
FM-4

Digital Audio Processor

Technical Manual

 *Wheatstone Corporation*

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VORSIS ULTRA-HIGH RESOLUTION PROCESSING

FM-4 Digital Audio Processor Technical Manual

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About Wheatstone



**Wheatstone Corporate Headquarters
New Bern, North Carolina USA**

Wheatstone Corporation is *the* world-leader in *extreme-reliability* broadcast audio equipment. Its product lines include audio mixing consoles for the radio and television broadcast industries, audio control surfaces and digital audio networks, and our award winning line of Vorsis digital audio processors. Design and manufacturing of all Wheatstone equipment takes place in our ultra-modern New Bern, North Carolina, USA headquarters.

Wheatstone's roots go back over 35 years to the "Audioarts" company when its product line included very high quality audio equalizers, electronic crossovers, and specialized compressor/limiters. In 1977 its first audio mixing control console was introduced to the marketplace.

In 2006 Wheatstone returned to its roots in audio processing when it introduced its broadcast line of signal processing products for radio

The History of Wheatstone Audio Processors

Introduced in 2005, the Vorsis product line evolved from Wheatstone's return to its original roots in audio processing. Having designed and integrated analog and then later, complex digital audio processing, into their radio and television consoles and control surfaces, Wheatstone was perfectly poised to address the challenges of combining very high audio quality with competitive on air loudness.

Wheatstone audio processors are built to the same exacting standards as all Wheatstone products. Research and development, manufacturing, testing, and quality control for the line of audio processors are all accomplished in Wheatstone's large state-of-the-art facility located in New Bern, North Carolina. Keeping everything under one roof allows Wheatstone to have control over every facet of product production and ensures that our customers receive products of the highest possible quality *and* reliability. Staying true to "Made in the USA," Wheatstone does not utilize offshore manufacturing.

A dozen experts with deep experience in Digital Signal Processing, broadcast audio processing and other engineering disciplines comprise our design team. Led by audio processing expert and broadcast engineering veteran Jeff Keith, the team combines their talents to design and build audio processors that achieve new and higher standards of on air sound quality.

In its short history Wheatstone Processing has already invented many new and unique audio processing algorithms – algorithms that push audio processor performance to new and higher levels. Wheatstone was the *first* to develop a Vorsis intelligent, 'program density aware' AGC (2007 - Sweet Spot Technology, or SST). We were also the first to employ the science of human psychoacoustics in the design of a multiband limiter (2005, our acclaimed 31-band final limiter). In addition, our well-regarded Vorsis Bass Management System (2007, our VBMS) solves the bass intermodulation problems that plague other brands of audio processors when pushed for competitive loudness.

Each Wheatstone Processing product comes equipped with its own Windows® software based intuitive Graphical User Interface for control of the processor. Carefully tuned factory presets ensure that our audio processors can be placed into use quickly and easily and in any size market with a minimum of effort.

FM-4 Digital Audio Processor for FM



Introduction

Borrowing technologies from our very popular VP-8PLUS audio processor, the new FM-4 combines a four-band version of our acclaimed DSP-based AGC and limiter structure with a lab-grade digital stereo generator to create a flexible, low cost, and yet surprisingly powerful FM audio processor. The FM-4 has the on-air clarity, power, and accuracy of sound not found in *any* other FM broadcast audio processor in its price range.



FM-4 GUI Lite User Interface

GUI Lite control software (shown left) is shipped as a standard accessory with the FM-4.

GUI Lite allows non-technical personnel to quickly achieve their signature on-air sound without having to understand deep and technical audio processing terms. No audio processor has ever been so simple to set up and use.

The power and intelligence of GUI Lite provides the end user with six simple-to-use controls that are smart enough to enable morphing of any FM-4 factory preset to a completely new sound. This flexibility means that if you can think of the on-air sound you want your station to have, the FM-4's DSP audio processing algorithms and its clever user interface can most likely create it for you.

The FM-4 may be remotely controlled from anywhere via a TCP/IP network connection and the Windows-based GUI (Graphical User Interface) software application.

Note that for those users with experience adjusting audio processing, a professional version of the FM-4's GUI ("FM-4 GUI Pro") is available at no cost by registering at www.wheatstone-processing.com.

Feature Highlights

- Four band time-aligned crossover
- Four band AGC/Compressor with adjustable inter-band coupling.
- Four band limiter
- Exclusive Vorsis Bass Management System (VBMS[®])
- FM peak control via oversampled lookahead limiter or oversampled distortion masked clipper.
- Four band full parametric equalizer.
- Input high pass filter which can be operate in stereo or M/S mode.
- Phase rotator for symmetrical voice waveforms for cleaner processing.
- Precision DSP-based digital FM stereo generator.
- Composite clipper with multiplex filter to protect stereo pilot and SCA region.

Audio I/O

- Analog and AES3 digital audio inputs.
- AES3 digital input accepts sample rates from 32 kHz to 96 kHz.
- AES3 digital output automatically synchronizes to AES3 digital input.
- Separate audio input gains for analog and AES3 digital inputs.
- Low impedance composite MPX output.
- Rear panel SCA/RDS Input
- Front panel headphone output with level control via front panel GUI.

Input/Output Latency

8.9 milliseconds.

Local Control

- Front panel navigation for setup, security and headphone volume control.

Misc. Control I/O

- Eight optoisolated GPI trigger inputs activate presets in storage slots 1-8.

Remote Control

- 10/100 Ethernet-based remote control via rear panel Auto-MDIX RJ-45 jack.
- Windows-based GUI Lite Graphical User Interface*.

Software Updates

- Download to hardware via Windows-based Graphical User Interface.

Presets

- Equipped with more than 25 carefully tuned factory presets.
- 80 preset memory capacity.

Electrical Requirements

Voltage: 90–260 VAC, 50-60Hz.

Power consumption: 42 VA (29 watts).

Connector: IEC male, EMI-suppressed. Detachable 3-wire power cord supplied.

Safety Standards: ETL listed to UL standards, CE marked.

Physical

Rack space requirement: One RU (1.75”).

Chassis dimensions: 19” wide x 13.5” deep x 1.75” high.

Unit Weight: 18 lbs (9.98 kg).

Shipping Weight: 26 lbs (16.33 kg)

Environmental

Operating temperature range: 32 degrees F to 122 degrees F (0C to 50C)

Storage temperature range: 20 degrees F to 140 degrees F (-7C to 60C)

Humidity: 0% to 95% RH, non-condensing.

Altitude: 7500 feet AMSL maximum.

Approvals and Compliance

CE and FCC Class A Device.

European Restriction of Hazardous Substances (RoHS) compliant.

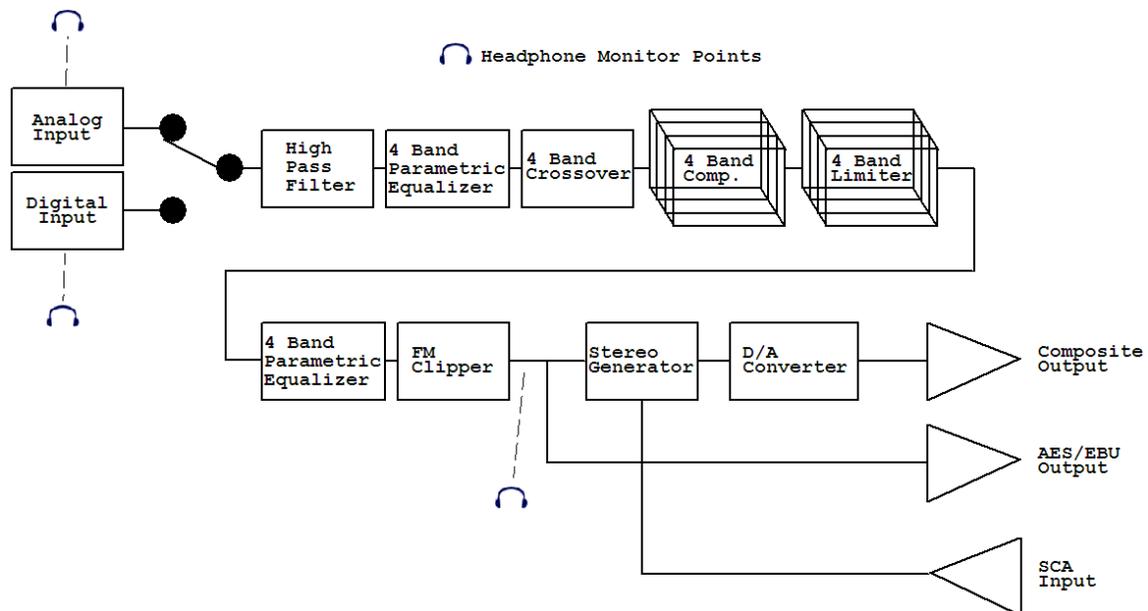
* FM-4 GUI Pro is available for download after registering the FM-4 product at www.wheatstone-processing.com.

