

Goblin-EXP

Installation, Configuration and Usage

This document describes the installation (page 2 - 4), configuration (page 5 - 7) and usage (page 8 - 11) of the Goblin-EXP MIDI mod version 1.0.3/1.0.4 For a description of the product, its features and further information visit: <https://oscillatordevices.com/goblin>

Electrical Properties

Electrical Properties	Min	Typ	Max	
Supply Voltage (+9V terminal)	7	9	20	VDC
Current Consumption	3	10	30	mA
Maximum voltage at RLY, LED, SW , EXPA and EXPW terminals			5	VDC
Output voltage at SW terminals			5	VDC

The Goblin-EXP has reverse polarity protection at the +9V terminal. Be careful nonetheless to not reverse polarity upon installation, as long as other wires are connected. Negative currents could flow through the microcontroller and damage it.

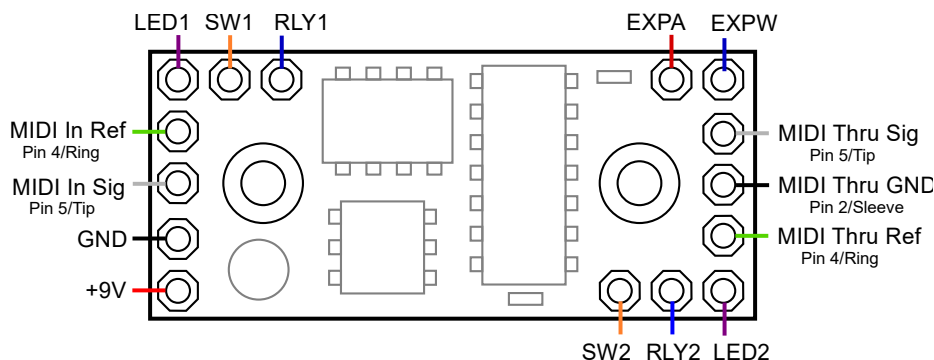
Attention: Digital signals, such as MIDI signals, can lead to crosstalk on other lines. This particularly applies to effects with multiple gain stages (distortion, fuzz, etc.). Pay attention to keep the MIDI wires as far away from the analog circuit as possible. Otherwise it can happen that a click can be heard in the audio signal with every MIDI command. To further reduce possible crosstalk, use shielded wires.

Overview

The *Goblin-EXP* is made to take control over effects devices that are controlled with non latching SPST (or (ON)-OFF) switches, as well as control expression inputs. The original switch is connected to the Goblin and the Goblin is connected to the effects devices instead. The Goblin then emulates a footswitch. The effects device can then be triggered via MIDI or with the foot switch.

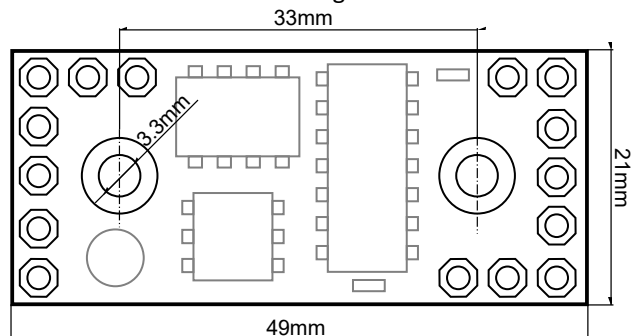
The Goblin-EXP has two identical ports to control two individual switches, as well as one expression port. Here's a quick overview over the connections:

- **+9V/GND:** This is the power supply. Connect them directly to the DC jack of the guitar pedal.
- **SW1/2:** This is where one side of the foot switch is connected. The other side has to be connected to GND.
- **RLY1/2:** This is the connection to the guitar effects. Connect it to where the foot switch was originally connected. It emulates the foot switch.
- **LED1/2:** This is the connection for the status monitoring. It has to be connected to a voltage that represents the state of the guitar effects. The Goblin measures this voltage to determine the state. Most of the time it is connected to one side of the LED.
- **MIDI Sig:** This is the active MIDI signal. It is connected to **Pin 5** of a DIN 5-PIN MIDI Connector, or **Tip** if a TRS connector according to MIDI standard (Type A) is used.
- **MIDI Ref:** This is the reference MIDI signal. It is connected to **Pin 4** of a DIN 5-PIN MIDI Connector, or **Ring** if a TRS connector according to MIDI standard (Type A) is used.
- **MIDI GND:** This is the GND signal for MIDI Thru. It is connected to **Pin 2** of a DIN 5-PIN MIDI Connector, or **Sleeve** if a TRS connector according to MIDI standard (Type A) is used. Note that only MIDI Outputs have a connection to GND. Do not connect GND to the MIDI Input.
- **EXPA/EXPW:** Connection to a 50kΩ digital potentiometer. EXPW is the wiper, one side is connected to GND, the other to EXPA.



