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Information technology – Fibre channel – Part 251: Framing and signalling (FC-FS)

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INFORMATION TECHNOLOGY – FIBRE CHANNEL –

Part 251: Framing and signalling (FC-FS)

FOREWORD

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International Standard ISO/IEC 14165-251 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 14165 series, under the general title *Information technology – Fibre channel,* 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.

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INTRODUCTION

This International Standard combines the following Fibre Channel standards (for full reference, see Bibliography):

ANSI INCITS 230-1994 (R1999)

ANSI INCITS 230-1994/Amendment 1-1996 (R2001)

ANSI INCITS 230-1994/Amendment 2-1999 (R2001)

ANSI INCITS 297-1996 (R2002)

ANSI INCITS 303-1998 (R2002)

This International Standard includes the following changes with respect to the above publications:

— definitions of existing services have been clarified and/or improved based on experience with existing implementations;
— outdated functions and features have been deleted;
— additional link services in support of new functions defined by the Fibre Channel family of documents have been included;
— definition of other capabilities which enhance the performance of existing Fibre Channel products and fit them for new applications.

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INFORMATION TECHNOLOGY – FIBRE CHANNEL –

Part 251: Framing and signalling (FC-FS)

1 Scope

This part of ISO/IEC 14165 describes the framing and signalling interface of a high-performance serial link for support of FC-4s associated with upper level protocols (for example SCSI, IP, SBCCS, VI).

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.

2.1 Approved references

[1] SO/IEC 14165-116, *Information technology – Fibre channel – Part 116: 10 Gigabit fibre channel (10GFC)*

[2] ISO/IEC 14165-122, *Information technology – Fibre channel – Part 122: Arbitrated loop-2 (FC-AL-2)*

[3] ISO/IEC 9314-2:1989, *Information processing systems – Fibre distributed data interface (FDDI) – Part 2: Token ring media access control (FDDI-MAC)*

[4] ISO/IEC TR 8802-1, *Information technology – Telecommunications and information exchange between systems - Local and metropolitan area networks – Specific requirements – Part 1: Overview of Local Area Network Standards*

[5] ISO/IEC 8802-2, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 2: Logical link control*

[6] ISO/IEC 14165-414, *Information technology – Fibre channel – Part 414: Generic services – 4 (FC-GS-4)* [ANSI INCITS 387-2004]

2.2 References under development

[7] ISO/IEC 14165-133, *Information technology – Fibre channel – Part 133: Switch fabric–3 (FC-SW-3)*, [ANSI INCITS 384-2004]

[8] ISO/IEC 14165-142, *Information technology – Fibre channel – Part 142: - Physical interfaces–2 (FC-PI-2)*, [ANSI INCITS 404-2006]

[9] ISO/IEC 14776-223, *Information technology – Small computer system interface (SCSI) – Part 223: Fibre channel protocol for SCSI, Version 3 (FCP-3)* [ANSI INCITS 416-2006]

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

2.3 Other references

All references in this subclause were correct at the time of approval of this International Standard. The provisions of the referenced specifications, as identified in this subclause, are valid within the context of this International Standard. The reference to a specification within this International Standard does not give it any further status

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within ISO/IEC; in particular, it does not give the referenced specification the status of an International Standard.

IETF Requests for Comments (RFCs) may be obtained directly from the IETF web site at http://www.ietf.org/rfc.html.

[11] INCITS TR-20:1998, *Information technology - Fibre Channel – Fabric Loop Attach (FC-FLA)*

[12] RFC 2625, *IP and ARP over Fibre Channel*

[13] RFC 2597, *Assured Forwarding PHB Group*, June 1999

[14] RFC 2598, *An Expedited Forwarding PHB*, June 1999

[15] RFC 768, *User Datagram Protocol*, August1980.

[16] RFC 791, *Internet Protocol*, September 1981.

[17] RFC 793, *Transmission Control Protocol*, September 1981.

[18] RFC 854, *Telnet Protocol Specification*, May 1983.

[19] RFC 1157, *A Simple Network Management Protocol (SNMP)*, May 1990.

[20] RFC 1901, *Introduction to Community-based SNMPv2*, January 1996

[21] RFC 2373, *IP Version 6 Addressing Architecture*, July 1998.

[22] RFC 2460, *Internet Protocol, Version 6 (IPv6) Specification*, December 1998.

[23] RFC 2616, *Hypertext Transfer Protocol -- HTTP/1.1*, June 1999.

[24] RFC 2818, *HTTP Over TLS*, May 2000.

[25] RFC 2406, *IP Encapsulating Security Payload (ESP)*, November 1998.

