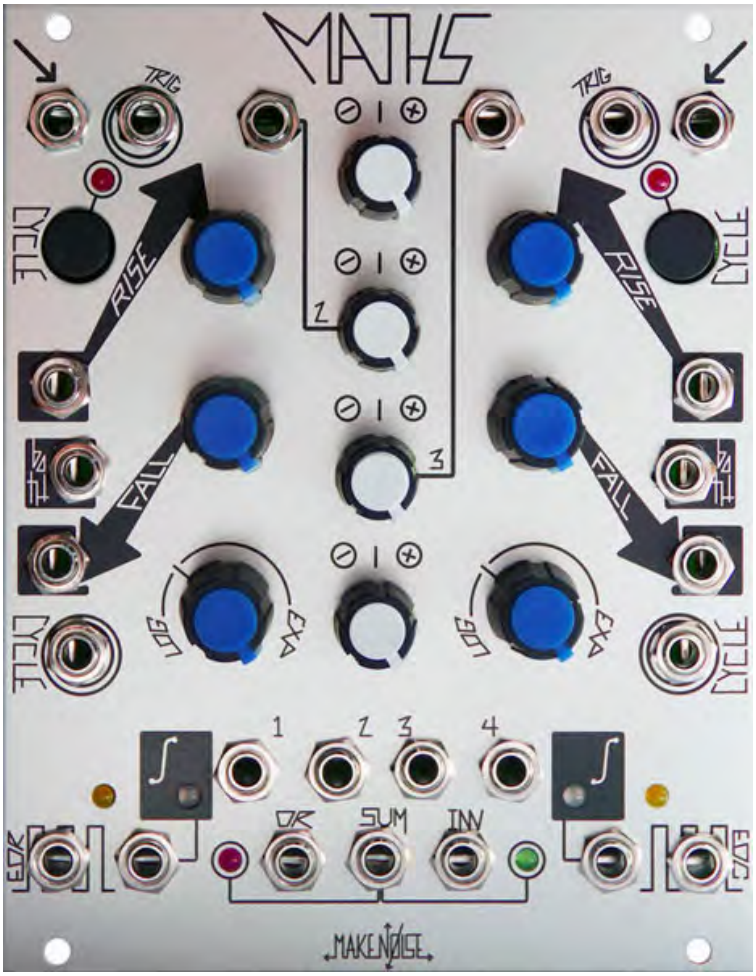
MATHS



MAKE NOISE

v2.0

Limited WARRANTY:

Make Noise warrants this product to be free of defects in materials or construction for a period of one year from the date of purchase (proof of purchase/invoice required).
Malfunction resulting from wrong power supply voltages, backwards or reversed eurorack bus board cable connection, abuse of the product or any other causes determined by Make Noise to be the fault of the user are not covered by this warranty, and normal service rates will apply.

During the warranty period, any defective products will be repaired or replaced, at the option of Make Noise, on a return-to-Make Noise basis with the customer paying the transit cost to Make Noise. Please contact technical@makenoisemusic.com for Return To Manufacturer Authorization.

Make Noise implies and accepts no responsibility for harm to person or apparatus caused through operation of this product.

Please contact technical@makenoisemusic.com with any questions, needs & comments, otherwise...
go MAKE NOISE!

http://www.makenoisemusic.com



THANK YOU
Design Assist: Matthew Sherwood
Beta Analyst: Walker Farrell
Test Subjects: Joe Moresi, Pete Speer, Richard Devine

INSTALLATION

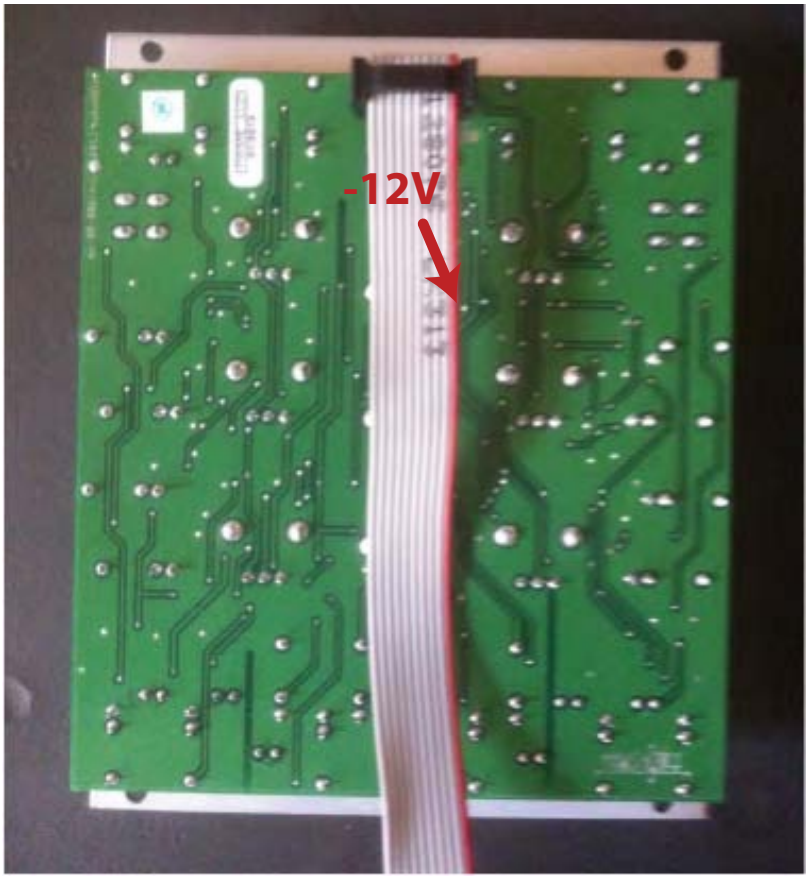
Electrocution hazard!

Always turn the Eurorack case off and unplug the power cord before plugging or un-plugging any Eurorack bus board connection cable cable.
Do not touch any electrical terminals when attaching any Eurorack bus board cable.

The Make Noise MATHS is an electronic music module requiring 60mA of +12VDC and 60 mA of -12VDC regulated voltages and a properly formatted distribution receptacle to operate. It is designed to be used within the Eurorack format modular synthesizer system.

Go to http://www.makenoisemusic.com/systems.shtml for examples of Eurorack Systems and Cases.

To install, find necessary space in your Eurorack synthesizer case, confirm proper installation of included eurorack bus board connector cable on backside of module (see picture below), plug the bus board connector cable into the Eurorack style bus board, minding the polarity so that the RED stripe on the cable is oriented to the NEGATIVE 12 Volt line on both the module and the bus board. On the Make Noise 6U or 3U Busboard, the negative 12 Volt line is indicated by the white stripe.



Please refer to your case manufacturers' specifications for location of the negative supply.

