

# Sega Saturn Floppy Disk Drive Communication Protocol

Version 1.4

By Sanford T. Freedman

## Contents

Introduction.....	1
Electrical Specifications .....	2
Communication Protocol.....	6
Checksum.....	6
Block Transfers .....	6
Full block transfers.....	6
Partial block transfers.....	7
Commands.....	7
View Contents.....	8
Change Partition .....	10
Status.....	11
Read .....	12
Write .....	13
Delete File.....	14
Format .....	15
History .....	16

## 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](http://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 a 5V power indicator, 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, Figure 4, and Figure 5), 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: Sega Saturn Floppy Drive Internals

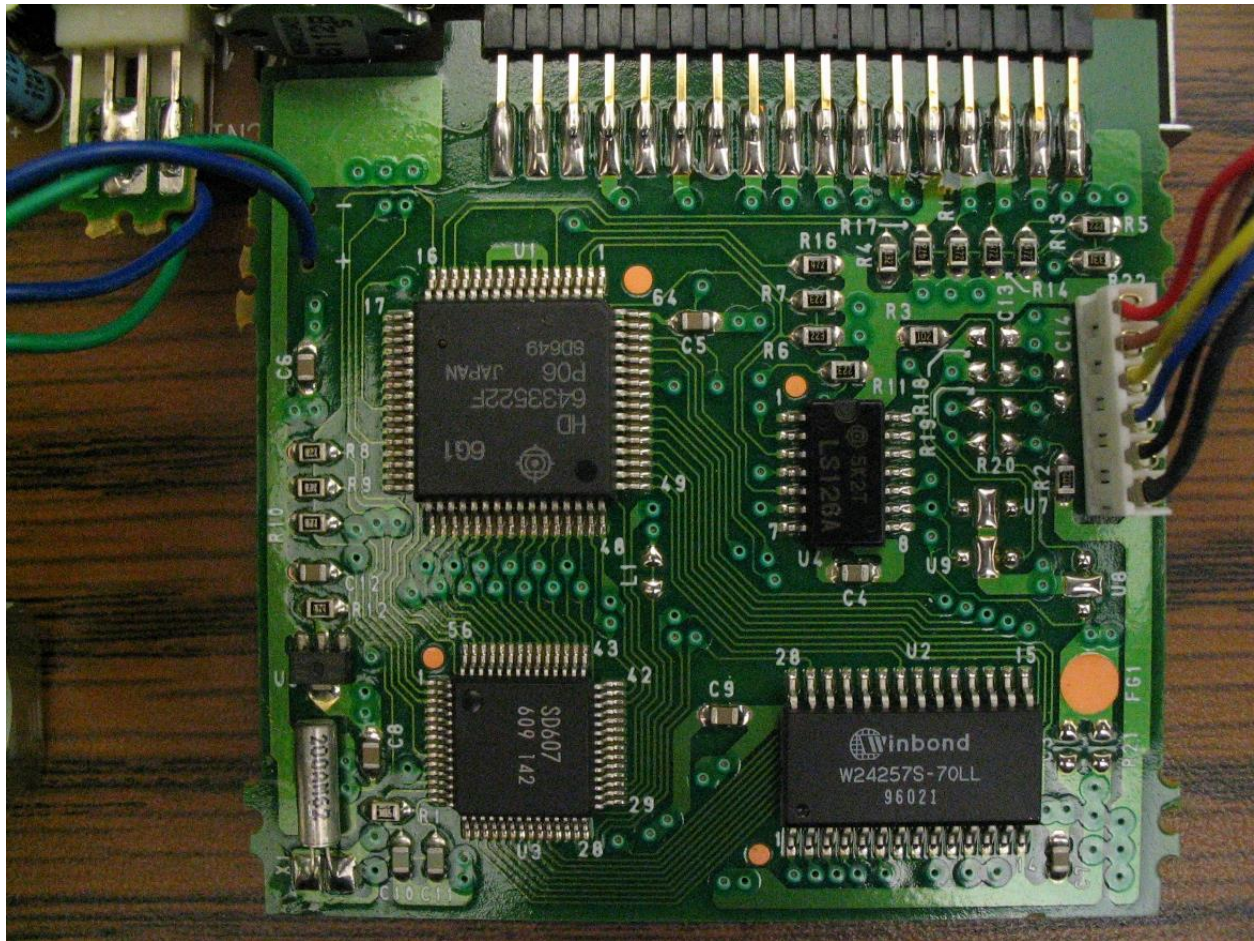
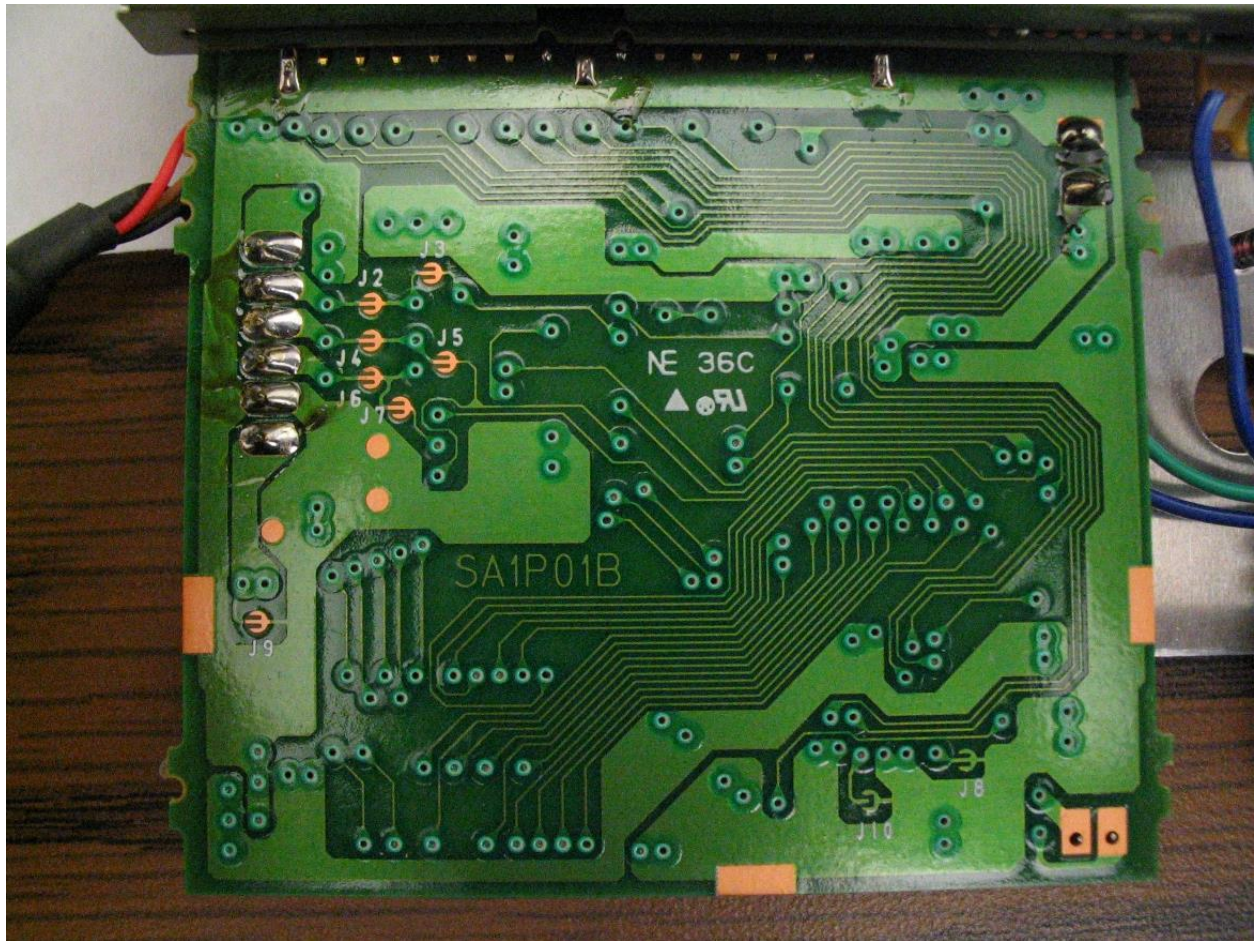


