FREQUENCY CENTRAL

HIGH TOWERS
USER MANUAL

High Towers is a flexible module, based on the principles of clock division of an incoming clock signal. There are four assignable binary outputs, each of which can be assigned a clock division.

1. Table Of Contents

2. Getting Started

High Towers can be used to great effect without understanding the intricacies of it's operation.

It has two main modes of operation; 'Gates' and 'Cues', selected by a switch on the front panel.

When in the 'Gates' configuration, High Towers performs much like a regular clock divider that you may already be familiar with, just with added features. Patch the four 'out' sockets to whatever you want to receive clock divisions, feed a clock to the clock input, and then play with the 'division', 'preset', and 'mode' knobs. 'Gates' is great for everything you'd use a clock divider for; controlling sequencers at different rates, creating drum patterns, etc. See **5. Gates** for more information on this mode of operation.

When in the 'Cues' configuration, High Towers sends out short pulses 'on cue' at an interval. The cue for when the pulse occurs can be shifted with the 'mode' knob, and the intervals can be changed with the 'division' knobs. An example use of this mode would be triggering a snare on every 7th beat of a 16 beat measure. Patch the four 'out' sockets to whatever you want to trigger (eg drum sounds, samples, filter pings, etc), select some intervals with the 'division' knobs (or pick a set with 'preset'), and then select when events occur within the intervals with the 'mode' knob. See **6. Cues** for more information on this mode of operation.

When addressed via CV, all of High Tower's knobs become attenuators. The CV range is 0V to 5V.

3. Functionality Explanation
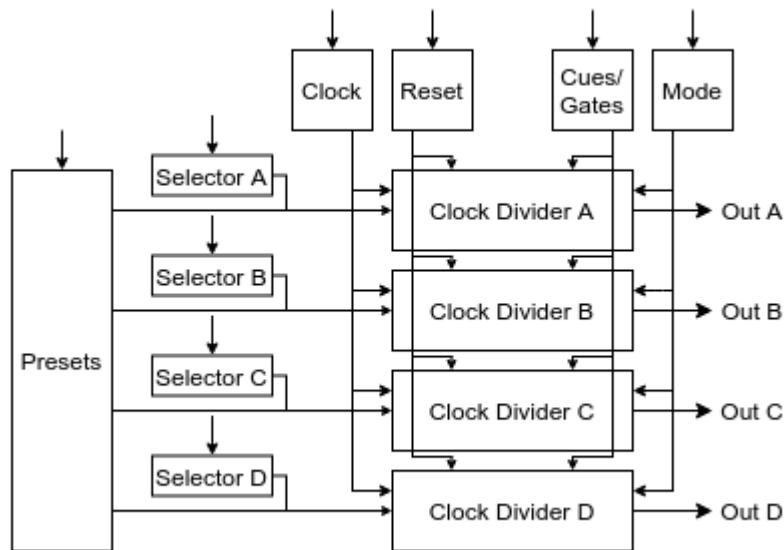
High Towers Block Diagram

High Towers has 4 clock dividers – labelled **A**, **B**, **C**, and **D**. They all receive clocks from the same source, but are not set to specific clock divisions. Instead, the divisions are selected using the division knobs and the presets knob – see the **4. Divisions & Presets** section.

In 'Gates' mode, the clock dividers can be set to count up, down, or to one of a variety of modes that oscillate between counting up and down – see the **5. Gates** section.

In 'Cues' mode, the clock dividers function very differently - see the **6. Cues** section.

4. Divisions & Presets

Both 'Gates' and 'Cues' configurations of High Towers operate on the principles of clock division. The division and preset knobs function the same for both configurations, so they are worth discussing seperately. Changing divisions on the fly is one of key features of High Towers, and both of these knobs allow the user to select the divisions applied to the channels, either all at once (preset parameter), or individually per channel (division parameter).

The divisions of the clock dividers are denoted **/1**, **/2**, **/4**, **/8**, **/16**, **/32**, **/64**, and **/128**. In Gates mode, /1 denotes a gate that toggles between low and high every clock pulse, whilst /128 denotes a gate that takes 128 clock pulses to toggle state. In Cues mode, /1 denotes a pulse that occurs on every clock cycle, whilst /128 denotes a pulse that has an interval of 128 clock cycles between pulses.

