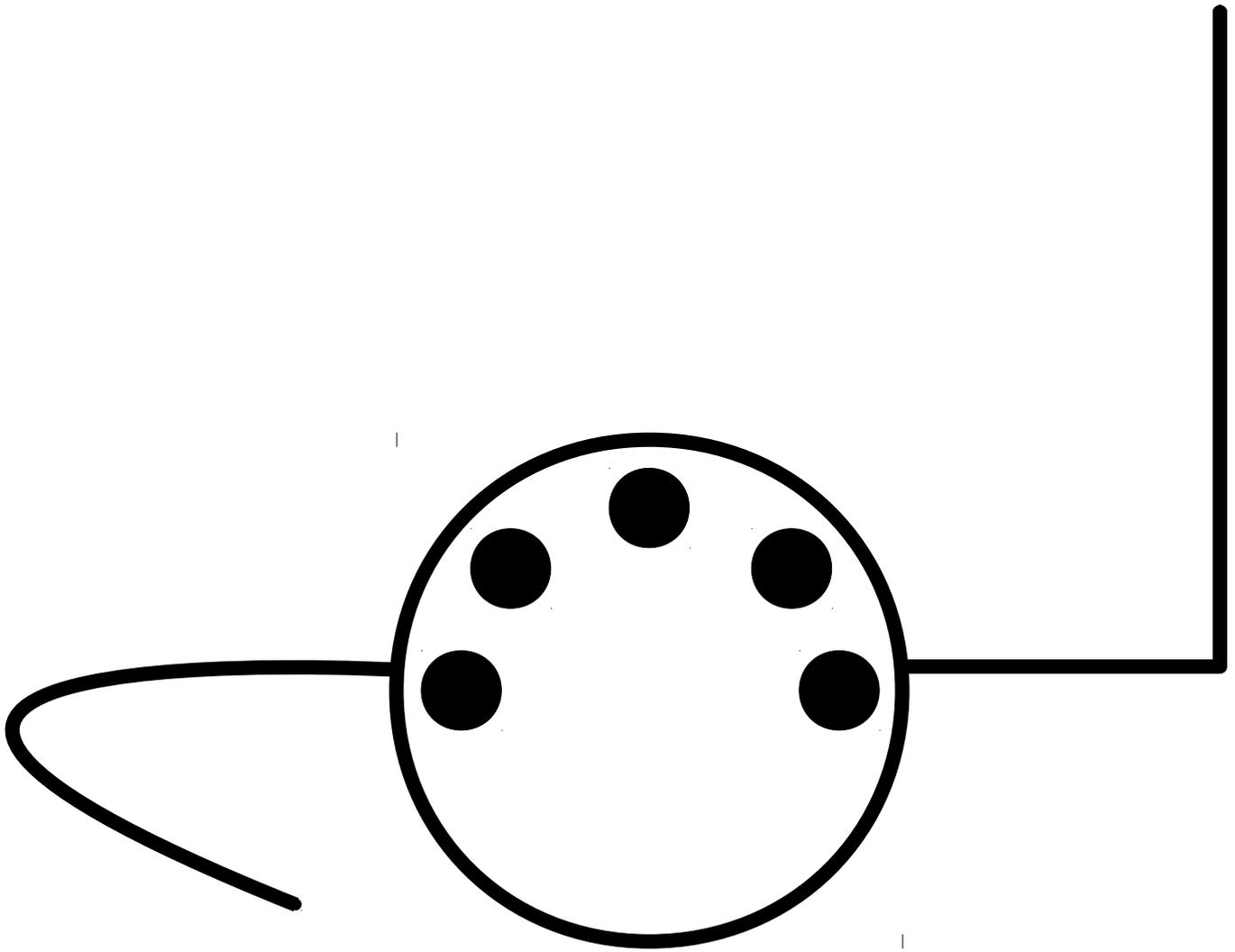


MIDI and Theremin

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Introduction

This document aims at describing what you can do with MIDI and theremins. It is destined to people who know what is a theremin and want to enhance their theremin performance by playing or controlling external devices thanks to the Musical Interface for Digital Instrument.

It presents what is a MIDI theremin, how you can connect it to other devices, how you can translate hand control into MIDI messages and how these messages are understood by external devices.

It shows also some specific situations in which you can use MIDI for your playing performance.

Notices:

- This document covers only MIDI 1.0 standard.
- The theremins on which I base my experience are Eric Wallin's D-Lev Digital Theremin and Urs Gaudens' Open Theremin V3 and V4 (alternative MIDI software written by the author of this document).

What is MIDI

I won't describe full MIDI standard here but just give a few basics. Please refer to existing literature from <https://www.midi.org/> for more detail.

