SMSM INTERFACE
USER GUIDE 1.00

Contents

Overview

The SMSM Interface allows one to have complete control over the two sound chips (The SN76489 and the YM2413 (optional in many systems)) within the SEGA Master System 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 SMSM 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 SMSM hardware interface.
3. Insert the SMSM 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. Depending on the console type, you may need to manually add audio outputs or use a DIN-type connection adaptor.
5. MIDI channels 1 to 4 are mapped to SN76489 channels 1 to 4.
6. MIDI channels 5 to 14 are mapped to YM2413 channels 1 to 9 (if YM2413 is available).

SMSM MIDI Quick Reference

See the following sections for more information.

MIDI channels 1 to 4 are mapped to SN76489 channels 1 to 4.

MIDI channels 5 to 14 are mapped to YM2413 channels 1 to 9 (if YM2413 is available).

SN76489 PSG

Global Control

Parameter	CC	Data Range
Pitch Transposition	42	128
PAL / NTSC Tuning	83	2
Bass mode enabled	85	2

Noise Channel Control (MIDI Ch 4)

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 3, periodic type
B:	Frequency is determined by channel 3, noise type

Voice Control

Parameter	CC	Data Range
AM mode enabled	70	2
AM speed	18	128
AM depth	19	16
FM mode enabled	71	2
FM speed	20	128
FM depth	21	128
Set channel volume	11	16

Channel 2 Sample Mode

Parameter	CC	Data Range
Sample mode enabled	78	2
Sample playback speed	86	128

YM2413 FM

Global Control

Parameter	CC	Data Range
Set the value of A in Hz	81	128
Equal Tempered Octave Division	80	128
Set pitch bend resolution in semitones	79	10.5
Percussion mode enabled	78	2

Percussion Mode Control (MIDI Ch 14 when Percussion Mode is Enabled)

C: Kick Drum

D: Snare Drum

E: Tom

F: Cymbal

G: Hi-hat

Voice Control

Parameter	CC	Data Range
Set instrument	14	16
Custom voice AM (modulator) enabled	15	2
Custom voice AM (carrier) enabled	16	2
Custom voice Vib (m) enabled	17	2
Custom voice Vib (c) enabled	18	2
Custom voice EG type (m)	19	2
Custom voice EG type (c)	20	2
Custom voice KSR on (m)	21	2
Custom voice KSR on (c)	22	2
Custom voice mul (m)	23	16
Custom voice mul (c)	24	16
Custom voice KSL (m)	25	4
Custom voice KSL (c)	26	4

Custom voice TL modulation	27	2
Custom voice rectify wave (m)	28	2
Custom voice rectify wave (c)	29	2
Custom voice FM feedback (m)	30	16
Custom voice attack (m)	31	16
Custom voice decay (m)	32	16
Custom voice sustain (m)	33	16
Custom voice release (m)	34	16
Custom voice attack (c)	35	16
Custom voice decay (c)	36	16
Custom voice sustain (c)	37	16
Custom voice release (c)	38	16
Custom voice sustain mode enabled	70	2

MIDI Mapping – SN76489

The SN76489 PSG chip contains four channels that are mapped to MIDI channels 1 to 4. Channels 1, 2 and 3 are pulse channels that feature a simple tone generator, which can be used for melodic lines. Channel 4 is a pseudo-random noise generator, which can be used for percussion or effects. Channel 4 can be clocked using channel 3 (in other words – the pitch of channel 3 controls the pitch of channel 4).

The MIDI mapping for the SN76489 is relatively simple and straightforward compared with the YM2413. The SN76489 will respond to the following MIDI CC messages as well as note on, note off and pitch bend events.

SN76489: Global Parameters

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.

Pitch Transposition **CC42** **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.

