GEN/MDM INTERFACE
USER GUIDE 1.00

Contents

Overview

The Gen/MDM Interface allows one to have complete control over the two sound chips (The YM2612 and the SN76489) within the SEGA Genesis / Mega Drive console via a MIDI connection.

The interface consists of two parts – a cartridge containing a custom program, and a hardware interface with pre-programmed microcontroller.

Setup

1. Connect the Gen/MDM hardware interface to the video game console via a 9-pin extension cable (available separately).
2. Connect the MIDI output from your host computer or other MIDI-enabled device to the Gen/MDM hardware interface.
3. Insert the Gen/MDM cartridge into the video game console.
4. Connect the audio output of the video game console to amplification or recording equipment. Video output is not needed.
5. MIDI channels 1 to 6 are mapped to YM2612 channels 1 to 6. Note that the polyphonic mode is set to ON as a default (see page 7 for details).
6. MIDI channels 7 to 10 are mapped to SN76489 channels 1 to 4.

Gen/MDM MIDI Quick Reference

See the following sections for more information.

YM2612 FM sound chip is mapped to MIDI channels 1 – 6. SN76489 PSG sound chip is mapped to MIDI channels 7 – 10.

YM2612 FM

Global Control

Parameter	CC	Data Range
Polyphonic Mode Enable / Disable	84	2
LFO Enable (Global)	74	2
LFO Speed	1	8
Pitch Transposition	85	128
Octave Division	84	128
PAL / NTSC Tuning	83	2

DAC Control

Parameter	CC	Data Range
DAC Enable	78	2
DAC Data	79	128
DAC Sample Pitch Speed	86	128
DAC Sample Oversample	88	16
DAC Noise / Custom Wave Mode	89	2
Custom Wave Byte 1 of 14	100	128
Custom Wave Byte 2 of 14	101	128
Custom Wave Byte 3 of 14	102	128
Custom Wave Byte 4 of 14	103	128
Custom Wave Byte 5 of 14	104	128
Custom Wave Byte 6 of 14	105	128
Custom Wave Byte 7 of 14	106	128
Custom Wave Byte 8 of 14	107	128
Custom Wave Byte 9 of 14	108	128
Custom Wave Byte 10 of 14	109	128
Custom Wave Byte 11 of 14	110	128

Custom Wave Byte 12 of 14	111	128
Custom Wave Byte 13 of 14	112	128
Custom Wave Byte 14 of 14	113	128

Channel / Voice Control

Parameter	CC	Data Range
Preset Instrument Setting	9	16
Frequency	(note number)	128
Pitch Bend Amount	81	18
FM Algorithm	14	8
FM Feedback	15	8
Stereo Configuration	77	4
Amplitude Modulation Level	76	8
Frequency Modulation Level	75	8

Operator Control

Parameter	CC	Data Range
Total Level OP1	16	128
Total Level OP2	17	128
Total Level OP3	18	128
Total Level OP4	19	128
Multiple OP1	20	16
Multiple OP2	21	16
Multiple OP3	22	16
Multiple OP4	23	16
Detune OP1	24	8
Detune OP2	25	8
Detune OP3	26	8
Detune OP4	27	8
Rate Scaling OP1	39	4
Rate Scaling OP2	40	4
Rate Scaling OP3	41	4
Rate Scaling OP4	42	4
Attack Rate OP1	43	32

Attack Rate OP2	44	32
Attack Rate OP3	45	32
Attack Rate OP4	46	32
First Decay Rate OP1	47	32
First Decay Rate OP2	48	32
First Decay Rate OP3	49	32
First Decay Rate OP4	50	32
Secondary Decay Rate OP1	51	16
Secondary Decay Rate OP2	52	16
Secondary Decay Rate OP3	53	16
Secondary Decay Rate OP4	54	16
Secondary Amplitude Level OP1	55	16
Secondary Amplitude Level OP2	56	16
Secondary Amplitude Level OP3	57	16
Secondary Amplitude Level OP4	58	16
Release Rate OP1	59	16
Release Rate OP2	60	16
Release Rate OP3	61	16
Release Rate OP4	62	16
Amplitude Modulation Enable OP1	70	2
Amplitude Modulation Enable OP2	70	2
Amplitude Modulation Enable OP3	70	2
Amplitude Modulation Enable OP4	70	2

