syntaxis

micromodular

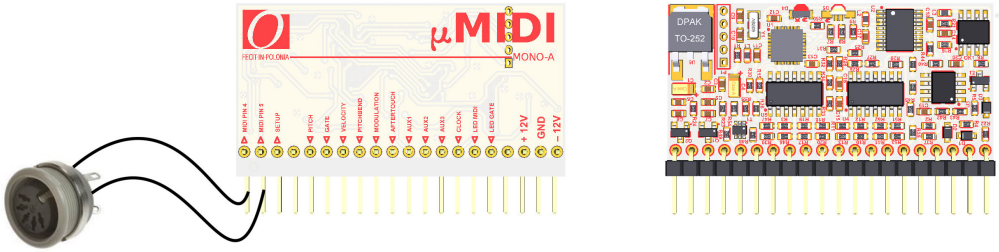
μMIDI

MONO·8·16·MONO·A

full functionality of a midi keyboard

translated to flexibly configurable and unbeatably accurate voltages

and more...!



1 Description

μMIDI$_{\text{MONO·8·16·MONO·A}}$ is a monophonic MIDI-to-CV converter in the form of a compact micromodule, offering eight high-precision control voltages plus GATE and CLOCK signals. The module is designed to translate the complete set of control signals produced by a MIDI keyboard into control voltages for an analog synthesizer. In addition to PITCH, GATE, VELOCITY, AFTERTOUCH, PITCHBEND, MODULATION, and SUSTAIN messages, which are handled by default, 3 user-selectable CC controllers may be assigned to three auxiliary CV channels.

The device receives MIDI signal through standard, disturbance-safe UART (DIN) input, what also simplifies integration with user circuits including digital part.

Thanks to the on-board 8-channel 16-bit analog-to-digital converter, the module offers eight CV outputs of uncompromising accuracy with output voltage step being at the level of 0.3mV! This allows to achieve pitch voltage precision of less then $\frac{1}{2}$ cent and full 14-bit resolution of control voltages, even when the output range is reduced to $\frac{1}{4}$ of the maximal one.

All CV outputs except PITCH may be configured to generate control voltage in any range within the limits of $-10V \div +10V$ with the choice of 5 response curves and polarity.

The 1V/Oct PITCH output range is $0 \div 10V$, what translates to 10 octaves, with additional possibility to choose the lowest C note corresponding to 0V. Hz/V pitch voltage standard is also provided.

A unique feature of uMIDI-MONO-A is its ability to generate pitch voltages corresponding not only to the most commonly used tempered intonation, but also to 12 natural intonations. There is more: the user may define up to 3 custom intonations, by adjusting the CV curve in arbitrary way, even for each separate note in the whole keyboard. Custom intonations may also be used to adjust the PITCH output for a specific voltage controlled oscillator in order to compensate its nonlinearity.

2 Features

- 8 highest-precission voltage outputs provided by 8-channel 16-bit digital-to-analog converter
- all keyboard control sources handled: PITCH, GATE, VELOCITY, PITCHBEND, AFTERTOUCH, MODULATION, SUSTAIN
- PITCHBEND voltage accessible independently and/or summed with PITCH voltage
- VELOCITY, PITCHBEND, AFTERTOUCH, MODULATION channels may be also reassigned to arbitrary CC controls
- 3 auxiliary CV channels CV1, CV2, CV3 for user assignable CC controls
- PITCH output precision: $\frac{1}{2}$ cent
- PITCH CV standards: 1V/Oct or Hz/V
- 3 user intonations allow to shape the pitch CV curve in arbitrary way
- pitch deviation vector allows to define pitch shifts for each note in the octave
- custom intonations allow to map independently each MIDI note to arbitrary voltage with $\frac{1}{2}$ cent precision
- 14-bit control messages handled with true 14-bit resolution on all CV channels
- output voltage smoothing for low-resolution controlers
- configurable voltage range on all CV channels, max: -10V ÷ +10V
- 5 response curves to choose on all CV channels
- portamento
- user configurable midi clock translation
- MIDI channel selection and OMNI mode
- GATE, CLOCK and MIDI activity signals exposed for external LEDs
- two configuration methods: keyboard and MIDI (with Bank Select, Program Change and CC messages)
- easy to handle UART (DIN) MIDI input
- power supply voltage: $\pm 12V$ to $\pm 15V$
- dimensions: 50.8mm x 26.7mm

