

# MIDI2CV 3.0

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## Operating Modes

Supplement to 9700 MIDI2CV8  
Kit Assembly and Users Manual

# Guide to MIDI2CV8 firmware version 3.0 Operating Modes.

John Simonton / Roy Gwinn / PAiA

- Updates versions 1.0 and 2.01, John Simonton / PAiA
- Eight new modes
- Enhancements to existing modes.
- Remote mode selection
- Remote parameter control

## MIDI2CV8 v3.0 Firmware Operating Modes

Initially there are eight operating modes, set with the switches 5, 6 and 7.

When the Volt/Hz option is not present, it is possible to enable another eight modes with a hardware modification to bring switch 8 into use. Although these additional modes are not compatible with the Volt/Hz option, they do things that would not need it anyway.

To modify switch 8, ground pin 8 of the switches with a wire link to pin 7, which is already grounded. Connect pin 9 to IC3 pin 6 with a short insulated piece of wire (example on last page).

**Low-Key Transpose** - Most digital keyboards assign the midi note number 36 to their lowest key. By default, the key is transposed down by 36 semitones (3 octaves) so that the lowest key produces 0V at the pitch output(s).

The MIDI2CV8 has a Low Key Transpose feature that transposes the lowest key on any keyboard to key #0 for a 0V output. Activate this feature by turning on the MIDI keyboard and holding down its lowest key WHILE the MIDI2CV8 is turned on or reset. Releasing the key then sets it as the lowest note. After setting Low-Key Transpose you must next do some action that will send a MIDI Status Byte so the MIDI2CV8 can know the correct Running Status. Usually rolling the pitch wheel or sending a program change is the easiest way, but in some cases the keyboard controller must be reset by turning it off and back on again.

When the V/Hz option is installed, the lowest key defaults to key 36 so Low-Key Transpose will not usually be necessary.

Notes below the transpose point have a CV of zero, and the gate is suppressed so they do not sound. This allows the oscillators to be set to a low note without opening the ADSRs, which is useful when used with portamento so that the first note played after that has a portamento swoop up to its final pitch.

**Poly/Multi** - The midi2cv8 defaults to Poly (Multi disabled). Multi is enabled by sending a MIDI mono mode on message on the Basic Channel and is disabled by sending a MIDI poly mode on message, or resetting the midi2cv8. When Multi is enabled, notes on the Basic Channel are assigned to the first output group (Pitch, Gate, etc.), notes on the next channel above the Basic Channel route to output group 2 and so on as output groups are available. For example, in Two Voice Mode with Multi enabled a midi2cv8 set to Basic Channel 4 will route notes on midi channel 4 to output group 1 and notes on midi channel 5 will go to output group 2.

## MODES

- 1 One Voice
- 2 Two Voice
- 3 Four Voice
- 4 Control Change (base continuous controller set)
- 5 Analog Drum
- 6 DIN Sync
- 7 Duophonic
- 8 Self-Test
- 9 Control Change (continuous controller numbers 21-28)
- 10 Control Change (continuous controller numbers 41-48)
- 11 Control Change (continuous controller numbers 70-77)
- 12 Pitch Wheel, Mod Wheel, common controllers
- 13 Pitch Wheel, Mod Wheel, alternate set of common controls
- 14 Transport Controls (product specific)
- 15 Extended Duophonic
- 16 Program Change (base number set)

## Mode 1: One Voice

Switches 5, 6, 7 on.

Provides complete control of a single synth voice.

This mode uses most-recent priority. If more than one note is pressed, the most recent will sound. When that most recent note is released, the preceding note will resume, if it is still held. The 'stack' of notes held in this way is five deep.

Two notes can be played legato either as a result of the second being pressed while still holding the first ( a 'hammer') or by releasing the second and returning to the first (a 'pull-off'). The triggering modes are configurable so that the note will retrigger, or not, as required. There are continuous controllers, CC\_LEGATO and CC\_BUTTON\_4, described in detail in the continuous controllers section, which control retriggering modes. The Gate signal is high as long as any key is down. The 5ms re-trigger pulse occurs when a new note retriggers according to the retriggering policy.

