thump" you get, and not "tubby."

Common audio processing terms and the parts of the spectrum they govern are at the bottom of the chart. The top part of the chart shows the frequency range of common musical instruments heard on the radio (male and female voice included).

Audio Terms and LiON

THUMP / RUMBLE / BOTTOM

These terms describe bass generally found at and below about 80Hz. Good stereo systems, closed or noise reduction headphones and car audio systems with subwoofers can usually reproduce audio way down here. Many times such systems even have their own complex bass enhancement features such as LiON's very specialized bass clipper system. This system is an intelligent clipper that samples the bass frequency relationship between compressor bands 1 and 2 and is able to make changes to the audio based on user settings.

The bass clipper has a Drive control as well as a Threshold control which allows you to tailor how the bass clipper sounds. Moving the Threshold control clockwise raises the

bass clipper threshold and allows more bass through to the main clipper while turning the Threshold control in the other direction lowers it.

PUNCH / BOOM / TUBBY / WARM

The sound of bass "punch" and "boom" usually fall in the range of 70Hz to 150Hz. "Tubby" on the other hand usually falls between 150Hz and 300Hz. Band #2 of the parametric Equalizer may be used to gently and broadly boost audio in the range of 75Hz to 120Hz to safely reinforce the "punch" and "boom" of lower bass without creating undesirable effects such as "tubbiness."

The enhancement of "punch" and "boom" can be especially tricky because many listeners' sound systems can't reproduce very low and sub bass frequencies. Therefore it's especially important to use several known reference radios when adjusting low frequency enhancement because it is very easy to create distortion or "muddiness." Quiz Time: How many stations have awesome sounding bass on the PD's car stereo but end up sounding terrible on clock radios and boom boxes? Always listen on multiple radios in multiple listening environments to get the best feel for the effects created by purposeful bass enhancement.

MUD

When someone says that audio is "muddy" they usually mean too much energy is in the 250Hz to 400Hz frequency range. Sometimes it's caused by a misadjusted Equalizer or a processor maladjustment that is allowing a leveler or compressor to add too much gain at lower frequencies so in *most* cases it's a good idea to keep from boosting energy in this region.

Expert Tip! Additional clarity and detail can be created by a *broad* equalization cut in the range between 180Hz and 400Hz. To do this, set one of the parametric equalizers to 300Hz, its boost to minus 6db and its Bandwidth to 1.20 octaves. This surprising little (pro) secret can be more effective at "adding" detail to both low bass and midrange than any other 'boost equalization can do. It's true! Try it!

HONK

Think Saxophone. Honk is above "mud" but below "fuzzy" and "tinny." The honk effect occurs between about 400Hz and 1,200Hz, and begins to overlap "fuzzy" and "tinny" at around
1000Hz.

Usually audio in this frequency range stands out on its own in the mix and any enhancement should be *slight* because our ears are already very sensitive to these frequencies.

This frequency range is also quite delicate to work with because much of the perceived stereo sound field we perceive also occurs in this range. When the audio has a "honk," "fuzzy," or "tinny" texture (and it's usually a texture that we don't like), often slightly faster attack times in the Compressor for the corresponding frequency band can help smooth things out.

WHACK

This is the sound where percussion sounds just "explode". But first, note that this is much less of an equalization issue, and much more about creating a temporarily dense sound by momentary fast compression. To achieve more "whack" it can help to speed up the Leveler or Compressor release times in Band 3. Another trick is to slow down the attack time of the Band 3 and/or Band 4 levelers which will allow them to be less active on rapidly occurring impulses and enhancing "whack."

FUZZY/TINNY

Yes, "fuzzy" and "tinny" really are this far down in the audio spectrum! A "tinny" sound might be described by some as a harsh midrange, or too much presence, instead of something happening higher up in the audio spectrum. Both "fuzzy" and "tinny" live between about 1,200Hz and 2,000Hz and one of the best ways to manage either (or both) is to broadly and slightly *reduce* equalization in this range, or perhaps even increase the attack time in Band 3 of the AGC and Compressor.

Often there is a tradeoff between getting more "whack" and keeping "fuzzy/ tinny" at bay. Speeding up the compressor in the 1,000Hz to 1,500Hz range to get more compression "whack" can sometimes add undesirable side effects, one of which is the creation of what sounds like "fuzzy," "dense," or even "tinny." In audio processing, especially broadcast audio processing, *everything* is a tradeoff. While Audioarts and Wheatstone audio processors provide the most wiggle room for getting the sound you can hear in your head actually on the air, more often than not compromises will need to be made.

SIBILANCE

Sibilance is a vocal artifact and because it sounds so unnatural it tends to stick out like a sore thumb. Excessive sibilance can be the result of too much high-end boost or too much final clipper drive. Sibilance tends to be most prevalent in the 4,000Hz to 8,000Hz portion of the frequency spectrum. Microphone processors (like the Wheatstone Voice1 and M4) are great tools for keeping vocal sibilance under control. Their specialized de-esser sections are specially tailored for removing or minimizing excessive "esses." When excessive sibilance is an issue and there is no microphone processor to control it, lowering LiON's Band 4 to Band 5 band mixes and/or using a slightly faster attack time on the Band 5 Leveler/Compressor can help.

Sibilance can sometimes *also* be found in an unlikely place; the L-R. "But voice is mono…" you say, "…so there is no L-R…" Well, yes and no. When the left and right channels don't have perfect balance or there is phase shift between the channels, energy ends up in the L-R, but why?

By definition the L-R signal is the *difference* between the left and right channels, regardless of whether it's level, or phase, or both. When phase is the culprit the error is generally larger at high frequencies, making the L-R energy also greater at higher frequencies. As if by magic, sibilance appears in the L-R and the only way to fix it is to tend to what's causing it or reduce the level of L-R at frequencies where sibilance might reside. The Leveler's multiband mixer can help with this. Slightly reducing the setting of the Band 4 and Band 5 L-R mixers can help tame sibilance without having too negative an effect on stereo separation.

TREBLE / BRIGHT / OPEN

Treble (like its friends, Bass and Midrange) is a generalized term for the high end in most broadcast and recording systems. Bright and Open are oft-used descriptive terms of treble styles.

