Memory Stick Standard

Memory Stick PRO
Specification Summary
- Non-Licensee version -

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1. Introduction

1.1 Overview
Silicon media is a new and innovative recording medium. This type of medium is expected to create many possibilities in the digital era.

Memory Stick is the medium that provides a higher data transfer rate, more flexibility for a variety of digital contents, and higher interchangeability among various devices than the other new media.

Memory Stick PRO specified in this document is the medium with which a higher speed data transfer rate and higher data capacity than the conventional Memory Stick are attained.

This document provides the physical specifications, electrical specifications, serial and parallel interface protocols, data format specifications, and command operation procedures to which Memory Stick PRO compliant products shall conform.

For compatibility in the application layer, details are specified in an appropriate Application Format for each application described separately.

1.2 Scope
This document provides the specifications of a product corresponding to Memory Stick PRO.
1.3 Layer Structure
A product to use a Memory Stick PRO shall have the layer structure shown below.

<table>
<thead>
<tr>
<th>Layer Structure of System</th>
<th>Items Processed in Each Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Layer</td>
<td>Still images, Moving pictures, Music, Text, etc.</td>
</tr>
<tr>
<td>File Management Layer</td>
<td>FAT file system, Logical format</td>
</tr>
<tr>
<td>Protocol Layer</td>
<td>Serial interface protocol, Parallel interface protocol, Command operation procedure</td>
</tr>
<tr>
<td>Physical Layer</td>
<td>Physical specifications, Electrical specifications</td>
</tr>
</tbody>
</table>

**Fig. 1.3.1 Layer Structure of System**
This document describes the physical layer, the protocol layer, and the file management layer in the above figure.

1.4 Reference Materials
Reference materials are shown below.

- Memory Stick Standard  Format Specifications ver.1.x
1.5 Abbreviations

BS : Bus State
CIS : Card Information Structure
CRC : Cyclic Redundancy Check
ECC : Error Correcting Code
FAT : File Allocation Table
Hi-Z : High Impedance
IDI : Identify Drive Information
I/F : Interface
LBA : Logical Block Addressing
LSB : Least Significant Bit
MBR : Master Boot Record
MSB : Most Significant Bit
NVM : Non-Volatile Memory
PBR : Partition Boot Record
TPC : Transfer Protocol Command
DCIM : Digital Camera Image
SCLK : Serial Clock
Serial I/F : Serial Interface
Parallel I/F : Parallel Interface
SDIO : Serial Data I/O
X signal name : Negative logic of “signal name”
Z (Hi-Z) : High Impedance
X : Not applicable
1.6 Notation

- In this specification, a Host Product means the product compliant with Memory Stick PRO.
- Unless otherwise specified, a numerical value is written by big-endian.
- Unless otherwise specified, a numerical value is the decimal numeral, when an end finishes it as “h”, the number notates of hexadecimal and an end finishes it as “b”, the number notates of binary numeral.
- Although the value of 0 is usually written in the portion expressed as Reserved, no matter what other values may be written, it shall be ignored.
2. Physical Specifications

2.1 Overview

2.1.1 Outside Dimensions

2.1.2 Material Specifications

2.1.2.1 Environmental Protection Measures
The following materials shall not be used.

- Harmful substances
- Banned substances
- Substances likely to be banned in the future
- Ozone-dedestroying substances
- Environmental pollutants

2.1.2.2 Electrode Portion
Plating specifications : Au-plating surface

2.1.2.3 Substrate Portion
Flame resistance : UL94HB equivalent

2.1.2.4 Outer Case
Flame resistance : UL94V2 equivalent
2.2 Connector
The connector herein refers to a connector used in a host product.

2.2.1 Requirements
The connector shall conform to PC Card Standard (Volume 3) Physical Specifications.

2.2.2 Temperature and Humidity Characteristics under Various Environments

2.2.2.1 Operating Environment
Ambient air temperature: -25 ~ 85 [°C]
Ambient air humidity: Max 95 [%] (Saturated state)

2.2.2.2 Storage Environment
Ambient air temperature: -40 ~ +100 [°C]
Ambient air temperature: Max 95 [%] (Saturated state)

2.2.3 Durability

2.2.3.1 Room Environment
Plug/Unplug: 12,000 times (Reciprocating)
The connector shall conform to PC Card Standard (Volume 3) Physical Specifications Section 8.1.

