IONIZER - Real-Time Noise Reduction, Expansion, Compression and 512-Band Equalization Software.

Arboretum SYSTEMS Ionizer™ Manual

Arboretum Systems, 75 Aura Vista, Pacifica California 94044 USA.

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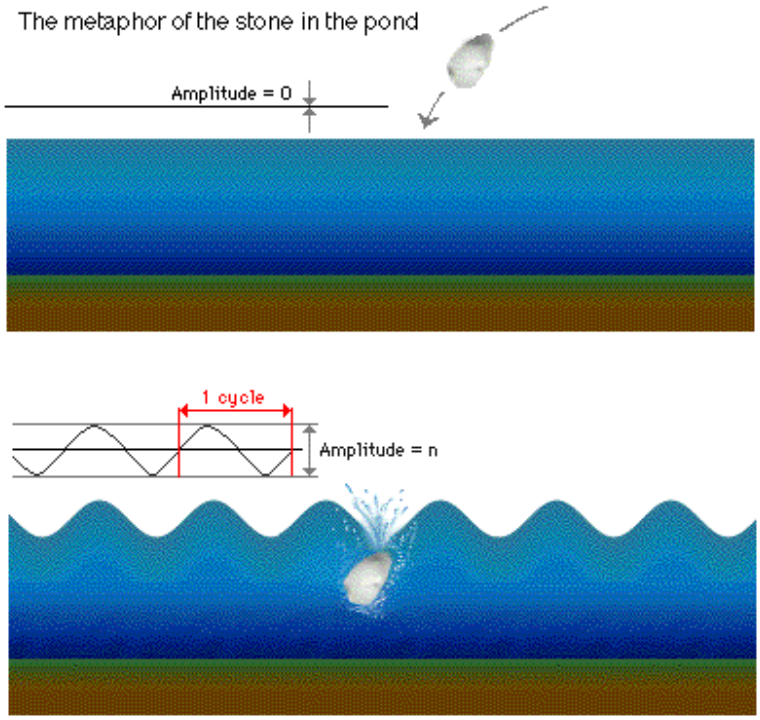
Background : Audio Basics & EQ

Sound can be compared to waves in water. When you drop a stone into a still pond, waves propagate out in all directions from the central splash point. Imagine you were viewing the pond not from above, but from the side, looking at a section along the surface of the water. When the water is perfectly still, we could say this is our "zero point." As the dropped stone pushes on the water, the surface rises above the zero point to a crest, then drops back down to zero, and then falls below zero, into a trough or valley, then subsequently cycles back up toward zero.

In an audio system, sound waves are transmitted by variations in an electrical current, rather than the undulating surface of water, but the concept is the same. Please refer to the accompanying illustration to see how such a wave is plotted....One wave cycle begins at the zero-voltage center line, moves up to the highest voltage, down to the corresponding lowest voltage, then back up to the zero crossing, at which point the next wave cycle begins.



the propagation of sound waves can be compared to waves in a body of water

The characteristics of any wave, and therefore any sound, can be roughly described by using two simple variables, frequency and amplitude.

Frequency is a measure of how frequently a wave cycle repeats, which is calculated in "cycles-per-second," or Hertz (Hz) for short. Frequency is related to pitch, our perception of whether a sound is a low rumble or a high squeal. The frequency range of human hearing is theoretically from 20 Hz at the lowest end to 20,000 Hz at the high end (your actual mileage may vary). You'll often see high-frequency numbers written as kiloHertz (kHz), which is metric-speak for "thousand Hertz." So the figure 20 kHz means "twenty kilohertz," literally "twenty thousand cycles per second."

☞ The horizontal (X) axis of Ionizer's grid is labeled with Hz and kHz values, representing the range of the audible frequency spectrum.

The second variable that describes a wave is amplitude, which is a measure of the wave's energy level (picture the amount of displacement above and below the zero point, in our water-wave metaphor). Amplitude relates to our perception of volume or loudness. Big waves with lots of energy are high-amplitude, and sound loud. Small waves with little energy are low-amplitude, and sound soft or quiet. Amplitude is measured in decibels (dB).

Decibels are talked about in a couple different ways. When measuring Sound Pressure Levels, zero dB is defined as the effective bottom limit of human hearing, the point of silence. 120 dB is the effective top limit or human hearing, the veritable threshold of pain, exemplified by the sound of a jet aircraft (or a Who concert). Another common use of decibels is the Full Scale measurement. For example, the dynamic range of a compact disc is 96 dB, with 0 dB representing maximum loudness and -96 dB representing silence.

We'll dispense with the dBSPL measurement; assume that we're talking about dBFS (Full Scale) from here on out.

☞ The vertical (Y) axis of Ionizer's grid is labeled with dB values. Note that the values along the left edge of the grid relate to threshold settings and the values along the right edge relate to gain settings (more about these in a moment). For the purposes of Ionizer, 0 dB on the left hand scale represents the maximum input amplitude allowed by the system. Zero dB on the right hand scale represents no gain or attenuation being applied to the input signal; both positive and negative gain values are allowed.

Equalization, or EQ for short, is best known from the bass and treble knobs found on any home stereo. In the most basic scenario, the range of frequencies across the audible spectrum is divided into two bands by a filter; one band contains the low end (bass) and the other contains the upper range (treble). You'd use the bass and treble controls to boost or cut the volume energy (loudness, a.k.a. amplitude) of the signal within that band.

A more complicated type of equalizer you may have seen is the graphic EQ. The typical graphic EQ filters the frequency spectrum into many bands, perhaps ten or twenty, so you can make more precise adjustments to the sound by boosting or cutting the volume level of narrow frequency ranges.

Ionizer filters the frequency spectrum into 512 EQ bands per channel so that you can pinpoint specific frequencies with a high degree of accuracy. Each Ionizer band covers a 43 Hz range within the 0 Hz to 20 kHz frequency spectrum. Instead of forcing you to adjust 512 different knobs or sliders, Ionizer uses lines on a grid to simplify the process of viewing and setting energy levels across the frequency spectrum.

One of Ionizer's core operations is spectral analysis. Ionizer's Noise and Spectrum functions measure portions of the input signal (or the entire file) and then draw a map of the amplitude (or volume energy) of each EQ band across the spectrum. This map, or "envelope," is called the frequency profile.

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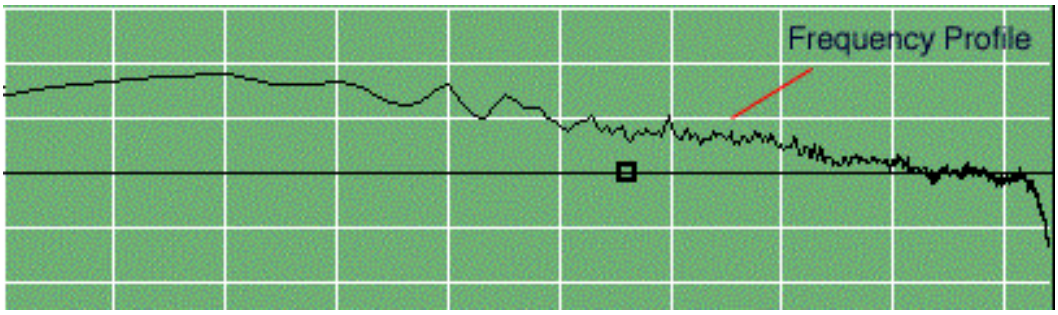

a frequency profile

The usual garden-variety graphic EQ is a static, set-it-and-forget-it type of tool, in which you simply define a level of boost or cut for each frequency band. This is OK if your signal never changes, but musical signals, like a vocal line or a song mix, typically have volume changes and different frequency contents at various places within the piece.

To maximize your control over sound, Ionizer adds a level of sophistication to the "graphic EQ" metaphor, by allowing the amount of boost or cut on any frequency band to be adjusted up or down in real-time. The degree of this volume adjustment is derived from the amount of energy (amplitude) in the given band, at a particular moment. This concept may be confusing at first, so let's examine how these gain adjustments work...

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Background : Gates & Dynamics Processing

A gate is a common audio circuit which lets you turn on, or off, the flow of a signal. The gate continuously measures the signal which is being fed to it. If the input signal is at a low amplitude (quiet) then the gate stays shut, allowing no signal to pass. If the amplitude of the input signal rises above an arbitrary line (i.e., is "loud enough") then the gate opens and passes the signal to its output. This arbitrary "loud enough" line, which triggers the gate's opening and closing, is known as the "threshold."

In Ionizer, each of the 512 EQ bands are gated, so that boost or cut can be applied within each band as the program material's energy level rises above, or falls below, the threshold for that band. These threshold levels are set by the Blue and Red Curves. We'll examine the specifics of these curves in just a moment; first, a few more concepts:

A simple use for a gate is the process known as "limiting." A limiter measures an input signal; when the amplitude is below the threshold, the signal passes untouched. As the input amplitude rises above the threshold, attenuation (cut) is applied to the signal, so as to reduce unwanted peaks in the audio material. This is also commonly known as "downward compression."

"Upward Compression" is a process that's similar to limiting, except in this case gain (volume boost) is applied to signals which fall below the threshold. This increases the volume level of soft passages; signal that exceeds the threshold is passed unamplified.

A common studio tool is the "compressor/limiter," which is typically a hardware device that combines the two functions described above. Imagine that you're watching a volume meter and you have your hand on a volume knob--when the signal is low you crank it up, when the signal is too hot, you turn it down. Thus, soft program material is boosted in volume, loud program material is dropped in volume, and the dynamic range (the difference between softest and loudest) of the signal is reduced. Compressor/limiters are very useful for smoothing out uneven volume levels in recordings.

An "expander" is essentially the opposite of a compressor/limiter; it expands the dynamic range by exaggerating the differences between soft and loud passages. Expanders attenuate (cut) the volume of low-amplitude signals and/or add gain to (boost) the volume of high-amplitude signals. The process of attenuating low-amplitude signals is called "downward expansion;" the corresponding process of adding more gain to signal peaks is called "upward expansion." Downward expansion is helpful for noise reduction, one of the key uses of Ionizer.

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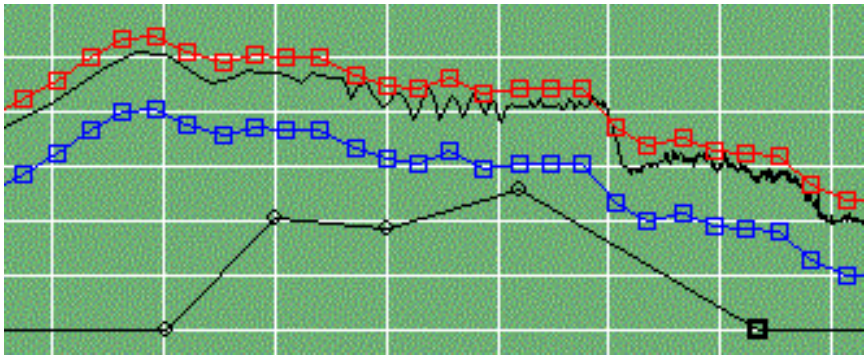
Ionizer Functional Overview : The Curves Defined



the Red, Blue and Black Ionizer curves, plus frequency profile

Each of the 512 bands in Ionizer can either limit, compress or expand the signal within their frequency band, depending on how you configure the three curves on the grid.

Let's examine the functions of the three Ionizer curves:

The Red Curve · The Red Curve, also known as "threshold," defines the initial threshold of Ionizer's gates. As a band's energy level crosses the Red Curve, that band's gate is activated. Gates can be set to activate when band energy is either above or below the Red Curve, and this is determined by the position of the Blue Curve.

The Blue Curve · The Blue Curve defines the limit of the active zone and sets the gates' triggering direction. If the Blue Curve is above the Red Curve, gates turn on as band energy exceeds threshold. If the Blue Curve is below the Red Curve, gates turn on as band energy drops below threshold. The scale for both the Red and Blue Curves is shown along the left edge of the grid, and ranges from -120 dB to 0 dB.

The Black Curve · The Black Curve, also known as "gain," sets the degree of boost or attenuation that is applied to a band when its signal energy falls within the gate transition zone and the active zone (see the next section, "Green Window Zones," for further explanation). The Black Curve's scale is shown along the right edge of the grid, and ranges from -84 dB to +36 dB. By creating Black Curve settings that vary across the spectrum (curve shapes other than a straight line) you may simultaneously boost or attenuate different frequencies by different amounts.

☞ Throughout the course of this manual, we will be referring to "gain." Please bear in mind that the term "gain" applies equally to volume decreases (or cut, negative dB of gain) as well as volume increases (or boost, positive dB of gain).

Summary:

- **Red Curve =** Threshold
- **Blue Curve =** Gate Direction
- **Black Curve =** Gain

Ionizer Functional Overview : Green Window Zones

The Blue and Red curves divide the Ionizer grid into three functional zones: the passive zone, the gate transition zone and the active zone.

The passive zone · The passive zone is the area beyond the Red Curve threshold. When an EQ band's energy level falls outside the Red Curve, that band's gate is closed and input signal is passed with no volume change.

☞ When we say "beyond the Red Curve" or "outside the Red Curve" (above) that can mean **above or below** the curve, depending on the specific curve configuration. Read on through the next section for further clarification...

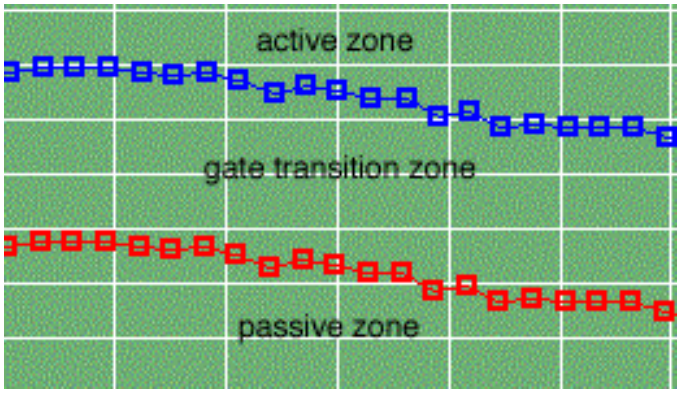
The gate transition zone · The gate transition zone is the area between the Red and Blue Curves. It is within this zone that Ionizer's dynamic processing functions are active. When an EQ band's energy level is in the transition region, that band's gate is opened and gain is applied to the band. The amount of gain applied varies dynamically, depending on the band's energy level relative to the Blue Curve. Gain varies from 0% as band energy crosses the Red Curve threshold on up to 100% as band energy crosses the Blue Curve.

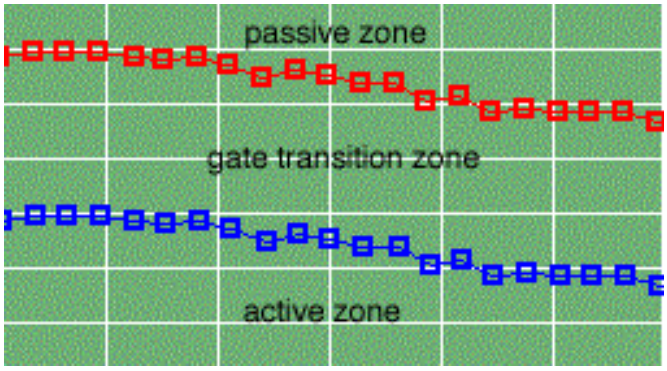
☞ Remember that the gain change fluctuates in the gate transition zone. The degree of value change depends on where that band's energy is falling between the Red and Blue curves. If an EQ band's energy has gone 10% above the Red Curve, 10% of the gain setting is applied; if energy is at the 50% mark between the Red and Blue Curves, 50% of boost or attenuation is applied, and so forth.

The active zone · The active zone is the area beyond the Blue Curve. When an EQ band's energy level is in the active zone, that band's gate is fully open and 100% of the Black Curve gain is applied to the band.

Where Are the Zones

Note that the actual screen positions of the passive and active zones will vary, depending on whether the Red Curve is above the Blue Curve, or vice-versa. In either case, the gate transition zone is always the area between the Red and Blue Curves, the passive zone is always the area beyond the Red Curve, and the active zone is always the area beyond the Blue Curve. Note also that these zones are not labeled or denoted in any way on the Green Screen, other than by the Red and Blue Curves which mark their borders and by the Mood Bar which shows their action. For the sake of clarity, we've labeled the zones in the pictures below:





Zone configuration is determined by the relative positions of the Red and Blue Curves

☞ The important thing to remember is that Black Curve gain only takes partial effect when a band's energy level is between the Red and Blue Curves, in the gate transition zone. Black Curve gain is in full effect when a band's energy goes beyond the Blue Curve, into the active zone.