Unfortunately, bright can be a positive or negative term. For instance, laser-bright is usually a negative term and is used to describe too much enhancement in the upper end. The term probably borrows its origins from the early days of CDs when brighter supposedly meant cleaner.

Open is a term usually reserved for describing audio texture in the upper midrange, where it doesn't sound overly processed, packed in, or lacking in detail. To achieve a more open sound in any processor there is usually some sacrifice in loudness. Fortunately LiON is much more forgiving in this regard, and most users have an easier time being loud with LiON while still being quite clean and open.

Operating the Leveler and Compressor with slower attack and release times and making some minor tradeoffs in loudness will push perceived on-air sound quality off the charts while going a long way towards achieving an open and easy to listen to sound. When this is the target sound, starting with one of our Classical or Jazz presets and then "turning things up" is a good way to approach achieving this sound. These presets are surprisingly competitive without sounding "processed."

FINALLY

As always, our Technical Support team is available to answer any questions, help with setup, or even assist in tweaking your station to the sound you hear in your head but might not know how to achieve. Shoot us an email at techsupport@wheatstone.com or give is a call at 252-638-7000. We know our processors inside and out and can make them sit up and dance in any market or format.

APPENDIX B

That Great Sound You Hear In Your Head?

Here's how to get it *On the Air*!

It is in our nature that our human ears adapt quickly, but they tire quickly, too! When adjusting audio processing, recognizing that one simple fact will go a long way towards reaching your on-air processing goals and without spending what seems like 'years at the knobs'.

Our decades-long experience with all things audio processing not only gives us some unique perspectives on audio processing, it also allows us to offer some very important advice. So, to begin with the obvious:

Tweak Small and Listen Large

(a well-respected colleague and audio processing field consultant once shared his secret, above, to quickly getting a client's on-air processing right where they wanted it)

What he meant by Tweak *Small and Listen Large* is to approach *any* audio processing tweaking session with care, some research beforehand to learn what the station's goals are, and then diligently, not haphazardly, work toward arriving at the sound that's craved.

But that doesn't mean many hours in front of blaring speakers or with headphones clamped to your head, in fact, quite the contrary. Make a few adjustments towards where you're trying to get to, make some notes, SAVE those settings as a preset, and then WALK AWAY. Come back again only after you've taken an ear break and then listened for a while and reviewed any written or mental note you've made for what to touch next.

Without at least taking an ear break it'll be like driving into a roundabout and always making left turns. You will <u>never</u> arrive anywhere else, and more importantly, you will <u>never</u> escape!

LiON's fifty or so factory presets give the end user a wide variety of sounds, textures, and on the dial loudness, and more often than not one of LiON's Factory Presets will be perfect for the station's format and market. But, and as luck would have it, sometimes a Factory Preset just isn't "it" and you'd like to make your own new preset, perhaps even by starting from scratch.

Well, that isn't actually possible due to myriad under the hood interactions and adjustments we've made in order to create a factory preset, but you can get close…

There are a few LiON presets that we recommend as starting points when trying to build from scratch: Quick Start Natural, Max Dynamics, Smoothie, Modern Jazz and Classical

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Natural. Each of those presets have attributes that are great starting points for creating something completely new, and we recommend listening to each of them to find the one that's *closest* in spectral balance and general dynamics behavior to what the end goal is. Having made many hundreds of presets over the last few decades while designing and tuning on-air audio processors, our own Jeff Keith shares how he goes about creating a new preset from scratch after choosing one of our recommended presets as a starting point. The following is from Jeff Keith, Senior Audio Processing Development Engineer for Wheatstone:

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I generally start by making a good sounding 'lame' preset that has nice spectral balance and dynamics behavior and then run it through the mill with as many musical and vocal tracks as I can in order to ascertain (actually, train my ears) as to how it behaves with myriad programming types. The five presets previously recommended are just those presets – I created them to serve best for how I then named them and all of the other 45 or so LiON presets were created using one of them as a starting point.

It is usually recommend that the following 'tuning' not be done while the unit is on the air. At worst your station would sound pretty weak on the dial for a while and at most, well; let's just say your competition would be getting a really good laugh over your new sound. ☺

Instead, bench the unit, provide it a source of really good *linear* audio (analog or digital) and connect its MPX output to a good quality stereo decoder such as a Belar FMSA-1. Alternately the MPX output can be connected to a spare FM exciter with the resulting FM signal demodulated by a good quality modulation monitor or FM tuner.

It is critically important that the audio going into LiON be as pristine as possible, lest the subtle changes made to the processing be masked by (for instance) codec artifacts.

My rule for this part is: LOUNDESS is NOT the primary goal here, spectral balance, texture, and the behavior of the dynamics section with changing program material, IS.

➢ The first order of business is to back off the main clipper by setting it to -3dB.

➢ Next, disable the Multiband Limiter by setting its mode to "No".

➢ Next, shut off the Bass Clipper by setting its mode to "No".

➢ Next, go the GUI's Para EQ page and shut off the EQ (EQ Enabled should not be illuminated).

➢ Finally, navigate to the iAGC/Comps page of the GUI and turn the Detail Enhance control "Off".

➢ Next, make sure that the iAGC, MB Compressor and MB Leveler dots at the top of the page are filled in with orange (they are all 'On').

At this point only the multiband Leveler/AGC/Compressor stages are active.

➢ Next, navigate to the graphical area of the iAGC/Comps GUI page, locate the Thresh tab at the bottom, right click on one of the blue dots, and select "Group All Adjusters". Then, right click again and select "Flatten".

➢ Do the same tasks in the same order for the remaining tabs; Levlr Atk, Levlr Rls, Density, Comp Atk, Comp Rls, Ratio, AGC Mix, and St Enh.

➢ Next, navigate back to the Density tab and pull all the dots down by left clicking (no double click!) on one of the dots and pulling it down to the bottom of the graph. All of the other dots should follow whichever one was grabbed by the mouse.

➢ Next, open the AGC Mix tab and set all dots to the middle 0dB position.

➢ Finally, open the ST Enh tab and set all the dots to their middle 0dB position.

At this point we have the multiband section operating 'flat' with mostly the incoming audio's dynamics being changed. Listen to this result with a couple of very familiar musical or speech cuts to become familiar with the spectral balance and dynamics. Evaluate whether the spectral balance and dynamics meet your criteria, and if not the spectral balance should be worked on next.

