DAVID IV 719N

FM Audio Broadcast Processor

Installation & User Guide

INOVONICS BROADCAST

www.inovonicsbroadcast.com

PRODUCT REGISTRATION RECORD
Model 719N – Serial No. _____
Purchase Date _____
Warranty Registered via Web?
Reg. Date _____ By: _____

Installation & Operation User Guide

DAVID IV

Model 719N

FM Audio Broadcast Processor

May, 2021

Inovonics, Inc. 5805 Highway 9
Felton, CA 95018
Tel: (831) 458-0552 Fax: (831) 458-0554
Register online at www.inovonicsbroadcast.com

TABLE OF CONTENTS

Section IV – PROCESSOR SETUP

Section I

INTRODUCTION

DAVID IV PRODUCT DESCRIPTION

History

The 719 was fourth in Inovonics' series of "DAVID" FM Broadcast Processor/Stereo Generators, the name David inferring Biblical reference to this series of airchain audio processors that deliver giant-killing performance with modest cost of ownership and simplicity of operation.

DAVIDs I through III made exclusive use of analog circuitry, but the DAVID IV moved into the digital realm as a DSP-based product. As such it more approximates an audio processing *engine* that is easily upgraded in the field as new processing algorithms are suggested, developed and released.

The latest version, the 719N, 'N' for 'Networked,' truly brings the DAVID IV into the Information Technology Age. Setup and operating functions are available over LAN and Internet using any browser, and SNMP is fully supported. Additional software is no longer required.

DAVID IV FEATURES

Framework Features

Non-subjective *framework* features that set the DAVID IV apart from competitive products:

- Total local and remote control of DAVID IV setup and operation using either the front-panel menu and jogwheel or any computer, tablet or smart-phone browser over private or public networks (Internet).
- Full SNMP support interfaces with network management systems.
- 25 Factory Presets and space for 20 User Presets.
- Analog and AES3 digital inputs and outputs interface easily with all program audio feeds and ancillary plant equipment. Failover provision between inputs for loss of audio, plus emergency monaural operation from Left, Right or L+R inputs.
- Dual composite/MPX outputs feed main and backup transmitters. Simultaneous analog and digital line outputs may be configured for FM and digital HD Radio® broadcast requirements or Internet streaming.

- Optional “Diversity Delay” of the composite multiplex and FM-mode line outputs to synchronize analog FM and digital broadcasts.
- Internal RDS subcarrier combiner includes built-in metering to obviate the need for specialized monitoring equipment and closed-loop servo stabilization of the MPX output peak level.
- Built-in test-tone generator to simplify setup.
- Low latency allows off-air monitoring.
- The DAVID IV boots or resets *in less than one second* and draws only 8 watts from the AC mains.

Processing Attributes

User-adjustable *processing* attributes of DAVID IV that directly influence the ‘sonic signature’ of program audio processing:

- An adjustable, steep high-pass filter attenuates unwanted sub-bass program components.
- Dual-slope “windowed” AGC automatically corrects wandering levels from the console or playout system, maintaining long-term consistency between diverse program sources without altering the intended tonal balance.
- 5 bands of dynamic range compression and equalization help create a ‘sonic signature’ tailored to the station’s format and personality.
- Low-bass augmentation gives independent control over both the transient and the sustained program bass elements.
- Stereo-enhancement options address both the apparent width of the stereo image as well as solo (center channel) fullness.
- ‘Look-ahead’ final limiting includes Inovonics’ proprietary PIPP™ limiter technology to assure unprecedented modulation efficiency.
- Support for the European ITU-R BS.412.9 Standard with flexible, automatic control of r.m.s. power in the composite, multiplex output.

DAVID IV TECHNICAL SPECIFICATIONS

Some specifications of the DAVID IV are difficult to quantify in tabular form. Please refer to a corresponding section of the manual text for additional information or discussion.

GENERAL PERFORMANCE

PLEASE NOTE:

1) The gain structure of an audio processing system is determined in large part by how the user sees fit to set numerous 'subjective' adjustments. In addition, various processing functions intentionally upset the tonal balance (static and dynamic frequency response) and the waveshape ('native distortion' inherent in all program material). Thus it has become customary to establish and publish performance specifications with audio processing features disabled or bypassed. Unless otherwise expressed or implied herein, this is the case with figures shown here, as indeed seems also the practice of our worthy competitors.
2) Measurements taken from the Composite/MPX outputs, or analog/digital line outputs in the FM mode, presume use of an appropriate de-emphasis network.

Frequency Response:

Composite/MPX Output:
±0.25dB, 20Hz–15kHz

L/R Analog Line Outputs:
±0.25dB, 20Hz–15kHz, FM mode;
±0.25dB, 20Hz–20kHz, Flat mode.

AES Digital Output (Digital Input):
±0.25dB, 20Hz–15kHz, FM mode;
±0.1dB, 20Hz–20kHz, Flat mode.

Noise (unweighted r.m.s.)**:**

Composite/MPX Output:
SNR >85dB referred to full carrier modulation.

L/R Analog Line Outputs:
Residual noise better than 100dB below the output clipping point.

AES Digital Output (Digital Input):
Residual noise better than 130dB below 0dBFS.

Distortion:

Composite/MPX Output:
<0.01% THD

Line Outputs (Digital or Analog):
<0.006% THD

Stereo Separation:

Composite/MPX Output:
>65dB, 20Hz–15kHz assuming the use of a lab-quality FM-multiplex decoder.

L/R Analog Line Outputs:
>100dB at 1dB below the output clipping level.

AES Digital Output (Digital Input):
>130dB at 0dBFS

MPX Crosstalk:
>78dB Linear Crosstalk (main/sub or sub/main).

Program Signal Latency
≤3.6 milliseconds for composite/MPX;
≤4.2 milliseconds from any input to any output in any operating mode.

19kHz Stereo Pilot Protection:
>65dB referred to 9% pilot injection.

38kHz Suppression:
>80dB referred to full carrier modulation.

57kHz RDS Subcarrier Protection:
>65dB referred to 5% RDS subcarrier injection.

REAR-PANEL APPOINTMENTS

Digital Line Input:
The AES3 stereo input (XLR) accepts 16- or 24-bit program sources at sampling rates of 32kHz, 44.1kHz, 48kHz and 96kHz. Input gain is adjustable for average program levels between –5dBFS and –35dBFS.

Analog Line Inputs:
L/R active balanced/bridging (XLR) inputs accept average program line levels between –15dBu and +15dBu. +26dBu peak input level.

Digital Line Output:
The AES3 (XLR) 24-bit stereo output may be adjusted between –20dBFS and 0dBFS, corresponding to full carrier modulation. The output sampling rate may be set to follow the Digital Line Input or forced to 32kHz, 44.1kHz, 48kHz or 96kHz.

(continued)

Analog Line Outputs:
Active balanced (XLR) outputs are adjustable between –10dBu and +24dBu (+21.5dBm), corresponding to full carrier modulation; source impedance is 200 ohms.

Line Output Characteristics:
The Digital and Analog Line Outputs may each be configured independently for 20kHz flat response, or for 15kHz 'FM' characteristics, either with pre-emphasis or normalized to flat.

Composite/MPX Output:
Two unbalanced (BNC) outputs are independently adjustable between 0.8V p-p and 9V p-p (+12dBu), corresponding to 100% carrier modulation; source impedance is 75 ohms. Pre-emphasis may be set to 75µs, 50µs or OFF.

RDS Input:
Unbalanced/bridging (BNC) input accepts a 57kHz RDS subcarrier at any level between 0.5V p-p and 5.0V p-p for a typical injection level of 5% of total carrier modulation.

19kHz RDS Sync:
When RDS is enabled, the Sync Output (BNC) delivers a 5V p-p TTL-compatible square wave at the 19kHz pilot frequency; 75-ohm source.

IP Network Port:
An RJ45 jack accepts TCP/IP network connections for remote setup and operation of the DAVID IV via LAN or Internet with any Web browser, plus full SNMP support.

Headphone Jack (Front Panel):
A quarter-inch (TRS) headphone jack allows the user to monitor the processed program audio. A volume control next to the jack adjusts the listening level.

AUDIO PROCESSING FEATURES

Program High-Pass:
A user-programmable high-pass filter attenuates sub-audible noise that could compromise modulation efficiency. The filter is adjustable between 20Hz and 65Hz.

AGC:
Unobtrusive, 'windowed' AGC is both peak- and average-responding with a capture/correction range of ±18dB. Positive AGC gain may be truncated to any value between +18dB and 0dB. The AGC window and correction rate are user-programmable.

Stereo Enhancement:
This dual-action utility effectively broadens the soundstage for the stereo program and the center-channel 'solo' component independently.

5-Band 'Multipressor':
Program audio is split into five frequency bands. Each user-adjustable band imparts parameter-programmable dynamic compression and adjustable static gain to afford both static and dynamic equalization 'signature' control over the program audio.

Bass Augmentation:
Sub-bass program frequencies undergo independent dynamic compression, expansion, selective clipping and filtering for control over both static 'Rumble' and dynamic 'Punch' of bottom-end components.

PIPP™ Peak Limiter:
Inovonics' exclusive Polarity-Independent Peak Processor assures optimum modulation of the FM carrier or other transmission system.

ITU Multiplex Power Control:
The Peak Limiter section may optionally be configured to control the r.m.s. power of the composite multiplex signal to meet European Standard ITU-R BS.412.9.

Adaptive Pre-Emphasis:
User-defined HF limiting and/or distortion-cancelled clipping provide independent amplitude management of program frequencies subjected to the FM pre-emphasis curve. This helps preserve program brightness and clarity despite power bandwidth constraints native to FM broadcasting.

Composite Clipping:
At the user's discretion, up to 3dB of clipping may be applied to the composite/baseband signal. Clipping is performed before the injection of the stereo pilot and RDS subcarrier.

(continued)

HD Radio Delay (Optional):
An optional plug-in circuit board allows the composite/MPX output of the DAVID IV to be delayed from 1ms to 9.999 seconds in 1ms increments, relative to the analog and digital program line outputs when they are set to the 20kHz (Flat) output mode. When set to either of the FM modes, the line outputs are subjected to the programmed delay as well.

THE USER INTERFACE

Front-Panel:
A front-panel graphic display and jog-wheel allow menu-guided *in-situ* setup and operation of the DAVID IV. LED-bar displays indicate in/out levels and audio processing action.

Web Interface:
The IP network port enables full remote setup and operation of the DAVID IV over a local network or the Internet using any computer, tablet or smart phone browser. No additional software is required. SNMP operation is fully supported.

MISCELLANEOUS

Test Tone Generator:
20Hz–20kHz, pre- or post-processing; 60dB attenuator.

AC Mains Requirements:
105–130VAC or 210–255VAC, 50/60Hz; 8 watts.

Size:
H: 1¾in/44mm, W: 19in/483mm, D: 13in/330mm (1U).

Weight:
9lb/4kg (net), 12lbs/5.4kg (shipping).

Environmental:
Continuous operation guaranteed at ambient temperatures between 32˚F/0˚C and 122˚F/50˚C; 0-95% relative humidity, non-condensing; altitudes to 10,000ft/3048m.

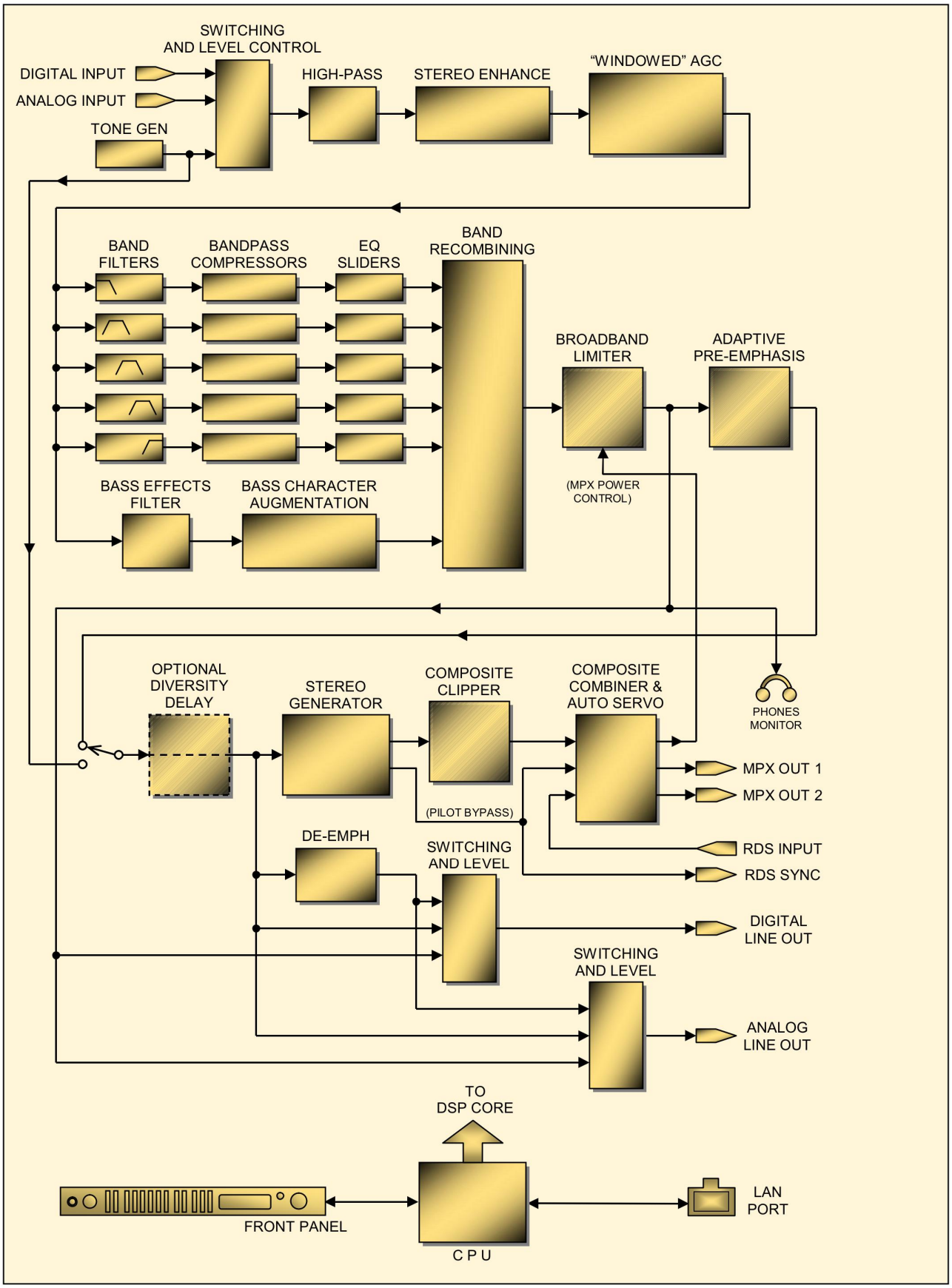
Conformances:

CE EN50081-1
EN50082-1
93/68/EEC

RoHS 2002/95/EC

BLOCK DIAGRAM

The DAVID IV is entirely DSP-based with virtually all its functionality provided through firmware coding. Our Block Diagram on the following page, on the other hand, has been deliberately organized as if the DAVID IV were an *analog* processor. It is our expectation that this surreptitious measure on our part will provide the reader with a more familiar and understandable functional representation of this fine product. This means of clarification does imply a good deal of 'literary license,' however, so do be advised that the illustration is not an accurate representation of the actual signal path of all those mischievous ones and zeroes. ***"Sit emptor confundi!"***



DAVID IV - 719N Block Diagram

Section II

INSTALLATION

This section of the manual addresses the physical installation of the DAVID IV in its operating location, the 'nuts and bolts' of connecting the unit. It also references pages where pertinent adjustments are discussed.