Output 8 is portamento control. A zero voltage means no portamento. A most-recent-priority scheme is ideal for fingered portamento, where notes played legato have portamento between them, and notes played staccato do not. Fingered portamento is the default in this mode. The control change messages for PORTAMENTO TIME, FINGERED PORTAMENTO, PORTAMENTO ON/OFF and SNAP all affect the portamento output.

### Poly (all from Basic Channel)

output 1 = Pitch  
output 2 = Attack Velocity  
output 3 = Gate  
output 4 = Trigger Pulse  
output 5 = Pitch Wheel  
output 6 = Mod Wheel  
output 7 = Aftertouch  
output 8 = Portamento control voltage

### Multi

No Multi Enabled functions



## Mode 2: Two MIDI2CV8 Voice

Switches 6,7 on.

Provides Pitch, Velocity and Gate control of two synth voices. New notes are always assigned to a synth channel. Notes are assigned first to a channel on which no note is sounding. If both channels are in use, one is 'stolen' for the new note, and the older note is pushed into a stack to be retrieved if a channel comes available. Orphan note-offs (when a note is to be turned off on an output that has already been reassigned) do not affect the sound, but remove the note from the stack. Mod Wheel and Pitch Wheel or two Pitch Wheel outputs are also provided.

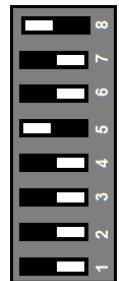
In multi mode, notes are assigned to a channel based on the midi channel that they arrive on, and there is no allocation algorithm.

### Poly

output 1 = Basic Channel Pitch 1  
output 2 = Basic Channel Velocity 1  
output 3 = Basic Channel Gate 1  
output 4 = Basic Channel Pitch 2  
output 5 = Basic Channel Velocity 2  
output 6 = Basic Channel Gate 2  
output 7 = Basic Channel Pitch Wheel  
output 8 = Basic Channel Mod Wheel

### Multi

output 1 = Basic Channel Pitch  
output 2 = Basic Channel Velocity  
output 3 = Basic Channel Gate  
output 4 = BC+1 Pitch  
output 5 = BC+1 Velocity  
output 6 = BC+1 Gate  
output 7 = BC Pitch Wheel  
output 8 = BC+1 Pitch Wheel



### Mode 3: Four Voice

Switches 5,7 on.

Pitch and Gate control of four synth voices. New notes are first assigned to channels that they have been recently sounding on. If a note's CV is not already on a channel, it searches for an unused channel. If there are no unused channels, it steals a channel for this new note, and the pre-empted note is pushed onto a stack for possible later retrieval. Orphan Note-Offs (when a note is to be turned off on an output that has already been reassigned) do not affect the sound, but remove the note from the stack.

In multi mode, notes are assigned to a channel based on the MIDI channel that they arrive on, and there is no allocation algorithm.

### Poly

output 1 = Basic Channel Pitch 1  
output 2 = Basic Channel Gate 1  
output 3 = Basic Channel Pitch 2  
output 4 = Basic Channel Gate 2  
output 5 = Basic Channel Pitch 3  
output 6 = Basic Channel Gate 3  
output 7 = Basic Channel Pitch 4  
output 8 = Basic Channel Gate 4

### Multi

out 1 = BC Pitch  
out 2 = BC Gate  
out 3 = BC+1 Pitch  
out 4 = BC+1 Gate  
out 5 = BC+2 Pitch  
out 6 = BC+2 Gate  
out 7 = BC+3 Pitch  
out 8 = BC+3 Gate



## Mode 4: Control Change

Switch 7 on.

Converts MIDI Control Change messages for cc0 to cc7 to CVs.

This copies the behavior of the previous firmware version for backwards compatibility.