NOTE: *We covered the behavior of the dots in the graphical sections of the GUI some time back, so if you're not sure how to manipulate them, please go back and re-read that section before moving on.*

We'll move on from here using *examples* since each station, its market, its competition and a slew of other factors are as individual to each station as our own fingerprints.

Example #1: The sound of the multiband as it is currently tuned sounds pretty good, but you'd like a little more *deep* low end. What to do?

Navigate to the Thresh tab of the graphical area, double click on the first dot on the left, and after it turns orange, move it up a few dB from its current position. Better low end now?

Example #2: The sound has a bit more bottom end now, but lacks the feel of 'processing' i.e, you'd like it to be a little more 'energetic'. What to do?

There are at least two possible cures:

1. Increase the setting of the AGC Drive control;

2. On the Density tab of the graphical area, double click the dot that was turned orange in a previous step (to make it yellow or blue again) and using the mouse, slide the Density adjusters up, maybe to around +3dB (use scale on left). The higher the dots the more short term density is added to the audio. Better now?

Example #3: Things are sounding pretty good now but you noticed that the program content isn't sounding quite as 'stereo' as you'd like. We can fix that!

1. Navigate to the St Enh tab of the graphical area – this is where we can make adjustments to the perceived stereo sound field width overall, or on a processing band per band basis. There are some important things to consider before jamming all the dots to the top of the scale!

    A. There is very little stereo separation at low frequencies in most musical material, so boosting say, the Band 1 dot above the 0dB mark won't do much good other than to potentially exacerbate multipath.

    B. Most of our perceived stereo effect comes from what happens in the midrange, or Bands 2 through 4.

    C. Be careful adding L-R in Band 5, lest it make your audio sound 'splashy' on stereo receivers when they're in weak signal areas.

Stereo enhancement, when done frequency band by frequency band as we do in LiON, can be quite effective at tailoring not only how the station's overall stereo sound field sounds, but by being careful with adjustments in Band 1 and Band 5 you can actually *improve* how some receivers behave when tuned to your station.

If not happy yet with the spectral balance and dynamics behaviors, a little more tweaking using this section as a guide will be necessary. If things are now good with the spectral balance and dynamics behavior it's time to move on to the Limiters. But first, some housekeeping...

Navigate to the Limiters portion of the GUI and turn the Multiband Limiter Drive down to -6dB and the Multiband Limiter Enable switch to "Yes". Note that the apparent gain may change up or down depending on what's happening in the iAGC/Comps page of the GUI. Do not worry about that now…

➢ Next, click on the Threshold tab of the graphical area and ensure the Threshold dots are all on the 0dB line (scale at left).

➢ Next click on the Attack tab of the graphical area and ensure that all dots are on the 5mS line (about halfway between top and bottom).

➤ Next, click on the Release tab of the graphical area and set all dots to the 50mS position (scale on left).

➤ Enable the Bass Clipper by setting its mode switch to Yes.

➤ Set the Bass Clip Drive to +1.5dB.

➤ Set the Bass Clip Threshold to -5dB.

Now we have 'normalized' the Limiters section.

Of all the stages of on-air processing, limiters only control very short term dynamics, the pre-clipper peak control, and to some degree, short term spectral balance. For these reasons it is always best to attack (pun intended) the Limiters section *after* the AGC creates the desired spectral balance and dynamics. Get the AGC stuff right, and first, and only then move on to the back end!

Once again we'll move on from here using *examples* since each station, its market, its competition and a slew of other factors are as individual to each station as our own fingerprints.

Example #1: Sounding pretty good now but not very loud on the dial.
Okay…remember we backed way out of the main clipper so we could tweak a bunch of stuff prior to it? It's still backed off and we'll get to that!

Example #2: I'd like to get some additional short term density. Can I do it with the limiters?
Sure can, and there are two ways we can approach that!

1. Increase the Multiband Limiter Drive until some limiter gain reduction is being displayed in the graphical area of the Limiters GUI page.

2. If Drive settings reach about +3dB and not much if any gain reduction activity is being seen, go to the Threshold tab of the graphical area and pull the dots down a dB or two. Rinse and repeat until the desired amount of limiter activity is observed (and heard).

Example #3: The Density is there now, but can I get more bottom end punch?
The Bass Clipper Threshold is still at the -5dB setting we set it to earlier, so now let's raise it to say, -3dB. Then we'll slowly increase the Bass Clip Drive until we start to get the bottom end sound and feel we're looking for. Some back and forth iteration is always necessary with any bass clipper.

Main Clip
Threshold

Bass Clip
Threshold
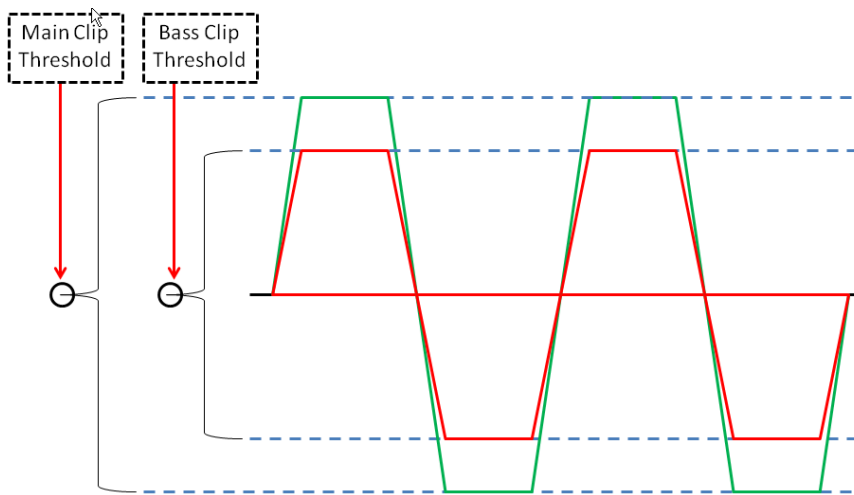
The Bass Clipper Threshold control sets how close clipped and filtered bass waveforms can get to the threshold of the main clipper. The control is calibrated in negative dB which represent how far below the main clipper threshold bass is allowed to go. Bass waveforms should *never* reach the main clipper threshold or IM distortion will result!

Now we get the fun part, on the dial **loudness**! With everything running as it's been tuned up to now, we can start working on loudness. But first, some housekeeping.