2.2.3.2 Harsh Environment
Plug/Unplug: 6,000 times (Reciprocating)
The connector shall conform to PC Card Standard (Volume 3) Physical Specifications Section 8.2.
2.2.5 Shapes of Connector Portions

2.2.5.1 Contact Timing
- When a Memory Stick PRO is inserted, Pin1 (VSS) or Pin10 (VSS) shown in "Fig. 4.2.1 Terminal Name" shall first make contact with the connector contact point. When a Memory Stick PRO is removed, Pin1 or Pin10 shall make contact with the connector contact point until it is completely removed.
- When a Memory Stick PRO is inserted, Pin6 (INS) shown in "Fig. 4.2.1 Terminal Name" should last make contact with the connector contact point.

2.3 Options
Other options are shown below.

2.3.1 Label
When applying a label on a Memory Stick PRO, following conditions shall be provided.

- Material: High-quality paper, a thickness of 0.15mm (Maximum)
- Peel strength: Unsticking or peeling shall not be allowed under storage conditions.
- Number of labels: 1 label (Two or more labels shall not be overlapped)
- Label area: Within the Memory Stick PRO labeling area

2.4 Memory Stick Duo Adapter
If a Memory Stick PRO Duo is set into a Memory stick Duo Adapter, it will be mechanically and electrically compatible with the Memory Stick PRO.
Thus, a Memory Stick PRO Duo will be compatible with Memory Stick PRO compliant products.
3. **Reliability Test Criteria**
4. **Electrical Specifications**
This section describes the electrical characteristics of a Memory Stick PRO.

**4.1 Overview**

Electrical specifications of a Memory Stick PRO

- Number of connector pins : 10
- Connector shape : Planar electrode one-row
- Maximum transfer rate : 19.7 [MByte/s] *1
- Maximum capacity : 32 [GByte]
- Maximum transfer measure : 512 [Byte]
  - Power source voltage : 2.7~3.6 [V]
- Maximum data transmission clock : 20 [MHz] (Serial)
  - 40 [MHz] (Parallel)

*1: Burst data transfer rate in consideration of overhead.

**4.1.1 Block Diagram**

"Fig. 4.1.1 An example of Memory Stick PRO Block Diagram" shows a sample block diagram of a Memory Stick PRO, incorporating non-volatile memory and a controller.
4.1.2 Interface Overview

A Memory Stick PRO can be controlled, as shown in "Fig. 4.1.2 Interface (Serial)" and "Fig. 4.1.3 Interface (Parallel)", through the communication with the three-wire half-duplex serial protocol, or through communication with the six-wire half-duplex parallel protocol.

In the subsequent figures for the explanation of the parallel interface, the 4 signal lines (DATA3 ~ DATA0) are collectively denoted as DATA[3:0].

For details on interfaces, refer to "5. Interface".

---

![Fig. 4.1.2 Interface (Serial)]

![Fig. 4.1.3 Interface (Parallel)]
4.2 Terminal Name

"Fig. 4.2.1 Terminal Name" shows the terminal names of a Memory Stick PRO.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin1</td>
<td>VSS</td>
</tr>
<tr>
<td>Pin2</td>
<td>BS</td>
</tr>
<tr>
<td>Pin3</td>
<td>DATA1</td>
</tr>
<tr>
<td>Pin4</td>
<td>SDIO / DATA0</td>
</tr>
<tr>
<td>Pin5</td>
<td>DATA2</td>
</tr>
<tr>
<td>Pin6</td>
<td>INS</td>
</tr>
<tr>
<td>Pin7</td>
<td>DATA3</td>
</tr>
<tr>
<td>Pin8</td>
<td>SCLK</td>
</tr>
<tr>
<td>Pin9</td>
<td>VCC</td>
</tr>
<tr>
<td>Pin10</td>
<td>VSS</td>
</tr>
</tbody>
</table>

Note: Both Pin1 and Pin10 shall be connected to VSS.
For a product supporting parallel interface, the left figure of "Fig. 4.2.1 Terminal Name" shall be used.
For a product supporting serial interface only, Pin3, Pin5, and Pin7 shall be open.
4.3 Terminal Functions

The terminal functions of a Memory Stick PRO are shown below.