Overview:
MATHS is an analog computer designed for musical purposes. Amongst other things, it will allow you to:

1. Generate a variety of linear, logarithmic, or exponential triggered or continuous functions
2. Integrate an incoming signal
3. Amplify, attenuate and Invert an incoming signal
4. Add, subtract and OR up to 4 signals
5. Generate analog signals from digital information (Gate/ Clock)
6. Generate digital information (Gate/ Clock) from analog signals
7. Delay digital (Gate/ Clock) information

If the above list reads like science rather than music, here is the translation:
1. Voltage Controlled Envelope or LFO as slow as 25 minutes and as fast as 1khz
2. Apply Lag, Slew or Portamento to control voltages
3. Change the depth of modulation and modulate backwards!
4. Combine up to 4 control signals to create more complex modulations
5. Musical Events such as Ramping up or Down in Tempo, on command
6. Initiating Musical events upon sensing motion in the system
7. Musical note division and/ or Flam

MATHS revision 2013 is a direct descendent of the original MATHS, sharing the same core circuit and generating all the fantastic control signals that the original was capable of generating, but with some upgrades, additions and evolutions:

1. The layout of the controls has been changed to be more intuitive and to work more fluidly with the forthcoming CV Bus and existing modules in our system such as the DPO, MMG and ECHOPHON.

2. The LED indicition for signals has been upgraded to show both positive and negative voltages as well as to increase the display resolution. Even small voltages will be readable on these LEDs.

3. As Make Noise now offers a Multiple the Signal OUT Multiple (from the original MATHS) has been changed to a Unity Signal OUTput. Useful as it allows for creating two variations of output, one at unity and the other as processed through the Attenuvertor. Also allows for ease in patching function responses not possible with the Vari-Response control alone (see pg.).

4. An INVerted SUM OUTput has been added for greater modulation possibilities.

5. LED indication for the SUM Bus has been added for increased signal awareness.

6. LED indication added to show the state of the End Of Rise and End Of Cycle.

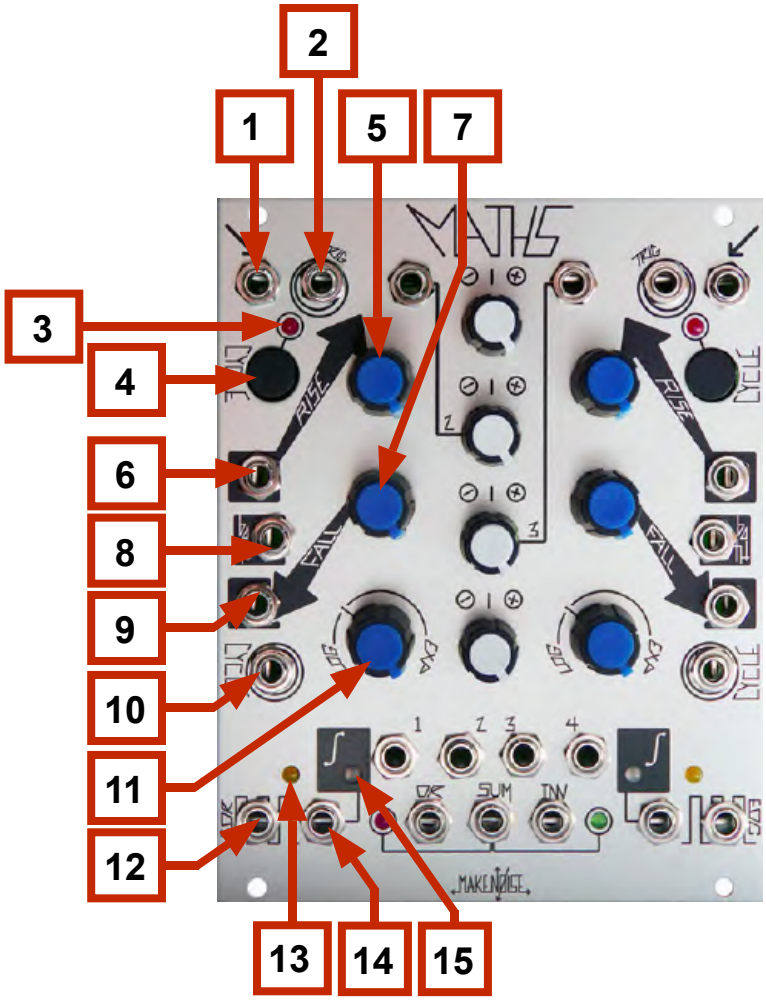
7. End Of Cycle OUTput is now buffered for improved circuit stability.

8. Added reverse power protection.

9. Added +/-10V offset range. User has choice of +/-10V offset at CH. 2 or +/-5V offset at CH. 3.

10. Added greater Logarithmic range in Vari-Response control allowing for East Coast style Portamento.

11. The evolution in the circuit is the CYCLE INput which allows for voltage control of the CYCLE state in Channels 1 and 4. On Gate HIGH, the MATHS will CYCLE. On Gate LOW MATHS will not CYCLE (unless the CYCLE button is engaged).



MATHS Channel 1

1. Signal IN: Direct Coupled input to circuit. Use for Lag, Portamento, ASR (Attack Sustain Release type envelopes). Also input to SUM/ OR Bus. Range +/-10V

2. Trigger IN: Gate or Pulse applied to this input will trigger the circuit regardless of activity at the Signal IN. The result being a 0V to 10V function, aka Envelope, whose characteristics are defined by the Rise, Fall, and Vari-Response parameters. Use for Envelope, Pulse Delay, Clock Division, LFO Reset (only during Falling portion).

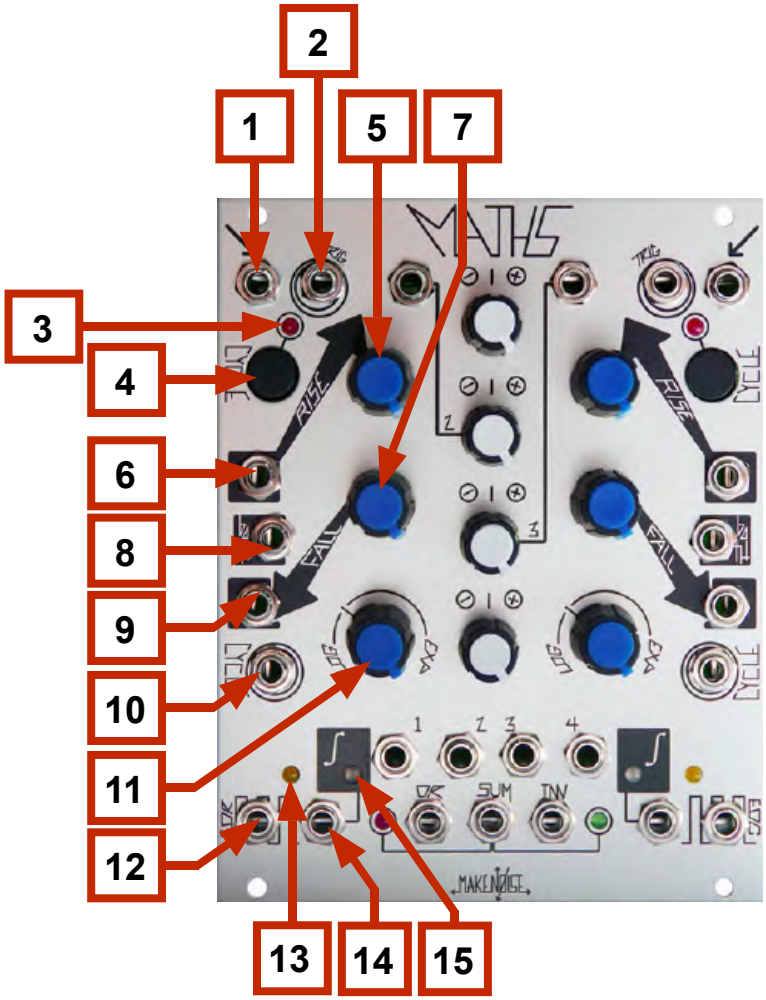
3. CYCLE LED: Indicates CYCLE ON or OFF.

