Q173 Gate Math

Aug 22, 2016

The Q173 Gate Math module divides and multiplies gates and clocks, produces random gates, sequence patterns, drum patterns and various irregular patterns. Four separate outputs are individually programmed with hundreds of possible options.

Six configurations can be programmed then selected manually or via voltage control. Each configuration selects the options you've programmed for each of the 4 outputs. This allows you to easily switch between divisors or patterns.

Gate output options include Binary which has a 50% gate time, Trigger which has a short 5ms gate time, and Gate which duplicates the width of the incoming gate. The output can be switched between normal and inverted polarity, and the 'S' option causes the first incoming step to be skipped. This allows for an amazing array of possible output patterns.

Each of the 4 outputs can receive its gate/clock from the IN jack, or from other outputs using the Source setting.

Setting options is easy - just set the desired option with the top knob and the three toggle switches, then press the Set button for the output you want to program.

The Simple setting provides quick access to divide-by-2, 4, 8, 16 at the 4 outputs.

Without a plug inserted into the IN jack, the Configuration knob and jack operates as an internal clock source to drive the outputs. This clock is available at the Thru jack. This allows the Q173 to be used as a stand-alone gate sequencer, random gate source, or drum pattern generator.

The Q173's wide array of features and programmability makes it the most powerful and unique gate math module available.

Q173 Gate Math Specifications

Panel Size: Single Width 2.125"w x 8.75".
Divisors: 0 (off), 1, 1.33 (4:3), 1.5, 2, 2.5, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 16, 17, 20, 32 + many more.
Multiplier: 1.5, 2, 2.5, 3, 4, 8 + more.
Random: 50%, 33%, 25%, individual output, or multiple outputs exclusive, and bursts.
Sequences: 2 step, 3 step, 4 step.
Drum Patterns: Irregular for hats, snare, bass, tom.
Gate Outputs: 5V positive or 5ms trigger pulse, or inverted versions of these.
Thru Output: Matches input frequency with 90% duty cycle.
Reset Input: 5V positive rising edge, 1ms minimum.
Voltage Controlled Configuration: 6 total configurations, 0V, 1V, 2V, 3V, 4V, 5V.
Internal Clock: 240-480bpm (4-8hz), voltage and manual control.
Power Requirement: +15V@30ma, -15V@30ma, +5V@50ma.

Q173 Gate Math

Aug 2016

Panel Overview

To set options for each output, simply select the options with the top knob and toggle switches, then press the Set button for the Output you want to program.

Option Knob
Multiply, Divide, Random,
Sequence, or Alt patterns.

Source sets source of gates
to IN, output #1,
or the previous output.

Option Switch
Combined with top knob
to make selection 1, 2 or 3.

Configuration Selection
This Jack and Knob selects
1 of the 6 user-programmed
configurations.

Gate/Clock Input.
If no plug inserted, then the
Configuration knob produces
clocks at variable speed.

Thru is an output,
a copy of the Input gate.
Makes it easy to daisy-chain
to other modules.

Buttons to set each output
according to the top knob
and switches.

Divisors.

Output Type control.
Normal, Inverted or
S=Skip first gate pulse.

Gate=Incoming gate time,
B=Binary (50% gate time),
Trig=5ms gate time.

Set the Configuration knob
to 0 if you don't need
multiple configurations.

A gate here resets
patterns to the beginning.

Gate outputs.
Four separate channels.
Individually programmed with
the Set button.
Each can get its input
from the IN jack,
from the internal clock,
or from another output.
Gate outputs have 2 states -
On = about 5 volts,
Off = about 0 volts.

LED for each output
shows its status.

Q173 Gate Math

Aug 2016

Simple Mode

The Q173 can be programmed with many complex options but sometimes you just need a simple clock divider, and that's exactly what the SIMPLE setting does. Just turn the top knob to SIMPLE and the outputs provide /2, /4, /8, /16. Turn the rotary switch off of SIMPLE to return to whatever the settings were before.

Set the Option knob to SIMPLE.

The option switch is ignored in SIMPLE mode.

OUTPUT option switches operate in real-time in SIMPLE mode.

Configuration settings are ignored in SIMPLE mode.

Gate/Clock Input. If no plug inserted, then the CONFIGURATION knob produces clocks at variable speed.

/2 output

SET buttons are ignored in SIMPLE mode but cause reset.

/4 output

/8 output

/16 output

Q173 Gate Math

Aug 2016

Programming Outputs

Programming the 4 outputs is easy, just set the option knob and the option switches for the desired functions then press the SET button for the output you want to program.   Options are saved through power-off.

Each knob position has 3 options selected by the toggle switch.

Turn the knob to this position. Divide-by-16 is the 3nd option.

Divide-by-16 is the 3nd option of the knob position, so set the toggle switch to 3.

Set the OUTPUT type to NORMAL and GATE.

Turn the Configuration knob to 0 and no CV input.

Patch a gate signal into the IN jack. Or a clock from a sequencer or a pulse wave from an oscillator.

Press the SET button to set the options for this output.

This output will now be divide-by-16.

Q173 Gate Math

Aug 2016

Programming Configurations

Configurations are groups of options for outputs. When you press SET to set options for an output, the CONFIGURATION knob and CV jack determine which of the 6 configurations are being set. Each configuration stores options for all 4 OUTPUTS. Configurations let you switch between multiple options easily with the knob or under voltage control. If you don't need multiple configurations, just leave the CONFIGURATION knob set to 0.

With the Configuration knob at 0, set options for each output by setting the top knob and the toggle switches, then press SET. Do this for each output.

Then set the configuration knob to 1 and set the outputs to other options.

This is the gate or clock input.

Press the SET button to set options for each output according to the top knob and option switches. The position of the CONFIGURATION knob and the voltage at the CV IN jack determines which configuration is being programmed.

Pressing the SET buttons while a moving waveform is patched into the CONFIGURATION CV In jack will result in the settings being applied to an unknown configuration number.

Configurations are selected using a combination of the voltage at the CV IN jack and the voltage created by the CONFIGURATION knob. These 2 sources are summed together.

Less than 0.5V = Config 0
0.5v - 1.5v = Config 1
1.5v - 2.5v = Config 2
2.5v - 3.5v = Config 3
3.5v - 4.5v = Config 4
Greater than 4.5v = Config 5

Set the knob to 0 to program configuration 0 or to select configuration 0. There are 6 different configurations, each storing options for all 4 outputs.

Each of the 6 possible configurations stores options for each of the 4 outputs.

All of this programming is saved through power-off.

Output Types

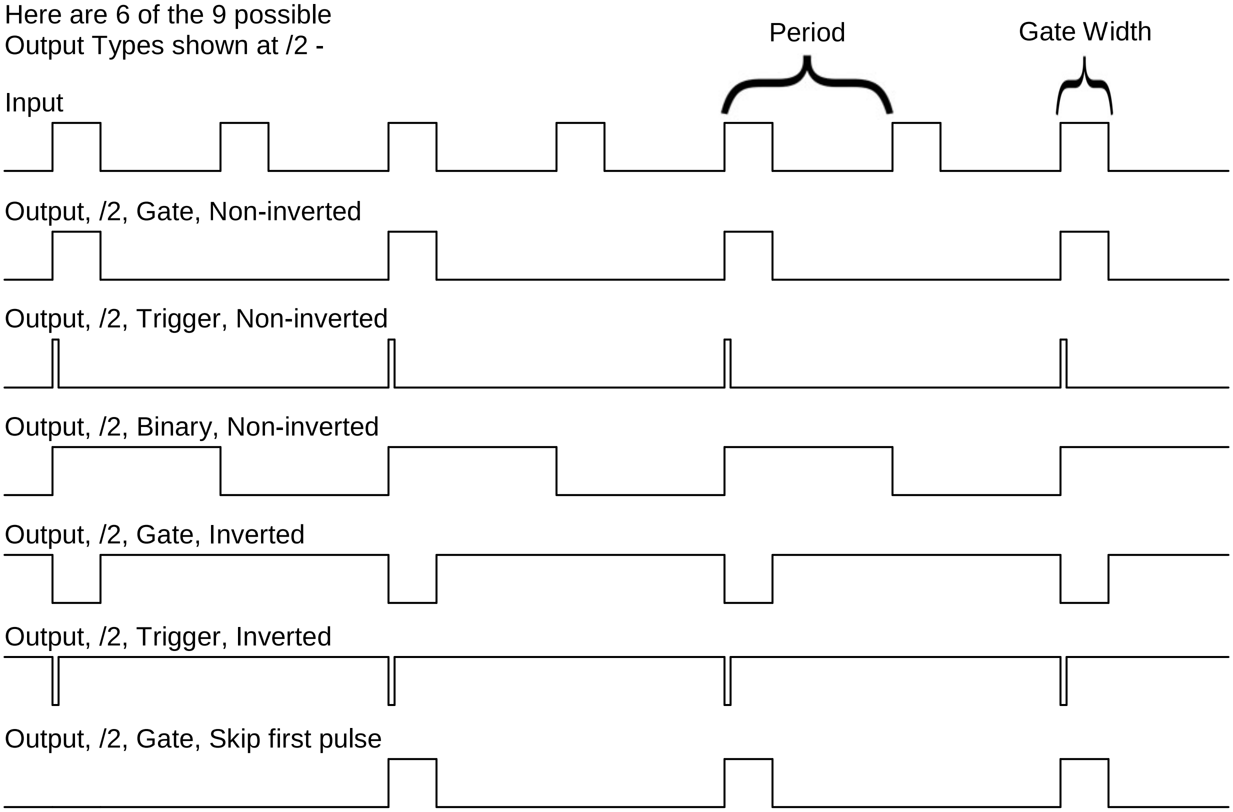
Q173 outputs types are controlled using 2 toggle switches. When programming an Output using the SET buttons, these toggle switches determine how the outputs behave.

