Midimuso CV-12 ORAC

(Overflow, Re-trigger, Aftertouch, Chainable)

Features:

Converts MIDI into control voltages

Allows 1V / 0.5V / 1.2 V per octave conventions.

11 modes which offer a balance of pitch / velocity voltages / control voltages / gates.

Monophonic / polyphonic modes (up to 6 note poly per chip)

Chainable: ICs can be connected together to produce more outputs.

IC uses a single 5 volt supply and requires a 16MHz crystal and 2 x 22 pF capacitors.

Requires auxiliary circuitry to bring its output range up to 0V to +10V i.e. full 10 octave range (see schematics below). PCB kit available (see midimuso.co.uk)

Contents: **Page**

Overview:

The **Midimuso CV-12** is a pre-programmed microcontroller IC which reads MIDI and produces 18 separate voltage outputs for:

Note Gates (5V for “note on” or 0V for “note off”) and corresponding...

Pitch-Voltages (0V to 5V pulse-width modulated)
One note per MIDI channel (max 6 Notes simultaneously per chip) or 4 note Poly Mode.

Control-Voltages (maximum **12** outputs per chip, all 0V to 5V)

Pitch-Bend (0V to 5V continuous, 2.5V centred, available in all modes)

Aftertouch (Channel Pressure) 0V to 5V available in all modes – appears on same pin as Resonance (CC71) i.e. pin 27

Auxiliary Gates (maximum 11 per chip) 5V for “note on” or 0V for “note off” events on **one** MIDI channel)

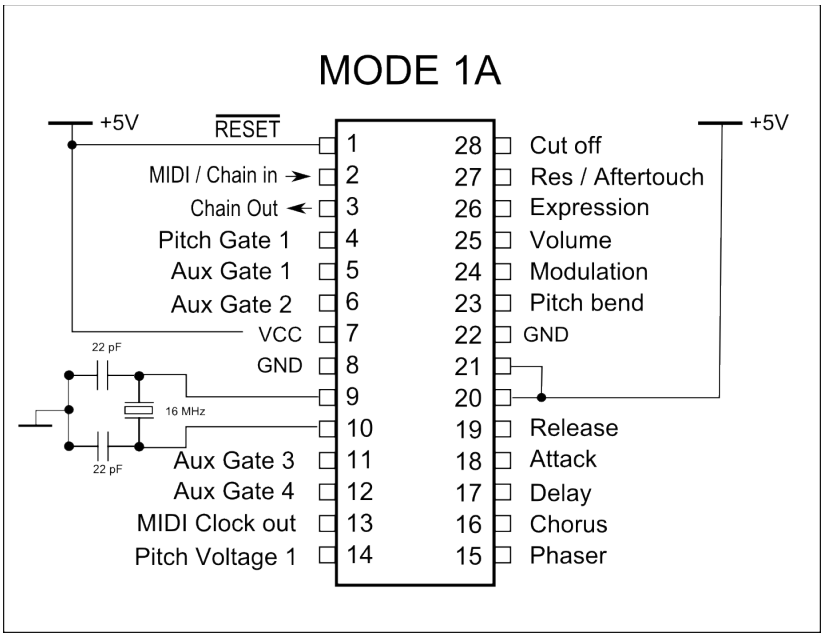
Midi Clock (0V to 5V. Pulse length = 1ms, (available in all modes except Mode 6)
Produces 24 pulses per quarter note e.g. 48 pulses / second @ 120 B.P.M.

Re-trigger Mode Pitch gate(s) are repeated for overlapping notes

Continuous Controllers

Modulation (all modes)	Release
Volume (all modes)	Attack
Expression (all modes)	Delay
Resonance (all modes)	Chorus
Cut Off (all modes)	Phaser
	Foot Control

Pinout Mode 1A



Modes Table

On arrival, the IC is set to MODE 1A, re-trigger is on.

