MINICV
micro MIDI-2-CV device
USER MANUAL

1. Overview

Thank you for choosing MINICV as your new MIDI2CV converter. This short manual will guide you through installation, and available settings.

The board was designed to be mounted where no other converter would fit, most likely hand held battery operated instruments and noise boxes, but also directly on VCO boards of monster vintage analog synths. No mounting holes are provided, only a few soldering pads. The connecting wires are enough to secure it in place, as it weighs less than 1 gram.

There's 1 analog output, capable to control analog synths with **V/oct** and **Hz/V** scales. MINICV comes factory set to 1V/oct scale _(at 100k load)_ responding to MIDI channel 1 with "C2" as lowest key. The CV can be reassigned to different type of MIDI event, not only notes, but also PitchBend or Continuous Controllers. If set to V/oct scale, CV may represent not only note pitch, but combined with Pitch Bender.

MINICV is packed with features, and each of them is user configured. A full set of settings may be considered as a „program". It is possible to store up to 16 different programs in MINICV memory. Those programs may be recalled by regular MIDI Porogram Change message, provided such option is enabled (off by default).

Like with any MIDI device, it is possible to have multiple MINICV converters running off the same MIDI signal, in case it is distributed by MIDI THRU box. In order to access settings of each MINICV individually, you may want to set different Address of each one, and then they will listen only to SysEx messages destined to them. Default Address is 0, which is also a broadcast address. Meaning that even if you have all MINICV set at different Address IDs, sending MIDI SysEx with Address = 0 will cause all units in the system to respond in the same way.

The device requires only one (positive) power supply. Basic setup, that is assigning MIDI channel and starting note, can be done with MIDI-learn button. Much more options are accessible via MIDI System Exclusive commands. All user settings are memorized in nonvolatile memory, taking power off does not reset anything to defaults, the settings are kept as they were last entered.

2.   Layout

Picture explains all connections in MINICV board.

- MIDI input (1-2)
- MIDI learn input (3)
- MIDI Clock output (4)
- Gate output (5)
- CV output (6)
- GND (7)
- Power supply (8)
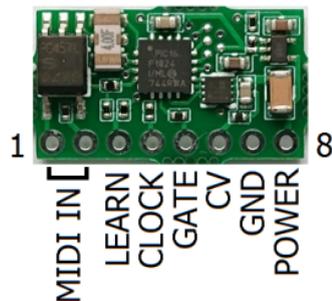
The board has no holes for mounting screws. It can be soldered to synth circuit as additional component - its size is comparable to SIP integrated circuit and uses only leading wires as support. MIDI IN signal (DIN socket pins 4 and 5) should be connected to pads 1 and 2 as indicated in the picture. Middle pin of DIN socket, number "2", must not be connected anywhere, it must be left open to comply with MIDI specification. But to enable shielding from high frequency interferences like radio waves, the „2" pin should be connected via 100n capacitor to GND of your device, the best spot to do it is directly to the case at the point where DIN jack is mounted. Obvioously it is pointless if your case is wooden or plastic, then you connect this capacitor to device's GND.

3.   Power supply

Make sure that all leading wires are as short as possible, especially the one connecting GND (ground, 0V potential). The best way to place the module is inside VCO circuit, or at the "star ground" of the instrument if it has one, where tuning reference point can be easily found. The quality of ground connection directly affects the quality of generated Control Voltage. MINICV is designed to work with supply voltages commonly found in synths. It requires only one supply, between +5V and +22V, although for best performance at least 5.2V is recommended. Average current draw is about 2mA. Power input must be DC. **Connecting AC power, or reversing the power leads will immediately damage the board.** Most of the time it may be easily repaired after such event, but please don't do try to test that.

