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Foreword

1) ISO (International Organization for Standardization) and IEC (International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards. Their preparation is entrusted to technical committees; any ISO and IEC member body interested in the subject dealt with may participate in this preparatory work. International governmental and non-governmental organizations liaising with ISO and IEC also participate in this preparation.

2) In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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International Standard ISO/IEC 14776-151 was prepared by subcommittee 25: Interconnection of Information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

The list of all currently available parts of the ISO/IEC 14776 series, under the general title *Information technology – Small computer system interface (SCSI),* can be found on the IEC web site.

This International Standard has been approved by vote of the member bodies and the voting results may be obtained from the address given on the second title page.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IMPORTANT - the “colour inside” logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer

Introduction

This International Standard defines the Serial Attached SCSI (SAS) interconnect and three transport protocols that use the SAS interconnect.

a) Serial SCSI Protocol (SSP): a mapping of SCSI supporting multiple initiators and targets.
b) Serial ATA Tunneled Protocol (STP): a mapping of Serial ATA expanded to support multiple initiators and targets.
c) Serial Management Protocol (SMP): a management protocol.

The standard is organized as follows:

Clause 1 (Scope) describes the relationship of this standard to the SCSI and ATA families of standards.
Clause 2 (Normative references) provides references to other standards and documents.
Clause 3 (Terms, definitions, symbols, abbreviations, keywords and conventions) defines terms and conventions used throughout this standard.
Clause 4 (General) describes architecture, names and identifiers, state machines, resets, I_T nexus loss and provides an expander device model.
Clause 5 (Physical layer) describes the physical layer. It describes passive interconnect components (connectors, cables and backplanes) and defines the transmitter and receiver electrical characteristics.
Clause 6 (Phy layer) describes the phy layer. It describes 8b10b encoding, bit order, out of band (OOB) signals, phy reset sequences, phy layer state machines, and spin-up.
Clause 7 (Link layer) describes the link layer. It describes primitives, clock skew management, idle physical links, CRC, scrambling, address frames, the identification sequence and its state machine, power management, SAS domain changes, connections, rate matching and SSP, STP and SMP connection rules and link layer state machines.
Clause 8 (Port layer) describes the port layer, which sits between one or more link layers and one or more transport layers. It includes port layer state machines.
Clause 9 (Transport layer) describes the transport layer. It includes SSP, STP and SMP frame definitions and transport layer state machines.
Clause 10 (Application layer) describes the application layer. It describes SCSI protocol services, mode parameters, log parameters and power conditions, ATA specifics and SMP functions.

Annex A (normative) (Jitter tolerance patterns) describes the jitter tolerance patterns.
Annex B (normative) (Signal performance measurements) describes signal measurement techniques.
Annex C (informative) (SAS to SAS phy reset sequence examples) provides additional phy reset sequence examples.
Annex D (informative) (CRC) provides information and example implementations of the CRC algorithm.
Annex E (informative) (SAS address hashing) provides information and example implementations of the hashing algorithm.
Annex F (informative) (Scrambling) provides information and example implementations of the scrambling algorithm.
Annex G (informative) (ATA architectural notes) describes ATA architectural differences from Serial ATA and Serial ATA II.
Annex H (informative) (ALIGN and/or NOTIFY insertion rate summary) describes the minimum ALIGN and/or NOTIFY insertion rates for clock skew management, rate matching and STP initiator phy throttling.
Annex I (informative) (Expander device handling of connections) describes expander device behavior in a variety of connection examples.
Annex J (informative) (Primitive encoding) lists the primitive encodings available for future versions of this standard.
Annex K (informative) (Messages between state machines) contains a list of messages between state machines.
Annex L (informative) (Discover process example implementation) provides an example implementation of the discover process.
Annex M (informative) (SAS icon) defines the general SAS icon.
Bibliography

The following figure shows the organization of the layers of this standard.

