NEURON

FM/HD/DAB+ SPECTRAL AUDIO PROCESSOR

Wheatstone

Meet NEURON

Energize your station with the FM/HD/DAB+ spectral audio processor. Fully dynamic, yet powerful, NEURON produces the kind of “draw you in” sound that even the best ears in the business love to hear.

Only NEURON FM/HD/DAB+ spectral audio processor gives you patented 1/3 octave band resolution for precision transient peak control without pulling down critical frequencies with it. This means you’ll be able drive more energy into the processor, yet maintain peak compliance for a much fuller, vibrant on-air sound.

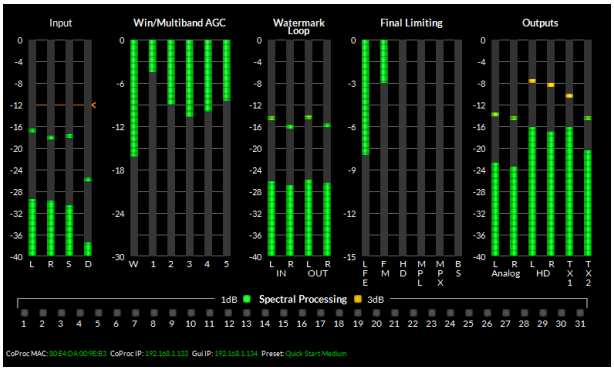

NEURON
DIGITAL SPECTRAL PROCESSOR
SYSTEM OVERVIEW
Analog
Digital
WheatNet-IP
INPUT SETUP
EQUAL-IZER
WIN / MB AGC
SPECTRAL PROCESS
Watermark Send
Watermark Return
FM CLIP & BASS
HD DELAY
STEREO GEN
Analog MPX
Digital MPX
FM Digital
HD LIMITER
HD OUTPUT
ANALOG L/R
Analog L/R
HD Digital
PRESETS
SCHEDULE
SECURITY
NETWORK
RDS/RBDS
SYSTEM
LOGGING
ESC

M/HD ANALOG OUT
RT
AES IN
PUSH
AES OUT
FM
HD
GPI
WATERMARK
ETHERNET
Designed and Built in USA
CAUTION — To avoid the risk of electric shock refer all service to a qualified technician
90-240 VAC/50-60Hz

Overview

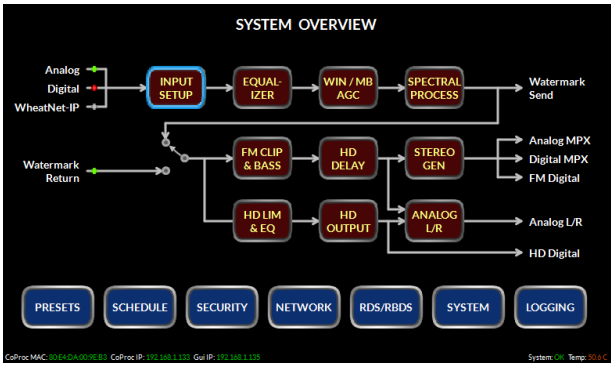
NEURON FM/HD/DAB+ SPECTRAL AUDIO PROCESSOR

It's no secret that radio has sounded tired for some time now. With modern delivery options, new technology, and our brains buzzing with more choices than ever, it's time to bring new life to the radio dial. Only the NEURON FM/HD/DAB+ audio processor uses spectral processing techniques to produce a full, energetic on-air sound. With its super smart controls doing the calculations for you and adjusting all the right parameters as you tweak, you don't need an advanced degree to set the ideal sound.



The left front panel screen always shows the metering for input and output levels, watermark engine send and receive levels, and metering for all of the dynamics processing that occurs within NEURON'S DSP engine.

The right front panel screen is equipped with a touch interface and hosts the navigation menu for all input/output and processing adjustments.



