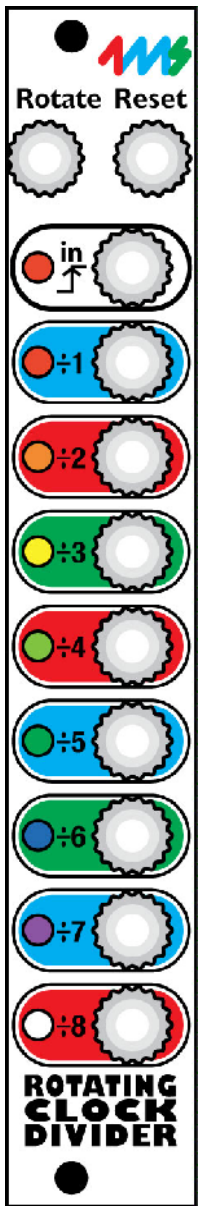


Rotating Clock Divider

Eurorack Module User Manual for firmware v1.1

4ms Pedals

Features

•Divide-by-1 to Divide-by-64, on 8 output jacks

•CV Rotate jack to shift divide-by amount on all jacks

•CV Reset to reset/re-sync all jacks

•Jumpers or optional break-out panel:
- ◦ Select auto-reset
- ◦ Select "Spread" mode
- ◦ Select maximum divide-by amount (8/16/32/64)
- ◦ Gate or Trigger outputs
- ◦ Count-up or Count-down mode

•UART header
- ◦ Reserved for expansion to future devices (MIDI, master clock controller...)
- ◦ Arduino-compatible

•ISP header
- ◦ Connects to in-circuit programmer such as AVR ISP MKII for reprogramming code