Both knobs have 8 positions. The division knobs, which affect just a single channel, start at /1 at the leftmost position (fully counter-clockwise), and go to /128 at the rightmost position (fully clockwise). They increase following the pattern /1, /2, /4, /8, /16, /32, /64, /128. The preset knob affects all four channels, but affects each channel differently, following the pattern listed in the **Division Presets** table below.

When the preset knob is changed, it always changes all four channels at once. However, an individual channel can still be changed with it's division knob without changing the rest of the preset. For example, if the first preset (A /1, B /2, C /4, D /8) is selected, we can still turn A's division knob to change just channel A. Divisions for B, C, and D will remain at /2, /4, and /8, respectively, until either their channel's division knob changes or the preset changes again. If the preset were to be changed (for example to the second preset) after having changed A's division knob, A will also change, in this example, changing to /16.

As a rule of thumb: The preset knob changes all divisions at once, regardless of their current setting, but an individual channel's division knob can take control back from the preset, at least until the preset changes again.

Division Presets

Preset Setting	A	B	C	D
	/1	/2	/4	/8
	/16	/32	/64	/128
	/1	/16	/4	/64
	/2	/32	/8	/128

Preset Setting	A	B	C	D
	/128	/8	/32	/2
	/64	/4	/16	/1
	/128	/64	/32	/16
	/8	/4	/2	/1

5. Gates

The Cues/Gates switch on High Towers completely changes the module functionality. In this section, we are discussing how High Towers performs when the switch is set to the 'Gates' setting.

When in the 'Gates' setting, High Towers performs much like a regular clock divider that you may already be familiar with.

High Towers has eight counting modes, which change how the clock dividers operate. It can be set to count up, down, or one of several pendulum-like combinations that we call 'Up / Down'.

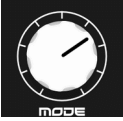| Mode Setting	Function
"Count Up"	Counts up linearly, resetting after 256 clock pulses. (ie: Starts with all divisions low, resets on the clock pulse after all divisions go high).
"Count Down"	Counts down linearly, resetting after 256 clock pulse. (ie: Starts with all divisions high, resets on the clock pulse after all divisions go low)
"Up / Down 4"	The same as Count Up, but every 4 clock pulses, any dividers with /1 or /2 are inverted (effectively counting down again for four pulses).
"Up / Down 8"	The same as Up / Down 4, but every 8 clock pulses, /1, /2, and /4 are inverted.
"Up / Down 16"	The same as Up / Down 4, but every 16 clock pulses, /1, /2, /4, and /8 are inverted.
"Up / Down 32"	The same as Up / Down 4, but every 32 clock pulses, /1, /2, /4, /8, and /16 are inverted.
"Up / Down 64"	The same as Up / Down 4, but every 64 clock pulses, /1, /2, /4, /8, /16, and /32 are inverted.
"Up / Down 128"	The same as Up / Down 4, but every 128 clock pulses, /1, /2, /4, /8, /16, /32 and /64 are inverted.

5.1 Gates Up / Down 4 Table Example

This table shows states of the clock dividers whilst in Up / Down 4 mode to illustrate the counting inversion. States where /1 and /2 have been inverted have been highlighted in grey.


| Clock	/1	/2	/4	/8	/16	/32	/64	/128
0	Low	Low	Low	Low	Low	Low	Low	Low
1	High	Low	Low	Low	Low	Low	Low	Low
2	Low	High	Low	Low	Low	Low	Low	Low
3	High	High	Low	Low	Low	Low	Low	Low
4	High	High	High	Low	Low	Low	Low	Low
5	Low	High	High	Low	Low	Low	Low	Low
6	High	Low	High	Low	Low	Low	Low	Low
7	Low	Low	High	Low	Low	Low	Low	Low
8	Low	Low	Low	High	Low	Low	Low	Low
9	High	Low	Low	High	Low	Low	Low	Low
10	Low	High	Low	High	Low	Low	Low	Low
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251	High	High	Low	High	High	High	High	High
252	High	High	High	High	High	High	High	High
253	Low	High	High	High	High	High	High	High
254	High	Low	High	High	High	High	High	High
255	Low	Low	High	High	High	High	High	High
256[*]	Low	Low	Low	Low	Low	Low	Low	Low

*Clock 256 is equivalent to Clock 0.