SN76489 PSG

Global Control

Parameter	CC	Data Range
Pitch Transposition	85	128
PAL / NTSC Tuning	83	2

Noise Channel Control

C and C#: High frequency, periodic type

D and D#: Medium frequency, periodic type

E: Low frequency, periodic type

F:	High frequency, noise type
F#:	Medium frequency, noise type
G and G#:	Low frequency, noise type
A and A#:	Frequency is determined by channel 9, periodic type
B:	Frequency is determined by channel 9, noise type

MIDI Mapping – YM2612

The YM2612 FM chip contains six channels that are mapped to MIDI channels 1 to 6. Each channel contains four operators, which can be set to different configuration algorithms. Additionally, channel 6 can be used as a digital to analogue converter in order to playback samples. An LFO that can be used to modulate amplitude or frequency is also part of the YM2612.

YM2612: Global Parameters

Polyphonic Enable **CC84** **Any Channel**

2 values over the range of 0 to 127. A CC value of less than 64 disables polyphonic mode for the interface. A value of more than 63 enables polyphonic mode for the interface. Note that the default is so that the polyphonic mode is enabled. When enabled, the polyphonic mode allows for chords played on MIDI channels 1 to 6 to be played by dynamically routing note on and note off events to the next available channel. For music sequencing, it is recommended that this mode be set to OFF as a default. However, for live keyboard playing or use with other MIDI controllers, it may be very much beneficial to turn this mode to ON. Note that a MIDI CC message sent to MIDI channels 1 to 6 with polyphonic mode set to ON will update ALL YM2612 channels, so that all channels will have the same instrument settings (as one would expect of a polyphonic instrument).

PAL / NTSC Tuning **CC83** **Any Channel**

2 values over the range of 0 to 127. A CC value of less than 64 sets the interface to the PAL tuning. A value of more than 63 sets the interface to the NTSC tuning. The default setting is PAL.

LFO Enable **CC74** **Any Channel**

2 values over the range of 0 to 127. A CC value of less than 64 disables the LFO on a global scale. A value of more than 63 enables the LFO on a global scale. In addition to this parameter, each individual channel requires an LFO enable for either amplitude or frequency LFO modulation.

LFO Speed **CC1 (Mod. Wheel)** **Any Channel**

8 values over the range of 0 to 127. This CC sets the speed of the LFO. 0 is the slowest speed. 127 is the fastest speed.

Pitch Transposition **CC85** **Any Channel**

128 values of the range of 0 to 127. Set a global pitch offset of – 64 to + 63 semitones. Default is + or – 0 semitones which is equivalent to a CC value of 64.

Equal Tempered Octave Division **CC84** **Any Channel**

128 values of the range of 0 to 127. Sets the global equal-tempered division of the octave. The tuning of the interface is equal to (CC + 1) TET. The default is an equal division of the octave into twelve parts (the Western music scale), which is equivalent to a CC value of 11.

Pitch Bend Range **CC81** **Any Channel**

10 values of the range of 0 to 127. This parameter sets the bend amount in semitones, from 0 semitones to 10 semitones.

YM2612: DAC Control

DAC Enable **CC78** **Any Channel**

2 values over the range of 0 to 127. A CC value of less than 64 disables the DAC on channel 6. A value of more than 63 enables the DAC on channel 6. Note that with the DAC enabled, MIDI notes as played back on channel 6 will trigger samples *or* noise *or* custom waveforms instead of FM synthesis sounds.

The mapping of samples to MIDI notes wraps around every two octaves in the range of MIDI note 60 to MIDI note 127. A note-on on MIDI channel 6 will trigger sample playback. A note-off on MIDI channel 6 will stop sample playback.

01. C-1 - kick 1
02. C#1 - snare 1
03. D-1 - hat closed 1
04. D#1 - hat open 1
05. E-1 - tom low 1
06. F-1 - tom hi 1
07. F#1 - cow bell
08. G-1 - kick 2
09. G#1 - snare 2
10. A-1 - hat closed 2
11. A#1 - hat open 1
12. B-1 - tom low 1
13. C-2 - tom hi 1
14. C#2 - ride 1
15. D-2 - crash
16. D#2 - kick 3
17. E-2 - snare 3
18. F-2 - ride 2

From MIDI note 0 to MIDI note 59, the DAC is used to play either a noise waveform or a customisable periodic waveform. By changing CC89, the choice between noise waveform or the customisable periodic waveform can be made. By changing CC100 to CC113, the individual bytes that make up the customisable waveform can be changed, thereby manipulating the timbre of the sound. Throughout this range of MIDI notes (0 to 59), the higher the note, the higher the pitch of the DAC waveform.