4.   Connections

4.1.   CV output

CV output shows resistance of 220 ohms, so take this in consideration when calculating required V/oct scale. Even as large resistance as 100k will affect scale to some extent. It will cause 13 cents drop at top note when using 1V/oct scale. MINICV can drive its CV output to nearly 5V, and unfortunately 5.000V may not be reachable most of the time. But no worries, this is nothing which cannot be compensated by $0.01 worth resistor. Since MINICV should always be used as part of wider MIDIfication process, and not as standalone box, there's noone to tell you that you need specific voltage at certain point. What matters in VCO is the current flowing into its summing node. So if you have a converter in, say, 1.2V/oct scale connected to 120k VCO input resistor, and another one in 0.8V scale connected to 80k VCO input resistor, they both will control the VCO exactly the same way in the same scale. So considering that MINICV upper limit is typically 4.997V, it may be better to drive VCO summing node with lower resistor, for example 91k, and set V/oct scale to 0.91V/oct. This way you can make sure MINICV has enough headroom to drive top note. Of course if there's less than 61 notes in range of interest, there's no point in doing that, in fact it may be even better to set the scale to 1.2V/oct for 4-octave keyboard. Setting of V/oct scale is possible in wide range via MIDI System Exclusive messages in steps of about 0.1mV/oct.

CV may also be reversed, giving 5V voltage at lowest note, and 0V at top note. This can sometimes greatly simplyfy MIDIfication of instrument, when there's some inverting asmplifier on the way.

The CV output can respond to one of those MIDI events:

- Note on/off with optional Pitch Bend
- Pitch Bend alone
- Continuous Controller (CC# from 0 to 120)

If CV is configured as MIDI event different than notes, 0V represents lowest MIDI value, and 5V is output when highest MIDI value is received. When it's configured to respond to PitchBend only, neutral position is 2.5V at MINICV output. When MINICV is responding to MIDI notes, you may wish to add PitchBender voltage to the same CV. This option is available as one of SysEx controlled user settings. Also the bend range is configured in semitone steps in wide range (default is +/-2 semitones)

All MIDI CC messages are represented in voltage as one of 128 levels, while Pitch Bend is presented with full 14-bit resolution. Steppy CV response caused by slow feeding with MIDI messages may be smoothed out with adjustable glide feature.

For note on/off, CV scale can be adjusted in wide range, from 0.29 to about 2.16V/oct. If the scale is higher than 1V/oct, there is of course no room for 61 notes in 5V range, so actual usable number of notes is limited by highest achievable voltage. Every note higher

than that gives 5V. Of course you may shrink response range of notes, so MINICV will not activate GATE output above certain point.

4.2. Gate output

Gate output is push-pull type (meaning it can source and sink current) with 5V active state and 1k output resistance. Gate polarity can be reversed by user settings (+5V for note off and 0V for note on) - it may be useful in some synths or if you want to achieve higher gate voltage with single external transistor or if you need S-trigger circuit requiring only one external diode.

The Gate pulse indicates the duration of MIDI note. When MINICV is configured to respond to MIDI notes, gate output remains at 0V as long as no note from selected range is held. Notes playd within range make it go to +5V, and it stays there until all notes get released. It is typical V-trigger mode. If MINICV is set to respond to CC or PitchBend, Gate output remains at 0V at all times. It is possible to enable retrigger function, so gate will go off for very short pulse at the beginning of next note played. The gap is adjustable via MIDI System Exclusive messages between 0.1ms to 5ms.

To have true S-trigger gate, add a transistor and resistor. Transistor's base to Gate output via 20k-100k resistor, Emitter to GND, and Collector is your S-trigger gate. Even simpler circuit may also work as S-trigger: reverse Gate operation by SysEx, and then connect only one diode with cathode towards MINICV gate output, and anode is your S-trigger.

4.3. MIDI CLOCK

MINICV outputs short (0.4ms) pulse at dedicated clock output whenever MIDI Clock is received. The pulse appears immediately after reception of full MIDI Clock byte. Delay is very short (45µs on average) with low jitter: +/-16µs maximum. MIDI Clock may be divided before leaving MINICV by user defined ratio between 1 and 128. Clock output acivity is also controlled by MIDI Start/Stop/Continue messages.

4.4. MIDI-learn input

MIDI-learn is input for optional momentary switch serving as basic setup: MIDI channel, event, and starting note if the event is note on/off. Only Notes, Ccs and PitchBend can be „learned" so MINICV will stay in learn mode until one of those messages arrive. To use learn mode, short this input momentarily to ground, and the first MIDI data received will become the one that MINICV will respond to afterwards. If it was a MIDI note (on or off), it will also become the lowest note of MINICV response range.