4. CYCLE Button: Causes the circuit to self cycle, thus generating a repeating voltage function, aka LFO. Use for LFO, Clock, VCO.

5. RISE Panel Control: Sets the time it takes for the voltage function to ramp up. CW rotation increases Rise Time.

6. RISE CV IN: Linear control signal input for Rise parameter. Positive Control signals increase Rise Time, Negative control signals decrease Rise Time with respect to the Rise panel control setting. Range +/-8V

7. FALL Panel Control: Sets the time it takes for the voltage function to ramp down. CW rotation increases Fall Time.



MATHS Channel 1 (Cont'd)

8. BOTH CV IN: Bi-Polar Exponential control signal input for ENTIRE function. Contrary to the Rise and Fall CV IN, BOTH has an Exponential response and Positive control signals decrease total time while Negative control signals increase total time. Range +/-8V

9. FALL CV IN: Linear control signal input for Fall parameter. Positive control signals increase Fall time, Negative control signals decrease Fall Time with respect to the Fall panel control. Range +/-8V

10. CYCLE IN: On Gate HIGH, circuit will CYCLE. On Gate LOW MATHS will not CYCLE (unless the CYCLE button is engaged). Requires minimum +2.5V for HIGH.

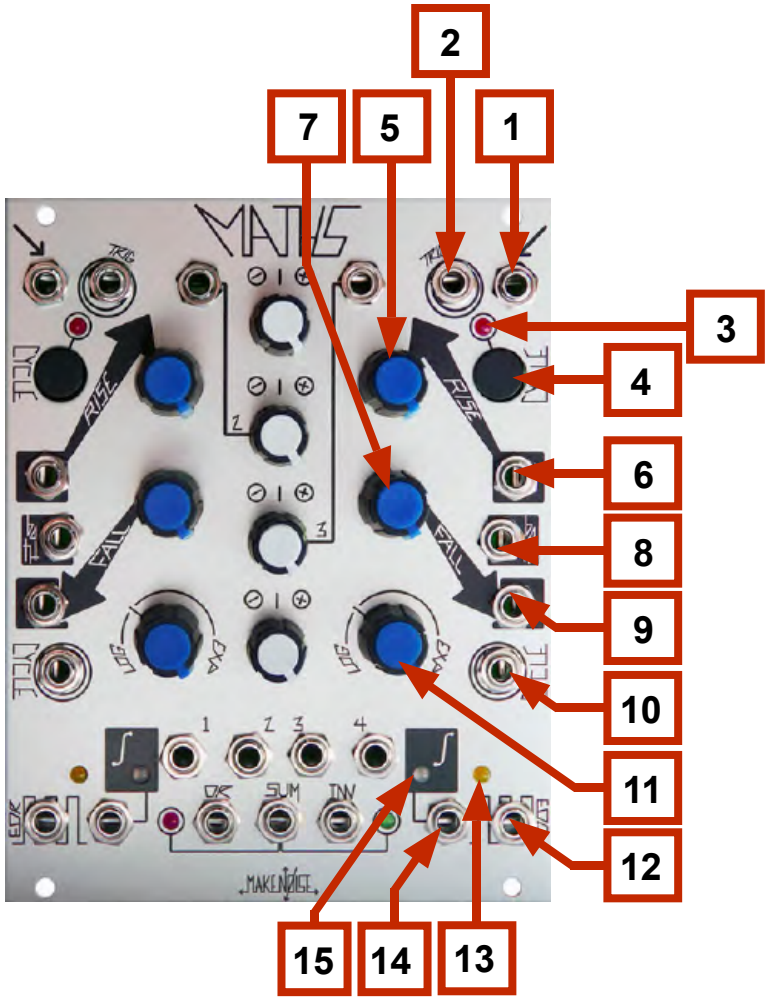
11. Vari-Response Panel Control: Sets the response curve of the voltage function. Response is continuously variable from Logarithmic through Linear to Exponential to Hyper-Exponential. The Tick mark shows the Linear setting.

12. End Of Rise OUT (EOR): Goes high at the end of the Rise portion of the function. 0V or 10V.

13. EOR LED: Indicates the states of the EOR output. Lights when EOR is HIGH.

14. Unity Signal OUT: signal from the Channel 1 circuit. 8V peak to peak when Cycling. Otherwise this output will follow the amplitude of the input.

15. Unity LED: indicates activity within the circuit. Positive voltages GREEN, Negative voltages RED.



MATHS Channel 4

1. Signal IN: Direct Coupled input to circuit. Use for Lag, Portamento, ASR (Attack Sustain Release type envelopes). Also input to SUM/ OR Bus. Range +/-10V

2. Trigger IN: Gate or Pulse applied to this input will trigger the circuit regardless of activity at the Signal IN. The result being a 0V to 10V function, aka Envelope, whose characteristics are defined by the Rise, Fall, and Vari-Response parameters. Use for Envelope, Pulse Delay, Clock Division, LFO Reset (only during Falling portion).