The middle toggle switch sets the Output's polarity. Options are Normal, Inverted or S=Skip which is Normal polarity and the first incoming clock pulse is skipped. This has the effect of shifting a pattern by one clock pulse and provides some interesting results.

The right toggle switch sets the length of the Output signal. GATE causes the Output gate length to be equal to the incoming clock pulses. TRIG produces a short 5ms trigger. B=Binary results in Outputs being ON 50% of the period time. These options can result in different effects when driving envelopes, VCAs and other modules.

To control outputs types.

Here are 6 of the 9 possible Output Types shown at /2 -



Using the Internal Clock

Normally the Q173 operates on gate and clock signals coming from a sequencer or an oscillator pulse waveform, but the Q173 also has an internal clock. This is very convenient and allows the Q173 to be used as a stand-alone pattern generator, drum machine, gate sequencer, or random pulse generator. When the internal clock is active, configuration 0 is used since the configuration feature is replaced by the clock.

Speed of the internal clock is set by the CONFIGURATION knob and/or the CV IN.

If there is no external source of clocks patched into the IN jack, an internal clock is generated with speed controlled by the CONFIGURATION knob and CV jack.

The configuration used is 0.

When the internal clock is operating, the Thru jack provides a clock output, and it drives all of the outputs according to their programming.

A gate patched into the RESET jack resets the programmed patterns.

Q173 Gate Math

Aug 2016

Division

The Q173's primary function is to provide divisions of input gates, typically from sequencers to produce musically useful patterns that trigger and control other modules. These include the standard /2, /4 and other integers up to /32, but also some that may look unusual such as /1.33. These fractional divisions provide musically useful ratios:

/1.33 = 4:3 (4 inputs to 3 outputs)
/1.5 = 3:2 (3 inputs to 2 outputs)
/2.5 = 5:2 (5 inputs to 2 outputs)

The /0 and /1 options are useful when programming configurations where you want some to turn off (/0) and some to match the input gates (/1).

Dividers
Each knob position provides 3 dividers selected by the OPTION toggle switch.

Select 1 of 3 options for each knob position

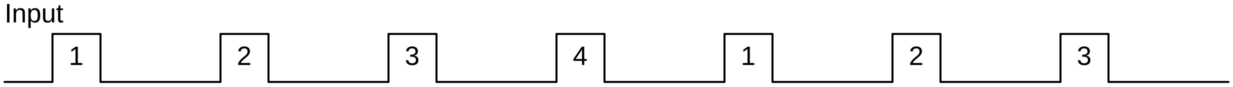
The 2 OUTPUT switches provide control over outputs.

The middle switch selects normal polarity or inverted, S=skip first step.

The right switch selects the gate width:
Gate = Output same as input.
Binary = 50% duty cycle.
Trig = 5ms trigger pulse.

/1.33 (4:3)

Input



Output, /1.33, Gate, Non-inverted

Division - continued

Different types of division use different methods and formulas to produce the most robust outputs that can tolerate the widest possible range of varying income pulse speeds and widths.

Divide-by-0
This just forces the output off. It can come in handy when you want to turn an output off in a different configuration.

Divide-by-1
Divide-by-1 uses a special routine that exactly follows the gate input on the rising edge, but gives you control of the gate width output. Gate mode measures the previous cycle's width and sets the output width to that. Binary mode measures the previous cycle's period and sets the output to 50% of that. Trigger mode sets the width of the output to a fixed 5ms (or whatever the global trigger width is set to).

Even Divisors
Division with even divisors such as 2, 4, 8, etc, rely on the rising edges of incoming gates to determine the placement output gates. This makes dividing with even divisors very robust and tolerant of varying period and width measurements. Gate mode uses the previous cycle's width and Binary uses the previous cycle's period to determine output gate width.

Odd Divisors
Division with odd divisors relies on rising edges like even divisors, but in Binary gate mode a calculation must be made to cause the falling edge to land between two pulses. This calculation relies on the previous period measurement. If the period between incoming clocks is varying much, this calculation will be off.

Ratio Dividing
Ratios such as 4:3 (divide by 1.33) and 3:2 (divide by 1.5) use a special formula to predict and calculate where the pulses should be since it can't rely on rising and falling edges of the incoming gate. When the first gate comes in, a calculation is made using the previous cycle's period and width measurements. With these measurements, all of the output pulse placement and widths are calculated. When that is finished, the routine waits for the next input gate to begin again. With ratio dividing, when the incoming gates vary in speed or width, the output will lag or be off since it uses the cycle before the first one to create output gates. With moderate speed changes, this is not an issue. With fast speed changes it might result in musically useful chaotic behavior.

All types of dividing relies on the measurement of the previous cycle to determine Gate and Binary pulse widths.

Random Gates

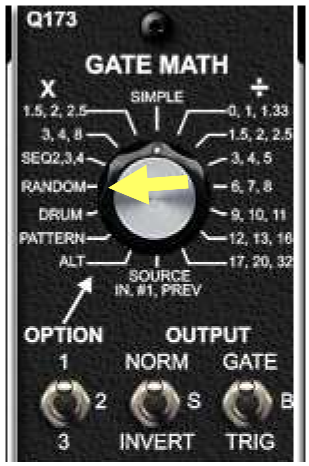
In addition to dividing and multiplying, the Q173 can produce random gate outputs. These random gates can be confined to a single output, or grouped together with up to 4 outputs to create exclusive random gate patterns where only one of the outputs is on at a time.

Individual Random Outputs

Individual random gates operate independently, and if more than one output is set to this option they may fire together.

For individual random gate outputs, turn the knob to RANDOM, and the OPTION toggle switch to select one of these 3 options.

1 = 1-in-2 or 50% chance
2 = 1-in-3 or 33% chance
3 = 1-in-4 or 25% chance



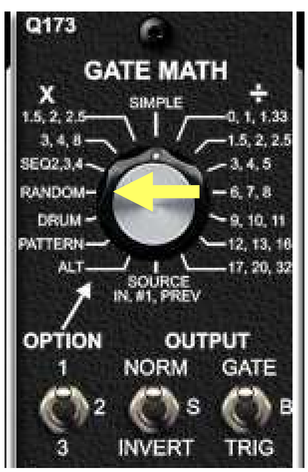
Then press the SET button for whichever output you want to program. If several outputs are set to random, some may fire at the same time, or none may fire at all for each gate input.

Exclusive Random Outputs

Exclusive random gates are when multiple outputs are set to random and one random gate will fire at a time.

For exclusive random gate outputs, turn the knob to RANDOM, and the toggle switch to select one of these 3 options.

1 = Random 1 out of 2
2 = Random 1 out of 3
3 = Random 1 out of 4



Then press and hold the SET button for 2 seconds for each of the outputs you want to program. If you set more than one output, then one and only one of the outputs programmed will fire at a time.

Sequences

The SEQ option turns the 4 outputs into a multi-stage gate sequencer. The OPTION toggle switch selects 3 different sequence counts.

For Sequences, when the BINARY gate type is set, the outputs stay ON the entire time of each step.

Sequence patterns

1 = 2 step sequence
2 = 3 step sequence
3 = 4 step sequence

Set Gate output options as desired.

Internal clock speed if there is no plug inserted into the IN jack below.

Internal clock speed if there is no plug inserted into the IN jack below.

Patch your gate or clock signal into the IN jack. If there is no plug inserted, an internal clock is generated with the CONFIGURATION knob and CV jack, and the configuration used is 0.

Reset the sequence.

Gate outputs.

Press SET for each output that you want to be part of the sequence. Other outputs can have other options such as dividing or random.

With 2-step sequences, outputs 3 and 4 provide alternative useful patterns.

With 3-step sequences, output 4 provides an alternative pattern.

Q173 Gate Math

Aug 2016

Sequence Patterns

Sequence patterns can be used for more than sequential triggering, they can be used to provide resets which stop other patterns short to create new patterns, used along with drum patterns for accents, or driven by random gates for bizarre patterns.

Option switch #1

Channel	01	02	03	04
1	X	_	X	_
2	_	X	_	X
3	X	X	_	_
4	_	_	X	X

This is a 2-step sequence, but if channels 3 and 4 are set, they provide double beats.

Option switch #2

Channel	01	02	03
1	X	_	_
2	_	X	_
3	_	_	X
4	X	X	_

This is a 3-step sequence. If channel 4 is set, it provides 2 beats per cycle.

Option switch #3

Channel	01	02	03	04
1	X	_	_	_
2	_	X	_	_
3	_	_	X	_
4	_	_	_	X

This is a 4-step sequence. Remember you don't have to program all channels, any channel can be set to any option.

Q173 Gate Math

Aug 2016

Drum Patterns

The DRUM option provides common patterns useful for triggering drum sounds beyond those that can be created with simple divisions of /2, /4, etc. The DRUM option provides 3 options using the OPTION toggle switch, and each channel has it's own unique patterns. This results in a total of 12 possibilities. Additionally, these patterns can be sourced from either the main Input, channel 1 output or the previous output which provides many additional pattern possibilities.

You can use any output to trigger any drum sound, but the patterns are designed with the following usage in mind:

Output #1 - Hat
Output #2 - Snare
Output #3 - Bass
Output #4 - Tom/alt

Pattern Options 3 different options for each of the 4 outputs.

CV control of pattern configurations

Patch your gate or clock signal into the IN jack. If there is no plug inserted, an internal clock is generated with the configuration knob and CV jack, and the configuration used is 0.

Press SET for each output you want to program. Each output has its own 3 possible unique patterns.

