
Application Note AN3201-03: Wide Stereo Chorus
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Introduction

This application note describes a typical method for creating chorus effects on the DRE. A chorus effect adds a slowly time-varying delay and pitch (less than 1Hz) to an original voice to simulate additional voices (a chorus).

Algorithm

The basic parameters of a chorus are the modulation depth, modulation rate and pre-delay. The DRE's LFOs are used in sine mode to modulate the delay of the signal. Maximum delay is determined by the amplitude of the LFO, or modulation depth. As the LFO sine wave crosses zero, maximum change in delay versus time results in maximum change in pitch. This rate of delay change is determined by both modulation depth and modulation rate. The generated chorus is added back to the original dry signal with a certain amount of constant pre-delay to avoid objectionable phase cancellation artifacts.

A chorus effect requires delay memory for each channel and at least one LFO set to sine mode. The output of the LFO can be thought of as a 13 bit integer part that specifies address offset (LFOA) and a 7 bit fractional part (LFOK) that is the coefficient used to interpolate between adjacent memory locations. The interpolation is mandatory for smooth change in delay.

The complete chorus effect requires two chorus commands. The pair of commands calculates the average of two adjacent memory locations weighted by the fractional part of the LFO (LFOK). The first chorus command is passed the middle location of the delay line and the second is passed the adjacent-to-middle location. The first command also latches in the current LFO value and complements the fractional portion (COMPK) for use in the second chorus command. The actual memory location read is the location passed plus an offset determined by the integer part of the LFO (LFOA).

$$\text{chorus} = \text{value}(\text{address} + \text{LFOA}) * \text{LFOK} + \text{value}(\text{address} + 1 + \text{LFOA}) * (1 - \text{LFOK})$$

If the LFO is set to its maximum amplitude (32767) it will add 4095 or subtract 4096 to the specified address, requiring a memory block size of 8192. Smaller modulation amplitudes (typical) can get away with a smaller memory block.

The implementation described mixes the dry signal with the chorus within the DRE, so no further mixing should be performed externally to evaluate the effect. The mixing is done internally to give the programmer complete control over pre-delay in order to hear its effect. In a finished implementation, the DRE is typically used only to generate the chorus, mixing is adjustable externally and pre-delay must take into account the different signal path delays of the dry and processed audio. Conveniently the different signal path delays often provide a good amount pre-delay on their own.

The implementation described is a Wide Stereo Chorus. Left and right channels are processed independently with independent LFOs. Starting with a stereo recording of a single voice, this will simulate two additional voices, one on each channel. A Stereo Chorus would use one LFO for both channels and starting with a stereo recording of a single voice, would create one additional stereo voice.

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Application note revised March, 2005

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