MIDI is an acronym for Musical Interface for Digital Instrument. It is a quite old standard dating back to 1983 that was initially designed to connect together (keyboard) synthesizers. Some adaptation aimed at making it more versatile, allowing to use various controllers (other than keyboards), standardizing some aspect (e.g. General MIDI), etc... It recently evolved into MIDI 2.0 to cover more modern aspects of today's musical technology. However, MIDI 1.0 stays valid.

Physically, MIDI instruments are often recognized by their 5 pin DIN connectors: MIDI In, MIDI Out or MIDI Thru.



Today, these are sometimes replaced by a USB connector and more recent standard evolution also authorize use of TRS jacks for sake of miniaturization.

These connectors aim at connecting device in a master/slave scheme:



The master sends MIDI messages to the slave and the slave obey to these message in real time.

MIDI master can broadcast on 16 different channels. Only the slaves tuned on the appropriate channel will obey.

For example if the slave has following configuration:

- Channel 1: Piano
- Channel 2: Organ

It will play a piano sound for each message sent on channel 1 and an organ sound for each message sent on channel 2. It will ignore channel 3 to 16.

Last but not least, MIDI devices are not only “music instruments”, they can physical or virtual, running in a digital audio workstation (DAW) installed on a computer,...

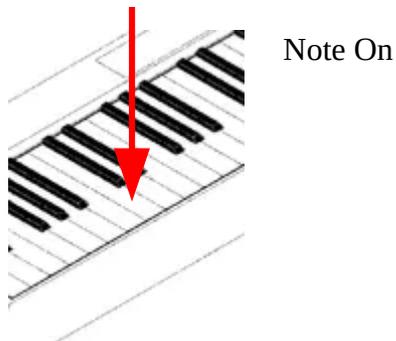
MIDI messages

Note On message

It contains the following information:

- Its Status is “Note On”
- Channel number (from 1 to 16)
- Note number (from 0 to 127)
- Velocity(from 0 to 127)

This message tells to the slave to start playing a note, with a given velocity on a given channel.

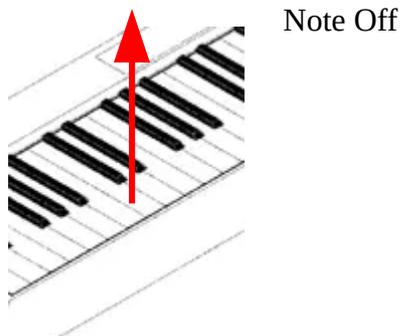


Note Off message

It contains the following information:

- Its Status is “Note Off”
- Channel number (from 1 to 16)
- Note number (from 0 to 127)
- Velocity(from 0 to 127)

This message tells to the slave to stop playing a note, on a given channel. Velocity is not much useful. The standard also specifies that a Note On with velocity = 0 will have same effect as a Note Off.



Pitch bend messages

It contains the following information:

- Its Status is “Pitch Bend”
- Channel number (from 1 to 16)
- Value (from 0 to 16383)

This message tells to the slave to change the pitch of notes played on a given channel.

Value = 8192 corresponds to center pitch. On most synth it is associated to the Pitch wheel.



The effect depends on Pitch Bend Range: how much pitch changes for maximum value of Pitch Bend.

This message is particularly interesting with the theremin: it allows to play a continuous pitch.

Continuous controller (CC) messages

It contains the following information:

- Its Status is “Continuous Controller”
- Channel number (from 1 to 16)
- Controller number (from 0 to 127)
- Value (from 0 to 127)

This message tells to the slave to change the value of an internal parameter (e.g. the CC #7 = volume). MIDI CC number can follow MIDI standard or may be assigned freely.

It generally corresponds to synth's buttons and knobs.

List of CC as per MIDI standard

CC # Decimal	CC # Hexadecimal	CC Description
0	00H	Bank Select
1	01H	Modulation wheel or lever
2	02H	Breath Controller
3	03H	Undefined
4	04H	Foot controller
5	05H	Portamento time
6	06H	Data entry MSB
7	07H	Channel Volume (formerly Main Volume)
8	08H	Balance
9	09H	Undefined
10	0AH	Pan
11	0BH	Expression Controller
12	0CH	Effect Control 1
13	0DH	Effect Control 2
14-15	0E-0FH	Undefined
16-19	10-13H	General Purpose Controllers (1-4)
20-31	14-1FH	Undefined
32-63	20-3FH	LSB for values 0-31
64	40H	Damper pedal (sustain)
65	41H	Portamento On/Off
66	42H	Sostenuto
67	43H	Soft pedal
68	44H	Legato Footswitch (w = 00-3F:Normal, 40-7F=Legatto)
69	45H	Hold 2
70	46H	Sound Controller 1 (default: Sound Variation)
71	47H	Sound Controller 2 (default: Timbre/Harmonic Intensity)
72	48H	Sound Controller 3 (default: Release Time)
73	49H	Sound Controller 4 (default: Attack Time)
74	4AH	Sound Controller 5 (default: Brightness)
75-79	4B-4FH	Sound Controllers 6-10 (no defaults)
80-83	50-53H	General Purpose Controllers (5-8)
84	54H	Portamento Control
85-90	55-5AH	Undefined
91	5BH	Effects 1 Depth (formerly External Effects Depth)
92	5CH	Effects 2 Depth (formerly Tremolo Depth)
93	5DH	Effects 3 Depth (formerly Chorus Depth)
94	5EH	Effects 4 Depth (formerly Celeste (Detune) Depth)
95	5FH	Effects 5 Depth (formerly Phaser Depth)
96	60H	Data increment
97	61H	Data decrement
98	62H	Non-Registered Parameter Number LSB
99	63H	Non-Registered Parameter Number MSB
100	64H	Registered Parameter Number LSB
101	65H	Registered Parameter Number MSB
102-119	66-77H	Undefined
120-127	78-7FH	Reserved for Channel Mode Messages

