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Information processing systems — Small Computer System Interface (SCSI)

Systèmes de traitement de l'information — Interface système pour petits ordinateurs (SCSI)

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Contents

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 9316 was prepared by Technical Committee ISO/TC 97, *Information processing systems.*

Annexes A, B, C, D, E and F are for information only.

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Printed in Switzerland

Information processing systems — Small Computer System Interface (SCSI)

1 Scope

This International Standard provides the mechanical, electrical, and functional requirements for a small computer input/output bus and command sets for peripheral device types commonly used with small computers.

The small computer system interface, described in this International Standard, is a local I/O bus that can be operated at data rates up to 4 Mbytes/s depending upon circuit implementation choices. The primary objective of the interface is to provide host computers with device independence within a class of devices. Thus, different disk drives, tape drives, printers, and even communication devices can be added to the host computer(s) without requiring modifications to generic system hardware or software. Provision is made for the addition of nongeneric features and functions through vendor unique fields and codes.

The interface uses logical rather than physical addressing for all data blocks. For direct access devices, each logical unit may be interrogated to determine how many blocks it contains. A logical unit may coincide with all or part of a peripheral device.

Provision is made for cable lengths up to 25 m using differential drivers and receivers. A single-ended driver and receiver configuration is defined for cable lengths of up to 6 m and is primarily intended for applications within a cabinet.

The interface protocol includes provision for the connection of multiple initiators (SCSI devices capable of initiating an operation) and multiple targets (SCSI devices capable of responding to a request to perform an operation). Optional distributed arbitration (i.e., bus-contention logic) is built into the architecture of SCSI. A priority system awards interface control to the highest priority SCSI device that is contending for use of the bus. The time to complete arbitration is independent of the number of devices that are contending and can be completed in less than 10 μs.

The physical characteristics are described in clause 4. There are two electrical alternatives: single-ended and differential. Single-ended and differential devices are electrically different and shall not be mixed on the same bus. In addition, there are several options: shielded or unshielded connectors may be used and parity may or may not be implemented.

Clause 5 describes the logical characteristics of the interface. An arbitration option is defined to permit multiple initiators and to permit concurrent I/O operations. All SCSI devices are required to be capable of operating with the defined asynchronous transfer protocol. In addition, an optional synchronous transfer protocol is defined. Clause 5 also specifies a message protocol for control of the interface. In most cases, messages are not directly apparent to the host computer software. Only one message, COMMAND COMPLETE, is mandatory; all others are optional and are not necessarily implemented. Note that some options (e.g., synchronous transfer) require the implementation of certain messages.

The SCSI command structure is specified in clause 6. Commands are classified as mandatory (M), extended (E), optional (O), or vendor unique (V). SCSI devices shall implement all mandatory commands defined for the appropriate device type and may implement other commands as well. Extended SCSI devices shall implement all extended plus all mandatory commands and may implement other commands as well. Extended SCSI devices contain commands that facilitate the writing of self-configuring software drivers that can "discover" all necessary attributes without prior knowledge of specific peripheral characteristics (such as storage capacity). Extended commands for direct access devices also implement a very large logical block address space (2^{32} blocks), although mandatory commands for direct access devices implement a somewhat smaller logical block address space (2^{21} blocks).

Clause 7 specifies those commands that have a consistent meaning for all device types.

Clauses 8 through 13 contain commands for direct-access (*e.g.*, magnetic disk), sequential-access (*e.g.*, magnetic tape), printer, processor, write-once-read-multiple (*e.g.*, optical disk), and read-only direct-access devices, respectively. The commands in each of these clauses are unique to the device type, or they have interpretations, fields, or features that are specific for the device type. Thus, for example, although the WRITE command is used for several device types, it has a somewhat different form for each type, with different parameters and meanings. Therefore, it is specified separately for each device type.

Clause 14 describes the status byte for all device types. Status is returned by targets at the end of each command.

2 Normative references

The following standards contain provisions, which through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 8482:1987, *Information processing systems — Data communication — Twisted pair multipoint interconnections.*

This International Standard defines codes which controllers may use to identify that storage media conform to the following storage media standards.