Table 4.3.1 Terminal Functions

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Terminal Name</th>
<th>I/O</th>
<th>Serial transfer</th>
<th>Parallel Transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VSS</td>
<td></td>
<td></td>
<td>Vss</td>
</tr>
<tr>
<td>2</td>
<td>BS</td>
<td>I</td>
<td></td>
<td>Bus State signal</td>
</tr>
<tr>
<td>3</td>
<td>DATA1</td>
<td>I/O</td>
<td>Hi-Z</td>
<td>Data signal 1</td>
</tr>
<tr>
<td>4</td>
<td>SDIO/DATA0</td>
<td>I/O</td>
<td>Data signal</td>
<td>Data signal 0</td>
</tr>
<tr>
<td>5</td>
<td>DATA2</td>
<td>I/O</td>
<td>Hi-Z</td>
<td>Data signal 2</td>
</tr>
<tr>
<td>6</td>
<td>INS</td>
<td>O</td>
<td></td>
<td>Memory Stick PRO Insertion/Removal detection terminal</td>
</tr>
<tr>
<td>7</td>
<td>DATA3</td>
<td>I/O</td>
<td>Hi-Z</td>
<td>Data signal 3</td>
</tr>
<tr>
<td>8</td>
<td>SCLK</td>
<td></td>
<td></td>
<td>clock signal</td>
</tr>
<tr>
<td>9</td>
<td>VCC</td>
<td></td>
<td></td>
<td>Vcc</td>
</tr>
<tr>
<td>10</td>
<td>VSS</td>
<td></td>
<td></td>
<td>Vss</td>
</tr>
</tbody>
</table>
5. Interface
This chapter provides the specifications of interfaces and protocols used in a Memory Stick PRO.

5.1 System Configuration
A Memory Stick PRO consists of six blocks, the Serial I/F, Parallel I/F, Registers, Data Buffer, Memory I/F Sequencer, and Memory blocks.

![System Configuration Diagram]

The Serial I/F provides protocols to transfer data with three signal lines, SCLK, BS, and SDIO.
The Parallel I/F provides protocols to transfer data with six signal lines, SCLK, BS, and DATA [3:0].
A host product accesses the Registers and Data Buffer with command groups called TPC (Transfer Protocol Command).
Memory I/F Sequencer transfers data between Data Buffer and Memory based on parameters set in Registers or sent by an EX_SET_CMD TPC, then reads, writes, and erases data.
When a Memory Stick PRO is turned on, it operates in the Serial I/F mode and can be switched to the Parallel I/F mode with a TPC. It can be also switched from the Parallel I/F mode to the Serial I/F mode with the TPC.
5.2 Interface

The following provides the specifications of interfaces used in communicating with a Memory Stick PRO.

5.2.1 Serial Interface

A host product and a Memory Stick PRO are connected with six signal lines. When communicating via the Serial I/F, three of those signal lines, BS, SDIO, and SCLK shall be used. "Table 5.2.1 Specifications of Serial Interface Signals" shows specifications of respective signal lines. The host product always initiates communication.

![Serial Interface Signals](image)

**Fig. 5.2.1 Serial Interface Signals**

<table>
<thead>
<tr>
<th>Signals</th>
<th>Host Product</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS (Bus State)</td>
<td>Out</td>
<td>Indicates the Bus State (0 ~ 3) on the SDIO and the timing to start signal transfer. For details on the Bus State, refer to &quot;5.2.3 Bus State&quot;.</td>
</tr>
<tr>
<td>SCLK (Serial Clock)</td>
<td>Out</td>
<td>A host product outputs signals on BS and SDIO at a falling edge and inputs (latches) at a rising edge. SCLK is always output during BS1 ~ BS3.</td>
</tr>
<tr>
<td>SDIO (Serial Data In/Out)</td>
<td>In/Out</td>
<td>Serial Data Bus. Transfer direction and types of data change depending on the Bus State.</td>
</tr>
</tbody>
</table>

In the Serial I/F, a TPC and data shall be transferred from the MSB (Most Significant Bit) to the LSB (Least Significant Bit) in 1 bit by 1 SCLK. "Fig. 5.2.2 Data Transfer Order in Serial I/F" shows data transfer order in the Serial I/F.

![Data Transfer Order in Serial I/F](image)

**Fig. 5.2.2 Data Transfer Order in Serial I/F**

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5.2.2 Parallel Interface

A host product and a Memory Stick PRO are connected with six signal lines. When communicating via the Parallel I/F, those six signal lines, BS, DATA[3:0], and SCLK are used. Specifications of each signal line are shown in "Table 5.2.2 Specifications of Parallel I/F Signals".

The host product always initiates communication.