What is a MIDI theremin

A MIDI theremin can connect to other MIDI devices. By its “controller” nature, it is usually a master in the connection scheme:

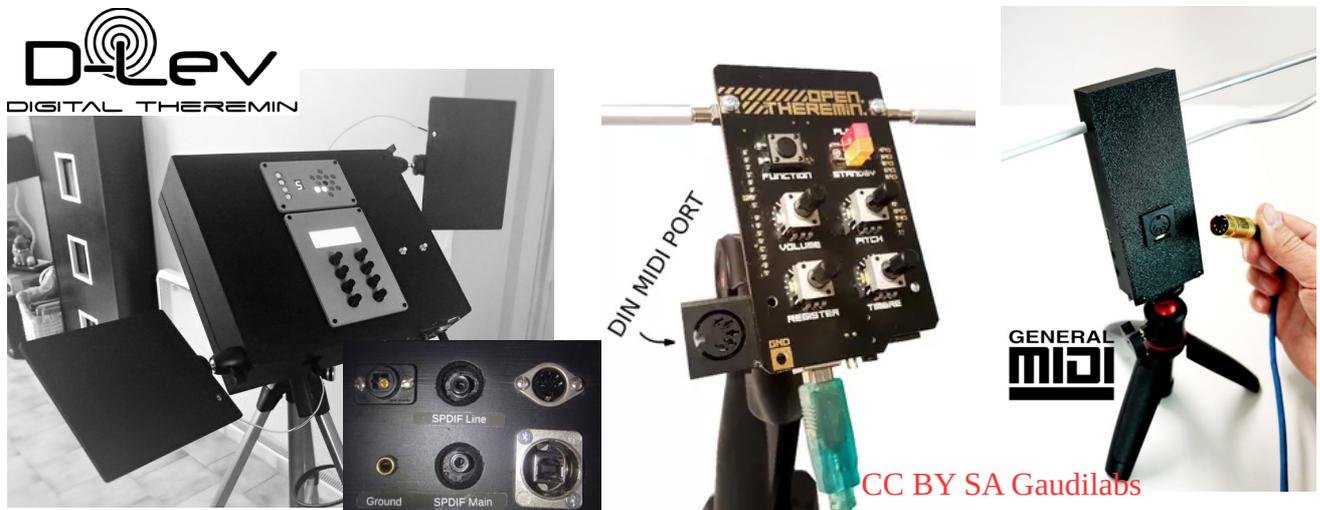


And, as a Master, it has a MIDI output (a physical DIN 5 MIDI OUT, or a USB MIDI out port recognized as such by a computer, etc ...) and can generate MIDI messages.

Although opposite situation may exist as well, if one wants to control theremin’s sound generation with an external device, we will only focus on the case where the theremin is the master in this document.

MIDI theremins on which is based this document:

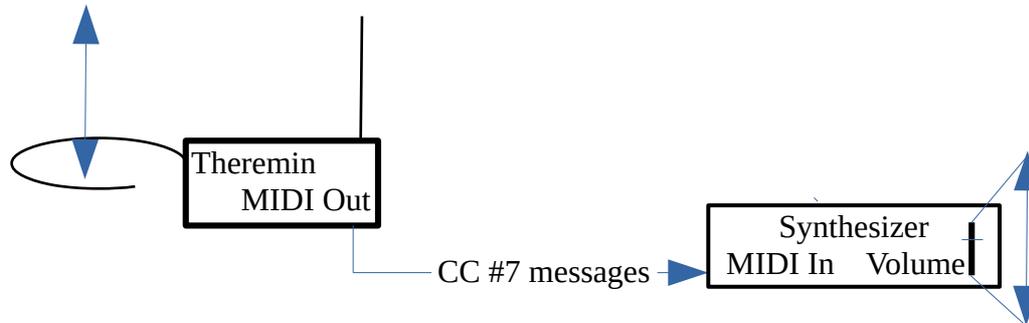
- D-Lev
- Open theremin V3 and V4 with MIDI



