The SAAYM 8-bit ISA dual SAA1099 + YM2151 Sound Card by TexElec.com
GameBlaster / Creative Music System Compatible

Introduction

The SAAYM sound card is designed for any vintage PC with a standard 8- or 16-bit ISA slot. It has three separate sound chips on board: 2 Phillips SAA1099 programmable sound generators (PSG) and one Yamaha YM2151 FM synthesizer chip with its accompanying YM3012 stereo DAC. The card mixes all three stereo outputs through a high quality TL072 OPAMP and WIMA film capacitors for the best sound possible. The output is line level and uses a single stereo 1/8" or 3.5mm stereo headphone-style jack for output. Amplified stereo speakers with volume adjustments are required.

GameBlaster / Creative Music System Support

This card is a fully functional clone of the original GameBlaster or Creative Music System (CMS) card by Creative Labs. The original card used two SAA1099 ICs to generate sound. This card has the necessary circuitry to allow the CMS driver to load, as well as pass detection by games which probe for and support the CMS.

VGM Tracker Playback

SBVGM is a great and light DOS application to allow playback of VGM or VGZ type files on various types of real sound hardware. In the process of developing this card, we reached out to OPLx who is the author of SBVGM to see if support could be added for the YM2151. SBVGM already supported emulated playback of RP2A03, SN76489 & variants, AY-3-8910 & YM2149 VGM data on the SAA1099. Now, version v1.28 (or higher) has the YM2151 under its belt. This means many different existing Arcade / Game soundtrack rips can be played back on the original hardware. SBVGM autodetects the SAAYM and converts and plays files automatically when supported. In addition, the SAAYM supports two different clock speeds for both the YM2151 as well as the SAA1099 ICs. See the clock speed setting in the Jumpers / Settings section for information on how to select the speed. Also see the resources section below a link to SBVGM.

Jumpers / Settings

Jumper J1: BASE IO Address for Card

This card supports 8 different selections for the base IO address. The official default port for the CMS was 0x210, however, it would seem nearly all programs expect it to be at 0x220. As a result, the card is marked as default 0x210 but will be shipped set to 0x220 for ease of use. Please note, this is the same default address as many sound cards including the SoundBlaster. Each card in your machine must use a unique IO Port, or neither card will function properly.

J1 - **0 1 2** 0=Jumper Removed 1=Jumper Installed
0 0 0 - 0x200
1 0 0 - 0x210

0 1 0 - 0x220
1 1 0 - 0x230
0 0 1 - 0x240
1 0 1 - 0x250
0 1 1 - 0x260
1 1 1 - 0x270

Jumper J2: IRQ for YM2151 Only

This circuit is untested on the YM2151. It is implemented the same way as the IRQ circuit was designed on the Adlib OPL2 / YM3812. Curiously, the Adlib had a circuit, but no jumpers to enable the interrupt, so as far as I can tell it was never used. It is straight-forward and should work fine if someone wanted to take advantage of this in software. Alternately, this jumper may be removed if no IRQ line to the YM2151 is desired. The available interrupts are 2, 3, 5 & 7. Please note, IRQ 2 is shared with IRQ 9 on AT class systems and conflicts may occur if another device is set for IRQ 9.

Jumper J3: IO Channel Ready SAA1099 Only

This jumper will connect or disconnect the IO Channel Ready line from the SAA1099 ICs to the ISA bus. The circuit driving this line is derived from the original GameBlaster, however, many of the other GameBlaster clones have not implemented this circuit so a jumper was added. This jumper should remain installed as games may rely on it for proper playback timing. The IO Channel Ready line will "stretch" the CPU cycle longer to allow a SAA1099 to commit previous instructions if it is still busy. This line on the ISA card is not often used and can cause the machine to become unstable if used incorrectly. We have tested this card extensively, and the line seems to be working as designed and CMS apps are working as expected.

Jumper J4: SAA1099 Clock Speed Setting

This jumper will toggle between a 7.16MHz or 8MHz clock source for the SAA1099 tone generation. The original CMS card used 7.16MHz by default. However, some arcade systems use 8MHz and changing this will allow the pitch to playback correctly. This setting changes both SAA1099s at the same time.

Setting 1-2 (default) selects the 7.16MHz setting
Setting 2-3 selects the 8Mhz setting

Jumper J5: YM2151 Clock Speed Setting

This jumper will toggle between a 3.58MHz (NTSC) or 4MHz clock source for the YM2151 tone generation. From casual observation, most arcade systems use the NTSC clock frequency of 3.58Mhz as the tone source generator, so this is the default setting. The next most common is 4Mhz, so it is also selectable as an option.

Setting 1-2 (default) selects the 3.58MHz setting
Setting 2-3 selects the 4Mhz setting

Programming the SAAYM

The SAA1099 IC has no read register, so it is not possible to detect the presence of this IC directly. The original CMS card employed a custom IC to overcome this issue. The IC is a large 40 pin device, but its functions are quite simple. The SAAYM card will behave and respond programmatically just as the original GameBlaster / CMS Card. In addition, there are several other IO ports used for the YM2151 and additional detection circuitry.