ISO 1863:1976, *Information processing — 9-track, 12,7 mm (0.5 in) wide magnetic tape for information interchange recorded at 32 rpmm (800 rpi).*

ISO 3788:1976, *Information processing — 9-track, 12,7 mm (0.5 in) wide magnetic tape for information interchange recorded at 63 rpmm (1 600 rpi), phase encoded.*

ISO 4057:1986, *Information processing — Data interchange on 6,30 mm (0.25 in) magnetic tape cartridge 63 bpmm (1 600 bpi) phase-encoded.*

ISO 5652:1984, *Information processing — 9-track, 12,7 mm (0.5 in) wide magnetic tape for information interchange -- Format and recording, using group coding at 246 cpmm (6 250 cpi).*

ISO 5654/1:1984, *Information processing — Data interchange on 200 mm (8 in) flexible disk cartridges using two-frequency recording at 13 262 ftprad, 1, 9 tpmm (48 tpi), on one side — Part 1: Dimensional, physical and magnetic characteristics.*

ISO 5654/2:1985, *Information processing — Data interchange on 200 mm (8 in) flexible disk cartridges using two-frequency recording at 13 262 ftprad, 1, 9 tpmm (48 tpi), on one side — Part 2: Track format.*

ISO 6596/1:1985, *Information processing — Data interchange on 130 mm (5.25 in) flexible disk cartridges using two-frequency recording at 7 958 ftprad, 1,9 tpmm (48 tpi), on one side — Part 1: Dimensional, physical and magnetic characteristics.*

ISO 6596/2:1985, *Information processing — Data interchange on 130 mm (5.25 in) flexible disk cartridges using two-frequency recording at 7 958 ftprad, 1,9 tpmm (48 tpi) on one side — Part 2: Track format.*

ISO 7065/1:1985, *Information processing — Data interchange on 200 mm (8 in) flexible disk cartridges using modified frequency modulation recording at 13 262 ftprad, 1,9 tpmm (48 tpi), on both sides — Part 1: Dimensional, physical and magnetic characteristics.*

ISO 7065/2:1985, *Information processing — Data interchange on 200 mm (8 in) flexible disk cartridges using modified frequency modulation recording at 13 262 ftprad, 1,9 tpmm 48 (tpi), on both sides — Part 2: Track format.*

ISO 7487/1:1985, *Information processing — Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, 1,9 tpmm (48 tpi), on both sides — Part 1: Dimensional, physical and magnetic characteristics.*

ISO 7487/2:1985, *Information processing — Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, 1,9 tpmm (48 tpi), on both sides — Part 2: Track format.*

ISO 7487/3:1986, *Information processing — Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, 1,9 tpmm (48 tpi), on both sides — Part 3: Track format B.*

ISO 8063/1:1986, *Information processing — Data interchange on 6,30 mm (0.25 in) wide magnetic tape cartridge using IMFM recording at 252 ftpmm (6 400 ftpi) — Part 1: Mechanical, physical and magnetic properties.*

ISO 8063/2:1986, *Information processing — Data interchange on 6,30 mm (0.25 in) wide magnetic tape cartridge using IMFM recording at 252 ftpmm (6 400 ftpi) — Part 2: Track format and method of recording for data interchange in start/stop mode.*

ISO 8378/1:1986, *Information processing — Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, 3,8 tpmm (96 tpi), on both sides — Part 1: Dimensional, physical and magnetic characteristics.*

ISO 8378/2:1986, *Information processing — Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, 3,8 tpmm (96 tpi), on both sides — Part 2: Track format A.*

ISO 8378/3:1986, *Information processing — Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad, 3,8 tpmm (96 tpi), on both sides — Part 3: Track format B.*

ISO 8462/1:1986, *Information processing — Data Interchange on 6,30 mm (0.25 in) magnetic tape cartridge using GCR recording at 394 ftpmm (10 000 ftpi), 39 cpmm (1 000 cpi) — Part 1: Mechanical, physical and magnetic properties.*

ISO 8462/2:1986, *Information processing — Data Interchange on 6,30 mm (0.25 in) magnetic tape cartridges using GCR recording at 394 ftpmm (10 000 ftpi), 39 cpmm (1 000 cpi) — Part 2: Streaming mode.*

ISO 8630/1:1987, *Information processing -- Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 13 262 ftprad, on 80 tracks on each side — Part 1: Dimensional, physical and magnetic characteristics.*

ISO 8630/2:1987, *Information processing -- Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 13 262 ftprad, on 80 tracks on each side — Part 2: Track format A for 77 tracks.*

ISO 8630/3:1987, *Information processing -- Data interchange on 130 mm (5.25 in) flexible disk cartridges using modified frequency modulation recording at 13 262 ftprad, on 80 tracks on each side — Part 3: Track format B for 80 tracks.*

ISO 8860/1:1987, *Information processing - Data interchange on 90 mm (3.5 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad on 80 tracks on each side — Part 1: Dimensional, physical and magnetic characteristics.*

ISO 8860/2:1987, *Information processing -- Data interchange on 90 mm (3.5 in) flexible disk cartridges using modified frequency modulation recording at 7 958 ftprad on 80 tracks on each side — Part 2: Track format.*

3 Definitions, abbreviations and conventions

3.1 Definitions

For the purposes of this International Standard the following definitions apply.