DAC Sample Speed **CC86** **Any Channel**

128 values over the range of 0 to 127. This parameter sets the playback rate for the samples on channel 6. 0 is the fastest speed and 127 is the slowest speed. The default value is 0. This parameter will only have an effect on the audio output when the DAC is enabled.

DAC Sample Speed (Over Sample Rate) **CC88** **Any Channel**

128 values over the range of 0 to 127. This parameter sets the playback over sampling rate for the samples on channel 6. In other words, it changes the playback rate (ie. Pitch and speed) by a factor of 1 x, 2 x, 3 x or 4 x. The default value is 1 x, which is equivalent to a CC value of 0 to 31. This parameter will only have an effect on the audio output when the DAC is enabled.

DAC Data **CC79** **Any Channel**

128 values over the range of 0 to 127. This parameter will set the output voltage of the DAC to a value of CCVALUE * 2. The default value is 0. This parameter will only have an effect on the audio output when the DAC is enabled.

Noise / Custom Waveform **CC89** **Any Channel**

2 values over the range of 0 to 127. This parameter will select between the noise DAC waveform and the customisable DAC waveform. A value of less than 64 will select the noise type (which is the default). A value of more than 63 will select the customisable type. CC100 to CC113 are used to set the customisable bytes of the waveform.

Custom Wave Byte 1 of 14	**CC100**	**Any Channel**
Custom Wave Byte 2 of 14	**CC101**	**Any Channel**
Custom Wave Byte 3 of 14	**CC102**	**Any Channel**
Custom Wave Byte 4 of 14	**CC103**	**Any Channel**
Custom Wave Byte 5 of 14	**CC104**	**Any Channel**
Custom Wave Byte 6 of 14	**CC105**	**Any Channel**
Custom Wave Byte 7 of 14	**CC106**	**Any Channel**
Custom Wave Byte 8 of 14	**CC107**	**Any Channel**
Custom Wave Byte 9 of 14	**CC108**	**Any Channel**
Custom Wave Byte 10 of 14	**CC109**	**Any Channel**
Custom Wave Byte 11 of 14	**CC110**	**Any Channel**
Custom Wave Byte 12 of 14	**CC111**	**Any Channel**
Custom Wave Byte 13 of 14	**CC112**	**Any Channel**
Custom Wave Byte 14 of 14	**CC113**	**Any Channel**

128 values over the range of 0 to 127. The DAC and the Gen/MDM Interface make provisions for a simple 14-byte user-customisable waveform. The above CC messages allow for user control of the custom wave for MIDI channel six when (a) the interface is set to DAC enable mode via MIDI CC

78 and (b) the custom waveform is selected via MIDI CC 89.

Each of the above CC messages sets one byte in the 14 byte waveform whereby w*aveform value = ccvalue * 2*.

YM2612: Channel Control

Frequency **MIDI Note Pitch** **Channel Specific**

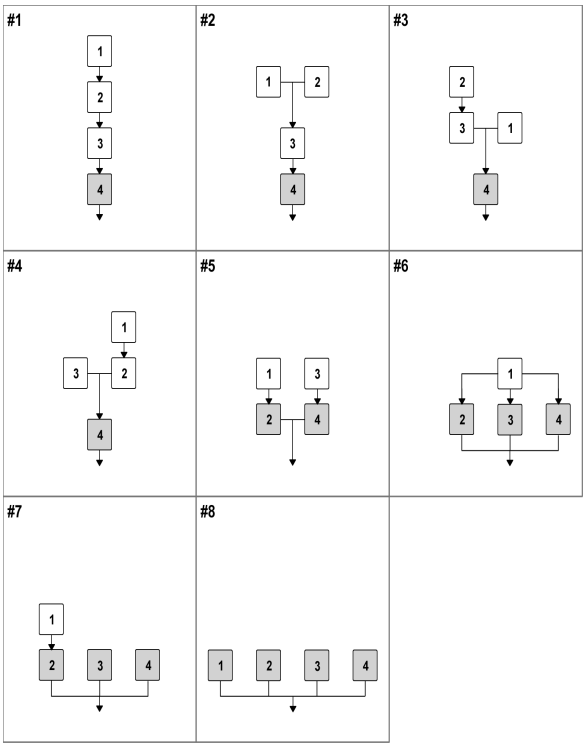
The frequency of the channel is determined by the pitch of an incoming MIDI note-one event.