### Poly

output 1 = Basic Channel cc 0  
output 2 = Basic Channel cc 1  
output 3 = Basic Channel cc 2  
output 4 = Basic Channel cc 3  
output 5 = Basic Channel cc 4  
output 6 = Basic Channel cc 5  
output 7 = Basic Channel cc 6  
output 8 = Basic Channel cc 7

### Multi

output 1 = BC cc 0  
output 2 = BC + 1 cc 0  
output 3 = BC + 2 cc 0  
output 4 = BC + 3 cc 0  
output 5 = BC + 4 cc 0  
output 6 = BC + 5 cc 0  
output 7 = BC + 6 cc 0  
output 8 = BC + 7 cc 0





## Mode 5: Analog Drum

Switch 5, 6 on.

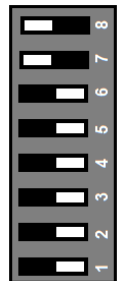
This mode provides for control of devices that use variable amplitude pulses for triggering, such as analog drum circuits. Each output corresponds to a key and the each key activation produces a 5ms pulse with amplitude proportional to velocity.

### Poly

output 1 = Note 24h  
output 2 = Note 25h  
output 3 = Note 26h  
output 4 = Note 27h  
output 5 = Note 28h  
output 6 = Note 29h  
output 7 = Note 2ah  
output 8 = Note 2bh

### Multi

No Multi Enabled Functions



## Mode 6: DIN Sync

Switch 6 on.

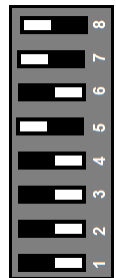
This mode converts MIDI Real Time messages into useful electrical control lines. The 24 ppqn clock pulses and run/stop line are as required by DIN-Sync protocols. The 5ms. reset pulse is provided for control of analog sequencers and other applications where a distinction is made between MIDI Start and Continue commands. In poly mode, the single voice outputs are handled in the same way as mode 1, with most recent note priority and a stack of previous notes. In multi mode, the two channels are handled with most recent note priority, but with no stack. Once a note is replaced with a new note it cannot return.

### Poly

out 1 = Basic Channel pitch  
out 2 = Basic Channel velocity  
out 3 = Basic Channel gate  
out 4 = Basic Channel re-trigger  
out 5 = Basic Channel pitch wheel  
out 6 = DIN start reset pulse  
out 7 = DIN run/stop  
out 8 = DIN 24 ppqn 1ms pulses

### Multi

out 1 = Basic Channel pitch  
out 2 = Basic Channel velocity  
out 3 = Basic Channel gate  
out 4 = BC + 1 pitch  
out 5 = BC + 1 velocity  
out 6 = BC + 1 gate  
out 7 = DIN run/reset  
out 8 = DIN 24 ppqn



## Mode 7: Duophonic

Switch 5 on.

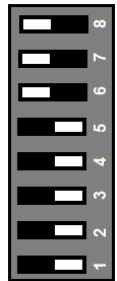
This mode emulates an analogue synthesizer keyboard, with high-note and low-note priority outputs. Typically either the high-note-priority gate and CV pair are used, or the low-note-priority pair. If both CV outputs are used, the keyboard becomes duophonic, in the style of late seventies analogue synthesizers. The gate signals are almost identical, but each gate output notches retriggers relevant to its own CV output only. This mode keeps a complete map of all keys, so when a key is released, the next-highest or next-lowest is output.

Two notes can be played legato either as a result of the second being pressed while still holding the first ( a 'hammer') or by releasing the second and returning to the first (a 'pull-off'). The triggering modes are configurable so that the note will retrigger, or not, as required. There are continuous controllers, CC\_LEGATO and CC\_BUTTON\_4, described in detail in the continuous controllers section, which control retriggering modes.

A channel is made to retrigger, without a specific trigger output, by momentarily setting to zero ("notching") the gate line. This notch lasts for 1.25ms.

## Poly

- out 1 = pitch, high note priority
- out 2 = gate for high note, with hammers and pull-offs notched in.
- out 3 = pitch, low note priority
- out 4 = gate for low note, with hammers and pull-offs notched in.
- out 5 = attack velocity
- out 6 = aftertouch
- out 7 = pitch wheel
- out 8 = mod wheel



## Mode 8: Self-Test

Switches 5-8 off.