Figure 4: Component side

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



**Figure 5: Solder side of main board**

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 resistors 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 resistors 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.


**Note:**

The Official Sega Saturn Link Cable (not the cable attached to the Sega Saturn Floppy Drive) is not a straight pass-through cable. Some of the pins are not connected and other pins may be crossed.

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.

Sega Saturn Floppy Drive power adapter information is shown in Figure 6. Any power adapter with the same plug and output specifications will be compatible with the Sega Saturn Floppy Drive and using a location specific adapter is recommended.

Model: AC Adapter SA-200
Input: AC 100V 50/60 Hz 20VA
Output: DC 9V 1A 
Plug:
EIAJ Type 3
Outer Diameter: 4.7 mm
Inner Diameter: 1.7 mm
RadioShack Plug Code: C

**Figure 6: Sega Saturn Floppy Drive Power Adapter**

# 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 set to 0x0000. The upper two bytes are used in the calculation of the checksum.

## *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. The maximum size of a block is 4096 bytes.

## **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.**

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

**Table 3: Full Block - Transferred by the receiver.**

<b>Name</b>	<b>Bytes</b>	<b>Value</b>
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)	
	<b>Received successfully</b> Acknowledgement (0x20000000) CRC (4)  <b>CRC mismatch</b> Error (0x2000FF42) CRC (4)
Start of 32-byte argument (0x40000000) File name filter (11) Match length (1) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x0000) Max dir count (2) CRC (4)	
	<b>Received successfully</b> Acknowledgement (0x20000000) CRC (4)  <b>CRC mismatch</b> Error (0x2000FF42) CRC (4)
	<b>No files</b> Number of files (0x00000000)  <b>Dir count value exceeded</b> Number of files (4)  <b>Files are present</b> Per file File name (11) Comment (10) Language (1) Size in blocks (2) Date (4) Size in bytes (4)
0x80000000 CRC (4)	
	<b>Floppy present</b> 0x2000FF00 CRC (4)  <b>Floppy not present</b> 0x2000FF21 CRC (4)  <b>Floppy not formatted</b>



	0x2000FF24 CRC (4)
--	-----------------------

**Notes:**

The View Contents command lists the files located on the storage medium. A string-matching file name filter limits the file entries that are reported when “Match length” is greater than zero. The “Match length” parameter indicates the number of consecutive characters that must match. “Match length” values greater than eleven are treated the same as a value of eleven. Testing with the BUP Library present in Bios version 1.00a detected a bug in the BUP\_Write function when the osw parameter is set to a value of ON. The value of “Match length” is off by one for file names less than eleven characters, and incorrect matching can occur.

## Change Partition

Sega Saturn	Sega Saturn Floppy Disk Drive
Command start token (0x80) Command id (0x11) Partition (2) CRC (4)	
	<b>Received successfully</b> Acknowledgement (0x20000000) CRC (4)  <b>CRC mismatch</b> Error (0x2000FF42) 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)	
	<b>Received Successfully</b> Acknowledgement (0x20000000) CRC (4)  <b>CRC mismatch</b> Error (0x2000FF42) CRC (4)
	<b>Floppy is missing or not formatted</b> Bytes free (0x00000000) Blocks free (0x00000000) Items that can be written (0x00000000)  <b>Floppy is present</b> Bytes free (4) Blocks free (4) Items that can be written (0x00000000)
	<b>Floppy is present</b> 0x2000FF00 CRC (4)  <b>Floppy is missing</b> 0x2000FF21 CRC (4)  <b>Partition not formatted</b> 0x2000FF24 CRC (4)