Mechanical Properties

Height is approx. 10mm. If using the Goblin Screw set, account at least for 15mm height.



Installation

The installation consists of two parts. The actual wiring, which is described in this chapter, and the configuration described in chapter Configuration.

Ports and Roles

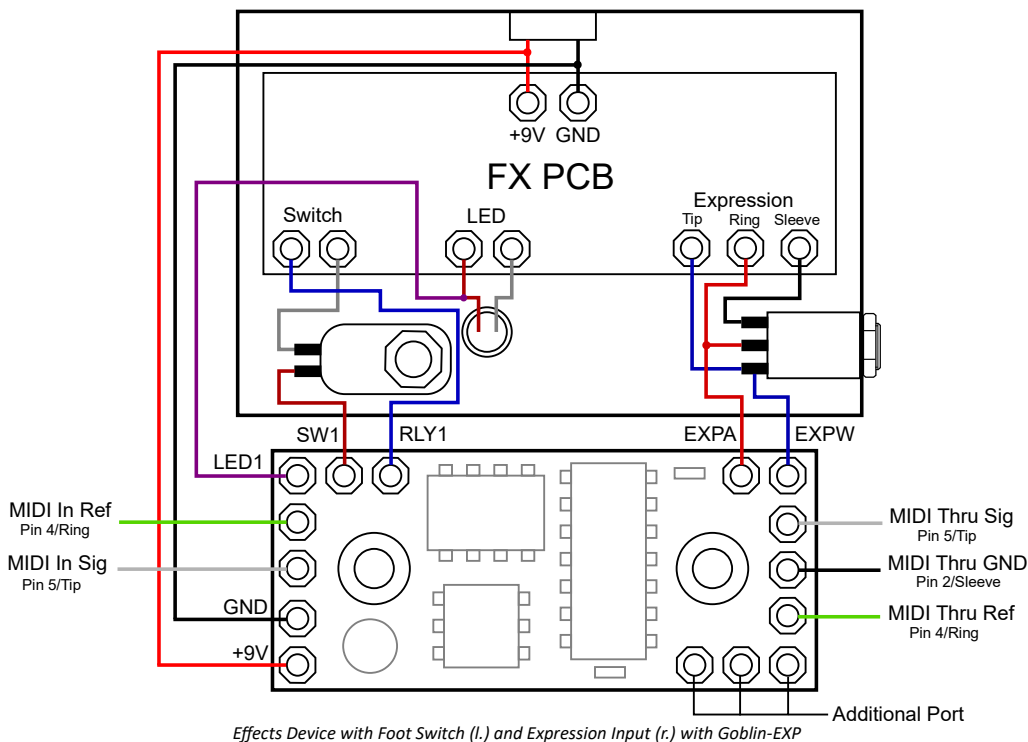
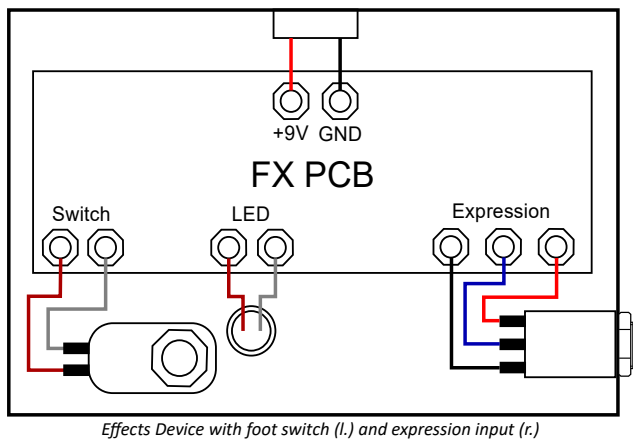
The installation depends on how the three ports of the Goblin are used, i.e. what *Role* they have.

- Role **Switch**: A switch is, for example, a conventional bypass switch or a tap tempo switch.
- Role **TRS**: In the role of *TRS*, the Goblin imitates an external switch with “Ring” and “Tip” (often marked with Footswitch, Ext-Ctl, CTL, EXT). The two lines can be open or closed to GND. This way, external switch connections can be operated from inside the device.
- Role **Expression**: Port 3's default role in the **Goblin-EXP**. A digital 5V potentiometer to control expression functions.

Port 1 and 2 are able to take on any role, port 3 is always *Expression*. If a bypass switch is available, port 1 should be used for this in order to make the configuration easier.

Installation for Role Switch and Expression

In the images below you can see an example of an effects device with a non latching SPST foot switch and an expression input. The first image depicts the device before installation, the image after that shows the wiring for that particular case.



