FM5 Digital Audio Processor
Preliminary Quick Start Guide

Version 0.9.jk – July 2007

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Please inspect the contents of the package to ensure that the following items are present:

Vorsis FM5 Unit	Quantity 1
Vorsis GUI Software CD	Quantity 1
AC Power Cord	Quantity 1
Technical Manual	Quantity 1
Quick Start Guide	Quantity 1
Vorsis Warranty Card	Quantity 1

Install and connect the Vorsis FM5:

1. Install the FM5 in the equipment rack using at least two rack screws. If only two screws are used they *must* be installed in the bottom holes of the rack ears to prevent undue stress on the front panel and possible bending.

2. Connect the audio input(s) to the appropriate XLR female input connector(s) on the rear panel.

3. Connect the line level analog outputs, the AES digital output, or FM composite stereo output(s) as required in your installation.

4. To use the Vorsis FM5 GUI software connect the rear panel Ethernet RJ-45 jack as appropriate for your intended use:

   a) For direct connection to a PC use a crossover CAT5 cable;
   b) For connecting into your LAN use a straight through CAT5 cable from Ethernet switch or HUB.

5. Connect the AC power cord to the FM5 rear panel AC power connector and then plug it into AC power. The FM5 will power up and all DSP related signal paths should be intact within 15 seconds.

Operating the FM5 locally:

The front panel of the FM has only two user controls, a rotary encoder with integral push switch and a black push button located directly below the rotary encoder and these controls are assigned to the following functions:

Unlocking the front panel:

The factory default passcode is "**1234**". To do this, press in and hold the jog wheel until the "Pass 0000" prompt appears - the first two digits will be flashing. Turn the rotary encoder clockwise until "12" appears in the display and then press the encoder wheel to lock these digits in place and move the cursor to the second pair of digits. When the second pair of digits appears, turn the rotary encoder clockwise again until "34" appears in the display, then press the jog wheel in. The message "OK" should appear. At this point the front panel is unlocked and will remain so for several minutes after which automatic relocking will take place.

The front panel lock/unlock passcode can be changed using the remote control GUI software. Additionally, the front panel does not need to be unlocked in order to connect to the unit with the remote GUI software.

Adjusting the headphone level:

When used in conjunction with the rotary encoder, the black pushbutton allows the audio level of the front panel headphone jack to be adjusted.

To turn the volume up, press in the black pushbutton and then turn the rotary encoder clockwise. The relative position of the control is shown by digits ranging from "0" to "100", with "0" being "Off" and "100" being full volume.

Operating the Vorsis FM5 Remotely – Installing the GUI Software

For remote operation via the GUI software supplied with the unit, insert the Vorsis FM5 software CD into a Windows XP/2000 computer and follow the steps below to install the software. If the software installation does not automatically start when the CD is inserted into the drive, you can start the installation manually by:

- Click Start
- Then click Run
- Then click Browse

- Browse the “My Computer” device tree to locate the CDROM device and then double click it.

- When the contents of the CDROM drive appear in the window, locate the FM5GUISetup_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 FM5 TCP/IP Address[1]

Once the GUI has been installed you must configure it and the FM5 so that they can communicate with each other. This requires configuration for both the FM5 and the remote GUI so that they agree on the networking parameters.

Before starting the configuration procedure, please locate and carefully make a note of the FM5'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:C2:23:xx:xx where xx:xx are the digits unique to your FM5.

Note that if the MAC address is not entered carefully and correctly in the following steps, the FM5's IP address will not be changed!

Start the FM5 GUI software. Then right click on the control area of the GUI and select Hardware/Assign IP Address. The following window will appear:

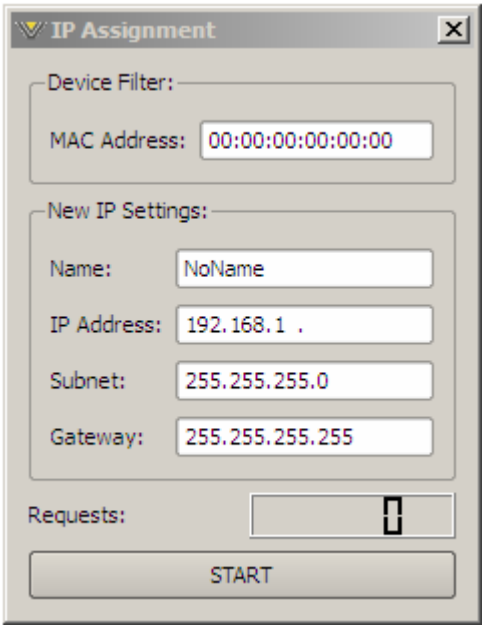


Figure 1 - FM5 Device IP Address Configuration

Next, carefully enter your FM5'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 that was entered in this step. If the MAC address is incorrect, the FM5 will never 'hear' it.

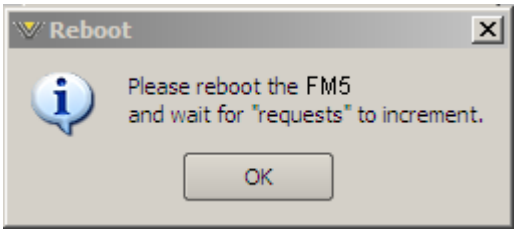
[1] *The FM5 does not support DHCP (Dynamic Host Configuration Protocol) and therefore requires a static TCP/IP address on the network. Its presence on the network will not interfere with DHCP addressing of other network connected devices as long as the IP address that is configured for the FM5 does not conflict with the address of any other device on the network. Please consult your friendly IT manager if necessary.*

Next, enter a pet name for your FM5, like WKRP, etc.

Then, enter the IP address that you wish the FM5 to have, noting that this address must be unique if the FM5 will be communicating over your network.

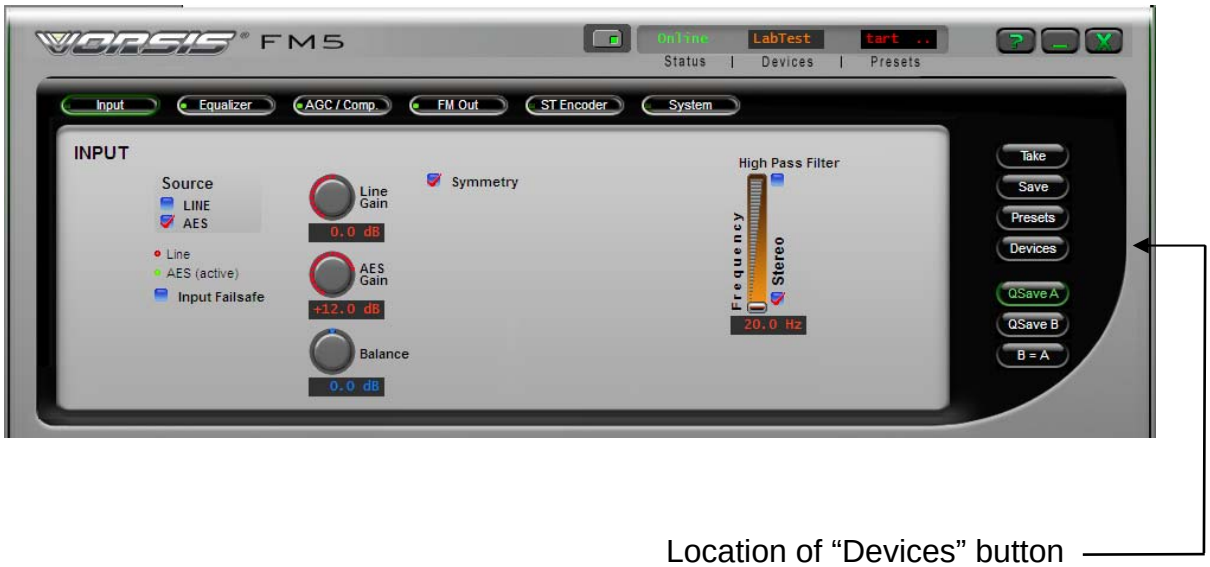
Next enter the desired Subnet Mask and Gateway IP addresses. In some cases (but not all) it is sufficient for these both to be 255.255.255.255.

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:



Click OK and then remove power to the FM5 for a few seconds and then reapply it. As the FM5 is booting up, the “Requests” number in the IP Address window should increment to something other than zero (please see the bottom of the image in Figure 1). When this occurs the FM5 has been programmed with its new IP address and is ready for use.

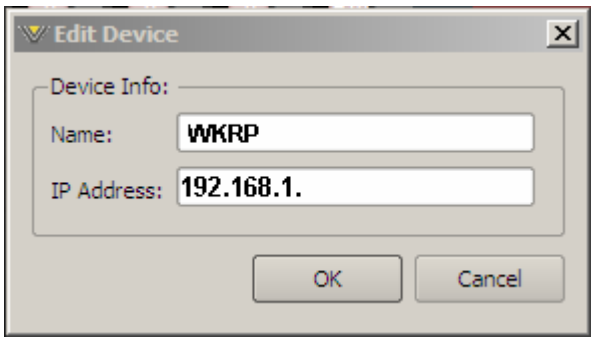
Now that the FM5 has its own TCP/IP identity, we must configure the GUI so that it can talk to the FM5. This is done by adding “devices” to the list of FM5’s that the GUI knows about. To do this, locate and click on the “Devices” button that is located along the right side of the GUI.



When this is done, the following window will pop up:

Devices Dialog Box

Next, click the “Add” button and a new dialog box will appear - this is how new devices are added or the configuration of existing ones modified



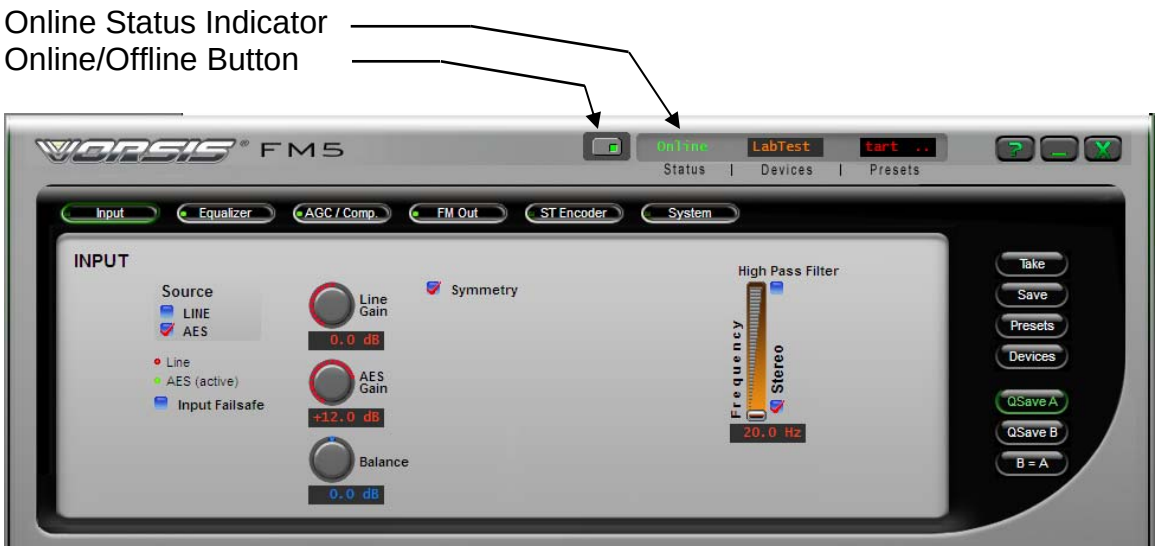
Edit Device Dialog Box

First, enter the same pet name that you used when you assigned the IP address to the FM5.

Next enter the IP address that you configured the FM5 for in the previous steps. Note that it is always best to completely delete any existing data in the IP Address box and enter the IP address from scratch. We apologize for this inconvenience.