## Read

Sega Saturn	Sega Saturn Floppy Disk Drive
Command start token (0x80) Command id (0x41) Command argument (0x0000) CRC (4)	
	<p><b>Received successfully</b> Acknowledgement (0x20000000) CRC (4)</p> <p><b>CRC mismatch</b> Error (0x2000FF42) CRC (4)</p>
Start of 32 byte argument (0x40000000) File name (11) Unknown (0x00) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) Unknown (0x00000000) CRC (4)	
	<p><b>Received successfully</b> Acknowledgement (0x20000000) CRC (4)</p> <p><b>CRC mismatch</b> Error (0x2000FF42) CRC (4)</p>
	<p><b>File present</b> File data (*)</p> <p><b>Floppy not formatted</b> A block of 0 bytes</p> <p><b>File not found</b> A block of 0 bytes</p>
0x80000000 CRC (4)	
	<p><b>File present</b> 0x2000FF00 CRC (4)</p> <p><b>Floppy not present</b> 0x2000FF21 CRC (4)</p> <p><b>Not formatted</b> 0x2000FF24 CRC (4)</p> <p><b>File not found</b> 0x2000FF30 CRC (4)</p>

## Write

Sega Saturn	Sega Saturn Floppy Disk Drive
Command start token (0x80) Command id (0x50) Command argument (0x0000) CRC (4)	
	<b>Received successfully</b> Acknowledgement (0x20000000) CRC (4)  <b>CRC mismatch</b> Error (0x2000FF42) 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)	
	<b>Received successfully</b> Acknowledgement (0x20000000) CRC (4)  <b>CRC mismatch</b> Error (0x2000FF42) CRC (4)
File data (*)	
	<b>Success</b> 0x2000FF00 CRC (4)  <b>Not formatted</b> 0x2000FF24 CRC (4)

## Delete File

Sega Saturn	Sega Saturn Floppy Disk Drive
Command start token (0x80) Command id (0x30) Command argument (0x0000) CRC (4)	
	<b>Received successfully</b> Acknowledgement (0x20000000) CRC (4)  <b>CRC mismatch</b> Error (0x2000FF42) 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)	
	<b>Received successfully</b> Acknowledgement (0x20000000) CRC (4)  <b>CRC mismatch</b> Error (0x2000FF42) CRC (4)
	<b>Success</b> 0x2000FF00 CRC (4)  <b>Write protected</b> 0x2000FF23 CRC (4)  <b>Not formatted</b> 0x2000FF24 CRC (4)  <b>File missing</b> 0x2000FF30 CRC (4)

## Format

Sega Saturn	Sega Saturn Floppy Disk Drive
Command start token (0x80) Command id (0x20) Command argument (0x0000) CRC (4)	
	<b>Received successfully</b> Acknowledgement (0x20000000) CRC (4)  <b>CRC mismatch</b> Error (0x2000FF42) CRC (4)
Required delay	
	<b>Success</b> 0x2000FF00 CRC (4)  <b>Floppy not present</b> 0x2000FF21 CRC (4)  <b>Write protected</b> 0x2000FF23 CRC (4)

## History

- 03/30/2016 – 1.4 - Added comment that the official link cable is not a straight pass-through cable
- Added floppy drive power adapter information
  - Added max block size
  - Added the 5V power indicator to the list of features the communication port supports
- 01/21/2011 – 1.3 - Changed description of the upper two bytes in the CRC values.
- Added image of the Sega Saturn Floppy Drive Internals.
  - Added Floppy not present error code to the Read command.
  - Changed “Unknown” field in the Status command to “Items that can be written”.
  - Added file name filter to the View Contents command.
  - Added CRC mismatch error code to the acknowledgement fields.
- 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.