➢ Navigate to the Process & SCA tab of the MPX & Output page of the GUI.

➢ Locate the Composite Clipper Drive control and turn it down to the -3dB setting.

➢ Navigate back to the Limiters page and locate the Main Clip control.

Right now is a good time to have a way to compare LiON to your competition, and if you're happy with everything but loudness, you can put LiON on the air for the rest of the tuning process. In fact, I recommend it!

Even if LiON isn't on the air we can do a lot of subjective tuning with the Main and Composite Clippers which in most competitive markets are turned up until one of two things happen:

➢ The on-air loudness is achieved and things can be left right where they are, or;

➢ The point is reached where your station is at least as loud as the competition across town, but you're more distorted than they are.

Let's start with the Main Clipper…. Start increasing the Main Clipper Drive (Main Clip) until you begin to hear a little distortion. Leave the control at the current setting and play a few other cuts of program content so see how those compare. If for instance a particular cut seems to create more distortion than others, turn the Main Clip control down a little until the unwanted artifacts are either minimized to your satisfaction, or gone. Then, and with the Main Clip control left where it is:

- ➢ Navigate to the MPX & Output page of the GUI.

- ➢ Locate the Composite Clipper Drive control.

- ➢ Begin increasing the drive until some clipping artifacts are heard – remember to be using the same source material that caused you to reduce the Main Clip drive!

Now is the time to compare competitive loudness between LiON and the competition. If the loudness goal is now met, crack open a cold drink and relax.

If loudness isn't quite there yet there are a few things still left to do:

- ➢ We can slightly increase the Multiband Limiter Drive by perhaps a half dB (-0.5dB) and then listen again for any objectionable clipper induced distortion.

- ➢ If there is distortion, but it seems to be mostly low frequency related, slightly lower the Bass Clip Threshold accompanied by a slight, maybe half dB (+0.5dB) increase in Bass Clipper Drive (the latter partially offsets the effect of lowering the Bass Clipper Threshold).

- ➢ We can build a little more pre-clipper density by lowering the Multiband Limiter Thresholds, perhaps by a half dB (-0.5db).

Once those parameters have been altered, we can go back to the Main and Composite Clipper Drives once again to see whether a slight drive increase in either or both results in one of two things: the loudness comes up to target, or the unwanted distortion is back again.

One thing to remember about LiON is that although it packs some very competent audio processing under its little hood, it is after all a low cost on-air processor costing a fraction of what the 'big' boxes do. Even so, we have been extremely pleased with the feedback we've been getting from the field. It really is the Little Processor That Roars!

Happy Tweaking, and please let us know if we can help!

Jeff Keith

APPENDIX C

RDS Functions

Radio Data System is an international standard protocol which allows the broadcaster to embed text and other metadata into the FM signal. FM radios receiving this signal can decode that metadata and display it as text or act upon it in other ways. The RDS standard is documented in IEC-62106 (2009). The North American variant, RBDS, is documented in NRSC-4-B (2011). LiON is compliant with both standards.

Basic Settings
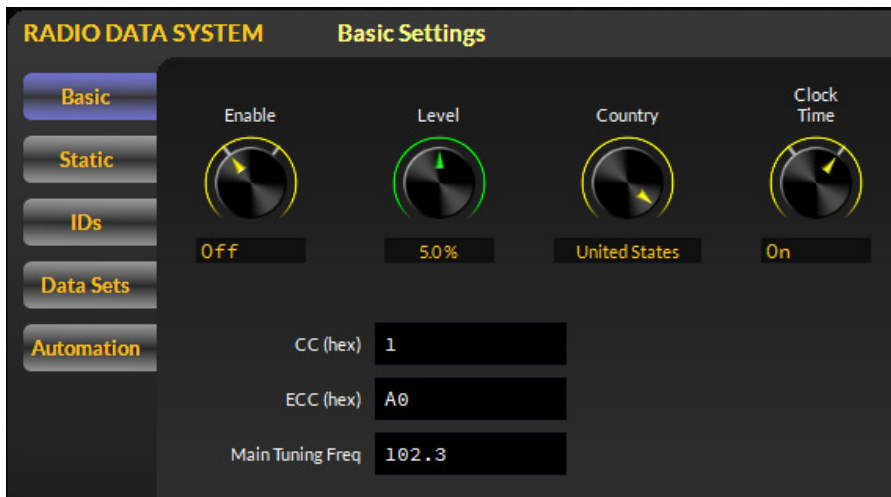
RDS must be configured first before it is enabled and it is quick and easy to do.

> ➢ Select the RDS screen and go to the Basic Settings panel. Do not enable RDS yet. Leave the level setting at 4%.

> ➢ Dial in your Country Code (CC). If your country is not listed, choose the Manual Entry setting and 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.

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, 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".

   IMPORTANT NOTE: The knob values are divided into two sets. The RBDS categories in the *second half* of the knob settings are appropriate for stations in North America, while the RDS categories in the *first half* 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.

There are two settings which are largely deprecated in current RDS practice (and also ignored by most receivers), but they are provided in LiON for backwards compatibility:

➢ The 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 Total Muzica". 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 the receiver how, or even if, to display this message and when it is shown, it is often displayed in a smaller font than the PS message.

Note that Radio Text is also often scrolled <u>by the receiver</u> inside a "window" of less width than the entire message can fit. If your message is seen as truncated on certain radios, it is being done *by the radio's RDS decoder software* and not by LiON's RDS generator.

➤ 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 and it is moving out of the coverage area of the station currently being listening to.

When setting all of these parameters, carefully note 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.

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. There are 128 Data Sets available and you *must* use at least one.

The Data Sets window displays data from left to right and in columns as follows:

> ➢ 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
> ➢ Radio Text

Automation
Ah, now we 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, and 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 LiON GUI, going to the RDS screen, and typing away.

That would work, but you'd be very, 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 Scheduler. These methods may be used independently, simultaneously, in any combination.