You can switch between drum patterns by switching between 6 programmed configurations using either the knob or voltage-control via CV in. Changing configurations resets the patterns to their first step.

Without a gate input, the Q173 provides a built-in LFO clock to create a stand-alone drum pattern generator.

Output options add more pattern possibilities.

Thru provides another output of beats that match the input. Good for 16th high hats.

Reset the pattern here.

Gate outputs

High Hat

Snare

Bass

Toms or other

Synthesizers.com

Q173 Gate Math

Aug 2016

Drum Patterns

The Thru output can be used for 16th high hat notes. /2 can be used for 1/8 or alternate notes and inverting /2 provides up-beat alternating notes. A lot of drum patterns can be created with simple division, so these drum patterns are irregular.

Option switch #1

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	X	_	X	_	X	_	X	X	X	_	X	_	X	_
2	_	_	_	_	X	_	_	_	_	_	_	_	X	_	_	_
3	X	_	_	_	_	_	_	_	X	_	X	_	_	_	_	_
4	_	_	_	_	_	_	X	_	_	X	_	_	_	_	_	_

Option switch #2

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	X	X	X	_	_	X	_	X	_	X	_	X	_	X	_
2	_	_	_	_	X	_	_	_	_	_	X	_	_	_	X	_
3	X	_	_	_	_	_	X	_	_	_	X	_	_	_	_	_
4	_	_	_	_	_	X	_	X	_	_	_	_	_	_	X	_

Option switch #3

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	X	X	X	_	X	_	X	_	X	_	X	_	X	_
2	_	_	_	_	X	_	X	_	_	_	_	_	X	_	_	_
3	X	_	_	_	_	X	_	_	X	_	_	_	_	_	X	_
4	_	_	X	_	_	_	X	_	_	_	_	_	_	_	_	_

Drum Pattern Template

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1																
2																
3																
4																

Patterns

The PATTERN option provides 12 special musically-useful patterns not possible with standard division or multiplication settings. Turn the option knob to PATTERN, then move the OPTION switch to 1, 2 or 3. Now, each of the 4 outputs can be programmed with one of its 3 unique patterns using the SET buttons. Since each of the 4 outputs has 3 possible unique patterns, the total number of possible patterns is 12.

Patterns

Pattern Options
3 options for each
of the 4 outputs.

Patch your gate or clock signal into the IN jack. If there is no plug inserted, an internal clock is generated with the CONFIGURATION knob and CV jack, and the configuration used is 0.

Press SET for each output you want to program. Each output has its own 3 possible unique patterns.

Reset Behavior
Unlike divisions, a reset causes patterns to move to their first step.

Reset the pattern to the beginning.

Gate outputs

Patterns

Remember that the "S" option and INVERT options along with Gate options can be added to these patterns to create even more patterns.

Option switch #1

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	_	_	X											
2	X	X	_	_	_											
3	X	_	X	_	_	_	X	X	_	_						
4	_	X	_	X	_	_	_	_	_	X						

Option switch #2

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	_	_	_	X										
2	X	X	_	_	_	_										
3	X	_	_	_	X	_	X	_								
4	_	X	_	X	X	_	X	_								

Option switch #3

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	_	_	_	_	X									
2	X	_	X	_	_	_	_	_	_							
3	X	_	X	_	_	_	_	X	_							
4	_	X	X	_	_	_	X	X								

Alternate Patterns

The ALT option provides 12 special musically-useful patterns not possible with standard division or multiplication settings. Turn the option knob to ALT, then move the option switch to 1, 2 or 3. Now, each of the 4 outputs can be programmed with one of its 3 unique patterns using the SET buttons. Since each of the 4 outputs has 3 possible unique patterns, the total number of possible Alt patterns is 12.

Alternate patterns

Reset Behavior
Unlike divisions, a reset causes patterns to move to their first step.

Pattern Options
3 options for each of the 4 outputs.

Patch your gate or clock signal into the IN jack. If there is no plug inserted, an internal clock is generated with the CONFIGURATION knob and CV jack, and the configuration used is 0.

Reset the pattern to the beginning.

Press SET for each output you want to program. Each output has its own 3 possible unique patterns.

Gate outputs

Q173 Gate Math

Aug 2016

Alternate Patterns

These patterns include Hockets to create bouncing gates, counts which can be used for reset, and some patterns with gates grouped together called batches. Remember that the "S" option and INVERT options along with gate options can be added to these patterns to create even more patterns. The 4th channel contains counters that can sync sequencers to 8, 12 and 16-step drum patterns or any other pattern.

Option switch #1

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	
1	X	_	X	_	X												Hocket 5
2	X	_	X	_	X	_	X	_	X	_	X						Hocket 11
3	X	X															Burst of 2 on reset, never repeated
4	_	_	_	_	_	_	_	X									Count 8

Option switch #2

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	
1	X	_	X	_	X	_	X										Hocket 7
2	X	_	X	_	X	_	X	_	X	_	X	_	X				Hocket 13
3	X	X	X														Burst of 3 on reset, never repeated
4	_	_	_	_	_	_	_	_	_	_	_	X					Count 12

Option switch #3

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	
1	X	_	X	_	X	_	X	_	X								Hocket 9
2	X	_	X	_	X	_	X	_	X	_	X	_	X	_	X		Hocket 15
3	X	X	X	X													Burst of 4 on reset, never repeated
4	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	X	Count 16

Q173 Gate Math Programming Sheet

Aug 2016

Circle Options

Configuration: 0

Channel	Math Function	Source	Output Type	
1	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
2	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
3	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
4	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger

Configuration: 1

Channel	Math Function	Source	Output Type	
1	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
2	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
3	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
4	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger

Configuration: 2

Channel	Math Function	Source	Output Type	
1	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
2	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
3	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
4	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger

Configuration: 3

Channel	Math Function	Source	Output Type	
1	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
2	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
3	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
4	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger

Configuration: 4

Channel	Math Function	Source	Output Type	
1	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
2	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
3	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
4	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger

Configuration: 5

Channel	Math Function	Source	Output Type	
1	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
2	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
3	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger
4	______________	In #1 Prev	Norm Skip Invert	Gate Binary Trigger

Default Configurations

Options and configurations you program into the Q173 are saved and will be there the next time you turn power On. The Q173 begins with factory defaults that provide common, musically-useful settings for each channel and configuration. You can reset the Q173 to the factory defaults by holding the channel #1 SET button while powering up.

Factory Defaults

All channels are set to Normal Gate output and the Source set to the Gate Input.

Configuration 0 - A 4-step sequence using all 4 channels
- Channel 1 - Step 1
- Channel 2 - Step 2
- Channel 3 - Step 3
- Channel 4 - Step 4

When the Q173 powers-on using these defaults, and set to configuration 0, Channel #1 output will be ON because that's the first step of a sequence.

Configuration 1 - One of the 4 channels fire randomly for each gate input.
- Channel 1 - Random 4:1 chance, exclusive
- Channel 2 - Random 4:1 chance, exclusive
- Channel 3 - Random 4:1 chance, exclusive
- Channel 4 - Random 4:1 chance, exclusive

SIMPLE mode is available at any time providing easy access to standard /2, /4, /8 and /16 divisions along with /1 at the Thru output.

Configuration 2 - Common 4/4 drum pattern.
- Channel 1 - High Hat (/2)
- Channel 2 - Snare 3, 7 out of 8 steps
- Channel 3 - Bass Drum 1, 5, 6 out of 8 steps
- Channel 4 - Tom 7 and 10 out of 16 steps
- The Thru output can be used as 1/16 note high hat beats

Configuration 3 - A 3-step sequence and a Random channel.
- Channel 1 - Step 1
- Channel 2 - Step 2
- Channel 3 - Step 3
- Channel 4 - Random 1:4 chance

Reset to the factory defaults by holding the channel #1 SET button during power up.

Configuration 4 - Various patterns.
- Channel 1 - /2
- Channel 2 - 11-step Hocket x_x_x_x_x
- Channel 3 - Random 1:4 chance
- Channel 4 - /17

Configuration 5 - All 4 channels are off.
- Channel 1 - Off
- Channel 2 - Off
- Channel 3 - Off
- Channel 4 - Off

Q173 Gate Math

Aug 2016

Finding Patterns

Here are 2, 3, 4 step patterns and how to implement them.
'X' is where a beat is, '_' is no beat.
'/' = divide by. 's' = Skip first beat using the middle toggle switch.
There are multiple ways to achieve some patterns.
'A' means hold for 2 seconds. 'B' means hold for 4 seconds.

2 Step Patterns

1	2	
_	_	/0
_	X	/2s
X	_	/2
X	X	/1

3 Step Patterns

1	2	3	
_	_	_	/0
_	_	X	Seq 3, Ch 3
_	X	_	Seq 3, Ch 2
_	X	X	Seq 3, Ch 4s
X	_	_	/3
X	_	X	Pat 1
X	X	_	Seq 3, Ch 4
X	X	X	/1

4 Step Patterns

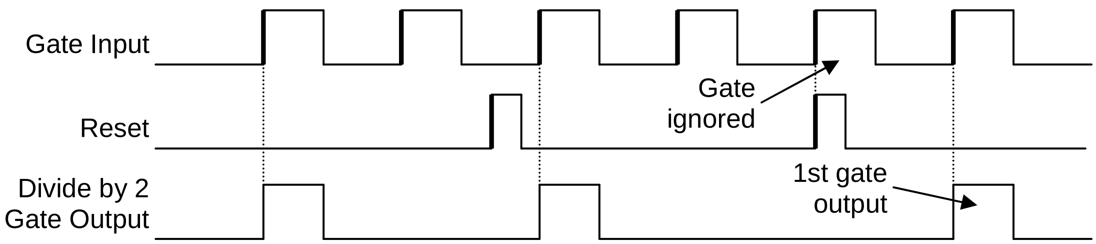
1	2	3	4	
_	_	_	_	/0
_	_	_	X	Seq 4, Ch 4
_	_	X	_	Seq 4, Ch 3
_	_	X	X	Seq 2, Ch 4
_	X	_	_	Seq 4, Ch 2
_	X	_	X	/2s
_	X	X	_	Seq 2, Ch 3s
_	X	X	X	Pat 2s
X	_	_	_	/4
X	_	_	X	Seq 2, Ch 4s
X	_	X	_	/2
X	_	X	X	Pat 1A
X	X	_	_	Seq 2, Ch 3
X	X	_	X	Pat 2A
X	X	X	_	Pat 2
X	X	X	X	/1

Reset Behavior

Here are the events that cause reset:
- A rising edge on the RESET input.
- Pressing then releasing one of the SET buttons.
- A configuration change, either via the knob or control voltage.
- Going into or out of SIMPLE mode using the option knob.