Bass Mode Enabled **CC 85** **Any Channel**

2 values over the range of 0 to 127. A CC of less than 64 disables Bass Mode for channel 2. A CC value of more than 63 enables Bass Mode for channel 2. When bass mode is enabled, the resources of SN76489 channels 3 and 4 are combined in such a way that MIDI channel 3 is a bass-like voice. This is a simple and musical way to 'clock' SN76489 channel 4 using SN76489 channel 3. See 'SN76489: Noise Channel Control' for more information.

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 4. Any given pitch (regardless of octave) 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 4 using channel 3 is by sending note on events on channel 3 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 4 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).

'Bass Mode' simplified way of controlling the frequency of the noise channel using channel 3. See 'Bass Mode Enabled' for more information.

SN76489: Voice Control Control

AM Mode Enabled **CC 70** **Channels 1, 2 and 3**

2 values over the range of 0 to 127. A CC of less than 64 disables AM Mode a given channel. A CC value of more than 63 enables AM mode for a given channel. AM (amplitude modulation) allows for a range of effects, from timbral changes to tremolo and distortion.

AM Speed **CC18** **Channels 1, 2 and 3**

128 values over the range of 0 to 127. The lower the CC value, the fast the speed of the amplitude modulation. Whether or not or not other MIDI channels are very active or have AM enabled will influence the actual frequency of the amplitude modulation for a given channel.

AM Depth **CC19** **Channels 1, 2 and 3**

16 values over the range of 0 to 127. The lower the CC value, the less of an effect the amplitude modulation will have on a given voice.

FM (Vibrato) Mode Enabled **CC 70** **Channels 1, 2 and 3**

2 values over the range of 0 to 127. A CC of less than 64 disables FM Mode a given channel. A CC value of more than 63 enables FM mode for a given channel. AM (frequency modulation) allows for a range of effects, from timbral changes to vibrato and distortion.

FM (Vibrato) Speed **CC18** **Channels 1, 2 and 3**

128 values over the range of 0 to 127. The lower the CC value, the fast the speed of the amplitude modulation. Whether or not or not other MIDI channels are very active or have FM enabled will influence the actual frequency of the frequency modulation for a given channel.

FM (Vibrato) Depth **CC19** **Channels 1, 2 and 3**

16 values over the range of 0 to 127. The lower the CC value, the less of an effect the frequency modulation will have on a given voice.

Set Channel Volume **CC11** **All Channels**

16 values over the range of 0 to 127. Set the volume of a given channel. Can be used to draw envelopes.

SN76489: Channel 2 Sample Mode

Sample Mode Enabled **CC78** **Channel 2**

2 values over the range of 0 to 127. A CC of less than 64 disables the sample mode. A CC value of more than 63 enables the sample mode. The sample mode can only be enabled for SN76489 channel 2. Note that due to the difference in volume for samples compared to the pulse waves, when sample mode is enabled, the volume of all notes is set to 1/3.

Sample Playback Speed **CC86** **Channel 2**

128 values over the range of 0 to 127. The lower the CC value, the faster the sample playback speed is.

MIDI Mapping – YM2413

The YM2413 is an FM chip and can play either 9 pitched channels or 6 pitches channels and 5 percussive sounds at once. The FM synthesis is relatively simple, and consists of a single modulator / single carrier-type model. The sound chip contains 15 preset instruments.

MIDI channels 5 to 13 are mapped to YM2413 pitched channels 1 to 9.

MIDI channel 14 is mapped to YM2413 percussion mode.

YM2413: Global Control

Set the value of A in Hz **CC81** **Any Channel**

128 values over the range of 0 to 127. The value of the concert A and all other pitches relative to concert A is set by the following equation: *Concert A = 381 + CC value (in Hz)*. For example, a CC value of 63 will give that Concert A = 381 + 63 = 440 Hz. This CC gives the user control over tuning; there is no need to change this CC from the default value in order to have standard tuning.

Equal Tempered Octave Division **CC80** **Any Channel**

128 values over 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. Values above CC value = 17 may yield unexpected results. This CC gives the user control over tuning; there is no need to change this CC from the default value in order to have standard tuning.