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3 Definitions, abbreviations, conventions and keywords

3.1 Definitions

3.1.1 acknowledged class: Any class of service that acknowledges a transfer.

3.1.2 Active: The state of Sequence Initiator until all the Data frames for the Sequence have been transmitted. The state of Sequence Recipient until all the Data frames for the Sequence have been received (see 17.6.1).

3.1.3 address identifier: An address value used to identify source (S_ID) or destination (D_ID) of a frame (see 9.4).

3.1.4 Alias_ID: An address identifier recognized by one or more Nx_Ports or the Alias Server, if the Nx_Port has registered with the Alias Server as a member of a group. An Alias_ID may be common to multiple Nx_Ports (see clause 24).

3.1.5 Alias_Token: A 12-byte field to indicate the type of Alias_ID and certain properties associated with the Alias_ID (see 12.3.2.33).

3.1.6 Arbitrated Loop topology: A Fibre Channel topology where L_Ports use arbitration to gain access to the loop (See FC-AL-2).

3.1.7 BB_Buffer: The buffer associated with buffer-to-buffer flow control (see 18.5).

3.1.8 buffer-to-buffer credit (BB_Credit): The controller parameter for buffer-to-buffer flow control (see 18.5.3).

3.1.9 B_Port: A bridge port is a fabric inter-element port used to connect bridge devices with E_Ports on a switch. The B_Port provides a subset of the E_Port functionality (see [7], FC-SW-3.).

3.1.10 buffer: A logical construct that holds a single frame.

3.1.11 byte: An eight-bit entity with its least significant bit denoted as bit 0 and most significant bit as bit 7. The most significant bit is shown on the left side, unless specifically indicated otherwise.

3.1.12 character: An 8B10B encoding of a data byte or control value transmitted and interpreted by the FC-1 layer of Fibre Channel (see clause 5).

3.1.13 circuit: A bi-directional path within the Fabric.

3.1.14 circuit-oriented frames: Frames sent through a Class 4 circuit.

3.1.15 classes of service: Type of frame delivery services used by the communicating Nx_Ports that may also be supported through a fabric (see 4.8 and clause 13).

3.1.16 Class 1 service: A service that establishes a dedicated connection between two communicating Nx_Ports (see 4.8.2 and 13.2).

3.1.17 Class 2 service: A service that multiplexes frames at frame boundaries to or from one or more Nx_Ports with acknowledgement provided (see 4.8.3 and 13.3).

3.1.18 Class 3 service: A service that multiplexes frames at frame boundaries to or from one or more Nx_Ports without acknowledgement (see 4.8.4 and 13.4).

3.1.19 Class 4 circuit: A pair of unidirectional Virtual Circuits between two communicating Nx_Ports (see 25.3.5).

3.1.20 Class 4 service: A fabric service that establishes Virtual Circuits to provide fractional bandwidth service

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between communicating Nx_Ports. The fabric service multiplexes frames at frame boundaries using in-order delivery to or from one or more Nx_Ports with acknowledgment provided (see 4.8.5, 13.6 and clause 25).

3.1.21 Class 4 Circuit Initiator: The Nx_Port that initiates a Class 4 Circuit setup to establish a Class 4 Circuit (see 25.3.5).

3.1.22 Class 4 Circuit Recipient: The Nx_Port that receives a Class 4 Circuit setup request from a Class 4 Circuit Initiator and accepts the setup request by transmitting a valid response (see 25.3.5).

3.1.23 Class 6 service: A service that allows an Nx_Port to establish simultaneous dedicated connections with multiple Nx_Ports (see 4.8.6 and 13.7).

3.1.24 Class F service: A service that multiplexes frames at frame boundaries with acknowledgement provided. The service is used for control and coordination of the internal behavior of the Fabric (see [7], FC-SW-3).

3.1.25 Class N service: A class of service other than Class F (see [7], FC-SW-3).

3.1.26 code violation: An error condition that occurs when a received Transmission Character is not able to be decoded to a valid data byte or special code using the validity checking rules specified by the transmission code (see 5.3.3).

3.1.27 comma: The seven-bit sequence ‘0011111’ b or ‘1100000’ b in an 8B10B encoded stream (see 5.5.1).

3.1.28 Common Controlling Entity : The entity that controls and manages the resources for a Hunt Group (see clause 22)

3.1.29 concatenation: A logical operation that “joins together” strings of data and is represented with the symbol “||”. Two or more fields are concatenated to provide a reference of uniqueness (for example, S_ID||X_ID).