Summary:

- **Passive zone =** Band energy short of threshold, no gain applied
- **Gate transition zone =** Band energy past threshold, incremental gain applied up to Blue Curve
- **Active zone =** Band energy past Blue Curve, full gain applied
- **Red Curve =** Border between passive zone and gate transition zone.
- **Blue Curve =** Border between gate transition zone and active zone.
- **Black Curve:** Gain is applied incrementally across gate transition zone, full gain within active zone, no gain in the passive zone.

Green Windows Buttons

The buttons above the grid control curve generation.

the Green Window buttons

The buttons below the grid control curve display and curve editing.

the curve display and curve editing buttons

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Generating Curves

At the top left are three buttons which control curve generation : Spectrum, Noise, Fit.

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Displaying & Hiding Curves

Below the grid, the three left buttons toggle the display of Ionizer's curves.

curve display buttons

➠ Click the button corresponding to the color of the curve you wish to hide or show (either Red, Blue or Black). When the button's green light is illuminated, that curve will be displayed.

➠ To hide a curve, click the button again; the green light goes out and the curve is ghosted.

☞ Hiding a curve does not bypass the curve's effect on your audio; the curve function remains active even when it's hidden from view on the grid.

Automatic Curve Generation

The fastest and simplest way to set curves is by using the Spectrum or Noise buttons with the Fit button.

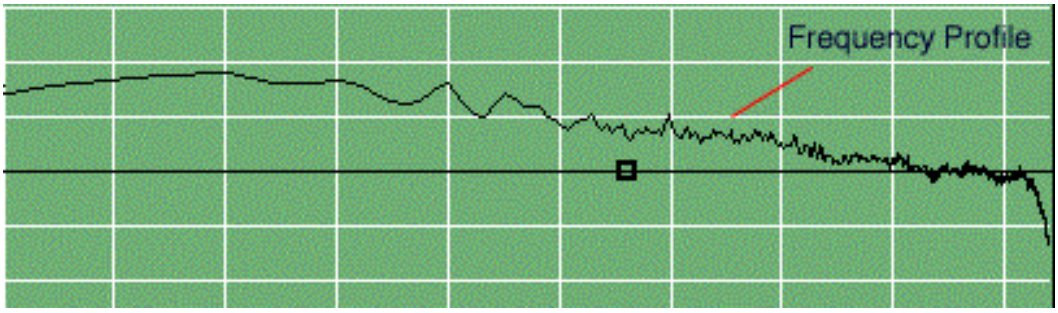
➠ Select a segment of your audio file by using a selection tool in your host application (such as Sound Forge).

➠ There are two methods of obtaining the frequency profiles: For shorter audio files or selections, open the Ionizer, click on the Spectrum or Noise button, play the audio selection and click off the Spectrum or Noise button. For longer files, open the Ionizer, click on the Spectrum or Noise button, click OK, the Ionizer window will close as the curve is generated, re-open Ionizer.

➠ NOTE: Using the second method does not process the file in any way as long as you do not do anything else but click on the Spectrum or Noise button! It processes the file offline so you do not have to wait for the file to play through to generate the Spectrum curve.

➠ Once a Noise or Spectrum frequency profile is generated by the above process, you can toggle back and forth between the two profiles by clicking either the Noise or Spectrum button and obtain an accurate reading.

➘ The black frequency profile line will appear, graphing the signal's amplitude across the frequency spectrum. Note that the appearance of this line will vary according to the audio you have selected.



a typical frequency profile

➠ Click on the Fit button.

➘ The Red and Blue curves will automatically be fit to the contours of the frequency profile. The Red Curve is placed above the Blue Curve by default; this is the usual configuration for noise reduction tasks.

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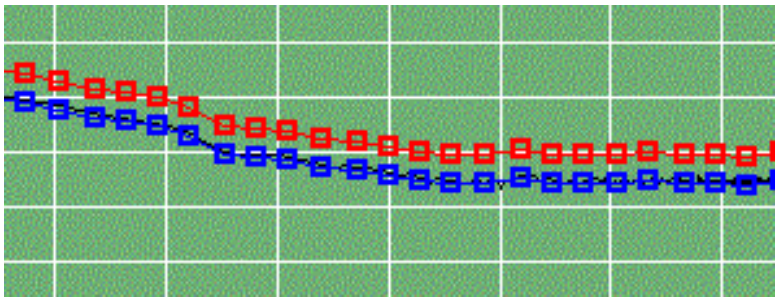

Red and Blue Curves fitted to the frequency profile; note default arrangement of Red Curve above Blue Curve with a 6 dB offset

☞ Note that the number of breakpoints along the Blue and Red Curves is determined by the Fit Points setting...

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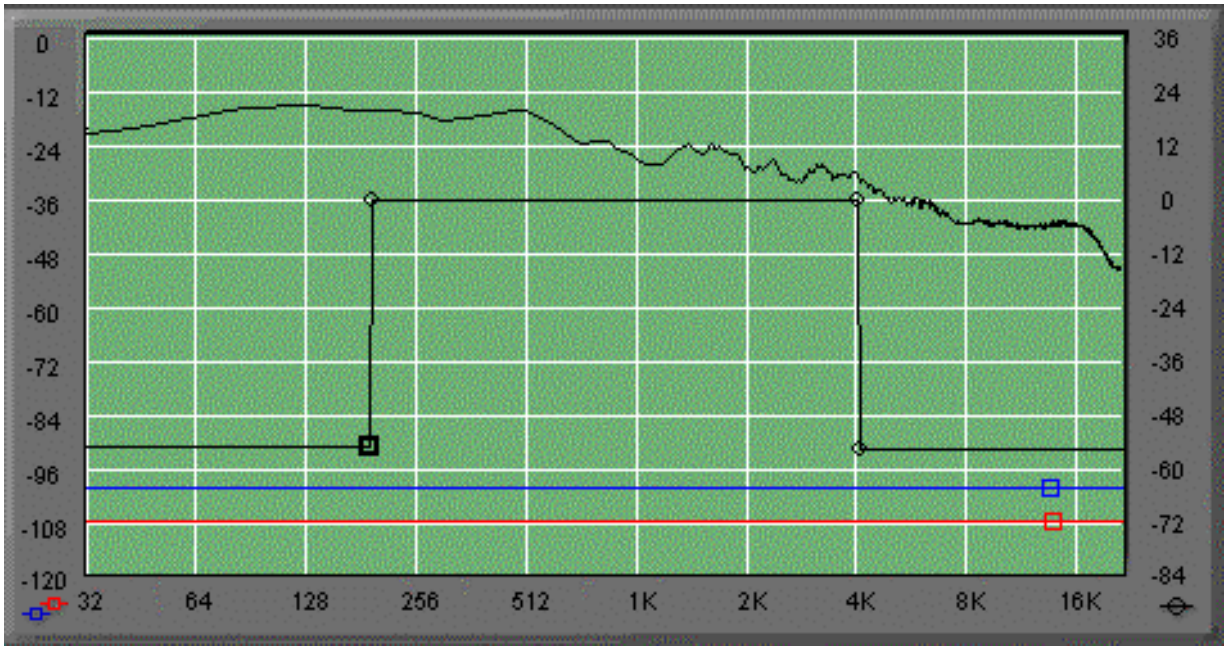
Equalization

Set the Blue Curve above the Red Curve and drag them both towards the bottom of the screen.

By making essentially the entire screen (in this case all band energy above -96 dB) the Active zone, all bands will get 100% of the Black Curve gain setting, all the time.

Since there's no band energy below -96 dB (the presumed threshold of silence) there's effectively no passive or transition zone

Use the Black Gain Curve to create any filter shape you desire. Here we've made a band pass filter.



Unlike all other analog and digital EQs, Ionizer's filters are 100% phase linear and offer equalization that is entirely free of phase interference which can "smear" your sound.

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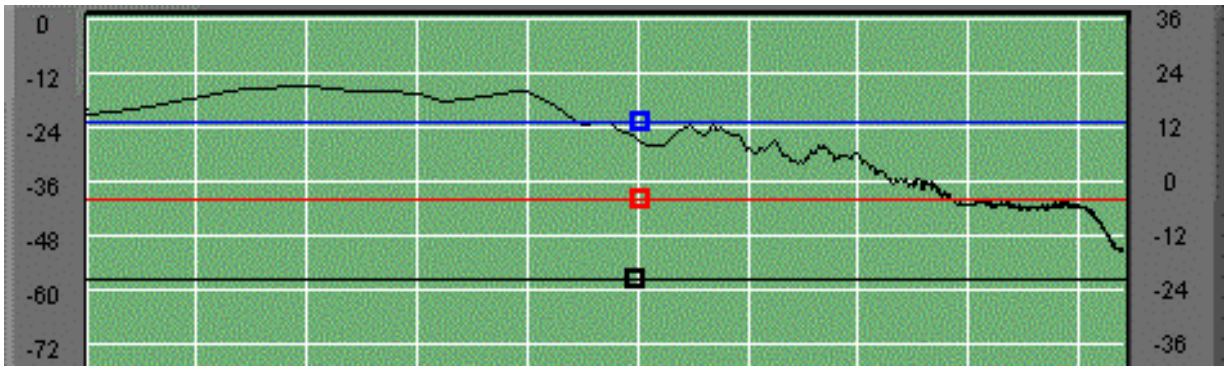
Limiting (Downward Compression)

➠ Set the Blue Curve above the Red Curve, with the Black Curve attenuating (see the scale along the right edge of the grid, this is "negative decibels").



a simple limiting configuration

➘ When band energy rises above the Red Curve threshold (into the gate transition zone), gates turn on and apply varying degrees of attenuation to the signal, reducing peaks in the program material.

➘ Signal that exceeds the Blue Curve line, and goes into the active zone, is attenuated by the full value of the Black Curve (gain) setting.

➘ When band energy falls below the Red Curve threshold, into the passive zone, signal is passed unchanged.

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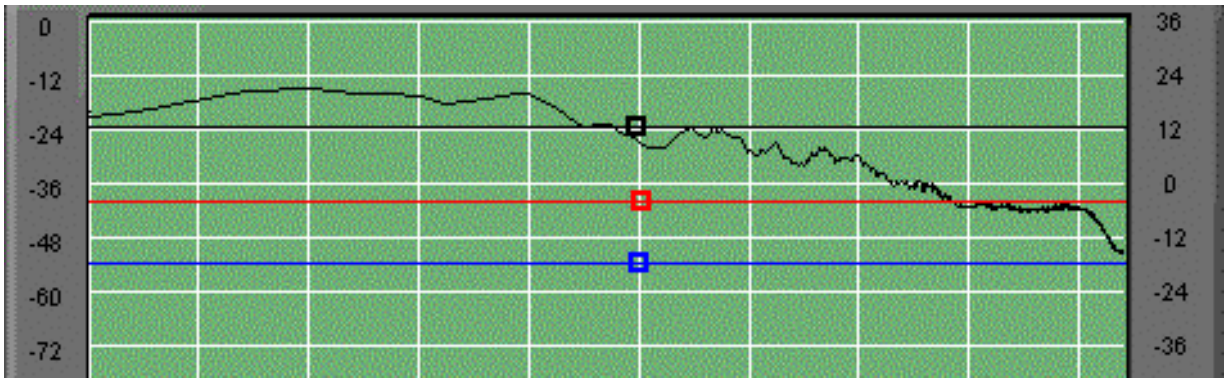
Upward Compression

➠ Set the Red Curve above the Blue Curve, with the Black Curve adding gain (in the positive dBs part of the grid).



a simple compression configuration

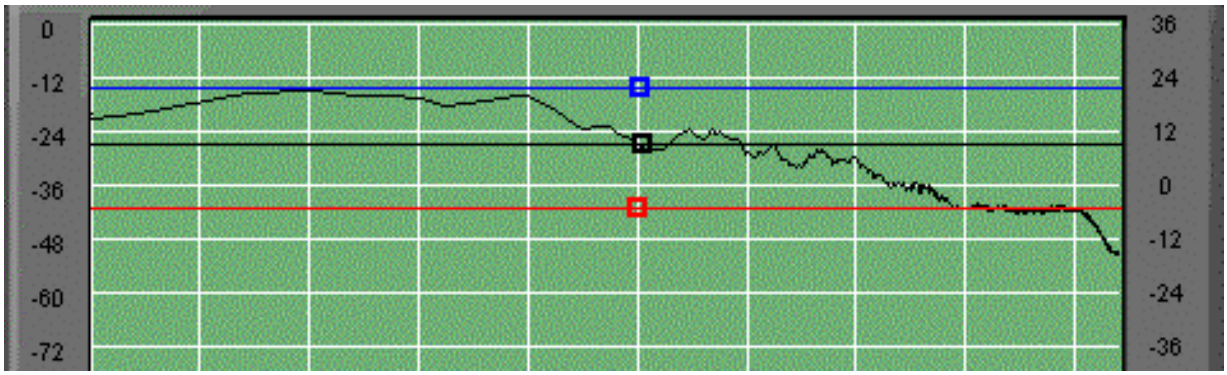
➘ When band energy falls below the Red Curve threshold into the gate transition zone, gates turn on and apply varying amounts of gain to the signal, boosting the volume of soft passages.

➘ When band energy falls below the level of the Blue Curve into the active zone, 100% of the gain setting is applied to the band's signal.

➘ Band energy that exceeds the Red Curve threshold, rising into the passive zone, is passed unchanged.

Upward Expansion

➠ Set the Blue Curve above the Red Curve with the Black Curve adding gain (check the scale along the right edge of the grid, this is "positive decibels").



a simple upward expansion configuration

➘ As band energy rises above the Red Curve threshold into the gate transition zone, gates turn on and apply varying amounts of gain to the signal, accentuating peaks in the program material.

➘ As band energy rises above the level of the Blue Curve into the active zone, 100% of the gain setting is applied to that band's signal.

➘ When band energy falls below the Red Curve threshold, into the passive zone, signal is passed unchanged.

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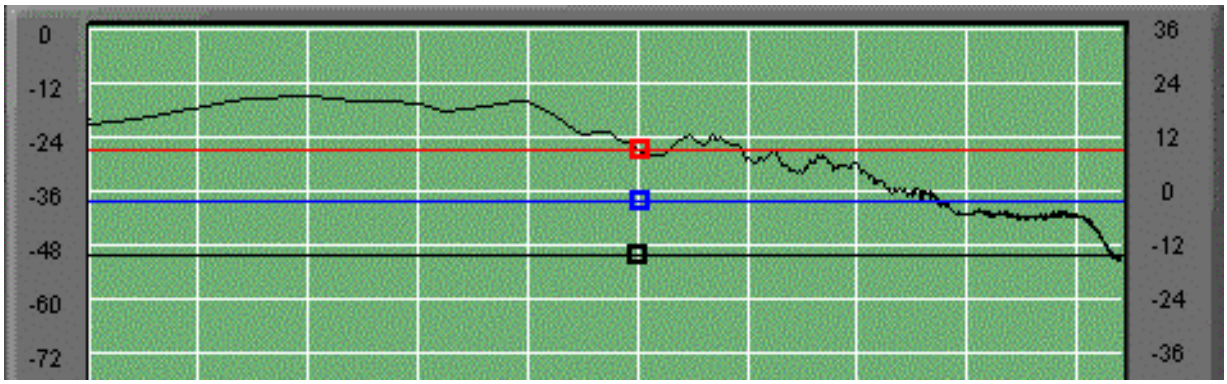
Downward Expansion

➠ Set the Red Curve above the Blue Curve, with the Black curve adding attenuation (negative dB settings).



a simple downward expansion configuration

➘ As band energy falls below the Red Curve threshold, gates turn on and attenuate the signal to varying degrees, further decreasing the volume of soft program material.

➘ As band energy falls below the Blue Curve into the active zone, 100% of the Black curve attenuation value is applied to the band.

➘ When band energy exceeds the Red Curve threshold, rising into the passive zone, the signal is passed unchanged.

Note: This downward expansion function can be used to reduce noise in a signal--more on that in a moment!

The question you're likely to have at this point is "how do I set the curves?" We'll examine the Green Window tools in detail in the following section, but first try this little exercise...