•Maximum input frequency 3kHz

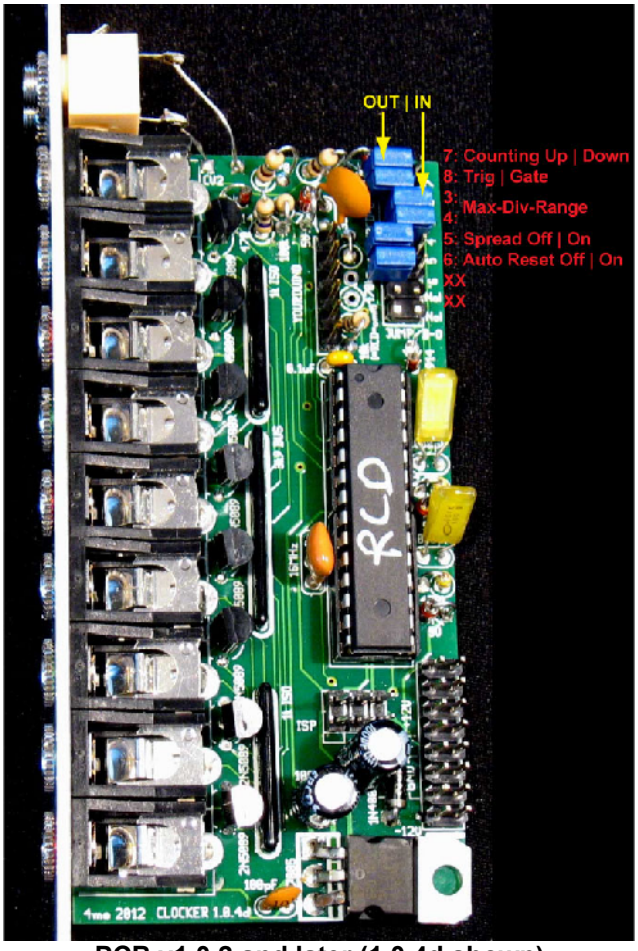
•4 H.P. Eurorack module

•60mA maximum power draw on +12V or +15V rail

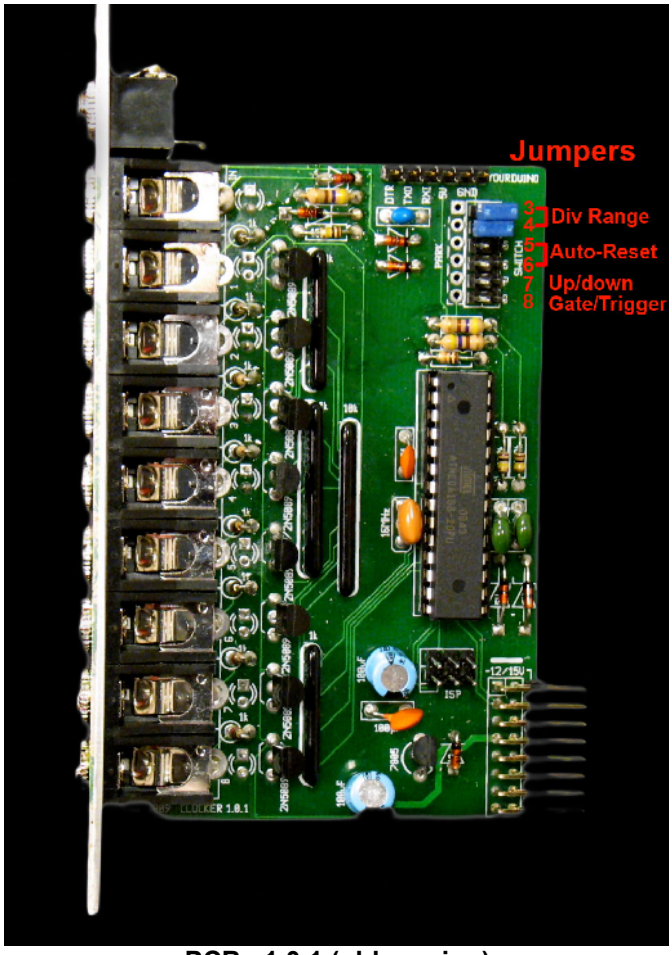
Jacks

- Clock Input (3.5V to 15V clock, rising edge triggered)
- CV Rotate (0V to +5V input)
- CV Reset (3.5V to 15V trigger)
- Divided Clock Outputs (8 jacks):
  - Divide-by (1+R)
  - Divide-by (2+R)
  - Divide-by (3+R)
  - Divide-by (4+R)
  - Divide-by (5+R)
  - Divide-by (6+R)
  - Divide-by (7+R)
  - Divide-by (8+R)

  ...where R is the CV Rotation (0 to 63)



PCB v1.0.2 and later (1.0.4d shown)



PCB v1.0.1 (old version)

Jumpers

There are six jumpers on the back, labeled 3, 4, 5, 6, 7, and 8. Each can be set with a jumper plug, or an optional break-out panel with switches. See the above photos to identify the location of jumpers on your PCB (the PCB version is written in white letters near the /8 Jack). Chances are your RCD is version 1.0.2 or later.

Jumpers 3, 4, and 5: Max Divide-by Range and Spread Mode

Div Range Jumpers		Total Rotatable Divide-by range	Default Divide-by amount on jacks with no voltage applied to CV Rotate jack (tables 2-5) (Applying CV to Rotate jack makes each output increase by 1)	
3	4		Spread off	Spread on
on	on	1 to 8	1, 2, 3, 4, 5, 6, 7, 8	1, 2, 3, 4, 6, 8, 12, 16
on	off	1 to 16	9, 10, 11, 12, 13, 14, 15, 16	2, 4, 6, 8, 10, 12, 14, 16
off	on	1 to 32	17, 18, 19, 20, 21, 22, 23, 24	4, 8, 12, 16, 20, 24, 28, 32
off	off	1 to 64	33, 34, 35, 36, 37, 38, 39, 40	8, 16, 24, 32, 40, 48, 56, 64

Jumper 6: Auto-Reset

Auto-Reset Jumper	Auto-reset with Divide-by range of...			
	1 to 8	1 to 16	1 to 32	1 to 64
on	16	32	64	128
off	none	none	none	none

Jumper 7: Up/Down-beat counting

Up/ Down	Mode
on	Down-beat counting
off	Up-beat counting

Jumper 8: Gate/Trigger mode

Gate/Trigger	Mode
on	Gate mode
off	Trigger mode

Up-beat/Down-beat counting:

In Up-beat counting, each jack fires after "N" number of pulses are counted on the input jack (where N is the divide-by-number). So, after a Reset pulse, only the /1 jack will fire on the first clock pulse. On the next clock pulse, the /1 and the /2 jack will fire, then on the next pulse the /1 and /3 jacks will fire, etc... This is the default method for pcb v1.0 and v1.0.1, unless it has been upgraded to v1.0.2 or later firmware.

