

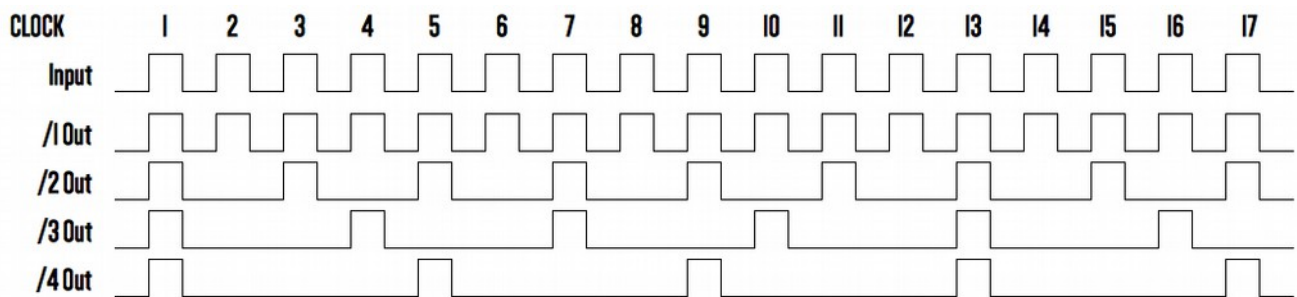


USER MANUAL – KOSMODROM CHAOS DIVIDER (V 1.4.2 FIRMWARE)

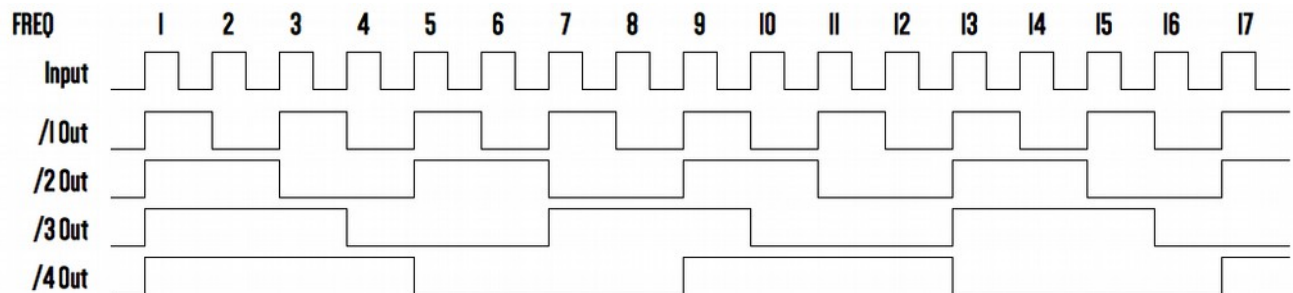
Greetings, Comrade! Welcome to the user manual for the Tsyklon Labs Kosmodrom Chaos Divider. This pamphlet will guide you through the Chaos Divider's Controls, I/O, and features. Before we start with the specific features of the Chaos Divider, let us review the general concept of clock division. If you are already familiar with how a clock divider works, feel free to skip to page 2.

THE CONCEPT OF CLOCK DIVISION

In the simplest terms, a clock divider takes a series of clock pulses as an input and passes that along to a set of outputs according to the selected division table. For example, in the case of 1 input, 4 outputs, and a division table of one's [/ = divide by] /1, /2, /3, /4, the outputs for a given input pulse train would look like this:



As you can see in the chart above, the /1 output turns itself on and off with every input clock pulse. The /2 output turns itself on and off with every other input clock pulse. The /3 output, every third input clock pulse, and the /4 output, every fourth input clock pulse. The other function available with the Chaos Divider is a frequency divider. As you can see on the chart below, instead of the outputs following the input clock pulse, the outputs alternate between on and off with the state change being triggered by where the outputs clock pulses would have been triggered.



These two types of clock modulation are the basic modulation functions of the Tsyklon Labs Chaos Divider. The rest of the features available in the Chaos Divider are extensions of these functions.



