

## 3 Manual Declicking (NN-101)

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The Manual Declicking option for SonicStudio™ is designed to assist in removing unwanted intrusive noises such as clicks, pops, thumps, etc. By following a simple procedure, you can replace such noises and discontinuities in the audio waveform with continuous audio:

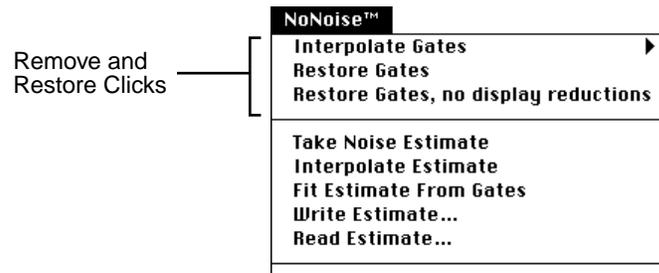
- Use the Left and Right Gates to identify a (usually) short area of the sound file containing an anomaly to be removed.
- Use one of several interpolation algorithms selected from the system's NoNOISE™ menu.

The algorithm analyzes audio on either side of the anomaly. Based on this context information, the algorithm synthesizes replacement sound for the anomaly.

The replacement sound is substituted for the original sound and the original sound is stored in a special file (called a Restore File) from which it can be retrieved if need be.

### The NoNOISE Menu

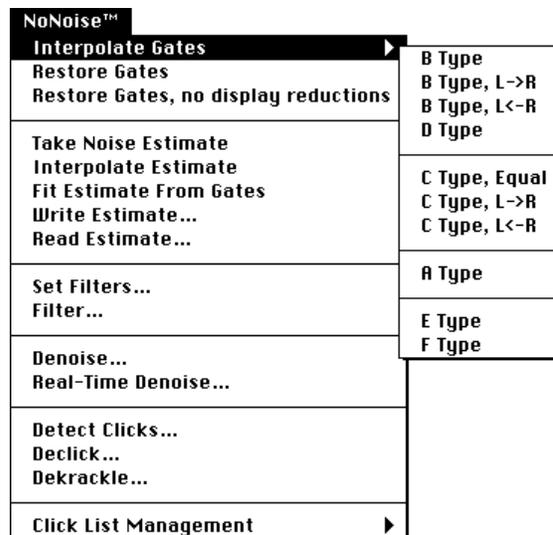
The commands for removing (interpolating) clicks and other noises are located in the NoNOISE menu in the main menu bar.



Unless other NoNOISE options are installed, the only commands active in this menu are the ones associated with Manual Declicking.

## Interpolation Gates Command

The command for removing clicks is Interpolate Gates, at the very top of the menu. This command has a pull-left menu that lists several selections.



The process of removing a click or noise consists of identifying the anomaly to be removed by placing the Left and Right Gates on either side of the problem area in the waveform display. Once the section to be replaced is so identified, the user selects one of the interpolation types from the Interpolate Gates menu.

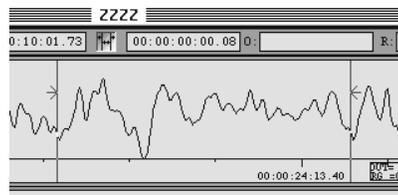
Once the interpolation algorithm is selected, the system performs a frequency and phase analysis of the audio on either side of the glitch to be removed. It then synthesizes a section of audio to interpolate smoothly from the spectrum prior to the click to the spectrum following the click.

## Removing Clicks

The process of removing a click consists of identifying and marking the anomaly in the waveform display, and then selecting an interpolation algorithm from the NoNOISE menu.

### Identification

1. On the waveform display, identify the location of the click or other anomaly to be removed.
2. Zoom in until the area of the glitch fills a substantial part of the display.
3. Place the Left and Right Gates around the area of the click. Be careful to gate as narrowly as possible without leaving any part of the anomaly outside the gates.



Clicks Gated prior to Interpolation

Clicks scratches vary in length, with most between 1 and 15 milliseconds. Areas as long as 1/2 second can sometimes be interpolated with good results, but the results in that case depend very much on the audio context.

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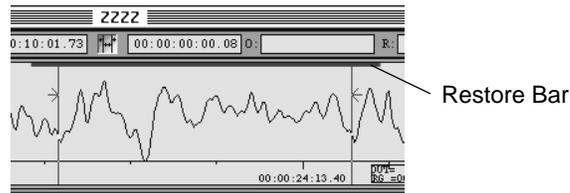
Note – Be sure that the click to be removed lies entirely between the Left and Right Gates.

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The Declicking interpolators use the area immediately outside the gates to determine the spectrum of the synthesized replacement audio. Because of this, poor results will be obtained if any part of the anomaly is left outside the Left and Right Gates.