After this is done you may click “OK” on the Edit Device box. Then, in the Devices Dialog box highlight (single left click) the FM5 device that you just added and click on “Select”. This step tells the GUI specifically which FM5 you want to connect to.

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 FM5. Once the handshake is complete and communication protocols are locked in the Status message should revert to “Online”.

If for same reason the GUI cannot connect with the FM5, the “Trying” status message will remain and will occasionally blink as the GUI retries the establishment of a connection. Under these circumstances the configuration of the GUI and FM5 should be carefully examined to ensure that the destination TCP/IP address is consistent between the two.

Of particular importance is that the controlling PC and the FM5 must be on the same network subnet. For instance, if the FM5 was assigned the IP address 192.168.1.194, then the PC’s IP address must be between 192.168.1.1 and 192.168.1.254, noting of course that the FM5 and GUI PC cannot share the same IP address.

Additional Notes on FM5 GUI Connectivity:

The Vorsis FM5 uses both TCP port 55892 and UDP port 60001 during communications sessions.

TCP is used for controlling the FM5 because TCP works to repair any transmission errors that need to be corrected. This ensures that the FM5’s controls will always do exactly what you told it to do from the remote GUI.

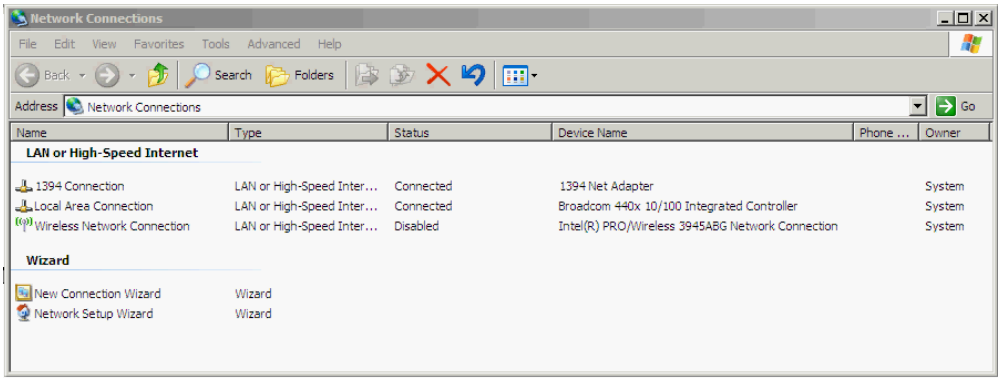
UDP on the other hand is used only for returning meter data back to the GUI from the FM5. We use UDP because of its low overhead and because we don't really mind if a meter data packet is dropped occasionally. They are updated so fast that missed meter packets are inconsequential to the operation of the unit.

What this means is that network traffic on TCP port 55892 and UDP port 60001 must be allowed on the portion of the network between the computer that the GUI is running on and the actual FM5 hardware. If this is not true, then they will not be able to communicate with each other.

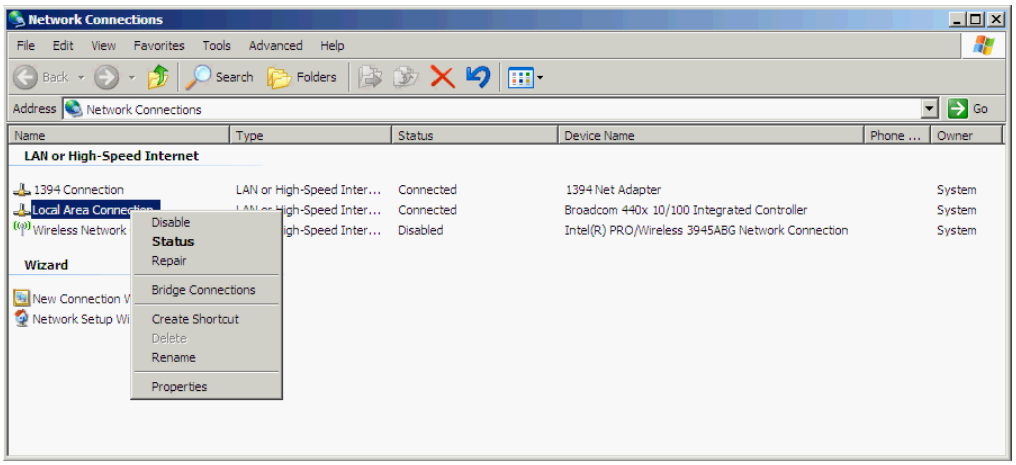
A Known Windows Networking Issue:

We've observed that certain builds of WindowsXP exhibit inconsistent behavior during either the IP address configuration process or later during attempts to connect to the FM5 with the GUI. In most cases this is due to old data being in the PC's ARP (Address Resolution Protocol) cache – the first place Windows looks for how to connect to a networked device.

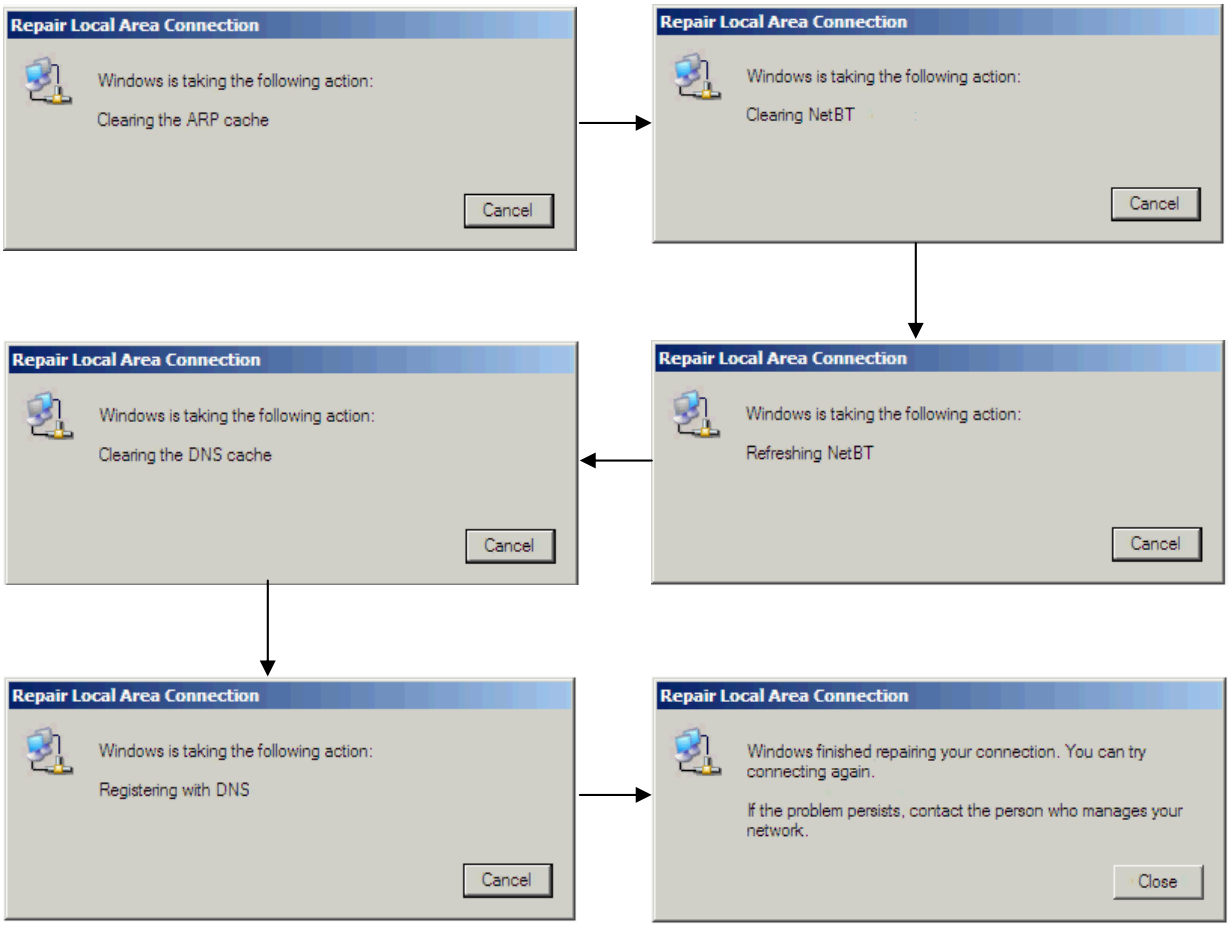
The ARP cache can be cleared manually at a command line, but it's much easier done using the built in tools within Windows. To do this, open the Windows Network Connections dialog:



Next, highlight the Local Area Connection and then right click it. A drop down menu similar to the following will appear:



One of the options in the drop down box is “Repair Connection”. What this does is reset the PC’s Ethernet interface – in essence ‘refreshing’ it. During this process the following six messages will go by:



This process usually completes in a few seconds and when it does the network connection should be fully functional. If it still does not work, then some friendly assistance from your local IT guru might be required.

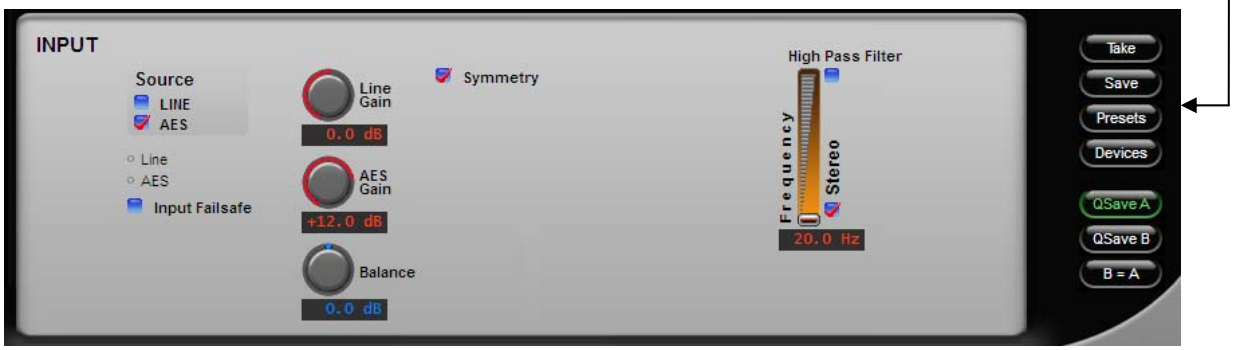
Factory Presets:

The FM5 is currently shipping with approximately 20 factory presets. They were created for use with various programming formats and were compared to those of competing products currently on the market to ensure that there is some compatibility between them, format-wise. Please take the time to cycle through the various factory presets to find the one that best suites your particular situation. Once this is done, any fine adjustments can be made to personalize it for your station.

Note that the factory presets are locked and cannot be deleted or overwritten. This is done to ensure that there is always a known reference point to return to.

The factory presets are also located on the CDROM that came with your FM5. If for some reason you wanted to re-copy them to the FM5 you would use the "Install Preset Package"[1] option in the presets dialog in the remote GUI.