When reset happens, all outputs are turned Off (or On if the programmed polarity is INVERT) for 5ms. This provides enough time to reset envelope generators and other modules using the Q173 outputs.

At the end of the 5ms reset holding time, the next gate input rising edge will become the first gate to activate the math processors. So, if a gate input occurs at the exact same time as a reset, or within the 5ms reset holding time, it will be ignored, and counting begins on the next gate input signal.



In these examples: Output type is set to GATE so it's the same width as the incoming gate.

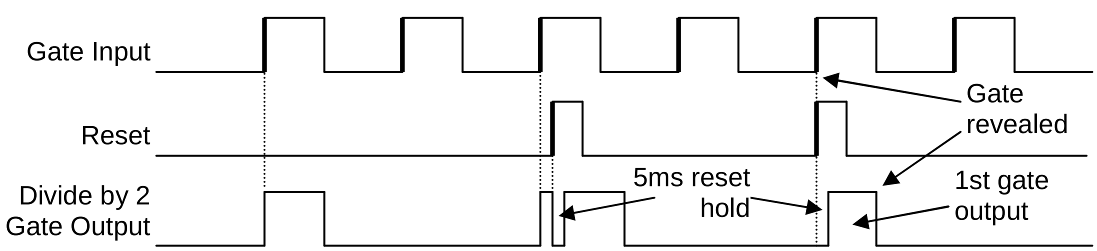
Optional Reset Reveal Behavior

An option is available if you prefer the gate input to be acknowledged when the gate input is high at the end of the reset holding time.

An example of this in operation is a Q960 Sequencer with the oscillator output patched into the Q173's gate input, and a TRIGGER output patched into the Q173's RESET input. In this case, gate and reset will occur at the same time and normally this gate would be hidden by the reset signal and ignored.

With the optional Reset Reveal behavior, when the 5ms reset hold time is finished and the gate input is still high, a new gate will be created to advance the math processors, instead of waiting for the rising edge of the next gate input.

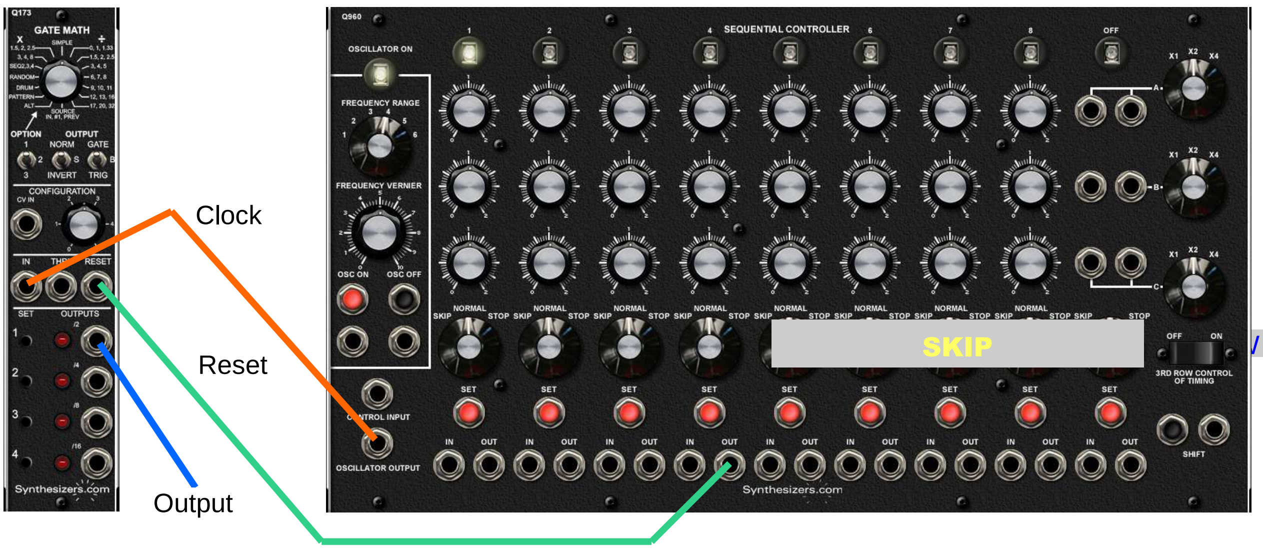
To activate the Reset Reveal behavior, set the option knob to SOURCE, the OPTION toggle switch to 2, then press and hold SET button #1 for 2 seconds. This behavior applies to all channels and is saved through power cycling. To return to the normal behavior, set the knob to SOURCE, the OPTION toggle switch to 1, then press and hold SET button #1 for 2 seconds.

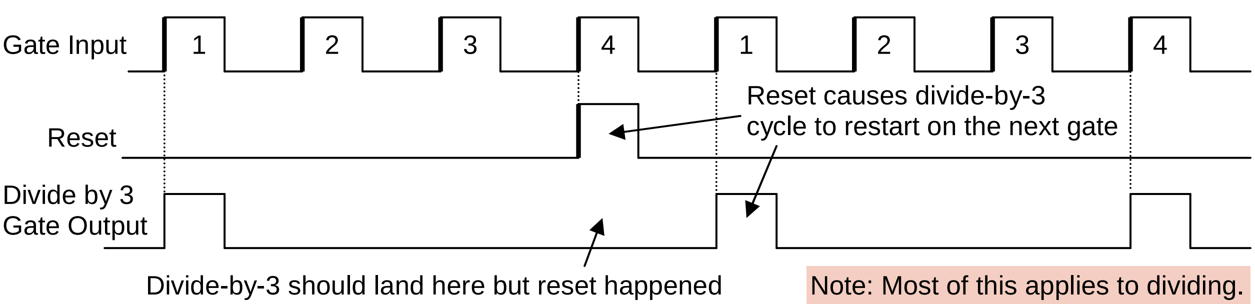


Reset Behavior Continued

Here is an example using the Q960 Sequencer. In this patch, the Q960's oscillator output drives the gate input on the Q173. The sequencer is set to 4 steps, and the 4th Trigger output is patched into the Q173's RESET input. The Q173 is set to divide-by-3.

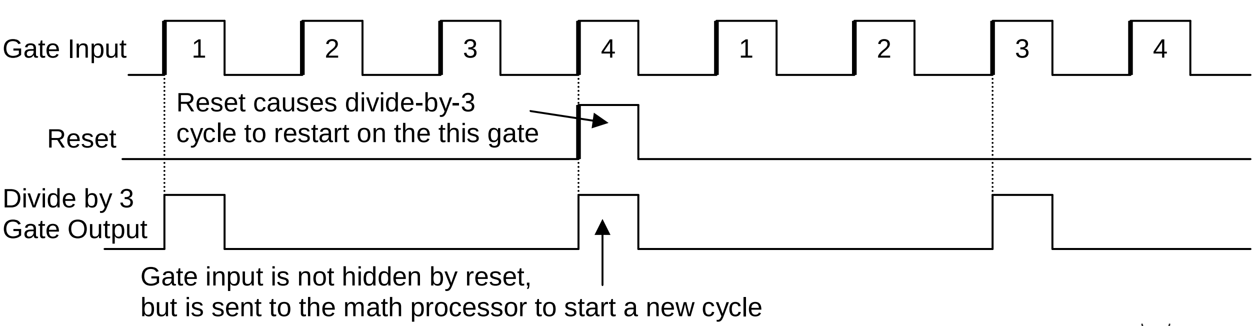
This is the normal reset behavior. The gate input and the reset input arrive at the same time. The reset hides the gate and the next gate starts the division counting.





Note: Most of this applies to dividing. Patterns return to their first position on reset without a gate.

And here is the response if the Reset Reveal option is set when gate and reset happen at the same time.



Q173 Gate Math

General Behavior

Dividing
When a reset occurs, a dividing channel will turn OFF. When the first gate input is received, the first step of divide math output is ON. The math processors will then count based on the selected divisor.

Reset
Reset drives every output OFF for 5ms.
For dividers, the output will stay OFF until the first gate is received then turn ON.
For patterns, the output will go to the first step which can be OFF or ON depending upon the pattern.
If the polarity is set to INVERT, all of these states will be opposite.

If a reset is received at the same time as a gate input, the gate will be hidden and dividers will remain OFF until the first gate appears, as will Randoms. Patterns will go to the first step upon reset.

This is the desired behavior for the most intuitive operation.

Even Integer Dividing
This form of division includes the standards like /2, /4, /8 and is the most robust because it relies solely on gate edges. When gates start and stop or change speed, the outputs remain locked to the edges.