Set Pitch Bend Resolution in Semitones **CC79** **Any Channel**

10.5 values over the range of 0 to 127. Sets the global pitch-bend value in semitones, from +/- 0 semitones to +/- 12 semitones.

Percussion Mode Enabled **CC78** **Any Channel**

2 values over the range of 0 to 127. A CC of less than 64 disables percussion mode. A CC value of more than 63 enables percussion mode. Percussion mode uses the resources of pitched channel 7, 8 and 9 in order to create 5 percussive sounds: kick drum, snare drum, tom, cymbal and hi-hat.

When in percussion mode:

• Only YM2413 pitched channels 1 to 6 are available for direct use

• As a result, only MIDI channels 5 to 10 will respond properly to MIDI note on / off events.

• MIDI channel 14 allows control over the YM2413 percussion mode

YM2413: Percussion Mode Control

MIDI Channel 14 control the percussive sounds. A note / off event for the following pitches (regardless of octave) will trigger the following percussive sounds when Percussion Mode is enabled (see 'Percussion Mode Enabled').

C: Kick Drum

D: Snare Drum

E: Tom

F: Cymbal

G: Hi-hat

Yamaha recommends a predetermined frequency setting for each of the operators that constitute the percussion when in drum mode, but these preset frequencies can sound quite bland and boring. By sending a CC value of more than 64, these preset-values are recalled automatically.

However, because these sounds are made using the operators that normally make up YM2413 pitched channels 7, 8 and 9, it is still possible to tune the operators to a certain degree by simply sending MIDI pitches to MIDI channels 11, 12 and 13. This then essentially 'tunes' the drum sounds, giving a wider variety of sounds, and even the possibility of playing melodies using the percussive sounds.

YM2413: Voice Control

Set Instrument **CC14** **Any Channel**

16 values over the range of 0 to 127. Sets a given channel to an instrument preset. The instrument presets are as follows:

1. (Custom Voice)
2. Violin
3. Guitar
4. Piano
5. Flute
6. Clarinet
7. Oboe
8. Trumpet
9. Organ
10. Horn
11. Synthesizer
12. Harpsichord
13. Vibraphone

14. Synthesizer Bass
15. Acoustic Bass
16. Electric Bass

Note that the custom voice settings are identical for all channels – the custom voice is a global instrument with global parameters. See below for these parameters and how they are controlled.

Custom Voice AM (Modulator) Enabled CC15 Any Channel

2 values over the range of 0 to 127. A CC of less than 64 disables AM mode for the custom voice modulator. A CC value of more than 63 enables AM mode for the custom voice modulator.

Custom Voice AM (Carrier) Enabled CC16 Any Channel

2 values over the range of 0 to 127. A CC of less than 64 disables AM mode for the custom voice carrier. A CC value of more than 63 enables AM mode for the custom voice carrier.

Custom Voice Vibrato (Modulator) Enabled CC17 Any Channel

2 values over the range of 0 to 127. A CC of less than 64 disables vibrato mode for the custom voice carrier. A CC value of more than 63 enables vibrato mode for the custom voice carrier.

Custom Voice Vibrato (Carrier) Enabled CC18 Any Channel

2 values over the range of 0 to 127. A CC of less than 64 disables vibrato mode for the custom voice carrier. A CC value of more than 63 enables vibrato mode for the custom voice carrier.

Custom Voice EG Type (Modulator) CC19 Any Channel

2 values over the range of 0 to 127. A CC of less than 64 sets the envelope generator of the custom voice modulator to the sustained type. A CC of more than 63 sets the envelope generator of the custom voice modulator to the percussive type.

Custom Voice EG Type (Carrier) CC20 Any Channel

2 values over the range of 0 to 127. A CC of less than 64 sets the envelope generator of the custom voice carrier to the sustained type. A CC of more than 63 sets the envelope generator of the custom voice carrier to the percussive type.

