Sega Saturn Floppy Disk Drive Communication Protocol
Version 1.2

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Contents

Introduction

This file describes the communication protocol used by the Sega Saturn game console to communicate with the Sega Saturn Floppy Disk Drive (Figure 1). Information presented in this document is not guaranteed to be correct, especially with respect to error conditions and failures. The latest version of this document can be found at www.psfake.com.

Figure 1: Sega Saturn Floppy Drive

Electrical Specifications

The Sega Saturn Floppy Disk Drive connects to the Sega Saturn console through the communications port connector (Figure 2). While the connector possesses a pin labeled Pin 12, only eleven pins are present (Pin 2 through Pin 12). The communications port supports MIDI, two SPI channels (mode 3), and two UART channels.

Figure 2: Communications port

The Sega Saturn Floppy Disk Drive consists of three main electrical components, a main board (Figure 3 and Figure 4), a small power board, and a standard floppy drive. Standard PC floppy disks are used with the device, but a normal computer is unable to read data written to the disks. The Sega Saturn Floppy Disk Drive communications cable connects directly to the main board. Electrical connections between the game console and floppy drive are shown in Table 1.
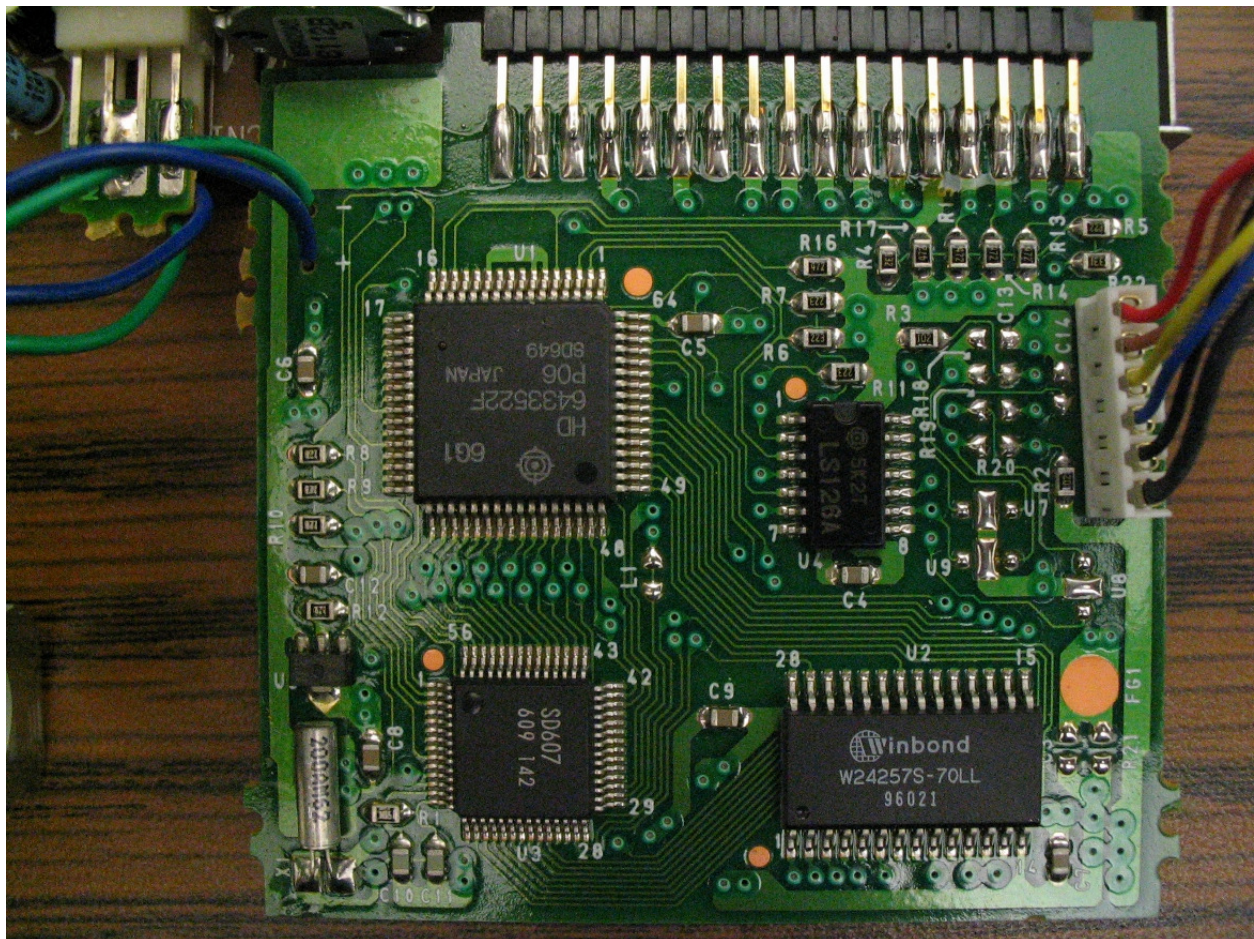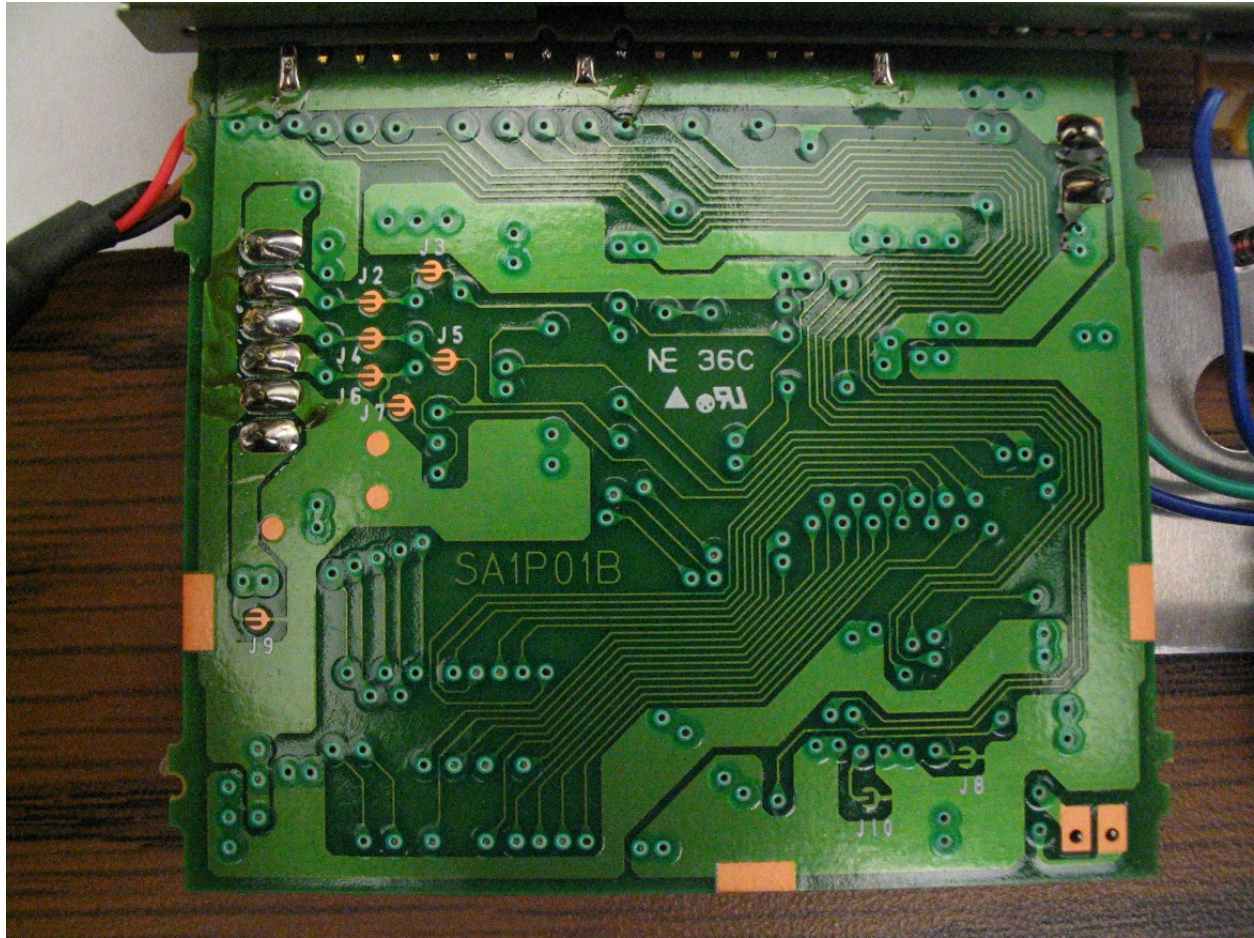

Figure 3: Component side

Figure 4: Solder side of main board

Table 1: Electrical connections

Internal (CN2)	External	Function (Drive Perspective)	Function (Saturn Perspective)
1	2	+5V (Signal)	+5V (Signal)
2	5	Rx	Tx
3	6	Tx	Rx
4	7	SCK	Sck
5	8, Shield	GND	GND
6	8, Shield	GND	GND