Select a range of your audio file for processing by using a selection tool in your host application (such as Sound Forge or Cool Edit Pro)

Click on the Spectrum button, Preview selected audio, click Spectrum button off to calculate the frequency profile.

The frequency profile will appear on the grid as a squiggly black line.

Click Fit.

Spectrum and Fit buttons

You should now see the Red and Blue Curves, conformed to the audio region's frequency profile. You've been spared the laborious guesswork of getting a useful initial setting. From here you can begin adjusting the Ionizer curves to meet your specific application.

At this point, you probably know enough about Ionizer to begin using it in its most basic mode, to reduce noise in a signal. If you want to dive right in, click on these underlined words to get step-by-step instructions on Noise Reduction. Otherwise, keep reading and we'll examine the functions of each of the Ionizer's controls, in detail.

File Formats and Sample Rates

Ionizer processes any monophonic (one-channel) or stereophonic (two-channel) sound file. Files can be imported, processed and exported at the 44.1 and 48 kHz sample rates, as well as a number of lower sample rates. Ionizer uses 32-bit floating point internal calculations so we're actually processing files at a far higher bit depth, preserving the integrity of the sound.

Stereo File Support

When processing stereo audio files Ionizer treats each channel separately, even though the display and control interface is integrated into a single grid and set of curves. Frequency-band gate action and gain changes are calculated independently between the right and left channels. Threshold, range size/direction and gain curve settings are set globally for both channels in the Green Window.

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The Spectrum Button

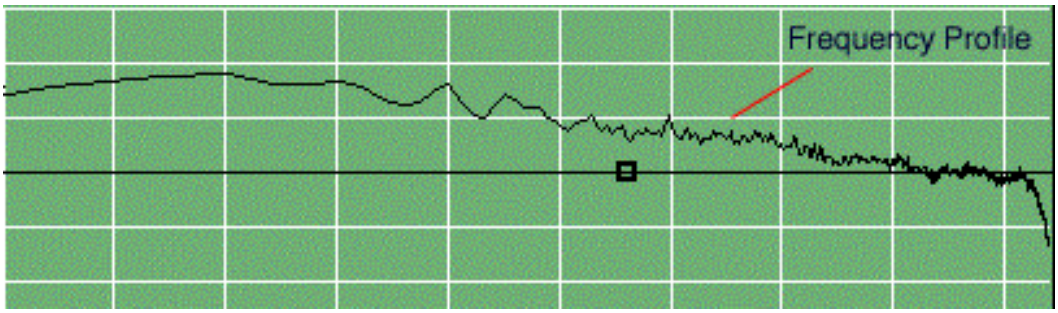
Spectrum performs a spectral analysis on the currently selected audio file segment, and draws a black "frequency profile" envelope on the grid. The frequency profile is a graphic representation of the energy within each EQ band. It serves as a visual display of your sound file's spectral content, and is a guide for the Fit tool. The frequency profile is not editable, other than by processing the sound file.

There are two methods of obtaining the frequency profile: For shorter audio files or selections, open the Ionizer, click on the Spectrum button, play the audio selection and click off the Spectrum. For longer files, open the Ionizer, click on the Spectrum button, click OK, the Ionizer window will close as the profile is generated, re-open Ionizer.

NOTE: Using the second method does not process the file in any way as long as you do not do anything else but click on the Spectrum button! It processes the file offline so you do not have to wait for the file to play through to generate the frequency profile.

The frequency profile will appear on the grid as a squiggly black line.

The Spectrum calculation happens "pre-effect" so that an accurate spectral profile may be derived (without being influenced by the current Ionizer settings).



a frequency profile

How Does Spectrum Work?

The Spectrum function uses an averaging scheme to measure band amplitude. This process eliminates problems associated with phase cancellation which could impair the measurement process.

The smallest audio segment that Spectrum can measure is 1024 samples. Spectrum takes 44 measurements per second of the amplitude of each of the 512 bands per channel. Each band value measurement is squared, then added to each band's running sum. When all data is measured, the square roots of those running sums are divided by the number of measurements made. The results of those calculations are the frequency profile points for each EQ band.

Naturally, there's no need to remember that "a frequency profile is the root-mean-square of band energy level over time" in order to make use of Ionizer, but it's a nice thing to know.

The Noise Button

The Noise function looks at your audio file or selection, makes an "educated guess" about where the noise is, then displays the frequency profile of the noise signature. This "guess" feature brings speed and convenience to noise reduction work. It's especially valuable when working with audio files in which you're unable to find a noise-only segment for Spectrum analysis. We've informed Ionizer about typical noise characteristics, so it can discern noise in any ongoing waveforms and intelligently separate it from the desired signal. The Noise feature is a major improvement over other downward expansion noise reducers which force you to always select the noise floor by hand.

Beyond that, Noise works much like the Spectrum function described above, performing a spectral analysis on the derived noise signature, then drawing a black "frequency profile" envelope on the grid. The frequency profile is a graphic representation of the noise's energy within each EQ band. It serves as a visual display of your noise's spectral content, and is a guide for the Fit tool. The frequency profile is not editable, other than by processing the sound file.

Click on the Noise button, preview selected audio, click Noise button off to calculate the frequency profile.

The frequency profile will appear on the grid as a squiggly black line.

The Noise calculation happens "pre-effect" so that an accurate spectral profile may be derived (without being influenced by the current Ionizer settings).

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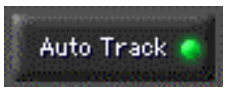
Automatic Tracking (Auto Track)



Automatic Tracking assists your noise reduction work by riding the noise level in your signal. When Auto Track is engaged, the Ionizer thresholds will be raised and lowered to match the changing amplitude of the noise signature, resulting in much smoother, more pleasing results. (Note that the Red and Blue curves remain stationary on screen; Auto Track is invisible to the user.)

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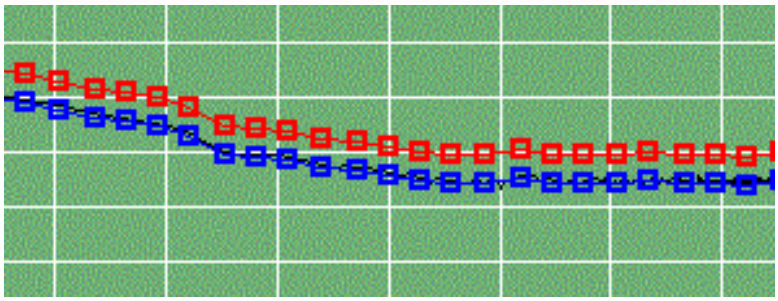
The Fit Button

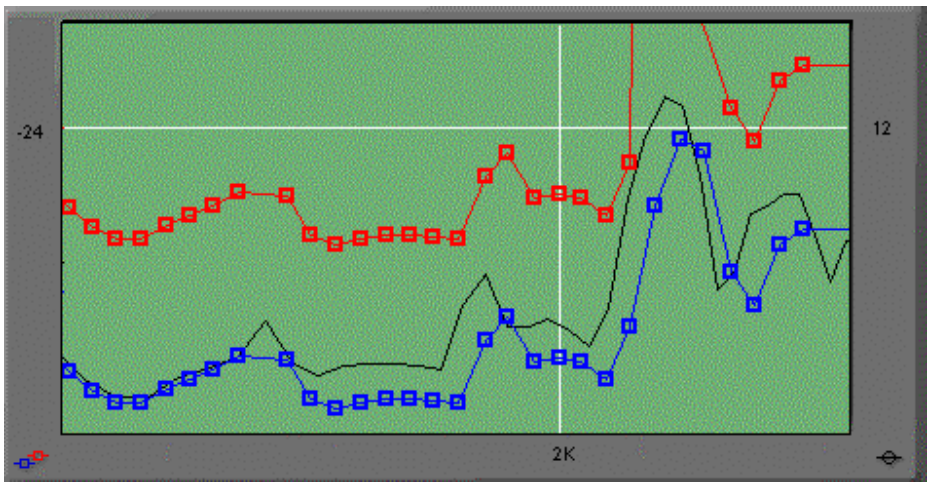
Fit automatically conforms the Red and Blue Curves (threshold and gate direction) to the contours of the frequency profile. This speeds the process of getting useful initial settings.

➠ Click on the Fit button, to shape the Red and Blue Curves along the frequency profile.



Red and Blue Curves fitted to the frequency profile

➠ If you want to Fit only over a selected portion of the frequency profile, utilize the Zoom function Simply Zoom in until only the target area of your frequency profile is displayed, then click the Fit button.



an example of Zoom-in and Fit in a selected area

➘ Fit points will be set along the frequency profile in the currently-displayed area, and nowhere else.

➘ Fit places the Red Curve above the Blue Curve, with a 6 dB difference, by default; this is a good starting point for noise reduction (downward expansion) applications .

The EQ Points Setting

The Eq Points setting, located above the grid, next to the Fit button, determines the number of individual breakpoints created when you click the Fit button. The default setting of 32 is a good place to start when fitting a curve across the frequency spectrum. Increase the number of points (to a maximum of 512) if you wish to increase the level of detail when fitting Red and Blue Curves.

Click and mouse-drag in the Fit Points value field to scroll to a new setting, or click in the field and type in a new numeric value.

The Fit Points setting only determines the number of Red and Blue curve breakpoints. This has no effect on the number of gated EQ bands; Ionizer always has 512 active bands of gated EQ per channel.

When fitting a curve to a selected range of frequencies, you may wish to reduce the number of Fit Points, since the default setting of this parameter may create more points than are convenient when you're only dealing with a portion of the spectrum. In other words, if your are only fitting about 1/4 of the frequency range, you may wish to reduce the default fit points to 8, rather than 32.

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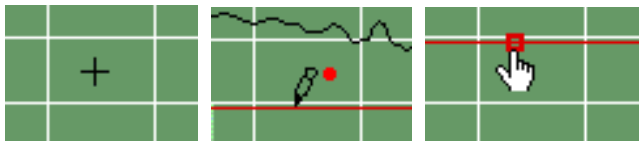
The Pencil Tool

The Pencil tool, located above the grid to the right, lets you add or delete Fit points on a curve, one at a time. The Pencil tool is toggled with the Zoom tool, the button to its immediate right. Click on the Zoom to disable the Pencil tool; click on the Pencil tool to disable the Zoom tool.

The Pencil tool makes the mouse pointer behave differently than the cursors you may be familiar with from other programs. The Pencil tool's functions vary, depending on the cursor's proximity to the curves on the grid. The Pencil tool's operational mode is indicated by its appearance: It's either a Cross-hair (select), a Pencil (draw) or a Hand (move).

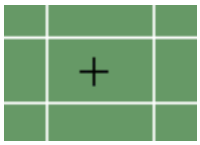


the Pencil Tool's three cursor modes (from left): Cross-hair, Pencil and Hand

Pencil Tool Modes : Selecting and Moving Fit Points

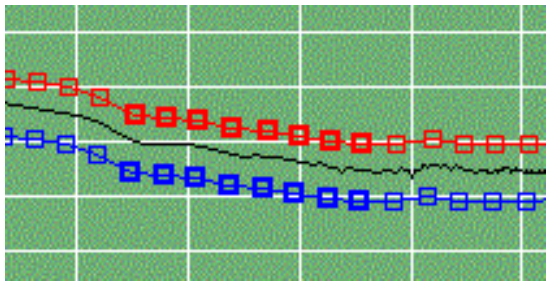
Take a moment now, and drag the pencil tool around the Green Window.

The cursor's current Green Window location is displayed below the grid. Note that the location is shown in threshold decibels, hertz **and** gain decibels, reflecting the different scales along the left and right sides of the grid.



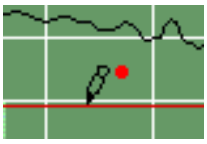
cursor location display

You'll notice that the cursor appears as a Cross-hair much of the time; hold down the mouse button while in Cross-hair mode and drag across any curve to create a "marquee" or "group" selection. This provides a fast way of selecting a number of Fit points.



the result of a "marquee" or "group" selection

When the cursor is directly over a curve line, the cursor changes into a Pencil, indicating "draw"mode. To the immediate right of the Pencil you'll see a little dot; this dot's color (red, blue or black) shows which curve the Pencil tool is active for.



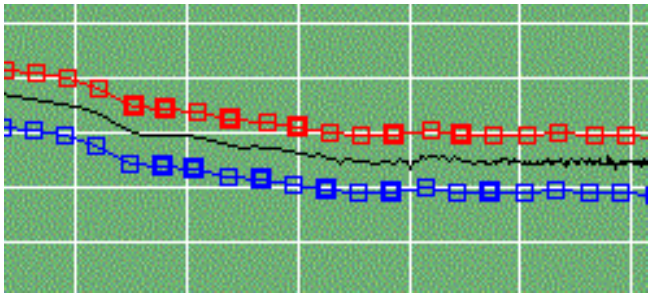
the Pencil tool in "draw" mode

To draw in a new Fit point, simply mouse click on the curve.

Pencil Tool Modes : Selecting and Creating Fit Points

As the cursor passes over a Fit point on any curve, the cursor changes into a Hand. The Hand is used to select Fit points and move them to new positions on the grid. You can move points one at a time, or select multiple points and move them as a group, while in Hand mode.

To select multiple points, drag across the grid to make a "marquee" selection, as described in the previous section. Alternately, you can hold down the Shift key on your keypad while marquee-selecting or mouse-clicking on any Fit Points to select (or de-select) multiple, discontiguous Fit points.



the result of shift-clicking to select (or de-select) multiple discontiguous fit points

When more than one Fit points are selected, they can be moved as a group without changing their position relative to each other.

Note that there are normally no constraints on the movement of Fit points within the grid. If you radically displace one or more fit points from their original position, those points' curve lines will redraw, allowing you to quickly create interesting new curve contours. Note also that you can preview the sound of such changes in real time, by simply moving Fit points around while listening to Ionizer's preview playback.

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More About Moving Fit Points

If you wish to limit the movement of Fit points when repositioning them in Hand mode, use the Control key.

Holding down the Control key constrains mouse movement of Fit points along the horizontal or vertical axes.

Sometimes this Control key constrained-movement control is a little finicky; you may way to move the points a little first with the mouse, then engage the Control key to restrain their movement.

Another way to move Fit points around, which provides an even finer degree of control, is to simply use the arrow keys (up/down/left/right). Select any Fit point, or any group of Fit points, then press arrow keys to "nudge" the Fit points to the desired position.

Each arrow key press moves the selected points +/- 1 dB vertically or +/- 1 semitone horizontally.

Arrow key movement can be modified by using the arrow keys in combination with the Shift and Control keys:

- Shift-arrow makes small movements, +/- 0.1 dB vertically, +/- 0.1 semitone horizontally.
- Control-arrow makes large movements, +/- 6 dB vertically or +/- 1/2 octave horizontally.

Note that the arrow key feature can be used in lieu of the Control key+Hand combination (as described above) for achieving constrained vertical or horizontal movement.

There's one subtle difference between Hand movement and arrow key movement of group selections: If you've selected breakpoints across all three curves (Blue, Red and Black), you can move the points on all three curves with the arrow keys. Repositioning a similar 3-curve selection with the Hand only moves the Blue and Red Curves, the Black Curve Fit points are unaffected.

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Selecting All Fit Points

You may select all the Fit points on all currently-visible Ionizer curves by typing Control-C on your keypad. Alternately, make a "marquee" or "group" selection of all points by holding down the mouse button and dragging the cursor across the grid while in Cross-hair mode

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Pencil Tool Modes : De-selecting Fit Points

To de-select all currently selected Fit Points click in an empty region of the grid (while the cursor is in Cross-hair mode) If you have made a "group" selection, omit one or more Fit Points from the group by holding down the Shift key while mouse-clicking on the points you wish to de-select. Alternately, hold down the Shift key while mouse-dragging (ala "marquee" selection) to group-deselect multiple fit points.

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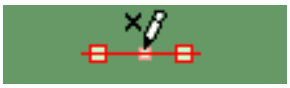
Pencil Tool Modes : Deleting Fit Points

To delete any Fit point on the grid, hold down the Alt key and move the mouse pointer to the Fit point you wish to delete. You'll notice that the Pencil tool now displays a small "x" to its immediate left, denoting that the Pencil is in "erase" mode. Mouse click while holding down the Alt key to delete individual Fit Points.



the Pencil tool in "erase" mode

Another way to delete one or more Fit points is to do a "marquee" or "group" selection while in Cross-hair mode (detailed above) then simply hit the Delete key on your keypad to erase the selected points.