FM-4 Processing Structure

The FM-4 is equipped with audio inputs for professional analog and digital sources and the signal processing structure is as follows:

- Analog or AES3 digital audio input;
- High pass filter – L/R or M/S domain;
- Pre-AGC four-band fully parametric equalizer;
- Four-band AGC/compressor;
- Four-band limiter;
- Post-limiter four-band fully parametric equalizer;
- Oversampled, low distortion FM peak controller;
- Lab grade DSP-based digital stereo generator;
- Oversampled composite clipper.

The overall signal flow of the FM-4 is shown in the following block diagram.



FM-4 Block Diagram – Signal Flow

The FM-4 is equipped with a flexible headphone routing scheme to allow monitoring of audio in various parts of the signal path. It is even possible to monitor an audio input that is not selected to be on the air. For instance, if the AES digital input is being used and an analog backup signal is also connected to the FM-4, the analog input signal can be listened to for confidence monitoring without having to switch to that input and putting it on the air.

Audio Inputs

Input audio can be applied to either the analog left/right inputs or to an AES3 digital input. The AES3 input accepts sample rates between 32 kHz and 96 kHz. An AES3 digital input applied to the FM-4 determines the FM-4's AES3 output sample rate, even if the digital input is not being used. In other words, the FM-4's digital input *also* serves as a sync input for the digital output.

SCA Input

The SCA input accepts audio from an SCA or RDS (Radio Data System) generator. This input is digitized at 192 kHz after being low pass and high pass filtered to remove potentially out of band signals.

Audio Outputs

Composite stereo appears on a rear panel BNC female connector and AES3 digital with selectable de-emphasis according to any pre-emphasis in use. The Composite output is calibrated at the factory to 3.5V P-P, the de-facto standard level for 100% modulation (75 kHz deviation).

Headphones

A high-power, overload protected headphone output is available on the front panel for local monitoring. The headphone source can be selected in software to be from one of several important signal points inside the processing algorithm including both analog and AES inputs even if those inputs are not selected to feed the audio processing chain.

Network Connection

The FM-4 hosts a 10/100BaseT Ethernet connector on its rear panel for use with the Windows-based Graphical User Interface (GUI). The Ethernet interface is Auto-MDX and therefore the port will accept either straight-through or crossover cables.

GPI

The rear panel hosts a DB-9 female connector assigned to General Purpose Input (GPI) functions. The eight inputs are optically isolated to prevent external ground loops and to keep dangerous voltages from being introduced into the FM-4. Please see the manual chapter on GPI for the pin assignments for this connector.

AC Power

An industry standard IEC male connector is provided on the rear panel for accepting a mating AC power cable. In order to enhance product reliability there is no power switch.

The AC line input voltage may be between 85 and 265VAC, 50 or 60Hz and power consumption is under 100VA.

Aggressive AC input filtering is utilized at the AC input of the FM-4, however it is always advisable to use external surge protection and/or an uninterruptible power supply (UPS), especially where AC power quality can be questionable such as at a remote transmitter site.

Power conditioning, surge suppression and even power backup devices are wise investments when using sensitive modern electronic devices such as the FM-4, which for all practical purposes, is a 'computer'.

The use of a UPS (uninterruptible power supply) is a good idea and will protect the FM-4 from short duration power interruptions which can cause the unit to reboot. During boot up, audio is interrupted for approximately 15 seconds.

Rack Mounting

The FM-4 is designed to fit into an industry-standard 19" equipment rack and requires one rack unit (1.75 inches) of vertical space.

The FM-4 does not have, nor need, top or bottom cover vent holes. Latent heat is vented out of the enclosure by natural convection through slots in the top of the rear panel. Cooler air is drawn into the unit through vertical slots positioned lower in the side panels.

The FM-4 may be mounted between other devices in the equipment rack, and in accordance with good engineering practice should not be mounted directly above devices that generate significant amounts of heat. If such a location is unavoidable, then it is advisable to utilize an extra 1RU blank rack panel between the FM-4 and devices immediately above and/or below it.

Installation Tips

Always place surge protection circuits as close as possible to the FM-4 or other devices being protected.

Establish a low impedance common ground in your facility and try to route all grounds to that point.

Choose the best power conditioning / UPS units that you can afford and suitable for your equipment - focus on the features and options you need. High quality UPS products can prevent thousands of dollars in equipment damage – some even come with an external equipment damage warranty.

Unbalanced audio connections to the FM-4 should be made with shielded two-conductor cable such as Belden 8451 or 9451 as if connecting a balanced source. At the unbalanced source's output connect the + Output to the HI input wire and connect the source GND wire to the LO wire. Connect the shield at the *FM-4 end only*.

For digital audio connections always use a good quality digital audio cable with a characteristic impedance of 110 ohms.

Generic “audio” cable such as Belden 8451 *may* be used for interconnecting AES3 digital audio devices, though for best digital performance it is recommended that wire length not exceed 10 feet. The actual cable length that will work well in any installation is determined by the characteristics of the AES3 transmitter in the audio source, the error correction and jitter tolerance of the AES3 receiver device, and the actual cable used.

Where to install the FM-4

The recommended location for the FM-4 is at the transmitter site if an STL carrying left and right audio is involved in the signal path. A transmitter site installation will enable the use of FM-4’s built-in stereo encoder which will *a/ways* allow more precise control of modulation peaks.

If the FM-4 must be located at the studio and a composite or digital STL is used to send the program material to the transmitter there are several issues that need to be addressed:

Audio Compression (bit reduction)

When using a Digital STL that employs audio bit reduction algorithms (such as MP3, AAC, etc.) it is highly recommended that the FM-4 be placed at the transmitter site. This is because the encoding schemes that are used in coded STLs cannot accurately pass the well-defined peak levels created by the FM-4.

The FM-4 can be placed at the *studio end* of a compressed STL with at least two caveats:

1. The high performance composite clipper in the FM-4 cannot be used. While most modern digital exciters offer a composite clipper function, they are typically quite crude in their operation compared to what is inside the FM-4. They are never the optimum choice when sound quality is important.
2. Data reduced STLs typically do not perform well when processed audio is applied to their inputs. Dense audio presents fewer ‘opportunities’ to remove redundant audio information and then correctly mask its removal. Under those conditions, codec operation may be much more obvious than it would otherwise, and potentially more so than when the processing is located after the codec. In the latter case, masked artifacts are occasionally unmasked by the increased ‘gain’ due to processing; and to our ears, this sounds better than when dense audio at a codec input forces it to throw away data that perhaps should not be thrown away.

TIP: If using the FM-4 at the studio be certain that the pre-emphasis and clippers in the stereo generator at the transmitter site are properly set up to match the settings in the FM-4. This will prevent gross distortion and large modulation overshoots. Also, in a FM system pre-emphasis should be 'on' only in the audio processor!

User Presets

The FM-4 comes with a variety of factory presets and it can hold a total of 80 presets in its onboard memory. Our factory pre-sets can be readjusted to taste and then saved under new names on the FM-4, in order to create your own unique and individual sound.

User presets can also be stored on the host PC (for the GUI) which in most cases has enough storage for a virtually *unlimited* number of presets (presets are typically only a few kilobytes in size).

Note: The factory presets are write-protected and changes to them cannot be written back to the same memory location. Remember that factory presets modified by the user are then considered "user" presets and must be saved to a new preset number.

Note: User presets stored in preset locations 1 through 8 on the FM-4 hardware are logically assigned to the remote GPI function. Two examples of presets that might be stored here are:

- A preset that has all processing turned off and has special input/output level calibrations (for Bypass or EAS Preset).
- A preset that has all processing sections enabled but has the 19kHz stereo pilot turned off in order to create a "Mono" preset.