Presets Button

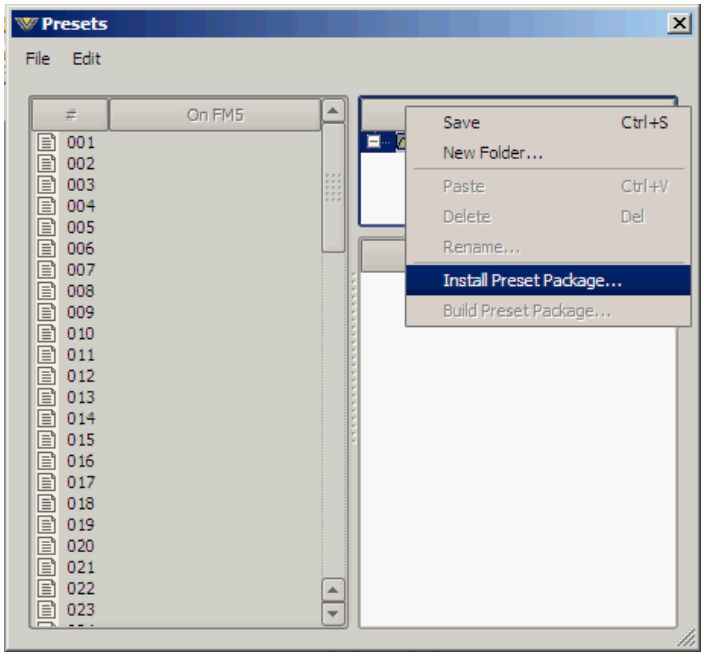


Note: The Presets dialog is available in all GUI screens of the FM5.

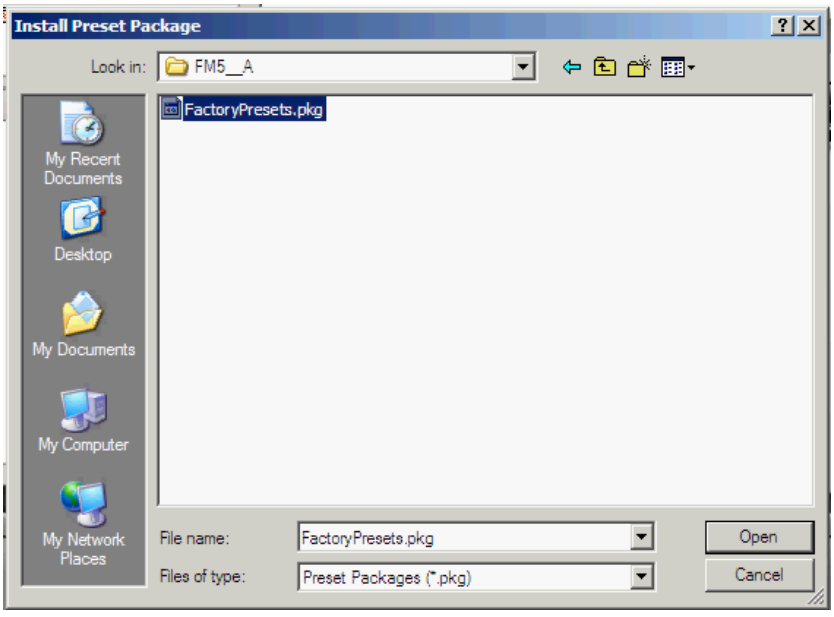
[1] A Preset Package is a compressed binary file that containing one or more Vorsis presets. The package is created using a special "Create Preset Package" utility and provides a handy way to distribute your Vorsis presets to others or simply back them up for safekeeping.

While in Preset Package form, the settings of the individual presets contained in the package are encrypted and cannot be viewed or extracted with other software utilities. The Preset Package installer is the only way to restore them to their original form.

Pressing the Presets button opens the Presets dialog, and right clicking on the Favorites folder brings up the option to save a preset, create a new preset folder, or install a preset package.



If the Install Preset Package option is chosen, a new dialog pops up to prompt for the location of the preset package file:



Once the Open button is pressed, the presets will be uncompressed and moved to the folder that was highlighted at the start of this process. If a new folder was created first and that folder was highlighted, then the new presets being installed would be placed there.

Architecture of the FM5 GUI (Graphical User Interface)

The FM5 GUI allows you to adjust the processor as well as view in real time how it is reacting to the audio passing through it. The FM5's GUI has been very carefully designed to put parameters never more than two mouse clicks away. This is a radical change from competing products where constant navigation through numerous layers of menus and screens is required.

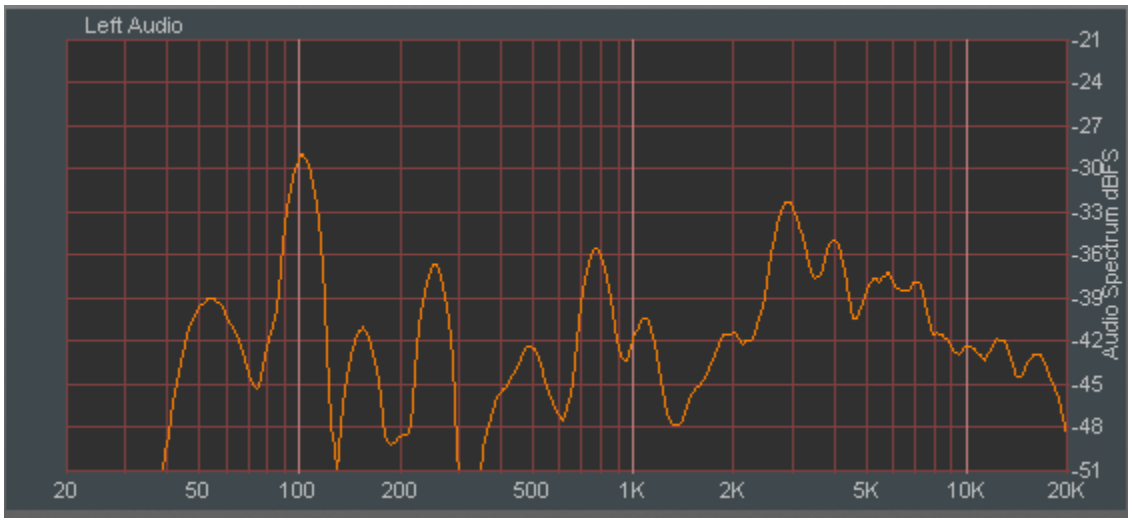
Using the FM5 GUI

The GUI may be positioned on the host computer's screen by left-clicking-and-holding the "Vorsis" logo, and dragging the GUI to the desired position. In true "Windows" fashion, the GUI may be minimized on the desktop (taken off the screen) and/or closed by way of the familiar controls at the extreme top right.

Descriptions of the features and functions of the GUI will follow different discrete regions of the screen; it will begin with the most eye-catching region – the Dynamic Displays – and then we'll explain the Control Area above it, followed by the Side Bar buttons, and lastly the Title Bar.

Frequency-Domain Graph

Visually the most important element on the main screen, and in fact dominating the lower half, is a large graphical display depicting the standard audio frequency range of 20 Hz – 20 kHz arranged in logarithmic fashion with gradations at ten salient frequencies. The vertical axis scale changes according to its context, however the overall vertical range remains at 30dB with gradations every 3dB.



FM5 Audio Spectrum Display

A number of real-time dynamically varying spectra and other frequency-response-versus-time data may be observed simultaneously. A row of large buttons under the graph determine what data is displayed, and there are also buttons to enable/disable the display of equalizer frequency response curves, filter responses, etc.

The display range of the display may be changed by dragging the right-hand scale up or down as desired.

Display Signal Selection

To the right beneath the input metering bargraphs are three large buttons:

Input, FM Pre-delay

By single clicking on a button a green indicator on the button will indicate when the selected signal is being analyzed by a Fast-Fourier Transform (FFT)[1] based real-time spectral analysis. This analysis is viewed on the large graphical display above the buttons.

An FFT is a mathematical filtering process which calculates the spectral content of a time domain signal. The FFT is widely used in test equipment in the audio industry because of its extremely precise measurement capability. Thanks to the extremely efficient DSP chips utilized in the FM5, we are able to offer the same exotic measurement capability in our audio processors. Thus what you see on our graphics displays is as precise as current technology permits.

INPUT — Pressing this button enables the FFT analysis of the selected (Left/Right, A/B) input signal.

FM Predelay – Enables the FFT analysis of the output of the FM processing chain prior to the diversity delay.

Immediately above those buttons are four small checkboxes which can be selected by single click. A red checkmark will appear within the box when parameters have been selected.

As each option is enabled (checked) its data will be added to the graphical display. When the L/R button is unchecked, Left Channel data is displayed. When checked, right channel data is displayed.

[1]The Fourier analysis is named after French mathematician and physicist Jean Baptiste Joseph Fourier who first explained it. For more information on the FFT and some of its capabilities, please consult the "Handbook for Sound Engineers" by Glen Ballou and published by the Howard W. Sams Company (ISBN 0-672-21983-2).

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Control Region
This is the large “enclosed” area directly above the graph and meters and contains all of the knobs, faders, switches and checkboxes affecting the audio processing itself. To operate them, either:

- Place the cursor over the desired control, and use the mouse’s scroll wheel to “increase” or “decrease” the control’s position, or;

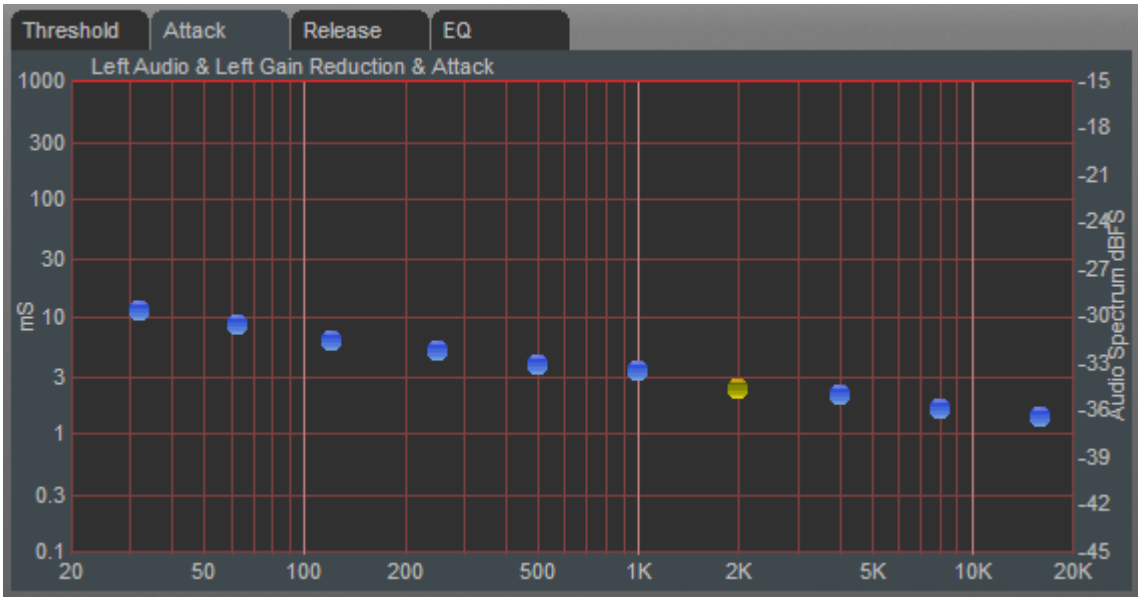
- Click on the control, and slide the mouse to move the control - up or right increases the control’s indicated position, down or left decreases it. In either case, the resolution of the control variation can be increased - made finer - by holding down the keyboard’s Shift key while adjusting the control as above.

Processing Section Selection Bar

From left-to-right across the upper portion of the graphical area are a series of buttons corresponding to logically arranged processing sections in general signal flow fashion in order of input to output. A small green indicator at the left end of each button indicates if any signal processing within that block is active. In the above graphic, the System menu has been selected. Left-clicking a button opens the associated control panel to gain access to the controls for that block of signal-processing or input/output controls.

FM5 Graphical Interface Operation

The operating parameters of each of the 10 bands of FM limiters can be individually adjusted. Each of the blue dots on the screen represents the center frequency of a band. By double clicking it (to highlight it) and dragging it with the mouse a particular parameter for each band can be adjusted.



Example Graphical Control Screen

There are other ways to set parameters too. In fact all of the controls on the graphical screen work the same way, and each parameter to be adjusted is selected by clicking on the tabs at the top of the screen.

