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Compute Project

Storage:
Storage device with Ethernet interface

Rev 3

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1 Scope

This specification defines the technical requirements for the storage device with Ethernet interface.

2 Contents

3 Figures

4 Tables

5 Overview

5.1 Description

The storage device with Ethernet interface provides a common configuration for the implementation of the Ethernet interface on a storage device. It is intended to support large configurations of storage devices in data center applications. Other applications may find the features of this device advantageous where communication to the device through the Ethernet interface is desired.

Some example implementations are documented in <Reference to the white paper>.

5.2 License

6 Normative references

Referenced standards and specifications contain provisions that, by reference in the text, constitute provisions of this specification.

I²C-bus specification and user manual, Rev. 5 — 9 October 2012
Serial-GMII Specification
RFC 2119, *RFC Key Words*
SFF-8201, *2.5" Drive Form Factor Drive Dimensions*
SFF-8301, *3.5" Drive Form Factor Drive Dimendions*
SFF-8223, *2.5" Drive Form Factor with Serial Connector*
SFF-8323, *3.5" Drive Form Factor with Serial Connector*
SFF-8482, *Serial Attachment 2X Unshielded Connector*
SFF-8680, *Serial Attachment 12 Gb/s 2X Unshielded Connector*
SFF-9639, *Multifunction 12 Gb/s 6X Unshielded Connector Pinouts*

7 Definitions, symbols, abbreviations, key words

7.1 Definitions

7.2 Symbols and abbreviations

Abbreviation	Meaning
GPIO	general purpose input/output
I²C	Inter-Integrated Circuit
mA	milliampere (i.e., 10-3 amperes)
RX	Receiver
TX	Transmitter
V	Volt

7.3 Key words

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119.

MAY This word, or the adjective "OPTIONAL", mean that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item. An implementation which does not include a particular option MUST be prepared to interoperate with another implementation which does include the option, though perhaps with reduced functionality. In the same vein an implementation which does include a particular option MUST be prepared to interoperate with another implementation which does not include the option (except, of course, for the feature the option provides.)

MUST This word, or the terms "REQUIRED" or "SHALL", mean that the definition is an absolute requirement of the specification.

MUST NOT This phrase, or the phrase "SHALL NOT", mean that the definition is an absolute prohibition of the specification.

SHOULD This word, or the adjective "RECOMMENDED", mean that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.

SHOULD NOT This phrase, or the phrase "NOT RECOMMENDED" mean that there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.

VENDOR SPECIFIC Something (e.g., a bit, field, code value) that is not defined by this specification and MAY be used differently in various implementations.

7.4 Editorial conventions

Certain words and terms used in this specification have a specific meaning beyond the normal English meaning. These words and terms are defined either in the glossary or in the text where they first appear.

Lists sequenced by lowercase or uppercase letters show no ordering relationship between the listed items.

Lists sequenced by numbers show an ordering relationship between the listed items.

If a conflict arises between text, tables, or figures, the order of precedence to resolve the conflicts is text; then tables; and finally figures. Not all tables or figures are fully described in the text. Tables show data format and values. Notes and examples do not constitute any requirements for implementers and notes are numbered consecutively throughout this specification.

8 Mechanical characteristics

8.1 Device and system connectors

8.1.1 Storage device connector

The storage device with Ethernet interface plug connector is the Device Free (Plug) connector defined in SFF-8482 and SFF-8680. See the SFF specifications for detailed dimensional requirements.

Figure 1 illustrates the interface plug connector.

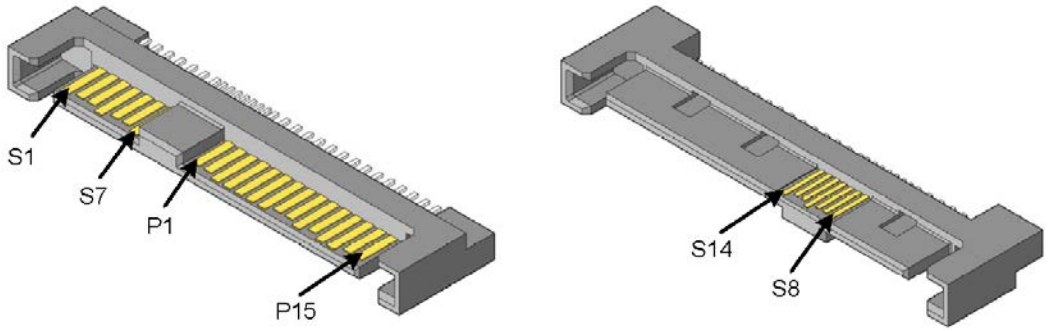

Figure 1 Device Free (Plug) connector

8.1.2 Device form factor and connector location

The storage device with Ethernet interface form factor SHALL comply with SFF-8201 or SFF-8301 (2.5” and 3.5” drive form factors, respectively).