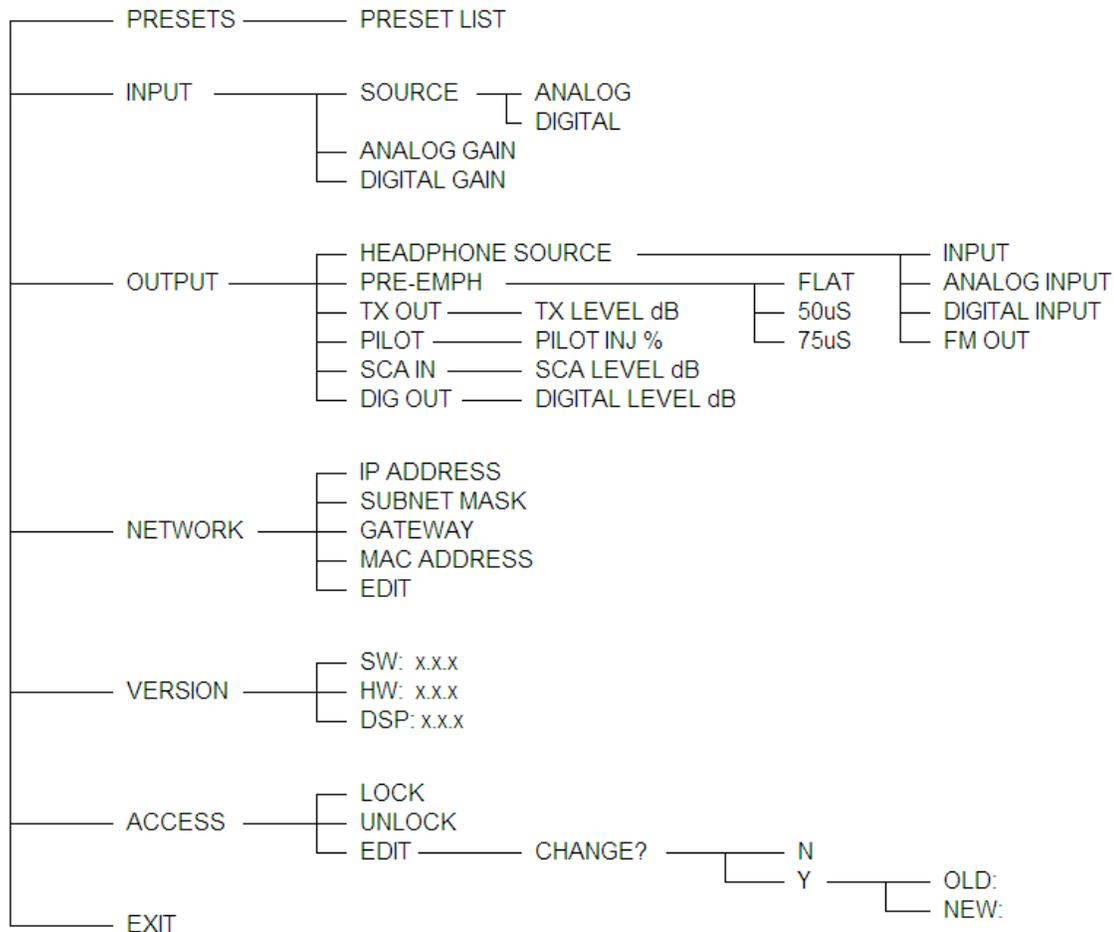
Installation and Setup Using the Front Panel

The FM-4 is equipped with a front panel menu navigation feature that permits field installation and configuration without needing a computer. The menu is navigated by the rotary encoder knob and illuminated “V” button. The items in the list are arranged in tree form in order to make navigation simple and logical. The menu is structured so that the Preset selection item is always at the top of the tree. Logically the navigation list is as follows:

- PRESETS
- INPUT
- OUTPUT
- NETWORK
- VERSION
- ACCESS

An item called “<<MENU” or “EXIT” is always present at the end of a list to enable backing out of the currently selected item by one level. The entire navigation tree is shown below.

FM-4 Front Panel Navigation

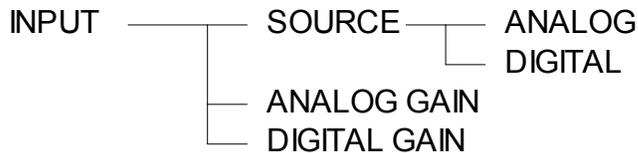


Presets

The first menu item in the list is PRESETS which allows scrolling through the list of factory (and/or user) presets stored on the FM-4 hardware. Once a preset is decided upon, pressing either the knob or the lighted “V” pushbutton will select that preset to be active. The active preset will then be displayed on the front panel alphanumeric display and the preset name will scroll if the name is longer than eight characters. The FM-4 will respond with “TAKEN” when the preset is selected, and is loaded and running.

Input

The INPUT menu item allows the appropriate audio input type to be selected (Analog or Digital) and also allows independent input gain adjustments to be made for each of the two input types.



A Note About Input Levels

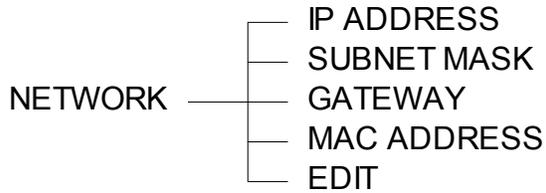
We strongly recommend that peak input audio levels are never set so that they peak higher than about -12dBFS as shown on either the GUI or the FM-4’s front panel meters.

This caution is necessary to allow appropriate headroom for the processing algorithms if they are presented with program material that has been clipped during the mastering process. Such material can achieve far higher peak levels after the first stage of signal processing (in any modern audio processor) and those signals may not have enough headroom to avoid clipping within the processor if the input level was already too high.

In other words, if you hear mysterious distortion, or what sounds like clipping or a snapping sound when very loudly mastered material is being played; it’s a good idea to check the input levels to the FM-4 to ensure they are not spending any significant time at levels of -12dBFS and above. GUI Lite has a “Ref” indicator on its input level meter at the -12dBFS calibration mark as a convenient reminder.

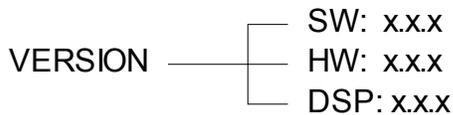
Network

After the Output options the Network Configuration is next in the list.



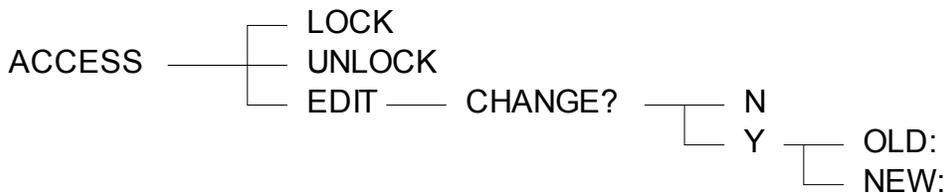
All of the parameters in the Network list can be edited *except* for the MAC address. A MAC address is a *fixed* and permanent hardware identification that is intended to be specific *to* and different *for* each networked device. As is the case with most network gear, our audio processor's MAC address cannot be changed.

Version



The version dialog displays the currently loaded versions of operating system, FPGA image, and DSP code, noting that these are displayed values only and cannot be changed without actually changing the version(s) of software that the FM-4 is running; i.e., updating it to a new version using the hardware update feature in the GUI.

Access



The Access menu item allows the front panel security features of the FM-4 to be customized. A front panel password may restrict access to the front panel controls, and can be set or changed when necessary to keep curious fingers out of the adjustments.

It is not possible to lock the front panel without first setting a password for it. Likewise, if the front panel has been locked it cannot be accessed without first entering the valid password.

Introducing (*drum roll please*) ... Vorsis GUI Lite!

Vorsis GUI Lite for the FM-4 is our standard simplified user interface whose under-the-hood intelligence distills the FM-4's hundreds of processing adjustments down to just six easy to use controls. Finding the perfect sound has never been quicker. Or easier!

We designed the GUI Lite tool for those who want to change the sound of our factory presets without having to know and understand the nuances of hundreds of tweakable parameters.

Adjust Sound Tab



FM-4 GUI Lite – 'Adjust Sound'

GUI Lite has only three basic pages for hosting the controls that an end user might need for installing the FM-4 and adjusting its sound.

- The first page of GUI Lite is called "Adjust Sound" and is solely dedicated to making refinements to our factory presets' default sound.

- The second page of GUI Lite is the “Stereo Generator” page which hosts the Input and Output Calibrations, the selector for the Headphone monitor source and the Input Audio Source selector.

- The third and last page of GUI Lite is the “Configuration” page, hosting controls for selecting the processor mode, configuring the GUI to communicate with the host VORSIS audio processor and programming the Scheduler.

Note that for user convenience we’ve *repeated* the appearance of some of the controls across the three pages noting that the Input, Output and processing-related metering are *always* visible on all three pages.



“Adjust Sound”



“Stereo Generator”



“Configuration”

Installing the GUI Lite Software

The GUI Lite software is provided to permit access to FM-4 sound processing controls not accessible via the front panel. To install the GUI Lite software insert the Vorsis FM-4 software CD into a Windows computer and:

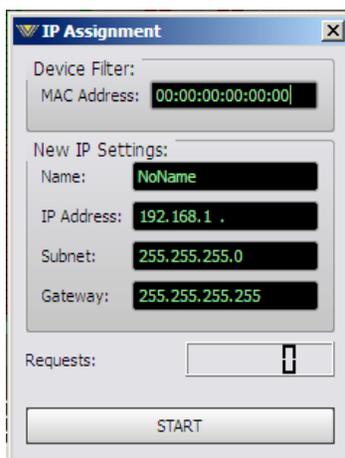
- Click “Start”
- Select “My Computer”
- Click on the CD Drive
- When the contents of the CDROM drive appear, locate the FM-4 GUI Lite Setup_x_x_x.exe file (where x_x_x is the version number) on the CDROM and double-click it.
- Follow the on-screen instructions to complete the GUI installation.