3 Input/Output

pin	label	description	range [V]
1	▷ MIDI PIN 4	pin 4 of MIDI DIN5 connector	
2	▷ MIDI PIN 5	pin 5 of MIDI DIN5 connector	
3	▷ SETUP	SETUP MODE selection (protected)	$0V \div +15V$
5	◁ PITCH	pitch CV output (not protected)*	$0V \div +10V$
6	◁ GATE	GATE signal output (protected)	$0V \div +5V$
6	◁ VELOCITY	VELOCITY CV output (protected)	$-10V \div +10V$
8	◁ PITCHBEND	PITCHBEND CV output (not protected)*	$-10V \div +10V$
9	◁ MODULATION	MODULATION CV output (protected)	$-10V \div +10V$
10	◁ AFTERTOUCH	AFTERTOUCH CV output (protected)	$-10V \div +10V$
11	◁ CV1	CV1 CV output (protected)	$-10V \div +10V$
12	◁ CV2	CV2 CV output (protected)	$-10V \div +10V$
13	◁ CV3	CV3 CV output (protected)	$-10V \div +10V$
14	◁ CLOCK	CLOCK output (protected)	$0V \div +5V$
15	◁ LED 1	output for exernal LED 1 (protected)	$0V \div 3.3V$
16	◁ LED 2	output for exernal LED 2 (protected)	$0V \div 3.3V$
18	$+12 \div +15$V	positive power supply	$+12V \div +15V$
19	GND	GND	
20	$-12 \div -15$V	negative power supply	$-12V \div -15V$

* PITCH and PITCHBEND outputs are not protected, otherwise output voltages would not be accurate: they would depend on reciver's impedance.

4 PERFORMANCE MODE and SETUP MODE

PERFORMANCE MODE is for playing music while SETUP MODE is for configuring the device.

The device is in SETUP MODE if at least one of the following conditions is met:

- positive voltage ($+5V \div +15V$) is applied to the SETUP pin.
- The device received a BANK SELECT message with either LSB or MSB set to 1.

The device is in PERFORMANCE MODE if both of the following conditions are met:

- The SETUP pin is connected to GND or unconnected.
- The device received a BANK SELECT message with both MSB and LSB different than 1 or did not receive any BANK SELECT message.

The default mode the device starts in is PERFORMANCE MODE.

LED indicators have diffent functions in PERFORMANCE MODE and SETUP MODE:

SETUP MODE

LED1 (blue)	**LED2 (red)**	**meaning**
OFF	ON	the device is in setup mode, no parameter selected
ON	OFF	the device is in setup mode, parameter selected, ready for editing the value
ON	ON	the device is in setup mode, parameter selected, waiting for further information (user intonations, pitch deviations, see below)

PERFORMANCE MODE

LED1 (blue) MIDI activity or uMIDI clock depending on the value of parameter LED 1

