Electric Druid Looping Envelope Generator

Introduction

This chip is a completely modern, microprocessor-based design that provides a fully voltage-controlled looping ADSR envelope generator. The output from the chip is a PWM pulse train which only requires simple lowpass filtering to produce a genuine ADSR envelope shape.

In addition to full voltage control of Attack, Decay, Sustain, and Release, the chip also has CV control of output level (envelope depth) and an overall Time CV which can modulate the length of the entire envelope.

A mode CV input allows selection between three envelope modes - a normal ADSR envelope, a gated looping mode and a LFO looping mode.

Features

Range of around 1 mSec to 10 Sec.

The Minimoog, Sequential Pro-One and SH101 all have a famously quick attack time. I've never measured it, but it's supposed to be around 1 mSec. This envelope generator can also produce times that short.

Most analogue synths can do a slow attack of a handful of seconds, but 10 seconds gives a neat range of 1:10000 to be covered by the control voltages, and allows really slowly evolving sounds to be generated.
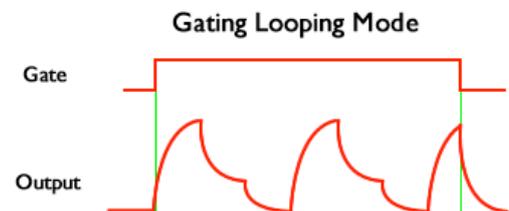
ADSR, Gated Looping, and LFO Looping modes

The MODE CV pin allows selection between three different modes of operation.

ADSR mode is a normal envelope.
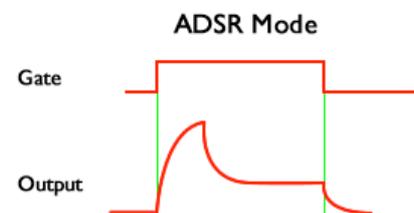
Gated Looping will trigger the ATTACK stage when the GATE goes high, then continue looping whilst the GATE remains high, and will RELEASE to zero when the GATE goes low.

The LFO Looping mode loops continuously and ignores input from the GATE. It is easy to provide a switch to select these modes.

LFO frequencies to 300Hz

Since the segment times can be as short as 1ms, it is possible to produce LFO waveforms up to around 300Hz. This is above Middle C!

Exponential and Linear Envelopes

The chip can produce classic exponential ADSR curves suitable for volume control with a linear VCA, or can produce linear envelopes typical of early digital synths. These can be more suitable for use with exponential VCAs.

Time CV for envelope/LFO modulation

The TIME CV input shortens the entire envelope, providing global modulation of ATTACK, DECAY and RELEASE times. Since this input works in LFO mode too, it can also provide frequency modulation of the LFO waveforms.

Level CV for voltage-controlled envelope depth

The chip also includes a LEVEL CV input which controls the output level of the envelope. This offers a very simple way to provide voltage-controlled envelope depth and saves a VCA.

8-bit resolution on the control voltages

The Sequential Prophet 5 used a 7-bit control resolution, so this is going slightly better. Whether a standard potentiometer actually has the accuracy to directly produce 8 bit resolution is another question.
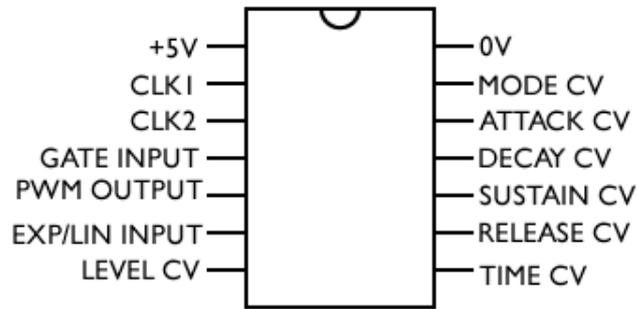
19.5KHz sample output rate

The PWM frequency is around 19.5KHz. This allows the PWM output to be heavily filtered for a smooth analogue output whilst maintaining the snappy response. The two-stage 24dB Bessel filter provides the best-possible pulse filtering.

Logarithmic time control response over 1:10,000 range

The A, D and R control voltage inputs give the full range from 1 mSec to 10 Secs in four even decades, eg 1-10mSecs, 10-100mSecs, 100-1000mSecs, and 1-10Secs. Since the response of the CV inputs is logarithmic, this is possible with simple linear potentiometers.