3.1.1 byte: In this standard, this term indicates an 8-bit (octet) byte.

3.1.2 command descriptor block (CDB): The structure used to communicate requests from an initiator to a target.

3.1.3 connect: The function that occurs when an initiator selects a target to start an operation.

3.1.4 disconnect: The function that occurs when a target releases control of the SCSI bus, allowing it to go to the BUS FREE phase.

3.1.5 initiator: An SCSI device (usually a host system) that requests an operation to be performed by another SCSI device.

3.1.6 INTERMEDIATE status: A status code sent from a target to an initiator upon completion of each command in a set of linked commands except the last command in the set.

3.1.7 logical unit: A physical or virtual device addressable through a target.

3.1.8 logical unit number: An encoded three-bit identifier for the logical unit.

3.1.9 one: A true signal value.

3.1.10 peripheral device: A peripheral that can be attached to an SCSI device (e.g., magnetic-disk, printer, optical-disk, or magnetic-tape).

3.1.11 reconnect: The function that occurs when a target selects an initiator to continue an operation after a disconnect.

3.1.12 reserved: The term used for bits, bytes, fields, and code values that are set aside for future standardization.

3.1.13 SCSI address: The octal representation of the unique address (0-7) assigned to an SCSI device. This address would normally be assigned and set in the SCSI device during system installation.

3.1.14 SCSI ID: The bit-significant representation of the SCSI address referring to one of the signal lines DB(7-0).

3.1.15 SCSI device: A host computer adapter or a peripheral controller or an intelligent peripheral that can be attached to the SCSI bus.

3.1.16 signal assertion: The act of driving a signal to the true state.

3.1.17 signal negation: The act of driving a signal to the false state or allowing the cable terminators to bias the signal to the false state (by placing the driver in the high impedance condition).

3.1.18 signal release: The act of allowing the cable terminators to bias the signal to the false state (by placing the driver in the high impedance condition).

3.1.19 status: One byte of information sent from a target to an initiator upon completion of each command.

3.1.20 target: An SCSI device that performs an operation requested by an initiator.

3.1.21 vendor unique: In this standard, this term indicates bits, fields, or code values that are vendor specific and are not defined by this standard.

3.1.22 zero: A false signal value.

3.2 Abbreviations

3.2.1 LSB. Least significant byte.

3.2.2 LUN. Logical unit number.

3.2.3 MSB. Most significant byte.

3.3 Editorial conventions

Certain words, terms, and phrases used in this standard have a specific meaning beyond the normal English meaning. These words, terms, and phrases are defined either in the definitions (see 3.1) or in the text where they first appear (*e.g.*, Arbitration Delay, see 4.7.1). Names of signals, phases, conditions, messages, commands, statuses, and sense keys are in all uppercase (*e.g.*, REQUEST SENSE). Lower case is used for words having the normal English meaning.

Hexidecimal numbers are indicated by the digits 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E and F followed by the lower case "h" (*e. g.* 3F6Ah). All other numbers are decimal values.

4 Physical Characteristics

This section contains the physical definition of the SCSI. The connectors, cables, signals, terminators, and bus timing needed to implement SCSI are covered.

4.1 Physical Description

SCSI devices are daisy-chained together using a common cable. Both ends of the cable are terminated. All signals are common between all SCSI devices. Two driver/receiver alternatives are available:

a) Single-ended drivers and receivers, which allow a maximum cable length of 6 m (primarily for connection within a cabinet).

b) Differential drivers and receivers, which allow a maximum cable length of 25 m (primarily for connection outside of a cabinet).

4.2 Cable Requirements

An ideal impedance match with cable terminators implies a cable characteristic impedance of 132 Ω (singled-ended option) or 122 Ω (differential option). In general, cables with this high of a characteristic impedance are not available; however, impedances that are somewhat lower are satisfactory. A characteristic impedance of 100 Ω ±10% is recommended for unshielded flat or twisted pair ribbon cable. A characteristic impedance greater than 90 Ω is preferred for shielded cables; however, most available cables have a somewhat lower characteristic impedance. To minimize discontinuities and signal reflections, cables of different impedances should not be used in the same bus. Implementations may require trade-offs in shielding effectiveness, cable length, the number of loads, transfer rates, and cost to achieve satisfactory system operation.