NEURON Rear Panel Connections

Subcarrier Audio Input #1 & #2

FM/HD Analog Audio Output Left and Right

FM AES3 or Digital MPX (Baseband192®) Output and HD AES3 Digital Audio Output

Watermark Engine Ethernet Network Port

Analog Left and Right Channel Audio Input

TX (MPX) Output #1 and #2

AES3 Digital Audio Input

General Purpose Input (GPIO)

DSP Coprocessor Ethernet Network Port

AC Power Input

Features

- **Density Compensation®:** Many studios today are unmanned and it's up to the AGC to know the difference between amplitude and dynamic range in order to manage levels properly. NEURON'S two-band windowed pre-processor and five-band AGC utilize a proprietary Density Compensation® algorithm for real-time analysis of the pre- and post-processed audio as well as data from the user's control settings to invisibly manage spectral balance and program density as incoming program content changes
- **Spectral Processor:** NEURON'S patented Spectral Processor technology applies human psychoacoustic characteristics to perform fine-grained peak control. By grouping frequencies into 1/3 octave 'critical bands' that model how the human ear perceives sound, peak limiting is applied to only the narrowest frequency band possible without affecting nearby frequencies. Limiting in this way lets you drive the processor for optimum loudness and still get a richer, fuller sound out the other end. The result is uncannily transparent and musical audio completely devoid of the usual artifacts related to peak limiting.
- **Bass Extra:** Add bass texture without overdriving modulation and driving up clipping IM distortion. Bass is sidechained in the NEURON so you can get the bass you want without adding amplitude to the overall signal.
- **Pre-emphasis Optimization:** In more traditional audio processing designs, pre-emphasis is either managed by specialized limiting or carefully designed clipping that merely tolerates the pre-emphasis curve. The NEURON'S FM peak control technology reconstructs the audio after pre-emphasis is applied to reproduce vibrant highs.
- **Super Smart Settings:** You don't need to be a processing pro or spend weeks getting the ideal sound. NEURON gives you simple controls on the front or GUI, many working with associated controls on the back end for exponentially enhancing the sound. Start with any one of the dozens of factory settings, and create your own signature sound in minutes, not hours or days, with a few adjustments.
- **Multipath Mitigator:** This user control helps mitigate the audible effects of multipath as well as reduce receiver-induced stereo blend by managing the stereo image for a more consistent and predictable sound.
- **Unified, Smart Processing:** Using Unified Processing®, the NEURON shares information between ALL stages. iAGC, compression, and limiting/clipping work together no matter which control a user adjusts. Changes are made automatically, in real time, in ways never envisioned (or heard) before.

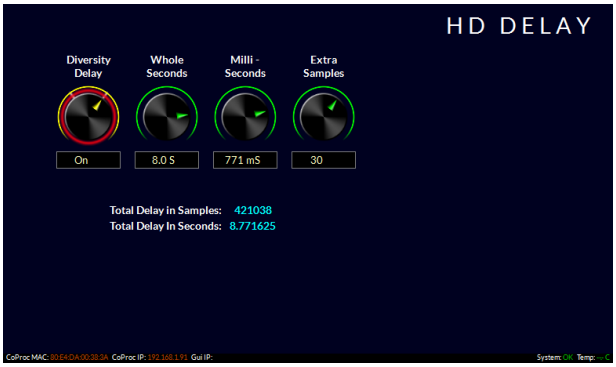
- **Stereo Generator**: A DSP-based stereo generator generates the stereo multiplex signal and provides for two separately adjustable "TX" outputs to feed (for instance) main and backup transmitters.
- **SCAs:** The two analog subcarrier inputs are digitized at 192 kHz, mixed with the stereo MPX signal in the digital domain, and will accept subcarrier signals up to 80 kHz.
- **Full RDS/RBDS Generator:** Neuron includes a fully featured RDS/RBDS generator that is compliant with nearly all playout systems, includes advanced RT+ tagging and provides all the tools needed for either a static or dynamic listener experience.
- **Wheatstone® baseband192:** Wheatstone® baseband192 digitizes the entire multiplex spectrum up to and including the RDS/RBDS, doing away with an analog composite interface between processing and transmission. A single AES/EBU cable carries the digitized signal between this baseband192-equipped processor and any FM transmitter equipped with a digital baseband input, bypassing the need for multiplexing in the exciter and eliminating the resulting signal overshoot and its associated loudness tradeoff.
- **Separate FM and HD/DAB+ Paths:** The FM and HD/DAB+ signal paths share the four-band parametric equalizer, two-band windowed pre-processor, five-band AGC/leveler and multiband Spectral Processor. Post Spectral Processing, the FM and HD/DAB+ paths have their own specialized program aware peak controllers optimized for their respective broadcast mediums.
- **Daypart Scheduler:** A fully configurable daypart scheduler allows scheduled preset changes or RDS/RBDS dataset changes.
- **WheatNet IP Connectivity:** NEURON is WheatNet IP compatible, making it easy to manage settings remotely though the WheatNet IP audio networked studio.