Odd Integer Dividing
This form of division includes /3, /5, etc and while it relies on edges to do the counting, it must also calculate an output gate width when in Binary gate mode. The turn-off time with odd divisions adds 1/2 of the period to an incoming gate edge and the period of the previous incoming gate is used for this calculation. For example, in /7 in Binary gate mode, the output will turn on at the first incoming gate, count 3, then add 1/2 cycle to turn off to provide a 50% gate output duty cycle.

Ratio Dividing
This dividing takes the form of 4:3 which is /1.33 or 3:2 which is /1.5. With ratio dividing, the gate edges do not line up and this requires some calculations, assumptions and estimations. In the 4:3 example, there will be 4 incoming gates for 3 outgoing gates, and these outgoing gates can have various gate types including Binary, Trigger, inversion, etc. If the incoming gate period or width changes much in this process, strange patterns can result. This can be a good thing or a bad thing depending upon your needs.

Patterns
Patterns include Drum patterns, Alt patterns, Patterns and Sequences. With all of these patterns, each step is clocked in using the input gate's rising edge. In Gate mode, the output width is determined by the input width, and in Binary mode, the width is set to 50% of the previous period.

For all Patterns, reset returns the pattern to step #1 after a 5ms Off-time.

General Behavior - Continued

Stopped Gates
The Q173 performs calculations based on the period and width of the incoming gates. When a stream of incoming gates are turned off, the Q173 makes a decision about whether the speed of gates has changed, or they have been stopped. This is important because the period and width of the previous gate determines the width of Binary gate type outputs and the timing of Ratio dividing such as 4:3.

A Stop Factor value is built into the software to make this decision. The default Stop Factor is 10, meaning that if the current incoming gate period is 10 times that of the previous one then the gates were stopped, not simply slowed way down. This feature allows the Q173 to begin again when the gates restart using the correct period calculations.

Stop Factor default is 10. Stop Factor can be set by turning the knob to SOURCE, selecting an Option switch position of 1, 2 or 3, then pressing and holding SET button #2 for 2 seconds or 4 seconds.

Knob	Option Switch	Hold for	Stop Factor
SOURCE	1	2 sec	10 (Default)
SOURCE	2	2 sec	100
SOURCE	3	2 sec	OFF
SOURCE	1	4 sec	5
SOURCE	2	4 sec	25
SOURCE	3	4 sec	50

If you don't hold the SET button for 2 or 4 seconds, it will just set the channel source.

Parameter Saving
Option settings for each channel and configuration including math type, gate type and source are saved to non-volatile memory and restored the next time you power-on the Q173.

Global variables including the Reset Reveal setting, Stop Factor value, Trigger Width and Reset Hold time are also preserved.

The previous gate input period and width are also preserved in order to make a better prediction for the very first incoming gate after power-up.

All of these values are saved whenever one of the SET buttons is pressed then restored on the next power-up.

Global Parameters

Global parameters apply to all channels and configurations. These values are saved along with all options whenever a SET button is pressed, then restored on the next power-up.

Reset Reveal
The default is OFF which means incoming gates are hidden during the reset hold time.
The other option is ON which causes gates that occur during reset hold time to be processed.

Reset Reveal can be set by turning the knob to the SOURCE position, then the OPTION toggle switch to 1 for OFF and 2 for ON. Then press and hold channel #1's SET button for 2 seconds.
See the Reset page for detailed information.

Stop Factor
The default is 10, meaning if the incoming gates stop for more than 10x the previous period they will be considered stopped, not just lengthened, and math that is calculated when the incoming gates resume will use the previous period and width measurements instead of the current measurements.

Stop Factor can be set turning the knob to the SOURCE position, then the OPTION toggle switch to 1 for 10ms (default), or 2 for 100ms, or 3 for Off. Then press and hold channel #2's SET button for 2 seconds.
For 5ms, 25ms or 50ms, press the SET button for 4 seconds.
See the page discussing Stop Factor for more information.

Reset Hold Time
This is the Off-time that a reset causes. Refer to the pages describing Reset for more complete information. Reset Hold time can be set by turning the knob to the SOURCE position, then the OPTION toggle switch to 1 for 5ms (default), or 2 for 3ms, or 3 for 15ms. Then press and hold channel #3's SET button for 2 seconds.

Trigger Width
The default trigger width is 5ms. This is sufficient to retrigger most envelope generators and other modules having typical gate inputs.

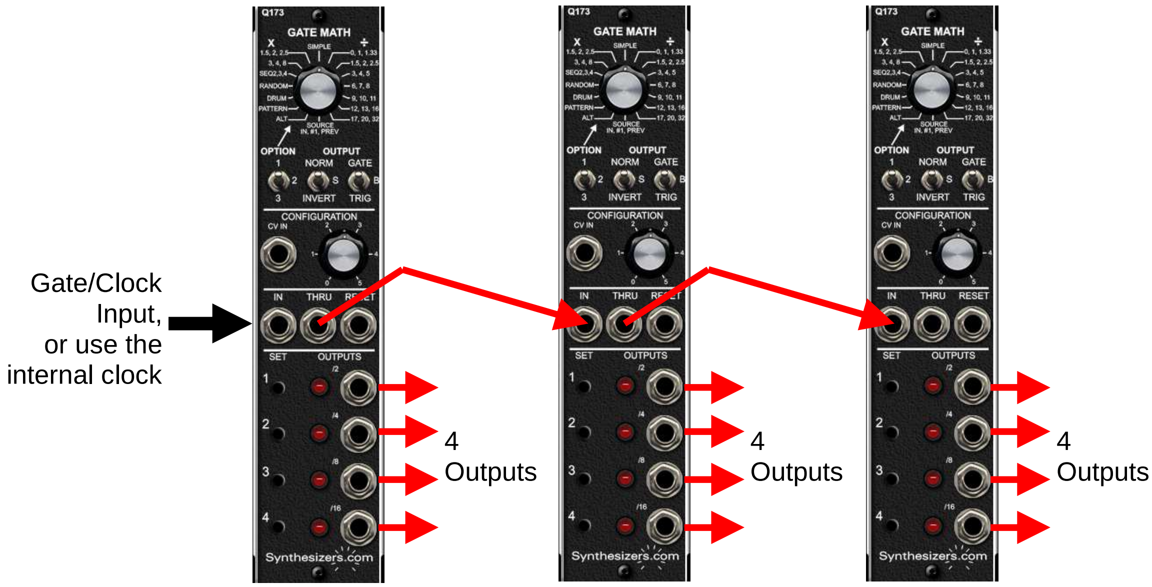
Trigger Width can be set by turning the knob to the SOURCE position, then the OPTION toggle switch to 1 for 5ms (default), or 2 for 10ms, or 3 for 25ms. Then press and hold channel #4's SET button for 2 seconds.

Factory Defaults
To set factory defaults for global parameters and all channel and configuration options, hold the SET #1 button during power-up.

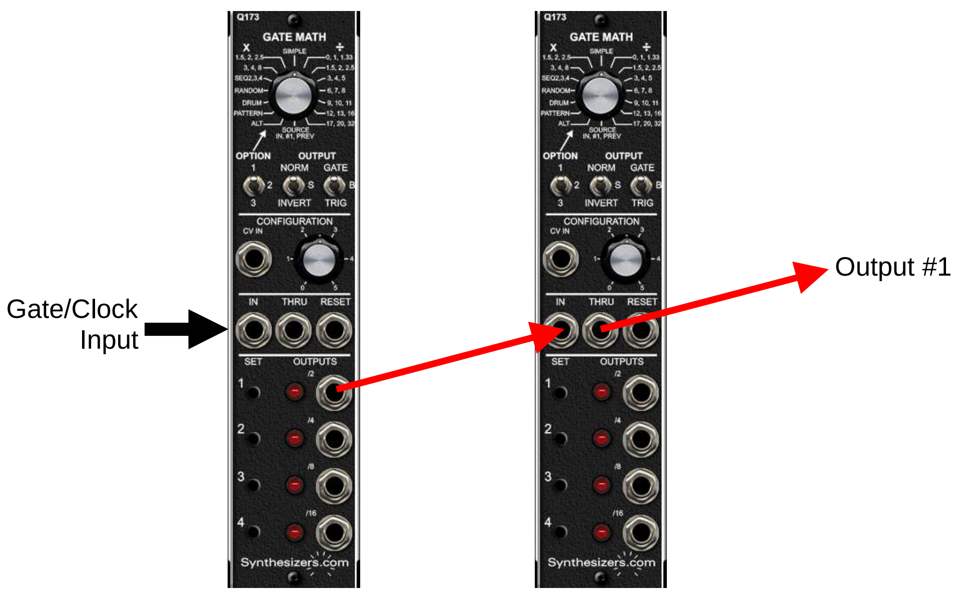
Daisy-Chaining Multiple Q173 Modules

The Q173 provides a THRU jack that makes daisy-chaining multiple Q173 modules easy.

This example provides 12 programmable outputs via three Q173 modules.