The Sega Saturn Floppy Disk Drive communicates with the Sega Saturn console using the first SPI channel (connected to the Sega Saturn's main CPU). Communication is performed using SPI mode 3 and all lines are at TTL logic levels. Each byte transmitted on the SPI bus is sent LSB first. Internal to the Sega Saturn console, 100pF of capacitance is added to all non-ground lines and a 100Ω series resistor is present on the game console's Tx, Rx, and Sck data lines. Additionally, 10kΩ pull-up resisters are present on the game console's Rx and Sck. A complete schematic for the Sega Saturn can be found at http://green.ap.teacup.com/junker/25.html. The Sega Saturn Floppy Disk Drive adds 1kΩ pull-up resisters on its Rx and Sck lines. While pin 2 on the Communications Port connector provides 5V, this is a signal line and should not be used to power external circuitry. The Sega Saturn Floppy Disk Drive uses this line to determine when a connected Sega Saturn console is currently powered on. Pressing the game console's reset switch does not affect this signal line.

Communication between the Sega Saturn and the Sega Saturn Floppy Disk Drive occurs in a non-standard fashion. Unlike normal SPI communications where one device assumes the master role throughout the entire communications protocol, the Sega Saturn and the Sega Saturn Floppy Disk Drive each switch roles between master and slave. When one of the two devices needs to transmit data, that device becomes the master and the other becomes the slave. No explicit handshaking is performed to indicate when the master-slave relationship is about to change. The Sega Saturn uses a clock frequency of roughly 100kHz while the Sega Saturn Floppy Disk Drive uses a frequency closer to 500kHz. SPI communication is synchronous and the devices appear to be tolerant to other Sck frequencies. Current limits for the two devices are not known, but the Hitachi datasheet for the SH7604 CPU suggests limits of 2mA and -2mA. Observance of these limits by the devices has not been confirmed.

Communication Protocol

The Sega Saturn Floppy Disk Drive protocol supports seven commands (List 1). These commands do not have a one to one correspondence with the commands present in the SBL Backup Library (see Sega Document ST-162-R1-092994.pdf). The communications protocol transfers data in big-endian format and incorporates CRC16 checksums and block transfers.

List 1: Available commands
1. View Contents
2. Change Partition
3. Status
4. Read
5. Write
6. Delete File
7. Format

Checksum

A CRC16 CCITT (0xFFFF) checksum is used throughout the protocol. The checksum is always transferred as a 32-bit value, with the upper 16-bits generally set to 0x0000. The upper 16-bits are occasionally filled with non-zero values, but testing suggests these values can be ignored.

Block Transfers

Five of the commands employ a data block transfer operation. Block format depends on the amount of remaining data to be transferred. When the amount exceeds the size of a full block, the first formation (labeled Full Block) is employed. If the amount of data is less than or equal to the size of a full data block a second format is used (labeled Partial Block). All block transfers are required to end with a Partial Block.

Full block transfers

When the amount of remaining data to be transferred is larger than one data block, the sender transmits one block of data using the format shown in Table 2. In the table, the * symbol represents a variable number of bytes, while the – symbol indicates that the value is dependent on the data. The receiver then acknowledges the successful reception of the data by transferring an acknowledgement message shown in Table 3.

Table 2: Full Block - Transferred by the sender.

Name	Bytes	Value
Start token	1	0x10
Full block indicator	1	0x00
Block size	2	–
Data	*	–
CRC	4	–

Table 3: Full Block - Transferred by the receiver.

Name	Bytes	Value
Data received	4	0x20000000
CRC	4	–

Partial block transfers

When the amount of data to be transferred is less than or equal to the size of one block, the sender transmits the data in the format shown in Table 4. Unlike the Full Block transfer, the Partial Block transfer does not include an acknowledgement from the receiver.

Table 4: Partial Block - Transferred by the sender.

Name	Bytes	Value
Start token	1	0x10
Partial block indicator	1	0xFF
Size of data	2	----
Data	*	----
CRC	4	----

Commands

This section describes the transmission protocol for the seven available commands. Each command is described with a two column table; the left column represents data transmissions from the Sega Saturn while the right column presents the data sent from the Sega Saturn Floppy Disk Drive. The command protocols are described as a collection of data items.

Individual data items shown in the protocol tables are presented in one of three possible forms. The first form lists a fixed value displayed in hex. The length of these data items is represented by the size of the hex value. The second form lists the name of the data item and its size in bytes. Items using this form possess values dependent on the state of the system and the data to be transferred. The third form provides the name of the item and a constant hex value. Item length is indicated by the size of the hex value. All data items are transmitted in big-endian format. Some data items listed as unknown may act as padding bytes.

The transferred data format in some of the cells shown below is dependent on the state of the system. These cells possess text shown in bold. Each bolded heading represents one possible response. In each cell, only one option is used per command.

