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SEGA SATURN
Sound Tools Manual
Supplement

• SEGA SATURN Sound Tools Manual V1.27 11/15/94
• SATURN Sound Driver System Interface V3.02 12/1/94
• SATURN Sound Simulator Manual V2.10 11/15/94

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<u>REFERENCES</u>

In translating/creating this document, certain technical words and/or phrases were interpreted with the assistance of the technical literature listed below.

1. *Dictionary of Science and Engineering, 350,000 words, 3rd Edition*
    Inter Press
    Tokyo, Japan
    1990

2. *Computer Dictionary*
    Kyoritsu Publishing Co., LTD.
    Tokyo, Japan
    1978

3. *IBM Dictionary of Computing*
    McGraw-Hill, Inc.
    New York, New York
    1994

Contents

1. SEGA Custom Sound Processor (SCSP)

1. Overview
- The clock speed of the SCSP chip is 22.58 MHz.
- The playback sampling frequency is 44.1 kHz.
- DMA is built in.

2. Generator
- PCM waveforms can be assigned individually to the 32 slots (oscillators) separately. The standard AIFF format is used for the PCM waveform data, and 16-bit and 8-bit linear data are used. The ADPCM format is also supported. Each of the slots has a completely independent LFO and envelope, and loop playback of PCM waveforms can be set to any one of four modes: ONESHOT, FORWARD, REVERSE and ALTERNATE.

- FM
  One slot can be freely assigned as a carrier or a modulator, and a self-feedback feature is also available. A waveform that can sufficiently stand up to practical use can be output by the use of the self-feedback feature alone, in which case the maximum FM output polyphony is 32 notes.

3. Built-in Sound DSP
- A sound DSP that can be programmed up to 128 steps is built in the SCSP. The 16 effects that are standard in the DSP library include Reverb, Early Reflection (ER), Delay, Pitch Shift, Chorus, Flanger, Symphonic (type of Chorus), Surround (type of Reverb), Voice Canceler, Auto Pan, Phaser, Distortion, Filter (high-pass, low-pass, band-pass), Dynamic Filter, Parametric EQ, and Mixer. The addition of an expansion library that includes 3D sound is currently under development.

4. Dedicated CPU for Sound Control
· A 16-bit 11.3 MHz 68EC000 is used as the sound control CPU for the SCSP. The 68EC000 is connected directly to the SCSP and operates independently of the SH2. The interface also allows access of the SCSP from the SH2. During access from the SH2, neither the SCSP nor 68000 CPU will stop. However, since time-shared processing is used, the performance of the 68000 CPU will decrease if there is frequent access from the SH2.

2. SEGA SATURN Sound Box (Model M)

The SEGA SATURN Sound Box (Model M) has two sets of MIDI IN, OUT and THRU ports and a SCSI port, so it may be operated like a commercially available MIDI sound module.

Also, beginning with version 1.21 of the sound driver, error codes can be output from the MIDI OUT port, thus making it possible to detect data problems.

3. Sound Development Tools and Library Provided by SEGA

· Sound Simulator
· Tone Editor
· Waveform Editor
· DSP Linker and DSP Effect Library
· Macintosh-based 68000 Assembler programming tool (SDSS)
· Macintosh-based 68000 debugging tool (SSBug)
· Invision sound library
· DSP Assembler for the SCSP (dAsm)
· Development board diagnostics program
· Sound driver
· Installation guide and ReadMe file explaining the use of the development board diagnostics program.
· Sample demo tune

In addition to the resources above, manuals such as this one are provided by SEGA. The SCSI firmware and the development board diagnostics program are supplied as ROMs on the development board.

4. Functions of the Wave Editor

· Supports 16-bit and 8-bit AIFF formats
· The following are editing functions that can be applied to waveforms.
   Resample
   Pitch Shift
   Size Shift (time compression)
   Scale (normalize)
   Filter
   Compressor
   Noise Gate
   Cross Fade
   Fade In
   Fade Out

5. Functions of the Tone Editor

· FM sound editing with a graphical user interface.
· Velocity curves can be set as desired.
· Supports hardware LFO from 0.17 to 172.3 Hz.
· Supports playback range from -8 octaves to +7 octaves.
· Graphical editing of a 5-parameter envelope.
· Effect send level, effect return level and pan/mixer settings for 16 channels.
· Ability to edit a maximum of up to 128 layers and 128 voices.