How works a MIDI theremin:

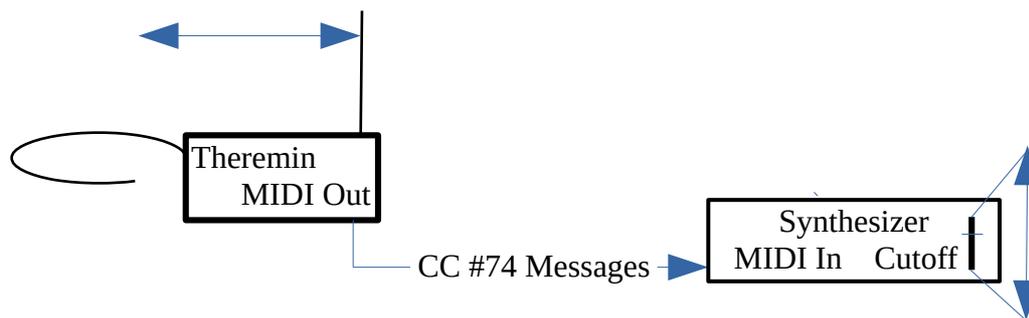
A MIDI theremin can generate continuous controller

For example you may assign volume CC #7 to your volume loop:



Volume will change on your synth as you move your left hand (provided that CC #7 is associated to volume in the synth).

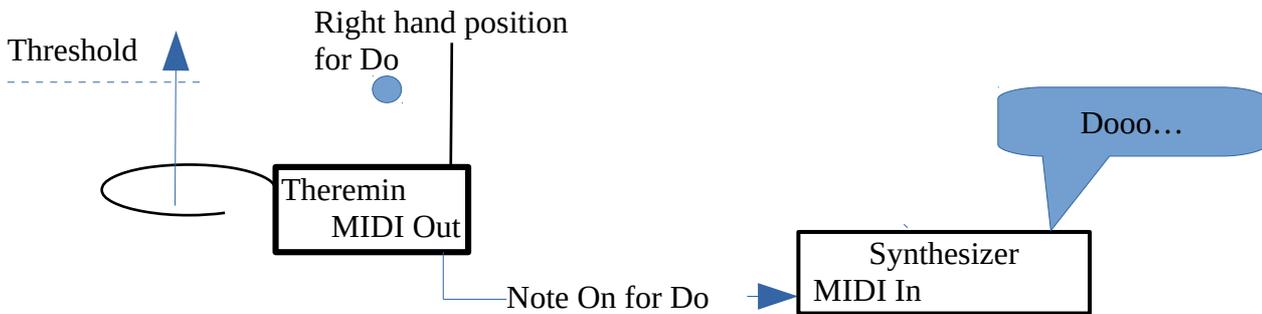
Or you may assign cutoff frequency of the filter CC #74 to your pitch rod:



Cutoff (brilliance) will change on your synth as you move your right hand (provided that CC #74 is associated to cutoff in the synth).

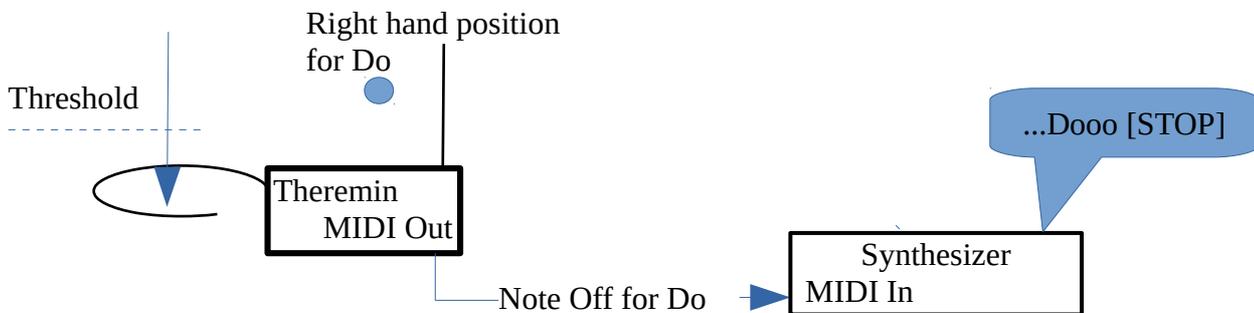
A MIDI theremin can generate Note On / Note off

If you move your left hand away from the volume antenna the MIDI theremin can detect it and generate a Note On message to tell to your external synth to start singing this note:

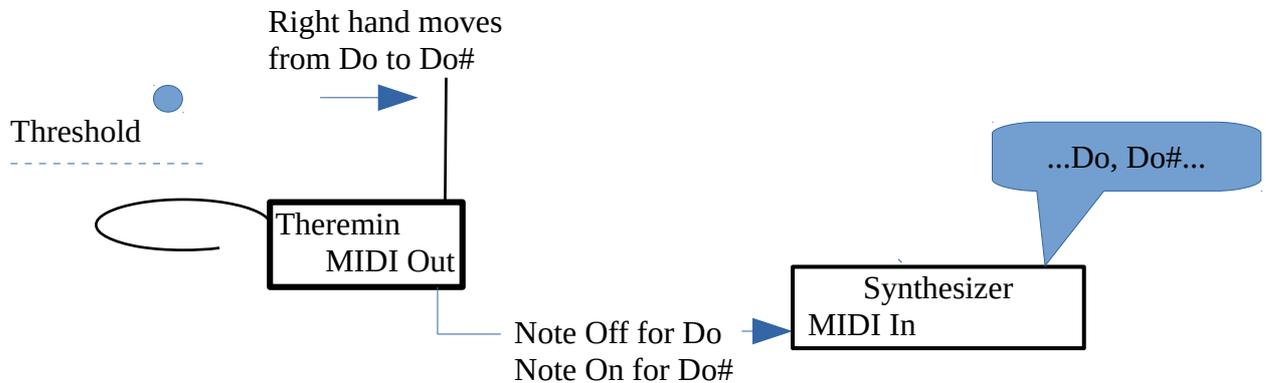


The note played depends on right hand position (a Do in the example). Velocity may depend on how fast you move left hand when generating the note.

If you approach your left hand close to the volume antenna, the MIDI theremin can detect it and generate a Note Off message to tell to your external synth to stop singing this note:

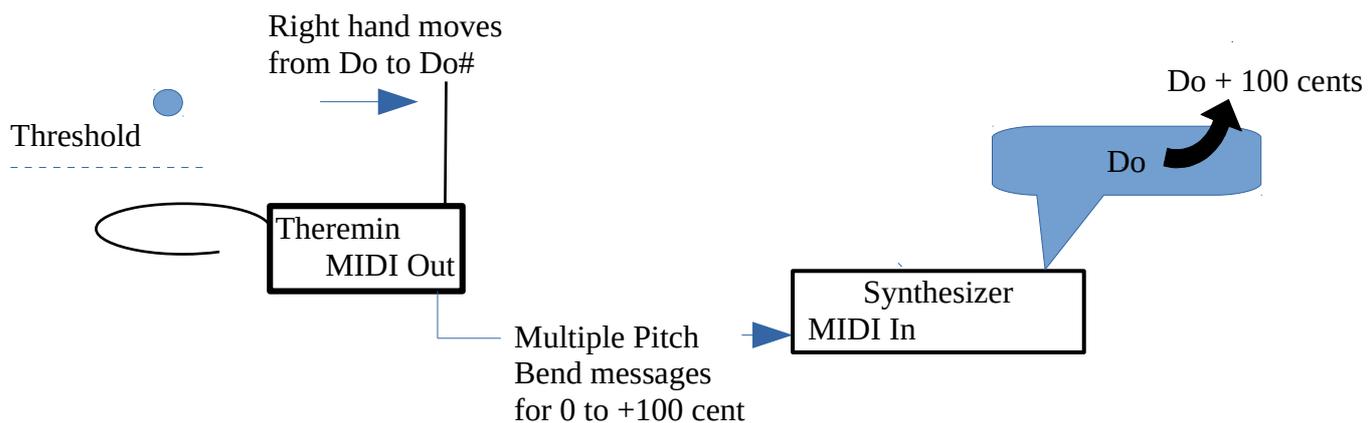


If you move your right hand after a note is played, you may (or may not) want that your theremin change the note following your right hand position:



A MIDI theremin can generate Pitch Bend

Rather than changing the note by step, just like in the previous example, the theremin can generate Pitch Bend messages for continuous pitch control:



Pitch Bend message are associated to a Pitch Bend Range: How much Pitch will change for the maximum value of Pitch Bend message. The Pitch Bend Range must be the same on Master and Slave for correct pitch interpretation.

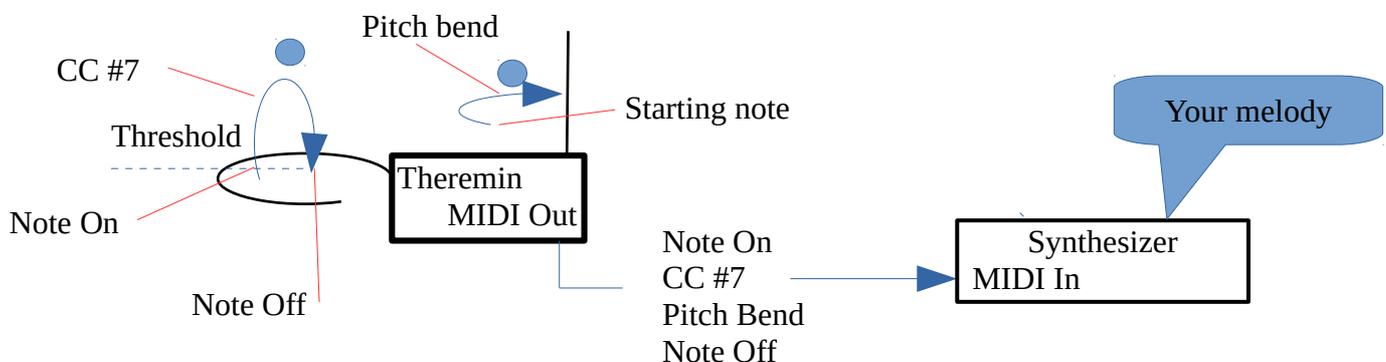
How to play a theremin voice on a synthesizers