This section is a 'catch-all' as well, containing discussions of features, functions or options that aren't a good fit for other specific manual sections.

Front-Panel vs. Web Interface Setup

The DAVID IV may be set up and operated either by using the front-panel menu and jog-wheel knob, or by using the Web interface 'Webpages.' You are going to find the Webpages faster and easier, and this access method will be stressed during these tutorials. We do advise gaining some familiarity with the front-panel approach, at the very least to set up a network connection initially from the front panel. Page 55 shows a complete listing of the front-panel menu tree.

UNPACKING AND INSPECTION

As soon as the equipment is received, inspect carefully for any shipping damage. If damage is found or suspected, notify the carrier at once, and then contact Inovonics.

We recommend retaining the original shipping carton and packing materials for return or transshipment. If returned for Warranty repair, shipping damage sustained as a result of improper packing for return may invalidate the Warranty!

IT IS IMPORTANT to register the Warranty of your DAVID IV. This assures coverage of the equipment under terms of the Warranty, provides a means of tracing lost or stolen gear, and adds the user to a database to receive specific service instructions or software/firmware updates when issued. Register online at :

https://www.inovonicsbroadcast.com/support/productRegistration

PLEASE NOTE: Many users choose first to familiarize themselves with equipment on the bench or at their desk, in which case they may immediately turn to Section III that describes DAVID IV setup and use. Do please refer back to this section, however, to confirm proper physical installation and interconnection with other equipment.

MOUNTING

Rack Requirement The DAVID IV mounts in a standard 19-inch equipment rack and requires only 1¾ inches (1U) of vertical rack space. We recommend using plastic or fiber washers to protect the painted finish around the mounting holes.

Heat Dissipation Consuming less power when it's running than many consumer products do when they are turned off, the DAVID IV itself generates negligible heat and thus has no noisy internal fan and associated filter to change. The unit is specified for operation within an ambient temperature range extending from freezing to 120˚F/50˚C. But because adjacent, un-green and less efficient equipments may themselves radiate substantial heat, be sure that the equipment rack is adequately ventilated to keep internal temperature below the specified maximum ambient.

AC (MAINS) POWER

Mains Voltage Selector Unless specifically ordered for export shipment, the DAVID IV is set at the factory for operation from 115V, 50/60Hz AC mains.

To change the mains voltage, first *disconnect the mains cord* and then remove the top cover of the unit. A clearly marked slide switch is directly behind the AC mains connector on the circuit board. Use a small screwdriver to set the switch for 115V or 230V operation.

Mains Fuse It is important to install the appropriate fuse as noted on the rear panel next to the fuseholder: ½A for 115V mains, ¼A for 230V operation. Fuses are the GMA/S500 type (5mm X 20mm size, 'fast blow').

Power Cord The detachable IEC-type power cord supplied with the DAVID IV is fitted with a North-American-standard male plug. If you need to replace the mains plug with another, you will find that the individual cord conductors are color-coded in one of two ways. US standards specify black for AC 'hot,' white for AC neutral and green for earth ground. European CEE standards specify brown for AC 'hot,' blue for AC neutral and green with a yellow stripe for earth ground. Please keep these straight.

RADIO FREQUENCY INTERFERENCE (RFI)

Location Although it is expected that the DAVID IV may be co-located with FM transmitters, please practice care and common sense in locating the unit away from *abnormally* high RF fields.

Ground Loops Because the unbalanced RDS input and composite/MPX outputs of the DAVID IV are chassis-ground-referenced, a mains frequency or RF ground loop could be formed between cable

shield grounds and the AC power cord ground. A 'ground-lifting' AC adapter may well remedy such a situation, although the chassis must somehow be returned to earth ground for safety. Generally, being screwed-down in the equipment rack will satisfy the safety requirement.

PROGRAM LINE INPUTS

AES Digital Input

The female XLR connector labeled AES DIGITAL INPUT is a balanced, transformer-coupled digital stereo program input conforming to the AES3 (AES/EBU) specification. This input accepts digital audio signals up to 24 bits in word length, and at sampling rates of 32kHz, 44.1kHz, 48kHz and 96kHz. The onboard sampling rate converter (SRC) locks onto the input signal automatically and gives a display of the data rate on the Now Playing and Setup Webpages, and in the front-panel Setup / Sample Rate Converter menu.

The digital input will accept average program levels between –5dBFS and –35dBFS, presupposing a nominal, "zero-VU" average level close to –20dBFS. Gain is programmed in Setup.

Analog Line Inputs

The DAVID IV has electronically-balanced (transformerless) left- and right-channel ANALOG INPUTS with female XLR connectors. These are bridging, high-impedance inputs. They do not provide termination for the console or other equipment that feeds the DAVID IV. Here's why.

With few exceptions, audio line impedance matching is ridiculed by today's hip broadcasters (you) and erudite equipment manufacturers (us). The concept of 600-ohm line matching dates from the age of transformer-coupled telephone transmission lines and the necessity of optimizing telephony return loss performance.

The analog line inputs accept "zero-VU" program levels between –15dBu and +15dBu, adjusted under Setup.

Unbalanced Operation

It's not uncommon for broadcasters to include consumer audio products in their installations. There may be a legitimate reason to feed the DAVID IV directly from a CD or MP3 player or a computer sound card in, hopefully, a temporary or emergency situation. Sufficient gain has been included to interface with single-ended inputs in the –10dBV, consumer-level range.

For unbalanced inputs, the single center conductor of the shielded lead should be connected to Pin 2 of the XLR plug, and the shield braid split and connected both to Pin 1 and to Pin 3.

PROGRAM LINE OUTPUTS

DAVID IV digital and analog line outputs are available simultaneously and are independently adjustable and assignable to a specific output characteristic. These outputs, found under Setup, have options described as follows:

20kHz Flat

20k-Flat is a full-range (20kHz) output that comes directly from the output of the broadband peak limiter. This output is suitable for any form of full-power-bandwidth digital radio broadcasting, for audio production and recording, or for high quality streaming. The 20k-Flat output option does *not* include the independent HF limiting afforded by adaptive pre-emphasis, 15kHz low-pass filtering, nor will it incorporate the HD Radio delay when it is implemented for the multiplex output.

Pre-Emphasized FM Output

When the FM-Pre output characteristic is selected, the output is configured to feed an FM exciter that has a built-in stereocoder (stereo-gen). The line output will include adaptive pre-emphasis and the 15kHz low-pass filtering required for stereo pilot protection, and is pre-emphasized in this mode. This means that any pre-emphasis option in the exciter should be switched OFF. If HD Radio delay is enabled, the FM-Pre line output will be delayed just as it is for the multiplex output.

Normalized (Flat) FM Output

The FM-Flat output characteristic is similar to FM-Pre, except that the signal has been 'normalized' with a de-emphasis network to restore a flat frequency characteristic. This output would be the proper feed to an FM exciter that does its own pre-emphasis. Although the audio response from this output is flat, it still includes the 15kHz low-pass filter and independent HF limiting to protect the spectrum and the stereo pilot, plus it will also have the HD Radio delay if it is enabled.

Both FM modes retain full benefit of independent HF limiting to protect the pre-emphasis curve, that curve specified by the setting of the DAVID IV's own stereo-gen, whether used or not.

AES Digital Line Output

The male XLR connector labeled AES DIGITAL OUTPUT is a balanced, transformer-coupled, 24-bit digital stereo program output conforming to the AES3 (AES/EBU) specification. The AES Output Rate: is selected on the Setup Webpage, or under the Setup / Sample Rate Converter front-panel menu. The digital output rate may be selected either to follow the input rate, or to fix the output sample rate at 32kHz, 44.1kHz, 48kHz, or 96kHz.

The digital output level shown below the slider control is the program peak level, which has been limited by the DAVID IV to the 100% modulation point.

The Digital Level (dB): is variable between 0dBFS and –20dBFS. 'FS' refers to digital-full-scale, or as high as the digital signal can go. This means that audio peaks in the program signal, which have been limited to 100% modulation, can assume any level between digital-full-scale and a value 20dB below this.

In digital signal distribution it is customary to maintain the *average* level of the program audio ("zero" on a VU meter) a comfortable value below digital full scale to allow headroom for program peaks. This 'headroom offset' is historically on the order of 20dB for raw, unprocessed audio, but since the output of the DAVID IV is tightly peak-limited there is no headroom issue even when this is set wide-open at 0dB. Nevertheless, running program peaks to 0dBFS is not a good idea because of what's called "zero dBFS plus," a phenomenon leading to overshoots, clipping and distortion in the eventual D-to-A converter somewhere downstream. Try an Internet search for: "dBFS+" to learn more about this.

Analog Line Outputs

Male XLR left- and right-channel ANALOG OUTPUTS on the rear panel are electronically-balanced. This means that they are ground-referenced and *not* transformer-coupled.

Analog line outputs are adjusted with the Analog Level (dB): slider. You can set these to any level between –10dBu and +24dBu. The dBu numbers beside the slider are based on traditional dBm voltage values, the 'u' referring to unloaded, open-circuit volts (0dBu = 0.775V r.m.s), rather than one milliwatt in a 600-ohm circuit (0dBm). The outputs have a resistive source impedance of 200 ohms; that is, there is a 100-ohm 'buildout' resistor in each leg. When feeding a 600-ohm load, the actual dBm level will be 2.5dB below the Analog Level shown under the slider.

The range of the Analog Level (dB): slider covers traditional studio line levels (e.g.: "Plus Four") and the lower levels common to semi-pro audio gear. This lower output range is useful when, for example, the DAVID IV feeds the input of a conventional computer sound card.

Unbalanced Operation

Should you have need to connect the analog line outputs of the DAVID IV to consumer-grade, unbalanced inputs, connect the center conductor of the shielded output lead to Pin 2 of the XLR connector, and the shield to Pin 1. Leave Pin 3 floating (unconnected).

NOTE: Connected as described above the unbalanced output line level will be 6dB lower than shown by the slider.

Front-Panel Headphone Jack

The headphone jack on the front panel monitors the broadband-limited output of the peak limiter. This is a 'flat' monitor point that does *not* reflect action of the 15kHz low-pass filter and adaptive pre-emphasis for FM transmission, nor the effects of composite clipping. The volume control next to the jack adjusts only the headphone volume.

COMPOSITE-MPX OUTPUTS

There are two independent composite/MPX outputs on the rear panel of the DAVID IV. These are unbalanced BNC connectors, not surprisingly labeled MPX OUT 1 and MPX OUT 2. Their source impedance is a resistive 75 ohms.

Composite-MPX and Pilot Levels

The level of the multiplex signal at each output is independently adjusted with the MPX Level 1 (Vp-p): and MPX Level 2 (Vp-p): sliders in the Stereo Generator section under Setup. The peak program level in open-circuit peak-to-peak volts is indicated next to the sliders for the two outputs, and can be adjusted between 0.8Vp-p (≈–20dBu) and 9Vp-p (≈+12dBu).

Pilot Injection (%): is adjusted in this Setup area as well, generally for the default injection level of 9%. The MPX output servo (see below) holds peak modulation constant as pilot is adjusted.

Confirming Pre-Emphasis

FM broadcasting imparts high-frequency pre-emphasis to the program audio signal in transmission; the FM receiver provides complementary de-emphasis. The time constant of the pre- and de-emphasis networks is determined by geographic location. The Americas (Western Hemisphere) have standardized on a 75-microsecond curve, and Europe has chosen 50-microseconds. Other parts of the world have opted for one or the other of these, so make sure you know what setting is the proper one for you location before proceeding. The Pre-Emphasis setting is on the Setup Webpage and under Setup / Stereo Generator in the front-panel menu.

Monaural Operation Options

Unforeseen instances could arise when you'd need to revert to monaural operation. For example, sudden transmitter power loss would greatly compromise the expected station's coverage area, and reverting to mono would improve the compromised SNR by 20dB, restoring listenability for at least part of the usual area.

Or perhaps your stereo feed to the transmitter site drops a channel, or a channel becomes noisy. In that case, you could switch the one good channel to drive the DAVID IV monaurally.

The DAVID IV offers three modes of monaural operation. These are selected in the Web interface and front-panel Stereo Generator sections of Setup, and of course selection can be addressed via SNMP as well. Here are the operating options:

1) Stereo: This is the normal and default operating mode.
2) Mono L+R: The 19kHz stereo pilot is removed and the Left and Right input channels are combined to feed the processing section and, ultimately, the Analog/Digital Line and MPX Outputs.
3) Mono L: Like 2), but only the Left input channel is used to feed the system.
4) Mono R: Just the Right input channel feeds the system.

Multiplex Output Servo

The DAVID IV employs an open-loop servo system to maintain the multiplex output at the precise level set by the user. As either the 19kHz stereo pilot level or the RDS injection level is adjusted (or even turned off), the composite/MPX output remains constant so that no back-and-forth tweaking is required.

RDS COMBINING PROVISION

The Radio Data System, or RDS (called the Radio *Broadcast* Data System, or RBDS in the US), enables the FM broadcaster to transmit certain digital 'metadata' along with his program audio. The transmitted information includes certain mandatory housekeeping functions that identify the station format, keep track of rebroadcast translators, send time information, etc. It can also display advertising or music artist and title info on the faceplate of RDS radios.