6. Functions of the DSP Linker

· The following are the standard DSP effects:
Reverb
ER (Early Reflection)
Delay
Pitch Shift
Chorus
Flanger
Symphonic (type of chorus)
Surround (type of reverb)
Voice Canceler
Auto Pan
Phaser
Distortion
Filter (high-pass, low-pass, band-pass)
Dynamic Filter
Parametric EQ
Mixer (2 input, 3 input, 4 input, 8 input)

· Can patch input and output for up to 16 channels.

7. List of MIDI Channel Messages Supported by Sound Driver Version 1.27

Supported: 8nH Note Off
Supported: 9nH Note On
    Ignored: AnH Polyphonic Key Pressure (no plan to support)
Supported: CnH Program Change
    The voice number in the tone bank (SCSP.BIN) is set for each MIDI channel.
    If the voice number does not exist in the corresponding tone bank, the previous
    voice number (program #) is assigned. When in default mode, the program
    number is set to "0" for all MIDI channels.
    Ignored: DnH Channel Pressure (no plan to support)
Supported: EnH Pitch Bend

    : BnH control change

Supported: 01H Modulation Wheel Sound Generator Hardware LFO
    Ignored: 01H Modulation Wheel Sound Generator Software PEG
    Ignored: 01H Modulation Wheel Sound Generator Software PLFO
    Ignored: 05H Portamento Time
Supported: 07H Volume Control
    The volume can be adjusted for each MIDI channel. When the parameter is
    set to "0", the volume is at MIN, and when it is set to "7FH (127)", it is at MAX.
    Since this indicates amplitude attenuation and is not a scaling factor, use caution.
    The volume control functions even if issued during a note on event, but depending
    on the waveform, there may be some hardware-based noise (clicks, pops) due to the
    difference in volume.

Supported: 0AH PAN pot

Rewrites the layer parameter DIPAN of all applicable voice numbers in the tone bank (SCSP.BIN) that is set for each MIDI channel.

The normal default fixed position is the pan setting of the original voice data. When a MIDI program change is issued, the pan control data of the applicable MIDI channel become invalid.

Supported: 10H Mixer change

Uses MIDI control number 16.

When this control change is issued, the data of the applicable mixer number in the tone bank (TONE.BIN) of the applicable MIDI channel are written to the DSP block (EFREG0-15, EXTS0, EXTS1) of the SCSP sound generator. Therefore, it is important to understand the DSP effect status when a mixer change command is issued. Also, if the specified mixer number is invalid (data does not exist), then it is ignored.

Mixer # 0 of bank # 0 in map # 0 is set as the default.

Supported: 20H Tone bank change

The start address of the specified tone bank TONE.BIN is retrieved from the current Area Map. After this is done, the pitches accessed by the applicable channel are from this TONE.BIN. Also, since the voice number (program #) of the corresponding MIDI channel is forced to "0" at the same time, it is necessary to set the voice number by means of a MIDI program change command before a new sound is played.

Bank # 0 is set as the default.

Supported: 40H Damper

When the damper is enabled (on), key-off of the applicable channel is no longer executed. When the damper is disabled (off), all of the slots that were turned on during the damper-enabled period of the applicable channel are turned off.

Ignored: 41H Portamento ON/OFF

Supported: 46H Effect Pan Change

Supported: 47H Effect Volume Change

This changes the currently active mixer data. Since the tone bank data TONE.BIN is directly rewritten at this time, it is necessary to download mixer data again from the host to return the mixer to its original settings.

The channel number corresponds to EFREG0--15, EXTS0, and 1 of the sound source DSP block.