The first approach you may have is probably to play another sound on the external synthesizers but keeping a theremin playing style. For example, you want that your theremin sounds like a violin and then you connect your theremin's MIDI Out to your synth's MIDI In and select the violin sound on this device. Well... It is not that simple!

Always remember that MIDI was initially designed for keyboards and their tempered scale. Then You need to find a trick to achieve your goal.

1st Method: Pitch Bended notes

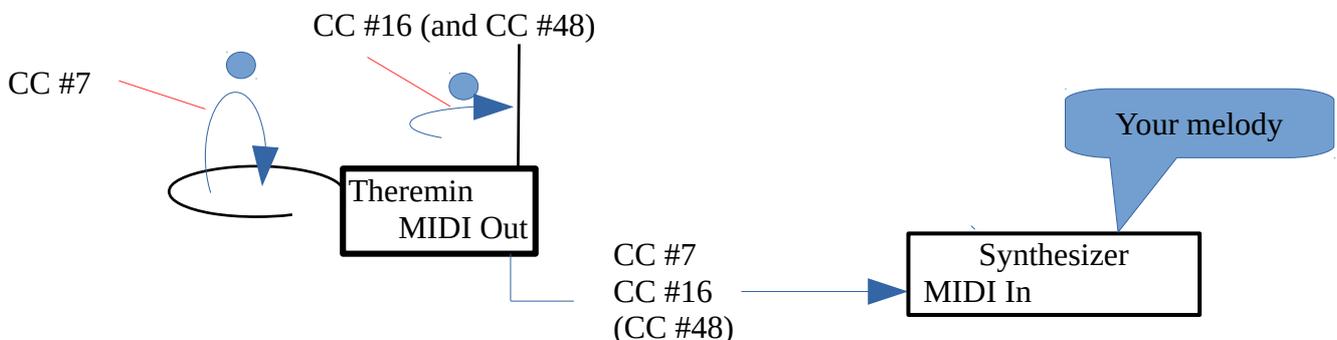
- Theremin configuration:
 - Channel = 1
 - Activate Pitch Bend messages.
 - Pitch Bend Range = **as high as possible** (1 octave minimum, 4 octave will be more than OK). The slave synth must handle such a Pitch Bend Range and be set in the same way (could be a limitation).
 - Note volume threshold as low as possible
 - Volume loop associated to CC #7
- Synth configuration:
 - Channel = 1
 - Accept Pitch Bend messages.
 - Pitch Bend Range = **same as the theremin** (default value is generally 200 cent – much too small!)
 - Volume associated to CC #7 (most probably already the case)



2nd Method: Free running oscillator and CC

The other method is inspired of analog synths and their continuous Control voltage. It requires a free running oscillator, I mean an oscillator that doesn't wait for a Note On message to run. Not so commonplace...

- Theremin configuration:
 - Channel = 1
 - You don't care about Note On/Off and Pitch Bend. (On open theremin, set Note Volume threshold as high as possible in order not to generate them).
 - Volume loop associated to CC #7
 - Pitch rod associated to CC #16 (and ideally to CC #48 – LSB, see CC table – for a 14 bit resolution and no audible step)
- Synth configuration:
 - Channel = 1
 - You need a free running oscillator having its frequency controlled by CC #16 (CC #48).
 - Ignore Pitch Bend messages.
 - Volume associated to CC #7 (most probably already the case)