In Down-counting, each jack fires when its count is 1. So all the jacks will fire after a Reset pulse, and then count up to "N", and fire again when they start over at 1. This is called "down-beat counting" because all the jacks fire on the down-beat (first clock pulse).

Gate/Trigger Mode:

In Trigger mode, the jacks output a pulse width equal to that of the input clock (the pulse width is not multiplied or divided proportionally to the jack's divide-by amount). This is the default method for pcb v1.0 and v1.0.1, unless it has been upgraded to v1.0.2 or later firmware.

In Gate mode, the width of the output pulses are 50% of the total wave. For example, the /6 jack will stay ON for 3 clock pulses, and then turn OFF for 3 clock pulses. For even numbered divisions (/2, /4, /6, /8, etc) the transitions happen on the input clock's rising edge.

Point of interest: In Gate mode, with odd-numbered divisions, the jack will turn ON on a rising edge of the input clock, and then will turn OFF on a falling edge. For example, the /5 jack ought to stay on for 2.5 clock pulses, meaning it should go OFF somewhere between the rising edge of clock pulses 2 and 3. Right in between these is the falling edge of pulse number 2, so we can safely call it 2.5!

When in Gate mode (jumper 8), the difference between Up-counting and down-counting is simply that the gates are inverted.

Spread mode:

Spread mode causes the output to "spread" evenly amongst the entire max division range. See the "Jumper 3, 4, and 5" table on the previous page. For instance, if Max-Div is set to 32, then in spread mode the jacks will output divisions evenly spaced from 1 to 32 (pus whatever rotation is applied). Since there are 8 jacks spread over 32 values, each jacks will always be offset by 4 divisions from its neighbors. ***See table 3b.*** For example:

> With no CV at the Rotate jack, the jacks will output:
> /4, /8, /12, /16, /20, /24, /28, /32
>
> Applying a small amount of CV to the Rotate jack will make each jack increment by 1:
> /5, /9, /13, /17, /21, /25, /29, /1
>
> Applying more CV Rotation will shift them further. Note how the difference between each jack is 4.
> /6, /10, /14, /18, /22, /26, /30, /2

A different thing happens when Max-Divide-by is set to 8. In this case, the jacks will only output standard "musical" divisions of triplets and sixteenth-notes:

> /1, /2, /3, /4, /6, /8, /12, /16
>
> Adding a little bit of CV Rotation will shift the outputs to
> /2, /3, /4, /6, /8, /12, /16, /1
>
> Adding more Rotation will shift them more.
> /3, /4, /6, /8, /12, /16, /1, /2

In all cases, the outputs will be limited to these "musical" divisions and no "weird" divisions such as /7 or /13 will ever appear. ***See table 2b.***

Auto Reset:

Jumper 6 selects the Auto-reset point, which causes the divide counters to reset after a certain number of clock pulses. Note that divide-by amounts which are evenly dividable by the reset amount are not affected: e.g. with an auto-reset of 16, divide-by outputs of 2, 4, 8, 16, etc are not changed.

Also, note that the CV Reset is independent of the Auto-reset. For example, Jack 7+R could be patched into the CV Reset with jumpers 3, 4, and 5 in. This would cause a reset every 7 clocks, plus an additional reset every 16 clocks.

There are too many combinations of Auto-reset and Max divide amounts to show all combinations!

Example: Auto-reset of 16 (Jumper 6 in), with Max Divide-by of 8 (Jumpers 3&4 in)

IN:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
3			X			X			X			X			X				X			X			X			X			X	
5					X					X					X						X					X					X	
7							X							X									X						X		

Operation

Apply a clock signal to the Clock Input jack. Rising edges of 5V or greater will cause the internal dividing counters to be incremented. Each jack has its own counter that counts from 1 to its divide-by-amount, and then resets back at 1. In up-beat counting, each jack outputs a trigger pulse when its counter reaches the divide-by amount assigned to that jack. In down-beat counting, each jack fires when its counter is 1. Typically, the outputs will patch to trigger-able or gate-able modules (drum modules, ADSR envelope/transient generators, step sequencer clock input, etc..), but the RCD can also operate in the audio frequency range, thus crudely stepping pitch downward.