By right clicking on the graphical display area with your mouse the following options will appear:

Group Adjusters
Ungroup Adjusters

Group All Adjusters
Ungroup All Adjusters

Flatten

Proportional Drag
Flat Drag

First, a short tutorial….

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

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

If you now double click another blue dot somewhere else on the line, it too will turn red….

Now if you move the mouse to a point *between* the two dots selected in the above steps, right click the mouse and select “Ungroup Adjusters”, all the points in between the first two dots you selected will now also turn red. At this point all of the dots between the first two can be *individually* adjusted up or down.

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

Right clicking on the graphical area and selecting “Group All Adjusters” removes all highlighted dots. Conversely, right clicking and selecting “Ungroup All Adjusters” turns all (remaining) blue points red, meaning they can now each be individually adjusted.

(The “Flatten” function although next in the list is best explained last….

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

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

So now, after these exercises the line is probably all messed up. You want to put it back to where it was or at least make it all flat again without having to move every single point back, right? But how do you do that? Easy…..

Right click on the graphical area again and select “Flatten”. If there were any points still highlighted red you’ll want to first click “Group All Adjusters” before you select “Flatten” in order to turn them off. In any case, hen you finally click “Flatten the line will return back to flat and you may move it up and down again with the mouse - this time as a whole.

To review:

Group Adjusters – gangs all the dots between two highlighted points into a commonly behaving entity.

Ungroup Adjusters – disconnects any dots that were grouped by “Group Adjusters”.

Group All Adjusters – gangs all the dots, regardless of highlighting.

Ungroup All Adjusters – un-gangs all the dots, regardless of highlighting.

Flatten – removes any variance to the dots not being horizontal to each other.

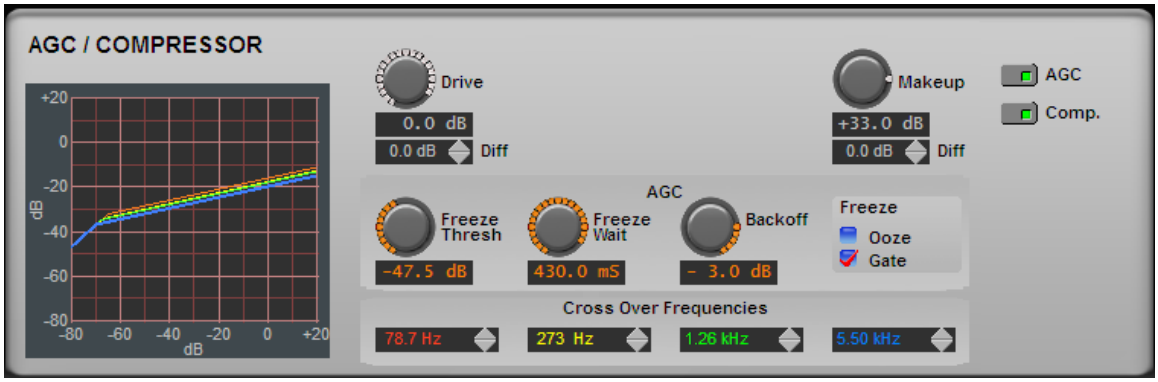
Proportional Drag – allows the dragging of dots to create slopes.

Flat Drag – allows the dragging of dots together in a ‘flat’ orientation.

AUTOMATIC GAIN CONTROL and COMPRESSOR MENUS

The FM5 AGC and Compressor sections are inextricably linked by DSP algorithms that logically connect them. Therefore they will be covered collectively in one chapter rather than discussed separately.

Although the AGC and Compressor sections' outputs may be separately enabled or disabled, the Compressor algorithm is always running so that the desired derivative control signals are available to the AGC section.



AGC / Compressor Control Screen

The automatic gain control (AGC) operates in five frequency bands and its long-term operation is a special derivative of the type of program-related processing occurring in the Compressor algorithms. The AGC and Compressor operates in Sum and Difference mode - the highest signal, whether in the sum or difference channel, determines the amount of processing to be applied to both channels.

Crossover Frequencies

The AGC/Compressor is a five band design, so there are four crossover frequencies to select.

- The Super Low to Low band crossover frequency is selected using the red list box. Frequencies between 40.5 Hz and 120 Hz may be selected.
- The Low to Low Mid crossover frequency is selected using the yellow list box. Frequencies between 149 Hz and 334 Hz may be selected.
- The Low Mid to High Mid crossover frequency is selected using the green list box. Frequencies between 817 Hz and 1.59 kHz may be selected.
- The Mid High to High band crossover frequency is selected using the blue list box. Frequencies between 2.52 kHz and 7.55 kHz may be selected.

Next we'll talk about how the AGC section works and the relationships between the Drive and Makeup gain controls and their "Diff Trim" sub-controls.

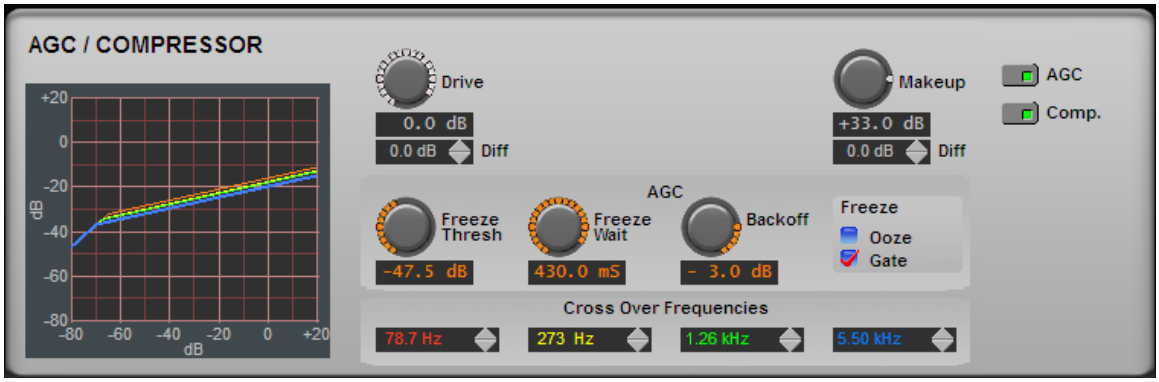
Drive:
The Drive control adjusts the amount of signal into the AGC/Compressor, determining the amount of compression that can be achieved. Driving harder (higher numbers) results in a more consistent on air sound, with an increased capability to pull up low passages in program material. Less drive creates a more 'gentle' on air sound and has less capability to bring up low passages. The Drive control simultaneously adjusts the sum and difference channels.

Diff Trim:
The List box below the Drive control contains the trim adjustment for the Difference channel, and may be adjusted +/- 6dB referenced to the Drive control. In other words, if the Drive control is set to +4.0dB and the difference trim to -5.0dB, the difference channel drive is actually -1.0dB.

Makeup:
The control adjusts the overall gain applied to the output of the AGC/Compressor. Because the five band is a feed-forward design, as gain reduction takes the audio levels down, there must be post-gain applied to “makeup” the gain that was reduced. The Makeup control simultaneously adjusts the Sum and Difference channels.

Diff Trim:
The list box below the Makeup control contains the trim adjustment for output of the difference channel and may be adjusted within +/-10.0dB referenced to the Makeup setting.

Example: If the Makeup control is set to +12.0dB and Diff Trim is set to +3.0dB, the difference channel is then scaled downward 9.0dB (12dB-3dB) below the sum channel.



AGC Button:
When illuminated by clicking on it, indicates that the output of the AGC section is in the audio path.

Comp Button:
When illuminated by clicking on it, indicates that the output of the Compressor section is in the audio path.

If the Compressor is Out and the AGC is Out:
When both AGC and Compressor are switched off, signal is being bypassed around the Compressor and AGC sections with no gain control being performed.

If the Compressor is In but the AGC is Out:
Signal is being routed through the Compressor only, which operates with relatively fast time constants. The sound of the processing will be quite obvious on most program material.

If the Compressor is Out but the AGC is In:
Signal is being routed through the AGC only, which operates with relatively slow time constants. The sound of the processing will be quite invisible on most program material but very short term variations in level will not be corrected.

If both Compressor and AGC are In:
Signal is being routed through the AGC and Compressor, which together operate with different time constants. The sound of the processing will be quite smooth with both short and long term variations in level being corrected. (also see AGC Backoff)

Freeze Gating and AGC Backoff

Freeze and AGC Backoff Controls in the AGC Screen

Freeze threshold:
The Freeze Threshold is the audio level at which the gain reduction release is modified from simple attack and release to a modified release (see explanation for Freeze and Ooze below).

Freeze wait:
The Freeze Wait is how long the gating circuit waits after the signal has fallen below the Freeze Threshold before it modifies the release time according to the “Freeze” setting. The Freeze Wait is adjustable from 50 milliseconds to 500 milliseconds, with values on the order of 50 milliseconds being useful for typical programming environments.

Note: Within the five band graphic are separate Freeze threshold offset controls for each band. This allows a +/-6dB offset to be applied to the overall setting of the Freeze Threshold control on a band by band basis.

Gate:
When “Gate” is selected and the audio falls below the Freeze Threshold, the gains of the five bands will “freeze” at their current values and will hold at those values until audio is present that is above the Freeze Threshold of each band. This prevents the increasing the gain in the absence of audio which would likely increase background noise.

Ooze:
When “Ooze” is selected and the audio input falls below the Freeze Threshold, rather than the gains of the bands ‘freezing’ as above, they will slowly return towards 0dB. This setting may be useful for formats that contain material with very wide dynamic range or for certain speech-based formats where the “Gate” setting may not be appropriate.

The Freeze controls are quite subjective and therefore should be adjusted entirely by the requirements of the program format. There is no right or wrong setting of the “Freeze” controls unless those settings cause undesired, unexpected, or unwanted behavior of the processor during low level program passages.

AGC Backoff:
The AGC Backoff adjusts the processing balance between slower AGC action and faster compression. Because (in the digital domain) the control element for both the AGC and compressor is common, this control may be best thought of as a ‘mixing’ control for the control signals that generate gain reduction for the control element that is common to both.

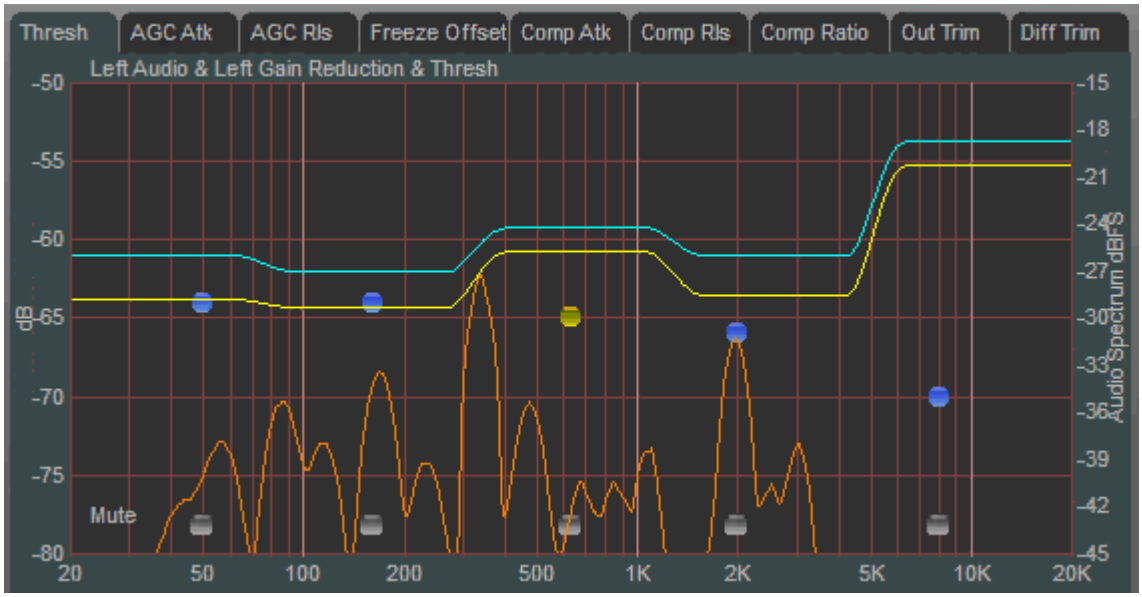
With the Backoff control set at “0”, the audio gain control is primarily due to slower AGC action and therefore short term program dynamics are largely unaffected.