Configuring the FM-4 TCP/IP Address*

The FM-4 is shipped from the factory with a default IP network address of **192.168.1.194**. If this address will work on your network there is no need to change the FM-4’s default IP address.

If the address must be changed, please follow the steps below.

1. Before starting the configuration procedure, please locate and carefully make a note of the FM-4’s 12-digit MAC address which is located on a label either on the top cover, or the rear panel. This address will be in the format 00:50:C2:xx:xx:xx, where xx:xx:xx are the digits that are *unique* to your FM-4 processor.



2. Next, start the FM-4 GUI Lite software. Then, right click on the control area of the GUI and select the Hardware/Assign IP Address option. The window to the left should appear.

3. Carefully enter your processor’s MAC address in the MAC Address field.*

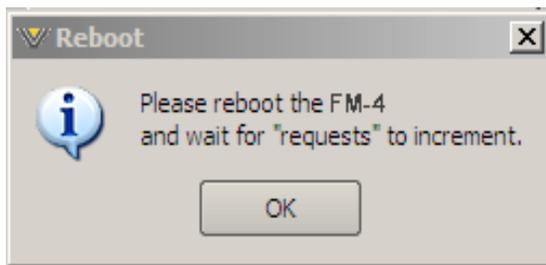
* The MAC address must be carefully entered because the GUI will “send” the IP address information to the device that owns the MAC address entered in this step. If the MAC address is entered incorrectly, the FM-4 will never hear it, causing it to remain on its factory default IP address!

4. Next, and if you wish (this is optional), enter a pet name for your FM-4 (call letters of your station, the FM-4's physical location, etc).

5. Then, enter the IP address that you wish this FM-4 to have, noting that its address must be unique if the FM-4 will be communicating over a network with other devices attached to it.

6. Next, enter the desired Subnet Mask and Gateway addresses.

7. Once this is done, click the "Start" button at the bottom of the IP address configuration box. A message similar to the one below should appear:



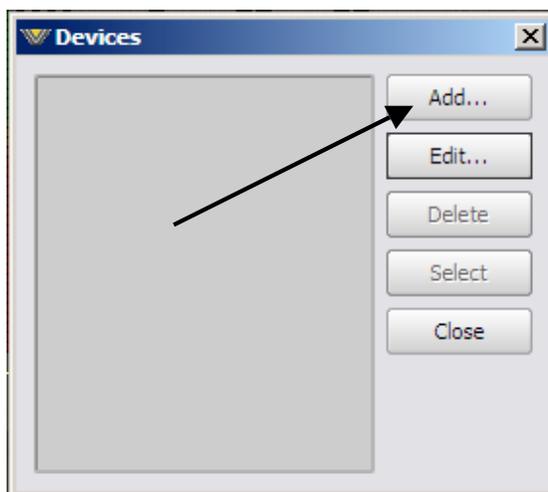
8. Click "OK," remove power to the FM-4 for a few seconds, and then reapply it. As the FM-4 is booting up, the "Requests" number in the IP Address window should increment to '1' or higher (please see the image in the IP Assignment figure above).

9. When the requests number increases and is no longer zero, the FM-4 has been programmed with its new IP address and is ready for use.

Device Configuration – Connecting to the FM-4

Now that the FM-4 has its own TCP/IP identity, we must configure the GUI so that it can talk to the FM-4. This is done by adding "Devices" to the list of FM-4's that the GUI knows about. To do this:

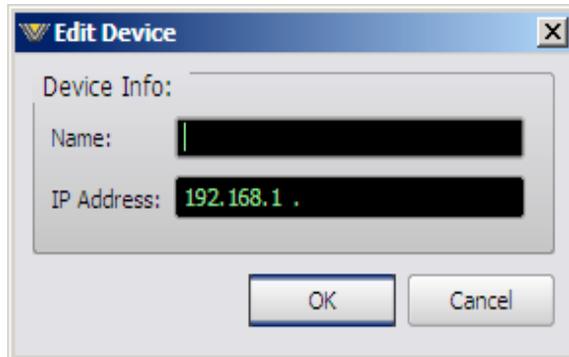
1. Place the mouse cursor near the GUI's meters and right click. Among the options are "Devices." Select it. When this is done, the following Devices window will pop up:



2. Next, click the "Add" button and the "Edit Device" dialog box will appear — this box is used for adding new devices or modifying the configuration of existing ones.

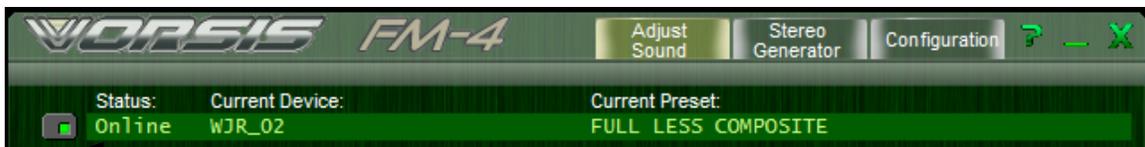
3. First, enter the same pet name that you used when you assigned the IP address to the FM-4. The device name is

not absolutely necessary but it makes for easy identification when there are many FM-4s in a facility because the FM-4's device name is shown in the Device window of the GUI when the GUI is in communication with the desired FM-4.



Edit Device Dialog

4. Next, enter the IP address that you configured the FM-4 for in the previous steps. It is recommended that any existing data in the IP Address box be deleted and new IP address entered from scratch, using the period key to jump forward to the next part of the IP address. This will ensure that there are no undesired blanks or spaces in the address.
5. After this is done you may click “OK” on the “Edit Device” box.
6. Then, in the “Devices” dialog box, highlight (single left click) the FM-4 device that you just added and click the “Select” button. This step tells the GUI specifically *which* FM-4 you want to connect to.



7. Next, click on the “Online/Offline” button just to the left of the Status indicator. In the Status window you may see the message “Trying” as the GUI is handshaking with the FM-4. Once the handshake is complete and communication protocols are locked in, the status message should revert to “Online.”

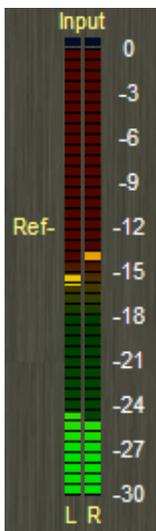
If for some reason the GUI cannot connect with the FM-4, the “Trying” status message will remain and will occasionally blink as the GUI retries the establishment of a connection. Conversely if the network is slow, you may see the word “Pending” appear in the Status window.

If the GUI cannot connect and be Online to the FM-4, the configuration of the GUI's networking parameters, those of the FM-4, and sometimes even those of the interconnecting network should be carefully examined to ensure that the destination TCP/IP address assigned to the FM-4, GUI Lite, and the host PC's network configuration conforms to the expected networking parameters for the host network.

Note also that unless special routing has been configured by the IT department, the controlling PC and the FM-4 must be on the same network subnet. As an example, if the FM-4 was assigned the IP address 192.168.1.194, then the PC's IP address *must* be between the addresses 192.168.1.1 and 192.168.1.254, noting that the FM-4 and GUI PC cannot share the same IP address.

Setting Input Audio Levels

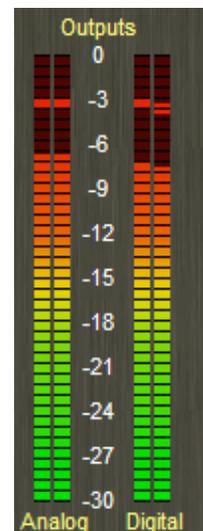
- Connect the Analog or Digital audio inputs as appropriate for your installation.
- Start up the FM-4 GUI Lite application and configure a device if you haven't done so already and then connect to the unit. (see page 17)
- Click on the "Calibrate Input/Output" menu tab at the top of the GUI and select the Input source to match the Input type you connected to the rear panel. If your audio source is already providing an audio feed, you should see meter activity on the Input and Output meters.



**INPUT
METERS**

While still in the Input menu and observing the Input meters within the GUI or on the front panel, adjust the Input Gain control (AES or Analog as required) until the input meters are peaking around the -12dBFS "Ref" marking with normal program levels applied.

NOTE: To ensure proper headroom inside the processor's algorithms frequent peak levels exceeded the -12dBFS "Ref" marking on the Input meters are strongly discouraged.



**OUTPUT
METERS**

Setting Output Audio Levels

Now it's time to make the audio output connections as appropriate for your installation and adjust audio output levels.