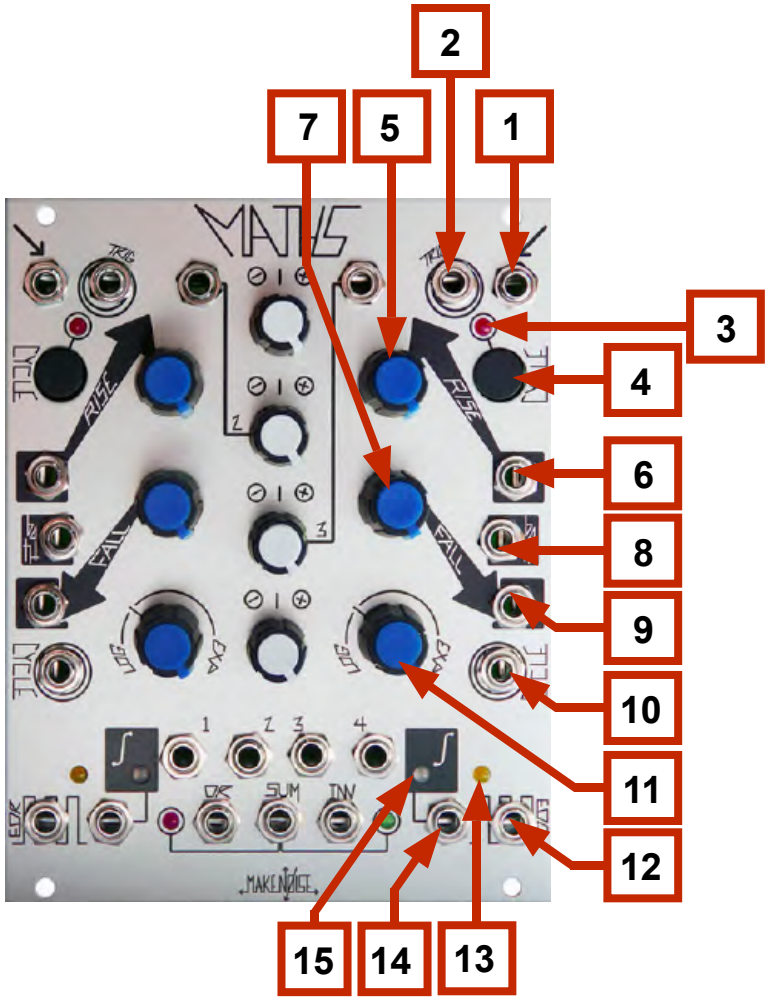
3. CYCLE LED: Indicates CYCLE ON or OFF.

4. CYCLE Button: Causes the circuit to self cycle, thus generating a repeating voltage function, aka LFO. Use for LFO, Clock, VCO.

5. RISE Panel Control: Sets the time it takes for the voltage function to ramp up. CW rotation increases Rise Time.

6. RISE CV IN: Linear control signal input for Rise parameter. Positive Control signals increase Rise Time, Negative control signals decrease Rise Time with respect to the Rise panel control setting. Range +/-8V

7. FALL Panel Control: Sets the time it takes for the voltage function to ramp down. CW rotation increases Fall Time.



MATHS Channel 4 (cont'd)

8. BOTH CV IN: Bi-Polar Exponential control signal input for ENTIRE function. Contrary to the Rise and Fall CV IN, BOTH has an Exponential response and Positive control signals decrease total time while Negative control signals increase total time. Range +/-8V

9. FALL CV IN: Linear control signal input for Fall parameter. Positive control signals increase Fall time, Negative control signals decrease Fall Time with respect to the Fall panel control. Range +/-8V

10. CYCLE IN: On Gate HIGH, circuit will CYCLE. On Gate LOW MATHS will not CYCLE (unless the CYCLE button is engaged). Requires minimum +2.5V for HIGH

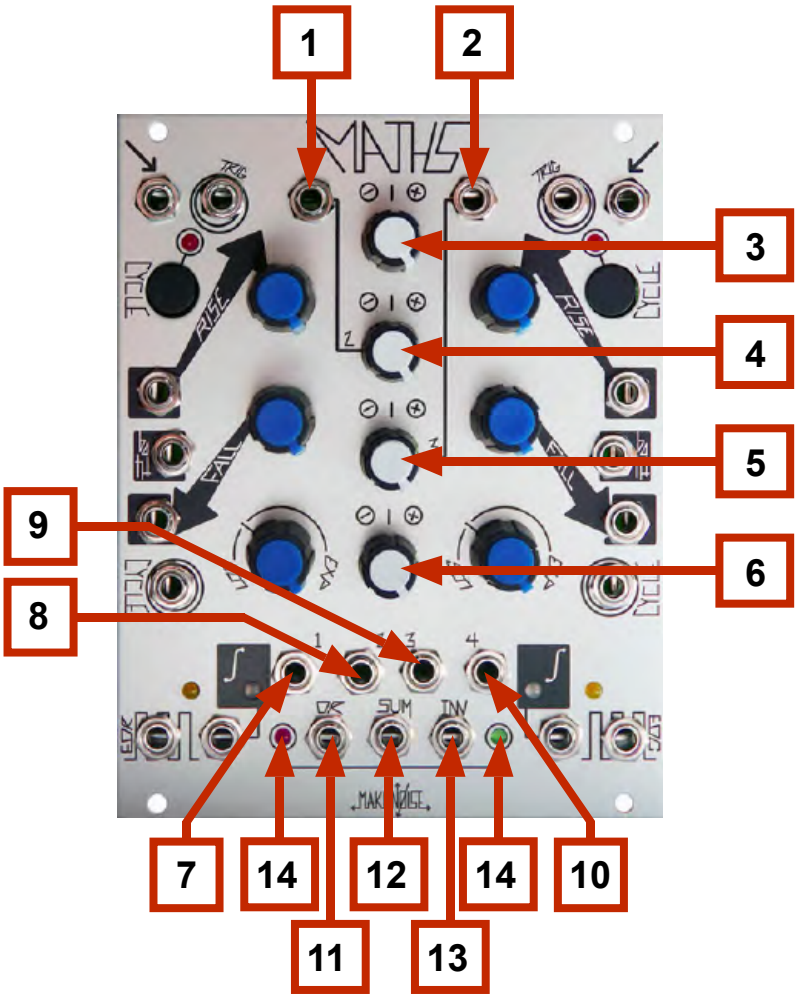
11. Vari-Response Panel Control: Sets the response curve of the voltage function. Response is continuously variable from Logarithmic through Linear to Exponential to Hyper-Exponential. The Tick mark shows the Linear setting.

12. End Of Cycle OUT (EOC): Goes high at the end of the Fall portion of the function. 0V or 10V.

13. EOC LED: Indicates the states of the EOR output. Lights when EOC is HIGH.

14. Unity Signal OUT: signal from the Channel 1 circuit. 8V peak to peak when Cycling. Otherwise this output will follow the amplitude of the input.

15. Unity LED: indicates activity within the circuit. Positive voltages GREEN, Negative voltages RED.



SUM and OR Bus

1. Signal IN Channel 2: Direct Coupled input to Attenuvertor and SUM/ OR Bus. Normalized to a +10V reference for generation of voltage offsets. Input Range +/-10V