An external encoder is required to generate the RDS subcarrier. When RDS is enabled, the DAVID IV supplies a synchronizing signal to lock the encoder to the stereo pilot. The DAVID IV has a self-metering combining network to add the RDS subcarrier to the composite/MPX output signal, and a servo to maintain constant MPX peak level.

19kHz Sync Output

The rear-panel 19kHz SYNC BNC connector gives a TTL-compatible square-wave output at the 19kHz stereo pilot frequency when the RDS input is enabled, both in normal stereo operation and in any of the monaural modes. This signal is used to synchronize an RDS encoder with the stereo pilot. It is a 5V p-p square wave with a 50% duty cycle, in-phase with the stereo pilot component of the FM multiplex signal.

RDS Input

The RDS INPUT BNC connector accepts the 57kHz RDS subcarrier for combining with the FM multiplex program signal. The p-p level of the subcarrier can range from 0.5V to 5V, corresponding to a typical injection level approximately 5% of total carrier deviation.

Injection Metering

The DAVID IV has an accurate and helpful internal metering utility for adjusting the RDS subcarrier injection. The number shown the RDS area of the Setup menus is the actual injection level as a percentage of total carrier modulation. This is quite useful during installation of the RDS encoder, especially when a modulation monitor that displays RDS subcarrier injection is not available.

Setting RDS Injection

The RDS injection level is adjusted in the Setup menus under RDS Input. But before connecting your RDS encoder, be sure first to set the Level: (Web interface) or RDS Injection (front-panel) slider all the way down. Note that the numbers associated with the slider do not change during this operation.

Next, connect your encoder. If it is programmed and ready to go, you may switch RDS Input: to Enable.

Watching the numbers associated with the slider, carefully advance Level or RDS Injection. The RDS Injection (%): or lighted portion of the slider will creep up from the bottom of the box, and at some point you should begin to see the injection percentage appear. Because the DAVID IV is actually measuring the RDS peak level, the relationship between the numbers and the position of the slider will depend on the output level of the encoder. The DAVID IV accepts a wide range of input levels, but an input between 0.5V p-p and 5V p-p is the recommended range.

When injection has been set for a typical working figure of 5%, the slider should be neither at the very top nor at the very bottom of the adjustment range. This would indicate an unusually low or absurdly high level from the encoder, respectively. As RDS injection is adjusted, total carrier modulation will not change. The multiplex output servo described earlier eliminates the need to reset the composite/MPX output level as the RDS subcarrier is adjusted.

THE HD RADIO™ DELAY MODULE

The HD Radio digital broadcasting system, employed principally in the U.S., is a 'hybrid' broadcasting system. This means that the all-digital signal carrier is transmitted 'on-channel,' simultaneously with the traditional analog FM (or AM) carrier. Legacy radios are thus able to receive the program in the usual manner, and new HD Radio receivers can recover both the analog and the digital versions of the program.

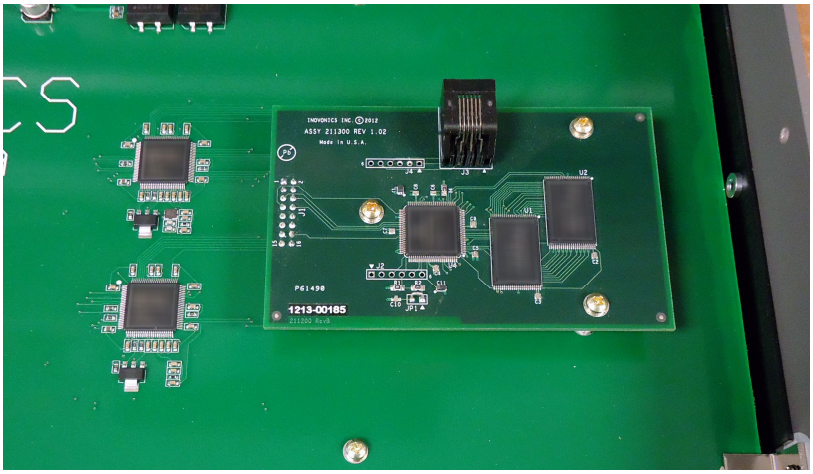
Because there is an obligatory delay of some 8 seconds(!) in the digital program encoding and decoding process, the analog signal must be delayed by this same amount to arrive in sync with the digital signal. The HD Radio receiver first tunes and plays analog audio to the listener, but then it cross-fades to digital reception once the digital signal is acquired. If this were not the practice, then using pushbutton presets would be an agonizing process, much as digital-TV channel-surfing can sometimes be frustrating, though to a lesser extent because of shorter delay in TV signal decoding.

This time-aligning "diversity delay," as it is called, is enabled in the DAVID IV with an optional accessory circuit board that is simply plugged into a header strip on the main board.

Installing the Delay Module

If you are adding the HD Radio delay option in the field, first disconnect power from the unit. Then remove the top cover and install the accessory board as shown in the photograph.

Mounting standoffs are already in place, just plug the accessory board squarely onto the header strip so that the screw holes line up. Fasten the board down with the screws that came with it. The DAVID IV will recognize the board when it boots, and you can then access and set up the delay menu.



NOTE: HD Radio Delay functions appear on the menus only if the accessory board is installed, and installed correctly.

Adjusting the Delay

HD Radio delay is available over a much wider range than required, in the expresses hope for improvements in the encoding/decoding process of the HD Radio system to lessen the delay substantially. Although this adjustment can be 'earballed' to a fairly close match, a seamless crossfade between analog and digital reception requires a better technique.

An HD Radio receiver in its normal operating mode will fade from analog to digital within a few seconds after the station is tuned. Tune away from your station and then tune back again. The transition should be 'seamless,' with no echo, gaps, stuttering or level shift as the radio cross-fades from analog to digital reception.

The delay may be set with fair accuracy using an HD Radio receiver that can be put into the "split" mode, where the analog program is heard in one stereo channel and the digital program in the other. Best to use headphones for this to home-in on reducing phase displacement between the programs.

Despite one's best effort to synchronize the analog and digital program channels, it has been found that the encoding equipment 'slips' over time, even when locked to a GPS time standard. For various reasons, some yet unknown, the HD Radio encoding process will allow the digital signal timing to wander back and forth over the broadcast day.

This yet-to-be-solved shortcoming in the HD Radio system justifies a shameless plug for the Inovonics JUSTIN 808, a fully automatic time-alignment processor. The JUSTIN constantly monitors your station off-air and makes incremental adjustments in the delay and in r.m.s. audio levels to keep the two programs in

flawless sync perpetually. This is a standalone processor that works with any audio processor, any make of HD Radio 'importer' or 'exporter,' and any FM exciter. You can check it out here:

https://www.inovonicsbroadcast.com/product/808

Section III

GETTING READY

This section of the manual introduces the initial steps for getting the DAVID IV set up for operation, and discusses certain implications of the many audio processing adjustments. Please refer back to the previous section for information on the physical interconnection of the unit with other station equipment.

In all discussions of DAVID IV operation, we assume the general signal-path order indicated by the Block Diagram on Page 10. As stated in its own introduction, the Block Diagram does not necessarily reflect the actual signal path or even the real order of audio processing stages.

Most setup and operating instructions are going to assume use of the Web interface, rather than the more laborious front-panel menu and jog-wheel knob. Not only is the Web interface faster and easier (entering text, for instance), but some firmware setup functions are adjustable only through the Webpages.

Nevertheless, very nearly anything that can be done through the Web interface can also be set or adjusted from the front panel. There are differences between the two menu structures, but both menus are quite intuitive, and a full listing of the front-panel menu tree can be found at the back of the manual on Page 55. Manual text will make mention of any major discrepancies in the appropriate places.

USER ADJUSTMENT GROUPINGS

Setup Adjustments

Setup adjustments are those performed as the unit is placed in service and then largely left alone. These include input/output gains and levels, networking and security settings. *Setup* adjustments are more relevant to the hardware aspect of the DAVID IV, not to be confused with processing presets.

Setup adjustments are automatically saved in non-volatile memory as they are made. They are relevant to the specific installation and should be the dominion of the engineering staff.

Processor Settings

Processing *Presets* (all settings related to processing) will determine how the station sounds, as opposed to the technical considerations of modulation, subcarrier injection, etc. Responsibility over these subjective adjustments will doubtless have to be shared with the Program Director or station management because of their intuitive and unassailable skill in such matters.

The DAVID IV comes with 25 *Factory* Presets and space for 20 *User* Presets. Presets are handled in more detail on Page 29, just ahead of the discussions of processor setup.

There are interactions between the two general groupings of DAVID IV adjustments. The processing sections depend on proper levels at the input, and output levels will be ambiguous unless the processing has been set up properly. Keep this in mind through the setup process, as it is arranged more-or-less in signal-path order.

Downloading and Backing-Up Settings

All DAVID IV setup adjustments, including User Presets, may be backed up as Hardware Profiles. Factory Presets are resident in firmware and do not require backup. Hardware Profile backup is explained on Page 27.

"QUICK START" TECHNOLOGY

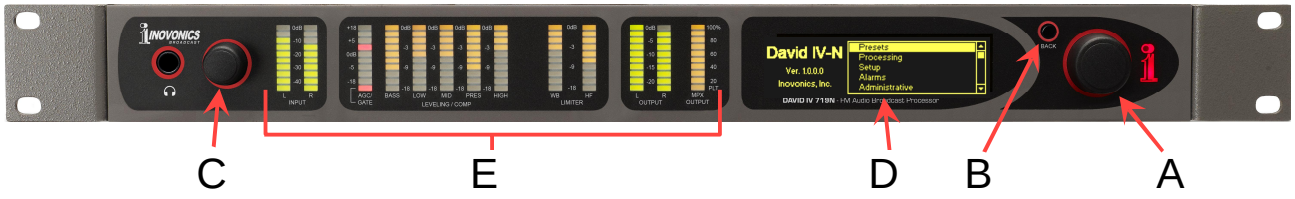
Instant Boot

'Boot' (startup) time of DAVID IV is less than one second. When AC power is first applied, or after any momentary power interruption, the unit is back in full operation very quickly. Setup and processing parameters in use previous to the power interruption are reloaded instantly from non-volatile memory.

Brownout Detection

Although the DAVID IV power supply and digital logic circuits will operate at AC mains voltages down to about 50% of nominal, the graphic display and LED readouts would fail to give consistent indications at very low mains voltages. A 'brownout' detector reboots the unit at a mains voltage somewhat below the "low-line" value given in the product specification.

THE DAVID IV FRONT PANEL



Setup values and processing adjustments of the DAVID IV are firmware-controlled. There are no jumpers, switches or mechanical potentiometers, only the front-panel jog-wheel A, Back button B, and headphone volume control C identified in the front-panel illustration above, along with the Web interface menus that will be discussed in greatest detail.

Graphic Display

The graphic display screen D presents the local-setup menu tree in an easy-to-read format. The display uses a screen saver, so when the screen goes completely dark, simply push the jog-wheel or Back button once to bring things back to life. No selection or change is made with this 'wake-up call.'

Metering

Bargraph meters E give peak-responding readouts of input and output levels, as well as AGC gain and compressor/limiter gain-reduction values.

Jog-Wheel and Back Button

Turn the jog-wheel to cycle among highlighted menu items, and then *push* the jog-wheel to select or adjust the highlighted item. The Back button returns you to the previous menu. Push the Back button repeatedly to return to the Main Screen.

Front-Panel Setup Example

For local, front-panel setup, the menus and their various levels are addressed with a 'string of commands.' As an example, starting at the Main Screen shown here, navigate to: Setup / Stereo Generator / RDS Input / RDS Injection. You do it this way:

1) *turn* the jog-wheel so that Setup is highlighted;
2) *push* the jog-wheel to enter the setup menu;
3) *turn* the jog-wheel to highlight Stereo Generator;
4) *push* the jog-wheel to enter the stereo-gen sub-menu;
5) *turn* the jog-wheel to select RDS Input; 6) *push* again to access to the RDS sub-menu;
7) *turn* the jog-wheel to position the brackets over the RDS Input Level adjustment 'slider';
8) *push* the jog-wheel to enable the slider;
9) *turn* the jog-wheel to dial-in the desired injection.

If you make a mistake (for example, you might *push* the jog-wheel off-center, which could also rotate it and bring up the wrong menu), simply push the Back button to return to the previous menu and try again.

Menu Timeout and Screensaver

Once you've made an adjustment, either press the Back button until you return to the Main Screen, or simply leave any current screen showing. After 30 seconds, the current screen will 'deselect,' meaning that the knob will no longer execute an adjustment command without that command once again being selected.

After another couple of minutes the screen will go dark. This screen-saving feature prolongs the life of the OLED graphic display. At any time, however you can press the jog-wheel or Back button to bring the dark screen to life and display the last menu accessed.

Languages

The front-panel OLED menu screen has the option for text in English, Spanish or Portuguese. From the default English-language Main Screen select Language. *Turn* the jog-wheel to position the brackets and *push* to check the box appropriate to your language selection.

The Web interface is English-only, but Google Translate works like a champ.

CONNECTING TO THE DAVID IV

LAN Setup

Without a doubt, initial setup is best done with a PC, as mouse-and-keyboard options for navigation and for adjusting things is more precise than the touch screen of a tablet or phone.

The DAVID IV and the setup computer should both be connected to the same local network for setup.

