4ms Shuffling Clock Multiplier

Eurorack Module User Manual (updated Sept 2015)

PCB v1.2 (released November 2014)

Firmware 1.0.4 (released February 2012)

4ms Pedals

http://www.4mspedals.com/scm.php

Features

- Multiply-by-1 to Multiply-by-8, on 8 output jacks
  - Maximum Multiply-by-32 with optional breakout panel
  - Five Slipped/Shuffled/Skipped clock outputs (S3, S4, S5, S6, S8). Each is based on a multiple of the input clock frequency (x3, x4, x5, x6, and x8, respectively)
  - Three steady clock outputs (x1, x2, and x8), which are not effected by Slip/Shuffle/Skip effects
- CV Rotate jack to shift multiply-by amount on all jacks
- CV Slip causes particular beats to land ahead in time
- Optional SCM Breakout panel: *(see separate manual)*
  - CV Shuffle jack and knob selects which beats are “slipped” by CV Slip (default=every other beat)
  - CV Pulse Width jack and knob controls width of output pulses (default=50%)
  - CV Skip jack and knob omits certain beats in a pattern (default=no skip)
  - Re-sync CV Trigger input
  - Additional CV Rotate and CV Slip jacks on breakout panel
  - “4x Fast” CV jack and switch speeds up multiply-by amounts
  - “Mute” CV jack and switch stops any more beats from starting

- LED dimmer trimpot allows you to set a custom LED brightness
- Bus Clock support (slave only). Clock can be taken from the Gate pins on the power header.
- 5V Select jumper allows you to power the SCM from either the 12V rail or the 5V rail.
- ISP header
  - Connects to in-circuit programmer such as AVR ISP MKII for reprogramming code
- Maximum input frequency 3kHz

- 4 HP Eurorack module
- 5V Jumper set to INT:
  - 33mA maximum power draw from +12V rail
  - 0mA max on the +5V rail
  - 4mA maximum power draw on the -12V rail
- 5V Jumper set to EXT:
  - 19mA maximum power draw on the +12V rail
  - 14mA max on the +5V rail
  - 4mA maximum power draw on the -12V rail
- Using SCM Breakout adds 14mA maximum draw to the +12V rail

Jacks

- Clock Input (3.5V to 15V clock, rising edge triggered)
- CV Rotate (0V to +5.1V input)
- CV Slip (0V to +5.1V input)
- Multiplied Clock Outputs (8 jacks):
  - Multiply-by (1+R)
  - Multiply-by (2+R) and slip/shuffle/skip
  - Multiply-by (3+R) and slip/shuffle/skip
  - Multiply-by (4+R) and slip/shuffle/skip
  - Multiply-by (5+R) and slip/shuffle/skip
  - Multiply-by (6+R) and slip/shuffle/skip
  - Multiply-by (7+R) and slip/shuffle/skip
  - Multiply-by (8+R)

...where R is the CV Rotation (0 to 7)

Operation

The SCM measures the **time between the previous two pulses**, and uses that value to calculate the frequency of the clock signals on the output jacks. Applying a steady clock will produce an output clock of equal frequency on the x1 jack, and a clock of double the frequency on the x2 jack... and a clock of eight times the frequency on the x8 jack.

Since the SCM only remembers the **time between the previous two pulses**, you can simply “tap” it twice and it will run at that tempo indefinitely. There is inherently some tempo drift and human error in taking this “tap tempo” approach if your goal is to synchronize the SCM to another clock, so it's recommended to use a common input clock when possible if sync'ing tempos is desired. The SCM can handle rapidly changing clock signals, including complex waveforms that cross the 3.5V boundary at erratic intervals.

Three of the jacks will always produce regular clock pulses that are multiples of the input clock: x1, x2, and x8. These jacks are not effected by CV Slip or the breakout panel's Shuffle and Skip effects. The other five jacks produce a clocks that are also multiples of the input clock, but these jacks will “rag” the beat (Slip and Shuffle), as well as drop some beats out (Skip): S3, S4, S5, S6, S8.

Note that S7 has been left out to make room for both S8 and x8: playing a non-slipped and a slipped clock at the same time results in some fascinating phasing and variable-shifting effects, especially if CV Slip is modulated slowly and both tempos are heard side-by-side. If desired, S7 or x7 can be obtained on any jack by applying rotation (see table below).