Switch Connection (SW)

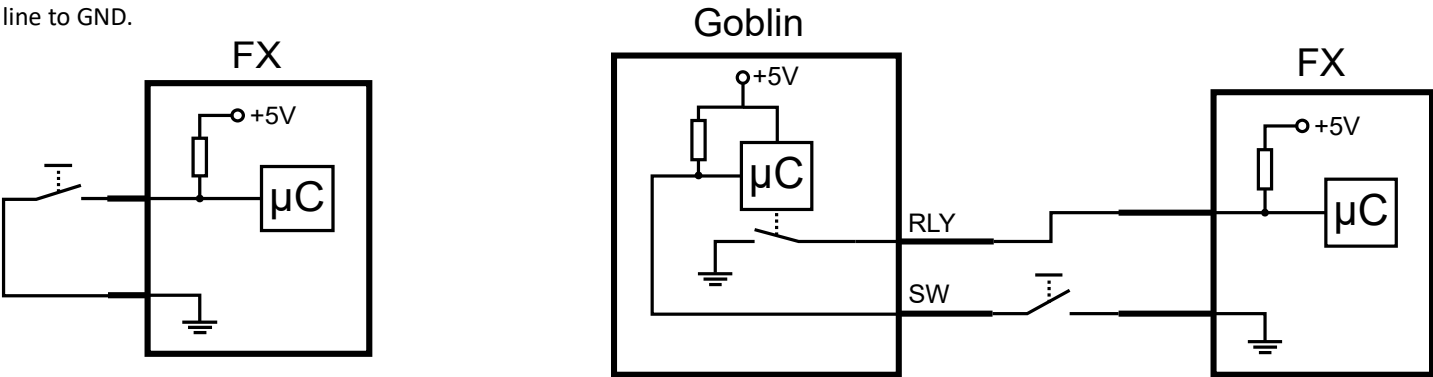
The connection SW is for connecting a non latching SPST switch. All SW terminals have internal 5V pull ups. The other side of the switch has to be connected to GND, so the switch connects SW to GND, when closed.

For regular cases, like the one above, the active (or high) side of the switch has to be disconnected from the effects device and connected to the Goblin, while the GND side stays connected. Measure both sides with a DMM, do not rely on wire colors.

Most switches are normally open. In rare cases there are normally closed switches. Refer to chapter Configuration for further information.

PCB connection (RLY)

The connection RLY emulates a switch. For that it connects to GND for a brief moment. In the picture on the left you can see a typical effects device switching scheme. A microcontroller detects the switching, when the 5V line is pulled to GND via the switch. On the right you can see how the Goblin connects to that scheme. Instead of the switch, the internal microcontroller of the Goblin pulls the line to GND.



Before connecting the Goblin it is important to control, that the voltage on the effects device does not exceed 5V. Below is fine.

Status monitoring connection (LED)

With the connection SW and RLY the FX device can be switched by the Goblin. If you're dealing with a Tap Tempo switch, or anything else that doesn't have a particular state (like on or off) you're done now.

If you're dealing with say, a bypass switch, simple switching is not enough. The state is important and the Goblin needs to know that state to carry out an "on" or "off" command. For that the Goblin can measure a voltage and determine the current state by that. The only thing needed for that is a voltage that changes with the state of the effects device and is not higher than 5V. In most cases the voltage of the LED is perfect for that.

To find out to which pin of the LED the Goblin has to be connected to, proceed as follows:

1. Switch the effects device **on** and measure the voltage on both pins of the LED relative to GND.
2. Switch the effects device **off** and measure the voltage on both pins of the LED relative to GND.
3. On one of the pins the voltage changes. Connect this pin to LED on the Goblin. Write down the measured voltages, we need them later.

Here is a real world example of the EQD White Light. Two pins of the LED (called A and B) are measured to GND:

	Effects device on	Effects device off
Pin A	0V	0V
Pin B	1.8V	0V

For this example, Pin B would be used for the LED connection.

Expression Connection (EXP)