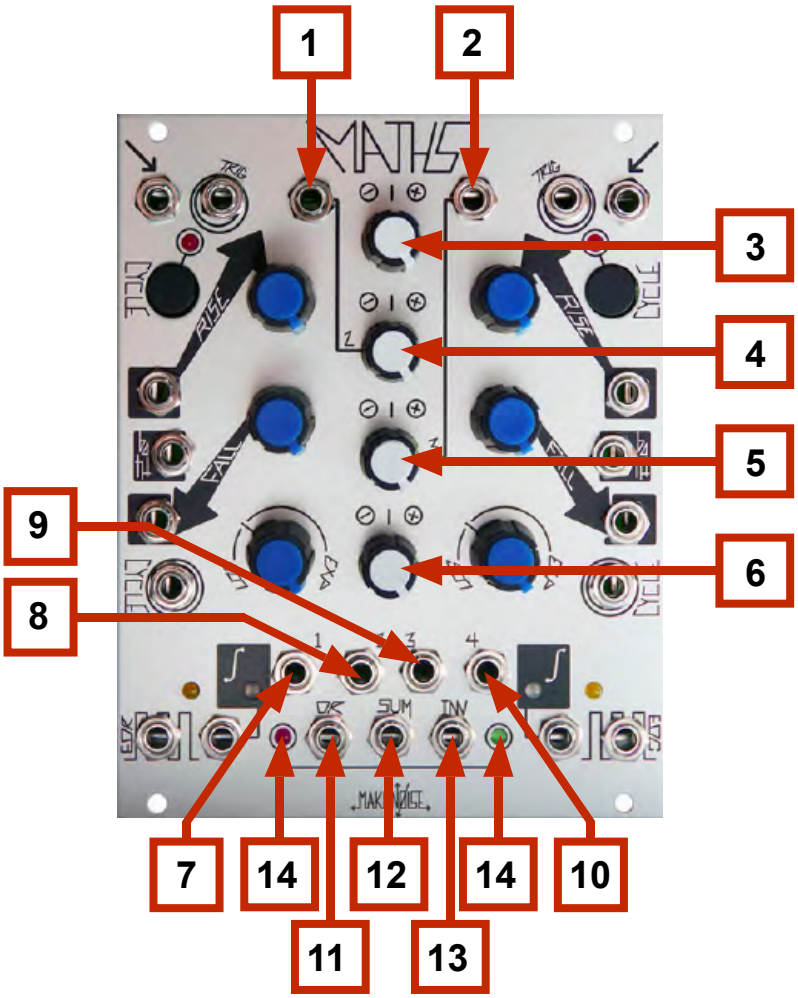
2. Signal IN Channel 3: Direct Coupled input to Attenuvertor and SUM/ OR Bus. Normalized to a +5V reference for generation of voltage offsets. Input Range +/-10V

3. CH. 1 Attenuvertor Control: provides for scaling, attenuation and inversion of the signal being processed or generated by CH. 1. Connected to CH. 1 Variable OUT and SUM/ OR Bus.

4. CH. 2 Attenuvertor Control: provides for scaling, attenuation, amplification and inversion of signal patch to CH. 2 Signal IN. With no signal present it will control the level of the offset generated by CH. 2. Connected to CH. 2 Variable OUT and SUM/ OR Bus..

5. CH. 3 Attenuvertor Control: provides for scaling, attenuation, amplification and inversion of signal patch to CH. 3 Signal IN. With no signal present it will control the level of the offset generated by CH. 3. Connected to CH. 3 Variable OUT and SUM/ OR Bus.

6. CH. 4 Attenuvertor Control: provides for scaling, attenuation and inversion of the signal being processed or generated by CH. 4. Connected to CH. 4 Variable OUT and SUM/ OR Bus.



SUM and OR Bus (cont'd)

7. CH. 1 Variable OUT: The applied signal as processed by CH. 1 controls. Normalized to the SUM and OR busses. Inserting a patch cable will remove the signal from the SUM and OR busses. Output Range +/-10V

8. CH. 2 Variable OUT: The applied signal as processed by CH. 2 controls. Normalized to the SUM and OR busses. Inserting a patch cable will remove the signal from the SUM and OR busses. Output Range +/-10V

9. CH. 3 Variable OUT: The applied signal as processed by CH. 3 controls. Normalized to the SUM and OR busses. Inserting a patch cable will remove the signal from the SUM and OR busses. Output Range +/-10V

10. CH. 4 Variable OUT: The applied signal as processed by CH. 4 controls. Normalized to the SUM and OR busses. Inserting a patch cable will remove the signal from the SUM and OR busses. Output Range +/-10V

11. OR Bus OUT: Result of the Analog Logic OR function with respect to the settings of the attenuvertor controls for channels 1, 2, 3 and 4. Range 0V to 10V.

12. SUM Bus OUT: Sum of the applied voltages with respect to the settings of the attenuvertor controls for channels 1, 2, 3 and 4. Range +/-10V

13. INVerted SUM OUT: signal from SUM OUT turned upside down. Range +/-10V

14. SUM Bus LEDs: indicate voltage activity in the SUM bus (and therefore the INVerted SUM as well). RED LED indicates negative voltages. GREEN LED indicates positive voltages.

MATHS is laid out top to bottom, with symmetrical features between CH. 1 and 4. The signal inputs are at the top, followed by the panel controls and control signal inputs at the middle. The signal outputs are at the bottom of the module. LEDs are placed near the signal they are indicating.

Channels 1 and 4 are able to scale, invert or integrate an incoming signal. With no signal applied, these channels may be made to generate a variety of linear, logarithmic, or exponential functions upon the reception of a trigger, or continuously when the CYCLE is engaged. One small difference between CH. 1 and 4 is in their respective Pulse outputs; CH.1 having End of Rise and CH. 4 having End of Cycle. This was done to facilitate the creation of complex functions utilizing both CH. 1 and 4. Channels 2 and 3 are able to scale, amplify and invert an incoming signal. With no external signal applied, these channels generate DC offsets. The only difference between CH. 2 and 3 is that CH. 2 generates a +/-10V offset while Ch. 3 generates a +/-5V offset.

All 4 channels have outputs (called Variable OUTs) which are normalized to a SUM, INVerted Sum and OR bus so that addition, subtraction, inversion and analog logic OR manipulations may be achieved. Inserting a plug to these Variable OUT sockets will remove the associated signal from the SUM and OR bus (Channels 1 and 4 have unity outputs, which are NOT normalized to the SUM and OR bus). These outputs are controlled by the 4 Attenuvertors at the center of the module.

SIGNAL IN

These inputs are all Direct Coupled to their associated circuit. This means they are able to pass both audio and control signals. These inputs are used to process external control voltages. CH. 1 and 4 Signal IN could also be used to generate Attack/ Sustain/ Release type envelopes from a gate signal. Channels 2 and 3 are also normalized to a voltage reference so that with nothing patched to the input, that channel could be used for generation of voltage offsets. This is useful for level shifting a function or other signal that is at one of the other channels by adding the voltage offset to that signal and taking the SUM OUT.

TRIGGER IN

CH. 1 and 4 also have a trigger input. A gate or pulse applied to this input will trigger the associated circuit regardless of activity at the Signal IN. The result being a 0V to 10V function, aka Envelope, whose characteristics are defined by the RISE, FALL, Vari-Response and Attenuvertor parameters. This function will rise from 0V to 10V and then immediately fall from 10V to 0V. There is NO SUSTAIN. To get a sustaining envelope function, use the Signal IN (see above). MATHS will re-trigger during the falling portion of the function, but will NOT re-trigger on the rising portion of the function. This allows clock and gate division since MATHS could be programmed to IGNORE incoming clocks and gates by setting the RISE Time to be greater than the time between the incoming clocks and/ or gates.