## Removal

1. From the NoNOISE menu, select the Interpolate Gates command.
2. Choose an interpolator type from the pull-right menu that appears. The five interpolator types available are A, B, C, D, and E. Details on the use of each type are provided in a later section of this manual.



Clicks after Interpolation

The interpolation algorithm analyzes the anomaly identified and constructs replacement sound. After the replacement sound is inserted to substitute for the anomaly, a red (gray on a B&W monitor) bar above the waveform extending over the area that has been repaired. This “Restore Bar” indicates that sound has been replaced in this area of the waveform.

If the results produced by declicking are not acceptable, the original sound may be restored using Restore Gates from the NoNOISE menu.

To restore a previously interpolated section of audio to its original state:

1. Place the gates around the Restore Bar left by the interpolation
2. Select the Restore Gates command from the NoNOISE menu.  
The bar disappears and the original sound again appears in the waveform.

Declicking operates on the original soundfile. If clicks are removed from a sound segment in an edited schedule, the same Restore Bars will appear anytime that sound file is opened or edited into other audio.

## Interpolation Algorithms

There are several interpolators that are available in the NoNOISE System. Each type is suited to a particular type of audio problem and context.

<b>B Type</b> <b>B Type, L-&gt;R</b> <b>B Type, L&lt;-R</b> <b>D Type</b>
<b>C Type, Equal</b> <b>C Type, L-&gt;R</b> <b>C Type, L&lt;-R</b>
<b>A Type</b>
<b>E Type</b> <b>F Type</b>

The different types, A, B, etc., were designated in the order that they were developed. However, this is not the order of most frequent use. The submenu lists the interpolation types in approximate order of the frequency of their use.

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Note – The B type interpolator is the most general. The majority of declicking situations can be handled by simply choosing this first selection.

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## Type B Interpolation

This is the most general-purpose of the declicking algorithms, and works well on complex musical waveforms (for example, where several signals are combined with instruments that produce non-periodic waveforms, such as sax, strings, etc.).

The basic Type B interpolator examines the audio on either side of the click to determine the context for resynthesizing audio to fill the gap. In most situations this basic interpolator will produce the best results.

There are two variations of the command that *load* the context information in a particular way. If, for example, a click occurs just prior to the beginning of the attack of a piano note, the basic Type B interpolator would include part of the piano note in its resynthesis, producing the impression that the piano starts a bit early.

In this case, the B Type, L-> R variation, would avoid getting the piano note into the interpolation. Likewise, the R->L variation might be used in an instance where a click follows immediately after a sudden change in the audio waveform.

## Types A and C Interpolation

The Type A and Type C interpolators are waveform interpolators. A waveform interpolator is most useful in dealing with periodic waveforms, such as brass instruments or the human voice. The Type A and C interpolators take context information from six periods (the distance between successive peaks in the waveform) to the left and right of the area identified by the Left and Right gates.

Note that after interpolation, the Restore Bars extend for a short distance outside the gated area. This is because the waveform interpolator performs a short-duration crossfade of its results back into the original sound. It is the area of the crossfade that extends beyond the Gate positions.

The difference between these two types is that the Type C has protections built into it for certain cases for which waveform interpolation algorithm produces bad results. Type A lacks these protections. The Type A interpolator will *always* produce an interpolation, but the results may not always be pleasing. The C Type interpolator will sometimes fail to interpolate the signal designated. (If this occurs, the user should try a different interpolation algorithm.)

The variations on the basic Type C interpolator, marked C Type, L->R and C Type, L<-R, provide control of the loading of context information into the interpolator, emphasizing either the sound to the left, or sound to the right of the gated sound.

## Types D and E Interpolation

These are very high-order interpolation that may be used to correct problems that elude other interpolation algorithms. Be warned however. The process runs from about 1000 to 2500 *times* real-time. Both interpolations use 80-bit precision arithmetic to produce very high quality interpolation.

The Type D interpolation is only capable of replacing up to about 2 milliseconds (0.002 seconds) before it runs out of memory. The Type E Interpolator provides a very similar algorithm that can be used on large sections of audio.

If there is a particularly problematic area, then Type-E manual interpolation (perhaps left to run overnight) can help clean up small regions. As with the other interpolation algorithms, Type E operates directly on the sound file, and it produces restore bars to show where replacement has been performed.

## Strategies for Isolating and Identifying Clicks

Often, the most difficult part of declipping a cut is to locate the clicks to interpolate. The interpolators included in the NoNOISE System are very powerful, but they can be used only after the clicks have been found. In only a small percentage of cases are the clicks in a recording easily visible in the waveform itself.