See SFF-8223 and SFF-8323 for the storage device with Ethernet interface plug connector locations on 2.5” and 3.5” drive form factors, respectively. These SFF specifications define the location of the connector relative to the device side mounting holes and the device bottom mounting holes, as applicable. Figure 2 illustrates the connector on a 2.5” hard disk drive. The connector location on the storage device with Ethernet interface SHALL comply with the applicable SFF specification.

Figure 2 2.5” hard disk drive with Ethernet interface plug connector

Figure 3 illustrates the connector on a 3.5” hard disk drive.

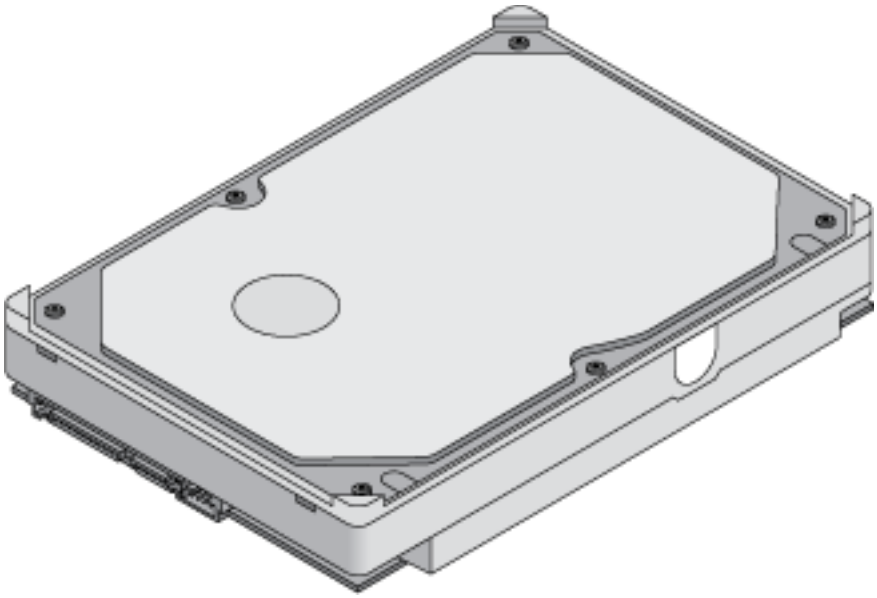

Figure 3 3.5” hard disk drive with Ethernet interface plug connector

8.1.3 System connector

The system backplane receptacle connector is the Backplane Fixed (Receptacle) connector defined in SFF-8482 and SFF-8680. The backplane receptacle connector defined by SFF-8639 MAY also be used.

Figure 4 illustrates the SFF-8482/SFF-8680 system Fixed (Receptacle) connector.

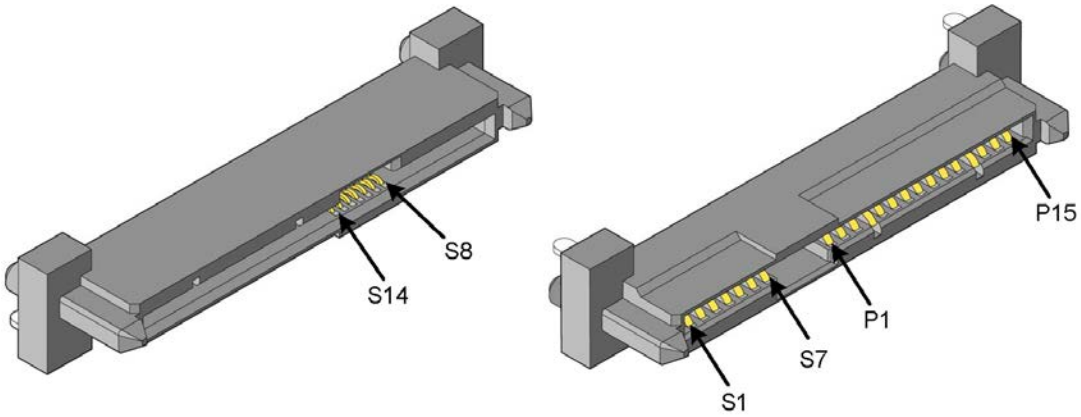

Figure 4 System Backplane Fixed (Receptacle) connector

8.1.4 Connector pin assignment

Table 1 defines the system and device connector pin signal assignments. The storage device with Ethernet interface SHALL comply with this pin assignment. Other interfaces use common form factors and connectors that MAY physically mate with the device or system connector used

in the storage device with Ethernet interface. See SFF-9639 for a list of these interfaces and pin signal assignments.