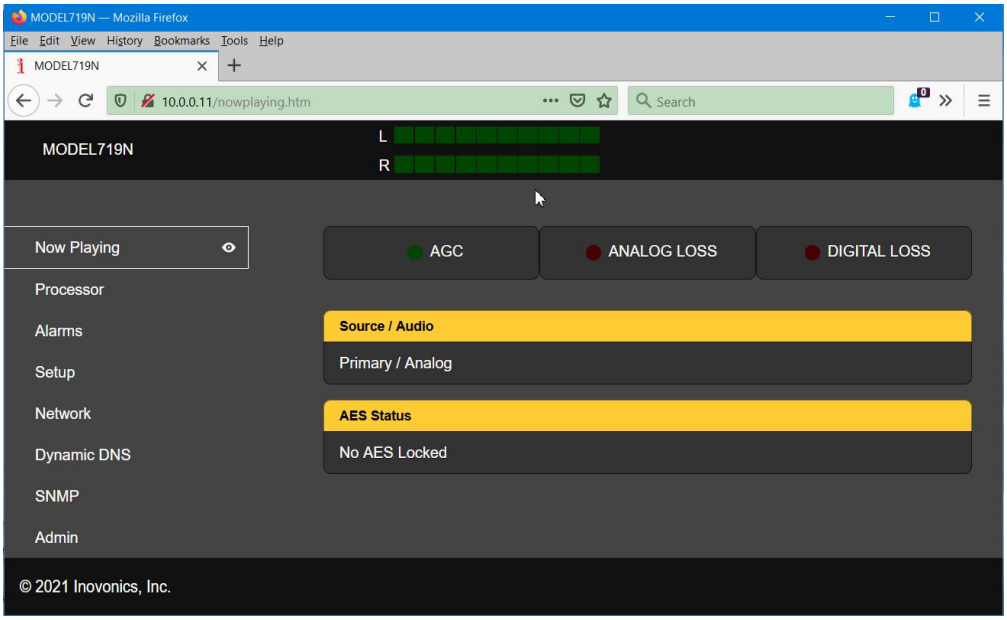
IP Address and DHCP vs. Static IP

From the front panel of the unit, use the jog-wheel knob to navigate to: Setup / Network / IP Settings to reveal the IP address of the DAVID IV. In this example the router has assigned an IP of 10.0.0.11

The factory default networking mode for the DAVID IV is the ☒ DHCP (automatic assignment) selection shown above. If you need to assign a static IP address to your unit, check the ☐ Static IP box, either through front-panel selection or using the Web interface (easier!). After selecting a static IP, you will be instructed to enter the desired IP address and associated information.

Connecting

Next, open a browser window on your computer and enter the IP address of your DAVID IV into the Address Bar. The Now Playing Webpage should pop-up on your screen.



As already suggested, the Web interface Webpages are clearly a more efficient means of controlling the DAVID IV. Because of

differences between the front-panel and Web interface menu trees, you may have to search a bit when using the jog-wheel knob, but almost all settings available on the Webpages can be made from the front panel as well. Any major differences will be addressed in the discussions.

THE NOW PLAYING PAGE

Now Playing is the DAVID IV home screen. At the very top you'll find product ID and a bargraph readout of the processor input level.

Other Webpages (menu headings) for the unit are listed along the left side of this and every other Web screen. Click on any heading to go to that setup page.

Only the Now Playing and the Admin Webpages are discussed in this section of the manual. The other Webpage menus, those that have earned more-in-depth setup instructions, has its own manual section.

Product ID MODEL719N is the factory-default IT-language "Hostname" identifying this particular unit on your network. You can actually enter the Hostname in the address bar of Windows browsers to launch the Web interface. This name can be changed on the Network setup Webpage, which you may wish to do if you have more than one DAVID IV on your LAN.

Input Level Meters The bargraph display at the top of the screen is a peak-responding meter at the input to the processor section. This meter appears at the top of every Webpage. Like the front-panel L/R INPUT LED display, it shows the input level applied to the input of the processing section in 5dB steps, from 0dB to –45dB. A steady-state tone at –20dB will approximate a "zero-VU" *average* program level and drive the AGC stage to the center of correction range.

Indicators Three virtual LEDs beneath the level meter indicate aspects of DAVID IV operation.

The AGC indicator lights when the AGC gate is open; that is, when normal programming is active. It will close during brief pauses, but should normally be glowing green.

ANALOG LOSS and DIGITAL LOSS glow red when the respective program signal disappears from that input. These indicators are tied to alarm functions, and parameters for these alarms, plus the failover option between inputs, are set on the Alarms Webpage or under Alarms on the front panel meu tree.

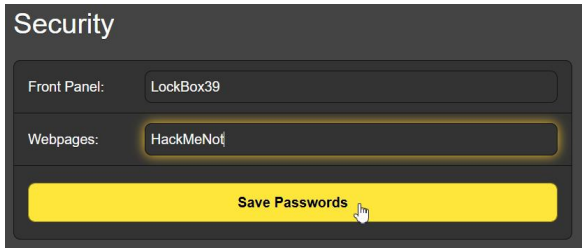
Program Input

The first information panel under the alarm indicators shows which program input source, analog or digital, is currently feeding the DAVID IV. The lower panel displays the incoming AES digital audio sample rate when AES audio is connected, whether or not the digital input is currently feeding program to the unit.

THE ADMIN PAGE

Security and Passwords

Anticipating that well-meaning coworkers (or station hackers!) may wish to 'assist' (or do mischief!) with your audio processing, we've included password protection, both for local, front-panel operation of the DAVID IV and for remote network connection to the unit. When settings have been protected by a password, that password must then be entered before any subsequent changes can be made. Passwords independently lock front-panel (jog-wheel) and/or network control over the processor.



Bring up the Admin Webpage, and under Security simply type-in passwords for Front Panel: access and/or Webpages: (network) access to the unit. You can of course use the same password for both, or enter just a network or just a front-panel one. Don't forget to write these down somewhere, and then click Save Passwords. To remove a password, simply clear the box and save.

If you now try to navigate away from the current Admin page, you'll get an error message. When you close your browser and try to reconnect, you will be prompted to enter your Webpages: password. If your browser asks for a Username as well, simply leave that box blank.

From the front panel, highlight Security on the Administrative Settings menu and push the knob. Just as described above, you'll find two boxes to put in passwords. *Push* and *turn* the jog-wheel, and then *turn* and *push* to make the entries, using uppercase and lowercase alphabet, numbers and any punctuation marks shown, up to 31 characters. Use Backspace to correct, and Save to enter the password(s) into processor memory.

The DAVID IV will lock any time the screen times-out and goes dark, about two minutes after the knob is left untouched. It may also be locked immediately by holding down the Back button for a few seconds.

Once the DAVID IV is password-protected it prompts you to enter the password before any menu can be accessed and any adjustments made. After entering the password, highlight: Done and *push* the knob. This will be necessary each time the unit is awakened from a dark screen. To obviate this nuisance when dealing with extended tests and setups, use Backspace to clear the password and then exit the menu with a Save. Now the unit is NOT password-protected for local operation, but you can simply reenter the original local password when you've finished.

WARNING: Local and Webpages passwords are accessible to others when the unit is unlocked. Keep in mind that if you do *not* protect the front-panel with a password, then your networking Webpages password can be made visible to anyone with access to the physical DAVID IV.

Lost Password (Hard Reset)

To recover control of the DAVID IV if the password is lost, you must do a "hard reset" of the unit. This can only be done *in situ*. You must hold-down the Back button as you power-cycle the unit (disconnect and then reconnect AC-mains power).

WARNING: A hard reset deletes not only the password, but will also return the DAVID IV to factory-default setup values. ***User Presets, your current on-air processing setup and in/out level settings will all be lost!*** Be sure to keep a backup of the DAVID IV Hardware Profile (all settings) on your computer. We discuss this procedure shortly.

OLED Display Brightness

The front-panel Administrative menu also has an OLED Brightness slider. The user may set the brightness of the graphic display from the 50% default value to a higher or lower setting as desired. We don't recommend a higher setting because there is little visible difference between 50% and 100%, and a high setting might shorten the life of the OLED graphic display. A lower setting may actually appear a bit sharper, kinder on the eyes and even romantic in the subdued lighting of a snowy mountaintop transmitter building.

The Hardware Profile

The DAVID IV Hardware Profile is a small text file that you can download from the processor to your computer. The file includes the settings of input and output levels, mode options, and your own audio processing User Presets. Factory Presets are resident in the firmware.

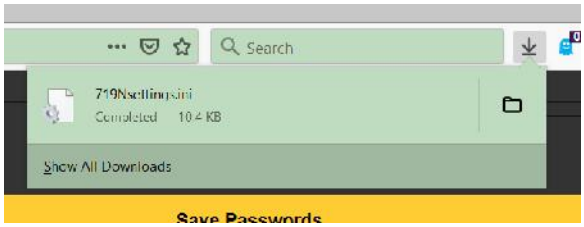
If you should need to restore your DAVID IV to factory defaults for some reason, perhaps share settings with others in your broadcast group, or clone another DAVID IV, this little file can save you a lot of time and trouble. It's a quick and easy procedure, and should be considered *de rigeuer* whenever you up-

date processor settings, change-out exciters or otherwise revise any adjustments.

Downloading (Saving) the Profile

1) In the Hardware Profile section of the Admin Webpage, click Download Hardware Profile. Your browser will probably ask whether you want to Run or Save this file. Save it.

2) In this example, the Foxfire browser for Windows saves this file to the computer's Downloads folder. From there you can drag it onto your Desktop or to a dedicated folder created for such things. Saved settings are in plain text and may be viewed directly with Windows Notepad or equivalent. The file must be saved with a name that carries the .ini extension like the default 719Nsettings.ini.

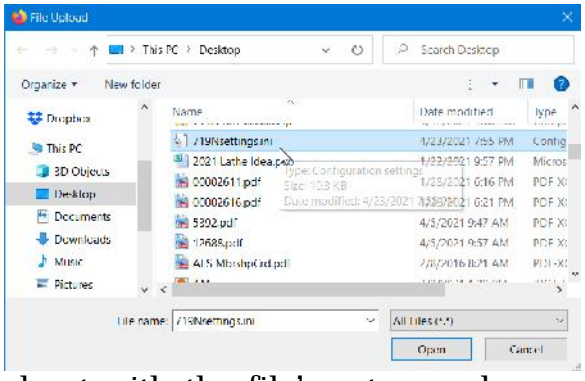


Uploading a Profile

1) In the Hardware Profile section of the Admin Webpage, click Select Hardware Profile. You'll be directed to locate the file that you previously downloaded and saved. In this example the file had been saved to the Desktop.

2) Double-click or select and Open the file. You'll see the file name populate the Select Hardware Profile bar on the Admin screen.

3) Click Upload Hardware Profile. The file will be uploaded to the DAVID IV, which will then reboot with the file's setup and operating preferences.



About

At the bottom of the Admin Webpage, and in the About section of the front-panel Administrative menu, you'll find the firmware and Webpages versions resident in the DAVID IV, along with the serial number of your unit.

IMPORTANT: For proper operation of the Web interface, the Firmware Rev: and Webpage Rev: numbers *must be identical!*

The updating procedure is described later in the manual. The Webpage also has a link in this area to check for new versions of firmware.

Section IV

PROCESSOR SETUP

PROCESSOR PRESETS

The DAVID IV comes with 25 thoughtfully-crafted *Factory* Presets that cover a wide range of programming genres. You are free to modify any of these and save them as your own *User* Presets, up to a total of 20 additional ones in fact, leaving the Factory Preset you started with intact. If this is a new, out-of-the-box installation of your DAVID IV, we recommend listening to and selecting one of our Factory Presets to begin you processor setup journey.

User Presets are saved in the Hardware Profile, along with basic level and other more-hardware-related settings. Be sure to make a fresh backup of the Hardware Profile after creating or changing any User Preset (or other adjustment!).

Selecting Presets

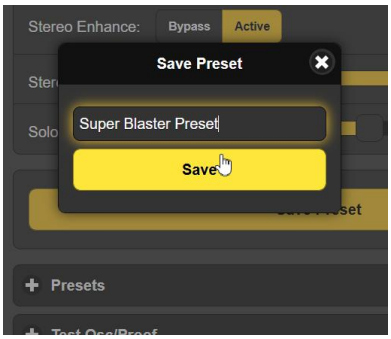
Bring up the list of Presets for processor settings by clicking on + Presets at the bottom of any Processor Webpage.

In the list that pops-up, the 25 Factory (F) Presets come first. Click on one and it will be on-air immediately. This selection may be automated using SNMP as well (see Page 49).

Note the 20 slots marked (Empty) below the (F) Factory Presets. These are the spaces for your User Presets. These will populate from the top of the Empty listings downward as you save your own.

Creating, Managing and Saving Presets

User Presets are created by changing existing (F) Factory Presets. Once you home-in on a sound you like, fine-tune it as will be discussed shortly, then name-and-save it as a User Preset. Just scroll down to the bottom of any Processor Webpage to find the yellow Save Preset bar. Click this bar to bring up the box shown here. Type-in a name for your User Preset. The processor setup currently on-air at the moment you click the Save button will become a User Preset resident on the list.



User Presets may be deleted by clicking on the big **X** to the right of the User Preset name. Factory Presets are resident in firmware and cannot be deleted.

SELECTING THE INPUT

Inputs

The DAVID IV has both an AES3 (stereo) digital input and individual left/right analog inputs. Either set can serve as the program input to the unit, and the selected input is shown on the Now Playing Webpage. Characteristics of these inputs are discussed in the Specifications pages and in Section II of this manual.

Inputs are selected and level-adjusted on the Setup Webpage and under the corresponding Setup / Audio Input front-panel menu.

SETTING INPUT GAIN

Importance of AGC Action

The DAVID IV has an intelligent dual-slope 'windowed' AGC (Automatic Gain Control), a long-term 'gain-riding' utility to normalize input levels between sources and individual songs. AGC capture range is ±18dB, meaning that the input signal can wander aimlessly over this 36dB range and be automatically corrected to the proper level for subsequent processing stages. AGC gain is shown in the bargraphs that headline each Processing Webpage and by the front-panel LED bargraph display.

AGC has been designed for symmetrical correction around a resting-point of 0dB, or unity gain. It will bring up lower levels and pull down higher ones at the selected correction rate. AGC action is 'gated' to freeze the gain during brief program pauses, returning it to the 0dB resting point during extended periods of silence. The Now Playing Webpage and front-panel gate indicators glow when the gate is 'open,' AGC active, and dark with no valid input signal.

AGC is considered a processing parameter of the DAVID IV, but one that, by design, does not really make a contribution to the station's "signature sound." The sole purpose of the AGC is to normalize levels ahead of the other processing stages without adding coloration. This is possible only with a wideband AGC, which should always be the first stage in any comprehensive audio processing system. "Multiband AGC" is a misnomer. Long-term *leveling* in individual frequency ranges may have utility in some instances, but this still amounts to spectrum-shaping, a subjective parameter. Using multiband AGC to normalize levels from diverse sources or to correct for sloppy operators is analogous to turning the listening volume in your living room up and down using the individual sliders of a graphic equalizer.

DAVID IV AGC gain is based on both the peak and average energy content of the program signal. Regardless of changes you might want to make in AGC operation for a specific need (this will be addressed later), check that the AGC is set to factory defaults during setup of input levels. Check under Processor

headings to confirm that the AGC is active, with a correction rate of 1.75dB/sec, a (maximum) AGC Gain of +18dB, and a Window setting of 6dB.

Test Tones ...or Not?

Although a "zero-VU" test tone may certainly be used during DAVID IV setup, input gain is most accurately set with actual program material. Here's why.