CHAOS DIVIDER FEATURES

Let us take a look at the front panel to learn more about the Chaos Divider's specific functions and features:

At the top of the Chaos Divider is the MODE indicating Nixie Tube as well as the division table "cheat sheet". Along the left side of the front panel are three control knobs and a pushbutton. Down the middle of the front panel is a toggle switch and CV/Trigger/Gate input jacks. All of the output jacks run down the right side of the front panel. As we tour the Chaos Divider, we will start with basic functionality and move to more advanced functions.

The **CLOCK** input jack for the Chaos Divider is where the clock pulse train is injected. According to the logic in the Microcontroller, the beginning of each clock cycle begins on the "rising edge" of a clock pulse. That is to say, when the clock pulse signal goes from 0VDC to 5VDC [or slightly greater – there are over-voltage protection diodes to protect the Microcontroller input pin]. The clock cycle continues until the next "rising edge" event from the clock pulse train.

The **MODE** knob is used to select the Operating Mode [division table] for the Chaos Divider. As you turn the **MODE** control knob, the currently selected **MODE** is displayed by the Nixie Tube at the top-center of the Chaos Divider. If you are unfamiliar with which division table is associated with each mode, they are displayed to the left of the Nixie Tube. The **<MODE** CV input jack gives you CV control over the **MODE** parameter from 0-10VDC. When using the **<MODE** CV input jack, the **MODE** control knob acts as an attenuator for the CV signal present at the **<MODE** CV input jack. In other words, if you want full range of the CV input control, turn the **MODE** control knob completely clockwise. In most Operating Modes, the Nixie Tube displays a **BLUE** backlight. In Operating Mode 8 [Chaos Mode – more on this later], the Nixie Tube backlight displays **RED**. Below is a listing of the available division tables:

Mode	Odds	Ones	Twos	Threes	Fours	Fives	Binary	Fibonacci	Chaos	Primes
Nixie	0	1	2	3	4	5	6	7	8	9
Out 1	1	1	1	1	1	1	1	1		1
Out 2	3	2	2	3	4	5	2	2		2
Out 3	5	3	4	6	8	10	4	3		3
Out 4	7	4	6	9	12	15	8	5		5
Out 5	9	5	8	12	16	20	16	8		7
Out 6	11	6	10	15	20	25	32	13		11
Out 7	13	7	12	18	24	30	64	21		13
Out 8	15	8	14	21	28	35	128	34		17
Out 9	17	9	16	24	32	40	256	55		19
"Out 10"	19	10	18	27	36	45	512	89		23
"Out 11"	21	11	20	30	40	50	1024	144		29
"Out 12"	23	12	22	33	44	55	2048	233		31
"Out 13"	25	13	24	36	48	60	4096	377		37
"Out 14"	27	14	26	39	52	65	8192	610		41

You will notice in the table above that it runs fourteen “Outputs” deep, while the Chaos Divider hardware only has nine outputs. We will get to that in a moment, but yes, that is on purpose.

NOTE: When the first clock pulse enters the Chaos Divider after a reset, all of the outputs turn on for that clock pulse. After that, the selected division table determines when each of the outputs is ready for another pulse.

The next controls we will review are the **RESET** pushbutton and the **RESET** input jack. When the **RESET** pushbutton is pressed [and for as long as it is held down], the pulse counters in the Microcontroller are reset to zero and no outputs will turn on. When the **RESET** pushbutton is released, the Chaos Divider resumes modulating the input clock signal with the very next input clock pulse. Also, a trigger/gate signal of at least 5VDC injected into the **RESET** input jack will perform the same function as pressing the **RESET** pushbutton.

Moving on to the **NORM/INV** toggle switch. When the toggle switch is in the Normal [down] position, the outputs will behave as previously described. When the toggle switch is in the Invert [up] position, the outputs will be inverted from normal behaviour – e.g. If the normal state of an output is to be “Off”, the inverted behaviour will be “On”.