With the control at the other extreme, or -12dB, gain control is primarily due to fast compression and short term dynamics will be aggressively controlled.

The setting of the Backoff control allows you to change the texture of the audio from gentle, unobtrusive gain control (backoff between “0” and about -3.0dB), to very obvious compression (backoff control at “-4.0” or greater negative numbers) creating a sound that is similar to vintage compressors and limiters from the 1960’s.

Note that regardless of the setting of the AGC backoff control, the AGC and Compressor stages operate with their algorithms linked mathematically in order to derive the longer AGC time constants. If for some reason “less” AGC control signal is desired, it may be achieved by lengthening the AGC attack time to large values – say something greater than about 300mS.

AGC/Compressor Gain Reduction



AGC/Compressor Gain Reduction Display

The curve above is broken into five segments representing the instantaneous gain control in each of the five processing bands. The blue line depicts the gain reduction occurring in the slower AGC, while the yellow line depicts gain reduction in the faster compressor.

Just below the Graphical display is a row of several checkboxes. We will describe these in order, starting with the left-most one.

Audio:
When this box is checked and the O-Scope box is unchecked, the graphical display will show an FFT of the audio as selected by the . The displayed range may be modified by left clicking on the scale on the right-hand side and sliding it up and down with the mouse. The displayed viewing range is always 30dB.

- When the Input button is illuminated, the FFT shows the audio spectrum of the Input audio.

- When the FM Predelay button is illuminated, the FFT shows the audio spectrum of the output of the FM processing chain prior to the diversity delay.

☞ When the HD Output button is illuminated, the FFT shows the audio spectrum of the HD output audio.

Gain Reduction:
When this box is checked, the graphical display includes information related to the amount of gain reduction occurring in the AGC and compressor.

Controls:
When this box is checked, and if there are controls available for the page being viewed, they will be shown within the graphical display window itself.

L/R (Left/Right):
When this box is checked the right channel of the audio is displayed on the graphical display according to the selection made by the Audio checkbox. Alternately, when L/R is *not* checked, the left channel is displayed.

O-Scope:
When this box is checked *and* the Audio box is also checked, an oscilloscope-like display of the audio waveform is displayed. Which waveform is being displayed at any instant is a function of the selection made for the “Input” or “FM PreDelay” as explained previously.

Selecting Crossover Frequencies:
The selection of crossover frequencies plays an important role in determining how an audio processor sounds with different types of program material and therefore crossover frequencies should be selected carefully.

Crossover frequencies are often adjusted empirically according to an individuals experience with the program format and/or personal preference. In fact, if you ask ten people what the correct crossover frequencies should be for a particular type of format, you'll likely get at least twenty answers.

The table below serves as a starting point for most formats:

Program Format	SL to L	L to LM	LM to HM	HM to H
Classical/Jazz	120 Hz	250 Hz	1.0 kHz	3.00 kHz
Country/AC	102 Hz	204 Hz	817 Hz	4.49 kHz
Dance/Hip Hop	80 Hz	180 Hz	1.16 kHz	5.50 kHz
Modern Rock	93.6 Hz	216 Hz	1.30 kHz	4.62 kHz
Oldies/CHR	111 Hz	250 Hz	1.37 kHz	4.00 kHz
Classic Rock	83.4 Hz	193 Hz	1.59 kHz	6.17 kHz
Talk	120 HZ	250 Hz	917 Hz	3.00 kHz
Sports	120 HZ	281 Hz	817 Hz	2.52 kHz

SL = Super Low Band
L = Low Band
LM = Low Mid Band
HM = High Mid Band
H = High Band

For most genre of music, a Super Low to Low frequency crossover of 120 Hz will be quite satisfactory. Likewise, a High Mid to High frequency crossover of about 4 kHz works for most material.

For fine tuning the sound with different types of program formats, some general guidelines can be given:

For Rock music, a slightly lower Super Low to Low crossover of 80 Hz can put some extra 'gut' into the feel of the music. Likewise, with Dance or music of other formats that contain punchy, deep bass. There is normally not a *significant* amount of fundamental energy below about 60Hz - 80Hz in most program material.

Lowering the Super Low to Low band crossover down to even lower frequencies, perhaps to 70 Hz or even 60 Hz, can definitely put some "thump" in the audio with certain music formats. But this can be an inappropriate tradeoff with other

types of program material, particularly voice, so some care and perhaps even experimentation is advised!

If excessive brilliance is an issue, the High Mid to High crossover can be reduced slightly down to around 5 kHz or perhaps lower.

To achieve the opposite effect, that is, to impart a certain ‘shimmer’ to the highs, one might opt instead to move the Mid High to High crossover up in frequency to around to 7 kHz.

For more middle of the road music and for Classical and Jazz, the Super Low to Low band crossover may be moved *up* to around 120 Hz. The High to Mid High crossover may then be moved *down* slightly, to around 2.7 kHz. These crossover settings prevent the high band from taking too much gain and making the audio shrill, while the higher than normal Low to Mid Low crossover prevents too much low frequency extension on music that just doesn’t sound natural with it.

These are very general suggestions and your particular program format may sound better (or worse!) with other settings. Please feel free to experiment!

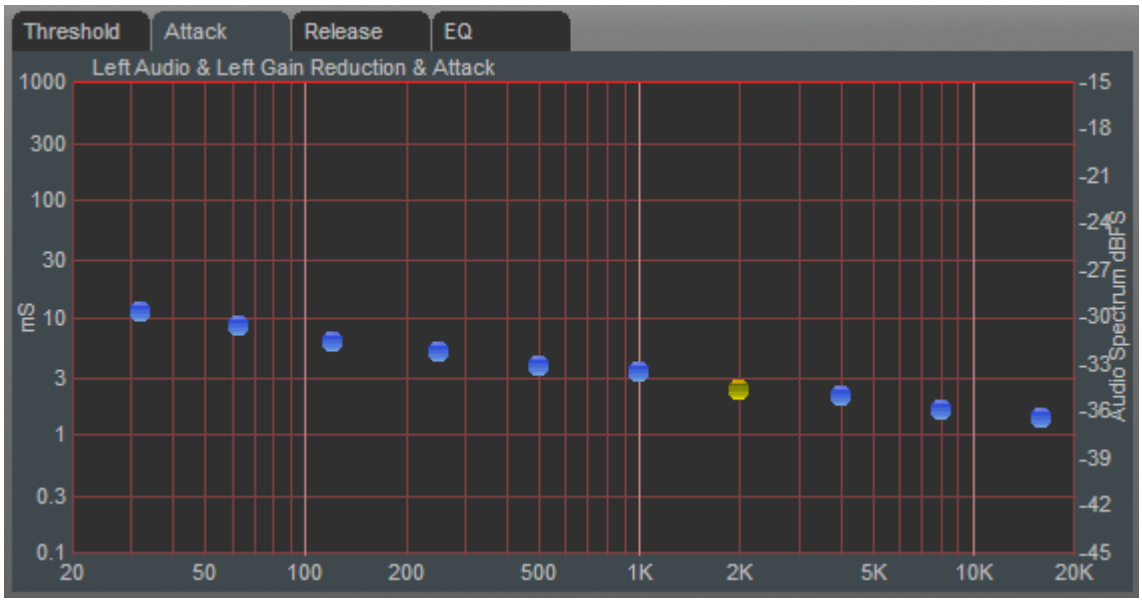
NOTE: Although the AGC/Compressor always operate in sum and difference mode, the crossover frequency settings always perfectly track assuring a stable stereo image under all settings and program material.

What Next? A 10 Band Limiter!

The FM5 contains a proprietary 10 band final limiter. The way we recommend operating the limiters is to allow them to only take care of short transients that the 5 band Compressor/AGC intentionally misses.

The settings in our factory presets are by no means the only way to operate the FM5's multiband section. In fact there may be dozens of ways to do it depending on the. The settings used in our factory presets were arrived at through *hundreds* of hours of listening with all types of program material. They are simply our personal assessment of the best tradeoffs between what we know our DSP algorithms are technically capable of, and the limitations of human hearing and what the typical listener might find appealing….or not!

10 Band Limiter Attack Time



10 Band Limiter Attack Control Screen

The attack time of a limiter determines how fast it responds to an audio peak that is above threshold (too high). Shorter attack times cause more accurate peak control, but excessively short attack times can suck the life out of musical material. Conversely, excessively long attack times can allow audio peaks to completely escape the limiter, leaving them to be controlled solely by the final lookahead output limiter (if enabled) or final clipper.

The attack times of each band may be individually or collectively modified using the GUI operating instructions provided in the "GUI Tutorial" previously covered.

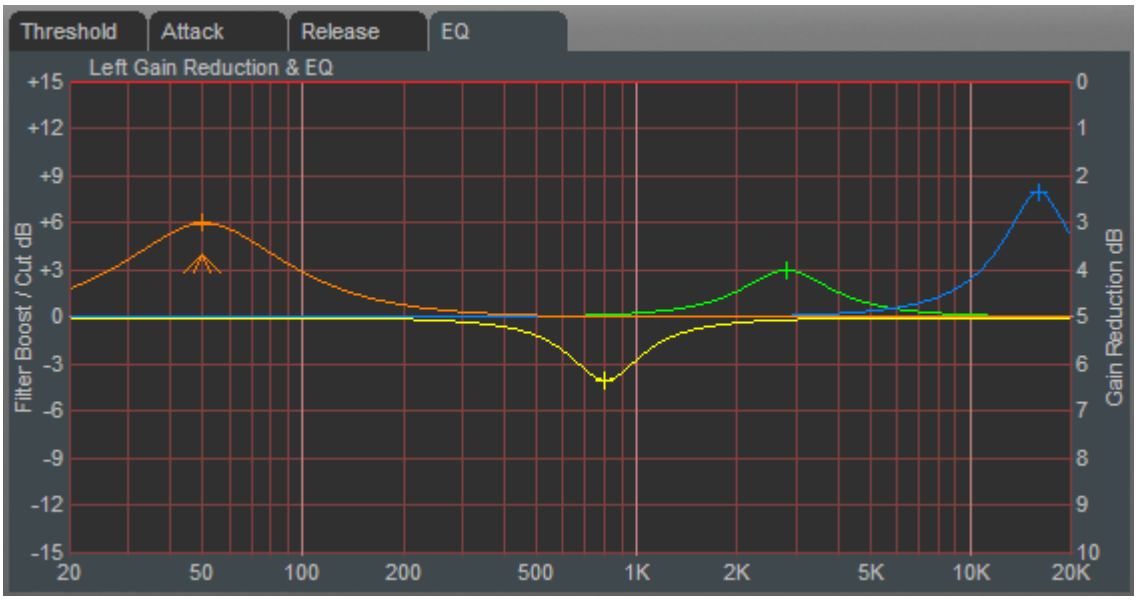
10 Band Limiter Release Time

The release time of a limiter determines how fast it recovers from an audio peak that causes a momentary decrease in gain. Shorter release times create more densely packed audio, and excessively short release attack times can also increase intermodulation distortion (the mixing of low and high frequency energy – or a muddying of the sound).

Conversely, excessively long release times can allow audio peaks to duck the gain down, where it remains for a noticeable period of time. As release times are slowed down clarity and detail are increased and distortion is decreased, but at the expense of overall loudness.

The release times can easily be modified using the operating instructions found in the “GUI” chapter.