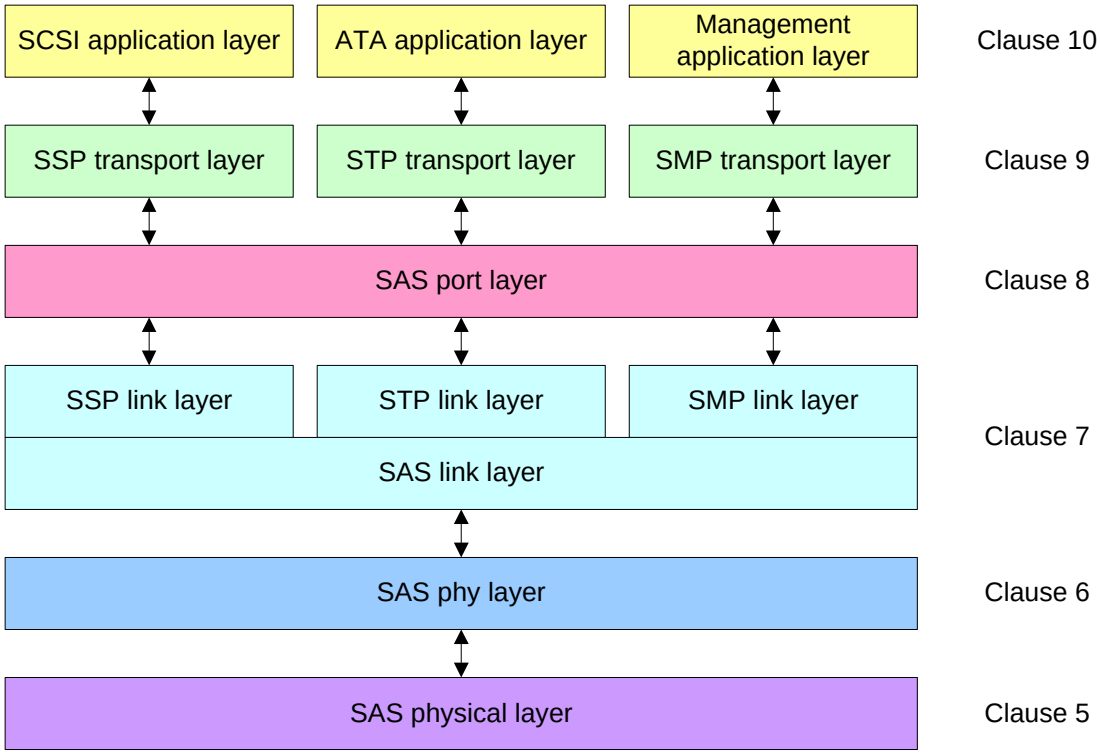

Figure 0 - Organization of this standard

INFORMATION TECHNOLOGY – SMALL COMPUTER SYSTEM INTERFACE (SCSI) –

Part 151: Serial attached SCSI-1.1 (SAS-1.1)

1 Scope

The SCSI family of standards provides for many different transport protocols that define the rules for exchanging information between different SCSI devices. This part of ISO/IEC 14776 defines the rules for exchanging information between SCSI devices using a serial interconnect. Other SCSI transport protocol standards define the rules for exchanging information between SCSI devices using other interconnects.

Figure 1 shows the relationship of this International Standard to the other standards and related projects in the SCSI family of standards.

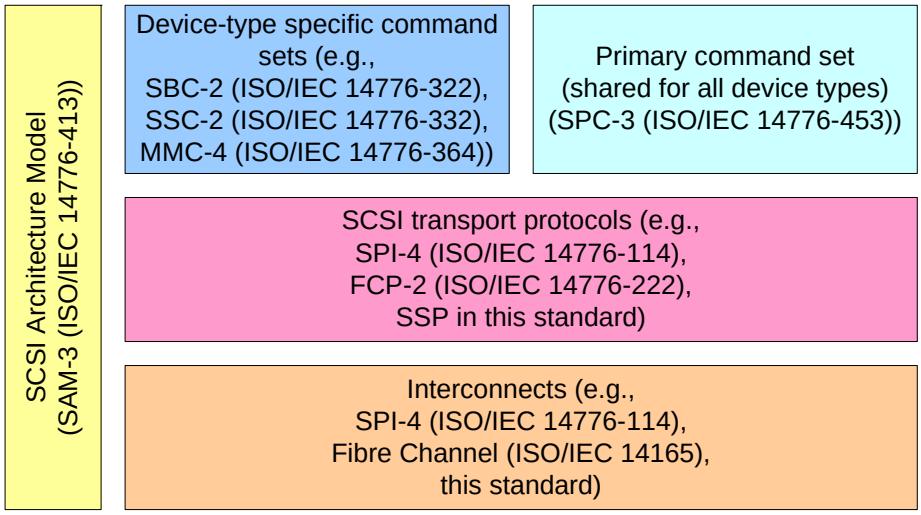

Figure 1 — SCSI document relationships

This standard also defines the rules for exchanging information between ATA hosts and ATA devices using the same serial interconnect. Other ATA transport protocol standards define the rules for exchanging information between ATA hosts and ATA devices using other interconnects.

Figure 2 shows the relationship of this standard to other standards and related projects in the ATA family of standards.