CYCLE

The CYCLE Button and CYCLE IN both do the same thing... they make MATHS self-oscillate aka CYCLE, which are just fancy terms for LFO! When you want LFO, make MATHS CYCLE and you will be satisfied.

RISE/ FALL/ Vari-Response

These controls shape the signal that is output at the Unity Signal OUT and Variable OUT for CH. 1 and 4. The RISE and FALL controls determine how fast or slow the circuit will respond to signals applied to the Signal IN and Trigger IN. The range of times is larger than the typical Envelope or LFO. MATHS will create functions as slow as 25 minutes (Rise and Fall full CW and external control signals added to go into "slow-ver-drive") and as fast as 1khz (audio rate).

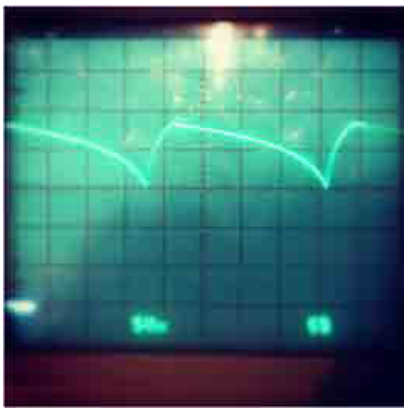
RISE sets the amount of time the circuit takes to travel up to the maximum voltage. When triggered the circuit starts at 0V and travels up to 10V. RISE determines how long it takes for this to happen. When used to process external control voltages the signal applied to the Signal IN is either increasing, decreasing or at a steady state (doing nothing). RISE determines how fast that signal could increase. One thing MATHS cannot do is look into the future to know where an external control signal is headed, therefore MATHS cannot increase the rate at which an external voltage changes/ moves, it can only act upon the present and slow it down (or allow it to pass at same speed).

FALL sets the amount of time the circuit takes to travel down to the minimum voltage. When triggered the voltage starts at 0V and travels up to 10V, at 10V the upper threshold is reached and the voltage begins to drop back down to 0V. FALL determines how long it takes for this to happen. When used to process external control voltages the signal applied to the Signal IN is either increasing, decreasing or at a steady state (doing nothing). FALL determines how fast that signal could decrease. Since it cannot look into the future to know where an external control signal is headed, MATHS cannot increase the rate at which an external voltage changes/ moves, it can only act upon the present and slow it down (or allow it to pass at same speed).

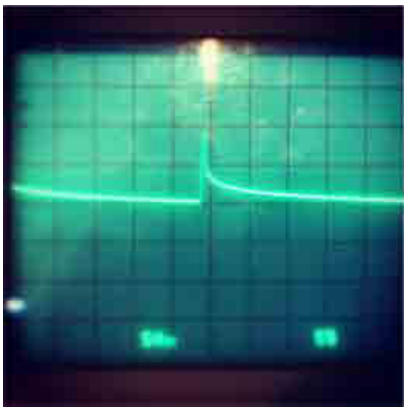
Both RISE and FALL have independent CV inputs for voltage control over these parameters. If attenuation is required, use CH. 2 or CH. 3 in series to the desired destination. In addition to the RISE and FALL CV INs there is also the BOTH CV INs. The BOTH CV input changes the rate of the ENTIRE function. It also responds inversely to the RISE and FALL CV INs. More positive voltages make the entire function shorter and more negative voltages make the entire function longer.

Vari-Response shapes the above rates of change (RISE/ FALL) to be Logarithmic, Linear or Exponential (and everything in-between these shapes). With the LOG response, the rate of change DECREASES and the voltage INCREASES. With EXPO response the rate of change INCREASES and the voltage INCREASES. The LINEAR response has no change in rate as the voltage changes.

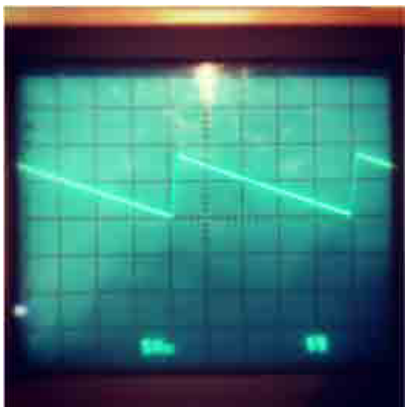
LOG



EXPO



LINEAR



Signal OUTS
There are many different signal outputs on the MATHS. All of them are situated at the bottom of the module. Many of them have LEDs situated nearby for visual indication of the signals.

The Variable OUTs
These outputs are labelled 1, 2, 3 and 4 and are associated with the four Attenuvertor controls in the center of the module. These outputs are all determined by the settings of their associated controls, esp. the CH. 1 thru 4 Attenuvertor controls. All of these jacks are normalled to the SUM and OR Bus. With nothing patched to these outputs, the associated signal is injected into the SUM and OR Bus. When you patch a cable into any one of these output jacks, the associated signal will be REMOVED from the SUM and OR Bus. These outputs are useful when you have a modulation destination where there is no attenuation or inversion available (the CV inputs on the MATHS or FUNCTION modules for example). They are also useful when you want to create a variation of signal that is at a different amplitude or phase.

EOR OUT
This is the End Of Rise output for CH. 1. This is an event signal. It is either at 0V or 10V and nothing between. It defaults to 0V, or LOW when there is no activity. The event in this case is when the associated channel reaches the highest voltage to which it will travel. This is a good signal to choose for Clocking or Pulse shaped LFO. It is also useful for Pulse Delay and clock division since the Rise will set the amount of time it takes for this output to go HIGH.

EOC OUT
This is the End Of Cycle output for CH. 4 This is an event signal. It is either at 0V or 10V and nothing between. It defaults to +10V, or HIGH, when there is no activity. The event in this case is when the associated channel reaches the lowest voltage to which it will travel. The associated LED will be lighted when nothing is happening. This is a good signal to choose for Clocking or Pulse shaped LFO.

Unity Signal OUTs CH. 1 and 4
These outputs are tapped directly off the core of the associated channel. They are not affected by the channel's Attenuvertor. Patching into this output will NOT remove the signal from the SUM and OR Buses. This is a good output to use when you do not require attenuation or inversion or when you want to use the signal both independently and within the SUM/ OR Bus.

OR OUT
This is the output from the analog OR circuit. The inputs are CH. 1, 2, 3 and 4 Variable OUTputs. It will always output the highest voltage out of all the voltages applied to the inputs. Some people call this a Maximum Voltage selector circuit! The attenuators allow for weighting the signals. It will not respond to negative voltages, therefore it could also be used to rectify a signal. Useful for creating variations on a modulation or sending CV to inputs that only respond to positive voltages (e.g. Organize CV IN on the Phonogene).

SUM OUT This is the output from the analog SUM circuit. The inputs are CH. 1, 2, 3 and 4 Variable OUTs. Depending upon how the Attenuvertors are set, you could add, invert or subtract voltages from each other using this circuit. This is a good output to use for combining several control signals in order to generate more complex modulations.

INV OUT This is the inverted version of the SUM output. It will allow you to modulate backwards!