MIDI-learn input may also be used to check current firmware version of MINICV. Hold it shorted to GND while power is being turned on, and MINICV will generate GATE pulses, long ones (not really long, less than a second) and short ones. The number of long pulses mean „big number", while number of short GATE blinks indicates the number after the dot. For example version 2.1 will be presented as 2 long blinks and 1 short blink. Powering MINICV this way also makes MINICV show some varying voltage at CV output for diagnostic purposes.

5.   User settings

After successful installation, you can set up the MIDI event, CV range and gate polarity. To do so, your synth must be powered on and you need the MIDI-learn button connected or have any kind of Sys-Ex editor. There are many parameters to set but you don't have to access them all, MINICV comes preconfigured to most typical use. Here are all user settings:

1. MIDI channel and event for CV/gate
2. V/oct scale tune
3. on/off flags for several features
4. offset of CV voltage
5. smoothing ratio of CC and PitchBend messages
6. CC number recognized as Portamento Time
7. CC number recognized as Portamento on/off
8. Pitch Bend range added to note pitch voltage
9. gate retrigger duration
10. MIDI Clock division ratio
11. Device ID or Address
12. Program Change response

The System Exclusive command's structure is as follows:

Sys-Ex header (F0), manufacturer ID (00 20 7A - MIDI-hardware), product ID (09 - MINICV), Address ID (00-7F), command (01-0F), related parameters and Sys-Ex footer (F7). The *address* parameter mentioned here serves the purpose of configuring multiple MINICV boards hooked up to single MIDI line with help of THRU-BOX. This way one can access up to 126 MINICV converters separately. If *addres* is set to 0, every MINICV will respond to such message regardless of its own address, this is broadcast.

All numbers shown here are represented in **hexadecimal** format. You may use any kind of Sys-Ex editor to send those commands to MINICV. Examples are Send SX: www.bome.com or MIDI-OX: www.midiox.com

It is crucial to proper operation to NOT send all SysEx messages in one long string, but always add at least 10ms delay between packets.

5.1. Channel and event

Channel and event can be set by MIDI-learn button, or Sys-Ex. For example to make MINICV respond to your keyboard, push the MIDI-learn button momentarily, and play the lowest note. Same thing if you want to assign Pitch Bend or CC - push the button, and move the MIDI controller you want to be assigned to CV.

CV response to MIDI note on/off

F0 00 20 7A 09 address 01 channel 09 startnote range F7

where *address* is the ID of given MINICV, *channel* is MIDI channel in range 1-16 (01-10 in hex), *startnote* is note number in MIDI notation which is the lowest in range assigned to this MINICV, *range* is number of notes starting from startnote, to which MINICV will respond. The *range* parameter is optional, range stays unchanged if this parameter is omitted or set to unacceptable value. If you set MINICV to respond to notes, regular MIDI controls for portamento (on/off and portamento time) will affect CV. This has nothing to do with smoothing PitchBend or CC described later. Smothing of note CV changes, aka portamento is controlled only by portamento controls.

CV response to Pitch Bend alone

F0 00 20 7A 09 address 01 channel 0E F7

where *address* is the ID of given MINICV, *channel* is MIDI channel in range 1-16 (01-10 in hex). MINICV will drive CV determined solely on received PitchBend messages, ignoring notes. PitchBend CV smoothing control is described later in paragraph 5.5. It is not affected by portamento controls!

CV response to Continuous Controller

F0 00 20 7A 09 address 01 channel 0B ccnumber F7

where *address* is the ID of given MINICV, *channel* is MIDI channel in range 1-16 (01-10 in

hex), *ccnumber* is MIDI Continuous Controller number from 00 till 77 hex. CC CV smoothing control is described later in paragraph 5.5. It is not affected by portamento controls!

5.2.   V/oct scale tune

V/oct scale may be set in wide range with high precision from 0.29V/oct to 2.16V/oct. Any scale selected shows very little tuning errors, thanks to high quality DAC onboard. Because of CV upper limit being at 5V, setting the scale above 1V/oct will limit usable range to less than 5 octaves.