Audio levels are typically measured and monitored in any of several different manners. The traditional US mechanical "VU" meter and the European "PPM" (Peak Programme Meter) each adhere to audio industry measurement standards based on exhaustive studies. But there are many knock-offs and alternative level-indicating gizmos in use as well, few of which have traceability to any recognized standard. Substandard meters may have floppy mechanical movements or take the form of flashy LED and other bargraph readouts, or they can be fancy and colorful computer screen displays.

But compliant or not, all these devices have their own response to, and provide their own representation of, program peak and average levels; that is, program dynamics. What's more, board operators lend their individual interpretations to what they see, assuming that they are even paying attention to meters in the first place.

Adjusting Input Gain

From the Setup Webpage, or with the Setup / Audio Input front-panel menu, grab the slider for whichever input you have selected. With program material playing, adjust the appropriate Digital Gain (dB): or Analog Gain (dB): slider so that the AGC bargraph readout hovers around 0dB most of the time.

NOTE: This is a bit more tedious using the Web interface because you must toggle back and forth to the Processing Webpage to see the results of your actions in Setup. Take your time.

The DAVID IV AGC is a slow gain-riding function with a dual correction rate. Don't rush this process as there will be some delay before the AGC meter settles-down each time the slider is adjusted. Once the input level has been adjusted to keep the AGC hovering around 0dB, you'll know that AGC action is more or less centered and working in its 'sweet spot.'

There will, of course, be a range over which the AGC wanders; it is not realistic to expect the bargraph to sit right at the 0dB mark all the time. But over an extended period the indicator should spend about as much time above 0dB as it does below.

If you have used a 'zero-VU' tone from your console for input gain setup you will probably need to correct the setting once you're running actual program material. With the exception of studio-smashed (over-processed) pop music, the average-to-peak ratio of a test tone is lower than that of natural, unprocessed speech and music.

The dB gain numbers shown beside each input gain slider are handy for reference and have been scaled so that 0dB equates to the program *average* level at nominal studio line level figures. This might be +4dBu for analog inputs or –20dBFS for digital feeds. For example, a well-tempered +4dBm program line would suggest an Analog Gain (dB): setting of –4.0dB, and digital program levels with a typical headroom allowance of 20dB (relative to 0dBFS) would need a Digital Gain (dB): figure of 0dB. Again, the scaling holds true more for actual program material than for steady-state tones.

THE HIGH-PASS FILTER

Subaudible Noise

The DAVID IV is equipped with a steep high-pass filter to lessen the modulation-robbing effects of unwanted subaudible program audio components. The term 'unwanted' is the keyword here, as "mega-bass" seems a mandatory part of any car audio installation, and a "big bottom-end" characterizes the sonic signature of nearly all contemporary music stations.

The high-pass setting is found in the Processor menus. The front-panel OLED menu actually animates the filter action with a stylized representation of the cutoff characteristic.

This filter is a 4th order (24dB/octave) high-pass, which may be set for a turnover frequency (–0.15dB point in this case) between 20Hz and 65Hz. The factory default is 20Hz, which is probably a valid setting for any music format, unless you have severe turntable rumble (say, what?), noisy studio air conditioning, do a lot of outdoor sports remotes in windy stadiums, or have creditors pounding on the front door.

This high-pass function has been included in the DAVID IV design to define a low-frequency limit to the station airchain. But the use of this high-pass filter should generally be considered a Band-Aid® fix for problems that are best addressed at their source.

OPTIMIZING "WINDOWED" AGC ACTION

Actually, factory-default settings, the ones used for the preceding setup process, should work pretty well for nearly any broadcast format. But there may be instances where they might want to be changed.

Defeating the AGC

Turning AGC: Off (☒ Bypass on the OLED) is never a good idea in everyday operation. The AGC presents downstream processing stages with an input signal optimized for further processing. AGC has been carefully engineered for intelligent response to program material, taking into account both the peak and average values of the audio signal. The only justification for turning AGC off is for test purposes, or if the user is 100%

confident that the board operator is diligent and knows his stuff. Even in the latter instance, trust the AGC to know best what the downstream processing stages want to see.

AGC Maximum Gain

Classical music and jazz are two genres that often have wide level variations that beg to be preserved. *Pianissimo* classical passages and a standup-bass solo are two examples. In these instances, a normal configuration of the AGC stage would slowly bring up these passages to the 100%-modulation point, which would not sound right at all.

The AGC Gain (dB): slider is generally kept at +18.0 to allow full AGC action, and this is just fine for the majority of today's programming. But, if you want to limit the amount of *positive* gain that the AGC can impart to the program input, this slider can be adjusted anywhere between +18.0 and 0.0. This does not change the static, 'resting' gain of the AGC section, nor does it limit the amount of negative gain that the AGC can introduce for inputs that are too loud. AGC Gain (dB): only limits how far the AGC can bring up low-level material. Experiment with settings for formats that call for a wider dynamic range.

'Windowing' and the AGC Correction Rate

The DAVID IV has a 'windowed' AGC. It has one correction rate when AGC gain is close to the target value, and a faster, 'makeup' rate when the incoming program level shifts abruptly.

The AGC Window (db): may be set to any figure between 0 (no window) and 12, 12 meaning ±6dB. With the window set for the factory-default value of 6, if the input signal wanders ±3dB or less from the present corrected value, any small required correction is a very unobtrusive 0.5dB/second. However, if the input signal suddenly blasts or takes a big dive, the correction rate then increases to whatever figure has been set by the AGC Rate (dB/sec): slider… say 2dB/second, which is four times faster. If the Window slider is set to 0, the windowing function is essentially defeated, and *all* AGC action will be at the speed set by the AGC Rate (dB/sec): slider. This accelerated makeup-gain rate is adjustable between 0.50 dB/sec, which is quite slow, to 3.00 dB/sec, which is pretty darn quick.

With AGC Gain (dB): fixed at 0, the AGC Window (db): set to 0, an AGC Rate (dB/sec): setting of 0.50 might prove a proper choice for a classical music format where extended *pianissimo* passages want to remain below *mezzo-piano* ones, *forte* passages then calling for a modicum of compression.

Alternatively, AGC could be turned completely off in such a case, assuming that the classical Boss-Jock knows the music like the back of his hand and can make judicious artistic manual corrections on the fly, watching his meters with nary a blink.

A fast rate with a mid-value window might be just the ticket in an aggressive pop-music format. Even with this setting, AGC in the DAVID IV shouldn't alter the perceived dynamics of the

program, although it will definitely erase longer-term level variations in a hurry.

Some settings might allow AGC action to be audible in speech, during a talk-show segment for example, but not during musical programming. You might want to experiment with various AGC rates using program material representative of your format. The default settings work quite well in most situations.

STEREO ENHANCEMENT

The DAVID IV has a twin-action stereo enhancer with provision to turn the enhancement effects on and off, plus two sliders that control action of this feature. The front-panel OLED actually depicts the action of these features graphically, as will be shown below.

Stereo Width The Stereo Width: slider increases the perceived width of the soundstage, which is the area between the listener's left and right loudspeakers. Increasing Stereo Width: will make the stereo 'wider,' exaggerating the stereo effect even to the point of its appearing to extend outside the confines of the normal soundstage; that is, to the left of the left speaker and to the right of the right one.

As the control is advanced, the front-panel OLED graphic display will highlight an area outside the normal soundstage as shown here. The shaded area, as well as the number shown below it, is somewhat arbitrary, serving only to illustrate what's intended and to give a number for setup reference.

Stereo-width growth is active only on stereophonic program material, it does not imply any sort of stereo synthesis from a monaural source.

Solo Width The Solo Width: slider, on the other hand, acts only on center-channel (monaural) program components.

Contemporary music is typically recorded in very sterile multitrack sessions. Generally, each instrument has its own microphone (or several!), and these mic channels are recorded as individual monaural tracks. In post-production, the recording engineer, under the skilled and unquestionable guidance of the session's Producer, uses a 'pan pot' to place each track somewhere between full-left and full-right, essentially creating a pseudo-stereophonic soundstage, or sound field. Vocal solos are almost always panned dead-center, just like the talent mic in the radio studio.

As Solo Width processing is introduced and increased, the centered vocalist (and on-air talent) will appear to 'spread' across the soundstage. This is illustrated on the front-panel display as

shown here. Just like the stereo width enhancement, the lighted area in the OLED and numbers in both locations are arbitrary and relative.

Use this enhancement technique with some caution. A hawker of toilet tissue who seems to fill the listener's automobile may be a bit intimidating to driver and passengers alike!

Stereo enhancement effects can be subtle, depending in large part on program source. In making these adjustments, switch between Active and Bypass in judging the action. This will make changes more clear than simply moving the sliders back and forth. Keep this in mind also: seasoned broadcast engineers concur that overuse of stereo enhancement techniques exacerbate FM multipath effects… and make them worse, too!

THE FIVE-BAND 'MULTIPRESSOR'

The heart of DAVID IV's dynamics processing is the 5-band Multipressor (Multiband Compressor). This processing block divides the program audio into five discrete frequency bands with nominal crossovers and filter slopes optimized for each range of frequencies. Each band undergoes dynamic range compression, with the threshold, waveform response and transfer function engineered for the most effective action within each band.

Optimum Multipressor parameter settings were derived from exhaustive tests by a core of listeners comprising both technical and non-technical types, including those with extensive musical training. Many of these parameters are fixed, as providing user control over the thousands of parameter permutations would make setup a veritable nightmare… not the objective of this product. Some parameters, those that most readily define 'sonic signature,' have been made available for user adjustment over a reasonable range.

Compressor Drive

Master Drive (dB): varies the total signal level going into the DAVID IV multiband compressor section. The setting of this control determines how hard the compressor will work, overall, and to a large extent how 'busy' or dense the program will sound. Incidentally, density is only one factor affecting perceived loudness. Additional discussions on the subject of loudness follow in due course.

Master Drive (dB): has been afforded a very wide range. At the minimum setting of 0dB, program material may not even 'tickle' the compressors, giving no visible indication of gain reduction (G/R) in any band. Advanced all the way to 30dB, all five bands will probably be dancing down close to the bottom of the bargraph displays.

A proper setting for Master Drive (dB): will probably be somewhere near the center of its range. Indeed, the factory-default setting is 15dB, although individual Factory Presets will have varying values for specific formats. Generally, a lower setting is called for with classical, jazz and 'easy-listening' formats, and a more aggressive setting for pop/rock.

Spectral Loading™

The greatest audible effect of multiband processing is realized when each band operates independently of the others. Of course there is some duplicity at the band crossover frequencies, but fully independent operation of each band will increase 'spectral density.' This means that it will tend to maximize the energy at all frequencies, even if the incoming program material has a 'peaky' (varied) spectral profile. We have named this effect 'Spectral Loading.'

A good way to understand this is to imagine the input program profile as seen on a real-time audio analyzer, or RTA, which displays audio energy at specific frequency intervals across the audible spectrum. Solo voices and instruments will have high energy levels at their fundamental frequencies, whereas a band or orchestra will have a broader spectral profile with energy spread over a wide range of frequencies.

The Spectral Loading process *decreases* energy at frequencies where it is the greatest, thus actually *increasing* program components with lower energy at other frequencies. As displayed on the RTA, the shape of the audio spectrum will be flatter and the sound of the program will appear 'busier.' Spectral Loading almost always imparts additional 'brightness' to the sound, as higher frequencies are typically lower in total energy and will be brought up.

Band Coupling

One element of control over loudness and the sonic signature of a station is to establish the degree to which multiband processing is used. Fully independent operation of the bands will create an artificially busy and bright sound that may not reflect the desired signature goal.

The DAVID IV allows the user to proportionally 'link' the five bands, allowing the unit to serve as a compressor that's effectively variable between five bands and one band.

But full linking does not really turn the DAVID IV into a true, single-band processor. Each band is still able to respond independently to peaks in program energy within that band's range. When bands are coupled the amount of *average* compression in bands 2, 3 and 4 is integrated over time and used as a 'platform' release value for all five bands. Band 1 is excluded in the integration, as the high bass energy in modern music must not be allowed to reduce the gain of other bands, lest a kick drum 'punch holes' in the audio.

The Coupling (Linked-Indep): slider on the Compressor submenu gives eleven levels of band coupling, from zero (fully linked) to

10 (fully independent). The factory-default value is 5, midway between the extremes, although the various Factory Presets will have varied settings. Use your ears with this slider to determine how 'busy' you want the audio to sound.

PROGRAM EQUALIZATION

Not surprisingly, the same 5 Multipressor bands are the basis for a 5-band graphic equalizer that enables static equalization control over the program's spectral shape.

The 5 Bands Defined

The five DAVID IV bands are labeled: Bass, Low, Mid, Pres and High. Although we have afforded some user adjustment over crossover frequencies, bands have these nominal boundaries:

Bass The really deep bass frequencies that are generally lost without a good subwoofer.

Low This range would be perceived as 'bass' on radios with puny speakers and covers a range that includes male voices. Excessive energy in this band tends to make the program sound 'tubby' or 'muddy.'

Mid This is the 'articulation' region, pretty much smack-dab in the center of the audible range. Female vocals and the 'melody' in music reside here.

Pres 'Presence' frequencies are responsible for brightness, aliveness, immediacy and closeness… the effect that the program source is live and up-front.

High Frequencies above the presence range contribute to the qualities generally dubbed 'sparkle,' 'crispness,' 'tinkle' and 'air' in the program audio.

The five EQ (dB): sliders are simply level controls in the outputs of the five bands where the spectrum is recombined. Use these EQ sliders to craft the general shape of the station's sonic signature. You've got to use your ears for adjusting EQ and for making decisions regarding Multipressor drive and band coupling. The factory default for EQ sliders is a flat setting of 0dB in all bands. Factory Presets, on the other hand, will show these controls in positions that complement the selected format.

Multipressor Crossovers and Time Constants

The Crossover / AR submenu is a sort of a mysterious 'gray area' in the multiband compressor setup routine. These, like other settings, have been optimized following hours of critical listening and endless experimenting. You really need to take time and thought when departing from factory-default values. Other than this warning, additional guidance in the matter is really beyond the scope of this manual. Please study, learn and understand what you're attempting and exercise caution.