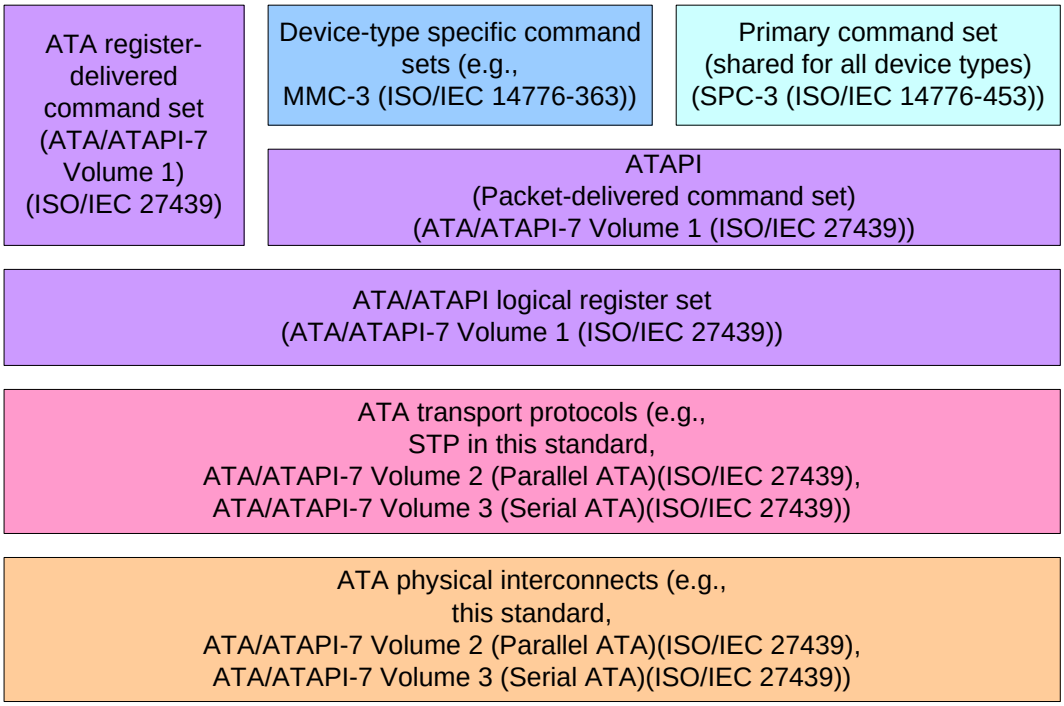

Figure 2 — ATA document relationships

Figure 1 and figure 2 show the general relationship of the documents to one another and they do not imply a relationship such as a hierarchy, protocol stack or system architecture.

These standards specify the interfaces, functions and operations necessary to ensure interoperability between conforming implementations. This standard is a functional description. Conforming implementations may employ any design technique that does not violate interoperability.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document, including any amendments, applies.

The provisions of the referenced specifications other than ISO/IEC, IEC, ISO and ITU documents, as identified in this clause, are valid within the context of this International Standard. The reference to such a specification within this International Standard does not give it any further status within ISO/IEC. In particular, it does not give the referenced specification the status of an International Standard.

ISO/IEC TR 14165-117, *Information technology – Fibre channel – Part 117: Methodologies for jitter and signal quality (MJSQ)* [ANSI INCITS TR-35-2004]

NOTE 1 - When MJSQ is referenced from this standard, the FC Port terminology used within MJSQ should be substituted with SAS phy terminology.

ISO/IEC 14776-413, *Information technology – Small computer system interface (SCSI) – Part 413: Architecture model-3 (SAM-3)* [ANSI INCITS 402-2005]

ISO/IEC 14776-322, *Information technology – Small computer system interface (SCSI) – Part 322: Block commands-2 (SBC-2)* [ANSI INCITS 405-2005]

ISO/IEC 14776-372, *Information technology – Small computer system interface (SCSI) – Part 372: Enclosure services-2 (SES-2)* (under consideration) [ANSI INCITS 448-2008]

ISO/IEC 14776-453, *Information technology – Small computer system interface (SCSI) – Part 453: Primary commands-3 (SPC-3)* [ANSI INCITS 408-2005]

ISO/IEC 24739-1, *Information technology – AT Attachment with Packet Interface – Part 1: Register delivered command set, logical register set (ATA/ATAPI-7 V1)* [ANSI INCITS 397-2005]

ISO/IEC 24739-3, *Information technology – AT Attachment with Packet Interface-7 – Part 3: Serial Transport Protocols and Physical Interconnect (ATA/ATAPI-7 V3)* (under consideration) [ANSI INCITS 397-2005]

AT Attachment with Packet Interface-7 Amendment 1 [ANSI INCITS 397-2005/AMD1]

ISO/IEC 19501, *Information technology -- Open Distributed Processing -- Unified Modeling Language (UML) Version 1.4.2*

SFF-8086, *Compact Multilane Series: Common Elements*

SFF-8087, *Compact Multilane Series: Unshielded*

SFF-8088, *Compact Multilane Series: Shielded*

SFF-8223, *2.5" Drive Form Factor with Serial Connector*

SFF-8323, *3.5" Drive Form Factor with Serial Connector*

SFF-8523, *5.25" Drive Form Factor with Serial Connector*

SFF-8416, *Measurement and Performance Requirements for HPEI Bulk Cable*

SFF-8460, *HSS Backplane Design Guidelines*

SFF-8470, *Shielded High Speed Multilane Copper Connector*

SFF-8482, *Unshielded Dual Port Serial Attachment Connector*

SFF-8484, *Multi-Lane Unshielded Serial Attachment Connectors*

SFF-8485, *Serial GPIO (SGPIO) Bus*

NOTE 2 - For more information on the current status of SFF document, contact the SFF Committee at 408-867-6630 (phone) or 408-867-2115 (fax). To obtain copies of these documents, contact the SFF Committee at 14426 Black Walnut Court, Saratoga, CA 95070 at 408-867-6630 (phone) or 408-741-1600 (fax) or see http://www.sffcommittee.org.