For the AES Digital Output, connect it to the equipment being fed by the FM-4, navigate to the Stereo Generator screen and adjust the Digital Output level as appropriate. The Digital Output may be operated either pre-emphasized or de-emphasized.

In the absence of a digital input to the FM-4, its default digital output sample rate is 48kHz. If the output sample rate needs to be something other than 48kHz, connecting a digital audio source of the desired sample rate to the input of the

FM-4 will lock its output to that rate (even if the digital audio input is not selected as the on air source! The FM-4's digital audio input is also the digital sync input).

For the Composite output associated with the rear panel BNC connector, connect the FM-4 to the MPX or composite input connector (usually a BNC connector like the one on the back of the STL or exciter). Then, navigate to the Stereo Generator screen and adjust the TX Output control to set the desired modulation level.

Taking Presets

The FM-4 arrives from the factory set to operate with our 'A Quick Start' preset selected. This preset has been carefully tuned to provide a well balanced sound and medium competitiveness and is usually a good starting point for many program formats, markets and competitive requirements.

To select another preset, two methods are available:

1. When the front panel is unlocked turn the rotary encoder until "Presets" is displayed and then press the "V" button. Now the preset list can be scrolled through. When the desired preset name is displayed, press and release the "V" button or encoder knob. The display will briefly show "TAKEN" and then begin showing the new preset name. If the name is longer than 8 characters, the display will scroll to display the entire name.
2. GUI Lite's preset tree can be navigated with the host PC's mouse, and presets are selected for air simply by double clicking on them.

It's good to remember that our preset names don't necessarily mean that the preset can ONLY be utilized by a station with a format of a similar name. Please feel free to try each Factory preset to see how each one sounds on *your* station with *your* format in *your* market!

We frequently add new presets to our Wheatstone Processing website for customers to download. Presets can easily be installed into our FM-4 using the Preset Management tools built into both GUI Lite and GUI Pro (more about GUI Pro later on...).

Tuning Audio Processing – an Introduction

By installing and tuning audio processors in broadcast facilities all over the world we've learned a couple of things that seem to be consistently true across all of those facilities. Since it seems like now is the perfect time to do it we'd like to share a few of those with you now:

No one at a radio station listens more critically to it than after the audio processing is changed.

It can take many weeks or more to narrow down the perfect sound for a station - even more for a station in a major market.

Radio markets are moving targets – you make a change, 'they' make a change, you make another change, 'they' make another change...

Expectations of sound improvement when changing audio processors will almost always surpass reality.

No one in the station's audience hears what we 'radio people' hear.

Changing to a more modern audio processor can make the station sound worse by revealing previously masked problems in the station's audio chain.

There is almost never enough loudness, bass, or high end.

There is no free lunch –you must always pick something to give up to get something that you want even more.

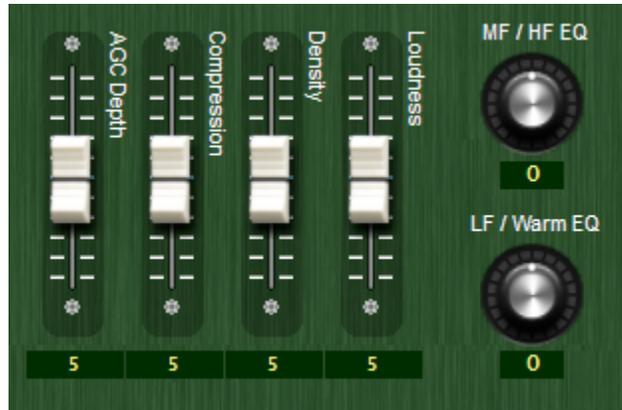
The most important advice that we can share about setting up audio processing, particularly new audio processing, is this:

Make *small* adjustments and listen over a long enough period of time and on as many receivers as you can in order to hear what your current settings sound like on most program material (none of us will live long enough to hear all program material. ☺).

The second most important advice we can give is this:

Resist the temptation to try to fix the processing for the one song that sounds bad. Instead, try to determine *why* that cut sounds bad. If it's the source material that's bad, then fix it. If it's not, *then* work on the processing. Too many get these processes reversed and end up spending a lot of unnecessary time tuning and retuning a processor, trying to fix a particular song or nasty source material and of course, get nowhere.

The tweaking controls in GUI Lite are located on the 'Adjust Sound' tab of the GUI. On this tab are four vertical sliders for 'processing' adjustments and two knobs for 'equalization' adjustments. The image below shows how GUI Lite's 'Adjust Sound' tweakers appear...



GUI Lite's six 'Adjust Sound' Controls

GUI Lite's six tweakers were specifically designed for manipulating our factory presets and each of GUI Lite's six controls has eleven positions. If someone wanted to know how many different sound settings (preset iterations) that makes, simply multiply eleven times eleven, and do it six times (once for each control). The resulting number is how many *different* sound textures can be achieved using GUI Lite with just one factory preset – the number is 1,771,561.

If we take into account the FM-4's two dozen or so factory presets, we can multiply the above result by 24 to arrive at the new total number of possible sound variations. With 24 presets, that turns out to be 42,517,464 (over 42 million) different sound textures that can be created from just the factory presets and the six GUI Lite controls.

Six Controls! Why Not Just One?

There have been simplified user controls on audio processors before. One of the most recognized was a one-knob 'less-more' adjustment. After a factory preset was recalled the user would adjust the less-more control up or down to see if a desired sound could be found.

When asked about it, most customers told us that one knob "didn't allow enough control". They wanted *more*, but didn't want it to be complicated or force them to know audio processing technical terms. They just wanted to be able to take a factory preset and then crank on a couple of tweakers (knobs) that could get them to the sound they wanted. We took their advice and set about to design a better way.

There are only six tweakers associated with adjusting the sound of FM-4 factory presets. Four of them are assigned to tuning the processing “texture” while the remaining two are there to tweak “equalization”.

As mentioned before, each tweaker has eleven positions numbered 0 through 10. When a factory preset is recalled all six tweakers reset to their midpoint positions - “5” for the texture tweakers and “0” for the EQ controls. Each tweaker then allows adjustments up and down from our factory preset’s known starting point.

We’ve made the adjustment range of each tweaker large enough to provide plenty of range around our factory preset values. As we’ve previously seen; with just six tweakers literally millions of possible sound textures can be created. As always, you can safely get right back to where you started out simply by recalling the original factory preset!

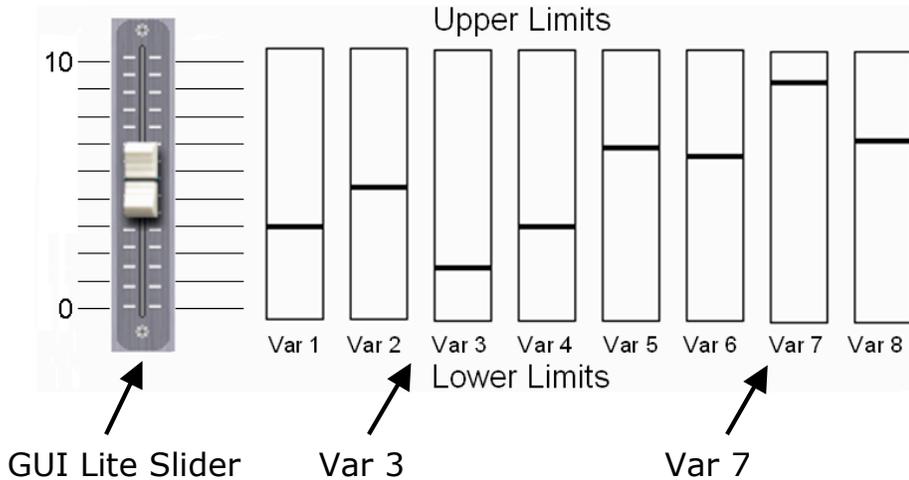
How Do the Tweakers Work?

Each GUI Lite tweaker moves a group of controls that would normally be associated with GUI Pro. Note that the controls in GUI Lite are not *new* controls or ones that are hidden behind some secret back door. Rather, they are the same controls that exist in the “GUI Pro” version of the graphical user interface. The biggest difference between the two GUIs is that GUI Lite can intelligently move *many* controls at once and in any desired direction and by any amount while GUI Pro can only move one of its hundreds of controls at a time.

What Causes a GUI Lite Control to Stop Before Reaching 0 or 10?

Because GUI Lite is adjusting parameters that would normally be associated with GUI Pro, it’s possible for one of the parameters being adjusted to encounter its normal end point while being adjusted by a GUI Lite tweaker.

Since the controls associated with the tweakers are not allowed to go past a processing control’s natural end point, GUI Lite must do something to let users know that an end point that they can’t see has been reached. This is managed by preventing the GUI Lite tweaker from going any further in whatever direction is causing a parameter to reach that natural internal limit, noting that this is the same limit that GUI Pro would bump into if *it* were being used to make changes to a preset. The following graphic tries to illustrate this behavior.