Table 1 Connector signal assignments

Segment	Pin	Backplane receptacle	Device plug
Signal	S1	GROUND	GROUND
	S2	TX0+	RX0+
	S3	TX0-	RX0-
	S4	GROUND	GROUND
	S5	RX0-	TX0-
	S6	RX0+	TX0+
	S7	GROUND	GROUND
	S8	GROUND	GROUND
	S9	TX1+	RX1+
	S10	TX1-	RX1-
	S11	GROUND	GROUND
	S12	RX1-	TX1-
	S13	RX1+	TX1+
	S14	GROUND	GROUND
Power	P1	PRESENCE DETECT	PRESENCE DETECT
	P2	I^2C CLOCK	I^2C CLOCK
	P3	I^2C DATA	I^2C DATA
	P4	GROUND	GROUND
	P5	GROUND	GROUND
	P6	GROUND	GROUND
	P7	+5V PRECHARGE	+5V PRECHARGE
	P8	+5V	+5V
	P9	+5V	+5V
	P10	GROUND	GROUND
	P11	VENDOR SPECIFIC	VENDOR SPECIFIC
	P12	GROUND	GROUND
	P13	+12V PRECHARGE	+12V PRECHARGE
	P14	+12V	+12V
	P15	+12V	+12V

1. See 7.1 for TX and RX electrical characteristics..
2. See 7.2 for I^2C electrical characteristics.
3. See 7.3 for +5V and +12V requirements.
4. See 7.4 for P1 and P11 electrical characteristics.

9 Electrical characteristics

9.1 TX and RX signals

The TX and RX signals SHALL meet the requirements defined by the *Serial-GMII Specification*. This specification may be obtained at

ftp://ftp-eng.cisco.com/smii/sgmii.pdf

9.2 I^2C signals

The I^2C signals are OPTIONAL, however, a storage device with Ethernet interface that supports multiple speeds provides maximum performance if the Device Network Speed (see 10.3.11) is set through the I^2C interface. (A storage device with Ethernet interface that supports multiple speeds defaults to 1 Gbps Ethernet speed, providing backwards compatibility with single speed devices.) If implemented, the I^2C signals SHALL comply with the *I^2C-bus specification and user manual* at V_{DD} of 3.3V and operation at the standard mode speed of 100 kHz. The storage device with Ethernet interface is a slave device and lacks internal pull-up resistors. These resistors are omitted to allow the greatest flexibility when implementing shared bus. The host device SHOULD include pull-up resistors that meet the guidelines of the I^2C specification. The I^2C specification and user manual may be obtained at

www.nxp.com/documents/user_manual/UM10204.pdf.

9.3 +5V and +12V

The storage device with Ethernet interface MAY require +5V, +12V, or both +5V and +12V. See the device product data sheet for specific voltage and power requirements.

9.4 PRESENCE DETECT (P1)

The P1 signal is a bidirectional signal that MAY be used to assign unique device addresses and/or to detect the removal of a storage device from the chassis. The use of this signal requires the host to pull-up the signal to 3.3V. The pull-up resistor SHOULD result in a sink current of less than or equal to 8 mA.

9.5 VENDOR SPECIFIC (P11)

Application of P11 is VENDOR SPECIFIC. This pin MAY be not connected or the device MAY connect a GPIO with the following electrical characteristic limits:

Maximum voltage applied to device by chassis: 3.6 V

Minimum device sink current capability: 8 mA

10 Ethernet storage device I^2C communication

10.1 Overview

The I^2C interface provides a means of communication between the chassis and the storage device with Ethernet interface independent of the Ethernet interface. The I^2C interface is used to configure operating elements of the storage device with Ethernet

interface and to communicate information about the device to the chassis.

The storage device with Ethernet interface is designed to behave as an I^2C Slave device at a device address of 0x2F. There are two types of commands that the storage device with Ethernet interface responds to:

a) Set Commands that send data to the storage device with Ethernet interface;

b) Get Commands that return data from the storage device with Ethernet interface.