The Automation Settings panel displays controls for two "Units" which receive messages on the selected UDP port. There are four different message formats which may be received; two are UECP, and two are plain text.
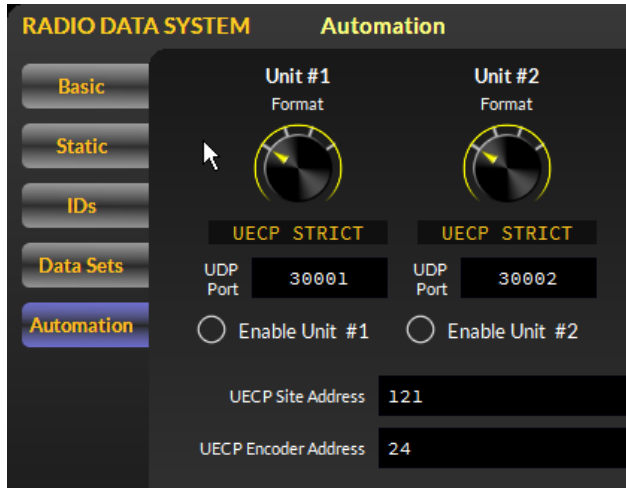
The Universal Encoder Communication Protocol
UECP (often pronounced "you-sep") is described by the RDS Forum Technical Specification SPB 490 (2010). In the strict interpretation of the protocol each message is bounded by special start and stop bits, there is a CRC (Cyclic Redundancy Check) word, and also 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 UESP message has to "unpack" it – it has to strip off the start and stop bits, check and remove the CRC, and then 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 where 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 LiON 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.

LiON 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/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	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 LiON's RDS generator 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 Scheduler can 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 changes as well as RDS Data Set changes.

RDS Level

The RDS Level control is found on the **RDS Basic** page of the GUI and should normally be set at around 4% of total modulation. Make sure you have a modulation monitor capable of reading the RDS subcarrier injection level in order to set this accurately.

RDS Country Codes and Extended Country Codes

European Broadcasting Area

Country / Area	ISO Code	Country Code	Extended CC
Albania	ALB	9	E0
Algeria	ALG	2	E0
Andorra	AND	3	E0
Armenia	AM	A	E4
Austria	AUT	A	E0
Azerbaijan	AZ	B	E3
Azores [Portugal]	AZR	8	E0
Belgium	BEL	6	E0
Belarus	BLR	F	E3
Bosnia-Herzegovina	BIH	F	E4
Bulgaria	BUL	8	E1
Canaries [Spain]	CNR	E	E0
Croatia	HRV	C	E3
Cyprus	CYP	2	E1
Czech Republic	CZE	2	E2
Denmark	DNK	9	E1
Egypt	EG	F	E0
Estonia	EE	2	E4
Faroe Islands [Denmark]	DK	9	E1
Finland	FI	6	E1
France	FR	F	E1
Germany	DE	D or 1	E0
Georgia	GE	C	E4
Gibraltar [United Kingdom]	GI	A	E1
Greece	GR	1	E1
Hungary	HU	B	E0
Iceland	IS	A	E2
Iraq	IQ	B	E1
Ireland	IE	2	E3
Israel	IL	4	E0
Italy	IT	5	E0
Jordan	JO	5	E1
Kazakhstan	KZ	D	E3
Kyrgyzstan	KG	3	E4
Latvia	LV	9	E3
Lebanon	LB	A	E3
Libya	LY	D	E1
Liechtenstein	LI	9	E2
Lithuania	LT	C	E2
Luxembourg	LU	7	E1
Macedonia	MK	4	E3
Madeira [Portugal]	PT	8	E2
Malta	MT	C	E0

Morocco	MA	1	E2
Moldova	MD	1	E4
Monaco	MC	B	E2
Netherlands	NL	8	E3
Norway	NO	F	E2
Palestine	PS	8	E0
Poland	PL	3	E2
Portugal	PT	8	E4
Romania	RO	E	E1
Russian Federation	RU	7	E0
San Marino	SM	3	E1
Slovakia	SK	5	E2
Slovenia	SI	9	E4
Spain	ES	E	E2
Sweden	SE	E	E3
Switzerland	CH	4	E1
Syrian Arab Republic	SY	6	E2
Tajikistan	TJ	5	E3
Turkmenistan	TM	E	E4
Tunisia	TN	7	E2
Turkey	TR	3	E3
Ukraine	UA	6	E4
United Kingdom	GB	C	E1
Uzbekistan	UZ	B	E4
Vatican	VA	4	E2
(Yugoslavia)	YU	6	E3

African Broadcasting Area

Country / Area	ISO Code	Country Code	Extended CC
Ascension Island	??	A	D1
Cabinda	??	4	D3
Angola	AO	6	D0
Algeria	DZ	2	E0
Burundi	BI	9	D1
Benin	BJ	E	D0
Burkina Faso	BF	B	D0
Botswana	BW	B	D1
Cameroon	CM	1	D0
Canary Islands [Spain]	ES	E	E0
Central African Republic	CF	2	D0
Chad	TD	9	D2
Congo	CG	C	D0
Comoros	KM	C	D1
Cape Verde	CV	6	D1

Cote d'Ivoire	CI	C	D2
Djibouti	DJ	3	D0
Egypt	EG	F	E0
Ethiopia	ET	E	D1
Gabon	GA	8	D0
Ghana	GH	3	D1
Gambia	GM	8	D1
Guinea-Bissau	GW	A	D2
Equatorial Guinea	GQ	7	D0
Republic of Guinea	GN	9	D0
Kenya	KE	6	D2
Liberia	LR	2	D1
Libya	LY	D	E1
Lesotho	LS	6	D3
Mauritius	MU	A	D3
Madagascar	MG	4	D0
Mali	ML	5	D0
Mozambique	MZ	3	D2
Morocco	MA	1	E2
Mauritania	MR	4	D1
Malawi	MW	F	D0
Niger	NE	8	D2
Nigeria	NG	F	D1
Namibia	NA	1	D1
Rwanda	RW	5	D3
Sao Tome & Principe	ST	5	D1
Seychelles	SC	8	D3
Senegal	SN	7	D1
Sierra Leone	SL	1	D2
Somalia	SO	7	D2
South Africa	ZA	A	D0
Sudan	SD	C	D3
Swaziland	SZ	5	D2
Togo	TG	D	D0
Tunisia	TN	7	E2
Tanzania	TZ	D	D1
Uganda	UG	4	D2
Western Sahara	EH	3	D3
Zaire	ZR	B	D2
Zambia	ZM	E	D2
Zanzibar	??	D	D2
Zimbabwe	ZW	2	D2