Output Test - On power-up or reset this test first strobes the eight outputs in sequence, holding each high for 1 second before turning it off and stepping to the next. When all eight outputs have been turned on and off the test next sequentially ramps each output high over a 5 second period and leaves the output high when done. This part of the test loops continuously until midi data is received.

MIDI In Test - When MIDI data is received, the output test is interrupted and the MIDI In LED flashes brightly and regularly to indicate the kind of data that was received. Reset to start the test again.

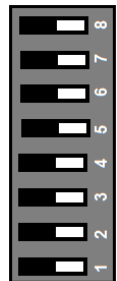


**Mode 9:** Control Change, continuous controller set 21-28

Switches 5, 6, 7, 8 on.

The MIDI continuous controllers set the output voltage.

- output 1 = controller 21
- output 2 = controller 22
- output 3 = controller 23
- output 4 = controller 24
- output 5 = controller 25
- output 6 = controller 26
- output 7 = controller 27
- output 8 = controller 28

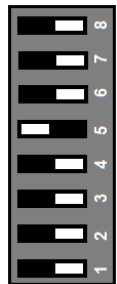


**Mode 10:** Control Change, continuous controller set 41-48

Switches 6, 7, 8 on.

The MIDI continuous controllers set the output voltage.

- output 1 = controller 41
- output 2 = controller 42
- output 3 = controller 43
- output 4 = controller 44
- output 5 = controller 45
- output 6 = controller 46
- output 7 = controller 47
- output 8 = controller 48

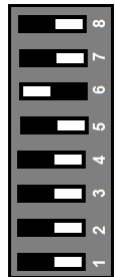


**Mode 11:** Control Change, continuous controller set 70-77

Switches 5,7,8 on.

The MIDI continuous controllers set the output voltage.

output 1 = controller 70	sound variation
output 2 = controller 71	resonance
output 3 = controller 72	release time
output 4 = controller 73	Attack time
output 5 = controller 74	filter cutoff
output 6 = controller 75	decay time
output 7 = controller 76	vibrato rate
output 8 = controller 77	vibrato depth



**Mode 12:** Pitch wheel, Mod Wheel, common controls

Switches 7,8 on.

- output 1 = pitch wheel
- output 2 = mod wheel
- output 3 = breath controller
- output 4 = foot controller
- output 5 = portamento time
- output 6 = expression
- output 7 = filter cutoff
- output 8 = release time





**Mode 13:** Pitch Wheel, Mod Wheel, alternate set of common controls.

Switches 5,6,8 on.

Output 8 is a pulse sent on the All Sound Off message.

output 1 = pitch wheel

output 2 = mod wheel

output 3 = expression (cc11 )

output 4 = aftertouch

output 5 = soft pedal (cc67) (digital)

output 6 = portamento time (cc5)

output 7 = release time (cc72)

output 8 = All Sound Off (cc120) pulse to clear ADSR



**Mode 14:** Transport Controls, product specific

Switches 6,8 on.

Momentary buttons produce digital pulses at the outputs.

The release time CV output is calculated from two continuous controller settings. The release time (cc5) sets the voltage, and the sustain pedal (cc64) gates it on and off.

output 1 = Rewind

output 2 = Fast Forward

output 3 = Stop

output 4 = Play

output 5 = Cycle

output 6 = Record

output 7 = calculated release time CV (combined from sustain pedal and release controller)

output 8 = Sustain pedal (digital)



**Mode 15:** Extended Duophonic.

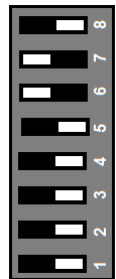
Switches 5,8 on.

This is similar to mode 7 (duophonic) but with the wheels replaced with two new control voltages that are derived from the keyboard when multiple notes are played.

