

## Collidoscope MIDI messages reference

(v0.2)

Collidoscope uses the [Teensy++ 2.0](#) (Teensy) microcontroller, the [Raspberry Pi 3 model B](#) (Pi) single-board computer and two USB MIDI keyboard. The Teensy and the keyboards must be connected to the Raspberry pi via a USB cable.

The Teensy gathers all the sensor information (knobs, buttons etc.) and sends it as MIDI messages to the Pi. Note that the Teensy can be configured to become a class-compliant USB MIDI device and so doesn't need any additional driver to work with the Pi.

The Pi runs all the visuals and sounds and is exclusively controlled via MIDI.

In this document we refer to the software that runs on a Pi as **CollidoscopeApp**, whereas the software running in the Teensy will be referred to as **CollidoscopeTeensy**.

This document reports which MIDI messages are sent from the CollidoscopeTeensy to CollidoscopePi and describes the parameters they control.

### MIDI channels

The Collidoscope is a collaborative unit that sports two granular synthesis engines placed in front of each other; each with a separate keyboard, input controls, visual wave and sound. The two engines are separated from the user perspective, but a unique Teensy and a unique Pi run both the engines.

The messages from the Teensy and the keyboards are exactly the same for each engine besides they are sent on **two different MIDI channels** to differentiate between each engine. More specifically, the first engine (red wave) receives messages on **MIDI channel 1**, whereas the second engine (yellow wave) receives messages on **MIDI channel 2**.

In the rest of this document the description of midi messages will refer to no specific engine as they are exactly the same except for the channel they're sent on.

### Note Messages

The keyboard sends **Note On** and **Note Off** messages to the Pi. CollidoscopeApp creates a new voice of the granular synthesis engine upon receiving a Note On messages and it releases the voice upon receiving the related Note Off message.

When played through the keyboard, the granular synthesis engine shifts the pitch of the grain according to the note played. This turns it into an instrument that can be played on the chromatic scale.

The granular synthesis engine is polyphonic up to 6 voices. When all 6 voices are on, then no further voice is created until one is released first. That is, note messages are ignored as long as 6 voices are playing at the same time.

### Pitch Bend Messages

Pitch bend messages are used to control the position of the selection in the wave. The low-resolution style wave is made up of 150 bars, called "chunks". Since normal MIDI control change

messages have values that only go from 0 to 127, pitch bend messages were adopted to cover all the possible chunks.

The Teensy reads the position of the knob along the wave through the strip sensor underneath and sends pitch bend messages to the Pi. The value of the messages **ranges from 0 to 149**. This value determines the **start of the selection** in the wave. All values outside the range are ignored.

### Control Change Messages

All the others controls of Collidoscope are sent from the Teensy to the Pi as MIDI Control Change messages. The controller values always range from **0 to 127**. CollidoscopeApp then maps each controller value to the right parameter range using a linear scale.

### MIDI Controller numbers

The MIDI control messages are sent on the following controller numbers:

Parameter	MIDI Controller number
Selection Size	1
Loop on/off	4
Record	5
Filter	7
Duration	2

### Parameters Description

#### Selection Size

Controls the size of the selection. A new MIDI message is triggered as the user twists the wave knob. The selection size ranges from 1 to a maximum of 37 chunks. So MIDI values are mapped from [0,127] range to [1, 37] range.

The selection determines how big the grain is and also how frequently a new grain is triggered. The bigger the selection, the bigger the grain duration; and the bigger the selection the lower the trigger rate. In fact, a new grain is triggered exactly when the previous grain has been played entirely (this is true only assuming a duration coefficient equal to 1, see below for more details). This basically equivalent to looping the selection.

#### Loop on/off

Starts/stops the automatic looping of the selection. A new MIDI message is triggered as the user flicks the loop switch. When a zero MIDI value is received, the looping is stopped; whereas when any MIDI value greater than zero is received, the looping is started.

#### Record

Starts recording of a new sample into Collidoscope from the microphone. A new MIDI message is triggered when the user pushes the record button. The MIDI value doesn't matter really: any value will start the recording, as long as it's received on MIDI controller number 5.

#### Filter

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A low-pass filter applied to the output of the granular synthesis engine. A new MIDI message is triggered as the user flicks the fader with sun and moon icons (original Collidoscope prototype) or moves the side knob up and down (new Collidoscope prototype).

The parameter controls the cut-off frequency and ranges from 22050 Hz (MIDI value 0) to 200 Hz (MIDI control value 127). So MIDI values are mapped from [0,127] range to [22050, 200] range.

### **Duration**

Controls the duration coefficient of each grains of the engine. A new MIDI message is triggered as the user flicks the fader with the dot and cloud icons (original Collidoscope prototype) or twists the side knob (new Collidoscope prototype).

The parameter ranges from 1 to 8. So MIDI values are mapped from [0,127] range to [1,8] range.

When the parameter value is 1, the duration of each grain is exactly the same as the selection size. This means that a new grain is triggered exactly when the previous grain has finished playing, which results in the selection being played as a loop.

When the coefficient is greater than one, then the grains last more than the selection's triggering rate. So a new grain is started before the previous grain has finished. This results in the overlaying of the different grains, which gives the peculiar character of the granular synthesis to the sound.