

ISO/IEC 14165-226:2020-01 (E)

Information technology - Fibre channel - Part 226: Single-byte command code sets mapping protocol - 6 (FC-SB -6)

Contents	Page
1 Scope	1
2 Normative References	2
2.1 Qualification and availability of references	2
2.2 Approved References	2
2.3 References Under Development	3
3 Definitions and Conventions	5
3.1 Overview	5
3.2 Definitions	5
3.3 Editorial Conventions	8
3.3.1 English Usage Conventions	8
3.3.2 FC Link Functions	8
3.3.3 Bit Numbering	8
3.3.4 Binary Notation	9
3.3.5 Hexadecimal Notation	9
3.4 Abbreviations, Acronyms, and Symbols	9
3.5 Keywords	11
4 Structure and Concepts	13
4.1 Introduction	13
4.2 FC-4 General Description	13
4.3 FC-SB-6 General Description	13
4.3.1 FC-SB-6 Instance	13
4.3.2 FC-SB-6 Protocols	13
4.4 Channel-Path Elements	14
4.4.1 Overview of Channel-Path Elements	14
4.4.2 Channel	14
4.4.3 Channel Image	14
4.4.4 Control Unit	15
4.4.5 Control-Unit Image	15
4.4.6 Link	16
4.5 Channel-Path Configurations	16
4.5.1 Channel-Path Configuration Overview	16
4.5.2 Point-to-Point Configuration	16
4.5.3 Fabric Configuration	17
4.5.4 Physical Path	19
4.5.5 Logical Path	19
4.5.6 Channel-to-Channel Communication	20
4.6 Information Transfer	21
4.7 Protocols	21
4.7.1 Protocol Overview	21
4.7.2 Link Level Protocol	21
4.7.3 Device Level Protocols	22
4.7.4 Addressing	22
5 FC-FS-4 Link Control	25
5.1 FC-FS-4 Link Control Overview	25
5.2 Class of Service	25
5.3 Buffer-to-Buffer Credit Reclamation	25
5.4 FC-SB-6 Sequences and Exchanges	26
5.4.1 FC-SB-6 Sequences	26

5.4.2	FC-SB-6 Exchanges	26
5.5	FC Frame Header Fields	28
5.5.1	Frame Header Field Overview	28
5.5.2	R_CTL Field	29
5.5.3	D_ID and S_ID Fields	29
5.5.4	CS_CTL	29
5.5.5	TYPE Field	30
5.5.6	F_CTL Field	30
5.5.7	SEQ_ID	30
5.5.8	DF_CTL	30
5.5.9	SEQ_CNT	30
5.5.10	OX_ID	30
5.5.11	RX_ID	30
5.5.12	Parameter Field	31
6	Link-Level Functions	33
6.1	Link-Level Function Overview	33
6.2	FC-FS-4 Basic Link Services	33
6.2.1	Basic Link Services Overview	33
6.2.2	Abort Sequence	33
6.3	FC-LS-3 Extended Link Services	33
6.3.1	Extended Link-Services Overview	33
6.3.2	F_Port Login	33
6.3.3	N_Port Login	33
6.3.4	N_Port Logout	34
6.3.5	Reinstate Recovery Qualifier	34
6.3.6	Registered State Change Notification	34
6.3.7	State-Change Registration	35
6.3.8	Query Security Attributes	36
6.3.9	Request Node-Identification Data	36
6.3.10	Registered Link-Incident Record	42
6.3.11	Link-Incident-Record Registration	46
6.3.12	Read Link Error Status Block	46
6.3.13	Registered Fabric Change Notification	46
6.3.14	Process Login	47
6.3.15	Process Logout	50
6.3.16	Read Exchange Concise	54
6.4	FC-SB-6 Link-Control Functions	54
6.4.1	FC-SB-6 Link-Control Function Overview	54
6.4.2	Establish Logical Path	57
6.4.3	Remove Logical Path	59
6.4.4	Logical Path Established	60
6.4.5	Logical Path Removed	60
6.4.6	Link-Level Acknowledgment	61
6.4.7	Test Initialization	62
6.4.8	Test Initialization Result	65
6.4.9	Link-Level Reject	69
6.4.10	Link-Level Busy	71
7	N_Port Link Initialization	73
7.1	N_Port Link Initialization Overview	73
7.2	Link-Initialization Procedure	74
7.3	Initialization Process for a Channel	75
7.3.1	Channel Initialization Overview	75