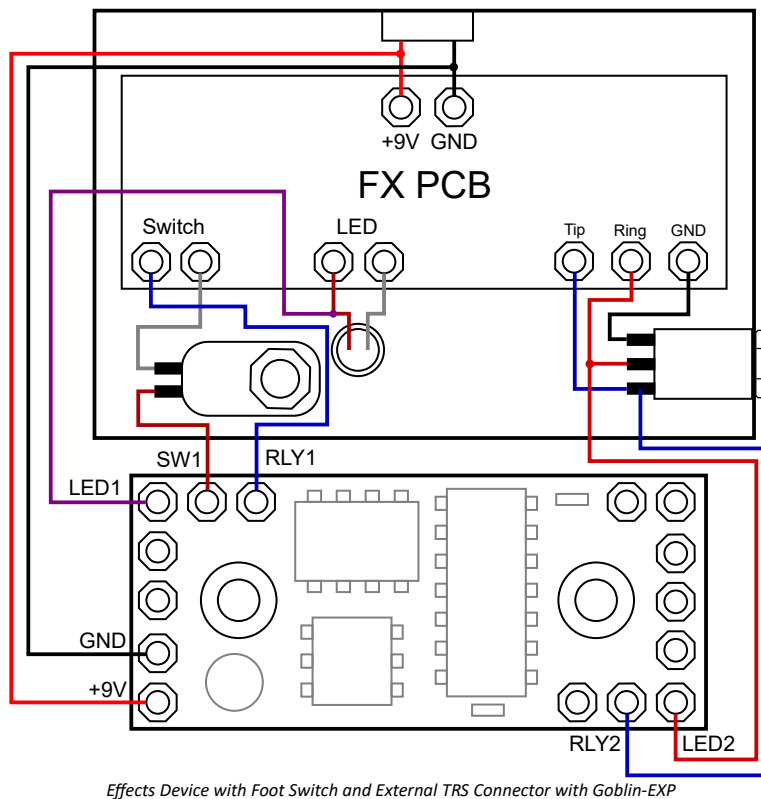
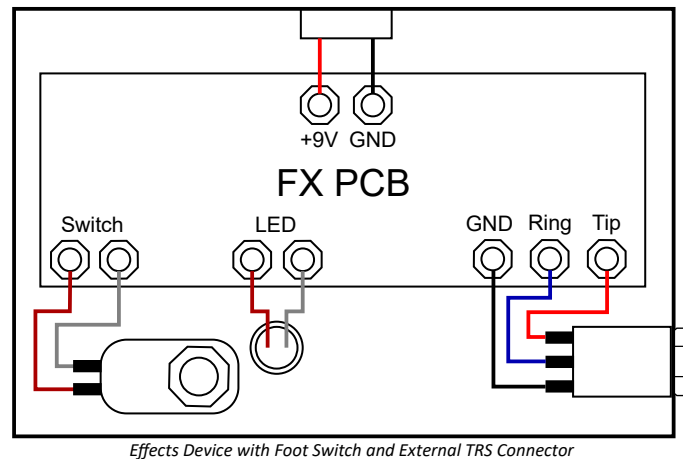
The two connections *EXPW* (for Expression Wiper) and *EXPA* (for Expression Active) are connected to the expression socket as shown in the figure. This is the standard wiring used in common effect devices. A constant voltage (usually 5V, sometimes less, very rarely more) is applied to the ring and thus to *EXPA*; a voltage reduced by the voltage divider is returned to *EXPW*, which represents the state of the expression pedal.

Many effect devices only react to the expression signals when a plug is plugged in. This can be eliminated with a suitable piece of shrink tubing over the contacts, or by inserting a dummy plug.

Depending on the effects device, the starting state of the potentiometer must be set in order to achieve correct function without MIDI control. See chapter Initial state of potentiometer.

Installation for Role TRS

Besides foot switches, the Goblin-EXP can control external foot switch connections, like connections for external tap tempo switches, Strymon FAV-Switches etc. In the image below is a typical effects pedal with a bypass foot switch (left) and a TRS socket for an external foot switch (right).



For a Port in the Role TRS the wiring is very simple. The corresponding lines are connected to the pins of the socket. To operate the switch, the Goblin either leaves the lines open (switch open) or closes them to GND (switch closed).

TRS can be configured as *Normally Open* and *Normally Closed*. With *Normally Open*, the two lines are open at system start and pulses are executed as Open → Closed → Open. With *Normally Closed*, the lines are closed to GND at system start and pulses are executed as Closed → Open → Closed.

Configuration

In order to be able to adapt the Goblin to as many effects devices as possible, various parameters can be set via the configuration procedure. **The configuration is always carried out via MIDI CC messages and consist of 4 messages per parameter.** The actual configuration message, two passcode messages and a save message. The configuration messages are described below. For passcode and save message, see chapter Saving the Configuration.

Roles

The role of a port describes the function that the Goblin performs. For a detailed explanation, see chapter Ports and Roles.

CC	#	Function
Port 1: 27 Port 2: 47 Port 3: 67	0	Disabled
	1	N.A.
	2	Switch (Default setting)
	3	Tap Tempo (Like Switch, but w/o defined state)
	4	TRS Normally Open
	5	TRS Normally Closed

LED Polarity

In the *Switch* role, the polarity must be set according to the measured values from chapter Status monitoring connection (LED).

- Low Active: Voltage below the LED threshold is recognized as "On".
- High Active: Voltage above the LED threshold is recognized as "On".

In the example above, the LED polarity is "High Active" because when the effects device is active, the voltage is high.

CC	#	Function
Port 1: 28 Port 2: 48 Port 3: 68	0	Low Active
	1	High Active (Default setting)

LED Threshold

The Goblin monitors the voltage on the active side of the LED for the *Switch* role. Depending on whether the threshold is exceeded or not, the status is recognized as "on" or "off". Since LED voltages can vary greatly, the threshold can be set for each port.