Custom Voice KSR (Modulator) Enabled CC21 Any Channel

2 values over the range of 0 to 127. A CC of less than 64 disables key scale rate mode for the custom voice modulator. A CC value of more than 63 enables key scale rate mode for the custom voice modulator. Key scale rate can give instruments a more natural sound – as the pitch of the instrument rises, the amplitude envelope becomes faster.

Custom Voice KSR (Carrier) Enabled CC22 Any Channel

2 values over the range of 0 to 127. A CC of less than 64 disables key scale rate mode for the custom voice carrier. A CC value of more than 63 enables key scale rate mode for the custom voice carrier. Key scale rate can give instruments a more natural sound – as the pitch of the instrument rises, the amplitude envelope becomes faster.

Custom Voice Mul (Modulator) CC23 Any Channel

16 values over the range of 0 to 127. Sets the frequency multiplier of the custom voice modulator, from a ratio of ½ to a ratio of 15.

Custom Voice Mul (Carrier) CC24 Any Channel

16 values over the range of 0 to 127. Sets the frequency multiplier of the custom voice carrier, from a ratio of ½ to a ratio of 15.

Custom Voice KSL (Modulator) CC25 Any Channel

4 values over the range of 0 to 127. A CC of less than 64 disables key scale level mode for the custom voice modulator. A CC value of more than 63 enables key scale rate mode for the custom voice modulator. Key scale level can give instruments a more natural sound – as the pitch of the instrument rises, the output volume level drops.

Custom Voice KSL (Modulator) CC26 Any Channel

4 values over the range of 0 to 127. A CC of less than 64 disables key scale level mode for the custom voice carrier. A CC value of more than 63 enables key scale rate mode for the custom voice modulator. Key scale level can give instruments a more natural sound – as the pitch of the instrument rises, the output volume level drops.

Custom Voice TL Modulation CC27 Any Channel

64 values over the range of 0 to 127. The TL modulation controls the amount that the custom voice modulator modulates the custom voice carrier by. A wide variety of tones can be achieved by changing the TL modulation amount in conjunction with other custom voice parameters.

Custom Voice Rectify (Modulator) Enabled CC28 Any Channel

2 values over the range of 0 to 127. A CC of less than 64 disables rectify waveform mode for the custom voice modulator. A CC value of more than 63 enables rectify waveform mode for the custom voice modulator.

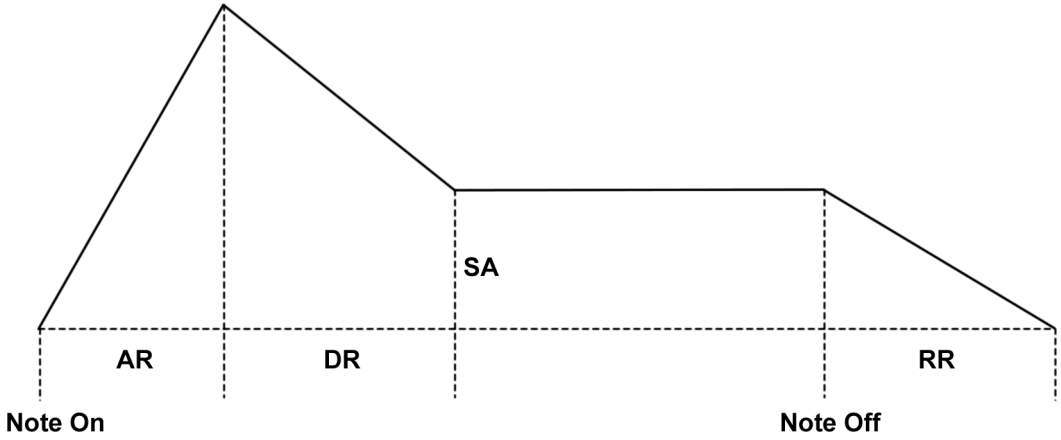
Custom Voice Rectify (Carrier) Enabled CC29 Any Channel

2 values over the range of 0 to 127. A CC of less than 64 disables rectify waveform mode for the custom voice modulator. A CC value of more than 63 enables rectify waveform mode for the custom voice modulator.