The difference voltage is non-zero when two or more notes are played. It is the difference between the highest and the lowest note, scaled at 0.5V/semitone. It is not intended to drive a VCO, which is why it is scaled much higher. It is intended to be used as a sound modifying control voltage. The scale would be appropriate for an interpolating scanner which accepts one volt per channel, so tones on the keyboard select channels, and semitones select 50/50 mixes between channels.

The enclosed voltage is non-zero when three or more notes are played. It is the difference between the second highest note (the highest enclosed note) and the lowest note, also scaled 0.5V/semitone. This is also intended as a sound-modifying control voltage. It uses information from the keyboard that would otherwise be ignored. On a high/low note priority scheme, enclosed notes would otherwise have no effect.

- output 1 = pitch (high)
- output 2 = gate (high)
- output 3 = pitch (low)
- output 4 = gate (low)
- output 5 = attack velocity
- output 6 = aftertouch
- output 7 = difference voltage high – low key (0.5V/semitone)
- output 8 = highest enclosed key - low key (0.5V/semitone)





## Soft Control – MIDI Control Change parameter map

The following continuous controllers affect the way the MIDI2CV behaves.

### 5. PORTAMENTO TIME

continuous  
default=70

This is used as a direct output of the controller (mode 12 output 5, and mode 13 output 6) and as part of the calculated portamento CV (mode 1 output 8). The default is nonzero so the calculated portamento CV is usable even if there is no actual controller attached.

### 57. FINGERED PORTAMENTO

digital  
default=ON

This controller switches between two ways of deriving the portamento control voltage in mode 1 output 8. In fingered portamento mode (when it is on), portamento is only applied between notes that are played legato. When it is off, the portamento control voltage does not depend on fingering style, but does depend on it being gated through by the portamento on/off controller. See the SNAP controller for further information.

Fingered portamento = on:

$$\text{PORTAMENTO CV} = (\text{PORTAMENTO TIME}) * !( \text{SNAP} ) * (\text{notes played legato})$$

Fingered portamento = off:

$$\text{PORTAMENTO CV} = (\text{PORTAMENTO TIME}) * !( \text{SNAP} ) * (\text{PORTAMENTO ON/OFF})$$

### 58. 5V RANGE

digital  
default=OFF

Continuous controllers usually produce control voltages in the range 0-10V (actually 0 – 10.24V). The scaling of all continuous controllers can be changed to 0-5V (actually 0 - 5.12V) if required. This only affects analogue/continuous controls. Digital controls and digital pulses are 0V off and +5V on, regardless of this setting. Set this controller ON for voltages 0-5V.

#### **64. SUSTAIN (hold pedal)**

digital

default=OFF

Typically a momentary switch, sent by a pedal. It is available by itself as a digital output. It is also used in the calculated release time in mode 14 output 7. The release time continuous controller is gated on/off by the sustain pedal. This is intended as a control voltage for ADSR release time.

#### **65. PORTAMENTO ON/OFF**

digital

default=OFF

Typically a momentary switch, sent by a pedal.

This is used to create the portamento time CV in mode 1. See the description of portamento CV for CC57 (fingered-portamento).

#### **67. SOFT PEDAL**

digital

default=OFF

Typically a momentary switch, sent by a pedal. When this controller is on, suppress gate-on. This affects the way a note starts:

SOFT ON stops the gate setting, and a new note, instead of being retriggered by a hammer or pull-off, clears the gate.

SOFT OFF allows normal gate behavior. This can be used to set the pitch of the oscillators without articulating a note with the ADSRs.

#### **68. LEGATO PEDAL**

digital

Typically a momentary switch, sent by a pedal.

default=OFF

The default triggering mode is hammers on, pulloffs off.

New notes caused by a NoteOn message on a synth channel that is already sounding will retrigger. This is sometimes called multiple-triggering. When LEGATO is on, the pitch CV changes but that retriggering does not happen. This is sometimes called single-triggering.