First, notice the 0 to 10 GUI Lite control on the left and the eight vertical bars to its right, labeled Var 1 through Var 8. Those eight vertical bars represent the processing variables that will be altered by moving the GUI Lite slider up and down. Remember that the *real* controls associated with variables Var 1 through Var 8 are *not* seen by a GUI Lite user but they *do* exist in GUI Pro and each 'Var' has its own internal and pre-determined minimum and maximum limits.

Imagine now that the GUI Lite slider is being moved from its current position of '5' and towards '10' – all eight of the Vars assigned to this slider will follow along on a 1:1 basis. Now notice that the parameter assigned to "Var 7" is going to reach its natural upper limit before the others. It might also be obvious too that Var 7 may reach its upper limit before the GUI Lite tweaker even reaches "10". In fact, the GUI Lite tweaker might only reach '8' before "Var 7" actually maxes out. Whenever an internal value reaches its limit the GUI Lite control trying to push that internal value beyond its normal end stop is *prevented* from going any further in *that* direction.

The opposite scenario is also true – when the GUI Lite tweaker is being pulled down towards zero, "Var 3" which is already nearer its lower limit, reaches its lower limit before any of the others. Since the GUI Lite slider must stop when this happens it might only be able to reach a setting of '3' before being prevented from going any lower.

It is very important to remember this concept - if a GUI Lite control won't go any further in one direction or the other it's because one of the variables that it is modifying has reached its normal, and predefined, internal limit.

Each GUI Lite tweaker does the work of many dozens of controls, and each tweaker has enough range to provide a lot of variability from our factory presets, even when the adjustment range seems to be inexplicably restricted by control limits that cannot be seen by the GUI Lite user.

The Six GUI Lite “Tweakers”

“AGC Depth”



Some users prefer deeper AGC action than our Factory presets provide. Others prefer less. The “AGC Depth” tweaker allows this component of the overall processing texture to be adjusted up or down from our factory settings.

Higher settings will cause deeper gain reduction which will tend to hold program levels up longer during a fade. Likewise, lower settings leave less gain available to pull up the softer passages in programming.

Note: the FM-4 GUI indicates up to 30dB of AGC/Compressor gain reduction while the front panel is limited to 22dB. Because there is over 48dB of *distortionless gain reduction* available in our gain control algorithms, users need not be too concerned about deep amounts of AGC or Limiting activity shown on the meters. If it sounds right, it *IS* right!



Tech Tip: Our feed-forward AGC algorithms sound exactly the same at 10dB of gain reduction as they do at 30dB. Therefore driving the AGC harder won't make the resulting sound 'denser'. That task is best left to the Compression and Density controls covered next...

“Compression”



While the “AGC Depth” tweaker adjusts how *deep* the compression is, the “Compression” tweaker adjusts how *audible* it is. Pushing the tweaker up to higher numbers causes an increase in the *audibility* of compression, an effect desirable in some formats in order to create a certain level of ‘excitement’ on the air. Likewise, reducing the setting of the “Compression” tweaker reduces the audibility of compression.

Hint: Those seeking that old ‘60’s’ retro sound from back when processing was quite simplistic (and made a lot of audible mistakes like pumping and breathing), will find the Compression tweaker quite useful.



Tech Tip: The Compression tweaker primarily alters the difference between slower AGC and faster Compressor activity. For very dynamic program material, higher settings of the Compression tweaker can become *quite* obvious. The reverse is also true – very compressed source material will be affected *less* by the Compression tweaker.

“Density”



The “Density” tweaker operates just like a power control. Higher settings increase both short-term density and the average audio level, making the audio not only louder, but also fuller. Some formats desire a denser sound in order to create a certain emotional feel for their on-air presentation, and this is the control that does it.

Lowering the setting of the “Density” tweaker reduces the short-term density and makes the audio sound more relaxed. A lower Density setting will be a little less loud to the ear even though the peak levels have not changed. Perceived loudness can be increased by using the Loudness tweaker (described next). Note that lower Density control settings can be beneficial to a station’s long-term listening ratings, especially those stations that are targeted towards female audiences.

“Loudness”



The operation of the Loudness tweaker is, and on purpose, **very** obvious ... higher settings become much louder while lower settings will be less so. At the upper extremes of this tweaker’s settings, and with some combinations of the other GUI Lite settings, the loudness versus distortion “ouch factor” might be reached before the Loudness tweaker reaches its “10” setting.

Basically, if it’s loud enough (or too loud) on the air and is also riding the hairy edge of distortion on some material – or perhaps is already over it – simply reduce the setting of this tweaker by one number and then listen and analyze again.

“MF/HF EQ”

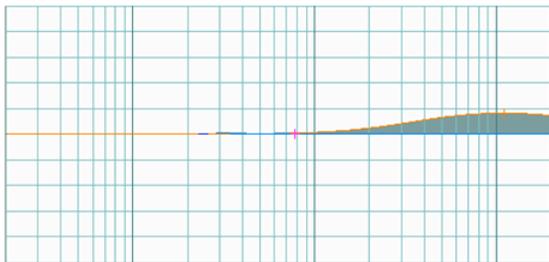


This tweaker modifies the *mid* and *high* frequency equalization balance to be different from that of our factory presets. Because of this the equalization tweakers in GUI Lite have been designed to operate *completely differently* from how the four texture tweakers work.

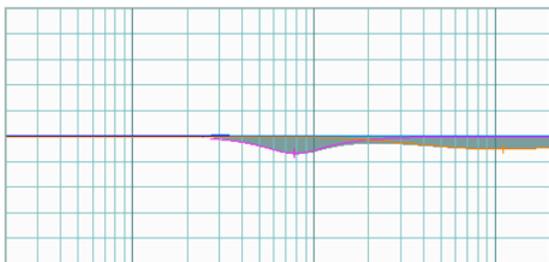
While the texture tweakers work by applying *offsets* to the settings recalled by factory presets, the EQ controls apply several different *fixed* values of frequency, Q (bandwidth) and equalization boost or cut. This allows a user to try out or apply a completely different style of equalization than that stored in the factory preset.

Because the factory equalization is, for all practical purposes, turned off when an EQ control is moved away from its initial ‘0’ setting, to reset the equalization back to the original starting point the last preset that was taken must be recalled.

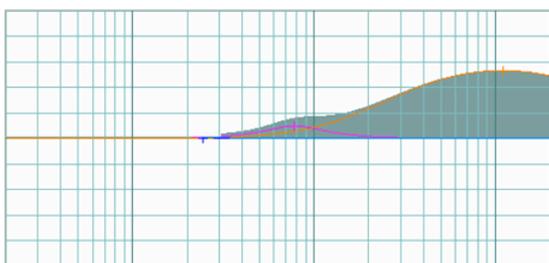
The series of graphics below show the default EQ of a sample preset compared to the resulting EQ at the maximum and minimum settings of the GUI Lite MF/HF (Mid Frequency/High Frequency) EQ knob.



Default MF/HF equalization as set in one of the Factory presets.



Response at the minimum setting of the MF/HF equalization control.



Response at the maximum setting of the MF/HF equalization control.

“LF/Warm EQ”

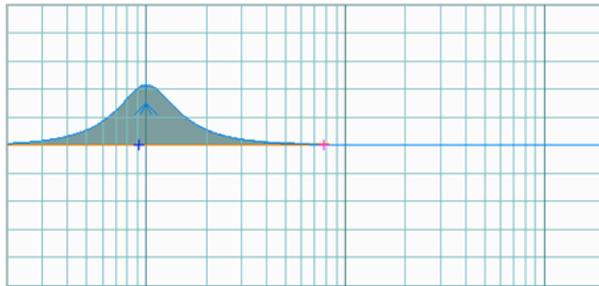


Rather than applying a boost and cut as the MF/HF controls do, we designed this tweaker to allow users to choose between *two completely different styles* of bass equalization.

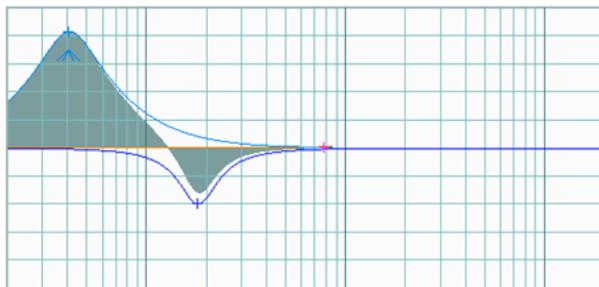
In the counterclockwise direction the tweaker provides increasingly *deep* bass with a small reduction of energy near 180-200Hz (one method to enhance bass in an automobile listening environment without exaggerating the inevitable interior resonances). In the clockwise direction of the LF/Warm EQ control, a *broad* bass equalization is increasingly applied, creating a warm, fat sound on the lower frequencies.