5.2 Gates Up / Down 4 Time Series Example

In this time series graph, we demonstrate Up / Down 4 mode. This shows the same data as the first 8 clocks from **4.1.1** but as a time series plot. States where /1 and /2 have been inverted have been highlighted in grey.
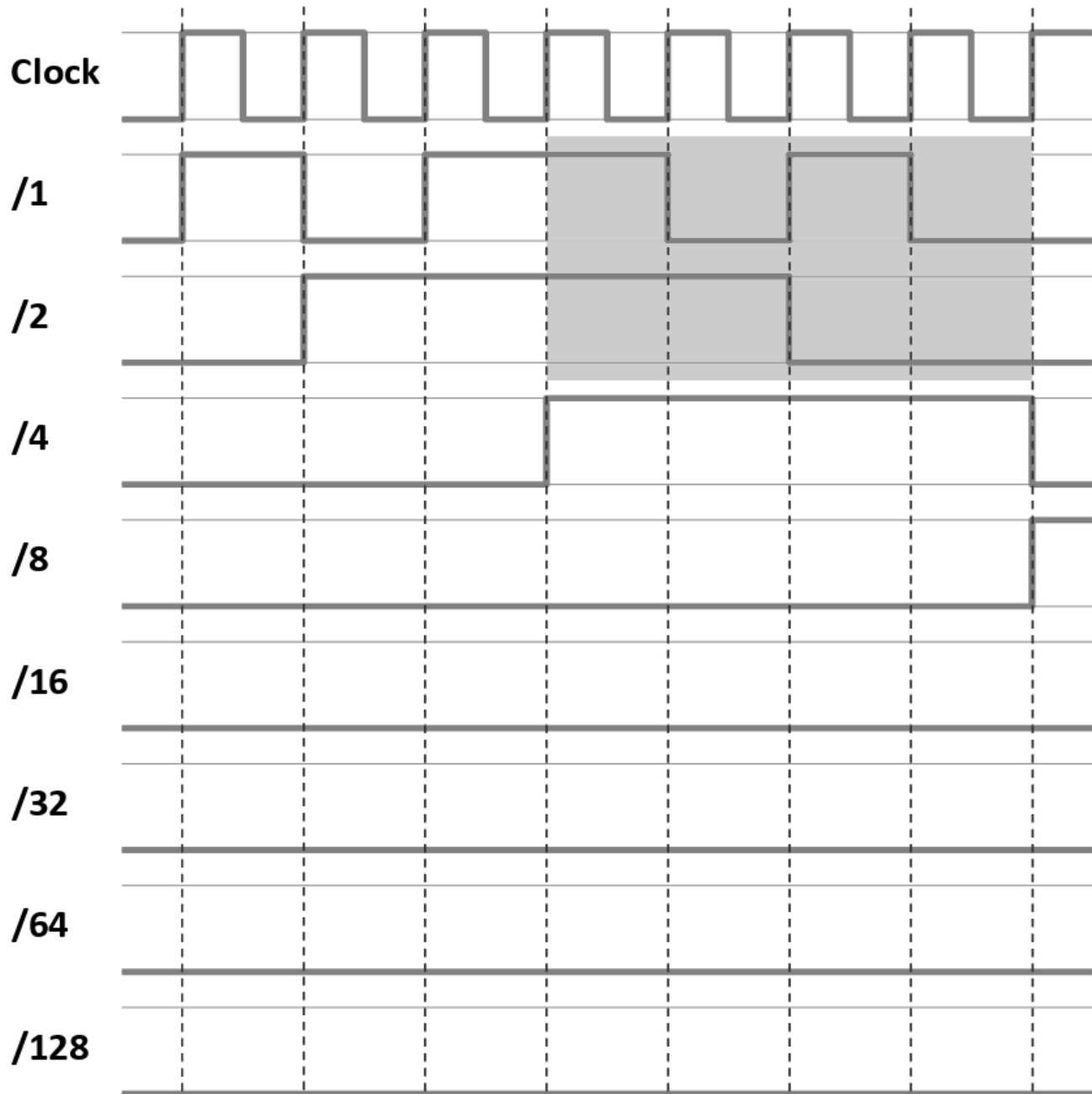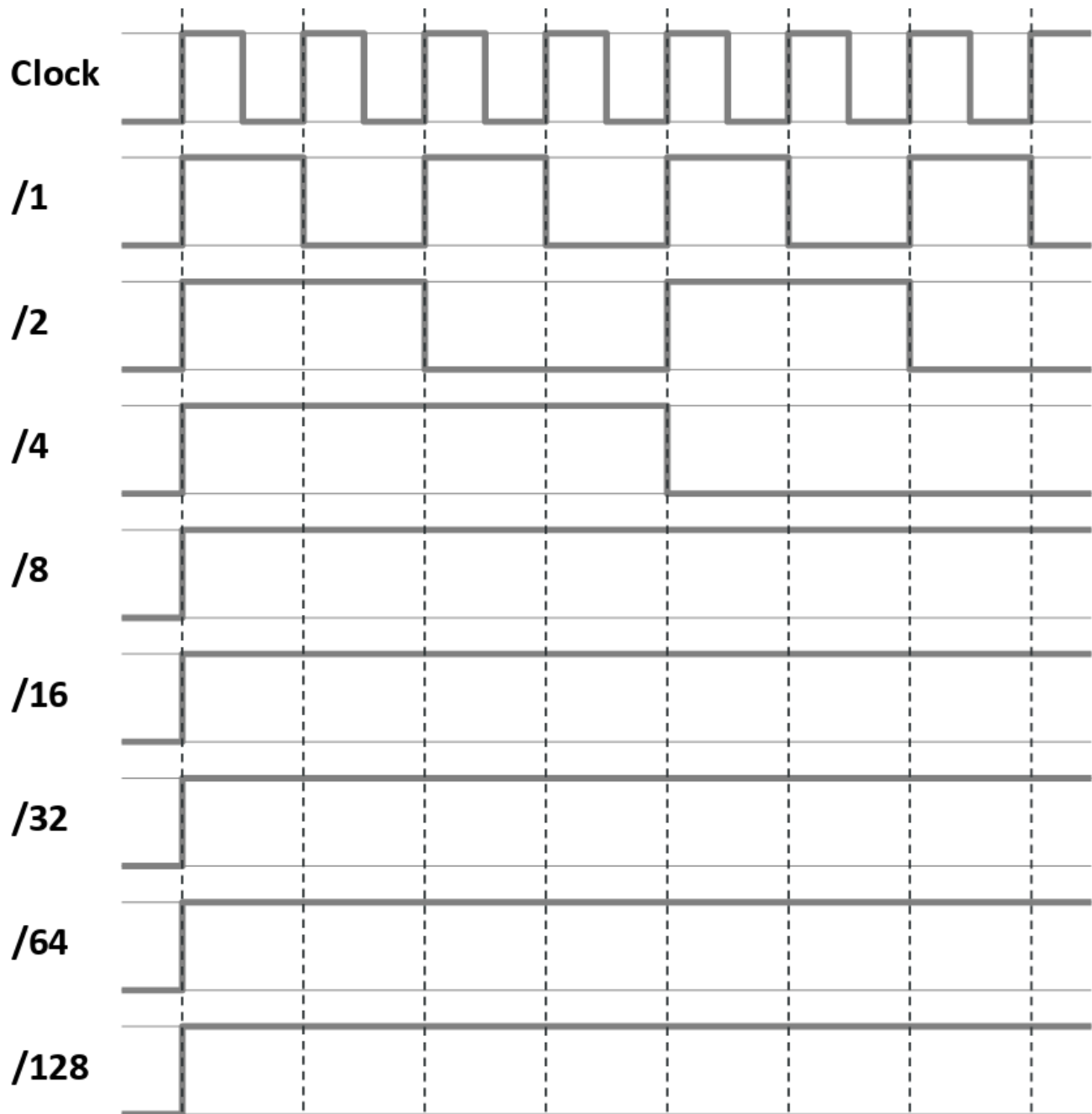
5.3 Gates Count Up Time Series Example
