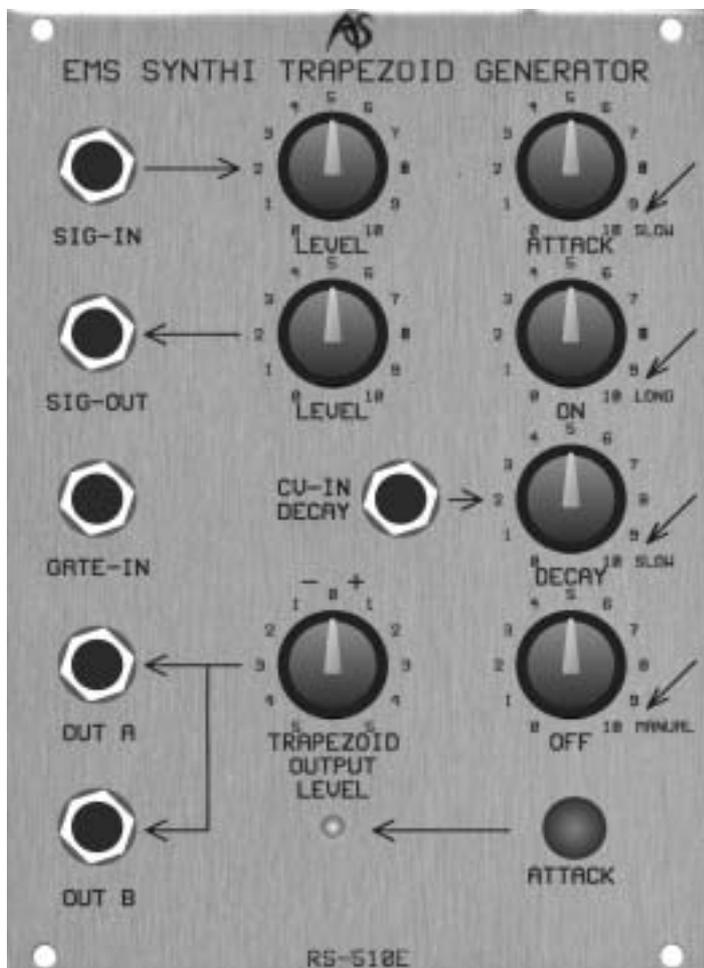


RS510E

EMS SYNTHI TRAPEZOID GENERATOR



INTRODUCTION

The combined contour generator and VCA used in the EMS VCS3 and various Synthi (the "Shaper") is a very clever piece of electronic design, and it allows you to create sounds and effects that are all but impossible on more conventional synthesisers.

The RS510E incorporates both elements of the VCS3 Shaper, comprising two modules that would often be found as separate modules. The first of these is the envelope generator itself, referred to as the Trapezoid Generator. The second is a VCA. We will deal with each of these in turn.

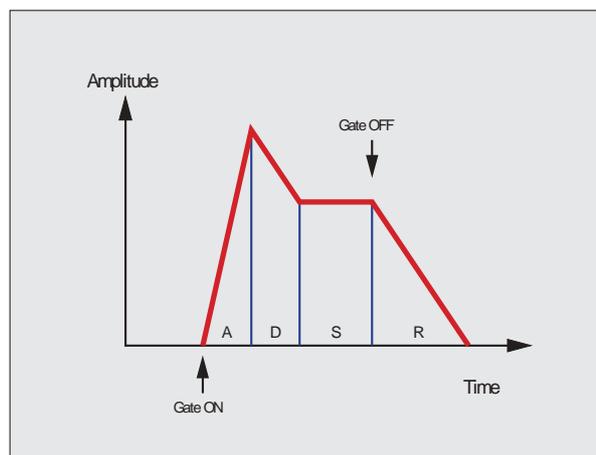
THE TRAPEZOID GENERATOR

The Background to the Trapezoid

The Trapezoid Generator was perhaps the most confusing module within the VCS3 and Synthi, largely because it acted in an unusual way that was not intuitive to users of other manufacturers' instruments. In retrospect, it's hardly surprising that players considered it arcane and impenetrable, but this is unfortunate, because it is a flexible and powerful tool.