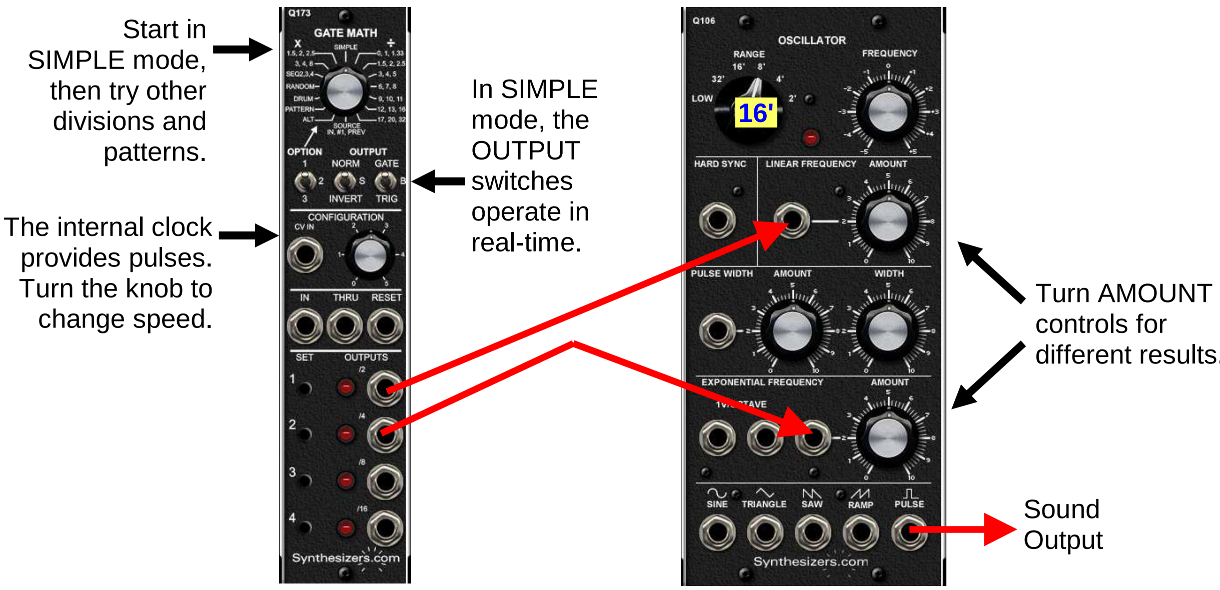


This example uses an output from one Q173 to drive the next Q173.

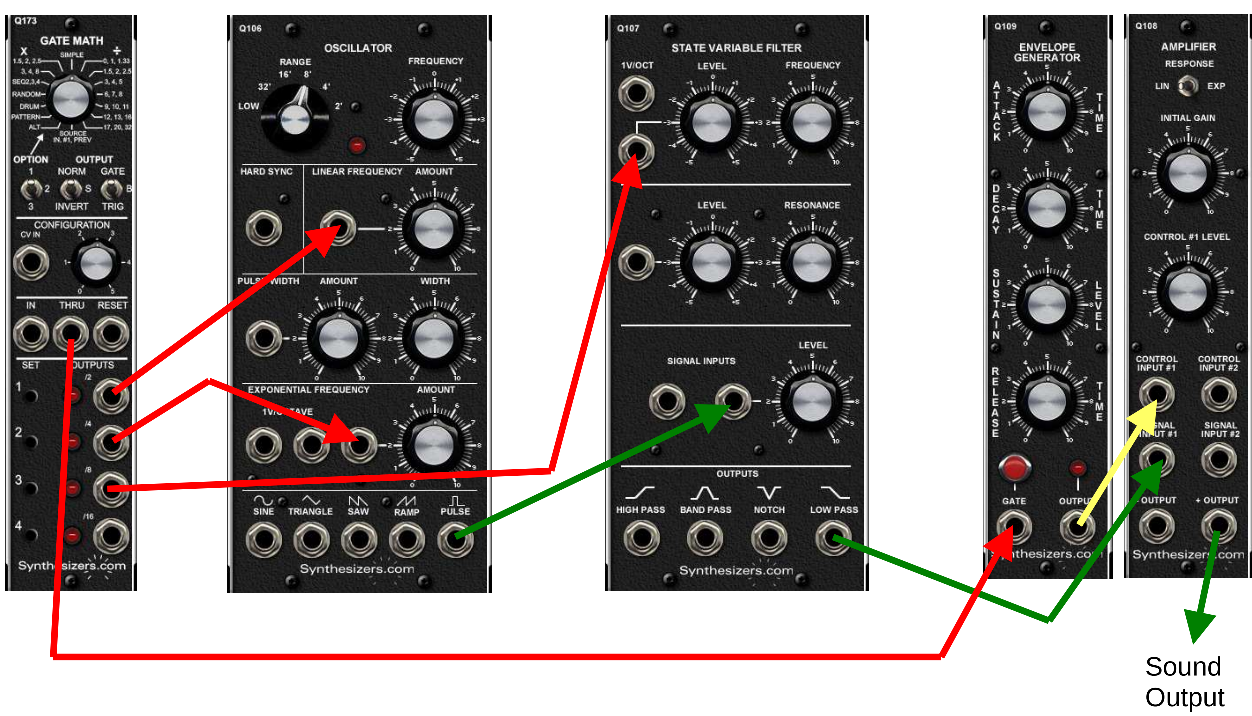


Q173 Patch Ideas

This patch uses just a Q106 oscillator to produce a bizarre array of sound sequences and effects using only the Q173 Gate Math module as a controller. In this simple example, 2 of the output channels produce 5v gates to transpose the oscillator by amounts controlled by the knobs. This creates a multi-step sequence. Try different divisions and patterns.



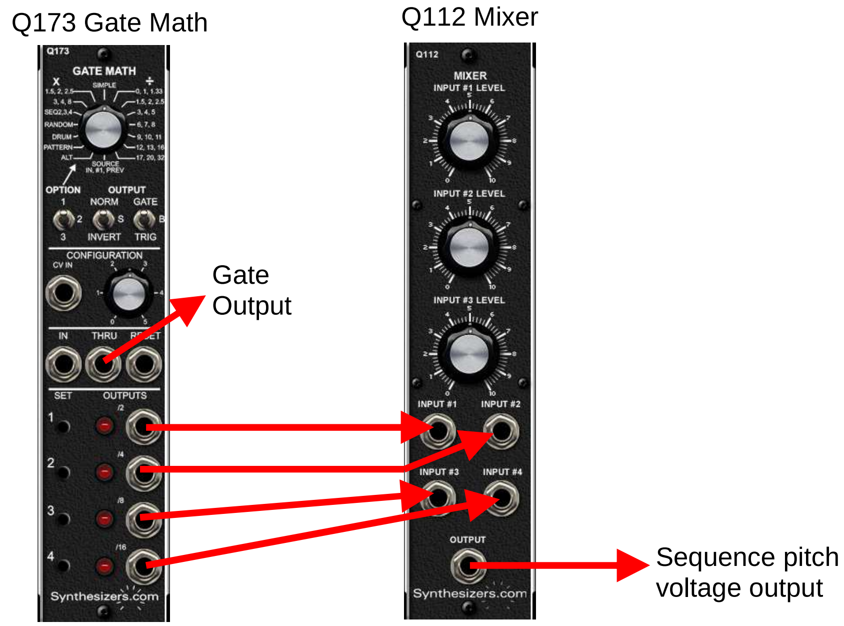
This example uses a Q106 Oscillator, a Q107 filter and a Q108 amplifier controlled by a Q109 envelope generator. These are very basic modules available in most systems. The Q173 provides control of the oscillator pitch, filter frequency, and firing the EG. Every pulse triggers the EG using the THRU output.



Q173 Patch Ideas - continued

This example turns a Q112 Mixer into a 4-step sequencer. The mixer knobs control the output value of each step. The 4th step is full-on. Turn the knob to SEQ and the Option switch to 3 for a 4-step sequence. Either use the Q173's internal clock or send pulses to the IN jack from another source.

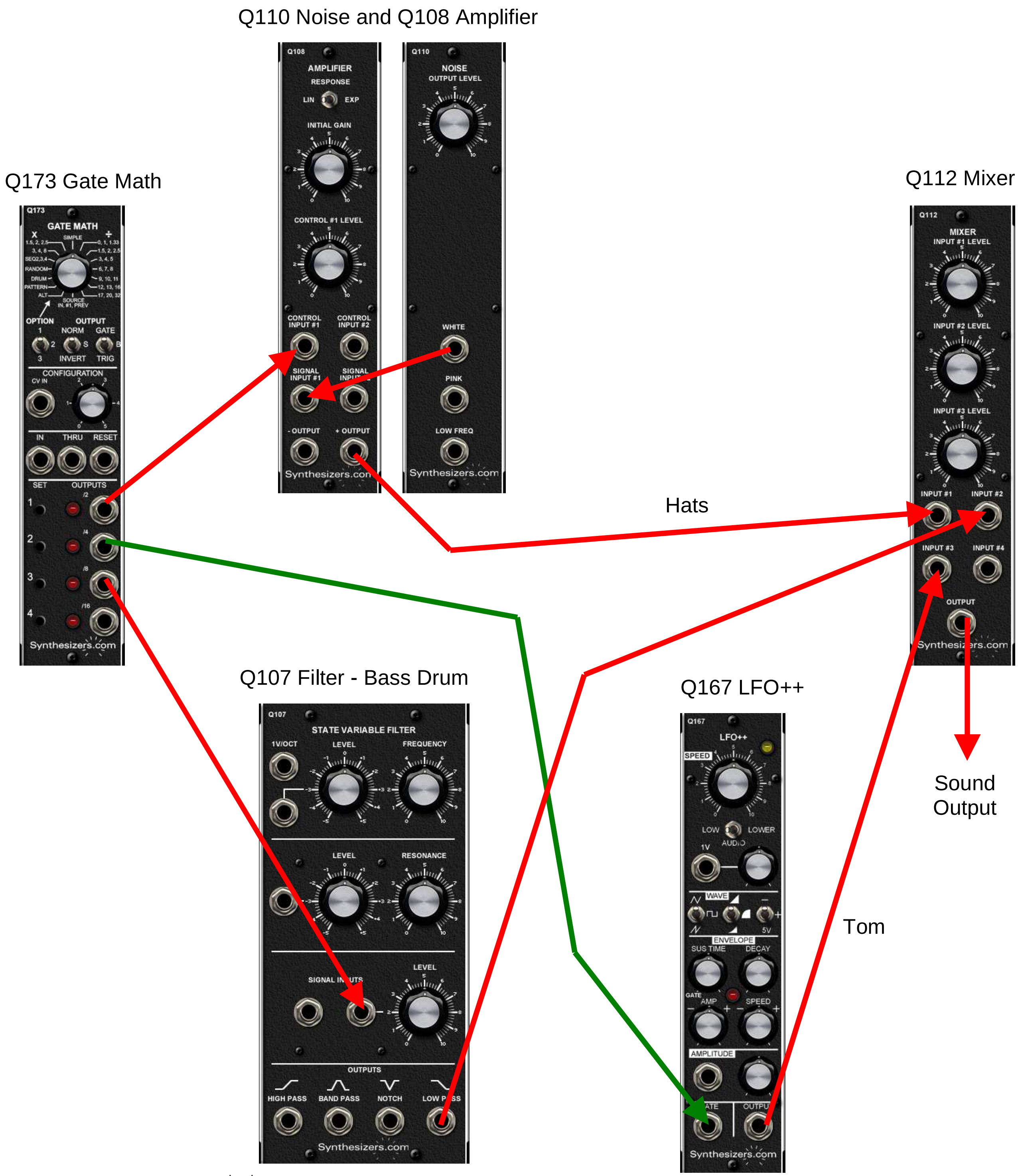
You're not limited to the SEQ pattern. Try other options for some very interesting results.