NEURON GUI'S

Bands 1 through 5

Spectral Processing

FM Clipping

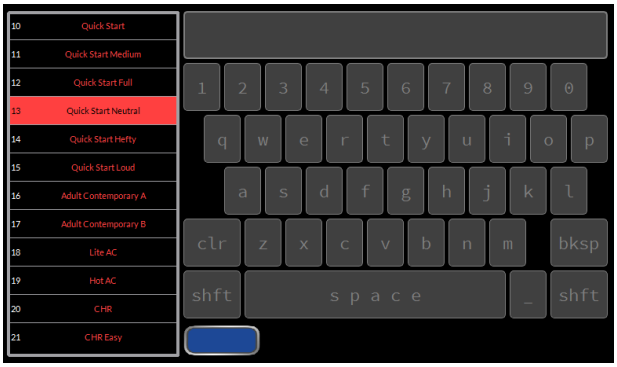


HD Delay

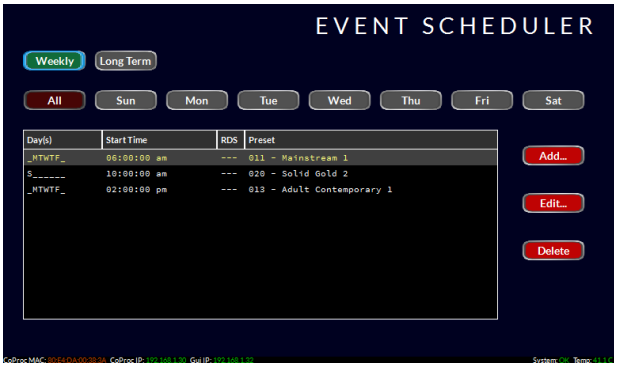
The equalizer is equipped with two parametric equalizers and two shelving filters.

Stereo Generator

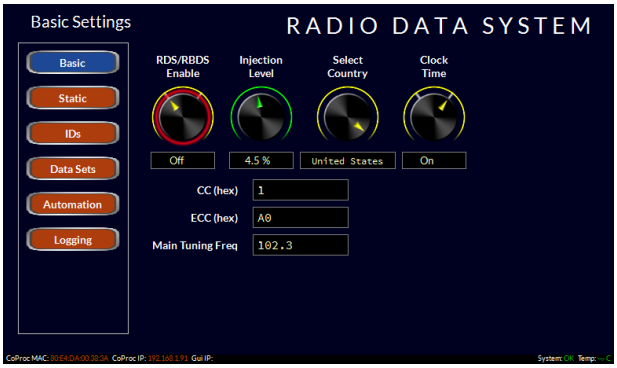
HD Limiter



Presets



Event Scheduler



RDS/RBDS

The NEURON GUI software

NEURON GUI'S

AGC DENSITY COMPENSATION®

NEURON's proprietary Density Compensation® technology maintains spectral balance and program density using a two-band windowed pre-processor and five-band AGC. A phase-linear Linkwitz-Riley crossover (200Hz or 500Hz, depending on preset) allows natural level variation to preserve short-term dynamics, avoiding the unnatural effects of basic compression.

The algorithm analyzes both pre- and post-processed audio in real time, along with user settings, to optimize amplitude and dynamic range. Subtle psychoacoustic enhancement can also be applied to improve on-air sound quality.