10.2 Command formats

10.2.1 Set Command format (byte)

Write

1. Length byte
2. Opcode byte
3. Payload byte(s) (if required)
4. Checksum byte

10.2.2 Get Command format (byte)

Dummy Write

1. Length byte
2. Opcode byte
3. Checksum byte

Delay (Minimum of 100 microsecond)

Read

1. Length byte
2. Opcode byte
3. Payload byte(s)
4. Checksum byte

10.2.3 Length

An unsigned integer that indicates the number of bytes being sent in a specific transmission. This number includes the length byte itself, opcode, payload, and the checksum byte.

10.2.4 Opcode

In the case of write transactions, this byte indicates the operation requested. For read transactions, this is a validation byte that SHOULD match the operation that requested data be returned. See section 10.3 for details on the assigned opcodes.

10.2.5 Payload

For set commands the payload is typically the parameters being set, although not every set operation requires parameters. Get commands only make use of the payload field on

the read portion of the transaction and consists of the data requested by the get operation. All integers greater than 8 bits follow big endian format.

10.2.6 Checksum format

Appended to the end of every transaction is a single byte checksum. This checksum takes the form of a modular sum where each character is summed as if it were an unsigned integer. Overflow bits are discarded and the two's complement of the final sum is appended as the checksum byte. Validation of the data MAY be accomplished by summing the characters in the same fashion, including the checksum. Valid data SHOULD result in a sum of zero. A nonzero result indicates an invalid message.

10.2.7 Delay requirements

Discrete Stop and Start conditions SHOULD be issued between any two transactions rather than a repeated start, which is not supported. In addition a 100 µs delay SHOULD be placed between any two transactions to ensure no reads or writes are lost.

10.3 Open Commands

10.3.1 Commands overview

I^2C commands for the storage device with Ethernet interface are listed in Table 2. See referenced paragraphs for detailed descriptions.

The commands are split into two ranges. 0x00 - 0x7f are reserved for Open Commands. 0x80 - 0xff are reserved for Vendor Specific Commands. This section defines Open Commands.

Table 2 Open I2C commands for the storage device with Ethernet interface

Opcode	Name
0x00	Extended command set
0x01	Get Extended Status
0x02	Get Manufacturer
0x03	Get Product ID
0x04	Set Device Present
0x05	Identify Device
0x06	Get Device Temperature
0x07	Set Device I^2C Address
0x08	Get Device IP Address
0x09	Set Device Network Speed
0x0a	Get Device Network Speed
0x0b	Get Device Operating State
0x0c	Get Command Set Version
0x0d	Get Write Status
0x0e	Enable External Loopback
0x0f	Disable External Loopback
0x10	Reset Device
0x11	Reset Interface

10.3.2 Extended command set (Opcode 0x00)

Description: This opcode is reserved for the future implementation of an extended command set.

10.3.3 Get Extended Status (Opcode 0x01)

Type: Get

Bytes Returned: 0-31 (Extended Status)

Description: Returns a value 32 bytes in length. The format of the returned value is vendor specific. This command SHOULD be used when the value returned by Device Operating State command indicates that Extended Status is available.

10.3.4 Get Manufacturer (Opcode: 0x02)

Type: Get

Bytes Returned: 0 - 15 (Manufacturer)

Description: Returns a 16 byte ASCII string indicating the manufacturer of the storage device with Ethernet interface.

10.3.5 Get Product ID (Opcode: 0x03)

Type: Get

Bytes Returned: 0 - 15 (Model Number)

Description: Returns a 16 byte ASCII string indicating the model number of the storage device with Ethernet interface.

10.3.6 Set Device Present (Opcode: 0x04)

Type: Set

Description: This command facilitates the detection of a device being removed from the system. In its default state the PRESENCE DETECT signal on pin P1 of the connector is high. If the command is sent to an attached storage device with Ethernet interface, then the storage device with Ethernet interface drives the PRESENCE DETECT signal low on pin P1 of the connector signal low until it is physically removed, powered down, or the operating system is rebooted.

10.3.7 Identify Device (Opcode 0x05)

Type: Get

Bytes Returned: 0 - 7 (WWN), 8 - 13 (Eth0 MAC), 14 - 19 (Eth1 MAC)

Description: Returns the 64-bit Worldwide Name of the storage device with Ethernet interface and the 48-bit MAC addresses of the device's two Ethernet ports. The first eight bytes returned are the WWN, the next six bytes are the Eth0 MAC, and the final six bytes are Eth1 MAC.