3.1.30 Connection Initiator: The Nx_Port that initiates a Class 1 or 6 Connection with a destination Nx_Port through a connect-request and also receives a valid response from the destination Nx_Port to complete the Connection establishment (see clause 20).

3.1.31 Connection Recipient: The destination Nx_Port that receives a Class 1 or 6 connect-request from the Connection Initiator and accepts establishment of the Connection by transmitting a valid response (see clause 20).

3.1.32 connectionless buffers: Receive buffers participating in connectionless service and capable of receiving connectionless frames (see clause 18).

3.1.33 connectionless frames: Frames participating in connectionless service (i.e., Class 1 or Class 6 frames with SOF_{c1}, Class 2, Class 3 and Class 4 frames referred to individually or collectively) (see clause 18).

3.1.34 connectionless service: Communication between two Nx_Ports performed without a dedicated connection.

3.1.35 continuously increasing relative offset: The condition of operation that requires frames ordered by SEQ_CNT within a Sequence to have a larger relative offset value in each frame (see 15.6.2.4.1).

3.1.36 credit: The maximum number of buffers available at a recipient to receive frames from a transmitting FC_Port (see 18.3).

3.1.37 current running disparity: The running disparity present at a transmitter when encoding of a valid data byte or special code is initiated, or at a receiver when decoding of a Transmission Character is initiated (see 5.3.3).

3.1.38 data block: An ordered string of application data contained in a single Information Category.

3.1.39 data character: Any Transmission Character associated by the transmission code with a valid data byte.

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(see 5.1).

3.1.40 data frame: An FC-4 Device_Data frame, an FC-4 Video_Data frame, or a Link_Data frame (see clause 11).

3.1.41 decoding: Validity checking of received Transmission Characters and generation of valid data bytes and special codes from those characters (see 5.3).

3.1.42 dedicated connection: A communicating circuit guaranteed and retained by the Fabric for two given Nx_Ports.

3.1.43 delimiter: An Ordered Set used to indicate a frame boundary (see 5.5, 8.3 and 8.7).

3.1.44 Destination_Identifier (D_ID): The address identifier used to indicate the targeted destination Nx_Port of the transmitted frame (see 9.4).

3.1.45 destination Nx_Port: The Nx_Port to where a frame is targeted.

3.1.46 discard policy: An error handling policy where a Sequence Recipient is able to discard Data frames received following detection of a missing frame in a Sequence (see 21.6.3).

3.1.47 disparity: The difference between the number of ones and zeros in a Transmission Character (see 5.5.3).

3.1.48 Domain Controller: The entity that controls activity within a given domain. Each Domain Controller is allocated an address (see [7], FC-SW-3.).

3.1.49 Domain_ID: The highest or most significant hierarchical level in the three-level addressing hierarchy (i.e., the most significant byte of the address identifier) (see 9.4.2 and [7], FC-SW-3).

3.1.50 EE_Buffer: Buffer(s) associated with end-to-end flow control (see 18.4).

3.1.51 encoding: Generation of Transmission Characters from valid data bytes and special codes (see 5.3).

3.1.52 E_Port: A Fabric expansion port that connects to another E_Port or B_Port to create an Inter-Switch Link (see [7], FC-SW-3).

3.1.53 Exchange: The unit of protocol activity that transfers information between a specific Originator Nx_Port and specific Responder Nx_Port using one or more related non-concurrent Sequences that may flow in the same or opposite directions. The Exchange is identified by an OX_ID and a RX_ID (see clause 17).

3.1.54 Exchange_Identifier (X_ID): A collective reference to OX_ID and RX_ID (see 9.2.1).

3.1.55 Exchange Status Block: A logical construct that contains the status of an Exchange. An Originator Nx_Port has an Originator Exchange Status Block and the Responder Nx_Port has a Responder Exchange Status Block for each active Exchange (see 4.12.4.4 and 17.8.1).

3.1.56 exclusive connection: A Class 1 or Class 6 dedicated connection without Intermix (see 4.8.2 and 13.5).

3.1.57 F_Port: The LCF within the Fabric that attaches to an N_Port through a link. An F_Port is addressable by the N_Port attached to it, with a common well-known address identifier (hex ‘FF FF FE’) (see 9.4.2).

3.1.58 Fabric: The entity that interconnects Nx_Ports attached to it and is capable of routing frames by using the D_ID information in a FC-2 frame header (see 4.7.3).

3.1.59 Fabric_Name: A Name_Identifier associated with a Fabric (see clause 14 and 15.6.4).

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3.1.60 FC_Port: A port that is capable of transmitting or receiving Fibre Channel frames according to the requirements defined in this standard. FC_Ports include N_Ports, NL_Ports, Nx_Ports, L_Ports, F_Ports, FL_Ports, Fx_Ports, E_Ports, and B_Ports.