<table>
<thead>
<tr>
<th>Signals</th>
<th>Host product</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS (Bus State)</td>
<td>Out</td>
<td>Indicates the Bus State (0 ~ 3) on the DATA[3:0] and the timing to start signal transfer. For details on Bus State, refer to &quot;5.2.3 Bus State&quot;.</td>
</tr>
<tr>
<td>SCLK (Serial CLocK)</td>
<td>Out</td>
<td>The host product outputs signals on BS and DATA[3:0] at a falling edge and inputs (latches) at the next falling edge. SCLK is always output during BS1 ~ BS3.</td>
</tr>
<tr>
<td>DATA [3:0]</td>
<td>In/Out</td>
<td>Four-bit-width Data Bus. Transfer direction and types of data change depending on the Bus State.</td>
</tr>
</tbody>
</table>

In the Parallel I/F, a TPC and data shall be transferred in a manner that the upper and lower 4 bits of 1 byte are transmitted respectively by 1SCLK. The upper 4 bits shall be transferred first. "Fig. 5.2.4 Data Transfer Order in Parallel I/F" shows data transfer order in the Parallel I/F.
Fig. 5.2.4 Data Transfer Order in Parallel I/F
5.2.3 Bus State

The Bus State used in serial/parallel protocols is classified into four states depending on the attributes and the transfer direction of the data on SDIO/DATA[3:0]. The output timing of each data is controlled by four states: one state (BS0) with no packet communication, and the other three states (BS1, BS2, BS3) with packet communication. States BS1 to BS3 are defined as one packet, and each communication must be completed within a packet.

A Memory Stick PRO normally operates in the Four State Access Mode in which it shifts from BS0 to BS3 in one cycle. But when an error occurs on a communication channel, it automatically transits to the Two State Access Mode in which it alters from BS0 to BS1 in one cycle to avoid collision on the SDIO and DATA[3:0].

<table>
<thead>
<tr>
<th>State</th>
<th>BS</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS0</td>
<td>Low</td>
<td>INT Transfer State: A state in which packet communication is not done, used to transmit INT (interrupt) signals from the Memory Stick PRO to the host product.</td>
</tr>
<tr>
<td>BS1</td>
<td>High</td>
<td>TPC Transfer State: Packet communication starts by transferring a TPC from the host product to the Memory Stick PRO.</td>
</tr>
<tr>
<td>BS2</td>
<td>Low</td>
<td>Read Packet, Write Packet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Handshake State: The host product waits for a RDY signal from the Memory Stick PRO. Data Transfer State: The host product transfers data to the Memory Stick PRO.</td>
</tr>
<tr>
<td>BS3</td>
<td>High</td>
<td>Read Packet, Write Packet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Data Transfer State: The Memory Stick PRO transfers data to the host product. Handshake State: The host product waits for a RDY signal from the Memory Stick PRO.</td>
</tr>
</tbody>
</table>
### Table 5.2.4  Bus State of Two State Access Mode

<table>
<thead>
<tr>
<th>State</th>
<th>BS</th>
<th>Explanation</th>
</tr>
</thead>
</table>
| BS0   | Low | High Impedance State  
|       |     | A state in which packet communication is not done. To avoid bus collision, the data line transits to a High Impedance (Hi-Z) state. |
| BS1   | High| TPC Transfer State  
|       |     | Packet communication starts by transferring a TPC from the host product to the Memory Stick PRO. |
5.6 Transfer Protocol Command (TPC)

5.6.1 TPC Code

The following shows the list of TPC codes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Code</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>READ_LONG_DATA</td>
<td>X</td>
<td>Transfer long length data from Data Buffer</td>
</tr>
<tr>
<td>READ_SHORT_DATA</td>
<td>X</td>
<td>Transfer short length data from Data Buffer</td>
</tr>
<tr>
<td>READ_REG</td>
<td>X</td>
<td>Read Registers</td>
</tr>
<tr>
<td>GET_INT</td>
<td>X</td>
<td>Read INT Register</td>
</tr>
<tr>
<td>WRITE_LONG_DATA</td>
<td>X</td>
<td>Transfer long length data to Data Buffer</td>
</tr>
<tr>
<td>WRITE_SHORT_DATA*</td>
<td>X</td>
<td>Transfer short length data to Data Buffer</td>
</tr>
<tr>
<td>WRITE_REG</td>
<td>X</td>
<td>Write Registers</td>
</tr>
<tr>
<td>SET_R/W_REG_ADRS</td>
<td>X</td>
<td>Address setting of READ_REG/WRITE_REG</td>
</tr>
<tr>
<td>SET_CMD</td>
<td>X</td>
<td>Set CMD</td>
</tr>
<tr>
<td>EX_SET_CMD</td>
<td>X</td>
<td>Set CMD and parameters</td>
</tr>
</tbody>
</table>
5.6.2 TPC Details

The following explains the operation of TPCs.