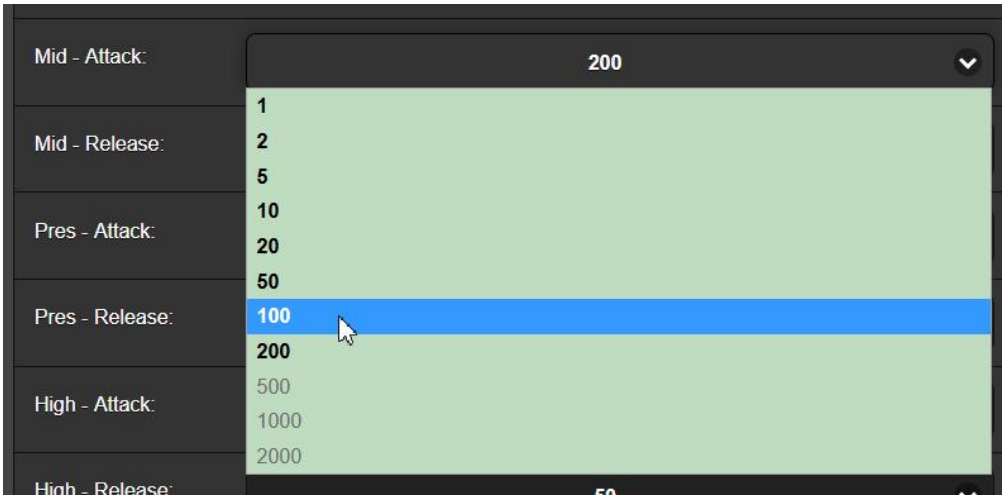
Crossover Points

The crossover frequencies for the 5-band Multipressor are variable over an octave's range, a 2:1 frequency ratio. Here is a screenshot of that setup area that shows basic factory-default values smack-dab in the middle of the range. Factory Presets may depart from these mid-value settings.

Compressor Attack and Release

Attack and release time constants for each of the Multipressor stages are variable over the very wide range of 1 millisecond to 2 seconds. Clearly there is great danger of creating objectionable distortion and processing artifacts if these settings are not selected with great care. Thus we urge most users to leave these settings at, or near, the values within the ranges that are defined by factory processing presets. You can pull this Webpage up and check what the current preset values are at any time. Remember, if you mess with these and get into trouble, just go back and choose a factory processing preset to reset these time constants to safe figures.

Each band has independent Attack: and Release: drop-down menus where the values can be changed. However, release times can never be shorter than attack times and, *vis-à-vis,* attack times cannot be longer than release times. This is illustrated in the screenshot below. Grayed-out numbers cannot be selected; time constants that are not compatible are locked-out.



If you find that you cannot set an attack time to a higher (slower!) value that you'd like to try, check the associated release time. You will have to set the release to a larger (slower) number before you will be allowed to increase the attack to the number you want to try.

Although the Multipressor sections are r.m.s. responding, a short attack time will cause the compressors to act more like peak limiters. A shorter release time will increase program energy in that band, but may also cause audible distortion due to sidechain self-modulation.

FINAL NOTE: We don't offer any hard-and-fast rules for choosing crossover frequencies and time constants, nor do we even proffer educated suggestions. These adjustments are very subjective and can easily open the door to really, really bad-sounding results. You are on your own. Our only word of advice is to return to the thoughtful and conservative factory values we endorse if you start hearing something you don't like. Bottom line: don't mess with these if you have questions or reservations about what you're doing!

BASS EFFECTS

The DAVID IV offers two separate and distinct options for augmenting deep-bass content in the program material.

DAVID IV bass-enhancement algorithms utilize compression, expansion, soft and hard clipping, intermodulation generation and sidechain re-modulation techniques. This processing is purposely conducted in the monaural (L+R) domain to optimize the effect and to prevent creation of stereo-difference energy at these low frequencies.

NOTE: Because bass enhancement is performed in the monaural domain there is indeed a compromise in stereo separation at very low frequencies. If system measurement specifications or your purist musical objectives make such a compromise (at low frequencies only, mind you) offensive to you, leave Bass Effects: set to Bypass!

'Punch' and 'Rumble'

Punch is that 'thump' that tries to rip the cone out of your speaker… the tight bass line that hits you in the chest. *Rumble*, on the other hand, refers to a pervading deep-bass line that seems to just sit there under the music, providing a sort of submelodic 'drone.'

The two sliders, Bass Punch: and Bass Rumble:, allow for individual adjustment of bass effects. Each control may be set between 0 (off) and 10 (maximum). In setting these, let your ears and your conscience be your guide. Despite the desire for that solid and pervasive 'bottom-end,' resist the temptation to run both these controls to the max. And when setting them, for-

sure listen with monitors that can reproduce the affects you are dialing-in!

Another tip is, like the Stereo Enhancement utility, use the Bass Effects: Active/Bypass switch to preview the action of this feature.

There is one caveat with respect to the bass enhancement section, one that is hinted on the Block Diagram (Page 10). Bass effects are added back into the multiband mix at the input to the peak limiting section, bypassing the Multipressor. 'Enhanced' bass energy will not be subject to compression before it hits the peak limiting section, and huge amounts of bass may cause some degree of broadband-limiter 'ducking' as a result. Listen for this and trim your adjustments accordingly.

PROGRAM PEAK CONTROL

Broadband and HF

The broadband peak limiter acts on program audio that is delivered to any of the unit's outputs, whether it's a flat, 20kHz signal for digital broadcasting or other full-power-bandwidth application, or for FM transmission. But FM transmission requires additional processing to restrict energy in the pre-emphasized portion of the spectrum. This is provided independently by the adaptive pre-emphasis stage that follows the broadband limiter, and is active only for FM transmission.

Broadband limiting and adaptive pre-emphasis will be discussed separately.

BROADBAND LIMITING

PIPP* Limiting

PIPP* is an acronym for *Polarity-Independent Peak Processing*, Inovonics-patented and proprietary technology used in both analog and digital processing products from our firm. This is a function that can be turned on or off by the user and, when it is disabled, the DAVID IV peak controller behaves much like any contemporary "lookahead" limiter.

In the PIPP* mode, the program audio waveform is split into positive-going and negative-going components. Each half of the waveform is then independently limited to a peak value that corresponds to 100% carrier modulation in its respective direction, and then the two components are recombined. The purpose of this somewhat roundabout exercise is to maximize carrier modulation regardless of waveform asymmetry.

The initial response to this elementary explanation is generally one of astonishment that such a degree of "distortion" would deliberately be introduced, much less tolerated. Please allow us to debunk this knee-jerk reaction.

The only truly undistorted audio waveform is a pure tone, a sine wave. A sine wave is inherently a symmetrical waveform with the positive and negative halves mirror-images of one another. The PIPP* limiter would divide, limit and recombine these halves to create a spitting image of the original: an amplitude-limited symmetrical sine wave with no added distortion components.

An asymmetrical program waveform, notably speech, vocals or a solo musical instrument, will demonstrate a 'peaky' nature in either the positive or negative direction. This is due to the addition of natural overtones (harmonics) that assign the source its distinctive 'sound' or timbre. The PIPP* limiter will hold the peaky side to the 100%-modulation point, and will 'expand,' or increase the amplitude of the companion, opposite polarity until it also reaches the 100%-modulation limit.

This implies that the waveform, which by definition is already "distorted" with natural harmonic content, will be further distorted by the PIPP* limiter. This is technically accurate; a solo saxophone will sound more saxophone-like and speech or solo vocals will exhibit a slight 'edge' or character. But pop music and other program material that contains a plurality of instruments and vocals will have less asymmetry and will be less affected by PIPP* limiting. Anyway, there's an option to turn this novel feature off if you are a purist or otherwise don't buy into any of this.

Lookahead Limiting

The DAVID IV broadband limiter is a *lookahead* limiter, acting to reduce program peaks essentially before they reach it. No, this limiter is not a member of the Psychic Friends Network®, it simply introduces a short delay in the signal path so the limiter can sense a peak and reduce gain before the peak actually comes along. The delay is only a couple of milliseconds, but this practice prevents flat-top-clipping of the program waveform during the limiter's initial gain-reduction 'attack.'

Avoiding flat-top-clipping through the use of lookahead limiting eliminates short-term (transient) intermodulation distortion (TIM) of the program audio. Clipping, whether hard or soft, is generally to be avoided in flat-power-bandwidth transmission, but can be used with some degree of success in pre-emphasized systems like FM broadcasting. More about this later.

ITU, Normal or PIPP* Limiting?

Under the Limiter heading on the Processor Webpage, the choice of which Peak Limiting: option to use is yours.

The first offering, ITU, is a special-purpose limiting mode that ensures compliance with a broadcasting standard practiced in certain European countries. This mode is important to European broadcasters and will be discussed in detail under the next subheading.

Action of the PIPP* limiter has been described above, and whether or not to use this mode will be predicated on how par-

ticular program material sounds to you, which of course also depends on the setup of other processing parameters.

To be on the safe side, you may initially elect to proceed with DAVID IV setup using the Normal limiter selection that does not include our controversial 'waveshape-symmetry management' technology, and then assess any advantage (or not) by switching back and forth between Normal and PIPP*.

Limiter Drive

The Limiter Drive (dB): slider sets the input level to the broadband peak controller section to determine how hard the limiter will be working. Much like the Master Drive (dB): control of the Multipressor section, this slider has been given a range far greater than required, so that the effect of essentially no limiting vs. a very great amount of limiting can be sampled and judged.

Actual limiter gain reduction (G/R) is shown in real time by the Webpage and front-panel bargraph displays. Limiter G/R will also be influenced to a lesser degree by Multipressor settings, so Limiter Drive (dB): should be adjusted *after* the Multipressor has been roughed-in for the desired spectral makeup of the station's signature sound.

Carrier modulation will top-out at the 100%, full-FM-deviation point when any degree of G/R is indicated by the Limiter WB display. So, generally, the more G/R that is shown, the more consistently program *peaks* will hover right at the 100% mark. Obviously, a high-energy rock format would justify a higher level of Limiter Drive, perhaps in excess of 10dB, and classical or jazz music should use a lower setting, perhaps less than even 5dB.

Limiter Density

While Limiter Drive (dB): forces program *peaks* toward the 100%-modulation point, Limiter Density (dB): serves a similar function to establish the *average* level (loudness) of the program.

The attack time of the DAVID IV peak controller roughly matches the delay of the limiter 'lookahead' feature. Limiter release, on the other hand, has a dual-slope, 'platform' function, with a quick release to the platform value, and then a much slower release of the platform itself. The limiter platform is based on an average of the program peak content, the working value of which is adjusted with the Limiter Density (dB): slider.

With the Limiter Density (dB): slider 'wide open' at a +5dB setting, limiter release is fast over the entire release range, imparting greatest density (loudness) to the program audio, but probably not without some audible side effects. At the minimum setting of –5dB, the limiter release characteristic assumes the platform value over the entire release range. Program *peaks* will continue to reach 100% modulation, but there won't be as many reaching that point. This reduces the *average* level of the program signal and allows program audio to retain more of its inherent dynamic range.

A proper setting of the Limiter Density (dB): control is determined entirely by subjective evaluation of the on-air sound. Density is one very important quality of the station's signature sound, and no other control has a greater effect over perceived loudness. The factory default value is a setting of 0dB, the center of the control range. There is no setting considered a wrong one, but the range extremes will probably be useful only in special situations. Use your ears and consider the long-term listener fatigue effects of very dense programming.

MULTIPLEX POWER CONTROL (BS.412-9)

The ITU 'Recommendation'

In 1998, the International Telecommunication Union (ITU), a key European standards organization, published their *Recommendation ITU-R BS.412-9*, the culmination of several years' work to study and mitigate interference between broadcast stations on the crowded European VHF-FM band.

Channel spacing, transmitter power and other assigned considerations were major factors in this study, but insofar as audio processing is concerned, the short version is that the ITU found direct correlation between FM carrier modulation and audible interference between stations on adjacent frequencies. What's more, it further found that *modulation density* was in large part responsible for this interference. In other words, not necessarily the absolute *peak* deviation of the carrier but the *r.m.s. power* of the modulating program signal integrated over a specified period of time.

The ITU *Recommendation* specifies the r.m.s. power of the composite-multiplex signal (including the stereo pilot and any audio (SCA) or data subcarriers), as measured and integrated in a 'floating' 1-minute measurement window. It states that this value should not exceed the r.m.s. power of a single-tone sine wave modulated with a peak deviation of ±19kHz.

Now, ±19kHz is just about 12dB below the ±75kHz peak deviation limit. This implies an average-to-peak ratio of the program signal that, by contemporary broadcasting standards, gives a rather pathetic showing… certainly not the in-your-face, highly-compressed dynamics that Program Directors have come to know and love(!) since the mid-1960s!

The ITU *Recommendation* has been mandatory in Germany, Austria and Switzerland since 2004, but with some latitude. Germany adheres to the letter of the *Recommendation*, "0dBr" they call it. But Austria and Switzerland are able to exceed that point by 3dB. In other words, their r.m.s. modulation is permitted to go to "+3dBr."

The DAVID IV provides compliance to the ITU standard by redefining the peak-limiting processing function when the ITU limiting mode is selected.

With ITU selected, the PIPP* limiter is defeated in favor of more conservative symmetrical peak control. Secondly, the Limiter Drive and Limiter Density (dB): sliders are re-scaled for less-aggressive overall processing. The Limiter Density (dB): slider becomes a dBr BS.412-9 (dBr): slider.

The dBr BS.412-9 (dBr): slider is recalibrated to the multiplex r.m.s. "0dBr" value cited in the ITU *Recommendation.* Nevertheless, it may be set at any value between –1dBr and +5dBr, accommodating any 'fudge factor' that might be permitted by the regulating authority in the station's location.

In operation, the DAVID IV continues to utilize the native algorithm of the Limiter Density (dB): slider to anticipate a certain amount of average-level modulation control based on audio program dynamics. This approximation works in concert with feedback of the r.m.s. value of the actual multiplex signal to arrive at a final and accurate correction factor.

Other ITU Processing Implications

The ITU mode will hold r.m.s carrier modulation to the prescribed limit, but processing ahead of the peak limiter section will have a second-order effect on how effective this utility will be in complying with both the letter and the law of the *Recommendation*.

One *caveat* of the ITU *Recommendation* is that audio processing used to satisfy the requirement must not create audible side-effects (i.e.: 'breathing,' 'pumping' and obvious level shifts). The user must thus exercise conservative judgment and avoid overuse of Multipressor and other 'sound-enhancement' features when the ITU mode is active.

ADAPTIVE PRE-EMPHASIS

FM Pre- and De-Emphasis

FM broadcasting makes use of audio pre-emphasis in transmission and complementary de-emphasis in the receiver. This practice requires special consideration with respect to program peak control.