## **72. RELEASE TIME**

continuous

default=70

This controller is available in mode 11 channel 3, mode 12 channel 8, mode 13 channel 7 and mode 14 channel 7 as calculated release time (combined from sustain pedal and release time controller).

## **82. SNAP**

digital

default=OFF

Typically a momentary pushbutton.

When pressed, the computed CV\_PORTAMENTO is set to zero, regardless of the setting of portamento time, or portamento on-off, or the fingered-portamento setting. It is used to 'snap' a gliding note to its destination pitch.

## **83. BUTTON 4**

digital

default=OFF

This controls the triggering mode when a note is a pull-off.

A pull-off is a note started by releasing another note on a duophonic highest-priority or lowest-priority scheme, or releasing a note in one-voice, two-voice or four-voice mode. If that release causes another note to sound, it is a pulloff. If this controller is on, that new note will retrigger. It would typically be used with hammers on as well, so notes retrigger on both press and release.

## **105. SET TRANSPOSE**

default = 36 (V/octave) or 0 (V/Hz)

Set the note number that relates to 0V at the CV output. Many keyboards send midi note 36 on their lowest key. The transpose value is subtracted from all note messages.

If a note message is below the lowest key setting, the CV is zero and the gate is not set. Transpose does not 'wrap round' from 0 to 127.

## **110. SET OPERATING MODE**

MIDI2CV8 set operating mode (1-16)

The default operating mode is set by switches 5,6,7,8 read at reset time.

mode 1 = one voice

mode 2 = two voice

mode 3 = four voice

mode 4 = control change

mode 5 = analog drum

mode 6 = DIN sync

mode 7 = duophonic

mode 8 (hardware test) cannot be entered with this message

mode 9 = continuous controllers 21-28

mode 10 = continuous controllers 41-48

mode 11 = continuous controllers 70-77

mode 12 = pitch wheel, mod wheel, common controllers

mode 13 = pitch wheel, mod wheel, alternate set of common controllers

mode 14 = transport controls

mode 15 = extended duophonic

mode 16 = program change PC1-PC8

## **112. REWIND**

digital

default=OFF

This is available as a digital output in mode 14 channel 1. This controller has the same effect as SOFT for testing convenience. That effect may not be implemented in the released code.

## **113. FAST FORWARD**

digital

default=OFF

This is available as a digital output in mode 14 channel 2.

## **114. STOP**

digital

default=OFF

This is available as a digital output in mode 14 channel 3. This controller has the same effect as BUTTON 4 for testing convenience. That effect may not be implemented in the released code.



**115. PLAY**

digital

default=OFF

This is available as a digital output in mode 14 channel 4.

**116. CYCLE**

digital

default=OFF

This is available as a digital output in mode 14 channel 5.

**117. RECORD**

digital

default=OFF

This is available as a digital output in mode 14 channel 6.

**120. ALL SOUND OFF**

channel mode message

This message is only accepted on the basic channel. Its value is ignored.

Switch off all gate outputs for this mode.

This message triggers a digital pulse in mode 13 channel 8. This pulse could be used to clear ADSRs and so stop all sound immediately.

**121. RESET ALL CONTROLLERS**

channel mode message

This message is only accepted on the basic channel. Its value is ignored.

Reset all controllers (including Pitchbend) to their power-on state.

This command is ignored when in Omni mode.

**123. ALL NOTES OFF**

channel mode message

only accepted on basic channel

Its value is ignored.

It is handled the same as ALL SOUND OFF, except that there is no pulse to clear ADSRs. The gate(s) are removed and the note releases naturally.

#### **124. OMNI MODE OFF**

channel mode message

This message is only accepted on the basic channel. Its value is ignored.  
The device powers up with OMNI mode off, in defiance of the MIDI specification.

#### **125. OMNI MODE ON**

channel mode message

This message is only accepted on the basic channel. Its value is ignored.  
OMNI mode is not supported as it has no practical use.  
There are no controls on the device enabling the user to manually switch off OMNI mode. All sounding notes are canceled.