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 SCM can also operate in the low audio range, thus crudely stepping pitch upward.

CV Slip

Slip is an effect where every “n” beats are shifted forward in time. By default, “n” is 2, so every other beat lands “late”: beats 2, 4, 6, etc... (The value of “n” can be changed by the Shuffle parameter, which is only controllable by the breakout panel.) The amount each beat is late is set by CV Slip.

CV Slip operates between 0V and +5V. Zero volts is no slippage (0%) and 5V is about 90% slippage. When Slip is at 0V, the “S” jacks act as straight “x” jacks (that is, there is no slipping/shuffling of the beat). Applying a small amount of CV to Slip causes every other beat to land a little bit late. Applying the maximum CV (5V) causes every other beat to land right before the next beat.

With no jack plugged into the CV Slip, the jack is normalized to about 2.5V. This translates to 50% slippage, which means every other beat is played about halfway where it normally would fall and where the next beat normally falls.

Internally, there's a counter that keeps track of whether each beat should be slipped or not. This counter resets itself on each input clock pulse. For example, if we have a steady regular clock input and we're slipping every other beat, then on the S5 jack beats 2 and 4 will be late. Then before beat 6 is supposed to happen, we have an input clock happening, so the counter resets and beat 6 becomes beat 1 and is on time. So then beats 7 and 9 are late. The Slippage diagram illustrates this interesting rhythm pattern.

Note that with the breakout panel, Pulse Width effects how much Slippage can occur. With very wide pulses, there's very little time between the end of a beat and the start of the next beat— therefore there's very little room to push the beat forward without encroaching upon the next beat. Therefore, the shorter the PW setting, the more dramatic the CV Slip effect.

Only the five “S” jacks are effected by CV Slip, no matter what the rotation is. That is, the slippage effect is linked to particular jacks and the effect doesn't rotate with the multiply-by amounts.

CV Rotation

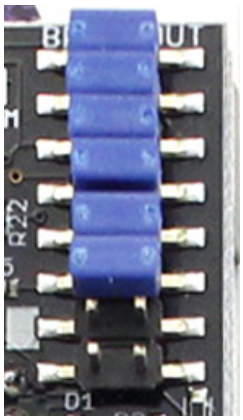
By applying a CV signal to the CV Rotate jack, the clock multiples will rotate throughout the output jacks (*see table*). The “S” jacks will always output a shuffled/slipped/skipped clock, and the “x” jacks will always output straight clock signals, no matter how the clock signals are rotated

For more explanation of Rotation, see the Rotating Clock Divider manual– the rotation effect is the same for the SCM.

Jacks	**Voltage at CV Rotate Jack**							
	<0.67V	0.67V - 1.3V	1.3V – 1.9V	1.9V – 2.5V	2.5V – 3.2V	3.2V – 3.8V	3.8V – 4.5V	>4.5V
x1	x1	x2	x3	x4	x5	x6	x7	x8
x2	x2	x3	x4	x5	x6	x7	x8	x1
S3	S3	S4	S5	S6	S7	S8	S1	S2
S4	S4	S5	S6	S7	S8	S1	S2	S3
S5	S5	S6	S7	S8	S1	S2	S3	S4
S6	S6	S7	S8	S1	S2	S3	S4	S5
S8	S8	S1	S2	S3	S4	S5	S6	S7
x8	x8	x1	x2	x3	x4	x5	x6	x7

See the SCM Breakout manual for details on using CV Shuffle, CV Skip, CV Pulse Width, 4x Fast, and Mute

Jumpers



There are six jumpers on the back, and all jumpers must be in place unless the breakout board is in use. The bottom four pins do not get a jumper, they are only used with the SCM Breakout.

Ground	o	o	0V=Normal, 5V=Faster
Ground	o	o	0V=Normal, 5V=Fast
2V ref.	o	o	0-5V Pulse Width CV
Ground	o	o	0-5V: Skip CV
Ground	o	o	5V: Resync Trigger input
Ground	o	o	0-5V: Shuffle CV
(nothing)	■	o	+12/15V (mains supply)
Slip CV	o	o	Rotate CV

Bus Clock (PCB version 1.2)

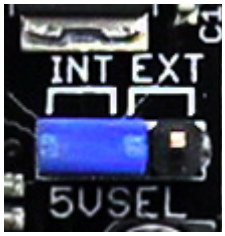
The SCM can be clocked by a master clock running on the Gate bus of the power header. If you have a master clock module that supplies a clock to the bus, you can take advantage of this by installing the BUS CLK jumper on the back of the SCM. The bus clock is buffered on the SCM, so there is no loading effect on the clock signal.