ITU Region 2

Country / Area	ISO Code	Country	Extended CC

		Code	
Anguilla	AI	1	A2
Antigua and Barbuda	AG	2	A2
Argentina	AR	A	A2
Aruba	AW	3	A4
Bahamas	BS	F	A2
Barbados	BB	5	A2
Belize	BZ	6	A2
Bermuda	BM	C	A2
Bolivia	BO	1	A3
Brazil	BR	B	A2
Canada	CA	C	A1
Cayman Islands	KY	7	A2
Chile	CL	C	A3
Colombia	CO	2	A3
Costa Rica	CR	8	A2
Cuba	CU	9	A2
Dominica	DM	A	A3
Dominican Republic	DO	B	A3
Ecuador	EC	3	A2
El Salvador	SV	C	A4
Falkland Islands	FK	4	A2
Greenland	GL	F	A1
Grenada	GD	D	A3
Guadeloupe	GP	E	A2
Guatemala	GT	1	A4
Guiana	GF	5	A3
Guyana	GY	F	A3
Haiti	HT	D	A4
Honduras	HN	2	A4
Jamaica	JM	3	A3
Martinique	MQ	4	A3
Mexico	MX	F	A4
Montserrat	MS	5	A4
Netherlands Antilles	AN	D	A2
Nicaragua	NI	7	A3
Panama	PA	9	A3
Paraguay	PY	6	A3
Peru	PE	7	A4
Puerto Rico	PR	8	A3
Saint Kitts	KN	A	A4
Saint Lucia	LC	B	A4
St Pierre and Miquelon	PM	F	A6
Saint Vincent	VC	C	A5
Suriname	SR	8	A4

Trinidad and Tobago	TT	6	A4
Turks and Caicos Islands	TC	E	A3
United States of America	US	1..9,A,B,D,E	A0
Uruguay	UY	9	A4
Venezuela	VE	E	A4
Virgin Islands [British]	VG	F	A5
Virgin Islands [USA]	VI	F	A5

ITU Region 3

Country / Area	ISO Code	Country Code	Extended CC
Afghanistan	AF	A	F0
Saudi Arabia	SA	9	F0
Australia	AU		
Australia - Capital Territory		1	F0
Australia - New South Wales		2	F0
Australia - Victoria		3	F0
Australia - Queensland		4	F0
Australia - South Australia		5	F0
Australia - Western Australia		6	F0
Australia - Tasmania		7	F0
Australia - Northern Territory		8	F0
Bangladesh	BD	3	F1
Bahrain	BH	E	F0
Myanmar [Burma]	MM	B	F0
Brunei Darussalam	BN	B	F1
Bhutan	BT	2	F1
Cambodia	KH	3	F2
China	CN	C	F0
Sri Lanka	LK	C	F1
Fiji	FJ	5	F1
Hong Kong	HK	F	F1
India	IN	5	F2
Indonesia	ID	C	F2
Iran	IR	8	F0
Iraq	IQ	B	E1
Japan	JP	9	F2
Kiribati	KI	1	F1
Korea [South]	KR	E	F1
Korea [North]	KP	D	F0
Kuwait	KW	1	F2
Laos	LA	1	F3
Macau	MO	6	F2
Malaysia	MY	F	F0
Maldives	MV	B	F2
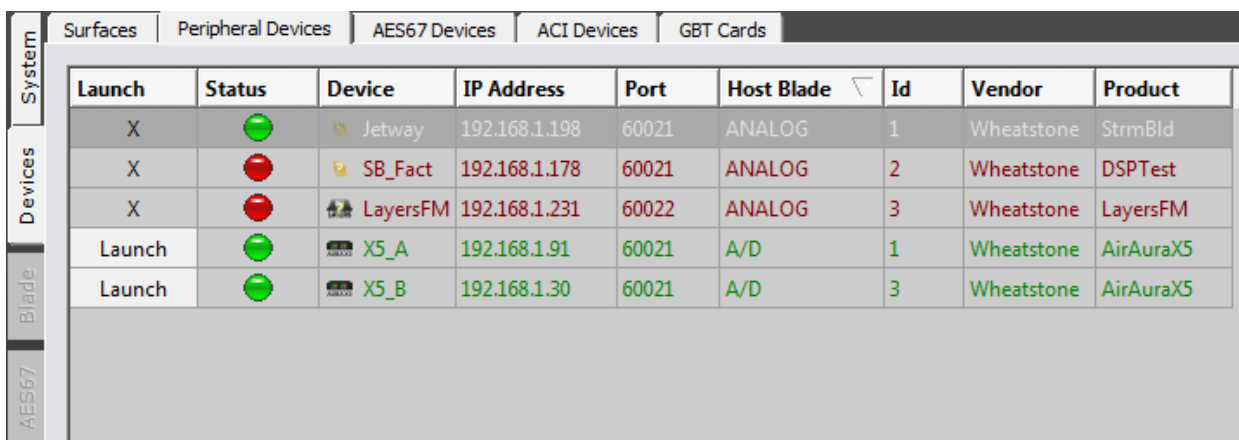
Micronesia	FM	E	F3
Mongolia	MN	F	F3
Nepal	NP	E	F2
Nauru	NR	7	F1
New Zealand	NZ	9	F1
Oman	OM	6	F1
Pakistan	PK	4	F1
Philippines	PH	8	F2
Papua New Guinea	PG	9	F3
Qatar	QA	2	F2
Solomon Islands	SB	A	F1
Western Samoa	WS	4	F2
Singapore	SG	A	F2
Taiwan	TW	D	F1
Thailand	TH	2	F3
Tonga	TO	3	F3
UAE	AE	D	F2
Vietnam	VN	7	F2
Vanuatu	VU	F	F2
Yemen	YE	B	F3

APPENDIX D

Adding LiON to your WheatnetIP Network

Once LiON is up and running and you wish to add it to your WheatnetIP network, just a few steps will get you there.

Open the WheatnetIP Navigator program and locate the Devices tab at upper left and then click on the Peripheral Devices tab at top. When the dialog opens it will look similar to our example below and no LiON will be present.