F0 00 20 7A 09 address 02 scaleMSB scaleLSB F7
where *address* is the ID of given MINICV, *scaleMSB* is upper 7 bits of scale coefficient, *scaleLSB* is lower 7 bits of scale coefficient.
The formula for calculating proper values of *scaleMSB* and *scaleLSB* is the following:
scale = (required scale / 0.114mV) - 2570
then: *scaleMSB* = integer value of (scale / 128)
         scaleLSB = *scale* – 128 * *scaleMSB*

for example to set scale to 0.9V/oct:
scale = (0.9V/0.114mV) – 2570 = 7895 – 2570 = 5325

5325 / 128 = 41.6015625, integer value is = 41

decimal value of *scaleLSB* = 5325 − 128 * 41 = 5325 − 5248 = 77

Now converting 41 and 77 to hexadecimal we get required bytes for SysEx: *scaleMSB* is 29, while *scaleLSB* is 4D, resulting in full message here: F0 00 20 7A 09 00 02 29 4D F7

5.3. ON/OFF control of binary features

This single SysEx command is controlling 6 different settings at once, so be careful while using it, as MINICV may start to work unexpectedly if some of the bits was set by mistake.

F0 00 20 7A 09 address 03 flags F7

where *address* is the ID of given MINICV, and *flags* is binary combination of all 6 bits described below:

- bit 0: Gate reversal - when this bit is 1, Gate on means 0V at Gate output, and Gate off is 5V
- bit 1: CV reversal – if this bit is 1, lowest note from assigned range brings 5V, and top note shows lowest CV
- bit 2: retrigger – with this bit set to 1, every new note played while any other is still held, will shortly turn off Gate (up to 5ms)
- bit 3: Hz/V scale – set this bit to 1 if you want Hz/V scale instead of V/oct

- bit 4: Bend notes – if this bit is set, CV determined by note pitch will also be altered by Pitch Bender
- bit 5: Autoportamento – with this bit set, portamento (if enabled by CC Portamento-ON) will be active only for notes played legato.

For example if you want to have Hz/V scale with Autoportamento and reversed Gate, the *flags* should be "29", or in case of V/oct with retrigger and PitchBend affecting note CV "14".

5.4. CV offset

F0 00 20 7A 09 address 04 offset F7

where *address* is the ID of given MINICV, and *offset* is offset voltage added to CV output. The range of this trim is +/-10mV with about 0.15mV steps. Neutral position with no offset is when it is set at mid value, 40. Maximum negative offset of -10mV is reached when this byte is 00, and maximum positive - when set to 7F. CV is affected starting with next incoming note.

5.5. Smoothing of CC and PitchBend steps

When your MIDI controller sends PitchBend or CC messages very slowly, you might notice steppy or jumpy changes. To avoid that, MINICV can smooth out the steps adding some sort of constant rate glide between steps. The rate of this process is set with this message

F0 00 20 7A 09 address 05 glide F7

where *address* is the ID of given MINICV, and *glide* is depth of smooting effort. Possible values are from 00 to 7F. If set to 00, no smotting occurs, and each time new MIDI message is received, CV gets updated to new value. Setting *glide* to a number between 01 and 7F affects the speed of this glide from "pretty fast" to "way too slow". This only affects CV if it is configured as CC or PitchBend. Smothing note steps is done separately, with portamento controls. In special case when PitchBend is added to note Pitch, also portamento controls will be used and not this setting described here.

5.6. CC assigned to Portamento control

F0 00 20 7A 09 address 06 PortaOnOff PortaTime F7

where *address* is the ID of given MINICV, *PortaOnOff* defines which Continuous Controller is used as Portamento on/off control (default is 41 in hex), *PortaTime* tells which Continuous Controller is recognized as Portamento Time (default 05)

5.7. Pitch Bend range

F0 00 20 7A 09 address 07 bendrange F7

where *address* is the ID of given MINICV, *bendrange* is number of semitones CV gets shifted when Bender wheel is at max or min position. Possible values are from 01 to 7F, but of course setting Bender sensitivity so high as 7F is unusable if not crazy. Default value is 2, so bend range is +/-2 semitones, most typical value for most synths.