10.3.8 Get Device Temperature (Opcode 0x06)

Type: Get

Byte Returned: 0 (Degrees Celsius)

Description: Returns a single byte signed integer (2's complement), indicating the storage device with Ethernet interface temperature in degrees Celsius.

10.3.9 Set Device I^2C Address (Opcode 0x07)

Type: Set

Parameter (Bytes): 0 (Address)

Description: In the case where multiple storage devices with Ethernet interface are attached to the same I^2C bus, this mechanism allows the default 7-bit address of 0x2f to be changed to a unique value. In addition, the storage device with Ethernet interface is set to the Present state. This command is only acted upon if the PRESENCE DETECT signal is driven low by the host. Since 7-bit addressing is used, the MSB of the address parameter is ignored.

10.3.10 Get Device IP Address (Opcode 0x08)

Type: Get

Bytes Returned: 0 (DHCP Enabled), 1-4 (Eth0 IPv4 Address), 5-20 (Eth0 IPv6 Address), 21-24 (Eth1 IPv4 Address), 25-40 (Eth1 IPv6 Address)

Description: Returns the IP (both v4 and v6) addresses of the attached storage device with Ethernet interface. The octets and hextets are numbered from left to right, in increasing order. Hextet is used in this context to indicate a 16-bit word.

Table 3 Get Device IPv4 Address Byte 0 Format

Bit	Setting
4 - 7	Reserved
3	eth1 DHCPv6 Enabled (0 = Disabled, 1 = Enabled)
2	eth1 DHCPv4 Enabled (0 = Disabled, 1 = Enabled)
1	eth0 DHCPv6 Enabled (0 = Disabled, 1 = Enabled)
0	eth0 DHCPv4 Enabled (0 = Disabled, 1 = Enabled)

Table 4 Ethernet Port 0 / Ethernet Port 1 Byte Format

Byte	Description (eth0)	Byte	Description (eth1)
1	IPv4 Octet 1	21	IPv4 Octet 1
2	IPv4 Octet 2	22	IPv4 Octet 2
3	IPv4 Octet 3	23	IPv4 Octet 3
4	IPv4 Octet 4	24	IPv4 Octet 4
5	IPv6 Hextet 1 (H)	25	IPv6 Hextet 1 (H)
6	IPv6 Hextet 1 (L)	26	IPv6 Hextet 1 (L)
7	IPv6 Hextet 2 (H)	27	IPv6 Hextet 2 (H)
8	IPv6 Hextet 2 (L)	28	IPv6 Hextet 2 (L)
9	IPv6 Hextet 3 (H)	29	IPv6 Hextet 3 (H)
10	IPv6 Hextet 3 (L)	30	IPv6 Hextet 3 (L)
11	IPv6 Hextet 4 (H)	31	IPv6 Hextet 4 (H)
12	IPv6 Hextet 4 (L)	32	IPv6 Hextet 4 (L)
13	IPv6 Hextet 5 (H)	33	IPv6 Hextet 5 (H)
14	IPv6 Hextet 5 (L)	34	IPv6 Hextet 5 (L)
15	IPv6 Hextet 6 (H)	35	IPv6 Hextet 6 (H)
16	IPv6 Hextet 6 (L)	36	IPv6 Hextet 6 (L)
17	IPv6 Hextet 7 (H)	37	IPv6 Hextet 7 (H)
18	IPv6 Hextet 7 (L)	38	IPv6 Hextet 7 (L)
19	IPv6 Hextet 8 (H)	39	IPv6 Hextet 8 (H)
20	IPv6 Hextet 8 (L)	40	IPv6 Hextet 8 (L)

10.3.11 Set Device Network Speed (Opcode 0x09)

Type: Set

Parameter (Bytes): 0, 1 (Eth0 Speed), 2, 3 (Eth1 Speed)

Description: This command sets the network interface speed of each Ethernet port on the storage device with Ethernet interface.

Byte Format: See Table 5

Table 5 Network Speed Byte Format

Bit	Speed
3 - 15	Reserved
2	10 Gbps
1	2.5 Gbps
0	1 Gbps

10.3.12 Get Device Network Speed (Opcode 0x0a)

Type: Get

Bytes Returned: 0, 1 (Eth0 speeds available), 2, 3 (Eth1 speeds available)

Description: Returns the network speed capabilities of the attached storage device with Ethernet interface. The storage device with Ethernet interface reports all network speed capabilities supported.