Launch	Status	Device	IP Address	Port	Host Blade	Id	Vendor	Product
X	🟢	Jetway	192.168.1.198	60021	ANALOG	1	Wheatstone	StrmBld
X	🔴	SB_Fact	192.168.1.178	60021	ANALOG	2	Wheatstone	DSPTest
X	🔴	LayersFM	192.168.1.231	60022	ANALOG	3	Wheatstone	LayersFM
Launch	🟢	X5_A	192.168.1.91	60021	A/D	1	Wheatstone	AirAuraX5
Launch	🟢	X5_B	192.168.1.30	60021	A/D	3	Wheatstone	AirAuraX5

To get LiON into the WheatnetIP system we need to add it and to do so, locate the Add / Edit / Remove buttons at Navigators right side.
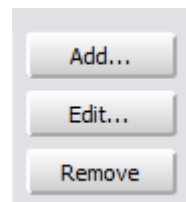
To add LiON to the system, click on the Add button and the following dialog will open.

To this dialog we've added LiON's system name, (LION), its IP address (192.168.1.170), and the Blade that we want LiON to be hosted by (ANALOG).

Once we click okay, Navigator will go out to the system, locate LiON if it is online, and then add it, and any associated signals that are associated with it, into the WheatnetIP system.

Now if we look at the Peripheral Devices dialog again we will see that LiON has indeed been added to the WheatnetIP system and is online and ready for signals to be connected.

Note that here the Add Peripheral Device screenshot was taken *before* we told the Add Peripheral Device dialog that we wanted LiON to be hosted by the A/D Blade and not the ANALOG one.

Launch	Status	Device	IP Address	Port	Host Blade	Id	Vendor	Product
X	●	Jetway	192.168.1.198	60021	ANALOG	1	Wheatstone	StrmBld
X	●	SB_Fact	192.168.1.178	60021	ANALOG	2	Wheatstone	DSPTest
X	●	LayersFM	192.168.1.231	60022	ANALOG	3	Wheatstone	LayersFM
Launch	●	X5_A	192.168.1.91	60021	A/D	1	Wheatstone	AirAuraX5
Launch	●	X5_B	192.168.1.30	60021	A/D	3	Wheatstone	AirAuraX5
Launch	●	LION	192.168.1.170	60021	A/D	2	Wheatstone	LION

Notice that in the image above the Status column is showing a green indicator which means LiON has been found, added to the system, and its signals are available to be routed.

If we look at LiON's host Blade we'll see that the Blade now has LiON's Source and Destination signals available for routing.

If we now look at Navigator's I/O signal grid we'll see that LiON now has its Output available to be routed to another signal. Likewise, its Input is available in the Destinations dialog.

Source Signals				Destination Signals		
Name	**Location**			**Name**	**Location**	
BL051S01	Blade51	Add...		BL051D01	Blade51	Add...
BL051S02	Blade51	Add Alias...		BL051D02	Blade51	Add Alias...
BL051S03	Blade51	Edit...		BL051D03	Blade51	Edit...
BL051S04	Blade51			BL051D04	Blade51	
BL051S05	Blade51	Delete		BL051D05	Blade51	Delete
BL051S06	Blade51			BL051D06	Blade51	
BL051S07	Blade51			BL051D07	Blade51	
BL051S08	Blade51			BL051D08	Blade51	
Aura_1	Blade51			BL51Hdpn	Blade51	
X5 FM	X5_A			Aura_1	Blade51	
X5 HD	X5_A			X5 Inp	X5_A	
X5 Pset	X5_A			LION Inp	LION	
LION Out	LION			X5 Inp	X5_B	
LIONPset	LION					
X5 FM	X5_B					
X5 HD	X5_B					
X5 Pset	X5_B					

Now that we know the signals have been generated, we can route LiON's input to give it some audio from an existing source.
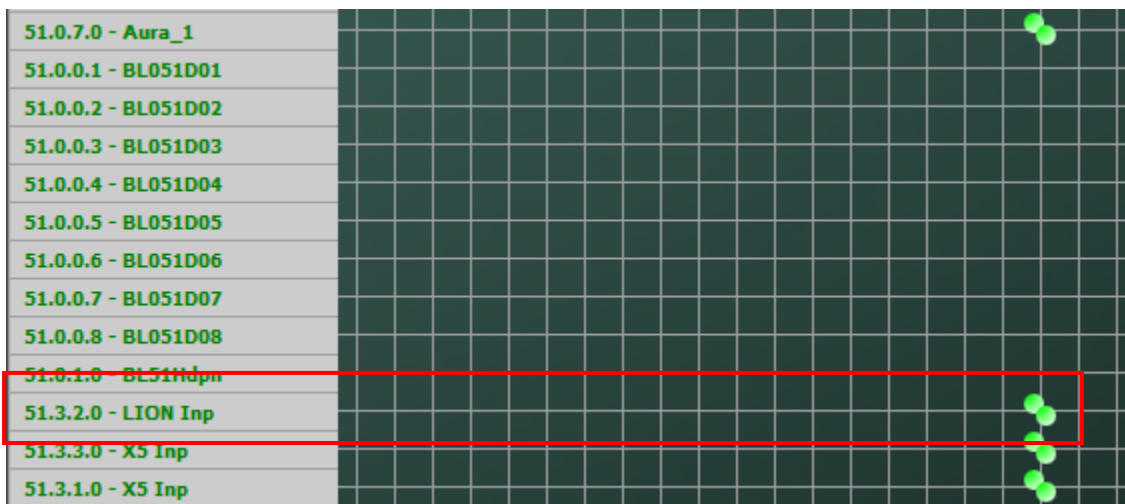
Above we've crosspointed LiON's WheatnetIP (WNIP) input to a source that is already providing audio, shown by the crosspoint connection dots being green. The pair of closely-spaced green dots signifies that LiON is a stereo device and that both channels are receiving audio from the source, whatever it may be.

Likewise LiON's output is available in the crosspoint matrix and can be routed to *any* desired destination.

As shown in the preceding examples and text, LiON has been successfully added to and working with the WheatnetIP system and its host Blade. Its Input and Output signals may stay statically routed, or they may be dynamically routed using programmable buttons on our GP Panels, Sideboard, TS-22 Talent Station, or by GPIO/LIO functions within the WheatnetIP system.