Because the factory equalization is, for all practical purposes, turned off when an EQ control is moved away from its initial ‘0’ setting, to reset the equalization back to the original starting point the last preset that was taken must be recalled.

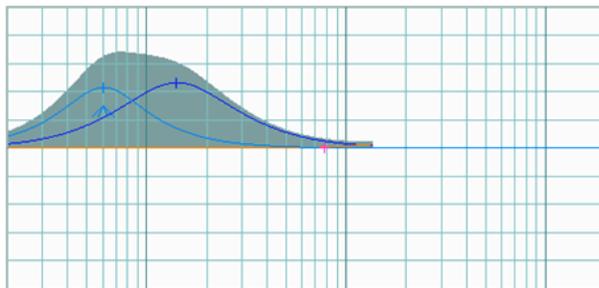
In the series of graphics below the default EQ of a preset is compared to the EQ at the maximum and minimum settings of the GUI Lite LF/Warm EQ knob.



Default LF/Warm equalization as set in one of the Factory presets.



Response at the minimum setting of the LF/Warm equalization control.



Response at the maximum setting of the LF/Warm equalization control.

GUI Lite Caveats

While 'GUI Lite' can't compete with 'GUI Pro' in terms of the ability to perform deep customization of the sound of our Factory presets, it *can* help customers with limited audio processing experience very quickly and easily achieve their desired sound without needing to learn all the interactions and idiosyncrasies of over a hundred of the FM-4's processing controls.

What follows is an overview of what facts to keep in mind about how GUI Lite interacts with both the FM-4 and the Pro version of the GUI.

1. GUI Lite can only modify *virgin factory presets*.

GUI Lite relies on factory-assigned default starting points within the factory presets before it can make any modifications and the only presets that can be modified by GUI Lite are factory presets.

2. Once a factory preset has been modified by GUI Pro it *cannot* be modified using GUI Lite.

If a factory preset has been modified by GUI Pro it is no longer a virgin 'factory' preset, and therefore it is not allowed to be modified using GUI Lite.

3. User-created presets *cannot* be modified again by GUI Lite.

User-created presets do not have the factory-assigned reference starting points known to GUI Lite and therefore GUI Lite cannot modify those presets.

4. GUI Pro can customize presets created by GUI Lite although the reverse is not true.

GUI Pro has full control of all parameters regardless of how, where, and by whom they were created. GUI Lite, in order to maintain its simplicity of use, does not have (and cannot have) the same level of freedom.

5. GUI Lite is not permitted to recall a factory preset, modify it, store it, recall it, and then modify it again.

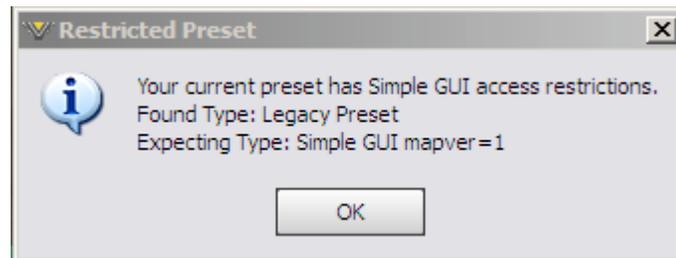
Such an exercise would likely not prove useful and would destroy the original factory assigned default reference points. If more control than GUI Lite is required, then GUI Pro is the tool to use.

Understanding the differences between Factory and Legacy presets, and how they work with GUI Lite.

- Factory presets are those created by the Factory using specialized tools.
- Legacy Presets are presets that are created and saved by a customer using either the full control program, GUI Pro, or GUI Lite.

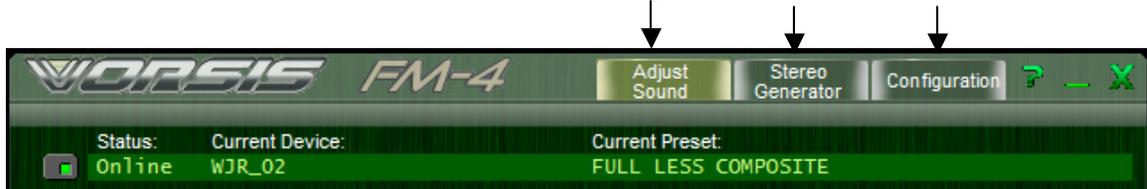
The biggest difference between the two types of presets is that GUI Lite is permitted to modify *only* Factory presets.

If while using GUI Lite you receive the “Restricted Preset” warning dialog shown below *and* you know for sure that the preset being adjusted is a virgin Factory preset, simply recall the preset again using GUI Lite and the error should disappear.

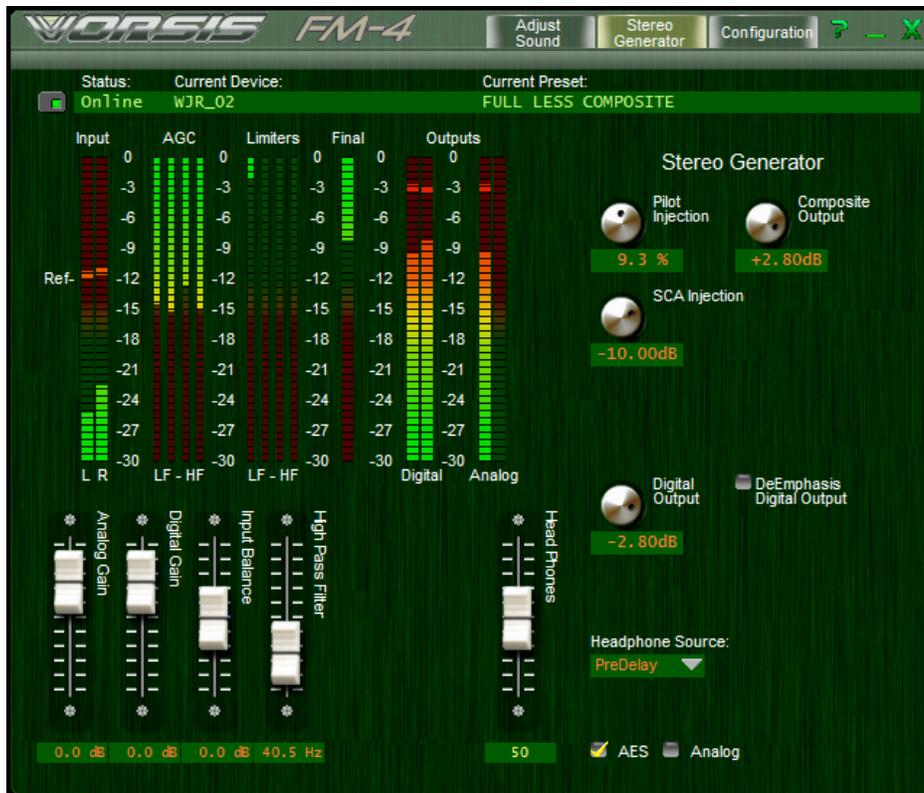


The Other Two Pages of GUI Lite...

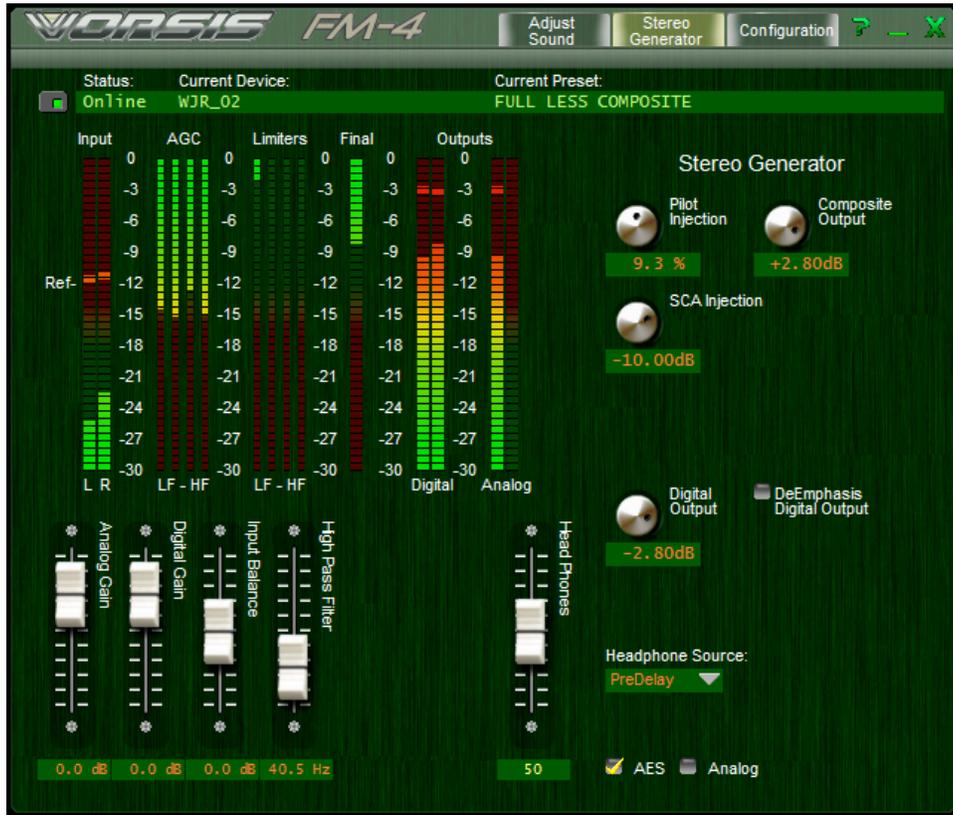
The ability to make simplified adjustments to Factory presets in order to put the FM-4 in service is nice, but a way to configure settings such as the Input Source and Output Levels is also needed and that's where the other two pages of GUI Lite come in. To find all the controls in GUI Lite simply press one of the three navigation buttons at the top of the GUI's navigation bar.