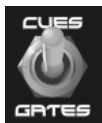
In this time series graph, we demonstrate Count Up mode.
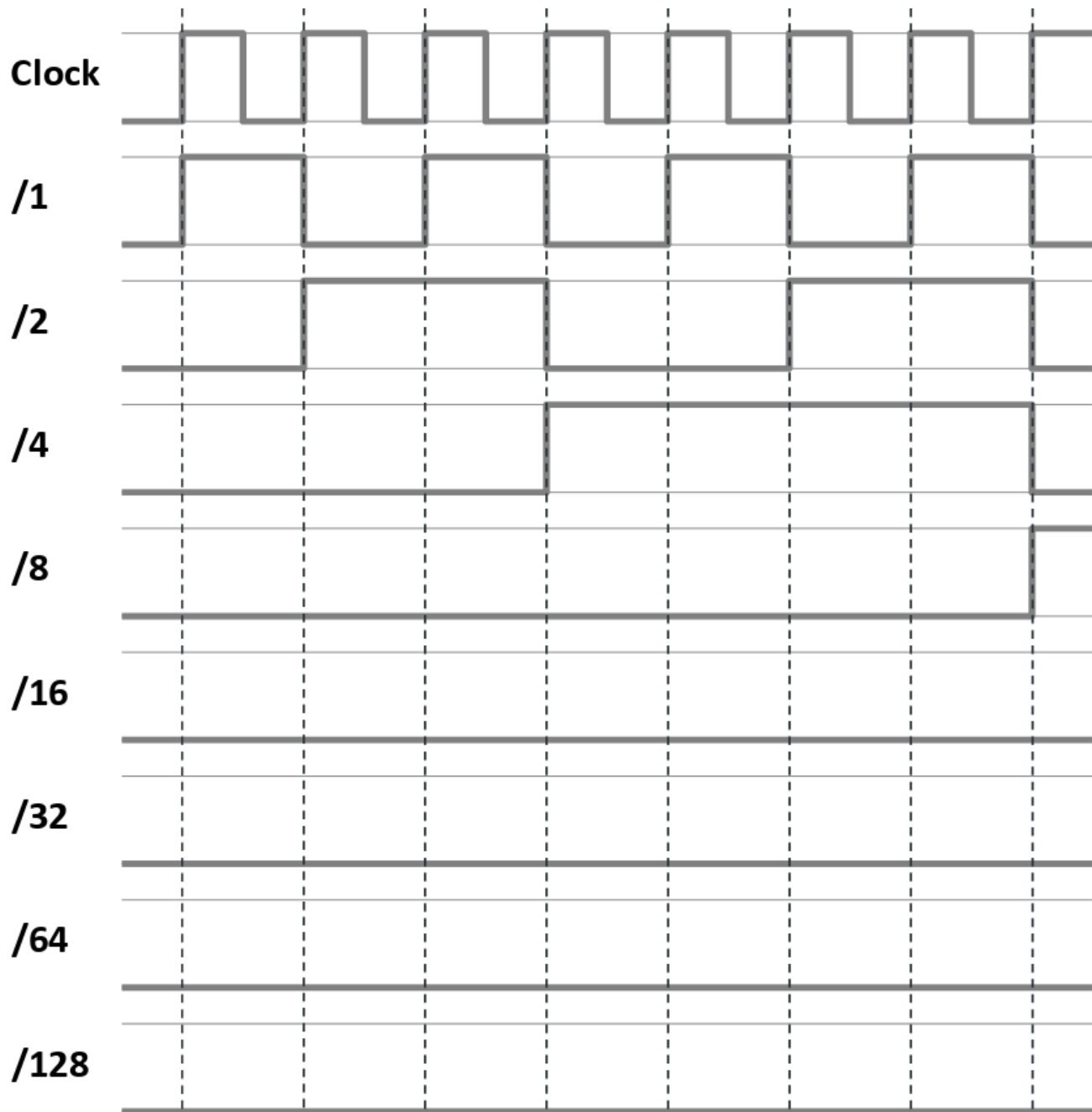
5.4 Gates Count Down Time Series Example