The Threshold must be set according to the measured values in chapter Status monitoring connection (LED). Set it to half way between the on and off value. In the example above the LED threshold would be half way between 0V and 1.8V, that'd be 0.9V.

CC	#	Function
Port 1: 29 Port 2: 49 Port 3: 69	n	LED threshold in 0.05V steps. Default is 24 (=1.2V)

MIDI Channel via MIDI command

The MIDI channel can easily be set with one of the footswitches. If that's not possible, it can be set with MIDI commands.

CC	#	Function
6	0	Set MIDI channel to Omni (reacts to every channel)
6	1...16	Set MIDI channel to channel 1...16

MIDI Channel via Switch

When setting the MIDI channel with one of the foot switches, port 1 is used by default. If another port is to be used, this can be set with the following command.

CC	#	Function
7	1/2/3	Change the port for the MIDI channel setting to port 1, 2, or 3

For the instructions to set the MIDI channel using the switch, see the User Guide at: <https://oscillatordevices.com/goblin>

Startup Delay

Some effects devices need some time to power up. This ranges from a few milliseconds to several seconds. So the Goblin can correctly restore the last state and the boot process of the effects device is not disturbed, a delay at the beginning can be useful.

CC	#	Function
8	n	Startup delay n*100 ms (Default n = 5)

Please note that a pressed button is immediately processed as soon as the Goblin is connected to the supply voltage, regardless of the startup delay, but depending on the polarities set.

Sensitivity of the MIDI Clock Detection

For commands that use automatic MIDI Clock detection, the sensitivity for resending the pulses can be set or the feature can be deactivated entirely. Raising the sensitivity is only necessary for systems with very high MIDI clock jitter.

CC	#	Function
5	0-16	Sensitivity (default = 12) 0 = Deactivated 1 = Very low sensitivity 16 = Very High sensitivity

Initial state of potentiometer

The initial state of the potentiometer can be set, so that the pedal can be used normally when it is not being operated with MIDI. The correct setting depends on the pedal.

CC	#	Function
59	n	0 = Open: The potentiometer is not connected to the terminals 1 = Toe (default setting) 2 = Heel

Configuration bits

The following configuration bits are only necessary in extremely exceptional cases. They allow more in-depth configuration. Each port has a set of identical configuration bits. Some settings are available as single commands. The following 5 parameters are set with a 7-bit word:

CC	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2-0
	POL-LED	FX-DRIV	POL-FX	POL-SW	ROLE
Port 1: 19 Port 2: 39 Port 3: 59	Polarity of the LED 0 = Low Active 1 = High Active (*)	Driver function of port 0 = Push Pull 1 = Open Drain (*)	Polarity of FX 0 = Normally Closed 1 = Normally Open (*)	Polarity of Switch 0 = Normally Closed 1 = Normally Open (*)	Role of the port 0 (000): Disabled 2 (010): Switch (*) 3 (011): Tap Tempo 4 (100): TRS Normally Open 5 (101): TRS Normally Closed

(*) = Default setting

- **ROLE:** The role of the port. See Roles
- **POL-SW:** Switch polarity. *Normally open* switches are used most of the time.
- **POL-FX:** Polarity of the FX. Usually this value is set to the same value as *POL-SW*. Only for role *Switch* and *Tap Tempo*.
- **FX-DRIV:** The FX side (connection RLY) usually expects a positive voltage of 5V or lower, that is briefly pulled to GND in order to switch the effect. If this is not the case (e.g. OBNE Dark Star) the Goblin can drive the + 5V high state itself. To do this, set this bit to *Push Pull*. Only for role *Switch* and *Tap Tempo*.
- **POL-LED:** The LED Polarity. See LED Polarity

It should be noted that these settings must always be made together. The entire word is always used.

There is a [spreadsheet](#) to help with calculation of the configuration bits and LED threshold.

Saving the Configuration

In order to save the above configurations, the following three commands must be called immediately one after the other. If another command is sent in between, the saving sequence is aborted. The effects device must be restarted for the changes to take effect.

CC	#	Function
9	18	1. passcode message for the saving sequence
9	52	2. passcode message for the saving sequence
9	0-9	Save messages: 0 Saving the Startup delay 1 Saving the role, led polarity and configuration bits of port 1 2 Saving the role, led polarity and configuration bits of port 2 3 Saving the initial state of the potentiometer 4 Saving the LED threshold of port 1 5 Saving the LED threshold of port 2 6 Saving the LED threshold of port 3 7 Saving the port for the MIDI channel setting with a switch 8 Saving the MIDI channel from command CC 06 9 Saving the Sensitivity of the MIDI Clock detection

Example: To set an LED threshold of 1.8V for port 2, the following four commands are sent back-to-back:

CC 49 36 -> CC 09 18 -> CC 09 52 -> CC 09 05

Dual Color LEDs

If the indicator LED is dual color, the LED inputs of port 1 and port 2 can be used together on port 1. One color is then connected to *LED1* and the other to *LED2*. To activate this feature, the role of **port 2 must be *Disabled*** and the **LED threshold value of port 2 must be set to 0**.