Byte Format: See Table 5

10.3.13 Get Device Operating State (Opcode 0x0b)

Type: Get

Bytes Returned: 0-3 (Error type)

Description: Returns the operating state of the storage device. If the Extended Status available bit is set, then the Extended Status MAY be read with the Extended Status command set. When the Extended Status is read the Extended Status Available bit is cleared.

Bit Description: See Table 6

Table 6 Device Operating State Bit Description

Bit	Status
4 - 32	Reserved
3	Loopback Enabled
2	Eth1 Link (0=Down, 1=Up)
1	Eth0 Link (0=Down, 1=Up)
0	Extended Status Available

10.3.14 Get Command Set Version (Opcode 0x0c)

Type: Get

Byte Returned: 0 (Major Revision Number), 1 (Minor Revision Number), 2 (Sub-minor Revision Number)

Description: Returns three bytes, all unsigned integers. The first byte returned is the major revision number, the second is the minor revision number, and the third is the sub-minor. This offers a method of determining the supported commands of a specific storage device with Ethernet interface.

10.3.15 Get Write Status (Opcode 0x0d)

Type: Get

Byte Returned: 0, 1 (Status Info), 2 (Op Code)

Description: Returns an unsigned 16-bit integer and a 1 byte Opcode. This value MAY be used to determine whether or not the command was successful. The opcode returned is that of the write that this status applies to.

Table 7 Get Write Status

Value	Status
4 - 65535	Reserved
3	Unrecognised Command
2	Length Mismatch
1	Checksum Mismatch
0	Success

10.3.16 Enable External Loopback (Opcode 0x0e)

Type: Set

Description: This command explicitly enables the external loopback mode of the storage device with Ethernet interface. While in this mode the storage device with Ethernet interface SGMII interfaces retransmit any packet received on that interface. This command is ignored if the loopback is enabled.

10.3.17 Disables External Loopback (Opcode 0x0f)

Type: Set

Description: This command explicitly disables the external loopback mode of the storage device with Ethernet interface. Once disabled, the storage device with Ethernet interface resumes normal network behavior. This command is ignored if the loopback mode is disabled.

10.3.18 Reset Device (Opcode 0x10)

Type: Set

Description: This command MAY be used to request a soft reset of the storage device with Ethernet interface.

10.3.19 Reset Network Interface (Opcode 0x11)

Type: Set

Parameter Byte: 0 (Interface)

Description: This command MAY be used to reset the specified interface by removing it's IP configuration, bringing the port down, and allowing it to come back up to make a fresh DHCP request. The parameter for this command is a single byte unsigned integer, the value determining the interface to reset. Parameter values specifying interfaces that do not exist on the storage device with Ethernet interface cause the command to be ignored.

10.4 I2C implementation requirements

10.4.1 I^2C signals

See 9.2

10.4.2 Clock stretching

Host devices need to support clock stretching. It is expected that storage device with Ethernet interface make use of clock stretching. Failure to properly handle clock stretching MAY lead to corrupt transactions due to a loss of synchronization between the Master and Slave.

10.4.3 Power down isolation

A storage device with Ethernet interface in the powered down state SHOULD NOT interfere with the I^2C communication between the host and other devices. Some I^2C controllers MAY require additional circuitry to isolate the I^2C clock and data signals so the storage device with Ethernet interface does not load the bus when the storage device with Ethernet interface not powered. This is an issue that needs to be addressed by the storage device with Ethernet interface.

11 FAQ

Q: Is there any software needed (Driver's etc.)?
A: The storage device with Ethernet interface uses standard Ethernet communication protocols

Q: Is there a physical keying mechanism to prevent insertion of the storage device with Ethernet interface in a SAS/SATA slot or vice versa? If not, can this cause damage to the system?
A: There is no physical keying mechanism to distinguish between different drive types. Signal locations and protocol prevent damage to the system and the device.

Q: How are the drives presented on the network?
A: Each drive has two IP addresses.

For additional FAQ regarding the Storage device with Ethernet interface refer to wiki FAQ:
https://developers.seagate.com/display/KV/FAQ

12 Revision History

Version	Date	Author	Changes
1	12/20/2013	Alvin Cox, Asghar Riahi	Initial Public Version
2	04/10/2014	Alvin Cox, Asghar Riahi	Updates to address initial feedback from the Incubation Committee
3	08/21/2014	Alvin Cox, Asghar Riahi, Bryan Wyatt	Added the following sections: I^2C, FAQs, and revision history plus PRESENCE DETECT, and figures and tables lists.