The Zoom Tool

When you click on the magnifying glass button (next to the Pencil tool), you have selected the Zoom tool. This tool allows you to change your grid display resolution, zooming in for fine detail work and zooming out to see the entire spectrum.

➠ To Zoom in, have the Zoom tool enabled by clicking on the magnifying glass button. The Pencil tool will be disabled and the mouse pointer will change to a magnifying glass. Now bring the mouse pointer to an area of the grid that you wish to enlarge, and click. Click repeatedly to zoom in to higher and higher resolutions.

➠ To Zoom out, select the Zoom tool and hold down the Control key while clicking in the grid.

➠ To move around the Zoomed display, hold down the Alt key while dragging with the mouse (when cursor is in Hand mode). This will let you fine-tune the area displayed, or move to another region, without de-Zooming and re-Zooming.

☞ One major use for the Zoom tool is limiting the action of the Fit tool. If you Zoom in on a portion of the frequency profile, then hit the Fit button, you'll create Fit points only within the currently displayed area, and nowhere else.

☞ The Zoom tool only alters your view of the grid display. The Zoom tool has no effect on the functionality of the Ionizer (other than limiting the Fit tool's placement area, as described above); higher view resolutions do not get you an increased number of gated EQ bands, nor do they limit the frequency spectrum which is being processed by Ionizer.

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The Undo Function

To undo any change to a curve, simply click the Undo button, located to the far right above the grid. Undo will reverse your last change. Note that the Spectrum and Noise calculation functions can not be undone. The usual Control-z shortcut is the keyboard alternative for the Undo function.

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Keying

The Keying function allows you to extract the spectral and dynamic content from one sound and use it to manipulate another sound. This mapping of spectral envelope characteristics from one sound to another can create a great number of unusual effects, including classic Vocoder sounds. Since Ionizer deals with stereo files, the Keying "source" sound must be present in one channel, and the Keying "target" sound must be present in the other channel. This means that your final processed "target" sound will be mono (same sound in both channels) since you can't process two channels at once with Keying.

To utilize keying you must be using a host application which supports stereo files.

The default mode for Keying is "None." In this mode stereo and mono sound files are processed normally by Ionizer.

The "L to R" mode is used when you want to apply the spectral and dynamic content of the sound in the left channel to the sound in the right channel.

The "R to L" mode is used when you want to apply the spectral and dynamic content of the sound in the right channel to the sound in the left channel.

For step-by-step instruction on using Keying, check out Lesson 4 from the Ionizer Tutorials section. To find out more about running Ionizer as a 512-band vocoder see Lesson 5.

The Gain Buttons

Near the top of the Ionizer window are two new buttons, making their first appearance in Ionizer 1.3: The Gain Fit and Morph buttons. These features enable you to do wholesale remapping of any sound's frequency profile.

Gain Fit and Morph buttons

The Gain Fit Button

Gain Fit works much like the original Fit feature, except that the Gain Fit button conforms the Black Gain Curve to the contours of the current Frequency Profile. Gain Fit does not affect the Red and Blue thresholds curves.

Mouse Click on the Gain Fit button.

You'll see that the Black Gain curve is configured to match the curves of the Frequency Profile.

The number of Fit Points and degree of accuracy for the Gain Fit are determined by the Fit Points setting, explained above.

There's no prescribed application for the Gain Fit feature; it's simply an alternate way of creating a customized gain curve which could be useful in any number of sound design situations. We do, however, have some definite applications in mind for the other new Gain button, which is called...

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The Morph Button

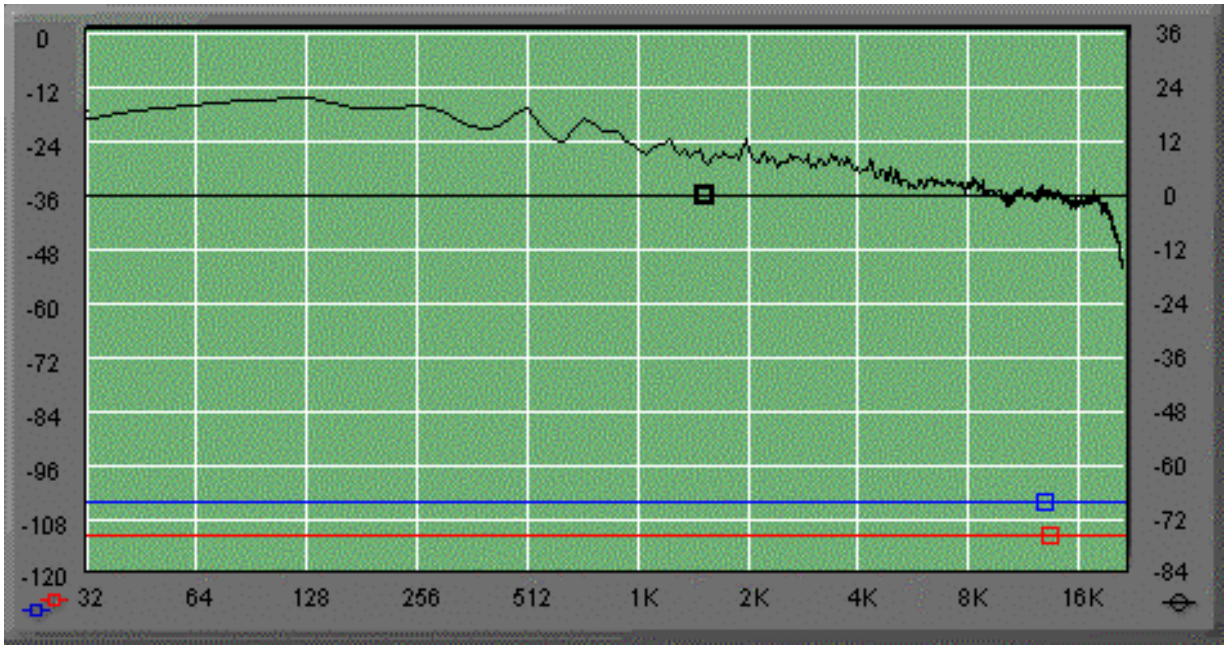
The Morph button is the key to one of Ionizer's most powerful functions: Mapping the spectral profile of one piece of audio to any other. We call the process Frequency Morphing or "EQ Theft."

Using the Morph button assumes that you're dealing with (at least) two separate sounds: A "source" sound which will be analyzed, and a "target" sound which will be morphed into the frequency profile of the source.

➠ Load the source sound and select the range you wish to use as the model for morphing. Then select the Ionizer plug-in.

➠ Click on Spectrum, begin audio playback, click Spectrum off at end of selection. Or for a longer file, click on the Spectrum button, click OK, the Ionizer window will close as the profile is generated, re-open Ionizer.

➠ Move the Red and Blue Curves to the bottom of the screen, with Blue above Red, so that Ionizer is in a graphic EQ configuration. The screen should look much like the example below:



Note that the Blue and Red Curves are at the bottom of the screen; this is a typical graphic EQ configuration, and is the recommended initial Blue and Red Curve setting for Frequency Morph work.

➠ Either save your current Ionizer settings as a Preset, or simply close Ionizer. The frequency profile of the source will be retained in either case.

➠ Load your "target" audio and select the entire range you wish to be processed.

➠ Re-open the Ionizer. The frequency profile of the source should still be displayed.

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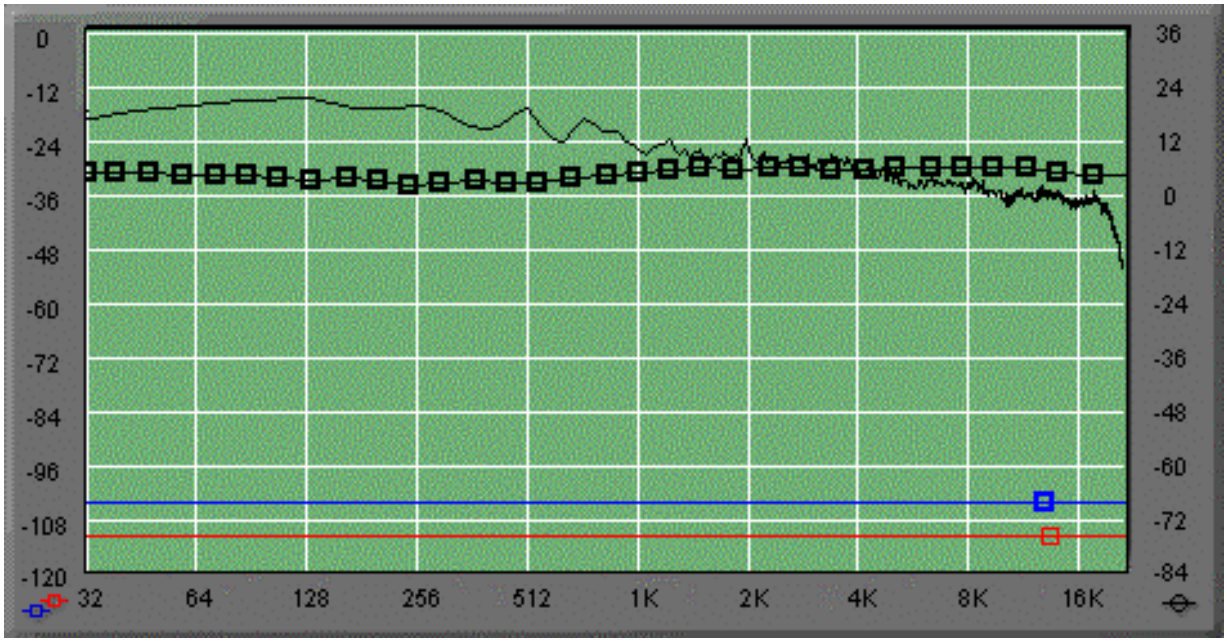
➠ Click on Spectrum again, begin audio playback, click Spectrum off at end of selection to generate a new Spectrum for the your target audio

➠ Hit the Morph button.

➘ After a brief calculating period a new Black Gain Curve will result, which represents the EQ settings required to make the target sound like the source.



Note the new Black Gain Curve, which shows the amounts of boost and cut applied to Morph the target audio to the source's frequency profile.

➠ If your audio host has the capacity, you can preview the result, toggling Bypass In and Out to compare the target's original sound with the new Morphed version.

➠ If you're pleased with the result, hit the OK button or save the settings as a preset.

Frequency Morphing at its most basic level is just a fancy way of adjusting the boost and cut on 512 different EQ bands so that one sound's EQ characteristics will mimic another's. Other programs have attempted to provide this type of functionality but because of the number of bands we use, Ionizer's high bit-depth internal precision, the phase-linear nature of our EQs and our proprietary means for reducing artifacts, no other software solution can come close to the spectral remapping capabilities and sheer sonic accuracy of Ionizer.

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More About Frequency Morphing

There's a number of specific potential applications for Frequency Morphing:

Sound Design: Make one voice or instrument mimic the frequency characteristics of another.

Mastering: "Sample" the EQ settings off a favorite album, then apply them to your own mix.

ADR/Foley: Analyze the sound from the set or location, then apply those characteristics to looped dialog or effects

A complete step-by-step tutorial on morph techniques is in Lesson #6: Frequency Morphing.

The Horizontal Sliders

Situated along the top part of the Ionizer window are three sliders which control the non-frequency dependent aspects of Ionizer. The Correlation, Attack and Release settings really come into play in Noise Reduction applications, allowing you to control gate/gain activity so as to minimize artifacts such as chirping, flanging and squishing.

the Ionizer sliders: Correlation, Attack and Release

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Correlation

Correlation controls the degree to which neighboring EQ bands follow each other. As band energy causes a gain change in one band, that change is applied (to a lesser degree) to the bands around it. Each band's movement pulls up and pushes down the gain on surrounding bands. A high degree of correlation means that a gain change is averaged over a large number of bands, while a low degree of correlation means that only those bands which are close together are averaged. Zero correlation causes each of Ionizer's individual frequency bands to act independently of each other. The range of this control is from 0% (no correlation) to 100% (correlation across all bands).

Attack

Users of traditional compressor/limiters will find this control familiar...Attack sets the time required for each EQ band's dynamic processing to take effect, once band energy level has crossed the Red Curve threshold into the gate transition zone or active zone. The default of this control is from 0 to 100, with 100 being equivalent to a one-second attack time.

Release

The Release setting determines how quickly or slowly each EQ band's gate closes, once band energy level has crossed the Red Curve threshold into the passive zone. The range of this control is from 0 to 100, with 100 being equivalent to a one-second release time.

Adjusting Slider Values

Simply click-and-hold your mouse over the numeric field you wish to reset, and drag the mouse up or down to adjust the slider value from the numeric field. Naturally you can also just mouse-drag on the slider's throw knob.

Using Presets

Presets let you store all the parameter settings of the current effect so you can restore them later or apply them to other files. Over time you'll create a library of custom effects settings that you can reuse at will. The Presets pop-up menu is located at various places dependent on your host audio application. The name of the current preset is displayed in the Preset box

The presets you store are specific to the application that they were created in. For example, if you stored a preset in Cool Edit Pro, you could not access that Preset in Sound Forge.

Simply mouse click on the Presets pop-up, and keep the mouse button depressed while you scroll down the list of presets; mouse-up to select the desired preset.

The "Default" preset is (predictably) loaded by default when first starting up the Ionizer application.

To create a new preset (meaning saving the current combination of slider and curve settings) select the "Save As" function. You'll be prompted to give a new name to the preset, after which the preset will be added to the list of currently-available presets.

To remove any preset from the list in the pop-up menu, select the undesired preset (if it's not already currently-loaded) then select the "Delete" function. You'll be prompted to confirm the deletion, after which the preset will be obliterated.

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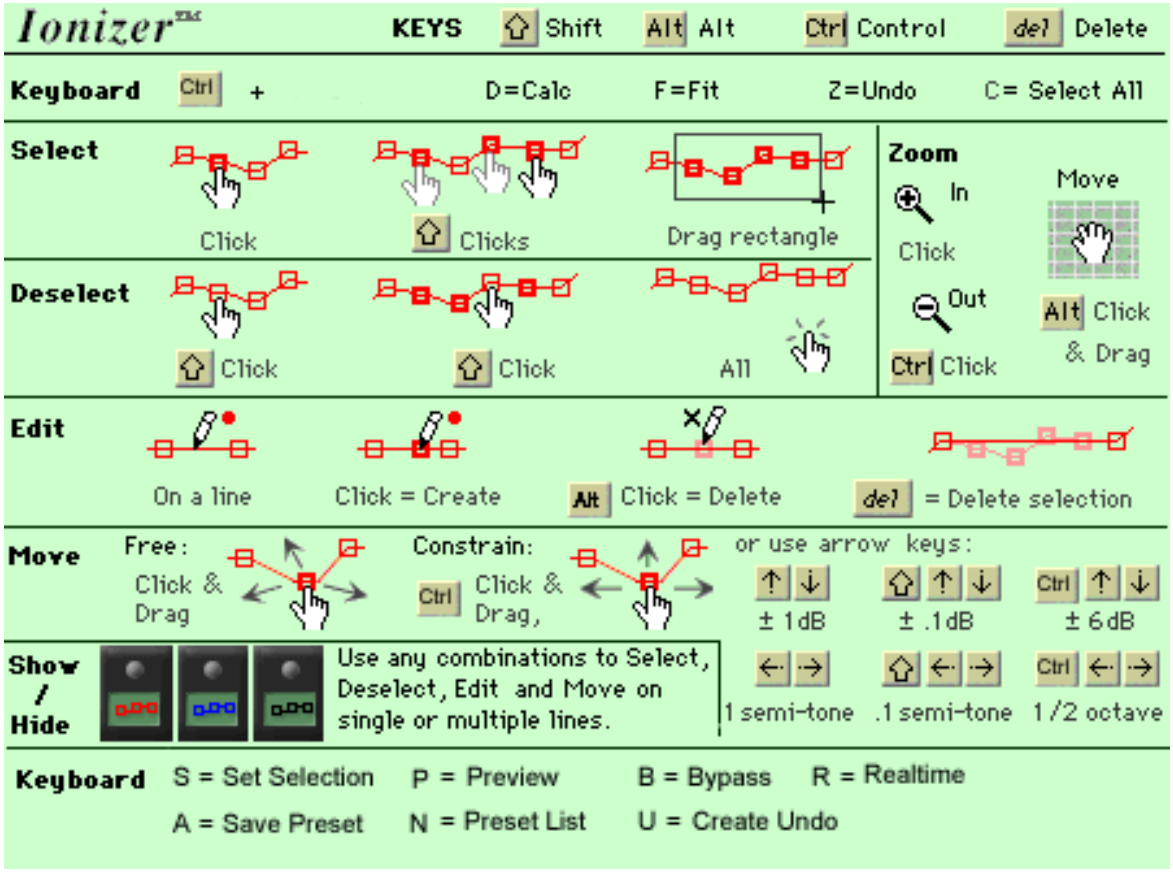
Ionizer Help Button

Clicking on the Help button brings up the Ionizer Help screen, which is a quick reference to Ionizer key commands and cursor modes. Click anywhere outside of the Help screen to remove it from view.



the Ionizer Help screen provides a handy reference to frequently-used key and mouse commands.