Recommended installation order

Here's a short guide how to get started with the installation:

1. Disassemble the effects device, find the positive and negative pins on the supply voltage and connect the +9V and GND connections to it.
2. Measure the connections of the foot switches and find the "active side" i.e. the pin of the switch that changes its voltage when the switch is pressed. Desolder the wire from the active side of the foot switch. Connect the loose end to RLY and connect the free pin of the foot switch to SW. The effects device should work now as before.
3. Measure both pins of the LED in the on and off state. Find the pin, that changes it's voltage when changing state, connect the LED connection of the Goblin there. Determine LED polarity and LED threshold like in chapter ***Status monitoring connection (LED)***.
4. Connect the MIDI sockets. Test if MIDI Thru works. Send a toggle command (CC 10 02) and check if there is any reaction. MIDI has to work before proceeding to the next step.
5. With the collected data figure out the configuration (if necessary) and send the configuration commands. Test.
6. Mount the Goblin and assemble the pedal.

Troubleshooting

The most common mistake during installation is the wrong configuration of the LED threshold value and/or the LED polarity. If this is not set correctly, the effect can be operated with the switch, but via MIDI the on and off command doesn't work properly. In this case, check the configuration and repeat the measurement if necessary. Also make sure that you have measured against GND!

To help with the configuration you can use the spreadsheet at:

https://oscillatordevices.com/doc/oscillator_devices_configuration_helper.xlsx

Usage

MIDI Channel

The *Goblin*'s MIDI channel is selectable. To change the MIDI channel, proceed as follows

1. Disconnect the device from the power supply
2. Press the button of the configuration port (normally port 1) and restore the power supply while it is pressed. The device starts to flash its LED after the startup delay has elapsed.
3. Press the button according to the number of the desired channel (e.g. twice for channel 2). The Goblin acknowledges this by emitting short flashing impulses according to the number of the channel.
4. Once the desired channel is set, press the button and hold it down until the Goblin switches off completely.
5. Disconnect supply voltage. The next time the Goblin is started, it reacts to the selected MIDI channel.

To put the Goblin in omni mode (i.e. it responds to every channel) skip step 3.

MIDI Commands for Role Switch

It is possible to switch port 1 and port 2 to a defined state at the same time. If one or more ports are not switches, they are ignored. If one of the switches doesn't have a defined state, use Role *Tap Tempo* to prevent it from switching when using this command.

CC	#	Port1	Port 2
00	00	Off	Off
	01	On	Off
	02	Off	On
	03	On	On
	04	Off	Off
	05	On	Off
	06	Off	On
	07	On	On

In addition, the ports can be controlled individually. The command "Hold", or MIDI clock synchronous commands, are interrupted by pressing the switch.

CC Port1	CC Port2	#	Function	#	Function
10	30	00	Port off	15	Toggle to the beat of the MIDI clock in 1/32 notes
		01	Port on	16	Toggle to the beat of the MIDI clock in 1/2 notes
		02	Port toggle (e.g. tap tempo)	17	Toggle to the beat of the MIDI clock in whole notes
		03	Port hold (Corresponds to a pressed and held switch)	18	Toggle to the beat of the MIDI clock every 2nd whole note
		04	Port release (Release held switch)	19	Toggle to the beat of the MIDI clock every 3rd whole note
		10	Toggle to the beat of the MIDI clock in 1/4 notes	20	Toggle to the beat of the MIDI clock every 4th whole note
		11	Toggle to the beat of the MIDI clock in 1/8 notes	21	Toggle to the beat of the MIDI clock every 5th whole note
		12	Toggle to the beat of the MIDI clock in triplet notes	22	Toggle to the beat of the MIDI clock every 6th whole note
		13	Toggle to the beat of the MIDI clock in 1/16 notes	23	Toggle to the beat of the MIDI clock every 7th whole note
		14	Toggle to the beat of the MIDI clock in dotted 1/8 notes	24	Toggle to the beat of the MIDI clock every 8th whole note

Some effects devices react strangely when a tap tempo signal is constantly being sent. There is the possibility to only give a limited number of impulses. Enough for the effect to take over the beat. With these commands, an automatic MIDI clock detection is carried out. If the MIDI clock changes by more than approx. 1%, the pulses are sent again. The sensitivity of the MIDI clock detection can be configured (see chapter Sensitivity of the MIDI Clock Detection).