Tips & Tricks

-Longer cycles will be achieved with more Logarithmic response curves. The fastest, sharpest functions will be achieved with extreme exponential response curves.

-Adjustment to the response curve will affect RISE and FALL Times.

-To achieve longer or shorter RISE and FALL Times than available from Panel Controls, apply a voltage offset to the Control Signal Inputs. Use CH. 2 or 3 for this offset voltage.

-Use the INV SUM OUT where you require reversed modulation but do not have means for inversion at the CV destination (MIX CV IN on ECHOPHON for example).

-Feeding an inverted signal from MATHS back into the MATHS at any of the CV inputs is highly useful for creating responses that are not covered by the Vari-Response control alone.

-When utilizing the SUM and OR outputs, set any unused CH. 2 or 3 to NOON or insert a dummy patch cable to Signal Input of associated channel to avoid unwanted offsets.

-If it is desired that a signal processed or generated by CH. 1, 4 is both on the SUM, INV and OR busses AND available as an independent output, utilize the Unity Signal OUT, as it is NOT normalized to the SUM and OR Busses.

-OR output will not respond to or generate negative voltages.

-End of Rise and End of Cycle are useful for generating complex control voltage functions where CH. 1 and CH. 4 will trigger from each other. Patch to each other’s Trigger, Signal, and CYCLE inputs.

Patch Ideas: Analog Voltages, Low Frequency Oscillators

Typical Voltage Controlled Triangle Function (Triangle LFO)
Set CH. 1 (or 4) to Cycle. Set RISE and FALL Panel Control to NOON. Set CH. 2 Attenuvertor to NOON. Patch SUM OUT to Both Control Input. Apply desired frequency modulation to CH. 3 Signal Input. The CH. 2 Attenuvertor will set Frequency. Output is taken from Signal OUTs of associated channel. Setting RISE and FALL parameters further CW will provide longer cycles. Setting these parameters further CCW will provide short cycles, up to audio rate. The resulting function may be further processed with attenuation and/ or inversion by the Attenuvertor. Alternatively, take output from the cycling channel's UNITY output and patch the Variable OUT to the RISE or FALL CV IN to morph LFO shapes with the CH 1 (or 4) Attenuvertor.

Typical Voltage Controlled Ramp Function (Saw/ Ramp LFO)
Same as above, only the RISE parameter is set FULL CCW, FALL parameter is set to at least NOON.

Arcade Trill (Complex LFO)
Set CH. 4 RISE and FALL to NOON, response to EXPonential. Patch EOC to a multiple, then to CH. 1 Trigger IN and Ch. 2 INput. Adjust Ch. 2 panel control to 10:00. Patch Ch.2 OUTput to Ch. 1 BOTH INput. Set CH. 1 RISE to NOON, FALL to full CCW, response to LINear. Engage CH. 4 CYCLE switch (Ch. 1 should not be cycling). Apply Unity OUT CH. 1 to modulation destination. Adjust Ch. 1 RISE panel control for variation (note that very small changes will have drastic effect on the sound).

Chaotic Trill (requires MMG or other Direct Coupled LP filter)
Begin with Arcade Trill patch. set CH. 1 Attenuvertor to 1 o'clock. Apply CH. 1 Signal OUT to MMG DC Signal IN. Patch EOR to MMG AC Signal IN, set to LP mode, no feedback, starting with FREQ at full CCW. Apply MMG Signal OUT to MATHS CH. 4 Both IN. Patch CH. 4 Variable OUT to CH. 1 BOTH CV IN. Unity Signal OUT to modulation destination. MMG FREQ and Signal IN controls and MATHS CH. 1 and 4 Attenuvertors will be of great interest in addition to the RISE and FALL parameters.

281 “Quadrature Mode” (Complex LFO)
In this patch, CH. 1,4 work in tandem to provide functions shifted by ninety degrees. With both Cycle Switches UN-ENGAGED, Patch End of RISE (CH. 1) to Trigger IN CH. 4. Patch End of Cycle (CH. 4) to Trigger IN CH. 1. If both CH.1 and 4 do not begin cycling, engage CH. 1 CYCLE Briefly. With both channels cycling, apply their respective Signal outputs to two different modulation destinations, for example two channels of the Optomix.

Patch Ideas: Analog Voltages, Triggered Functions/ Envelopes

Voltage Controlled Transient Function Generator (Attack/ Decay EG)
A pulse or gate applied to the Trigger IN of CH. 1 or 4 will start the transient function which rises from 0V to 10V at a rate determined by the RISE parameter and then falls from 10V to 0V at a rate determined by the FALL parameter. This function is re-trigger-able during the falling portion. RISE and FALL are independently voltage controllable, with variable response from Log thru Linear to Exponential, as set by the Vari-Response panel Control. The resulting function may be further processed with attenuation and/ or inversion by the Attenuvertor.

Voltage Controlled Sustained Function Generator (A/S/R EG)
A gate applied to the Signal IN of CH. 1 or 4 will start the function which rises from 0V to the level of the applied Gate, at a rate determined by the RISE parameter, Sustains at that level until the Gate signal ends, and then falls from that level to 0V at a rate determined by the FALL parameter. RISE and FALL are independently voltage controllable, with variable response as set by the Vari-Response panel Control. The resulting function may be further processed with attenuation and/ or inversion by the Attenuvertor.

Typical Voltage Controlled ADSR type Envelope
Apply Gate signal to CH.1 Signal In. Set CH. 1 Attenuvertor to less than Full CW. Patch CH. 1 End of Rise to CH. 4 Trigger IN. Set CH. 4 Attenuvertor to Full CW. Take output from OR bus OUT, being sure that CH. 2,3 are set to NOON if not in use. In this patch CH. 1 and 4 RISE will control the Attack Time. For typical ADSR adjust these parameters to be similar (Setting CH. 1 RISE to be longer then CH. 4 will or vice-versa, will produce two attack stages). CH. 4 FALL parameter will adjust the Decay stage of the envelope. CH. 1 Attenuvertor will set the Sustain level, which MUST be lower than that same parameter on CH. 4. Finally CH. 1 FALL will set the Release Time.

Bouncing Ball, 2013 edition thanx to Pete Speer
Set CH. 1 RISE full CCW, FALL to 3:00, response to Linear. Set CH. 4 RISE full CCW, FALL to 11:00, response to Linear. Patch CH. 1 EOR to CH. 4 CYCLE In, and Ch. 1 variable OUT to Ch.4 FALL input. Patch CH. 4 Output to VCA or LPG control input. Patch a gate or trigger source, such as the touch gate from Pressure Points, to CH. 1 TRIG in for manual start of "bounces". Adjust Channel 4 RISE and FALL for variations.

Independent Contours - thanx to Navs
By changing the level and polarity of the Variable OUT of CH. 1, 4 with the Attenuvertor, and feeding that signal back into CH.1, 4 at RISE or FALL Control IN, independent control of the corresponding slope is achieved. Take output from Unity Signal OUT. Best to have the Response panel control set to NOON.