This example uses a Q173 to drive a batch of Q167 LFO++ Oscillators. The Q167 has a built-in envelope generator and VCA along with an audio oscillator so it makes a great filter-less analog synth voice. This could also be 2 or 4 Q167 modules, or Q106 Oscillators with EGs and VCAs.

Q173 Patch Ideas - continued

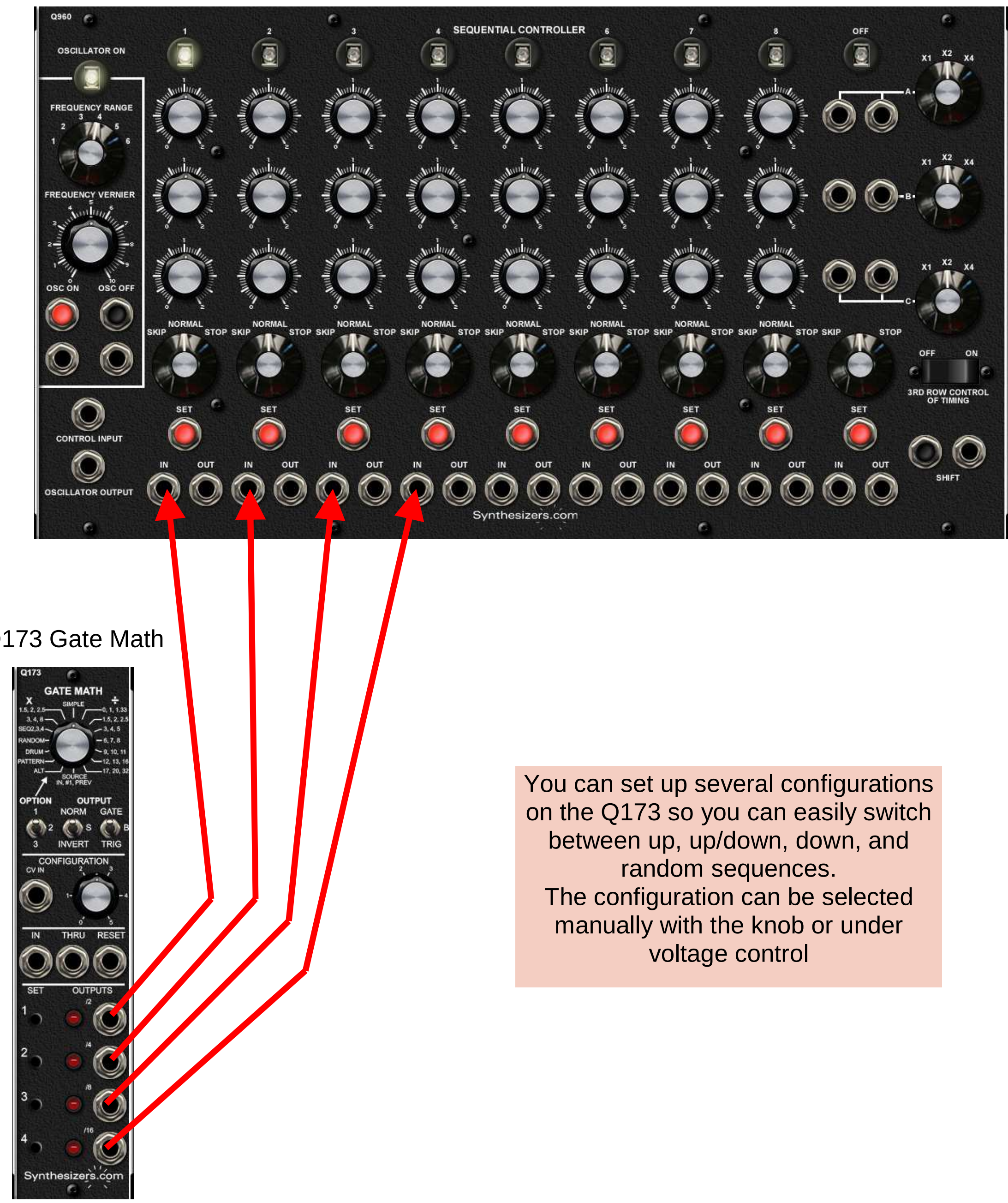
In this example, the Q173 is used as a drum machine. The voices are created with filters and oscillators and the Q110 Noise module. At the end, the Q112 mixer combines all of the sounds.



Q173 Patch Ideas - continued

In this example, the Q173 creates random gates to select random stages on a Q960 sequence through the trigger inputs. The Random Exclusive setting is used on the Q173 so there is only one random gate at a time.

Q960 Sequencer



Q173 Gate Math

You can set up several configurations on the Q173 so you can easily switch between up, up/down, down, and random sequences.
The configuration can be selected manually with the knob or under voltage control

Troubleshooting

The Q173 is complicated enough that when you think things are not working right, 99% of the time it is doing exactly what you've programmed it to do.

No Outputs
Remember that the configuration CV input and the configuration knob determines which set of options are active on the 4 channels. Configuration #5 is factory defaulted to OFF. Off is the /0 option.

Turn power OFF and check the module's power connector.

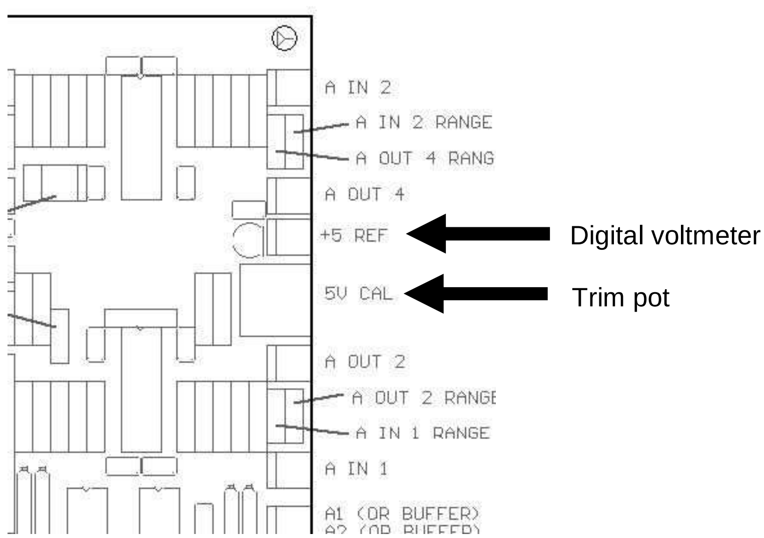
Stuttering
If your patterns are short bursts of stuttering outputs, check to see that a signal is resetting the cycle through the RESET input. A configuration change also resets the cycle.

Unexpected results
If the SOURCE for a channel is set to an unexpected setting, the output will be unexpected.

Perform a reset to factory defaults by pressing SET button #1 during power-up.

Calibration

Calibration includes setting the trim pot for exactly 5.00 volts. There are no other jumpers or settings.



Bonus Features

During development of the Q173 software, it became apparent I could add additional options and features without compromising usability. The result is a huge array of easy-to-access bonus divisions, multiplications with bursts of pulses, random bursts, sequence patterns including up and up/down, additional drum patterns and Alt patterns. This took some extra time to implement and document, but the effort was well worth the result.

-Roger Arrick

Q173 Gate Math

Aug 2016

Bonus Features

The Q173 front panel shows a rich set of features with 3 options for each knob position, but there are 3 layers of settings for most knob positions. The first layer is what you see on the front panel and accessed by simply pressing the SET buttons quickly. The second layer is accessed by pressing and holding the SET buttons for 2 seconds. The third layer is accessed by pressing and holding the SET buttons for 4 seconds.

Layer 2 Bonus Features
Hold SET button for 2 seconds

Division	/41
/15	/43
/18	/48
/19	/53
/21	/55
/24	/59
/27	/61
/29	/64
/31	/96
/34	/128
/37	/250

x2 burst in 50% period
x2 burst in 33% period
x2 burst in 25% period
x3 burst in 50% period
x4 burst in 50% period
x8 burst in 50% period

Up/Down Sequence - 2, 3 and 4 steps.

Random Exclusive (only 1 on at a time)
50%, 33%, 25% chance.

Irregular drum patterns for high hats (ch #1), snare (ch #2), kick (ch #3), toms (ch #4)

Alt provides various irregular patterns, and channel #4 provides counts of 4, 8, 16.