LED2 (red) gate

5 Summary of parameters

no	parameter	value	meaning	default
0	midi channel	1÷16	MIDI channel used to communicate with the device	1
1	omni mode	0÷1	0–off, 1–on	1
2	V/Oct or Hz/V	0÷1	0–V/Oct, 1–Hz/V	0
3	0V C note (V/Oct)	0÷9	C note corresponding to 0V (V/Oct)	0
4	1V C note (Hz/V)	0÷9	C note corresponding to 1V (Hz/V)	4
5	gate polarity	0÷1	0–high when open, 1–low when open	0
6	gate retrigger	0÷1	0–off, 1–on (see section **??**)	0
7	note-off velocity	0÷1	note-off velocity ignored (0) or handled (1)	0
8	portamento on	0÷1	0–off, 1–on	0
9	portamento rate	0÷127	0–no portamento, 127–longest rate	0
10	sustain on	0÷1	0–off, 1–on	0
11	pitchbend range	0÷60	semitones	2
12	pitchbend to pitch	0÷1	pitchbend mixed (1) or not (0) to pitch voltage	1
13	key priority	0÷2	0–last key, 1–lowest key, 2–highest key	
14	clock multiplier	0÷96		24
15	clock polarity	0÷1	0–positive, 1–negative	0
16	LED 1	0÷1	0–MIDI activity, 1–clock	0
20	velocity min voltage	−10000÷+10000	in millivolts	0
21	velocity max voltage	−10000÷+10000	in millivolts	5000
22	velocity curve	0÷4	0–lin, 1–exp, 2–log, 3–tanh, 4–atanh	0
23	velocity smoothing	0÷1	0–off, 1–on	1
24	velocity alt CC	0÷127	0–velocity, 1-127–alternative CC	0
30	pitchbend min voltage*	−10000÷+10000	in millivolts	0
31	pitchbend max voltage*	−10000÷+10000	in millivolts	5000
32	pitchbend curve*	0÷4	0–lin, 1–exp, 2–log, 3–tanh, 4–atanh	0
33	pitchbend smoothing*	0÷1	0–off, 1–on	1
34	pitchbend alt CC	1÷127	0–pitchbend, 1-127–alternative CC	0
40	aftertouch min voltage	−10000÷+10000	in millivolts	0
41	aftertouch max voltage	−10000÷+10000	in millivolts	5000
42	aftertouch curve	0÷4	0–lin, 1–exp, 2–log, 3–tanh, 4–atanh	0
43	aftertouch smoothing	0÷1	0–off, 1–on	1
44	aftertouch alt CC	1÷127	0–aftertouch, 1-127–alternative CC 0	
50	modulation min voltage	−10000÷+10000	in millivolts	0
51	modulation max voltage	−10000÷+10000	in millivolts	5000
52	modulation curve	0÷4	0–lin, 1–exp, 2–log, 3–tanh, 4–atanh	0
53	modulation smoothing	0÷1	0–off, 1–on	1
54	modulation alt CC	1÷127	0–modulation, 1-127–alternative CC	0
60	CV1 min voltage	−10000÷+10000	in millivolts	0
61	CV1 max voltage	−10000÷+10000	in millivolts	5000
62	CV1 curve	0÷4	0–lin, 1–exp, 2–log, 3–tanh, 4–atanh	0
63	CV1 smoothing	0÷1	0–off, 1–on	1
64	CV1 CC number	1÷127	CC number for CV1 channel	0
70	CV2 min voltage	−10000÷+10000	in millivolts	0
71	CV2 max voltage	−10000÷+10000	in millivolts	5000
72	CV2 curve	0÷4	0–lin, 1–exp, 2–log, 3–tanh, 4–atanh	0

73	CV2 smoothing	0÷1	0–off, 1–on	1
74	CV2 CC number	1÷127	CC number for CV2 channel	
80	CV3 min voltage	−10000÷+10000	in millivolts	0
81	CV3 max voltage	−10000÷+10000	in millivolts	5000
82	CV3 curve	0÷4	0–lin, 1–exp, 2–log, 3–tanh, 4–atanh	0
83	CV3 smoothing	0÷1	0–off, 1–on	1
84	CV3 CC number	1÷127	CC number for CV3 channel	
90	pitch deviation	−12000÷+12000	in cents	
91	user intonation 1	−12000÷+12000	in cents	
92	user intonation 2	−12000÷+12000	in cents	
93	user intonation 3	−12000÷+12000	in cents	

* PITCHBEND parameters: min voltage, max voltage, curve, and smoothing are only in effect when PITCHBEND channel is used for alternative CC controller.

6 SETUP MODE commands

Setup commands may be executed by pressing a combination of keys for at least 1 second or alternatively by sending MIDI CC messages.

command	**keyboard**	**MIDI**	**effect**
SELECT	2 keys (>1s)	Program Change	select parameter to edit
STORE	a major chord (>1s)	CC 102 (66H)	store current value, unselect parameter
UNDO	a minor chord (>1s)	CC 103 (67H)	undo changes, unselect parameter
EXIT	a diminished chord (>1s)	CC 104 (68H)	unselect parameter
RESET	4 consecutive white keys (>1s)	CC 105 (69H)	reset parameter to default value
RESET ALL	8 consecutive white keys (>1s)	—	reset all parameters to their default values
SHOW VALUE	1 white key (>1s)	CC 106 (6AH)	show the value of currently edited parameter
SHOW PROGRAM	1 black key (>1s)	CC 107 (6BH)	show current program

6.1 SELECT

The SELECT command selects the parameter to edit.

Keyboard — Press two keys for at least 1 second, see below for details. Short blink of both LEDs will indicate that one second has passed.

MIDI — Send a Program Change message with the parameter's number. Program n selects the parameter no. n.