FIVE BAND AGC

NEURON's automatic level control algorithm utilizes a slave compressor intimately tied to the leveler time constants for each band in the five-band AGC. The time constants closely interact to provide an extremely wide range of operating leeway. As density control is increased, the threshold of the AGC is raised while that for the compressor remains fixed at whatever the band's threshold setting is. The audible result is a 'thickening' and 'filling in' of the sound as the faster compressor's dynamics become more apparent than that of the slower leveler. Taken to an extreme, the compressor will do much of the work of the band, but at the same time prevent unnatural gain rush-up because the compressor can never have more gain than the leveler – all of which is useful for generating that full radio sound without adding listener fatigue.

PROPRIETARY SPECTRAL AUDIO PROCESSING

Wheatstone's patented spectral audio processing section performs fine-grained peak control based on how the human ear processes audio. By utilizing a 1/3 octave 'critical band' technique, limiting is applied to the narrowest frequency band possible without affecting nearby frequencies. Precision overshoot protection in this way provides for optimum loudness while enabling a richer, fuller sound. The result is uncannily transparent and musical audio that is completely devoid of the usual processing artifacts related to peak limiting.

The output is split into separate paths, one for FM and one for HD final processing. The FM path utilizes Wheatstone's limitless clipper technology and can receive pre-emphasized audio conditioned for 50µS or 75µS. The HD path utilizes broadband look-ahead limiting techniques for excellent peak control.

ADVANCED PEAK CONTROL

NEURON uses sophisticated FM clipping to provide aggressive peak control with very little perceived distortion. Unique to NEURON is its ability to adjust the spectral balance of the audio inside the clipper algorithm itself for effective peak control. In addition, to reduce perceived distortion with speech and other mono material, NEURON can automatically back down the FM clipper drive when speech or mono programming is detected. With this, stereo music can be more effectively and aggressively clipped while preserving speech intelligibility.

PRE-EMPHASIS OPTIMIZATION

In traditional audio processing designs, pre-emphasis is either managed by specialized limiting or carefully designed clipping that merely tolerates the pre-emphasis curve. NEURON FM peak control technology takes a different approach, including reconstructing the audio after pre-emphasis is applied to reproduce vibrant highs. NEURON's pre-emphasis can be set at 50µS or 75µS, or disabled entirely.

BASS EXTRA: CLIPPER AND MANAGER

Unlike the days of vinyl where very low frequencies had to be rolled off to prevent the stylus from jumping out of the record grooves, digital audio has no such limitation. In today's popular music it is not unusual to hear bass frequencies well down into the tens of hertz. Such program content can be problematic when primary peak control is applied, which is why NEURON has a separate Bass Clipper that is designed to artistically control low bass energy without rolling it off. The Bass Clipper not only controls low bass energy to prevent it from being clipped by the main FM clipper, therefore reducing IM distortion, it also makes it possible to add or remove texture from the bass to suit individual programming and competitive needs.

NEURON's bass manager serves both the analog and HD signal paths for improved consistency between the two transmission mediums.

BASS HARMONICS

Unique to NEURON is its ability to add harmonics from very low bass to create a fuller sound on today's smaller speakers. NEURON's algorithm uses an anomaly of human psychoacoustics to create harmonics from very low bass that can be perceive but are not actually reproduced on some smaller speakers.

SUB BASS SYNTHESIZER

NEURON can mathematically create sub bass frequencies between 25 and 60Hz from their higher frequency fundamentals (recall a popular boombox of the '70s) and add sub-bass energy to the mix without muddying things up. The Sub Bass Synthesizer maximum amount of enhancement is artistically limited to prevent over-enhancement and/or the unlocking of older style analog STL of FM exciter AFC loops.

NEURON GUI'S

SEPARATE FM AND HD OUTPUTS

NEURON processes analog FM and digital HD audio separately, with both paths sharing a four-band parametric EQ, two-band windowed pre-processor, five-band AGC/leveler, and multiband spectral processor. Each path includes a dedicated, program-aware peak controller optimized for its format.