3.1.61 FL_Port: An F_Port that contains Arbitrated Loop functions associated with Arbitrated Loop topology (see FC-AL-2).

3.1.62 fractional bandwidth: A portion of the total bandwidth available on a path (see clause 25).

3.1.63 frame: An indivisible unit of information used by FC-2 (see 8.1).

3.1.64 F_Port_Name: A Name_Identifier associated with an F_Port (see 9.4.2).

3.1.65 frame content: The information contained in a frame between its SOF and EOF delimiters, excluding the delimiters (see 8.3.1).

3.1.66 Frame Type 0: A type of Data frame used for Link Control (see clause 8.5).

3.1.67 Frame Type 1: A type of Data frame used for data exchange (see clause 8.5).

3.1.68 Fx_Port: A switch port capable of operating as an F_Port or FL_Port (see FC-AL-2).

3.1.69 Hunt Group: A set of Nx_Ports with a common Alias_ID managed by a Common Controlling Entity. The management and initialization of Hunt Groups is outside the scope of this standard (see clause 22).

3.1.70 Hypertext Transfer Protocol: A protocol for communicating various formats of text with embedded links and display controls (see [23], RFC 2616).

3.1.71 Idle: An Ordered Set of four Transmission Characters that are normally transmitted between frames (see 5.5).

3.1.72 Infinite buffer: A terminology to indicate that at FC-2 level, the amount of buffer available at the Sequence Recipient is unlimited.

3.1.73 Information Category: The category to which the frame Payload belongs (for example, Solicited Data, Unsolicited Data, Solicited Control and Unsolicited Control). Information category is indicated by the INFORMATION field in the frame header if the value of the ROUTING field in the frame header is ‘0000’b (Device_Data), ‘0010’b (Extended Link Services), ‘0011’b (FC-4 Link_Data), ‘0100’b (Video_Data), or ‘1111’b (Extended Routing) (see 9.3.3).

3.1.74 Information Unit: An organized collection of data specified by an upper level to be transferred as a single Sequence by FC-2.

3.1.75 initial relative offset: A relative offset value specified at the sending end by an upper level for a given data block and used by the sending FC-2 in the first frame of that data block (see data block, and relative offset). Initial relative offset value may be zero or non-zero (see clause 19).

3.1.76 Intermix: A service that interleaves Class 2 and Class 3 frames on an established Class 1 or Class 6 Connection (see 4.9 and 13.5).

3.1.77 Internet Protocol: A protocol for communicating data packets between identified endpoints on a multipoint network. It is in wide use in versions 4 and 6 (See [16], RFC 791 for version 4 or [21], RFC 2373 and [22] RFC 2460 for version 6).

3.1.78 IP Address: An identifier of an endpoint in Internet Protocol.

3.1.79 link: Two unidirectional fibres transmitting in opposite directions and their associated transmitters and

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receivers.

3.1.80 Link Control Facility (LCF): A hardware facility that attaches to an end of a link and manages transmission and reception of data. It is contained within each FC_Port (see 4.4).

3.1.81 local Fx_Port: The Fx_Port to which an Nx_Port is directly attached by a link or an Arbitrated Loop (see remote Fx_Port).

3.1.82 L_Port: A port that contains Arbitrated Loop functions associated with Arbitrated Loop topology (see FC-AL-2).

3.1.83 Name_Identifier: A 64-bit identifier, with a 60-bit value preceded by a 4-bit Network_Address_Authority Identifier, used to identify entities in Fibre Channel (for example, Nx_Port, node, F_Port, or Fabric) (see clause 14).

3.1.84 Network_Address_Authority (NAA): An organization such as IEEE that administers network addresses (see clause 14).

3.1.85 Network_Address_Authority (NAA) identifier: A four-bit identifier defined to indicate a Network_Address_Authority (NAA) (see clause 14).

3.1.86 NL_Port: An N_Port that contains the Loop Port State Machine defined in FC-AL-2. It may be attached via a link to one or more NL_Ports and zero or more FL_Ports in an Arbitrated Loop topology. Without the qualifier "Public" or "Private," an NL_Port is assumed to be a Public NL_Port.

3.1.87 node: A collection of one or more Nx_Ports controlled by a level above FC-2 (see 4.1).

3.1.88 Node_Name: A Name_Identifier associated with a node (see Clause 14 and 15.6.4).

3.1.89 N_Port: A hardware entity that includes a LCF but not Arbitrated Loop functions associated with Arbitrated Loop topology, and has the ability to act as an Originator, a Responder, or both. Well-known addresses are considered to be N_Ports (See [2], FC-AL-2, and 9.4.2).