FM pre- and de-emphasis characteristics were established in the 1940s. These were far simpler times in radio programming, long before the term 'competitive loudness' was on the lips of Program Directors. Broadcast practices and recording techniques from that era did not anticipate today's sizzling, high-energy, closely-mic'd and heavily-EQ'd music trends.

Today's program material severely taxes the ability of the FM transmission channel to pass content in a 'transparent' manner. High frequency energy must be controlled independently of the broadband levels, a necessity that can make music sound as 'dull' by today's standards as, in fact, any recorded music might have sounded to many of us if we were transported back to those halcyon days.

The DAVID IV utilizes 'adaptive pre-emphasis,' a term we coined to describe an independent high-frequency limiter that follows the broadband peak controller. Because this HF limiting is performed only in the pre-emphasized domain, a judicious amount of HF clipping may also be employed without causing painful audible artifacts. The clipper algorithm includes proprietary distortion-cancellation techniques that significantly reduce audible intermodulation artifacts, particularly those associated with vocal sibilants.

The FM HF-Lim: slider programs the attack time of the independent high frequency limiter. A minimum setting of 1 gives a near-instantaneous attack, and the HF limiter will be working its hardest to ensure negligible high frequency clipping. This will sound somewhat dull, especially with pop-music sources, but may keep artifacts to a minimum with more conservative fare. As the slider is moved to the right and attack time increased, more high-frequency peaks will slide through and be clipped, rather than limited. A setting of 10 gives maximum clipping, which will of course sound brighter, although clipping artifacts may be objectionable. The factory default setting of 5 is a good compromise for most broadcast formats.

As seen on the Block Diagram (Page 10), adaptive pre-emphasis is used only for FM program transmission. It is a fulltime function for the composite/MPX outputs, but is applied to the analog and digital line outputs only in their FM modes for feeding an FM exciter with a built-in stereocoder.

The characteristics of adaptive pre-emphasis are set when the pre-emphasis selection is made: 75 microseconds for the Western Hemisphere, 50 microseconds for Europe and most other export areas. Pre-emphasis is selected under Setup.

COMPOSITE CLIPPING

MPX Clipping

Although associated with the built-in stereo generator, composite clipping is considered a processing parameter. The Composite Clipping (dB): slider is under the Limiter heading on the Processor Webpage. Composite clipping has no effect on either the analog or digital line outputs, even when they are set to their FM modes.

At the user's discretion, up to 3dB of composite clipping may be introduced. This is brute-force, flat-topped clipping of the baseband signal, but before the 19kHz stereo pilot and RDS subcarrier are combined. Baseband clipping invariably generates harmonic components that can clutter the spectrum above the program signal to a greater or lesser extent.

Composite clipping does provide some degree of loudness advantage with less perceived harshness than program signal clipping in the L/R audio domain. Nonetheless, exercise this

advantage with care. A conservative figure, the factory default value of 1.0dB, is generally benign.

TEST OSCILLATOR

The DAVID IV sports a built-in test tone generator (audio oscillator) that may prove helpful in setting up the DAVID IV, for troubleshooting, or in verifying overall system performance. The Test Oscillator is accessed through + Test Osc/Proof at the bottom of any Processor Webpage, or from the front-panel Setup menu.

Pre and Post Modes

Off is the default selection for normal operation of the DAVID IV. For testing, tones may be applied ahead of the processing stages: Pre, or following all processing: Post.

The test tone is a monaural source applied in the digital domain to both the left and right inputs of the processing chain. Frequency (Hz): may be varied between 20Hz and 20kHz in 10Hz steps, and the Level (dB): of the tone set in 1dB steps between –60dBFS and 0dBFS.

DAVID IV Gain Structure

A –20dB, 400Hz test tone applied at the *input* to the processing chain (Pre) will bring the AGC to 0dB (unity) gain. –20dBFS is a nominal internal "zero-VU" reference level at this point and refers to the program's *average* level.

Gain associated with normal processing action is expected to drive the processor to full 0dB or 100%-modulation output. Thus when this same –20dB tone is applied *after* processing (Post), it drives the composite/MPX output only to the 10% point on the MPX level meter, and to –20dB on the L and R OUTPUT meters. Readjust Level (dB): to reach a desired output value.

The virtual sliders may of course be used to set and Level (dB):, but you may find it easier to highlight and overtype the numbers in the boxes to the left of the sliders. Alternatively, click on the slider knob and use keyboard cursor keys to step up and down.

Processor Bypass or 'Proof'

Processor Bypass: gives the choice of Operate, normal DAVID IV operation, or Proof Mode. In 'Proof,' the input and output level controls remain functional, but all dynamics-processing utilities are fixed at unity gain with a flat-frequency characteristic.

Section V

NETWORKING CONSIDERATIONS

The previous brief introduction to network connection and set-up allowed use of the Web interface for processor, stereo-gen and RDS setup. This section of the manual will go into a bit more detail on some points already covered, and will address other aspects and additional DAVID IV functions that require a better understanding of networking the unit.

From the start we encouraged use of the Web interface for DAVID IV setup and operation, but noting the more subtle departures from front-panel operation. As this section is about networking, discussions will reference Webpage setup exclusively, although most of what can be done with the Webpages can also be done from the front panel.

Much of what will be discussed here will be best understood, interpreted and executed by the station's IT department. Don't hesitate to ask for help.

COMMUNICATING FROM OUTSIDE THE LOCAL NETWORK

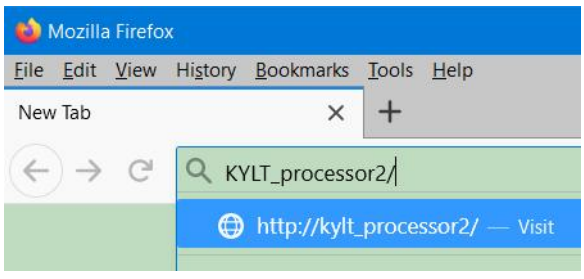
Static IP Assignment

To address the DAVID IV from outside your Local Area Network (LAN), the unit must have a *static* IP address assigned, rather than operating in DHCP mode with the IP assigned by a router. The static IP must be outside the router's DHCP range.

On the Network Webpage, set Mode: to Static IP. This unlocks the IP Address:, Gateway:, Subnet Mask: and Primary DNS: fields. You must enter data into these fields using proper decimal-delineated numbers as dictated by the specific requirements of your network. Definitely a job for your IT department.

Hostname

As touched-on previously, the *Hostname*, or 'Network Nickname' of your DAVID IV, can be changed from the factory-default MODEL719N to a name of your choice, for instance to differentiate one processor from another on the same local network. The Hostname, followed by a forward slash, can then be used to open the Web interface on a Windows computer. An example of a possible rename is depicted here, typed directly into the browser ad-



dress bar. Other operating systems generally require entering the numerical IP address of the unit.

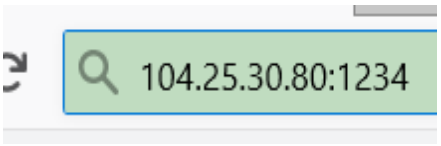
HTTP Port

HTTP Port: 80 is a customary default port assignment for HTTP traffic that rarely, if ever, needs to be changed. Be sure you are aware of the IT implications and consequences if you plan to change this.

The Incoming IP Address

Access to your DAVID IV from outside your LAN utilizes the router's Port Forwarding utility to direct traffic to the incoming, 'external' IP address of the DAVID IV. This address is based on assignment by the ISP, appended with the router port you have assigned the DAVID IV. If you don't know your external IP, there are "What is my IP?" utilities on the Web that will give you the address immediately.

Then to "dial-into" the DAVID IV Web interface from a remote location, enter the external IP address followed by a colon and the port number you have chosen, as in the example here.



When all fields have been entered, Save the settings and the unit will reboot with the new settings.

USING DYNAMIC DNS

What is Dynamic DNS?

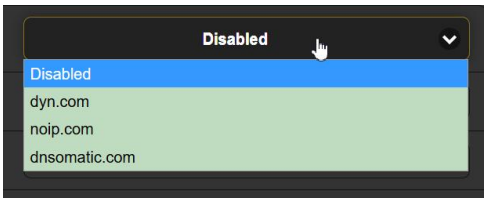
A router or server working in the DHCP mode makes efficient use of a limited IP address list by reassigning addresses as devices disconnect from the network. An Internet Service Provider (ISP) uses this same technique on their clients' primary external-IP (Web) addresses. Thus the incoming routing path to your DAVID IV may well change from time to time, perhaps daily. Most connections to the Internet through the usual ISPs are subject to these 'dynamic' IP assignments.

It would not be possible to address equipment behind a dynamic IP address if it were not for IP-forwarding providers available via the Internet. You may find a free-of-charge forwarding service, but the better-known ones comes at very modest charge. The service allows the DAVID IV to keep the provider apprised of its reassigned IP address whenever that IP address changes. The IP-forwarding provider will then intercept data attempting to connect with the DAVID IV and change the earlier and obsolete IP address to the current one.

Dynamic DNS Providers

There are three popular forwarding service providers available on the Internet. These services require registration on the appropriate Website.

Open the Dynamic DNS menu and click in the Mode: area to expose the drop-down menu shown here. Note that three DNS-forwarding services are named here. We advise to choose one of these as they have proven most dependable over time. Type any of these names into a Web browser to learn the features and cost of their respective services.



The three fields: Hostname, Username and Password must be filled-in with the information you receive when you register on the provider's Website. Type this information into the three fields. Alternatively, this information may of course be entered somewhat laboriously using the front-panel jog-wheel knob under: Setup / Network / Dynamic DNS.

Dynamic DNS System Abuse

The DAVID IV will normally communicate with the provider only when the IP address changes, but it also must check-in following a power interruption and whenever the Dynamic DNS mode is altered in any way.

Some small part of the forwarding provider's processing resources is used each time an IP address is renewed. These providers, especially the for-free ones, don't appreciate repeated and unnecessary IP address renewals. If a particular account makes a nuisance of itself, the provider may justifiably cut the user off. In that case the entire Dynamic DNS registration and setup process will have to be repeated.

SNMP NOTES

SNMP (Simple Network Management Protocol) allows other TCP/UDP/IP equipment on the same Local Area Network (LAN) to communicate directly with the DAVID IV, and for the unit itself to initiate an alarm to other equipment on the network.

This is an abbreviated discussion of SNMP operation. SNMP is a powerful and complex utility, managed exclusively by whatever SNMP Manager (monitoring equipment) is employed. Refer to all instructions supplied with Manager hardware for setup, and consult additional resources for a more complete understanding of SNMP features and protocols.

The SNMP Manager and MIB File

Under SNMP operation, the DAVID IV will interface directly with a network controller, the SNMP Manager. The DAVID IV has an embedded ASCII text file call a Management Information Base, or MIB. In setting up for SNMP operation, the MIB file will have to be downloaded from the DAVID IV through the Web interface and uploaded to the SNMP Manager as described shortly.

SNMP Settings

Click on SNMP in the main menu to bring up the SNMP Settings Webpage. (From the front panel: Setup / Network / SNMP.)

Mode is disabled by default, inhibiting any communications between the DAVID IV and the SNMP Manager. Reset this to Read Only to allow the DAVID IV to be interrogated by the SNMP Manager, enabling programmed setup parameters and alarms to be integrated with other equipment on the network. Set Mode to Read & Write and the SNMP Manager can send operating commands to the DAVID IV as well.

SNMP 'communities' serve as passwords. In the Read Community: and Write Community: fields, overtype the factory defaults and enter text that is specified for the read/write strings per requirements of the SNMP Manager.

The default SNMP Ports, General Port: 161 and Traps Port: 162 are customary for many SNMP operations. These may be overtyped to change them as required.

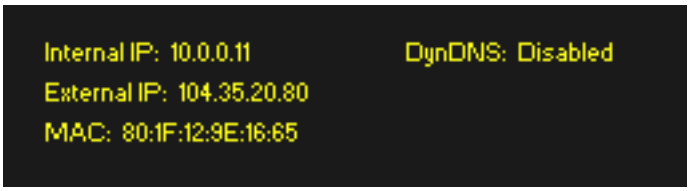
When the DAVID IV initiates an alarm, rather than being queried or polled for one, the alarm is known as a 'trap.' Three local network IP addresses may be entered into the Trap Destination 1:, 2: and 3: fields, each corresponding to other devices on the LAN that need to receive alarms from the DAVID IV.

The MIB file is a small text file required by the SNMP Manager. Click Download MIB to save this file in the customary Windows manner. The MIB file is in plain text with a .mib extension and may be read with Windows Notepad.

THE NETWORK STATUS SCREEN

Current Status

At the installation site, you can view the current status of your DAVID IV's network connection by navigating to: Setup / Network / Status:



This screen shows network settings as explained below.

Internal IP: Your DHCP router or server may automatically assign an IP address to your DAVID IV, or you will have assigned a static IP. This is known as the *internal* IP address.

External IP: When you are connected to the Internet, your local network (LAN) also has an IP address so that

anyone on the Web can find you. This is your *external* IP address and is assigned by your Internet Service Provider (ISP). The more common *dynamic* IP is subject to routine update (change), either on a schedule or as required. A *static* IP may be provided as an option by some ISPs and will remain constant.

MAC: MAC is the Media Access Control address of your individual DAVID IV unit. Each DAVID IV is registered at the factory with a unique, permanent MAC address. This is an essential element in providing reliable network connectivity of any hardware connected to your local network (LAN) or to the Internet. The MAC address of your DAVID IV cannot be changed.

Dyn DNS: This field shows the current status of the Dynamic DNS feature.

UPDATING THE FIRMWARE

A firmware update is done *in situ*, at the processor installation site.

The DAVID IV includes a 'bootloader' utility that allows firmware to be updated whenever Inovonics issues changes to add features to improve performance or otherwise expand the usefulness of the product. Inovonics supplies firmware updates at no additional charge.