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PlayBack and Processing

Situated to the right of the grid, the remaining controls govern preview, bypass and processing as determined by the host application.

Preview

Clicking the Preview control causes Ionizer to begin looped playback of your currently-selected audio. Playback will continue until the Preview button is clicked off. The keyboard shortcut for toggling Preview is Alt-P. The Preview is supplied by the host application.

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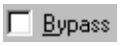
Bypass



The Bypass control lets you Preview your original sound with or without the effects of the current Ionizer settings. The Bypass is supplied by the host application.

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Process (OK)

Clicking the OK button stops preview playback and applies the current Ionizer settings to your currently-selected audio.

Depending on the length of the audio segment you've selected, processing could take a few moments.

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Cancel

Clicking on the Cancel button stops all Ionizer functions and returns you to your host application.

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Faders

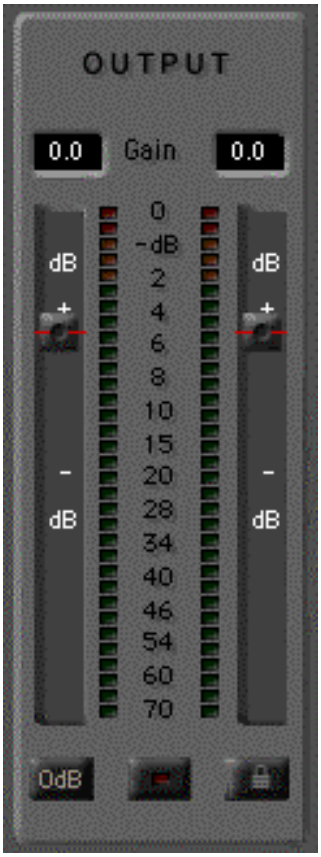
The Faders allow you to adjust the volume of the output signal. Note that the Faders only control output; they have no effect on signals being fed into Ionizer. The Faders also have no effect on EQ band gate/gain action; that's controlled by the Ionizer Curves. To reiterate: the Faders control channel gain **after** the Ionizer processing stage. The Faders can be adjusted up or down as required. Each channel can be adjusted individually, or the faders can be moved as a pair. Fader units are listed in dBs, up to 18 dB of positive gain (boost) and negative gain (attenuation) can be applied to the output signal.

The Meters give you a real-time display of the strength of the output signal, in dB.

➠ Mouse-click and drag on either side of the Fader "knobs" to adjust the left and right channels individually. Mouse-click on the Lock button (below the faders) until it is in the locked position and drag either one of the "knobs" to adjust both channels together.

➠ The 0 (zero) button at the bottom of the fader range automatically returns either, or both, Faders to the zero dB setting. No gain is being applied to the output signal when the faders are at zero dB.

➠ Mouse click on the “Clip” button (below the Faders in the middle) to reset the clip indicator



the Ionizer Faders and Meters; zero reset buttons at bottom

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Lesson 1 : Noise Reduction

In this lesson we will go over the steps required to get the best results for broad band noise reduction using the Ionizer. This example uses the included sound file Lesson1.wav.

When working through this lesson and the subsequent Ionizer tutorials, we advise you to listen to the results through headphones so that you're able to clearly hear subtle sound changes which you may miss when monitoring through speakers.

The first step in broad band noise reduction is the identification of the noise signature. The noise signature is a measure of the different frequencies present in the noise portion of the audio.

➠ Launch your audio editing program and load the example file Lesson1.wav which is included on the Arboretum CD in the Sound Examples folder.

➠ To obtain the noise signature, simply select a portion of the audio that contains only noise. Drag over the "silence" region in your waveform editor display as shown below. Figure 1 shows the noise portion we're grabbing from the audio file Lesson1.wav.

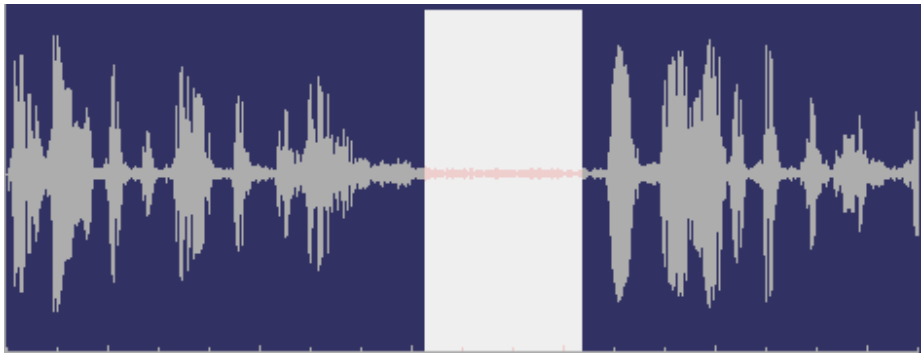

Figure 1, noise floor selection

After the noise segment is selected,

➠ Launch the Ionizer by selecting Ionizer from the Plug-ins menu.

➘ The Ionizer screen appears.

➠ Click on the Spectrum button, begin audio playback, click Spectrum off when end of selection is reached.

The Spectrum button tells the Ionizer to calculate the spectral content of the selected portion of audio. For the present case, this corresponds to the noise signature of our selection.

➘ After the calculating the noise signature, Ionizer will display the Frequency Profile, a black curve indicating the gain at each EQ band in your original audio.

➠ Click the Fit button to cause the Ionizer to fit the Blue and Red fit curves to the noise signature.

➘ `The Ionizer screen should now look like figure 2 (below):`

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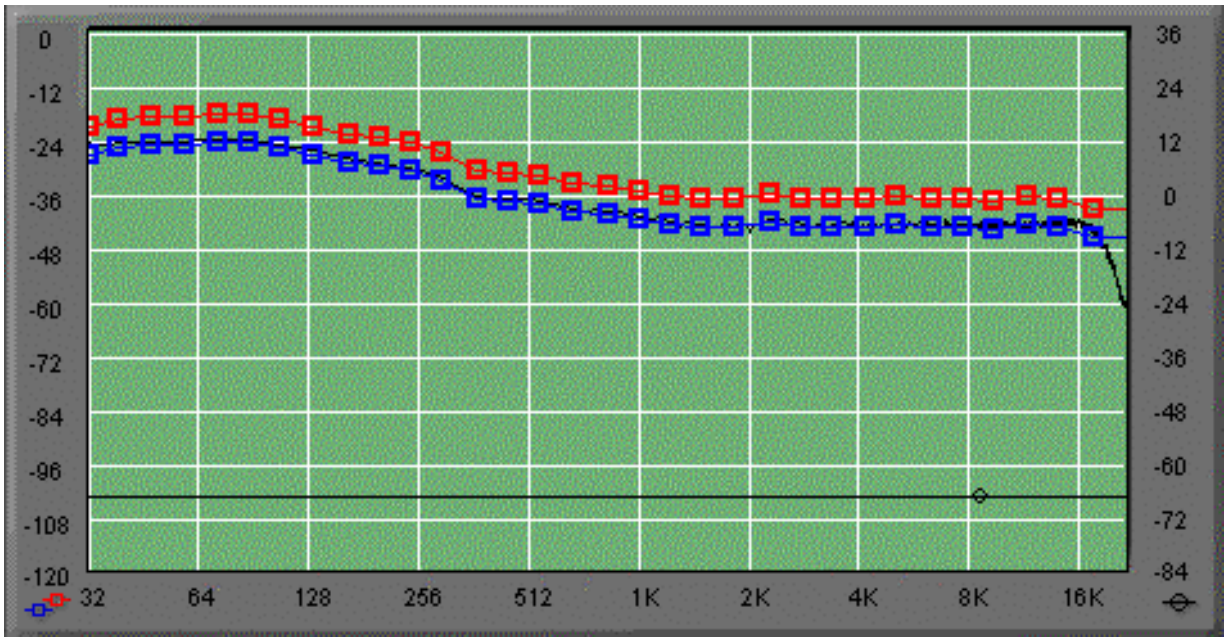

Figure 2., curves fit to frequency profile

The Red fit curve is displaced by +6 dB from the Blue fit curve. The Ionizer does this to create a gate transition zone. Check out the Ionizer Functional Overview chapter for explanation of the gate transition zone.

Close the Ionizer window (Press the Cancel button).

Now you're back at your waveform editing display. Select the entire audio file, then call the Ionizer again.

Ionizer remembers its settings as it is opened and closed; the curves you just created are still there.

Hit the Preview button to begin audio playback.

Make certain that the gain curve (the Black Curve) is visible by clicking the Black Curve display button. Click in the black circle of the Black Curve and drag it to about -24 dB as seen in figure 3 (below).

You should hear a significant reduction in the noise level of the signal at this point.

We find that gain reductions of 12 to 24 dB are often enough to push the noise floor below the perceptible level without inducing any noticeable artifacting.

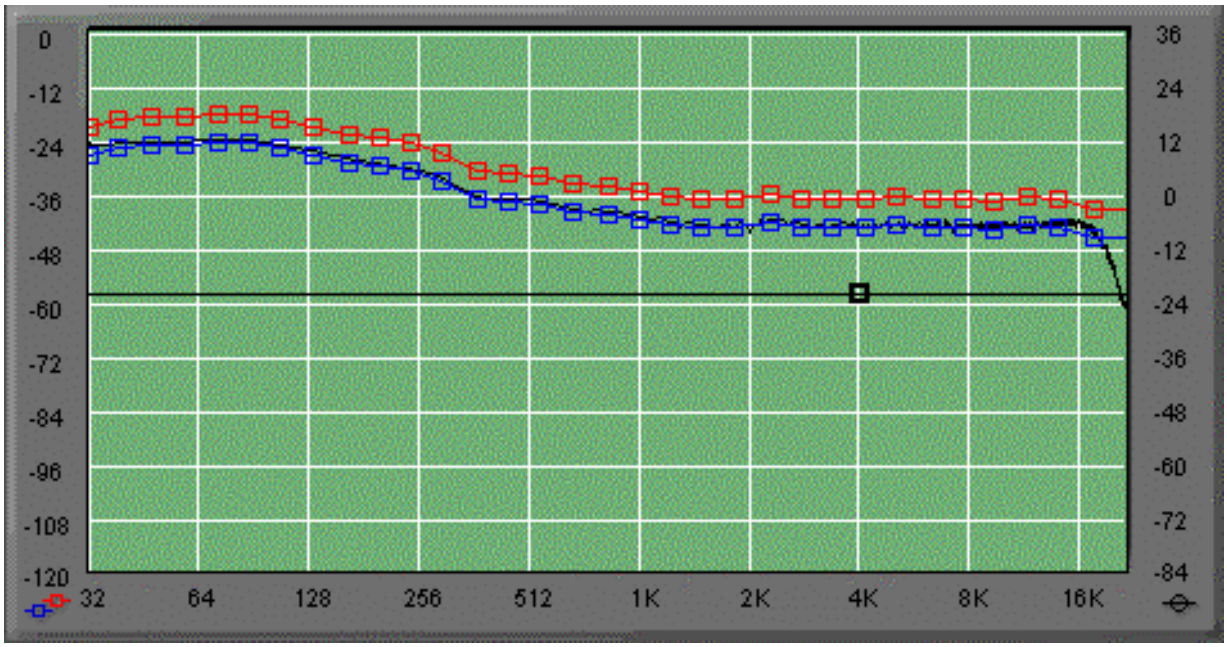

Figure 3, attenuating the noise signature by manipulating the Black Gain Curve

You've just finished the first part of our lesson, and learned to do "manual" noise reduction. Now let's explore Ionizer's automatic noise calculation function. The Noise button performs the following steps: It looks at your audio file and makes an "educated guess" about where the noise component of your signal is. Then it performs a spectral analysis of the presumed noise and displays the frequency profile. This eliminates several steps from the NR process and is especially helpful when confronted with audio files that don't have enough "silence" in them to get an accurate noise floor fingerprint with the Spectrum function.

To use the Noise button:

➠ Go to the waveform display and select all of Lesson1.wav.

➠ Select the Ionizer from the Plug-ins menu.

➠ Click on the Noise button, begin audio playback, click Noise button off when end of selection is reached.

➘ After a brief pause, the frequency profile of your noise signature appears.

➠ Now click on the Fit button to adjust the Red and Blue curves to the frequency profile.

➠ Manipulate the black Gain Curve as we did in the earlier example to pull the noise out of your signal.

The Noise function's "search-and-destroy" routine is all you'll need for most broad-band noise reduction work. However, if you're not getting the desired results, you can always revert to the first approach, manually specifying the noise range then calculating the profile with the Spectrum function.

Note that the Noise button ignores the current Ionizer settings so that its reading is always "pre-effect," it will only analyze the original, unprocessed signal. This is a new behavior in Ionizer v1.3 ensuring that

Ionizer's always "bypassed" when getting a Noise reading, thereby reducing the burden on the user.

Among the features added in Ionizer v1.3.0 is the Automatic Tracking function. Auto Track will "ride" the noise level, moving the Ionizer thresholds up and down to compensate for variations in the noise signature's volume. This feature is especially useful with program material that has changing amplitude levels, such as a piece of music which fades out during its ending. Try toggling the Auto Track on and off when doing NR on a piece of music with a fade to really hear its results.

The remainder of the lesson will focus on the topic of "Artifact Management." Artifacts occur when the processing alters the sound in an undesirable fashion. The most common types of artifacts are the "Chripies" and the "Flangies." The Chirpies sound like little metallic birds chirping away in your sound file. They occur when isolated spectral bands are rapidly turned on and off. The Flangies are more subtle. They make the audio sound as though it were passed through a flanger or phaser effects box. Flangies occur when the gains applied to nearby bands differ significantly. The Ionizer has several tactics for combating these artifacts, as will be seen in the following paragraphs.

Once you have the Red and Blue fit curves in a reasonable position, its time to start fine tuning the process. Start by adjusting the relative positions of the Red and Blue fit curves:

- Enable Preview so you can hear your effect changes.
- Select all fit points.
- Control-drag both curves up and down to get a sense for how they affect the noise reduction process.
- Now hide the Red Curve (by clicking off its display button).
- Move the Blue Curve down about 3 dB, to increase the size of the gate transition zone.
- By making a larger gate transition zone, we're specifying a longer, slower amplitude change, which helps eliminate the Chirpies.

I have also made a band pass filter with the Black gain curve; see the screen shot below. This is done by hiding the Red and Blue Curves then using the pencil tool to add Black Curve fit points. I did this because the noise is less noticeable in the bands where the voice is loudest. I made the gain reduction much greater in the high and low frequency bands than in the mid bands where the spectral content of the voice is strongest. Since voice generally resides in the 128 Hz to 1 kHz frequency range, it's OK to roll off the higher and lower bands.