10 Band Section Post Equalization



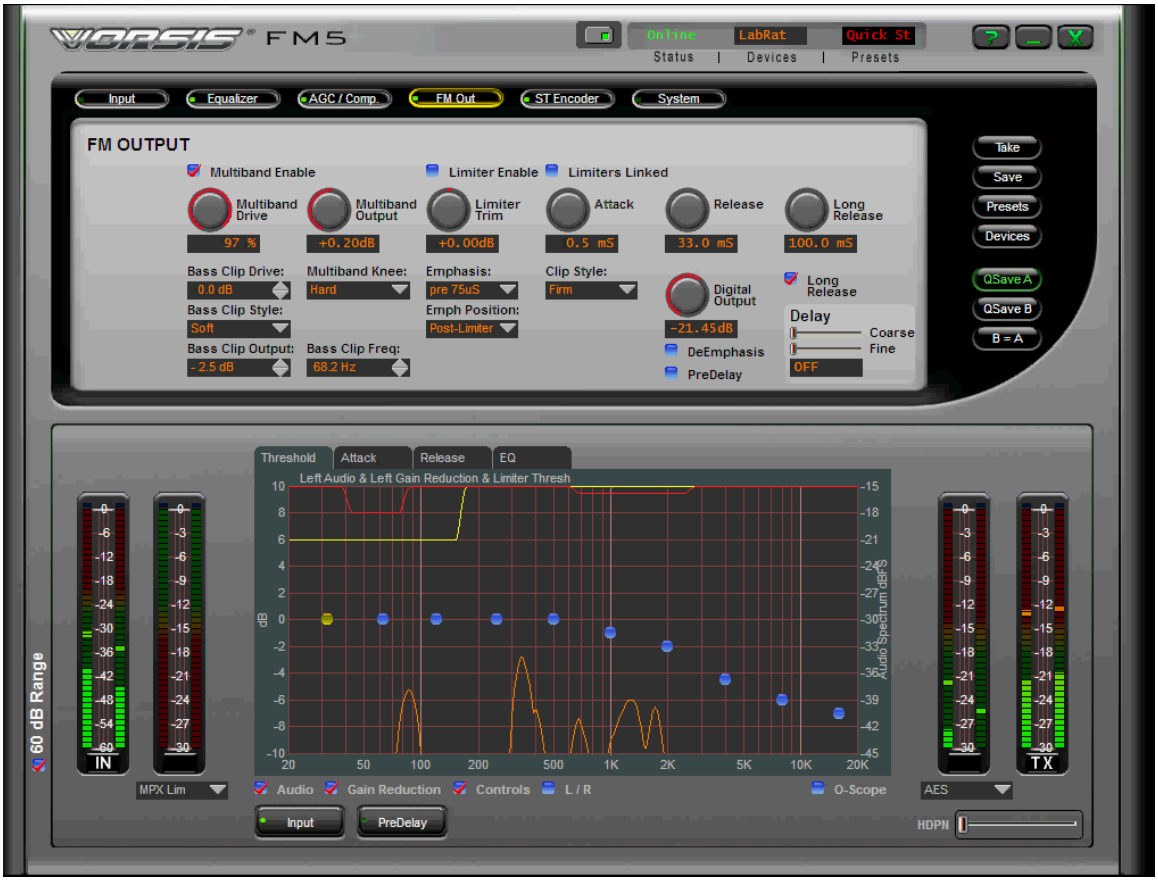
10 Band Limiter Equalization (EQ) Controls

The 10 band limiter section contains a four-band full parametric equalizer similar to that found in the “Equalizer” page in the main processing structure. The equalizer is provided at the output of the 10 band algorithm in order to allow the user to make subtle and careful alterations to the post-limiter sound of the 10 band section.

Since it is technically impossible to recombine many bands of peak limited audio and still retain the carefully controlled peaks emerging from each individual limiter, some (sensible) equalization tweaks can be accomplished post-limiter without radically disturbing the peak levels emerging from the that algorithm.

However, because this equalization is being carried out post-10 band limiting, one must be careful to not overuse the equalizer. It is provided simply for making minor corrections in sound that might be difficult to do within the 10 band structure itself and therefore, corrections in excess of more than plus or minus 2db to 3dB should probably be looked at with an eye of suspicion. In fact, we have purposely limited the adjustment range to +/- 6dB.

FM5 Final FM Clippers and Peak Limiter



FM5 FM Output Menu – Final Peak Control

The FM Output page contains the controls for the following:

- The 10 band limiter operating parameters
- The Vorsis Bass Management System© and Clipper
- The Look Ahead Limiter (if used)
- The Final Clip Styles (Hard, Firm, Round, or Off)
- The FM Diversity Delay
- The AES3 Output level and its source

Each section will be addressed in turn, starting with the 10 band limiter.

Ten Band Limiter

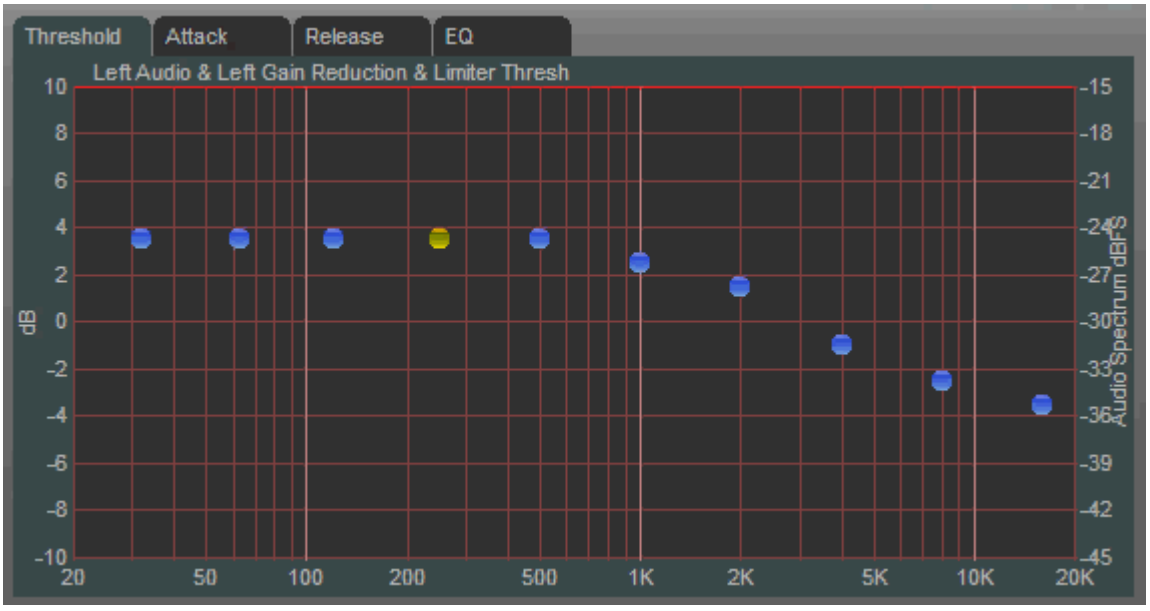
The Ten Band Limiter has been designed to be fully adjustable in order to accommodate a wide variety of program material and competitive needs. It also contains the VBMS section and interoperates with it to intelligently control bass

energy. The threshold, attack time and release times are all adjustable, as are the transfer functions (knee hardness) for the limiters and the VBMS.

Drive Control
The drive control adjusts the overall gain into the 10 band limiter section and its relative setting is dependent upon the setting of the Makeup Gain control in the five band section. It is not labeled in dB Drive, but instead in percent (%) due to the nature of this 'relativity'. With sane settings of the five band Makeup Gain control the 10 band limiter Drive control will usually be found between 80 and 100%.

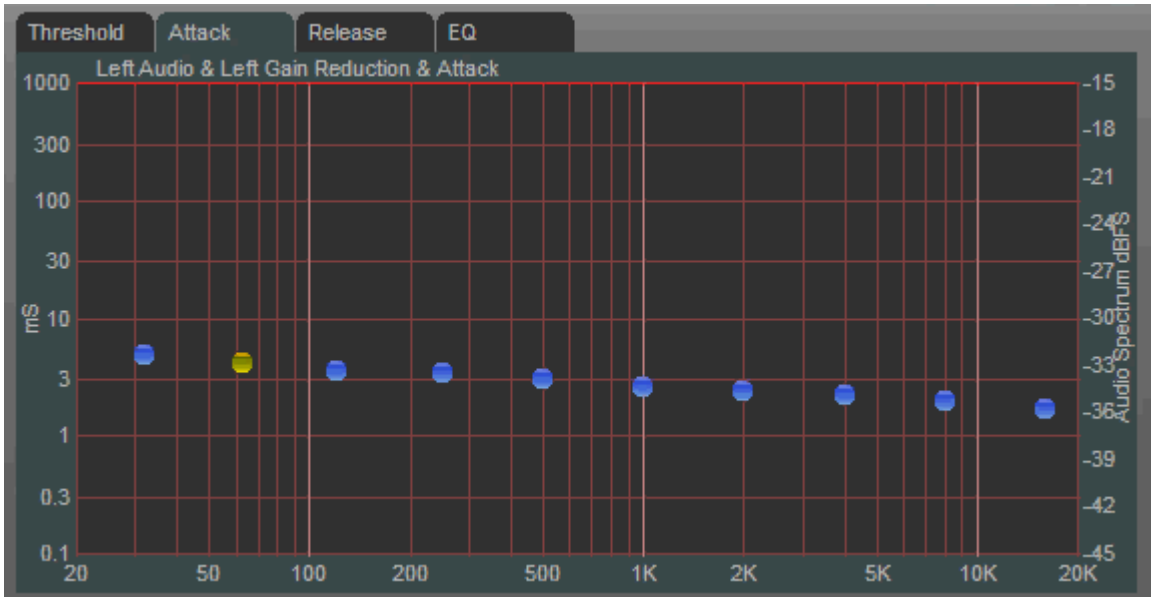
Threshold Screen
Clicking on the Threshold tab on the graphic opens up the adjustment screen for the limiter thresholds.

Limit thresholds are adjustable over a +/-10dB range and interact with the Drive control. Because the thresholds are adjustable over such a wide range, frequency conscious limiting can be created when desired.



10 Band Limiter Threshold Screen

Attack Time Screen
Clicking on the Attack tab opens up the attack time adjustment screen.

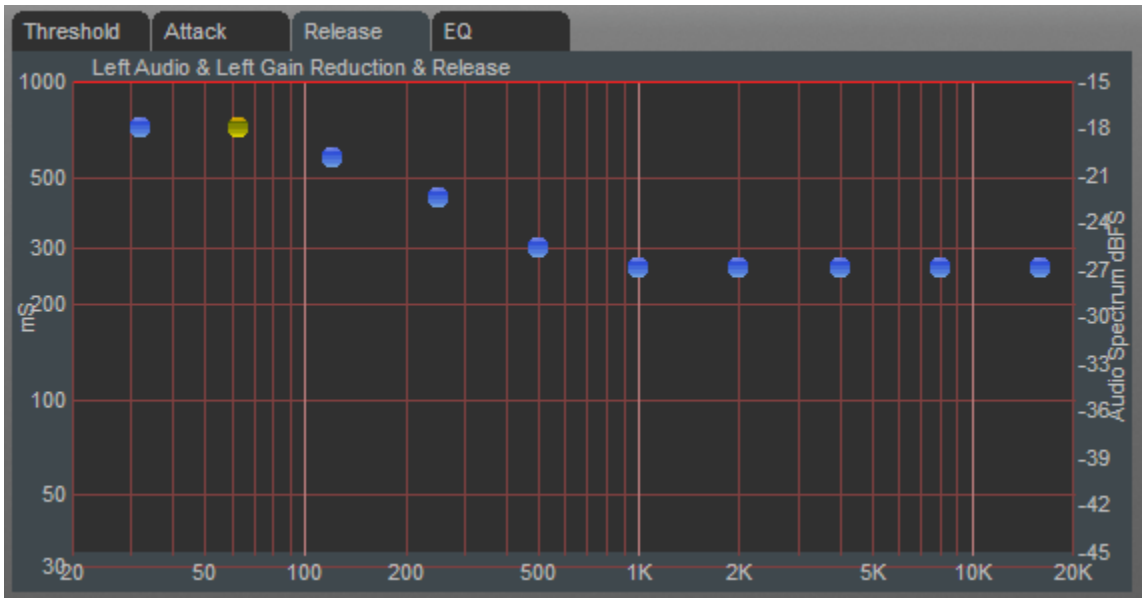


Attack Time Adjustment Screen

The attack times for each band are adjustable from 0.1 milliseconds (100 µ seconds) to 1000 milliseconds (1 second). Faster attack times exert more control over waveform excursions, while slower attack times allow peaks to escape the limiter section less controlled. Attack times should be adjusted to taste, keeping in mind that the slower the attack time the more work the final clipper or limiter must do, and the faster the attack time the less dynamics the program material will have.