A mininimum conductor size of nominal cross section 0,080 42 mm^2 shall be employed to minimize noise effects and ensure proper distribution of optional terminator power.

4.2.1 Single-Ended Cable

A 50-conductor flat cable or 25-signal twisted- pair cable shall be used. The maximum cable length shall be 6 m.

A stub length of no more than 0,1 m is allowed off the mainline interconnection within any connected equipment.

SCSI bus termination may be internal to the SCSI devices that are at the ends of the cable.

4.2.2 Differential Cable

A 50-conductor cable or 25-signal twisted-pair cable shall be used. The maximum cable length shall be 25 m.

A stub length of no more than 0,2 m is allowed off the mainline interconnection within any connected equipment.

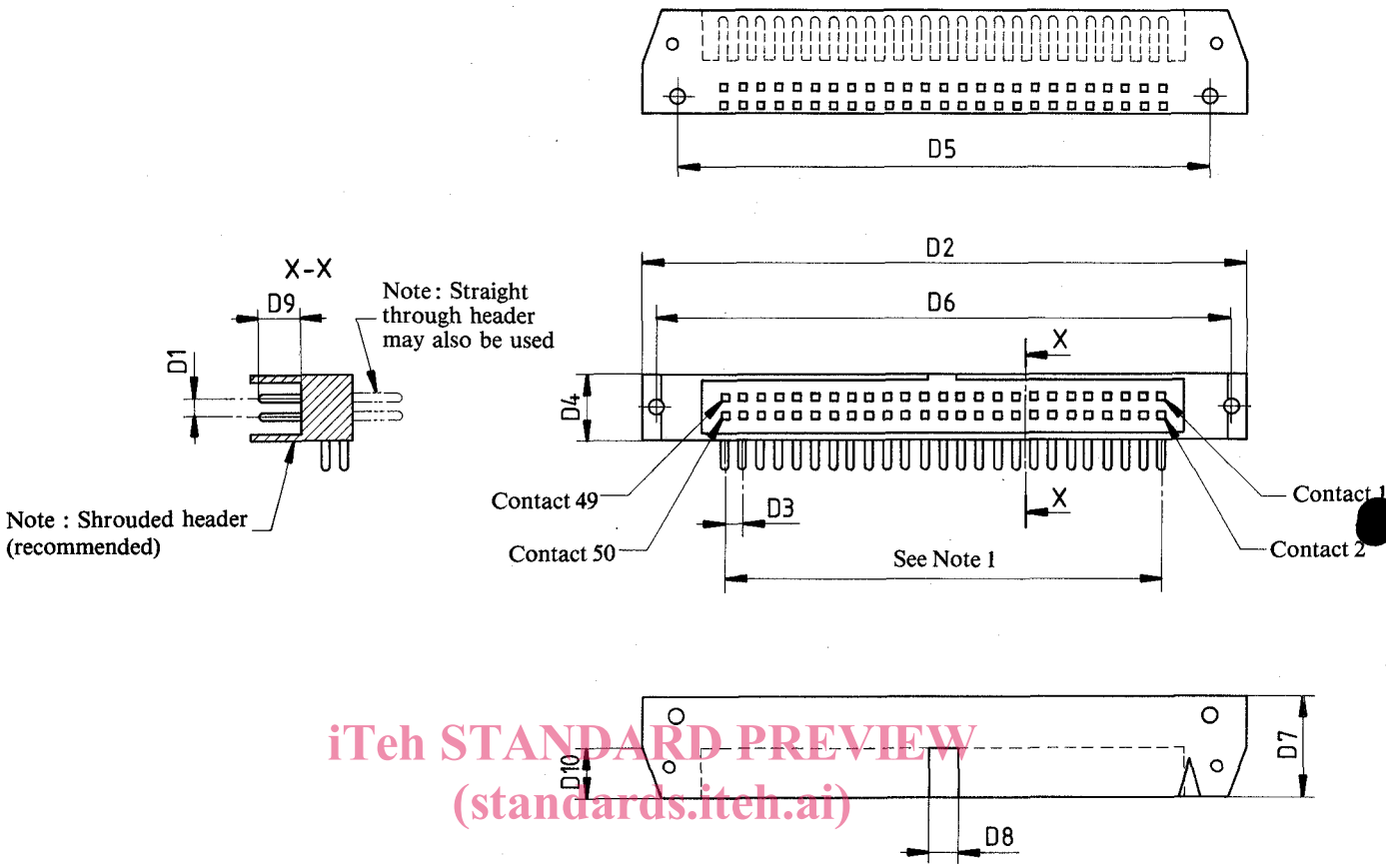
SCSI bus termination may be internal to the SCSI devices that are at the ends of the cable.