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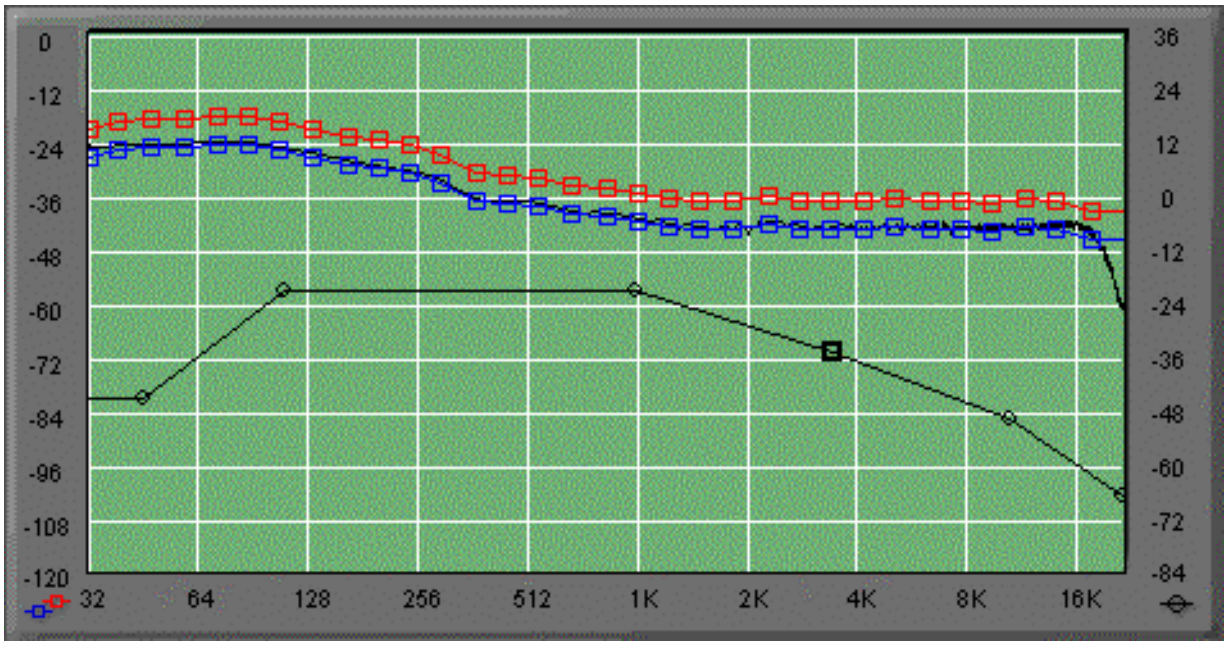

Figure 4, band pass filter

The final tweaking for artifact management is done with the three sliders labeled Correlation, Attack, and Release.

While still in the current example file/settings, you should play around with these sliders to get a feel for what they do the sound.

Correlation sets the degree to which the Ionizer preserves band-to-band correlation in the signal. In essence, it forces the gates to operate on adjacent bands as a group, instead of treating each band individually.

A Correlation setting between 25 to 50 does a good job of eliminating both chirpies and flangies.

Attack tells the Ionizer how quickly it should activate a gate as the energy of a given band crosses the threshold into the gate transition and active zones.

I prefer to keep the Attack setting rather small, usually less than 10 for noise reduction.

Release sets how quickly the gates release after the energy of a given band has crossed back over the threshold into the passive zone.

A release of 25 to 50 helps to fight chirpies by preventing the bands from rapidly turning on and off.

After you are happy with your settings, just hit the OK button and you're done!

Lesson 2 : Audio Restoration

In this lesson we will use the Ionizer to first compress the dynamic range of the sound file and then perform compression, expansion, and equalization simultaneously.

As with the other Ionizer tutorials, we suggest that you listen to the sound through headphones so that you're able to clearly hear subtle sound changes which you may miss when monitoring through speakers.

➠ Launch your audio editing software then load the sound file "lesson 2.wav" (from the Sound Examples folder on the Arboretum CD).

➠ Play the audio segment several times to familiarize yourself with it.

The music is an excerpt of "Stephie's Dream, ©1996 by Dave Carr, performed by Yahweh's Mistake. It is a live recording that has several problems.

➘ The first problem you might notice is the snare. It sits way above the rest of the mix, because the mic position was a seat directly in front of the stage.

➘ There are also several resonances in the sound file caused by an interaction between the PA and the room in which the performance took place.

➘ Lastly, the low end is a bit mushy so it would be nice to give it some definition.

Using the Ionizer, we will attempt to "resurrect" this sound file.

➠ Select the entire sound file in your waveform editing display.

➠ Launch the Ionizer.

➠ Click on the Spectrum button, begin audio playback, click Spectrum off when end of selection is reached.

➘ The spectrum analysis should look like the one shown in fig. 1 (minus the purple arrows).

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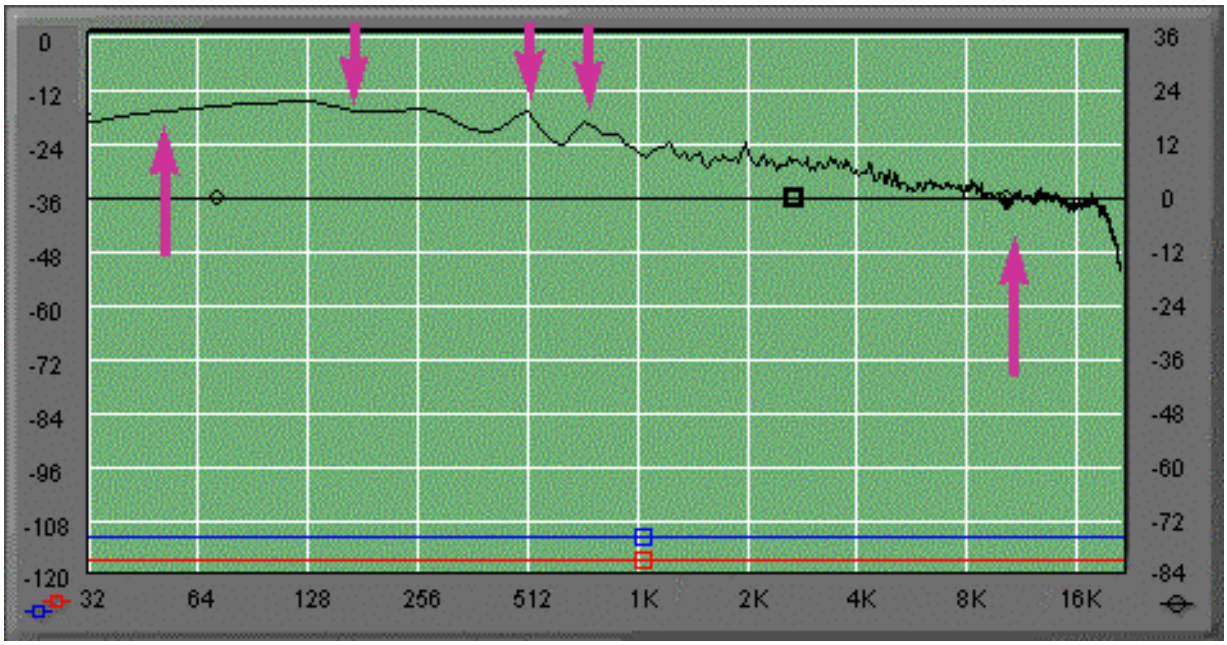

Figure 1, frequency profile

The arrows point to segments of the spectrum where we should pay special attention. Since the low end is muddy, we are going to attempt to expand the dynamic range in this region using upward expansion. We will use a cut around 256 Hz to help the definition of the low end. At about 500 and 700 Hz are two prominent peaks that are causing us much grief. They are clouding up the vocal and guitar lines and allowing the snare to ring out. Lastly, we will want to add just a touch of boost to the high end to liven the recording.

➠ Select all fit points.

➠ Hit the Delete key to reset the Ionizer curves to straight lines.

First off, I am going to push the snare down with the use of compression.

➠ Hide the Black and Red Curves by toggling their Curve Display buttons, allowing the Blue Curve to remain visible.

➠ Hit the Fit button.

➠ Make the Red and Black Curves visible by clicking again on their Curve Display buttons.

➠ Move the Red Curve to the bottom of the grid and pull the Black Curve down to about -12 dB.

➠ Select all the points in the display.

➠ Hold down the shift key while mouse clicking on the one Fit Point along the Red Curve so as to de-select it.

➠ With all Blue Curve Fit Points still selected, drag the blue line up and down while listening to the effects to familiarize yourself with its function.

➘ Listen to how the blue line pushes down the dynamic range of the signal.

➠ Once you are accustomed to the blue line's functioning, set it about 5 dB above the frequency profile.

Most of the problem with the dynamic range is in the mid-bands and that's where we want the compression to be greatest. This keeps us from pushing down too hard on the low or high ends of the spectrum which would be counter-productive.

➠ Add additional fit points to the black line as shown in fig. 2

➠ If possible, repeatedly compare with the original sound by hitting the Bypass button.

➘ You should notice the snare sitting down in the mix but not much other coloration of the sound. The Ionizer screen should now look like figure 2.

➠ Hit the OK button.

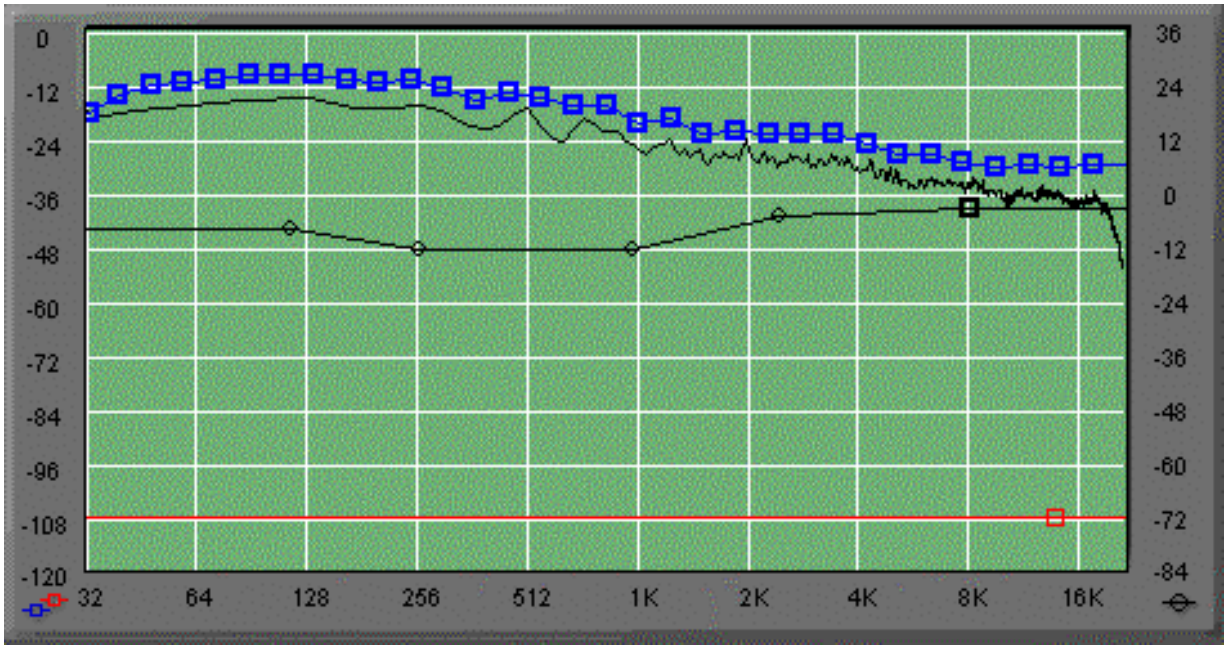

Figure 2

Now we are going to focus more on some of the trouble spots of the sound file.

➠ Make certain the processed sound file is selected and reopen the Ionizer.

➠ Select the 3 band EQ preset from the Presets pop-up menu. The resulting settings should appear as shown in fig. 3, below.

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➠ Click on the highest fit point of the black line at about 12 kHz and give about a 1 dB boost to the high end. Nothing too drastic, just add little presence to the sound.

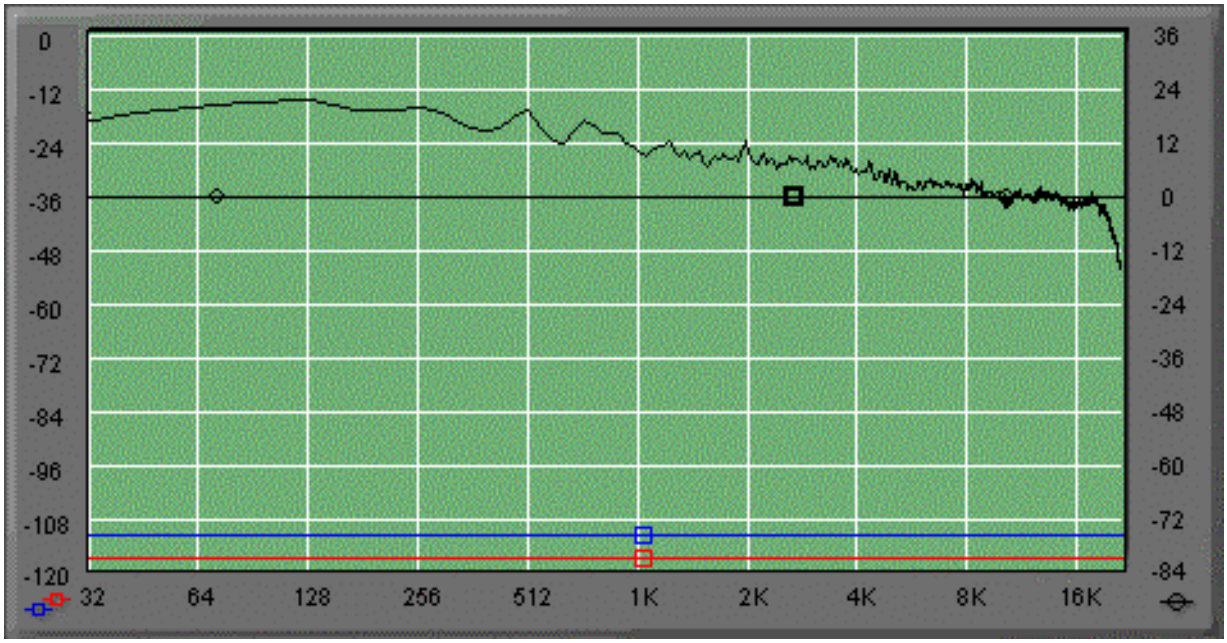

Figure 3

Now focus on the low end. I want to untangle the kick drum from the bass a bit so the low end is not so muddy.

➠ Add points to all three lines so that the lines look like those shown in fig. 4, below. Don't worry about getting it exact, just get the general idea and experiment.

What I am attempting to do here is set a threshold point for an upward expander that will boost the low end when it is above the red line. This should add definition to the low end by emphasizing the kick a bit.

➠ Again, play around with the curves while paying close attention to the effect of moving the Red and Blue Curves around.

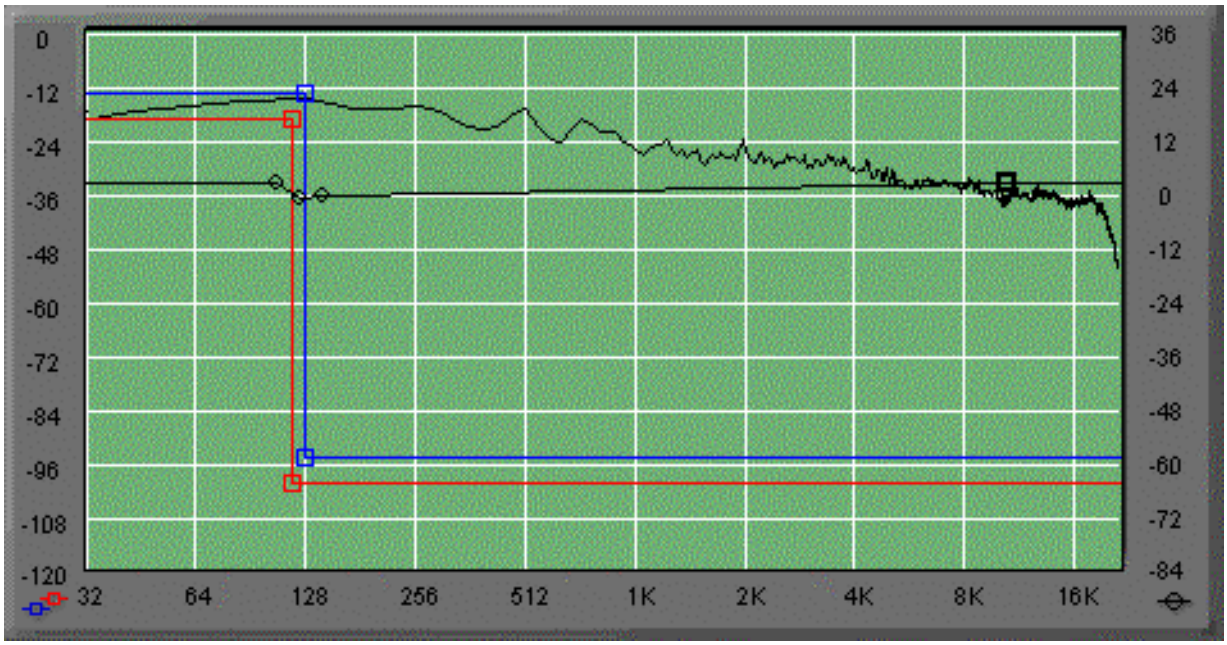

Figure 4

It's now time to correct the resonances.