To understand how the Trapezoid Generator differs from conventional contour generators, let's first consider the common ADSR envelope. This has four stages, as follows:

- A: The Attack stage determines the speed at which the voltage achieves its full value.
- D: The Decay determines the speed at which the voltage drops until it reaches...
- S: ... the Sustain Level, the level the voltage maintains while a Gate is detected, and ...
- R: The Release, which determines the speed at which the envelope voltage decays back to zero after the Gate is released.

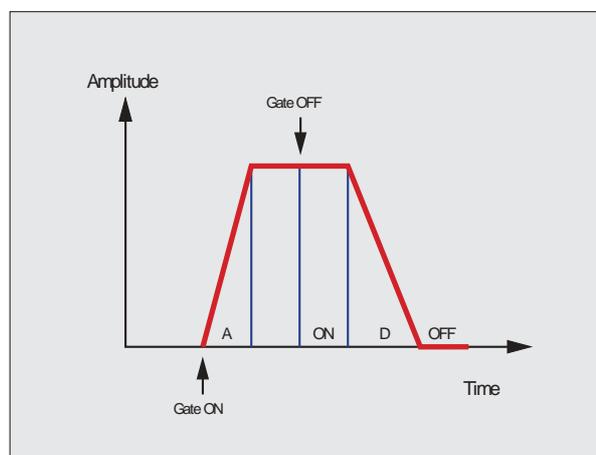


(For more information about the standard ADSR envelope generator please refer to Appendix 3.)

The Synthesizer Trapezoid also comprises four stages, but these are called Attack, On, Decay, and Off. It works as follows:

Manual operation (Contour Generator):

- A: When a Gate is detected, the contour enters its Attack phase, like a conventional ADSR. If the Gate is very brief (a trigger) the Attack is completed nonetheless, and the contour moves to the next stage...
- ON: After the Attack, the contour is "ON", and maintains its maximum voltage for as long as the Gate is present. Once the Gate is removed the contour remains ON for an additional time determined by the ON control.



- D: At the end of the ON period, the contour decays to zero.

Free running operation (LFO):

- A: From its initial state, the contour enters its Attack phase.
- ON: After the Attack, the contour is "ON" for a time determined by the ON control.
- D: At the end of the ON period, the contour decays to zero.
- OFF: Once the decay is complete, the contour remains at zero (i.e. "OFF") for a period determined by the OFF control, and then enters the Attack phase again.

IN USE

The RS510E Synthi Trapezoid Generator generates a four-stage A/ON/D/OFF voltage contour that varies from -5V to +5V, and back to -5V again. (The shape described by the Attack, On, and Decay stages is known geometrically as a trapezoid, which leads directly to EMS's use of the term.) The envelope can be attenuated and inverted if desired.

Note: If you are not already acquainted with the EMS Shaper, please set the "OFF" knob to its most clockwise position, labelled "MANUAL" before continuing to investigate the properties of the Trapezoid Generator. The reason for doing so will become clear as you work through the rest of this section.

GATE-IN

The Trapezoid is generated when the module receives a gate pulse of approximately +3V or greater at the GATE-IN.

ATTACK

With the OFF control set to MANUAL, the Attack is initiated upon receipt of a Gate or a Trigger at the GATE-IN, and the trapezoid voltage will rise from -5V to +5V in the time determined by the ATTACK knob. The minimum attack time is approximately 2ms. The maximum is approximately 2 seconds. This is significantly less "snappy" than the fast envelopes produced by the RS60 Envelope Generator, so sounds controlled by the RS510E can often have a different character to those produced using other contour generators.

ON

This determines the time that the trapezoid voltage will remain at its maximum after the completion of the Attack and once the Gate pulse is removed. The maximum ON time is approximately 4 seconds.

DECAY

The decay phase follows the ON stage. During this, the trapezoid voltage will fall from +5V to -5V in the time determined by the DECAY knob. The minimum decay time is approximately 3ms. The maximum is approximately 25 seconds.

OFF

The OFF knob performs two functions:

MANUAL:

When set to its maximum clockwise position ("MANUAL") the OFF knob allows you to play and use the trapezoid as a contour generator, whereby each Gate pulse initiates a fresh A/ON/D cycle.

Note 1: The trapezoid does not "reset to zero" when a new Gate is detected. If the trapezoid is in the ON or DECAY stages when the new Gate arrives, the Attack will be initiated from the voltage at that moment.