Pitch Bend **Pitch Bend** **Channel Specific**

The pitch bend function of the interface uses the high byte of the pitch bend event message, giving 127 steps. The pitch bend range in semitones can be set globally via CC81, as described previously.

Algorithm **CC14** **Channel Specific**

8 values over a range of 0 to 127. This parameter sets the algorithm of the selected channel. The algorithm determines the relationship between the four operators, and can change the timbre and complexity of the sound. There are 8 algorithms available, as follows. In the diagram below, a grey box indicates that a given operator is acting as a carrier (and is directly audible). A white box indicates that a given operator is acting as a modulator (and is modulating the frequency of another operator).



FM Feedback **CC15** **Channel Specific**

8 values over a range of 0 to 127. This parameter sets the amount that operator 1 feeds back onto itself. The higher the value, the more distorted the sound.

Stereo Configuration **CC77** **Channel Specific**

4 values over a range of 0 to 127. This parameter sets the stereo output (panning) of the specified channel. Note that the stereo placement of a channel will have no effect if a mono cable is used (generally from the AV output socket from the Genesis / Mega Drive Console). For the best separation of the left and right audio signals, a modification is recommended, or the use of the headphone output port from a Nomad or a Genesis / Mega Drive model 1 console.

A CC value of 0 to 31 indicates that the channel is OFF (muted). A CC value of 32 – 63 indicates that the channel is panned LEFT. A CC value of 64 – 95 indicates that the channel is panned RIGHT. A CC value of 96 – 127 indicated that the channel is panned CENTER. The default setting is CENTER.

Amplitude Modulation Level **CC76** **Channel Specific**

8 values over a range of 0 to 127. This parameter sets the depth of amplitude modulation by the LFO for the specified channel. The default CC value is 0 (no modulation).

Frequency Modulation Level **CC75** **Channel Specific**

8 values over a range of 0 to 127. This parameter sets the depth of frequency modulation by the LFO for the specified channel. The default CC value is 0 (no modulation).

Preset Instrument Setting **CC9** **Channel Specific**

16 values over a range of 0 to 127. This parameter activates one of 16 preset instrument settings. These instrument settings are stored in the memory of the interface itself, and cannot be altered by the user.

The preset instruments are as follow:

1. Lead Synth
2. Bass
3. Church Organ
4. Xylophone
5. String Pizzicato
6. Brass
7. -
8. -
9. -
10. -
11. -
12. -
13. -

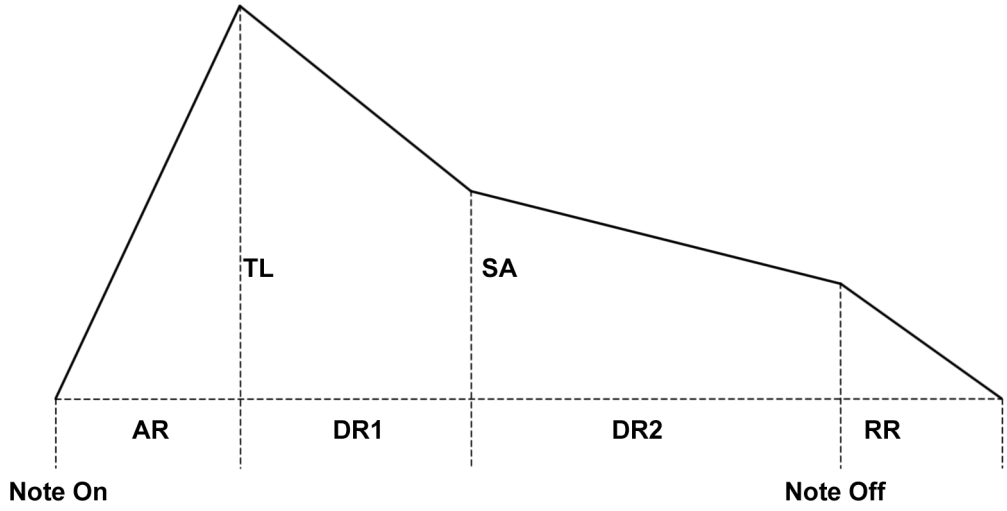
14. -
15. -
16. -

Note that the following parameters are affected by recalling one of the above presets:

- FM Algorithm
- FM Feedback
- Total Level of Operators 1, 2, 3 and 4
- Multiple of Operators 1, 2, 3 and 4
- Detune of Operators 1, 2, 3 and 4
- Attack Rate of Operators 1, 2, 3 and 4
- First Decay Rate of Operators 1, 2, 3 and 4
- Secondary Decay Rate of Operators 1, 2, 3 and 4
- Secondary Amplitude Level of Operators 1, 2, 3 and 4
- Release Rate of Operators 1, 2, 3 and 4

YM2612: Operator Control

One of the most important aspects of controlling each operator of the YM2612 is through the amplitude (volume) envelope generator. Below is a basic representation of the envelope and its parameters.