In this time series graph, we demonstrate Count Down mode.

6. Cues

The Cues/Gates switch on High Towers completely changes the module functionality. In this section, we are discussing how High Towers performs when the switch is set to the 'Cues' setting.

When in the 'Cues' setting, High Towers outputs a pulse with a duration that matches the length of the clock's gate - regardless of division setting.

The division setting is used to determine how many clocks are required for the output to pulse. For example, a /4 division pulses every 4th clock, whilst a /1 pulses for every clock.

Unlike in 'Gates' mode, there isn't a concept of 'counting modes'. Instead, the mode parameter determines the 'offset' of when the pulse occurs, where a higher offset means we have to wait fewer clock before an output pulses after a reset.

The mode parameter is atypical; it does not have a set number of positions that do distinct things. Instead, there are different numbers of positions based on which divider you are considering. For example, /2 has two positions; 'no offset' and '1 offset'. /4 has four positions; 'no offset', '1 offset', '2 offset', and '3 offset', and so on. /1 only has one position; 'no offset'.

Consider the table below.

Division	/1	/2	/4	/8	/16	/32	/64	/128
Number Positions	1	2	4	8	16	32	64	128
Visual								

The leftmost position (fully counter-clockwise) is always 'no offset'; this means that for a division of /n, we have to wait $n - 1$ clocks before we see a pulse after a reset. In 'no offset' mode, all divisions sync (pulse simultaneously) at the 256th clock.

In general, each position has an offset 1 clock earlier than position to the left of it. For a division /n and an offset o, we have to wait $n - (o + 1)$ clocks before we see a pulse after a reset.
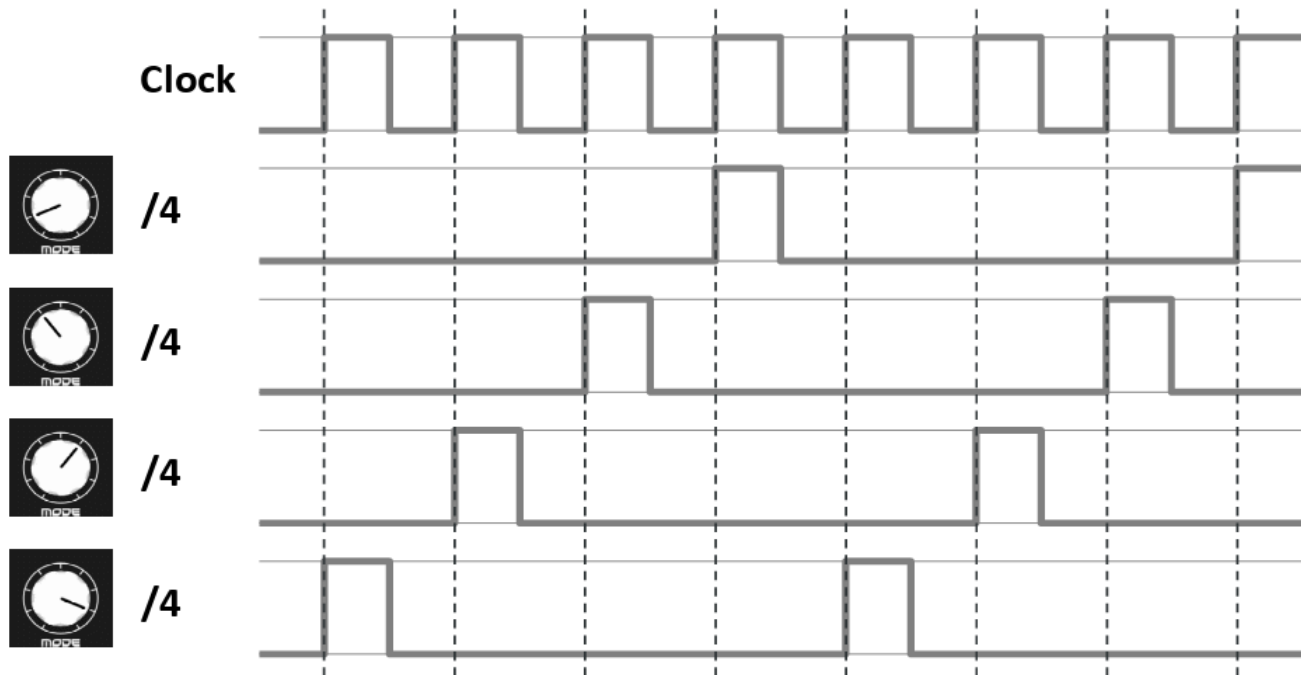
The rightmost position (fully clockwise) is always 'fully offset', where all divisions sync at the 1st clock.