7.3.2	Channel Login and Security Attribute Determination	75
7.3.3	Channel Node-Identifier Acquisition	76
7.3.4	Channel State-Change Registration	78
7.3.5	Channel Link-Incident-Record Registration	78
7.3.6	Process Login	79
7.3.7	Channel Logical-Path Establishment	79
7.4	Initialization Process for a Control Unit	80
7.4.1	Control Unit Initialization Overview	80
7.4.2	Control-Unit Login	80
7.4.3	Control Unit Node-Identifier Acquisition	82
7.4.4	Control Unit State-Change Registration	83
7.4.5	Process login	83
7.4.6	Control Unit Logical-Path Establishment	83
8	FC-SB-6 Information Units	85
8.1	FC-SB-6 Information Unit Overview	85
8.2	Rules for Sending FC-SB-6 IUs	85
8.2.1	Overview of Rules for Sending FC-SB-6 Information Units	85
8.2.2	Rules for Device-level Functions in Command Mode	87
8.2.3	Rules for Device-level Functions in Transport Mode	88
8.3	FC-SB-6 IU Structures	89
8.4	FC-SB-6 Header	93
8.4.1	FC-SB-6 Header Overview	93
8.4.2	FC-SB-6 Header Format	93
8.4.3	Channel Image ID	93
8.4.4	Control-Unit Image ID	93
8.4.5	Device Address	94
8.5	IU Header	94
8.5.1	IU Header Format	94
8.5.2	Information-Unit Identifier	95
8.5.3	Device-Header Flags	96
8.5.4	CCW Number	99
8.5.5	Token	101
8.6	Device Information Block (DIB) Structure	101
8.6.1	DIB Structure Overview	101
8.6.2	DIB Header	102
8.6.3	Longitudinal-Redundancy-Check Field	103
8.6.4	DIB Data Field	103
8.6.5	Cyclic-Redundancy-Check Field	104
8.7	Command DIB Structure	106
8.7.1	Command DIB Overview	106
8.7.2	Command Header	106
8.8	Command-Data DIB Structure	113
8.9	Data DIB Structure	113
8.9.1	Data DIB Overview	113
8.9.2	Data Header	114
8.10	Status DIB	114
8.10.1	Status DIB Processing	114
8.10.2	Status DIB Structure	116
8.10.3	Status Header	117
8.10.4	Supplemental Status Field	130
8.11	Control DIB Structure	131
8.11.1	Control DIB Structure Overview	131
8.11.2	Control Header	131

8.11.3	Control Payload	145
8.12	Link-Control DIB Structure	145
8.12.1	Link-Control DIB Structure Overview	145
8.12.2	Link Header	146
8.12.3	Link Payload	147
8.13	Transport Command IU	147
8.13.1	Transport Command Overview	147
8.13.2	FC-SB-6 Header	148
8.13.3	Transport Command Header	148
8.13.4	Transport Command Area Header	150
8.13.5	Transport Command Area	152
8.13.6	Longitudinal Redundancy Check	160
8.13.7	Data Length	161
8.13.8	Bidirectional Read Data Length	161
8.14	Transport Data IU	161
8.14.1	Transport Data IU Overview	161
8.14.2	Transport Data	162
8.14.3	Pad Bytes	162
8.14.4	Cyclic-Redundancy-Check	162
8.14.5	CRC Generation and Checking	163
8.15	Transport Response IU	163
8.15.1	Transport Response IU Overview	163
8.15.2	Transport Response IU Structure	164
8.15.3	FC-SB-6 Header	164
8.15.4	Status	165
8.15.5	Status LRC	170
8.15.6	Extended Status	170
8.16	Transfer Ready IU	186
8.16.1	Transfer Ready Structure Overview	186
8.16.2	Relative Offset	186
8.16.3	Burst Length	186
8.17	Transport Confirm IU	186
9	Device-Level Functions and Protocols	189
9.1	Device-Level Operations	189
9.1.1	Overview of Device-Level Operations	189
9.1.2	Channel Program Execution	189
9.2	CCW I/O operations	189
9.2.1	Initiating a CCW I/O Operation	189
9.2.2	Command Mode Data-Transfer Protocol	192
9.2.3	Ending a CCW I/O Operation	200
9.2.4	CCW Command Chaining	203
9.2.5	Priority	204
9.3	TCW I/O Operations	205
9.3.1	Initiating a TCW I/O operation	205
9.3.2	Transport Mode Data Transfer	206
9.3.3	TCA Processing	210
9.3.4	Ending a TCW I/O Operation	213
9.3.5	Extended Status	214
9.3.6	Priority	214
9.4	Device-Level Controls	215
9.4.1	Overview of Device-Level Control Functions	215
9.4.2	Stacking Status Function	215
9.4.3	Cancel Function	216