➠ Click on the Zoom tool to enable Zooming.

➠ Move the mouse pointer to where the frequency profile is, and mouse click TWICE right around the 700 Hz / -24 dB mark.

➠ Set the number of Fit Points to 6.

➠ Hit the Fit button.

➘ You'll have fitted six points on the Blue and Red Curves, limited to the Zoomed display area.

➠ Now hold down the Control key to enable Zoom Out, then mouse click twice in the grid to get back to your original full view.

➠ Add points to the Blue and Red Curves to anchor the curves down around -96 dB as shown in fig. 5, below.

➠ Under the Blue and Red Curves, add fit points to the Black Gain Curve to set up the compression in those bands.

➠ Again, experiment with the positions of the lines. Pay special attention to how certain elements in the sound file are affected by your actions.

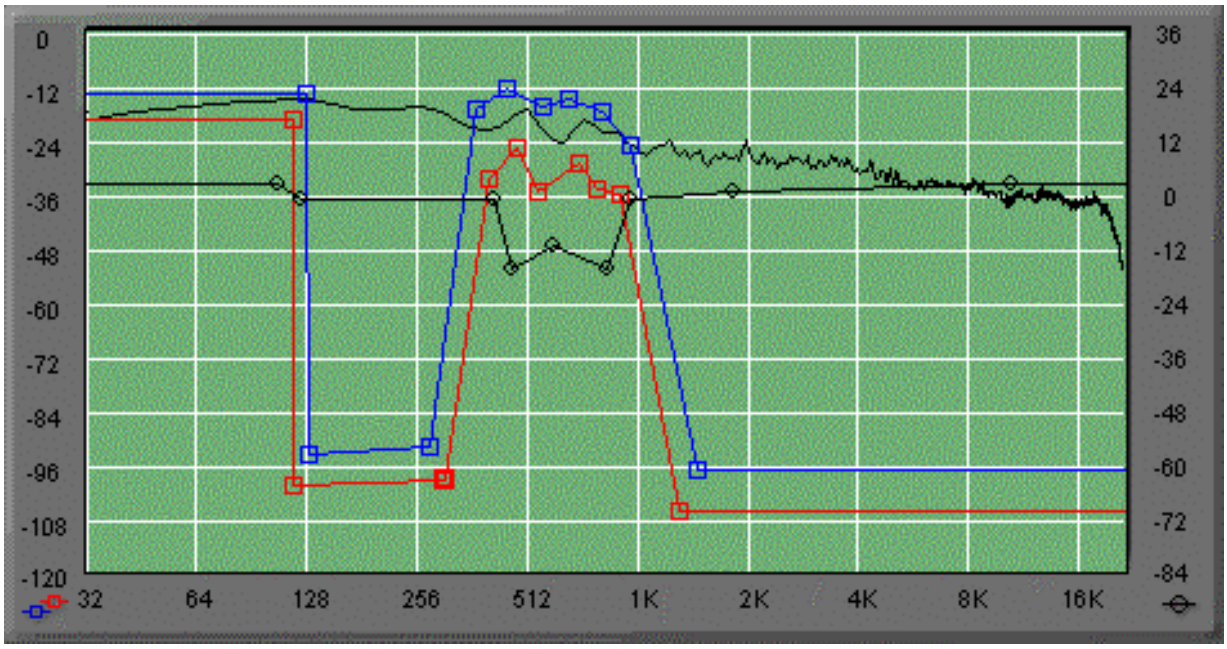

Figure 5

For the last tweak, cut a bit out of the 100-300 Hz band by moving the Black Gain curve into the attenuation (negative gain) area to clear up the 128-256 Hz low end, as shown in fig. 6, below.

Hit the OK button. You're done!

You should now have a good understanding of the roles each curve plays in the Ionizer. For more information about the Curves, refer to the Ionizer Functional Overview chapter. By creatively exploiting the relationships of the curves, you can create very complex processes very quickly and even resurrect an old sound file or two while you're at it!

Lesson 3 : Sonic Sculpture

In this lesson we will use the Ionizer to completely transform one sound into an entirely different sounding file. We will do this by using the Ionizer's gain curve to create extreme filters. This example uses the sound file Lesson3.wav included on the Arboretum CD in the Sound Examples folder.

As with the other Ionizer tutorials, we suggest that you listen to the sound through headphones so that you're able to clearly hear subtle sound changes which you may miss when monitoring through speakers.

➠ Launch your audio editing software then load the sound file "Lesson3.wav" (from the Sound Examples folder on the Arboretum CD).

➠ Select the entire sound file in your waveform editing display.

➠ Launch the Ionizer.

➠ If your host application allows, toggle the Bypass switch to "On" so that you can hear the untreated original sound file.

➠ Preview the sound file and listen to it as it loops several times.

➘ Note the rich tone at the low end of the spectrum and the clapping at the higher frequencies.

➠ Click on Spectrum, begin audio playback, click Spectrum off when end of selection is reached.

➠ Now click on Bypass again to toggle to the "Off" mode, so you can hear Ionizer's effect as you work.

First we isolate the low rich tone from the clapping by creating a "brick wall" filter as seen in fig. 1.

➠ Select the 3 band EQ preset from the Presets pop-up menu. The resulting settings should appear as shown in fig. 1, below.

➠ Move the Black Curve fit points around until you have a nice sharp filter.

➠ Play around with the cutoff frequencies to bring the clapping in and out.

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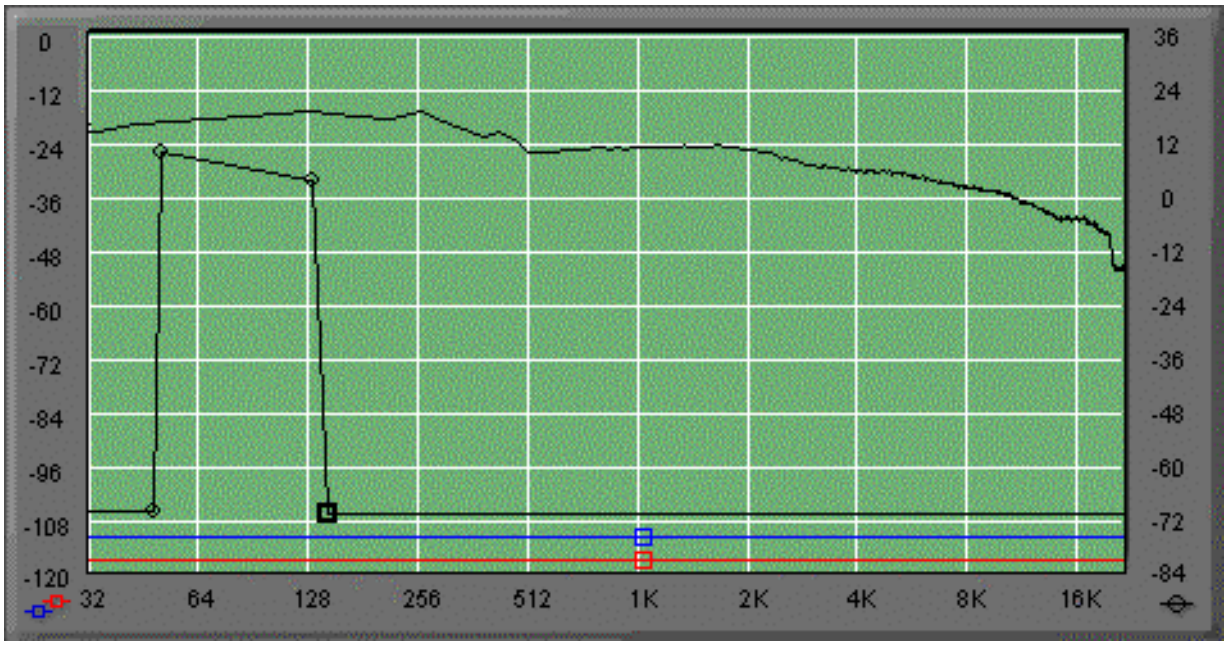

Figure 1

➠ Once you have isolated the low tone, start adding in harmonics from the clapping by creating very sharp band pass filters as shown in fig. 2, below.

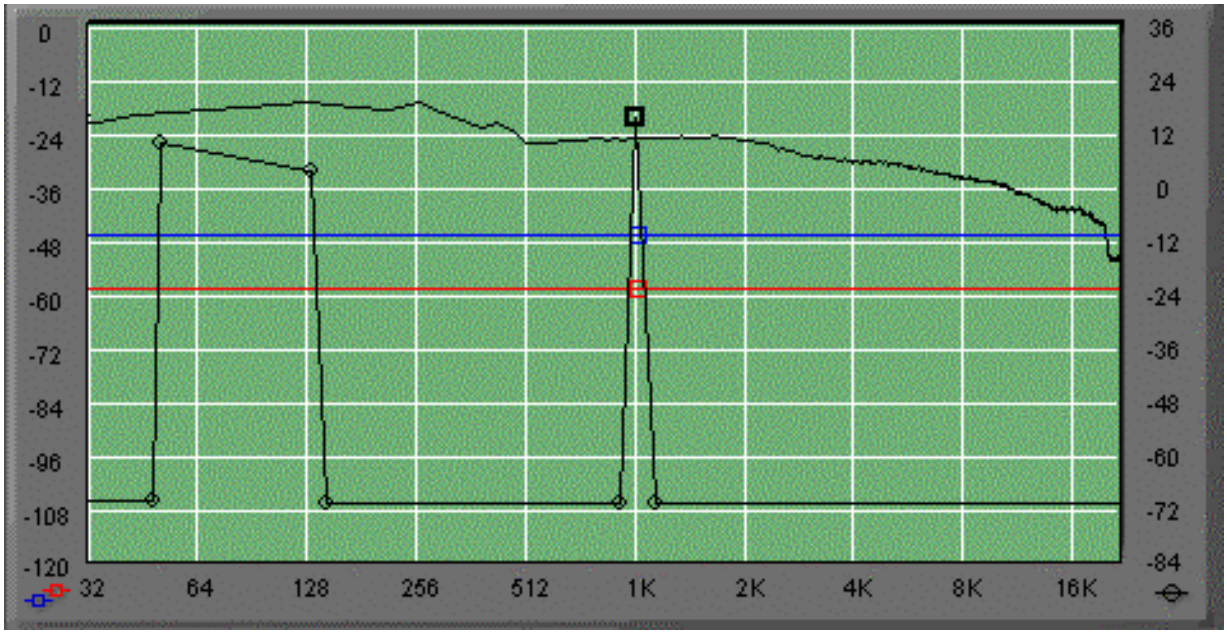

Figure 2

➠ Also experiment with the positions of the Red and Blue Curves. For this example, I chose to set the

lines so as to accentuate some chirpies for effect.

➠ Manipulate the Correlation, Attack and Release settings to change the character of the artifacts ("chirpies.") Figure 3 shows my settings:

Figure 3

➠ Once you get the hang of one band pass filter, go ahead and add several more.

You can add as many as 512 fit points to the gain curve so don't be shy. I added nine harmonics to my low tone (see fig. 4). Try adding even more. Experiment with the Red and Blue Curves as well. You may stumble across a few surprises.

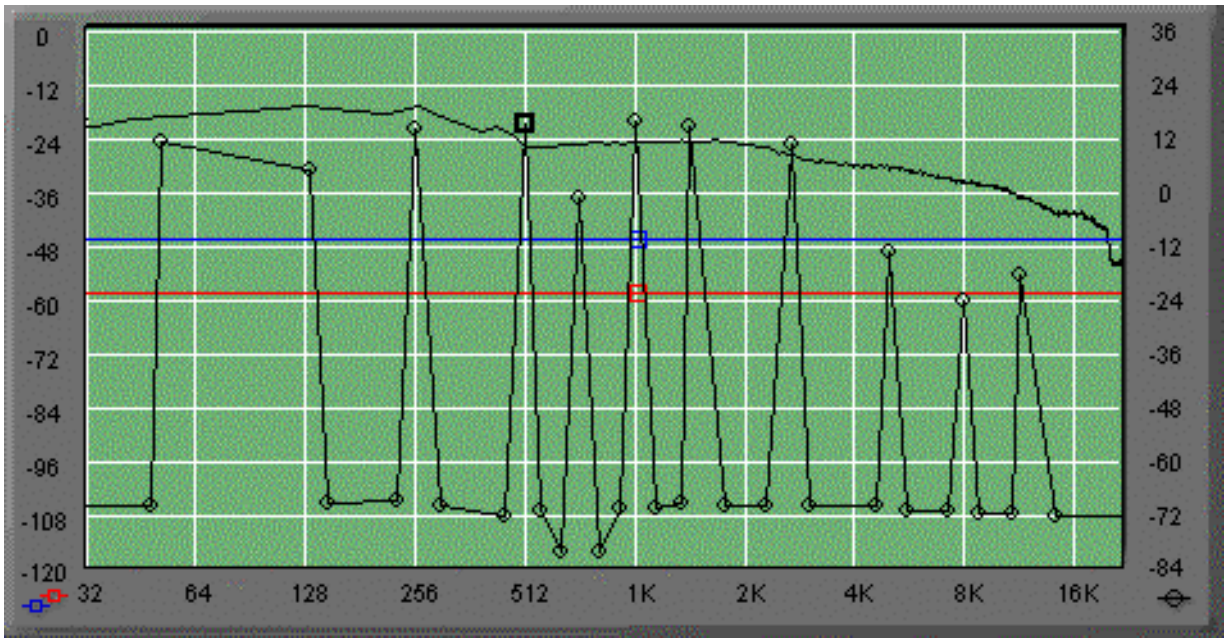

Figure 4

Now that you have worked through this lesson you can call yourself a sonic sculptor. Try sculpting different types of sound files. Sound files that have broad band spectral content make the best candidates for sonic sculpting. Even noise can yield very interesting results.

Lesson 4 : Keying Morph

In this lesson I will illustrate the powerful Keying feature by walking through the steps used to create a spectral morph effect.

To utilize Keying you must be using a host application which supports stereo files.

Spectral morphing is an effect created by modulating the spectral structure of one sound by another. We'll demonstrate this by using a drum loop to modulate an electronic bass sound. This imposes a rhythmic filter on the bass sound that is in sync with the drum loop.

As with the other Ionizer tutorials, we suggest that you monitor the sound through headphones so that you're able to clearly hear subtle sound changes which you may miss when monitoring through speakers.

Launch your audio editing software then load the sound file "Lesson 4.wav" (from the Sound Examples folder on the Arboretum CD).

Select the entire file. Play the sound file a few times to familiarize yourself with the sounds.

If you have the output of your computer connected to a mixer, you may now want to pan both the left and right channels from the output of your computer to the center position.

Launch the Ionizer.

Select all fit points.

Hit the Delete key to reset the Ionizer curves to straight lines

Toggle the Bypass button to "On."

Move the Red, Blue and Black lines so that they are in the positions shown in fig. 1.

Repeatedly hit the Keying button until it says "R to L"

Click on Spectrum, begin audio playback, click Spectrum off when end of selection is reached.

The displayed spectrum corresponds to the first channel shown on the Keying button. In our case the Right channel is first.

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Figure 1

➠ Switch the Bypass setting to "Off" again, to enable you to hear the processing.

➠ Hit the Preview button and listen to the modulated bass sound.

➠ You may want to mute the computer's right channel on your mixer if you are using one.

➘ You should hear a pulse of low frequencies in the low end of the bass sound that is sync'd to the kick drum of the drum loop.

☞ What is happening is this: When the energy at a given frequency from the right channel crosses the red line, the gain applied to that frequency band is determined by band energy level. When operating in this right to left Keying mode, the gain is applied to both the left and right channels. When in left to right Keying mode, the gain is determined from the left channel and applied to both.