This is illustrated below for the /4 division:

Offset 1   Offset 2

Offset 0 (No Offset)   Offset 3 (Fully Offset)
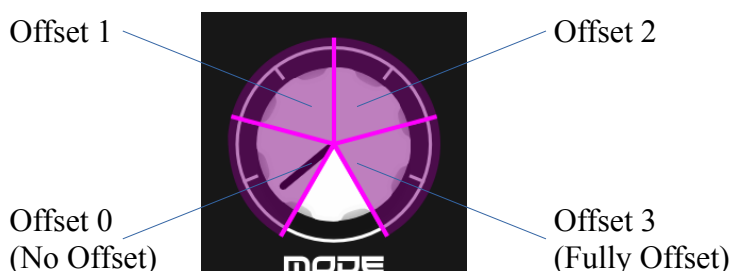
6.1 Cues /4 Time Series Example

In this time series graph, we demonstrate the effects on a /4 division Cues output with Mode set to different settings.
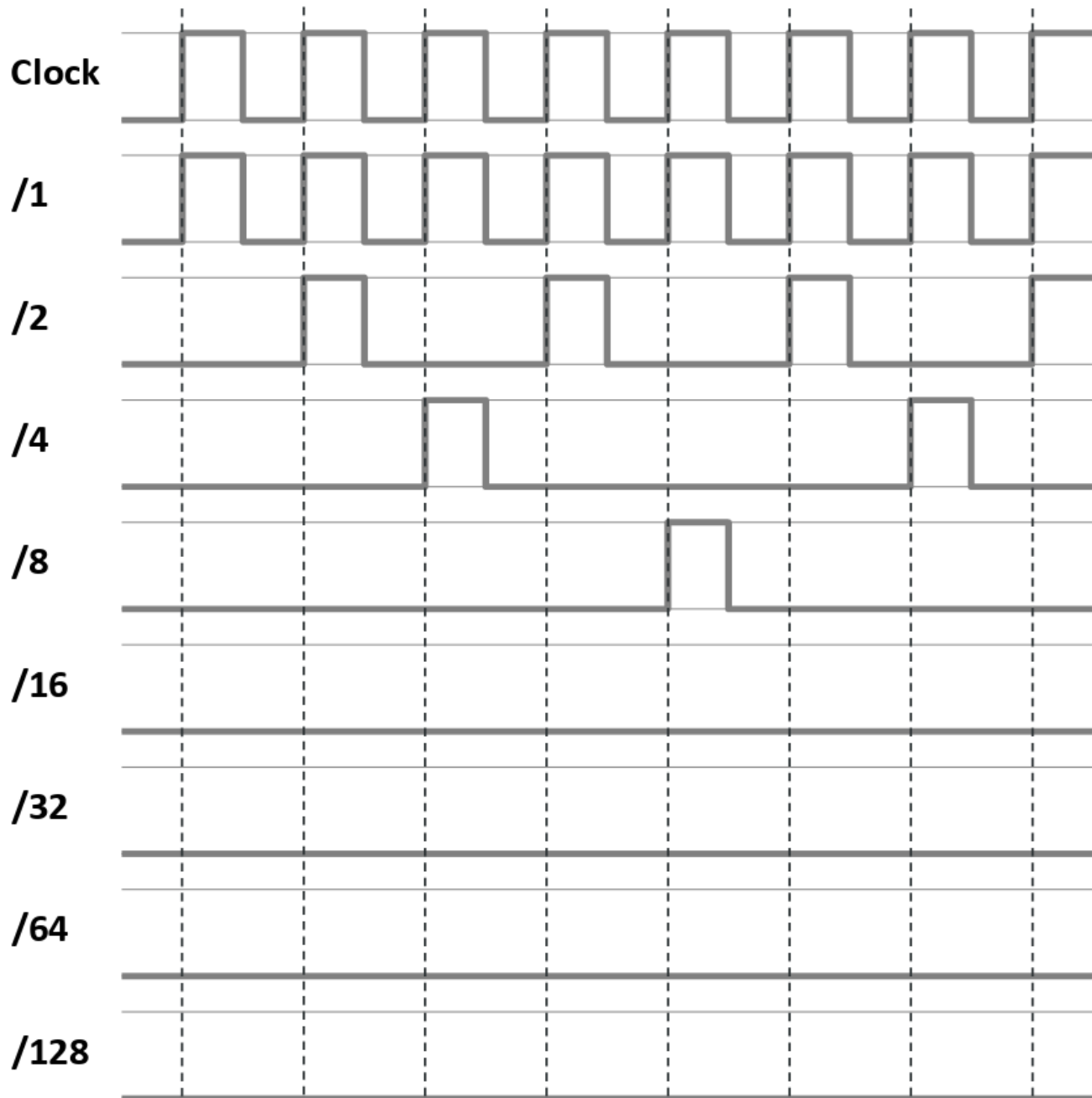
6.2 Cues 'No Offset' Time Series Example