9.4.4	System-Reset Function	218
9.4.5	Selective-Reset Function	220
9.4.6	Request-Status Function	221
9.4.7	Device-Level-Exception Function	222
9.4.8	Status-Acceptance Function	222
9.4.9	Device-Level-Acknowledgment Function	223
9.4.10	Control-Unit-Busy Condition	223
9.4.11	Confirm Completion Function	224
9.4.12	Transport Mode ABTS Function	224
9.5	Error Handling at the Device Level	224
9.5.1	Purge Path Function	224
9.5.2	Command Retry	225
9.5.3	Channel-Initiated Recovery Procedures	228
9.5.4	Address-Exception Condition	231
9.5.5	REC Function	232
9.6	Resetting Event	232
9.7	Special Functions	234
9.7.1	Path Groups	234
9.7.2	Dynamic Reconnection	235
10	Link Error Detection	237
10.1	Link Error Detection Overview	237
10.2	FC-SB-6 Timeouts	237
10.2.1	Overview of FC-SB-6 Timeouts	237
10.2.2	FC-SB-6 Protocol Timeout Value	237
10.2.3	FC-SB-6 Timeout Value	238
10.2.4	Logical Path Timeout Value	238
10.2.5	Cancel Function Timeout Value	239
10.2.6	Transport Command Timeout Value	239
10.2.7	Transport Command Secondary Timeout Value	239
10.2.8	Interrogate Timeout Value	240
10.2.9	Process Logout Timeout Value	240
10.2.10	Exchange Quiesce Timeout Value	240
10.2.11	REC Timeout Value	240
10.3	FC-SB-6 Link Failure	240
10.4	Logical Path Timeout Error	240
10.5	FC-SB-6 Exchange Error	241
10.5.1	FC-SB-6 Exchange Error Overview	241
10.5.2	FC-SB-6 Protocol Timeout	241
10.5.3	FC-SB-6 IU Integrity Error	241
10.5.4	FC-SB-6 Protocol Errors	243
10.5.5	Receive ABTS	244
10.5.6	Cancel Function Timeout Error	244
10.5.7	Abnormal Termination of Exchange	244
10.6	Logical-Path-Not-Established Error	244
10.7	Test Initialization Result Error	244
10.8	Transport Operation Error	245
10.9	Transport Error	245
10.9.1	Transport Error Overview	245
10.9.2	Transport Command IU Integrity Error	245
10.9.3	TCH Content error	245
10.9.4	TCCB Content error	245
10.9.5	Second I/O Operation Error	245
10.10	Interrogate Operation Error	246

10.11	REC Error	246
11	Error Recovery Actions	247
11.1	Error Recovery Action Overview	247
11.2	Link-Level Recovery	250
11.2.1	Link-Level Recovery Overview	250
11.2.2	Recovery for an FC-SB-6 Link Failure	250
11.2.3	Logical Path Timeout Error	250
11.2.4	Recovery for an FC-SB-6 Offline Condition	251
11.2.5	Recovery for an FC-FS-4 Link Failure Condition	251
11.2.6	Recovery for an FC-SB-6 Exchange Error	251
11.2.7	Recovery for a Logical-Path-Not-Established Error	252
11.2.8	Recovery for Link-Level Reject, P_RJT, and F_RJT	253
11.2.9	Recovery for a Test-Initialization-Result Error	254
11.2.10	Recovery for a Transport Operation Error	254
11.2.11	Recovery for a Transport Error	254
11.2.12	Recovery for an Interrogate Operation Error	255
11.2.13	Recovery for a REC Error	255
11.3	Device-Level Recovery	255
11.3.1	Device-Level Recovery Overview	255
11.3.2	Errors That Cause the Removal of a Logical Path	255
11.3.3	Errors that Do not Cause the Removal of a Logical Path	256
 Annexes		
A	Fabric Address Assignment	261
B	Correlation of Exchanges of an Exchange Pair	263
C	LRC Calculation	265
D	Status/Chaining Summary	267
E	Bibliography	269