Layer 3 Bonus Features
Hold SET button for 4 seconds

Division	/1.8 (9:5)
/1.14 (8:7)	/2.33 (7:3)
/1.16 (7:6)	/2.66 (8:3)
/1.125 (9:8)	/2.25 (9:4)
1.2 (6:5)	/4.5 (9:2)
/1.25 (5:4)	/22
/1.28 (9:7)	/23
/1.4 (7:5)	/25
/1.6 (8:5)	/36
/1.66 (5:3)	/80
/1.75 (7:4)	/216

x3.5 (3:7)
x1.33 (3:4)
x1.25 (4:5)
x1.66 (3:5)
x1.75 (4:7)
x1.75 (5:7)

Down Sequence - 2, 3 and 4 steps.

Random bursts 1-4 pulses,
50%, 33%, 25% chance.

Irregular drum patterns for high hats (ch #1), snare (ch #2), kick (ch #3), toms (ch #4)

Alt provides various irregular patterns.

Q173 Gate Math

Aug 2016

Layer 2 Bonus Features

Print this page as a cheat sheet

Access layer 2 features by holding the SET buttons for 2 seconds.

x2 bursts 50%, 33%, 25%
50% bursts x3, x4, x8
Up/Down Seq 2, 3, 4 steps
Random exclusive 50%, 33%, 25%
Drum patterns
Patterns
Hocket 11, 13, 15

/15, /18, /19
/21, /24, /27
/29, /31, /34
/37, /41, /43
/48, /53, /55
/59, /61, /64
/96, /128, /250

Drum, Patterns and ALT offer a different pattern for each of the channels.

Layer 3 Bonus Features

Access layer 3 features by holding the SET buttons for 4 seconds.

x3.5, x1.33 (3:4), x4.5 (4:5)
x1.66 (3:5), x1.75(4:7), x 1.75
Seq Down 2, 3, 4 steps
Random bursts 1:2, 1:4, 1:16
Drum patterns
Patterns
Hocket 5-, 7-, 9-

/1.14 (8:7), /1.16 (7:6), /1.125 (9:8)
/1.2 (6:5), /1.25 (5:4), /1.28 (9:7)
/1.4 (7:5), /1.6 (8:5), /1.66 (5:3)
/1.75 (7:4), /1.8 (9:5), /2.33 (7:3)
/2.66 (8:3), /2.25 (9:4), /4.5 (9:2)
/22, /23, /25
/36, /80, /216

Hockets are simply alternating patterns with an odd number of steps so the final step and the first step is the same.
A '-' after the number indicates the 2nd to last bit is removed.

Q173 Gate Math

Aug 2016

Layer 2 Drum Patterns

Option switch #1

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	X	_	X	_	X	_	X	_	X	X				
2	_	_	_	_	X	_	_	_	_	_	_	_				
3	X	_	X	X	_	_	_	_	X	_	_	_				
4	_	_	X	_	_	_	_	_	_	_	X	_				

Option switch #2

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	X	X	X	X	_	X	_	X	_	X	_				
2	_	_	X	_	_	_	_	_	_	X	_	X				
3	X	_	_	_	_	_	_	_	_	_	X	_				
4	_	_	_	_	_	_	X	X	_	_	X	_				

Option switch #3

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	_	X	_	X	X	_	X	_	X	_	X	X				
2	_	_	_	_	X	_	_	_	X	X	X	X				
3	X	_	X	_	_	_	X	_	_	_	X	_				
4	_	_	_	_	_	_	X	_	_	X	_	_				

Layer 3 Drum Patterns

Option switch #1

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	X	X	_	_	_	X	X	X	X	X	_	_	_	_	_
2	_	_	_	_	X	_	_	X	_	_	_	_	X	_	_	_
3	_	X	X	_	_	X	_	_	X	_	X	_	_	_	X	_
4	_	X	X	X	_	_	X	X	_	_	_	_	_	_	_	_

Option switch #2

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	X	X	_	_	X	X	X	X	X	_	_	_	X	_
2	_	_	_	_	X	_	_	_	_	_	_	_	X	X	X	X
3	_	_	X	_	_	_	_	_	_	_	X	_	_	X	_	X
4	_	X	_	X	_	_	X	_	_	X	_	X	_	_	X	X

Option switch #3

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	X	_	_	X	_	X	_	X	X	_	_	X	_	X	_
2	_	_	_	_	X	_	_	_	_	_	X	_	X	_	X	_
3	X	X	X	X	_	_	_	X	_	X	_	_	_	_	_	_
4	_	_	_	_	_	_	_	_	X	X	X	X	_	X	_	_

Q173 Gate Math

Aug 2016

Layer 2 Patterns

Option switch #1

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	_	X	_											
2	X	X	_	_	X											
3	X	_	_	_	_	X	_	_	_	X						
4	_	_	X	_	_	_	_	X	_	_						

Option switch #2

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	_	_	X	_										
2	_	_	X	X	_	_										
3	X	_	_	_	_	_	X	X								
4	_	X	_	X	_	_	_	X								

Option switch #3

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	_	_	X	_	_	X	_									
2	_	_	_	X	_	X	X	_	X							
3	X	_	_	X	_	_	X	_	X							
4	_	X	X	_	X	X	_	_								

Q173 Gate Math

Aug 2016

Layer 3 Patterns

Option switch #1

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	X	_	X	X											
2	_	_	X	_	_											
3	X	_	X	X	X	X	X	X	_	X						
4	_	_	X	_	_	_	X	_	X	_						

Option switch #2

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	_	X	_	x										
2	_	_	_	_	X	_										
3	X	_	_	_	X	X	X	X								
4	_	_	X	X	_	_	X	_								

Option switch #3

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	_	X	_	_	X	_	_									
2	_	X	_	X	_	_	X	_	_							
3	X	_	_	_	_	_	X	_	_							
4	_	X	X	_	_	X	X	_								

Q173 Gate Math

Aug 2016

Layer 2 Alternate Patterns

Option switch #1

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	X	_	X	_	X	_	X	_	X					
2	X	_	X	_	X											
3	_	_	X	X	_	_										
4	_	_	_	_	_	X		Count 6								

Option switch #2

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	X	_	X	_	X	_	X	_	X	_	X			
2	X	_	X	_	X	_	X									
3	_	_	X	X	X	X	_	_								
4	_	_	_	_	_	_	X		Count 7							

Option switch #3

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	X	_	X	_	X	_	X	_	X	_	X	_	X	
2	X	_	X	_	X	_	X	_	X							
3	_	_	_	_	_	_	_	_	X	X	X	X	_	_	_	_
4	_	_	_	_	_	_	_	_	_	X		Count 10				

Layer 3 Alternate Patterns

Option switch #1

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	X	_	_		Hocket 5-									
2	X	_	X	X	X					Hocket 5+						
3	_	_	_	_	X	X										
4	_	_	_	_	X		Count 5									

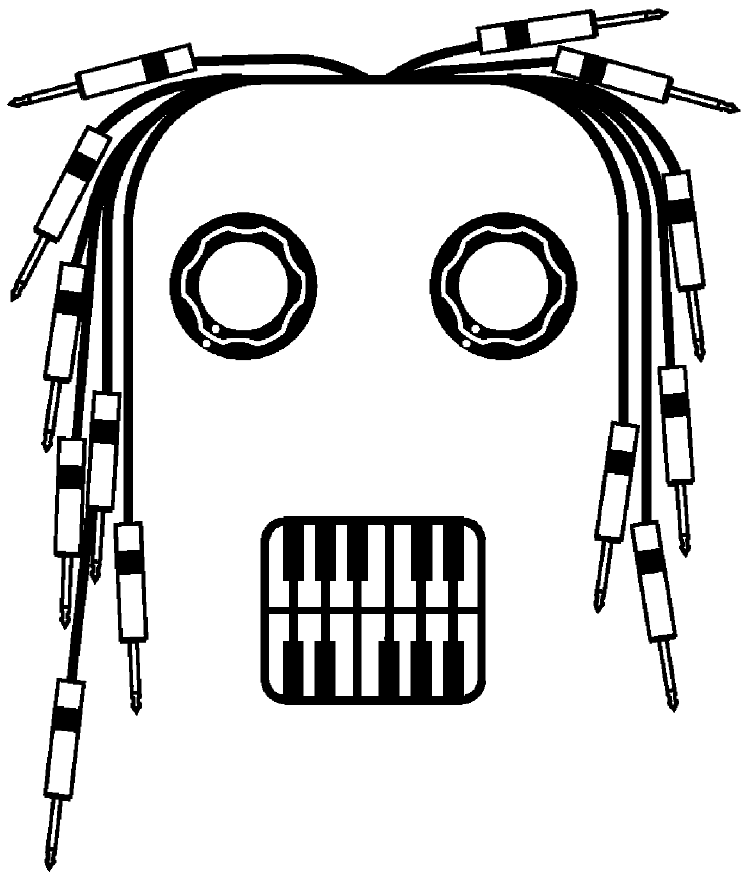
Option switch #2

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	X	_	X	_	_	Hocket 7-								
2	X	_	X	_	X	X	X			Hocket 7+						
3	_	_	_	_	_	_	X	X								
4	_	_	_	_	_	_	_	_	X		Count 9					

Option switch #3

Channel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
1	X	_	X	_	X	_	X	_	_	Hocket 9-						
2	X	_	X	_	X	_	X	X	X				Hocket 9+			
3	X	_	_	_	_	_	_	_	_	_	_	_	X	X	X	X
4	_	_	_	_	_	_	_	_	_	_	_	_	_	X	Count 14	

Patcher Jack



Synthesizers.com