IO Port Map (0x220 used as an example for the whole section):
0x220 – SAA #1 Data Port
0x221 – SAA #1 Register Select Port
0x222 – SAA #2 Data Port
0x223 – SAA #2 Register Select Port
0x224 – GameBlaster Read port (Always returns 0x7F)
0x225 – Not Used
0x226 – GameBlaster Write Port (Value written here read back from 0x22A or 0x22B)
0x227 – GameBlaster Write Port (Value written here read back from 0x22A or 0x22B)
0x228 – SAAYM Write Port (Value written here read back from 0x22C or 0x22D)
0x229 – SAAYM Write Port (Value written here read back from 0x22C or 0x22D)
0x22A – GameBlaster Read Port (Value written here written from 0x226 or 0x227)
0x22B – GameBlaster Read Port (Value written here written from 0x226 or 0x227)
0x22C – SAAYM Read Port (Value written here written from 0x228 or 0x229)
0x22D – SAAYM Read Port (Value written here written from 0x228 or 0x229)
0x22E – YM2151 Register Select Port
0x22F – YM2151 Data Port

*Values in **bold** are specific to the SAAYM for use with the YM2151 and SAAYM card detection.

Scheme for CMS / GameBlaster Detection

The CMS custom IC used two internal registers to write a value to and subsequently retrieve the same value from another location. For example, a detection scheme may write a value of 0xAA to IO port 0x226. You could then read IO port 0x22A and ensure that the same value is returned. In addition, reading port 0x224 will always return a value of 0x7F.

The exact internal behavior of the CMS custom IC in not fully known. However, the code used by various detection schemes uses the above behavior and may poll base IO addresses from 0x210 – 0x260 checking the detection ports. The SAAYM card only has one register to write to and read from. Writing to any of the detection ports results in a write to the same physical location. Likewise, reading from any of the detection ports will return this value. The exception is port 0x224 which always returns 0x7F. This means if a value is written to 0x226 and then a value is written to 0x227, the previous value will be overwritten.

Scheme for YM2151 / SAAYM Detection

Several IO ports were remaining in the existing CMS address scheme and they are used to provide IO ports for the YM2151 as well as a detection scheme like the CMS. As you may write to 0x226 or 0x227 and read from 0x22A or 0x22B for the CMS, you may also write to 0x228 or 0x229 and read from 0x22C

or 0x22D for the SAAYM. These locations are also tied to the same physical location as the CMS detection register. This means if a value is written to 0x228 and then a value is written to 0x227, the previous value will be overwritten.

Register and Data Ports for the SAA1099s and YM2151

0x220 – SAA1099 #1 Data Register
0x221 – SAA1099 #1 Address Register
0x222 – SAA1099 #2 Data Register
0x223 – SAA1099 #2 Address Register
0x22E – YM2151 Address Register
0x22F – YM2151 Data Register

The IO port range for the two SAA1099 ICs match that of the original CMS card, which not only allows existing applications to support the card, but it makes existing programming examples applicable to this card.

The YM2151 also has two ports and programming works in a very similar fashion to the OPL2 or OPL3. The exact timing may be slightly different, but code written to feed data to the YMF262 (OPL3) registers works correctly feeding data to the YM2151. The register structure is completely different, so that's where the similarities end. It is possible some of the code for the IBM Music Feature Card may be modified for use with this card as well, but the addressing and architecture is quite different.

It is beyond the scope of this document to discuss the register structures for the SAA1099 or YM2151 ICs. Please consult their respective datasheets for information on programming.

YM2151 IRQ Discussion & SAA1099 IO Channel Ready Discussion

The YM2151 can generate a HW interrupt or be disabled completely as previously discussed. The circuit used is untested as there is no code available to poll the interrupt to date. It should behave as any other interrupt and could be used to speed up code considerably. If you happen to test this feature, please let us know. We'd love feedback.

The IO Channel Ready line on the ISA card is often considered "dangerous" as it can cause the CPU to crash if held for too long. This line is used like an interrupt but works differently. A traditional HW interrupt will trigger and hold for a time. On the YM2151 when an IRQ is sent, you can read a register to check the status of the chip and take the appropriate action in code. There is no ability to read the SAA1099, so the status cannot be determined. The ready line from the SAA1099 ICs will invoke and hold if a write is attempted and the ICs are busy. From the best we can determine, this will halt the CPU briefly to allow the previous instructions to complete. The circuit used on the SAAYM was derived from the original circuit on the CMS card. It is designed such that it will only hold the line very briefly and has not caused problems during testing. We noticed that many of the other CMS card clones do not implement this circuit yet seem to function correctly. Our suspicion is that most games which support the CMS simply do not update the card quickly enough for it to invoke this line which means its addition may not be necessary. It should be identical in function to the original card, but jumper J3 can be removed to disable this behavior if desired.

Resources

SBVGM - http://www.oplx.com/code/
TexElec – https://texelec.com
Yamaha Synthesis Guide - http://map.grauw.nl/resources/sound/yamaha_ym2151_synthesis.pdf
Yamaha YM2151 Datasheet –
https://www.alldatasheet.com/datasheet-pdf/pdf/90457/ETC/YM2151.html
Phillips SAA1099 Datasheet –
https://www.alldatasheet.com/datasheet-pdf/pdf/155677/ETC1/SAA1099.html
Yamaha CX5M MSX (YM2151) Programming Info - http://www.cx5m.net/fmunit.htm

Contact TexElec at mailto:sales@texelec.com

Link to the latest version of this document –

This document may contain errors or assumptions which are incorrect. We strive to make this a good resource for the SAAYM sound card, so please contact us with any error or mistakes and we will keep the latest version on the link above.

This document Version: 1.0

Special Thanks

Thanks so much to OPLx, Barry Yost, The 8-Bit Guy, Sergey, Trixter and all the great folks at VCFED.org.

There is a lot of work ahead on the Commander X16, and this was a huge milestone to getting the sound system worked out. We're putting one YM2151 & one SAA1099 on the final X16, so this will be a great tool for developers to interact with most of the final sound system.

Please read our policies here: https://texelec.com/warranty-returns/

Thanks for buying a SAAYM! We hope it brings you much 8-bit joy!