In relation to the above diagram, the horizontal axis represents time while the vertical axis represents amplitude. The Note On and Note Off events refer to their MIDI counter parts in the context of this MIDI interface.

TL = Total Level

SA = Secondary Amplitude

AR = Attack Rate

DR1 = First Decay Rate

DR2 = Secondary Decay Rate

RR = Release Rate

Total Level of Operator 1	**CC16**	**Channel Specific**
Total Level of Operator 2	**CC17**	**Channel Specific**
Total Level of Operator 3	**CC18**	**Channel Specific**
Total Level of Operator 4	**CC19**	**Channel Specific**

128 values over a range of 0 to 127. The total level (TL) of an operator determines the amplitude of a given operator. If the operator is currently acting as a carrier, then the TL determines the volume of the operator. If the operator is currently acting as a modulator, then the TL determines the amount

that the operator will modulate another operator. In addition to the value as set by this CC, the velocity of a note on the specified channel will also control the TL as follows: *TL = (CC * Velocity) / 127*.

Multiple of Operator 1	**CC20**	**Channel Specific**
Multiple of Operator 2	**CC21**	**Channel Specific**
Multiple of Operator 3	**CC22**	**Channel Specific**
Multiple of Operator 4	**CC23**	**Channel Specific**

16 values over a range of 0 to 127. The multiple of an operator determines the frequency as an integer partial in relation to the fundamental pitch of the note being played back on the specified channel. The higher the value of the multiple, the higher the frequency of the multiple.

Detuning of Operator 1	**CC24**	**Channel Specific**
Detuning of Operator 2	**CC25**	**Channel Specific**
Detuning of Operator 3	**CC26**	**Channel Specific**
Detuning of Operator 4	**CC27**	**Channel Specific**

8 values over a range of 0 to 127. This determines how much a given operator on a specified channel is detuned. 0 is no detuning at all, 127 is the maximum amount of detuning.

Rate Scaling of Operator 1	**CC39**	**Channel Specific**
Rate Scaling of Operator 2	**CC40**	**Channel Specific**
Rate Scaling of Operator 3	**CC41**	**Channel Specific**
Rate Scaling of Operator 4	**CC42**	**Channel Specific**

4 values over a range of 0 to 127. 'Rate Scaling' is the degree to which the amplitude envelope becomes narrower as the frequency of the pitch of the specified channel becomes higher.

Amplitude Attack Rate of Operator 1	**CC43**	**Channel Specific**
Amplitude Attack Rate of Operator 2	**CC44**	**Channel Specific**
Amplitude Attack Rate of Operator 3	**CC45**	**Channel Specific**
Amplitude Attack Rate of Operator 4	**CC46**	**Channel Specific**

32 values over a range of 0 to 127. The amplitude attack rate controls a portion of the amplitude envelope of the operator in question. Specifically, it relates to the amount of time it takes for the amplitude to rise from 0 to a maximum level (TL) after starting the amplitude envelope cycle. The higher the attack rate, the quicker the attack time is. A CC value of 0 indicates a very slow attack time. A CC value of 127 indicates a very fast attack time.

First Decay Rate of Operator 1	**CC47**	**Channel Specific**
First Decay Rate of Operator 2	**CC48**	**Channel Specific**

First Decay Rate of Operator 3	**CC49**	**Channel Specific**
First Decay Rate of Operator 4	**CC50**	**Channel Specific**

32 values over a range of 0 to 127. The first decay rate controls a portion of the amplitude envelope of the operator in question. Specifically, it relates to the amount of time it takes for the amplitude to fall from the maximum level (TL) to a secondary amplitude (see below). The higher the first decay rate, the quicker the first decay time is. A CC value of 0 indicates a very slow first decay time. A CC value of 127 indicates a very fast first decay time.