CC Port1	CC Port2	#	Function	#	Function
11	31	0-19	1-20 times toggle to the beat of the MIDI clock in 1/4 notes	100-104	1-5 times toggle to the beat of MIDI clock 1/2 notes
		20-39	1-20 times toggle to the beat of the MIDI clock in 1/8 notes	105-109	1-5 times toggle to the beat of the MIDI clock every whole n.
		40-59	1-20 times toggle to the beat of the MIDI clock in triplet notes	110-114	1-5 times toggle to the beat of MIDI clock every 2nd whole n.
		60-79	1-20 times toggle to the beat of the MIDI clock in 1/16 notes	115-119	1-5 times toggle to the beat of MIDI clock every 4th whole n.
		80-99	1-20 times toggle to the beat of the MIDI clock in dot. 1/8th n.	120-124	1-5 times toggle to the beat of MIDI clock every 8th whole n.

MIDI Commands for Role TRS

If the port is in the role of an external switch (TRS, EXT, CTL etc.), this port then has two lines, referred to as "Tip" and "Ring", which emulates a plugged in external switch. This switch can be *Normally Open (NO)* or *Normally Closed (NC)*, which is set during configuration (see chapter Roles).

Line-specific Commands

Each line has a set of identical commands.

CC Tip	CC Ring	#	Function	#	Function
Port1: 10 Port2: 30	Port1: 20 Port2: 40	00	Set „Open“		
		01	Set „Closed“		
		02	Single pulse		
		03	Toggle		
		10	Pulse MIDI clock 1/4	30	Toggle MIDI clock 1/4
		11	Pulse MIDI clock 1/8	31	Toggle MIDI clock 1/8
		12	Pulse MIDI clock triplets	32	Toggle MIDI clock triplets
		13	Pulse MIDI clock 1/16	33	Toggle MIDI clock 1/16
		14	Pulse MIDI clock dotted 1/8	34	Toggle MIDI clock dotted 1/8
		15	Pulse MIDI clock 1/32	35	Toggle MIDI clock 1/32
		16	Pulse MIDI clock 1/2	36	Toggle MIDI clock 1/2
		17	Pulse MIDI clk every whole note	37	Toggle MIDI clock every whole note
		18	Pulse MIDI clk every 2nd whole note	38	Toggle MIDI clock every 2nd note
		19	Pulse MIDI clk every 3rd whole note	39	Toggle MIDI clock every 3rd note
		20	Pulse MIDI clk every 4th whole note	40	Toggle MIDI clock every 4th note
		21	Pulse MIDI clk every 5th whole note	41	Toggle MIDI clock every 5th note
		22	Pulse MIDI clk every 6th whole note	42	Toggle MIDI clock every 6th note
		23	Pulse MIDI clk every 7th whole note	43	Toggle MIDI clock every 7th note
		24	Pulse MIDI clk every 8th whole note	44	Toggle MIDI clock every 8th note

Pulse

It is also possible to send a certain number of pulses, e.g. to select a preset.

CC-Tip	CC-Ring	#	Function
Port1: 11 Port2: 31	Port1: 21 Port2: 41	0	1 pulse
		1	2 pulses
		n	n+1 pulses
		127	128 pulses

MIDI Clock Pulse

Some Tap Tempo effects react strangely when the Tap Tempo Pulse is sent continuously. It is therefore possible to only send a limited number of pulses until the effects device has recognized the tempo. With these commands, an automatic MIDI clock detection is carried out. If the MIDI clock changes by more than approx. 1%, the pulses are sent again automatically. The sensitivity of the MIDI clock detection can be configured (see chapter Sensitivity of the MIDI Clock Detection).

CC-Tip	CC-Ring	#	Function	#	Function
Port1: 12 Port2: 32	Port1: 22 Port2: 42	0-19	1-20 pulses MIDI clock 1/4 notes	100-104	1-5 pulses MIDI clock 1/2 notes
		20-39	1-20 pulses MIDI clock 1/8 notes	105-109	1-5 pulses MIDI clock every whole note
		40-59	1-20 pulses MIDI clock triplet notes	110-114	1-5 pulses MIDI clock every 2nd whole note
		60-79	1-20 pulses MIDI clock 1/16 notes	115-119	1-5 pulses MIDI clock every 4th whole note
		80-99	1-20 pulses MIDI clock dotted 1/8 notes	120-124	1-5 pulses MIDI clock every 8th whole note

Pulse Length

The standard length of a pulse is approx. 80 ms. If this is too short for some devices, the pulse length can be set in 10 ms steps.

CC-Tip	CC-Ring	#	Function
Port1: 15 Port2: 35	Port1: 25 Port2: 45	n	Pulse length in 10ms steps

MIDI Commands for Role Expression

Only Port 3 of the Goblin-EXP can act as Expression.