With the jumper installed by placing it on both pins, the SCM will be clocked by the bus clock. Patching a cable into the Clock In jack on the SCM will override the bus clock.

With the jumper not installed the Bus Clock will not be used. The jumper can be placed on one pin (either one is fine) so that you don't loose it.

Factory setting is Bus clock disabled, jumper installed on only one pin (shown on the left).

5V Select (PCB version 1.2)



Jumping the side marked "INT" will power the SCM from the +12V rail, using an internal regulator chip. Jumping the side marked "EXT" will power the SCM from the +5V rail.

When the RCD is in "EXT" mode, less current is drawn from the +12V rail, but if there is noise on the 5V rail, the RCD may glitch. If you are experiencing problems, try setting the jumper to “INT”.

Factory setting is "INT" mode (shown on the left).

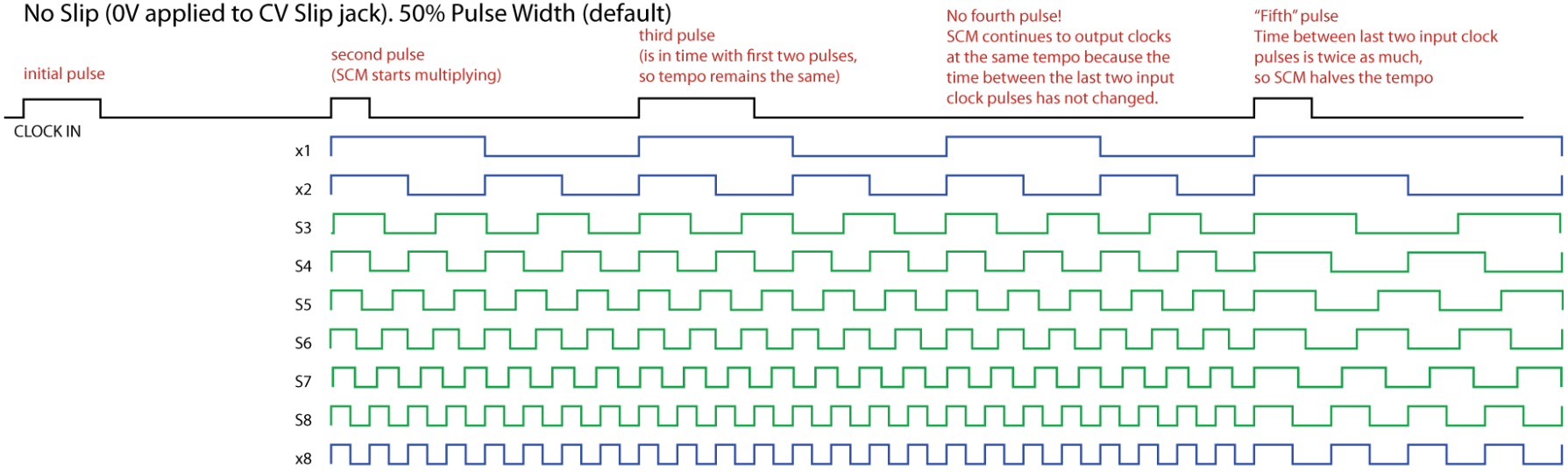
LED Dimmer Trimpot (PCB version 1.2)

The LEDs on the RCD can be dimmed or brightened by adjusting a trimpot. Use a very small phillips screwdriver (#00 or #000) to adjust the trimpot. Be careful and gentle as you adjust the trimpot. It's safe to adjust the trimpot while the RCD is powered on, but be careful not to touch any components or solder junctions on the board.

The factory default is about 50%.

4ms Shuffling Clock Multiplier
Slippage Timing Diagrams

No Slip (0V applied to CV Slip jack). 50% Pulse Width (default)



90% slip (about 5V on CV Slip jack). Shuffle set to default (every other pulse). 50% Pulse Width (default)