APPENDIX E

GENERAL SPECIFICATIONS

Analog Line Input

Type:	Electronic Differential
Input Impedance:	10Kohm bridging
Optimum Source Impedance:	< 1Kohm
A/D Converter:	TI PCM4202, 192kHz, 24-bit
Maximum Input Level:	+20dBu

Digital Line Input

Digital Audio Standard:	AES3 (AES/EBU)
Data Amplitude:	Per AES3-2003 assuming minimum allowable output signal amplitude of 2V P-P and minimum allowable input signal of 200mV P-P.
AES Receiver:	CS8416, 192kHz, 24-bit
Compatibility:	Digital sample rates between 32kHz and 96kHz are accepted and automatically synchronized.
Ethernet Data Type:	WheatnetIP
Ethernet Interface:	10/100BaseT Ethernet per IEEE 802.3u
Digital Audio Input Reference:	0dBFS externally results in 0.0dBFS internally.

Input Gain Accommodation

Gain Range:	+/- 12dB in 0.5dB steps
Gain Calibration:	A gain control setting of 0.0dB aligns an external 0dBFS signal with LiON's 0dBFS internal reference.

Input Failsafe

Type:	Automatic
Analog Fail Cause:	Audio level on <u>both</u> channels below -24dBu (fixed)
Response Time:	30 seconds (fixed)
Digital Fail Cause 1:	Audio level below -48dBFS (fixed)
Response Time:	30 seconds (fixed)
Digital Fail Cause 2:	Corrupted or invalid AES data
Response Time:	Immediate (fixed)
Failsafe Direction:	Digital to Analog / Analog to Digital (no Digital to Digital)

Audio Level Balance

Type:	Common to both Analog and Digital Inputs
Adjustment Range:	+/- 12dB
Adjustment Resolution:	0.5dB

Phase Rotator

Filter Topology:	4th Order Allpass
Operating Modes:	In or Out (bypass)

High Pass Filter

Filter Class:	24dB/Octave Butterworth response
Frequency Choices:	20, 30, 40, 50 60Hz

Equalizer

Number of sections:	Four
Low Shelf Frequency Range:	20Hz to 500Hz
Low Shelf Boost/Cut:	+/- 14dB
High Shelf Frequency Range:	2kHz to 20kHz
High Shelf Boost/Cut:	+/- 14dB
Parametric #1 Frequency Range:	20Hz to 20kHz
Parametric #1 Boost/Cut:	+/- 14dB
Parametric #1 Bandwidth:	0.2 to 3.0 octaves
Parametric #2 Frequency Range:	20Hz to 20kHz

Parametric #2 Boost/Cut:	+/- 14dB
Parametric #2 Bandwidth:	0.2 to 3.0 octaves

Five Band Leveler/Compressor with iAGC

Crossover Topology:	4th Order Linkwitz-Riley (phase linear)
iAGC parameters:	Automatic and Program Dependent
Leveler/Compressor Compression Ratio:	2:1 to 6:1
Interband Coupling:	0dB to 6dB
L+R Mixer:	Boost/Cut +/- 6dB
L-R Mixer:	Boost/Cut +/-6dB
Crossover Frequencies:	Factory Preset Dependent

FM Peak Controller

Type:	Proprietary
Stereo Pilot Protection:	>50dB
Pre-Emphasis Accuracy:	+/-0.25dB
FM Diversity Delay:	Off to 10 seconds in one sample steps when simultaneously using the keyboard Ctrl key and the mouse scroll wheel.

Stereo and RDS Encoder

Composite Processor:	Clipper operating at 192kHz.
D/A Conversion:	TI PCM1798, 192kHz, 24-bits
Automatic Multipath Limiter:	Program Dependent Timing Characteristics with adjustment range of Off to 100% in 5% steps.
Subcarrier Input Impedance:	10kOhms
Subcarrier Input Level Range:	-20dBu to +4dBu
Stereo Pilot Injection:	Off to 20% of Composite Output level
19kHz Stereo Pilot Frequency:	+/-0.2Hz
57kHz RDS Subcarrier Frequency:	+/-0.2Hz
Stereo Pilot Protection:	Better than 50dB
38kHz Suppression:	Better than 70dB

Analog Audio Outputs

Analog Left/Right Output Level:	-48dBu to +20dBu
Analog Left/Right Output Options:	Pre-emphasized, De-emphasized, and Pre-delay
D/A Conversion:	TI PCM1798, 192kHz, 24-bits
Signal to Noise:	>80dB in a 20kHz bandwidth
Total Harmonic Distortion:	<0.05% 20Hz – 20kHz

Digital Audio Outputs

AES3 Protocol Output Level:	>5V P-P into 110 ohm load
AES3 Audio Output Level:	-48dBFS to 0DBFS
Digital Left/Right Output Options:	Pre-emphasized, De-emphasized, and Pre-delay
Signal to Noise:	>80dB in a 20kHz bandwidth
Total Harmonic Distortion:	<0.05% 20Hz – 20kHz

Overall System

Headroom:	>20dB
Nominal Operating Level:	-20dBFS
Processing Latency Analog In to MPX Out:	57mS maximum
Processing Latency Analog In to HD Out:	34mS maximum
Total Harmonic Distortion:	<0.025%, 20Hz – 20kHz
Intermodulation Distortion:	<0.025% SMPTE
Signal to Noise Ratio:	>85dB
Stereo Separation:	>50dB into a low capacitance load
Crosstalk:	>75dB, 20Hz – 20kHz
Power Requirements:	100-250VAC, auto-sensing 50/60Hz, 9W/14VA
Power Connector:	IEC 60320 C14 (male)
Operating Temperature:	0 to 50 degrees C (32 to 122 degrees F) Overtemp alarm reporting via the GUI

NOTE #1:

Left/right audio specifications correspond to operation using the Factory Bypass preset, unity I/O gains, 75μS pre and de-emphasis and the AES3 I/O. Composite stereo separation measurements were performed under the same conditions using a Belar "Wizard" FMSA-1 Modulation Monitor/Analyzer connected to LiON with a 12" RG-58A/U cable with BNC male connectors at each end.

NOTE #2:

Static frequency response, harmonic distortion and intermodulation distortion measurements have no bearing whatsoever on the dynamic nature of FM audio processing and what those parameters may be doing under dynamic audio processing conditions. Further, harmonic distortion above 7.5kHz is meaningless (and absent) due to the 15kHz bandwidth restriction necessary to protect the spectrum surrounding the 19kHz stereo pilot.