Number encoding

Keyboard keys denote numbers:

C	C#	D	D#	E	F	F#	G	G#	A	A#	B
0	1	2	3	4	5	6	7	8	9	10	11

When two keys are pressed, the lower key translates to the number of tens, the higher key translates to the number of ones. For example:

lower key	higher key	value
C2	E3	4
C2	E2	4
F#2	D3	62
A2	C3	90
A2	C7	90

You can use keys in any octaves. The only thing that matters is which key is lower and which is higher.

6.2 STORE

The STORE command saves the parameter's value in permanent memory.

Keyboard — Press any major chord for at least 1 second. Short blink of both LEDs will indicate that one second has passed.

MIDI — Send Control Change message with controller number 102, data byte is ignored.

6.3 UNDO

The UNDO command cancels all modifications of a parameter made since the last STORE command and restores the value saved in permanent memory.

Keyboard — Press any minor chord for at least 1 second. Short blink of both LEDs will indicate that one second has passed.

MIDI — Send Control Change message with controller number 103, data byte is ignored.

6.4 EXIT

This action unselects the parameter being edited. Its current value is retained but not saved in permanent memory.

Keyboard — Press any diminished chord for at least 1 second. Short blink of both LEDs will indicate that one second has passed.

MIDI — Send Control Change message with controller number 105, data byte is ignored.

6.5 RESET

The RESET command resets the parameter's value to the default.

Keyboard — Press 4 consecutive white keys for at least 1 second. Short blink of both LEDs will indicate that one second has passed.

MIDI — Send Control Change message with controller number 104, data byte is ignored.

6.6 SHOW VALUE

The SHOW VALUE command displays the current value of a parameter by means of a sequence of LED blinks. The number of 1000s (longest blink) is shown first, then the number of 100s, 10s, and 1s (shortest blink).

The red LED (LED 2) blink denotes positive number, the blue LED (LED 1) denotes negative number.

It does not make much sense to provide exact durations of LED blinks encoding 1000, 100, 10, and 1. You will learn it when using the device.

Keyboard	Press 1 white key for at least 1 second. Short blink of both LEDs will indicate that one second has passed.
MIDI	CC 106 (send Control Change message with controller number 106, data byte is ignored)

6.7 SHOW PROGRAM

The SHOW PROGRAM command displays the current program number in the same way as SHOW VALUE.

Keyboard	Press 1 black key for at least 1 second. Short blink of both LEDs will indicate that one second has passed.
MIDI	CC 107 (send Control Change message with controller number 107, data byte is ignored)

7 Modifying parameter's value

Keyboard

Values are modified using increment/decrement commands issued by pressing white or black keys for a short time - **less than 1 second**. White keys are used to increment the value. Black keys are for decrementing the value. The more keys are pressed simultaneously the bigger the step:

1 white key (<1s)	increment by 1
2 white keys (<1s)	increment by 10
3 white keys (<1s)	increment by 100
4 white keys (<1s)	increment by 1000
5 white keys (< 1s)	increment by 10000
1 black key (<1s)	decrement by 1
2 black keys (<1s)	decrement by 10
3 black keys (<1s)	decrement by 100
4 black keys (<1s)	decrement by 1000
5 black keys (<1s)	decrement by 10000

Additionally, pressing a white and a black key simultaneously sets the value to 0. The exception is MIDI CHANNEL parameter, which is set to 1.

MIDI

Five MIDI messages may be used to change the value of a parameter:

- CC 6 (Data Entry MSB)
- CC 38 (Data Entry LSB)
- CC 96 (Data Increment)
- CC 97 (Data Decrement)

- CC 110

Data Increment and Data Decrement messages work in the same way for all parameters: they increment or decrement the value. The amount depends on the data byte. The CC 110 message is used to set the value to 0.

MIDI message	data byte	action
CC 96 (Data Increment)	0	increment by 1
CC 96 (Data Increment)	1	increment by 10
CC 96 (Data Increment)	2	increment by 100
CC 96 (Data Increment)	3	increment by 1000
CC 96 (Data Increment)	4	increment by 10000
CC 97 (Data Decrement)	0	decrement by 1
CC 97 (Data Decrement)	1	decrement by 10
CC 97 (Data Decrement)	2	decrement by 100
CC 97 (Data Decrement)	3	decrement by 1000
CC 97 (Data Decrement)	4	decrement by 10000
CC 110	ignored	set to 0

The way the Data Entry messages are interpreted depends on the parameter:

Parameters with value range not exceeding 0-127: For these parameters only Data Entry MSB is used. The parameter is simply set to the value contained in the data byte of the message.