4.3 Connector Requirements

Nonshielded connectors are specified. The nonshielded connectors are typically used for in-cabinet applications. Annex D defines recommended shielded connectors and their pin assignments. These connectors are typically used for external applications where electromagnetic compatibility (EMC) and electrostatic discharge (ESD) protection may be required. Either type of connector may be used with the single-ended or differential drivers.

The nonshielded SCSI device connector (figure 1) shall be a 50-conductor connector consisting of two rows of 25 male contacts with adjacent contacts 2,54 mm (0,1 in) apart. A shroud and header body should be used. The nonmating portion of the connector is shown for reference only.

The nonshielded cable connector (figure 2) shall be a 50-conductor connector consisting of two rows of 25 female contacts with adjacent contacts 2,54 mm (0,1 in) apart. It is recommended that keyed connectors be used.



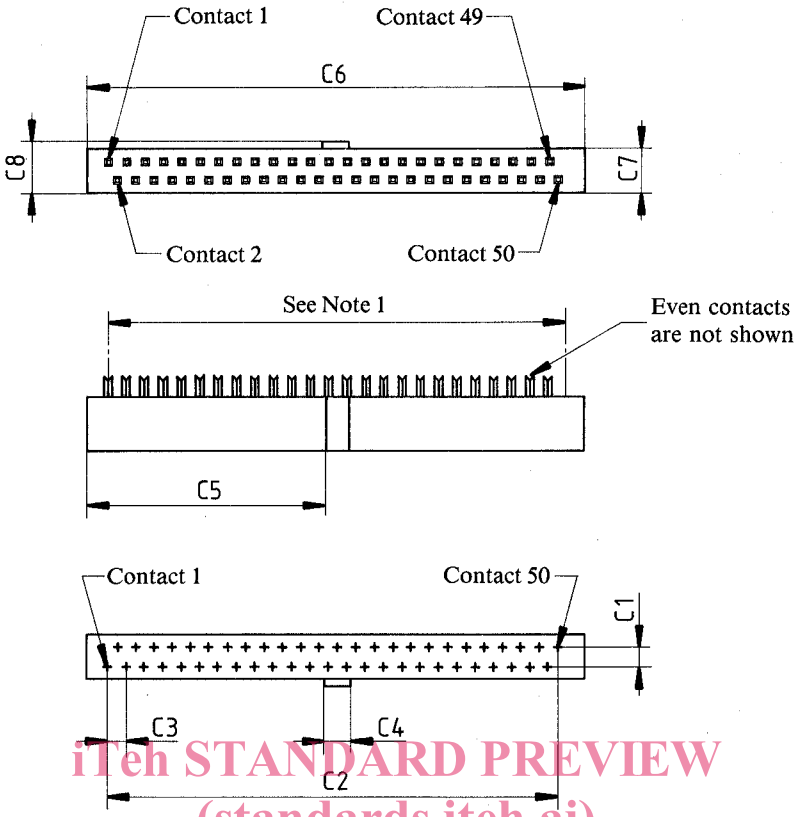
Dimensions	mm	in	Comments
D1	2,54	0,100	
D2	82,50	3,260	Reference only
D3	2,54	0,100	
D4	8,89	0,350	Reference only
D5	72,64	2,860	Reference only
D6	78,74	3,100	Reference only
D7	13,94	0,549	Reference only
D8	4,19 ± 0,25	0,165 ± 0,01	
D9	6,10	0,240	
D10	6,60	0,260	Reference only

NOTES :

1) Two rows of twenty five contacts on 2,54 mm (0,100 in) spacing = 60,96 mm (2,400 in).

2) Tolerances ± 0,127 mm (0,005 in) non-cumulative, unless specified otherwise.

Figure 1 — Nonshielded SCSI Device Connector



Dimensions	mm	in	Comments
C1	2,54	0,100	
C2	60,96	2,400	
C3	2,54	0,100	
C4	3,30	0,130	
C5	32,39	1,275	
C6	68,07	2,680	
C7	6,10	0,240	
C8	7,62	0,300	max.

NOTES :

1) Fifty contacts on 1,27 mm (0,05 in) staggered spacing = 62,23 mm (2,450 in) [reference only].

2) Tolerances ± 0,127 mm (0,005 in) non-cumulative, unless specified otherwise.

3) Connector cover and strain relief are optional.

Figure 2 — Nonshielded SCSI Cable Connector