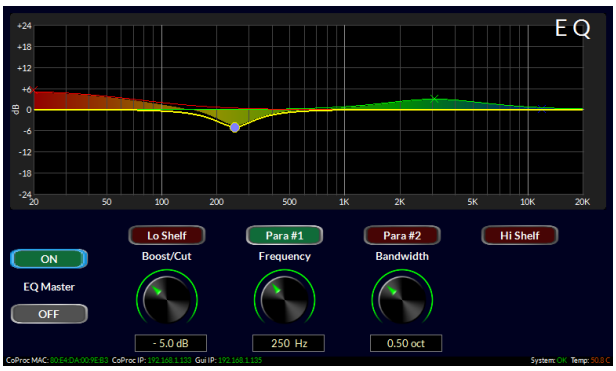
Processed FM and HD audio are output simultaneously via analog (balanced L/R), AES3 digital (L/R), and two configurable digital MPX channels using the Wheatstone® baseband192 protocol. Two analog MPX outputs and WheatNet-IP are also provided for monitoring. Analog L/R can be assigned to either FM or HD output. All outputs feature independent level controls and can follow preset changes as needed.

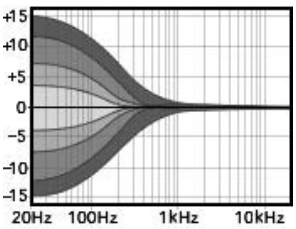
FM/HD DIVERSITY DELAY

NEURON provides up to 10 seconds of delay in the analog FM signal path to compensate for the delay in the HD side of the transmission system. FM diversity delay is adjustable with one sample (20.83µS) resolution.

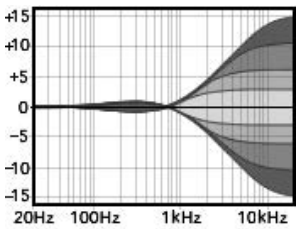
FULL EQ CONTROL

The equalizer is equipped with two parametric equalizers and two shelving filters, which are user adjustable for boost/cut. A Lo Shelf control offers frequency choices from 20Hz to 500Hz while a Hi Shelf control offers choices from 2 kHz to 20 kHz. Bandwidth can be set for desired boost or cut effect.

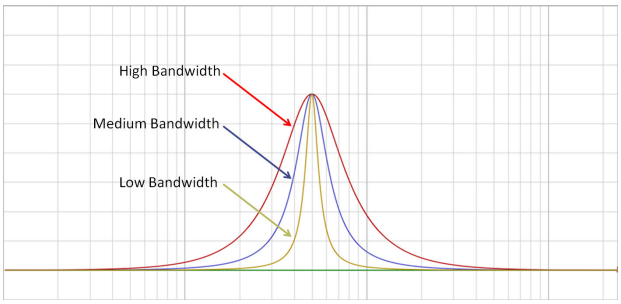




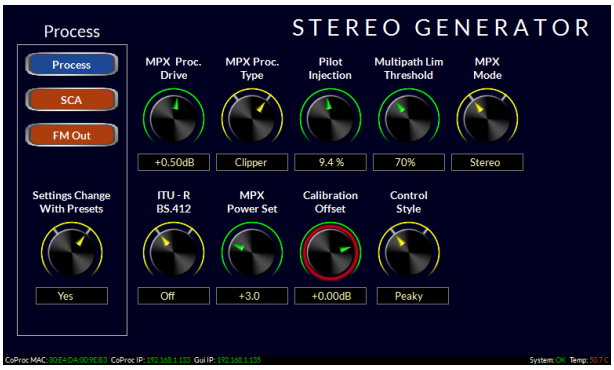
Lo Shelf



Hi Shelf



STEREO GENERATOR WITH MPX OVER AES



NEURON generates the stereo multiplex signal and provides for two separately adjustable outputs to feed the main and backup transmitters, for example. The stereo generator also outputs the Wheatstone® baseband192 digital MPX signals (often called MPX over AES) with both transmitter MPX outputs encoded on the left and right channels, respectively.

MULTIPATH MITIGATION

NEURON includes an advanced multipath mitigator that manages the stereo image to minimize the audible effects of multipath and receiver-induced stereo blending.