						MODE					1 x poly	4x mono
IC Pin#	PCB port	0A	0B	1A	1B	2A	2B	4A	4B	6	4PV	4MV
14	B1	4 foot ctl	A Gate 6	Pitch 1	Pitch 1	Pitch 1	Pitch 1	Pitch 1	Pitch 1	Pitch 1	Pitch P	Pitch 1
15	B2	95 phaser	A Gate 7	95 phaser	A Gate 5	Pitch 2	Pitch 2	Pitch 2	Pitch 2	Pitch 2	Pitch P	Pitch 2
16	B3	93 chorus	A Gate 8	93 chorus	A Gate 6	93 chorus	A Gate 4	Pitch 3	Pitch 3	Pitch 3	Pitch P	Pitch 3
17	B4	94 delay	A Gate 9	94 delay	A Gate 7	94 delay	A Gate 5	Pitch 4	Pitch 4	Pitch 4	Pitch P	Pitch 4
18	B5	73 attack	A Gate 10	73 attack	A Gate 8	73 attack	A Gate 6	73 attack	A Gate 2	Pitch 5	Velocity P	Velocity 1
19	B6	72 release	A Gate 11	72 release	A Gate 9	72 release	A Gate 7	72 release	A Gate 3	Pitch 6	Velocity P	Velocity 2
23	C1	Ptch bend	Ptch bend	Ptch bend	Ptch bend	Ptch bend	Ptch bend	Ptch bend	Ptch bend	Ptch bend	Ptch bend	Ptch bend
24	C2	1 mod	1 mod	1 mod	1 mod	1 mod	1 mod	1 mod	1 mod	1 mod	1 mod	1 mod
25	C3	7 vol	7 vol	7 vol	7 vol	7 vol	7 vol	7 vol	7 vol	7 vol	Velocity P	Velocity 3
26	C4	11 expr	11 expr	11 expr	11 expr	11 expr	11 expr	11 expr	11 expr	11 expr	Velocity P	Velocity 4
27	C5	71 res/aft	71 res/aft	71 res/aft	71 res/aft	71 res/aft	71 res/aft	71 res/aft	71 res/aft	71 res/aft	71 res/aft	71 res/aft
28	C6	74 cut off	74 cut off	74 cut off	74 cut off	74 cut off	74 cut off	74 cut off	74 cut off	74 cut off	74 cut off	74 cut off
4	D1	A Gate 1	A Gate 1	P Gate 1	P Gate 1	P Gate 1	P Gate 1	P Gate 1	P Gate 1	P Gate 1	Gate P	P Gate 1
5	D2	A Gate 2	A Gate 2	A Gate 1	A Gate 1	P Gate 2	P Gate 2	P Gate 2	P Gate 2	P Gate 2	Gate P	P Gate 2
6	D3	A Gate 3	A Gate 3	A Gate 2	A Gate 2	A Gate 1	A Gate 1	P Gate 3	P Gate 3	P Gate 3	Gate P	P Gate 3
11	D4	A Gate 4	A Gate 4	A Gate 3	A Gate 3	A Gate 2	A Gate 2	P Gate 4	P Gate 4	P Gate 4	Gate P	P Gate 4
12	D5	A Gate 5	A Gate 5	A Gate 4	A Gate 4	A Gate 3	A Gate 3	A Gate 1	A Gate 1	P Gate 5	A Gate 1	A Gate 1
13	D6	CT	CT	CT	CT	CT	CT	CT	CT	P Gate 6	CT	CT
	Prog Change	7	8	0	1	2	3	4	5	6	9	10
MIDI	Pitch			1	1	1 – 2	1 – 2	1 – 4	1 – 4	1 – 6	1	1 – 4
Channels	Control	1	1	1	1	1	1	1	1	1	1	1
	Aux Gate	16	16	16	16	16	16	16	16	-	16	16
Overflow	Pitch			2	2	3 – 4	3 – 4	5 – 8	5 – 8	7 – 12	1	5 – 8
to	Control	2	2	2	2	2	2	2	2	2	2	2
Next IC	Aux Gate	16	16	16	16	16	16	16	16	-	16	16

The bottom 6 rows indicate which MIDI channels the outputs respond to.
Mode 4PV receives notes on MIDI channel 1 and allocates them to an available output automatically. Chaining allows unlimited polyphony with delay between chips being around 1 millisecond.
CT = MIDI Clock. Pulse length = 1ms. Produces 24 pulses per quarter note e.g. 48 pulses / second @ 120 B.P.M.
The lower 3 rows show how a second IC will respond.

Changing Modes

Mode change is enabled by sending MIDI program change 99.
Then the desired Mode can be sent as MIDI program change
e.g. Mode 1A = program change "0".
There are MIDI files on the midimuso website to make this easier to do.

Program #	MODE
==========	==========
0	1A (default)
1	1B
2	2A
3	2B
4	4A
5	4B
6	6
7	0A
8	0B
9	4PV
10	4MV

Example

Hex	Decimal	
0xC1	193	Program Change
0x63	99	Enables Mode Change (until IC is powered down)
0xC1	193	Program Change
0x05	0	0 = mode 1A

Retrigger

Retriggering is where a gate is switched off and quickly back on when a new note arrives. It's useful in mono modes where you may be playing quickly and you want the envelope generator to be gated again for any overlapping key strokes.