The last front panel controls that we need to cover are the **INTENS** control knob, the **<INTENS** CV input jack, the **INTERV** control knob, and **<INTERV** CV input jack. Like the **MODE** control knob and **<MODE** CV input jack, when using the CV input jacks, the control knob acts as a signal attenuator. These two controls have special functions when the module is in Chaos Mode, but in non-Chaos Mode, they affect the outputs in the following way:

The **INTERV** control knob and **<INTERV** CV input jack scroll down through the rows of the selected division table. For example, if the “Twos” division table has been selected, Outputs 1 through 9 use the following divisors when the **INTERV** value is zero:

Output	1	2	3	4	5	6	7	8	9
Divisor	1	2	4	6	8	10	12	14	16

If you advance the **INTERV** value, the divisor moves one row down the table:

Output	1	2	3	4	5	6	7	8	9
Divisor	2	4	6	8	10	12	14	16	18

If you turn up the **INTERV** value the whole way, the divisor moves the whole way down the table:

Output	1	2	3	4	5	6	7	8	9
Divisor	10	12	14	16	18	20	22	24	26

The **INTENS** control knob and **<INTENS** CV input jack rotate through the rows of the selected division table. For example, if the “Odds” division table has been selected, Outputs 1 through 9 use the following divisors when the **INTERV** and **INTENS** values are zero:

Output	1	2	3	4	5	6	7	8	9
Divisor	1	3	5	7	9	11	13	15	17

Leaving the **INTERV** value at zero, if you advance the **INTENS** value, the divisors rotate up one row with the first divisor moving to the last position:

Output	1	2	3	4	5	6	7	8	9
Divisor	3	5	7	9	11	13	15	17	1

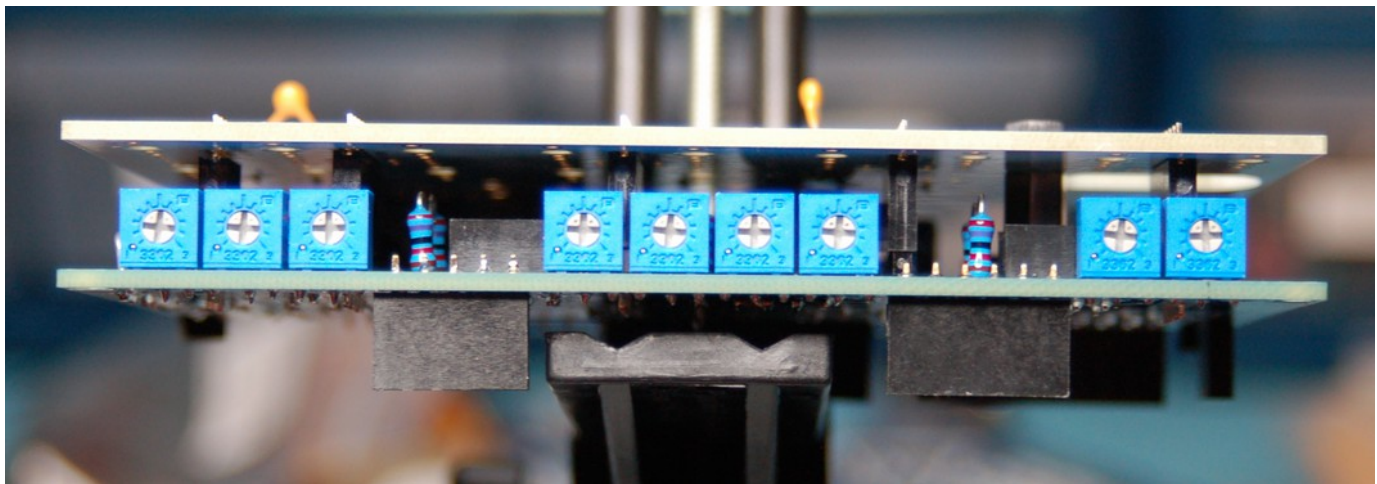
If you advance the **INTENS** value another step, the divisors continue to rotate:

Output	1	2	3	4	5	6	7	8	9
Divisor	5	7	9	11	13	15	17	1	3

Finally, if you advance the **INTERV** value 2 steps and leave the **INTENS** value where it is, the rotation stays the same, but we scroll everything down two rows of the "Odds" table:

Output	1	2	3	4	5	6	7	8	9
Divisor	9	11	13	15	17	19	21	5	7

Outputs **1** through **9** send an output pulse that matches the timing of the input clock pulse train with some outputs only turning on periodically according to the selected division table. While the Microcontroller only outputs a signal with an amplitude of 5VDC, those Microcontroller outputs are buffered with an Op-Amp circuit. On the right side of the module, is a set of 9 trim pots. With the faceplate pointing up towards the sky, the trimpot for output **1** is on the right and output **9** is on the left. These are used to individually set the output voltage amplitude for the module outputs. When the trim pot is completely anti-clockwise, the output voltage is approximately 5VDC. When the trim pot is completely clockwise, the output voltage is approximately 10VDC. In this way, you can adjust the outputs of the Chaos Divider to suit your system's needs.



If you want to set the output amplitudes more precisely, try this – flip the **NORM/INV** toggle switch “up” to the inverted setting. Then, when you either press and hold the **RESET** pushbutton or inject a 5VDC signal into the **RESET** input jack, all of the outputs will remain on. Then, set the trim pots while monitoring the voltage for each output jack with a meter or scope.

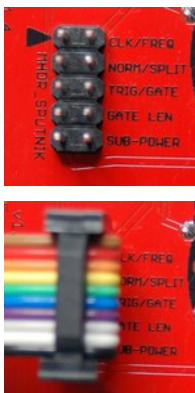
CD SPUTNIK FEATURES

Aside from the functions available from the front panel controls, the Kosmodrom Chaos Divider also has a companion expander module call the CD Sputnik [Sputnik means “Companion” in Russian, so we thought it was appropriate to name our expander module for the Chaos Divider “CD Sputnik”]. The CD Sputnik has the following controls to extend the functionality of the Chaos Divider – **DIVISION**, **SPLIT**, **TRIG/GATE**, **GATE LENGTH**, and **LENGTH CV**.

The **DIVISION** toggle switch has two settings, CLCK and FREQ. This toggle switch changes the output type of the Chaos Divider between a clock divider [left position] and a frequency divider [right position].

The **SPLIT** toggle switch also has two settings, NORM and 5+4. In normal mode [left position], each output has a different division table based value. In 5+4 [right position], or split/mirror mode, Output 9 = Output 1, Output 8 = Output 2, Output 7 = Output 3, and Output 6 = Output 4. If you don’t need clock divisions nine levels deep, you can use split mode as a limited buffered multiple.

The last toggle switch is the **TRIG/GATE** selection. In trigger mode [left position], the on/off timing of the outputs follows the pulse width of the input clock pulse. In gate mode [right position], the pulse width of the output signal can be adjust from approximately 5% to 95% of the length of time of each clock cycle by using the **GATE LENGTH** control knob. Like the other CV input jacks, when using the **LENGTH CV** CV input jack, the **GATE LENGTH** control knob acts as an attenuator for the CV signal present at the **LENGTH CV** CV input jack. Note that when **GATE** mode has been selected, frequency division is disable and only clock division is available.



If you do not have the CD Sputnik expansion module, you can still access the **DIVISION** and **SPLIT** functions. The back of the Chaos Divider module has an expansion header labelled **MHDR_SPUTNIK** – a 2 column, 5 row, 0.10” male pin header. This is where the CD Sputnik plugs into. To get the “standard” functions without the CD Sputnik, leave all of the jumpers off **MHDR_SPUTNIK**. The **CLK/FREQ** pins affects the Clock division type. Jumping those pins activates Frequency division. Leaving the jumper off the **NORM/SPLIT** pins allows normal outputs. Jumping those two pins activates the split output mode.