3.1.90 N_Port_ID: A Fabric unique address identifier of an Nx_Port. The identifier may be assigned by the fabric during the initialization procedure or by other procedures not defined in this standard. The identifier is used in the S_ID and D_ID fields of a frame (see 9.4).

3.1.91 N_Port_Name: A Name_Identifier associated with an Nx_Port (see clause 14 and 15.6.3).

3.1.92 Nx_Port: A port capable of operating as an N_Port or Public NL_Port, but not as a Private NL_Port. By use of the term Nx_Port, this standard neither specifies nor constrains the behavior of Private NL_Ports (see [2] FC-AL-2).

3.1.93 open: The period of time starting when a Sequence or an Exchange is initiated until that Sequence or Exchange is normally or abnormally terminated (see 17.6.1).

3.1.94 Ordered Set: A Transmission Word composed of a special character in its first (left-most) position and data characters in its remaining positions (see 5.5).

3.1.95 Originator: The logical function associated with an Nx_Port responsible for originating an Exchange.

3.1.96 Originator Exchange_ID (OX_ID): An identifier assigned by an Originator to identify an Exchange (see 4.12.4.2).

3.1.97 Payload: Contents of the Data Field of a frame, excluding Optional Headers and fill bytes, if present (see table 13, and clause 8, clause 10, and 11.1).

3.1.98 Policy: The rule used to determine how frames not received are handled during error recovery (see

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21.6.3).

3.1.99 Primitive Sequence: An Ordered Set transmitted repeatedly and continuously until a specified response is received (see 5.5.4 and 17.6.1).

3.1.100 Primitive Signal: An Ordered Set designated to have a special meaning. (for example, an Idle or R_RDY) (see 5.5.3).

3.1.101 Private NL_Port: An NL_Port that does not attempt a Fabric Login and does not transmit OPN(00,x) (see [2], FC-AL-2).

3.1.102 Process_Associator: A value used in the Association_Header to identify a process or a group of processes within a node. Process_Associator is the mechanism a process uses to address another communicating process. Process_Associator is a generic reference to Originator Process_Associator and Responder Process_Associator (see 10.4).

3.1.103 Public NL_Port: An NL_Port that attempts a Fabric Login (see [2], FC-AL-2).

3.1.104 random relative offset: The relationship specified between relative offset values contained in frame (n) and frame (n+1) of an Information Category within a single Sequence. For a given Information Category I within a single Sequence, initial relative offset (RO_I) value for a frame (n+1) is unrelated to that of the previous frame (n). (see initial relative offset and continuously increasing relative offset) (see 15.6.2.4.3).

3.1.105 receiver: The portion of a LCF dedicated to receiving an encoded bit stream from a fibre, converting this bit stream into Transmission Characters, and decoding these Transmission Characters using the rules specified by this standard (see 4.1).

3.1.106 relative offset: The displacement, expressed in bytes, of the first byte of a Payload related to an upper level defined origin for a given Information Category (see continuously increasing relative offset, random relative offset and 4.13.3).

3.1.107 relative offset space: A virtual address space defined by the sending upper level for a set of information carried in one or more information units.

3.1.108 remote Fx_Port: Relative to an Nx_Port that is communicating through a fabric to a remote Nx_Port, the Fx_Port to which the remote Nx_Port is directly attached (see local Fx_Port).

3.1.109 Responder: The logical function in an Nx_Port responsible for supporting the Exchange initiated by the Originator in another Nx_Port.

3.1.110 Responder Exchange_ID (RX_ID): An identifier assigned by a Responder to identify an Exchange and meaningful only to the Responder.

3.1.111 run length: Number of consecutive identical bits in the transmitted signal for example, the pattern ‘0011111010’ b has a maximum run length of five and a minimum run length of one (see 5.3.3.1).

3.1.112 running disparity: A binary value indicating the cumulative encoded signal unbalance between the one and zero signal state of all Transmission Characters since Transmission Word synchronization was been achieved (see 5.3.3.1).

3.1.113 Secured Hypertext Transfer Protocol: A protocol for communicating various formats of text with embedded links and display controls used in combination with a subordinate protocol that provides security features (see [24], RFC 2818).

3.1.114 Sequence: A set of one or more Data frames with a common Sequence_ID (SEQ_ID), transmitted unidirectionally from one Nx_Port to another Nx_Port with a corresponding response, if applicable, transmitted in response to each Data frame (see clause 17).

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