Clock outputs (up-beat counting):

IN:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X
3			X			X			X			X			X			X			X			X			X			X		
4				X				X				X				X				X				X				X				X
5					X					X					X					X					X					X		
6						X						X						X						X						X		
7							X							X							X						X					
8								X								X								X								X
9									X									X									X					
10										X										X									X			
11											X											X										
...																																
32																																X

Clock outputs (down-beat counting):

IN:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	X		X		X		X		X		X		X		X		X		X		X		X		X		X		X		X	
3	X			X			X			X			X			X			X			X			X			X			X	
4	X				X				X				X				X				X				X				X			
5	X					X					X					X					X					X					X	
6	X						X						X						X						X						X	
7	X							X							X							X										
8	X								X								X								X							

CV Rotation

By applying a CV signal to the CV Rotate jack, the clock divisions will rotate throughout the output jacks (*see table 2*). For example, if you apply just over 1.0V, Jack 1+R/Red will go from Divide-by-1 to Divide-by-2, and Jack 2+R/Orange will become Divide-by-3... up to Jack 8+R/White which will wrap ("rotate") around to become Divide-by-1. Applying more CV to the Rotate Jack will continue the rotation: next Jack 1 becomes Divide-by-3, then Divide-by-4, then Divide-by-5, until it's Divide-by-8 at the maximum input CV. Some non-linearities exist in the CV response, especially in the upper extreme. ***See diagram at end of this manual.***

CV Reset

Applying a CV of 5V or greater to the CV Reset jack will cause all the divide counters to reset **on the next clock pulse**. So, applying a reset pulse will not change the tempo, since the RCD will wait for the next clock pulse to actually do anything. Counting will begin back at 1 after a Reset. A low/slow output on the RCD can be patched into Reset, or a second RCD running on the same master clock can be set to run very slow and reset the first RCD after an arbitrary number of beats.

Rotation Tables

Table 2a: Spread mode off, max divide-by amount set to 8

Jacks	Spread off: Voltage at CV Rotate Jack							
	<1.0V	1.00V - 1.65V	1.65V - 2.30V	2.30V - 2.95V	2.95V-3.60V	3.6V-4.30V	4.30V-5.10V	>5.1V
1+R	1	2	3	4	5	6	7	8
2+R	2	3	4	5	6	7	8	1
3+R	3	4	5	6	7	8	1	2
4+R	4	5	6	7	8	1	2	3
5+R	5	6	7	8	1	2	3	4
6+R	6	7	8	1	2	3	4	5
7+R	7	8	1	2	3	4	5	6
8+R	8	1	2	3	4	5	6	7

Table 2b: Spread mode on, max divide-by amount set to 8

Jacks	Spread on: Voltage at CV Rotate Jack							
	<1.0V	1.00V - 1.65V	1.65V - 2.30V	2.30V - 2.95V	2.95V-3.60V	3.6V-4.30V	4.30V-5.10V	>5.1V
1+R	1	2	3	4	6	8	12	16
2+R	2	3	4	6	8	12	16	1
3+R	3	4	6	8	12	16	1	2
4+R	4	6	8	12	16	1	2	3
5+R	6	8	12	16	1	2	3	4
6+R	8	12	16	1	2	3	4	6
7+R	12	16	1	2	3	4	6	8
8+R	16	1	2	3	4	6	8	12

Table 3a: Spread off, max divide-by amount set to 16

Jacks	Spread off: Voltage at CV Rotate Jack															
	< 0.7V	0.7V - 1.0V	1.0V - 1.3V	1.3V - 1.7V	1.7V - 2.0V	2.0V - 2.3V	2.3V - 2.7V	2.7V - 3.0V	3.0V - 3.3V	3.3V - 3.7V	3.7V - 4.0V	4.0V - 4.3V	4.3V - 4.7V	4.7V - 5.1V	5.1V - 5.8V	> 5.8V
1+R	9	10	11	12	13	14	15	16	1	2	3	4	5	6	7	8
2+R	10	11	12	13	14	15	16	1	2	3	4	5	6	7	8	9
3+R	11	12	13	14	15	16	1	2	3	4	5	6	7	8	9	10
4+R	12	13	14	15	16	1	2	3	4	5	6	7	8	9	10	11
5+R	13	14	15	16	1	2	3	4	5	6	7	8	9	10	11	12
6+R	14	15	16	1	2	3	4	5	6	7	8	9	10	11	12	13
7+R	15	16	1	2	3	4	5	6	7	8	9	10	11	12	13	14
8+R	16	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Table 3b: Spread on, max divide-by amount set to 16