Parameters with value range exceeding 0-127: The value of Data Entry MSB and Data Entry LSB is scaled to the entire range of the parameters's value. In order to set the value of such parameter with maximal precision:

1. Use Data Entry MSB for coarse seting.
2. Adjust the value with Data Entry LSB to further approach to the desired value.
3. Use Increment/Decrement commands to adjust the value with maximal available precision.

8 The CLOCK output

The clock output generates short trigger signals with frequency based on MIDI CLOCK messages being received.

MIDI devices send CLOCK message 24 times per beat (quarternote). The CLOCK MULTIPLIER parameter determines how these signals are translated to uMIDI clock output.

When CLOCK MULTIPLIER parameter is set to n, the uMIDI CLOCK signal will be generated every n MIDI CLOCK messages received. For example, if you want the uMIDI module to generate a trigger signal once per quarternote, set the CLOCK MULTIPLIER parameter to 24. The value 96 will result in generating trigger signals once per whole note.

The uMIDI CLOCK output is by default deactivated. Activation and deactivation of the clock function is accomplished by using MIDI Real-Time messages.

START	activate the uMIDI CLOCK output with resetting the tick counter: the first trigger signal will be generated immediately
CONTINUE	activate the uMIDI CLOCK output without resetting the tick counter: the previous timing of trigger signals will be retained
STOP	deactivate the uMIDI CLOCK output

9 PITCH DEVIATION

This function allows to shift the pitch of each note within an octave up or down by arbitrary value. The basic use of this feature is to enable defining intonations other the tempered one. The default values stored in the pitch deviation vector produce pitch voltages corresponding to just intonation.

The user is free to modify the pitch deviation vector using the following procedure.

1. Enter the setup program no. 90. Both LEDs will be lit, what indicates that additional data is needed.
2. Press a key for at least 1 second to select the note you wish to edit.
3. Use the same increment/decrement procedure as for other parameters. The unit is 1 cent.

The value 0 means no deviation from the tempered intonation.

NOTE: In case of this program the STORE, UNDO and RESET commands always affect all 12 notes.

10 USER INTONATIONS

This feature allows to shape the pitch curve in arbitrary way by shifting selected notes with respect to the base 0-10V stright line.

There are at least two cases you might want to take advantage of this facility:

- adjusting pitch voltage curve to an oscillator which is not perfectly calibrated,
- define experimental intonations, eg. with quartertone intervals between notes instead of semitones.

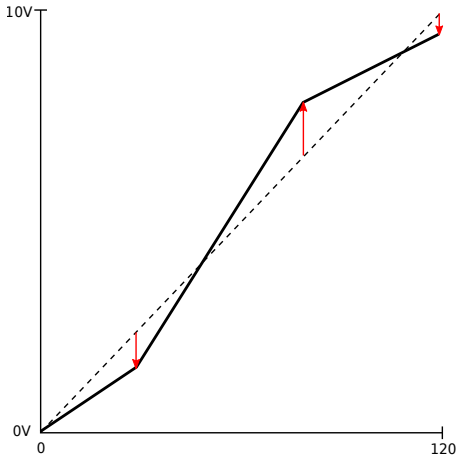
In fact possibilities are unlimited as each note may be mapped to any voltage.

The procedure:

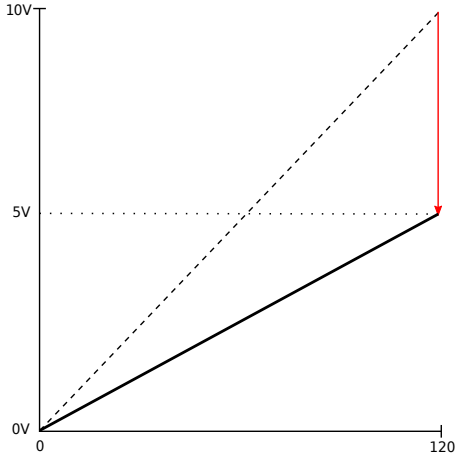
1. Enter the program no. 91-93. Both LEDs will light, what indicates that additional data is needed.
2. Press a key for at least 1 second to select the note you want to shift. The selected note becomes a “fixed” note: the setting for this note will be preserved when shifting next notes.
3. Shift the selected note using the standard increment/decrement procedure as for other parameters. The unit is 1 cent. The notes between the current note and the previous fixed note are automatically shifted appropriately. The same for the notes between the current note and the next fixed note.
4. Repeat steps 2-3 for other notes if needed.