Five of the commands employ a block transfer. These portions of the protocols are indicated with a heavier border around the respective table cells. Unlike the regular cells, these cells do not list every byte that is required to be transferred. Block transfer cells only list the data items present in the "payload" of the data blocks, block transfer overhead and CRC values also need to be transmitted.

View Contents

Sega Saturn	Sega Saturn Floppy Disk Drive
Command start token (0x80) Command id (0x40) Command argument (0x0000) CRC (4)	
	Acknowledgement (0x20000000) CRC (4)
Start of 32 byte argument (0x40000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x0000) Max dir count (2) CRC (4)	
	Acknowledgement (0x20000000) CRC (4)

	No files
	Number of files (0x00000000)
	
	Dir count value exceeded
	Number of files (4)
	
	Files are present
	Per file
	  File name (11)
	  Comment (10)
	  Language (1)
	  Size in blocks (2)
	  Date (4)
	  Size in bytes (4)

0x80000000 CRC (4)	
	Floppy present 0x2000FF00 CRC (4) **Floppy not present** 0x2000FF21 CRC (4) **Floppy not formatted** 0x2000FF24 CRC (4)

Change Partition

Sega Saturn	Sega Saturn Floppy Disk Drive
Command start token (0x80) Command id (0x11) Partition (2) CRC (4)	
	Acknowledgement (0x20000000) CRC (4)
	Unit id (1) Partition count (1) Unknown (0x050C) Total size (4) Total blocks (4) Block size (2) Unknown (0x1000) Unknown (0x00005000)
	0x2000FF00 CRC (4)

Status

Sega Saturn	Sega Saturn Floppy Disk Drive
Command start token (0x80) Command id (0x10) Command argument (0x0000) CRC (4)	
	Acknowledgement (0x20000000) CRC (4)
	Floppy is missing or not formatted Bytes free (0x00000000) Blocks free (0x00000000) Unknown (0x00000000) **Floppy is present** Bytes free (4) Blocks free (4) Unknown (0x00000000)
	Floppy is present 0x2000FF00 CRC (4) **Floppy is missing** 0x2000FF21 CRC (4) **Partition not formatted** 0x2000FF24 CRC (4)

Read

Sega Saturn	Sega Saturn Floppy Disk Drive
Command start token (0x80) Command id (0x41) Command argument (0x0000) CRC (4)	
	Acknowledgement (0x20000000) CRC (4)
Start of 32 byte argument (0x40000000) File name (11) Unknown (0x00) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) CRC (4)	
	Acknowledgement (0x20000000) CRC (4)
	File present File data **(*)** **Floppy not formatted** A block of 0 bytes **File not found** A block of 0 bytes
0x80000000 CRC (4)	
	File present 0x2000FF00 CRC (4) **Not formatted** 0x2000FF24 CRC (4) **File not found** 0x2000FF30 CRC (4)

Write

Sega Saturn	Sega Saturn Floppy Disk Drive
Command start token (0x80) Command id (0x50) Command argument (0x0000) CRC (4)	
	Acknowledgement (0x20000000) CRC (4)
Start of 32 byte Argument (0x40000000) File name (11) Unknown (0x00) Comment (10) Language (1) Unknown (0x00) Date (4) Size in bytes (4) CRC (4)	
	0x20000000 CRC (4)
File data (*)	
	Success 0x2000FF00 CRC (4) **Not formatted** 0x2000FF24 CRC (4)

Delete File

Sega Saturn	Sega Saturn Floppy Disk Drive
Command start token (0x80) Command id (0x30) Command argument (0x0000) CRC (4)	
	Acknowledgement (0x20000000) CRC (4)
Start of 32 byte argument (0x40000000) File Name (11) Unknown (0x00) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) CRC (4)	
	Acknowledgement (0x20000000) CRC (4)
	Success 0x2000FF00 CRC (4) **Write protected** 0x2000FF23 CRC (4) **Not formatted** 0x2000FF24 CRC (4) **File missing** 0x2000FF30 CRC (4)

Format

Sega Saturn	Sega Saturn Floppy Disk Drive
Command start token (0x80) Command id (0x20) Command argument (0x0000) CRC (4)	
	Acknowledgement (0x20000000) CRC (4)
Required delay	
	Success 0x2000FF00 CRC (4) **Floppy not present** 0x2000FF21 CRC (4) **Write protected** 0x2000FF23 CRC (4)

History

01/07/2011 – 1.2 - Removed erroneous CRC entries from the View Contents command.
01/04/2011 – 1.1 - Added a reference to the SPI bus using a LSB first protocol.
01/03/2011 – 1.0 - Initial version.