#### **126. MONO MODE ON**

channel mode message

This message is only accepted on the basic channel. Its value is ignored.  
The MIDI specification calls for the value in the message to be the number of channels the device should receive on. This is ignored; the number of channels is determined by the capabilities of the device given the mode selected. All sounding notes are canceled.

#### **127. POLY MODE ON**

channel mode message

only accepted on basic channel  
Its value is ignored.

Undo the effect of MONO MODE ON. The device receives on the basic channel only.  
A POLY MODE ON must be received on the basic channel, even if notes are being accepted on other channels. All sounding notes are canceled.

#### **Other messages with global effect**

MIDI byte FF System Reset

Switch off gate outputs.  
Set pitch wheel(s) to mid position.  
All continuous controller values are set to defaults.

# Self-Test



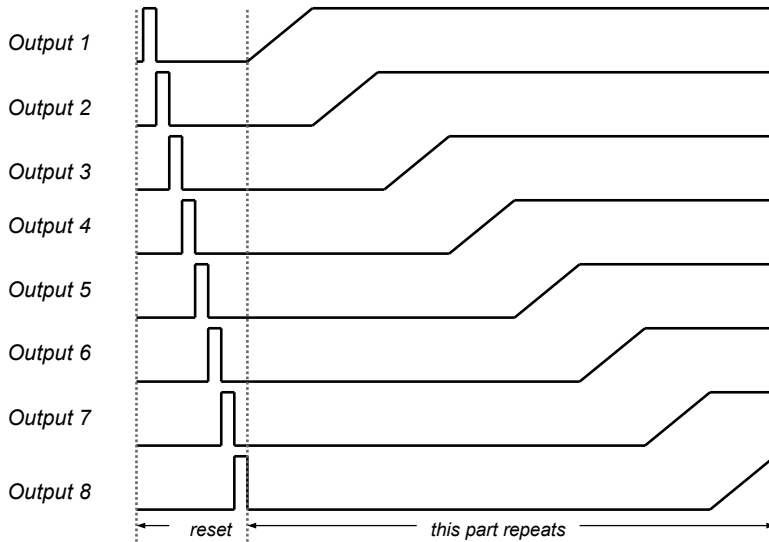
Mode 8

Self-Test

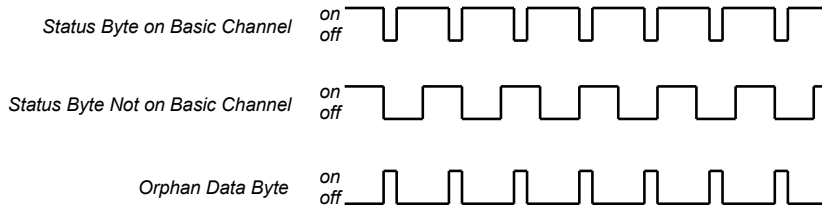
**Output Test** – On power-up or reset this test first strobes the eight outputs in sequence, holding each high for one second before turning it off and stepping to the next. When all eight outputs have been turned on and off, the test next sequentially ramps each output high over a five second period and leaves the output high when done. This part of the test loops continuously until reset or a MIDI message is received.

**MIDI In Test** – When MIDI is input to the MIDI2CV8, the output test is interrupted and the MIDI In LED flashes brightly and regularly indicating information about the message received.