NOTE: The arrow points to pin 1 of the expander cable for MHDR_SPUTNIK.

You will find the Expander connection for the CD Sputnik on the back of the CD Sputnik PCB. The arrow on the CD Sputnik also points to pin 1 of the expander cable. On both modules, pin 1 is at the top of the connector when the module is installed in your rack right-side up. For the rainbow colored ribbon-type expander cable that comes with the CD Sputnik, this is the BROWN conductor. [This ribbon cable has the right idea, it uses its brown wire!]



CHAOS MODE

Now that we have covered all of the features and controls of the Kosmodrom Chaos Divider in non-Chaos mode, let us review Chaos mode. Mode 8 [chosen because an arabic 8 looks like the mathematical symbol for infinity ∞ , which is not chaos specifically, but describes the infinite possibilities] is a special division table.

When Chaos mode is first selected, the Chaos Divider starts with an “All Ones” division table for one clock pulse. Depending on the settings of the **INTENS** control knob, **<INTENS** CV input, **INTERV** control knob, and/or **<INTERV** CV input, the values of the division table will change. While not literally a chaos algorithm, the **INTENS** and **INTERV** values can be considered the “initial conditions” of what we call Reactive Probability. Reactive Probability is more than just randomly triggered output pulses. There is one random seed that is generated when the module first powers up. That seed is used one time to select which output is first selected as the “lead” output. When input clock pulses enter the Chaos Divider and the selected number of pulses have been counted for the “lead” output, the Chaos Divider determines new divisors for all of the outputs and passes the “lead” output duties to the output above it. From there, the routine continues ad nauseum.

Seriously, it evolves over time and does all kinds of crazy stuff. Have fun with it and let it roll!

MODULE SPECIFICATIONS

Electrical:

+12VDC = 165mA
+5VDC = 0mA
-12VDC = 0mA

NOTE: The Kosmodrom Chaos Divider produces it's own internal +5VDC, +10VDC, and +155VDC (for the Nixie Tube Anode) from the +12VDC system supply.

Eurorack Power Cable should be installed Red Stripe (-12VDC) Down - Power connector is a 2x5 keyed 0.1" IDC style ribbon cable header



Physical:

Width = 12HP, 2.4 inches, 61mm
Height = 3U Eurorack, 5.095 inches, 129.4mm
Depth = 2 inches, 51mm (with Eurorack power and CD Sputnik expander cables installed)

Firmware Upgrade Cable Connection (ICSP):

Firmware updates for the Kosmodrom Chaos Divider [bug fixes, extended functionality, alternate firmware, etc.] will be available for download as a compiled firmware file. To update the firmware, you will need to have MicroChip's MPLAB X IDE software and their PICKIT3 ICSP [In Circuit Serial Programmer] cable. We have a separate document to walk you through the firmware upgrade process that works for all of our Microcontroller-based modules. It can be downloaded from www.tsyklon.com from the *Products | Product Support Page*. The PICKIT3 cable plugs into **MHDR_ICSP** at the top-left of the Power/Logic [bottom/**RED**] PCB. Take note that Pin 1 is identified by the arrow that is screen printed on the PCB. That arrow matches the arrow on Pin 1 of the PICKIT3.



Pre-Programmed Microcontrollers will also be available for purchase.

Nixie Tube Information:

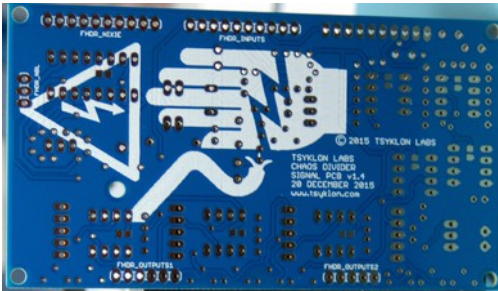
Nominal Anode Voltage = +155VDC

Nixie Model = Cold Cathode Russian 1N-17

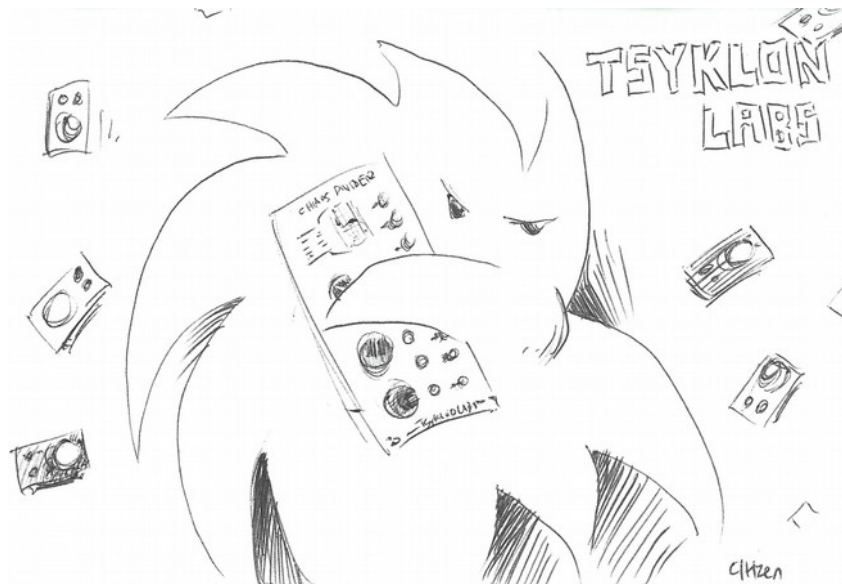
NOTE: Because the Nixie is a “Cold Cathode” vacuum tube, it does not have a heater element and therefore does not get warm under the operating conditions of this module. Depending on the data sheet you find, the typical lifetime is between 1000 to 5000 continuous hours. In practice, they last far, far, longer. Please let us know if you have any issues with your Nixie tube!

During operation of the Chaos Divider, the module will perform a routine approximately every half hour to exercise all of the digits. The Chaos Divider will scroll through all of the digits in a few seconds. This “sweep” only affects the Nixie display, the [MODE] is not changing during this time and the clock divisions will continue without interruption. At the end of the routine, the Chaos Divider will display the currently selected [MODE].

As mentioned above, the nominal Anode Voltage of the Nixie Tube is +155VDC. The central area of the “Signal” (middle/**BLUE**) PCB contains the boost circuit for the Nixie Tube. Physical contact with this area should be avoided while the Chaos Divider is powered up. The back of the PCB has the following symbols to denote this area:



And to finish things off, some Chaos Divider HV Artwork from cltzen!



EXPRESSIONS OF GRATITUDE

A Siberian Sized Spasibo to Kylee and Cory for testing the prototype Chaos Divider and CD Sputnik. Your feedback and suggestions regarding everything from packaging and component selection, to the modules themselves has been invaluable in making this module a lot of fun to use and durable as a tank.

Ursa Major [like giant Russian Circus Bear sized] thanks to Hannes Pasqualini at Papernoise for taking the disjointed thoughts, suggestions, and ramblings of my childhood love of all things Cosmonaut and turning them into the FREAKING AWESOME visual language that would be at home in a space station 250 miles [402 km] high traveling at 17,000 mph [27,359 kph].

SUPPORT AND CONTACT INFORMATION

Issues or questions about the operation of your Kosmodrom Chaos Divider or CD Sputnik can be sent to:

diy@tsyklon.com

We will make every effort to reply to you as soon as we possibly can.

To sign up for our mailing list (one monthly email max, and re-stock notifications):

<http://tsyklon.com/contact/>

If you prefer not to sign up for the email list, but still want to stay up to date, please keep an eye on this page:

<http://tsyklon.com/updates/>

User Manuals, DIY Build Documents and Schematics, Microcontroller source code, and Firmware upgrade files can be found here:

<http://tsyklon.com/product-support/>

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