There is no getting around the physics of multipath, which is caused by topological features (such as mountains or reflecting building structures) along the path between the station's transmitter and its listeners. However, NEURON can change how stereo receivers behave in multipath situations by modifying how much L-R (stereo) energy there is in the transmitted signal. By lowering the amount of L-R on a program-dependent basis, NEURON can lessen the effect when stereo receivers blend the left and right channels during multipath. By making blend less obvious, the listening experience is improved.

PHASE ROTATOR

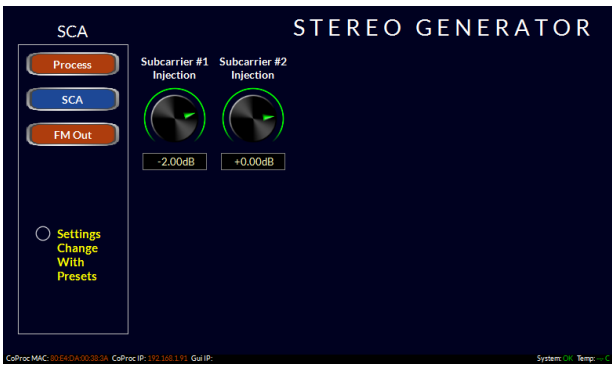
NEURON includes a phase rotator to correct the asymmetrical audio waveforms often found in human voice.

ITU-R BS.412 CONTROL

NEURON includes a control for stations regulated under ITU-R BS.412 for reducing interference in closely spaced broadcast channels, typically 100kHz apart. Depending on setting, NEURON will reduce the amount of MPX power required to reduce how much RF spectrum the station's signal consumes on the FM broadcast band.

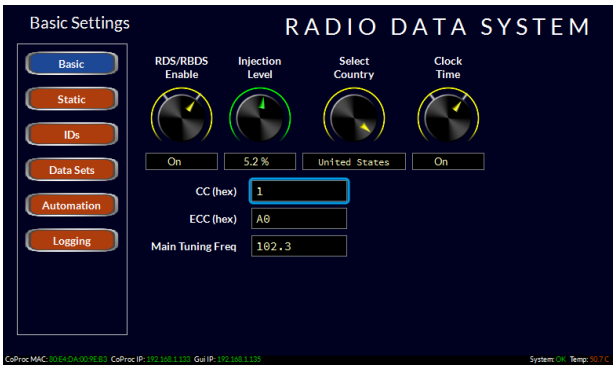
TWO SCA INPUTS

The two analog subcarrier inputs are digitized at 192kHz, mixed with the stereo MPX signal in the digital domain, and will accept subcarrier signals up to 80kHz.



NEURON GUI'S

FULL-FEATURED RBDS/RDS GENERATOR

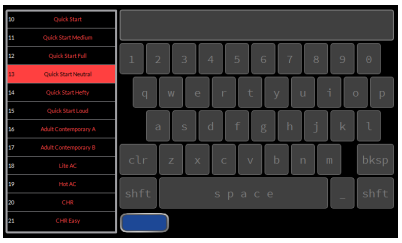


NEURON includes a fully featured RDS/RBDS generator that is compliant with nearly all playout systems, includes advanced RT+ tagging and provides all the tools needed for either a static or dynamic listener experience.

NEURON GUI

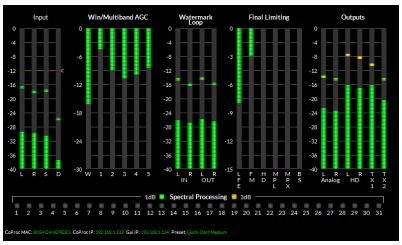
NEURON's GUI software can control an unlimited number of NEURON processors via a standard Ethernet network. Utilizing TCP and UDP protocols the app can be used to control the processor from anywhere in the world with an internet connection. This includes controlling it behind firewalls, NAT routers and VPN tunnels.

SETTING, NAVIGATING AND MANAGING NEURON



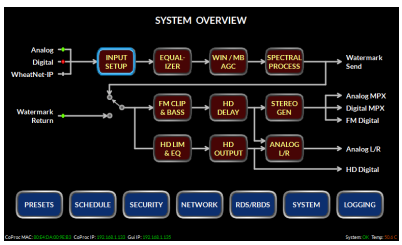
DIAL IN YOUR SOUND IN MINUTES.