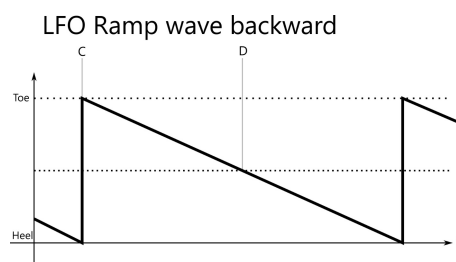
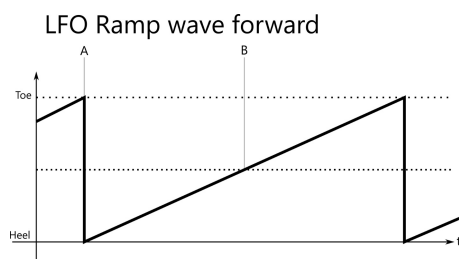
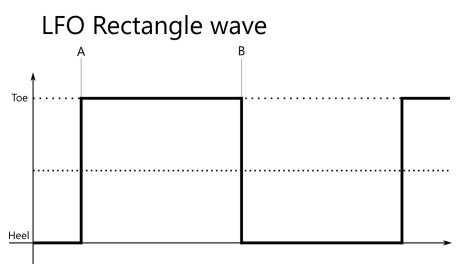
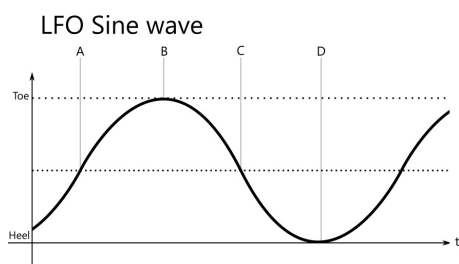
CC	#	Function
50	0...127	Expression out from heel (0) to toe (127)
51	0...127	Expression out from toe (0) to heel (127)
52	0...127	Expression out from heel (0) to middle position (127)
53	0...127	Expression out from middle position (0) to toe (127)

LFO-Waveforms

In addition, the Goblin-EXP has an internal, MIDI clock synchronous, LFO engine with 3 waveforms to drive the Expression/CV.

CC	#	Function
60	0	Stop LFO
	1	Restart LFO
	10	LFO sine wave with starting point A
	20	LFO sine wave with starting point B
	30	LFO sine wave with starting point C
	40	LFO sine wave with starting point D

CC	#	Function
60	50	LFO rectangle wave with starting point A
	60	LFO rectangle wave with starting point B
	90	LFO ramp forward with starting point A
	100	LFO ramp forward with starting point B
	110	LFO ramp backward with starting point C
	120	LFO ramp backward with starting point D



The LFO starts immediately at the specified start point. Resending the commands will reset the engine to start over from the starting point.

LFO-Speed

The speed of the LFO relative to MIDI clock can be increased or decreased. The commands above perform one pass of the waveform per 1/4 note. The commands to change the speed are determined by adding to the basic command (CC 60 10, CC 60 20 etc.).

- Basic Command: Normal speed
- Basic Command+1: Half speed
- Basic Command+2: Double speed
- Basic Command+3: Quarter speed
- Basic Command+4: Quadruple speed

For example:

CC	#	Function
60	10	LFO sine wave with starting point A, speed normal (1/4 Note)
	11	LFO sine wave with starting point A, half speed (1/2 Note)
	12	LFO sine wave with starting point A, double speed (1/8 Note)
	13	LFO sine wave with starting point A, quarter speed (Ganze Note)
	14	LFO sine wave with starting point A, quadruple speed (1/16 Note)

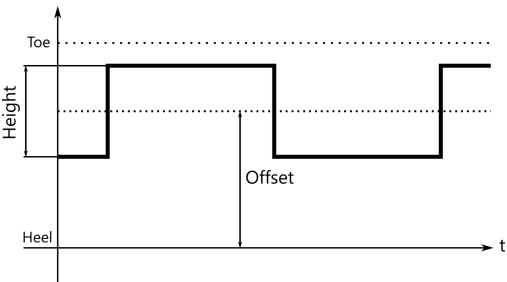
This procedure can be applied to all waveforms and starting points. E.g. rectangle with starting point B in 1/8 notes: CC 60 62.

LFO-Parameter

The waveforms set this way always run through the entire range, from heel to toe. The range can be reduced and moved.

The waveforms are shifted in 13 steps, with step 6 being the waveform in the middle. This corresponds to the *Offset* in the graphic.

CC	#	Funktion
61	00	Offset 0. The middle of the waveform is at Heel
	60	Offset middle: The middle of the waveform is right between the heel and toe (default)
	120	Offset Max: The middle of the waveform is at Toe



All values in increments of 10 are valid.

- Basic Command: Normal Height
- Base Command+1: Half Height
- Base Command+2: Quarter Height
- Base Command+7: Height 1/128

For example:

CC	#	Funktion
61	60	No constraint on height, waveform sweeps full range (default)
	61	Waveform height halved
	62	Waveform height 1/4
	63	Waveform height 1/8
	...	
	67	Waveform height 1/128

The *Offset* and *Height* settings are global, so they persist across a new waveform. Reset with CC 61 60.