Generally, lower frequencies require slower attack times and higher frequencies require faster attack times for a given amount of control.

Release Time Screen
Clicking on the Release tab opens up the release time adjustment screen.

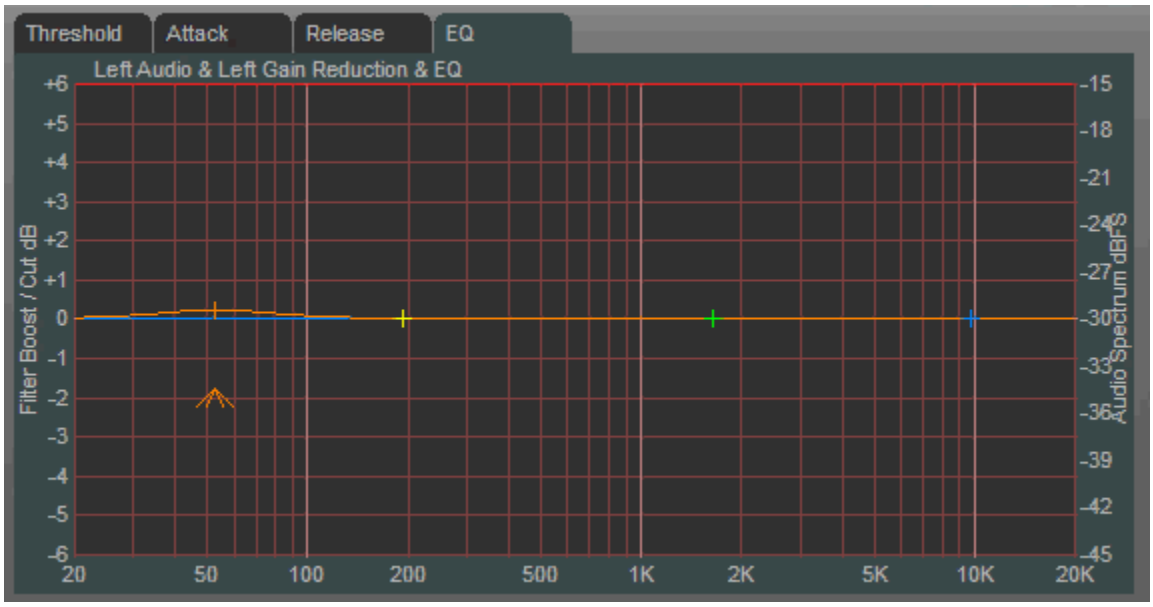


Release Time Adjustment Screen

The release times for each band are adjustable from 30 milliseconds to 1000 milliseconds (1 second). Faster release allows a more rapid recovery after a limiting event while slower release times do the opposite. Release times should be adjusted to taste, keeping in mind that the slower the release time the more dynamic the sound but may result in audible ‘ducking’, and the faster the release time the more dense the dynamics of the program material will have.

Generally, lower frequencies require slower release times and higher frequencies require faster release times for a given amount of control and inaudibility of action.

Final Equalization Screen
Clicking on the EQ tab opens up the final equalization screen.



Final Equalization Screen

Under certain program and competitive conditions and formats, it may be desired to slightly alter the sound exiting the final 10 band limiter. A small amount of equalization performed after limiting can ‘open’ up the sound or provide a slight enhancement to the overall feel of the sound.

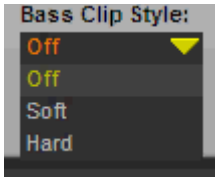
Notice in the above paragraph we used the words ‘*slightly*’, ‘*small*’, and ‘*slight*’. This is because only very small amounts of boost equalization are recommended once final limiting has been accomplished in the ten band section. We have purposely limited the adjustment range to +/- 6dB in order to curtail the temptation to perform wild equalization where it is the most inappropriate.

In general terms, small adjustments in EQ boost - on the order of 1dB or 2dB at most - are perfectly sufficient to alter the overall tonality of the 10 band section. Equalization cuts, since they do not *add* energy, can be made as desired.

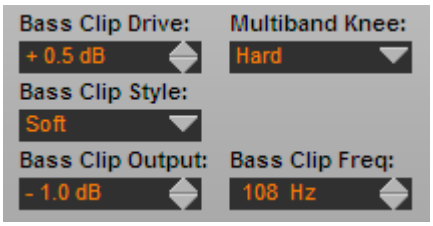
Equalization boosts must be approached with caution as they can add significant energy which then must be controlled by either the look-ahead limiter or final clippers.

Vorsis Bass Management System (VBMS)

The Vorsis Bass Management system uses special DSP algorithms to control low frequency program energy in a manner that is program content specific as well as artistic and natural. Additionally, a fully tunable Bass Clipper section allows bass punch to be set for the type of program material. It offers two clip styles, plus an OFF setting which when selected bypasses the bass clipper altogether.

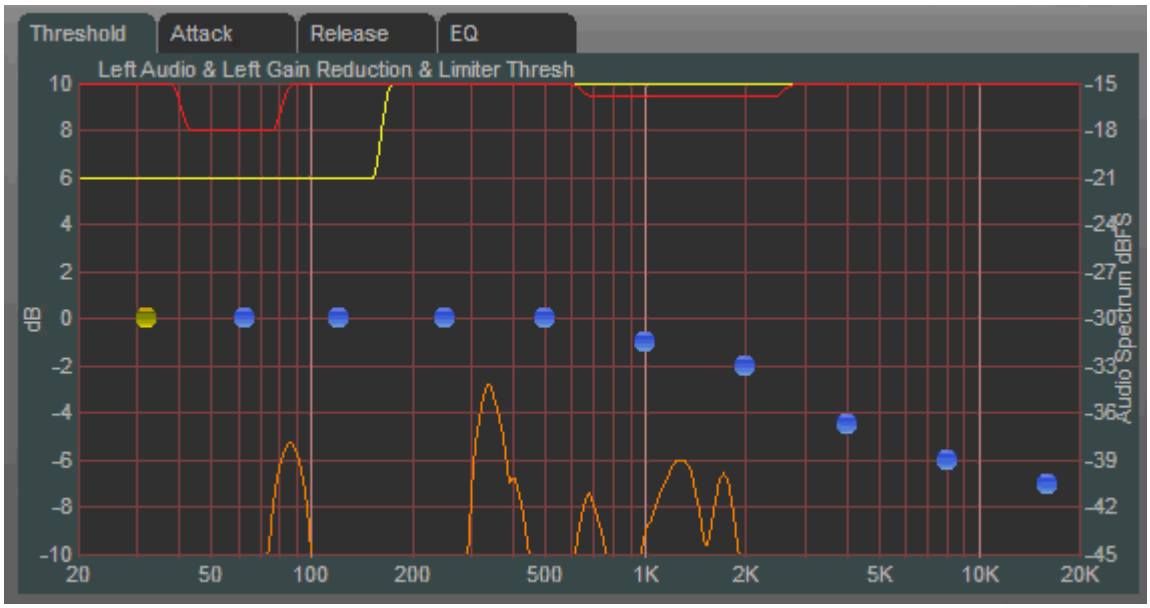


Bass Clip Styles



Bass Clipper Controls

The VBMS offers a visual indication of when program induced bass clipping is occurring and this can be viewed in the 10 band limiter gain reduction graphic as a solid yellow line extending from the Bass Clip filter turnover frequency downward in frequency to 20Hz and appears similar to that shown below.



Final Clipper and Look Ahead Limiter
Several final clipper styles are offered to enable the end user to create the sound desired. There are three styles of clipper offered:

Final Clipper Styles

Hard – Very abrupt onset of clipping – essentially an infinite ratio with no meaningful transition region. It is fully linear below threshold and a full hard clipper once threshold is achieved.

Firm – Operates with a transfer function that gradually transitions from linear to hard clipping over an input level change of 1dB.

Round – Operates with a transfer function that gradually transitions from linear operation to hard clipping over an input level change of 2dB.

While the above transfer functions might seem to be insignificant from each other, sound-wise they are not and each has a unique characteristic appropriate for certain program material or program formats. Do not be afraid to try each one to see how it sounds with your programming. There is no right or wrong setting.

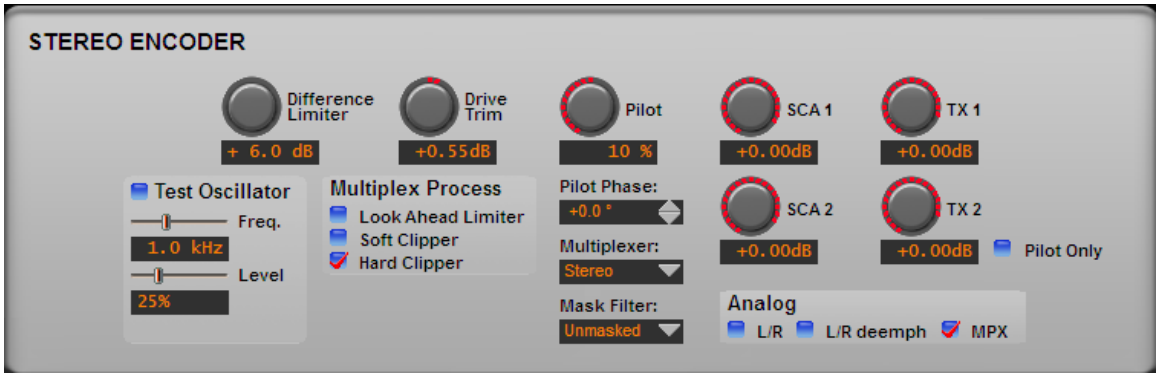
A highly oversampled look ahead limiter is available for those who wish to avoid clipping and instead use true limiting to control peaks. The look ahead time is three milliseconds and this latency is always present even when the look ahead limiter is not in use.

Look Ahead Limiter Controls

The look ahead limiter controls are self-explanatory. Limiter Enable turns it on and off. Limiters Linked joins the left and right channel gain controls together to prevent stereo image shifts during limiting. The Release and Long Release are the short and long time constant release time adjustments. Look Ahead Gain Reduction is shown by a bargraph when the bargraph is selected for “FM Limiter”.

Stereo Encoder

The FM5 contains a highly accurate DSP-based stereo generator. It has two adjustable outputs which can be routed to either the two BNC connectors on the rear panel, or to the two balanced line level outputs on the rear panel.



Stereo Encoder Controls

Difference Limiter – controls excess L-R energy if desired when the control is set for thresholds lower than +6.0dB.

Drive Trim – Controls the drive to one of three final composite peak limiting schemes: Look Ahead Limiter, Soft Clipper, or Hard Clipper as selected by the Multiplex Process checkboxes.

Pilot – Controls pilot injection in 1% increments.