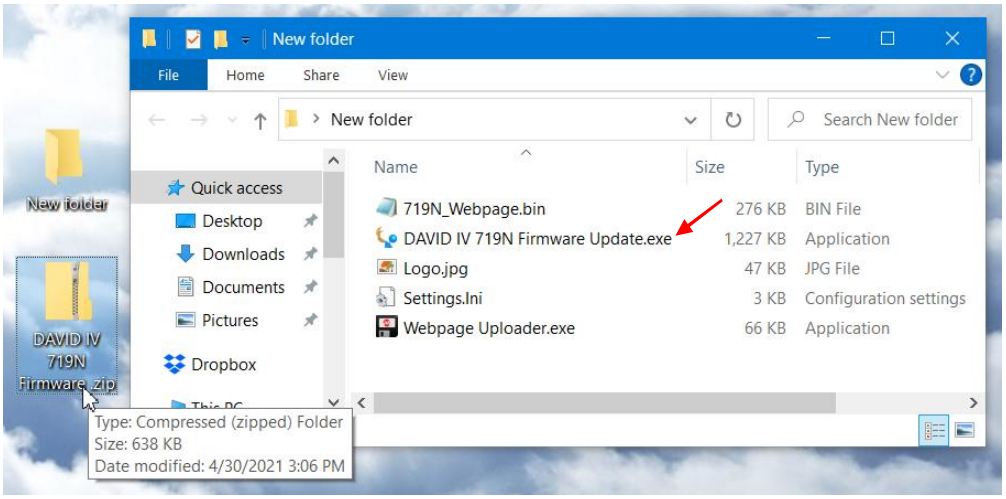
A bootloader is a simple software routine that runs on any PC that is on the same network as the DAVID IV. By now you are able to easily secure a connection between the DAVID IV and your computer. This *must* be a wired, LAN connection for both the PC and for the DAVID IV. Attempting to use a Wi-Fi link will almost always result in failure.

Warning A firmware update will restore the DAVID IV to factory defaults. *All settings and presets will be overwritten!* Always save a Hardware Profile before proceeding with an update so that your settings can be reloaded afterward.

Firmware Update Files A firmware update will be supplied as a 'zipped' folder containing a number of files, normally distributed as a download from the Inovonics Website.

One of the supplied files is a third-party bootloader utility, an 'executable' (.exe) file. .exe files are notorious for propagating malware, and many antivirus programs will not allow their download. But you must trust us, throw caution to the wind and do it anyway.

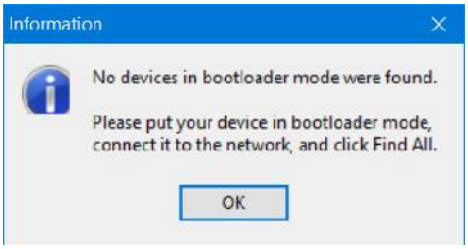
Make a temporary New Folder on your PC Desktop and unzip the update files to it as shown in the illustration below.



Running the Firmware Updater

Navigate to your temporary Desktop folder (New folder) and double-click the Firmware Update.exe file. This is the bootloader file marked with the arrow in the snapshot above.

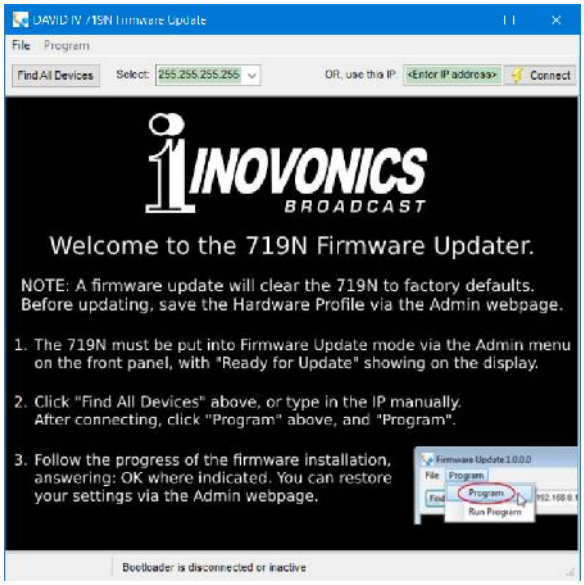
That will bring up this Information message, advising that the Firmware Updater does not yet find the DAVID IV. Click: OK. That will start the firmware updating utility and display its main screen.



The bootloader window outlines the firmware update process in three easy steps.

The first step advises that the DAVID IV must, itself, be in the Firmware Update mode.

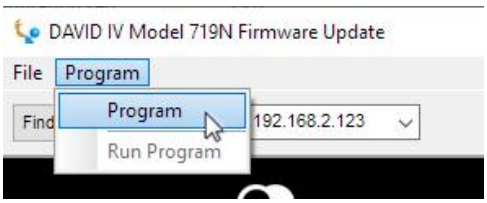
Using the front-panel jog-wheel, navigate to: Administrative / Firmware Update. This will bring up the first of two front-panel screens, each with a stern warning about proceeding. If you have backed up your Hardware Profile and are reasonably certain that the DAVID IV and your computer are ready to connect properly, select: ☒ Yes in both cases, paying close heed to the warnings in each.



When the DAVID IV is ready to accept the firmware update it will display the message on the right.

Next, click: Find All Devices at the top of the bootloader window. The IP address of your DAVID IV should appear in the Select: field, confirming that you are properly connected. If you do *not* see the IP address of your DAVID IV, abort the update (described below) and troubleshoot connection issues. You may always bring up the DAVID IV Webpages to test the interconnection. If you can bring up the Now Playing Webpage, the Firmware Updater should connect.

In step 2 of the Firmware Updater, first click: Program at the top of the bootloader screen to display the drop-down menu, where you'll click: Program (*not* Run Program!) to start the firmware update process.



The PC screen will display various progress bars as firmware is uploaded to the DAVID IV.

In Step 3 click: OK as directed at the end of the upload. The DAVID IV will revert to the main menu where you can confirm the version number of the uploaded firmware.

Aborting a Firmware Update

Before you have committed to a firmware update, pushing the Back button will return you to previous screens, effectively aborting the update process.

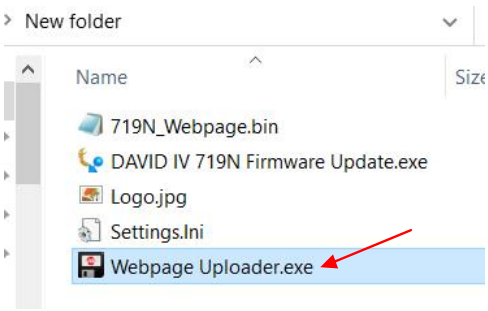
But once you see this message on your DAVID IV it is *almost* too late to turn back. If for some reason the Firmware Updater cannot connect to the DAVID IV, and you have not yet initiated Step 2 to begin the update routine, at this point and with this message showing, you may power-cycle the DAVID IV as a last-ditch means of aborting the process and returning to the existing version of the firmware. *Do not* hold down the Back button while doing this abort; that is, *do not* perform a hard reset!

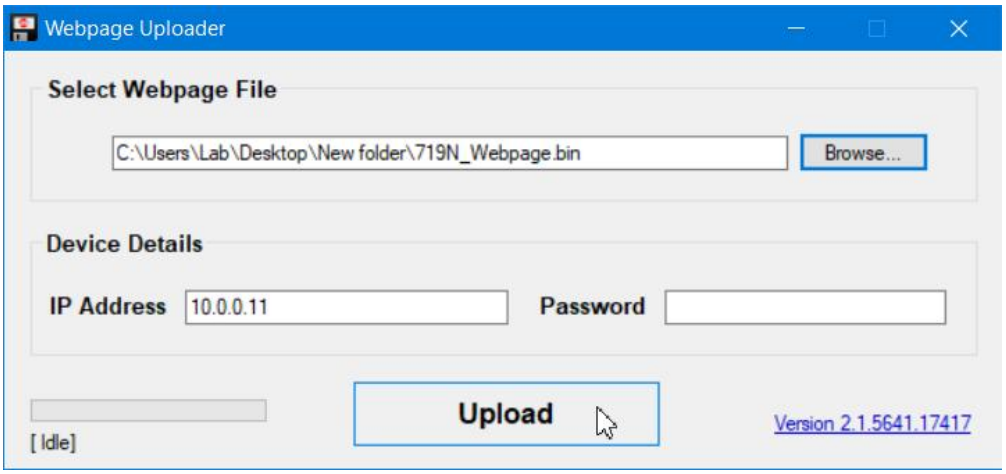
If for some reason the firmware update does not 'take,' do not power-cycle the DAVID IV. Continue to re-run the bootloader until all hope is gone, then give us a call and we can ~~scratch~~ put our heads together.

Updating the DAVID IV Webpages

The various Web interface Webpages are updated separately from the general firmware files and should always be updated during the same update session. Remember, for the Web interface to work properly, both updates must display the same version number.

So, immediately after the firmware update is bootloaded, and while the DAVID IV is still in communication with your computer, return to the unzipped bootloader folder and double-click the Webpage Uploader.exe file shown with an arrow at right. The third-party 'bootloader' screen below will pop up.





The location of your .bin file should automatically populate the Select Webpage File address field. You must enter the IP address of your DAVID IV in the IP Address box, so have it at the ready. The Webpage Updater will display progress and apprise you of update success.

FRONT-PANEL MENU TREE

OLED Menu Listing

This is a tabulated listing of the front-panel OLED menu tree to help identify any differences between Web interface and front-panel menu callouts.

The list shows all submenu levels under the main screen headings, and also indicates what actions may be taken at that level. Choices are: a slide control incremental-value setting: (set); a selection from a field of just a few options: (select); a field for entering alphanumeric characters: (data entry); or solely an information readout: (info).

- Presets
  - Save New Preset
    - 25 (F) Factory Presets (select)
    - 20 User Presets (data entry & set)
    - Delete (User Preset) (select)
- Processing
  - High Pass Filter
    - High Pass (select)
  - AGC
    - Active/Bypass (select)
    - Gain (set)
    - Rate (set)
    - Window (set)
  - Compression
    - Drive
      - Linked <—> Indep. (select)
    - Multipressor
      - EQ
        - Bass (set)
        - Low (set)
        - MID (set)
        - Pres (set)
        - High (set)
      - Crossovers
        - Bass/Low (set)
        - Low/Mid (set)
        - Mid/Pres (set)
        - Pres/High (set)
      - Attack & Release
        - Bass A&R (set)
        - Low A&R (set)
        - MID A&R (set)
        - Pres A&R (set)
        - High A&R (set)
    - Bass Effects
      - Active/Bypass (select)
      - Punch (set)
      - Rumble (set)
  - Peak Limiting
    - PIPP* / Normal / ITU (select)
    - Limiter Drive (set)
    - Limiter Density (set)
  - FM HF-Limiter
    - Clip <—> Limit set)
  - Stereo Enhance
    - Active/Bypass (select)
    - Stereo Width (set)
    - Solo Width (set)
  - Composite Clipper
    - Composite Clipping (set)
- Setup
  - Audio Input
    - Failover / Digital / Analog (select)
    - Digital Gain (set)
    - Analog Gain (set)
  - Analog Audio Output
    - 20k-Flat / FM-Pre / FM-Flat (select)
    - Analog Level (set)
  - Digital Audio Output
    - 20k-Flat / FM-Pre / FM-Flat (select)
    - Digital Level (set)
  - Sample Rate Converter
    - Input Rate (display)
    - Output Rate (select)
  - Stereo Generator
    - Pilot / Mode
      - Stereo / Mono L+R Mono Left / / Mono Right (select)
      - Pilot Injection (set)
    - Pre-Emphasis
      - None / 50us / 75us (select)
    - Multiplex Out
      - MPX Level 1 (set)
      - MPX Level 2 (set)
    - RDS Input
      - Enable / Disable (select)
      - RDS Injection (set)

(continued)

- Setup (continued)
  - Network
    - IP Settings
      - Port: (data entry)
      - DHCP / Static IP (select)
      - IP: (data entry for Static IP)
      - Gateway: (data entry for Static IP)
      - Subnet: (data entry for Static IP)
      - DNS: (data entry for Static IP)
    - SNMP
      - Mode & Communities
        - Mode: (select)
        - Com. Read: (data entry)
        - Com. Read&Write (data entry)
      - SNMP Ports
        - General Port: (data entry)
        - Trap Port: (data entry)
        - Trap Destinations
          - IP 1: (data entry)
          - IP 2: (data entry)
          - IP 3: (data entry)
    - Dynamic DNS
      - Mode: (select)
      - Hostname: (data entry)
      - Username: (data entry)
      - Password: (data entry)
  - Proof Mode
    - Operate / Proof Mode (select)
  - Oscillator
    - Off / Pre / Post (select)
    - Frequency (set)
    - Level (set)
  - HD Radio Delay
    - Enable / Disable (select)
    - Delay (set)
  - Alarms
    - Analog Audio Loss
      - Disable / Enable (select)
      - Threshold On (set)
      - Time On (set)
      - Threshold Off (set)
      - Time Off (set)
    - Digital Audio Loss
      - Disable / Enable (select)
      - Threshold On (set)
      - Time On (set)
      - Threshold Off (set)
      - Time Off (set)
  - Administrative
    - Security
      - Front Panel Password (data entry)
      - Webpages Password (data entry)
    - Brightness
      - OLED Brightness (set)
    - Firmware Update
      - Proceed? Yes / No (select)
    - About
      - Firmware Rev: (info)
      - Webpage Rev: (info)
    - Serial #: (info)

INOVONICS WARRANTY

I **TERMS OF SALE:** Inovonics products are sold with an understanding of "full satisfaction"; that is, full credit or refund will be issued for products sold as new if returned to the point of purchase within 30 days following their receipt, provided that they are returned complete and in an "as received" condition.

II **CONDITIONS OF WARRANTY:** The following terms apply unless amended *in writing* by Inovonics, Inc.

A. The Warranty Registration Card supplied with this product *must* be registered online at www.inovonicsbroadcast.com, within 10 days of delivery.

B. This Warranty applies only to products sold "as new." It is extended only to the original end-user and may not be transferred or assigned without prior written approval by Inovonics.

C. This Warranty does not apply to damage caused by misuse, abuse, accident or neglect. This Warranty is voided by unauthorized attempts at repair or modification, or if the serial identification label has been removed or altered.

III **TERMS OF WARRANTY:** Inovonics, Inc. products are warranted to be free from defects in materials and workmanship.

A. Any discrepancies noted within THREE YEARS of the date of delivery will be repaired free of charge, or will be replaced with a new or remanufactured product at Inovonics' option.

B. Parts and labor for factory repair required after the three-year Warranty period will be billed at prevailing prices and rates.

IV **RETURNING GOODS FOR FACTORY REPAIR:**

A. Equipment will not be accepted for Warranty or other repair without a Return Authorization (RA) number issued by Inovonics prior to its return. An RA number may be obtained by calling the factory. The number should be prominently marked on the outside of the shipping carton.

B. Equipment must be shipped prepaid to Inovonics. Shipping charges will be reimbursed for valid Warranty claims. Damage sustained as a result of improper packing for return to the factory is not covered under terms of the Warranty and may occasion additional charges.

Revised Aug. 2012