5.8.   Retrigger time

F0 00 20 7A 09 address 08 retriggertime F7

where *address* is the ID of given MINICV, *retriggertime* is the duration of GATE output
going to OFF state between notes played legato. This short off pulse may be detected by
envelope generators and cause restarting the envelope when needed. This time may be
set to any value between 0.1ms (*retriggertime*=0) up to 5ms (*retriggertime*=7F). If there
should be retrigger pulse in GATE output or not, is determined by proper settings in
another SysEx message, described in paragraph 5.3.

5.9.   MIDI Clock divider

F0 00 20 7A 09 address 09 divider F7

where *address* is the ID of given MINICV, *divider* is division ratio of incoming MIDI clock.
For example *divider*=1 means no division, CLK output will generate pulses at the same
rate as incoming MIDI clock. If *divider*=24, the pulse at CLK output will appear only once
per 24 incoming MIDI clocks. The duration of CLK pulse is not adjustable 0.4ms

5.10.   Program Change listen

F0 00 20 7A 09 address 0E pclisten F7

where *address* is the ID of given MINICV, *pclisten* tells if this MINICV should repond to
Program Change message. MINICV stores 16 programs in memory recalled by MIDI
Program Change between program 1 to 16. Each program is a set of all settings described

in this manual. So with one simple MIDI message like ProgramChange, you can change the MIDI channel, event, starting note or CC, tuning scale, all on/off options, offset, glide, portamento CCs, pitchbend range, retrigger time and MIDI clock division.

5.11. Unit Address

F0 00 20 7A 09 oldaddress 0F newaddress F7

where *oldaddress* is the ID of given MINICV, *newaddress* is... well, a new address for this MINICV. Of course in most cases *oldaddress* can be set to broadcast value, that is 00, so every connected MINICV will respod tho that. It only makes sense to set different address than default if you have more than one MINICV driven by the same MIDI line.

5.12. Factory defaults

Send this Sys-Ex sequence to MINICV to go back to default settings:

F0 00 20 7A 09 address 1B 15 37 56 2A 4F 50 61 28 F7

MINICV will be configured then as follows in every one of 16 programs:
- note range C2-C6 (36-84 in MIDI note numbers)
- channel 1
- 1V/oct scale (assuming 100k load at CV output)
- positive gate (off 0V, on 5V)
- auto retrigger, 2ms duration
- PitchBend added to note CV

- no offset
- PitchBend range +/-2 semitones
- CC smoothing at medium
- Portamento on/off is CC 65 (41 hex)
- Portamento Time is CC 05
- Address is 00
- no response to Program Change
- MIDI clock division set to 24

6.   Firmware upgrade

Whenever new firmware version appears, it will be dowloadable from midi-hardware.com website in a form of SysEx file. The firmware comes as series of short MIDI System Exclusive messages, they MUST be separated by at least 15ms delays or more. This can be easily done with programs like MIDI-OX, where it is explicitly adjusted in SysEx Configure window under "Delay After F7". Tick that checkbox beside it and set it to 15, or better 20ms. Sending all sysEx file in one go without delays between packets will corrupt the firmware and MINICV will not work. Likewise, if you're using cheap USB/MIDI cable, this wil not work either regardless of used SysEx program, don't even try. You need good reliable MIDI interface. It can be any kind built in to your audio interface, but if it's USB

used, make sure it's capable of sending long MIDI messages. Typical unbranded MIDI/USB converters are not capable of sending more than 4-byte messages, which rules them out from use in any System Exclusive transfers.

In case your MINICV will not receive proper data, it will not work anymore, but instead wakes up in boot mode, which may be recognized by measuring CV output – it then generates rising ramp voltage from 0 to 5V and the cycle repeats itself every 2 seconds. In such case try to send the SysEx file again, maybe this time from better MIDI interface, or checking if delay is really there.

In rare case when firmware upgrade file is corrupted in very peculiar way, like hacked, or not coming from official website, it may brick the MINICV. It will appear as working normally, not showing the boot-mode ramp, but not responding to MIDI either. In such case you may force it to power up in boot mode this way: power it off, connect CV output with GATE output (yes, that's no mistake, short those 2 outputs), and turn the power on. Then you can disconnect Gate from CV and MINICV will show 2s ramp on CV indicating it's waiting for the new firmware. It better be the right one this time, freshly downloaded from midi-hardware.com website.