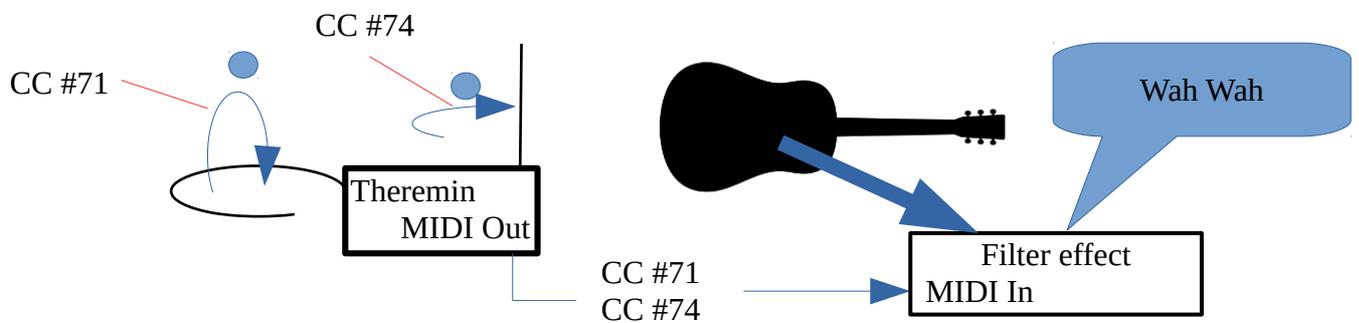
This method seems to be evident but you might have some difficulty to find a free running oscillator synth controlled by two CC combined in a 14bit resolution. If you're interested, you can try this Pure Data synth :<https://github.com/MrDham/Pure-Data-FM-Ribbon-Synth>. It is tailored for Open theremin with MIDI.

How to control effects with a theremin

You can control effects with a theremin:

- Theremin configuration:
 - Channel = 1
 - You don't care about Note On/Off and Pitch Bend. (On open theremin, set Note Volume threshold as high as possible in order not to generate them).
 - Volume loop associated to CC #y
 - Pitch rod associated to CC #x
- Effect configuration:
 - Channel = 1
 - A parameter associated to CC#y
 - A parameter associated to CC#x

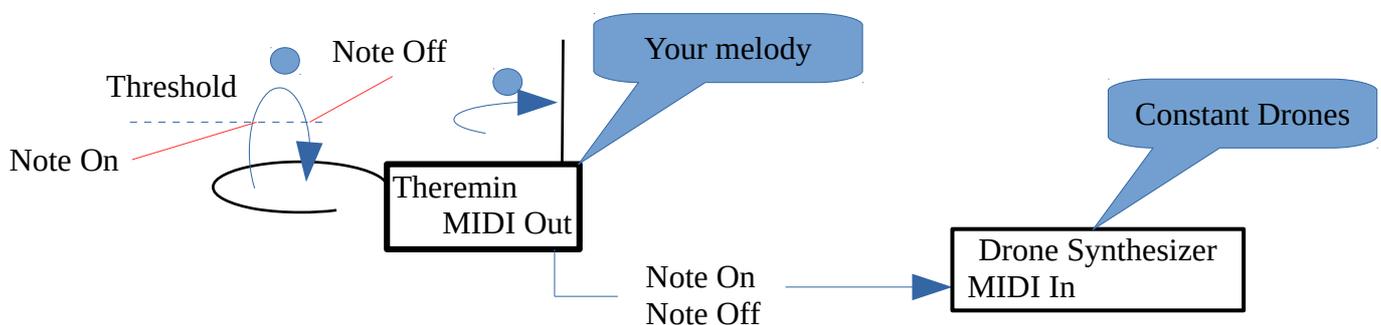
For example we may choose CC #y = 71 (Resonance) and CC #x = 74 (Cutoff) to get a wah-wah effect.



How to play drones along your theremin melody

Your Theremin has already very good sound but you want to play along some constant notes (drones).

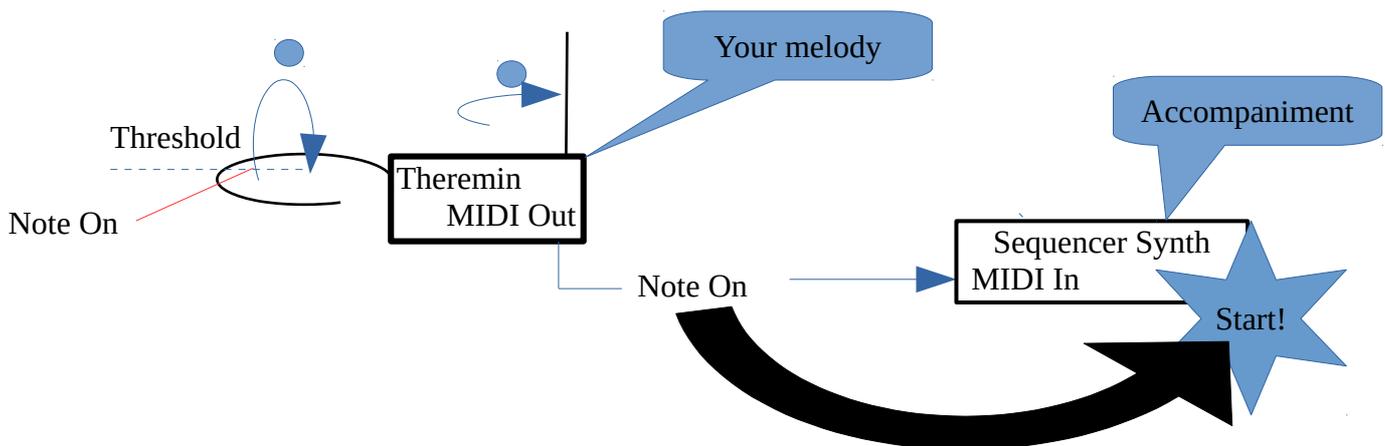
- theremin configuration:
 - Channel = 1
 - De-activate Pitch Bend messages.
 - Configure theremin so as it doesn't change the MIDI note when the pitch changes.
 - Volume threshold to an appropriate level (depends on attack of drone sound)
 - Velocity sensitivity to an appropriate level (depends on attack of drone sound)
- Synth configuration:
 - Channel = 1
 - Ignore Pitch Bend messages.
 - Optional: filter note out of the scale.