Secondary Decay Rate of Operator 1	**CC51**	**Channel Specific**
Secondary Decay Rate of Operator 2	**CC52**	**Channel Specific**
Secondary Decay Rate of Operator 3	**CC53**	**Channel Specific**
Secondary Decay Rate of Operator 4	**CC54**	**Channel Specific**

16 values over a range of 0 to 127. The secondary decay rate controls a portion of the amplitude envelope of the operator in question. Specifically, it relates to the amount of time it takes for the amplitude to fall from the secondary decay rate to either an amplitude of zero, or until a note off event is received (at which point the release section of the amplitude begins). The higher the secondary decay rate, the quicker the secondary decay time is. A CC value of 0 indicates a very slow secondary decay time. A CC value of 127 indicates a very fast secondary decay time.

Secondary Amplitude of Operator 1	**CC55**	**Channel Specific**
Secondary Amplitude of Operator 2	**CC56**	**Channel Specific**
Secondary Amplitude of Operator 3	**CC57**	**Channel Specific**
Secondary Amplitude of Operator 4	**CC58**	**Channel Specific**

16 values over a range of 0 to 127. The secondary amplitude rate controls a portion of the amplitude envelope of the operator in question. Specifically, it relates to the amplitude level that is the target point of the first decay ramp. The higher the secondary amplitude level, the louder the operator for this portion of the envelope.

Release Rate of Operator 1	**CC59**	**Channel Specific**
Release Rate of Operator 2	**CC60**	**Channel Specific**
Release Rate of Operator 3	**CC61**	**Channel Specific**
Release Rate of Operator 4	**CC62**	**Channel Specific**

16 values over a range of 0 to 127. The release rate controls a portion of the amplitude envelope of the operator in question. Specifically, it relates to the amount of time it takes for the amplitude to fall to zero after a note off event has been received. The higher the release rate, the quicker the release time is. A CC value of 0 indicates a very slow release time. A CC value of 127 indicates a very fast release time.

Amplitude Modulation Operator 1	**CC70**	**Channel Specific**
Amplitude Modulation Operator 2	**CC71**	**Channel Specific**

Amplitude Modulation Operator 3	**CC72**	**Channel Specific**
Amplitude Modulation Operator 4	**CC73**	**Channel Specific**

2 values over a range of 0 to 127. These MIDI CC messages control whether a given operator on a specified channel is enabled for amplitude modulation or not. A CC value below 64 will disable the amplitude modulation of a given operator (this is the default). A CC value above 63 will enable the amplitude modulation of a given operator.

MIDI Mapping – SN76489

The SN76489 PSG chip contains four channels that are mapped to MIDI channels 7 to 10. Channels 7, 8 and 9 are pulse channels that feature a simple tone generator, which can be used for melodic lines. Channel 10 is a pseudo-random noise generator, which can be used for percussion or effects. Channel 10 can be clocked using channel 9 (in other words – the pitch of channel 9 controls the pitch of channel 10).

The MIDI mapping for the SN76489 is relatively simple and straightforward compared withthe YM2612. The SN76489 will respond to the following CC messages as well as note on, note off and pitch bend events.

PAL / NTSC Tuning **CC83** **Any Channel**

2 values over the range of 0 to 127. A CC value of less than 64 sets the interface to the PAL tuning. A value of more than 63 sets the interface to the NTSC tuning. The default setting is PAL. This setting is separate from the YM2612 equivalent.

Pitch Transposition **CC85** **Any Channel**

128 values of the range of 0 to 127. Set a global pitch offset of – 64 to + 63 semitones. Default is + or – 0 semitones which is equivalent to a CC value of 64. This setting is separate from the YM2612 equivalent.

SN76489 Noise Channel Control

The SN76489 has an interesting noise channel. The setting for the noise channel at a given point in time is selected by sending a note on event on MIDI channel 10. Any given pitch will produce a different setting for the noise channel, as follows:

C and C#:	High frequency, periodic type
D and D#:	Medium frequency, periodic type
E:	Low frequency, periodic type
F:	High frequency, noise type
F#:	Medium frequency, noise type
G and G#:	Low frequency, noise type
A and A#:	Frequency is determined by channel 9, periodic type
B:	Frequency is determined by channel 9, noise type

One way of handling the control of channel 10 using channel 9 is by sending note on events on

channel 9 with a velocity below 7 (which will set the frequency of the noise channel) at the same time as sending note on events on channel 10 with a pitch of A, A# or B and with a high velocity (which will set the tone type – either noise or periodic – of the noise noise channel).