Now, what makes the Ionizer so powerful is its ability to apply different gains to up to 512 bands. This flexibility can be exploited by shaping the thresholds and gain curves to create various Keying effects.

➠ Alter the curves to accentuate different frequencies. Click on the left-most Blue Curve point and reposition it as shown below (figure 2).

Lowering the Blue Curve above 2 kHz makes the cymbal frequencies more pronounced in the bass sound. Since the cymbals are hit on beats different from the kick drum, rhythmic modulation or filtering of the bass sound becomes more complex.

Emphasize a peak around 600 Hz by adding and moving Fit Points in the Black Gain Curve to bring out these harmonics, as shown in figure 2, below:

Figure 2

You should spend some time playing with the curves to see the different effects possible. For instance, try applying a negative gain to the frequencies below 200 Hz so the bass line "ducks" the kick drum. Another thing to try is the use of radical filter curves like those shown in Lesson 3 to create strange and wonderful noises.

After spending some time with the Keying feature, I am certain that you will think of many more uses in your own work for this feature. Now read on to Lesson 5 and discover how to use Keying to create remarkable Vocoding effects...

Lesson 5 : 512 Band Vocoder

Believe it or not, the Ionizer can act as a 512 band vocoder. This remarkable feat is made possible by utilizing the "Keying" option.

When the "Keying" option is activated and you are processing a stereo signal, Ionizer uses the gain calculations from one channel and applies them to the other channel. By altering the Threshold and Gain curves and adjusting the Correlation, Attack, and Release sliders, one can create a nearly limitless range of vocoding effects. This lesson will teach you the necessary steps to transform your Ionizer into a lean-mean-vocoding-machine!

To utilize Keying you must be using a host application which supports stereo files.

➠ Launch your audio editing software then load the sound file "Freakazoid.wav" (from the Sound Examples folder on the Arboretum CD).

➠ Select the entire file. Play the sound file a few times to familiarize yourself with the sounds.

➠ Launch the Ionizer.

➠ Click on the Keying button in the Ionizer window once (see Figure 1, below).

With Keying set to "L to R" the Ionizer output will be calculated by taking the gain changes calculated for the left channel and applying them to the right channel. In vocoder-speak the left channel serves as the modulation channel and the right channel is the carrier.

(Figure 1-The Keying button)

Now we need to set up the threshold curves so that the keying produces a Vocoder effect.

➠ Click on Spectrum, begin Preview or Audition, click Spectrum off when end of selection is reached.

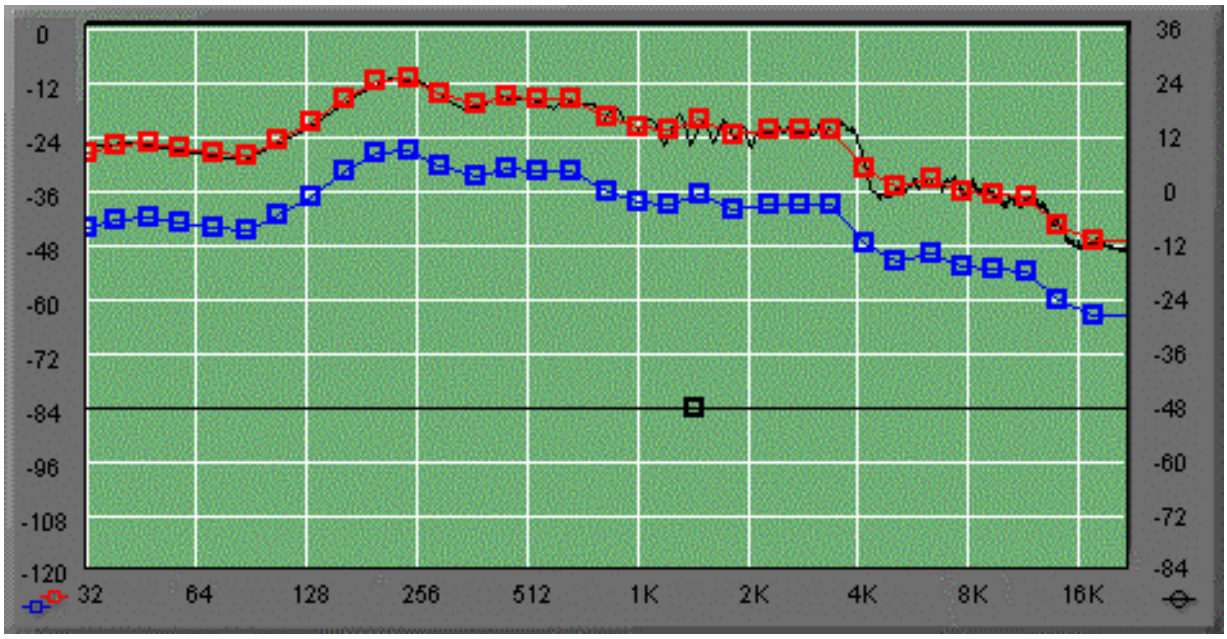
If no part of the audio is selected then the first second of audio will be selected by default, as is done in the example.

➠ Now hit the Fit button as indicated in Figure 2, below.

➘ Ionizer will calculate the positions of the Red and Blue Curves based on the calculated spectrum.

(Figure 2- The Spectrum and Fit buttons)

The Ionizer window should now look similar to Figure 3, below. Notice that the Red curve is above the Blue curve and that the Red curve is along the Frequency Profile.



(Figure 3-The Threshold and Gain curves)

Now it is time to play!

- Set the Correlation, Attack, and Release sliders to zero.
- Click on Preview to start playback.
- While the sound is playing back, drag the Black Gain curve to about -48 dB as illustrated in Figure 3, above.

This should give you the familiar vocoder sound.

- Start playing with the Correlation slider and notice the effect on the sound.

By increasing the value of the Correlation parameter you are effectively reducing the number of vocoder bands. With Correlation cranked up to 100 the vocoding effect is gone, replaced by an envelope following effect.

- Take some time now to play with the Attack and Release sliders to get a good feel for their effect.
- Try adjusting the values to Correlation = 40, Attack = 30, Release = 0.

This gives an interesting "ringing" envelope to the vocoding effect.

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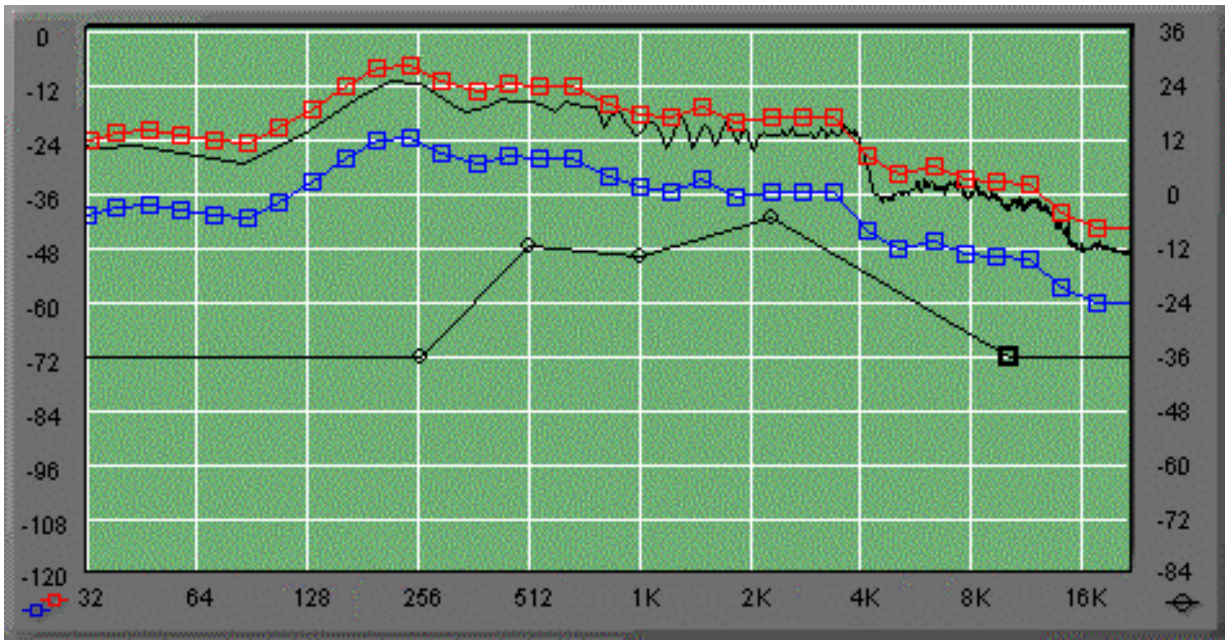
Now that you have an idea as to what the sliders do to the sound, start playing around with the Black Gain curve.

➠ Begin by adding points to the Gain curve and raising regions of the Gain curve to around 0 dB (See Figure 4, below).

➘ This reduces the vocoding effect in the bands that have a near-zero gain.

☞ When the Gain curve for a given frequency is at 0 dB, there is no vocoding effect at all. With this technique you can create sounds that only vocode in the regions of interest or you can fine tune the depth of the vocode effect in any frequency region.



(Figure 4-Frequency-dependent vocoding)

Now that you have mastered vocoding, try experimenting with the positions of the Red and Blue Curves.

➠ A potentially interesting effect is to Fit the Red and Blue curves to one sound then apply those same setting to another sound with a radically different character.

➠ Also try switching the carrier and modulator channels by setting the Keying button to "R to L."

As you can easily imagine, the possibilities for exploration are practically limitless.

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Lesson 6 : Frequency Morphing

Introduced in version 1.3 of Ionizer is the ability to analyze EQ curves of one recording and apply them to another. Frequency Morphing enables you to map the spectral profile from any sound to any other piece of audio.

Frequency Morphing can be used to transform instrumental or vocal tracks, to match looped dialog or Foley cues to audio recorded on set or location, or could be even applied as a means to "sample" the mix of a hit record, for use in mastering your own recordings.

In this lesson we will explore the ground breaking new Frequency Morph feature of Ionizer and show you how to become an instant mastering engineer in 4 easy steps (well, maybe not instant, but they represent some major steps in the right direction).

➠ Launch your audio editing software then load the sound file "nine inch nails-"Heresy" remix" (from the Nine Inch Nails folder in the Showcase section of the Arboretum CD.)

➠ Select the entire file. Play the sound file once to familiarise yourself with the sound.

➠ Launch the Ionizer.

➠ Click on Spectrum (Item 1 in Figure 1), begin audio playback, click Spectrum off when end of selection is reached.

➘ The Ionizer screen should now look like Figure 1. Save the settings using the Preset pop-up menu

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Figure 1-The Ionizer screen

➠ Close the Ionizer window.

➘ You should now be back in your audio editor's waveform display.

➠ Load the example audio file "Lesson 2.wav" (from the Sound Examples section of the Arboretum CD) into your sound editing software.

➠ Select the entire file. Play the sound file once to familiarise yourself with the sound.

➠ Launch the Ionizer.

➠ Make sure that the Red and Blue curves are set to the bottom of the green area with the Blue curve above the Red curve as shown above in Figure 1.

➠ Click on Spectrum again; begin audio playback, click Spectrum off when end of selection is reached. ➠ Click on Morph (Item 2 in Figure 1), Ionizer will now calculate the gain settings required to

give the sound file "Lesson 2.wav" the same EQ characteristics as the NIN sound file.

You'll see that Ionizer has created a new Gain Curve (the black line) which represents the amount of boost or cut that is to be applied to each band of "Lesson 2.wav" in order to make it conform to the spectral profile of the NIN example.

Take some time now to compare the morphed and un-morphed versions of the file. Toggle the Bypass switch on and off to hear the before and after results.

Not only has the EQ changed, but the volume has also increased to match that in the NIN file. The Morph feature accomplishes both tasks for you automatically. This is a huge time saver, no matter how skilled you are at setting up EQs.

Once you have the "Morphed" Gain curve, you can fine tune the settings by moving the points on the Gain curve, deleting points, or adding more.

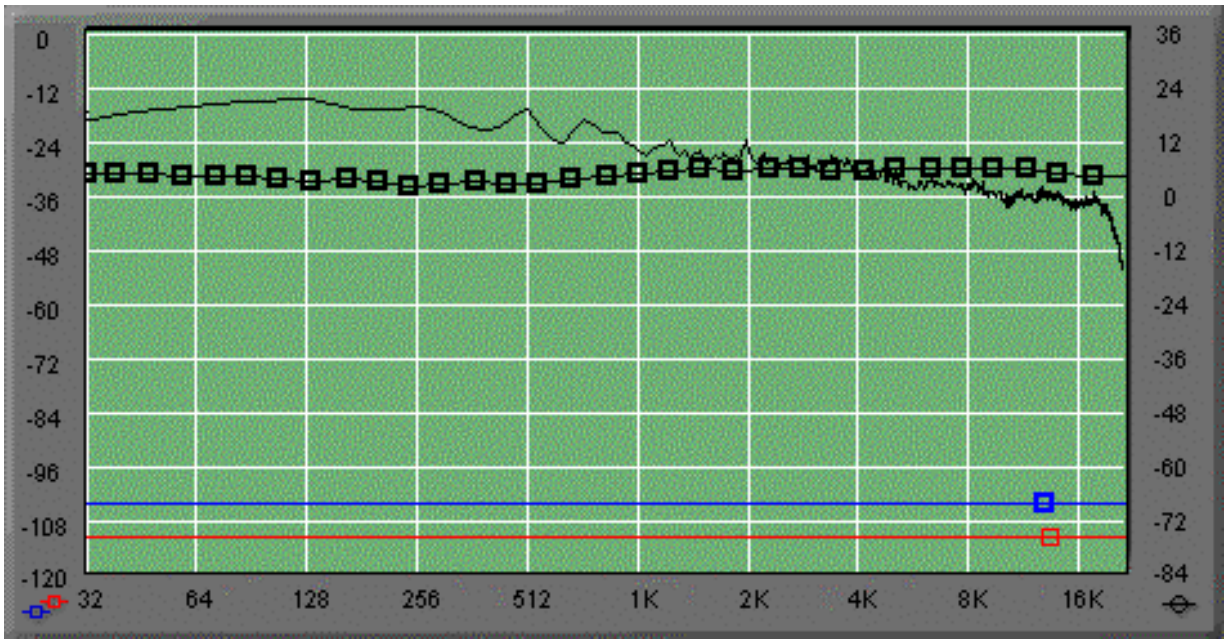

Figure 2, The "Morphed" EQ

Now that you have mastered the "morphing" technique, it is time to learn a bit more about the inner workings of the Morph algorithm.

Unlike other so called "EQ copying" programs, Ionizer is able to determine a file's overall EQ characteristic by analyzing as little as a few seconds of audio. It does this by using advanced feature extraction algorithms that go way beyond the typical "average the frequency bands" approach used by other products. However, with this power comes some responsibility on the part of the user...

In order to get the best results you need to pick sections that are typical of the sound you are interested in. For instance: If you have a sound file that starts off with a simple solo flute line and ends up with a raucous rock band in overdrive, then the first part of the sound file will not contain the information Ionizer needs to calculate the EQ curve of the raucous later part of the piece. If you like the sound of the coda, then analyze the coda.

Likewise, you should analyze sounds that have similar instrumentations. For instance, if you take a

Barbara Streisand solo voice recording and apply it to your latest Drum & Bass masterpiece then you will end up with this odd resonance in your Drum & Bass file where Bab's voice was in her recording. Not that there's anything wrong with that, it just might not be the effect you were actually looking for.

In the above example Ionizer was set to 32 Fit Points for conforming the Black Gain Curve to the frequency profile. This is, in effect, a 32-band analyzer. However, you can have as many as 512 Fit Points defining the Gain Curve. The number of Fit Points determines the "sharpness" of the calculated Gain Curve. With more bands, finer detail is added to the new gain calculation.

Typically, 16 to 32 Fit Points work well for copying the overall EQ from one file to another. However, interesting special effects can be created when using several hundred Fit Points.

Try analyzing a short segment of a human voice, a vowel sound for instance, and applying that result to a sound with a wide dynamic range, like a heavily distorted guitar.

Now that you are a Morph master, spend some time exploring the EQ curves of your favorite recordings. It can be very informative to see what types of frequency balances are used by various engineers. As always, be creative.

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