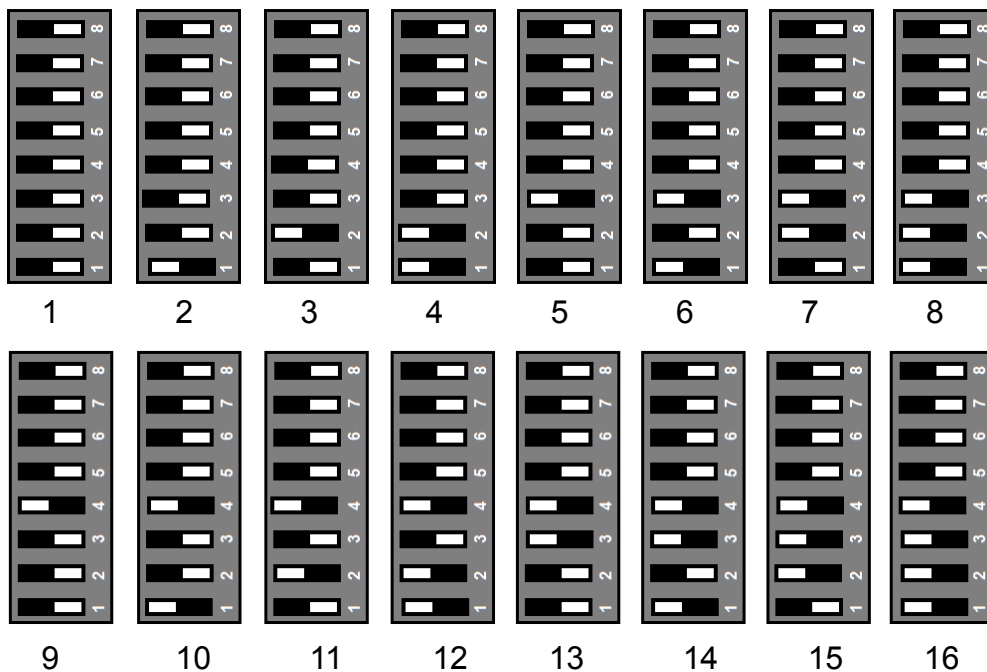
## Output Test



## MIDI In Test



# MIDI Channel

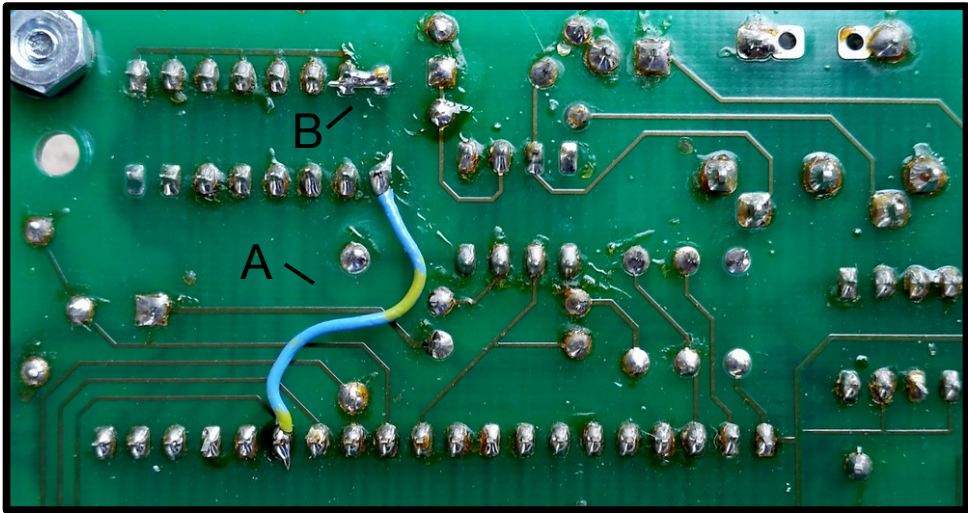


Set the switch section levers to the right for On/Closed.



Set the switch section levers to the left for Off/Open.





### **Jumpers to Add DIP Switch Section 8 (of 1 – 8)**

IC1, pin 6 (port 1.5) joins with pin 9 of the channel/mode select switch and pin 8 of this switch, S1, joins with neighboring pin 7 (ground).

Insulated, solid, 26 gauge wire is used to make the IC1 to S1 link (A) and a short piece of bare solid wire is used for the S1 pin 8 to pin 7 link (B).

Pre-cut, strip, and tin the wire for the IC to Switch link.

Steady it against one pin and flow the joint, then the next.

Pre-cut the pin to pin link, lay it next to the two pins and use the hot, clean, iron tip to roll/pull it into the solder of the joints for the two pins

[www.paia.com](http://www.paia.com)