Pilot Phase – Controls stereo pilot phase in 0.1 degree increments.

Multiplexer – Chooses whether or not the stereo generator is running.

Mask Filter – Switches a 53kHz low pass SCA protection filter in and out.

SCA1 and SCA2 – Controls the SCA injection levels (SCA's are digitized).

TX1 and TX2 – Controls the output levels of the composite outputs present at the BNC connectors AND the line level audio outputs.

Analog L/R, L/R De-emph, MPX – These checkboxes determine the type of outputs present on the rear panel analog output connectors. When L/R de-emph is checked, de-emphasis is applied that is complementary to any pre-emphasis applied in the FM Output Screen.

Getting That Special On-Air Sound

Okay…but first another few words about factory presets:

Factory presets are great starting points for the majority of applications, but we'll admit right now that they won't always work for everyone. Why? Simply because they can't. Here's a simple math problem to illustrate the point:

A x B x C x D = Number of Perfect Factory Presets Required, where:

A = number of different program formats
B = number of different sounding markets
C = number of opinions about the station's sound
D = number of adjustments your competitors will make once you install your new processor, also known as "moving target syndrome".

The product of **A x B x C x D** represents the very large number of factory presets that we (or any other processor manufacturer for that matter) would need to provide in order to match every possible programming / market / opinion / competitive combination. As you must imagine, not only is this not a trivial number, it's not even possible.

How the team at Vorsis approaches this problem is to spend literally thousands of hours carefully listening to a wide variety of reference material from our library of over 30,000 selections (as well as to other processors!) while crafting our factory presets. This process allows us to build presets that get you closer to your desired on air sound far quicker than if you had to build them from scratch.

The point is that we try our very best to supply good starting point settings in our factory presets. We're also always learning too, and that's why you'll periodically see new presets being offered for download on our Vorsis website.

What sound are you trying to achieve?

There are four basic goals that most people are generally shooting for in one way or another for when they buy and install a new audio processor:

1. You want to be louder than before;
2. You want to be cleaner than before;
3. You want to have better bass than before;
4. You want a cleaner and more open high end than before.

Unless you're replacing an old audio processor that's on its last legs (or stranger yet still uses 6386 variable mμ triodes!) you won't be getting all four of the above benefits simultaneously in mass quantities in any new box.

However, what the FM5 *can* and *will* give you are *improvements* in all of the four. A fellow colleague said it best some years ago:

"You can be louder, brighter, or cleaner – pick any two".

About Vorsis Bass

The FM5 processing chain includes our proprietary "VBMS", or "Vorsis Bass Management System" which includes in its algorithm a fully tunable bass clipper as well as other bass adaptation and control goodies hidden under the covers. The end result is very carefully controlled, natural, and well-balanced bass on all program material. There is no artificial and hokey bass trickery going on – just nice, clean, deep, and natural bass that sounds good on a wide variety of FM receivers – which is just as it should be.

A Note About Equalization

The majority of radio listeners don't have the quality of monitoring equipment found at most radio stations, therefore some care is advised when adjusting audio processing to accentuate the very low and high extremes of the audio spectrum.

Energy at these extremes is typically several dB below that in the more easily heard midrange, and overly boosted low and high frequencies take a lot more modulation power to become audible on a typical listener's radio. Over-accentuated bass and treble that can be heard by only a small percentage of listeners can result in reduced loudness and/or higher distortion.

What is your short term goal?

The majority of programming folks are interested in generating huge amounts of loudness in order to attract attention to the station as a listener scans across the dial. And this isn't wrong because almost as important as the station playing a potential listener's favorite record at the time they tune in, a station that's *LOUD* carries with it a certain 'authority' that can make someone stay tuned long enough to see what's next. And loudness on FM, though it doesn't technically increase the station's coverage area like it does on AM, it certainly does help mask noise at the fringes of the coverage area.

But, while loudness can attract a listener, so too can it drive them away. Extreme loudness usually carries with it subtle (or not so subtle!) forms of distortion and other artifacts that can subconsciously tire a listener and make them tune away

without realizing why. Loudness then, for loudness' sake, must be approached with a bit of caution.

Okay… But How Do I Make It LOUD?

The FM5 can easily be tuned to satisfy any competitive situation. In general terms in order to 'just be louder' (we'll cover that first – it's actually a bit easier) you can:

- Increase the density in the five band AGC by operating it with faster attack and release times;
- Increase the Drive to the 10 band limiters;
- Carefully use some equalization in the parametric section to gently boost frequencies that the ear is most sensitive to (1kHz to 4 kHz);
- Drive the clipper section harder to further increase the amount of RMS energy being generated by the processing;
- Operate the 10 band section with faster attack and release times, in fact staggering them slower for the lows, faster for the highs (see Proportional Drag in the section on the GUI) can easily create an extra 2dB of perceived overall loudness just from the increase in spectral density.
- Intentionally over modulate like the other guys in the market are probably already doing (we don't advocate this, but hey, it does happen!).

What Is Your Long Term Goal?

If you found that your situation didn't fit into the "just make it louder" goal as discussed in the previous section, your long term goal must be the opposite. You don't need to be loud just to be loud – you want to sound better, cleaner, brighter, punchier - pick an adjective…. We can do that!

When loudness isn't the first priority your options open up very quickly. Being 'cleaner' than the other stations can increase time sent listening, but be aware that being significantly cleaner carries with it the perception of not being as loud, even though electrically and in RMS terms, the station may in fact be just as loud. Why?

Think of a boombox with the volume cranked up to 11. Sounds loud, doesn't it? In electrical terms it probably isn't, but the distortion created by being overdriven creates an association in the brain that says "it's got to be loud because it's distorted".

The opposite is also true – if your station has no perceptible distortion at all when compared to 'the other guy' on the dial – then it might carry with it the perception

that it can't possibly be as loud. We're not saying don't be clean, we just saying that you shouldn't be fooled by this little psychoacoustic tidbit.

Being cleaner usually means you're not leaning into the processing as hard, which also means that you can use tools like equalization more freely than the really loud station across town can in order to craft the on air sound you really want. This is because equalization eats up headroom, and if you're trying to be really loud, you need all the headroom you can get and therefore less EQ can be used.

Clean is good, but cleaner is better? Loud is good, but louder is better? Which way do you want to go? You choose… the FM5 can get you there.

How to Be Clean and Still Perceptibly Loud

We can use the behavior of the human ear and brain (psychoacoustics) to fool it into thinking there are six pounds of sound in the five pound bag. The following adjustments when used together or in combination can be used to create a sound that's loud and punchy, but also quite subjectively clean:

- Use slower attack times in the AGC sections;
- Use slower release times in the AGC sections;
- Use slower attack times in the 10 band limiters;
- Leave the 10 band released times fairly fast (<100ms);
- Increase the drive to the final clipper (not too much!);
- Increase the drive to the composite processor and use the Mask Filter.
- Use a fairly low AGC Super Low to Low crossover frequency – something like 80Hz.
- Use a fairly high Mid High to High band crossover – something like 6 or 7kHz.
- Be gentle with any mid-frequency equalization. In fact, partially subduing the range between about 800 Hz and 2.5 kHz can subjectively clean up otherwise harsh-sounding material - especially that which has been data reduced. To do this, use the parametric equalizer configured for post AGC/Compressor operation with a center frequency of around 1.2 kHz, a bandwidth of about 1.5 octaves, and a cut of no more than about 1-2 dB.

This combination will somewhat 'relax' the sound because the AGC sections are operating slower, slightly lowering their average output levels and also because of the slightly reduced levels in the ear's most sensitive region due to the midrange equalization.

On the other hand, the drive has been increased to the clippers. The increased clipping depth, albeit only momentary, will increase the subjective loudness on the larger signal peaks restoring a sense of loudness and punch. It will also

create a feeling of better dynamics and loudness and will do it without generating the same kind of distortion artifacts that dense compression and higher duty cycle clipping might create.

With the crossover frequencies at the ends of the audio spectrum carefully tuned to the extremes (within reason!), the dynamic behavior of the AGC/Compressor can create that familiar “smile curve” equalization and lend an overall sense of Hi-Fi to the sound without having to rely on static equalization.

Can I Generate that ‘Sixties’ Compression Sound?

Yes! The way to do this is to purposely drive the multiband section harder and then trade off the slower acting AGC against the faster time constants of the compressors.

This is accomplished by operating the AGC Backoff control at negative numbers greater than about -2.0 to -3.0dB. By doing this, much of the instantaneous gain control will be accomplished using the faster compressor time constants. If you’re careful to not run the Backoff control too far negative, the AGC will still provide a ‘platform’ that the compressor can work against, preventing rapid suck-up of background noise that might be undesirable.

A word of caution if you’re also using reverb to augment that sixties sound… with faster and deeper compression reverb tails will become exaggerated. This artifact can be reduced in several ways:

- Operate the AGC Backoff control at slightly less negative numbers;
- Reduce the overall drive to the AGC/Compressor section;
- Raise the Freeze Threshold to more negative numbers and decrease the Freeze Wait time to something under 100mSec.

You can use these methods alone or in combination to control reverb tails. Alternately, if your station’s sound demands a fair amount of reverb during non-speech programming, then announcer microphones will almost certainly become a challenge. In this scenario you may have to come up with a way to reduce the contribution of the reverb, but only when talent microphones are on.

Two ways you might do this are:

- Use a reverb unit that has both GPI connections and presets, and then using microphone tally logic synchronize two different reverb presets when the microphones are on and off.

- Create the reverb mix level external to the reverb and change its attenuation when microphones are on and off. Note that while this is quite

easy to do in the analog domain, it becomes a challenge with all digital air chains!

FM5 General Purpose Input/Output - GPIO (GPI and GPO)
The FM5 is equipped with optically isolated control Inputs and Tally Outputs that may be used in a variety of ways. We provide eight optically isolated GPI Inputs, and four optically isolated GPO Outputs. First the Inputs:

GPI
The GPI interface provides eight separate General Purpose Inputs, sharing a common return. The GPI inputs are assigned to the first eight preset locations enabling the selection of presets by external signals.

NOTE: Factory presets start in position 10. Position 9 contains a “Bypass” preset that is useful for measurements of other tasks requiring all processing and EQ to be defeated. Preset positions 1 though 8 are reserved for GPI.

The GPI connector is a female DB15 connector with the following pin assignments. Note that all pins are isolated from FM5 internal circuitry – the metal chassis is not a return path!

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

The input circuits are optoisolated by Panasonic PhotoMOS relays. These are LED input, MOSFET output devices with an input/output isolation of 1,500VAC and I/O isolation capacitance of less than 2pF.

Each of the GPI inputs of the FM5 is current limited by an internal 475 ohm resistance. The LED device inside the PhotoMOS device is rated at a maximum forward current of 50mA and a normal operating current of 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 conveniently 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 quite sufficient.

Applied Voltage to GPI	External Resistance
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

GPO

The FM5 provides four General Purpose Output (GPO) circuits that may be used in a variety of ways. Like the GPI circuits, the GPO utilizes Panasonic PhotoMOS relays in order to provide high isolation from the outside world.

Unlike the GPI circuits, the GPO's each have completely isolated circuits – that is, they do not share a common return. Nor are they connected in any way to the FM5 chassis. Therefore each GPO may be used as desired without concern of cross coupling between unrelated external circuits.

The optoisolators on the GPO are rated at a maximum of 350 Volts AC or DC at a maximum load current of 100mA. Because of their AC rating polarity is unimportant. Therefore we will define the GPO pins as Source and Return.

The pin assignments for the rear panel DB-9 GPO connector are as follows:

GPO Pin Number	Source	Return
1	N/C	N/C
2	GPO 1	
3		GPO 1
4	GPO 2	
5		GPO 2
6	GPO 3	
7		GPO 3
8	GPO 4	
9		GPO 4