Pinout Diagram

Pin	Function	Details	Notes
1	+5V	Power supply	
2	CLK1	Connect to Xtal	20MHz Clock
3	CLK2	Connect to Xtal	20MHz Clock
4	GATE INPUT	0-5V digital input	Envelope goes to RELEASE stage on falling edge of 0-5V pulse.
5	PWM OUTPUT	0-5V digital output	PWM output at 19.5KHz
6	EXP/LIN INPUT	0-5V digital input	0V - Exponential envelope 5V - Linear envelope
7	LEVEL CV	0-5V analogue input	8 bit, values from 0 to 255
8	TIME CV	0-5V analogue input	8 bit, values from 0 to 255
9	RELEASE CV	0-5V analogue input	8 bit, values from 0 to 255
10	SUSTAIN CV	0-5V analogue input	8 bit, values from 0 to 255
11	DECAY CV	0-5V analogue input	8 bit, values from 0 to 255
12	ATTACK CV	0-5V analogue input	8 bit, values from 0 to 255
13	MODE CV	0-5V analogue input	Selects envelope mode: • 0-1.25V: Normal ADSR • 1.25-3.75V: Gated Looping • 3.75-5V: LFO/Looping
14	0V	Power supply	

Application Notes

Basic circuit diagram

Using a switch for MODE CV

A simple On-Off-On toggle switch can be used to produce the MODE CV.

The two 10K resistors provide 2.5V when the switch is off, giving Gated Loop mode. Switching the switch gives either +5V or 0V.

The simplest-possible PWM filter

The raw output from the chip is a 19.5KHz PWM pulse train. This needs to be lowpass filtered before it can be used. The 1KHz bessel filter in the circuit above provides good filtering performance, but needs two op-amps and associated components. The following three stage passive filter gives adequate performance for only 6 components. Cutoff is set at 338Hz.
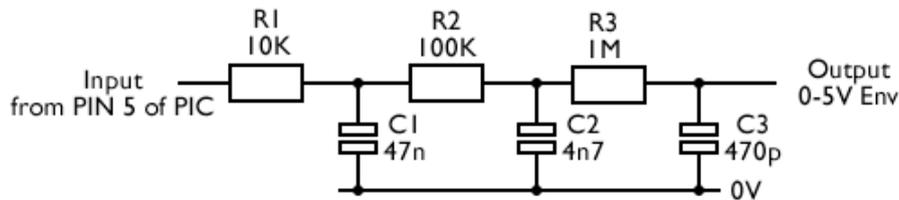
Inevitably with such a filter there is a trade-off between speed of response and smoothness of output. You may feel that a different balance between these two parameters suits your application or tastes better. If you experiment with the component values above, be sure to keep the x1, x10, x100 relationship of R1, R2, R3 and C3, C2, C1. This reduces the loading effect of one stage on the next.

Using potentiometers for CVs

The required control voltages can be generated directly by potentiometers as follows, or by a microprocessor driving a DAC in a programmable system.
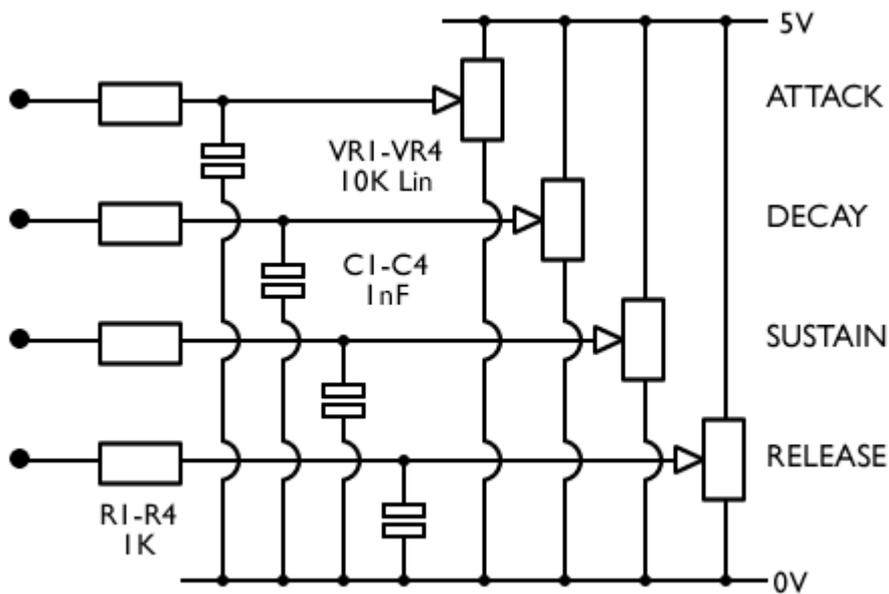
Disabling unwanted inputs

If not required, TIME CV should be connected to 0V via 1K. LEVEL CV can be disabled by connecting to +5V with a 1K resistor. If linear envelopes are not required, tie EXP/LIN to 0V with a 10K resistor.