Jacks	Spread on: Voltage at CV Rotate Jack															
	< 0.7V	0.7V - 1.0V	1.0V - 1.3V	1.3V - 1.7V	1.7V - 2.0V	2.0V - 2.3V	2.3V - 2.7V	2.7V - 3.0V	3.0V - 3.3V	3.3V - 3.7V	3.7V - 4.0V	4.0V - 4.3V	4.3V - 4.7V	4.7V - 5.1V	5.1V - 5.8V	> 5.8V
1+R	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	1
2+R	4	5	6	7	8	9	10	11	12	13	14	15	16	1	2	3
3+R	6	7	8	9	10	11	12	13	14	15	16	1	2	3	4	5
4+R	8	9	10	11	12	13	14	15	16	1	2	3	4	5	6	7
5+R	10	11	12	13	14	15	16	1	2	3	4	5	6	7	8	9
6+R	12	13	14	15	16	1	2	3	4	5	6	7	8	9	10	11
7+R	14	15	16	1	2	3	4	5	6	7	8	9	10	11	12	13
8+R	16	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Table 4: Spread off, Div-by amounts with max div-by amount set to 32 (Jumper 3 out, Jumper 4 in):

Jacks	Voltage at CV Rotate Jack															
	< 0.5V	0.68V	0.86V	1.04V	1.22V	1.38V	1.54V	1.70V	1.86V	2.02V	2.18V	2.36V	2.52V	2.68V	2.82V	3.00V
1+R	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
2+R	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	1
3+R	19	20	21	22	23	24	25	26	27	28	29	30	31	32	1	2
4+R	20	21	22	23	24	25	26	27	28	29	30	31	32	1	2	3
5+R	21	22	23	24	25	26	27	28	29	30	31	32	1	2	3	4
6+R	22	23	24	25	26	27	28	29	30	31	32	1	2	3	4	5
7+R	23	24	25	26	27	28	29	30	31	32	1	2	3	4	5	6
8+R	24	25	26	27	28	29	30	31	32	1	2	3	4	5	6	7

(con't)	3.18V	3.34V	3.50V	3.68V	3.82V	4.00V	4.18V	4.36V	4.54V	4.72V	4.94V	5.17V	5.43V	5.80V	6.52V	> 6.52V
1+R	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2+R	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
3+R	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	1
4+R	19	20	21	22	23	24	25	26	27	28	29	30	31	32	1	2
5+R	20	21	22	23	24	25	26	27	28	29	30	31	32	1	2	3
6+R	21	22	23	24	25	26	27	28	29	30	31	32	1	2	3	4
7+R	22	23	24	25	26	27	28	29	30	31	32	1	2	3	4	5
8+R	23	24	25	26	27	28	29	30	31	32	1	2	3	4	5	6

Table 5: Spread off, Div-by amounts at each jack, with max div-by amount set to 64 (no Jumper 3 or 4)

Jacks	Voltage at CV Rotate Jack															
	< 0.5V	0.68V	0.86V	1.04V	1.22V	1.38V	1.54V	1.70V	1.86V	2.02V	2.18V	2.36V	2.52V	2.68V	2.82V	3.00V
1+R	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
2+R	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
3+R	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
4+R	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
5+R	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
6+R	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
7+R	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
8+R	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55

(con't)	3.18V	3.34V	3.50V	3.68V	3.82V	4.00V	4.18V	4.36V	4.54V	4.72V	4.94V	5.17V	5.43V	5.80V	6.52V	> 6.52V
1+R	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
2+R	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	1
3+R	51	52	53	54	55	56	57	58	59	60	61	62	63	64	1	2
4+R	52	53	54	55	56	57	58	59	60	61	62	63	64	1	2	3
5+R	53	54	55	56	57	58	59	60	61	62	63	64	1	2	3	4
6+R	54	55	56	57	58	59	60	61	62	63	64	1	2	3	4	5
7+R	55	56	57	58	59	60	61	62	63	64	1	2	3	4	5	6
8+R	56	57	58	59	60	61	62	63	64	1	2	3	4	5	6	7

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