Start with any one of the 160+ NEURON presets optimized by format and tested in the Wheatstone lab by the best ears in the industry. Set it and go, or adjust with confidence knowing that with every adjustment you make, NEURON is managing associated controls to exponentially enhance the sound. NEURON lets you create your own signature sound in minutes, not hours or days.



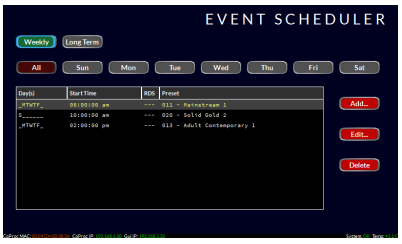
KEEP TABS ON THINGS.

NEURON's front panel screen shows at-a-glance the metering for input and output levels and all the dynamics processing that occurs within NEURON's DSP engine. At the bottom is information pertaining to the network, such as assigned IP address, and the currently running processing preset.



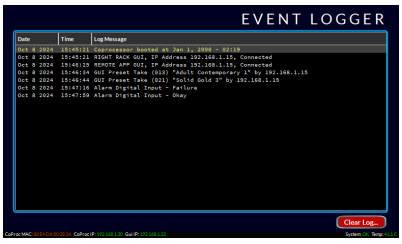
NAVIGATE EASILY.

Navigating NEURON is easy with touchscreen access to processing sections, presets, logging events, and setting up dayparts, SCAs, RDS, networking and security.



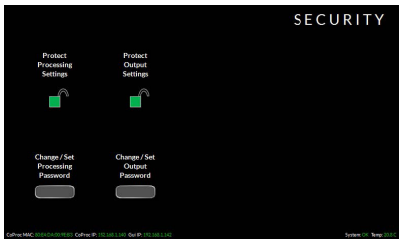
SCHEDULE IT.

NEURON includes a comprehensive scheduler for setting RDS, presets and more by the week or long term.



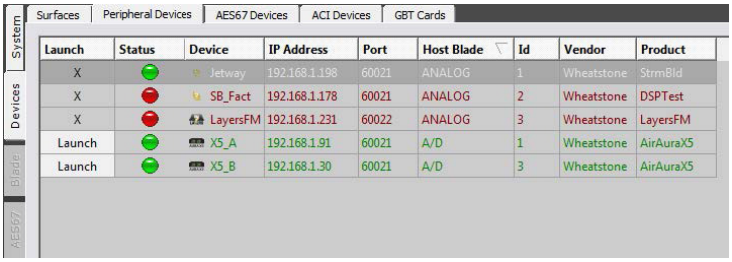
LOG IT.

NEURON also has an event logger than keeps track of various events and stores them in its onboard memory. Each event is time and date stamped.



SECURE IT.

Neuron has two security levels: one for protecting settings and another for protecting the output.



WHEATNET IP ENABLED.

NEURON can be added to your WheatNet IP audio network at any time. Its I/O signals can stay statically routed, or they can be dynamically routed using programmable buttons on audio GP panels, talent stations or by GPIO/LIO functions within the WheatNet IP system.

AUTOMATIC FAILOVER.

Neuron can automatically failover to a backup in order to restore on-air broadcast. Automatic failover from analog to AES3 or WheatNet IP is based on silence detection.

GENERAL SPECIFICATIONS

Analog Line Input

Type:	Electronic differential (SSM2143)
Input Impedance: >	10K Ohms (bridging)
Optimum Source Impedance:	<1k Ohms
A/D Conversion	AKM5394, 192 kHz, 24-bits
Maximum Input Level:	+20dBu

Digital Inputs

Data Standard:	AES3
Data Amplitude:	Per AES3-2023 assuming minimum allowable output signal of 2V P-P and minimum allowable input signal of 200mV P-P
AES Receiver:	CS8416, 192 kHz, 24-bits
AES Sample Rates Accepted:	32 kHz to 96 kHz
Input Reference Level:	-24dBFS with up to 12dB adjustable input gain
WheatnetIP Data Receiver:	100BaseTX Ethernet per IEEE 802.3u
Sample Rates Accepted:	44.1 kHz and 48 kHz