Note 2: Unlike a conventional ADSR contour generator (which will immediately enter its Release phase once the Gate is removed) the trapezoid will complete its A/ON/D cycle, no matter how brief the Gate/Trigger.

Other Positions:

When set to any position other than MANUAL, the position of the OFF knob determines the length of time that elapses between the completion of the Decay phase and the automatic start of a new Attack phase. In other words, at any position other than OFF=MANUAL, the trapezoid generator *repeats*, and acts as an LFO. No Gate is required to initiate this mode of operation.

If you set the ATTACK to a non-zero setting, ON to zero, and DECAY and OFF to zero, the output waveform will be a ramp wave. Other settings can generate triangle waves, sawtooth waves, skewed triangle waves, square waves, pulse waves and... various shapes of trapezoid waves.

The maximum OFF period is approximately 5 seconds. The minimum is of the order 10ms, meaning that the LF signal generated strays well into the bass end of the audio spectrum. The maximum amplitude of this signal is approximately +7V.

CV-IN DECAY Input

You can modulate the Decay time by presenting a positive or negative CV to the CV-IN DECAY input.

You can use this to change the shape and frequency of the waveform when the Trapezoid is repeating, thus creating a huge range of complex waveforms that are particularly useful when used as complex modulators for other modules such as oscillators and filters.

TRAPEZOID OUTPUT LEVEL

The output level and polarity are controlled by the TRAPEZOID OUTPUT LEVEL control. With this turned fully clockwise, the envelope will range from -5V (OFF) to +5V (ON). As you turn the knob anticlockwise, the signal will be attenuated until, with the knob in the 12 o'clock position, no envelope is generated. As you continue to turn the LEVEL knob anticlockwise, an attenuated inverted envelope will be output until, at the knob's fully anticlockwise position, the inverted envelope will range from +5V (OFF) to -5V (ON).

ATTACK Button

The ATTACK button allows you to trigger the trapezoid manually, whereupon it will pass through the Attack phase and hold the voltage ON until the button is released.

ATTACK LED

The red LED gives you a direct visual indication of the voltage being produced by the trapezoid:

- When the LED is extinguished, the trapezoid is OFF.
- As the LED becomes brighter, the trapezoid is passing through the Attack phase.
- When the LED is at its brightest, the trapezoid is ON.
- As the LED dims, the trapezoid is passing through its Decay.

Remember that a bright LED does not necessarily imply a +ve output voltage, because the trapezoid can be inverted using the OUTPUT LEVEL CONTROL.

Note: The voltages produced by the Trapezoid Generator may differ depending upon the triggering method (GATE-IN, free running, or ATTACK button) and by the positions of the A/ON/D/OFF controls. This is normal, and a consequence of the idiosyncrasies of the EMS circuit designs.

OUT A; OUT B

Two outputs are provided. These carry identical signals.

THE VCA

Amplifiers have a simple job - they amplify or attenuate the signals presented to them. Voltage controlled amplifiers (VCAs) are more sophisticated... they allow you to control the amount of amplification or attenuation by applying a voltage to a CV input. VCAs exist in every synthesiser that can shape a sound. For example, you may think that it's the envelope that is changing the volume of a sound, but it isn't. The envelope is producing a CV that, when applied to the VCA, causes it to modify the signal passing through it. The VCA is one of the fundamental modules that allow us to make sounds develop over time.

The RS510E incorporates an integrated VCA with user-controlled signal input and output levels. However, it has no external CV input. The voltage is provided directly by the Trapezoid Generator. This means that signals presented to the SIG-IN of the VCA will be amplified by the instantaneous Trapezoid level.

IN USE

Input and Output

The RS510E VCA offers one signal input, SIG-IN and a single output, SIG-OUT, each with an associated LEVEL control.

The input accepts audio signals in the range $\pm 10V$ and, at audio frequencies, the output will produce a signal in the range $\pm 10V$.

Note 1: The position and polarity of the TRAPEZOID OUTPUT LEVEL control does not affect the voltage applied internally to the VCA.

Note 2: The VCA is designed to modify audio frequency signals. If you present a low-frequency signal to the input, it will be severely attenuated at the output.

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