In polyphonic mode, retrigger only occurs when all available channels have been used up (e.g. holding down 4 keys in a one chip set up) and another key is pressed.

Switching retrigger off results in a legato style of play.
Program change 99 = allow mode changes, followed by:
Program change 101 = retrigger **on**
or
Program change 100 = retrigger **off**

e.g.

Hex	Decimal	
0xC1	193	Program Change
0x63	99	Enables Mode Change (until IC is powered down)
0xC1	193	Program Change
0x64	101	101 = retrigger on

You don't have to reset the IC after a Mode change and the IC will remember it is in the new mode even after power off.
The mode can be changed again at any time.

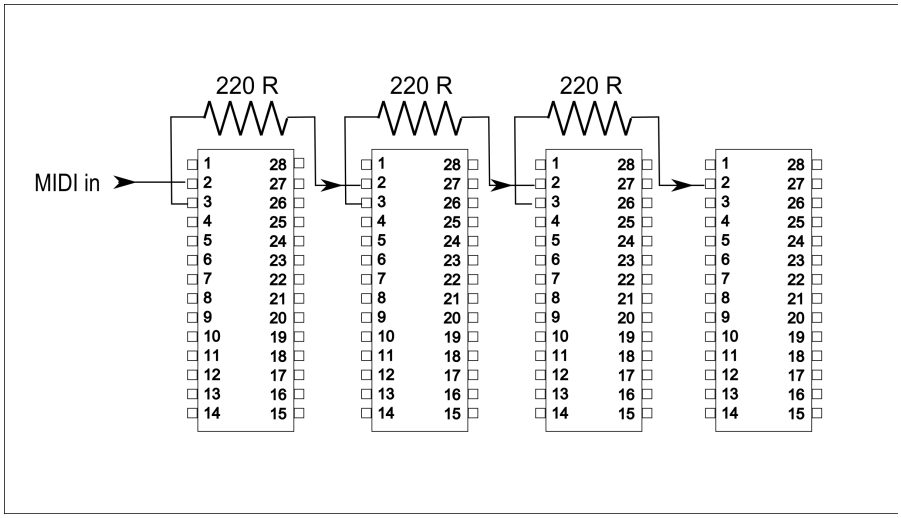
Aftertouch

Channel pressure or “aftertouch” is featured on higher-end keyboards and allows pressing the key(s) down whilst holding a note (or chord) to alter a characteristic such as volume or vibrato.
The signal appears at pin 27 or port C5 on the PCB – the same pin as used for resonance so you should decide on aftertouch or resonance – sending both will produce odd results.

Overflow and Polyphony

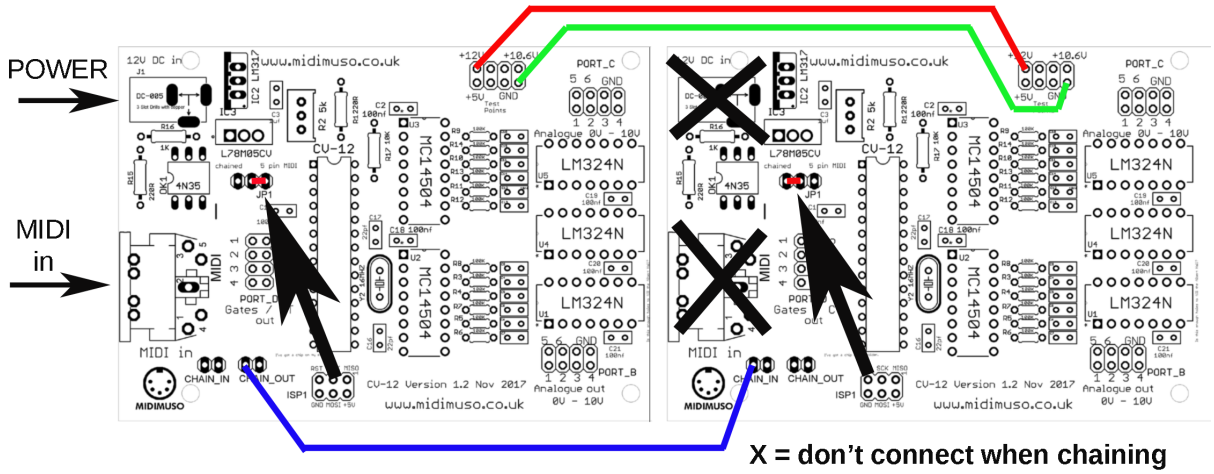
In mode 4PV, a single chip will allow 4 notes simultaneously.
If a 5th note is sent, it will steal from the oldest note currently playing.
If it is chained, it will pass the 5th note on to the next chip which will output if it can.
If it can't, it will pass on (if further chained), or note-steal from its own oldest note.