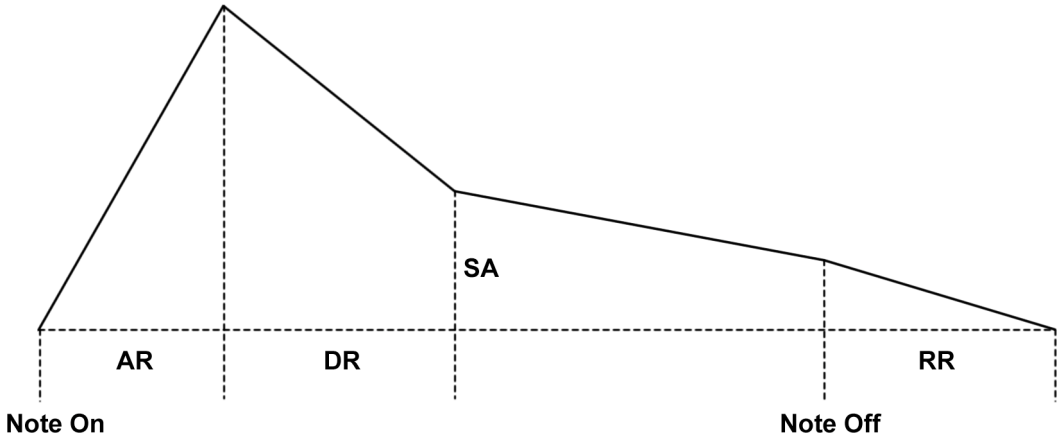
FM Feedback Amount **CC30** **Any Channel**

8 values over the range of 0 to 127. Sets the amount of FM feedback. Distortion and timbre can be explored via this parameter.

One of the most important aspects of controlling the two operators of the YM2413 custom voice is through the amplitude (volume) envelope generator. Below is a basic representation of the envelope and its parameters. The YM2413 custom voice has one of two envelope types – either a sustained envelope or a percussive envelope. See 'Custom Voice EG Type (Modulator)'.



(envelope for a sustained envelope – see 'Custom Voice EG Type (Modulator)')



(envelope for a percussive envelope – see 'Custom Voice EG Type (Modulator)')

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.

AR = Attack Rate

DR = Decay Rate

SA = Sustain Amount

RR = Release Rate

Custom Voice Attack (Modulator) **CC31** **Any Channel**

16 values over the range of 0 to 127. Sets the attack rate of the custom voice modulator.

Custom Voice Decay (Modulator) **CC32** **Any Channel**

16 values over the range of 0 to 127. Sets the decay rate of the custom voice modulator.

Custom Voice Sustain (Modulator) **CC33** **Any Channel**

16 values over the range of 0 to 127. Sets the attack rate of the custom voice modulator.

Custom Voice Release (Modulator) **CC34** **Any Channel**

16 values over the range of 0 to 127. Sets the attack rate of the custom voice modulator.

Custom Voice Attack (Carrier) **CC35** **Any Channel**

16 values over the range of 0 to 127. Sets the attack rate of the custom voice carrier.

Custom Voice Decay (Carrier) **CC36** **Any Channel**

16 values over the range of 0 to 127. Sets the decay rate of the custom voice carrier.

Custom Voice Sustain (Carrier) **CC37** **Any Channel**

16 values over the range of 0 to 127. Sets the attack rate of the custom voice carrier.

Custom Voice Release (Carrier) **CC38** **Any Channel**

16 values over the range of 0 to 127. Sets the attack rate of the custom voice carrier.

Custom Voice Sustain Mode Enabled **CC70** **Any Channel**

2 values over the range of 0 to 127. A CC of less than 64 disables sustain mode for the custom voice. A CC value of more than 63 enables sustain mode for the custom voice.