Independent Complex Contours
Same as above, but additional control is possible by using the EOC or EOR to trigger the opposite channel, and use the SUM or OR output to RISE, FALL or BOTH of the original channel. Alter RISE, FALL, attenuversion and response curve of opposite channel to achieve various shapes.

Asymmetrical Trilling Envelope - thanx to Walker Farrell
Engage cycling on CH. 1, or apply a signal of your choice to its Trigger or Signal IN. Set RISE and FALL to 12:00 with Linear response. Patch CH. 1 EOR to CH. 4 CYCLE input. Set CH. 4 RISE to 1:00 and FALL to 11:00, with Exponential response. Take output from OR (with CH. 2 and 3 set to 12:00). The resulting envelope has a "trill" during the fall portion. Adjust relative levels and RISE/FALL times and responses. Alternatively, swap channels and use the EOC output to CH. 1's CYCLE input for trilling during the rise portion.

Patch Ideas: Analog Signal Processing, Voltage MATHS!

ADD, Subtract Control Signals
Apply signals to be added/ subtracted to any combination of Signal IN CH. 1,2,3,4 (when using CH. 1,4 RISE and FALL must be set to full CCW, and Cycle switch not engaged). For channels to be added, set Attenuvertor controls to full CW. Set Attenuvertors for channels to be subtracted to full CCW. Take output from SUM OUT.

VC Portamento/ LAG/ Slew Processor
A signal applied to the Signal IN, is slewed according to the RISE and FALL parameters. Variable response from Log thru Linear to Exponential, is as set by the Vari-Response panel Control. The resulting function may be further processed with attenuation and/ or inversion by the Attenuator Panel Control.

Envelope Follower
Apply Signal to be followed to Signal IN CH. 1 or 4. Set RISE to NOON. Set and or modulate FALL Time to achieve different responses. Take output from associated channel Signal OUT for positive and negative Peak Detection. Take output from OR buss OUT to achieve more typical Positive Envelope Follower function.

Peak Detector
Patch signal to be detected to CH. 1 Signal IN. Set RISE and FALL to 3 'o' Clock. Take output from Signal OUT. Gate out from EOR OUT.

Voltage Mirror
Apply Control Signal to be mirrored to CH. 2 Signal IN. Set CH. 2 Attenuvertor to Full CCW. With nothing inserted at CH. 3 Signal IN (so as to generate an offset), set CH. 3 Attenuvertor to full CW. Take output from SUM OUT.

Voltage Comparator/ Gate Extraction w/ variable width
Apply signal to be compared to CH. 3 Signal IN. Set Attenuvertor to greater than 50%. Use CH. 2 for comparing voltage (with or without something patched). Patch SUM OUT to CH. 1 Signal IN. Set CH. 1 RISE and FALL to full CCW. Take extracted Gate from EOR. CH. 3 Attenuvertor acts as the input level setting, applicable values being between NOON and Full CW. CH. 2 acts as the threshold setting applicable values being from Full CCW to NOON. Values closer to NOON will be LOWER thresholds. Setting the RISE more CW, you will be able to Delay the derived gate. Setting FALL more CW you will vary the width of the derived Gate. Use CH. 4 for Envelope Follower patch, and CH. 3, 2 & 1 for Gate extraction, and you have a very powerful system for external signal processing.

Half Wave Rectification
Apply bi-polar signal to CH. 1, 2, 3, 4 IN. Take output from OR out. Mind the normalizations to the OR buss.

Full Wave Rectification
Mult signal to be rectified to both CH. 2 and 3 IN. CH 2 Scaling/ Inversion set to Full CW, CH. 3 Scaling/ Inversion set to Full CCW. Take output from OR Out. Vary the Scaling.

Multiplication
Apply positive going control signal to be multiplied to CH1 or 4 Signal IN. Set RISE to full CW, FALL to Full CCW. Apply positive going, multiplier Control Signal to BOTH Control IN. Take output from corresponding Signal OUT.

Pseudo-VCA with clipping - Thanx to Walker Farrell
Patch audio signal to CH. 1, with RISE and FALL at full CCW, or cycle CH. 1 at audio rate. Take output from SUM out. Set initial level with CH. 1 panel control. Set CH. 2 panel control full CW to generate a 10v offset. Audio will start to clip and may become silent. If it's still audible, apply an additional positive offset with CH. 3 panel control until it is just silent. Set CH. 4 panel control to full CCW and apply envelope to Signal IN, or generate envelope with CH. 4. This patch creates a VCA with asymmetrical clipping in the waveform. It will work with CV also, but be sure to adjust CV input settings to deal with the large base offset. The INV output may be more useful in some situations.

Patch Ideas: Digital Signals, Clocks, Gates, Pulses, Events, Timing

Typical Voltage Controlled Pulse/ Clock w/ Voltage Controlled Run/ Stop (Clock, pulse LFO)
Same as above, only the output is taken from EOC or EOR. CH. 1, RISE parameter will more effectively adjust frequency, and CH. 1 FALL parameter will adjust pulse width. With CH. 4, the opposite is true where RISE adjust more effectively Width and FALL adjust frequency. In both channels all adjustment to RISE and FALL parameters will affect frequency. Use CYCLE IN for Run/ Stop control.

Voltage Controlled Pulse Delay Processor
Apply Trigger or Gate to Trigger IN if CH. 1. Take output from End Of Rise. RISE parameter will set delay and FALL parameter will adjust width of the resulting pulse.

Voltage Controlled Clock Divider Clock signal applied to Trigger IN CH. 1 or 4 is processed by a divisor as set by RISE parameter. Increasing RISE sets divisor higher, resulting in larger divisions. Fall time will adjust the width of the resulting clock. If the Width is adjust to be greater the total time of the division the output will remain “high.”

FLIP-FLOP (1-Bit Memory)
In this patch CH. 1 Trigger IN acts as the “Set” input, and CH. 1 BOTH Control IN acts as the “Reset” input. Apply Reset signal to CH. 1 BOTH Control IN. Apply Gate or logic signal to CH. 1 Trigger IN. Set RISE to Full CCW, FALL to Full CW, Vari-Response to Linear. Take “Q” output from EOC. Patch EOC to CH. 4 Signal to achieve “NOT Q” at the EOC OUT. This patch has a memory limit of about 3 minutes, after which it forgets the one thing you told it to remember.

Logic Invertor
Apply logic gate to CH. 4 Signal IN. Take output from CH. 4 EOC.

Comparator/Gate Extractor (a new take) Send signal to be compared to CH. 2 IN. Set CH. 3 panel control into the negative range. Patch SUM out into CH. 1 Signal IN. Set CH. 1 RISE and FALL to 0. Take output from CH. 1 EOR. Observe signal polarity with CH. 1 UNITY LED. When signal goes slightly positive, EOR will trip. Use CH. 3 panel control to set the threshold. Some attenuation of CH. 2 may be necessary to find the right range for a given signal. Use CH. 1 FALL control to make the gates longer. CH. 1 RISE control sets the length of time the signal must be above the threshold to trip the comparator.