Chaining



Chaining 4 chips gives 16 note polyphony in Mode 4PV

Chaining CV-12 boards



How Chaining works:

Chained chips are connected via 220 Ohm resistors.
Chained boards are directly connected via chain in and chain out and jumper JP1 should connect centre and adjacent, left pin i.e. "chained" on the chained PCBs.
All chips **MUST** be **powered up** at the **same time** to allow handshaking.
The lowest rows of the modes table (page 3) show the following information:

Note on and off:

In mode 1A: notes sent over MIDI channel 1 will appear at the 1st chip
notes sent over MIDI channel 2 will appear at the 2nd chip
notes sent over MIDI channel 3 will appear at the 3rd chip etc.

In mode 2A: notes sent over MIDI channels 1 & 2 will appear at the 1st chip
notes sent over MIDI channels 3 & 4 will appear at the 2nd chip
notes sent over MIDI channels 5 & 6 will appear at the 3rd chip etc.

In mode 4A: notes sent over MIDI channels 1, 2, 3 & 4 will appear at the 1st chip
notes sent over MIDI channels 5, 6, 7 & 8 will appear at the 2nd chip
notes sent over MIDI channels 9, 10, 11 & 12 will appear at the 3rd chip etc.

In mode 6: notes sent over MIDI channels 1, 2, 3, 4, 5 & 6 will appear at the 1st chip
notes sent over MIDI channels 7, 8, 9 10, 11 & 12 will appear at the 2nd chip etc.

In mode 4PV: the first 4 notes held down and sent over MIDI channel 1 will appear at the 1st chip
the next 4 notes held down and sent over MIDI channel 1 will appear at the 2nd chip
the next 4 notes held down and sent over MIDI channel 1 will appear at the 3rd chip etc.
There's a 1 millisecond delay between chips so 32 note polyphony is practical (total 8 mSec delay)

Continuous Controllers, Pitch bend and Channel Aftertouch
appear at chip #1 for MIDI channel 1, chip #2 for MIDI channel #2 etc.

Aux gates are always sent on **MIDI Channel 16** and, if the 1st chip runs out of available gates, it sends the overflow to the next chip etc.

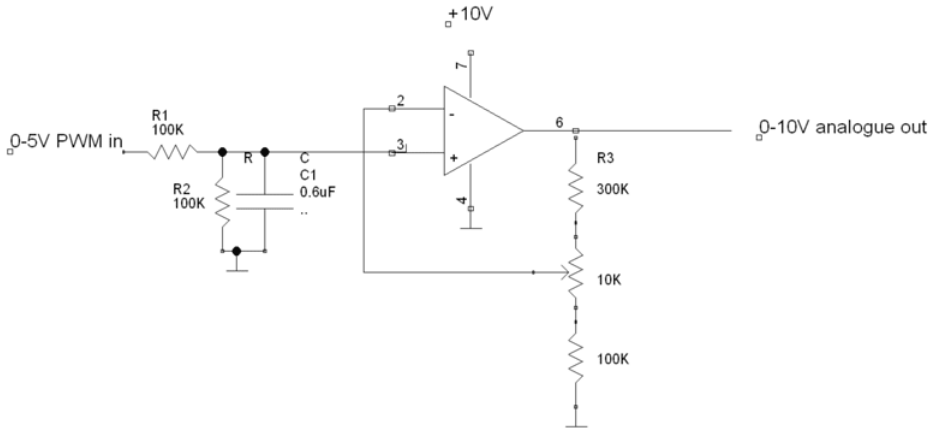
In mode 1A: notes C4 (60) to Eb4 (63) will appear at the 1st chip
notes E4 (64) to G4 (67) will appear at the 2nd chip etc.

In mode 0B: notes C4 (60) to Bb4 (70) will appear at the 1st chip
notes B4 (71) to Ab5 (81) will appear at the 2nd chip etc.

Program changes are passed on to every chip.

CT (Midi clock) is not passed on.