Analog Output

D/A Conversion	AK4396, 192 kHz, 24-bits
Output Type:	Balanced electronic differential (SSM2142)
Maximum Output Level	+20dBu into >1k ohms
Signal to Noise Ratio:	>80dB, 75µS de-emphasis and 15 kHz bandwidth*
Total Harmonic Distortion:	<0.05%, 75µS de-emphasis and 15 kHz bandwidth*
Intermodulation Distortion:	<0.05%, 75µS de-emphasis and 15 kHz bandwidth*
Stereo Separation:	>75dB, 20 Hz – 15 kHz

Left/Right Digital Output

Data Standard:	AES3
Maximum Output Level:	0dBFS
Sample Rate:	32 kHz to 48 kHz, synchronizes to AES Input if present
Signal to Noise Ratio:	>80dB, 75µS de-emphasis and 15 kHz bandwidth*
Total Harmonic Distortion:	<0.05%, 75µS de-emphasis and 15 kHz bandwidth*
Intermodulation Distortion:	<0.05%, 75µS de-emphasis and 15 kHz bandwidth*
Stereo Separation:	>75dB, 20 Hz – 15 kHz

Audio Input Failsafe

Type:	Automatic – user choice
Analog Fail Cause:	Audio level below -24dBu
Response Time:	30 seconds”
Digital Fail Cause 1:	Audio level below -48dBFS
Response Time:	30 seconds
Digital Fail Cause 2:	Corrupted or invalid digital data
Response Time:	Immediate
Failsafe Direction:	Digital to Analog, Analog to Digital (no digital to digital failover)

Phase Rotator

Filter Type:	4th order allpass

High Pass Filter

Filter Type:	4th order Butterworth

Audio Crossovers

Filter Types:	4th order Linkwitz-Riley

Stereo Generator

MPX D/A Conversion:	AK4396, 192 kHz, 24-bits
Maximum MPX Output Level:	9.5V P-P into >1k ohms
Digital MPX Output:	192 kHz sample rate, TX #1 on left channel, TX #2 on right channel
38 kHz Suppression:	>70dB
19 kHz Pilot Protection:	>60dB at 9% injection, no MPX processing
Signal to Noise Ratio:	>70dB (ref 75 kHz deviation/75µS de-emphasis, 15 kHz BW)
Sub/Main, Main/Sub Crosstalk:	>70dB
Total Harmonic Distortion:	<0.05%, 75µS de-emphasis and 15 kHz bandwidth*
Intermodulation Distortion:	<0.05%, 75µS de-emphasis and 15 kHz bandwidth*
Stereo Separation:	>50dB @ 1 kHz, >1k ohm load /NMT 100pF

SCA/RDS Input

Input Type:	Balanced and floating over chassis (SSM2143)
Input Impedance:	24k ohms
A/D Conversion:	AK4396, 192 kHz, 24-bits
Frequency Response:	Accepts analog subcarriers up to 80 kHz
Maximum Input Level:	5V P-P

AC Power

Input Voltage:	100-250VAC (auto sensing)
Input Frequency:	50/60 Hz
Power Consumption:	<50VA at 120 Volts AC Input
Operating Temperature:	0 to 50 degrees C (32 to 122 degrees F) | Over temperature alarm at 50C

* The harmonic and intermodulation distortion performance of FM audio processors cannot be properly characterized by sine wave bench tests.

SOUND. SIMPLE. SMART.

Wheatstone Corporation makes broadcast quality control surfaces, on-air audio processors, virtual mixers, audio editors, streaming appliances, voice/mic processors, and 200+ interconnected AoIP studio elements — all engineered, manufactured and supported under one roof by industry pros. Celebrating 50 years of innovating audio solutions for broadcast, commercial, and live sound excellence, Wheatstone markets products under VoxPro, Wheatstone and Audioarts Engineering brand names.

Designed and built by

Wheatstone Corporation
600 Industrial Drive | New Bern NC 28562-5440 USA
phone 1.252.638-7000 | fax 1.252.635-4857
wheatstone.com | sales@wheatstone.com

Wheatstone