One approach is to use the positions of the Gates and the Play To Gates command to get a precise fix on the location of a click. Simply keep moving the Left or Right Gate, and auditioning until the click is no longer audible. Or use the Rock N Roll feature to scrub over the area of the click. Once a small area has been identified, within which the click must lie, Zoom into a resolution at which the click should become visible.

In a recording with many clicks, this approach would be impractical. Also, even with careful auditioning and Zooming, some clicks will evade this type of search.

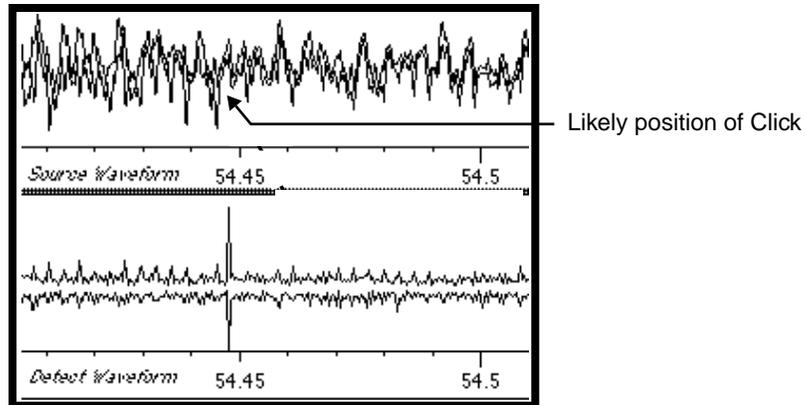
A useful technique is to use the SonicStudio's filtering to emphasize the clicks, and create a Detect File to identify clicks visually.

### Creating a Click Detect File

Most clicks constitute a burst of energy across the audible spectrum, and a high-pass filter will cause clicks to stand out in greater relief relative to musical program.

This principle can be used to create a soundfile specially for detecting clicks.

Segment of Complex Waveform with Synchronized Detect File



To create a Click Detect file:

1. Place the soundfile to be declicked in an Edit Decision List (EDL).
2. On the Mixing Desk, use a Hi Shelf or HiPass filter to emphasize clicks and glitches.
3. When satisfied with the filtering, follow the directions in the system User Manual to capture the output of the Mixing Desk in a new soundfile.
4. Open the new soundfile in a different panel of the EDL. Make sure it is synchronized with the original.

The clicks will be easily visible in the high-pass output.

The typical high-pass filter used to produce a Detect File for analog tape recordings (or old disk recordings transferred to tape) is a first order filter with high frequency of 12,000 Hz, or so, and Stop Ripple set at -40 dB.

The same high pass filter may not be appropriate to create a detect file in all circumstances. One recurring situation is declipping of optical clicks occurring on old movie optical sound tracks. Since the original click or dropout was band-limited, the resultant click does not have much high frequency energy.

A lower cutoff frequency (and perhaps a higher order) may be needed to focus the Detect File on the click energy between, say, 6,500 and 9,000 Hz. Unfortunately, much musical signal typically resides in this band. That makes click detection in such files somewhat problematic.

### Low Frequency Interference

Many older 78 RPM disk recordings are characterized by an abundance of low-frequency energy. In some cases these low-frequency sounds change quite rapidly and violently. The B Type interpolator has only a small area of the soundfile in which accurately to identify the low frequency components in a signal.

Because of this, there is some potential for error in the interpolation. When this happens a characteristic artifact is sometimes inserted into the soundfile. It sounds like a low level thump or thunk.

Under such circumstances, the best results usually are achieved when the source soundfile is first filtered aggressively to roll off the low frequency noise. Since the bandwidth of many older disk recordings was severely limited to begin with, it is often possible to apply a 2d or 3d order hi pass filter with a hi frequency as high as 50, 60 or even 70 Hz.

In addition to assisting the B Type interpolator, this procedure also has the beneficial effect of removing much low frequency noise that is annoying in its own right, such as hum, or turntable “rumble.”

### Thumps, Dropouts, and Such

Although the bulk of anomalies removed using the NoNOISE System are clicks, the interpolators may also be used to remove a variety of other ills such as needle thumps, oxide dropouts, etc.

In many of cases, the difficulty is not so much interpolating the anomalies, but finding them. Dropouts can be viewed directly by zooming in tight on the waveform display. For thumps, a Detect File built on a low pass filter (for example, first order low pass at 100Hz) may be useful.

## Summary

The SonicStudio's Manual Declick option provides a powerful set of tools to identify and correct clicks and other audible glitches embedded in program audio. In the hands of a knowledgeable and experienced operator, the Manual Declick tools can perform seeming *miracles* of sonic restoration.