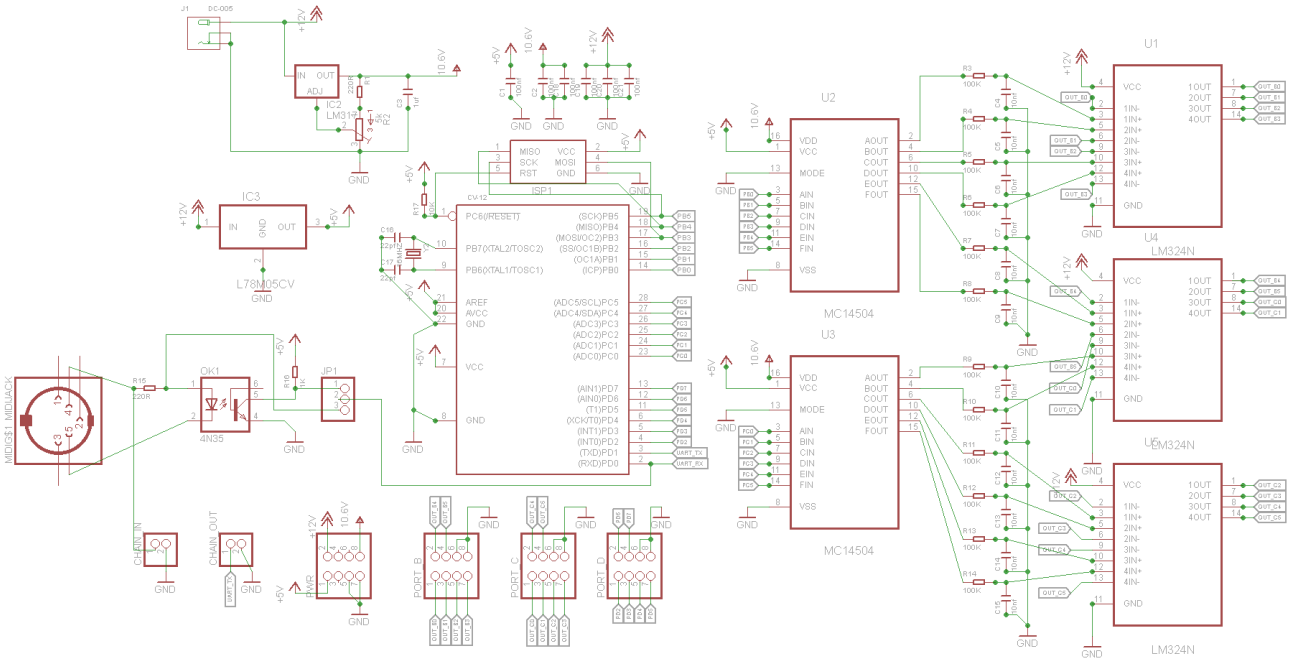
<u>Suggested Analogue Circuit for one Channel</u>



1st order low-pass filter (for control voltages). This circuit should be used for each pin producing a control voltage to smooth the PWM outputs and bring the range up to the full 10 volts.

Another good tip is to use the IC's outputs to switch a very stable reference voltage via analogue switches (see schematic below)

Full Schematic



Setting Up

Calibration for Pitch Voltages.
The IC outputs PWM from 0 Volts to +5 Volts.
Assuming you've set up a 2 x gain circuit, your outputs should be:
0 volts for MIDI note #21 (key A0)
8 Volts for MIDI note #117 (key A8)

Volts / Octave Moog scheme:

MIDI key	Value (hex)	Value (decimal	Output (volts)
A0	15	21	0.000
A1	21	33	1.000
A2	2D	45	2.000
A3	39	57	3.000
C4	3C	60	3.250
A4	45	69	4.000
A5	51	81	5.000
A6	5D	93	6.000
A7	69	105	7.000
A8	75	117	8.000

There is disagreement about MIDI key number standards. We used a free MIDI tool called MIDI Ox to display values from the controller keyboard.
http://www.midiox.com

Accuracy

Analogue voltages are produced by “bit spray” PWM at a refresh rate of 62 **kHz** per channel needing just a 1st order low pass filter for smoothing.

PWM accuracy is dependent on clock jitter. In practice, accuracy is around 1/30 semitone i.e. around 12 bits – good enough for pitch control.

Contact

email: info@midimuso.co.uk

Acknowledgements

Special thanks to Guy Wilkinson, Koen Pepping, Dave Wilson, Godric Wilkie and Matt Rhys Roberts for advice, encouragement and ideas.