NOTE: In case of this program the STORE, UNDO and RESET commands always affect all notes.

Examples



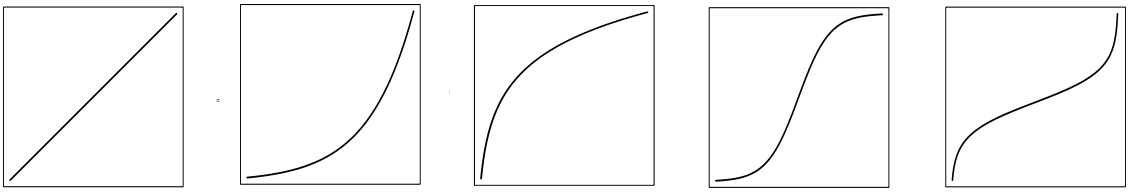
The effect of shifting three notes.



The effect of shifting the last note (120) down by 5V (6000 cents): intervals between subsequent notes reduced to a quartertone.

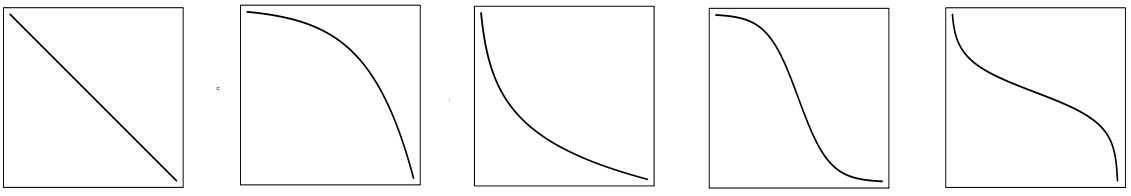
11 Response curves

When CV channel's min value higher then max value:



lin **exp** **log** **tanh** **atanh**

When CV channel's min value lower then max value:



lin **exp** **log** **tanh** **atanh**

12 GATE RETRIGGER parameter

Normally, when you press a key while another key is pressed the gate state does not change: it continues to be open. The GATE RETRIGGER parameter allows to change this behavior: each time when you press a key and this is the one that plays the gate is "retriggered": a short gate-off signal is generated to retrigger the envelope.

13 MIDI messages recognized in PERFORMANCE MODE

NOTE ON	
NOTE OFF	
PITCHBEND	
AFTERTOUCH	
SUSTAIN PEDAL (CC 64)	
CONTROL CHANGE	for controller numbers assigned to CV channels
BANK SELECT MSB (CC 0)	activates SETUP MODE when data byte is 1
BANK SELECT LSB (CC 32)	activates SETUP MODE when data byte is 1
PORTAMENTO ON/OFF (CC 65)	sets PORTAMENTO ON parameter
PORTAMENTO TIME (CC 5)	sets PORTAMENTO RATE parameter
ALL SOUND OFF (CC 120)	resets gate and sustain
ALL NOTES OFF (CC 123)	resets gate and sustain
PROGRAM CHANGE	selects intonation and pitch deviation
CLOCK	
START	activates the CLOCK output with period reset
CONTINUE	activates the CLOCK output
STOP	deactivates the CLOCK output

14 PERFORMANCE MODE programs

0	tempered intonation
1-12	tempered intonation + pitch deviation starting at n-th note (1–C, 2–C#, 3–D, ...)
20	user intonation 1
21-32	user intonation 1 + pitch deviation starting at $(20-n)$-th note
40	user intonation 2
41-52	user intonation 2 + pitch deviation starting at $(40-n)$-th note
60	user intonation 3
61-72	user intonation 3 + pitch deviation starting at $(60-n)$-th note

For example:

When the pitch deviation vector defines just intonation: program 1 sets C-based natural intonation, program

2 sets C#-based natural intonation, program 3 sets D-based natural intonation, and so on. Similarly for other intonations.

15 External LEDs

The outputs LED1 and LED2 are for connecting external LEDs. They duplicate functions of LEDs mounted on the module. External LEDs may be connected without resistors.