In this time series graph, we demonstrate Cues for all divisions with mode set to 'no offset'.
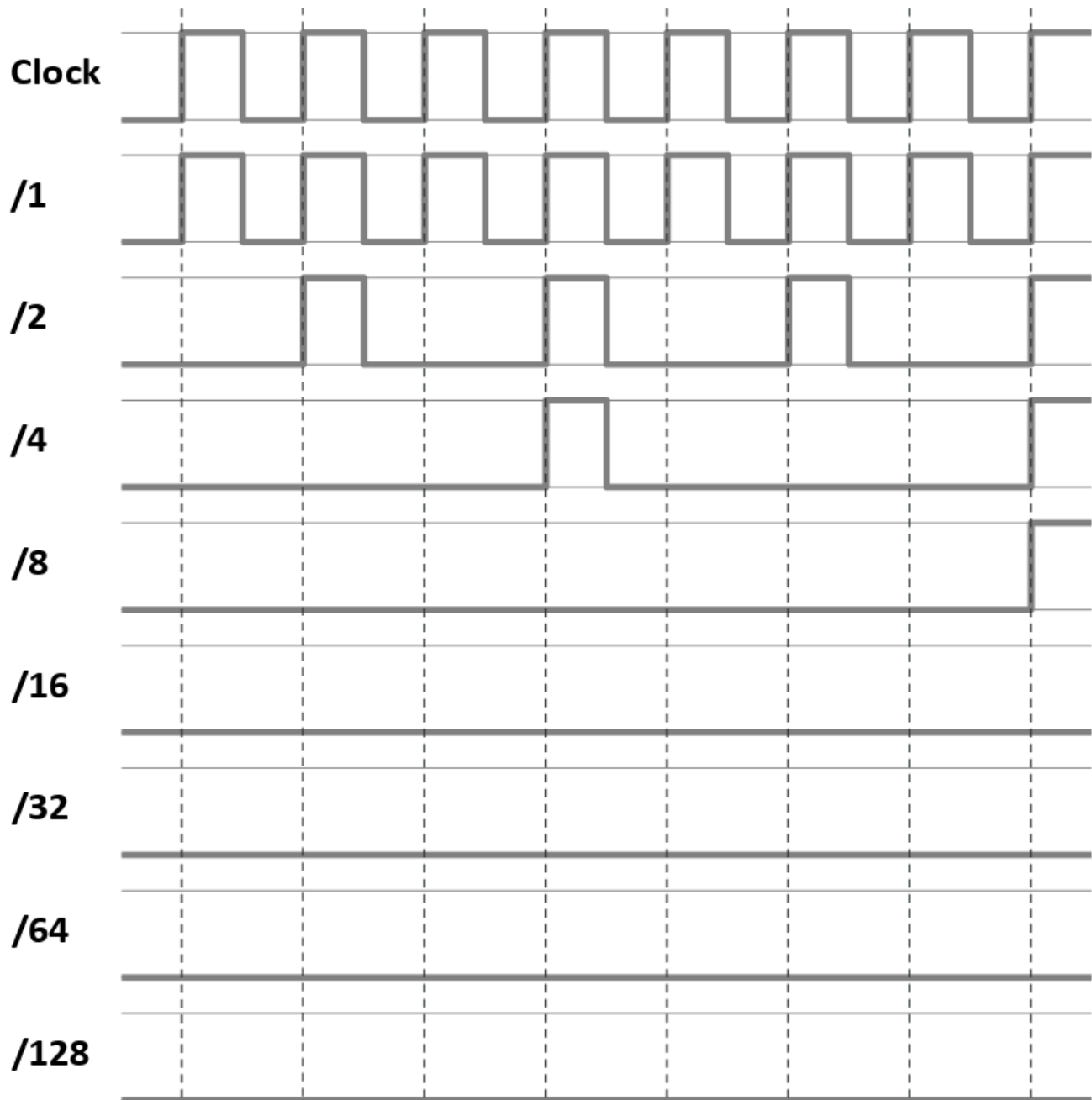
6.3 Cues 'Some Offset' Time Series Example

In this time series graph, we demonstrate Cues for all divisions with mode set at slightly left of the centerline.

6.4 Cues 'Fully Offset' Time Series Example

In this time series graph, we demonstrate Cues for all divisions with mode set to 'fully offset'.