Supported: 5BH Effect Change

Supported: 7BH Channel Note Off

8. List of MIDI System Messages Supported by Sound Driver Version 1.27

Supported: $F0 Exclusive   (see other table)
     Ignored: $F1 Quarter Frame Message   (no plan to support)
     Ignored: $F2 Song Position Data   (no plan to support)
     Ignored: $F3 Song Select   (no plan to support)
     Ignored: $F4   (no plan to support)
     Ignored: $F5   (no plan to support)
     Ignored: $F6 Tune Request   (no plan to support)
Supported: $F7 End of Exclusive
     Ignored: $F8 Timing Clock   (no plan to support)
     Ignored: $F9   (no plan to support)
     Ignored: $FA Start   (no plan to support)
     Ignored: $FB Continue   (no plan to support)
     Ignored: $FC Stop   (no plan to support)
     Ignored: $FD   (no plan to support)
     Ignored: $FE Active Sensing   (no plan to support)
Supported: $FF System Reset

* When a system reset [=$FF] MIDI system message or a System Exclusive reset is received, the sound target program starts up.

System Exclusive Command Table

Command	
$00: Data Dump Request	Saturn ← External
$01: Set Data	Saturn ← External
$02: Acknowledge	Saturn ←→ External
$03: Not Acknowledged	Saturn ←→ External
$04: Reset	Saturn ← External
$05: Tone Bank Data Change	Saturn ← External
$41: Data Dump	Saturn → External

9. Sound Driver CPU Execution Times

Software DSP control is executed in 8 ms.
Software PLFO control is executed in 4 ms.
Other target programs are executed in 2 ms.

10. Explanation of the Rear Panel LEDs on the Sound Target Box

The LED's flash in sequence from LED 1 to LED 8 while the boot ROM is starting up. This operation is momentarily interrupted while data is being transferred using the SCSI interface but is restored upon completion of the transfer.

When the target program is executed after being transferred, LED 1 flashes, which confirms that the CPU is operating normally.

The flashing of other LED's while LED 1 is flashing (CPU is operating normally) indicates the following.

LED 2:   CPU is operating at its maximum capability.
LED 3:   Interrupts for BGM decompression (normally flashes) in progress.
LED 4:   Ignore
LED 5:   Ignore
LED 6:   Ignore
LED 7:   MIDI input from MIDI-IN2 on the board.
LED 8:   MIDI input from MIDI-IN1 on the board.

Also, flashing of the other LED's when the LED 1 is off indicates the following errors (if continuously on, then either the SCSI interface is being used or the SCSI driver has halted).

LED No.								**Description**
1	2	3	4	5	6	7	8	
-	-	-	-	-	-	0	0	YM3802(MIDI-1) IRQ vector error
-	-	-	-	-	0	-	-	// (MIDI-2) //
-	-	-	-	-	0	-	0	MIDI data error
-	-	-	-	-	0	0	-	YM3802 (MIDI-1) MIDI out error
-	-	-	-	-	0	0	0	// (MIDI-2) //
-	-	-	0	-	-	-	-	MIDI control change $60-$7F input
-	-	-	0	-	-	-	0	Host I/F command execute error
-	-	-	0	-	0	-	.	. . . .
-	-	-	0	-	0	0		. . . .
-	-	-	0	0	0	-		Map change error
-	-	-	0	0	0	0		Bank change error
-	-	0	-	-	-	-		Mixer change error
-	-	0	-	-	-	-	0	Effect change error
-	0	-	-	-	-	-	-	68k undefined vector event
-	0	-	-	-	-	-	0	. . . .
-	0	-	-	-	0	-		68k bus error
-	0	-	-	-	0	0		68k address error
-	0	-	-	0	-	-		. . . .
-	0	-	-	0	-	0		68k level-3 event
-	0	-	-	0	0	-		68k level-4 event
-	0	-	-	0	0	0		68k level-7 event
-	0	-	0	-	-	-		
-	0	-	0	-	-	0		

12

11.   Precautions for the DSP Linker Version 1.11

· Modulation system effects cannot be used in version ES1 of the SCSP chip. It is recommended that they be used in versions ES2 and ES3.
· All modulation voices must be keyed on as monophonic sounds (due to a bug in Version 1.27 of the sound driver, use of the Tone Editor parameter MONO mode should be avoided).
· Ring Buffer in the Option Menu
  The Ring Buffer menu item is used to set the size of the ring buffer (memory for delay) used in the algorithms that are being edited. The ring buffer is located in the 4 MB sound DRAM. If the buffer size is too small, an error will occur when linking is executed. Even if the link is successful, it is recommended that the data size be set to the required minimum size by referring to the information contained in the link result dialog box.
· Since a slight noise glitch will result during an effect change due to the SCSP's chip design, the effect return level can be lowered through a mixer change command if the noise is annoying.