<table>
<thead>
<tr>
<th>TPC</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>READ_LONG_DATA</td>
<td>Transfer long length data from Data Buffer on a Memory Stick PRO to a host product.</td>
</tr>
<tr>
<td>READ_SHORT_DATA</td>
<td>Transfer short length data from Data Buffer on a Memory Stick PRO to a host product.</td>
</tr>
<tr>
<td>READ_REG</td>
<td>Transfer data from the Register of which address is set on a Memory Stick PRO to a host product. Address and data length are set by SET_R/W_REG_ADRS.</td>
</tr>
<tr>
<td>GET_INT</td>
<td>Transfer data from INT Register on a Memory Stick PRO to a host product.</td>
</tr>
<tr>
<td>WRITE_LONG_DATA</td>
<td>Transfer long length data to Data Buffer on a Memory Stick PRO from a host product.</td>
</tr>
<tr>
<td>WRITE_SHORT_DATA</td>
<td>Transfer short length data to Data Buffer on a Memory Stick PRO from a host product.</td>
</tr>
<tr>
<td>WRITE_REG</td>
<td>Transfer data to Register of which address is set on a Memory Stick PRO from a host product. Address and data length are set by SET_R/W_REG_ADRS.</td>
</tr>
<tr>
<td>SET_R/W_REG_ADRS</td>
<td>Transfer READ_ADRS, READ_SIZE, WRITE_ADRS and WRITE_SIZE to SET_R/W_REG_ADRS Registers.</td>
</tr>
<tr>
<td>SET_CMD</td>
<td>Transfer command code to CMD_REG on a Memory Stick PRO from a host product. This command is executed by a Memory Stick PRO. The result of command execution is reflected to the INT Register of a Memory Stick PRO and the INT signal(s) are output on DATA[3:0].</td>
</tr>
<tr>
<td>EX_SET_CMD</td>
<td>Transfer a command and parameters to a Memory Stick PRO. This command is executed by a Memory Stick PRO. The result of command execution is reflected to INT Register of a Memory Stick PRO and INT signal(s) is output on DATA[3:0].</td>
</tr>
</tbody>
</table>
6. Command Control

6.1 Command Overview
A Memory Stick RO executes each command defined below with issuing a SET_CMD TPC or an EX_SET_CMD TPC. The operation flow of these commands on a Memory Stick RO and a host product is shown in "Fig. 6.1.1 Operation Flow". There are two categories of commands to be defined: Memory Access Command, Function Command.

![Fig. 6.1.1 Operation Flow]
6.1.1 Memory Access Command
Memory Access Commands are used for accessing the memory chip on a Memory StickPRO.

Table 6.1.1 Memory Access Command

<table>
<thead>
<tr>
<th>Command</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>READ_DATA</td>
<td>XXh</td>
<td>Read data continuously from the assigned address in User Area.</td>
</tr>
<tr>
<td>WRITE_DATA</td>
<td>XXh</td>
<td>Write data continuously to the assigned address in User Area.</td>
</tr>
<tr>
<td>READ_ATRB</td>
<td>XXh</td>
<td>Read data continuously from the assigned address in Attribute Information Area.</td>
</tr>
<tr>
<td>STOP</td>
<td>XXh</td>
<td>Terminate the operation by READ_DATA, WRITE_DATA, READ_ATRB, ERASE, FORMAT.</td>
</tr>
<tr>
<td>ERASE</td>
<td>XXh</td>
<td>Erase data from the assigned address in User Area.</td>
</tr>
<tr>
<td>SET_IBD</td>
<td>XXh</td>
<td>Write Information Block Data</td>
</tr>
<tr>
<td>GET_IBD</td>
<td>XXh</td>
<td>Read Information Block Data</td>
</tr>
</tbody>
</table>

6.1.2 Function Command
Function Commands are used for special operations.

Table 6.1.2 Function Command

<table>
<thead>
<tr>
<th>Command</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FORMAT</td>
<td>XXh</td>
<td>Self-format with unique values(Recover to factory default)</td>
</tr>
<tr>
<td>SLEEP</td>
<td>XXh</td>
<td>Shifts to low power consumption status.</td>
</tr>
</tbody>
</table>
7. Data Format
8. Directory Specifications