Up to now we've been discussing the "Adjust Sound" page, as that's the one that most customers will want to play with first. But there are two *other* pages of GUI Lite that need some explanation too, the ones that are reached using the "Stereo Generator" and "Configuration" buttons. Below is the Stereo Generator page.



FM-4 GUI Lite 'Stereo Generator' Page



FM-4 GUI Lite 'Stereo Generator' Page

Along with Stereo Generator controls are others for selecting the Analog or AES Digital input, adjusting the gains of the Composite and Digital outputs, and selecting the audio source for the headphone output.

Note that for convenience the headphone volume control appears on *all* pages of GUI Lite, and the headphone source selector is present on both the Stereo Generator and Configuration pages.

Finally we come to the Configuration page, the third and final page of GUI Lite. This is the page that hosts the Device configuration dialog, Headphone Source selector, and the options for allowing presets to change the Input/Output settings, or retrieving metering data over the network via the TCP/IP protocol instead of UDP (the default).



FM-4 GUI Lite 'Configuration' Page

I/O Settings Change with Preset Takes

Sometimes it's useful to have a preset change some setting of the input or output when it is recalled. FM-4 has the capability to do this.

When a preset is saved, that preset is a snapshot of every setting in the FM-4, including the selected audio input source, the input gain settings, current output level settings, etc. Therefore, to use a preset to retrieve your custom I/O settings, simply save a preset with all of the settings that you'll need to change later on, and before retrieving that preset from the FM-4 memory check the box in the Configuration page that says "I/O Settings Change with Preset Takes."

IMPORTANT NOTE!

If a Factory preset is retrieved while the “I/O Settings Change With Preset Takes” option is checked, the settings that were current when **we** created the preset will become current! This creates a caveat of “I/O Settings Change with Preset Takes” usage that is perhaps best explained by example:

*We utilize the digital audio input in our lab to feed the audio processors when in the process of making Factory presets. This means that the Factory presets have the digital audio input selected and if your station is using the FM-4's **analog** inputs and a Factory preset is taken while the “I/O Settings Change with Preset Takes” option is checked **you will go off the air** because when the preset is recalled the processor will switch to the **digital input!!***

Resolving FM-4 'Network to GUI' Connectivity Issues

The FM-4 uses both TCP port 55987 and the first available UDP port in the range of 60001 to 60010 during communications sessions with the remote GUI software.

The TCP protocol is used for controlling the FM-4 and for reporting its control settings back to the GUI because that protocol works to repair *all* transmission errors that might occur on the network. Using the TCP/IP protocol guarantees that the FM-4's controls will *always* do exactly what you tell them to do and that the control settings you see on the GUI are in 100% agreement with what the FM-4 hardware thinks they are.

Getting metering from the FM-4 back to the GUI is however, a different story. For this task we chose the UDP protocol which is a simple data transmission model without any hand-shaking. UDP is used for metering because of its low overhead, and because we don't mind if an occasional meter data packet (or a bunch of meter packets) gets lost. Metering data is updated so frequently that a few dropped or corrupted metering packets will have an inconsequential effect on the visual appearance of the metering or graphics.

What this all means is that the FM-4 expects to be able to use TCP port 55987 and UDP ports in the range of 60001 to 60010 on the portion of the network connecting the FM-4 and the host PC running the GUI.

The most common 'connectivity' problem that we see in the field is when UDP packets are being blocked on the host network. When this happens, GUI Lite won't be able to receive metering data from the FM-4. The GUI will be connected and online to the FM-4 (GUI status shows as "Online") and will even be able to control the FM-4, but the meters and graphics will appear to not be working.

If this happens, navigate to GUI Lite's Configuration tab and check the box labeled "Metering Data over TCP/IP." Using TCP for metering will increase network traffic due to the handshaking required on every metering data packet. Therefore metering might - depending on network congestion - appear a bit slower or jerkier than if the default UDP protocol were being used.

Don't forget to check the Windows Firewall settings if the FM-4 GUI and hardware can't connect at all even if Metering via TCP/IP is selected!!

Unlocking the Front Panel

There is no factory default passcode for the FM-4 – it leaves our factory in an unlocked condition.

To *unlock* the front panel *after* it has been locked with a passcode:

- Scroll through the front panel menu until the word 'Access' is displayed. Press and hold the front panel knob until the "Pass 0000" prompt appears - the first two digits will be flashing. Next, turn the knob to select the first two numbers of the passcode. Once those numbers are visible and flashing, press the encoder knob or lighted "V" button in to lock those digits in place. This will move the flashing cursor to the second pair of digits.
- When the second pair of digits begins to flash turn the knob clockwise until the second two digits of the passcode is showing in the display. Then press the encoder knob or lighted "V" button in to lock those digits in place. The message "OK" should appear and the front panel should be unlocked.
- The front panel may be locked by scrolling through the front panel menu until the 'Access' item is displayed and then pressing in and holding the encoder knob or lighted "V" button until the display reads "LOCKED." The locking procedure utilizes the password that you have previously stored in the hardware.
- Note that if no front panel passcode has been assigned to the FM-4 the front panel *cannot* be locked.

Contacting Wheatstone Technical Support

Our technical support department is available weekdays during the hours of 8am to 5:30pm, U.S. East Coast time. Our telephone number is 1-252-638-7000.

Our website at www.wheatstone-processing.com provides a wealth of information about our products. User manuals, specialized presets, the very latest software and myriad Vorsis application notes in PDF format are available for download.

Our goal at Vorsis is to design and build the very best sounding, most reliable audio processors available anywhere. Customer input and product suggestions are taken seriously by our development team, and this data is always considered when we design new products or do product updates. Please feel free to email us at techsupport@wheatstone.com with your product suggestions. We do value your input – and we take it seriously!

FM-4 GUI Pro – What is it? Do I need it? How do I obtain it?

The full GUI, or GUI Pro, is *widely acclaimed* by our end users for its completely unrestricted access to all of our processing controls and its quantity and quality of visual feedback provided to the user.

However, such depth of control can be intimidating to users without much experience adjusting complex broadcast audio processors such as our top of the line processor, AirAura (and its 446 individual adjustable controls!).

Visit www.wheatstone-processing.com and sign up to receive GUI Pro at no charge. We'll provide you with login credentials, tell you how to download it and turn you loose on the Vorsis processor of your choice.

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Appendix

General Purpose Input – GPI

The FM-4 is equipped with eight optically isolated control Inputs that may be used in a variety of ways. The GPI interface provides eight separate **General Purpose Inputs**, sharing a common return. The connector is a female DB15 connector with the following pin assignments. Note that all pins are isolated from FM-4 internal circuitry!

Pin 6 - GPI 1 In Pin 2 - GPI 2 In
Pin 7 - GPI 3 In Pin 3 - GPI 4 In
Pin 8 - GPI 5 In Pin 4 - GPI 6 In
Pin 9 - GPI 7 In Pin 5 - GPI 8 In
Pin 1 - GPI COMMON

Each of the GPI inputs of the FM-4 is current limited by an internal 475 ohm resistance. The maximum rated forward current of the GPI input is 50mA with its normal operating current around 5mA, therefore it is necessary to calculate if an additional outboard series resistance will be required in your particular application.

The following table may be used to determine if an external resistance is required and if so, what value it should be. In all applications up to and including 48VDC, a one-half watt resistor is sufficient.

Applied Voltage to GPI	External Resistance Required
3.3 VDC	None
5.0 VDC	330 Ohms
6.0 VDC	470 Ohms
7.5 VDC	820 Ohms
10 VDC	1.3k Ohms
12 VDC	1.8k Ohms
15 VDC	2.4k Ohms
24 VDC	3.9k Ohms
30 VDC	5.1k Ohms
48 VDC	9.1k Ohms