12.   Precautions for the Sound Simulator

· Place SYSTBL.TSK and SDDRV.TSK in the same folder as SndSimulator. Also, do not change the names of these files.

13. Precautions for the Tone Editor Version 1.13 and Sound Driver Version 1.27

· Only the poly mode is not supported. Do not use the mono mode since it has a playback bug.

· PORTAMENTO TIME and VOLBIAS in the voice window do not function.

· Pan and Vol settings made with MIDI Control Change Events commands do not take effect until a voice of that channel is turned on again.

· There are several bugs in the operation of the PEG, so it may not operate as expected.

· The data format of the Tone Editor has been changed. Data created with Version 0.91 and older cannot be used.

· When playing a voice, send the number corresponding to the program change. If the program change number of a nonexistent voice is sent, then it is ignored.

· The Tone Editor references AIFF data by file name to prevent the increase in the amount of data due to redundant tone data. That is, if AIFF data is selected that is the same as another layer in the same tone data, then the data is not loaded again. Instead, the AIFF data already stored in DRAM from the preceding tone is used. Therefore, even if an AIFF file captured to the tone data is edited with a waveform editor, the Tone Editor will not read the newly edited AIFF data if the file name is the same. Because of this, the tone data will not be updated. To load the data, either change the file name or load it again after loading different data.

14. Precautions for the Wave Editor Version 1.13

· When recording audio, be sure to record after creating a new file with the New command.
· When playing back audio from memory, noise will be output after 7FFEH if the SCSP version being used is ES2.
· The only waveforms that can be played back in a loop are those with a sample size of less than 65535 (FFFEH) bytes. A sample size greater than FFFEH cannot be played back during memory playback, and therefore the unnecessary parts should be cut and the loop switched off or the loop should be reset.
· The Play Audio playback in the SCSP menu results in the Play button being de-pressed, and therefore Stop should be applied when appropriate. When the Macintosh itself is used for playback, notes at the high end of the keyboard are not played because the Macintosh Sound Manager will not produce sounds above 65.535 Hz. Also note that popping sounds may be emitted; however, this not a bug.
· Since the DRAM of the 68000 is used as a work area during hard disk recordings, everything above address 10000H is destroyed.
· Due to hardware limitations, stereo hard disk recording is not possible.
· Only 44.1 kHz can be used as the input sampling frequency (fs). Do not input audio data at other sampling frequencies.
· When using DAT output, second generation digital data recording (copying) cannot be performed due to the Serial Copy Management System (SCMS).
· The bug that prevented the loading of AIFF files created by Sound Designer II in version 1.00 has been corrected. However, since the LoopStartPoint, LoopEndPoint, BaseNote and other settings are ignored, reset them after loading the data in with the Wave Editor.   Also, since files loaded in with the Wave Editor are forcibly overwritten by default (a warning in English is displayed when opening), make sure to save a copy if necessary.
· Be sure to set the loop start and end points. Since these settings enable the Tone Editor to generate sounds, no sound will be generated if 0's or other incorrect values are used. In the case of single-shot playback samples in which a loop is not used, be sure to set loop start to 1 and end point to the same value as the sample size.

15. Problems with Sound Playback Control

· The Version 1.00 specification which required that the MIDI channels of sequences that could be simultaneously played to be set to different channels has been changed to a method that plays the sequences (songs, SE) by means of playback control numbers. Refer to the *SATURN Sound Driver System Interface* manual for details.

· Make sure that the tempo of the sequence does not exceed the range of 40 to 300 quarter notes.

16. Recommended Third Party Software/Hardware Tools for Sound/Music Development

· Contact the following companies for MIDI sequencers:
Performer from Mark of the Unicorn
Vision from Opcode Systems
Cubase from Steinberg
Notator Logic from E-Magic

* Basically, any sequencer that runs on either the NEC 9801 or the IBM PC compatible may also be used as long as it can output standard Type 1 MIDI format files.

· For advanced PCM waveform editing (requires the Audio Media II or other sound card), contact these companies:
Alchemy from Passport Design
Sound Designer II from DigiDesign

· CD players with optical output and DAT recorders.