How to synchro-start an accompaniment

Imagine that you have created a sequence to accompany yourself when you are playing. You push start and you need to run to your theremin to be in position to play in time... Impossible. Here is the solution: trigger the start of the sequence with the first note on you play.

- Theremin configuration:
 - Channel = 1
 - Note volume threshold as low as possible
- Sequencer synth configuration:
 - Activate synchro start on Note On from channel 1
 - Don't synchronize sequencer stop with Note Off messages. Manual stop is probably more convenient.
 - Configure your sequencer synth so as it doesn't play the notes as such.

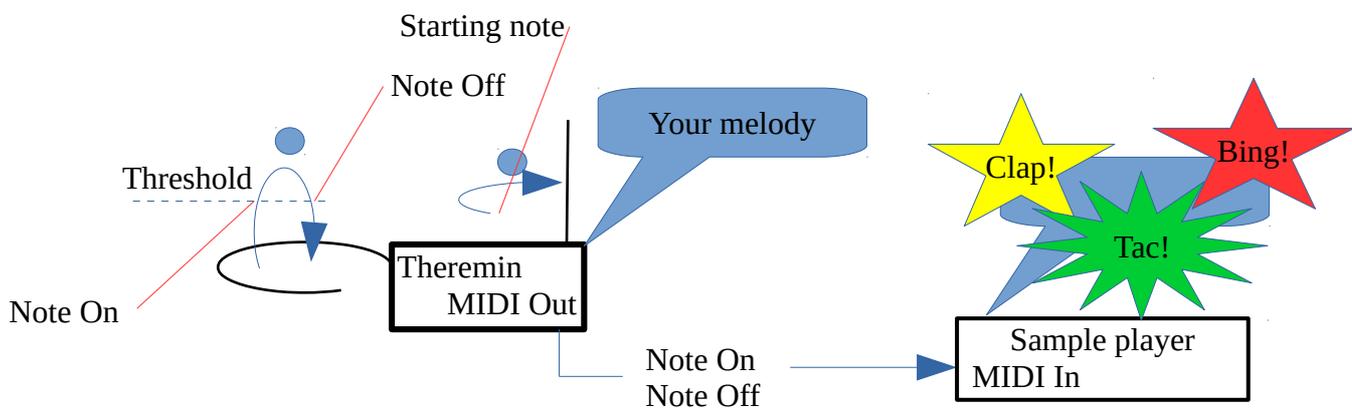


In this use case you don't care about which precise note you are playing, it is just the event that a note is played that triggers the accompaniment. If you are not playing straight on at beginning of the sequence, just stay under audible limit. Else, of course, you will have to start in tune.

How to play samples along your theremin melody

You might be interested in triggering some noises, short sequences, chords while you play the theremin. Here is the method that I use with sfz sample player (www.sfzformat.com).

- theremin configuration:
 - Channel = 1
 - Most of the time Pitch Bend messages are useless. De-activate them.
 - Configure theremin so as it doesn't change the MIDI note when the pitch changes.
 - Volume threshold to an appropriate level (depends on attack of sample sound)
 - Velocity sensitivity to an appropriate level (depends on attack of sample sound)
- Sampler configuration:
 - Channel = 1
 - You might choose to ignore (or not) note number, to play different samples for each note depending on note number, to play different samples in sequence,...



For example, create “Clap-Tac-Bing.sfz” with this text:

```
// Sequence
<group> seq_length=3 pitch_keytrack=0 loop_mode=one_shot
<region> seq_position=1 sample=Clap.wav
<region> seq_position=2 sample=Tac.wav
<region> seq_position=3 sample=Bing.wav
```

Ignore note number

Ignore Note Off

Put “Clap.wav”, “Tac.wav” and “Bing.wav” (record your own voice into *.wav file) in the same folder and open the *.sfz file with a sfz sample player. It will play “Clap”, “Tac” and “Bing” in sequence each time you rise your left hand.

Conclusion

Using MIDI with theremins opens many doors. Feel free to use any tips from this document. Explore, experiment, be creative!